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Assessment of Haddock on Eastern Georges Bank

Évaluation d'aiglefin sur l'est du banc Georges

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Abstract

Haddock catches from eastern Georges Bank fluctuated around 5,000 t from 1985 to 1990. Under restrictive management measures, combined Canada/USA catches declined from over 6,400 t in 1991 to a low of about 2,100 t in 1995, fluctuated between about 3,000 t and 4,000 t until 1999 and has since increased to over 7,000 t.

Adult population biomass (ages 3+) has steadily increased from near an historical low of about 10,000 t in 1993 to about 40,000 t at the beginning of 2001 and 2002 but remains below the average biomass during 1930-55 when productivity was higher. The recent increase was supported by improved recruitment in the 1990's. The exploitation rate for fully recruited ages 4+ has consistently been below the $F_{0.1}$ target of 20% since 1995. Reduced fishing mortality and avoidance of small fish in the fisheries in recent years has resulted in increased survival of incoming year-classes and greater abundance at older ages.

Projected total Canada/USA yield at $F_{0.1} = 0.25$ in 2002 would be about 10,700 t. The adult biomass is projected to increase considerably from about 40,000 t to 54,000 t by the beginning of 2003, largely due to recruitment of the strong 2000 year-class. The population age structure shows good representation at all ages.

Résumé

Les prises d'aiglefin dans les eaux de l'est du banc Georges ont fluctué aux environs de 5 000 t entre 1985 et 1990. Soumises à des mesures de gestion restrictives, les prises canadiennes et américaines combinées ont chuté de plus de 6 400 t en 1991 à un creux de d'environ 2 100 t en 1995, puis ont fluctué entre environ 3 000 et 4 000 t jusqu'en 1999, pour ensuite grimper à plus de 7 000 t.

La biomasse d'adultes (d'âge 3+) a augmenté régulièrement, passant d'un niveau se rapprochant du creux historique d'environ 10 000 t en 1993 à environ 40 000 t au début de 2001 et 2002, bien qu'elle demeure inférieure à la biomasse moyenne observée de 1930 à 1955, lorsque la productivité était plus élevée. La récente augmentation de la biomasse est imputable à un meilleur recrutement dans les années 1990. Le taux d'exploitation de l'aiglefin de 4 ans et plus pleinement recruté a toujours été inférieur au taux cible de $F_{0,1}$ de 20 % depuis 1995. Un taux réduit de mortalité par pêche et la prévention de la capture de petits poissons dans les dernières années sont à l'origine d'un taux accru de survie des nouvelles classes d'âge et d'une plus forte abondance d'individus âgés.

On prévoit que le rendement total des pêches canadiennes et américaines à $F_{0,1} = 0,25$ en 2002 se chiffrera à environ 10 700 t. On prévoit aussi que la biomasse d'adultes augmentera fortement d'ici le début de 2003, pour passer d'environ 40 000 t à 54 000 t, en grande partie à cause du recrutement de l'abondante classe d'âge 2000. La structure par âge indique en outre que tous les âges sont bien représentés dans la population.

Introduction

Since 1990, Canada has used eastern Georges Bank, fishery statistical unit areas 5Zej and 5Zem (Figure 1), as the basis for a management unit (Gavaris 1989), referred to as 5Zjm for brevity. This assessment applies the approach used by Van Eeckhaute and Gavaris (2001) using Canadian and USA fisheries information updated to 2001. Results from the Fisheries and Oceans Canada (DFO) survey, updated to 2002, and the USA National Marine Fisheries Service (NMFS) surveys in the spring and fall, updated to 2001, were incorporated.

The Fishery

Commercial Catches

Haddock on Georges Bank have supported a commercial fishery since the early 1920s (Clark et al 1982). For details on the historical aspects of the Georges Bank haddock fishery see Gavaris and Van Eeckhaute (1998).

Under restrictive management measures, combined Canada/USA catches declined from over 6,400 t in 1991 to a low of about 2,100 t in 1995, fluctuated between about 3,000 t and 4,000 t until 1999 and has since increased to over 7,000 t (Table 1, Figure 2). Greater catches in the late 1970s and early 1980s, ranging up to about 23,000 t, were associated with good recruitment. Substantial quantities of small fish were discarded in those years (Overholtz et al 1983). Catches subsequently declined and fluctuated around 5,000 t during the mid to late 1980s.

Total catches during the 1930s to 1950s ranged between 15,000 t and 40,000 t (Figure 3), averaging about 25,000 t (Schuck 1951, R. Brown pers. com.). Records of catches by unit area for the early 1960s period have not been located, however, based on records for Subdivision 5Ze, catches probably attained record high levels of about 60,000 t during the early 1960s. Since the early 1970s, catches have been substantially lower, generally fluctuating between 5,000 t and 10,000 t.

In 1995 to 1999 and 2001, Canadian catches were below the quota due to closure of some fleet sectors, when the cod quotas were reached. The 2000 catch of 5,402 t was slightly above the Canadian quota of 5,400 t. Since 1994, all Canadian groundfish fisheries on Georges Bank remained closed from January to early June to protect spawning concentrations.

Weight of all Canadian landings were monitored at dockside. At-sea observers monitored 10% of the 889 trips, which accounted for 14% of the total haddock landed. In 2001, samples were collected by DFO, observer and by two industry groups, Scotia Fundy Mobile Gear Fishermen's Association and High Liner Foods. Comparison of samples from at sea observations against landings indicated that there was little discarding or highgrading (Fig. 4). Discarding and misreporting have been considered negligible since 1992.

In recent years, the Canadian fishery has been primarily conducted by vessels using otter trawls and longlines with some handlines and gillnets. During 2001, all vessels over 65 ft operated on enterprise allocations, otter trawlers under 65 ft and fixed gear vessels 45-65 ft operated on individual quotas while fixed gear vessels under 45 ft operated on community quotas administered by local boards (Table 2). Most haddock were caught by otter trawlers and longliners in tonnage classes 2 and 3 (Table 3), approximately less than 65 ft. The highest catches occurred in July (Table 4, Figure 5). The Canadian fishery management plan allocations by fleet sector and reported landings are shown below:

Fishery Sector	1997		1998		1999		2000		2001	
	Quota	Catch	Quota	Catch	Quota	Catch	Quota	Catch	Quota	Catch
Fixed gear <65’	754	714	915	856	928	902	1271	1193	1731	1660
Mobile gear <65'	1625	1451	1984	1997	1972	1964	2743	2796	3465	3432
Fixed gear 65'-100'	32	36	39	39	39	8	54	51	70	2
Mobile gear 65'-100'	32	35	94	93	188	186	54	224	547	540
Vessels >100'	757	573	868	386	773	590	1278	1137	1176	1140
Totals	3200	2809	3900	3371	3900	3650	5400	5402	6989	6774

Source: Quota reports (will not match statistics exactly)

USA catches for 2001 were derived from logbooks coupled with dealer reports, as was done for 1994-2000. Effort in the USA fishery was regulated using closed areas and days-at-sea limits (Table 2). To curtail targeting of haddock, a 500 lb trip limit was introduced in 1994 and raised to 1,000 lb in July 1996. The trip limit resulted in an increase in the discard rate. The trip limit has been adjusted periodically and is currently 5,000 lb/day and a maximum of 50,000 lbs/trip. The combination of area closures, effort restrictions, and trip limits has precluded most operators from making long trips to 5Zjm, with the result that USA catches from 5Zjm have been low since 1993. While Area II remained closed in 2001, landings from 5Zjm, which come exclusively from tonnage classes 3 and 4 otter trawlers (Table 5), increased to 604 t and discards again were low because the day and trip possession limits remained high. Catches by month were not available for recent years (Table 6).

Size and Age Composition

The size and age composition of the 2001 Canadian fishery was characterised using port, at sea and industry samples from all principle gears and all seasons. Comparison of length frequencies from these sources did not reveal any persistent differences (Figure 4), therefore, all data was combined (Table 7, Figure 5). The size composition of catch in the Canadian fisheries peaked at 51 cm (20 in) for otter trawlers and at 58 cm (23 in) for longliners (Figure 6). Gill-netters caught few haddock but they were larger. No sampling was available for discards of haddock by-catch in the Canadian scallop fishery, though in previous years, the amount caught has not been large.

USA port samples and ageing data from eastern Georges Bank were used to characterise the size and age composition of the USA fishery catch from eastern Georges Bank.

The 2001 catch at age by quarter for Canada and the USA (Table 8) was used to augment the 1969-2000 results (Van Eeckhaute and Gavaris, 2001). Combined Canada/USA annual catch at age and average fishery weights at age are summarized in Tables 9 and 10

and Figure 7. The 1998 year-class (age 3) dominated the 2001 catch. In comparison to the age composition of the catch during periods when year-classes were quickly fished down, the older age groups (ages 7+) continued to contribute significantly to the 2001 catch (Figure 8). The percentage of age 2 fish in 2001 was well below historical averages. The low percentage of younger ages in the recent catches has been due in part to the type of gear used and to avoidance of areas with small fish. The age composition during the 1969 to 1974 period was dominated by the outstanding 1962 and 1963 year-classes which continued to contribute substantially as older fish and is not considered typical.

Abundance Indices

Commercial Catch Rates

Catch rates from the Canadian commercial fishery for selected trips (i.e., only those vessels which reported more than 1 t from 5Zjm during 1994 where cod, haddock and pollock comprised over 90% of the total catch) for tonnage classes 2 and 3 otter trawlers and longliners have generally increased since 1993 (Figure 9). Changes to regulations, gear modifications and varying fishing practices in recent years make comparison of catch rates from year to year difficult to interpret. Therefore, these were not used as indices of abundance.

Research Surveys

Surveys of Georges Bank have been conducted by DFO each year (February) since 1986 and by NMFS each fall (October) since 1963 and each spring (April) since 1968. All surveys used a stratified random design (Figures 10 and 11). For the NMFS surveys, two vessels have been employed and there was a change in the trawl door in 1985. Vessel and door type conversion factors (Table 11), derived experimentally from comparative fishing, have been applied to the survey results to make the series consistent. Additionally, two trawl nets were used on the NMFS spring survey, a modified Yankee 41 during 1973-81 and a Yankee 36 in other years, but no conversion factors are available for haddock.

The spatial distribution of catches for the most recent surveys of each series was similar to the distribution over the previous 5 year period (Figures 12, 13 and 14). In winter/spring, adults (ages 3+) are more abundant on the Northern Edge but age 1 fish are distributed broadly over the bank. An abundance of age 2 haddock (2000 year-class) was observed on the southern flank during the 2002 DFO survey. In fall, adult haddock are more concentrated in the deeper waters along the slopes of the Northeast Peak and the Northern Edge, however, age 1 fish remain somewhat more widespread.

Age specific abundance patterns from the three surveys track year-class strengths fairly well (Tables 12, 13 and 14; Figure 15). Some year effects are evident, for example, the low spring catches observed for both the 1997 DFO and NMFS surveys. The indices for ages 3-8 survey biomass peaked at record highs during the early 1960s (Figure 16). After declining to a record low in the early 1970s, they peaked again in the late 1970s, though at a lower level, and again during the mid to late 1980s at about half the level of the

1970s peak. Biomass generally increased during the 1990s, and has fluctuated somewhat in recent years.

Survey recruitment indices for ages 0, 1 and 2 indicate that the abundance of the 2000 year-class is comparable to the good 1975 and 1978 year-classes, with the 1998 year-class being the second strongest since the 1978 (Figure 17). The 1996 and the 1999 year-classes were comparable to the moderate 1983, 1985, 1987 and 1992 year-classes. These year-classes were considerably smaller than the strong 1975 and 1978 year-classes and the exceptional 1963 year-classes. Early indications from survey results suggest that the 2001 year-class is weak.

Although fishery weights at age (Table 10, Figure 19) for ages 2 and 3 are higher since 1993/1994, reflecting the change in gear selectivity which occurred, there have been no persistent trends in population weight at age derived from the DFO surveys. The survey weights at age (Table 15, Figure 18) for 2002, while generally within the range of observation, were notably lower than for 2001. Average weight at age of haddock from the 1989, 1990 and 1991 year-classes were higher than adjacent year-classes in both the surveys and the commercial fisheries, giving the false impression of a declining trend in recent years. The method of calculation of the weights at age from the DFO survey, which were used for beginning of year population weights, are given in Gavaris and Van Eeckhaute (1998) and were derived from weights observed during the survey, weighted by population numbers at length and age. Fishery weights at age are derived from a length-weight relationship (Waiwood and Neilson 1985). In some cases, the mean weight at age in the catch is larger than the population mean weight at age at the beginning of the following year for the same cohort. This feature was mostly attributable to bottom trawl gear changes which resulted in a change in partial recruitment since 1994 (Gavaris and Van Eeckhaute, 2000). However, some discrepancies in weights at age were more persistent and may be due to problems associated with the length weight equations and gutted to round weight conversion factors.

Estimation of Stock Parameters

Calibration of Virtual Population Analysis (VPA)

The adaptive framework, ADAPT, (Gavaris 1988) was used to calibrate the virtual population analysis with the research survey abundance information. An investigation of model formulations and model assumptions was conducted by Gavaris and Van Eeckhaute (1998) where details of model equations and the objective function are provided. The model formulation adopted 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. Similar model assumptions and methods were applied to the updated information here. Minor differences in the handling of zero terminal catches for a year-class were implemented as a refinement to the software to afford more flexibility. The population abundance for the 9+ age group was calculated but not calibrated to the indices. In the first quarter of the first year, the 9+ abundance calculation was based on the assumption that the fishing mortality for the 9+

age group was equal to the population weighted fishing mortality for ages 4 - 8. In the first quarter of subsequent years, the 9+ abundance was calculated as the sum of the age 8 and age group 9+ abundances at the end of the last quarter of the previous year.

The VPA used quarterly catch at age, $C_{a,t}$, for ages a = 0, 1, 2…8, 9+, and time t = 1969.0, 1969.25, 1969.5, 1969.75, 1970.0…2001.75, where t represents the beginning of the time interval during which the catch was taken. The VPA was calibrated to bottom trawl survey abundance indices, $I_{s,a,t}$, for

s = DFO spring, ages a = 1, 2, 3…8, time t = 1986.16, 1987.16…2001.16, 2002.0

s = NMFS spring (Yankee 36), ages a = 1, 2, 3…8, time t = 1969.29, 1970.29, 1971.29, 1972.29, 1982.29, 1983.29…2001.29

s = NMFS spring (Yankee 41), ages a = 1, 2, 3…8, time t = 1973.29, 1974.29…1981.29

s = NMFS fall, ages a = 0, 1, 2…5, time t = 1969.69, 1970.69…2001.69

Since forecast projections were required for the entire year 2002, the DFO spring survey in 2002 was designated as occurring at time 2002.0 instead of 2002.16. The NMFS fall survey captures young of the year and that information is included as 0 group, but older haddock appear less available during this season. Survey indices for older ages where catches were sparse and where there were frequent occurrences of zero catches were not included. Zero observations for abundance indices were treated as missing data as the logarithm of zero is not defined. During years when discarding was high, survey information was used along with interviews to obtain estimates of the USA catch. This lack of complete independence between catch and survey data does not influence population estimates but may deflate variance estimates marginally.

Statistical properties of estimators were obtained from model conditioned non-parametric bootstrap of the residuals (Efron and Tibshirani 1993) as described in Gavaris and Van Eeckhaute (1998). The population abundance estimates show a large relative error and substantial bias at ages 1 while the relative error for other ages is between about 30% and 45% and the bias is smaller (Table 16). 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 (Figures 20-24). Some patterns in the residuals (by cohort and by age) merit further investigation.

Retrospective Analysis

Assessment results for several other stocks have identified a discrepancy between past and current estimates of stock status (retrospective pattern). This stock assessment does not suffer from a retrospective pattern. Successive estimates of year-class abundance at age are fairly stable (Figure 25) although there is sometimes a substantial change after the first estimate of a year-class when more data becomes available, as evidenced for the 1992 and 1996 year-classes. There were no trends of concern for adult biomass (ages 3-8) or for F (ages 4-8 weighted by population numbers) in the retrospective patterns (Figure 26).

Stock Status

The results from the calibrated VPA 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 17-18). This approach for bias adjustment, in the absence of an unbiased point estimator with optimal statistical properties, was considered preferable to using the biased point estimates (O'Boyle 1998). Bias adjusted VPA results were based on bootstrap statistics. The weights at age from the DFO spring survey (Table 15) were used to calculate beginning of year population biomass (Table 19). A weight of 2.4 kg, which was midway between the age 6 and 8 weight for that cohort, was used for age 7 in 1995 as no data were available for that age group. For 1969-85, the 1986-95 average weight at each age was used.

Population biomass (ages 3+) has steadily increased from near an historical low of about 10,000 t in 1993 to about 40,000 t at the beginning of 2001 and 2002 (Figure 27). The 12% drop from 2001 to 2002, was due in part to lower weights at age. The recent increase has been due to more consistent and improved recruitment and was enhanced by increased survivorship and by reduced capture of small fish in the fisheries. Since the 1991 year-class, only the 2001 year-class has been below 5 million fish. Between the 1978 and 1991 year-classes, 7 of the 14 year-classes were below 5 million fish. The biomass increase is expected to be sustained by the 2000 year-class. Total biomass (ages 1+) trend is similar to the ages 3+ trend.

Population biomass during the late 1970s and early 1980s was about 50,000 t, due to recruitment of the strong 1975 and 1978 year-classes whose abundance was estimated at about 50 million. However, biomass declined rapidly in the early 1980s as subsequent recruitment was poor and these two year-classes were fished intensely at a young age.

Recruitment**,** estimated by the VPA, indicate that the 2000 year-class (48 million at age 1) is about equal in strength to the good 1975 and 1978 year-classes (Figure 28). The 1998 year-class (25 million at age 1) is the second strongest since that of 1978. The 1996 and 1999 year-classes were estimated to be about 13 million, comparable to the 1983, 1985 and 1987 year-classes, which were the strongest 3 year-classes over about a 20 year time span.

Exploitation rate on fully recruited ages 4+ has consistently been below that corresponding to $F_{0.1}$ (20%) since 1995 (Figure 29). Historically, exploitation rate has generally exceeded that corresponding to $F_{0.1}$ and showed a marked increase between 1989 and 1993 to about 40%, the highest observed. Reduced fishing mortality in recent years has resulted in increased survival of incoming year-classes. The number of haddock of the 1992 year-class surviving to age 8 was about four times that of the equally abundant 1983 year-class, and about the same as that of the 1975 or 1978 year-classes, which were more than 3 times as abundant (Figure 30). Fishery avoidance of small fish has resulted in the number of fish of the 1998 year-class surviving to age 3 to be almost as many as survived to age 3 of the 1978 year-class which was twice as strong. In both absolute numbers and percent composition, the population structure displays a broad

representation of age groups, reflecting improving recruitment and lower exploitation since 1995 (Figure 31).

Gains in fishable biomass may be partitioned into those associated with somatic growth of haddock, 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. Except for 2001, since 1993 surplus production (biomass gains from growth and from recruitment, decremented by losses due to natural deaths) has exceeded the fishery harvest yield, resulting in net increase (Figure 32). Growth of fish is the dominant component of the biomass gain but recruitment accounts for significant portions when stronger year-classes enter the population. (Figure 33).

Prognosis

Yield projections were done using the bias adjusted 2002 beginning of year population abundance estimates. The abundance of the 2002 year-class was assumed to be 10 million at age 0. For the forecast, partial recruitment to the fishery for ages 1, 2 and 3 and fishery weights at age were averaged over 1997 to 2001 while beginning of year population weights were those observed in 2002 (Table 20). Projected total Canada/USA yield at an exploitation rate of 20% corresponding to $F_{0.1} = 0.25$ in 2002 would be about 10,700 t (Figure 34). If fished at that rate in 2002, the adult biomass is projected to increase considerably from about 40,000 t to 54,000 t by the beginning of 2003, largely due to recruitment of the 2000 year-class. The 1998 year-class (age 4) is expected to comprise the highest proportion of the total 2002 yield, accounting for about 40%.

Uncertainty about year-class abundance generates uncertainty in forecast results. This was expressed as risk of achieving reference levels. For example, a combined Canada/USA catch of 8,000 t in 2002 would be required to obtain a low probability (less than 10%) that fishing mortality rate will exceed $F_{0.1}$ (Figure 35). At this yield, there is a negligible probability of not achieving a 10% or 20% biomass increase.

These uncertainties are dependent on the model assumptions and data used in the analyses. Though these assumptions were deemed most suitable, there may be other plausible assumptions. These calculations do not include uncertainty due to variations in weight at age, partial recruitment to the fishery, natural mortality, systematic errors in data reporting or the possibility that the model may not reflect the stock dynamics closely enough. The risk profiles provide a general sense of the associated uncertainties and can assist in assessing the consequences of alternative actions.

Management Considerations

The Canadian quota of 6,989 t in 2001 was expected to result in a negligible chance of exceeding $F_{0.1}$ but there was a low chance of achieving 10% growth. The Canadian catch in 2001 was very near the quota and resulted in an exploitation rate of about 17% and a decrease in adult biomass of about 12% from 2001 to 2002.

Data were available to approximate the age composition of the catch from unit areas 5Zj and 5Zm in order to reconstruct an illustrative population analysis for the period between 1930 and 1955 suitable for comparison of productivity. Total catches during the 1930s to 1950s ranged between 15,000 t and 40,000 t, averaging about 25,000 t. Catches probably attained record high levels of about 60,000 t during the early 1960s. Since the early 1970s, catches have been substantially lower, generally fluctuating between 5,000 t and 10,000 t. Although biomass has been increasing and is the highest it has been in about 30 years, it remains below the average biomass during 1930-55, when productivity was higher (Figure 36).

The pattern of recruitment indicates that the chance of a strong year-class is significantly reduced for adult biomass below about 40,000 t (Figure 37). Since 1969, only the 1975, 1978 and 2000 year-classes have been above the average abundance of year-classes observed during the period 1930-55. Examination of the recruits per adult biomass ratio suggests that survivorship to age 1, for several years during the 1980s, may have been lower than the norm (Figure 38). The present survivorship appears comparable to that of the 1930s to 1950s period, suggesting that higher recruitment might result if the biomass increases.

