Biological Update of Georges Bank Cod in Unit Areas 5Zj,m for 1978-95

by

J.J. Hunt and M-I. Buzeta

Gulf of Maine Section
Biological Station
St. Andrews
New Brunswick

Abstract

Total landings of cod in Div.5Zj,m for 1995 are estimated to be 2,100 t, the lowest in the time series. The Canadian fishery was restricted to a bycatch only. The 1992 year class accounted for about 45% of the catch in numbers. Canadian and USA surveys indices have declined since 1990 but showed an increase in the last year. An ADAPT formulation using the three survey indices was used to estimate stock abundance. Biomass and numbers of fish remain near the lowest observed in the time series but increased slightly in 1995 and 1996. Exploitation rates were between 30 and 40%, peaked near 50% in 1991 and have since declined to about 12% in 1995. Recruitment since the 1990 year class was well below average but the 1995 year class shows some improvement Catch projection for 1996 at the $F_{0.1}$ reference level indicates a yield of about 3,500 t with a slight increase in stock biomass for 1997. Exploitation at a level lower than $F_{0.1}$ is required in order to continue stock rebuilding. Risk analysis indicates an 80% probability that biomass would increase in 1997 at yield of 3,000 t in 1996.

Résumé

Le total des débarquements de morue de la division 5Zjm pour 1995 est estimé à 2 100 t, le plus bas de la série chronologique. La pêche canadienne était limitée aux prises accessoires seulement. La classe d'âge de 1992 représentait 45 % des prises, en nombre. Les indices des relevés canadiens et américains ont diminué depuis 1990, mais affichent tout de même une augmentation au cours de la dernière année. La formulation ADAPT basée sur les trois indices des relevés a servi à évaluer l'abondance des stocks. La biomasse et le nombre de poissons sont demeurés très près du niveau le plus faible de la série chronologique, mais ont augmenté légèrement en 1995 et en 1996. Les taux d'exploitation se situaient entre 30 % et 40 %, atteignant un sommet à près de 50 % en 1991, avant de diminuer par la suite jusqu'à 12 % en 1995. Le recrutement depuis la classe d'âge de 1990 était bien inférieur à la moyenne, mais la classe de 1995 montre des signes d'amélioration. Les prévisions des prises pour 1996 au niveau de référence $F_{0,1}$ indiquent un rendement d'environ 3 500 t, avec une légère augmentation de la biomasse du stock pour 1997. L'exploitation à un niveau inférieur à $F_{0,1}$ sera nécessaire pour permettre au stock de continuer à se rétablir. Les analyses de risque montrent une probabilité de 80 % que la biomasse augmente en 1997, si le rendement est de 3 000 t en 1996.

Introduction

This report incorporates commercial catch data and research survey results for the 1978-96 time period to estimate the stock status of cod in the two unit areas 5Zj and 5Zm (5Zj,m) (Fig. 1). Definition of this management unit was based on analysis of tagging results and commercial and survey catch distribution (Hunt, 1990). Hunt and Buzeta reported the status of the stock in 1995 (Hunt and Buzeta, 1995).

Cod are taken in 5Zj,m by both Canada and the USA 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.

The Fishery

Canadian landings of Georges Bank cod peaked at about 18,000 t in 1982 and have declined from about 14,000 t in 1990 to 1,100 t in 1995 reflectingthe TAC. USA landings reached 11,000 t in 1984 , were stable at about 6,000 t until 1993 when a closed area was implemented. Landings in 1994 (2,000t) and 1995 (1,000 t) are only estimates because of changes in reporting and collection of landing information. Almost 100 percent of U.S.A catches in 5Zj,m are taken by mobile gear.

The 1995 Canadian Georges Bank cod fishery was limited to a 1,000 t TAC (bycatch only) and remained closed until June 18, 1995. In addition, minimum IQ's of 2 t for cod and 8 t for haddock were required before license conditions were granted to individual vessels. Longline vessels were also required to have caught at least 25 t of mixed groundfish in any combination of three years since 1990 before being granted a license condition.The USA fishery was limited by a year-round closed area which restricted access to a large part of the USA zone in 5Zj,m (Fig. 1). Total reported 1995 landings for Canada were 1,100 t, consisting of 429 t by mobile gear, 545 t by longline gear and 126 t by gillnet gear (Table 1, Fig. 2). USA landings are expected to be about 1,000 t for a total 1995 combined catch of 2,100 t (Table 2, Fig. 3).

Samples of landings and catches (Commercial samples and Observer program) were used to estimate catch at length and age composition. A summary of the number of length and age samples used to estimate catch at age is shown in Table 3. About 12,000 length observations and 550 age determinations were available to construct the catch at age for 1995 (Table 4). In some cases keys from adjacent quarters were required to partition length frequencies. Landings by miscellaneous gears (scallop, etc) were added to mobile gear landings. Comparison of 1995 Observer samples with on-shore samples shows little evidence of discarding (Fig. 4).

Comparisons of age determinations between and within age readers were completed and results indicate good agreement. While the secondary age reader's results were not used in construction of the catch at age, they compared favorably with ages produced by the primary age reader. Otolith exchanges between the Canadian and USA labs were made from the 1995 Spring USA survey and the Canadian

commercial fishery. Canadian age comparisons were made with otoliths from the 1995 commercial fishery. Results for all comparisons are summarized in Table 5.

Calculated percent catch at age is given in Table 6. The Canadian mobile gear catch at age was prorated with the estimated USA landings in 1994 and 1995 since sampling and ages were not available for USA landings. Overall, the 1992 year class accounted for about 53% of the catch in numbers and about 43% of the catch biomass in 1995. The 1992 year class contributed a somewhat higher proportion (45 vs. 30%) and the 1990 year class (20 vs. 30%) lower than projections made in the 1995 (Fig. 5). Catch at length and the contribution by agegroups for 1995 is shown in Figure 6.

Total removals at age, average weight at age and average beginning-of-year weight are given in Table 7. Mean weights at age 3 (1978-95) are shown in Figure 7. Weights in 1995 were above both the short (1990-95) and longterm (1978-95) average but lower sample size in 1995 and a slight shift to later in the season are probably contributing factors. Weight at age appears to have been variable over the 1978-95 time period and without evidence of trend.

Indices of Abundance

Research Surveys

Hunt et al (1991) describe the approach used to estimate mean catch per tow specific to the 5Zj,m area for Canadian and USA surveys. Only sets within the 5Zj,m area were used with strata area adjusted to conform to the 5Zj,m boundary. Vessel and gear conversion factors, reported by Serchuk *et al* 1994 were used to adjust results of the USA surveys to RV *Albatross IV* equivalents (*see results of vessel conversion factor analysis in Assessment Results section).*

The Canadian survey was initiated in 1986 while the USA surveys started prior to 1978. Results of analysis for each of the surveys are given in Table 8.

The 1982 USA spring survey is influenced by one tow of 1,000 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.

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. fall 1977 age one vs spring 1978 age two).

The Canadian surveys show a marked decline between 1990 and 1995 with a substantial increase in 1996. The 1994 USA fall survey catch per tow has a slight increase from 1993, decreased in 1995 and remains at a low level. The 1994 USA spring was the lowest observed but increased in 1995 to the recent average level. The three surveys for ages 3+ in number per tow, adjusted by the estimated catchability (Q's)

from recent ADAPT formulations, excluding the USA spring 1982 survey, are shown in Figure 8. In general, all three surveys appear to track year class strength and provide a consistent index.

Estimates of recruitment at age one from the surveys are shown in Figure 9 as population numbers derived from catch per tow adjusted by catchability factors. Both the 1995 USA fall and 1996 Canadian spring survey indicate an increase in recruitment for the 1995 year class over the 1993-95 year classes. However, estimates for the 1995 year class are less than 25% of the large 1990 and 1985 year classes and similar to the average 1987 year class.

Catch in numbers and weight for the 1996 Canadian survey are shown in Figure 10. Highest catch rates were in the Canadian zone with relatively small catches west of the International Maritime Boundary. The 1996 distribution pattern is similar to that seen in recent years.

Longline Research Survey

A survey of the Georges Bank area was completed by five longliners in 1995 using a box design with one set in each selected box. Gear was standardized between vessels (number of hooks, hook size, bait, etc) to minimize between vessel variance and boxes were assigned to vessels to achieve a mix of high and low expected catch rates.

Twenty-two sets were completed and catches were sampled to determine length frequency and weight caught for cod and haddock. Standardized (1,500 hooks) catches of cod ranged from 0 to about 800 and from 0 to about 1,500 kg with an overall mean of 170 fish and 420 kg per 1,500 hooks set. Catch rates were similar to those observed in the commercial fishery.

Further interpretation of this index will require additional years of data before trends or changes in stock abundance can be evaluated.

Commercial Fishery Catch Rates

The mobile catch rate was used as an index of abundance in the 1995 evaluation of stock status. However, the reduced TAC and bycatch limitations imposed for the 1995 fishery preclude use of catch rates. Effort information for the longline fleet was not collected in 1994 and therefore catch rates for this fleet sector are not available.

A summary of landings, effort and catch per day for the mobile, longline and gillnet fleets for 1990-95 is given in Table 9. Estimated total effort (number of fishing days) is calculated from the catch per day and reported landings to account for missing effort data for some trips. For example, only 30% of longline vessels reported effort in 1990 representing 825 fishing days with an average catch of 1.91 t per day. This catch per day was divided into the total reported landings to estimate total fishing days (5202/1.91 = 2724 days). The number of active vessels and total effort in 1995 were less than 50% of the 1990-94 average for all three fleet sectors.

ESTIMATION OF STOCK PARAMETERS

The adaptive framework (Gavaris 1988) was used to calibrate the sequential population analysis with the research survey indices of abundance. The integrated formulation used the following data:

$C_{a,y}$ = catch
a=1 to 8, y=1978 to 1995

$I_{1,a,y}$ = USA spring survey
a=1 to 8, y=1978 to 1995

$I_{2,a,y}$ = USA fall survey
a=0 to 4 y=1977 to 1995

$I_{3,a,y}$= Canadian spring survey
a=1 to 8, y=1986 to 1996

The spring survey results were compared to beginning of year population abundance. The fall survey for ages 0-4was also compared to beginning of year population abundance in year t+1 (ie fall 1977 ages 0-4 compared to 1978 population ages 1-5). Natural mortality was assumed constant and equal to 0.2. The fishing mortality rate on age 8 was calculated as the unweighed average for ages 4 to 6 in the same year. Errors in the catch at age were assumed negligible relative to those for the abundance index. The errors for the log transformed abundance index were assumed independent and identically distributed.

A model formulation using *ln* population abundance at the end of the terminal year (beginning of year y = t+1) as parameters was used. Natural log population abundance was used because this parameterization displayed a more "close to linear" behaviour improving performance of the search algorithm.

ADAPT was used to solve for the parameters using the techniques described by Gavaris (1993) and Hunt and Buzeta (1994).

Additional ADAPT formulations were examined to evaluate the influence of each of the indices. The three formulations, using only the Canadian spring, the USA spring and the USA fall index were compared for differences in estimated exploitation rate and population biomass. Results are shown in *Addendum* Figure 1. The USA fall index results provide the most pessimistic outlook for stock status followed by the USA spring survey and the Canadian survey is the most optimistic. All three indices show the same general trend and differ only in the magnitude of the change seen since 1990. However, precision of the estimates derived using only a single index is low.

Seasonal differences in catchability for the three indices is shown in *Addendum* Figure 2. The Canadian spring has the highest Q followed by the USA spring and the USA fall has the lowest catchability.

The impact of USA vessel conversion factors was evaluated by estimation of catchability for each of the vessels from ADAPT formulations using a) only *Albatross* and b) only *Delaware* unadjusted indices. The Q's for the vessel-specific USA spring index were examined and regression analysis indicated a slope of 0.74 with an intercept of 1.68 for the *Albatross* to *Delaware* relationship. Results are shown below and are consistent with the reported conversion factor of 0.79 for *Delaware* to *Albatross* equivalents.

Vessel-specific Q's at age for USA spring surveys

Age	1	2	3	4	5	6	7	8
Albatross	6.76	6.63	7.42	7.35	7.28	7.55	8.20	9.35
Delaware	6.84	7.12	7.26	7.37	7.92	8.03	8.54	10.36

Assessment Results

Population estimates derived from the above ADAPT formulation are given in Tables 10a-d. Parameter estimates and bias adjustment are given in Table 11. Population parameter estimates have a relative error of 32 to 62% for ages 1 to 8, similar to those seen in other ADAPT-based analytical assessments. In general, catchabilities for survey indices show a flat top PR at ages 4 and older. Catchabilities were highest for the Canadian spring survey, followed by the USA survey and the USA fall survey (*Addendum* Fig. 3).

Considerable differences in the stock abundance for 1994 and 1995 exist between the present evaluation and the 1995 results (Hunt and Buzeta, 1995). For example, adult biomass for 1994 and 1995 was 15,300t and 12,800t, respectively, in last years assessment compared to 17,100t and 18,100t from the current analysis. Most of this apparent increase is a result of the improved survey indices seen for 1995 and 1996 with associated lower exploitation in 1995 and higher population size for 1996. The impact of population size in 1996 influences cohort estimates for earlier years.

