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1999 Update of Stock Status of Georges Bank (5Zjmnh) Yellowtail Flounder

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Abstract

Combined Canada/USA landings of yellowtail flounder on Georges Bank have been increasing over the past four years, and population biomass has been increasing since 1995. Other measures of stock abundance, such as fishery catch rates and survey size composition, support the view that the resource is recovering. Results from surplus production analyses suggest that total population biomass at the beginning of 1999 is about ¾ of the level that can produce maximum sustainable yield. Exploitation rates have been low during the past three years. Recent recruitment is improved relative to the 1980s, and the 1997 year-class appears to be the strongest since 1980. With combined Canada/USA catches of 3100 t in 1999 (equivalent to total catches in 1998), there is a low risk of exceeding $F_{0.1}$, and a high probability that the population biomass will continue to increase. A major source of uncertainty in the assessment is the size of the 1997 year-class. That year-class is expected to make up about 42% of the population biomass at the beginning of 2000, and comprise about 13% of the fishery catch in 1999.

Résumé

Les débarquements canado-américains combinés de limande à queue jaune du banc Georges sont en hausse depuis quatre ans, et la biomasse de la population augmente depuis 1995. D'autres mesures de l'abondance du stock, comme les taux de capture de la pêche commerciale et la composition par taille dans les relevés, viennent confirmer que la ressource est en voie de rétablissement. Les résultats des analyses de la production excédentaire permettent de penser que la biomasse totale de la population se trouve, au début de 1999, à environ ¾ du niveau qui doit permettre d'atteindre un rendement maximal soutenu. Les taux d'exploitation sont faibles depuis trois ans. Le recrutement s'est amélioré par rapport aux années 80, et la classe de 1997 semble la plus forte depuis 1980. Avec des prises combinées canado-américaines de 3 100 t en 1999 (volume équivalent au total des prises de 1998), il existe un risque faible de dépasser $F_{0,1}$, et une forte probabilité de voir la biomasse de la population continuer à augmenter. La source principale d'incertitude est l'évaluation de la taille de la classe 1997 ; on prévoit que cette classe d'âge devrait représenter environ 42 % de la biomasse de la population au début de l'an 2000, et constituer environ 13 % des prises commerciales en 1999.

Introduction

Georges Bank yellowtail flounder are a transboundary resource. This paper updates the last major stock assessment of yellowtail flounder on Georges Bank which was completed jointly by Canada and the USA (Neilson and Cadrin,1998). Similar methods are used in the current assessment, with updated catch information and indices of abundance from both countries.

Yellowtail flounder (*Limanda ferruginea*) range from Labrador to Chesapeake Bay and are typically caught at depths between 37 and 73 m, and a major concentration occurs on Georges Bank from the NE peak to the east of the Great South Channel. Yellowtail flounder appear to be relatively sedentary, although seasonal movements have been reported (Royce et al. 1959). Spawning occurs during spring and summer, peaking in May. Larvae are pelagic for a month or more, then develop demersal form and settle to benthic habitats. Growth is sexually dimorphic, with females growing at a faster rate than males (Moseley 1986). Based on tagging investigations (Royce *et al.* 1959; Lux 1963), the management unit is considered to include Georges Bank encompassing statistical areas 5Zj, 5Zm, 5Zn and 5Zh (Fig. 1). Thus, the management unit is transboundary in nature. Both the USA and Canada employ the same convention for the management unit.

The Fisheries

Landings of Georges Bank yellowtail flounder from 1935 to the present are shown in Fig.2 (top panel). Landings, which have been predominantly taken by the U.S. fleet, gradually increased to 7,300 mt in 1949, decreased in the early 1950s to 1,600 mt in 1956, and increased again in the late 1950s. Annual catches including discards are available since 1963 (see Fig. 2, bottom panel), and have averaged 16,300 mt during 1962-1976, with some taken by distant water fleets. No foreign catches of yellowtail have occurred since 1975. In every year since 1985, catches have been 5,000 mt or less.

USA

The principle fishing gear used in the USA fishery to catch yellowtail flounder is the otter trawl, but scallop dredges and sink gillnets contribute some landings. In recent years, otter trawls caught greater than 95% of total landings from the Georges Bank stock, dredges caught 2-5% of annual totals, and gillnet landings were less than 0.1%. Current levels of recreational and foreign fishing are negligible. Discarding of small yellowtail is an important source of mortality due to intense fishing pressure, discrepancies between minimum size limits and gear selectivity, and recently imposed trip limits for the scallop dredge fishery. U.S. trawlers that land yellowtail flounder generally target multiple species on the 'Southwest Part' of the Bank, and on the northern edge just east of the closed area adjacent to the international boundary. Methods of estimating U.S. discards described in NEFSC (1997) indicate that 1998 discards were approximately 114 mt.

Canada

The Canadian fishery for yellowtail flounder is directed and began in 1993. Prior to 1993, Canadian landings were small, typically less than 100 t (Table 1, Fig. 2). Peak landings of 1,328 t of yellowtail occurred in 1994, when the fishery was unrestricted. After a TAC of 400 t was established, yellowtail landings dropped to 397 t in 1995. In 1998, landings of yellowtail flounder were 1,175 t against a quota of 1,200 t (Table 1).

The majority of Canadian landings of yellowtail flounder are made by otter trawl, from vessels less than 65 ft, Tonnage Classes (TC) 2 and 3. The fishery takes place from June to December, with peak months for fishing activity occurring from July to October in 1998.

The Canadian yellowtail directed fishing activity was concentrated in the southern half of the Canadian fishing zone, in the portion of 5Zm referred to as the "Yellowtail Hole" The distribution of fishing activity over the past four years is shown on Fig. 3. The fishery distribution in 1998 was comparable to that observed in the previous three years.

Flatfish landed as "unspecified" in the Canadian fishery have been significant in previous years, and generally consist of yellowtail on Georges Bank. The unspecified flounder problem has become less significant recently, due to improved monitoring of the landings. In 1998, only 16 t of unspecified flounder were landed from 5Zm, and all were assumed to be yellowtail flounder. Total unspecified flounder from 5Zjm were 32 t.

In previous years, there have been some landings of yellowtail flounder in the Canadian scallop fishery on Georges Bank. Management measures established in 1996 prohibit the landing of yellowtail flounder by this fleet, and no records of discarded quantities are available for 1997. This represents a source of mortality for this resource that is of unknown magnitude, and efforts are required to quantify discarded catches. In 1996, at-sea observer records estimated the amount of discarded yellowtail flounder as 11 t.

Age and Length Composition

Sampling information for 1998 is summarized in Table 2. In general, sampling of the fishery by both countries continues to be inadequate. For the United States, no sampling information is available to characterize the fishery during the fourth quarter of 1998. Canada has more length measurements available through that period, but no age determinations have been made (Canada collects age determination material, but the age determination program is not yet operational). The low number of age determinations available has once again hampered the development of reliable age length keys, to an even greater extent. Only 293 age determinations were available, compared with 579 in the previous assessment.

However, the suspected problem in species misidentification in the Canadian sea samples in 1997 did not recur in 1998. Thus, that source of information was used to characterize the size composition of the Canadian fishery, along with length samples from the DFO port sampling program. The comparability of the length-frequency information from the two sources supports the view that culling on the basis of length was not a major concern in the 1998 fishery (Fig. 4).

The combined catch at age and weight at age information for both countries is shown in Tables 3 and 4, respectively. Ages 3 and 4 dominate in both the Canadian and USA fisheries (Fig. 5), and there is limited indication of year-class tracking (Fig. 6). There has been no recent trend in the weight at age data (Fig. 7).

The USA fishery caught smaller fish in 1998 than those landed in the Canadian fishery (Fig. 8). The length-frequency distributions of the USA catch exhibited a steeply ascending left-hand limb compared with the Canadian distributions, that may reflect size-related discarding or differential distribution by size within the management unit. The Canadian fishery is also typified by an increasing average size of the landings from 1994 to 1998 (Fig. 9).

Abundance Indices

Commercial Fishery Catch Rates

Catch (t) and effort (h) for less than 65 ft Canadian otter trawlers fishing for yellowtail flounder in 1993-98 were summarized on a trip basis. Initial examination of the trip records showed a large proportion of trips with very small amounts of yellowtail in the total catch. These trips were not considered to be representative of yellowtail directed effort, and therefore only trips with reported landings from 5Zm of more than 500 kg (1100 lb.) were included in the CPUE estimates. As well, only vessels with reported landings in two or more years in 1993-97 were included in the analysis.

Yellowtail landings and effort for trips were aggregated by month and year, and monthly catch rates (t/h) are shown in Fig. 10. The catch rate decreased between 1993 and 1994 but increased by a factor of over two between 1994 and 1995 and increased further in 1996 and 1997. The catch rate declined somewhat from 1997 to 1998.

Substantial gear changes occurred in the fishery between 1993 and 1994 with the introduction of 'flounder gear' which uses a small diameter footgear. However, fishing practices have been relatively constant since then. Fishermen have indicated that while the increasing trend of catch rates from 1994 to 1997 reflect increased abundance, they also acknowledged that there was a learning factor associated with this relatively young fishery. While catch rates may prove to be useful as an index of abundance for this resource, the time series is too short to be included directly in the assessment at present.

Research Vessel Surveys

Bottom trawl surveys are conducted annually on Georges Bank by the Canadian Department of Fisheries and Oceans (DFO) in February and by the USA NMFS in March and October - November. Both agencies use a stratified random design, though different strata boundaries are defined (Fig. 11). USA spring and autumn bottom trawl survey catches (strata 13-21), USA scallop survey catches, and Canadian bottom trawl survey catches (strata 5Z1-5Z4, Fig. 11) were used to estimate relative stock biomass and relative abundance at age for Georges Bank yellowtail. Standardization coefficients, which compensate for survey door, vessel, and net changes in USA groundfish surveys (1.22 for old doors, 0.85 for the Delaware II, and 1.76 for the 'Yankee 41' net; Rago et al. 1994) were applied to the catch of each tow.

The DFO spring survey series has followed an increasing trend since 1995 and the 1999 value is the highest in the series. The NMFS spring series is longer, and tracks the DFO series well during the years of overlap (Tables 5 and 6, Fig. 12). The NMFS fall series also increases in 1995, but the recent values are still low compared with the early years of this survey, which is the longest running series of the three groundfish surveys (Table 7, Fig. 13). The NMFS scallop survey is used as an index of abundance for age 1. The index has been following an increasing trend since 1990. The most recent value is the second highest in the series (Table 8, Fig. 14).

For all three groundfish surveys, the distribution of catches in the most recent survey is comparable with those distributions observed in the previous five years, on the average (see Figs. 15, 16 and 17 for the DFO spring, NMFS spring and fall surveys, respectively).

The length composition of the catch of yellowtail flounder taken in the DFO surveys has shown a trend of increasing size from 1995 to 1998 (Fig. 18). This is consistent with the increase in average length of the catch of yellowtail flounder.

Age-structured indices from the survey do not always track cohort well (Fig. 19). Also, there are some indications of year-effects in the series, as indicated in the DFO spring surveys.

Estimation of Stock Parameters

Calibration of VPA

The Virtual Population Analysis (VPA) used annual catch at age, $C_{a,t}$, for ages a = 1 to 5+, and time t = 1973 to 1998, where t represents the beginning of the time interval during which the catch was taken. The VPA was calibrated to bottom trawl and scallop survey abundance indices, $I_{s,a,t}$, for

s = DFO spring, ages a = 1 to 5+, time t = 1987 to 1999

s = NMFS spring (Yankee 36), ages a = 1 to 5+, time t = 1982 to 1998

s = NMFS spring (Yankee 41), ages a = 1 to 5+, time t = 1973 to 1981

s = NMFS fall, ages a = 1 to 5+, time t = 1973.5 to1998.5
s = NMFS scallop, age a = 1, time t = 1982 to 1998

The NMFS spring age-length key is used with the DFO spring survey to derive survey abundance at age. As a corresponding age-length key for the DFO spring 1999 survey was not available, an iterative technique using the NMFS spring 1998 length at age information was applied (Kimura and Chikuni 1987). The NMFS scallop survey captures young fish and information for age 1 is used, but older yellowtail appear less available to this survey. Zero observations for abundance indices were treated as missing data as the logarithm of zero is not defined. Data were aggregated for ages 5 and older to mitigate against frequent zero observations. The fishing mortality rate for the 5 plus group was calculated according to the "alpha" method (Restrepo and Legault 1994).

The adaptive framework, ADAPT, (Gavaris 1988) was used to calibrate the sequential population analysis with the research survey abundance trend results. The model formulation employed assumed that the random error in the catch at age was negligible. The errors in the abundance indices were assumed independent and identically distributed after taking natural logarithms of the values. The annual natural mortality rate, M, was assumed constant and equal to 0.2. The fishing mortality rates for age groups 4 and 5+ were assumed equal. These model assumptions and methods were similar to those applied in the last assessment (Neilson and Cadrin 1998). Both analytical and bootstrap statistics of the estimated parameters were derived. For consistency with the risk analysis, bias adjusted VPA results were based on bootstrap statistics.

The population abundance estimates show large relative error and substantial bias at age 2 while the relative error for other ages is about 35% or less and the bias is small (Table 9). The average magnitude of residuals is large and though several large residuals can be identified, the respective observations do not appear influential and should not impact parameter estimates of current abundance (Figs. 20-25).

Surplus Production Analyses

As was done last year, and recognizing the uncertainties in the age-structured information, an assessment method that does not rely upon age-structured data was also used. The ASPIC non-equilibrium surplus production methodology requires total catch and one or more indices of abundance. The indices used were DFO spring survey (1987 to 1999, lagged one year to reflect end of previous year biomass), USA spring (1968 to 1998), and USA fall (1963 to 1998). As with the VPA, the spring survey was further subdivided into two series reflecting periods when the Yankee-36 trawl (1968-1972; 1982-1997) and the Yankee-41 trawl (1973-1981) were used. Yield input includes estimates of USA discards. Following the advice of Prager (1995), the first five years of output from ASPIC are not presented, since the starting biomass in the first year is poorly estimated.

Stock Status

Virtual Population Analysis

The results from the standard lognormal model formulation were considered appropriate on which to base the status of the stock. For each cohort, the terminal population abundance estimates from ADAPT were adjusted for bias and used to construct the history of stock status (Tables 10-11). In the absence of an unbiased point estimator with optimal statistical properties, this approach was considered preferable to using the biased point estimates. The fishery weights at age, assumed to represent mid-year weights, were used to derive beginning of year weights at age, (Table 12) and these were used to calculate beginning of year population biomass (Table 13). A value of 0.1 kg was assumed for population weight at age 1 in all years.

Population biomass (ages 1-5+) declined from about 37,000 t in 1973 to a historic low of about 7,000 t in 1991 and has subsequently increased steadily to almost 28,000 t at the beginning of 1999 (Fig. 26). The increasing trend is due principally to improved recruitment in the 1990s, but was also enhanced by increased survivorship of young yellowtail from reduced exploitation. Biomass for ages 3+ (considered to reflect mature biomass) shows a similar trend and was estimated at 17,287 t at the beginning of 1999. The strength of the 1996 year-class was estimated to be almost 30 million at age 1, the largest since the 1980 year-class (Fig. 27). Preliminary indications for the 1997 year-class indicate that it may be strong at up to almost 60 million recruits. Exploitation rate for ages 3+ has been below 20%, equivalent to $F_{0.1} = 0.25$, since 1996 (Fig. 28). Since 1973, exploitation rate has substantially exceeded $F_{0.1}$ averaging about 50%. Reduced fishing mortality in recent years has resulted in increased survival of incoming year-classes.

Gains in fishable biomass may be partitioned into those associated with somatic growth of yellowtail which have previously recruited to the fishery and those associated with new recruitment to the fishery (Rivard 1980). We used age 2 as a convenient age of first recruitment to the fishery. On average, growth contributes about 60% of total production with little variation in the proportion since 1973 (Fig. 29). Surplus production is defined as the gains in fishable biomass which are in excess of the needs to offset losses from natural mortality. When the fishery yield is less than the surplus production, there is a net increase in the population biomass. Since 1995, there has been considerable production in excess of fishery removals (Fig. 29).

Surplus Production Analyses

Results of the surplus production analyses are provided in Appendix A. ASPIC results indicate that a maximum sustainable yield of 13,240 t can be produced when the stock biomass is 44,360 t. The population biomass in 1999 continues to increase, and is

now estimated to be 36,210 t. Trends in biomass indicated from the surplus production analyses are very similar to those obtained from the VPA, but depart in 1998 with the VPA showing a less rapid increase (Fig. 26). The exploitation rate on total biomass in 1998 (.098) increased slightly from 1997 (.080), but is still low. Trends in exploitation rate are again qualitatively similar to those obtained from the VPA (Fig. 28).

Fishery Reference Points

Yield per Recruit

The yield per recruit analysis was updated in Neilson and Cadrin (1998). We adopted those results here.

Stock and Recruitment

There is evidence of reduced recruitment at low levels of age 3+ biomass (Fig. 30). However, management actions by both countries appear to have been successful in building the population to levels where the probability of good recruitment is enhanced.

Outlook

Surplus Production Analyses

As was done last year, the projection was completed assuming a biomass-weighted approximation to $F_{0.1}$ (0.172). Biomass at the beginning of 2000 is projected to be 42,620 t. The projected 1999 yield at the $F_{0.1}$ projected fishing mortality is 6836 t, (combined Canada and USA catch).

The projection results from the surplus production analyses imply a greater rate of population biomass increase than do the VPA projections, presented in the next section. To achieve such growth, continued successive strong year-classes are implied. Since consecutive strong year-classes are rarely observed (Fig. 27), we considered the projection results from the surplus production approach to be optimistic.

Virtual Population Analysis

Yield projections were done using the bias adjusted 1999 beginning of year population abundance estimates. The abundance of the 1998 and 1999 year-classes was assumed to be 19 million at age 1. Partial recruitment to the fishery for ages 1, 2 and 3, fishery weights at age and beginning of year population weights at age were averaged over the previous 4 years for use in the 1999 forecasts (Table 14).

Projected total Canada/USA yield at $F_{0.1} = 0.25$ in 1999 would be about 4,300 t. If fished at $F_{0.1}$ in 1999, the total biomass is projected to increase from 27,633 t to 30,838 t by the beginning of 2000 and an increase in 3+ beginning of year biomass of about 50%

is anticipated (Fig. 31). The 1997 year-class contributes about 13% of the expected yield in 1999, and about 42% of the total biomass.

Uncertainty about year-class abundance generates uncertainty in forecast results. This uncertainty was expressed as risk of achieving reference targets. For example, with *status quo* Canada and USA catches of 3100 t, there is a small probability of exceeding $F_{0.1}$, and a very high probability that total biomass will continue to increase (Fig. 32).

These uncertainty calculations do not include variations in weight at age, partial recruitment to the fishery and natural mortality, or systematic errors in data reporting and model mismatch. Therefore, overall uncertainty would be greater, but these results provide guidelines.

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Table 1. Commercial catch (000s t) of Georges Bank yellowtail flounder.

Year	U.S. landings	U.S. Discards	Canadian Catch	Foreign Catch	Total Catch
1963	10.990	6.368	0.000	0.100	17.458
1964	14.914	4.855	0.000	0.000	19.769
1965	14.248	4.266	0.000	0.800	19.314
1966	11.341	2.545	0.000	0.300	14.186
1967	8.407	4.389	0.000	1.400	14.196
1968	12.799	3.722	0.000	1.800	18.321
1969	15.944	3.105	0.000	2.400	21.449
1970	15.506	6.037	0.000	0.250	21.793
1971	11.878	2.824	0.000	0.503	15.205
1972	14.157	1.330	0.000	2.243	17.730
1973	15.899	0.364	0.000	0.260	16.523
1974	14.607	0.980	0.000	1.000	16.587
1975	13.205	2.715	0.000	0.091	16.011
1976	11.336	3.021	0.000	0.000	14.357
1977	9.444	0.567	0.000	0.000	10.011
1978	4.519	1.669	0.000	0.000	6.188
1979	5.475	0.720	0.000	0.000	6.195
1980	6.481	0.382	0.000	0.000	6.863
1981	6.182	0.095	0.000	0.000	6.277
1982	10.621	1.376	0.000	0.000	11.997
1983	11.350	0.072	0.000	0.000	11.422
1984	5.763	0.028	0.000	0.000	5.791
1985	2.477	0.043	0.000	0.000	2.520
1986	3.041	0.019	0.000	0.000	3.060
1987	2.742	0.233	0.000	0.000	2.975
1988	1.866	0.252	0.000	0.000	2.118
1989	1.134	0.073	0.000	0.000	1.207
1990	2.751	0.818	0.000	0.000	3.569
1991	1.784	0.246	0.000	0.000	2.030
1992	2.859	1.873	0.000	0.000	4.732
1993	2.089	1.089	0.696	0.000	3.874
1994	1.589	0.141	2.142	0.000	3.871
1995	0.292	0.024	0.495	0.000	0.811
1996	0.751	0.039	0.483	0.000	1.273
1997	0.966	0.058	0.810	0.000	1.834
1998	1.822	0.114	1.175	0	3.111

Table 2. Sampling intensity (or lack thereof) for estimation of landings at age for Georges Bank yellowtail flounder.

US	Port	Samples			Sea	Samples		Landings
Quarter	size	trips	lengths	ages	trips	lengths	ages	(mt)
1	small	5	365					43.4
	large	3	356					153.1
	all	5	721	176				196.6
2	small	1	88					106.3
	large	1	134					251.2
	all	2	222	55				381.0
3	small	2	199					238.2
	large	1	85					91.4
	all	2	284	62				331.5
4	small							476.5
	large							435.2
	all	0	0	0				912.8
Canadian 2	all	1	238	0				36
3	all	9	2096	0	3	1277	0	770
4	all	7	1645	0	1	567		353

Table 3. Total catch at age(number), including US discards, of Georges Bank yellowtail flounder (thousands).

					Age				
Year	1	2	3	4	5	6	7	8+	Total
1973	347	4,890	13,243	9,276	3,743	1,259	278	81	33117
1974	2,143	8,971	7,904	7,398	3,544	852	452	173	31437
1975	4,372	25,284	7,057	3,392	2,084	671	313	164	43337
1976	615	31,012	5,146	1,347	532	434	287	147	39520
1977	330	8,580	9,917	1,721	394	221	129	124	21416
1978	9,659	3,105	4,034	1,660	459	102	37	35	19091
1979	233	9,505	3,445	1,242	550	141	79	52	15247
1980	309	3,572	8,821	1,419	321	85	4	10	14541
1981	55	729	5,351	4,556	796	122	4	-	11613
1982	2,063	17,491	7,122	3,246	1,031	62	19	3	31037
1983	696	7,689	16,016	2,316	625	109	10	8	27469
1984	428	1,917	4,266	4,734	1,592	257	47	17	13258
1985	650	3,345	816	652	410	60	5	-	5938
1986	158	5,771	978	347	161	52	16	8	7491
1987	140	2,653	2,751	761	132	39	32	41	6549
1988	483	2,367	1,191	624	165	15	20	3	4868
1989	185	1,516	668	262	68	11	8	-	2718
1990	219	1,931	6,123	800	107	17	3	-	9200
1991	412	54	1,222	2,430	293	56	4	-	4471
1992	2,389	8,359	2,527	1,269	510	20	7	-	15081
1993	5,194	1,009	2,777	2,392	318	65	9	1	11765
1994	71	861	5,742	2,571	910	99	37	1	10291
1995	14	157	895	715	137	13	11	4	1944
1996	50	383	1,509	716	167	9	5	1	2841
1997	16	595	1,258	1,502	341	26	45	19	3802
1998	19	1308	3095	1500	883	60	7	1	6871

Table 4. Mean weight at age for the total catch, including US discards, of Georges Bank yellowtail flounder (kg).

	Age							
Year	1	2	3	4	5	6	7	8+
1973	0.010	0.347	0.462	0.527	0.603	0.689	1.067	1.136
1974	0.010	0.339	0.498	0.609	0.680	0.725	0.906	1.249
1975	0.010	0.309	0.489	0.554	0.618	0.687	0.688	0.649
1976	0.010	0.304	0.542	0.636	0.741	0.814	0.852	0.866
1977	0.010	0.337	0.524	0.634	0.782	0.865	1.036	1.013
1978	0.010	0.309	0.510	0.684	0.793	0.899	0.930	0.948
1979	0.010	0.325	0.460	0.649	0.728	0.835	1.003	0.882
1980	0.010	0.318	0.492	0.656	0.813	1.054	1.256	1.214
1981	0.010	0.340	0.490	0.603	0.707	0.798	0.832	1.042
1982	0.010	0.297	0.485	0.650	0.748	1.052	1.024	1.311
1983	0.010	0.296	0.440	0.604	0.736	0.952	1.018	0.987
1984	0.010	0.240	0.378	0.500	0.642	0.738	0.944	1.047
1985	0.010	0.363	0.497	0.647	0.733	0.819	0.732	1.042
1986	0.010	0.342	0.540	0.664	0.823	0.864	0.956	1.140
1987	0.010	0.309	0.521	0.666	0.680	0.938	0.793	0.788
1988	0.010	0.319	0.555	0.688	0.855	1.054	0.873	1.385
1989	0.010	0.342	0.542	0.725	0.883	1.026	1.254	1.042
1990	0.010	0.281	0.389	0.574	0.696	0.807	1.230	1.042
1991	0.010	0.258	0.359	0.479	0.725	0.820	1.306	1.042
1992	0.010	0.283	0.360	0.519	0.646	1.203	1.125	1.042
1993	0.010	0.275	0.367	0.503	0.561	0.858	1.263	1.044
1994	0.010	0.262	0.351	0.471	0.628	0.786	0.896	1.166
1995	0.010	0.260	0.367	0.463	0.582	0.777	0.785	0.540
1996	0.010	0.309	0.409	0.523	0.667	0.866	0.916	1.215
1997	0.010	0.309	0.458	0.592	0.712	0.874	0.989	1.042
1998	0.01	0.332	0.411	0.534	0.606	0.965	0.907	

Table 5. Canadian DFO spring survey indices of Georges bank yellowtail flounder abundance at age (#/tow) and stratified total biomass.

	Age							
Year	1	2	3	4	5	6	Total	Wt (000s t)
1987	0.12	0.68	2.00	1.09	0.06	0.00	3.95	1.264
1988	0.00	0.66	1.89	0.80	0.59	0.01	3.96	1.235
1989	0.11	0.78	0.80	0.32	0.10	0.02	2.13	0.471
1990	0.00	1.27	4.62	1.12	0.43	0.01	7.45	1.578
1991	0.02	0.59	1.72	2.91	0.99	0.00	6.24	1.759
1992	0.22	10.04	4.52	1.21	0.16	0.00	16.14	2.475
1993	0.33	2.16	5.04	3.47	0.62	0.00	11.63	2.642
1994	0.00	6.03	3.33	3.08	0.75	0.33	13.51	2.753
1995	0.21	1.31	4.07	2.22	1.14	0.11	9.07	2.027
1996	0.45	5.54	8.44	7.49	1.37	0.16	23.45	5.304
1997	0.10	9.48	15.16	19.09	3.11	0.54	47.49	13.292
1998	0.92	3.10	3.81	5.15	2.44	0.59	16.01	4.292
1999	0.20	11.66	14.96	14.40	12.99	2.87	57.07	17.666

Table 6. NMFS spring survey indices of Georges bank yellowtail flounder abundance at age (#/tow) and total biomass (kg/tow).

