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Status of the Atlantic cod stock on Georges Bank
in unit areas 5Zj and 5Zm, 1978-91

by

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Abstract

Total landings for cod in Div.5Zj,m in 1991 were 20000 t, about equal to that of last year, and above the long term average of 17000 t. The 1987 yearclass (age 4) was dominant (37% in numbers). Size at age 1 for Canadian samples shows an increase over long term averages. The most recent Canadian and USA surveys show a decline in mean catch per tow, and the USA fall survey is anomalously low. A shift in distribution or in catchability of cod in this area may have occurred. Vessel and door conversion factors were applied to USA surveys and most of the decrease in the population estimates was attributed to these factors. Results of an ADAPT formulation were not significant and estimated unrealistically high exploitation in 1991. Analysis of catch and effort information suggests that exploitation rates have increased since 1989 but were similar in 1990 and 1991. Therefore population numbers for 1992 were derived using a 1991 F of 0.7 and projections completed at twice $F_{0.1} = 0.4$ for 1992 and 1993. Results of this projection indicate a catch biomass of less than 15000 t for 1992 and 1993. Actual catches in 1992 are expected to be similar to 1991, since the 1992 management plan has already been implemented. This implies a 1992 F of about 0.8, nearly twice F_{max} . Joint action by the USA and Canada will be required if conservation measures are to be effective.

Résumé

Les débarquements totaux de morue provenant des divisions 5Zj,m se sont établis à 20 000 t en 1991, ce qui équivaut à peu près à ceux de l'an dernier et est supérieur à la moyenne à long terme (17 000 t). La classe d'âge de 1987 (âge 4) dominait dans les prises (37 % du nombre). Dans les échantillons canadiens, la taille à l'âge 1 est en hausse par rapport aux moyennes à long terme. Les campagnes d'évaluation canadiennes et américaines les plus récentes révèlent une diminution des prises moyennes par trait et les résultats de la campagne d'évaluation américaine d'automne sont anormalement bas. Cela peut être dû à un changement dans la distribution ou dans le potentiel de capture de la morue dans la région considérée. La majeure partie de la baisse constatée dans les estimations de population obtenues lors de la campagne d'évaluation américaine a été imputée aux facteurs de conversion appliqués aux bateaux et aux panneaux. Les résultats d'un calcul utilisant la méthode ADAPT n'étaient pas probants et aboutissaient à une estimation irréaliste de forts taux d'exploitation en 1991. L'analyse des renseignements sur les prises et l'effort donne à penser que les taux d'exploitation ont augmenté depuis 1989, mais qu'ils étaient comparables en 1990 et en 1991. Les estimations de population pour 1992 ont donc été calculées à partir d'une valeur F de 0,7 en 1991 et les projections ont été établies à deux fois $F_{0.1} = 0,4$ pour 1992 et 1993. D'après ces projections, la prise pour 1992 et 1993 serait inférieure à 15 000 t. On s'attend à ce que les prises réelles de 1992 soient comparables à celles de 1991, le plan de gestion de 1992 ayant déjà été mis en oeuvre. Cela situe F à environ 0,8 en 1992, soit près de deux fois F_{max} . Une intervention commune du Canada et des États-Unis serait requise pour que les mesures de conservation soient efficaces.

Introduction

The present report incorporates commercial catch data and research survey results to estimate stock status of cod for the 1978-91 time period in the two unit areas 5Zj and 5Zm (Figure 1). Definition of this management unit is based on analysis of tagging results as well as commercial and survey catch distribution and more recent tagging studies (Hunt, 1990).

Cod are taken by both Canada and the USA in unit areas 5Zj and 5Zm and all data relating to USA catches and research vessel surveys were provided by the National Marine Fisheries Service (NMFS) at the Woods Hole, Mass., Laboratory.

Trends in Reported Landings

Catches by the USA in unit areas 5Zj and 5Zm are thought to be or mis-reported with extensive discarding prior to 1978 (Serchuk and Wood, 1981) and estimates of population status prior to this time are suspect. Catch statistics since 1977, when foreign fleets were excluded from the 200 mile economic zones of Canada and the USA, are thought to be more reliable. As well, spatial distribution of foreign fleet catches in Subdiv. 5Ze are unknown. There have been no reported landings by foreign fleets since 1978.

Fishery by Country and Gear

Canadian catches of cod are taken on the "Northeast Peak" of Georges Bank primarily between April and November. Landings have been dominated by otter trawlers, except in 1984 and 1989 (Table 1, Fig. 2). The below average 1989 catch by otter trawlers reflects early closure of the fishery when the combined quota for Div. 4X+5 was exceeded.

In 1990, a 6000 t increase in Canadian landings was the result of a return to historic catches by the OTB fleet and an overall catch of 14310 t, the second highest in the time series. Canadian landings in 1991 were 13455t. USA landings in 1991 were 6549 t, about the average for recent years. Management of the Canadian fishery in 1990 and 1991 was by individual and equal boat quotas of 280000 lb with by catch restrictions.

Catches by Canada and the USA in unit areas 5Zj and 5Zm for 1978-91 are summarized in Table 2 and in Figure 3. Catches peaked at 26000 t in 1982, averaged to about 15000 t between 1983-87 and increased to 20000 t in 1988. Since 1985, Canada has taken about 65% of the total catch. The reduction in 1989 to 14000 t was a result of decreased mobile gear catch by both Canada and the USA.

Age Composition of the Commercial Catch

Sampling Intensity

Sampling coverage of the Canadian fishery prior to 1985 averaged about one sample per 1000t landed. Prior to 1978, sampling levels for Canadian catches were very low and it is unlikely that reliable estimates of removals at age could be obtained. Since 1985 sampling has increased and in 1991, 45 samples were collected. Numbers of fish aged and measured for USA and Canadian

samples for 1978-91 are shown in Table 3. Combinations of length and age samples used to estimate the 1991 catch at age for Canada and the USA are shown in Table 4a,b.

Age Composition

For the length-weight relationship, values for a and b were derived from Canadian commercial sampling data. With round weight in kilograms and length in centimetres these values were $\text{weight (kg)} = 0.0000163 \times \text{length}^{2.9048}$ and they were used for both Canadian and USA sampling data.

Canadian samples were used to obtain statistics by age. Initial aggregation was by gear type and quarter. The bias introduced by applying otter trawl length frequencies to partition longline catches may be significant in years (1978-80) lacking samples for this gear.

Catch at age in the USA fishery for 1991 was estimated from USA samples of 5Zj and 5Zm catches for each year. Annual samples by market category and month (or less frequent intervals if samples were not available) were combined to provide estimates of catch at age by market category.

Comparison of percent catch at length for Canadian and USA otter trawlers in the second quarter of 1991 is shown in Figure 4 and indicates some difference in the two fisheries. In general, the USA fleet appears to catch a higher proportion of larger fish.

Estimated total removals at age are given in Table 5 by country.

Percent catch at age for total landings of 5Zj,m cod are shown in Table 5 and in Figure 5 and the 1987 yearclass was dominant (37%) in 1991.

Neilson et al (1991) conclude that using the sum of Canadian and USA derived catch at age gives the best estimate of total removals by the 5Zj,m fishery. This is consistent with the approach taken by USA biologists in their assessment of Georges Bank cod (Anon, 1992)

Mean length and weight at age for Canadian samples are given in Table 7. The plus age group was set to 115 cm and 15 kg, the approximate mean for ages 10-15. There appears to be no trend in size or weight at age over the 12 year time series, although mean weight at age in 1990 and 1991 appear to be above the long term average. Mean weights at ages 2 and 3 in 1990 and 1991 are above the average and will have a substantial positive impact on estimated population biomass.

Stock Abundance Trends

Research Surveys

Depth-stratified, random bottom trawl surveys have been conducted by NMFS in the autumn since 1963 and a spring survey was added in 1968. A summer survey was conducted from 1977 to 1981. Surveys in Subdivision 5Ze were completed by Canada in March 1986-92. The USA spring survey used the larger "Yankee 41" trawl from 1973-81. However, the USA has not adjusted its surveys for this factor, based on the conclusions of an intervention study suggesting minimal

impact on catches of haddock and, presumably cod (Anon, 1992). New trawl doors have been used for both spring and autumn surveys since 1985. Analysis of a study to develop conversion factors indicates the new trawl doors are more effective by a factor of 1.56 for cod (Anon, 1992). Therefore USA survey estimates for 1977-84 were adjusted upward by this factor. The USA has also reported a difference in the fishing power of the vessels used to conduct their bottom trawl surveys (Anon, 1992). The Albatross was determined to be less efficient than the Delaware II by a factor of 0.79 (Anon, 1992) and therefore all Delaware surveys were adjusted by this factor. These conversions results in standardization of indices to the equivalent of the Albatross IV.

Hunt (1990) describes the approach used to estimate mean catch per tow specific to the 5Zj,m area for Canadian and USA surveys. The technique required selecting only sets within the 5Zj,m boundary and using strata areas also within the 5Zj,m boundary.

Results of analysis for each of the surveys are given in Table 8. The 1982 USA spring survey is influenced by one tow of 1000 fish and the resultant high catch rate has a high standard error. This tow has been excluded by USA researchers in their analyses (Anon, 1992). Examination of tows in the 1982 survey indicates above average catches in several sets and strata and therefore all tows were included in the present study.

Total catch per tow has been variable for each of the surveys but has been relatively stable in recent years. However, the 1991 Canadian survey shows a marked decline from the high 1990 value and the decline continues in 1992. The 1991 USA fall survey catch per tow is the lowest on record. Catch per tow is strongly influenced by progression of year-classes over time and in particular the 1983 and 1985 yearclasses.