As has been noted in the past, there appear to be strong year effects in the residuals for survey indices. The 1982 USA spring survey has relatively large positive residuals, and negative residuals predominate in the last several years. The USA fall survey and the Canadian spring survey appear to overestimate population size (positive residuals) (Fig. 11). However, residuals by age for all three surveys appear to be reasonably well balanced and without trend within cohorts. The relatively high number of positive residuals for USA surveys prior to 1985 may be a function of trawl door conversion factors and should be investigated further. Residuals for the three indices are shown in Figures 12, 13 and 14.

The decline in adult biomass between 1990 and 1995 is substantial and was the lowest observed in 1994 with an indication of marginal increase in 1995 and 1996 (Fig. 15). Fishing mortality (Table 10c) increased rapidly between 1989 and 1991 and was over

three times the $F_{0.1}$ = 0.2 reference level in 1991-93. The decline seen in 1994, due to reduced effort, still results in a fishing mortality of over twice the $F_{0.1}$. In 1995, fishing mortality was further reduced to less than the $F_{0.1}$. The rate of exploitation for the stock has been over 30% for most of the time series, above 40% in 1991-93 and about 32% in 1994 and less than 10% in 1995 (Fig. 15).

Spawning stock biomass (40% age 2, 75% age 3 and 100% age 4, Hunt, 1995) also declined between 1990 and 1995 and is near the lowest observed level. Recruitment since the 1990 year class has been well below average and the 1994 year class will contribute very little to the stock. Preliminary estimates for the 1995 year class indicate some improvement to about the long term average recruitment. (Fig. 16 and Table 10d).

Prognosis

Catch projections were completed using the bias-adjusted beginning of year population abundance for 1995 derived from ADAPT. Partial recruitment was derived from the 1990-95 fishing mortality matrix, to reflect possible changes in PR associated with both gear and season. Mean weights at age were the 1978-95 average. Recruitment for 1996 age one was set to 6.5 million, the 1978-95 geometric mean. Input for the catch projection is shown below:

Age Group	Population Numbers in 1996	Mean Weight at age	1990-95 Mean Partial Recruitment
1	5996	0.844	0.01
2	811	1.423	0.31
3	1194	2.278	0.75
4	1877	3.472	0.82
5	970	4.807	1.00
6	1067	6.250	1.00
7	185	8.004	1.00
8	67	9.365	1.00
9+	23	10.698	1.00

The **combined** Canada and USA $F_{0.1}$ catch in 1996 is estimated to be about 3,500 t and details of the projection are given in Table 12. There is about a 20% relative error associated with the projected catch. However, even fishing at the $F_{0.1}$ reference level will not result in any substantial increase stock biomass between 1996 and 1997. The 1990 at age 6 and the 1992 at age 4 year classes are expected to account for about 30% and 25% of the catch biomass in 1996, respectively. Yield and biomass projections at a range of exploitation rates are shown in Figure 17. Only a small increase above the $F_{0.1}$ reference yield will result in zero biomass increase in 1997 and even with zero yield in 1996 the 1997 biomass would increase by about only 4,000t Given the very low spawning stock biomass in 1996 (20,000 t compared to the longterm average of 32,000 t) and low levels of recruitment since 1990, a stock rebuilding strategy should be considered. (Addendum Fig. 4).

Uncertainty associated with the yield projection indicates that even at $F_{0.1}$ there is a 45% probability that the adult biomass will decrease in 1997. A yield of about 3,000t in 1996 reduces this probability to about 20%. It is also important to note that even small increases in yield above the $F_{0.1}$ level substantially increases the chances that biomass in 1997 will decline. Results are shown in Figure 18.

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Table 1. Nominal landings(t) of cod by gear and month for Canada in unit areas 5Zjm.(OT-ottertrawl; 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
92	OT	261	375	0	1	12	2835	972	287	214	541	132	9	5638
	GN	0	0	0	0	1	294	350	342	203	26	2	0	1217
	LL	114	340	475	275	237	799	676	612	509	337	101	0	4474
	MISC	9	13	19	21	24	141	75	47	0	4	8	1	383
	TOT	384	726	494	296	274	4068	2073	1287	945	909	243	10	11712
93	OT	826	998	77	380	0	1203	590	162	123	237	178	114	4890
	GN	0	0	0	0	0	287	367	261	212	48	0	0	1175
	LL	4	30	166	76	148	422	515	462	261	122	118	63	2387
	MISC	9	4	10	14	17	4	5	1	0	1	2	0	67
	TOT	839	1032	253	470	165	1916	1477	886	596	408	298	177	8519
94	OT	0	0	0	0	0	777	410	115	128	263	117	83	1893
	GN	0	0	0	0	0	133	539	243	97	19	0	0	1031
	LL	0	0	0	0	0	409	481	869	492	5	30	0	2287
	MISC	7	7	10	14	9	6	4	2	0	1	3	1	66
	TOT	7	7	10	14	9	1327	1434	1229	717	288	150	84	5276
95	OT	0	0	0	0	0	100	62	57	82	25	41	27	395
	GN	0	0	0	0	0	17	39	0	70	0	0	0	126
	LL	0	0	0	0	0	116	161	122	98	20	20	7	544
	MISC	1	4	4	5	4	5	8	3	1	0	0	0	35
	TOT	1	4	4	5	4	238	271	182	251	45	61	34	1100

Table 2.Summary of total catches (t) by Canada and the USA in unit areas 5Zjm for 1978-1995. USA catches for 1994 and 1995 were estimated.

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	6777	20232
1992	11712	5080	16792
1993	8519	4019	12538
1994	5277	2000	7277
1995	1100	1000	2100

Table 3. Canadian and USA commercial landings samples for 1978-95. Canadian 1994 and 1995 lengths include IOP samples. Sampling data for USA in 1994 and 1995 are not yet available.

	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
92	25	2048	445	48	10878	1906
93	29	2215	440	51	12158	2146
94	-	-	-	104	25845	1268
95	-	-	-	41	11598	548

Table 4. Summary of commercial and IOP samples used to estimate catch at age.

GEAR	MONTH	TONS by Month	#LEN	#AGES	TONS by Quarter
OTB+Misc					
	Jan	1.638	132		
	Feb	3.74			
	Mar	4.326	232		9.704
	Apr	4.592			
	May	4.389			
	Jun	104.808	1355	75	113.789
	Jul	69.862	333		
	Aug	59.854	1151	154	
	Sep	82.883	236	46	212.599
	Oct	25.4	230	46	
	Nov	41.165	1157	77	
	Dec	26.652			93.217
Total Canadian		429.309	4826	398	
Total USA		1000			
Total		1429.309			
Longline	Jan				
	Feb				
	Mar				0
	Apr				
	May				
	Jun	116.298	765		116.298
	Jul	161.306	266		
	Aug	122.465	4574		
	Sep	97.585	254	42	381.356
	Oct	19.899			
	Nov	20.279	354	53	
	Dec	6.737			46.915
Total		544.569	6213	95	
Gillnet	Jan				
	Feb				
	Mar				0
	Apr				
	May				
	Jun	17.285	155		17.285
	Jul	39.385	161		
	Aug				
	Sep	69.705	243	55	109.09
	Oct				
	Nov				
	Dec				0
Total		126.375	559	55	
Age Keys	Q1		364	0	9.704
	Q2		2275	75	247.372
	Q3		7218	297	703.045
	Q4		1741	176	140.132
TOTAL CANADIAN		**1100.253**	**11598**	**548**	
TOTAL		**2100.253**			

Table 5. Comparison matrices for age assignments by the USA and Canadian age readers.

Spring exchange: USA survey AL9503

USA AGE \ CANADIAN AGE	1	2	3	4	5	6	7	8	9	-	TOT
1	[1]										0
2		[1]									1
3			[17]								17
4				[12]	1						13
5				1	[14]	1					16
6					1	[5]					6
7							[4]	1			5
8								[0]			0
9									[1]		1
-			1							[0]	1
TOT	0	1	18	13	16	6	4	1	1	0	[60]

92% AGREEMENT

Fall Exchange: Canadian commercial samples.

USA AGE \ CANADIAN AGE	1	2	3	4	5	6	7	8	9	10	-	TOT
1	[0]											0
2		[7]										7
3		4	[17]	1								22
4			2	[7]								9
5			1	2	[18]	1						22
6						[2]					1	3
7						2	[2]					4
8							1	[4]				5
9								1	[3]		1	5
10									1	[0]		1
TOT	0	11	20	10	18	5	3	5	4	0	2	[76]

79% AGREEMENT

Primary ager: Canadian commercial samples

2nd AGE \ 1st AGE	1	2	3	4	5	6	7	8	9	TOT
1	[1]									0
2		[10]	1							11
3		1	[19]	1						21
4				[9]	5					14
5					[13]	1				14
6						[4]				4
7							[3]	4		7
8								[0]	2	2
9								1	[2]	3
TOT	0	11	20	10	18	5	3	5	4	[76]

79% AGREEMENT

Comparison tests between both Canadian agers.

2ry AGE \ PRIMARY AGER	1	2	3	4	5	6	7	8	9	TOT
1	[0]									0
2		[7]								7
3		4	[16]	1						21
4			3	[8]						11
5			1	1	[18]	2				22
6					1	[1]				2
7						1	[2]			3
8						1	1	[4]		6
9								1	[2]	3
10									2	2
TOT	0	11	20	10	19	5	3	5	4	[77]

75% AGREEMENT

Table 6. Percent catch at age for the combined 5Zj,m cod fishery

Year	Agegroup 1	2	3	4	5	6	7	8
a) numbers								
78	0.0	2.3	**67.6**	20.3	5.8	2.1	1.6	0.4
79	0.3	21.7	10.6	**47.2**	14.5	4.0	0.6	1.2
80	0.0	23.9	**36.1**	6.4	22.1	8.3	2.6	0.5
81	0.4	14.0	**33.6**	29.1	3.6	13.8	3.9	1.5
82	0.1	**35.5**	22.3	18.9	14.1	2.5	4.6	2.1
83	0.6	18.6	**48.1**	20.8	6.6	4.0	0.4	1.0
84	0.3	7.5	25.3	**37.4**	14.2	8.1	6.4	0.9
85	0.2	**46.4**	20.3	10.5	15.6	3.7	1.6	1.7
86	0.7	8.5	**56.7**	13.3	7.9	10.4	1.5	1.0
87	0.2	**60.0**	14.2	18.0	2.4	2.0	2.7	0.6
88	0.2	5.4	**62.1**	11.0	14.6	2.4	1.7	2.4
89	0.0	19.4	17.1	**48.1**	5.1	8.2	1.5	0.7
90	0.1	10.8	**50.8**	15.3	19.0	1.8	1.9	0.2
91	0.2	11.9	14.9	**36.9**	18.1	15.0	1.8	1.1
92	1.6	**42.5**	22.6	7.8	16.4	4.5	4.2	0.5
93	0.1	10.5	**49.9**	20.5	5.5	8.4	2.8	2.4
94	0.1	11.6	26.7	**41.3**	13.8	2.1	2.9	1.3
95	0.1	14.5	**52.6**	16.9	12.8	2.3	0.4	0.3
b) biomass								
78	0.0	1.0	**57.0**	24.1	8.6	4.1	4.0	1.2
79	0.1	8.7	6.1	**53.5**	19.1	7.7	1.4	3.3
80	0.0	9.8	25.1	6.6	**35.2**	15.7	6.2	1.2
81	0.1	5.7	21.6	27.0	5.1	**27.2**	9.2	4.1
82	0.0	14.8	17.6	21.5	**22.4**	4.8	12.7	6.1
83	0.2	9.9	**40.7**	24.5	10.8	9.1	1.2	3.7
84	0.1	3.0	15.5	**33.8**	18.0	13.2	14.2	2.2
85	0.1	23.3	15.0	14.4	**28.2**	8.5	4.6	6.0
86	0.2	3.6	**40.5**	14.2	12.9	21.8	3.9	2.9
87	0.1	**34.3**	13.6	29.1	5.3	5.9	9.4	2.3
88	0.0	2.5	**44.6**	11.7	24.1	5.0	4.6	7.4
89	0.0	8.9	11.0	**51.4**	7.7	15.6	3.4	2.0
90	0.0	5.3	**39.3**	16.9	29.2	3.7	5.1	0.5
91	0.1	5.1	9.9	**32.9**	22.6	23.1	3.4	2.9
92	0.6	22.3	18.9	10.2	**26.2**	9.5	10.7	1.5
93	0.0	5.3	**37.3**	20.5	8.0	15.6	6.4	6.8
94	0.0	4.8	18.1	**44.4**	18.7	4.3	6.5	3.3
95	0.0	7.1	**43.1**	20.5	21.8	5.0	1.6	1.0