	Age									biomass
Year	1	2	3	4	5	6	7	8+	Total	(kg)
1968	0.149	3.364	3.579	0.316	0.084	0.160	0.127	0.000	7.779	2.813
1969	1.015	9.406	11.119	3.096	1.423	0.454	0.188	0.057	26.758	11.170
1970	0.093	4.485	6.030	2.422	0.570	0.121	0.190	0.000	13.911	5.312
1971	0.791	3.335	4.620	3.754	0.759	0.227	0.050	0.029	13.564	4.607
1972	0.138	7.136	7.198	3.514	1.094	0.046	0.122	0.000	19.247	6.450
1973	1.931	3.266	2.368	1.063	0.410	0.173	0.023	0.020	9.254	2.938
1974	0.316	2.224	1.842	1.256	0.346	0.187	0.085	0.009	6.265	2.719
1975	0.420	2.939	0.860	0.298	0.208	0.068	0.000	0.013	4.806	1.676
1976	1.034	4.368	1.247	0.311	0.196	0.026	0.048	0.037	7.268	2.273
1977	0.000	0.671	1.125	0.384	0.074	0.013	0.000	0.000	2.267	0.999
1978	0.936	0.798	0.507	0.219	0.026	0.000	0.008	0.000	2.494	0.742
1979	0.279	1.933	0.385	0.328	0.059	0.046	0.041	0.000	3.072	1.227
1980	0.057	4.644	5.761	0.473	0.057	0.037	0.000	0.000	11.030	4.456
1981	0.012	1.027	1.779	0.721	0.205	0.061	0.000	0.026	3.830	1.960
1982	0.045	3.742	1.122	1.016	0.455	0.065	0.000	0.026	6.472	2.500
1983	0.000	1.865	2.728	0.531	0.123	0.092	0.061	0.092	5.492	2.642
1984	0.000	0.093	0.809	0.885	0.834	0.244	0.000	0.000	2.865	1.646
1985	0.110	2.198	0.262	0.282	0.148	0.000	0.000	0.000	3.000	0.988
1986	0.027	1.806	0.291	0.056	0.137	0.055	0.000	0.000	2.372	0.847
1987	0.000	0.128	0.112	0.133	0.053	0.055	0.000	0.000	0.480	0.329
1988	0.078	0.275	0.366	0.242	0.199	0.027	0.000	0.000	1.187	0.566
1989	0.047	0.424	0.740	0.290	0.061	0.022	0.022	0.000	1.605	0.729
1990	0.000	0.065	1.108	0.393	0.139	0.012	0.045	0.000	1.762	0.699
1991	0.435	0.000	0.254	0.675	0.274	0.020	0.000	0.000	1.659	0.631
1992	0.000	2.010	1.945	0.598	0.189	0.000	0.000	0.000	4.742	1.566
1993	0.046	0.290	0.500	0.317	0.027	0.000	0.000	0.000	1.180	0.482
1994	0.000	0.621	0.638	0.357	0.145	0.043	0.000	0.000	1.804	0.660
1995	0.040	1.180	4.810	1.490	0.640	0.010	0.000	0.000	8.170	2.579
1996	0.030	0.990	2.630	2.700	0.610	0.060	0.000	0.000	7.020	2.853
1997	0.019	1.169	3.733	4.081	0.703	0.134	0.000	0.000	9.837	4.359
1998	0.000	2.081	1.053	1.157	0.759	0.323	0.027	0.000	5.400	2.582

Table 7. NMFS fall survey indices of Georges bank yellowtail flounder abundance at age (#/tow) and total biomass (kg/tow).

	Age										biomass
Year	0	1	2	3	4	5	6	7	8+	Total	(kg)
1963	0.000	14.722	7.896	11.226	1.858	0.495	0.281	0.034	0.233	36.746	12.788
1964	0.000	1.721	9.723	7.370	5.998	2.690	0.383	0.095	0.028	28.007	13.623
1965	0.014	1.138	5.579	5.466	3.860	1.803	0.162	0.284	0.038	18.345	9.104
1966	1.177	8.772	4.776	2.070	0.837	0.092	0.051	0.000	0.000	17.775	3.988
1967	0.106	9.137	9.313	2.699	1.007	0.309	0.076	0.061	0.000	22.708	7.575
1968	0.000	11.782	11.946	5.758	0.766	0.944	0.059	0.000	0.000	31.254	10.536
1969	0.135	8.106	10.381	5.855	1.662	0.553	0.149	0.182	0.000	27.023	9.279
1970	1.048	4.610	5.133	3.144	1.952	0.451	0.063	0.017	0.000	16.417	4.979
1971	0.025	3.627	6.949	4.904	2.248	0.551	0.234	0.024	0.024	18.586	6.365
1972	0.785	2.424	6.525	4.824	2.095	0.672	0.279	0.000	0.000	17.604	6.328
1973	0.094	2.494	5.497	5.104	2.944	1.216	0.416	0.171	0.031	17.996	6.602
1974	1.030	4.623	2.854	1.524	1.060	0.460	0.249	0.131	0.000	12.133	3.733
1975	0.361	4.625	2.511	0.877	0.572	0.334	0.033	0.000	0.031	9.420	2.365
1976	0.000	0.336	1.929	0.475	0.117	0.122	0.033	0.000	0.067	3.078	1.533
1977	0.000	0.928	2.161	1.649	0.618	0.113	0.056	0.036	0.016	5.614	2.829
1978	0.037	4.729	1.272	0.773	0.406	0.139	0.011	0.000	0.024	7.443	2.383
1979	0.018	1.312	1.999	0.316	0.122	0.138	0.038	0.064	0.007	4.041	1.520
1980	0.078	0.761	5.086	6.050	0.678	0.217	0.162	0.006	0.033	13.217	6.722
1981	0.000	1.584	2.333	1.630	0.500	0.121	0.083	0.013	0.000	6.345	2.621
1982	0.000	2.424	2.185	1.590	0.423	0.089	0.000	0.000	0.000	6.711	2.270
1983	0.000	0.109	2.284	1.914	0.473	0.068	0.012	0.000	0.038	4.898	2.131
1984	0.012	0.661	0.400	0.306	2.428	0.090	0.029	0.000	0.018	3.944	0.593
1985	0.010	1.350	0.560	0.160	0.040	0.080	0.000	0.000	0.000	2.200	0.709
1986	0.000	0.280	1.110	0.350	0.070	0.000	0.000	0.000	0.000	1.810	0.820
1987	0.000	0.113	0.390	0.396	0.053	0.079	0.000	0.000	0.000	1.031	0.509
1988	0.011	0.019	0.213	0.102	0.031	0.000	0.000	0.000	0.000	0.376	0.171
1989	0.027	0.248	1.992	0.774	0.069	0.066	0.000	0.000	0.000	3.176	0.977
1990	0.147	0.000	0.326	1.517	0.280	0.014	0.000	0.000	0.000	2.284	0.725
1991	0.000	2.100	0.275	0.439	0.358	0.000	0.000	0.000	0.000	3.172	0.730
1992	0.000	0.151	0.396	0.712	0.162	0.144	0.027	0.000	0.000	1.592	0.576
1993	0.000	0.842	0.136	0.587	0.536	0.000	0.000	0.000	0.000	2.101	0.545
1994	0.010	1.200	0.220	0.980	0.710	0.260	0.030	0.030	0.000	3.440	0.897
1995	0.070	0.280	0.120	0.350	0.280	0.050	0.010	0.000	0.000	1.160	0.354
1996	0.000	0.140	0.350	1.870	0.450	0.070	0.000	0.000	0.000	2.880	1.303
1997	0.000	1.392	0.533	3.442	2.090	1.071	0.082	0.000	0.000	8.611	3.781
1998	0.000	1.9	4.817	4.202	1.19	0.298	0.055	0.019	0	12.481	4.829

Table 8. NMFS scallop survey index of Georges bank yellowtail flounder age-1 abundance.

year	#/tow
1982	0.313
1983	0.140
1984	0.233
1985	0.549
1986	0.103
1987	0.047
1988	0.116
1989	0.195
1990	0.100
1991	2.117
1992	0.167
1993	1.129
1994	1.503
1995	0.609
1996	0.508
1997	1.062
1998	1.872

Table 9. Statistical properties of estimates for population abundance and survey calibration constants (10^{-3}) for Georges Bank yellowtail.

		Bootstrap				Analytical Approximation			
Age	Estimate	Standard Error	Relative Error	Bias	Relative Bias	Standard Error	Relative Error	Bias	Relative Bias
				Population Abundance (000 s)					
2	55583	29340	0.528	6979	0.126	27361	0.492	6771	0.122
3	19565	6796	0.347	1217	0.062	6638	0.339	1090	0.056
4	6581	2414	0.367	96	0.015	2418	0.367	345	0.052
5+	13268	2507	0.189	53	0.004	2717	0.205	207	0.016
				Survey Calibration Constants					
Scallop									
1	0. 024	0. 005	0.202	0. 001	0.034	0. 005	0.205	0. 000	0.020
DFO Spring Survey									
2	0. 189	0. 044	0.231	0. 006	0.033	0. 045	0.237	0. 005	0.027
3	0. 581	0. 129	0.221	0. 013	0.022	0. 136	0.234	0. 016	0.027
4	1. 043	0. 239	0.229	0. 045	0.043	0. 244	0.234	0. 029	0.028
5+	0. 993	0. 227	0.229	0. 048	0.048	0. 233	0.235	0. 027	0.028
NMFS Spring Survey – Yankee 36 –1982-98									
1	0. 003	0. 001	0.254	0. 000	0.039	0. 001	0.265	0. 000	0.034
2	0. 060	0. 013	0.213	0. 001	0.022	0. 013	0.209	0. 001	0.021
3	0. 137	0. 027	0.200	0. 004	0.028	0. 028	0.202	0. 003	0.020
4	0. 228	0. 046	0.200	0. 005	0.024	0. 046	0.202	0. 005	0.020
5+	0. 363	0. 071	0.195	0. 008	0.022	0. 073	0.202	0. 007	0.020
NMFS Spring Survey – Yankee 41 – 1973-81									
1	0. 008	0. 002	0.271	0. 000	0.013	0. 002	0.292	0. 000	0.043
2	0. 084	0. 024	0.283	0. 002	0.022	0. 023	0.275	0. 003	0.038
3	0. 107	0. 029	0.272	0. 003	0.033	0. 029	0.275	0. 004	0.038
4	0. 106	0. 029	0.270	0. 003	0.029	0. 029	0.275	0. 004	0.038
5+	0. 084	0. 023	0.277	0. 004	0.043	0. 023	0.275	0. 003	0.038
NMFS Fall Survey									
1	0. 040	0. 007	0.172	0. 000	0.012	0. 007	0.168	0. 001	0.014
2	0. 087	0. 013	0.150	0. 001	0.017	0. 014	0.163	0. 001	0.013
3	0. 191	0. 031	0.164	0. 003	0.015	0. 031	0.163	0. 003	0.013
4	0. 222	0. 035	0.157	0. 001	0.003	0. 036	0.163	0. 003	0.013
5+	0. 264	0. 042	0.161	0. 005	0.018	0. 047	0.178	0. 004	0.016

Table 10. Beginning of year population abundance numbers (000's) for Georges Bank yellowtail from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 1999.

Year	Age Group							
	1	2	3	4	5+	1+	2+	3+
1973	27924	23579	28598	16161	9340	105602	77677	54099
1974	49152	22549	14906	11589	7865	106062	56909	34360
1975	67224	38308	10434	5164	4921	126051	58827	20519
1976	22189	51094	8981	2301	2391	86957	64767	13673
1977	15244	17612	14303	2778	1401	51337	36093	18481
1978	49738	12183	6765	2948	1124	72757	23019	10837
1979	22651	32032	7185	1956	1294	65117	42466	10435
1980	21340	18335	17695	2808	831	61009	39669	21334
1981	59640	17193	11797	6621	1340	96591	36951	19758
1982	21188	48780	13418	4879	1676	89941	68753	19973
1983	5785	15487	24267	4642	1507	51689	45904	30417
1984	8458	4109	5822	5689	2299	26378	17920	13811
1985	14312	6538	1653	1007	734	24244	9932	3394
1986	6518	11131	2372	625	427	21072	14555	3424
1987	6961	5194	3970	1067	342	17534	10573	5379
1988	18854	5573	1887	820	267	27401	8547	2974
1989	8288	15000	2446	489	162	26387	18098	3098
1990	11547	6619	10914	1403	223	30706	19159	12540
1991	21680	9256	3686	3489	507	38618	16938	7682
1992	16108	17378	7529	1922	813	43750	27643	10264
1993	14112	11036	6769	3899	641	36457	22345	11308
1994	18412	6902	8126	3058	1245	37743	19331	12429
1995	23598	15011	4875	1584	365	45433	21835	6824
1996	17740	19308	12148	3186	810	53192	35451	16143
1997	29152	14479	15462	8586	2464	70144	40991	26512
1998	59386	23853	11318	11525	7307	113388	54002	30149
1999	19000	48604	18349	6485	13209	105648	86648	38044

Table 11. Fishing mortality rate for Georges Bank yellowtail from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 1999. The rate for ages 4 to 8 is weighted by population numbers.

Year	Age Group					
	1	2	3	4	5+	3+
1973	0.014	0.259	0.703	0.976	0.976	0.832
1974	0.049	0.571	0.860	1.175	1.175	1.038
1975	0.074	1.251	1.312	1.239	1.239	1.276
1976	0.031	1.073	0.974	1.009	1.009	0.986
1977	0.024	0.757	1.379	1.113	1.113	1.319
1978	0.240	0.328	1.041	0.946	0.946	1.005
1979	0.011	0.393	0.739	1.164	1.164	0.872
1980	0.016	0.241	0.783	0.799	0.799	0.786
1981	0.001	0.048	0.683	1.358	1.358	0.955
1982	0.113	0.498	0.861	1.270	1.270	0.995
1983	0.142	0.778	1.250	0.784	0.784	1.156
1984	0.057	0.711	1.554	2.187	2.187	1.921
1985	0.051	0.814	0.772	1.205	1.205	0.994
1986	0.027	0.831	0.599	0.924	0.924	0.699
1987	0.022	0.812	1.377	1.464	1.464	1.400
1988	0.029	0.623	1.150	1.701	1.701	1.351
1989	0.025	0.118	0.356	0.873	0.873	0.465
1990	0.021	0.385	0.940	0.966	0.966	0.944
1991	0.021	0.006	0.451	1.392	1.392	0.941
1992	0.178	0.743	0.458	1.252	1.252	0.670
1993	0.514	0.106	0.595	1.094	1.094	0.795
1994	0.004	0.147	1.434	2.265	2.265	1.722
1995	0.001	0.011	0.224	0.675	0.675	0.353
1996	0.003	0.022	0.145	0.280	0.280	0.178
1997	0.001	0.043	0.092	0.209	0.209	0.141
1998	0.000	0.056	0.321	0.150	0.150	0.214

Table 12. Beginning of year weight at age for Georges Bank yellowtail. Age group 5+ is catch weighted.

Year	Age Group				
	1	2	3	4	5+
1973	0.100	0.290	0.402	0.464	0.813
1974	0.100	0.184	0.416	0.530	0.632
1975	0.100	0.176	0.407	0.525	0.639
1976	0.100	0.174	0.409	0.558	0.674
1977	0.100	0.184	0.399	0.586	0.802
1978	0.100	0.176	0.415	0.599	0.810
1979	0.100	0.180	0.377	0.575	0.748
1980	0.100	0.178	0.400	0.549	0.805
1981	0.100	0.184	0.395	0.545	0.720
1982	0.100	0.172	0.406	0.564	0.698
1983	0.100	0.172	0.361	0.541	0.707
1984	0.100	0.155	0.334	0.469	0.648
1985	0.100	0.191	0.345	0.495	0.628
1986	0.100	0.185	0.443	0.574	0.740
1987	0.100	0.176	0.422	0.600	0.734
1988	0.100	0.179	0.414	0.599	0.838
1989	0.100	0.185	0.416	0.634	0.830
1990	0.100	0.168	0.365	0.558	0.765
1991	0.100	0.161	0.318	0.432	0.669
1992	0.100	0.168	0.305	0.432	0.621
1993	0.100	0.166	0.322	0.426	0.556
1994	0.100	0.162	0.311	0.416	0.588
1995	0.100	0.161	0.310	0.403	0.550
1996	0.100	0.176	0.326	0.438	0.597
1997	0.100	0.176	0.376	0.492	0.628
1998	0.100	0.182	0.356	0.495	0.661
1999	0.100	0.174	0.342	0.457	0.609

Table 13. Beginning of year biomass for Georges Bank yellowtail from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 1999.

Year	Age Group							
	1	2	3	4	5+	1+	2+	3+
1973	2792	6830	11508	7498	7597	36224	33432	26602
1974	4915	4152	6196	6147	4968	26379	21463	17312
1975	6722	6734	4248	2712	3144	23561	16839	10105
1976	2219	8909	3675	1283	1611	17697	15478	6569
1977	1524	3233	5709	1628	1123	13218	11693	8460
1978	4974	2142	2804	1765	911	12595	7622	5480
1979	2265	5775	2709	1125	969	12842	10577	4802
1980	2134	3270	7076	1542	669	14690	12556	9287
1981	5964	3170	4657	3606	964	18362	12398	9227
1982	2119	8407	5449	2754	1170	19897	17779	9372
1983	579	2664	8772	2513	1065	15594	15015	12351
1984	846	637	1948	2669	1490	7588	6742	6106
1985	1431	1246	571	498	461	4207	2776	1530
1986	652	2058	1050	359	316	4435	3784	1725
1987	696	913	1676	640	251	4176	3480	2567
1988	1885	995	782	491	224	4377	2491	1496
1989	829	2774	1017	310	135	5065	4236	1462
1990	1155	1109	3981	783	170	7198	6044	4934
1991	2168	1487	1171	1506	339	6671	4503	3016
1992	1611	2923	2295	830	505	8163	6553	3629
1993	1411	1830	2181	1659	356	7438	6027	4197
1994	1841	1117	2525	1271	732	7486	5645	4528
1995	2360	2420	1512	638	201	7131	4771	2351
1996	1774	3394	3961	1396	484	11009	9235	5841
1997	2915	2545	5817	4225	1548	17051	14135	11590
1998	5939	4346	4033	5699	4829	24847	18908	14562
1999	1900	8445	6279	2963	8045	27633	25733	17287

Table 14. Deterministic projection results for Georges Bank yellowtail for 1999 at F0.1 using the bootstrap bias adjusted population abundance at the beginning of 1999.

Year	Age Group							
	1	2	3	4	5+	1+	2+	3+
Beginning of Year Population Numbers (000s)								
1999	19000	48604	18349	6485	13209			
2000	19000	15556	38138	12117	12558			
Partial Recruitment to the Fishery								
1999	0.00	0.17	0.86	1.00	1.00			
Fishing Mortality								
1999	0.000	0.043	0.215	0.250	0.250			
Weight at beginning of year for population (kg)								
2000	0.100	0.174	0.342	0.457	0.609			
Beginning of Year Projected Population Biomass (t)								
2000	1900	2703	13050	5537	7648	30838	28938	26235
Projected Catch Numbers (000s)								
1999	0	1834	3229	1306	2659			
Average weight for catch (kg)								
1999	0.100	0.303	0.411	0.528	0.681			
Projected Yield (t)								
1999	0	556	1327	689	1811	4383		

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.65) BOOTSTRAP Mode

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CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	36	Number of bootstrap trials:	500
Number of data series:	4	Lower bound on MSY:	5.000E+00
Objective function computed:	in EFFORT	Upper bound on MSY:	5.000E+01
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	1.000E-01
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	5.000E+00
Relative conv. criterion (effort):	1.000E-04	Random number seed:	1964287
Maximum F allowed in fitting:	5.000	Monte Carlo search trials:	50000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

1 USA Fall Survey	1.000			
	36			
2 USA Spring Survey 36	0.769	1.000		
	22	22		
3 USA Spring Survey 41	0.796	0.000	1.000	
	9	0	9	
4 Canadian Survey - lagged	0.676	0.556	0.000	1.000
	13	13	0	13
	1	2	3	4

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	1.676E+00	1	N/A	1.000E+00	N/A	
Loss(1) USA Fall Survey	8.602E+00	36	2.530E-01	1.000E+00	1.016E+00	0.613
Loss(2) USA Spring Survey 36	5.174E+00	22	2.587E-01	1.000E+00	9.934E-01	0.528
Loss(3) USA Spring Survey 41	2.047E+00	9	2.924E-01	1.000E+00	8.790E-01	-0.033

Loss(4)	Canadian Survey - lagged	2.688E+00	13	2.444E-01	1.000E+00	1.052E+00	0.627

TOTAL OBJECTIVE FUNCTION: 2.01868810E+01

NOTE: B1-ratio constraint term contributing to loss. Sensitivity analysis advised.

Number of restarts required for convergence: 28
Est. B-ratio coverage index (0 worst, 2 best): 1.9057
Est. B-ratio nearness index (0 worst, 1 best): 1.0000

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1963	7.300E+00	2.000E+00	1	1
MSY	Maximum sustainable yield	1.323E+01	1.400E+01	1	1
r	Intrinsic rate of increase	5.872E-01	6.000E-01	1	1
.....	Catchability coefficients by fishery:				
q(1)	USA Fall Survey	1.097E-01	1.000E-01	1	1
q(2)	USA Spring Survey 36	1.351E-01	1.000E-01	1	1
q(3)	USA Spring Survey 41	9.302E-02	1.000E-01	1	1
q(4)	Canadian Survey - lagged	2.939E-01	3.000E-01	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	
MSY	Maximum sustainable yield	1.323E+01	Kr/4	
K	Maximum stock biomass	9.010E+01		
Bmsy	Stock biomass at MSY	4.505E+01	K/2	
Fmsy	Fishing mortality at MSY	2.936E-01	r/2	
F(0.1)	Management benchmark	2.643E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	1.309E+01	0.99*MSY	
B-ratio	Ratio of B(1999) to Bmsy	8.299E-01		
F-ratio	Ratio of F(1998) to Fmsy	3.231E-01		
Y-ratio	Proportion of MSY avail in 1999	9.711E-01	2*Br-Br^2	Ye(1999) = 1.284E+01
.....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	USA Fall Survey	2.677E+00	r/2q(1)	f(0.1) = 2.409E+00

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1963	0.086	3.289E+02	2.042E+02	1.746E+01	1.746E+01	-1.679E+02	2.912E-01	7.300E+00
2	1964	0.167	1.436E+02	1.184E+02	1.977E+01	1.977E+01	-2.275E+01	5.688E-01	3.187E+00
3	1965	0.215	1.010E+02	9.001E+01	1.931E+01	1.931E+01	-1.511E-01	7.308E-01	2.243E+00
4	1966	0.184	8.157E+01	7.729E+01	1.419E+01	1.419E+01	6.417E+00	6.251E-01	1.811E+00
5	1967	0.200	7.380E+01	7.089E+01	1.420E+01	1.420E+01	8.858E+00	6.820E-01	1.638E+00
6	1968	0.285	6.846E+01	6.435E+01	1.832E+01	1.832E+01	1.077E+01	9.697E-01	1.520E+00
7	1969	0.383	6.091E+01	5.599E+01	2.145E+01	2.145E+01	1.240E+01	1.305E+00	1.352E+00
8	1970	0.462	5.186E+01	4.719E+01	2.179E+01	2.179E+01	1.316E+01	1.573E+00	1.151E+00
9	1971	0.361	4.323E+01	4.215E+01	1.520E+01	1.520E+01	1.317E+01	1.228E+00	9.595E-01
10	1972	0.459	4.119E+01	3.865E+01	1.773E+01	1.773E+01	1.295E+01	1.562E+00	9.144E-01
11	1973	0.482	3.641E+01	3.426E+01	1.652E+01	1.652E+01	1.246E+01	1.642E+00	8.082E-01
12	1974	0.558	3.235E+01	2.975E+01	1.659E+01	1.659E+01	1.169E+01	1.899E+00	7.180E-01
13	1975	0.654	2.745E+01	2.449E+01	1.601E+01	1.601E+01	1.046E+01	2.227E+00	6.093E-01
14	1976	0.760	2.189E+01	1.889E+01	1.436E+01	1.436E+01	8.751E+00	2.588E+00	4.860E-01
15	1977	0.674	1.629E+01	1.486E+01	1.001E+01	1.001E+01	7.282E+00	2.295E+00	3.615E-01
16	1978	0.444	1.356E+01	1.392E+01	6.188E+00	6.188E+00	6.912E+00	1.514E+00	3.009E-01
17	1979	0.418	1.428E+01	1.482E+01	6.195E+00	6.195E+00	7.271E+00	1.424E+00	3.170E-01
18	1980	0.436	1.536E+01	1.574E+01	6.863E+00	6.863E+00	7.629E+00	1.485E+00	3.409E-01
19	1981	0.368	1.612E+01	1.704E+01	6.277E+00	6.277E+00	8.113E+00	1.254E+00	3.579E-01
20	1982	0.769	1.796E+01	1.560E+01	1.200E+01	1.200E+01	7.565E+00	2.619E+00	3.987E-01
21	1983	1.132	1.353E+01	1.009E+01	1.142E+01	1.142E+01	5.242E+00	3.855E+00	3.003E-01
22	1984	0.966	7.346E+00	5.997E+00	5.791E+00	5.791E+00	3.284E+00	3.289E+00	1.631E-01
23	1985	0.509	4.839E+00	4.953E+00	2.520E+00	2.520E+00	2.748E+00	1.733E+00	1.074E-01
24	1986	0.625	5.067E+00	4.893E+00	3.060E+00	3.060E+00	2.717E+00	2.130E+00	1.125E-01
25	1987	0.664	4.724E+00	4.481E+00	2.975E+00	2.975E+00	2.501E+00	2.261E+00	1.049E-01
26	1988	0.479	4.250E+00	4.424E+00	2.118E+00	2.118E+00	2.470E+00	1.630E+00	9.434E-02
27	1989	0.221	4.602E+00	5.459E+00	1.207E+00	1.207E+00	3.010E+00	7.530E-01	1.022E-01
28	1990	0.562	6.405E+00	6.354E+00	3.569E+00	3.569E+00	3.468E+00	1.913E+00	1.422E-01
29	1991	0.282	6.304E+00	7.201E+00	2.030E+00	2.030E+00	3.889E+00	9.601E-01	1.399E-01
30	1992	0.598	8.163E+00	7.911E+00	4.732E+00	4.732E+00	4.238E+00	2.037E+00	1.812E-01
31	1993	0.495	7.669E+00	7.832E+00	3.874E+00	3.874E+00	4.199E+00	1.685E+00	1.702E-01
32	1994	0.469	7.994E+00	8.261E+00	3.871E+00	3.871E+00	4.406E+00	1.596E+00	1.775E-01
33	1995	0.075	8.529E+00	1.075E+01	8.110E-01	8.110E-01	5.548E+00	2.569E-01	1.893E-01
34	1996	0.078	1.327E+01	1.639E+01	1.273E+00	1.273E+00	7.852E+00	2.645E-01	2.945E-01
35	1997	0.077	1.985E+01	2.393E+01	1.834E+00	1.834E+00	1.028E+01	2.610E-01	4.405E-01
36	1998	0.095	2.829E+01	3.279E+01	3.111E+00	3.111E+00	1.220E+01	3.231E-01	6.280E-01
37	1999		3.738E+01						8.299E-01

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) USA Fall Survey

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed yield	Model yield	Resid in log effort	Resid in yield
1	1963	1.365E+00	7.797E-01	0.0855	1.746E+01	1.746E+01	0.56018	0.000E+00
2	1964	1.451E+00	1.523E+00	0.1670	1.977E+01	1.977E+01	-0.04826	0.000E+00
3	1965	2.121E+00	1.956E+00	0.2146	1.931E+01	1.931E+01	0.08097	0.000E+00
4	1966	3.557E+00	1.673E+00	0.1835	1.419E+01	1.419E+01	0.75409	0.000E+00
5	1967	1.874E+00	1.826E+00	0.2002	1.420E+01	1.420E+01	0.02607	0.000E+00
6	1968	1.739E+00	2.596E+00	0.2847	1.832E+01	1.832E+01	-0.40073	0.000E+00
7	1969	2.312E+00	3.493E+00	0.3831	2.145E+01	2.145E+01	-0.41281	0.000E+00
8	1970	4.377E+00	4.211E+00	0.4618	2.179E+01	2.179E+01	0.03875	0.000E+00
9	1971	2.389E+00	3.289E+00	0.3607	1.520E+01	1.520E+01	-0.31973	0.000E+00
10	1972	2.802E+00	4.183E+00	0.4587	1.773E+01	1.773E+01	-0.40066	0.000E+00
11	1973	2.503E+00	4.397E+00	0.4823	1.652E+01	1.652E+01	-0.56358	0.000E+00
12	1974	4.443E+00	5.084E+00	0.5575	1.659E+01	1.659E+01	-0.13460	0.000E+00
13	1975	6.770E+00	5.961E+00	0.6538	1.601E+01	1.601E+01	0.12727	0.000E+00
14	1976	9.365E+00	6.929E+00	0.7599	1.436E+01	1.436E+01	0.30132	0.000E+00
15	1977	3.539E+00	6.143E+00	0.6738	1.001E+01	1.001E+01	-0.55162	0.000E+00
16	1978	2.597E+00	4.053E+00	0.4445	6.188E+00	6.188E+00	-0.44518	0.000E+00
17	1979	4.076E+00	3.811E+00	0.4180	6.195E+00	6.195E+00	0.06709	0.000E+00
18	1980	1.021E+00	3.975E+00	0.4359	6.863E+00	6.863E+00	-1.35920	0.000E+00
19	1981	2.395E+00	3.358E+00	0.3683	6.277E+00	6.277E+00	-0.33815	0.000E+00
20	1982	5.285E+00	7.012E+00	0.7690	1.200E+01	1.200E+01	-0.28270	0.000E+00
21	1983	5.360E+00	1.032E+01	1.1320	1.142E+01	1.142E+01	-0.65526	0.000E+00
22	1984	9.766E+00	8.804E+00	0.9656	5.791E+00	5.791E+00	0.10361	0.000E+00
23	1985	3.554E+00	4.639E+00	0.5088	2.520E+00	2.520E+00	-0.26642	0.000E+00
24	1986	3.732E+00	5.703E+00	0.6254	3.060E+00	3.060E+00	-0.42406	0.000E+00
25	1987	5.845E+00	6.053E+00	0.6638	2.975E+00	2.975E+00	-0.03498	0.000E+00
26	1988	1.239E+01	4.365E+00	0.4787	2.118E+00	2.118E+00	1.04298	0.000E+00
27	1989	1.235E+00	2.016E+00	0.2211	1.207E+00	1.207E+00	-0.48963	0.000E+00
28	1990	4.923E+00	5.121E+00	0.5617	3.569E+00	3.569E+00	-0.03953	0.000E+00
29	1991	2.781E+00	2.570E+00	0.2819	2.030E+00	2.030E+00	0.07870	0.000E+00
30	1992	8.215E+00	5.454E+00	0.5981	4.732E+00	4.732E+00	0.40970	0.000E+00
31	1993	7.108E+00	4.510E+00	0.4947	3.874E+00	3.874E+00	0.45491	0.000E+00
32	1994	4.315E+00	4.272E+00	0.4686	3.871E+00	3.871E+00	0.01002	0.000E+00
33	1995	2.291E+00	6.878E-01	0.0754	8.110E-01	8.110E-01	1.20329	0.000E+00
34	1996	9.770E-01	7.080E-01	0.0776	1.273E+00	1.273E+00	0.32202	0.000E+00
35	1997	4.851E-01	6.988E-01	0.0766	1.834E+00	1.834E+00	-0.36512	0.000E+00
36	1998	7.157E-01	8.651E-01	0.0949	3.111E+00	3.111E+00	-0.18963	0.000E+00