Anecdotal reports from Canadian fishermen suggest that cod were found in deeper water during the 1991 season and if this trend persisted into the fall of 1991 then catchability for cod during the USA fall survey may have decreased. The USA survey includes strata in deeper water outside the 5Zj,m area. To determine if changes in the distribution had occurred, the USA fall surveys were examined to estimate relative abundance between the 5Zj,m area and the adjacent deeper water area. In 1991, the index for the management area declined abruptly but there was no increase in the adjacent area. This does not suggest a change in distribution between these areas.

YEAR	Strata Adjacent to 5Zj,m	Management area 5Zj,m
1984	2.12	6.74
1985	0.84	4.75
1986	0.42	6.09
1987	0.42	2.45
1988	0.21	4.44
1989	0.50	5.68
1990	0.66	4.01
1991	0.41	0.72

The fall survey is assumed to be a post-fishery index and spring surveys are assumed to be a pre-fishery index. Therefore the fall survey is lagged by one year for comparison of indices (ie.

pre-fishery index. Therefore the fall survey is lagged by one year for comparison of indices (ie. fall 1977 age one vs spring 1978 age two). In general, all three surveys appear to track yearclass strength and provide a consistent index. The 1987 yearclass, which will be a substantial factor in the 1990-93 fishery, appears to be above average in the Canadian and USA spring surveys in 1989-91. The 1990 yearclass also appears to be above average in the Canadian 1992 survey but the 1991 yearclass at age 1 is the minimum observed.

Commercial Catch Rates

Canadian C/E for the mobile gear fleet in 1989 was not considered to be a reliable index because of the premature closure of the fishery and an updated C/E series was not possible. USA C/E was not yet available for 1988-91. Therefore commercial OTB C/E was not included in the analysis.

A longline CPUE series, using Canadian vessels of TC 2 and 3 was examined by Hunt et al (1991). However, there were several discrepancies between the series which convinced them that the CPUE series, as currently developed, is not useful for inclusion in the ADAPT formulation. For example, the CPUE declined from the highest to the lowest observed value between 1989 and 1990 when other indications were that biomass levels were currently very high. Pending further analysis of this C/E series, they concluded that it would be inappropriate to include it in the ADAPT formulation.

Estimation of Stock Size

The ADAPT formulation used to estimate used population parameters for 1978-91 included all three survey indices.

Year-class estimates $N_{i,1991}$ $i=2,9$

Calibration coefficients for each of the three surveys, where

$K_{i=1,4}$ USA spring survey
 $K_{i=0,3}$ USA autumn survey
 $K_{i=1,4}$ Canadian spring survey

Assumed catchability for ages greater than age 4 (age 3 autumn) equal the oldest estimated for each survey. The following structure was imposed in ADAPT model:

- error in catch assumed negligible
- F on oldest age group set to weighted F for ages 3-8
- no intercept term fitted
- natural mortality set to 0.2
- logarithmic transform for indices

Input for the model consisted of:

- $C_{i,t}$ $i=1,9$; $t=1978-91$

- RV1i,t i=1,9; t=1978-91 USA spring survey
- RV2i,t i=0,8; t=1977-91 USA fall survey
- RV3i,t i=1,9; t=1986-92 Canadian spring survey

and the objective function required minimization of:

$$\begin{aligned}
 & \{ \text{obs}(\ln RV1i,t) - \text{pred}(\ln RV1i,t) \}^2 \\
 + & \{ \text{obs}(\ln RV2i,t) - \text{pred}(\ln RV2i,t) \}^2 \\
 + & \{ \text{obs}(\ln RV3i,t) - \text{pred}(\ln RV3i,t) \}^2
 \end{aligned}$$

and a total of 20 parameters were estimated. Residuals for survey indices with zero catch at age (predominantly the USA fall survey) were excluded from the overall sum of residuals.

Coefficients of variation were very high for all three surveys. Residuals for both USA survey indices were balanced in most cases but some year effect was evident for several years and was very strong in the 1991 USA surveys (Table 9). Calibration coefficients and population estimates were not statistically significant from the above run (Table 10).

Assessment Results

Population estimates from the above ADAPT formulation are given in Table 11 and indicate that the 1985 year-class is the largest observed with about 22 million fish at age 1. The 1980, 1983 and 1987 are also estimated to be well above the 1978-89 average abundance. The 1989 year-class appears to be average in abundance at age 1. For ages 3+ abundance has decreased from a high of 16 million in 1978 to a low of about 4 million in 1991. The 3+ biomass in 1991 is less than 19000 t and at its lowest level in the 14 year average time series. Fishing mortality also shows a dramatic increase in 1991 to 1.15. Population biomass, abundance, fishing mortality for ages 3+ are given in Figures 6-8.

However, as noted above all parameter estimates are not statistically significant and do not reflect the actual abundance of the stock. The impact of conversion factors for the USA surveys and their combined effect of reducing the 1984-91 indices account for the apparent decline in abundance from that estimated in the 1991 assessment of this stock. The additional impact of the anomalously low estimate for the 1991 fall USA survey further reduces the estimate of abundance for 1991.

To assess the impact of survey conversion factors and the anomalously low USA fall 1991 survey results, Adapt formulations were examined without survey conversions and without the 1991 fall survey. Results for 1992 estimates are shown below:

	Without conversion		With conversion	
	Without 1991	With 1991	Without 1991	With 1991
1992 3+				
Biomass	40492	32067	23754	18620
Numbers (000's)	9419	7243	5811	4428
F	0.59	0.78	0.90	1.15

The impact of survey conversions accounts for most of the reduction in biomass.

Comparison of survey indices for ages 1-9 with estimated population numbers for 1978-92 is shown in Figure 8. In general the surveys track population abundance and all three surveys indicate a decline since 1990.

Catch and effort in the USA fishery are assumed to have been relatively stable in recent years. However, effort by mobile gear in the Canadian fishery is known to have increased since 1989 with the introduction of boat quotas in 1990 and 1991. Effort by Canadian fixed gear components has also increased in the last number of years. An analysis of Canadian landing statistics for days fished, as a measure of effort, is shown below (OTB= mobile gear, LL=longline, GN= gillnet):

Year	OTB	LL	GN
88	1006	355	92
89	554	860	203
90	3267	760	185
91	2532	678	272

These data suggest that the effort in 1990 and 1991 was higher than in 1988-89 and that effort in 1991 was similar to that in 1990 and not close to twice the 1990 value as indicated from the ADAPT results.

Prognosis

Results of ADAPT using survey conversions and the 1991 USA fall survey are not significant and are inconsistent with other indicators of exploitation rates. However, the downward trend in abundance in recent years is probably correct as well as the relative age-specific exploitation rates. Measures of effort for 1990 and 1991 suggest that exploitation was similar for both years. Therefore, the 1992 population was estimated by prorating the 1991 F's from ADAPT (Table 12a) by the ratio of 0.7 to 1.15 and the resultant F's used with the 1991 catch to estimate a 1991 population. The projection was run for 1991-93 with fishing mortality set to twice $F_{0.1}=0.4$ in 1992 and 1993, with mean weights at age, average partial recruitment and the geometric mean for recruitment at age one. Input for the projection is shown below:

Age	January 1, 1992 Population (000's)	Average Weight (kg)	Partial Recruitment
1	8360	0.696	0.004
2	6835	1.391	0.320
3	3494	2.249	1.000
4	1945	3.579	1.000
5	819	5.012	1.000
6	550	6.448	1.000
7	1166	8.333	1.000
8	162	10.340	1.000
9	123	10.948	1.000
10+	18	15.000	1.000

Results of the projection are as follows:

	1992	1993
Biomass 3+	26673 t	28046
Numbers (000's)	23470	24649
F 3+	0.4	0.4
Catch t	11715	12264

and indicate a catch biomass of less than 15000 t for 1992 and 1993 at F_{max} . Actual catches in 1992 are expected to be similar to those of 1991 since the 1992 management plan has already been implemented. If 1992 catches are 20000 t it would imply a 1992 F of 0.8 or more than twice F_{max} . Yield and population biomass under alternative harvesting strategies are shown in Figure 10 for 1992 and in Figure 11 for 1993 assuming a 1992 catch of 20000 t. Ages 1-3 are projected to account for about 30% of the 1992 catch biomass. However, preliminary results of length frequency sampling for 1992 OTB catches indicate that the 1990 yearclass at age two accounts for over 50% of the catch in numbers (Figure 12).

Joint action by the USA and Canada will be required if conservation measures are to be effective and of benefit to Canada. Lowering Canadian catches may not be effective unless the USA respond with similar actions. The USA could take a substantial part of the total projected catch which could negate conservation measures adopted unilaterally by Canada.

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References

- Anon. 1992. Report of the thirteenth Northeast Regional stock assessment workshop (13th SAW), fall 1991. NOAA/Northeast Fisheries Science Center Ref. Doc. 92-02.
- Hunt, J.J. 1990. Status of the Atlantic cod stock on Georges Bank in Unit Areas 5Zj and 5Zm, 1978-89. CAFSAC Res. Doc. 90/80, 37p
- Hunt, J.J., M-I. Buzeta and J.D. Neilson. 1991. Status of the Atlantic cod stock on Georges Bank in Unit Areas 5Zj and 5Zm, 1978-90. CAFSAC Res. Doc. 91/41, 21p
- Neilson, J.D., M-I. Buzeta and J.J. Hunt. 1991. Comparison of catch at age matrices employed by Canada and the USA in the assessments of stock status of Atlantic cod in 5Z. CAFSAC Res. Doc. 91/51, 22p
- Serchuk, F.M and P.W. Wood. 1981. Assessment and status of the Georges Bank and Gulf of Maine Atlantic cod stocks-1981. NMFS. Lab. Ref. Doc. No. 81-06.

Table 1. Nominal landings of cod by gear and month for Canada in unit areas 5Zjm. (OT-otter trawl;LL-longline;GN-gillnet;MISC-miscellaneous).