Table 7. Summary of commercial fishery data for 5Zj,m cod

a) **Removals at age** for the combined Canada and USA fishery

	1	2	3	4	5	6	7	8
78	2	121	3588	1076	307	110	83	21
79	10	814	399	1774	545	149	22	45
80	1	987	1495	265	916	345	109	20
81	19	603	1443	1249	155	595	169	65
82	6	2682	1686	1429	1066	189	345	157
83	40	1319	3416	1474	466	283	31	71
84	10	269	911	1346	511	290	230	31
85	12	2792	1221	631	941	224	96	100
86	28	326	2188	513	304	400	58	39
87	14	3666	865	1099	144	121	167	37
88	10	320	3653	646	861	144	102	143
89	1	740	652	1837	193	314	56	25
90	7	678	3196	962	1195	116	122	10
91	11	626	783	1939	953	790	93	56
92	86	2358	1251	432	908	250	233	25
93	4	414	1967	809	215	332	110	93
94	3	239	548	847	284	44	60	27
95	1	100	362	116	88	16	3	2

b) **Average weight at age** in the commercial fishery

	1	2	3	4	5	6	7	8
78	0.71	1.31	2.46	3.47	4.34	5.79	7.37	8.49
79	0.89	1.49	2.15	4.21	4.89	7.18	9.18	10.31
80	0.84	1.46	2.47	3.67	5.65	6.68	8.39	9.09
81	0.88	1.50	2.36	3.42	5.21	7.22	8.57	9.89
82	0.77	1.40	2.66	3.83	5.35	6.51	9.36	9.90
83	0.97	1.49	2.38	3.31	4.64	6.39	7.96	10.29
84	1.05	1.64	2.45	3.62	5.08	6.58	8.91	10.10
85	0.91	1.42	2.09	3.89	5.09	6.41	8.10	10.24
86	0.93	1.48	2.45	3.66	5.60	7.19	8.91	9.96
87	0.73	1.48	2.50	4.19	5.81	7.73	8.95	10.01
88	0.79	1.52	2.36	3.51	5.40	6.65	8.78	9.99
89	0.81	1.62	2.27	3.77	5.40	6.69	8.22	10.72
90	0.83	1.56	2.46	3.52	4.89	6.33	8.46	10.65
91	1.11	1.63	2.55	3.42	4.77	5.89	7.41	10.52
92	1.15	1.54	2.46	3.84	4.70	6.16	7.51	9.85
93	0.88	1.57	2.31	3.08	4.50	5.73	7.08	8.88
94	0.91	1.46	2.41	3.83	4.80	7.09	7.86	8.93
95	0.90	1.49	2.51	3.72	5.22	6.52	11.06	10.12
1990-95	0.96	1.54	2.45	3.56	4.81	6.29	8.23	9.83
1978-95	0.84	1.42	2.28	3.47	4.81	6.25	8.00	9.37

c) **Average beginning-of-year weight at age**

	1	2	3	4	5	6	7	8	9
78	0.49	0.96	1.80	2.92	3.88	5.01	6.53	7.91	9.11
79	0.69	1.03	1.68	3.22	4.12	5.58	7.29	8.72	9.11
80	0.63	1.14	1.92	2.81	4.88	5.71	7.76	9.14	12.20
81	0.70	1.12	1.86	2.90	4.37	6.39	7.56	9.11	9.04
82	0.55	1.11	2.00	3.01	4.28	5.83	8.22	9.21	10.73
83	0.75	1.07	1.83	2.97	4.22	5.85	7.20	9.81	10.64
84	0.91	1.26	1.91	2.93	4.10	5.52	7.55	8.97	10.78
85	0.71	1.22	1.85	3.09	4.29	5.71	7.30	9.55	11.38
86	0.74	1.16	1.86	2.76	4.67	6.05	7.56	8.98	10.97
87	0.50	1.17	1.92	3.20	4.61	6.58	8.02	9.45	11.04
88	0.55	1.05	1.87	2.96	4.76	6.21	8.23	9.45	10.61
89	0.58	1.13	1.86	2.98	4.35	6.01	7.39	9.70	10.55
90	0.59	1.12	2.00	2.83	4.30	5.85	7.52	9.36	11.84
91	0.95	1.16	1.99	2.90	4.10	5.37	6.85	9.43	12.12
92	0.98	1.31	2.00	3.13	4.01	5.42	6.65	8.54	11.73
93	0.69	1.34	1.89	2.75	4.16	5.19	6.60	8.17	11.35
94	0.71	1.13	1.95	2.97	3.85	5.65	6.71	7.95	9.66
95	0.71	1.16	1.91	2.99	4.47	5.60	8.85	8.92	10.04
96	0.70	1.21	1.91	2.91	4.16	5.48	7.39	8.35	10.35
1990-95	0.79	1.22	1.94	2.94	4.12	5.45	7.18	8.56	10.88
1978-95	0.69	1.15	1.89	2.96	4.29	5.74	7.43	8.98	10.70

Table 8. Research survey standardized catch per tow in numbers by year and agegroup for 5Zj,m cod.

a) **Canada spring**

	1	2	3	4	5	6	7	8
86	1.78	8.19	7.41	0.77	1.60	1.03	0.51	0.08
87	0.12	4.31	1.55	1.81	0.39	0.21	0.44	0.21
88	0.36	1.08	12.85	1.36	2.02	0.23	0.19	0.43
89	0.84	5.22	1.84	4.11	0.62	0.80	0.10	0.20
90	0.25	1.91	8.36	4.70	10.60	1.29	2.63	0.35
91	2.83	2.43	3.40	3.93	2.06	2.87	0.36	0.60
92	0.11	4.93	2.94	0.99	1.55	1.09	0.72	0.22
93	0.07	0.85	4.15	1.50	0.89	1.82	0.66	0.64
94	0.03	1.51	1.66	3.10	1.15	0.44	0.88	0.20
95	0.08	0.45	2.99	1.82	1.25	0.45	0.11	0.16
96	0.22	0.49	4.20	10.44	3.45	2.49	1.07	0.26

b) **USA spring**

	1	2	3	4	5	6	7	8
78	0.27		5.10	1.12	1.61	0.34	1.37	0.19
79	0.69	2.65	0.22	2.57	1	0.34	0.17	0.22
80	0.03	2.96	2.90	0.28	3.01	0.59	0.12	0.08
81	1.70	1.57	2.43	1.73	0.07	0.60	0.31	0.12
82	0.79	11.58	24.99	22.29	16.98		5.55	1.24
83	0.69	3.63	6.33	1.36	1.06	0.66	0.28	0.11
84	0.20	0.22	0.81	1.22	0.48	0.39	0.34	
85	0.08	3.67	1.15	1.92	2.75	0.60	0.35	0.45
86	1.13	0.62	2.05	0.55	0.78	0.98	0.05	0.21
87		2.17	0.46	0.98		0.34	0.28	0.06
88	0.58	0.45	5.05	0.50	0.84	0.08	0.03	0.14
89	0.21	1.55	0.47	2.39	0.46	0.54	0.07	0.06
90	0.13	0.62	3.14	1.09	1.18	0.29	0.30	0.03
91	1.31	1.12	0.92	1.63	0.83	0.69	0.08	0.03
92	0.14	1.20	0.65	0.17	0.45	0.27	0.29	0.05
93		0.83	2.32	0.47	0.08	0.33	0.08	0.08
94	0.10	0.37	0.29	0.36	0.09	0.02	0.06	
95	0.09	0.52	1.64	0.88	1.63	0.35	0.47	0.06

c) **USA fall**

	1	2	3	4	5
78	0.10		6.31	1.26	0.35
79	0.21	2.64	0.26	5.10	0.73
80	0.32	2.96	2.93	0.21	2.71
81	0.60	1.43	0.76	1.21	0.05
82	0.60	4.24	2.19	1.69	0.48
83		1.05	1.29	0.08	0.12
84	1.47	0.12	0.42	0.89	0.05
85	0.06	2.84	0.14	1.03	1.68
86	2.24	0.39	1.80	0.30	0.03
87	0.22	5.20	0.11	0.35	
88	0.29	0.24	1.53	0.23	0.19
89	0.18	1.02	0.33	2.13	0.25
90	0.41	0.72	1.68	0.28	0.77
91	0.36	0.72	0.79	1.49	0.21
92		0.36	0.13	0.16	0.02
93		0.37	1.31	0.28	
94		0.14	0.19	0.28	0.03
95	0.02	0.14	0.54	0.39	0.28
96	0.40	0.05	0.22	0.54	0.12

Table 9. Summary of landings and effort data by gear sector for Georges Bank cod (value in brackets for effort is the calculated value of total landings divided by landings per day)

	Mobile	Gillnet	Longline
1990			
Total	7854	910	5202
Total with effort	7285	534	1579
Boats	176	14	103
Percent with effort	92.7	58.7	30.4
Effort (fish_days)	3837(4133)	215(367)	825(2724)
Landings per day	1.90	2.48	1.91
1991			
Total	6698	1688	4706
Total with effort	6395	1084	1581
Boats	188	26	118
Percent with effort	95.5	64.2	33.6
Effort (fish_days)	3769(3940)	308(480)	849(2530)
Landings per day	1.70	3.52	1.86
1992			
Total	5638	1217	4474
Total with effort	5583	684	1893
Boats	138	19	130
Percent with effort	99.0	56.2	42.3
Effort (fish_days)	2051(2073)	389(691)	1076(2542)
Landings per day	2.72	1.76	1.76
1993			
Total	4890	1175	2387
Total with effort	4877	943	1179
Boats	125	20	135
Percent with effort	99.7	80.3	49.4
Effort (fish_days)	2377(2385)	635(789)	1377(2776)
Landings per day	2.05	1.49	0.86
1994			
Total	1893	1031	2287
Total with effort	1886	79	73
Boats	95	21	78
Percent with effort	99.6	7.7	3.2
Effort (fish_days)	1926(1932)	-	-
Landings per day	0.98	-	-
1995			
Total	313	123	505
Total with effort	313	116	494
Boats	64	11	49
Percent with effort	99.9	94.3	97.8
Effort (fish_days)	506(506)	202(216)	522(532)
Landings per day	0.62	0.57	0.95

Table 10. Population estimates derived from ADAPT.

a) Beginning of Year Population Numbers (000's)

	1	2	3	4	5	6	7	8	9
78.00	11292	2208	10307	3533	1071	247	280	60	0
79.00	9275	9243	1699	5223	1927	602	104	155	30
80.00	9085	7585	6834	1032	2686	1089	359	65	86
81.00	17151	7437	5321	4251	607	1378	582	196	36
82.00	6259	14025	5545	3060	2359	358	596	325	102
83.00	4508	5119	9070	3027	1230	979	124	182	126
84.00	13403	3654	3006	4367	1163	590	548	74	85
85.00	4505	10964	2749	1644	2368	496	224	243	33
86.00	21325	3677	6469	1160	781	1096	206	98	109
87.00	7195	17434	2717	3335	491	367	539	116	45
88.00	13578	5878	10977	1448	1745	273	192	292	62
89.00	3982	11108	4524	5712	609	660	95	66	111
90.00	5847	3259	8427	3116	3029	325	260	28	32
91.00	11189	4781	2058	4038	1688	1410	162	104	14
92.00	3941	9151	3350	984	1576	535	452	50	36
93.00	4340	3149	5374	1623	420	483	215	162	19
94.00	1919	3550	2205	2638	607	152	102	78	50
95.00	991	1568	2691	1313	1400	244	85	30	39
96.00	5996	811	1194	1877	970	1067	185	67	23

b) Beginning of Year Population Biomass (t)

78.00	5492	2125	18506	10323	4154	1237	1829	475	0
79.00	6434	9499	2851	16814	7935	3358	758	1352	273
80.00	5680	8641	13123	2897	13098	6221	2786	594	1049
81.00	11998	8314	9873	12341	2654	8800	4401	1785	326
82.00	3431	15596	11066	9201	10085	2086	4901	2992	1095
83.00	3373	5465	16558	8987	5186	5727	893	1786	1340
84.00	12162	4604	5745	12808	4770	3259	4136	664	916
85.00	3204	13397	5077	5074	10160	2832	1635	2321	376
86.00	15690	4253	12050	3205	3645	6629	1557	880	1196
87.00	3610	20449	5212	10675	2264	2415	4324	1096	497
88.00	7441	6175	20518	4286	8298	1697	1581	2760	658
89.00	2320	12523	8402	17039	2651	3968	702	640	1171
90.00	3472	3661	16814	8809	13012	1900	1956	262	379
91.00	10594	5559	4103	11717	6918	7569	1110	981	170
92.00	3868	11994	6707	3079	6321	2899	3006	427	422
93.00	2983	4229	10138	4470	1746	2507	1419	1323	216
94.00	1356	4027	4290	7843	2335	858	685	620	483
95.00	700	1821	5143	3932	6262	1366	753	268	392
96.00	4199	984	2286	5457	4034	5846	1367	559	238

c) Fishing Mortality

	1	2	3	4	5	6	7	8	**3+**
78.00	0.000	0.062	0.480	0.406	0.377	0.665	0.393	0.483	0.46
79.00	0.001	0.102	0.298	0.465	0.371	0.317	0.264	0.384	0.40
80.00	0.000	0.155	0.275	0.331	0.467	0.427	0.405	0.408	0.34
81.00	0.001	0.094	0.353	0.389	0.329	0.638	0.383	0.452	0.40
82.00	0.001	0.236	0.405	0.712	0.679	0.855	0.989	0.749	0.59
83.00	0.010	0.332	0.531	0.756	0.535	0.381	0.319	0.557	0.57
84.00	0.001	0.085	0.404	0.412	0.653	0.768	0.614	0.611	0.47
85.00	0.003	0.328	0.663	0.544	0.570	0.679	0.631	0.598	0.61
86.00	0.001	0.103	0.463	0.659	0.555	0.509	0.370	0.574	0.50
87.00	0.002	0.263	0.429	0.448	0.388	0.448	0.414	0.428	0.43
88.00	0.001	0.062	0.453	0.667	0.771	0.853	0.862	0.764	0.53
89.00	0.000	0.076	0.173	0.434	0.427	0.730	1.016	0.530	0.35
90.00	0.001	0.259	0.536	0.413	0.564	0.495	0.715	0.491	0.52
91.00	0.001	0.156	0.538	0.741	0.950	0.938	0.973	0.876	0.77
92.00	0.024	0.332	0.525	0.652	0.983	0.713	0.824	0.781	0.68
93.00	0.001	0.156	0.512	0.783	0.815	1.357	0.816	0.973	0.65
94.00	0.002	0.077	0.318	0.433	0.713	0.382	1.021	0.479	0.43
95.00	0.001	0.073	0.160	0.102	0.072	0.075	0.040	0.076	0.12

d) Summary of Population Parameters

Year	Age 1 Recruits	3+ Numbers	3+ Biomass	3+ % Exploitation Rate
78	11292	15498	36524	34
79	9275	9740	33341	30
80	9085	12151	39767	26
81	17151	12371	40180	30
82	6259	12345	41425	41
83	4508	14738	40477	40
84	13403	9833	32297	34
85	4505	7757	27474	42
86	21325	9919	29162	36
87	7195	7610	26482	32
88	13578	14989	39797	38
89	3982	11777	34573	27
90	5847	15217	43131	37
91	11189	9474	32567	49
92	3941	6983	22862	45
93	4340	8296	21819	44
94	1919	5832	17113	32
95	991	5802	18114	10
96	5996	5383	19786	--

Table 11. Parameter estimates derived from ADAPT.

		PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
Age	1	8.919E0	6.224E-1	6.979E-2	3.577E-3	4.011E-4
	2	6.782E0	3.936E-1	5.804E-2	3.448E-3	5.084E-4
	3	7.148E0	3.489E-1	4.881E-2	8.886E-4	1.243E-4
	4	7.593E0	3.382E-1	4.454E-2	-3.268E-3	-4.304E-4
	5	6.927E0	3.154E-1	4.553E-2	-1.286E-3	-1.856E-4
	6	7.034E0	3.645E-1	5.181E-2	-6.499E-3	-9.238E-4
	7	5.314E0	4.480E-1	8.431E-2	-1.119E-2	-2.106E-3
	8	4.287E0	4.392E-1	1.025E-1	-1.584E-2	-3.695E-3
Cdn	1	-1.004E1	2.682E-1	-2.672E-2	-4.997E-3	4.978E-4
	2	-7.730E0	2.613E-1	-3.380E-2	-4.653E-3	6.020E-4
	3	-6.923E0	2.593E-1	-3.745E-2	-4.052E-3	5.853E-4
	4	-6.823E0	2.590E-1	-3.796E-2	-3.270E-3	4.793E-4
	5	-6.503E0	2.594E-1	-3.990E-2	-2.770E-3	4.260E-4
	6	-6.376E0	2.625E-1	-4.117E-2	3.085E-4	-4.838E-5
	7	-6.049E0	2.639E-1	-4.362E-2	3.288E-3	-5.436E-4
	8	-5.734E0	2.623E-1	-4.574E-2	6.382E-3	-1.113E-3
USF	1	-1.023E1	2.236E-1	-2.186E-2	-2.157E-3	2.108E-4
	2	-9.013E0	2.021E-1	-2.242E-2	-2.844E-3	3.156E-4
	3	-8.762E0	1.956E-1	-2.233E-2	-2.347E-3	2.678E-4
	4	-8.407E0	1.955E-1	-2.326E-2	-1.894E-3	2.253E-4
	5	-8.851E0	2.069E-1	-2.337E-2	-8.887E-4	1.004E-4
USS	1	-1.006E1	2.138E-1	-2.126E-2	-2.814E-3	2.797E-4
	2	-8.472E0	2.066E-1	-2.438E-2	-2.809E-3	3.315E-4
	3	-7.925E0	2.000E-1	-2.523E-2	-2.428E-3	3.063E-4
	4	-7.761E0	1.999E-1	-2.576E-2	-2.181E-3	2.810E-4
	5	-7.417E0	2.062E-1	-2.780E-2	-1.868E-3	2.519E-4
	6	-7.357E0	2.073E-1	-2.818E-2	-1.833E-4	2.491E-5
	7	-7.005E0	2.007E-1	-2.865E-2	1.387E-3	-1.980E-4
	8	-6.861E0	2.113E-1	-3.080E-2	2.527E-3	-3.684E-4

Table 12.Summary of Catch Projection Results

Pop'n Number	1	2	3	4	5	6	7	8	9+	Total
96	5996	811	1194	1877	970	1067	185	67	23	12190
97	6500	4899	624	841	1304	650	715	124	45	15702
Pop'n Biomass										
97	4485	5639	1181	2490	5597	3730	5315	1114	480	30031
F in 1996	0.002	0.062	0.150	0.164	0.200	0.200	0.200	0.200	0.200	0.200
Catch Number	11	44	151	258	160	176	30	11		841
Catch Biomass	9	63	344	896	769	1099	244	103		3527

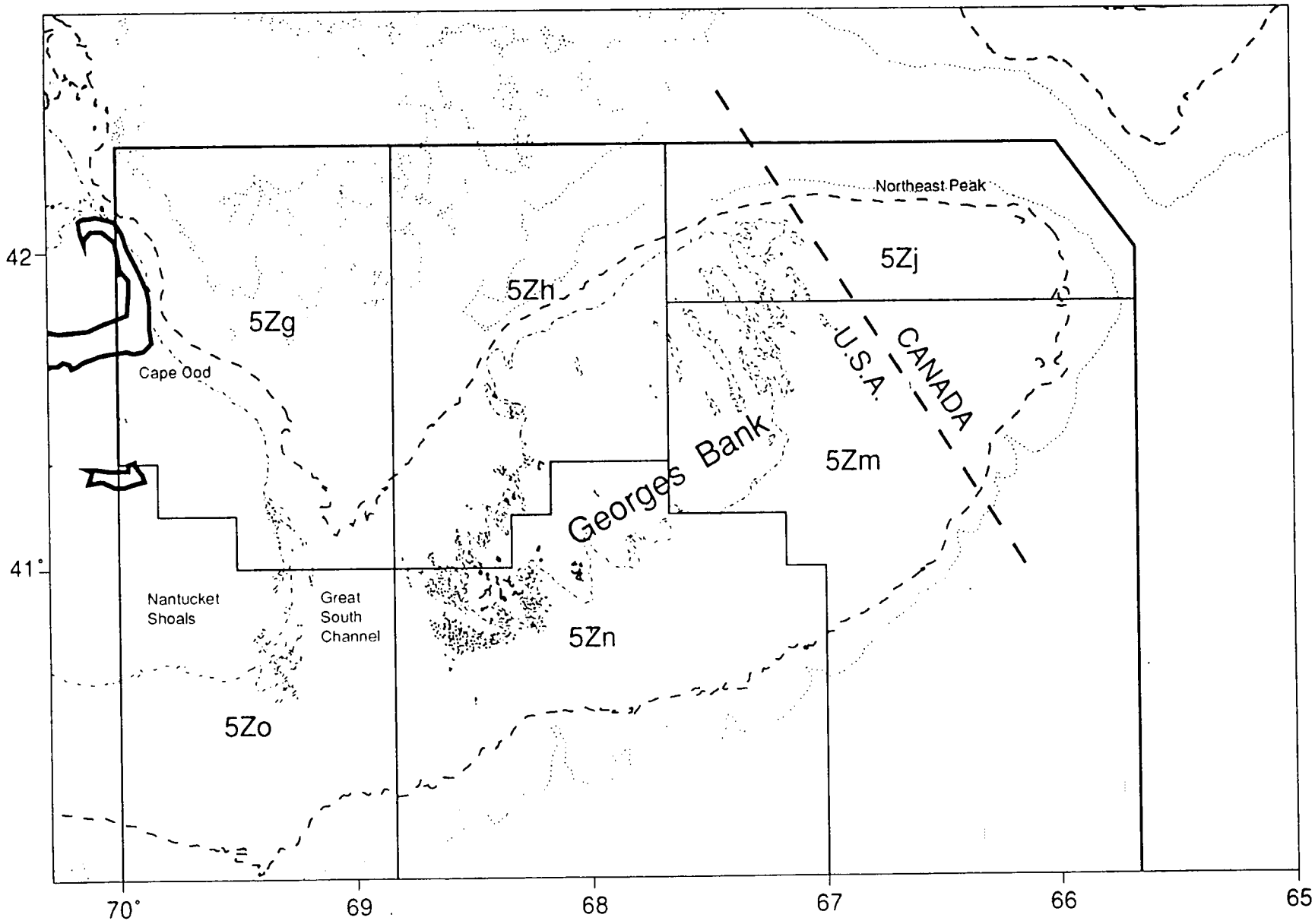


Figure 1. Canadian fisheries statistical unit areas in NAFO Division 5Ze.

Figure 2. Canadian landings of 5Zj,m cod by gear sector

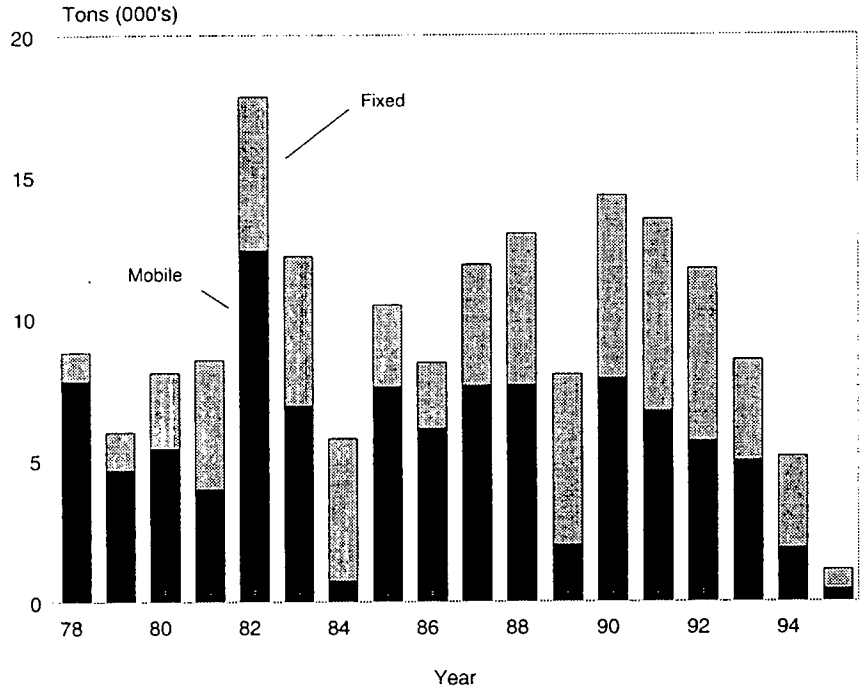


Figure 3. Landings of 5Zj,m cod by Canada and

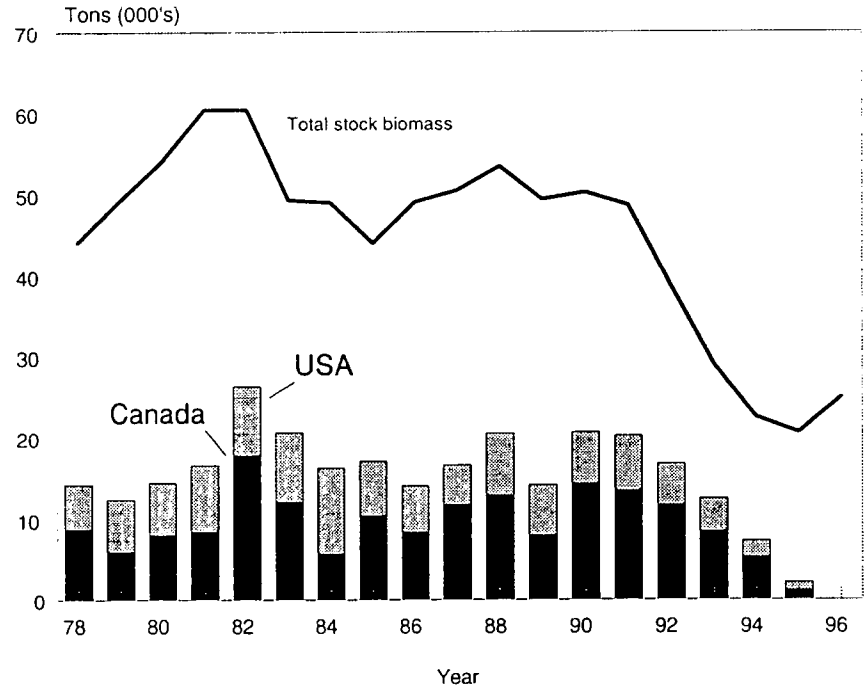


Fig 4. Comparison of 1995 OTB 5Z cod length frequencies for Observer and on-shore June-August samples