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

Year	Residual	-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
1963	0.5602	|==========
1964	-0.0483	= |
1965	0.0810	|==
1966	0.7541	|================
1967	0.0261	|=
1968	-0.4007	======== |
1969	-0.4128	======== |
1970	0.0387	|=
1971	-0.3197	====== |
1972	-0.4007	======== |
1973	-0.5636	========== |
1974	-0.1346	=== |
1975	0.1273	|===
1976	0.3013	|======
1977	-0.5516	========== |
1978	-0.4452	========= |
1979	0.0671	|=
1980	-1.3592	========================== |
1981	-0.3381	======= |
1982	-0.2827	====== |
1983	-0.6553	============ |
1984	0.1036	|==
1985	-0.2664	===== |
1986	-0.4241	======== |
1987	-0.0350	= |
1988	1.0430	|====================
1989	-0.4896	========== |
1990	-0.0395	= |
1991	0.0787	|==
1992	0.4097	|========
1993	0.4549	|=========
1994	0.0100	|
1995	1.2033	|========================
1996	0.3220	|======
1997	-0.3651	======= |
1998	-0.1896	==== |

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) USA Spring Survey 36

Data type I0: Start-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1963	0.000E+00	0.000E+00	0.0	*	4.444E+01	0.00000	0.0
2	1964	0.000E+00	0.000E+00	0.0	*	1.940E+01	0.00000	0.0
3	1965	0.000E+00	0.000E+00	0.0	*	1.365E+01	0.00000	0.0
4	1966	0.000E+00	0.000E+00	0.0	*	1.102E+01	0.00000	0.0
5	1967	0.000E+00	0.000E+00	0.0	*	9.972E+00	0.00000	0.0
6	1968	1.000E+00	1.000E+00	0.0	2.813E+00	9.250E+00	-1.19041	-6.437E+00
7	1969	1.000E+00	1.000E+00	0.0	1.117E+01	8.230E+00	0.30546	2.940E+00
8	1970	1.000E+00	1.000E+00	0.0	5.312E+00	7.008E+00	-0.27702	-1.696E+00
9	1971	1.000E+00	1.000E+00	0.0	4.607E+00	5.841E+00	-0.23725	-1.234E+00
10	1972	1.000E+00	1.000E+00	0.0	6.450E+00	5.566E+00	0.14747	8.844E-01
11	1973	0.000E+00	0.000E+00	0.0	*	4.919E+00	0.00000	0.0
12	1974	0.000E+00	0.000E+00	0.0	*	4.370E+00	0.00000	0.0
13	1975	0.000E+00	0.000E+00	0.0	*	3.709E+00	0.00000	0.0
14	1976	0.000E+00	0.000E+00	0.0	*	2.958E+00	0.00000	0.0
15	1977	0.000E+00	0.000E+00	0.0	*	2.200E+00	0.00000	0.0
16	1978	0.000E+00	0.000E+00	0.0	*	1.832E+00	0.00000	0.0
17	1979	0.000E+00	0.000E+00	0.0	*	1.930E+00	0.00000	0.0
18	1980	0.000E+00	0.000E+00	0.0	*	2.075E+00	0.00000	0.0
19	1981	0.000E+00	0.000E+00	0.0	*	2.179E+00	0.00000	0.0
20	1982	1.000E+00	1.000E+00	0.0	2.500E+00	2.427E+00	0.02983	7.347E-02
21	1983	1.000E+00	1.000E+00	0.0	2.642E+00	1.828E+00	0.36852	8.144E-01
22	1984	1.000E+00	1.000E+00	0.0	1.646E+00	9.925E-01	0.50585	6.535E-01
23	1985	1.000E+00	1.000E+00	0.0	9.880E-01	6.538E-01	0.41290	3.342E-01
24	1986	1.000E+00	1.000E+00	0.0	8.470E-01	6.847E-01	0.21278	1.623E-01
25	1987	1.000E+00	1.000E+00	0.0	3.290E-01	6.383E-01	-0.66277	-3.093E-01
26	1988	1.000E+00	1.000E+00	0.0	5.660E-01	5.742E-01	-0.01442	-8.218E-03
27	1989	1.000E+00	1.000E+00	0.0	7.290E-01	6.218E-01	0.15898	1.072E-01
28	1990	1.000E+00	1.000E+00	0.0	6.990E-01	8.655E-01	-0.21361	-1.665E-01
29	1991	1.000E+00	1.000E+00	0.0	6.310E-01	8.518E-01	-0.30010	-2.208E-01
30	1992	1.000E+00	1.000E+00	0.0	1.566E+00	1.103E+00	0.35048	4.630E-01
31	1993	1.000E+00	1.000E+00	0.0	4.820E-01	1.036E+00	-0.76539	-5.542E-01
32	1994	1.000E+00	1.000E+00	0.0	6.600E-01	1.080E+00	-0.49263	-4.202E-01
33	1995	1.000E+00	1.000E+00	0.0	2.579E+00	1.152E+00	0.80548	1.427E+00
34	1996	1.000E+00	1.000E+00	0.0	2.853E+00	1.793E+00	0.46473	1.060E+00
35	1997	1.000E+00	1.000E+00	0.0	4.359E+00	2.681E+00	0.48587	1.678E+00
36	1998	1.000E+00	1.000E+00	0.0	2.324E+00	3.823E+00	-0.49770	-1.499E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2

Year	Residual	-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
1963	0.0000	
1964	0.0000	
1965	0.0000	
1966	0.0000	
1967	0.0000	
1968	-1.1904	==========
1969	0.3055	|======
1970	-0.2770	======|
1971	-0.2373	=====|
1972	0.1475	|===
1973	0.0000	
1974	0.0000	
1975	0.0000	
1976	0.0000	
1977	0.0000	
1978	0.0000	
1979	0.0000	
1980	0.0000	
1981	0.0000	
1982	0.0298	|=
1983	0.3685	|=======
1984	0.5058	|==========
1985	0.4129	|========
1986	0.2128	|====
1987	-0.6628	============|
1988	-0.0144	
1989	0.1590	|===
1990	-0.2136	====|
1991	-0.3001	======|
1992	0.3505	|=======
1993	-0.7654	==============|
1994	-0.4926	==========|
1995	0.8055	|================
1996	0.4647	|=========
1997	0.4859	|==========
1998	-0.4977	==========|

RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) USA Spring Survey 41

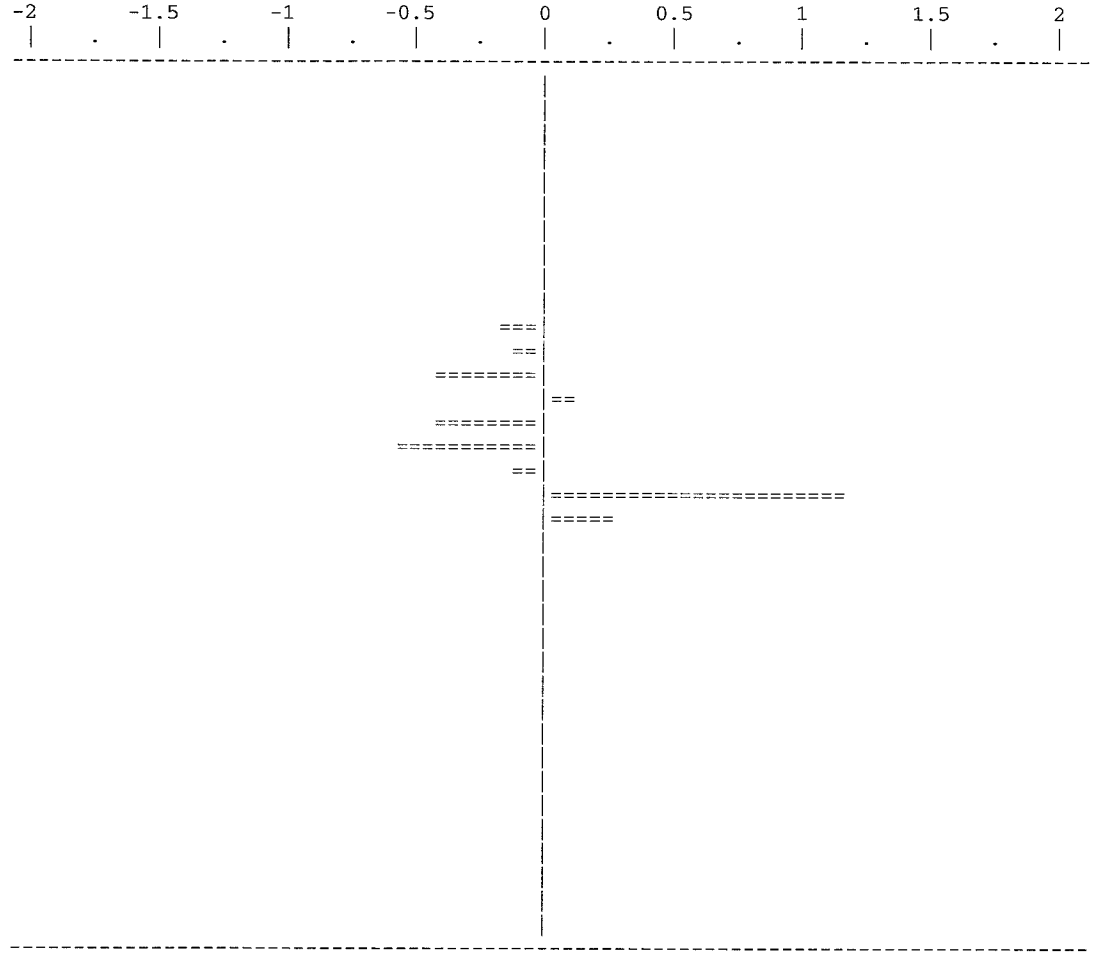
Data type I0: Start-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1963	0.000E+00	0.000E+00	0.0	*	3.059E+01	0.00000	0.0
2	1964	0.000E+00	0.000E+00	0.0	*	1.335E+01	0.00000	0.0
3	1965	0.000E+00	0.000E+00	0.0	*	9.398E+00	0.00000	0.0
4	1966	0.000E+00	0.000E+00	0.0	*	7.587E+00	0.00000	0.0
5	1967	0.000E+00	0.000E+00	0.0	*	6.864E+00	0.00000	0.0
6	1968	0.000E+00	0.000E+00	0.0	*	6.368E+00	0.00000	0.0
7	1969	0.000E+00	0.000E+00	0.0	*	5.665E+00	0.00000	0.0
8	1970	0.000E+00	0.000E+00	0.0	*	4.824E+00	0.00000	0.0
9	1971	0.000E+00	0.000E+00	0.0	*	4.021E+00	0.00000	0.0
10	1972	0.000E+00	0.000E+00	0.0	*	3.831E+00	0.00000	0.0
11	1973	1.000E+00	1.000E+00	0.0	2.938E+00	3.387E+00	-0.14209	-4.486E-01
12	1974	1.000E+00	1.000E+00	0.0	2.719E+00	3.009E+00	-0.10122	-2.896E-01
13	1975	1.000E+00	1.000E+00	0.0	1.676E+00	2.553E+00	-0.42087	-8.770E-01
14	1976	1.000E+00	1.000E+00	0.0	2.273E+00	2.036E+00	0.10998	2.367E-01
15	1977	1.000E+00	1.000E+00	0.0	9.990E-01	1.515E+00	-0.41630	-5.158E-01
16	1978	1.000E+00	1.000E+00	0.0	7.420E-01	1.261E+00	-0.53032	-5.190E-01
17	1979	1.000E+00	1.000E+00	0.0	1.227E+00	1.328E+00	-0.07934	-1.013E-01
18	1980	1.000E+00	1.000E+00	0.0	4.456E+00	1.428E+00	1.13769	3.028E+00
19	1981	1.000E+00	1.000E+00	0.0	1.960E+00	1.500E+00	0.26769	4.603E-01
20	1982	0.000E+00	0.000E+00	0.0	*	1.670E+00	0.00000	0.0
21	1983	0.000E+00	0.000E+00	0.0	*	1.258E+00	0.00000	0.0
22	1984	0.000E+00	0.000E+00	0.0	*	6.833E-01	0.00000	0.0
23	1985	0.000E+00	0.000E+00	0.0	*	4.501E-01	0.00000	0.0
24	1986	0.000E+00	0.000E+00	0.0	*	4.713E-01	0.00000	0.0
25	1987	0.000E+00	0.000E+00	0.0	*	4.394E-01	0.00000	0.0
26	1988	0.000E+00	0.000E+00	0.0	*	3.953E-01	0.00000	0.0
27	1989	0.000E+00	0.000E+00	0.0	*	4.281E-01	0.00000	0.0
28	1990	0.000E+00	0.000E+00	0.0	*	5.958E-01	0.00000	0.0
29	1991	0.000E+00	0.000E+00	0.0	*	5.864E-01	0.00000	0.0
30	1992	0.000E+00	0.000E+00	0.0	*	7.593E-01	0.00000	0.0
31	1993	0.000E+00	0.000E+00	0.0	*	7.133E-01	0.00000	0.0
32	1994	0.000E+00	0.000E+00	0.0	*	7.436E-01	0.00000	0.0
33	1995	0.000E+00	0.000E+00	0.0	*	7.934E-01	0.00000	0.0
34	1996	0.000E+00	0.000E+00	0.0	*	1.234E+00	0.00000	0.0
35	1997	0.000E+00	0.000E+00	0.0	*	1.846E+00	0.00000	0.0
36	1998	0.000E+00	0.000E+00	0.0	*	2.632E+00	0.00000	0.0

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 3

Year	Residual
1963	0.0000
1964	0.0000
1965	0.0000
1966	0.0000
1967	0.0000
1968	0.0000
1969	0.0000
1970	0.0000
1971	0.0000
1972	0.0000
1973	-0.1421
1974	-0.1012
1975	-0.4209
1976	0.1100
1977	-0.4163
1978	-0.5303
1979	-0.0793
1980	1.1377
1981	0.2677
1982	0.0000
1983	0.0000
1984	0.0000
1985	0.0000
1986	0.0000
1987	0.0000
1988	0.0000
1989	0.0000
1990	0.0000
1991	0.0000
1992	0.0000
1993	0.0000
1994	0.0000
1995	0.0000
1996	0.0000
1997	0.0000
1998	0.0000



RESULTS FOR DATA SERIES # 4 (NON-BOOTSTRAPPED) Canadian Survey - lagged

Data type I2: End-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1963	0.000E+00	0.000E+00	0.0	*	4.219E+01	0.00000	0.0
2	1964	0.000E+00	0.000E+00	0.0	*	2.969E+01	0.00000	0.0
3	1965	0.000E+00	0.000E+00	0.0	*	2.397E+01	0.00000	0.0
4	1966	0.000E+00	0.000E+00	0.0	*	2.169E+01	0.00000	0.0
5	1967	0.000E+00	0.000E+00	0.0	*	2.012E+01	0.00000	0.0
6	1968	0.000E+00	0.000E+00	0.0	*	1.790E+01	0.00000	0.0
7	1969	0.000E+00	0.000E+00	0.0	*	1.524E+01	0.00000	0.0
8	1970	0.000E+00	0.000E+00	0.0	*	1.270E+01	0.00000	0.0
9	1971	0.000E+00	0.000E+00	0.0	*	1.211E+01	0.00000	0.0
10	1972	0.000E+00	0.000E+00	0.0	*	1.070E+01	0.00000	0.0
11	1973	0.000E+00	0.000E+00	0.0	*	9.506E+00	0.00000	0.0
12	1974	0.000E+00	0.000E+00	0.0	*	8.066E+00	0.00000	0.0
13	1975	0.000E+00	0.000E+00	0.0	*	6.434E+00	0.00000	0.0
14	1976	0.000E+00	0.000E+00	0.0	*	4.786E+00	0.00000	0.0
15	1977	0.000E+00	0.000E+00	0.0	*	3.984E+00	0.00000	0.0
16	1978	0.000E+00	0.000E+00	0.0	*	4.197E+00	0.00000	0.0
17	1979	0.000E+00	0.000E+00	0.0	*	4.513E+00	0.00000	0.0
18	1980	0.000E+00	0.000E+00	0.0	*	4.738E+00	0.00000	0.0
19	1981	0.000E+00	0.000E+00	0.0	*	5.278E+00	0.00000	0.0
20	1982	0.000E+00	0.000E+00	0.0	*	3.975E+00	0.00000	0.0
21	1983	0.000E+00	0.000E+00	0.0	*	2.159E+00	0.00000	0.0
22	1984	0.000E+00	0.000E+00	0.0	*	1.422E+00	0.00000	0.0
23	1985	0.000E+00	0.000E+00	0.0	*	1.489E+00	0.00000	0.0
24	1986	1.000E+00	1.000E+00	0.0	1.264E+00	1.388E+00	-0.09383	-1.243E-01
25	1987	1.000E+00	1.000E+00	0.0	1.235E+00	1.249E+00	-0.01122	-1.393E-02
26	1988	1.000E+00	1.000E+00	0.0	4.710E-01	1.353E+00	-1.05487	-8.815E-01
27	1989	1.000E+00	1.000E+00	0.0	1.578E+00	1.882E+00	-0.17638	-3.044E-01
28	1990	1.000E+00	1.000E+00	0.0	1.759E+00	1.853E+00	-0.05193	-9.377E-02
29	1991	1.000E+00	1.000E+00	0.0	2.475E+00	2.399E+00	0.03117	7.595E-02
30	1992	1.000E+00	1.000E+00	0.0	2.642E+00	2.254E+00	0.15892	3.882E-01
31	1993	1.000E+00	1.000E+00	0.0	2.753E+00	2.349E+00	0.15855	4.036E-01
32	1994	1.000E+00	1.000E+00	0.0	2.027E+00	2.507E+00	-0.21240	-4.797E-01
33	1995	1.000E+00	1.000E+00	0.0	5.304E+00	3.899E+00	0.30778	1.405E+00
34	1996	1.000E+00	1.000E+00	0.0	1.329E+01	5.832E+00	0.82376	7.460E+00
35	1997	1.000E+00	1.000E+00	0.0	4.292E+00	8.315E+00	-0.66127	-4.023E+00
36	1998	1.000E+00	1.000E+00	0.0	1.767E+01	1.099E+01	0.47497	6.679E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 4

Year	Residual	-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
1963	0.0000	|
1964	0.0000	|
1965	0.0000	|
1966	0.0000	|
1967	0.0000	|
1968	0.0000	|
1969	0.0000	|
1970	0.0000	|
1971	0.0000	|
1972	0.0000	|
1973	0.0000	|
1974	0.0000	|
1975	0.0000	|
1976	0.0000	|
1977	0.0000	|
1978	0.0000	|
1979	0.0000	|
1980	0.0000	|
1981	0.0000	|
1982	0.0000	|
1983	0.0000	|
1984	0.0000	|
1985	0.0000	|
1986	-0.0938	==|
1987	-0.0112	|
1988	-1.0549	==========|
1989	-0.1764	====|
1990	-0.0519	=|
1991	0.0312	|=
1992	0.1589	|===
1993	0.1585	|===
1994	-0.2124	====|
1995	0.3078	|======
1996	0.8238	|================
1997	-0.6613	==========|
1998	0.4750	|=========

RESULTS OF BOOTSTRAPPED ANALYSIS

Param name	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
B1ratio	8.944E+00	7.300E+00	-18.38%	7.336E+00	2.971E+01	8.451E+00	2.971E+01	2.126E+01	2.377
K	8.871E+01	9.010E+01	1.56%	8.088E+01	9.370E+01	8.596E+01	9.049E+01	4.535E+00	0.051
r	5.968E-01	5.872E-01	-1.60%	5.434E-01	6.523E-01	5.774E-01	6.235E-01	4.612E-02	0.077
q(1)	1.103E-01	1.097E-01	-0.56%	9.524E-02	1.233E-01	1.035E-01	1.162E-01	1.269E-02	0.115
q(2)	1.458E-01	1.351E-01	-7.30%	1.287E-01	1.733E-01	1.366E-01	1.634E-01	2.678E-02	0.184
q(3)	9.914E-02	9.302E-02	-6.18%	8.084E-02	1.299E-01	8.979E-02	1.141E-01	2.433E-02	0.245
q(4)	3.168E-01	2.939E-01	-7.24%	2.626E-01	3.816E-01	2.891E-01	3.551E-01	6.597E-02	0.208
MSY	1.324E+01	1.323E+01	-0.07%	1.276E+01	1.373E+01	1.305E+01	1.345E+01	4.056E-01	0.031
Ye(1999)	1.293E+01	1.284E+01	-0.65%	1.162E+01	1.358E+01	1.233E+01	1.328E+01	9.427E-01	0.073
Bmsy	4.436E+01	4.505E+01	1.56%	4.044E+01	4.685E+01	4.298E+01	4.525E+01	2.267E+00	0.051
Fmsy	2.984E-01	2.936E-01	-1.60%	2.717E-01	3.261E-01	2.887E-01	3.117E-01	2.306E-02	0.077
fmsy(1)	2.716E+00	2.677E+00	-1.43%	2.450E+00	3.174E+00	2.596E+00	2.894E+00	2.982E-01	0.110
fmsy(2)	2.058E+00	2.173E+00	5.57%	1.700E+00	2.341E+00	1.860E+00	2.191E+00	3.314E-01	0.161
fmsy(3)	3.045E+00	3.157E+00	3.66%	2.370E+00	3.692E+00	2.633E+00	3.354E+00	7.203E-01	0.237
fmsy(4)	9.509E-01	9.991E-01	5.07%	7.882E-01	1.149E+00	8.761E-01	1.051E+00	1.753E-01	0.184
F(0.1)	2.686E-01	2.643E-01	-1.44%	2.445E-01	2.935E-01	2.598E-01	2.806E-01	2.075E-02	0.077
Y(0.1)	1.310E+01	1.309E+01	-0.07%	1.263E+01	1.359E+01	1.292E+01	1.332E+01	4.015E-01	0.031
B-ratio	8.347E-01	8.299E-01	-0.57%	6.778E-01	1.017E+00	7.504E-01	9.349E-01	1.845E-01	0.221
F-ratio	3.212E-01	3.231E-01	0.61%	2.564E-01	4.038E-01	2.833E-01	3.591E-01	7.589E-02	0.236
Y-ratio	9.736E-01	9.711E-01	-0.26%	8.999E-01	9.995E-01	9.429E-01	9.948E-01	5.195E-02	0.053
f0.1(1)	2.444E+00	2.409E+00	-1.29%	2.205E+00	2.856E+00	2.336E+00	2.604E+00	2.684E-01	0.110
f0.1(2)	1.853E+00	1.956E+00	5.01%	1.530E+00	2.107E+00	1.674E+00	1.972E+00	2.983E-01	0.161
f0.1(3)	2.741E+00	2.841E+00	3.29%	2.133E+00	3.323E+00	2.370E+00	3.018E+00	6.483E-01	0.237
f0.1(4)	8.558E-01	8.992E-01	4.56%	7.094E-01	1.034E+00	7.885E-01	9.463E-01	1.578E-01	0.184
q2/q1	1.317E+00	1.232E+00	-6.49%	1.137E+00	1.856E+00	1.222E+00	1.485E+00	2.633E-01	0.200
q3/q1	8.919E-01	8.481E-01	-4.91%	7.101E-01	1.206E+00	7.853E-01	1.034E+00	2.488E-01	0.279
q4/q1	2.843E+00	2.680E+00	-5.74%	2.329E+00	3.570E+00	2.588E+00	3.227E+00	6.392E-01	0.225

NOTES ON BOOTSTRAPPED ESTIMATES:

- The bootstrapped results shown were computed from 500 trials.
- These results are conditional on the constraints placed upon MSY and r in the input file (ASPIC.INP).
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.
- The bias corrections used here are based on medians. This is an accepted statistical procedure, but may estimate nonzero bias for unbiased, skewed estimators.