Exploitation rate and biomass can be used to compare consequences of alternative harvest yields. The projections above show those results. Other attributes like recruitment, age structure and spatial distribution reflect possible fluctuations in the productive potential and can be used to qualify reference points and acceptable risk. While conditions have improved, maintaining exploitation rate at current levels would enhance further rebuilding.

Consistent management by Canada and the USA is required to ensure that conservation objectives are not compromised.

Cod and haddock are often caught together in Canadian groundfish fisheries. However, their catchabilities to the fisheries differ and they are not necessarily caught in proportion to their relative abundance. With current fishing practices, exploitation of haddock at $F_{0.1}$ may compromise the achievement of rebuilding objectives for cod.

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Table 1. Nominal catches (t) of haddock from unit areas 5Zjm. For "Other" it was assumed that 40% of the total 5Z catch was in 5Zjm.

Year	Canada	USA	Other	Discards	Total
1969	3941	6622	695		11258
1970	1970	3153	357		5480
1971	1610	3534	770		5914
1972	609	1551	502		2662
1973	1565	1396	396		3357
1974	462	955	573	757	2747
1975	1353	1705	29		3087
1976	1355	973	24		2352
1977	2871	2429		2966	8266
1978	9968	4724		1556	16248
1979	5080	5211			10291
1980	10017	5615		7561	23193
1981	5658	9077			14735
1982	4872	6280			11152
1983	3208	4454			7662
1984	1463	5121			6584
1985	3484	1683			5167
1986	3415	2200			5615
1987	4703	1418			6121
1988	4046*	1693			5739
1989	3060	787			3847
1990	3340	1189			4529
1991	5456	949			6405
1992	4058	1629			5687
1993	3727	421			4148
1994	2411	33		258	2702
1995	2065	22		25	2112
1996	3663	36		41	3740
1997	2749	48		63	2859
1998	3371	311		14	3696
1999	3681	355			4036
2000	5402	187			5589
2001	6712	604			7316

* 1895 t excluded because of suspected area misreporting.

Table 2. Regulatory measures implemented for the 5Z and 5Zjm fishery management units by the USA and Canada, respectively, from 1977, when jurisdiction was extended to 200 miles for coastal states, to the present.

	USA	**Canada**
1977-82	**Mesh** size of 5 1/8" (140 mm), seasonal spawning closures, quotas and trip limits.	
1982-85	**All** catch controls eliminated, retained closed area and mesh size regulations, implemented minimum landings size (43 cm).	**First** 5Ze assessment in 1983.
1984 Oct.	**Implementation of the 'Hague' line .**	
1985	**5 ½"** mesh size,. **Areas** 1 and 2 closed during February-May.	
1989		**Combined** cod-haddock-pollock quota for 4X-5Zc
1990		**5Zjm** adopted as management unit. **For** MG < 65 ft. – trip limits with a 30% by-catch of haddock to a maximum of 8 trips of 35,000 lbs per trip between June 1 and Oct. 31 and 130 mm square mesh required. **Fixed** gear required to use large hooks until June
1991	**Established** overfishing definitions for haddock.	**MG** < 65 ft similar to 1990 but mesh size increased to 145 mm diamond.
1992		**Introduction** of ITQs and dockside monitoring.
1993	**Area** 2 closure in effect from Jan 1-June30.	**OT** fishery permitted to operate in Jan. and Feb. **Increase** in use square mesh.
1994	Jan.: **Expanded** Area 2 closure to include June and increased extent of area. **Area** 1 closure not in effect. **500** lb trip limit. **Catch** data obtained from mandatory log books combined with dealer reports (replaces interview system). May: **6**" mesh restriction. Dec.: **Area** 1,2 closed year-round.	**Spawning** closure extended to Jan. 1 to May 31. **Fixed** gear vessels must choose between 5Z or 4X for the period of June to September. **Small** fish protocol. **Increased** at sea monitoring. **OT** > 65 could not begin fishng until July 1. **Predominantly** square mesh by end of year.
1995		**All** OT vessels using square mesh. **Fixed** gear vessels with a history since 1990 of 25t or more for 3 years of cod, haddock pollock, hake or cusk combined can participate in 5Z fishery. **ITQ** vessel require at least 2t of cod and 8t of haddock quota to fish Georges.
1996	July: **Additional** Days-at-Sea restrictions, trip limit raised to 1000 lbs.	**Fixed** gear history requirement dropped.
1997	May: **Additional** scheduled Days-at-sea restrictions. September: **Trip** limit raised to 1000 lbs/day, maximum of 10,000 lbs/trip.	**Vessels** over 65 ft operated on enterprise allocations, otter trawlers under 65 ft on individual quotas, fixed gear vessels 45-65 ft on self-administered individual quotas and fixed gear vessels under 45 ft on community quotas administered by local boards.
1998	Sept. 1: **Trip** limit raised to 3000 lbs/day, maximum of 30,000 lbs/trip.	**Fixed** gear vessels 45-65 ft operated on individual quotas.
1999	May 1: Trip limit 2,000 lbs/day, max. 20,000 lbs/trip. Square mesh size increased to 6.5" (diamond is 6"). June 15: Scallop exemption fishery in Closed Area II. Nov. 5: Trip limit 5,000 lbs/day, max. 50,000 lbs/trip.	Same as 1997 and 1998.
2000	October: Daily trip limit suspended to April 2001but retained max. trip limit of 50,000 lbs/trip.	Same as 1999.
2001	Similar to 2000 with day and trip limit adjustments.	Same as 2000.

Table 3. Canadian catch (t) of haddock in unit areas 5Zjm by gear category and tonnage class for principle gears.

Year	Otter Trawl						Longline			Other	Total
	Side	Stern									
		2	3	4	5	Total[1]	2	3	Total[1]		
1969	777	0	1	225	2902	3127	2	21	23	15	3941
1970	575	2	0	133	1179	1314	6	72	78	2	1970
1971	501	0	0	16	939	955	18	129	151	3	1610
1972	148	0	0	2	260	263	23	169	195	3	609
1973	633	0	0	60	766	826	23	80	105	0	1565
1974	27	0	6	8	332	346	29	59	88	1	462
1975	222	0	1	60	963	1024	25	81	107	0	1353
1976	217	0	2	59	905	967	48	108	156	15	1355
1977	370	92	243	18	2025	2378	43	51	94	28	2871
1978	2456	237	812	351	5639	7039	121	47	169	305	9968
1979	1622	136	858	627	1564	3185	190	80	271	2	5080
1980	1444	354	359	950	6254	7917	129	51	587	69	10017
1981	478	448	629	737	2344	4159	331	99	1019	2	5658
1982	115	189	318	187	3341	4045	497	187	712	0	4872
1983	106	615	431	107	1130	2283	593	195	815	4	3208
1984	5	180	269	21	149	620	614	192	835	3	1463
1985	72	840	1401	155	348	2745	562	33	626	41	3484
1986	51	829	1378	95	432	2734	475	98	594	35	3415
1987	48	782	1448	49	1241	3521	854	113	1046	89	4703
1988[2]	72	1091	1456	186	398	3183	428	200	695	97	4046
1989	0	489	573	376	536	1976	713	175	977	106	3060
1990	0	928	890	116	471	2411	623	173	853	76	3340
1991	0	1610	1647	81	689	4028	900	271	1309	119	5456
1992	0	797	1084	56	645	2583	984	245	1384	90	4058
1993	0	535	1179	67	699	2489	794	156	1143	96	3727
1994	0	495	911	79	112	1597	498	47	714	100	2411
1995	0	523	896	14	214	1647	256	75	390	28	2065
1996	1	836	1405	166	270	2689	561	107	947	26	3663
1997	0	680	1123	91	96	1991	501	116	722	36	2749
1998	0	863	1340	98	71	2422	570	252	921	27	3371
1999	0	954	1471	174	145	2761	486	241	887	33	3680
2000	0	1313	2269	230	246	4146	619	258	1186	71	5402
2001	0	1558	2492	0	743	5050	754	302	1634	29	6712

[1] Total includes catches for tonnage classes which are not listed, only tonnage classes with substantial catches listed

[2] Catches of 26t, 776t, 1091t and 2t for side otter trawlers and stern otter trawlers tonnage classes 2, 3 and 5 respectively were excluded because of suspected area misreporting.

Table 4. Monthly catch (t) of haddock by Canada in unit areas 5Zjm.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1969	105	74	6	291	588	691	559	580	551	360	102	34	3941
1970	2	105	0	1	574	345	103	456	242	103	26	12	1970
1971	0	9	1	0	400	132	283	278	97	246	141	21	1610
1972	0	119	2	0	2	111	84	116	98	68	7	2	609
1973	4	10	0	0	0	184	198	572	339	232	22	4	1565
1974	19	0	1	0	0	58	63	53	96	61	92	19	462
1975	4	14	0	0	0	166	256	482	100	166	118	45	1353
1976	0	7	62	68	60	587	152	190	186	26	9	7	1355
1977	102	177	7	0	23	519	1059	835	13	59	56	22	2871
1978	104	932	44	22	21	319	405	85	642	5433	1962	0	9968
1979	123	898	400	175	69	1393	885	396	406	261	53	22	5080
1980	38	134	14	29	223	2956	2300	965	1411	1668	104	176	10017
1981	38	481	568	4	254	1357	1241	726	292	82	378	239	5658
1982	129	309	1	11	46	1060	769	682	585	837	398	44	4872
1983	32	67	29	47	60	1288	387	483	526	195	88	6	3208
1984	3	5	81	88	73	433	219	254	211	71	25	0	1463
1985	1	11	33	99	26	354	392	1103	718	594	61	93	3484
1986	11	28	79	99	40	1339	1059	369	233	139	12	8	3415
1987	24	26	138	70	12	1762	1383	665	405	107	97	14	4703
1988[1]	39	123	67	79	15	1816	1360	315	130	65	13	24	4046
1989	33	94	48	7	20	1398	356	566	141	272	108	18	3060
1990	35	14	50	0	7	1178	668	678	469	199	18	22	3340
1991	144	166	49	26	21	1938	1004	705	566	576	123	137	5456
1992	118	205	97	152	36	1381	619	414	398	401	209	28	4058
1993	468	690	96	78	25	723	505	329	202	198	230	183	3727
1994	3	3	1	2	0	398	693	373	375	220	211	133	2411
1995	5	1	1	1	0	762	327	290	281	109	197	93	2065
1996	0	0	0	0	0	1067	672	706	359	278	191	391	3663
1997	0	0	0	0	0	328	751	772	426	190	116	166	2749
1998	0	0	0	0	0	687	420	580	707	542	164	271	3371
1999	37	0	0	0	0	898	975	562	573	295	269	70	3681
2000	1	0	0	0	0	1368	1175	1026	848	658	175	150	5402
2001	0	0	0	0	0	971	1335	930	1268	1075	647	485	6712

[1] Catches of 3t, 1846t and 46t for Jan., Feb., and Mar., respectively for otter trawlers were excluded because of suspected area misreporting

Table 5. USA catch (t) of haddock (excluding discard estimates) in unit areas 5Zjm by gear category and tonnage class. Details for 1994-2001 are not available because data is preliminary.

Year	Otter Trawl			Other	Total
	3	4	Total		
1969	3010	3610	6621	0	6622
1970	1602	1551	3154	0	3153
1971	1760	1768	3533	0	3534
1972	861	690	1551	0	1551
1973	637	759	1396	0	1396
1974	443	512	955	0	955
1975	993	675	1668	36	1705
1976	671	302	972	2	973
1977	1721	700	2423	5	2429
1978	3140	1573	4713	11	4724
1979	3281	1927	5208	4	5211
1980	3654	2955	5611	4	5615
1981	3591	5408	9031	45	9077
1982	2585	3657	6242	37	6280
1983	1162	3261	4423	29	4454
1984	1854	3260	5115	5	5121
1985	856	823	1679	4	1683
1986	985	1207	2192	9	2200
1987	778	639	1417	1	1418
1988	920	768	1688	6	1693
1989	359	419	780	6	787
1990	486	688	1178	4	1189
1991	400	517	918	13	931
1992	597	740	1337	292	1629
1993	142	191	333	88	421
1994			32	0	33
1995			21	0	22
1996			36	0	36
1997			48	0	48
1998			311	0	311
1999			355	0	355
2000			187	0	187
2001			602	2	604

Table 6. Monthly catch (t) of haddock (excluding discard estimates) by USA in unit areas 5Zjm. Details for 1994-2001 are not available because data is preliminary.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1969	525	559	976	1825	670	809	204	219	249	226	203	157	6622
1970	169	219	242	375	608	374	324	333	179	219	61	50	3153
1971	155	361	436	483	668	503	338	152	147	165	58	68	3534
1972	150	196	91	90	239	261	97	164	84	63	52	64	1551
1973	90	111	77	85	138	365	217	196	37	3	22	55	1396
1974	135	70	47	70	122	160	165	43	27	6	19	91	955
1975	152	123	32	116	388	489	138	95	57	24	52	39	1705
1976	116	147	83	106	323	162	7	6	5	2	3	13	973
1977	75	211	121	154	374	372	434	191	73	52	146	226	2429
1978	336	437	263	584	752	750	467	221	245	426	194	49	4724
1979	274	329	352	548	766	816	588	659	224	202	281	172	5211
1980	632	1063	742	784	711	461	324	254	221	91	110	222	5615
1981	550	1850	634	627	882	1326	1233	873	321	284	242	255	9077
1982	425	754	502	347	718	1801	757	145	201	216	276	138	6280
1983	492	931	272	181	310	1145	231	178	187	110	227	190	4454
1984	540	961	366	281	627	1047	370	302	250	196	92	89	5121
1985	165	190	254	300	352	206	60	47	1	24	41	43	1683
1986	184	396	334	479	496	221	31	6	12	6	6	29	2200
1987	225	52	43	307	233	342	67	30	24	4	23	68	1418
1988	196	152	207	245	366	316	30	19	6	1	45	110	1693
1989	114	56	47	164	161	145	15	8	1	5	25	46	787
1990	148	21	155	274	214	306	23	3	5	5	16	19	1189
1991	105	28	76	133	89	434	1	20	6	0	19	19	931
1992	253	81	51	149	353	669	20	20	17	3	2	12	1629
1993	15	12	16	55	84	209	6	3	3	7	2	8	421
1994													33
1995													22
1996													36
1997													48
1998													311
1999													355
2000													187
2001													604

Table 7. Sampling for catch at age for the 2000 5Zjm Canadian haddock fishery.

Country	Quarter	Aged	Month	Gear / TC	Measured	Landings
Canada	2	393	June	OT / 0-3	12784	821
				OT / 4-6	3903	146
				LL		4
				GN		< 1
	3	504	July	OT / 0-3	10109	880
				OT / 4-6	3558	174
				LL	2649	273
				GN	478	8
			August	OT / 0-3	1352	489
				OT / 4-6		
				LL	6718	437
				GN	350	5
			September	OT / 0-3	1700	702
				OT / 4-6	599	145
				LL	2872	410
				GN		11
	4	496	October	OT / 0-3	4289	641
				OT / 4-6	2492	79
				LL	7072	354
				GN		2
			November	OT / 0-3	2042	419
				OT / 4-6	1199	96
				LL	446	129
				GN	210	3
			December	OT / 0-3	2845	340
				OT / 4-6		118
				LL	238	28
				GN		

OT=Otter Trawl Bottom, GN=Gill Net, LL=Longline (includes Handline) TC=Tonnage Class.

Table 8. Components of catch at age numbers of haddock from unit areas 5Zjm by quarter.

Quarter	Age Group									
	1	2	3	4	5	6	7	8	9+	1+
Canada										
2001	0	0	0	0	0	0	0	0	0	0
2001.25	0	9962	291307	98979	117781	36310	27329	17640	10391	609699
2001.5	1726	24713	864290	258412	375705	103025	105240	89441	82747	1905299
2001.75	362	24957	459760	121948	254461	81839	43678	87708	56342	1131056
Year total	2088	59632	1615357	479339	747947	221174	176247	194789	149480	3646054
USA										
2001	0	0	13197	16828	13158	14463	7960	6180	5173	76959
2001.25	0	0	24527	31274	24453	26879	14793	11486	9614	143026
2001.5	0	0	5162	6583	5147	5658	3114	2418	2023	30104
2001.75	0	0	5371	6849	5355	5886	3239	2515	2105	31321
Year total	0	0	48258	61533	48112	52886	29105	22599	18915	281409
Total										
2001	0	0	13197	16828	13158	14463	7960	6180	5173	76959
2001.25	0	9962	315834	130253	142234	63189	42122	29126	20005	752724
2001.5	1726	24713	869453	264995	380852	108682	108353	91859	84771	1935403
2001.75	362	24957	465131	128797	259816	87726	46918	90224	58447	1162376
Year total	2088	59632	1663615	540872	796060	274060	205353	217388	168395	3927463

Table 9. Total annual commercial catch at age numbers (000's) of haddock from unit areas 5Zjm.

Year	Age Group										
	0	1	2	3	4	5	6	7	8	9+	1+
1969	0	0	18	1441	260	331	2885	819	89	279	6123
1970	0	25	82	7	347	147	126	1140	364	189	2425
1971	0	0	1182	247	31	246	157	159	756	407	3185
1972	0	259	1	376	71	21	92	37	16	431	1303
1973	0	1015	1722	6	358	37	10	37	8	163	3358
1974	0	17	2105	247	0	31	3	0	29	57	2488
1975	0	0	270	1428	201	5	34	1	2	28	1969
1976	0	73	149	166	814	125	0	19	0	17	1363
1977	0	0	7836	64	178	303	162	0	15	14	8571
1978	0	1	285	9831	161	169	302	80	10	9	10848
1979	0	0	15	199	4250	362	201	215	43	14	5300
1980	0	3	17561	342	299	2407	191	129	51	12	20995
1981	0	0	660	6687	393	494	1234	119	33	7	9627
1982	0	0	713	1048	2799	201	377	723	62	65	5988
1983	0	0	140	648	546	1629	207	104	402	34	3710
1984	0	0	76	249	341	264	1120	186	165	314	2716
1985	0	0	2063	374	176	189	123	371	53	114	3463
1986	0	6	38	2557	173	142	122	118	173	41	3369
1987	0	0	1990	127	1515	96	56	82	68	108	4042
1988	0	4	51	2145	121	877	109	36	46	98	3487
1989	0	0	1153	78	734	129	320	31	20	45	2510
1990	0	2	7	1265	126	743	68	163	42	42	2457
1991	0	6	441	89	2041	88	389	72	145	61	3332
1992	0	7	230	311	127	1446	89	315	26	90	2640
1993	0	7	247	343	279	85	635	34	153	74	1856
1994	0	1	241	737	148	54	48	125	29	39	1423
1995	0	2	60	525	414	53	25	3	51	16	1149
1996	0	1	29	481	862	419	61	18	3	72	1946
1997	0	2	81	80	542	483	194	13	8	34	1438
1998	0	1	163	282	258	539	446	114	12	35	1851
1999	0	1	35	737	315	244	344	253	97	25	2052
2000	0	0	309	437	1245	249	200	209	182	65	2896
2001	0	2	60	1664	541	796	274	205	217	168	3927

Table 10. Average weight at age (kg) of haddock from the commercial fishery in unit areas 5Zjm. The 1989 to 1991 year-classes (shaded) grew faster than adjacent year-classes.

Year	Age Group							
	1	2	3	4	5	6	7	8
1969	0.600	0.763	1.282	1.531	1.649	1.836	2.298	2.879
1970	0.721	1.067	0.812	1.653	1.886	2.124	2.199	2.841
1971	0.600	0.928	1.059	1.272	2.011	2.255	2.262	2.613
1972	0.759	1.000	1.562	1.750	2.147	2.505	2.411	2.514
1973	0.683	1.002	1.367	1.804	2.202	1.631	2.885	3.295
1974	0.600	0.970	1.418	1.800	1.984	3.760	2.700	3.128
1975	0.600	0.872	1.524	2.062	1.997	2.422	4.114	3.557
1976	0.596	0.956	1.293	1.857	2.417	2.700	2.702	3.000
1977	0.600	0.970	1.442	1.809	2.337	2.809	2.700	3.095
1978	0.619	1.151	1.433	2.055	2.623	2.919	2.972	2.829
1979	0.600	0.987	1.298	1.805	2.206	2.806	3.219	3.277
1980	0.405	0.892	1.034	1.705	2.115	2.593	3.535	3.608
1981	0.600	0.890	1.262	1.592	2.270	2.611	3.505	4.009
1982	0.600	0.965	1.363	1.786	2.327	2.557	2.958	3.531
1983	0.600	1.024	1.341	1.750	2.118	2.509	2.879	3.104
1984	0.600	0.876	1.354	1.838	2.159	2.605	2.856	3.134
1985	0.600	0.950	1.230	1.915	2.227	2.702	2.872	3.180
1986	0.452	0.981	1.352	1.866	2.367	2.712	2.969	3.570
1987	0.600	0.833	1.431	1.984	2.148	2.594	2.953	3.646
1988	0.421	0.974	1.305	1.708	2.042	2.350	3.011	3.305
1989	0.600	0.868	1.450	1.777	2.183	2.522	3.012	3.411
1990	0.639	0.999	1.419	1.787	2.141	2.509	2.807	3.002
1991	0.581	1.197	1.241	1.802	2.087	2.596	2.918	3.012
1992	0.538	1.163	1.622	1.654	2.171	2.491	2.988	3.388
1993	0.659	1.160	1.724	2.181	2.047	2.623	2.386	3.112
1994	0.405	1.135	1.661	2.235	2.639	2.422	2.831	3.223
1995	0.797	1.055	1.511	2.033	2.550	2.755	2.908	3.010
1996	0.576	1.022	1.439	1.795	2.294	2.485	3.322	2.032
1997	0.685	1.215	1.336	1.747	2.120	2.476	3.034	3.365
1998	0.568	1.131	1.573	1.697	1.983	2.312	2.864	3.395
1999	0.678	1.095	1.570	1.910	1.865	2.182	2.535	2.773
2000	0.664	1.103	1.470	1.920	2.242	2.098	2.497	2.816
2001	0.394	1.100	1.470	1.755	2.105	2.365	2.185	2.523
Low	0.394	0.763	0.812	1.272	1.649	1.631	2.185	2.032
High	0.797	1.215	1.724	2.235	2.639	3.760	4.114	4.009
Median	0.600	0.999	1.418	1.800	2.148	2.509	2.879	3.128
Average	0.595	1.009	1.383	1.813	2.171	2.510	2.857	3.127

Table 11. Conversion factors used to adjust for changes in door type and survey vessel in the NMFS surveys.