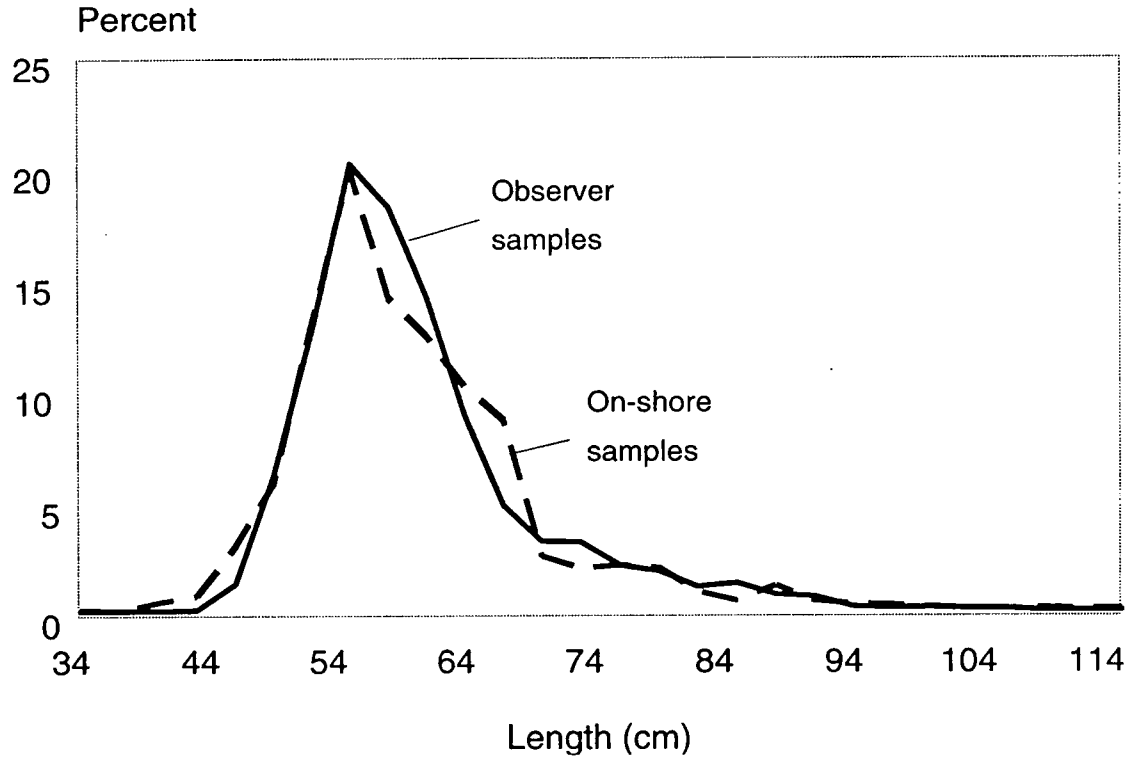


Figure 5. Proportional catch at age

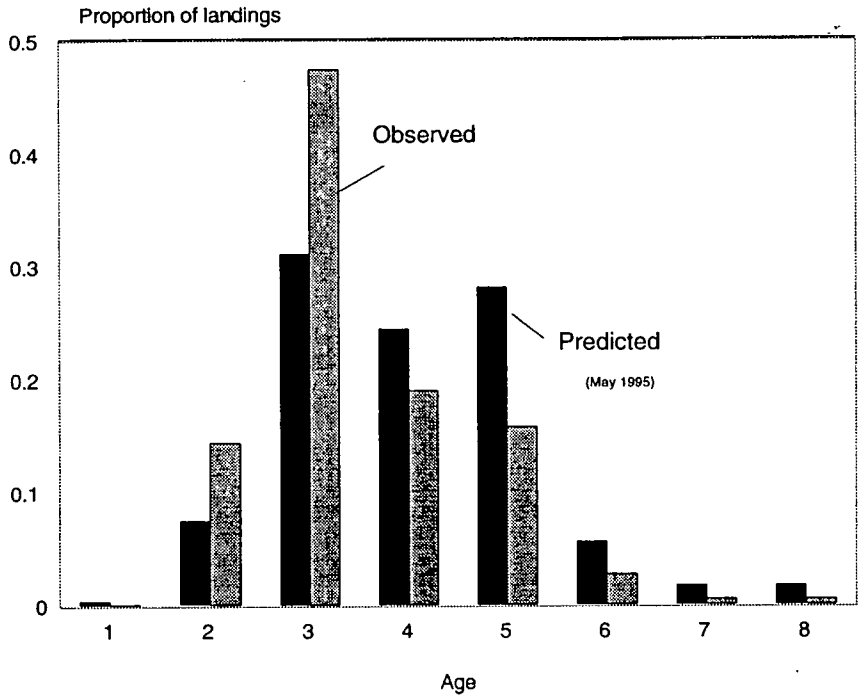


Figure 6. Total catch at length and agegroup for 1995 cod

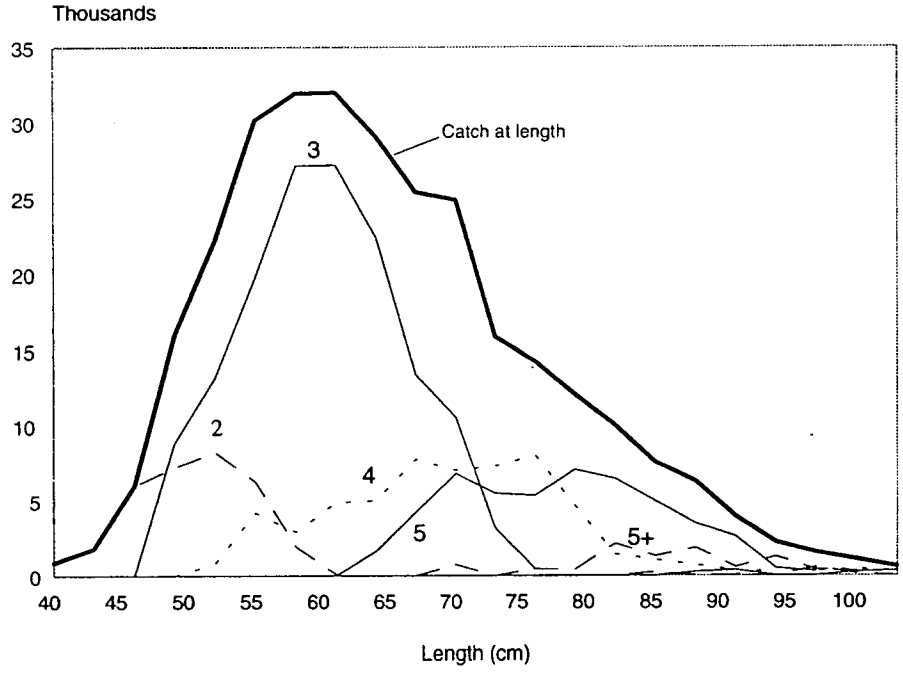


Figure 7. Commercial fishery mean weight at age 3

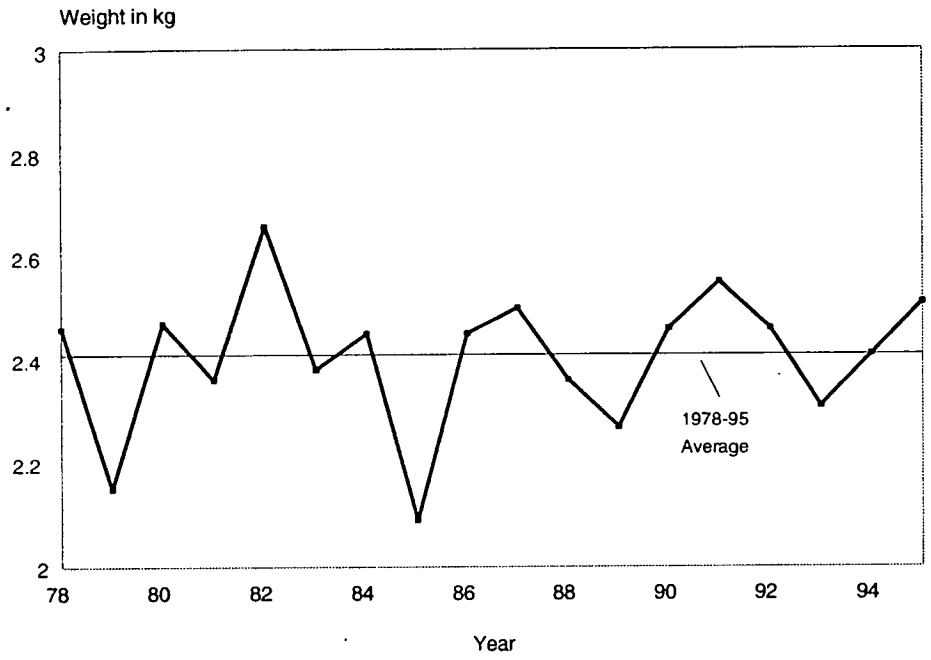


Figure 8. Estimated 3+population number for Canadian and USA survey indices adjusted by catchability

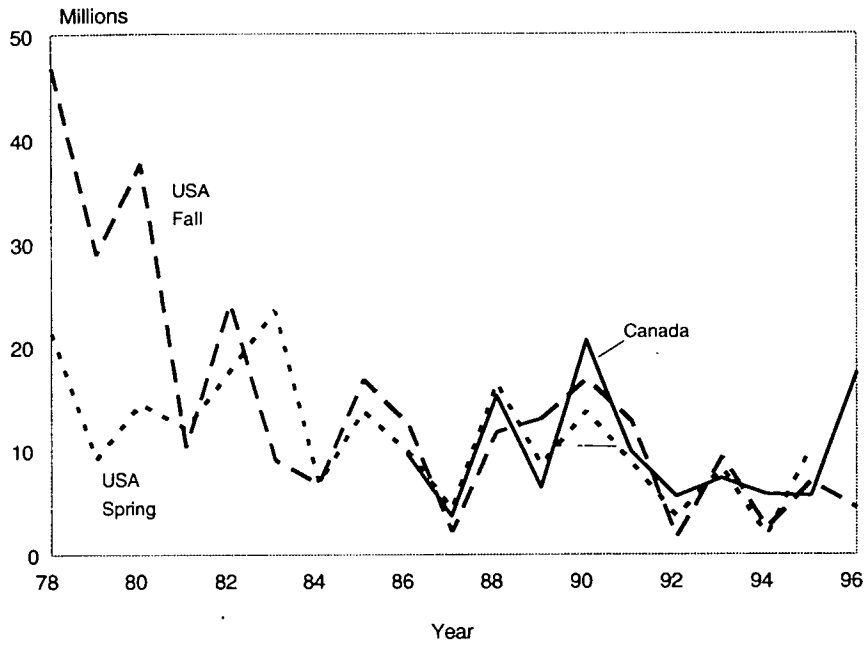


Figure 9. Estimated recruitment at age 1 for Canadian and USA survey indices adjusted by catchability