Trials replaced for lack of convergence: 44
Trials replaced for MSY out-of-bounds: 0
Trials replaced for r out-of-bounds: 12
Residual-adjustment factor: 1.0468

Georges Bank Yellowtail --Including Discards, Run 2
Trial Projection

Output from ASPIC-P.EXE Page 1
16 Apr 1999 at 02:35

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	aspic.bio
Name of output file (this file)	ytailtest.pr
Number of years of projections	1

Year	Input data	User data type
1999	1.760E+00	F:F(1998)

TRAJECTORY OF RELATIVE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1963	8.944E+00	7.300E+00	-18.38%	7.336E+00	2.971E+01	8.451E+00	2.971E+01	2.126E+01	2.377
1964	3.439E+00	3.187E+00	-7.34%	3.052E+00	7.689E+00	3.242E+00	7.524E+00	1.099E+00	0.319
1965	2.338E+00	2.243E+00	-4.06%	2.232E+00	2.690E+00	2.241E+00	2.687E+00	2.005E-01	0.086
1966	1.863E+00	1.811E+00	-2.82%	1.795E+00	2.032E+00	1.816E+00	1.932E+00	1.159E-01	0.062
1967	1.672E+00	1.638E+00	-2.00%	1.628E+00	1.754E+00	1.642E+00	1.715E+00	7.298E-02	0.044
1968	1.542E+00	1.520E+00	-1.46%	1.512E+00	1.787E+00	1.521E+00	1.574E+00	5.279E-02	0.034
1969	1.367E+00	1.352E+00	-1.09%	1.344E+00	1.758E+00	1.353E+00	1.389E+00	3.610E-02	0.026
1970	1.162E+00	1.151E+00	-0.89%	1.140E+00	1.347E+00	1.150E+00	1.178E+00	2.776E-02	0.024
1971	9.660E-01	9.595E-01	-0.66%	9.452E-01	9.974E-01	9.568E-01	9.816E-01	2.480E-02	0.026
1972	9.209E-01	9.144E-01	-0.70%	9.057E-01	9.425E-01	9.133E-01	9.318E-01	1.846E-02	0.020
1973	8.135E-01	8.082E-01	-0.65%	8.014E-01	8.320E-01	8.076E-01	8.223E-01	1.473E-02	0.018
1974	7.223E-01	7.180E-01	-0.59%	7.140E-01	7.449E-01	7.180E-01	7.313E-01	1.329E-02	0.018
1975	6.127E-01	6.093E-01	-0.55%	6.056E-01	6.272E-01	6.091E-01	6.199E-01	1.083E-02	0.018
1976	4.880E-01	4.860E-01	-0.41%	4.778E-01	5.038E-01	4.835E-01	4.933E-01	8.543E-03	0.018
1977	3.621E-01	3.615E-01	-0.15%	3.512E-01	3.762E-01	3.570E-01	3.676E-01	9.978E-03	0.028
1978	3.005E-01	3.009E-01	0.15%	2.867E-01	3.140E-01	2.942E-01	3.060E-01	1.188E-02	0.040
1979	3.169E-01	3.170E-01	0.05%	3.032E-01	3.286E-01	3.108E-01	3.218E-01	1.096E-02	0.035
1980	3.415E-01	3.409E-01	-0.18%	3.317E-01	3.536E-01	3.374E-01	3.466E-01	9.227E-03	0.027
1981	3.592E-01	3.579E-01	-0.37%	3.530E-01	1.050E+00	3.562E-01	1.046E+00	6.101E-03	0.017
1982	4.009E-01	3.987E-01	-0.55%	3.960E-01	1.928E+00	3.989E-01	1.928E+00	1.529E+00	3.815
1983	3.019E-01	3.003E-01	-0.53%	2.994E-01	1.860E+00	3.004E-01	8.787E-01	3.087E-03	0.010
1984	1.636E-01	1.631E-01	-0.32%	1.597E-01	5.895E-01	1.618E-01	1.656E-01	2.910E-03	0.018
1985	1.072E-01	1.074E-01	0.17%	1.030E-01	1.121E-01	1.054E-01	1.092E-01	3.868E-03	0.036
1986	1.124E-01	1.125E-01	0.11%	1.081E-01	1.169E-01	1.103E-01	1.141E-01	3.739E-03	0.033
1987	1.046E-01	1.049E-01	0.27%	9.989E-02	1.095E-01	1.024E-01	1.067E-01	4.306E-03	0.041
1988	9.357E-02	9.434E-02	0.82%	8.773E-02	9.991E-02	9.074E-02	9.630E-02	5.565E-03	0.059
1989	1.011E-01	1.022E-01	1.08%	9.406E-02	1.090E-01	9.774E-02	1.046E-01	6.890E-03	0.068
1990	1.413E-01	1.422E-01	0.64%	1.344E-01	1.499E-01	1.382E-01	1.454E-01	7.141E-03	0.051
1991	1.382E-01	1.399E-01	1.25%	1.301E-01	1.496E-01	1.345E-01	1.436E-01	9.148E-03	0.066
1992	1.800E-01	1.812E-01	0.69%	1.713E-01	1.951E-01	1.749E-01	1.871E-01	1.223E-02	0.068
1993	1.672E-01	1.702E-01	1.79%	1.538E-01	1.894E-01	1.604E-01	1.795E-01	1.712E-02	0.102
1994	1.720E-01	1.775E-01	3.20%	1.540E-01	2.089E-01	1.601E-01	1.903E-01	2.770E-02	0.161
1995	1.814E-01	1.893E-01	4.35%	1.500E-01	2.348E-01	1.638E-01	2.056E-01	4.180E-02	0.230
1996	2.877E-01	2.945E-01	2.36%	2.349E-01	3.674E-01	2.605E-01	3.277E-01	6.717E-02	0.233
1997	4.344E-01	4.405E-01	1.42%	3.505E-01	5.524E-01	3.870E-01	4.889E-01	1.019E-01	0.235
1998	6.258E-01	6.280E-01	0.36%	5.007E-01	7.764E-01	5.554E-01	6.991E-01	1.437E-01	0.230
1999	8.347E-01	8.299E-01	-0.57%	6.778E-01	1.017E+00	7.504E-01	9.349E-01	1.845E-01	0.221
2000	9.778E-01	9.697E-01	-0.83%	7.945E-01	1.173E+00	8.883E-01	1.089E+00	2.011E-01	0.206

TRAJECTORY OF RELATIVE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1963	2.461E-01	2.912E-01	18.35%	2.965E-02	2.908E-01	2.965E-02	2.692E-01	2.396E-01	0.974
1964	5.366E-01	5.688E-01	6.01%	2.914E-02	5.942E-01	2.914E-02	5.637E-01	5.210E-01	0.971
1965	7.072E-01	7.308E-01	3.34%	2.515E-02	7.358E-01	2.515E-02	7.222E-01	6.868E-01	0.971
1966	6.120E-01	6.251E-01	2.13%	1.870E-02	6.251E-01	1.870E-02	6.227E-01	6.040E-01	0.987
1967	6.724E-01	6.820E-01	1.42%	2.333E-01	6.839E-01	3.459E-01	6.812E-01	3.535E-02	0.053
1968	9.582E-01	9.697E-01	1.20%	2.367E-01	9.778E-01	9.377E-01	9.696E-01	1.308E-02	0.014
1969	1.292E+00	1.305E+00	0.97%	7.752E-01	1.317E+00	1.288E+00	1.305E+00	1.741E-02	0.013
1970	1.561E+00	1.573E+00	0.78%	1.487E+00	1.586E+00	1.553E+00	1.574E+00	1.794E-02	0.011
1971	1.220E+00	1.228E+00	0.69%	1.174E+00	1.242E+00	1.213E+00	1.229E+00	1.696E-02	0.014
1972	1.552E+00	1.562E+00	0.64%	1.507E+00	1.583E+00	1.538E+00	1.564E+00	2.622E-02	0.017
1973	1.633E+00	1.642E+00	0.61%	1.580E+00	1.668E+00	1.614E+00	1.645E+00	3.168E-02	0.019
1974	1.887E+00	1.899E+00	0.60%	1.844E+00	1.933E+00	1.863E+00	1.903E+00	4.033E-02	0.021
1975	2.215E+00	2.227E+00	0.52%	2.167E+00	2.264E+00	2.190E+00	2.232E+00	4.228E-02	0.019
1976	2.580E+00	2.588E+00	0.32%	1.328E+00	2.611E+00	2.562E+00	2.591E+00	2.899E-02	0.011
1977	2.292E+00	2.295E+00	0.14%	1.182E-01	2.313E+00	2.281E+00	2.300E+00	5.915E-03	0.003
1978	1.513E+00	1.514E+00	0.03%	7.660E-02	1.524E+00	7.934E-01	1.518E+00	7.677E-03	0.005
1979	1.421E+00	1.424E+00	0.20%	7.056E-02	1.434E+00	7.056E-02	1.426E+00	1.352E+00	0.952
1980	1.480E+00	1.485E+00	0.32%	7.583E-01	1.503E+00	7.664E-01	1.488E+00	1.262E-02	0.009
1981	1.247E+00	1.254E+00	0.58%	1.216E+00	1.283E+00	1.230E+00	1.259E+00	2.919E-02	0.023
1982	2.599E+00	2.619E+00	0.76%	2.503E+00	2.709E+00	2.553E+00	2.639E+00	8.528E-02	0.033
1983	3.831E+00	3.855E+00	0.64%	3.712E+00	3.964E+00	3.773E+00	3.882E+00	1.086E-01	0.028
1984	3.283E+00	3.289E+00	0.18%	3.221E+00	3.344E+00	3.254E+00	3.307E+00	3.001E-02	0.009
1985	1.735E+00	1.733E+00	-0.10%	1.723E+00	1.746E+00	1.726E+00	1.740E+00	7.108E-03	0.004
1986	2.135E+00	2.130E+00	-0.24%	2.100E+00	2.154E+00	2.119E+00	2.143E+00	1.461E-02	0.007
1987	2.276E+00	2.261E+00	-0.66%	2.215E+00	2.312E+00	2.248E+00	2.292E+00	4.247E-02	0.019
1988	1.649E+00	1.630E+00	-1.16%	1.578E+00	1.696E+00	1.618E+00	1.670E+00	5.202E-02	0.032
1989	7.612E-01	7.530E-01	-1.08%	7.312E-01	7.810E-01	7.480E-01	7.683E-01	2.029E-02	0.027
1990	1.930E+00	1.913E+00	-0.90%	1.846E+00	1.991E+00	1.882E+00	1.959E+00	6.325E-02	0.033
1991	9.721E-01	9.601E-01	-1.23%	9.094E-01	1.015E+00	9.406E-01	9.934E-01	4.764E-02	0.049
1992	2.069E+00	2.037E+00	-1.55%	1.882E+00	2.206E+00	1.978E+00	2.138E+00	1.506E-01	0.073
1993	1.728E+00	1.685E+00	-2.53%	1.496E+00	1.901E+00	1.607E+00	1.814E+00	2.079E-01	0.120
1994	1.655E+00	1.596E+00	-3.56%	1.341E+00	1.927E+00	1.476E+00	1.782E+00	3.061E-01	0.185
1995	2.643E-01	2.569E-01	-2.80%	2.098E-01	3.261E-01	2.350E-01	2.963E-01	6.133E-02	0.232
1996	2.689E-01	2.645E-01	-1.65%	2.100E-01	3.335E-01	2.377E-01	3.010E-01	6.325E-02	0.235
1997	2.629E-01	2.610E-01	-0.70%	2.064E-01	3.315E-01	2.342E-01	2.987E-01	6.450E-02	0.245
1998	3.212E-01	3.231E-01	0.61%	2.564E-01	4.038E-01	2.833E-01	3.591E-01	7.589E-02	0.236
1999	5.653E-01	5.687E-01	0.61%	4.512E-01	7.107E-01	4.985E-01	6.321E-01	1.336E-01	0.236

TABLE OF PROJECTED YIELDS

1999	6.836E+00	6.778E+00	-0.84%	6.669E+00	6.933E+00	6.754E+00	6.873E+00	1.184E-01	0.017

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

TRAJECTORY OF ABSOLUTE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1963	4.025E+02	3.289E+02	-18.30%	3.298E+02	1.398E+03	3.708E+02	1.398E+03	1.027E+03	2.553
1964	1.527E+02	1.436E+02	-5.97%	1.328E+02	3.508E+02	1.445E+02	3.457E+02	2.279E+01	0.149
1965	1.034E+02	1.010E+02	-2.32%	9.523E+01	1.160E+02	9.976E+01	1.107E+02	9.340E+00	0.090
1966	8.234E+01	8.157E+01	-0.93%	7.604E+01	9.265E+01	8.010E+01	8.610E+01	6.008E+00	0.073
1967	7.393E+01	7.380E+01	-0.17%	6.765E+01	8.008E+01	7.121E+01	7.637E+01	5.158E+00	0.070
1968	6.827E+01	6.846E+01	0.28%	6.311E+01	7.370E+01	6.593E+01	7.044E+01	4.511E+00	0.066
1969	6.059E+01	6.091E+01	0.53%	5.601E+01	6.488E+01	5.840E+01	6.228E+01	3.881E+00	0.064
1970	5.150E+01	5.186E+01	0.70%	4.774E+01	5.531E+01	4.971E+01	5.303E+01	3.323E+00	0.065
1971	4.284E+01	4.323E+01	0.89%	3.967E+01	4.622E+01	4.131E+01	4.424E+01	2.933E+00	0.068
1972	4.081E+01	4.119E+01	0.94%	3.812E+01	4.383E+01	3.953E+01	4.209E+01	2.566E+00	0.063
1973	3.604E+01	3.641E+01	1.04%	3.378E+01	3.861E+01	3.490E+01	3.710E+01	2.202E+00	0.061
1974	3.200E+01	3.235E+01	1.09%	2.992E+01	3.417E+01	3.102E+01	3.282E+01	1.801E+00	0.056
1975	2.713E+01	2.745E+01	1.17%	2.542E+01	2.903E+01	2.635E+01	2.788E+01	1.532E+00	0.056
1976	2.162E+01	2.189E+01	1.25%	2.019E+01	2.324E+01	2.096E+01	2.226E+01	1.301E+00	0.060
1977	1.604E+01	1.629E+01	1.52%	1.475E+01	1.748E+01	1.539E+01	1.658E+01	1.191E+00	0.074
1978	1.332E+01	1.356E+01	1.79%	1.206E+01	1.473E+01	1.268E+01	1.384E+01	1.165E+00	0.087
1979	1.404E+01	1.428E+01	1.69%	1.277E+01	1.544E+01	1.340E+01	1.456E+01	1.167E+00	0.083
1980	1.513E+01	1.536E+01	1.51%	1.388E+01	1.647E+01	1.450E+01	1.563E+01	1.128E+00	0.075
1981	1.592E+01	1.612E+01	1.30%	1.478E+01	1.713E+01	1.534E+01	1.637E+01	1.029E+00	0.065
1982	1.779E+01	1.796E+01	0.94%	1.687E+01	1.876E+01	1.733E+01	1.813E+01	8.036E-01	0.045
1983	1.341E+01	1.353E+01	0.89%	1.279E+01	1.410E+01	1.309E+01	1.365E+01	5.560E-01	0.041
1984	7.257E+00	7.346E+00	1.22%	6.806E+00	7.774E+00	7.017E+00	7.434E+00	4.169E-01	0.057
1985	4.756E+00	4.839E+00	1.74%	4.343E+00	5.232E+00	4.538E+00	4.918E+00	3.803E-01	0.080
1986	4.982E+00	5.067E+00	1.71%	4.571E+00	5.475E+00	4.768E+00	5.152E+00	3.835E-01	0.077
1987	4.634E+00	4.724E+00	1.94%	4.221E+00	5.132E+00	4.419E+00	4.813E+00	3.941E-01	0.085
1988	4.149E+00	4.250E+00	2.42%	3.693E+00	4.685E+00	3.902E+00	4.333E+00	4.310E-01	0.104
1989	4.471E+00	4.602E+00	2.94%	3.938E+00	5.082E+00	4.196E+00	4.681E+00	4.853E-01	0.109
1990	6.236E+00	6.405E+00	2.72%	5.687E+00	6.958E+00	5.962E+00	6.523E+00	5.609E-01	0.090
1991	6.087E+00	6.304E+00	3.57%	5.536E+00	6.958E+00	5.832E+00	6.457E+00	6.255E-01	0.103
1992	7.877E+00	8.163E+00	3.63%	7.208E+00	8.841E+00	7.551E+00	8.291E+00	7.401E-01	0.094
1993	7.284E+00	7.669E+00	5.29%	6.601E+00	8.590E+00	6.901E+00	7.891E+00	8.490E-01	0.117
1994	7.531E+00	7.994E+00	6.15%	6.526E+00	9.228E+00	7.053E+00	8.256E+00	1.203E+00	0.160
1995	7.886E+00	8.529E+00	8.16%	6.240E+00	1.037E+01	7.255E+00	9.104E+00	1.849E+00	0.234
1996	1.232E+01	1.327E+01	7.65%	1.004E+01	1.612E+01	1.134E+01	1.434E+01	3.005E+00	0.244
1997	1.878E+01	1.985E+01	5.68%	1.553E+01	2.395E+01	1.718E+01	2.155E+01	4.370E+00	0.233
1998	2.713E+01	2.829E+01	4.29%	2.243E+01	3.379E+01	2.470E+01	3.051E+01	5.816E+00	0.214
1999	3.621E+01	3.738E+01	3.24%	3.029E+01	4.363E+01	3.315E+01	4.000E+01	6.851E+00	0.189
2000	4.262E+01	4.368E+01	2.50%	3.516E+01	5.064E+01	3.900E+01	4.650E+01	7.495E+00	0.176

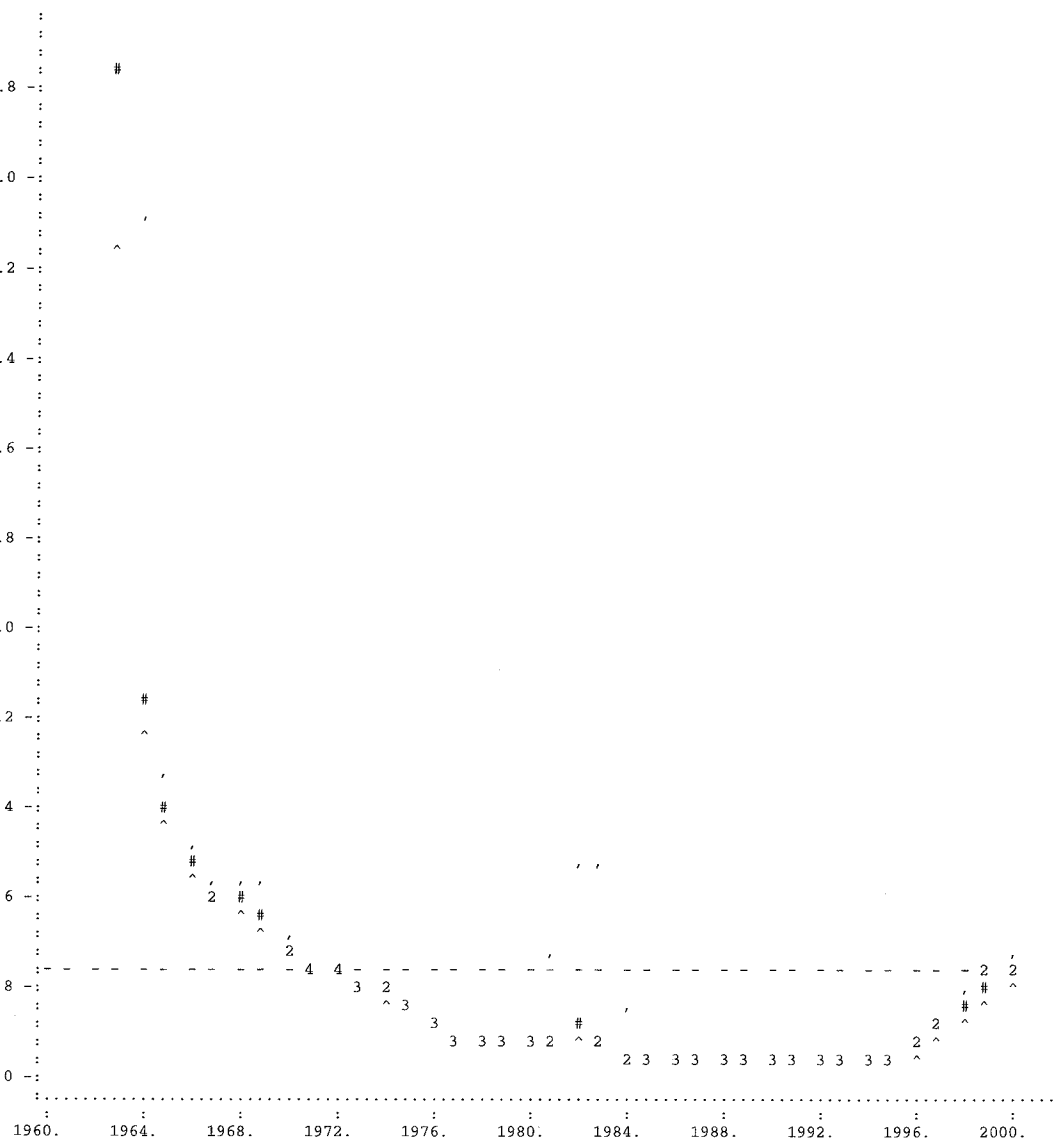
NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

TRAJECTORY OF ABSOLUTE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1963	7.306E-02	8.551E-02	17.04%	4.078E-02	8.606E-02	4.078E-02	8.398E-02	4.320E-02	0.591
1964	1.597E-01	1.670E-01	4.60%	1.152E-01	1.805E-01	1.205E-01	1.741E-01	1.763E-02	0.110
1965	2.114E-01	2.146E-01	1.48%	1.792E-01	2.289E-01	2.010E-01	2.182E-01	1.715E-02	0.081
1966	1.826E-01	1.835E-01	0.52%	1.652E-01	1.984E-01	1.751E-01	1.888E-01	1.373E-02	0.075
1967	2.004E-01	2.002E-01	-0.08%	1.855E-01	2.182E-01	1.942E-01	2.078E-01	1.358E-02	0.068
1968	2.858E-01	2.847E-01	-0.38%	2.665E-01	3.088E-01	2.779E-01	2.964E-01	1.854E-02	0.065
1969	3.856E-01	3.831E-01	-0.64%	3.591E-01	4.161E-01	3.740E-01	3.995E-01	2.546E-02	0.066
1970	4.656E-01	4.618E-01	-0.82%	4.320E-01	5.026E-01	4.510E-01	4.829E-01	3.197E-02	0.069
1971	3.640E-01	3.607E-01	-0.90%	3.381E-01	3.914E-01	3.527E-01	3.767E-01	2.393E-02	0.066
1972	4.632E-01	4.587E-01	-0.97%	4.322E-01	4.951E-01	4.500E-01	4.790E-01	2.898E-02	0.063
1973	4.874E-01	4.823E-01	-1.05%	4.562E-01	5.225E-01	4.753E-01	5.032E-01	2.788E-02	0.057
1974	5.639E-01	5.575E-01	-1.13%	5.272E-01	6.014E-01	5.493E-01	5.813E-01	3.205E-02	0.057
1975	6.615E-01	6.538E-01	-1.17%	6.173E-01	7.048E-01	6.434E-01	6.822E-01	3.878E-02	0.059
1976	7.702E-01	7.599E-01	-1.33%	7.113E-01	8.312E-01	7.464E-01	7.991E-01	5.271E-02	0.068
1977	6.845E-01	6.738E-01	-1.57%	6.243E-01	7.502E-01	6.616E-01	7.168E-01	5.525E-02	0.081
1978	4.520E-01	4.445E-01	-1.65%	4.104E-01	4.981E-01	4.360E-01	4.746E-01	3.856E-02	0.085
1979	4.245E-01	4.180E-01	-1.52%	3.878E-01	4.645E-01	4.100E-01	4.439E-01	3.383E-02	0.080
1980	4.419E-01	4.359E-01	-1.35%	4.080E-01	4.785E-01	4.286E-01	4.596E-01	3.101E-02	0.070
1981	3.724E-01	3.683E-01	-1.08%	3.498E-01	3.966E-01	3.641E-01	3.842E-01	2.014E-02	0.054
1982	7.759E-01	7.690E-01	-0.89%	7.367E-01	8.160E-01	7.616E-01	7.957E-01	3.419E-02	0.044
1983	1.144E+00	1.132E+00	-1.01%	1.078E+00	1.208E+00	1.120E+00	1.176E+00	5.582E-02	0.049
1984	9.793E-01	9.656E-01	-1.40%	9.038E-01	1.058E+00	9.527E-01	1.020E+00	6.692E-02	0.068
1985	5.174E-01	5.088E-01	-1.66%	4.705E-01	5.652E-01	5.008E-01	5.416E-01	4.084E-02	0.079
1986	6.364E-01	6.254E-01	-1.72%	5.771E-01	6.951E-01	6.147E-01	6.662E-01	5.153E-02	0.081
1987	6.777E-01	6.638E-01	-2.05%	6.070E-01	7.528E-01	6.515E-01	7.161E-01	6.459E-02	0.095
1988	4.908E-01	4.787E-01	-2.46%	4.335E-01	5.539E-01	4.700E-01	5.235E-01	5.351E-02	0.109
1989	2.271E-01	2.211E-01	-2.63%	2.021E-01	2.531E-01	2.178E-01	2.400E-01	2.222E-02	0.098
1990	5.781E-01	5.617E-01	-2.84%	5.127E-01	6.320E-01	5.496E-01	6.030E-01	5.341E-02	0.092
1991	2.915E-01	2.819E-01	-3.30%	2.576E-01	3.163E-01	2.769E-01	3.027E-01	2.580E-02	0.088
1992	6.226E-01	5.981E-01	-3.92%	5.459E-01	6.830E-01	5.870E-01	6.463E-01	5.927E-02	0.095
1993	5.192E-01	4.947E-01	-4.73%	4.365E-01	6.001E-01	4.801E-01	5.489E-01	6.883E-02	0.133
1994	4.980E-01	4.686E-01	-5.90%	3.978E-01	6.048E-01	4.481E-01	5.411E-01	9.305E-02	0.187
1995	8.043E-02	7.543E-02	-6.22%	6.184E-02	9.842E-02	7.008E-02	8.794E-02	1.786E-02	0.222
1996	8.230E-02	7.765E-02	-5.65%	6.353E-02	9.933E-02	7.165E-02	8.993E-02	1.828E-02	0.222
1997	8.025E-02	7.664E-02	-4.50%	6.418E-02	9.701E-02	7.092E-02	8.820E-02	1.728E-02	0.215
1998	9.784E-02	9.488E-02	-3.03%	8.044E-02	1.190E-01	8.814E-02	1.078E-01	1.970E-02	0.201
1999	1.722E-01	1.670E-01	-3.03%	1.416E-01	2.095E-01	1.551E-01	1.898E-01	3.467E-02	0.201

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

Bias-Corrected Time Plot of B-Ratio (#) with Approximate 80% Confidence Interval (^,)
(Dashed reference line is 1.0)



NOTE: At least one upper confidence limit was omitted from the plot.

NOTE: Estimates beginning in 2000 depend on the user projection data listed on page 1.

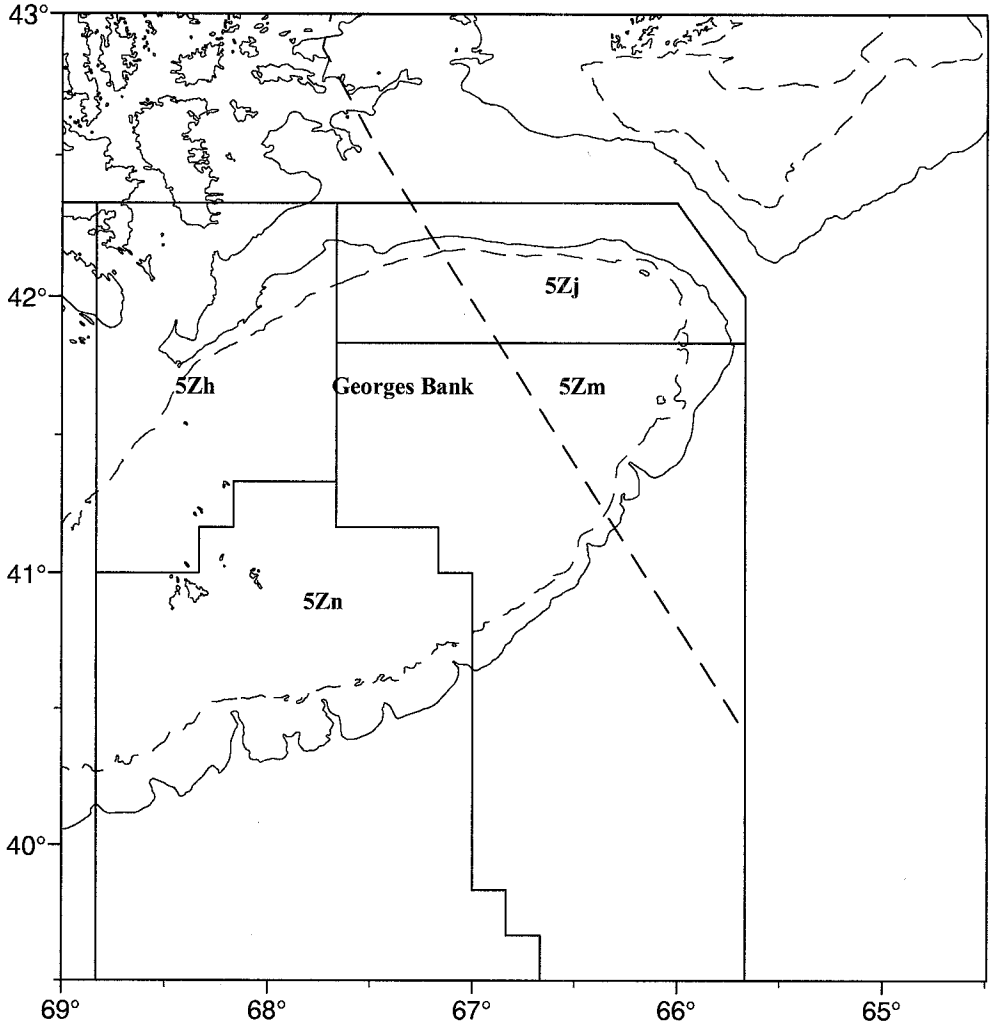


Fig. 1. Canadian fisheries statistical unit areas in NAFO Subdivision 5Ze.

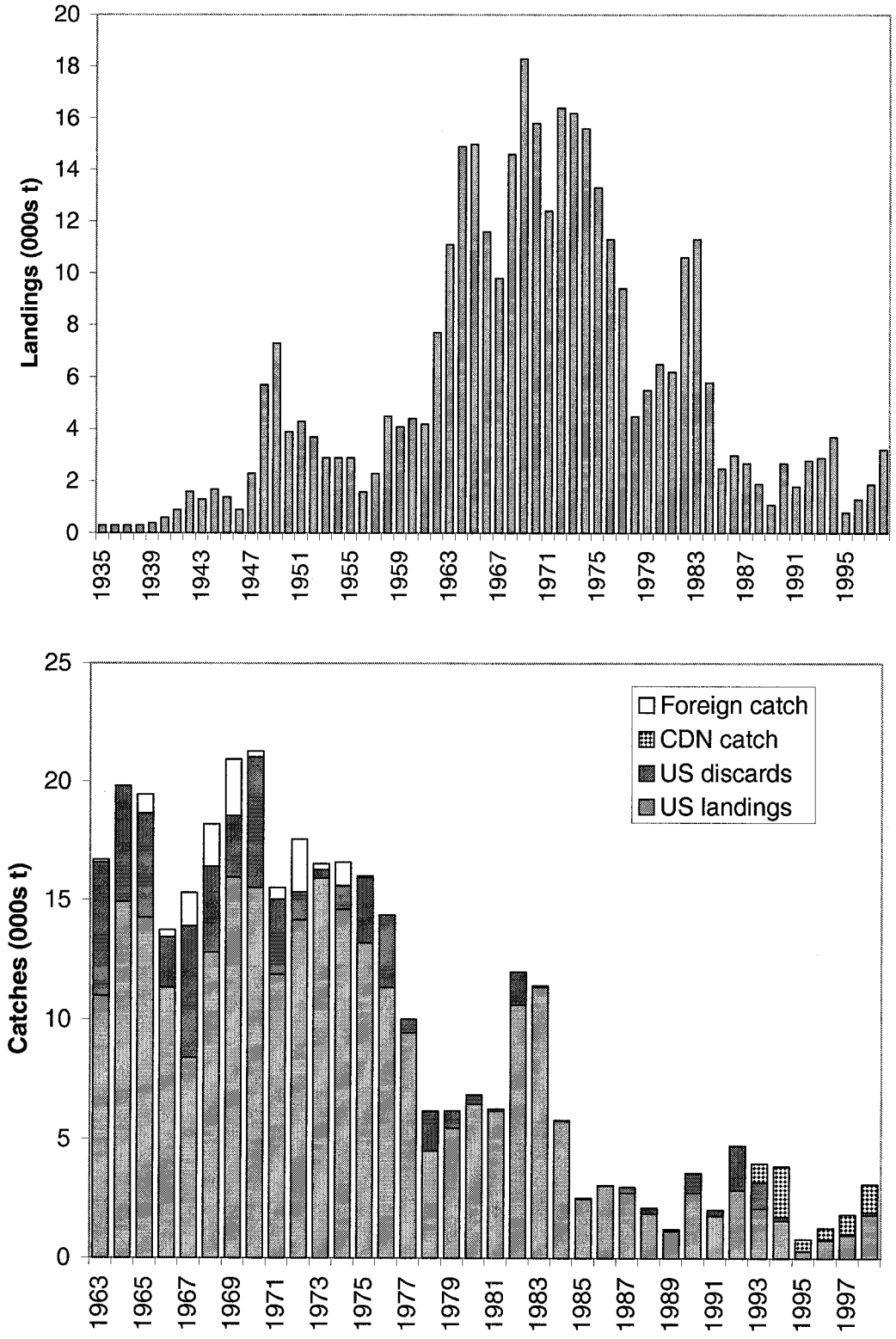


Fig. 2 . Landings of Georges Bank yellowtail flounder by Canada and the United States. The top panel shows landings (exclusive of discarding) from 1935 – 1998, and the bottom panel shows the national composition of catches from 1963 – 1998.