YEAR	GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
78	OT	166	762	187	26	304	1808	1095	75	219	1633	1487	0	7762
	LL	0	0	0	0	10	308	241	77	74	19	0	0	729
	MISC	0	0	55	1	0	17	102	0	0	14	98	0	287
	TOT	166	762	242	27	314	2133	1438	152	293	1666	1585	0	8778
79	OT	72	302	178	78	74	1634	649	674	648	293	28	7	4637
	LL	0	0	0	5	20	529	334	306	134	10	0	0	1338
	MISC	0	0	1	1	1	0	0	0	0	0	0	0	3
	TOT	72	302	179	84	95	2163	983	980	782	303	28	7	5978
80	OT	24	86	3	52	111	1373	1593	771	633	591	68	100	5405
	LL	0	0	0	0	208	951	596	496	337	47	0	0	2635
	MISC	0	0	1	2	1	2	1	16	0	0	0	0	23
	TOT	24	86	4	54	320	2326	2190	1283	970	638	68	100	8063
81	OT	2	205	55	7	38	529	1005	744	1013	36	229	97	3960
	LL	0	0	1	2	538	1476	1044	837	284	281	57	5	4525
	MISC	0	0	0	1	0	12	0	0	1	0	0	0	14
	TOT	2	205	56	10	576	2017	2049	1581	1298	317	286	102	8499
82	OT	90	73	0	0	11	845	4289	2109	1507	2360	934	119	12337
	LL	0	11	26	193	772	1035	1388	1082	635	308	33	4	5487
	MISC	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOT	90	84	26	193	783	1880	5677	3191	2142	2668	967	123	17824
83	OT	179	41	9	6	35	2209	1095	2115	956	171	76	11	6903
	GN	0	0	0	0	0	4	8	3	5	0	0	0	20
	LL	0	0	171	147	440	1440	698	574	1303	311	89	0	5173
	MISC	0	0	0	0	0	5	28	0	0	1	0	0	34
TOT	179	41	180	153	475	3658	1829	2692	2264	483	165	11	12130	
84	OT	5	3	13	0	37	267	92	240	60	19	0	0	736
	GN	0	0	0	0	0	34	3	0	0	0	0	0	37
	LL	0	0	167	152	112	1193	1209	1183	605	286	50	0	4957
	MISC	0	0	0	1	3	21	7	1	0	0	0	0	33
TOT	5	3	180	153	152	1515	1311	1424	665	305	50	0	5763	
85	OT	0	2	0	0	0	1336	2565	2440	693	435	5	80	7556
	GN	0	0	0	0	0	14	4	9	0	0	0	0	27
	LL	0	29	54	181	151	414	230	540	647	501	29	29	2805
	MISC	0	1	2	14	15	6	9	2	3	2	0	1	55
TOT	0	32	56	195	166	1770	2808	2991	1343	938	34	110	10443	
86	OT	14	9	0	15	6	2364	3138	477	49	11	4	22	6109
	GN	0	0	0	0	0	44	82	75	29	0	0	0	230
	LL	0	58	86	12	24	146	120	538	606	409	12	0	2011
	MISC	0	2	9	15	10	3	7	1	14	0	0	0	61
TOT	14	69	95	42	40	2557	3347	1091	698	420	16	22	8411	
87	OT	19	1	3	0	0	2485	3941	890	145	2	78	44	7608
	GN	0	0	0	0	0	109	249	308	38	0	0	0	704
	LL	0	6	112	68	8	293	591	1032	747	310	12	33	3212
	MISC	5	11	15	17	9	33	88	82	51	2	6	2	321
TOT	24	18	130	85	17	2920	4869	2312	981	314	96	79	11845	
88	OT	23	520	56	0	13	3247	3181	428	17	98	29	8	7620
	GN	0	0	0	0	0	180	224	141	50	21	0	0	616
	LL	54	86	68	205	27	1247	1685	392	426	134	10	1	4335
	MISC	2	9	12	10	16	41	95	97	53	0	20	2	357
TOT	79	615	136	215	56	4715	5185	1058	546	253	59	11	12928	
89	OT	5	140	7	0	2	1553	86	70	2	87	33	2	1987
	GN	0	0	0	0	0	131	359	440	175	9	0	0	1114
	LL	41	202	250	92	268	909	1057	1210	331	65	0	0	4425
	MISC	7	7	9	22	47	126	85	151	15	3	3	0	475
TOT	53	349	266	114	317	2719	1587	1871	523	164	36	2	8001	
90	OT	0	0	0	0	1	3187	1744	1547	929	436	9	1	7854
	GN	0	0	0	0	0	114	344	309	143	0	0	0	910
	LL	125	149	260	0	129	1156	1448	1098	581	252	4	0	5202
	MISC	6	12	19	19	10	62	77	58	63	5	11	2	344
TOT	131	161	279	19	140	4519	3613	3012	1716	693	24	3	14310	
91	OT	348	33	22	1	0	3455	1536	672	316	296	14	6	6698
	GN	0	0	0	0	17	427	696	364	163	20	0	0	1688
	LL	49	335	187	230	202	597	1028	860	699	363	113	43	4706
	MISC	8	8	7	25	15	59	71	104	51	6	9	0	363
TOT	405	376	216	256	234	4538	3331	2000	1229	685	136	49	13455	

Table 2. Summary of total catches by Canada and the USA in unit areas 5Zjm for 1978-1991.

YEAR	CANADA	USA	TOTAL
1978	8778	5502	14280
1979	5978	6408	12386
1980	8063	6418	14481
1981	8499	8094	16593
1982	17824	8565	26389
1983	12130	8572	20702
1984	5763	10551	16314
1985	10443	6641	17084
1986	8411	5696	14107
1987	11845	4792	16637
1988	12932	7645	20577
1989	8001	6182	14183
1990	14310	6378	20688
1991	13455	6549	20004

Table 3. Canadian and USA commercial landings samples for 1978-91.

	USA			Canada		
	Samples	Lengths	Ages	Samples	Lengths	Ages
1978	29	2047	385	29	7684	1308
79	21	1833	402	13	3991	656
1980	16	1258	286	10	2784	536
81	21	1615	456	17	4147	842
82	45	4111	778	17	4756	858
83	40	3775	903	15	3822	604
84	44	3891	1130	7	1889	385
85	23	2076	597	18	7644	1062
86	27	2145	644	19	5745	888
87	23	1865	525	33	9477	1288
88	37	3229	797	43	11709	1984
89	19	1572	251	32	8716	1561
1990	28	1989	287	40	9901	2012
91	23	1894	397	45	10873	1782

Table 4. Summary of commercial samples used to estimate catch at age in 1991.

GEAR	MONTH	WEIGHT (t)	LENGTHS	AGES	QUARTERLY TOTALS			GEAR TOTAL WEIGHT	TOTAL
					WEIGHT	LENGTHS	AGES		
a. Canadian catch									
OTB	JAN	356	701	111					
+MISC	FEB	41							
	MAR	30			427	701	111		
	APR	26							
	MAY	15							
	JUN	3514	1937	340	3555	1937	340	7061	
	JUL	1606	1125	148					
	AUG	776							
	SEP	367	115	26	2749	1240	184		
	OCT	301	280	44	330	280	44		
	NOV	23							
	DEC	6							
LL	JAN	49	220	53					
	FEB	335	947	135					
	MAR	187	403		571	1967	188	13455	
	APR	230	168	70					
	MAY	202	229	74					
	JUN	597	452	118	1029	743	356	4706	
	JUL	1028	581	94					
	AUG	860							
	SEP	699	1160	204	2587	1112	204		
	OCT	363	273	60					
	NOV	113	265						
	DEC	43	328	64	519	866	124		
GN	MAY	17							
	JUN	427	610	73	444	610	73	1688	
	JUL	696	268	41					
	AUG	364	244	36					
	SEP	163	567	81	1243	1079	158		
	OCT	20							
b. USA catch 92									
	JAN	607	206	46					
	FEB	745	384	64	2244	906	167		
	MAR	892	316	57					
	APR	1744	465	119					
	MAY	1257	399	94	3758	914	230		
	JUN	757	50	17				6549	
	JUL	94							
	AUG	33							
	SEP	17							
	OCT	17			547	74	-		
	NOV	231							
	DEC	155	74						

Table 5. Catch at age of cod in numbers (000's) for Canada, USA and total, in 5Zjm, 1978-1991.

		AGEGROUP									TOTAL
		1	2	3	4	5	6	7	8	9+	
78	CDN	2	62	2017	667	205	78	57	12	12	3112
	USA	0	59	1571	409	102	32	26	9	0	2208
	TOT	2	121	3588	1076	307	110	83	21	12	5320
79	CDN	0	371	328	763	302	55	18	9	4	1850
	USA	10	443	71	1011	243	94	4	36	0	1912
	TOT	10	814	399	1774	545	149	22	45	4	3762
80	CDN	1	775	1121	214	420	125	32	11	14	2713
	USA	0	212	374	51	496	220	77	9	19	1458
	TOT	1	987	1495	265	916	345	109	20	33	4171
81	CDN	2	145	608	504	134	380	87	51	21	1932
	USA	17	458	835	745	21	215	82	14	15	2402
	TOT	19	603	1443	1249	155	595	169	65	36	4334
82	CDN	6	1283	1358	1105	742	164	221	97	21	4997
	USA	0	1399	328	324	324	25	124	60	16	2600
	TOT	6	2682	1686	1429	1066	189	345	157	37	7597
83	CDN	27	744	2506	1212	201	54	10	17	12	4783
	USA	13	575	910	262	265	229	21	54	27	2356
	TOT	40	1319	3416	1474	466	283	31	71	39	7139
84	CDN	0	26	118	375	340	123	72	19	18	1091
	USA	10	243	793	971	171	167	158	12	53	2578
	TOT	10	269	911	1346	511	290	230	31	71	3669
85	CDN	4	2146	904	383	497	139	45	38	9	4165
	USA	8	646	317	248	444	85	51	62	5	1866
	TOT	12	2792	1221	631	941	224	96	100	14	6031
86	CDN	19	235	1283	365	143	215	29	19	9	2317
	USA	9	91	905	148	161	185	29	20	16	1564
	TOT	28	326	2188	513	304	400	58	39	25	3881
87	CDN	14	2595	602	741	91	79	117	22	15	4276
	USA	0	1071	263	358	53	42	50	15	9	1861
	TOT	14	3666	865	1099	144	121	167	37	24	6137
88	CDN	10	232	2360	324	421	69	61	111	29	3617
	USA	0	88	1293	322	440	75	41	32	10	2301
	TOT	10	320	3653	646	861	144	102	143	39	5918
89	CDN	0	318	284	918	124	179	31	23	37	1914
	USA	0	422	368	919	69	135	25	2	4	1944
	TOT	0	740	652	1837	193	314	56	25	41	3858
90	CDN	7	339	1769	617	799	95	102	8	14	3750
	USA	0	339	1427	345	396	21	20	2	0	2550
	TOT	7	678	3196	962	1195	116	122	10	14	6300
91	CDN	11	493	512	1241	585	516	74	47	15	3483
	USA	0	137	261	669	350	263	20	10	3	1713
	TOT	11	630	773	1910	935	779	94	57	18	5196