		Spring		Fall	
Year	Door	Vessel	Conversion	Vessel	Conversion
1968	BMV	Albatross IV	1.49	Albatross IV	1.49
1969	BMV	Albatross IV	1.49	Albatross IV	1.49
1970	BMV	Albatross IV	1.49	Albatross IV	1.49
1971	BMV	Albatross IV	1.49	Albatross IV	1.49
1972	BMV	Albatross IV	1.49	Albatross IV	1.49
1973	BMV	Albatross IV	1.49	Albatross IV	1.49
1974	BMV	Albatross IV	1.49	Albatross IV	1.49
1975	BMV	Albatross IV	1.49	Albatross IV	1.49
1976	BMV	Albatross IV	1.49	Albatross IV	1.49
1977	BMV	Albatross IV	1.49	Delaware II	1.2218
1978	BMV	Albatross IV	1.49	Delaware II	1.2218
1979	BMV	Albatross IV	1.49	Delaware II	1.2218
1980	BMV	Albatross IV	1.49	Delaware II	1.2218
1981	BMV	Delaware II	1.2218	Delaware II	1.2218
1982	BMV	Delaware II	1.2218	Albatross IV	1.49
1983	BMV	Albatross IV	1.49	Albatross IV	1.49
1984	BMV	Albatross IV	1.49	Albatross IV	1.49
1985	Polyvalent	Albatross IV	1	Albatross IV	1
1986	Polyvalent	Albatross IV	1	Albatross IV	1
1987	Polyvalent	Albatross IV	1	Albatross IV	1
1988	Polyvalent	Albatross IV	1	Albatross IV	1
1989	Polyvalent	Delaware II	0.82	Delaware II	0.82
1990	Polyvalent	Delaware II	0.82	Delaware II	0.82
1991	Polyvalent	Delaware II	0.82	Delaware II	0.82
1992	Polyvalent	Albatross IV	1	Albatross IV	1
1993	Polyvalent	Albatross IV	1	Delaware II	0.82
1994	Polyvalent	Delaware II	0.82	Albatross IV	1
1995	Polyvalent	Albatross IV	1	Albatross IV	1
1996	Polyvalent	Albatross IV	1	Albatross IV	1
1997	Polyvalent	Albatross IV	1	Albatross IV	1
1998	Polyvalent	Albatross IV	1	Albatross IV	1
1999	Polyvalent	Albatross IV	1	Albatross IV	1
2000	Polyvalent	Albatross IV	1	Albatross IV	1
2001	Polyvalent	Albatross IV	1	Albatross IV	1

Table 12. Total estimated abundance at age (numbers in 000's) of haddock for unit areas 5Zjm from DFO spring surveys.

Year	Age Group									
	1	2	3	4	5	6	7	8	9+	Total
1986	5057	306	8176	997	189	348	305	425	401	16205
1987	46	4286	929	3450	653	81	387	135	1132	11099
1988	971	49	12714	257	4345	274	244	130	686	19670
1989	48	6664	991	2910	245	526	40	34	265	11724
1990	726	108	12300	168	4466	299	1370	144	389	19968
1991	383	2163	134	10819	114	1909	117	505	225	16368
1992	1914	3879	1423	221	4810	18	1277	52	656	14249
1993	3448	1759	545	431	34	1186	19	281	147	7849
1994	4197	15163	5332	549	314	20	915	18	356	26864
1995	1231	3224	6236	3034	720	398	0	729	849	16422
1996	1455	2290	4784	5305	3113	303	274	38	684	18247
1997	1033	1550	1222	2742	2559	1397	150	65	372	11090
1998	2379	10626	5348	3190	5312	5028	2248	348	601	35080
1999	24593	4787	10067	3104	1963	1880	1764	448	174	48780
2000	3177	15865	7679	12108	2900	2074	2726	1591	813	48932
2001	23026	3519	14633	4255	5608	1808	1426	1963	2299	58536
2002	732	28174	5977	12659	2980	2644	647	528	2420	56760

Table 13. Total estimated abundance at age (numbers in 000's) of haddock for unit areas 5Zjm from NMFS spring surveys. From 1973-81, a 41 Yankee trawl was used while a 36 Yankee trawl was used in other years. Conversion factors to adjust for changes in door type and survey vessel were applied.

Year	Age Group									
	1	2	3	4	5	6	7	8	9+	Total
1968	0	3254	68	679	4853	2045	240	123	234	11496
1969	17	35	614	235	523	3232	1220	358	489	6724
1970	478	190	0	560	998	441	3165	2491	769	9092
1971	0	655	261	0	144	102	58	1159	271	2650
1972	2594	0	771	132	25	47	211	27	1214	5020
1973	2455	5639	0	1032	154	0	276	0	1208	10763
1974	1323	20596	4084	0	354	0	43	72	322	26795
1975	528	567	6016	1063	0	218	127	45	208	8773
1976	8228	402	424	1127	532	0	0	0	22	10735
1977	126	26003	262	912	732	568	0	22	102	28727
1978	0	743	20859	641	880	1163	89	23	116	24516
1979	10496	441	1313	9764	475	72	445	42	9	23056
1980	4355	66450	1108	1086	5761	613	371	693	360	80797
1981	3281	2823	27085	2906	751	2455	347	56	21	39725
1982	584	3703	1658	7802	767	455	697	0	0	15666
1983	238	770	686	359	2591	30	0	798	58	5529
1984	1366	1414	1046	910	847	1189	133	73	490	7469
1985	40	8911	1396	674	1496	588	1995	127	483	15709
1986	3334	280	3597	246	210	333	235	560	159	8953
1987	122	5480	144	1394	157	231	116	370	0	8013
1988	305	61	1868	235	611	203	218	178	0	3678
1989	84	6665	619	1343	267	791	58	92	47	9966
1990	1654	70	10338	598	1042	110	182	0	0	13995
1991	740	2071	432	3381	192	203	66	87	25	7198
1992	529	287	205	158	602	32	46	46	0	1905
1993	1870	1116	197	232	195	717	77	35	43	4480
1994	1025	4272	1487	269	184	118	278	28	84	7745
1995	921	2312	4184	1727	265	152	51	272	214	10099
1996	912	1365	3789	3190	1905	237	36	0	496	11931
1997	1635	1226	380	595	470	343	24	44	20	4736
1998	549	6046	2005	1281	1184	303	58	15	122	11562
1999	6286	1914	3655	661	1128	1062	468	476	46	15696
2000	2675	2131	3399	1624	636	564	438	305	165	11938
2001	10503	1186	3304	1232	374	294	113	20	20	17047

Table 14. Total estimated abundance at age (numbers in 000's) of haddock for unit areas 5Zjm from NMFS fall surveys. Conversion factors to adjust for changes in door type and survey vessel were applied.

Year	Age Group									
	0	1	2	3	4	5	6	7	8+	Total
1963	105993	40995	10314	3378	5040	4136	1477	451	276	172061
1964	1178	123976	46705	4358	807	1865	477	211	167	179742
1965	259	1503	51338	8538	479	302	142	148	208	62918
1966	9325	751	1742	20323	3631	671	138	133	84	36798
1967	0	3998	73	327	1844	675	141	88	88	7233
1968	55	113	800	28	37	2223	547	177	313	4293
1969	356	0	0	509	62	30	739	453	108	2257
1970	0	6400	336	16	415	337	500	902	578	9483
1971	2626	0	788	97	0	265	27	73	594	4471
1972	4747	2396	0	232	0	0	53	0	275	7702
1973	1223	16797	1598	0	168	0	0	8	16	19809
1974	151	234	961	169	0	6	0	0	70	1589
1975	30365	664	192	1042	239	0	0	0	28	32530
1976	738	121717	431	25	484	71	0	17	37	123521
1977	47	238	26323	445	125	211	84	4	4	27480
1978	14642	547	530	7706	56	42	94	0	0	23617
1979	1598	21605	14	335	1489	45	12	0	0	25098
1980	3556	2788	5829	0	101	1081	108	25	4	13492
1981	596	4617	2585	2748	89	136	318	0	15	11103
1982	62	0	673	465	2508	153	97	528	42	4527
1983	3609	444	236	501	289	402	17	12	86	5598
1984	45	3775	856	233	194	45	262	0	41	5451
1985	12148	381	1646	199	70	68	46	30	21	14611
1986	30	7471	109	961	52	50	72	24	23	8793
1987	508	0	843	28	152	38	22	0	0	1592
1988	122	3983	184	2348	155	400	142	140	38	7513
1989	167	83	2645	112	509	68	73	0	0	3656
1990	1217	1041	36	1456	65	196	24	5	0	4040
1991	705	331	267	52	289	25	10	0	0	1679
1992	3484	1052	172	110	0	95	0	18	18	4948
1993	652	6656	3601	585	0	87	96	30	0	11707
1994	625	782	927	419	96	32	0	24	0	2905
1995	892	1436	5993	3683	550	30	0	0	53	12637
1996	1742	453	570	2302	963	167	0	0	0	6196
1997	217	5738	3368	592	690	385	0	0	13	11004
1998	2566	2966	4214	1085	705	526	722	0	0	12784
1999	3268	1236	5364	5060	837	2825	148	1150	991	20879
2000	1368	5284	6226	3712	622	229	0	146	97	17684
2001	659	16626	1382	6939	3000	1586	306	127	58	30684

Table 15. Average weight at age (kg) from DFO spring surveys used to represent beginning of year weights.

Year	Age Group								
	1	2	3	4	5	6	7	8	9+
1986	0.135	0.451	0.974	1.445	3.044	2.848	3.598	3.376	3.918
1987	0.150	0.500	0.716	1.672	2.012	2.550	3.148	3.151	3.629
1988	0.097	0.465	0.931	1.795	1.816	1.918	2.724	3.264	3.871
1989	0.062	0.474	0.650	1.392	1.995	2.527	2.158	2.859	3.141
1990	0.149	0.525	0.924	1.181	1.862	2.073	2.507	2.815	3.472
1991	0.120	0.685	0.800	1.512	1.695	2.434	2.105	3.122	3.432
1992	0.122	0.602	1.118	1.061	2.078	2.165	2.709	2.284	3.440
1993	0.122	0.481	1.227	1.803	1.274	2.332	2.343	2.739	3.280
1994	0.107	0.469	1.047	1.621	1.927	2.154	3.154	2.688	3.084
1995	0.086	0.493	0.963	1.556	2.222	2.445		2.991	3.184
1996	0.139	0.495	0.919	1.320	1.932	2.555	2.902	2.611	3.588
1997	0.132	0.506	0.782	1.205	1.664	2.176	2.454	2.577	3.158
1998	0.107	0.535	1.035	1.161	1.570	1.954	2.609	3.559	3.462
1999	0.130	0.474	0.911	1.290	1.259	1.869	2.131	2.722	2.992
2000	0.116	0.543	0.949	1.478	1.871	1.789	2.298	2.508	2.901
2001	0.093	0.524	1.005	1.371	1.798	2.165	2.250	2.593	2.928
2002	0.096	0.332	0.778	1.138	1.494	1.965	2.177	2.206	2.707
Low	0.062	0.332	0.650	1.061	1.259	1.789	2.105	2.206	2.707
High	0.150	0.685	1.227	1.803	3.044	2.848	3.598	3.559	3.918
Median	0.120	0.495	0.931	1.392	1.862	2.165	2.480	2.739	3.280
Average	0.115	0.503	0.925	1.412	1.854	2.231	2.579	2.827	3.305

Table 16. Statistical properties of estimates for beginning of 2002 population abundance (numbers in 000's) and survey calibration constants (unitless, survey:population) for haddock in unit areas 5Zjm obtained from a bootstrap with 1000 replications.

Age	Estimate	Standard Error	Relative Error	Bias	Relative Bias
		Population Abundance (000's)			
1	4146	3748	0.904	1123	0.271
2	42703	18973	0.444	3743	0.088
3	8159	2855	0.350	521	0.064
4	12416	4341	0.350	759	0.061
5	3050	904	0.296	112	0.037
6	2537	833	0.329	85	0.033
7	815	274	0.337	39	0.048
8	609	221	0.364	20	0.034
		Survey Calibration Constants			
DFO Spring Survey					
1	0.214	0.050	0.233	0.004	0.019
2	0.497	0.113	0.227	0.011	0.022
3	0.926	0.223	0.241	0.029	0.032
4	0.879	0.207	0.235	0.009	0.011
5	1.022	0.235	0.230	0.023	0.023
6	0.847	0.197	0.233	0.016	0.019
7	1.112	0.273	0.245	0.026	0.023
8	1.103	0.262	0.237	0.028	0.025
NMFS Spring Survey – Yankee 36 – 1969-72/1982-99					
1	0.138	0.028	0.205	0.003	0.024
2	0.319	0.065	0.205	0.004	0.012
3	0.436	0.085	0.194	0.004	0.009
4	0.442	0.087	0.196	0.009	0.021
5	0.506	0.099	0.196	0.010	0.019
6	0.423	0.083	0.196	0.004	0.009
7	0.461	0.089	0.192	0.003	0.006
8	0.521	0.101	0.195	0.003	0.007
NMFS Spring Survey – Yankee 41 – 1973-81					
1	0.225	0.072	0.320	0.011	0.047
2	0.511	0.169	0.331	0.037	0.072
3	0.639	0.221	0.345	0.032	0.049
4	0.793	0.269	0.339	0.047	0.059
5	0.964	0.325	0.337	0.039	0.041
6	0.887	0.381	0.430	0.073	0.082
7	1.595	0.593	0.372	0.117	0.074
8	0.633	0.225	0.356	0.025	0.040
NMFS Fall Survey					
0	0.123	0.020	0.166	0.002	0.013
1	0.318	0.056	0.175	0.007	0.022
2	0.236	0.040	0.169	0.002	0.006
3	0.234	0.038	0.163	0.003	0.012
4	0.175	0.031	0.176	0.003	0.019
5	0.158	0.026	0.167	0.001	0.005

Table 17. Beginning of year population abundance (numbers in 000's) for haddock in unit areas 5Zjm from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 2002.

Year	Age Group											
	1	2	3	4	5	6	7	8	9+	1+	2+	3+
1969	768	189	4375	853	905	8990	3021	185	809	20096	19327	19138
1970	3349	629	138	2295	465	448	4796	1745	486	14352	11003	10374
1971	456	2715	439	107	1569	249	253	2904	1335	10027	9571	6857
1972	5375	373	1128	138	61	1064	64	67	2441	10711	5336	4963
1973	11030	4152	305	587	49	31	792	19	1661	18626	7596	3444
1974	3343	8121	1827	244	153	7	17	614	1224	15551	12208	4087
1975	3222	2718	4750	1279	200	99	4	14	1430	13715	10493	7775
1976	53928	2633	1972	2593	868	159	51	2	1156	63363	9435	6802
1977	5900	43961	2022	1467	1403	599	131	25	933	56440	50540	6580
1978	4205	4830	28839	1599	1043	885	349	107	759	42615	38410	33580
1979	51914	3437	3680	14522	1160	703	457	213	692	76779	24865	21428
1980	6636	42504	2799	2831	8088	625	400	185	690	64758	58122	15619
1981	5116	5424	18953	1988	2051	4507	342	216	661	39259	34142	28718
1982	1710	4189	3832	9540	1279	1239	2605	176	683	25254	23544	19355
1983	2530	1400	2767	2194	5288	864	679	1487	592	17801	15271	13871
1984	14881	2071	1015	1675	1305	2883	522	462	1318	26133	11252	9180
1985	1551	12184	1626	607	1064	836	1370	264	1034	20536	18985	6802
1986	13234	1267	8036	984	338	702	574	795	914	26845	13611	12344
1987	1274	10802	1002	4294	655	150	467	368	1213	20223	18949	8147
1988	14995	1043	7041	706	2154	449	73	309	1134	27904	12909	11866
1989	787	12243	808	3828	469	990	271	28	1054	20477	19690	7447
1990	2366	644	8976	590	2470	268	524	195	828	16862	14496	13852
1991	1800	1933	521	6201	371	1354	159	283	762	13385	11585	9652
1992	7751	1466	1179	347	3223	223	759	67	671	15685	7934	6468
1993	10596	6332	988	683	171	1343	105	339	501	21058	10462	4130
1994	12032	8662	4943	496	311	65	538	56	489	27592	15560	6898
1995	5116	9827	6860	3356	269	205	8	325	383	26349	21233	11407
1996	5299	4176	7981	5130	2367	172	145	4	519	25793	20494	16318
1997	12797	4329	3389	6086	3403	1549	84	102	358	32098	19301	14971
1998	8462	10451	3466	2699	4477	2337	1089	57	339	33377	24915	14464
1999	24539	6920	8392	2570	1969	3162	1500	787	281	50119	25580	18661
2000	11489	20066	5627	6178	1814	1388	2274	997	764	50596	39107	19041
2001	47644	9401	16144	4200	3902	1257	951	1668	1215	86383	38739	29338
2002	3024	38960	7637	11658	2938	2452	775	588	1999	70031	67008	28048

Table 18. Fishing mortality rate for haddock in unit areas 5Zjm from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 2002. The rate for ages 4+ is weighted by population numbers and is also shown as exploitation rate (%).

Year	Age Group										
	1	2	3	4	5	6	7	8	9+	4+	4+ (%)
1969	0.000	0.112	0.445	0.407	0.504	0.428	0.349	0.737	0.470	0.422	31
1970	0.010	0.159	0.057	0.180	0.425	0.371	0.302	0.258	0.543	0.287	23
1971	0.000	0.678	0.956	0.367	0.188	1.164	1.131	0.332	0.397	0.375	29
1972	0.058	0.003	0.453	0.832	0.467	0.096	0.993	0.288	0.210	0.219	18
1973	0.106	0.621	0.022	1.143	1.738	0.413	0.054	0.641	0.112	0.322	25
1974	0.007	0.336	0.156	0.000	0.242	0.491	0.003	0.051	0.050	0.059	5
1975	0.002	0.121	0.405	0.188	0.025	0.460	0.336	0.172	0.021	0.108	9
1976	0.004	0.064	0.096	0.414	0.171	0.000	0.522	0.000	0.016	0.262	21
1977	0.000	0.222	0.035	0.141	0.261	0.339	0.000	1.007	0.017	0.180	15
1978	0.002	0.072	0.486	0.121	0.194	0.460	0.293	0.107	0.013	0.195	16
1979	0.000	0.005	0.062	0.385	0.419	0.363	0.703	0.249	0.022	0.379	29
1980	0.002	0.608	0.142	0.122	0.385	0.402	0.416	0.346	0.019	0.308	24
1981	0.000	0.147	0.486	0.241	0.304	0.348	0.465	0.178	0.012	0.295	23
1982	0.000	0.215	0.358	0.390	0.192	0.401	0.361	0.481	0.107	0.358	27
1983	0.000	0.121	0.302	0.319	0.406	0.304	0.185	0.343	0.065	0.341	26
1984	0.000	0.042	0.314	0.253	0.246	0.544	0.481	0.486	0.298	0.390	29
1985	0.002	0.216	0.302	0.387	0.216	0.175	0.344	0.246	0.127	0.247	20
1986	0.003	0.035	0.427	0.208	0.610	0.209	0.246	0.263	0.049	0.221	18
1987	0.000	0.228	0.149	0.490	0.177	0.527	0.213	0.229	0.104	0.365	28
1988	0.003	0.056	0.410	0.209	0.577	0.304	0.759	0.174	0.099	0.362	28
1989	0.000	0.110	0.114	0.238	0.359	0.436	0.130	1.605	0.047	0.247	20
1990	0.002	0.013	0.170	0.265	0.401	0.321	0.416	0.269	0.057	0.318	25
1991	0.005	0.294	0.207	0.455	0.307	0.379	0.674	0.823	0.092	0.422	31
1992	0.002	0.194	0.345	0.507	0.675	0.554	0.607	0.541	0.159	0.582	40
1993	0.002	0.048	0.489	0.586	0.770	0.715	0.426	0.662	0.170	0.588	41
1994	0.002	0.033	0.187	0.412	0.220	1.883	0.303	0.877	0.095	0.334	26
1995	0.003	0.008	0.091	0.149	0.249	0.145	0.505	0.193	0.047	0.150	13
1996	0.002	0.009	0.071	0.210	0.224	0.516	0.151	2.096	0.171	0.218	18
1997	0.003	0.022	0.027	0.107	0.176	0.153	0.190	0.091	0.112	0.134	11
1998	0.001	0.019	0.099	0.115	0.148	0.244	0.125	0.263	0.121	0.158	13
1999	0.001	0.007	0.106	0.149	0.150	0.130	0.208	0.147	0.102	0.150	13
2000	0.001	0.017	0.093	0.259	0.166	0.178	0.110	0.228	0.102	0.202	17
2001	0.001	0.008	0.126	0.157	0.265	0.284	0.280	0.160	0.175	0.212	17

Table 19. Beginning of year biomass (tonnes in 000's) for haddock in unit areas 5Zjm from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 2002.