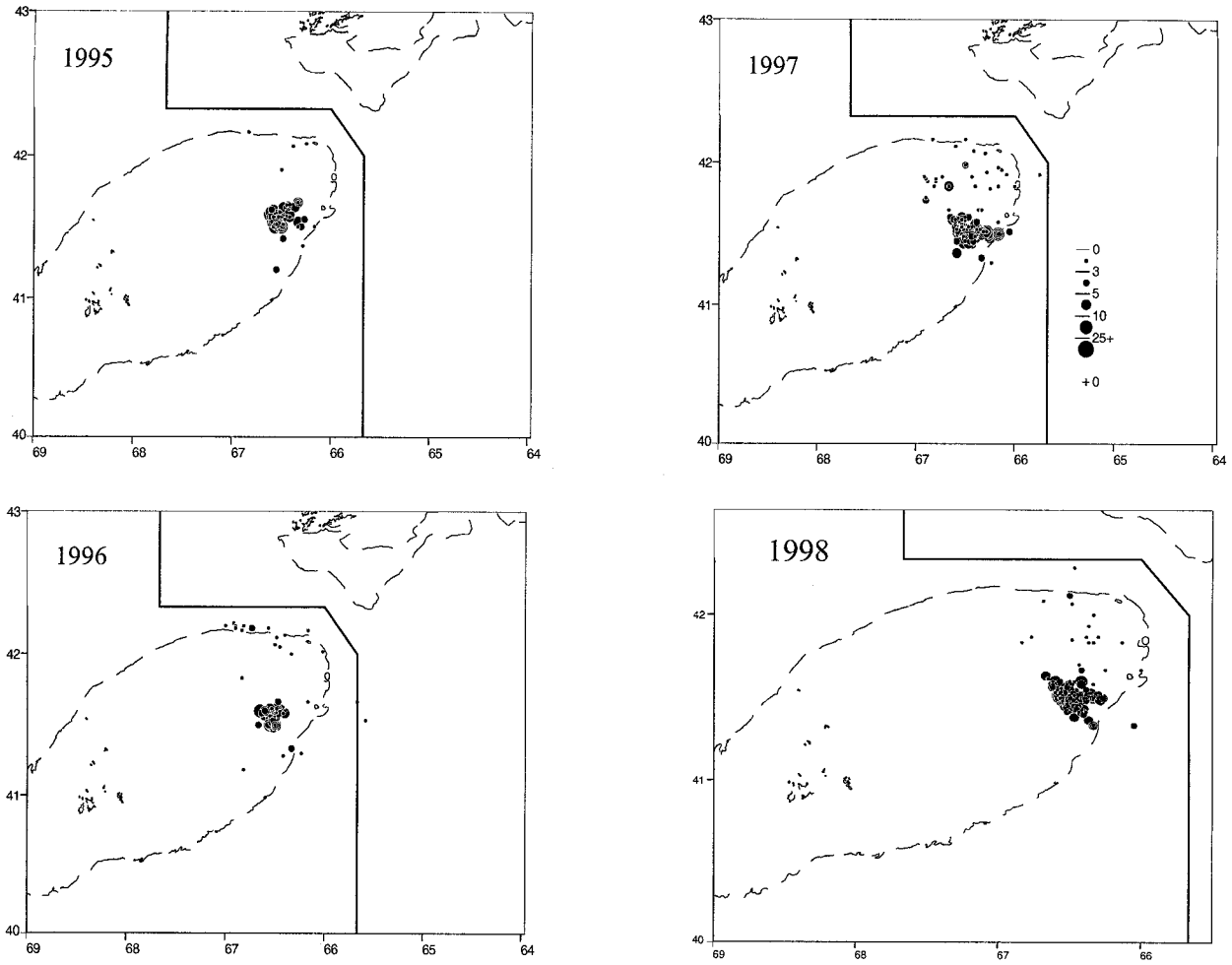
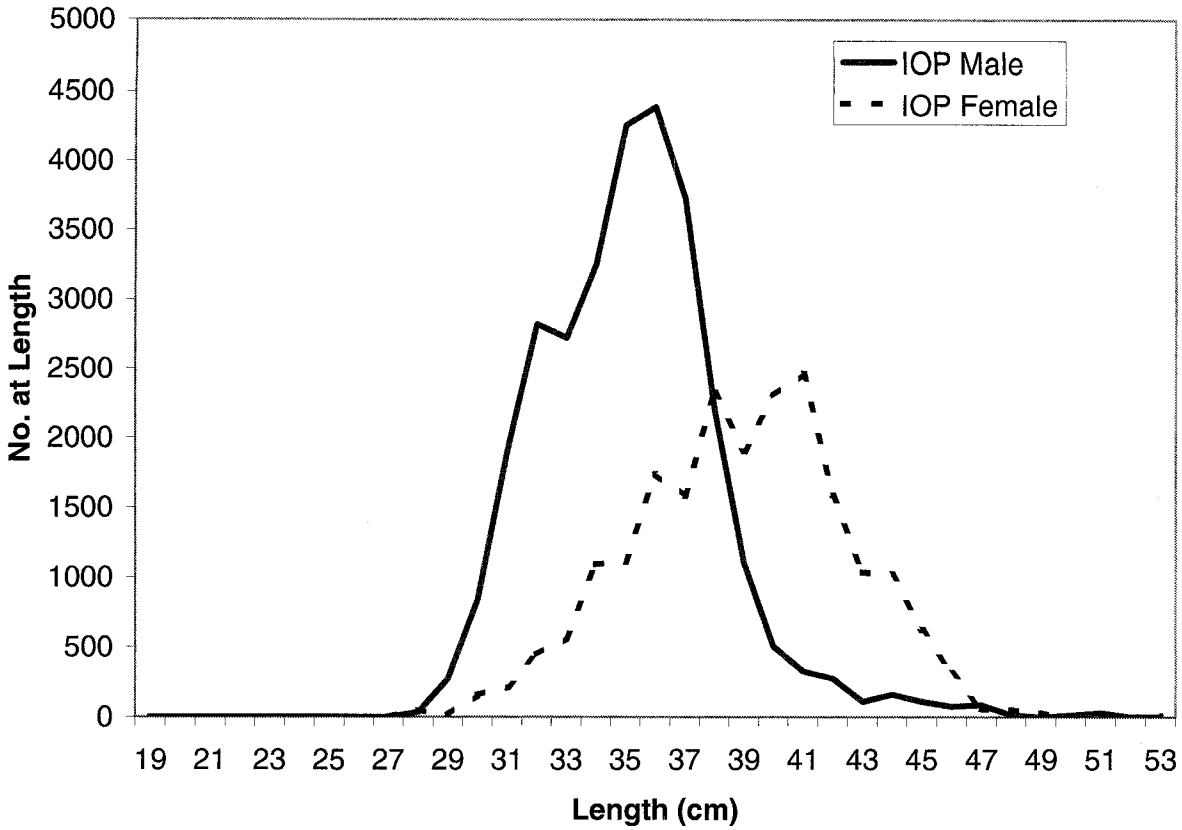


Fig 3. Distribution of Canadian mobile gear (TC 2 & 3) effort for 1995-98 where trip landings of yellowtail were > 0.5t, expanding symbols represent metric tonnes.



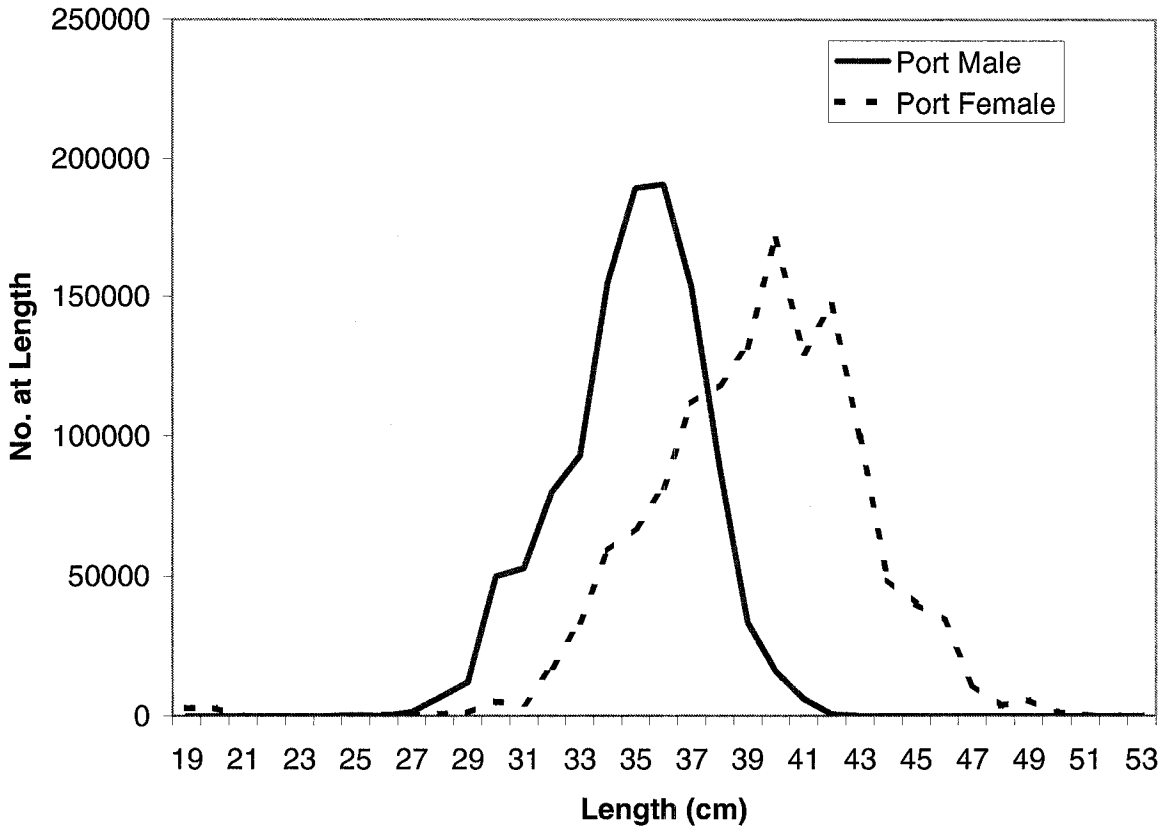
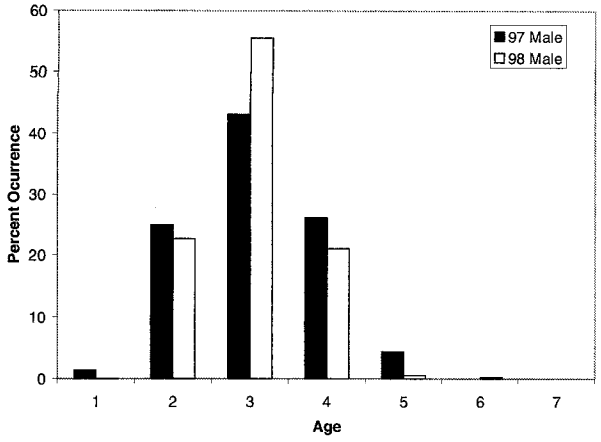
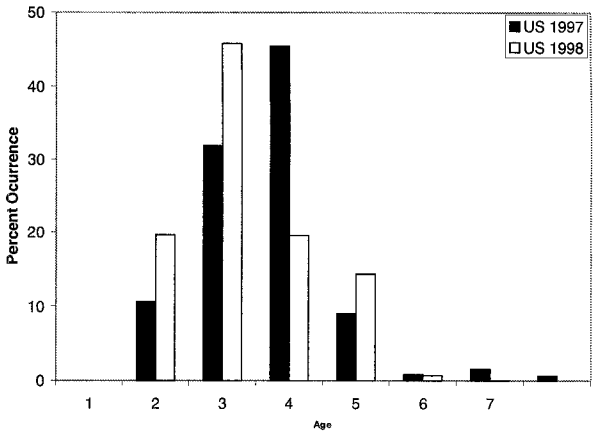


Fig. 4. Comparison of length frequency distributions of samples observed in 1998 by port technicians (Port) with those at sea samples collected with the Observer Program (IOP), 1998, Georges Bank.





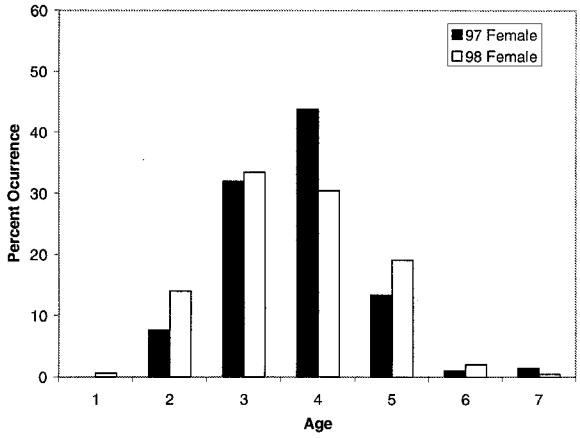


Fig. 5. Comparison of yellowtail flounder fishery age composition, 1997 and 1998, f or Canadian (left panels, males and females) and USA (right panel, sexes aggregated) catches on Georges Bank.

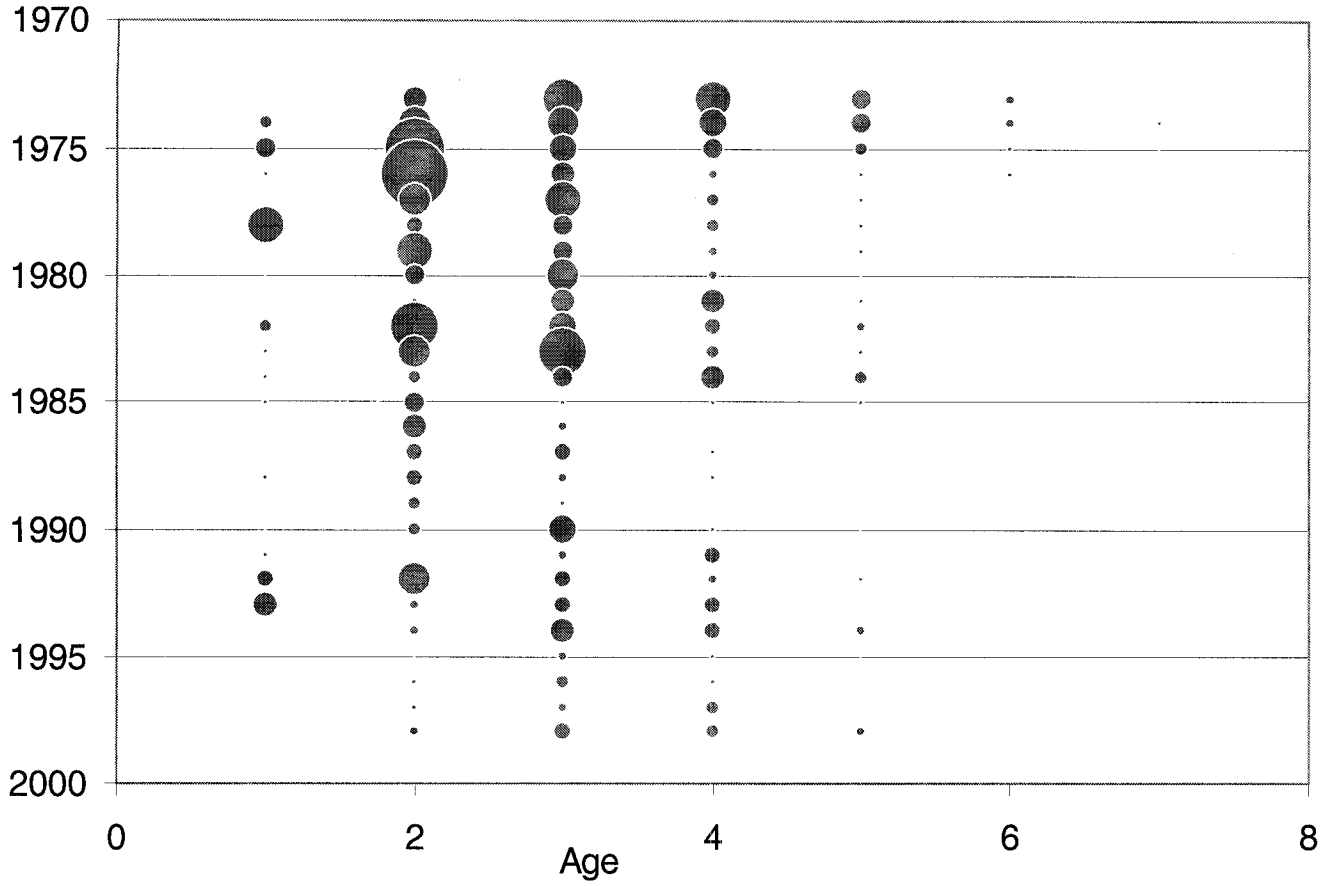


Fig. 6. Bubble plot in which the area of the bubble is proportional to the magnitude of the catch at age for Georges Bank yellowtail flounder, Canada and USA fisheries combined. Refer to Table 3 for the absolute value of the catch at age.

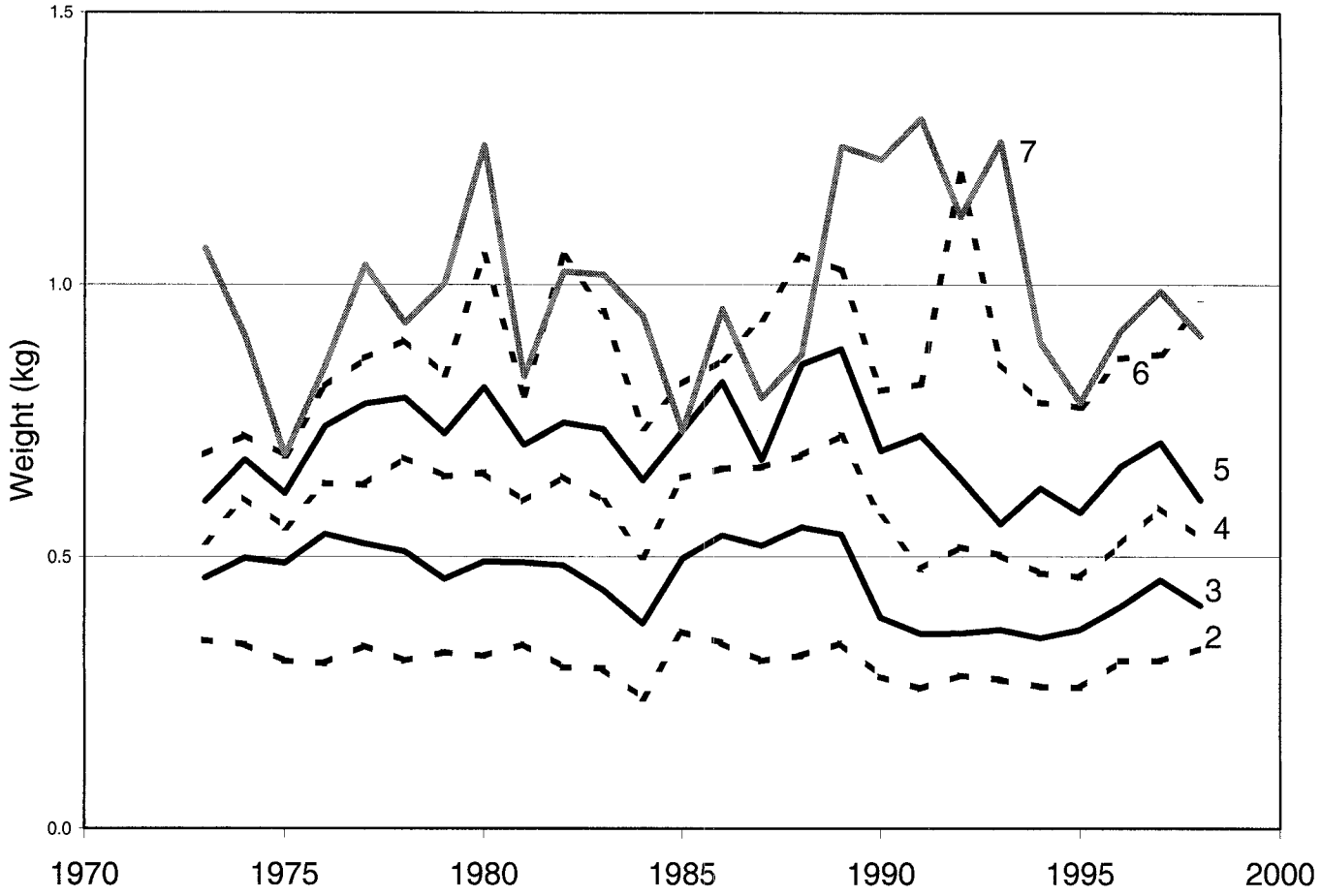


Fig. 7. Trend in mean weight at age from the 5Zjhmn yellowtail fishery, 1973 to 1998 (Canada and USA).

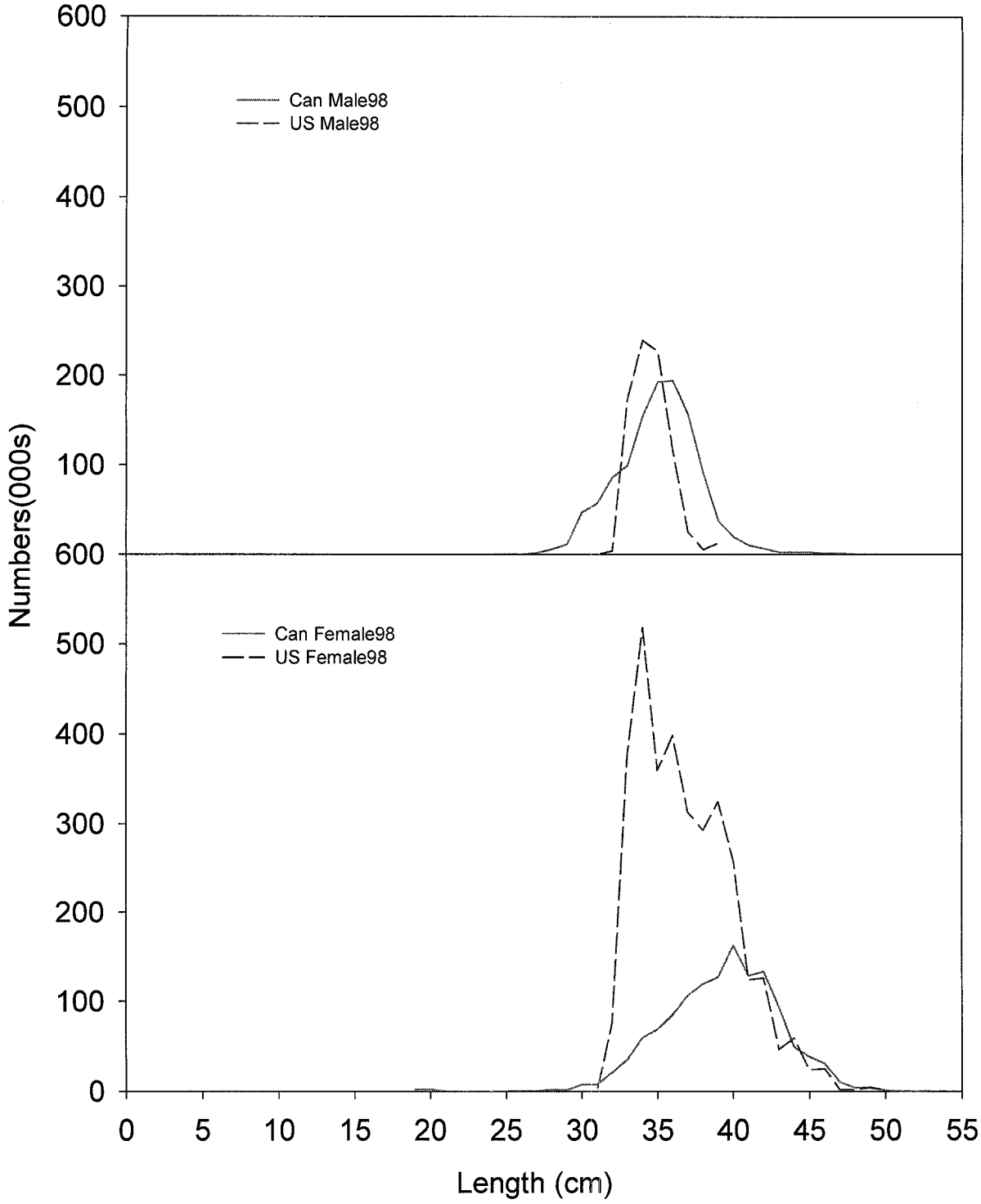


Fig. 8. Comparison of 5Zjhmn yellowtail fishery length composition in 1998 (Canada and USA).

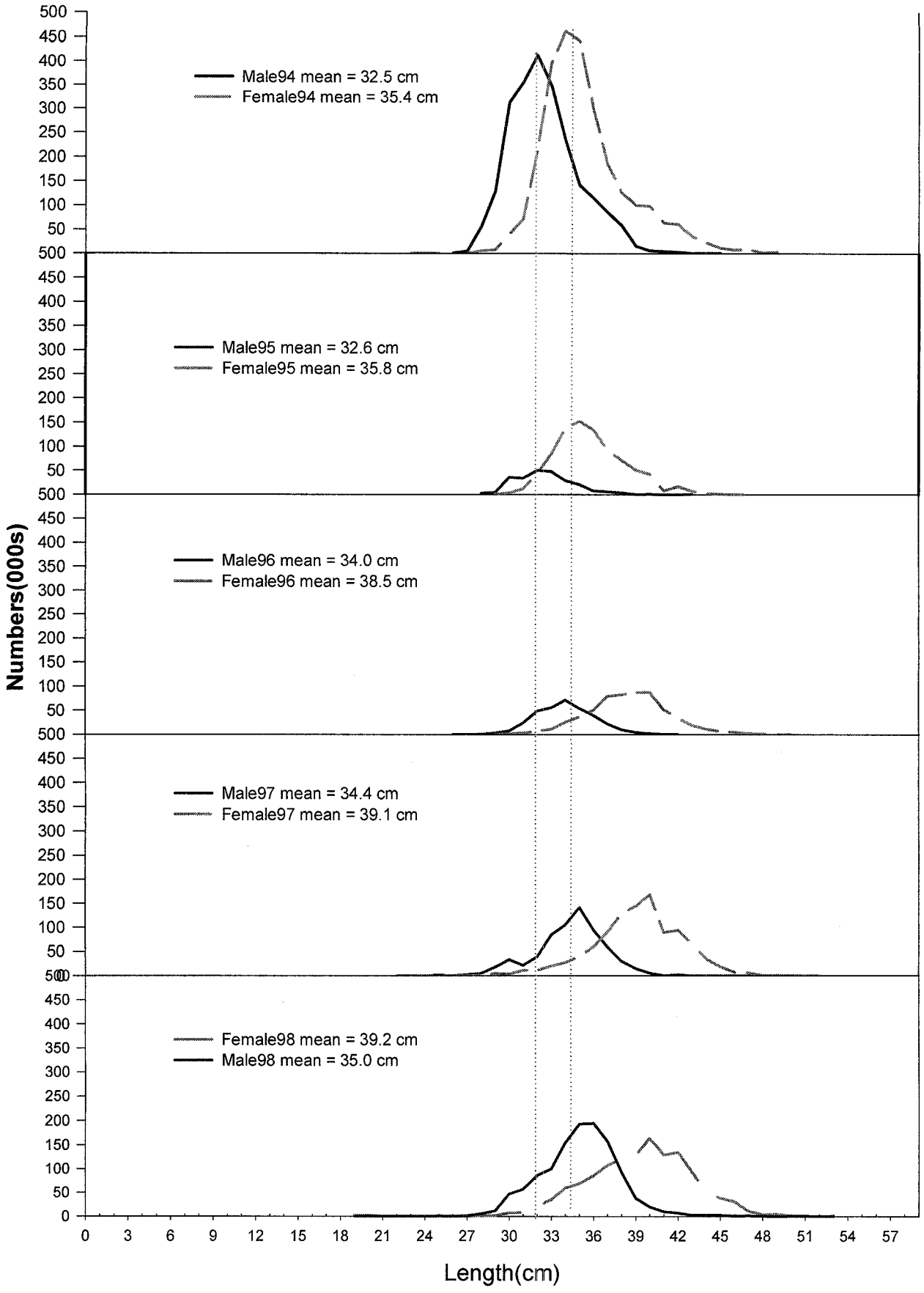


Fig. 9. Comparison of the yellowtail flounder length frequency composition taken in the Canadian Georges Bank fishery from 1994 to 1998.