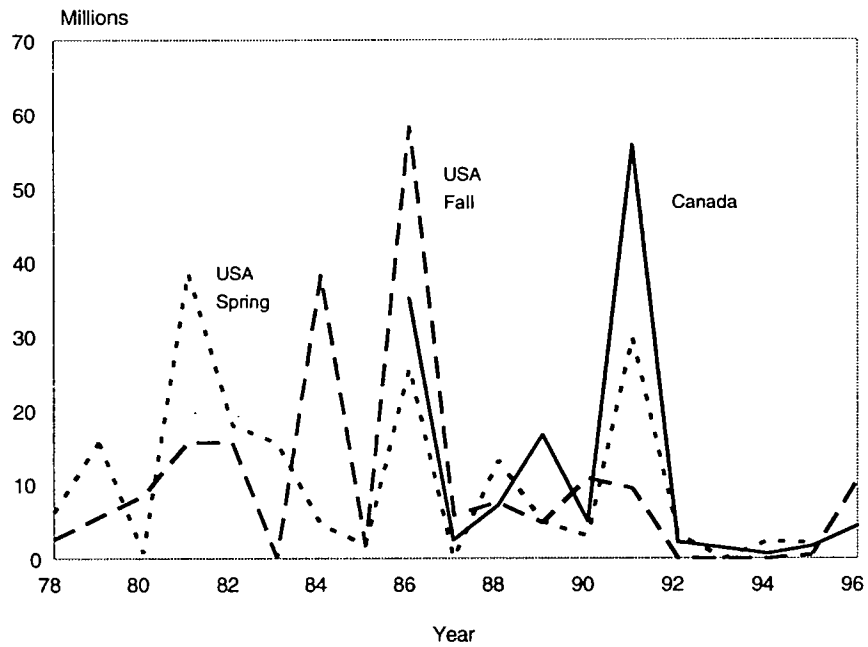
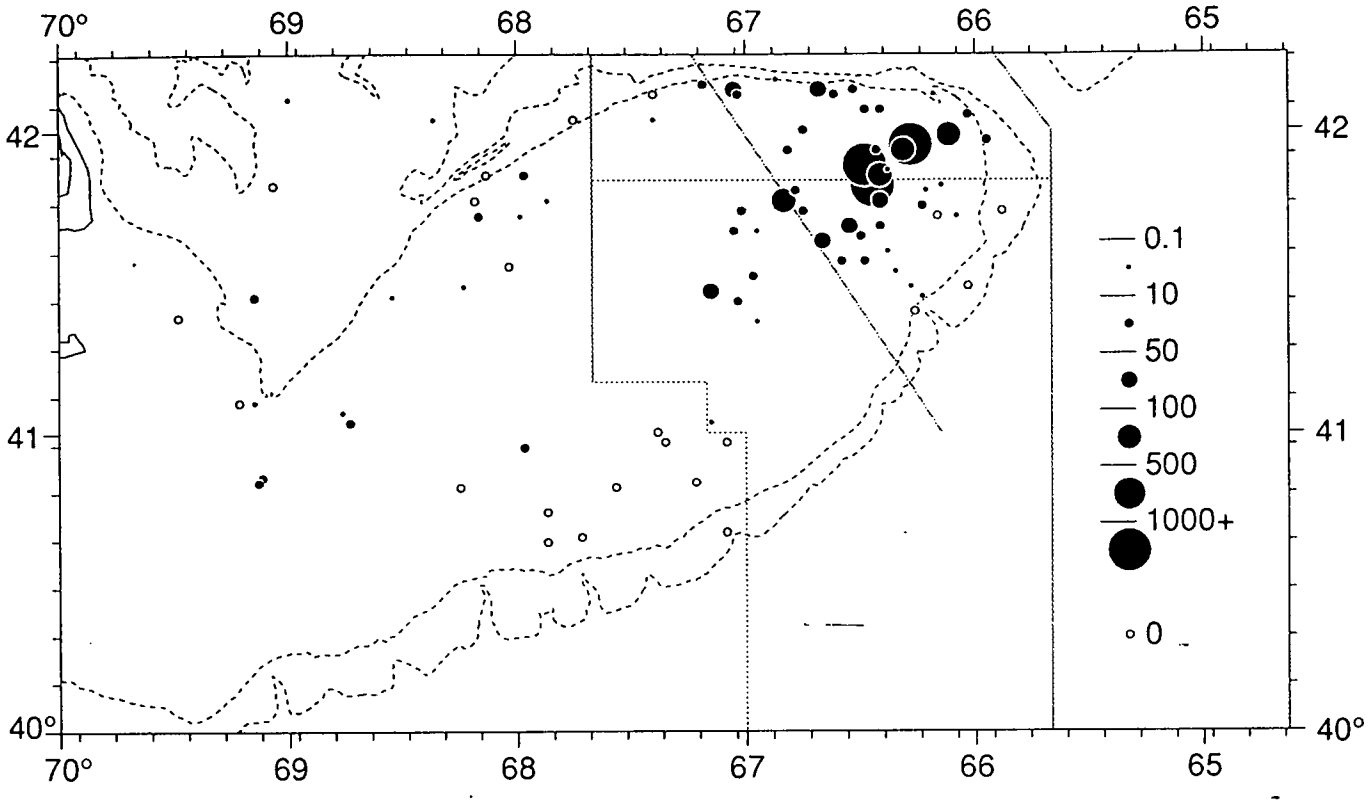


Figure 10. February 1996 Canadian survey: Cod weight per tow



February 1996 Canadian survey: Cod numbers per tow

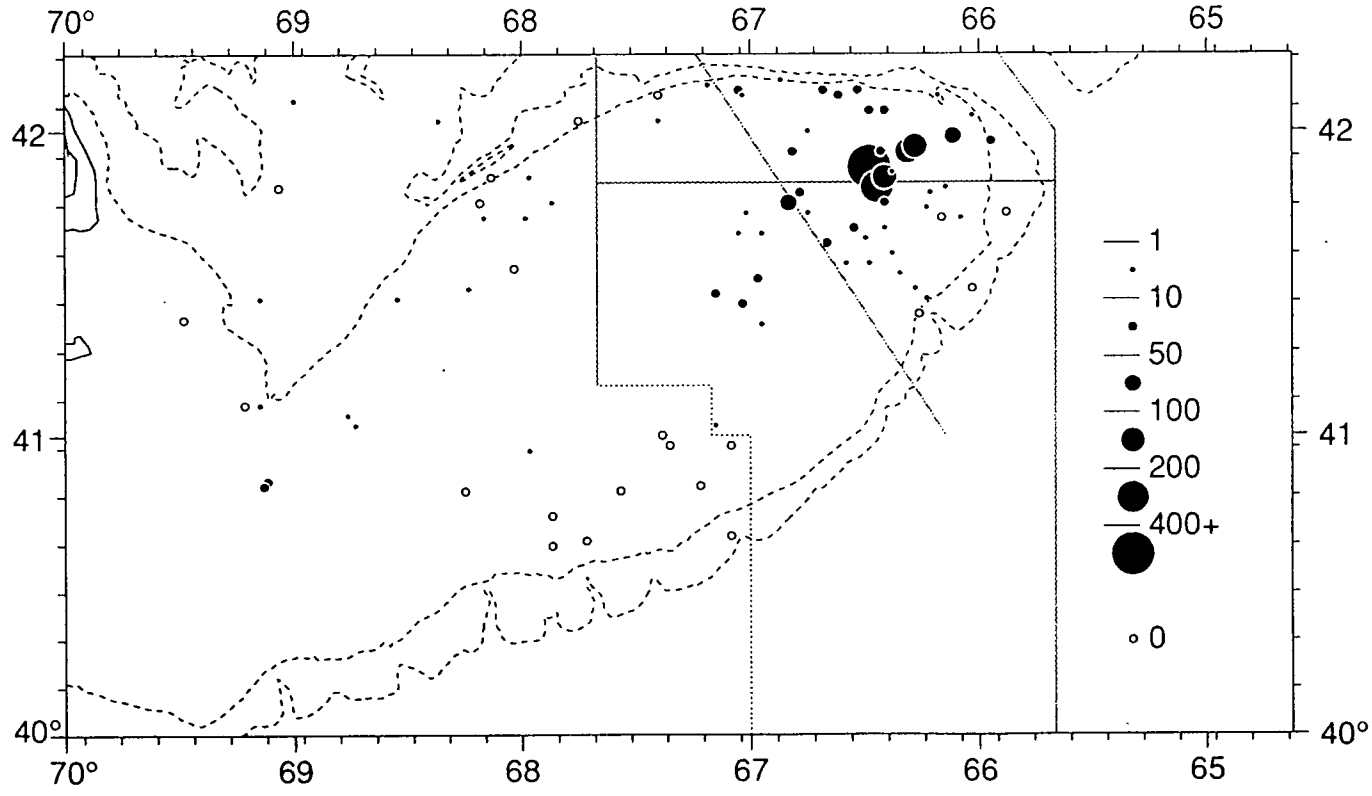
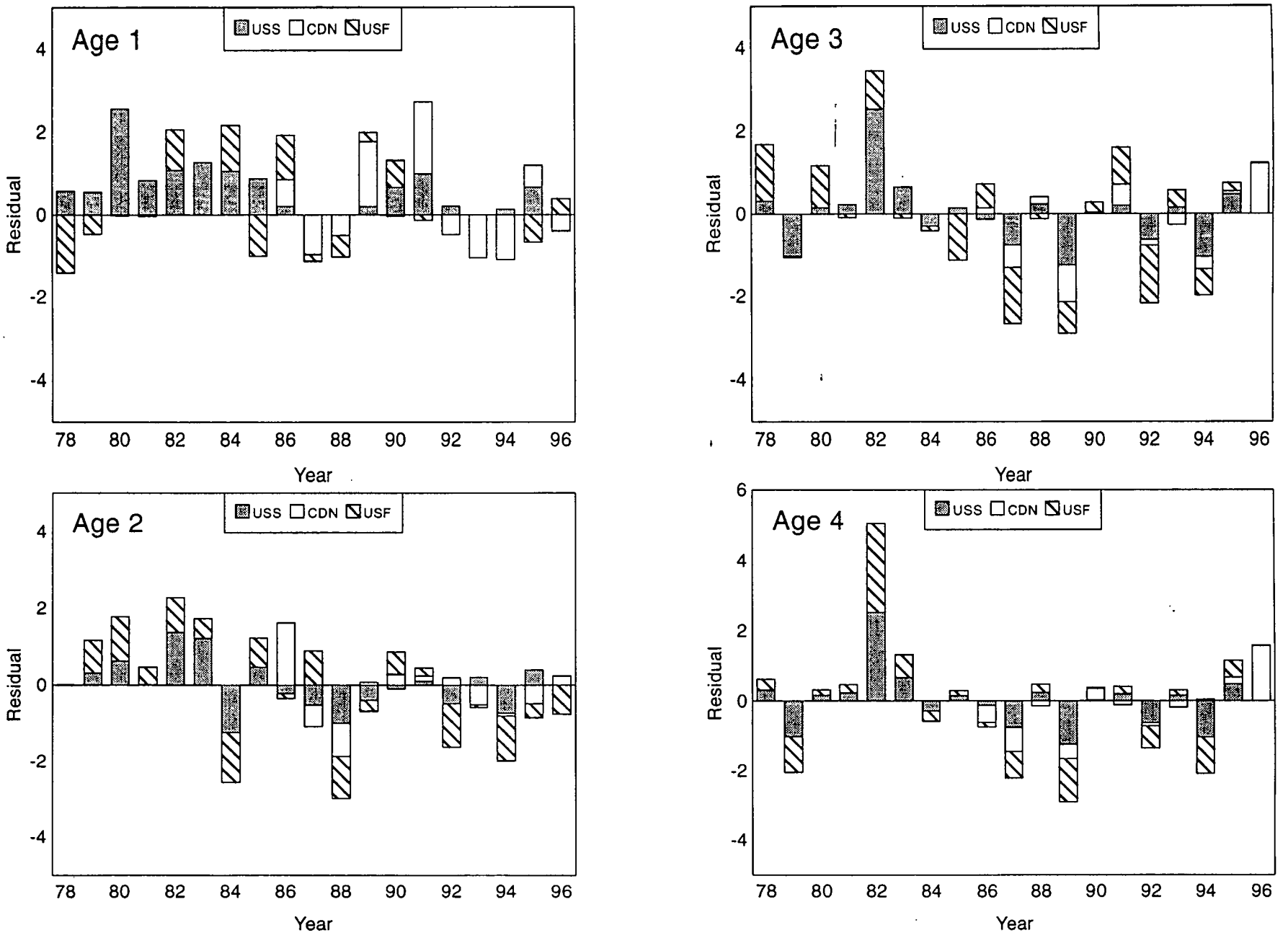


Figure 11 Residuals at ages 1-4 by year and index



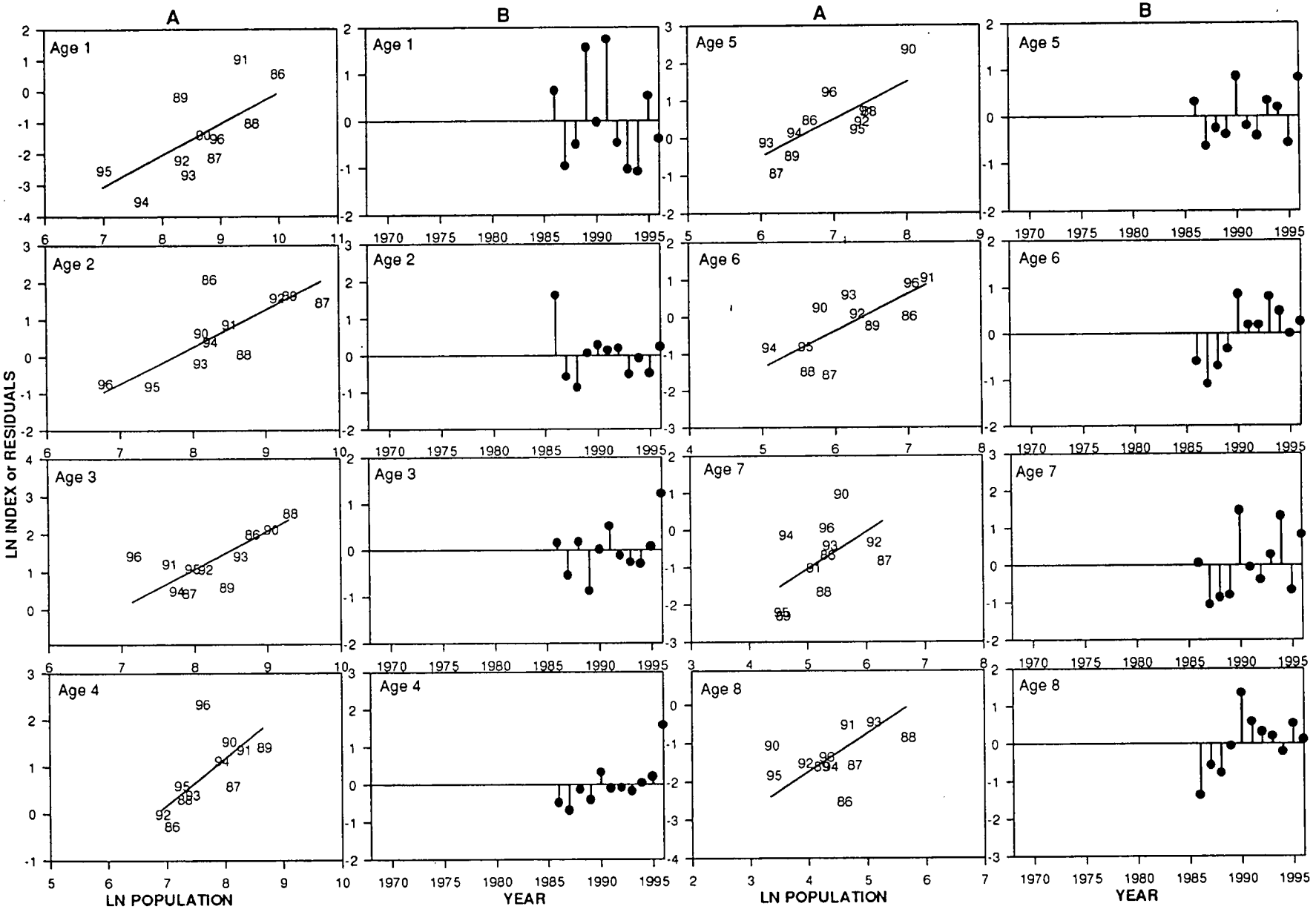


Figure 12. Age by age plots of A) the observed and predicted ln abundance index versus ln population numbers, and B) residuals plotted against year for the Canadian spring survey for cod in unit areas 5Zj and 5Zm.