Year	Age Group											
	1	2	3	4	5	6	7	8	9+	1+	2+	3+
1969	88	97	4091	1283	1803	21080	8204	541	2788	39975	39887	39789
1970	385	324	129	3451	926	1049	13027	5111	1676	26079	25694	25371
1971	52	1397	411	161	3127	583	687	8506	4600	19523	19471	18074
1972	618	192	1055	208	121	2495	173	196	8409	13467	12849	12657
1973	1268	2136	285	884	98	73	2150	56	5722	12672	11404	9268
1974	384	4179	1708	367	306	17	46	1799	4217	13021	12637	8458
1975	370	1398	4441	1924	398	231	10	40	4928	13740	13370	11972
1976	6199	1355	1844	3900	1729	374	138	6	3983	19528	13328	11974
1977	678	22619	1890	2206	2796	1404	355	73	3214	35235	34557	11938
1978	483	2485	26963	2404	2078	2074	949	313	2613	40362	39879	37394
1979	5968	1768	3441	21840	2310	1648	1242	625	2383	41226	35258	33489
1980	763	21869	2617	4258	16116	1464	1087	543	2377	51094	50331	28462
1981	588	2791	17720	2990	4087	10567	929	633	2278	42583	41995	39204
1982	197	2155	3583	14347	2549	2905	7076	515	2354	35681	35485	33329
1983	291	720	2587	3300	10535	2027	1845	4354	2038	27697	27406	26686
1984	1711	1066	949	2518	2601	6760	1418	1353	4541	22916	21206	20140
1985	178	6269	1520	913	2121	1959	3722	773	3562	21018	20839	14571
1986	1782	572	7830	1422	1028	1999	2065	2684	3582	22964	21182	20610
1987	191	5396	717	7181	1317	383	1469	1158	4401	22213	22022	16626
1988	1458	485	6552	1267	3912	861	198	1007	4391	20132	18674	18189
1989	49	5805	525	5330	936	2502	585	80	3310	19120	19072	13267
1990	352	338	8296	697	4601	556	1314	549	2873	19577	19224	18886
1991	215	1324	416	9374	628	3297	336	884	2616	19089	18874	17550
1992	948	883	1318	368	6698	483	2055	152	2309	15214	14266	13383
1993	1293	3046	1213	1233	218	3133	246	928	1642	12951	11658	8612
1994	1284	4064	5175	805	600	140	1696	151	1508	15420	14137	10073
1995	441	4849	6607	5223	598	500	19	972	1220	20430	19989	15140
1996	734	2067	7334	6772	4572	439	421	10	1862	24212	23478	21411
1997	1691	2193	2649	7335	5663	3372	206	263	1132	24503	22812	20619
1998	908	5595	3588	3135	7028	4567	2841	202	1172	29037	28129	22534
1999	3182	3277	7643	3314	2479	5909	3195	2142	842	31984	28802	25525
2000	1330	10903	5338	9133	3393	2483	5227	2499	2217	42523	41194	30291
2001	4448	4922	16230	5758	7015	2722	2140	4327	3557	51119	46671	41749
2002	289	12918	5942	13263	4389	4818	1687	1298	5412	50016	49727	36809

Table 20. Deterministic projection results for haddock in unit areas 5Zjm for 2002 at $F_{0.1}$ using the bootstrap bias adjusted population abundance at the beginning of 2002.

Year	Age Group											
	1	2	3	4	5	6	7	8	9+	1+	2+	3+
Beginning of Year Population Numbers (000s)												
2002	3024	38960	7637	11658	2938	2452	775	588	1999			
2003	8187	2476	31188	5518	7433	1873	1564	494	1650			
Partial Recruitment to the Fishery[1]												
2002	0	0.09	0.5	1	1	1	1	1	1			
Fishing Mortality												
2002	0	0.023	0.125	0.25	0.25	0.25	0.25	0.25	0.25			
Weight at beginning of year for population (kg)[2]												
2003	0.1	0.33	0.78	1.14	1.49	1.96	2.18	2.21	2.71			
Beginning of Year Projected Population Biomass (t)												
2003	783	821	24265	6278	11104	3681	3403	1090	4466	55892	55109	54288
Projected Catch Numbers (000s)												
2002	0	786	815	2347	592	494	156	118	402			
Weight at age for catch (kg)[3]												
2002	0.39	1.1	1.47	1.75	2.11	2.37	2.18	2.52	3.68			
Projected Yield (t)												
2002	0	864	1198	4118	1245	1168	341	299	1482	10715		

[1]Average of 1997 – 2001.
[2]Equal to 2002 from DFO survey.
[3]Equal to 2001 from fishery.

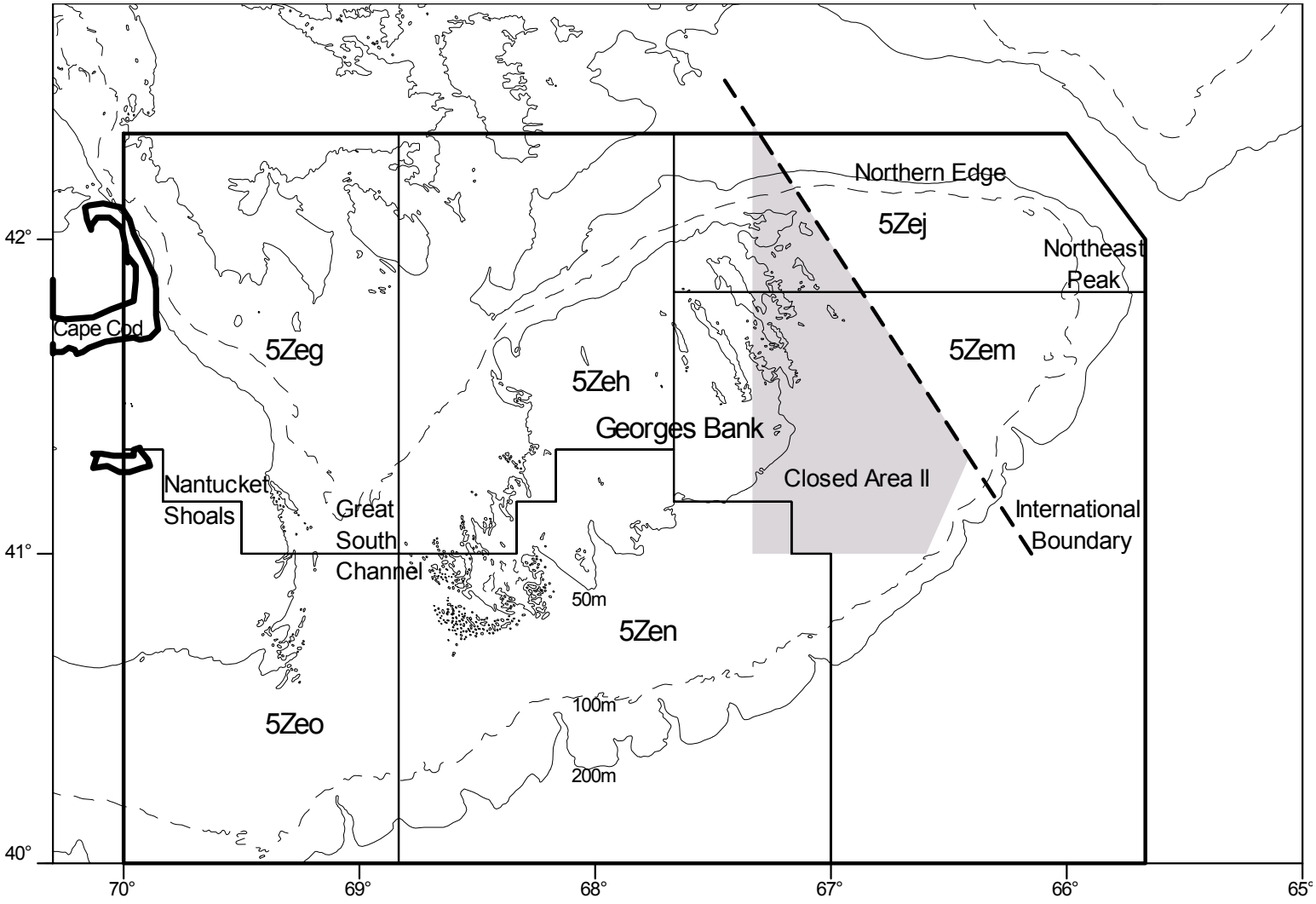

Figure 1. Fisheries statistical unit areas in NAFO Subdivision 5Ze.

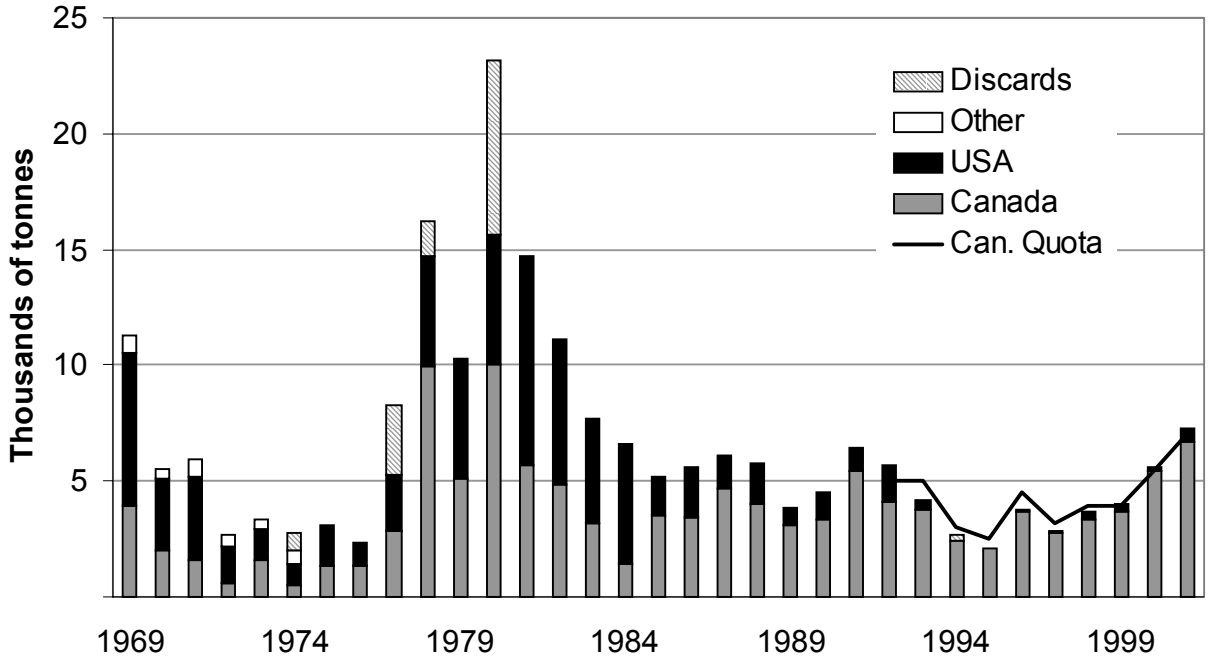

Figure 2. Nominal catch of haddock in unit areas 5Zjm.

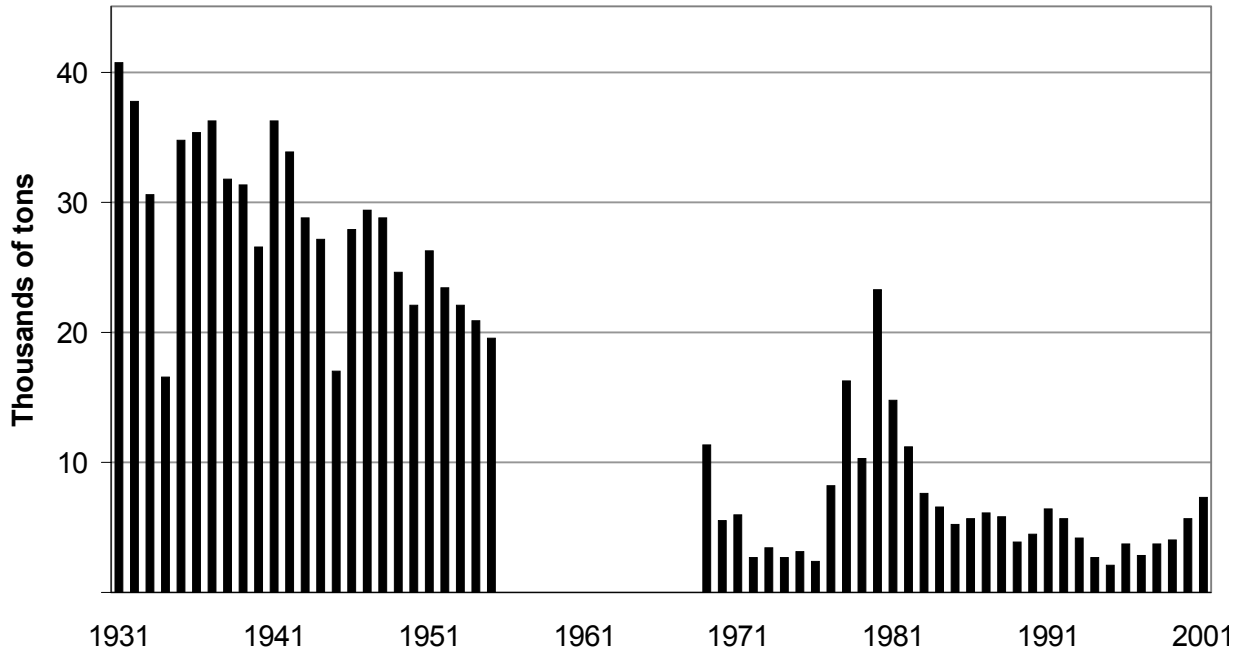

Figure 3. Historic catch of haddock in 5Zjm compared to recent catches.

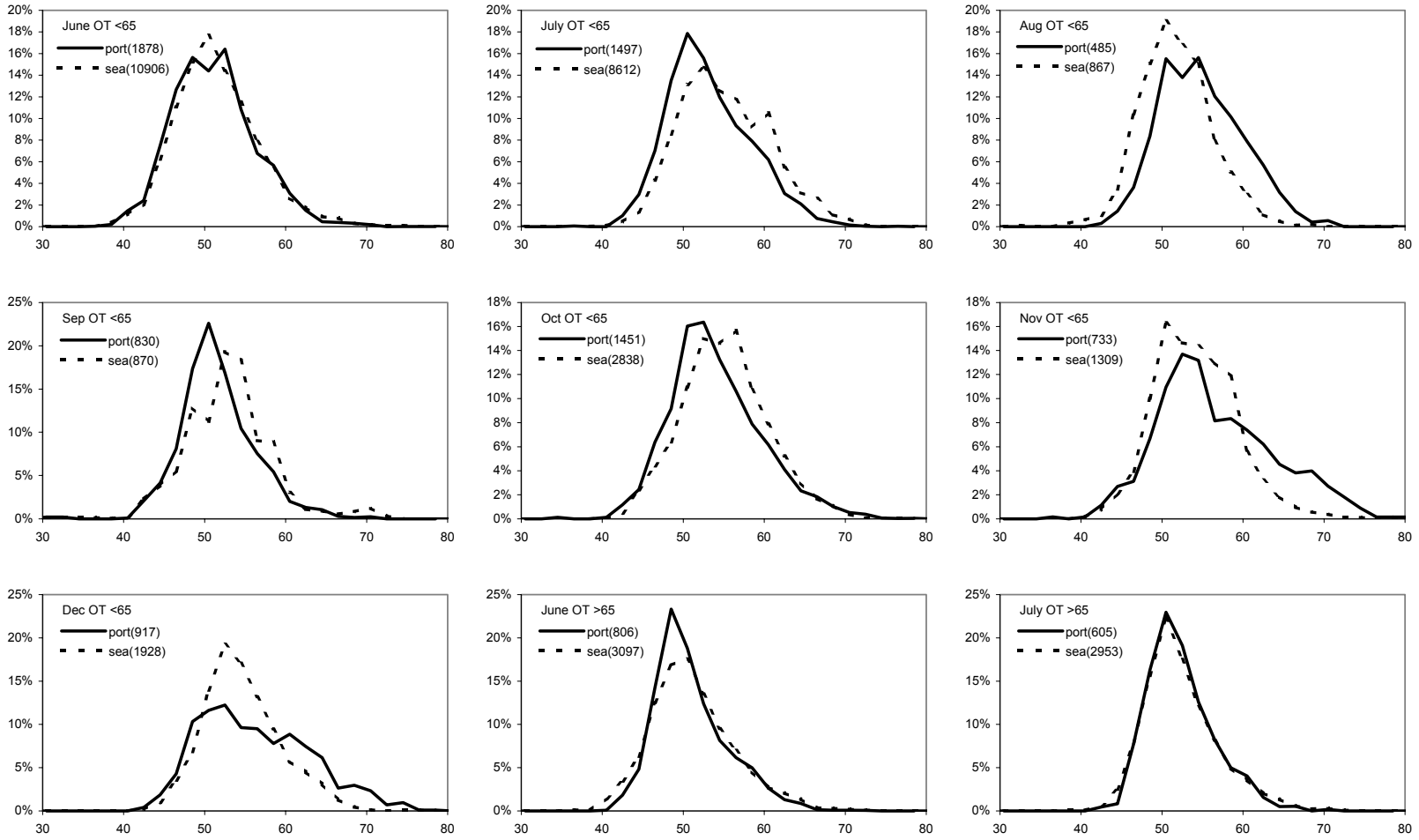

Figure 4. Comparison of length frequencies obtained at port and at sea from the Georges Bank commerical fishery in 2001. The number of fish measured is shown in brackets.

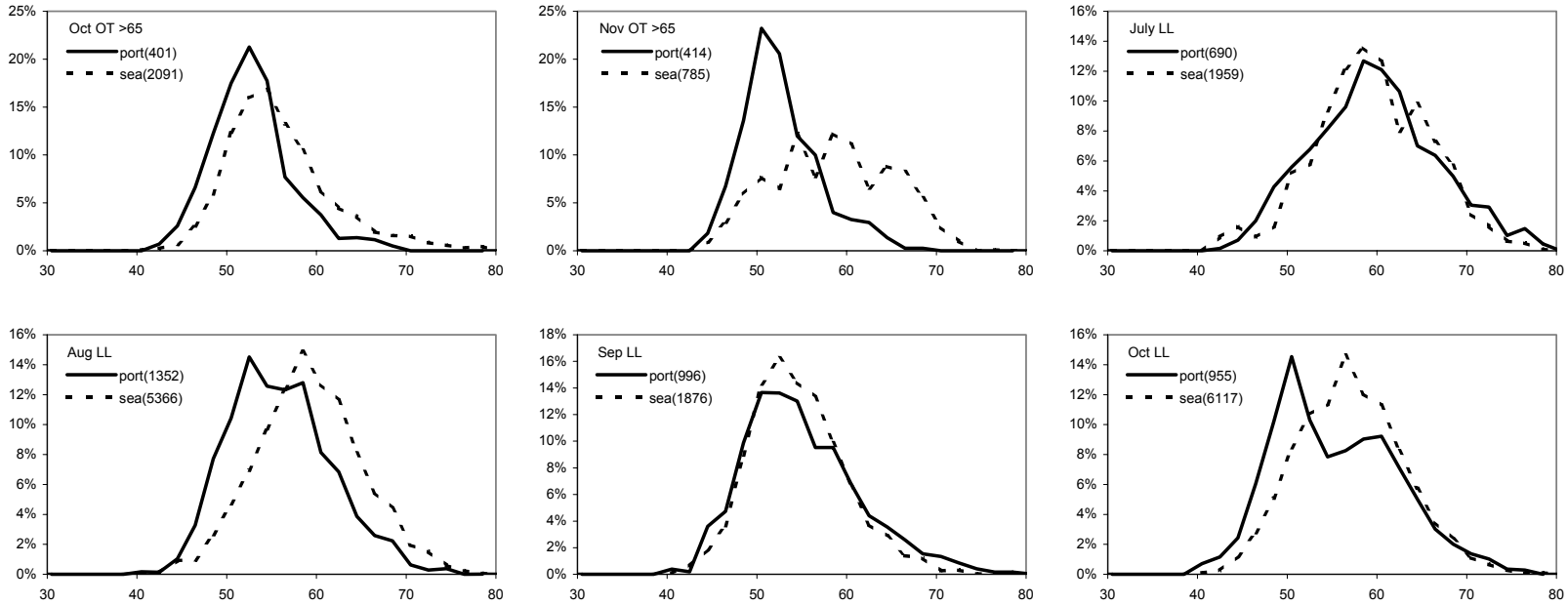

Figure 4. continued

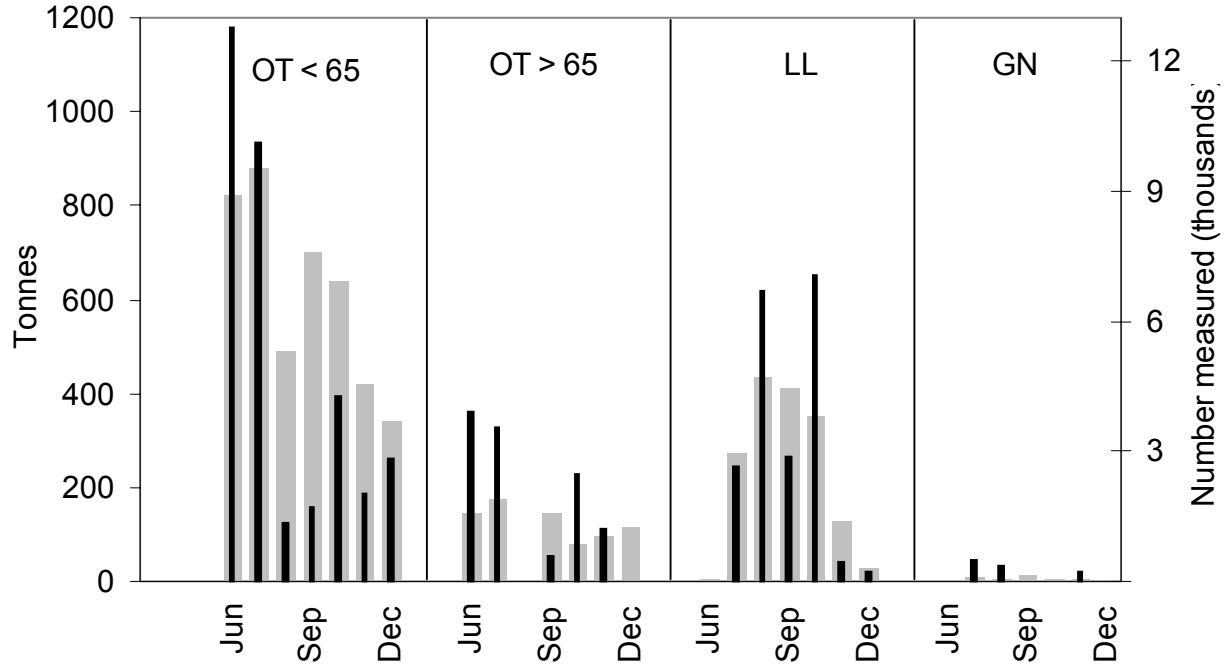

Figure 5. Haddock catches in 5Zjm by month and gear for the Canadian commercial fishery in 2001 (wide gray bars) with sampling levels (narrow black bars).