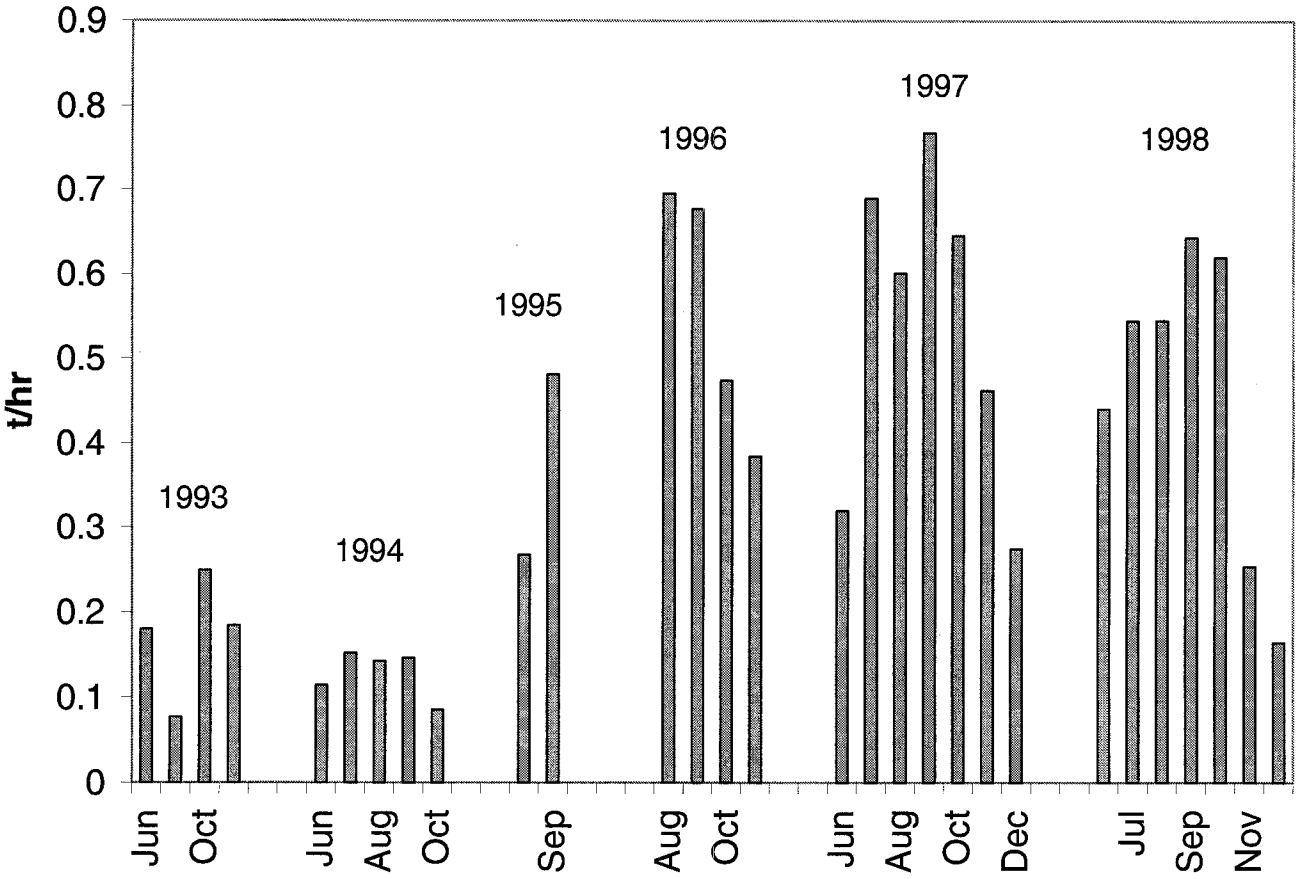


Fig. 10. Mean monthly catch rates of stern trawlers (TC 2-3), Georges Bank Yellowtail flounder, 1993 to 1998. Selected records included 5Zm only.

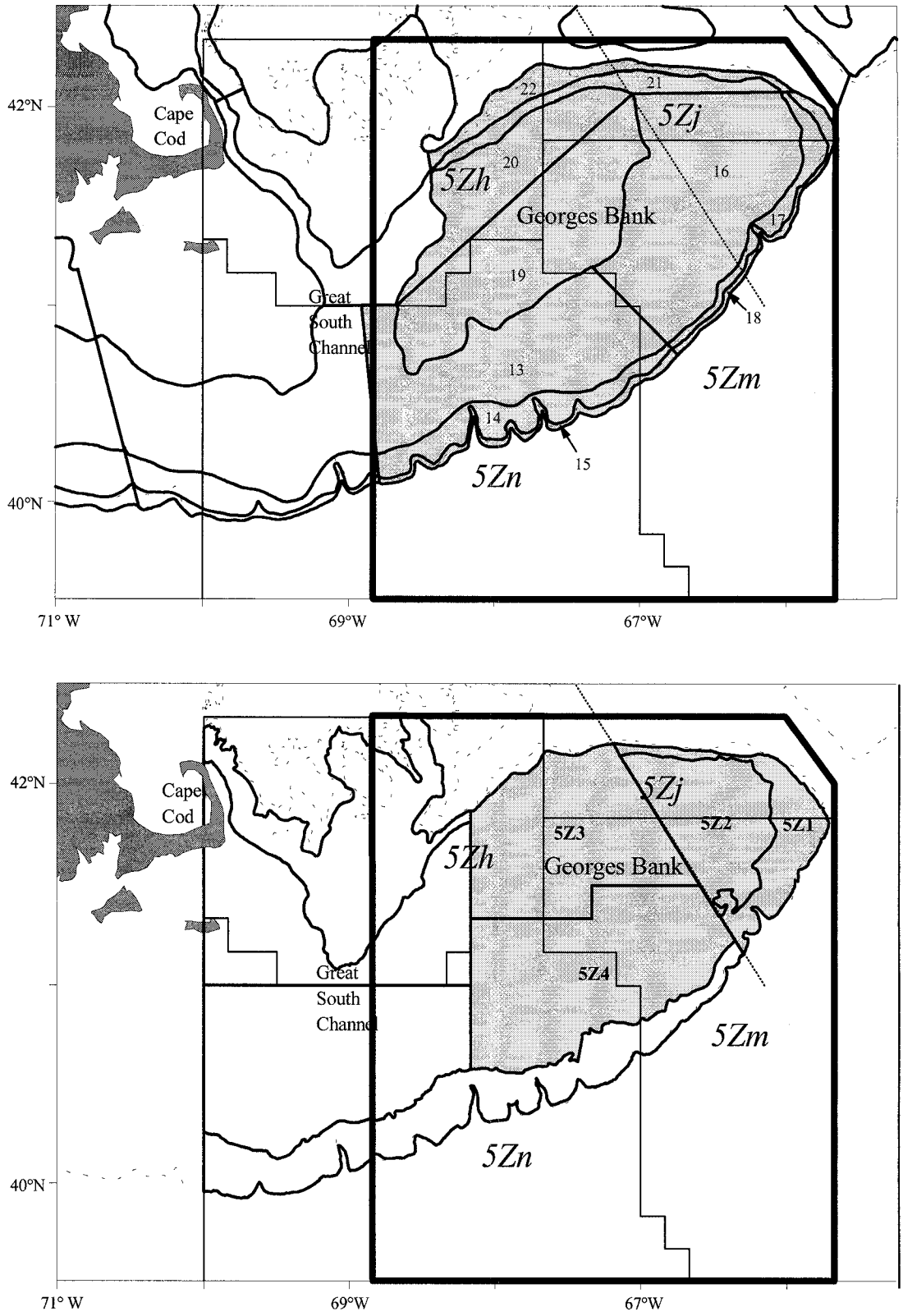


Fig. 11. USA (top) and Canadian (bottom) strata used to derive research survey abundance indices for Georges Bank groundfish surveys.

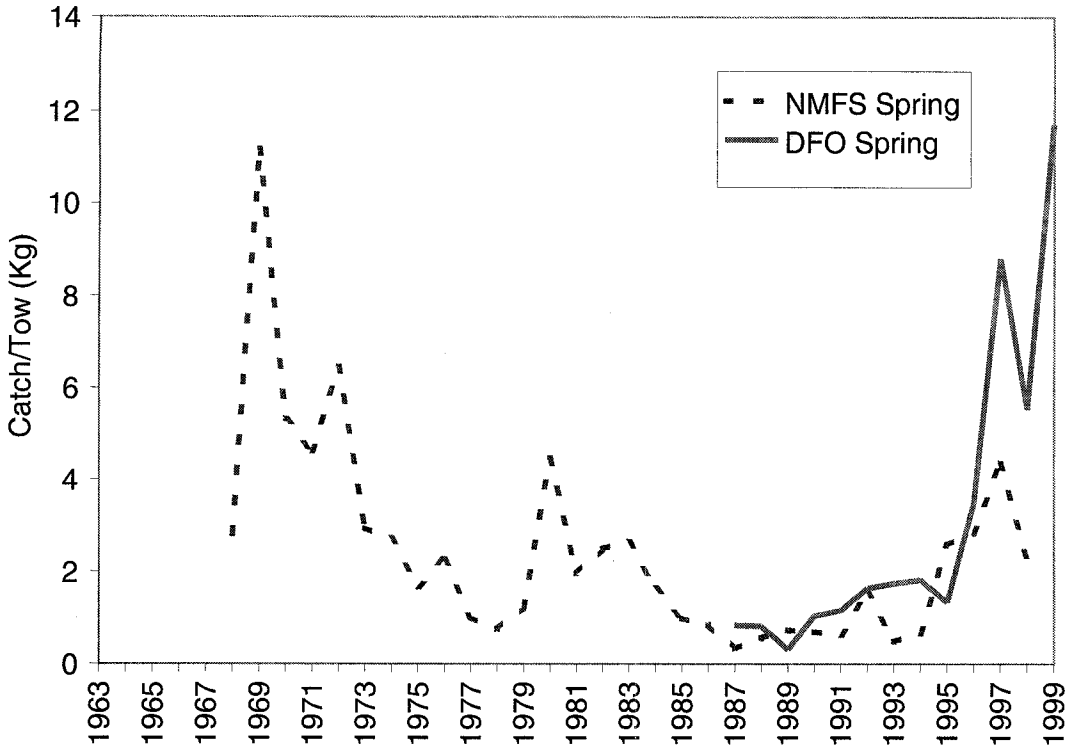


Fig. 12. NMFS and DFO spring survey results for yellowtail flounder (Strata 5Z1-4), 1987-1998 (the series includes 1999 for the DFO survey; the Canadian series was also adjusted for catchability differences).

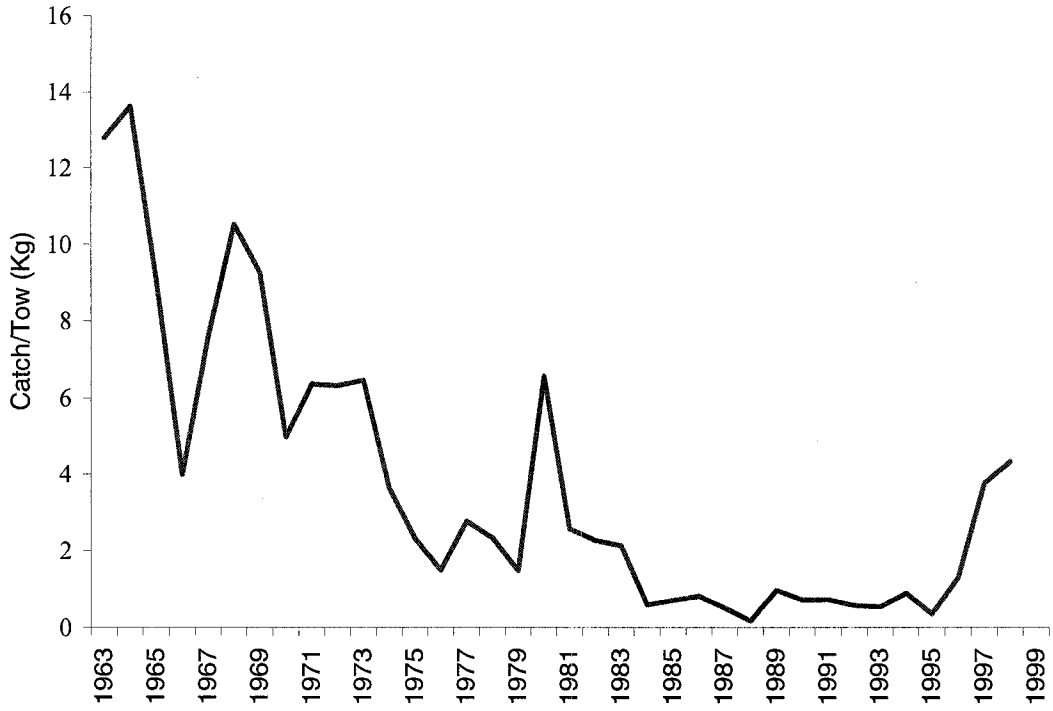


Fig. 13. NMFS fall survey results for yellowtail flounder on Georges Bank, 1963-1998.

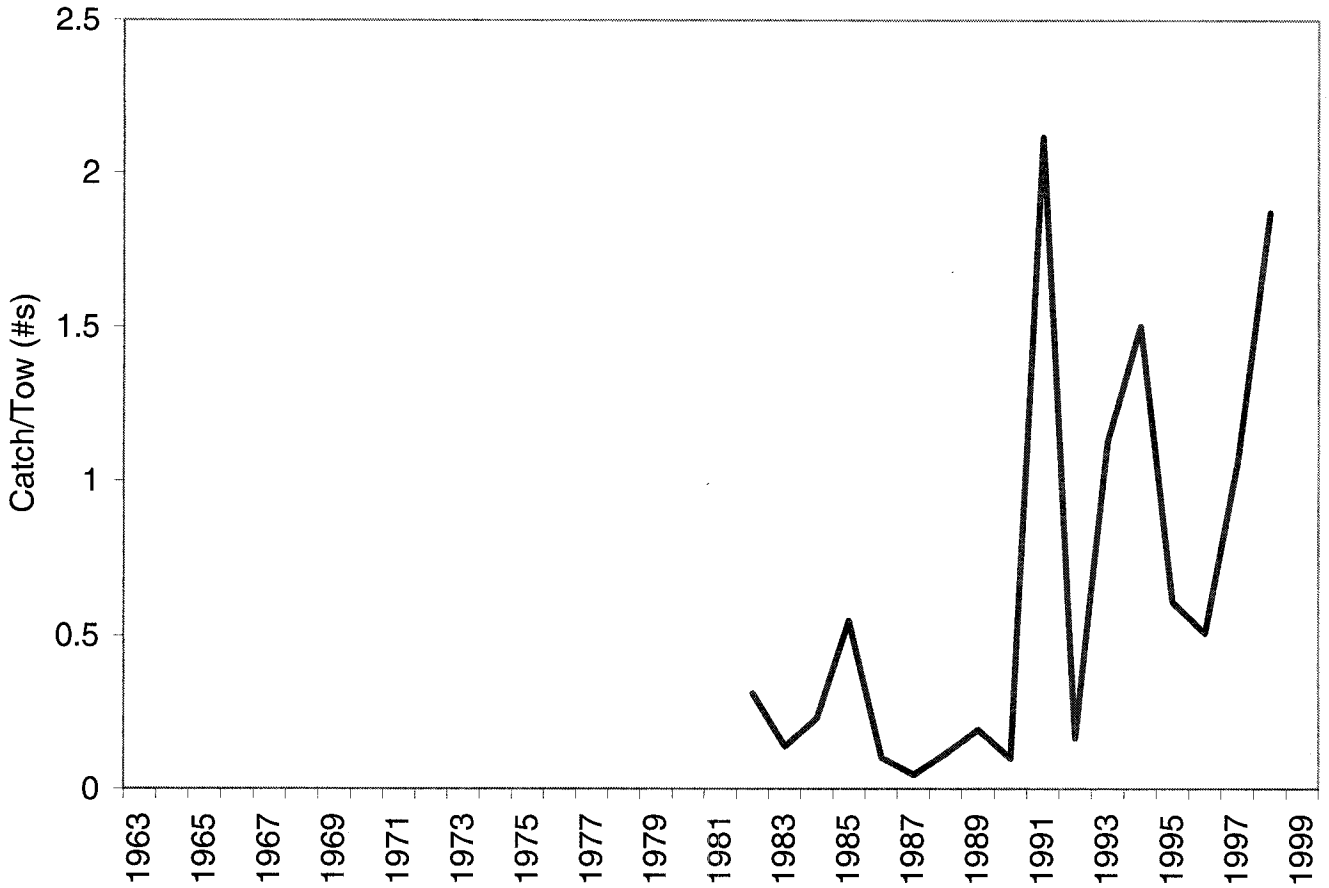


Fig. 14. Catches of yellowtail flounder in the NMFS scallop survey, Georges Bank.

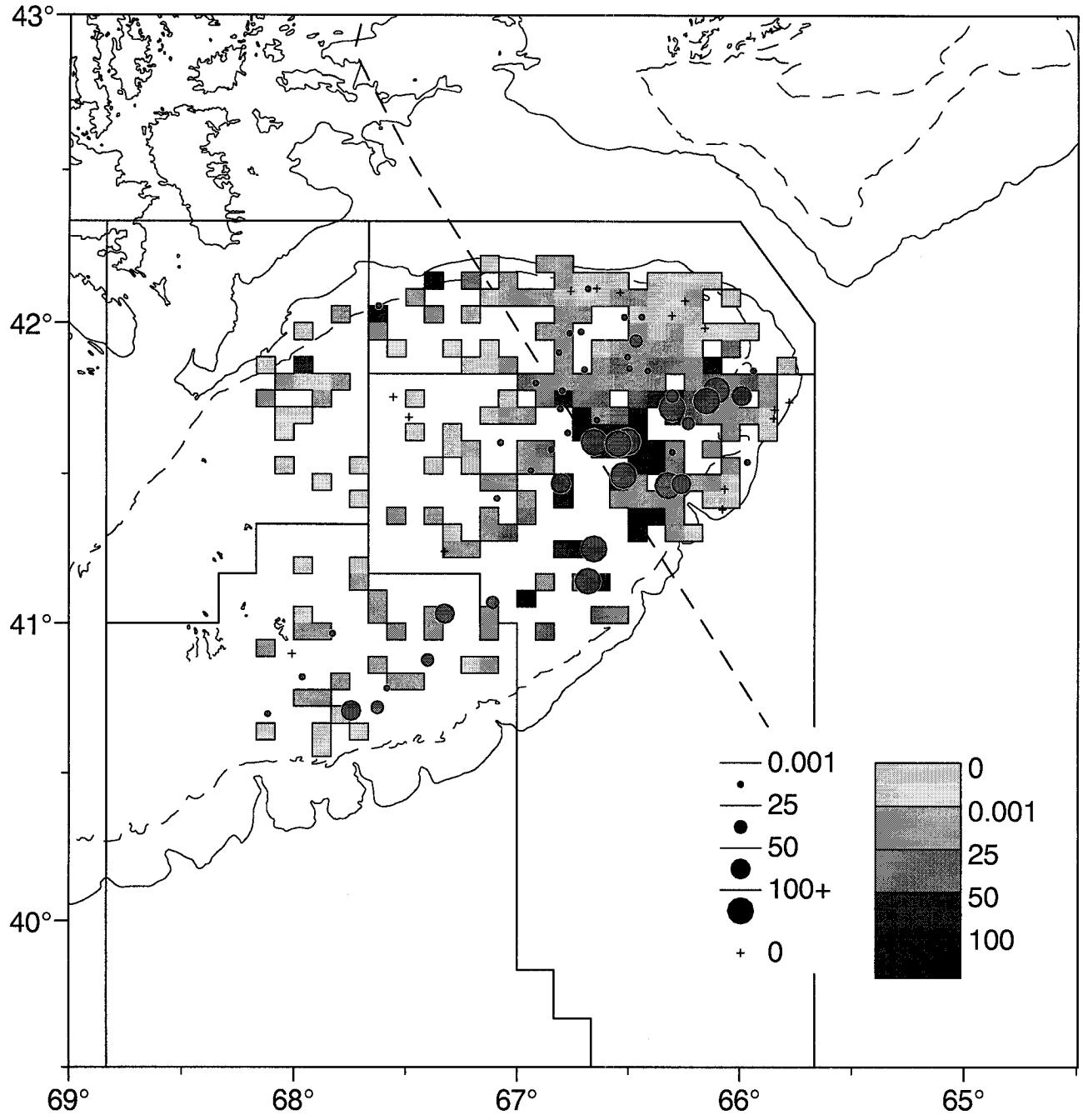


Fig. 15. The distribution of catches (#/tow) of yellowtail flounder (solid circles) in the DFO Georges Bank spring survey in 1999 compared with the average distribution in the previous five years (shaded rectangles), averaged by 3' squares.

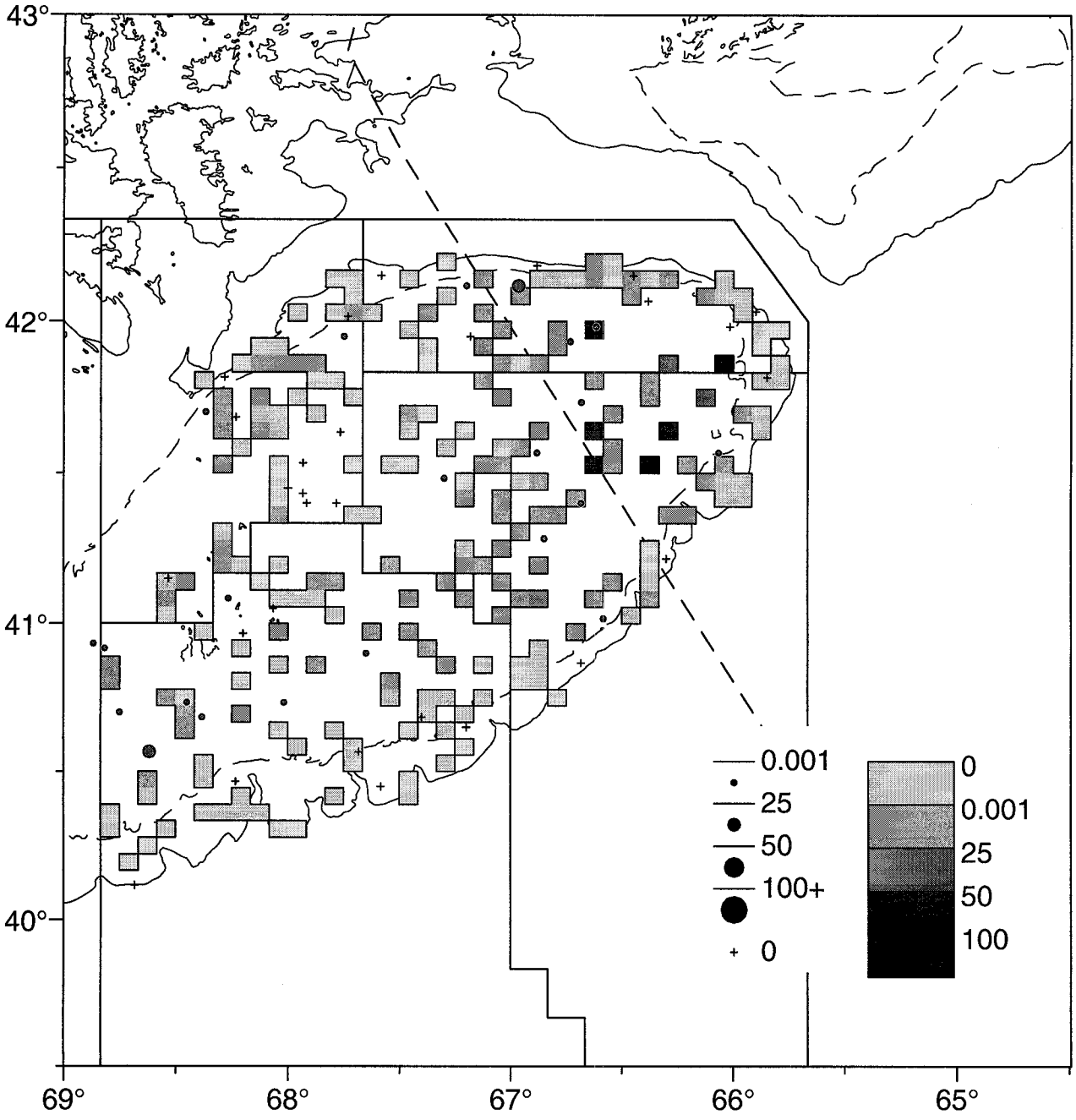


Fig. 16. The distribution of catches (#/tow) of yellowtail flounder in the NMFS Georges Bank spring survey in 1998 (solid circles), compared with the average distribution in the previous five years (shaded rectangles), averaged by 3' squares.

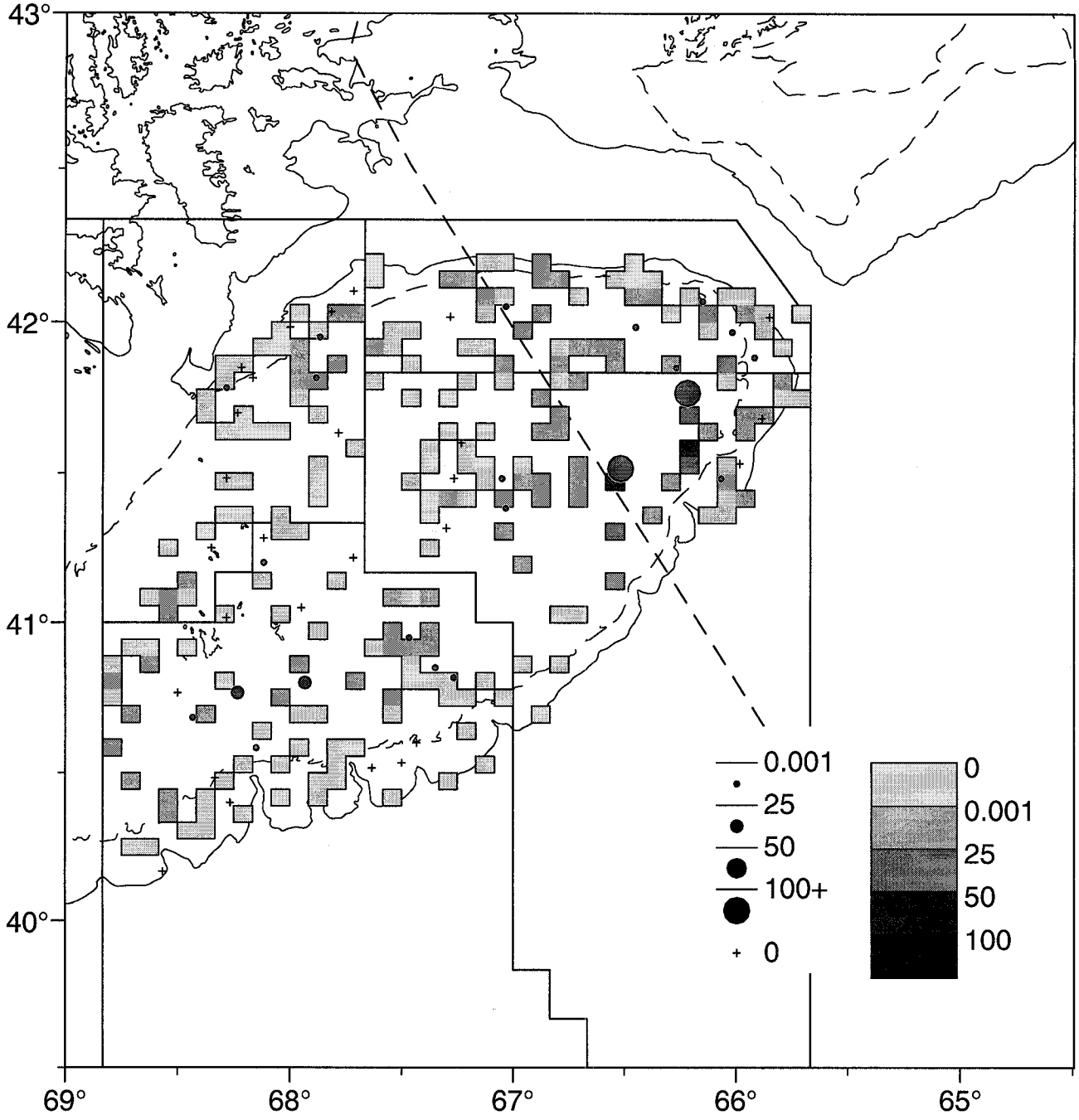


Fig. 17. The distribution of catches (#/tow) of yellowtail flounder in the NMFS Georges Bank fall survey in 1998 (solid circles), compared with the average distribution in the previous five years (shaded rectangles), averaged by 3' squares.