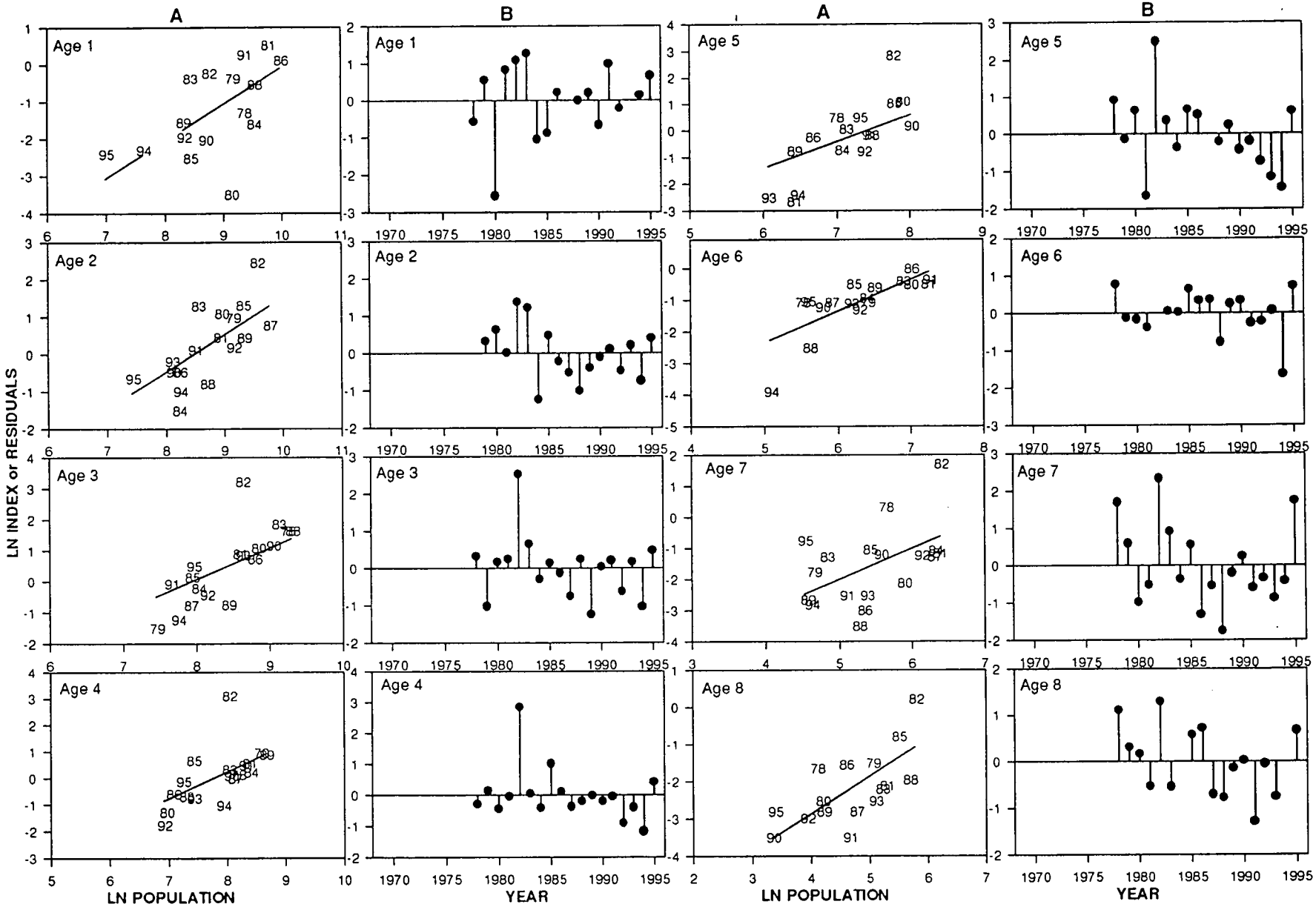


Figure 13. Age by age plots of A) the observed and predicted ln abundance index versus ln population numbers, and B) residuals plotted against year for the USA spring survey for cod in unit areas 5Zj and 5Zm.

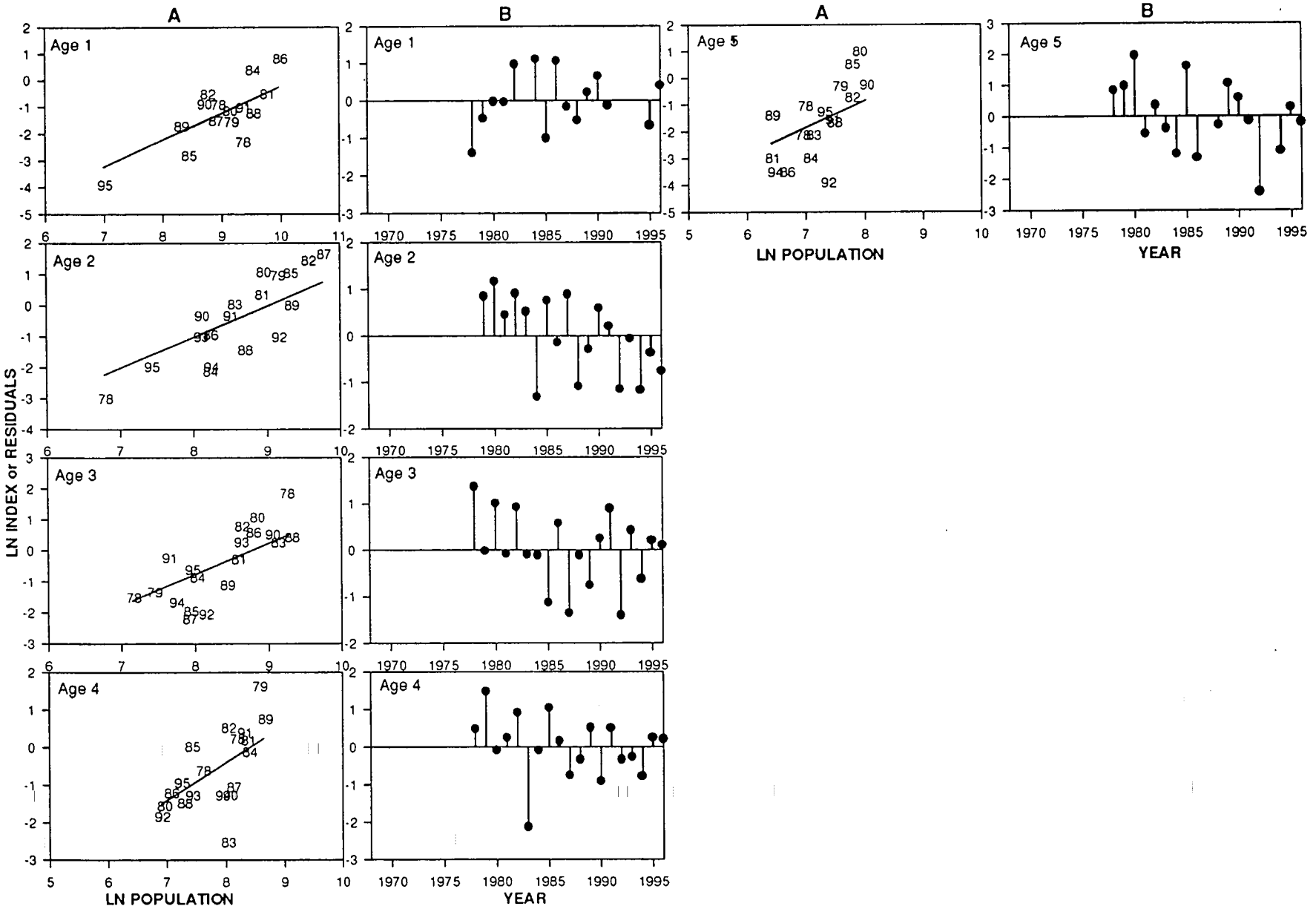


Figure 14. Age by age plots of A) the observed and predicted ln abundance index versus ln population numbers, and B) residuals plotted against year for the USA fall survey for cod in unit areas 5Zj and 5Zm.

Fig 15. Percent exploitation rate for cod in 5Zj,m

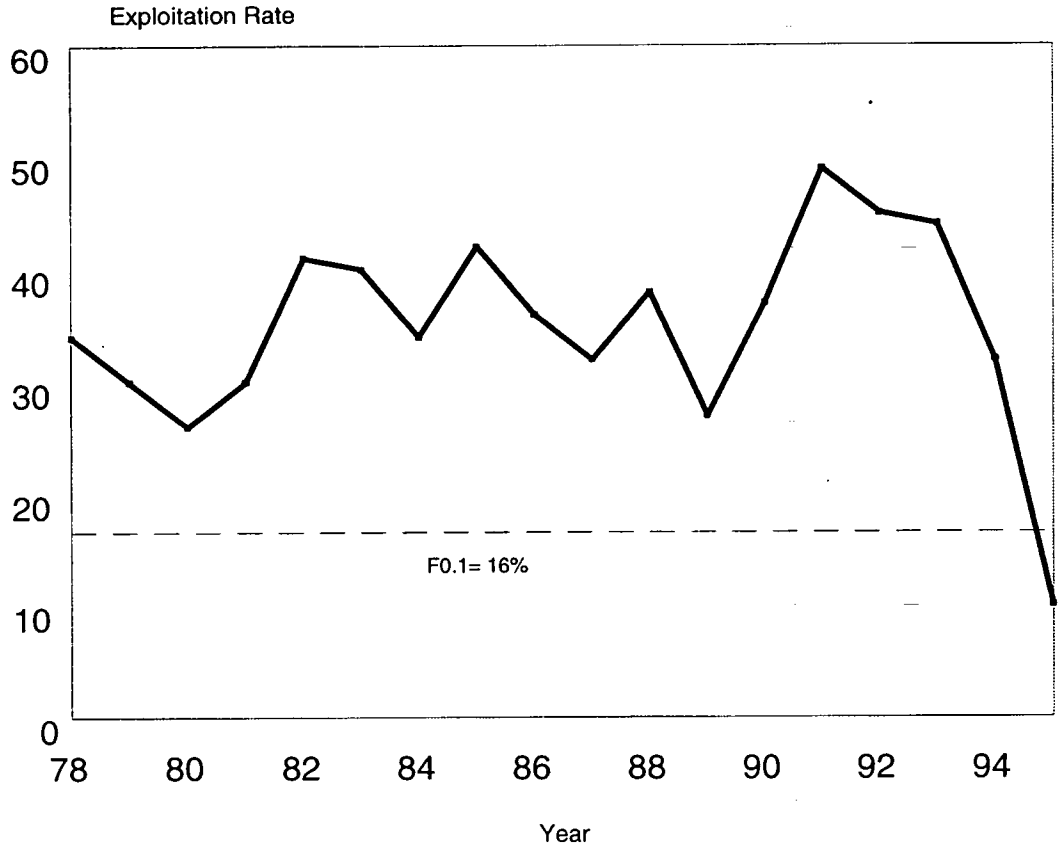


Figure 16. Recruitment at age one and associated adult biomass.