Table 6. Percent catch at age for total 5Zj.m landings, 1978-91

Age	Year													
	78	79	80	81	82	83	84	85	86	87	88	89	90	91
1	0.04	0.27	0.02	0.44	0.08	0.56	0.27	0.20	0.72	0.23	0.17	0.00	0.11	0.21
2	2.27	21.64	23.66	13.91	35.30	18.48	7.33	46.29	8.40	59.74	5.41	19.18	10.76	12.13
3	67.44	10.61	35.84	33.29	22.19	47.85	24.83	20.25	56.38	14.09	61.73	16.90	50.73	14.88
4	20.23	47.16	6.35	28.82	18.81	20.65	36.69	10.46	13.22	17.91	10.92	47.62	15.27	36.76
5	5.77	14.49	21.96	3.58	14.03	6.53	13.93	15.60	7.83	2.35	14.55	5.00	18.97	17.99
6	2.07	3.96	8.27	13.73	2.49	3.96	7.90	3.71	10.31	1.97	2.43	8.14	1.84	14.99
7	1.56	0.58	2.61	3.90	4.54	0.43	6.27	1.59	1.49	2.72	1.72	1.45	1.94	1.81
8	0.39	1.20	0.48	1.50	2.07	0.99	0.84	1.66	1.00	0.60	2.42	0.65	0.16	1.10
9	0.23	0.11	0.79	0.83	0.49	0.55	1.94	0.23	0.64	0.39	0.66	1.06	0.22	0.35

Table 7. Mean size at age of cod in 5Zj.m derived from Canadian samples, 1978-89.

Year	Age group									
	1	2	3	4	5	6	7	8	9	10+
1978	44.3	53.9	57.9	63.6	74.6	76.0	89.9	86.0	93.6	115.0
1979	-	50.7	53.3	69.1	75.3	80.4	95.9	104.4	99.6	115.0
1980	36.7	49.3	60.1	66.7	78.0	85.7	87.6	105.6	105.2	115.0
1981	42.2	49.2	58.8	67.8	77.4	85.7	94.5	96.0	97.4	115.0
1982	36.8	49.8	57.1	69.8	78.6	84.9	95.0	95.8	107.2	115.0
1983	42.6	50.4	58.4	67.1	77.8	84.8	93.0	99.3	104.4	115.0
1984	-	50.2	60.4	70.2	76.9	83.5	92.2	99.7	101.4	115.0
1985	38.7	49.3	55.3	67.9	74.8	83.2	90.1	95.6	98.8	115.0
1986	39.6	51.7	63.5	71.0	79.7	86.9	92.8	96.2	94.5	115.0
1987	38.5	51.9	60.3	73.5	82.5	88.1	96.2	100.3	106.0	115.0
1988	40.9	48.0	60.3	70.1	79.9	84.5	95.3	100.1	102.3	115.0
1989	37.0	48.5	57.6	69.9	77.0	82.6	88.1	100.4	102.8	115.0
1990	41.6	54.3	63.1	69.0	77.6	84.0	92.0	102.0	107.4	115.0
1991	45.1	53.7	63.6	67.2	73.3	78.8	86.2	96.1	90.6	115.0

Year	Weight									
	1	2	3	4	5	6	7	8	9	10+
1978	0.656	1.206	2.121	2.644	3.540	5.682	6.141	9.268	8.399	15.0
1979	-	1.483	1.723	3.691	4.730	5.986	9.586	12.058	10.412	15.0
1980	0.572	1.348	2.427	3.241	5.116	6.707	7.148	12.324	12.169	15.0
1981	0.864	1.368	2.312	3.467	5.113	6.816	9.108	9.575	10.485	15.0
1982	0.592	1.410	2.128	3.814	5.335	6.656	9.158	9.574	12.941	15.0
1983	0.885	1.466	2.265	3.371	5.210	6.641	8.593	10.428	11.999	15.0
1984	-	1.438	2.477	3.841	4.977	6.310	8.541	10.486	11.034	15.0
1985	0.680	1.391	1.950	3.571	4.742	6.399	8.074	9.664	10.584	15.0
1986	0.723	1.573	2.897	3.944	5.623	7.208	8.618	9.512	9.996	15.0
1987	0.600	1.600	2.506	4.447	6.148	7.484	9.538	10.759	12.565	15.0
1988	0.790	1.270	2.489	3.862	5.662	6.641	9.309	10.765	11.636	15.0
1989	0.585	1.303	2.178	3.830	5.128	6.348	7.554	10.799	11.576	15.0
1990	0.831	1.812	2.829	3.699	5.221	6.657	8.582	11.227	10.080	15.0
1991	1.051	1.756	2.783	3.470	4.432	5.591	7.116	9.604	8.457	15.0

Table 8. Stratified mean catch per tow in numbers for USA and Canadian research surveys in Szj,m, 1978-91, adjusted for vessel and door conversions.

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
USA spring a,b																
1	0.27	0.69	0.03	1.70	0.79	0.69	0.20	0.08	1.13	0.01	0.58	0.21	0.13	1.31		
2	0.01	2.65	2.96	1.57	11.58	3.63	0.22	3.67	0.62	2.17	0.45	1.55	0.62	1.12		
3	5.10	0.22	2.90	2.43	24.99	6.33	0.81	1.15	2.05	0.46	5.05	0.47	3.14	0.92		
4	1.12	2.57	0.28	1.73	22.29	1.36	1.22	1.92	0.55	0.98	0.50	2.39	1.09	1.63		
5	1.61	1.00	3.01	0.07	16.98	1.06	0.48	2.75	0.78	0.01	0.84	0.46	1.18	0.83		
6	0.34	0.34	0.59	0.60	0.01	0.66	0.39	0.60	0.98	0.34	0.08	0.54	0.29	0.69		
7	1.37	0.17	0.12	0.31	5.55	0.28	0.34	0.35	0.05	0.28	0.03	0.07	0.30	0.08		
8	0.19	0.22	0.08	0.12	1.24	0.11	0.01	0.45	0.21	0.06	0.14	0.06	0.03	0.03		
9	0.08	0.01	0.06	0.01	0.70	0.01	0.22	0.13	0.27	0.11	0.01	0.09	0.01	0.02		
USA autumn a,b																
0	0.10	0.21	0.32	0.60	0.60	0.01	1.47	0.06	2.24	0.22	0.29	0.18	0.41	0.36	0.01	
1	0.01	2.64	2.96	1.43	4.24	1.05	0.12	2.84	0.39	5.20	0.24	1.02	0.72	0.72	0.36	
2	6.31	0.26	2.93	0.76	2.19	1.29	0.42	0.14	1.80	0.11	1.53	0.33	1.68	0.79	0.13	
3	1.26	5.10	0.21	1.21	1.69	0.08	0.89	1.03	0.30	0.35	0.23	2.13	0.28	1.49	0.16	
4	0.35	0.73	2.71	0.05	0.48	0.12	0.05	1.68	0.03	0.01	0.19	0.25	0.77	0.21	0.02	
5	0.27	0.11	0.44	0.35	0.02	0.01	0.03	0.05	0.01	0.01	0.01	0.44	0.10	0.37	0.06	
6	0.33	0.11	0.16	0.04	0.05	0.01	0.03	0.06	0.03	0.02	0.01	0.01	0.04	0.04	0.01	
7	0.04	0.16	0.05	0.05	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.07	0.01	0.01	0.01	
8	0.01	0.01	0.04	0.05	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.09	0.01	0.02	0.01	
Canadian spring																
1								1.81	0.12	0.36	0.84	0.26	2.75	0.12		
2								8.33	4.31	1.08	5.01	1.81	2.31	4.69		
3								7.50	1.55	12.85	1.77	7.97	3.23	2.81		
4								0.76	1.81	1.36	3.90	4.49	3.74	0.94		
5								1.61	0.39	2.02	0.58	10.11	1.99	1.48		
6								1.04	0.21	0.23	0.76	1.23	2.70	1.04		
7								0.52	0.44	0.19	0.09	2.51	0.33	0.69		
8								0.08	0.21	0.43	0.19	0.33	0.56	0.21		
9								0.15	0.03	0.04	0.25	0.36	0.08	0.09		

a. Door conversion coefficient of 1.56 used on 1977-84 spring and fall surveys
 b. Vessel conversion coefficient of 0.79 used on 1981-82 and 1989-91 spring surveys and on 1977-81 and 1989-91 fall surveys.