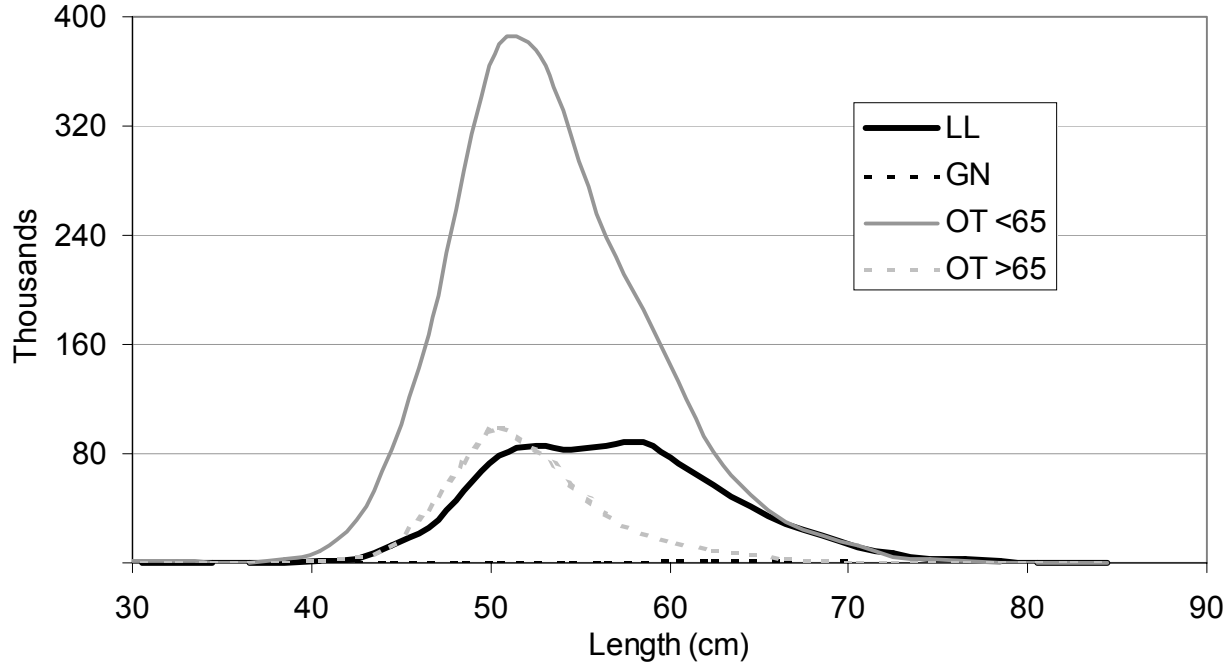

Figure 6. Catch at length by the principal Canadian 5Zjm commercial haddock fisheries in 2001.

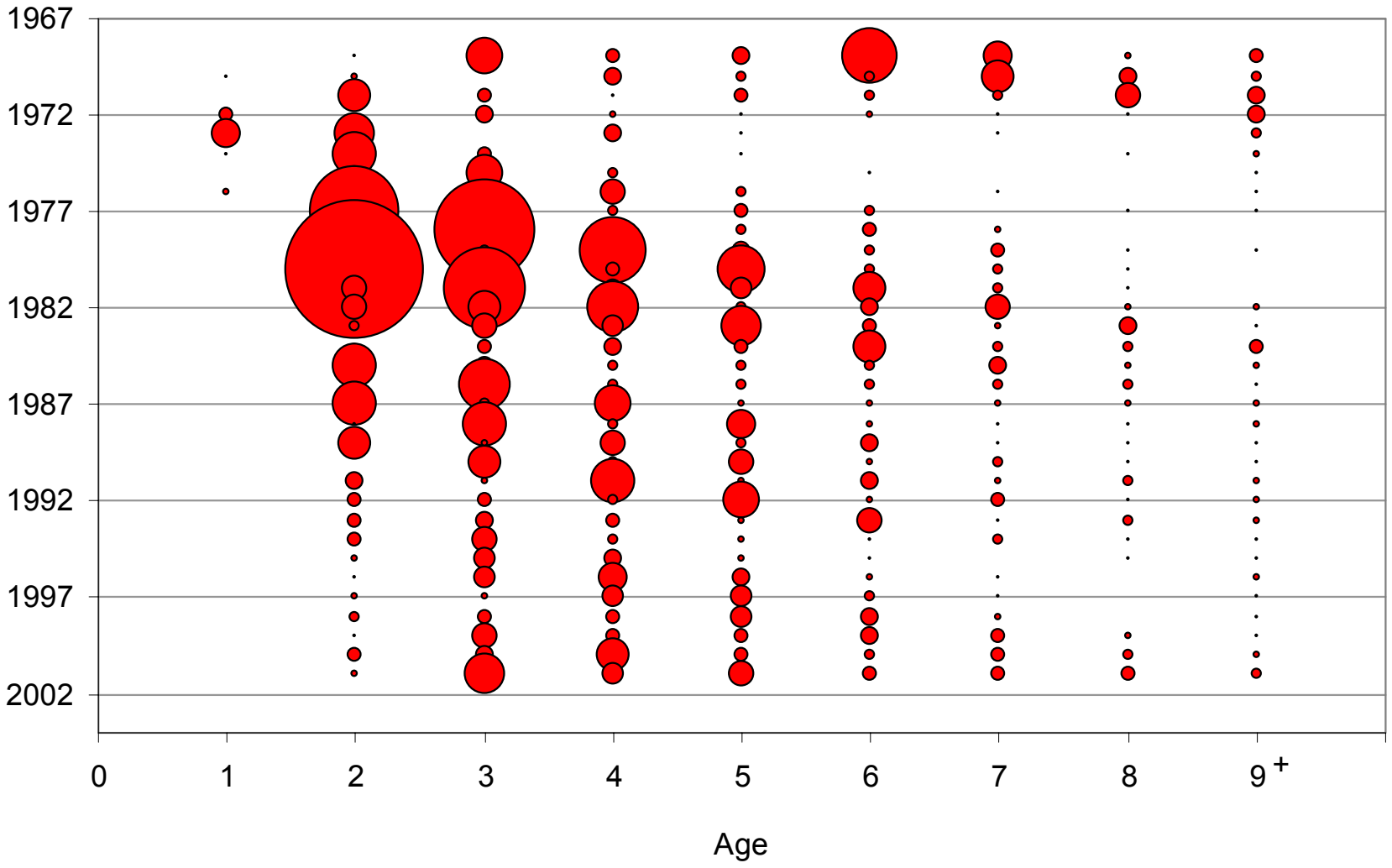

Figure 7. Total commercial catch at age (numbers) of haddock from unit areas 5Zjm. The bubble area is proportional to magnitude (see Table 9).

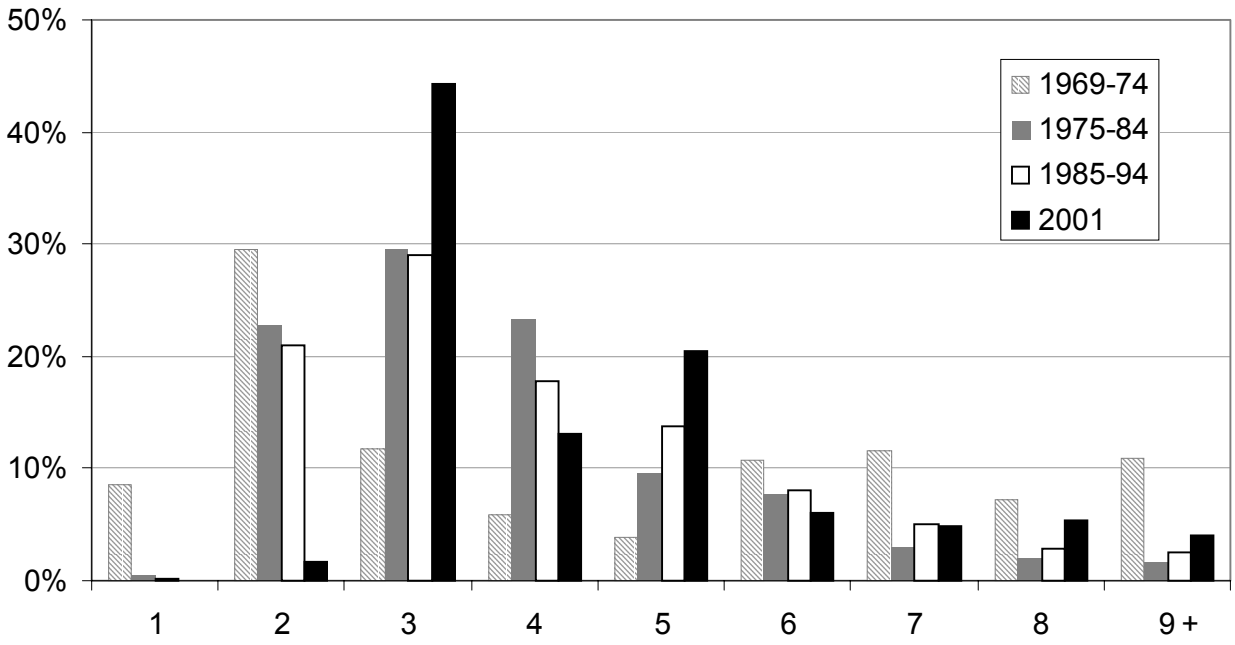

Figure 8. Age composition of the haddock catch for the Canadian 5Zjm commercial fishery in 2001 compared to the average age composition for the total catch of all fisheries during three earlier periods.

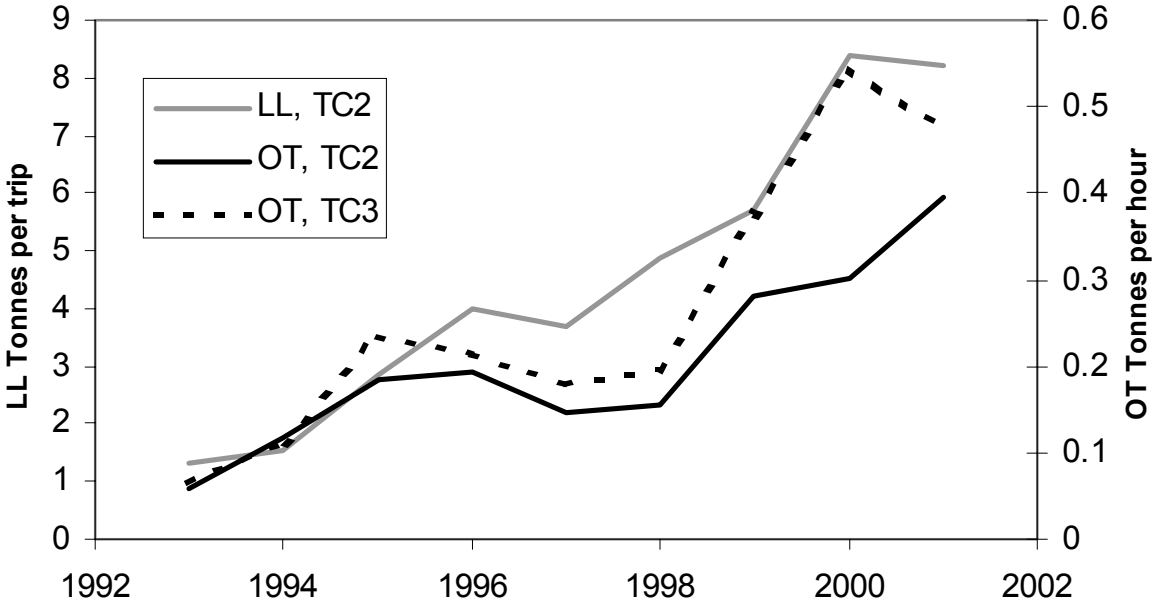

Figure 9. Catch rates for haddock from the Canadian commercial fishery in 5Zjm. (LL = longline, OT = otter trawl, TC = tonnage class).

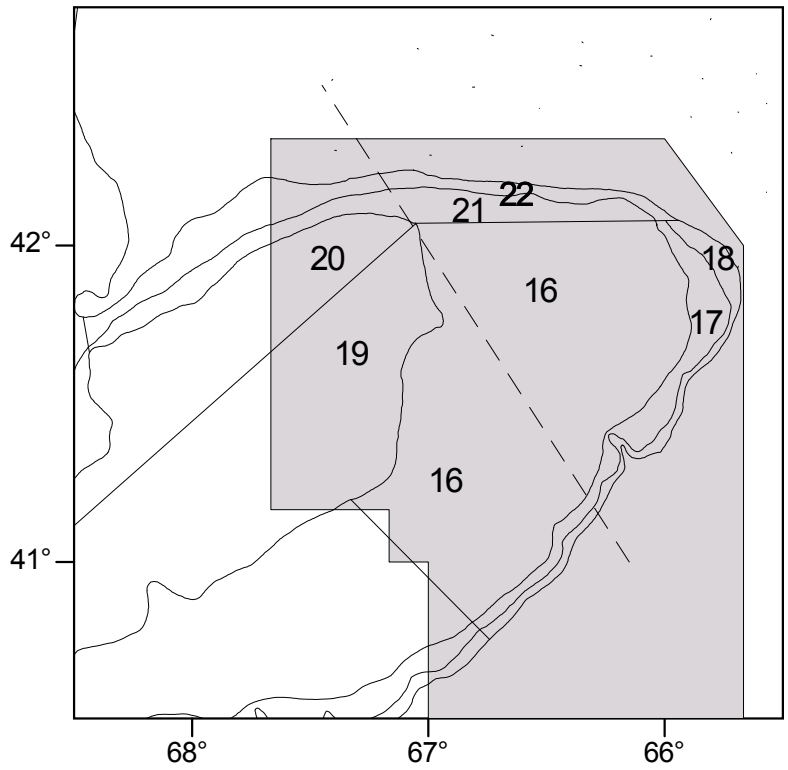

Figure 10. Stratification scheme used for NMFS surveys. The 5Zjm management area is indicated by shading.

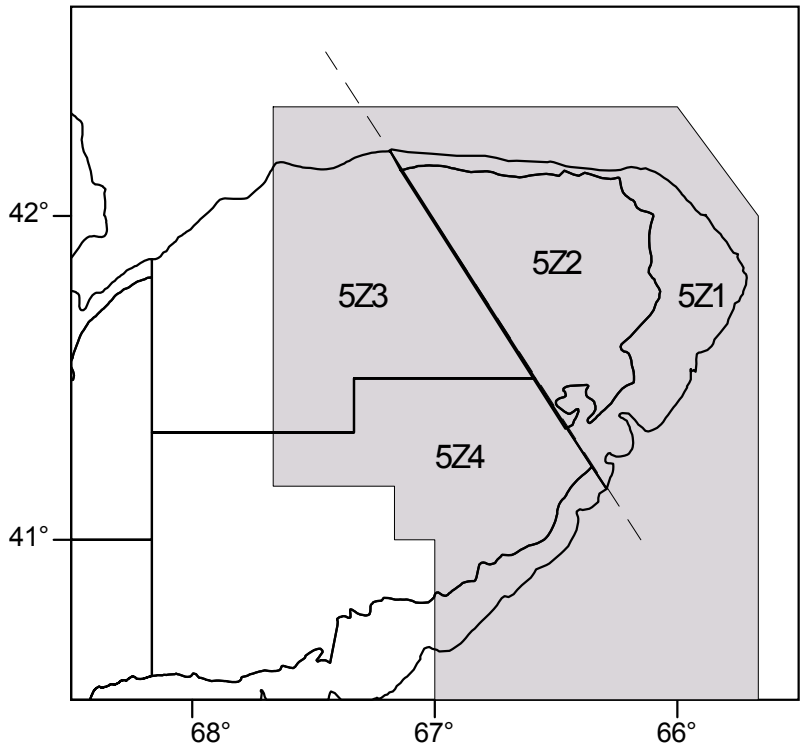

Figure 11. Stratification scheme used for the DFO survey. The 5Zjm management area is indicated by shading.

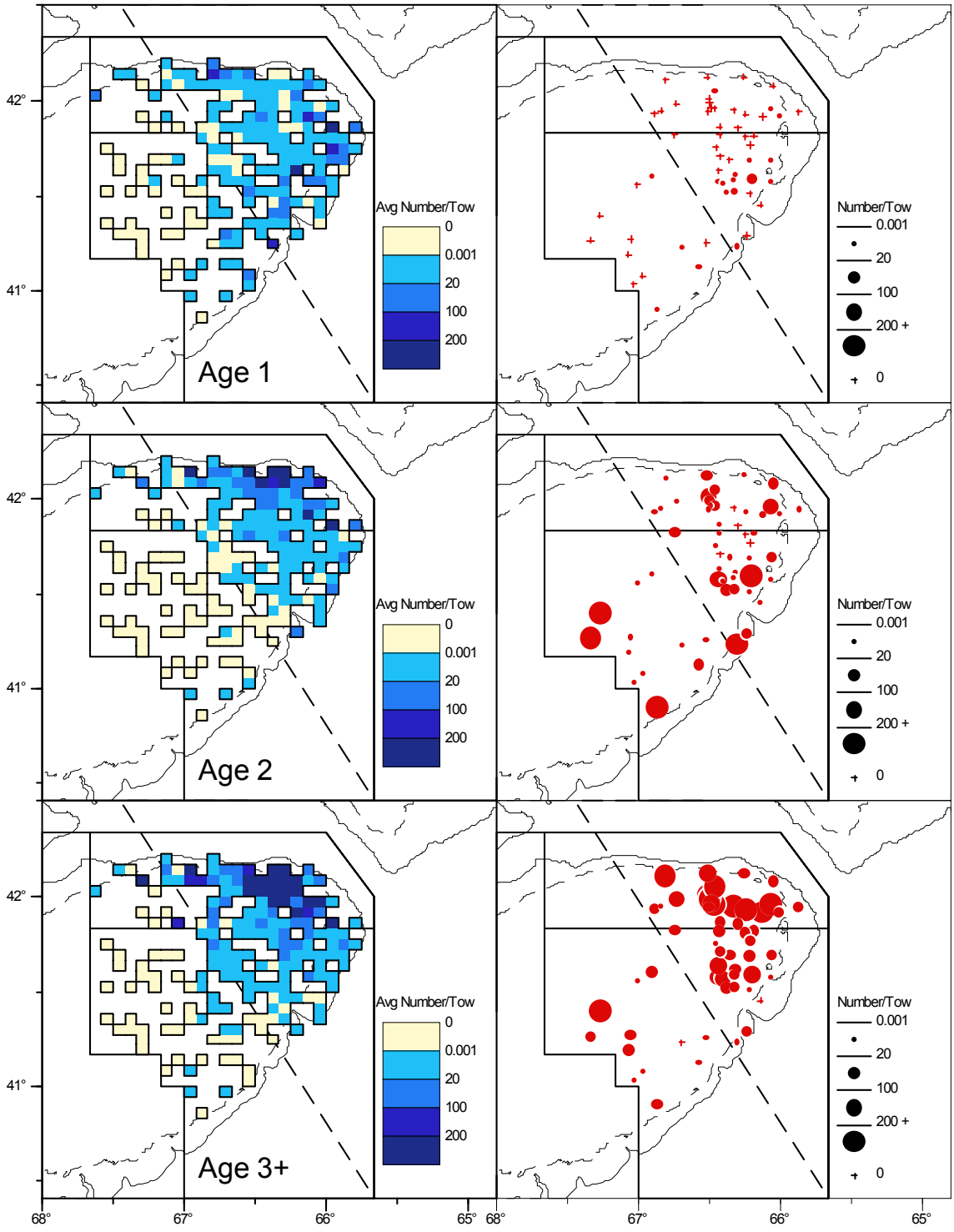

Figure 12. Distribution of 5Zjm haddock abundance (number/tow) as observed from the **DFO** survey. The squares are shaded relative to the average catch for 1997 to 2001. The expanding symbols represent the 2002 survey catches.

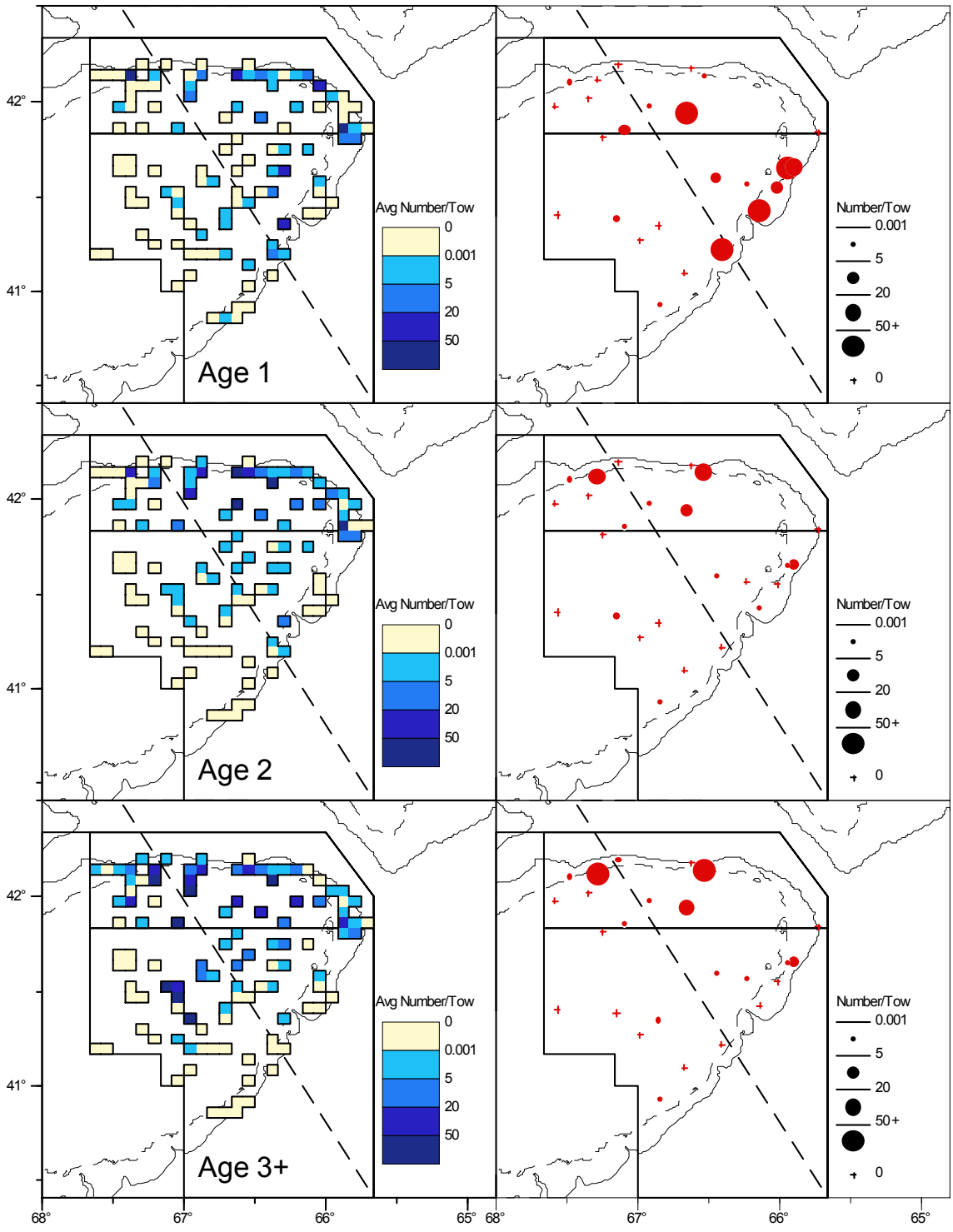

Figure 13. Distribution of 5Zjm haddock abundance (number/tow) as observed from the **NMFS spring** survey. The squares are shaded relative to the average catch for 1996 to 2000. The expanding symbols represent the 2001 survey catches.