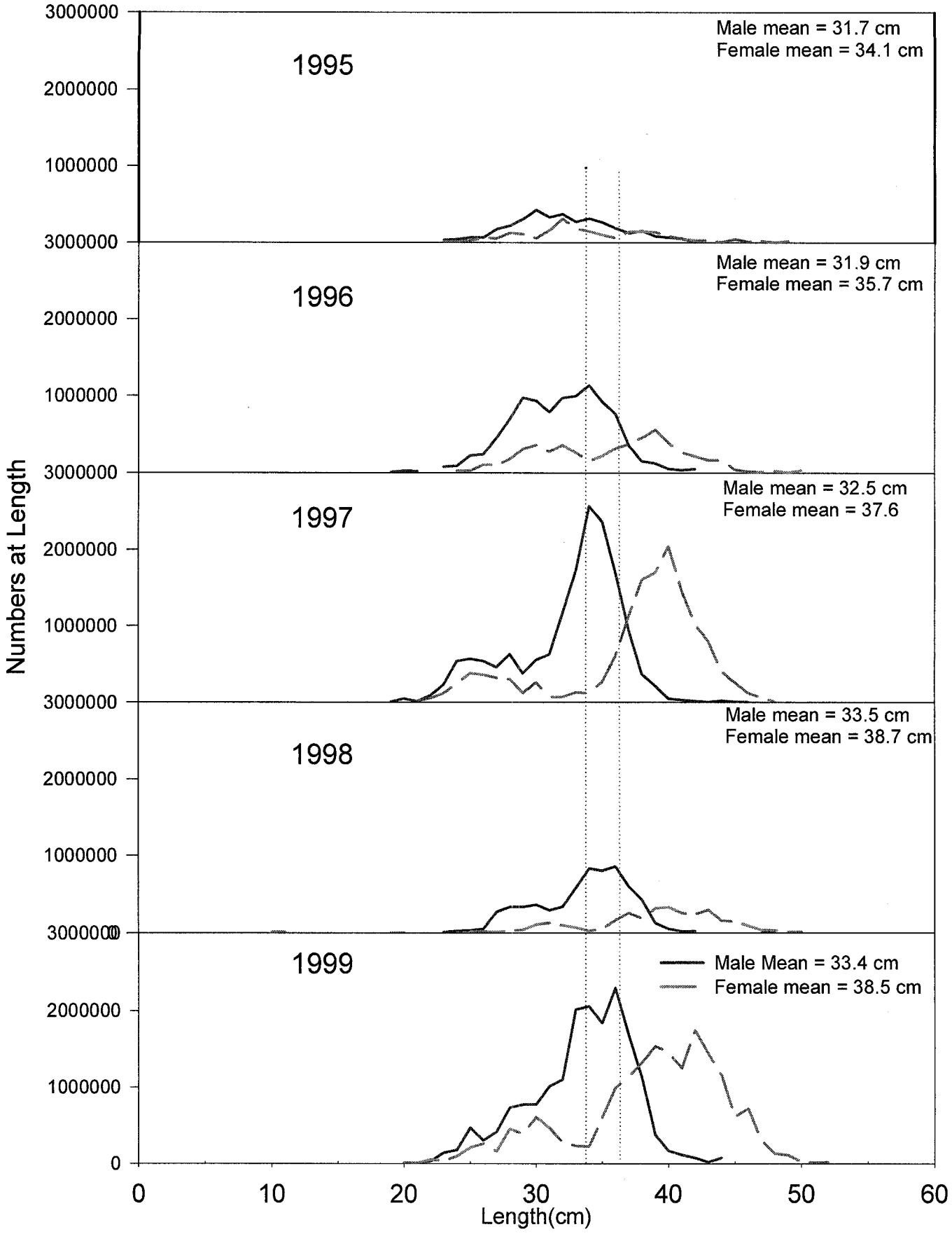


Fig. 18. Comparison of yellowtail flounder length composition in DFO spring surveys, 1995 - 1999, Georges Bank.

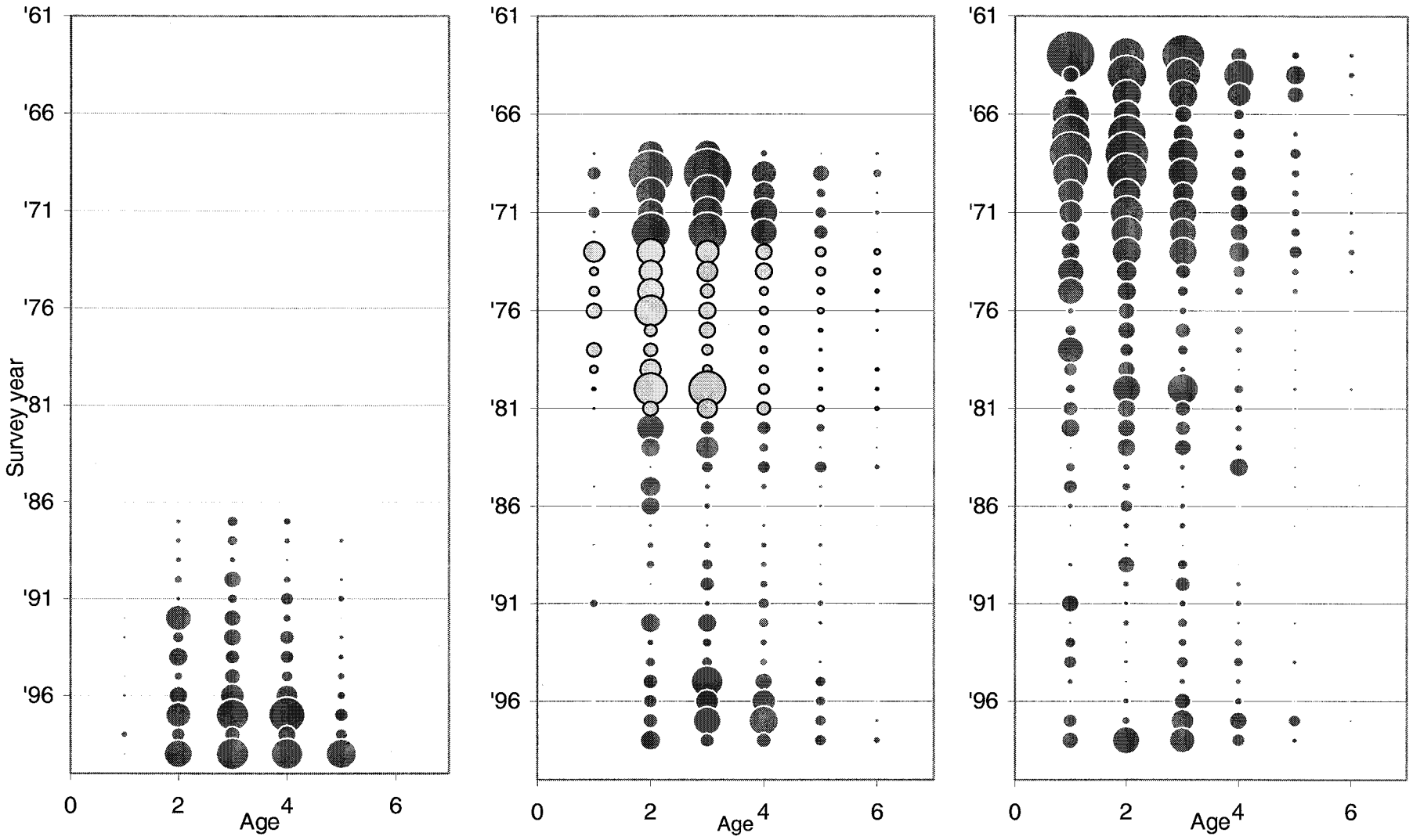


Fig. 19. Bubble plot in which the area of the bubble is proportional to the magnitude of the indices of abundance for the DFO spring (left), NMFS spring (middle), and NMFS fall (right) surveys. The grey shaded symbols in the USA spring series denote the period when the Yankee – 41 net was used. Refer to Tables 5, 6 and 7 for the absolute value of the indices.

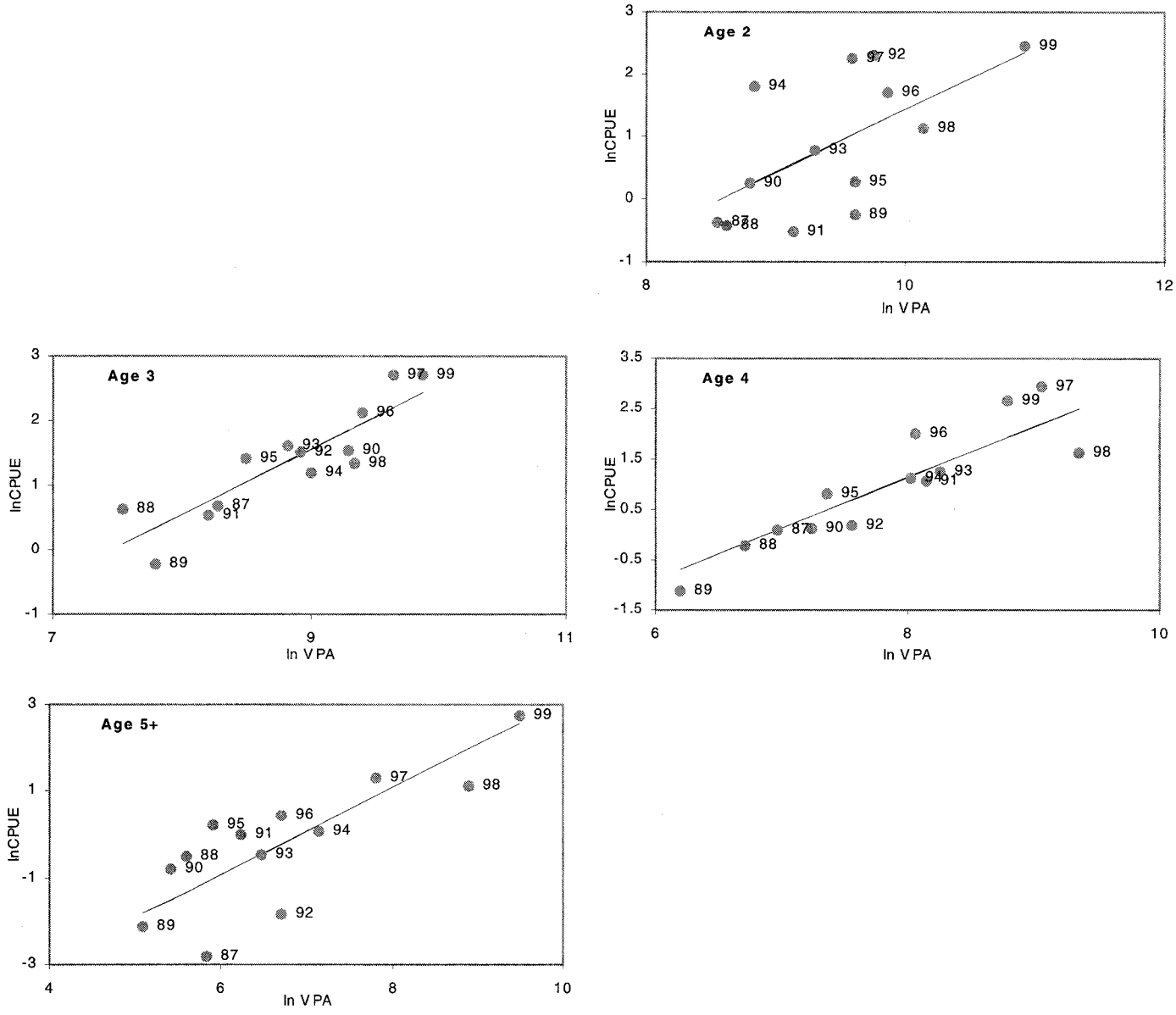


Fig. 20. Age by age residual plots for the DFO spring survey, Georges Bank yellowtail flounder.

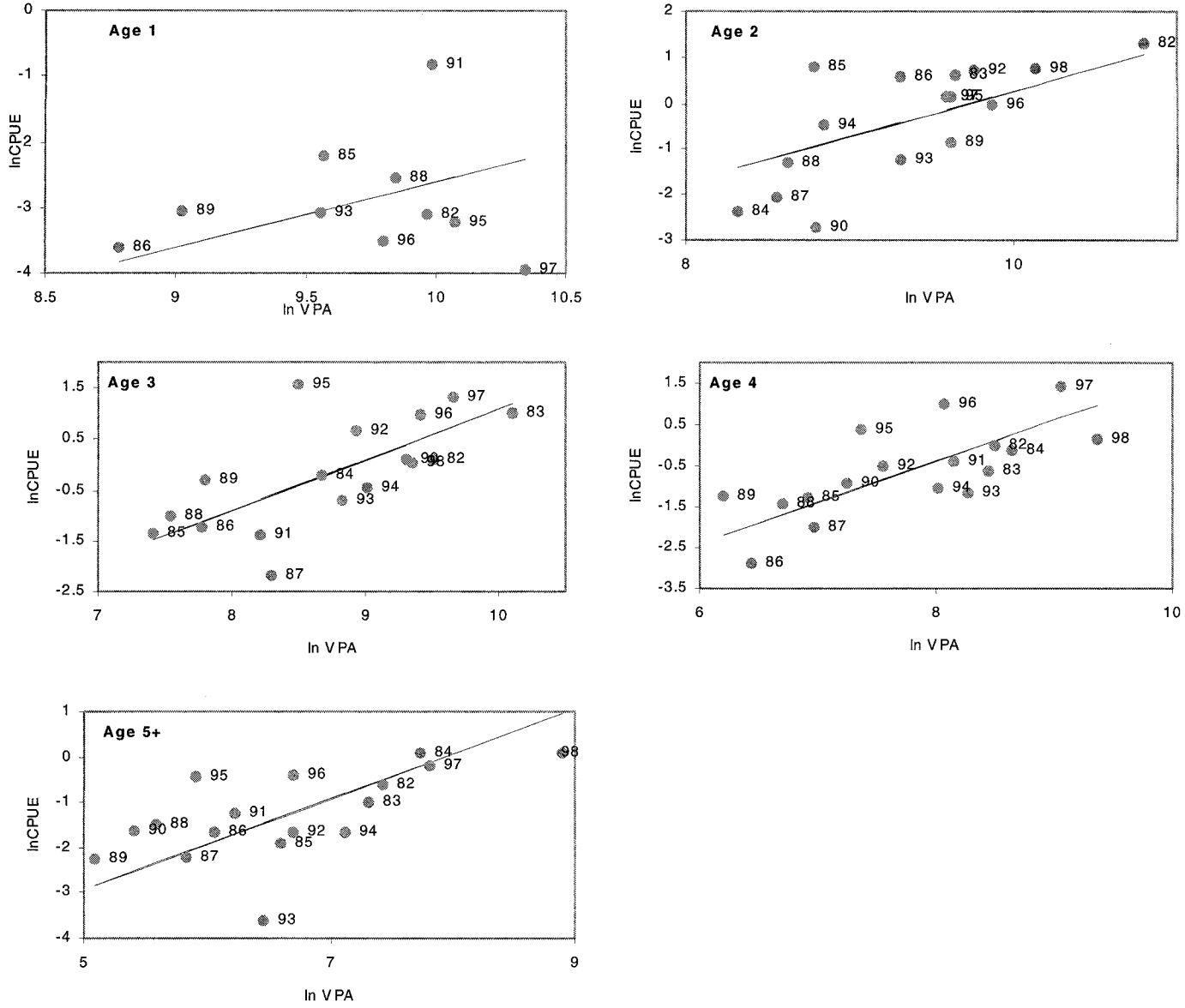


Fig. 21. Age by age residual plots for the NMFS spring survey (Yankee 36), Georges Bank yellowtail flounder.

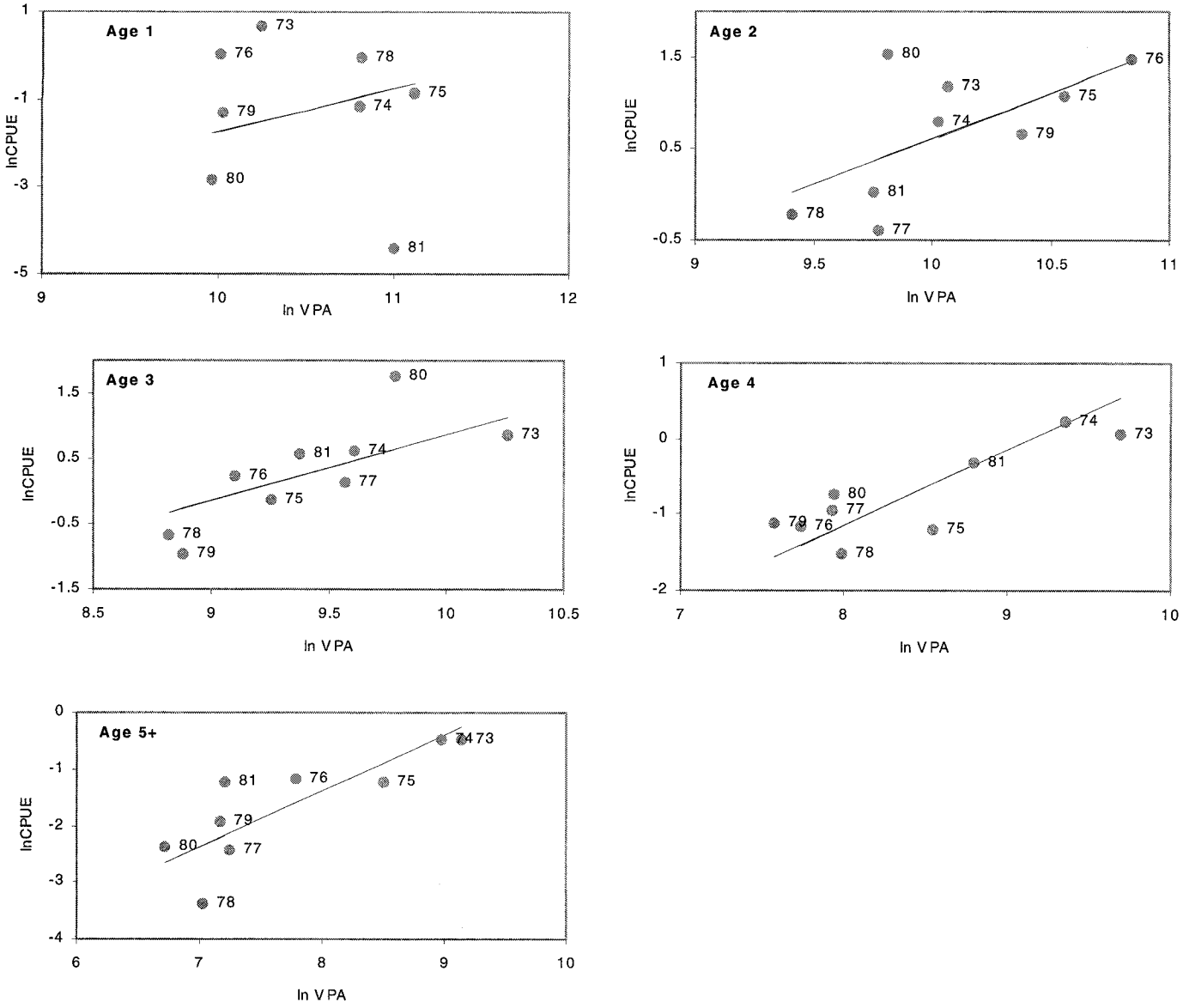


Fig. 22. Age by age residual plots for the NMFS spring survey (Yankee 41), Georges Bank yellowtail flounder.

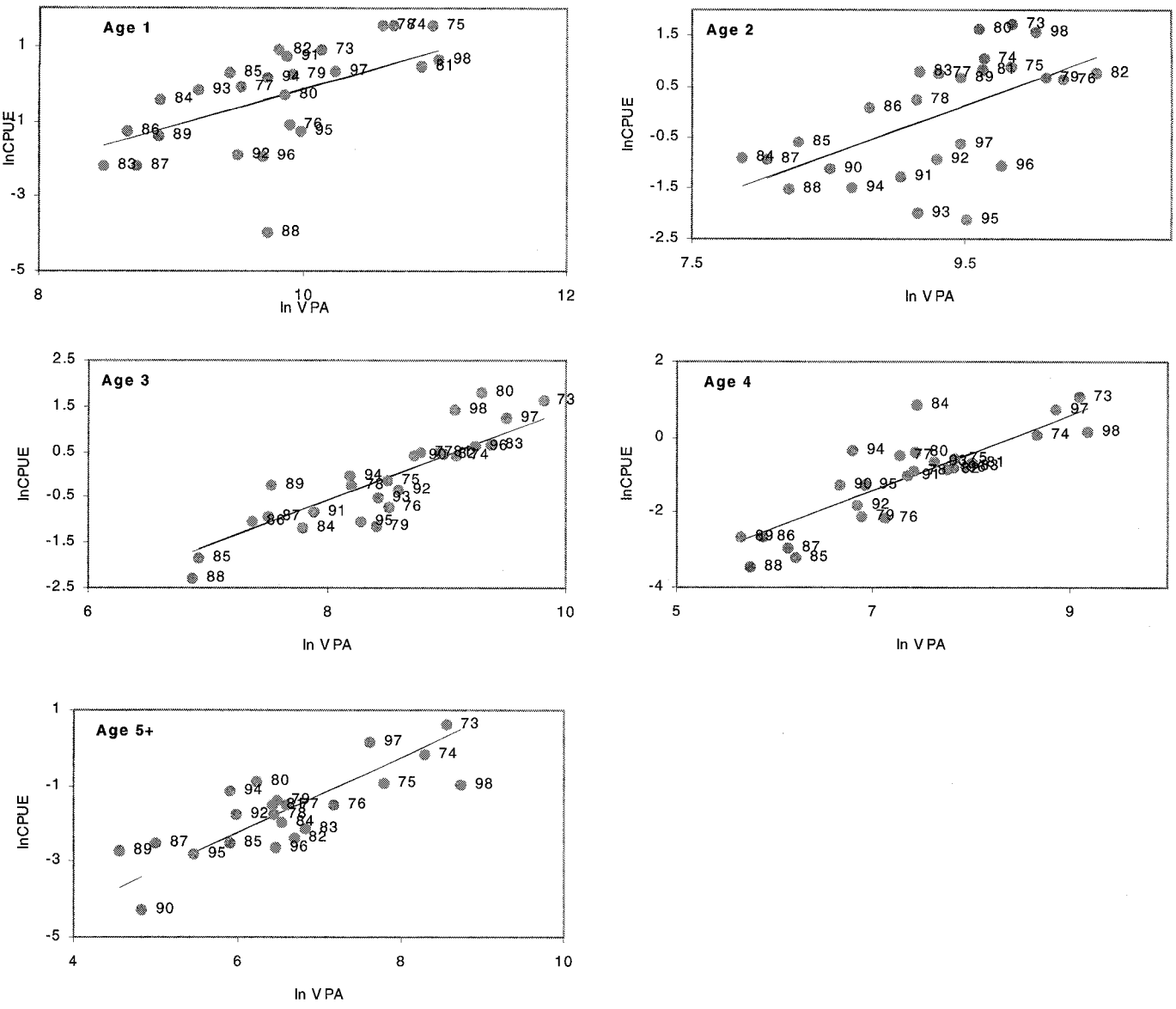


Fig. 23. Age by age residual plots for the NMFS fall survey, Georges Bank yellowtail flounder.

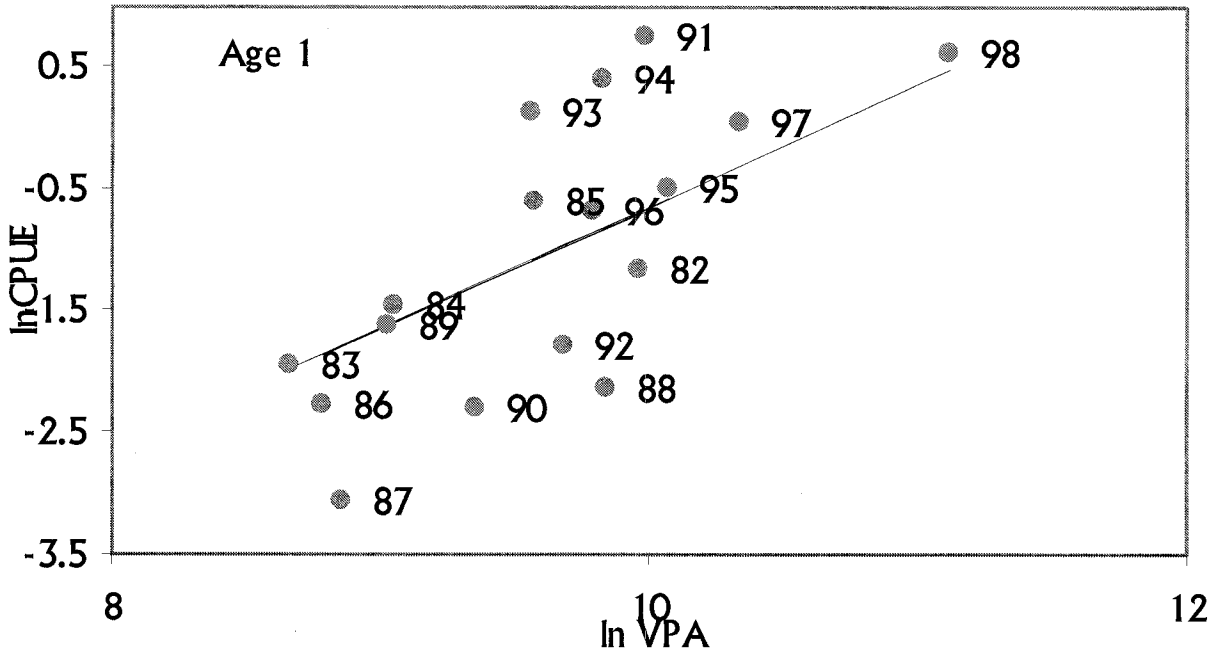


Fig. 24. Age-1 residual plot for the NMFS scallop survey, Georges Bank yellowtail flounder.