Table 9. Residuals for survey indices from ADAPT

Age	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
a. USA spring															
1	-0.59	0.52	-2.54	0.83	1.07	1.24	-1.06	-0.92	0.19	-3.31	0.23	0.19	-0.27	1.11	
2	-3.49	0.24	0.51	-0.10	1.28	1.12	-1.37	0.36	-0.35	-0.64	-0.98	-0.27	-0.22	0.43	
3	0.20	-1.13	0.09	0.12	2.42	0.57	-0.39	0.03	-0.24	-0.88	0.12	-1.21	0.20	0.09	
4	-0.88	-0.49	-1.05	-0.62	2.21	-0.57	-1.02	0.40	-0.53	-1.00	-0.86	-0.66	-0.64	-0.17	
5	0.72	-0.39	0.31	-1.86	2.26	0.04	-0.66	0.40	0.23	-3.71	-0.52	-0.13	-0.76	-0.20	
6	0.17	-0.22	-0.34	-0.67	-3.13	-0.07	-0.26	0.38	0.14	0.15	-1.08	-0.04	-0.01	-0.58	
7	1.77	0.07	-0.69	-0.36	2.31	1.04	-0.10	0.49	-1.29	-0.40	-1.65	-0.27	0.23	-0.71	
8	1.77	0.49	-0.40	-0.03	1.63	-0.66	-1.34	1.10	0.66	-0.59	-0.47	-0.04	-0.16	-1.26	
9	0.92	0.31	-0.23	-1.89	2.47	-1.75	0.57	1.57	1.62	0.58	-1.84	0.03	-1.32	-1.09	
b. USA fall															
1	-1.49	-0.57	-0.12	-0.11	0.89	-2.45	1.01	-1.08	0.96	-0.13	-0.38	0.11	1.00	-0.11	5.31
2	-3.31	0.64	0.92	0.22	0.68	0.29	-1.52	0.52	-0.40	0.65	-1.19	-0.28	0.34	0.40	-1.26
3	1.29	-0.08	0.98	-0.15	0.87	-0.14	-0.16	-1.19	0.51	-1.43	-0.19	-0.68	0.45	0.81	-0.90
4	0.44	1.40	-0.14	0.23	0.83	-2.22	-0.13	0.98	0.07	-0.82	-0.43	0.43	-0.77	0.95	-0.45
5	0.38	0.50	1.41	-1.06	-0.09	-0.89	-1.79	1.12	-1.82	-2.51	-0.80	0.47	0.02	-0.36	-1.15
6	1.14	-0.15	0.58	-0.02	-1.23	-2.60	-1.58	-0.97	-3.23	-2.17	-1.95	0.97	0.15	0.01	0.01
7	1.56	0.84	0.77	-1.27	-1.21	-0.64	-1.29	-0.03	-0.59	-1.83	-1.54	-1.02	-0.59	-0.19	-2.87
8	1.36	1.38	0.35	0.26	-1.78	-0.01	-0.13	-1.06	-1.18	-1.17	-1.91	1.41	-0.34	-1.44	-0.91
9	0.28	1.28	0.45	0.71	-0.36	-0.55	0.23	0.66	-0.47	-0.61	-0.63	1.27	-0.11	1.21	-0.66
c. Canadian spring															
1									-0.97	-2.45	-1.88	-0.07	-1.18	0.22	6.32
2									1.39	-0.81	-0.96	0.05	-0.01	0.30	0.05
3									0.16	-0.57	0.16	-0.78	0.23	0.44	0.36
4									-0.86	-1.04	-0.52	-0.82	0.13	0.01	-0.52
5									0.31	-0.70	-0.29	-0.55	0.74	0.02	1.13
6									-0.45	-0.99	-0.68	-0.34	0.78	0.13	1.08
7									0.40	-0.60	-0.46	-0.69	1.70	0.07	-0.26
8									-0.96	0.01	-0.00	0.55	1.53	0.97	0.51
9									0.38	-1.37	-1.10	0.43	1.85	0.57	-0.09

Table 10. Parameter estimates from ADAPT using adjusted survey indices.

	Estimate	Std. Error	Rel. Error	Bias	Rel. Bias
Age					
a. 1992 population numbers					
2	8.314E3	3.924E3	4.720E-1	1.015E3	1.221E-1
3	2.031E3	9.019E2	4.440E-1	1.961E2	9.654E-2
4	1.073E3	5.277E2	4.917E-1	1.122E2	1.045E-1
5	3.253E2	2.267E2	6.970E-1	7.988E1	2.456E-1
6	2.388E2	1.606E2	6.726E-1	5.085E1	2.130E-1
7	6.067E2	4.199E2	6.921E-1	9.734E1	1.604E-1
8	8.569E1	5.889E1	6.873E-1	1.473E1	1.719E-1
9	6.670E1	4.898E1	7.344E-1	1.412E1	2.116E-1
a. USA spring survey catchability					
1	4.266E-5	1.197E-5	2.806E-1	1.354E-6	3.174E-2
2	2.287E-4	6.355E-5	2.778E-1	6.937E-6	3.033E-2
3	3.913E-4	1.044E-4	2.667E-1	1.116E-5	2.850E-2
4	7.683E-4	9.090E-5	1.183E-1	-1.890E-6	-2.460E-3
b. USA fall survey catchability					
1	3.894E-5	1.093E-5	2.807E-1	1.186E-6	3.045E-2
2	1.513E-4	4.088E-5	2.701E-1	4.244E-6	2.804E-2
3	1.623E-4	4.211E-5	2.595E-1	4.418E-6	2.722E-2
4	2.298E-4	3.031E-5	1.319E-1	1.416E-7	6.164E-4
c. Canadian spring survey catchability					
1	2.168E-4	8.413E-5	3.881E-1	1.336E-5	6.162E-2
2	5.393E-4	2.094E-4	3.883E-1	3.241E-5	6.009E-2
3	9.625E-4	3.703E-4	3.847E-1	5.897E-5	6.127E-2
4	1.474E-3	2.715E-4	1.841E-1	7.413E-6	5.028E-3

Table 11. Fishing mortality, population numbers and population biomass for 52j,m cod from ADAPT

a. Fishing mortality		78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
Age																
a. Fishing mortality																
1	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.06	0.10	0.15	0.09	0.24	0.33	0.08	0.32	0.10	0.26	0.07	0.10	0.25	0.25		
3	0.46	0.30	0.28	0.34	0.40	0.53	0.40	0.65	0.45	0.41	0.44	0.20	0.77	0.50		
4	0.41	0.44	0.33	0.40	0.68	0.74	0.41	0.54	0.63	0.43	0.62	0.41	0.50	1.84		
5	0.40	0.38	0.43	0.32	0.72	0.49	0.62	0.57	0.54	0.35	0.73	0.38	0.52	1.51		
6	0.39	0.35	0.43	0.56	0.85	0.42	0.66	0.62	0.51	0.43	0.73	0.65	0.41	0.77		
7	0.36	0.12	0.47	0.39	0.76	0.31	0.72	0.48	0.32	0.42	0.81	0.72	0.57	0.69		
8	0.82	0.33	0.16	0.57	0.79	0.34	0.59	0.83	0.36	0.34	0.78	0.46	0.26	0.57		
9	0.40	0.35	0.44	0.47	0.76	0.46	0.67	0.58	0.51	0.40	0.75	0.53	0.52	1.05		
3+	0.45	0.39	0.34	0.39	0.57	0.56	0.47	0.60	0.48	0.42	0.51	0.36	0.63	1.15		
b. Population numbers (000's)																
1	11190	9543	9276	17300	6348	4642	13695	4696	21996	6408	10849	4145	3889	10167		
2	2236	9160	7804	7594	14147	5192	3765	11203	3834	17983	5234	8874	3394	3177	8314	
3	10666	1721	6763	5496	5672	9155	3057	2839	6646	2844	11406	3996	6596	2165	2031	
4	3539	5486	1048	4184	3194	3118	4405	1679	1219	3462	1546	6033	2682	2508	1073	
5	1023	1924	2886	618	2296	1322	1219	2389	803	534	1840	681	3277	1325	325	
6	377	559	1082	1534	366	915	661	536	1104	383	307	727	383	1602	239	
7	305	209	323	574	718	129	493	279	236	542	204	121	311	209	607	
8	41	175	151	166	317	276	77	196	141	141	293	75	48	144	86	
9	41	15	102	106	77	117	161	35	70	80	82	110	38	31	67	
3+	15992	10089	12356	12678	12639	15032	10073	7951	10220	7986	15677	11743	13336	7984	4428	
c. Biomass (t)																
1	6248	6462	5304	14840	3658	4093	9273	3133	15686	4211	8498	2427	3231	8448		
2	2208	13390	10517	10173	19631	7459	5347	15098	5932	28136	6527	11403	6150	5757	14674	
3	18626	2909	16203	12358	11710	20181	7431	5341	18684	6880	27593	8462	18646	6121	5804	
4	7608	19714	3398	14229	11819	10288	16572	5732	4741	14882	5791	22417	9919	9278	3721	
5	2888	8872	14747	3089	11993	6705	5976	10805	4369	3212	10080	3351	17111	6918	1425	
6	1692	3121	7266	10305	2391	5959	4115	3301	7721	2784	1980	4388	2549	10665	1300	
7	1447	1947	2313	5117	6503	1095	4095	2164	1996	5093	1863	881	2671	1790	4532	
8	320	2084	1864	1550	2939	2839	805	1804	1327	1492	3086	793	544	1622	875	
9	275	155	1248	1030	992	1397	1767	357	621	1001	917	1259	502	401	963	
3+	32855	38802	47039	47677	48348	48464	40761	29505	39460	35344	51310	41552	51943	36794	18620	