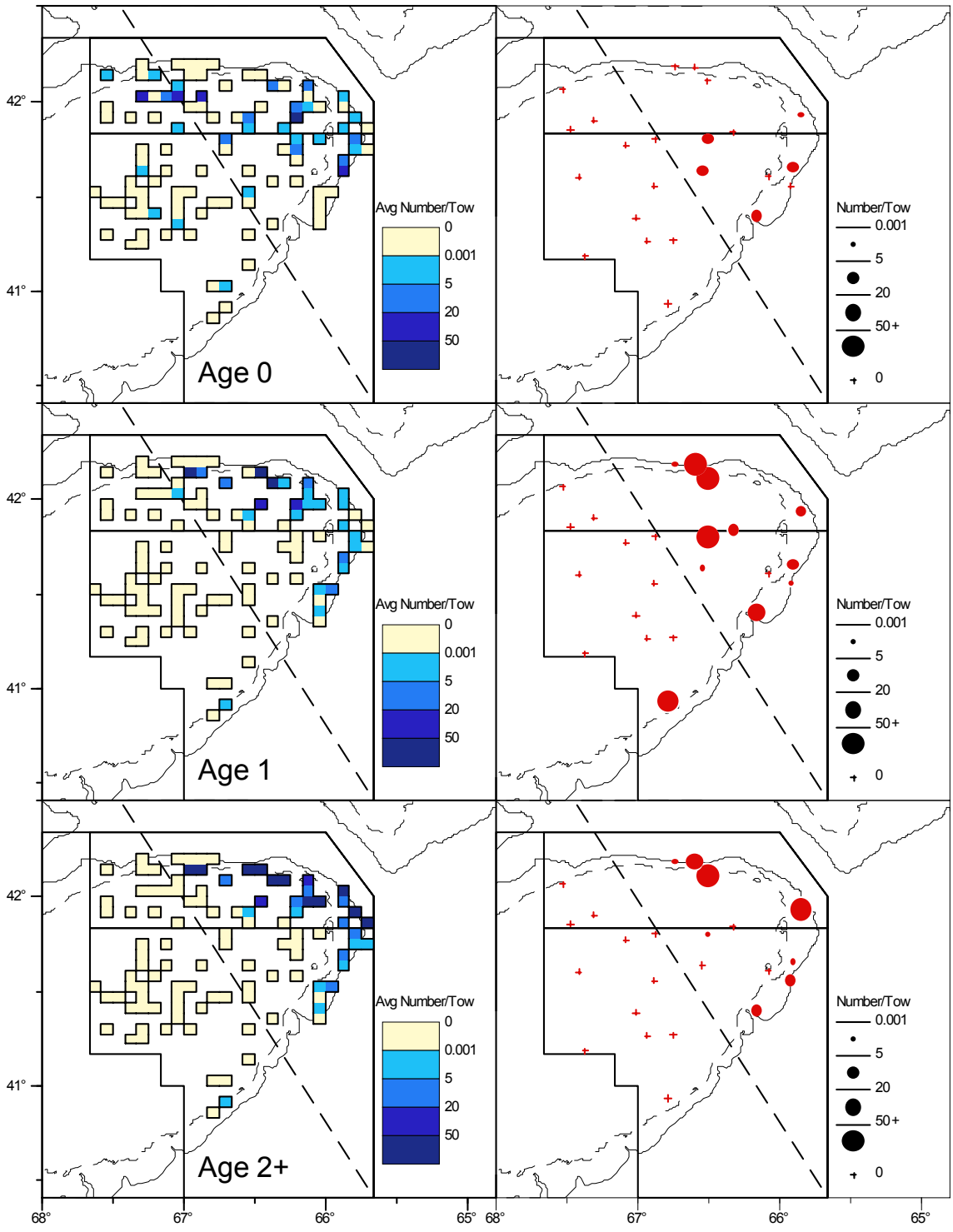

Figure 14. Distribution of 5Zjm haddock abundance (number/tow) as observed from the **NMFS fall** survey. The squares are shaded relative to the average catch for 1996 to 2000. The expanding symbols represent the 2001 survey catches.

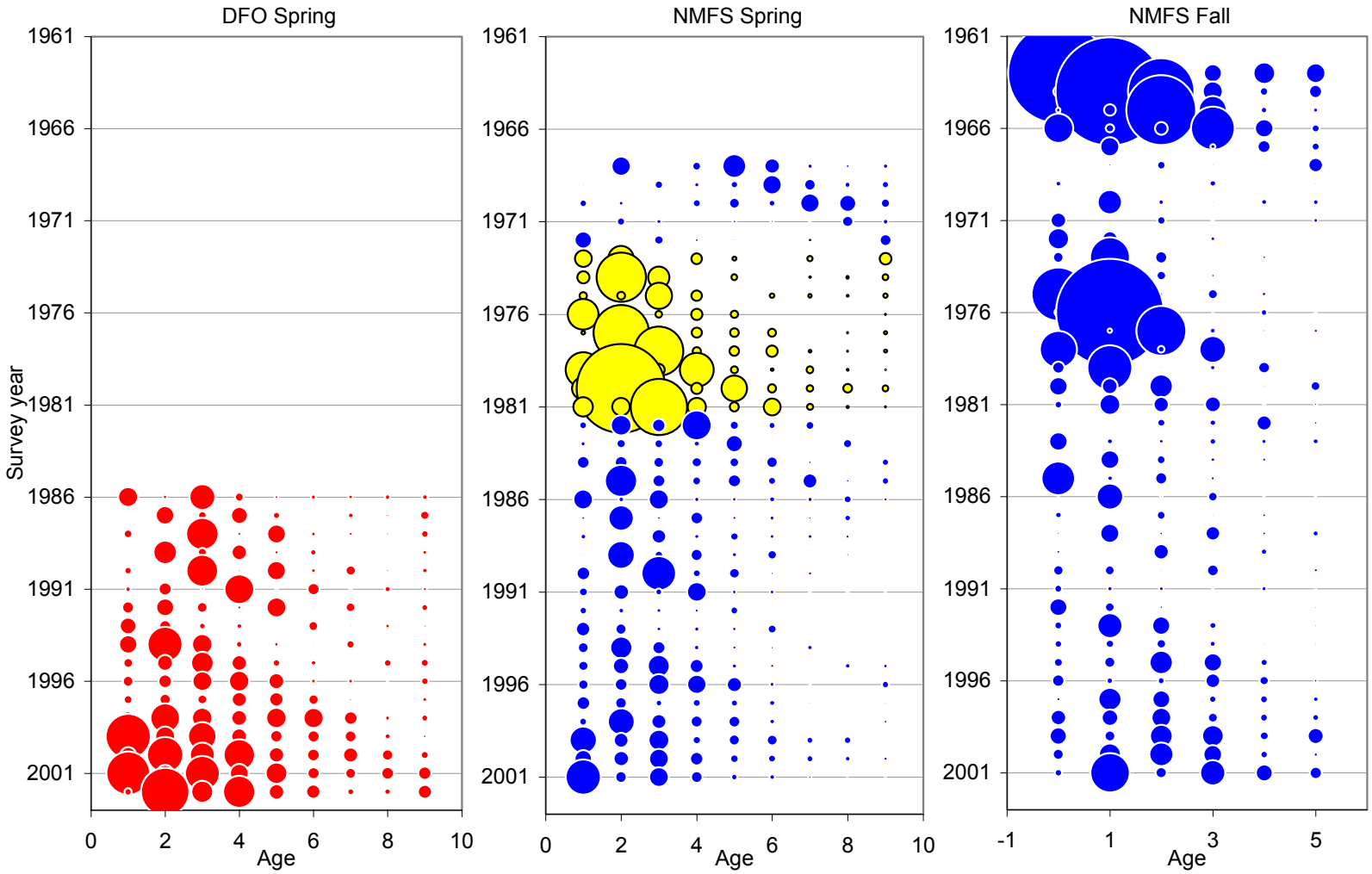

Figure 15. Estimated abundance at age (numbers in 000's) of haddock for the DFO and NMFS spring surveys and the NMFS fall survey. Bubble area is proportional to magnitude (see Tables 12-14). Conversion factors to adjust for changes in door type and survey vessel were applied to the NMFS surveys. From 1973-81 (pale circles), a 41 Yankee trawl was used for the NMFS spring survey while a 36 Yankee was used in the other years. Symbol size has not been adjusted between surveys for the catchability of the survey.

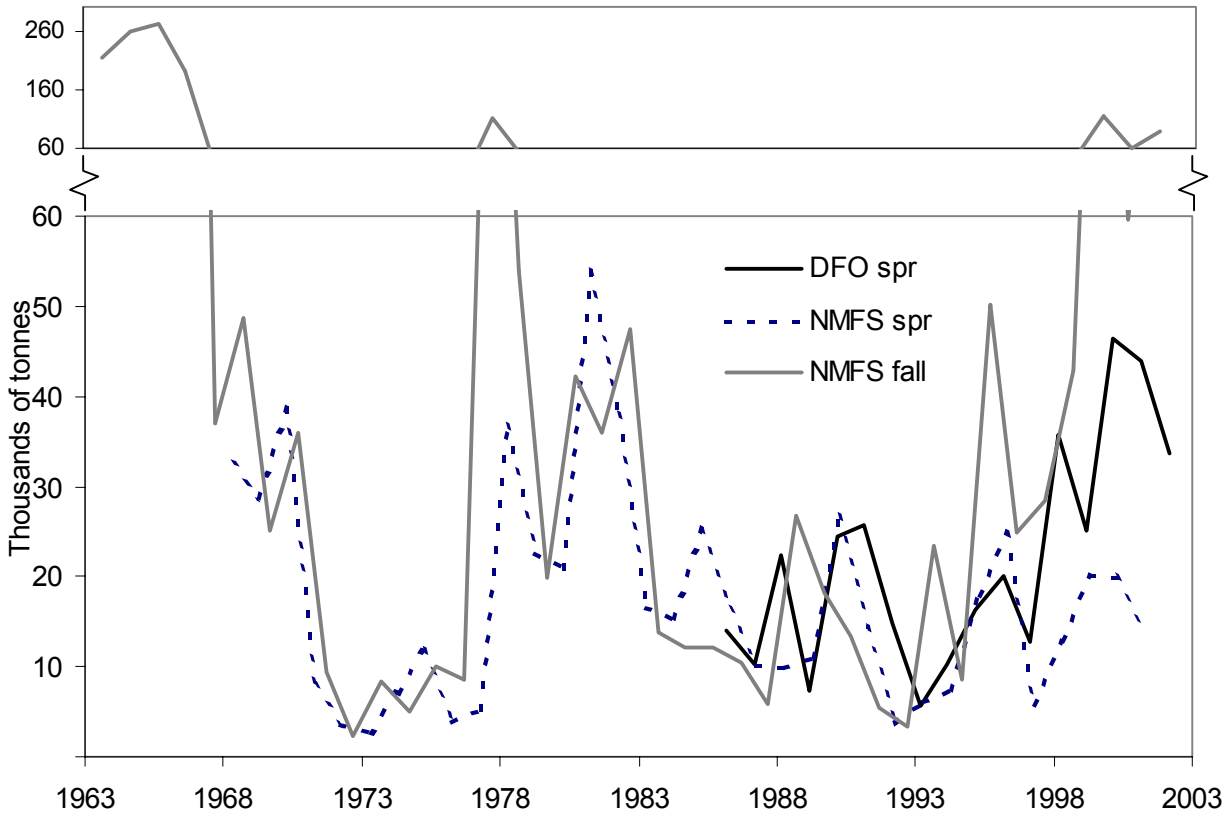

Figure 16. Biomass from NMFS fall (ages 2-8), NMFS spring (ages 3-8) and DFO (ages 3-8) research surveys (scaled by calibration constants, Table 16) for haddock in unit areas 5Zjm..

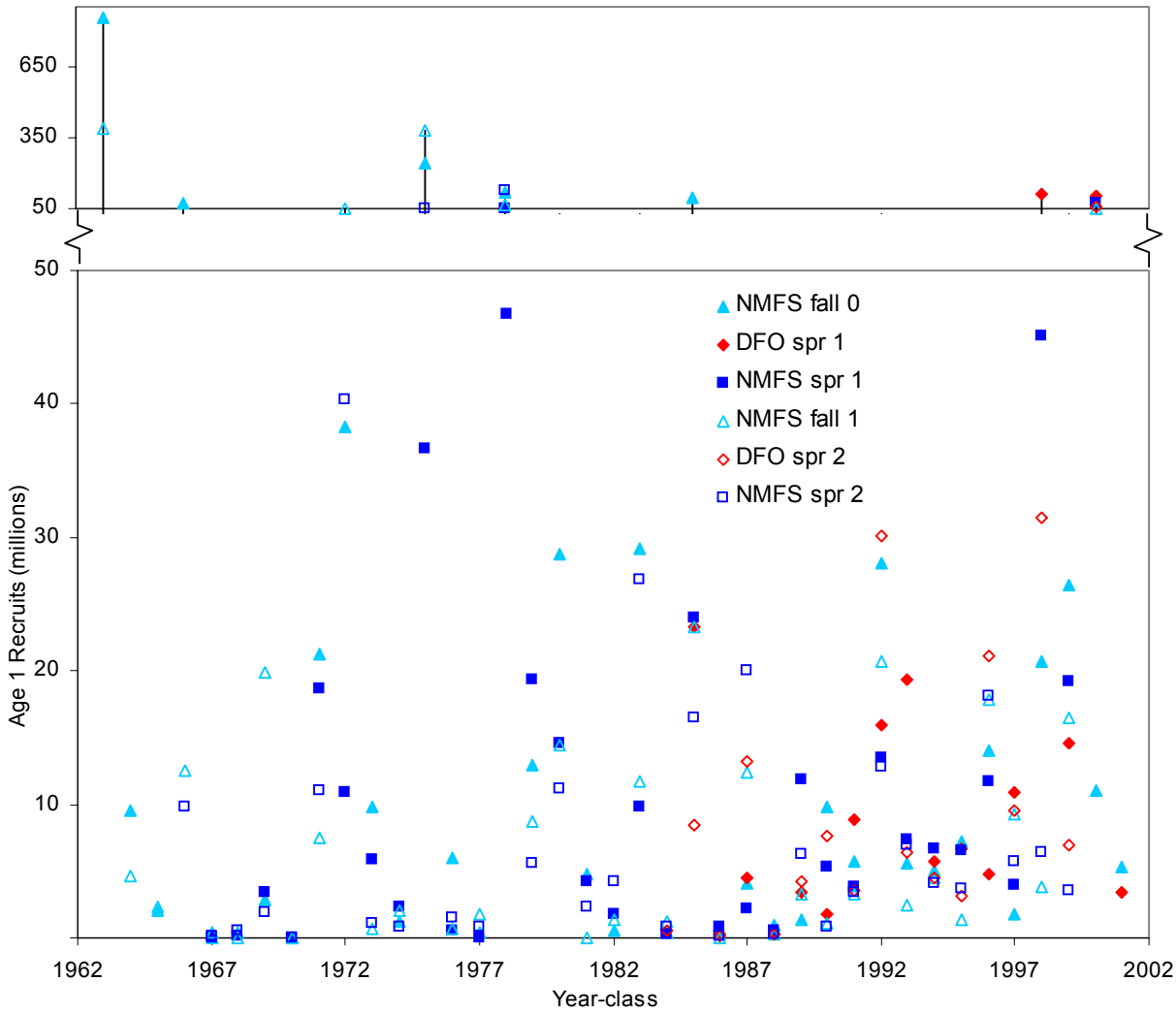

Figure 17. Year-class abundance for ages 0 and 1 from the NMFS fall and ages 1 and 2 from the NMFS and DFO spring research surveys (scaled by calibration constants, Table 16) for haddock in unit areas 5Zjm.

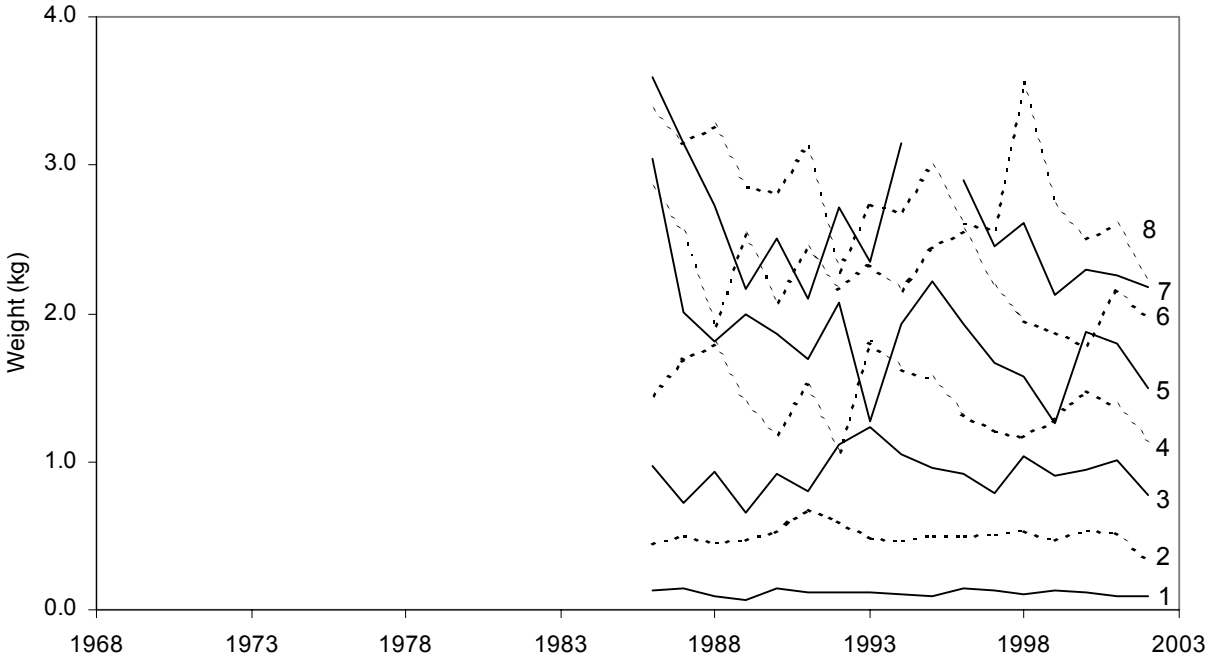

Figure 18. Weight at age for haddock in unit areas 5Zjm derived from the DFO spring surveys.

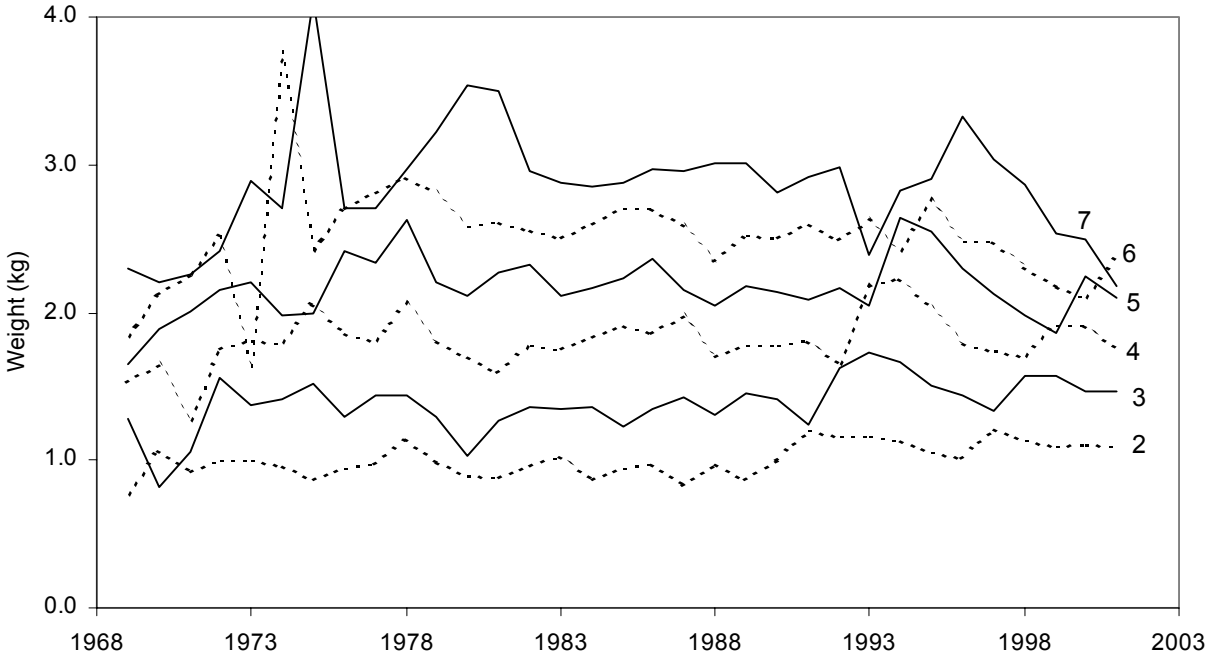

Figure 19. Weight at age for haddock in unit areas 5Zjm derived from the commercial fisheries.