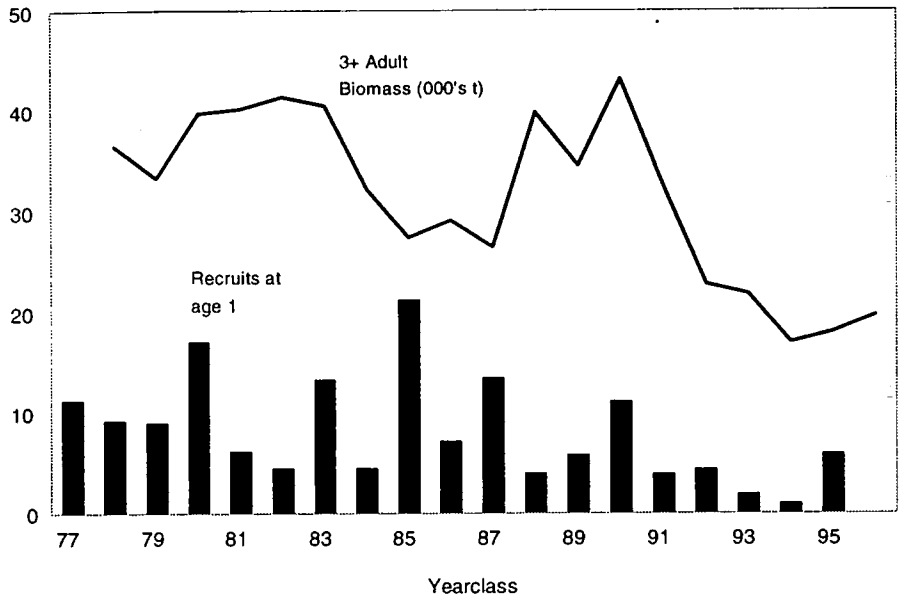


Figure 17. Projected 1996 yield and associated exploitation rates and net change in biomass between 1996 and 1997

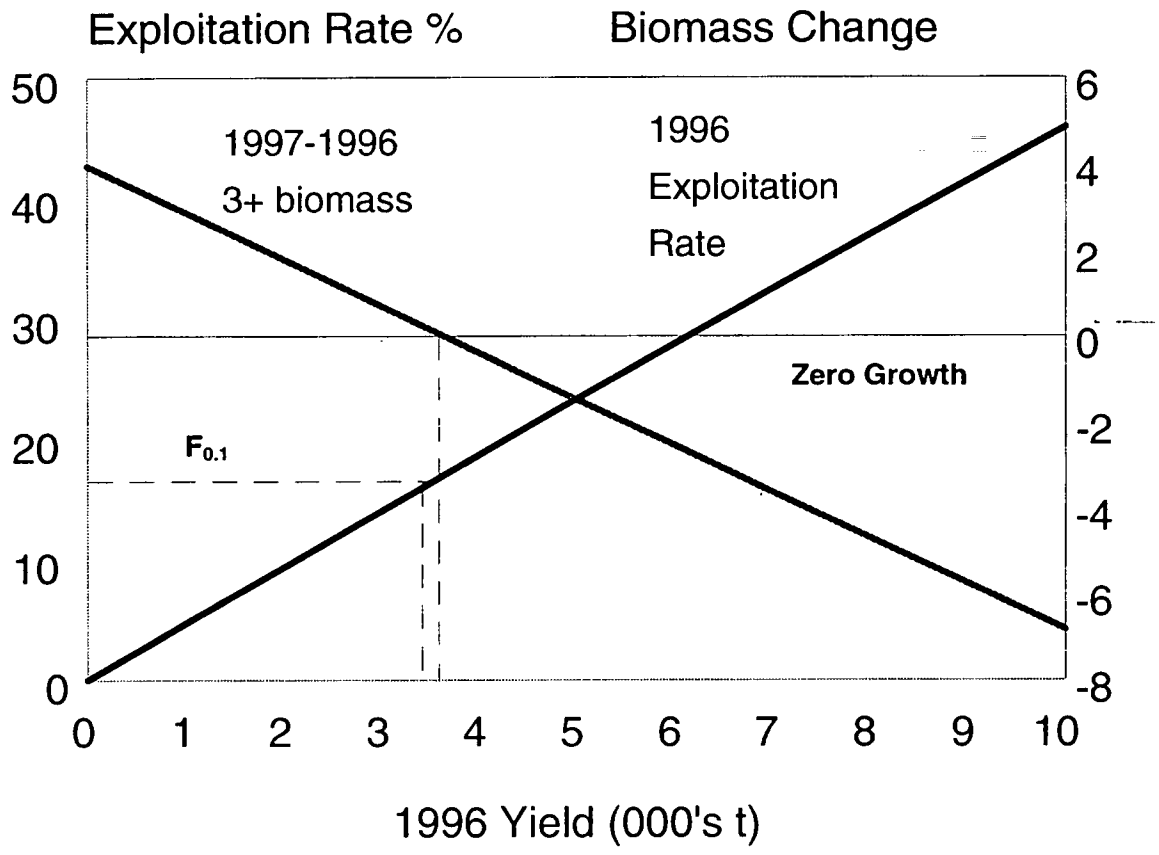
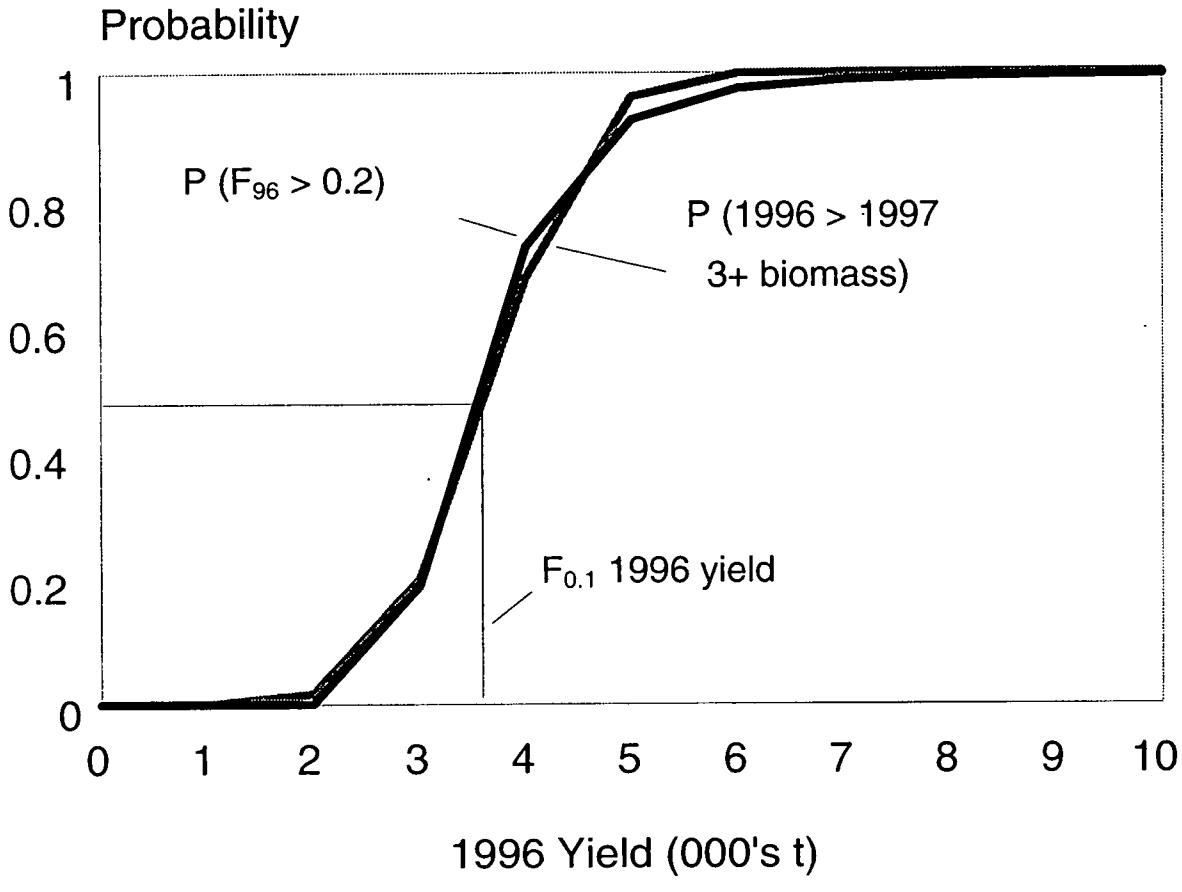


Figure 18. Comparison of probability that exploitation rate will exceed $F_{0.1}$ and that biomass will decline in 1997 from 1996 for a range of 1996 yields.



ADDENDUM

Figure 1. Comparison of exploitation rates derived from USA spring, USA fall and Canadian indices.

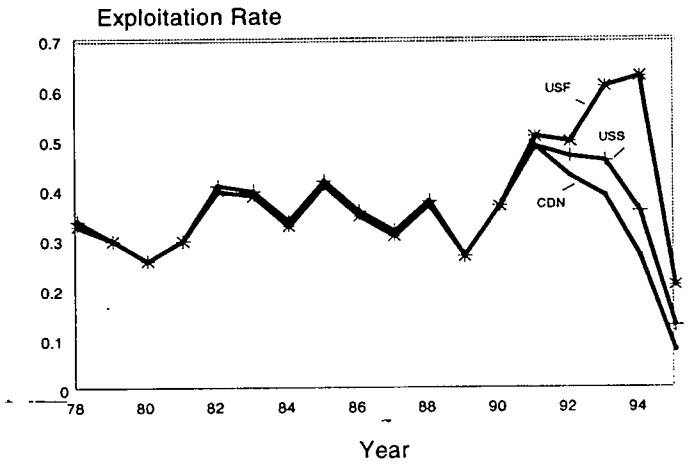


Figure 2. Comparison of population 3+ biomass USA spring, USA fall and Canadian spring indices

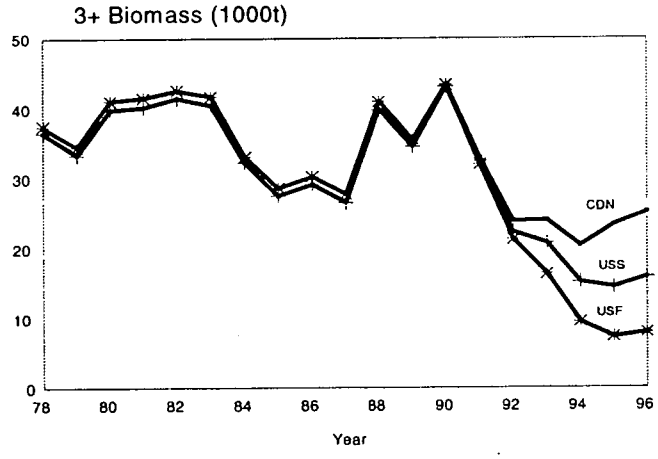


Figure 3. Comparison of slopes for RV indices

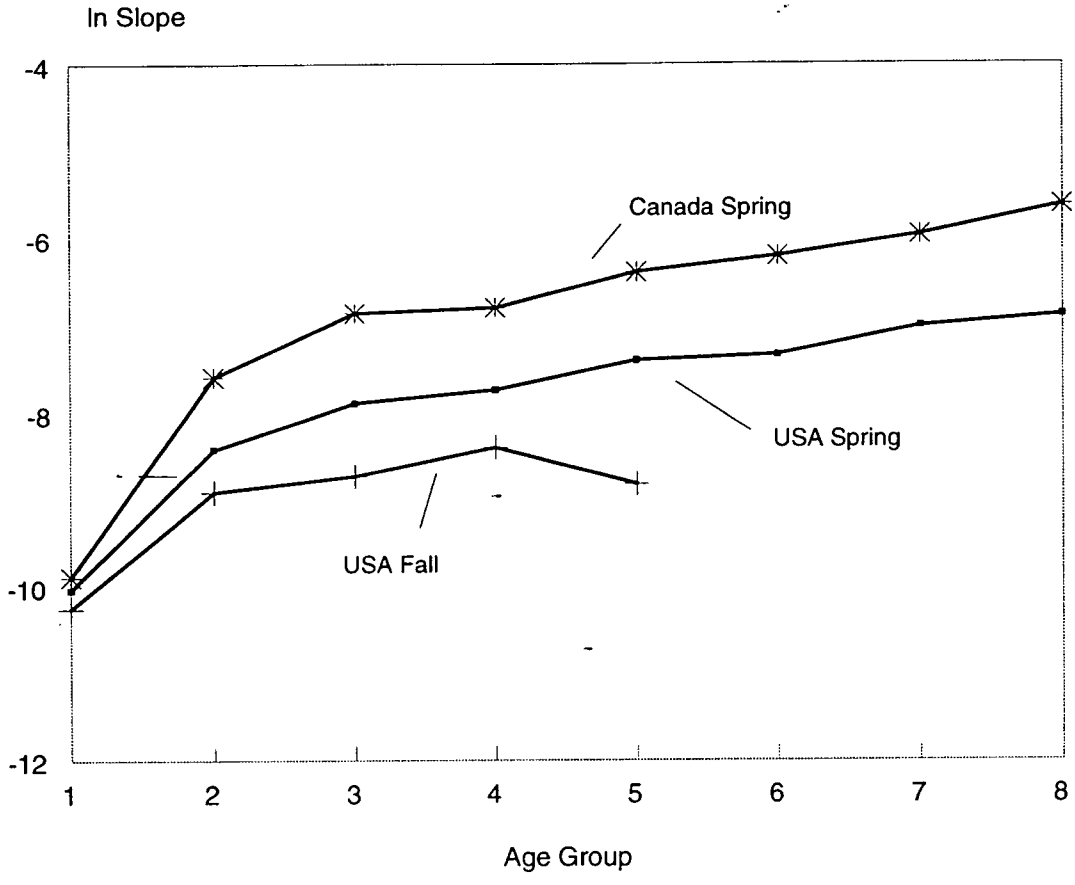


Figure 4. Spawning stock biomass for Georges Bank cod