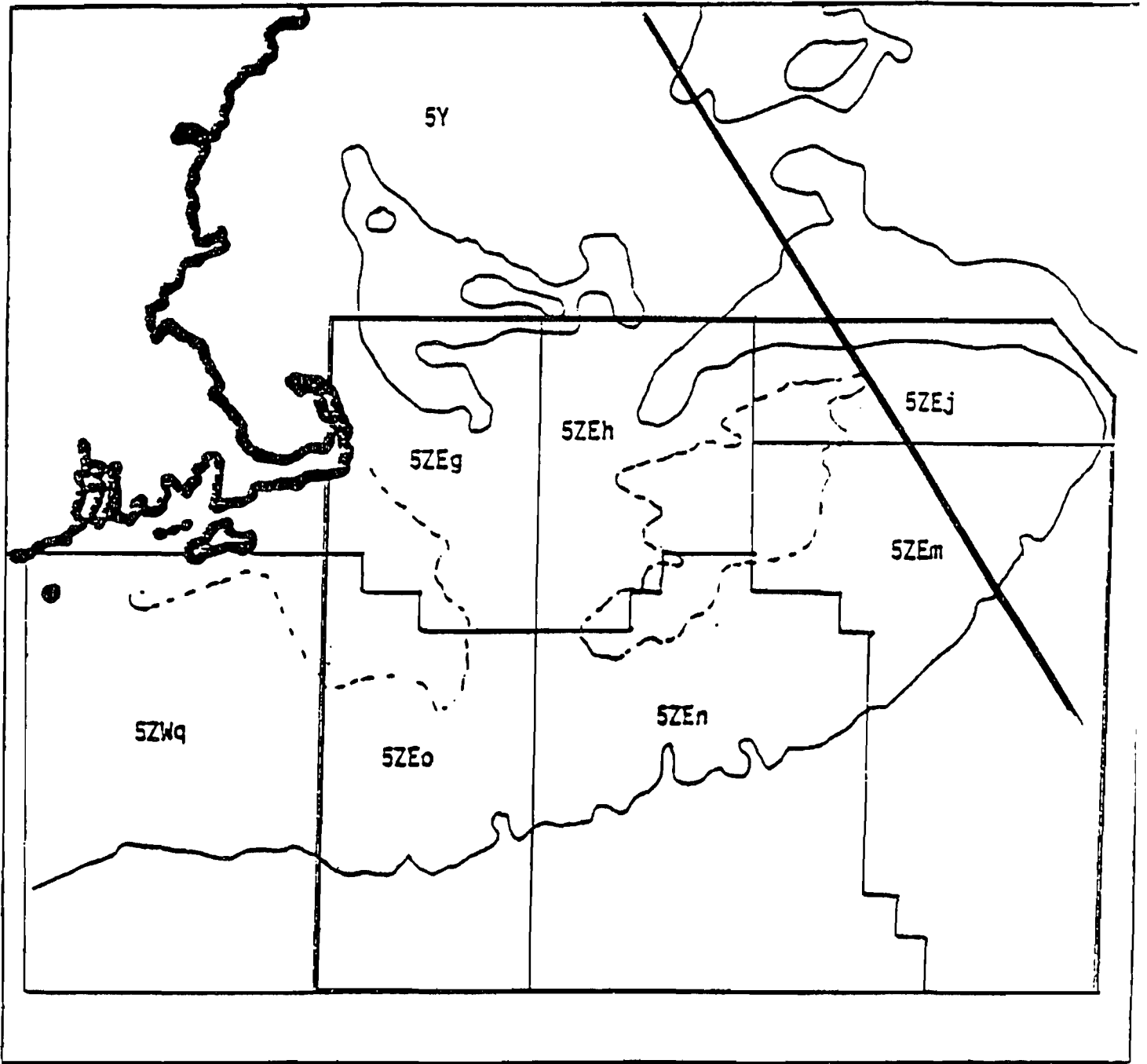


Figure 1. NAFO statistical areas for Georges Bank

Fig 2. Canadian landings by gear type

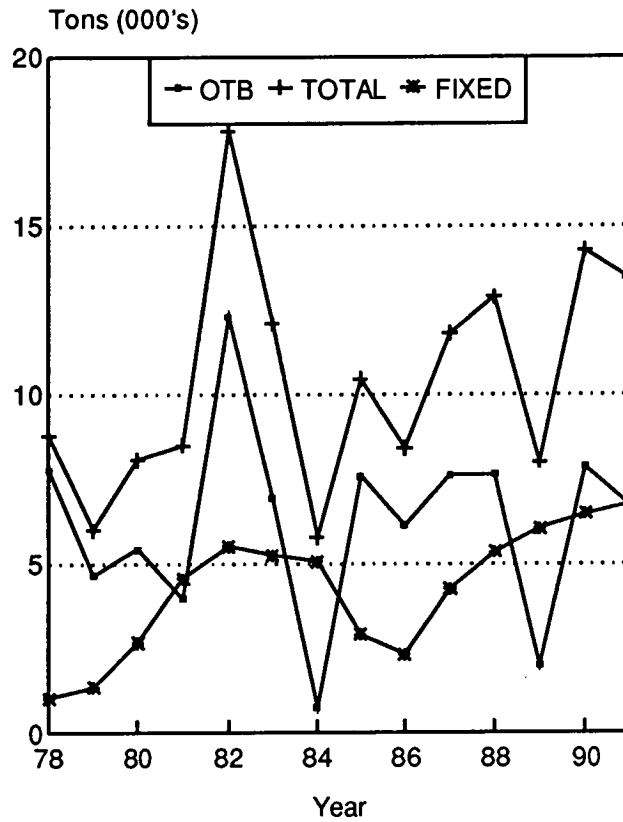


Fig 3. Canadian and USA landings of 5Zj,m cod.