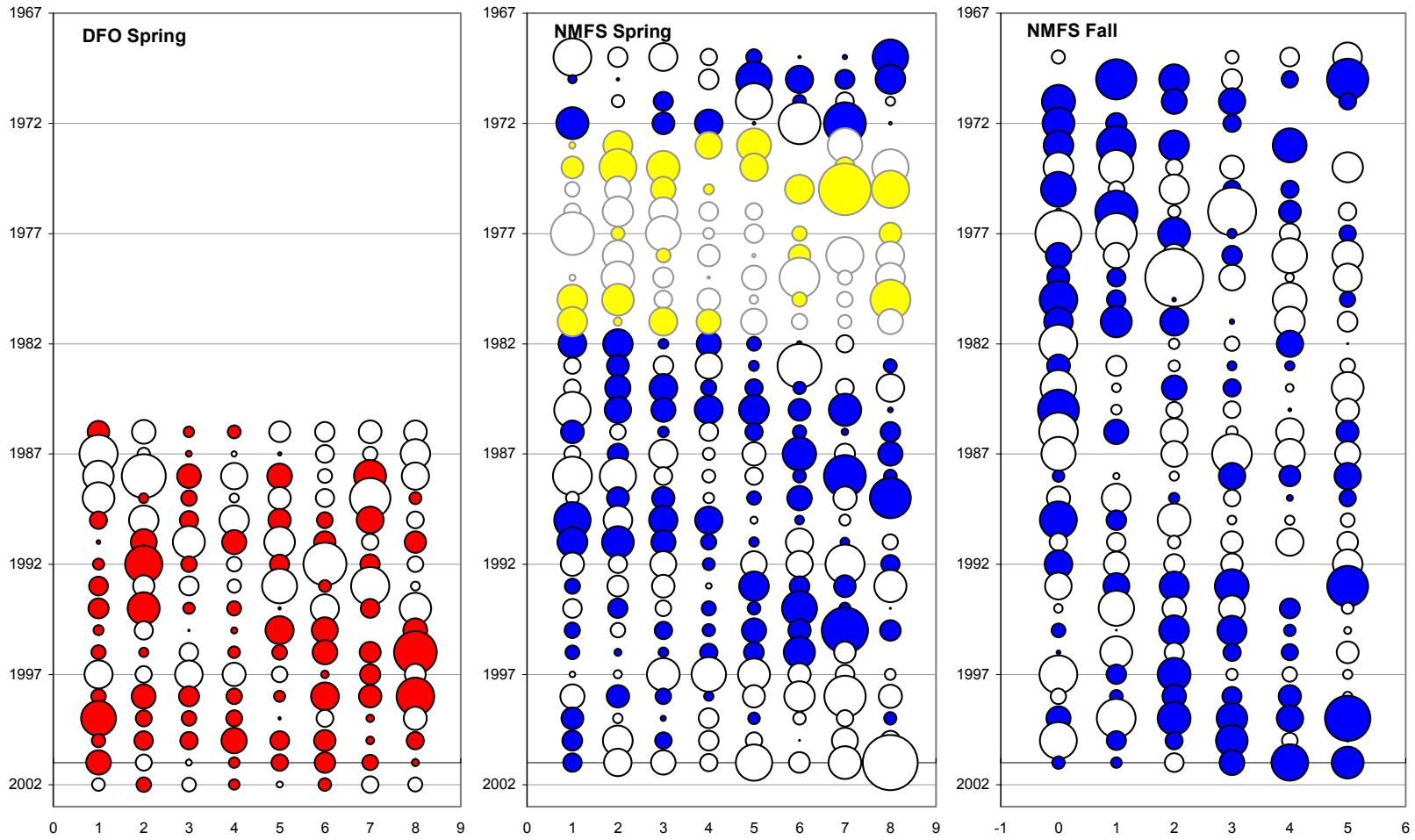

Figure 20. Residuals by year and age group for each research survey index. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude. From 1973-81 (pale circles), a 41 Yankee trawl was used for the NMFS spring survey while a 36 Yankee was used in the other years.

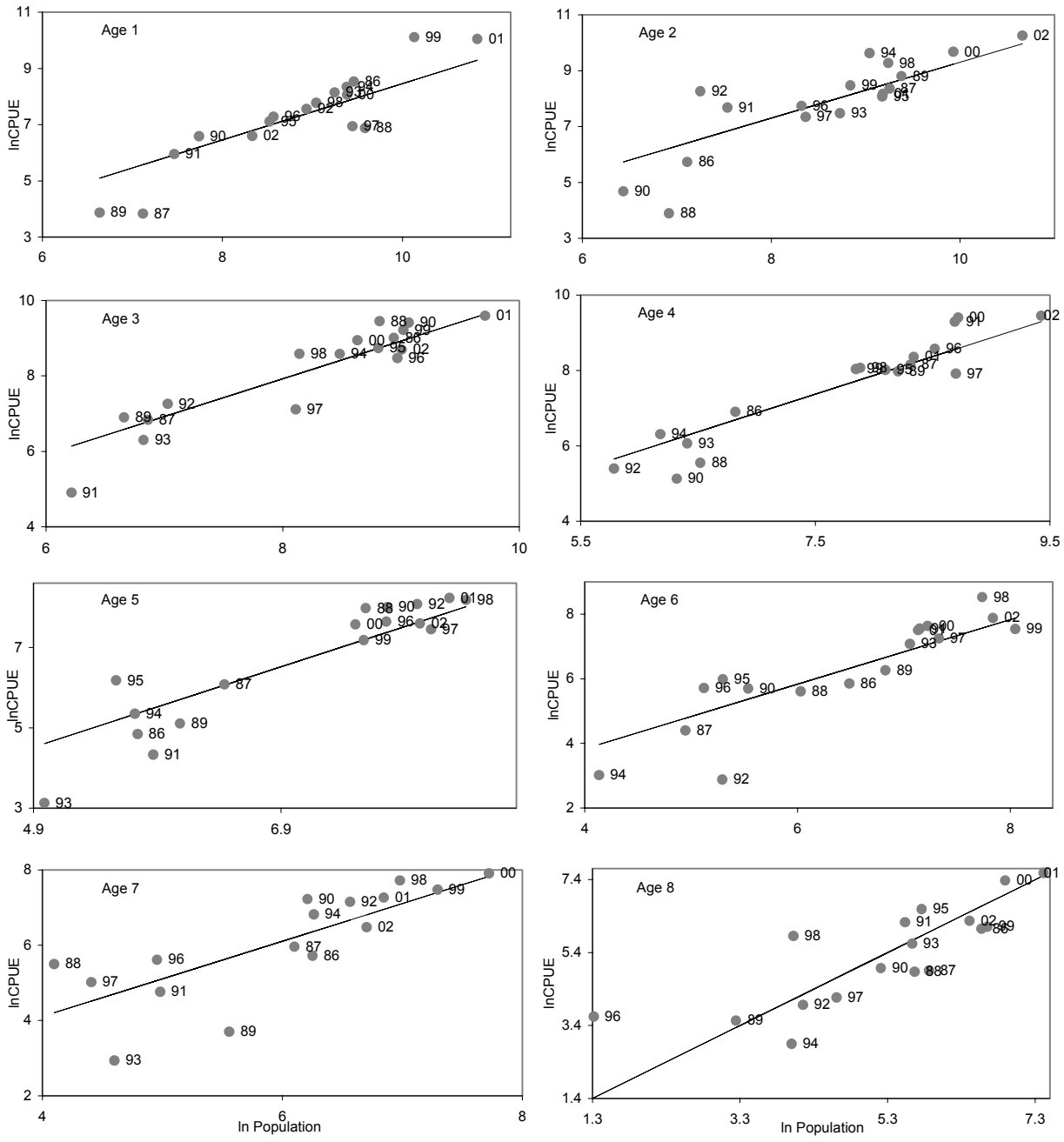

Figure 21. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for haddock in unit areas 5Zj and 5Zm from the **DFO** survey.

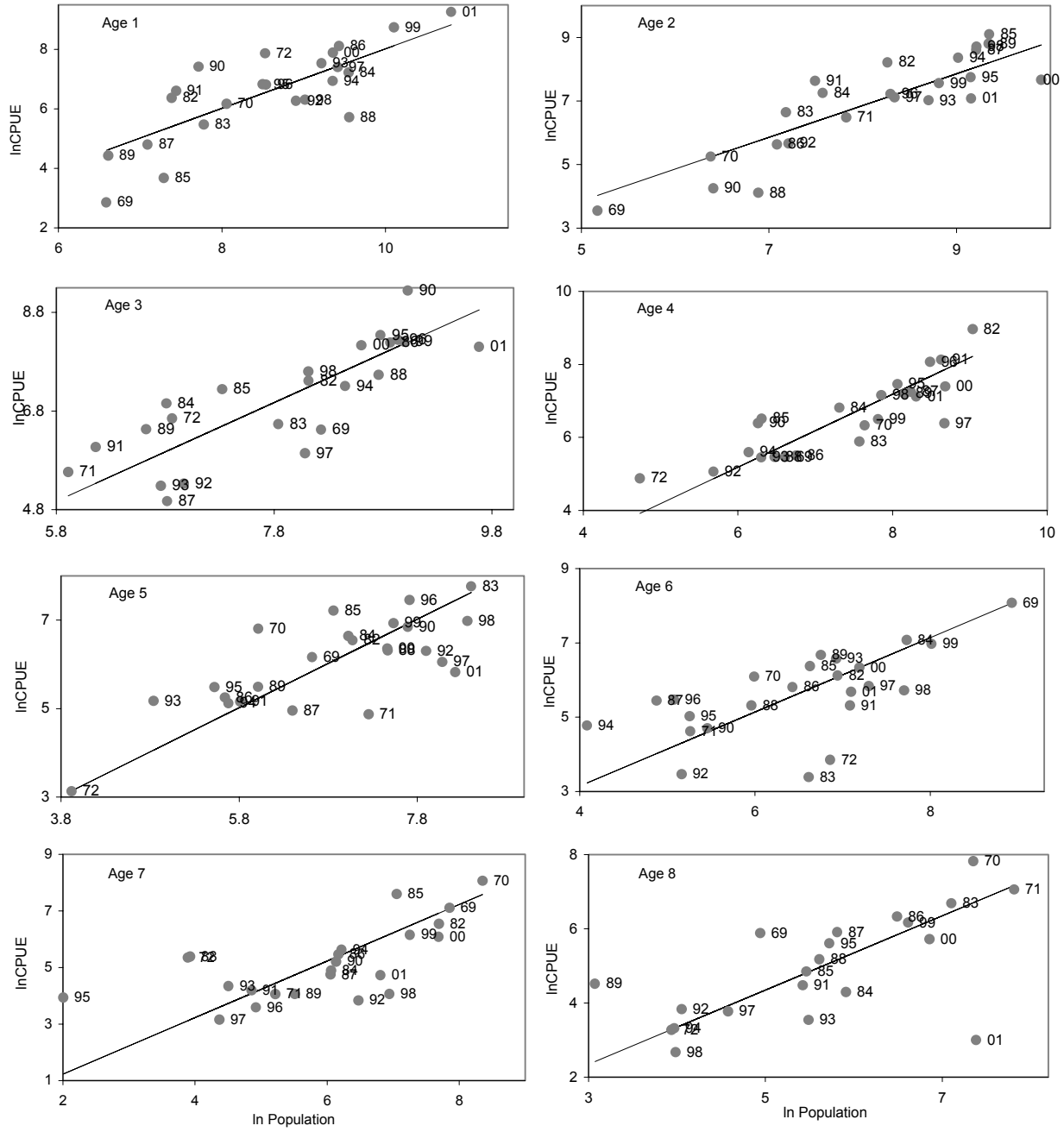

Figure 22. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for haddock in unit areas 5Zj and 5Zm from the **NMFS spring** survey with a Yankee 36 net.

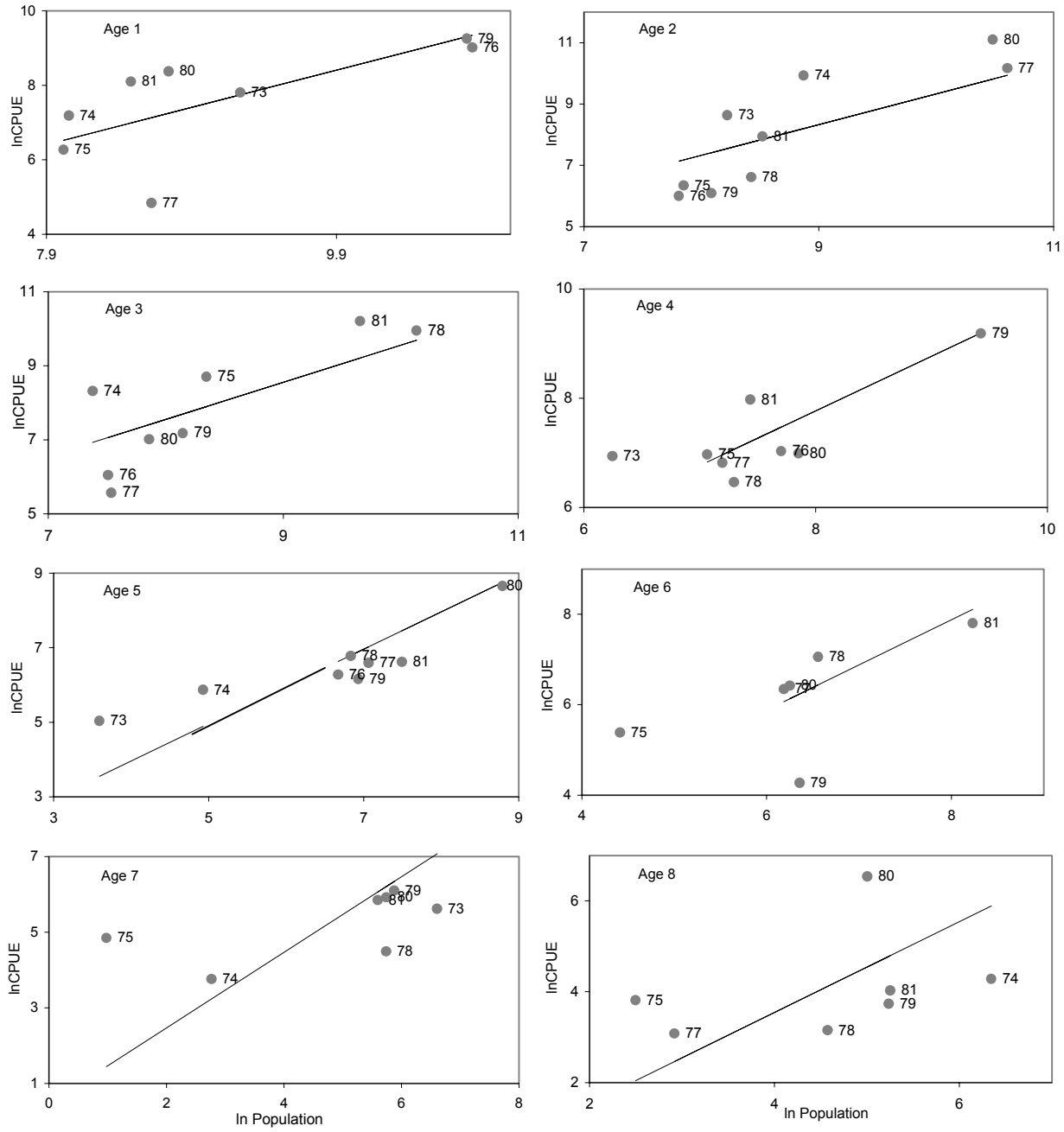

Figure 23. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for haddock in unit areas 5Zj and 5Zm from the **NMFS spring** survey with a Yankee 41 net.

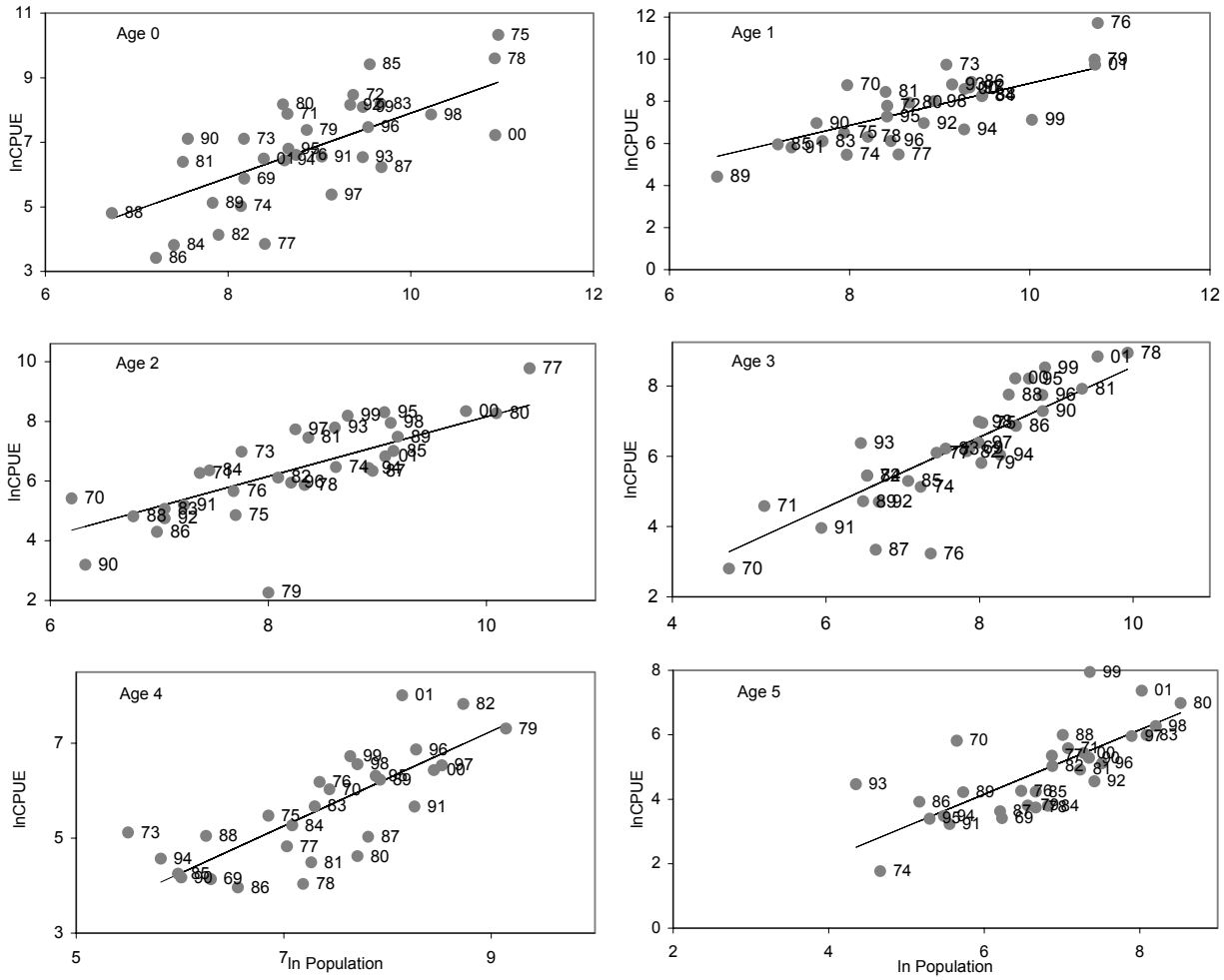

Figure 24. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for haddock in unit areas 5Zj and 5Zm from the **NMFS fall** survey.

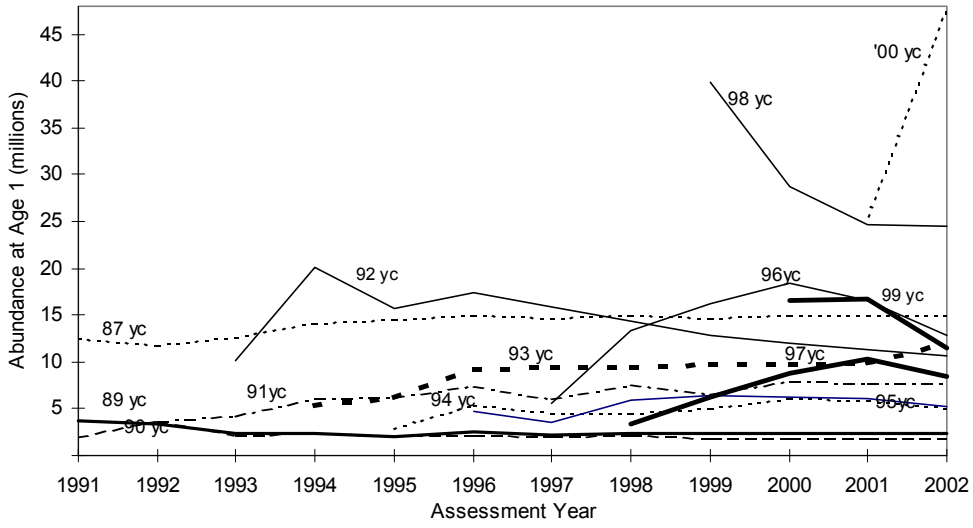

Figure 25. Successive estimates of 5Zjm haddock year-class abundance as additional years of data were included in the assessment did not display any persistent trends.