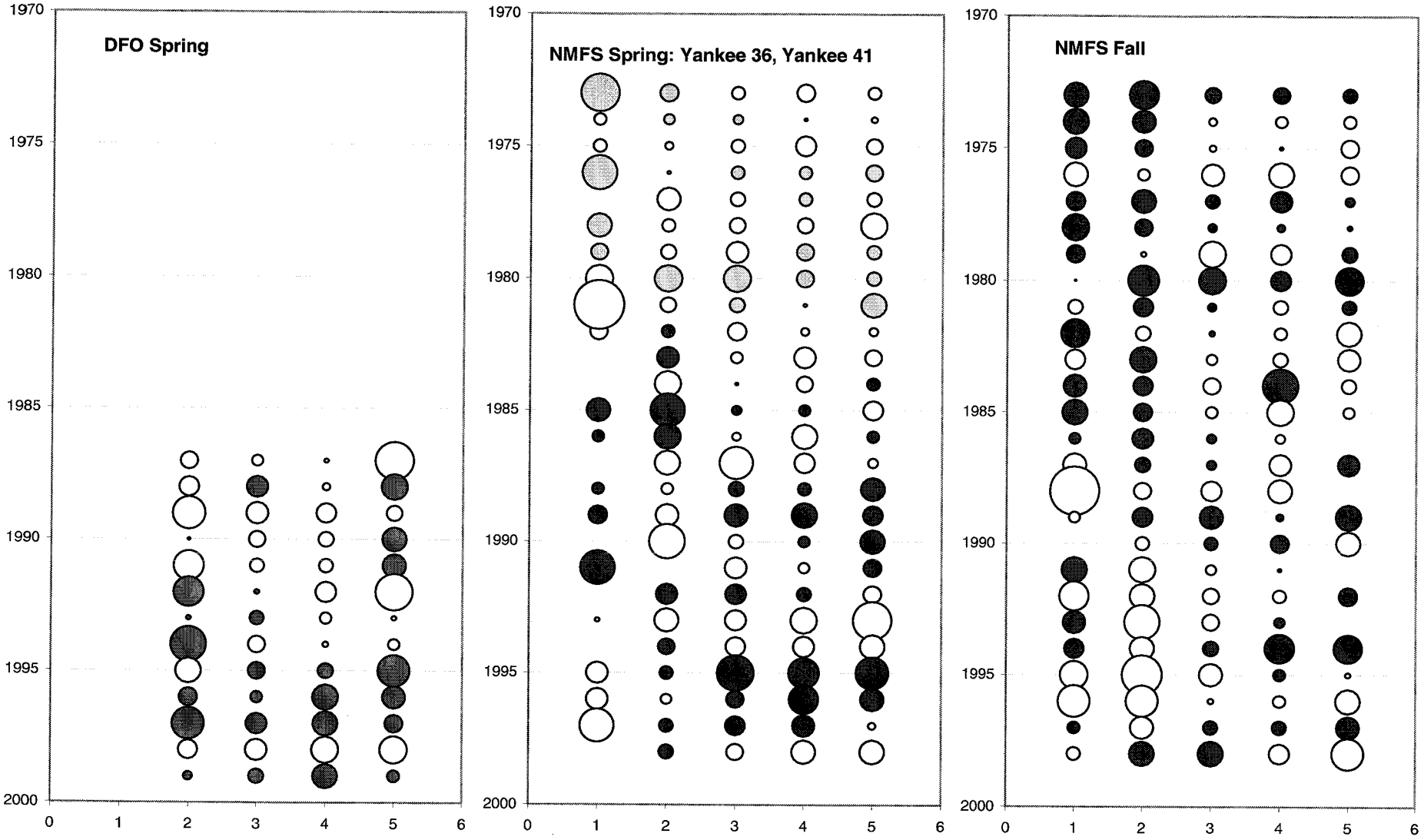


Fig. 25. Bubble plots where the area of the bubble is proportional to the magnitude of age by age residuals for the relationships between ln abundance index versus ln population numbers, Georges Bank yellowtail flounder. The grey shaded symbols in the NMFS spring series denote the period when the Yankee – 41 net was used. The open symbols denote positive residuals, and closed symbols denote negative residuals. Refer to Figs. 20-23 for the absolute value of the residuals.

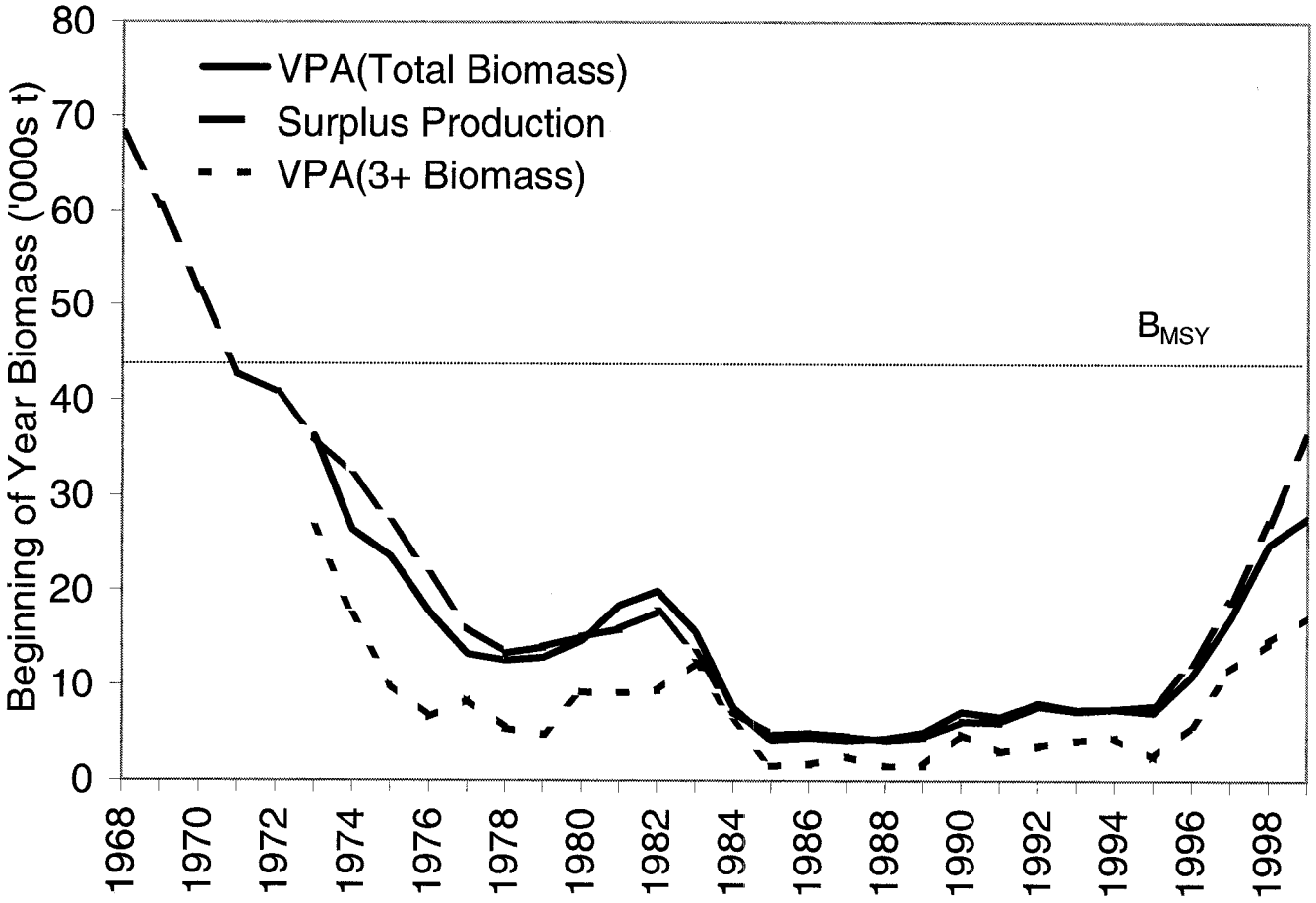


Fig. 26. Trends in total beginning of year biomass (000s t) as indicated from the VPA and surplus production model, yellowtail flounder on Georges Bank. The biomass values in 2000 are projected assuming $F_{0.1}$ fishery removals in 1999. The B_{MSY} level of 43,360 (from the surplus production model) is also shown.

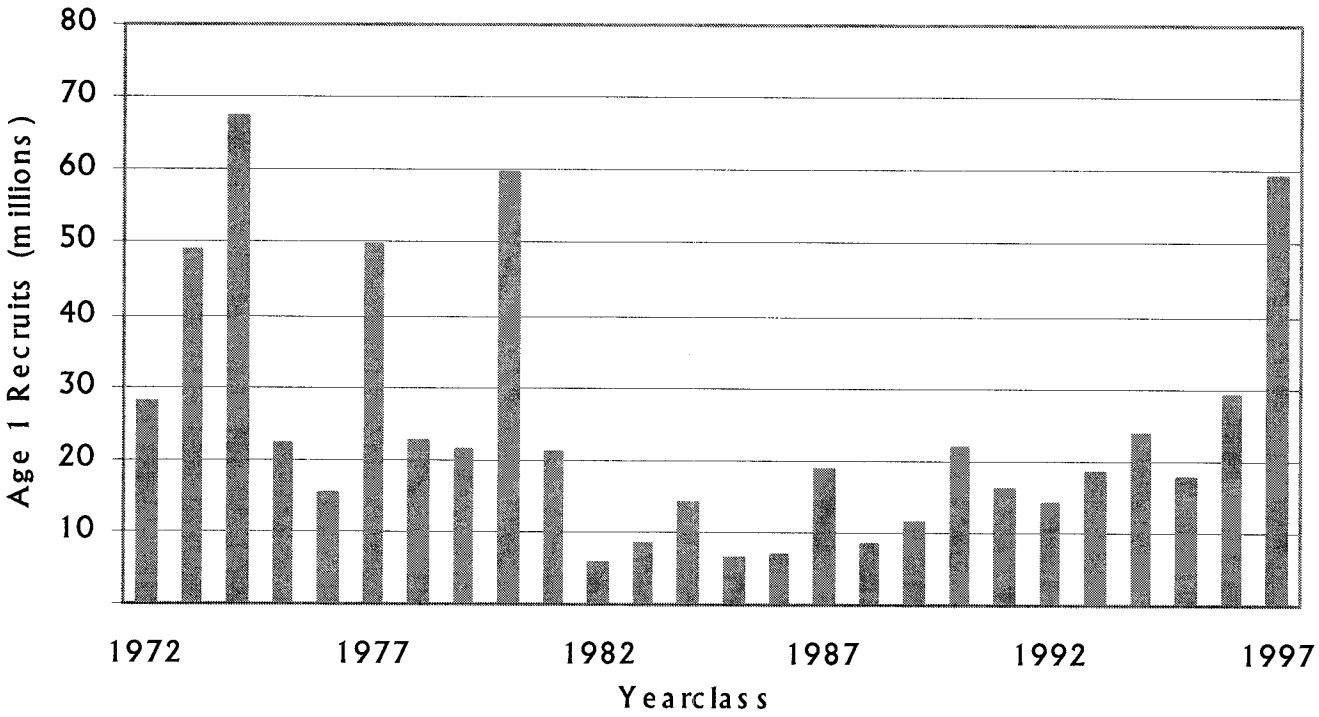


Fig. 27. Trend in age-1 recruitment, Georges Bank yellowtail flounder, 1972 – 1997.

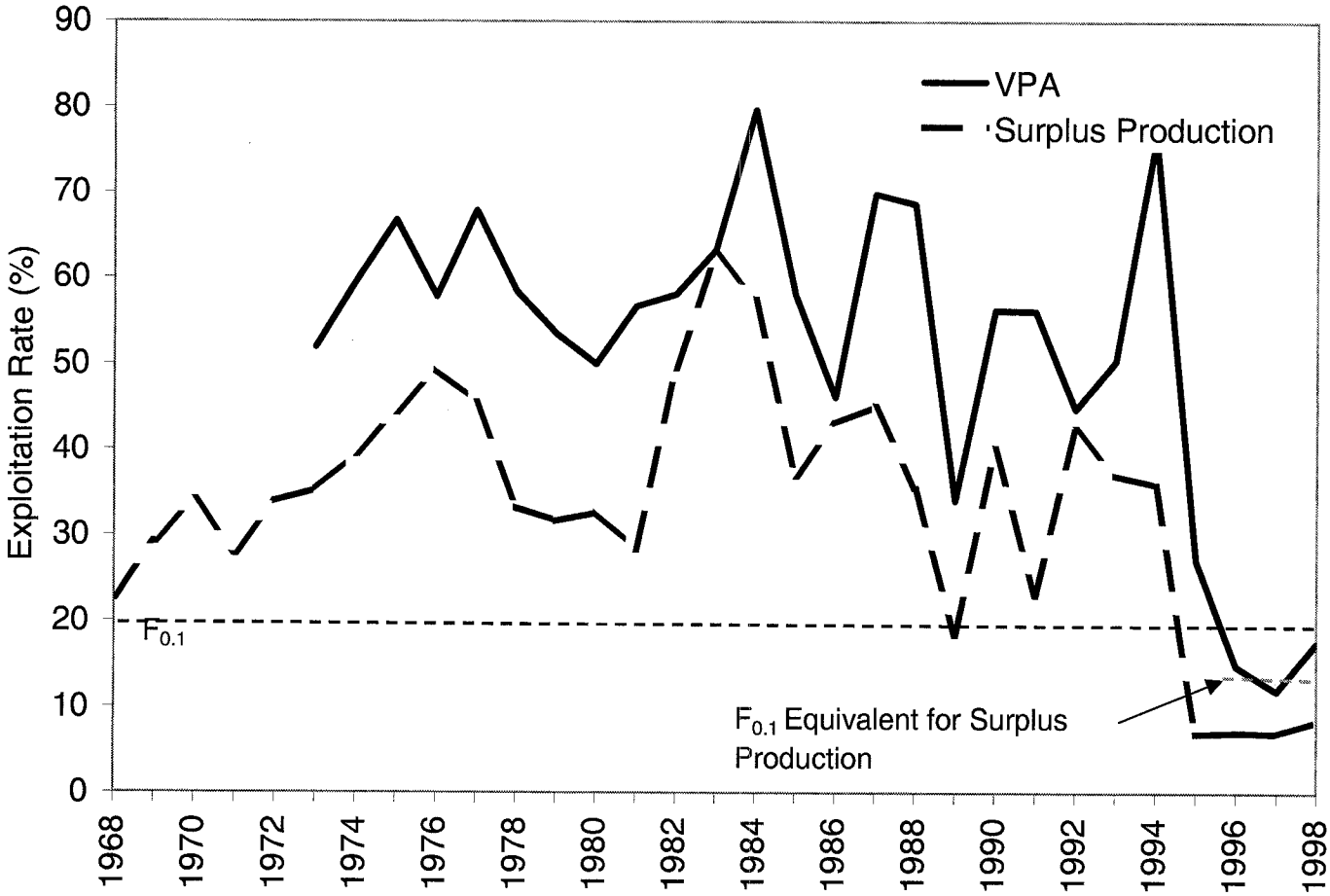


Fig. 28. Trends in 3+ exploitation rate (%) from the VPA and total exploitation rate from the surplus production model, yellowtail flounder on Georges Bank. Reference levels are also shown.

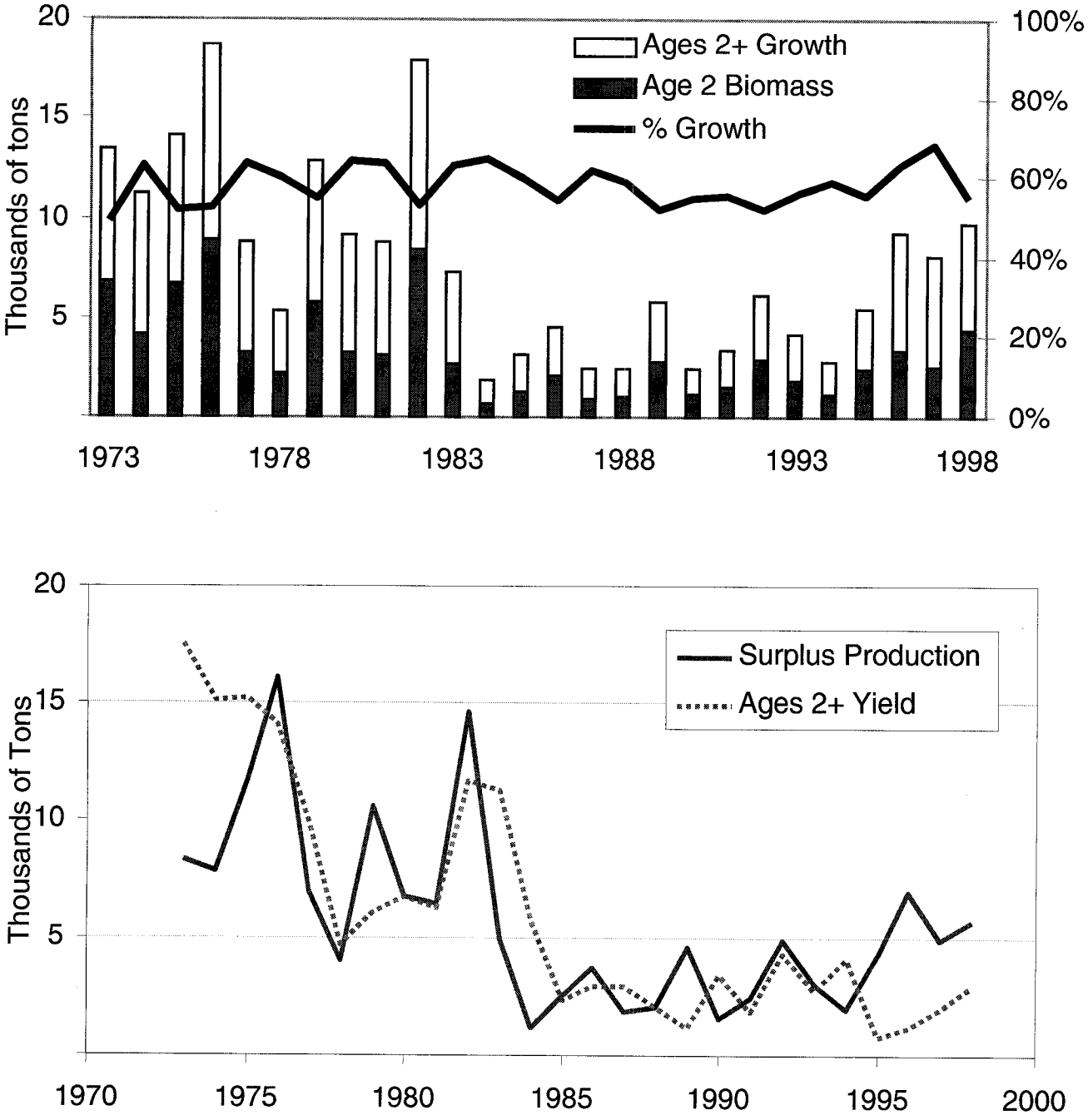


Fig. 29. Components of production (top panel), and production as indicated by the VPA, compared with fishery yield, Georges Bank yellowtail flounder.

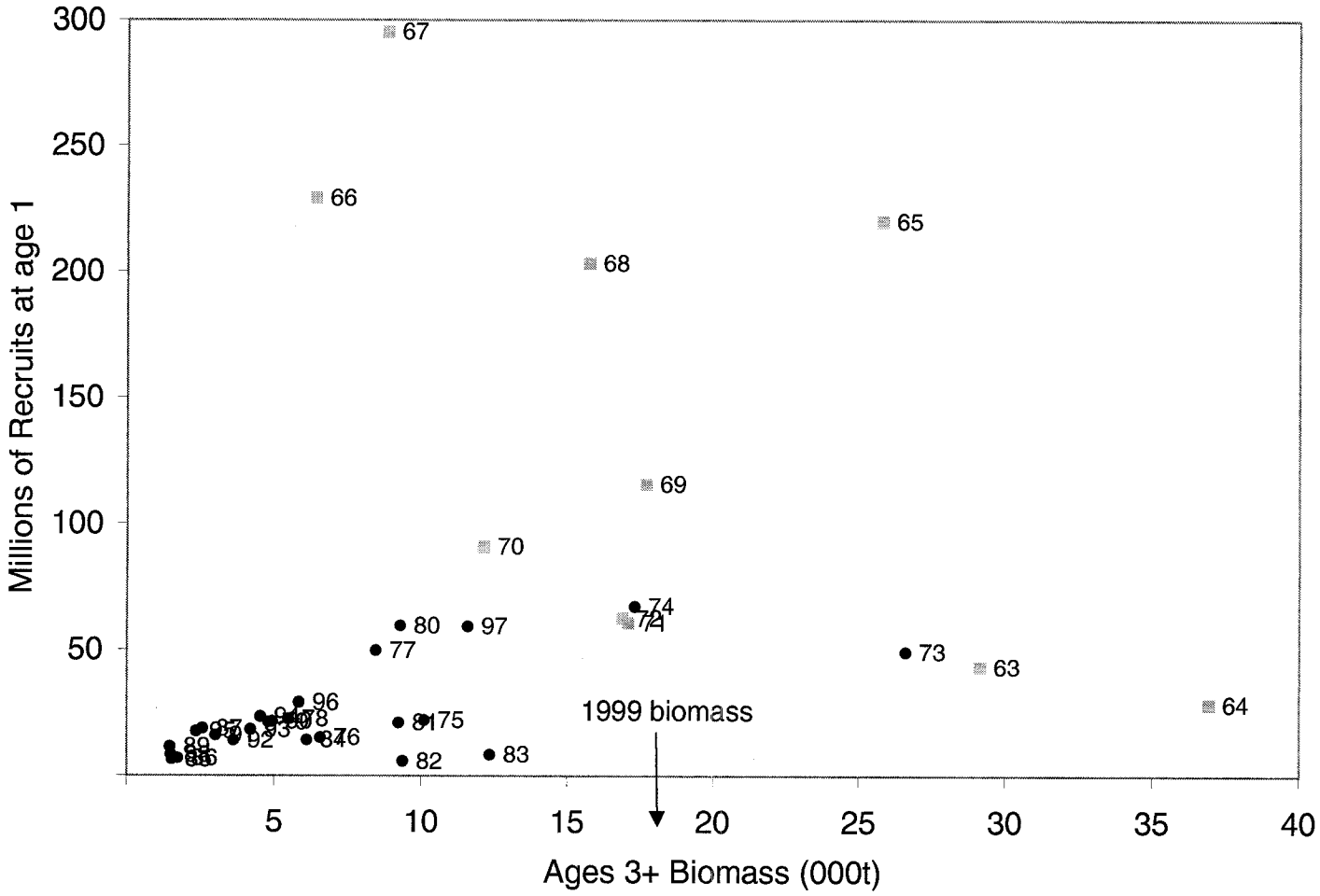


Fig. 30. Total biomass (000s t) and age 1 recruitment (millions) relationship from the VPA, Georges Bank yellowtail flounder. The current beginning of year biomass from the VPA is also shown.

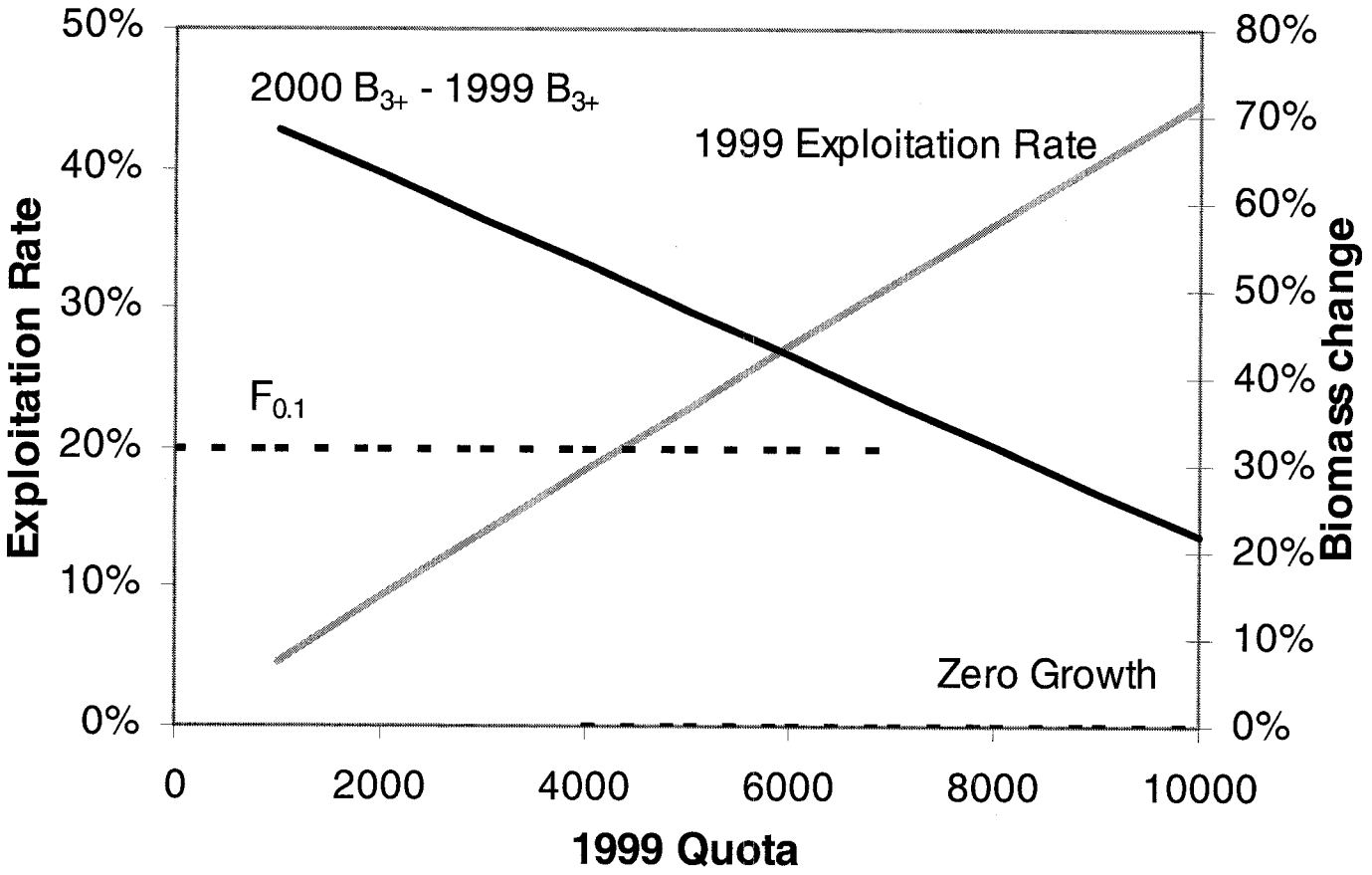


Fig. 31. Implications of various 1999 quotas (combined Canada and USA) on exploitation rate and change in the 3+ population biomass from 1999 to 2000.

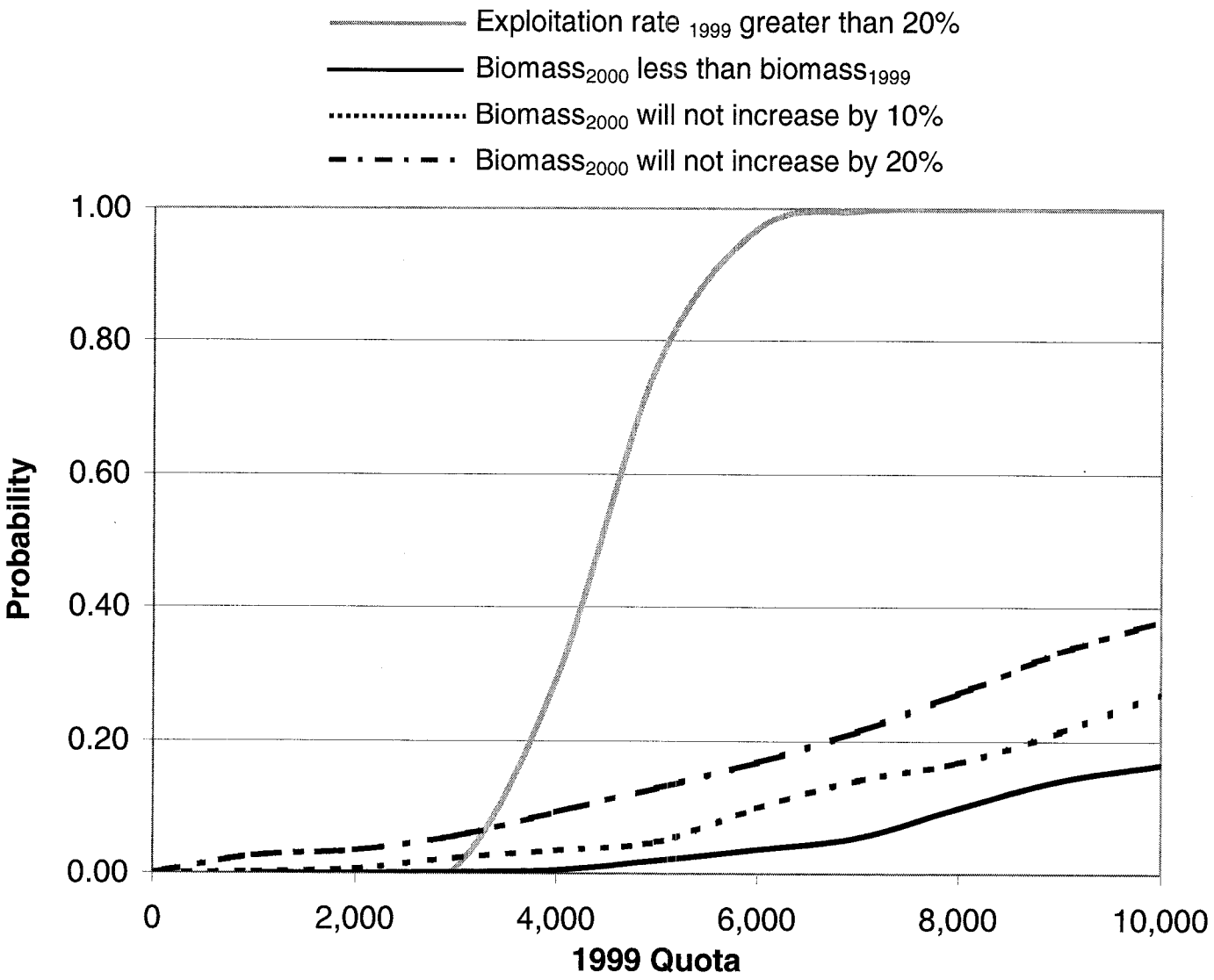


Fig. 32. Risk of exceeding the $F_{0.1}$ fishing mortality or not achieving increments of population biomass growth at various quotas for the 1999 fishery, Georges Bank yellowtail flounder.