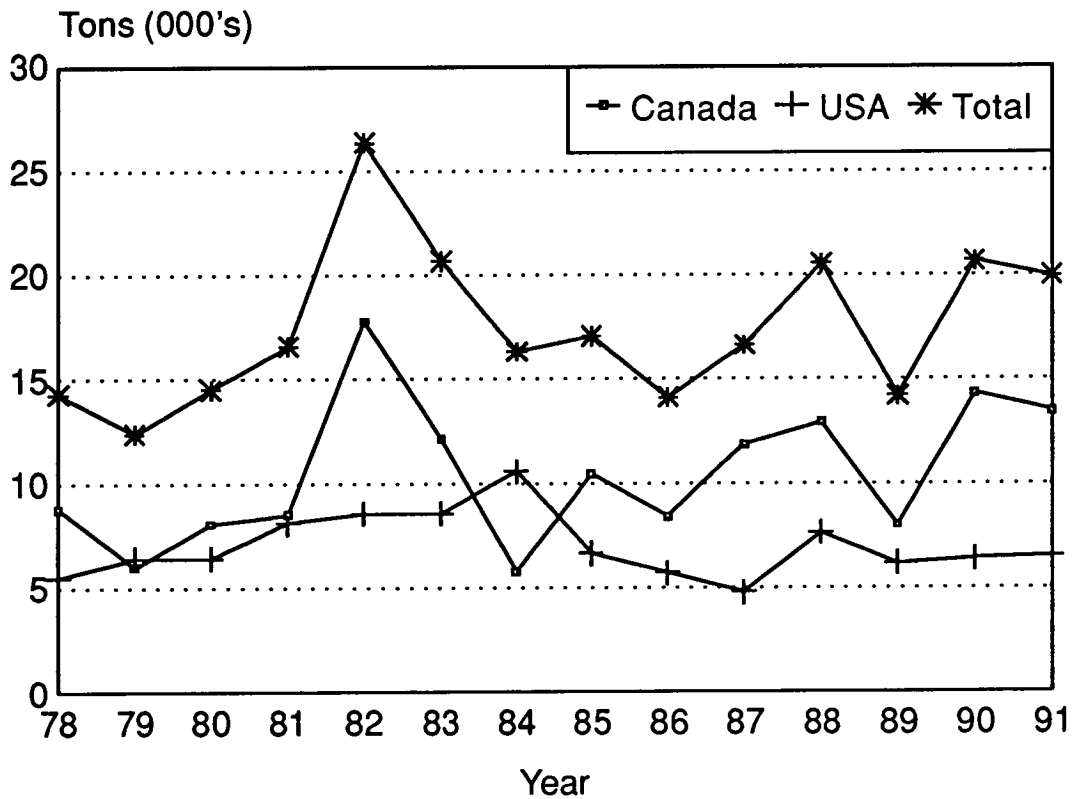


Fig 4. Percent catch at length for Canada and USA OTB in second quarter, 1991

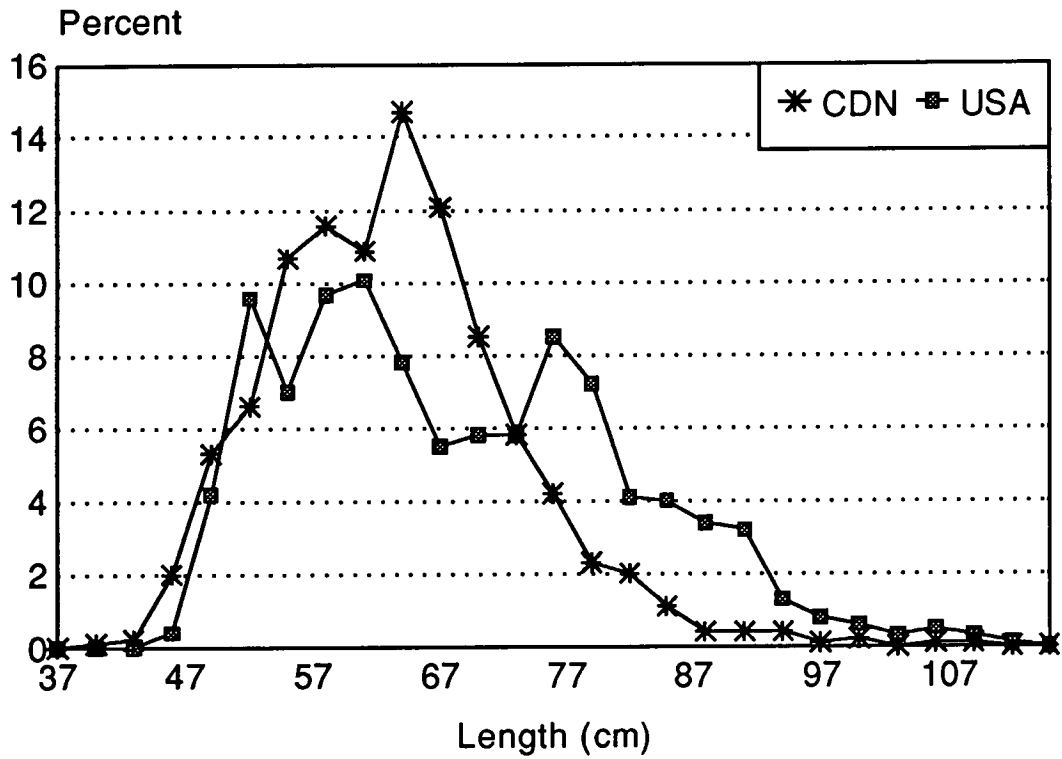
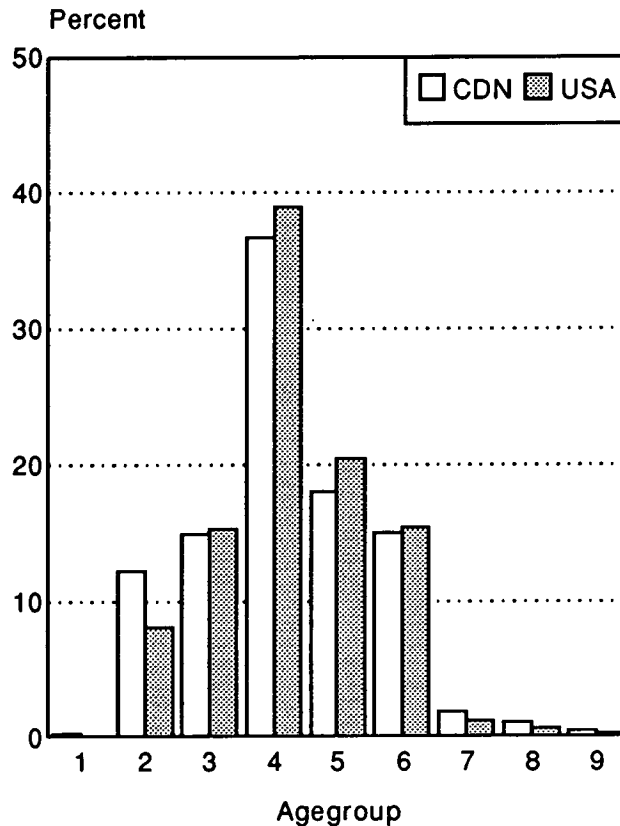


Fig 5. Percent catch at age for Canada and USA in 1991



20
Fig 6. Population numbers (3+) from ADAPT

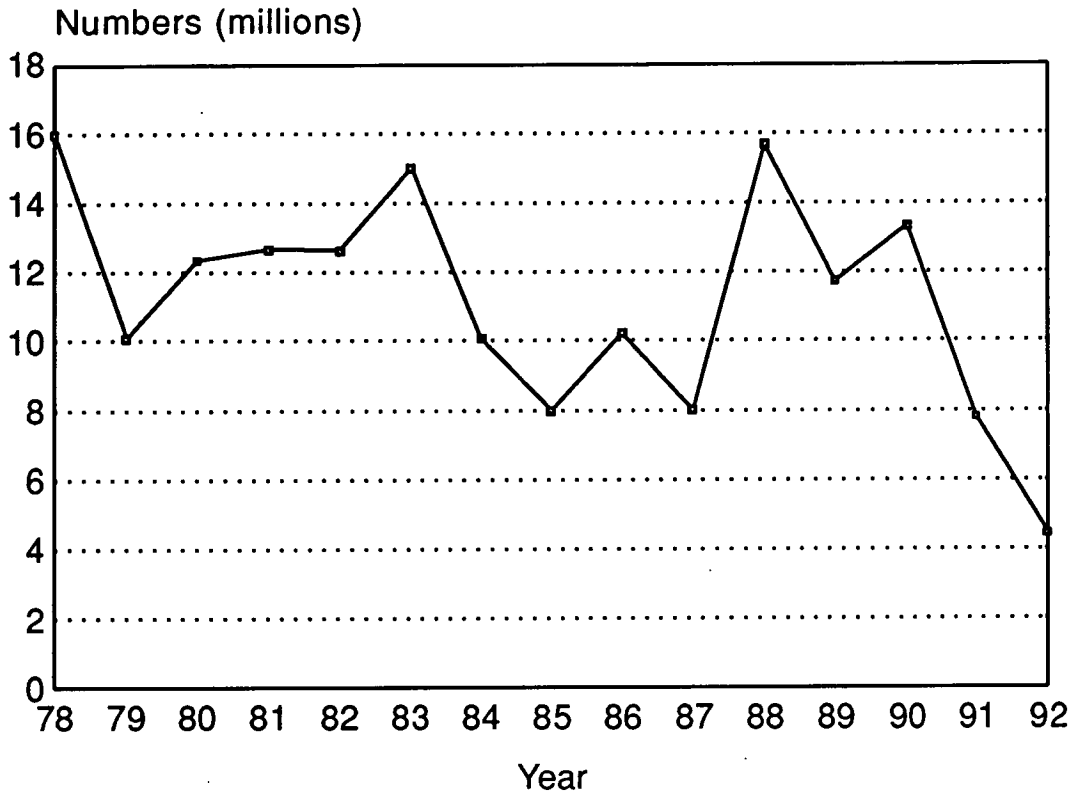


Fig 7. Population biomass (3+) from ADAPT

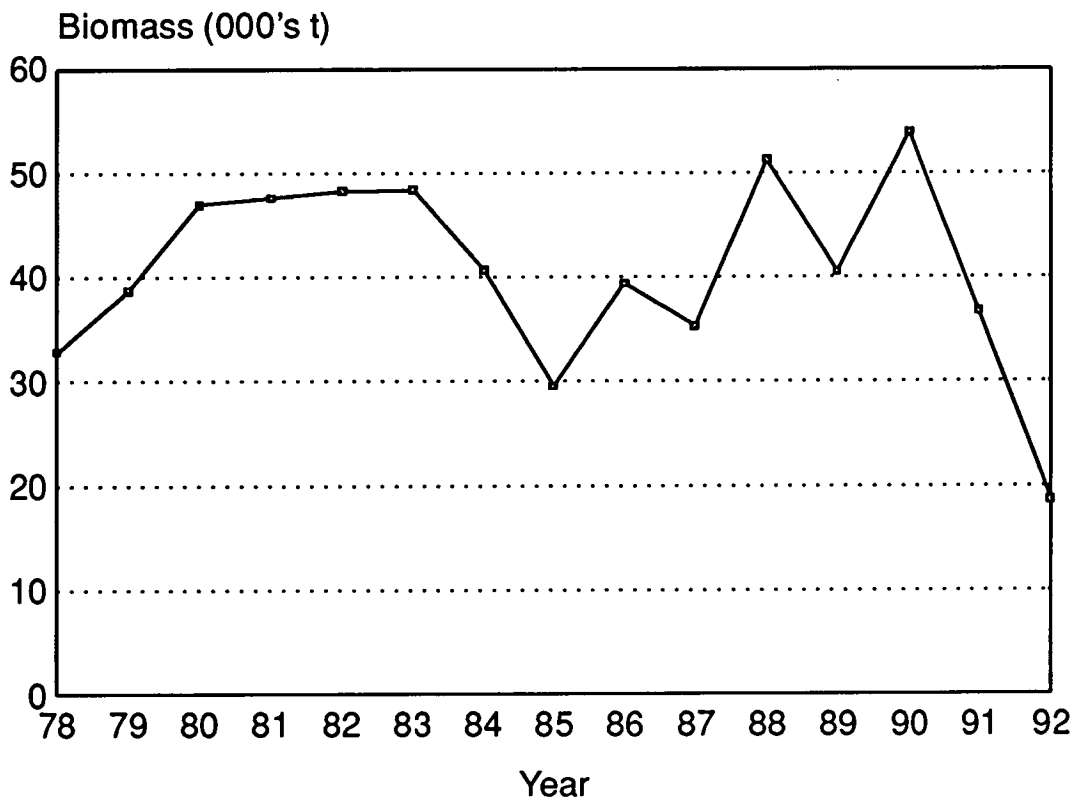


Fig 8. Fishing mortality (3+) from ADAPT

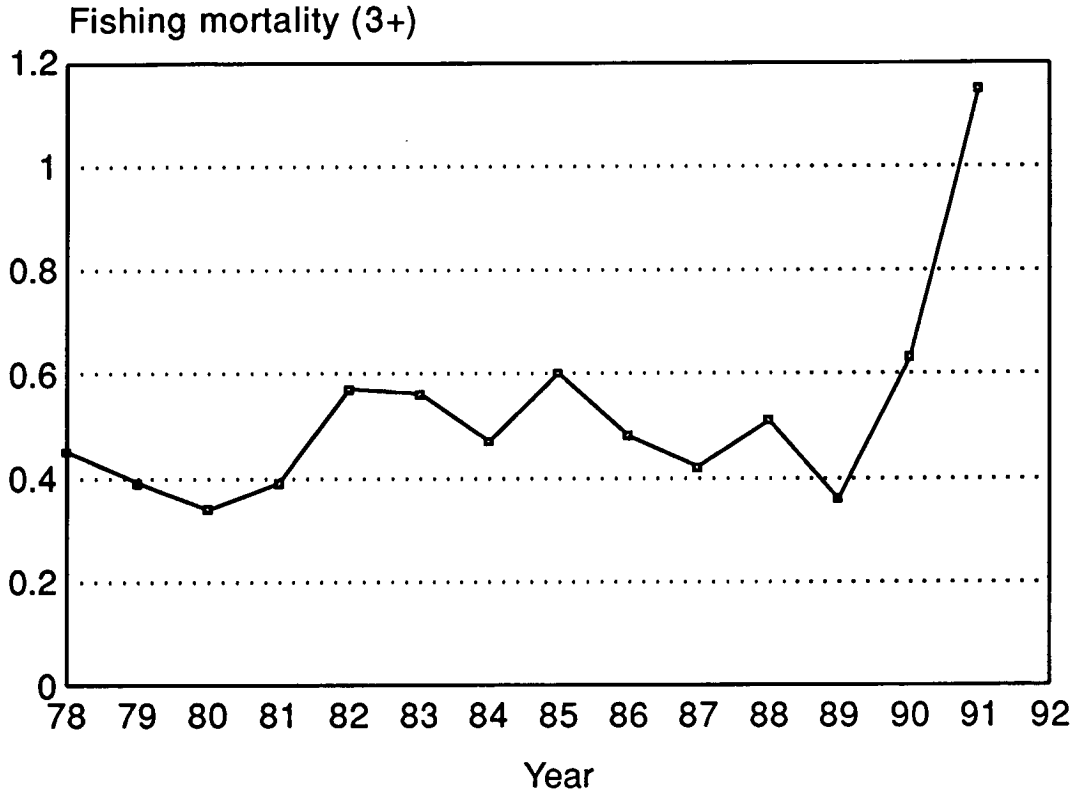


Fig 9. Comparison of abundance and survey indices
5Zjm Cod (with RV conversions)

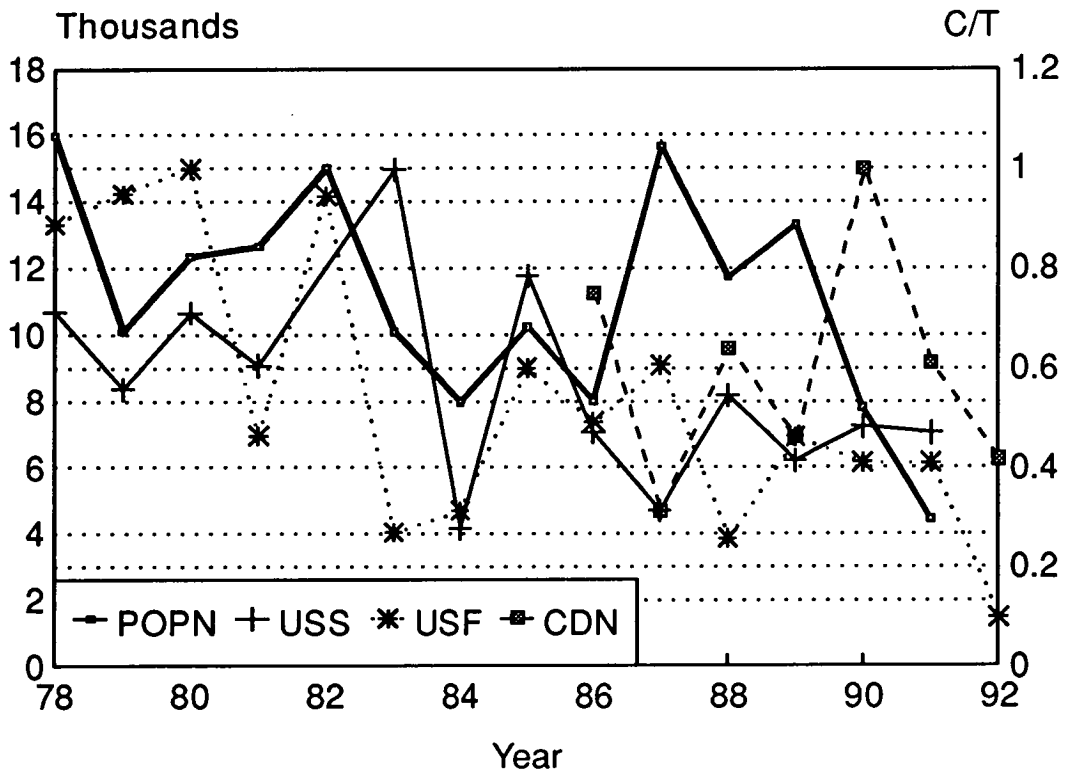


Fig 10. Yield and biomass in 1992 for 5Zj,m cod

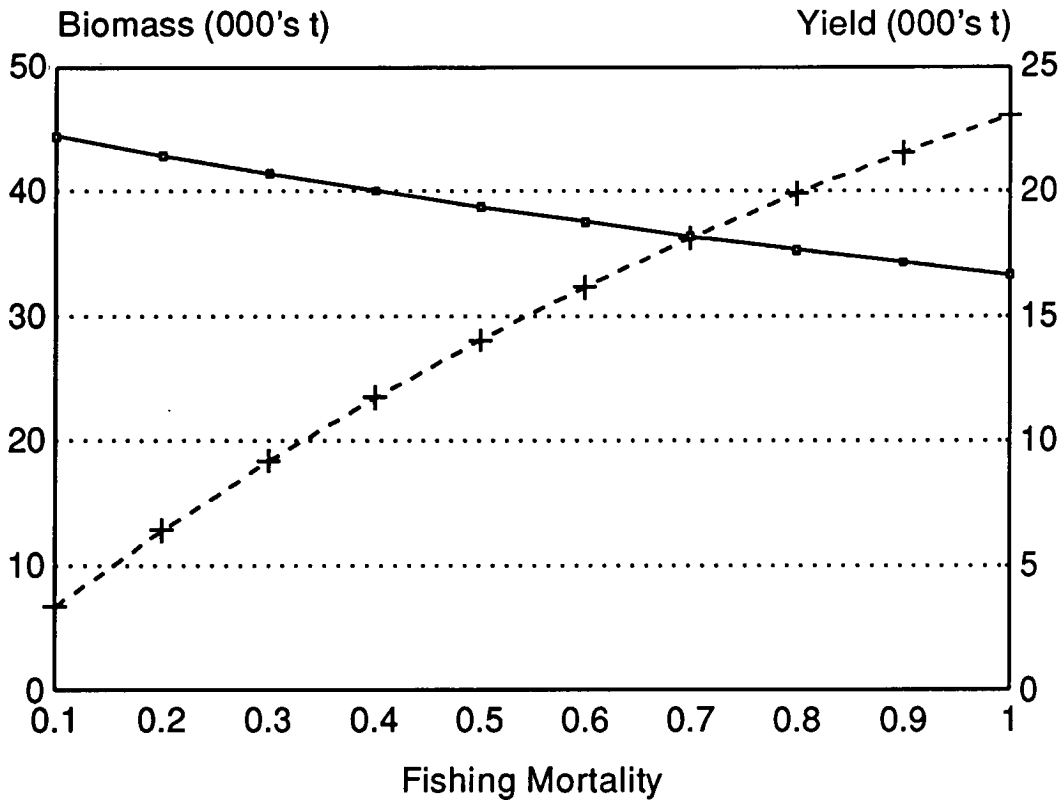


Fig 11. Yield and biomass in 1993 for 5Zj,m cod at selected exploitation rates with 20000 t 1992 catch.

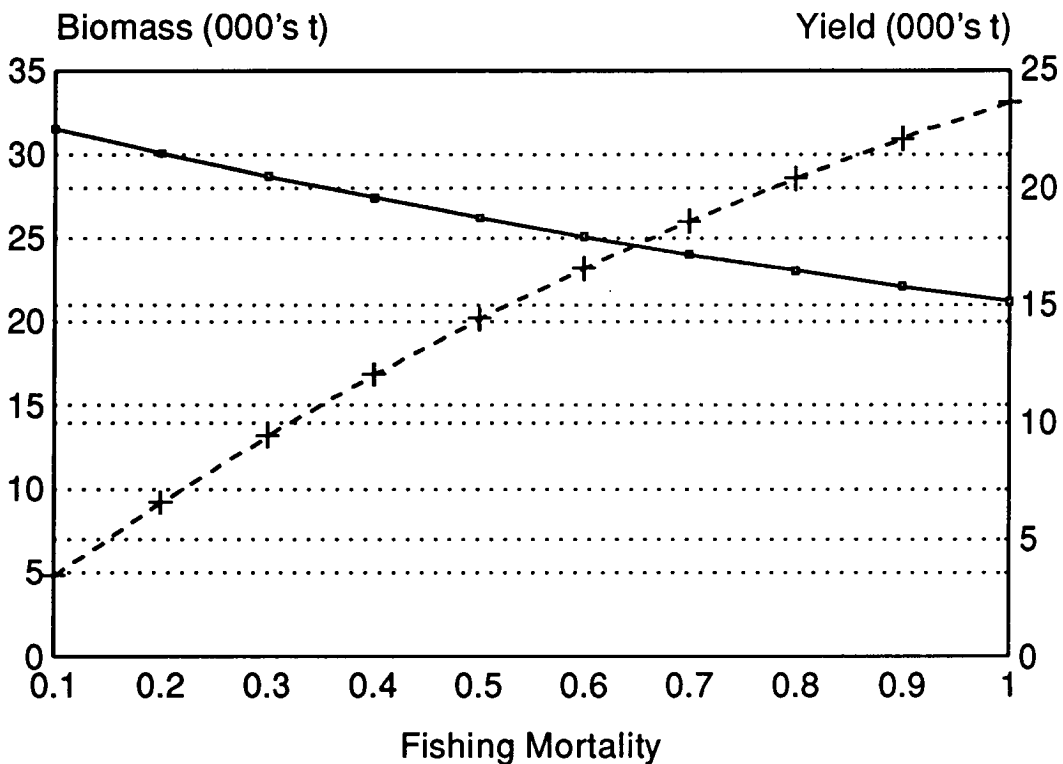


Fig 12. Length frequency for Canadian OTB cod landings
in June 1992.