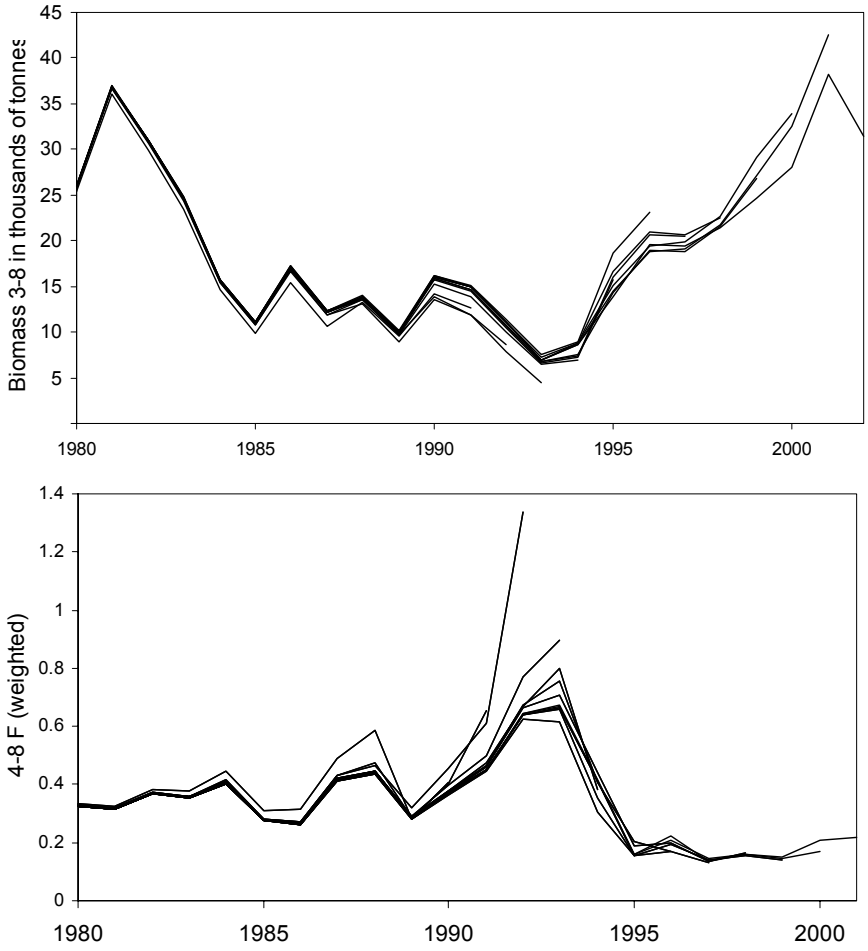

Figure 26. Retrospective estimates from VPA of 5Zjm haddock biomass and fishing mortality did not display any persistent trends for over or under estimation as successive years of data were excluded in the assessment.

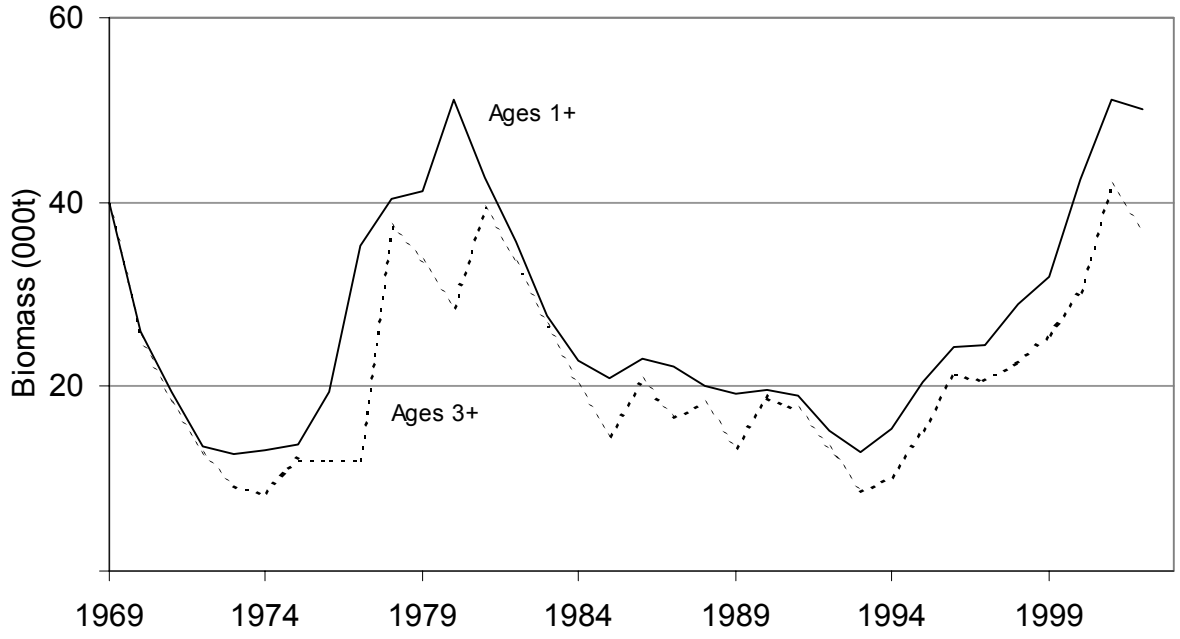

Figure 27. Beginning of year total (1+) and adult (3+) biomass for haddock in unit areas 5Zjm.

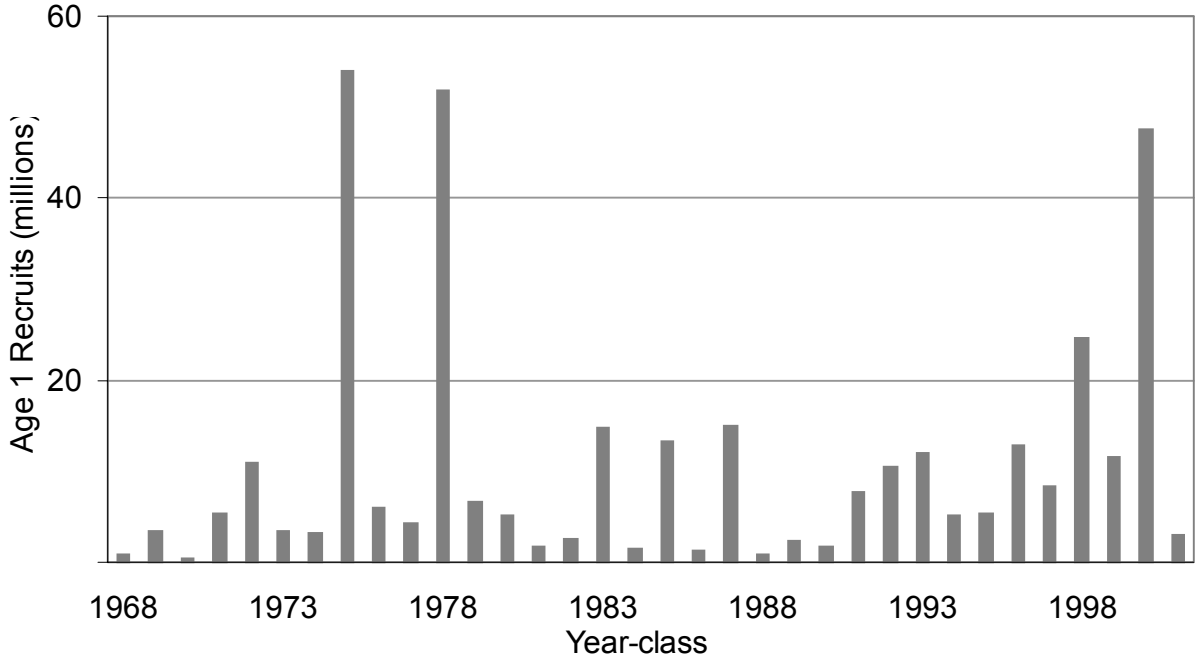

Figure 28. Number of age 1 recruits for haddock in unit areas 5Zjm.

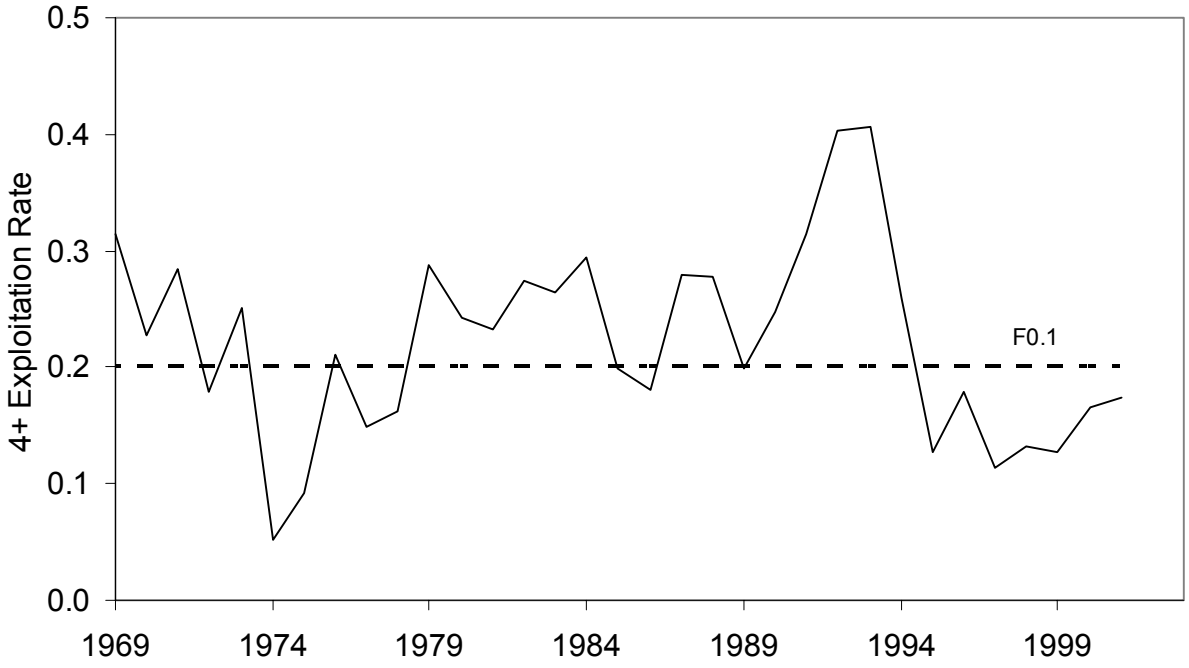

Figure 29. Exploitation rate for haddock ages 4+ in unit areas 5Zjm and the exploitation rate (20%) at $F_{0.1}$.

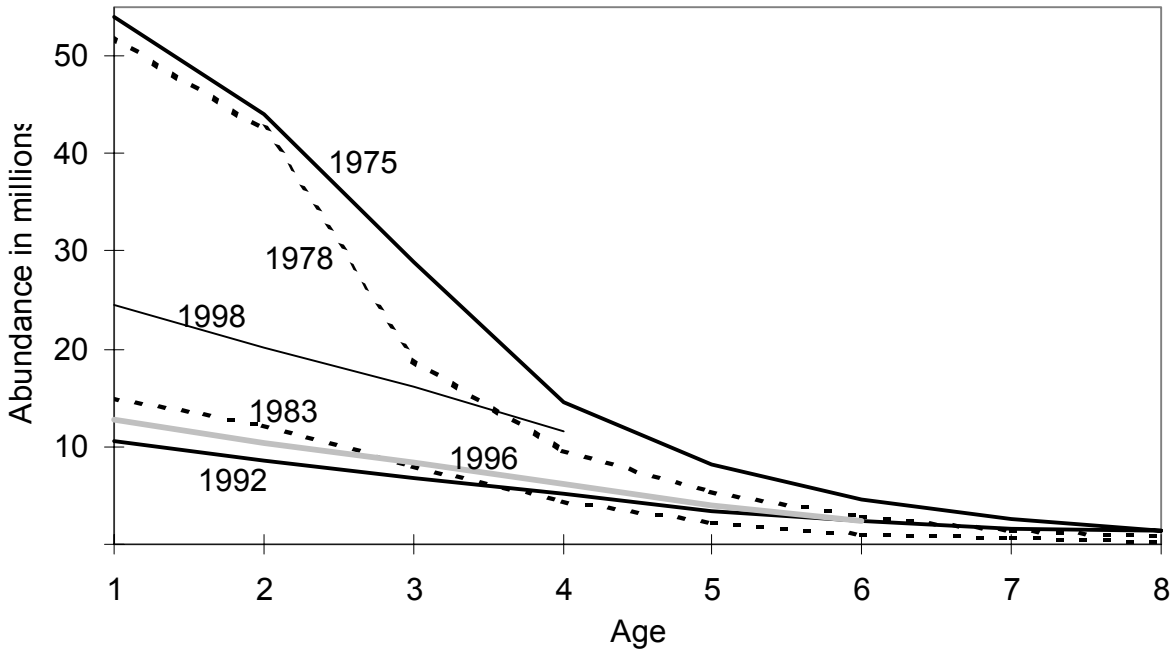

Figure 30. Decay of selected year-classes of the 5Zjm haddock population.

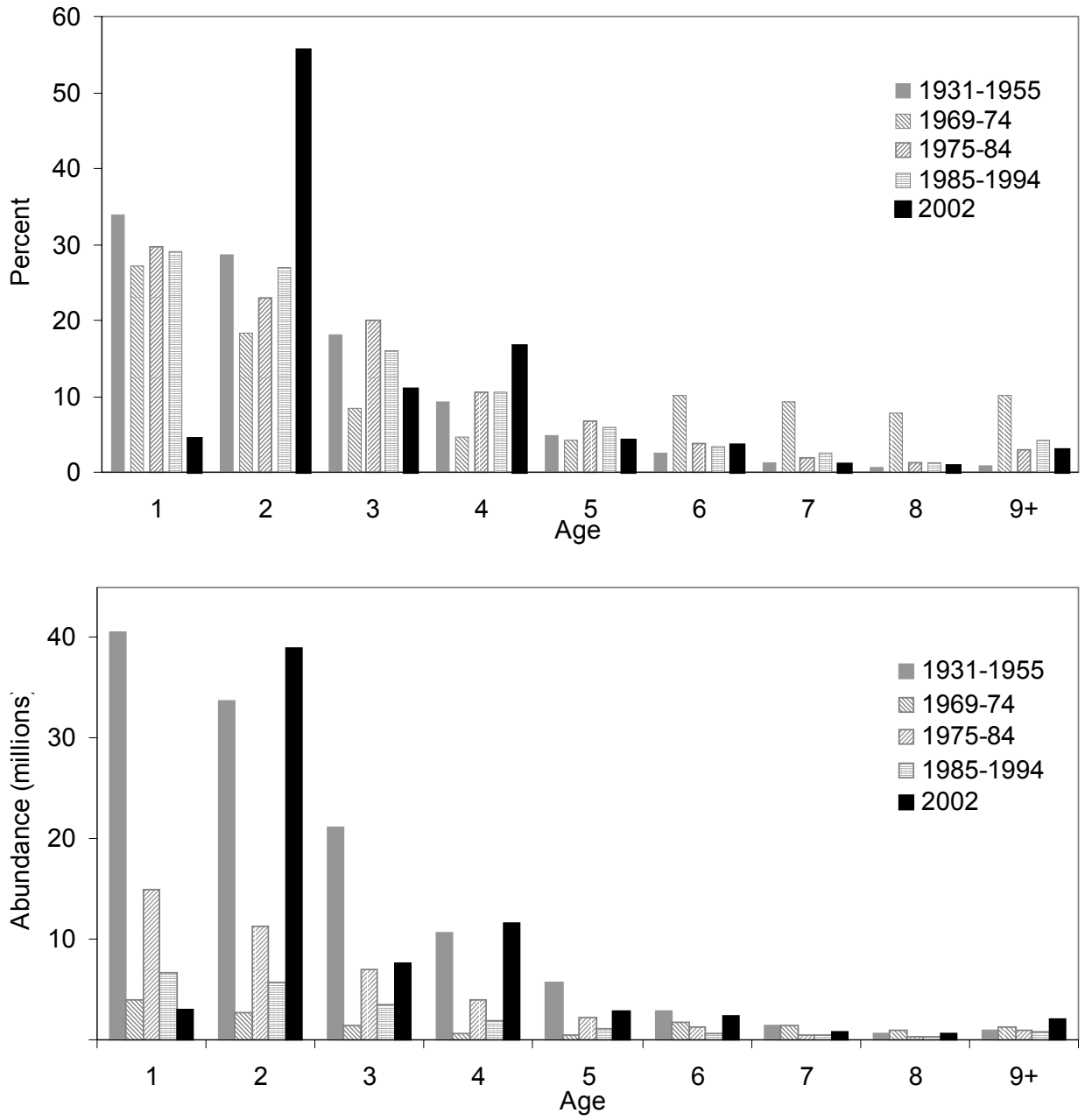

Figure 31. The age composition and absolute abundance at age of the 5Zjm haddock population in 2001 compared to earlier periods.

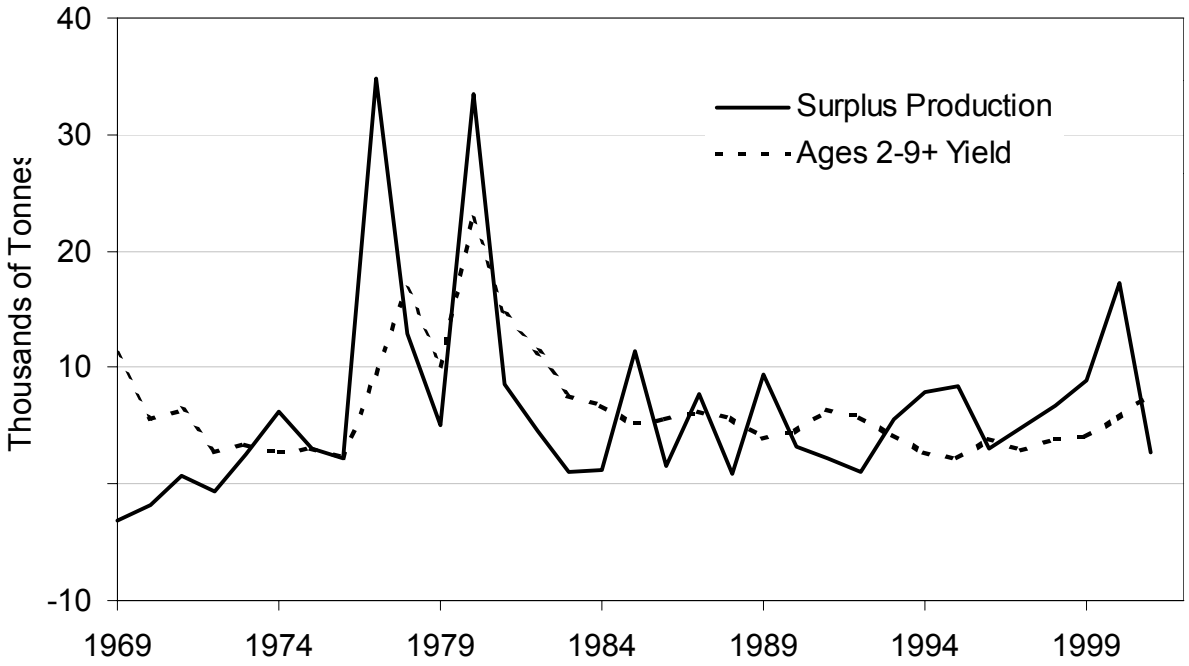

Figure 32. Surplus production of 5Zjm haddock available to the commercial fishery compared to the harvested yield.

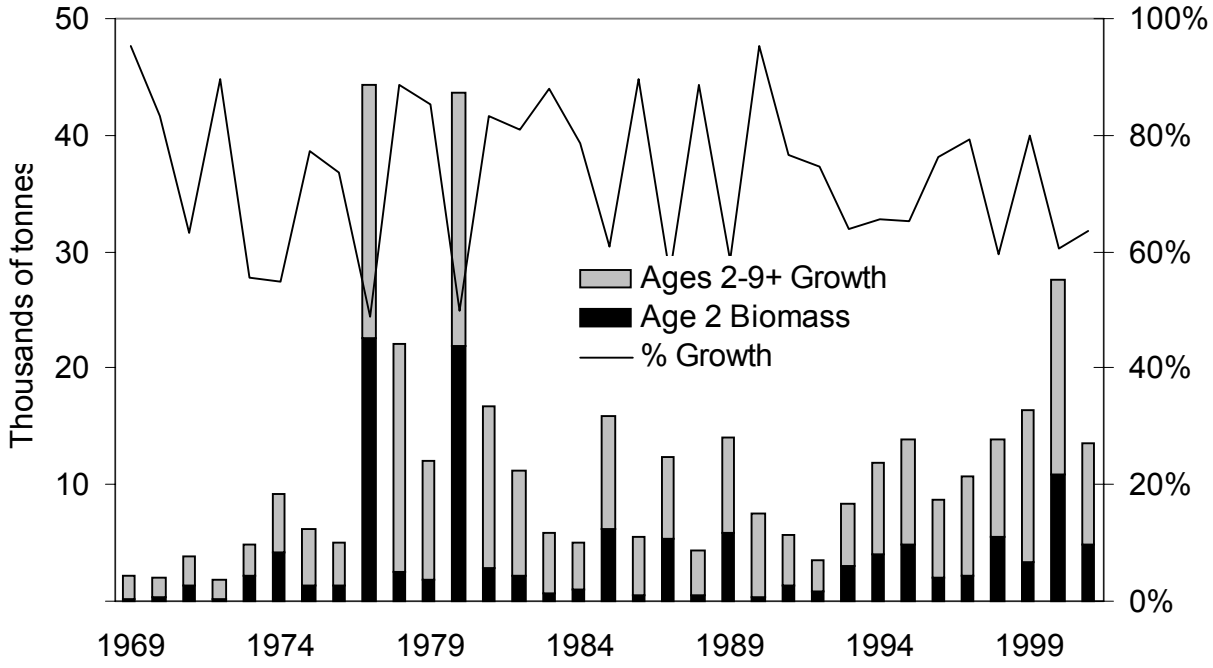

Figure 33. Amount of productivity attributible to growth (ages 2 to 9+) of 5Zjm haddock and the amount contributed by recruitment (age 2).

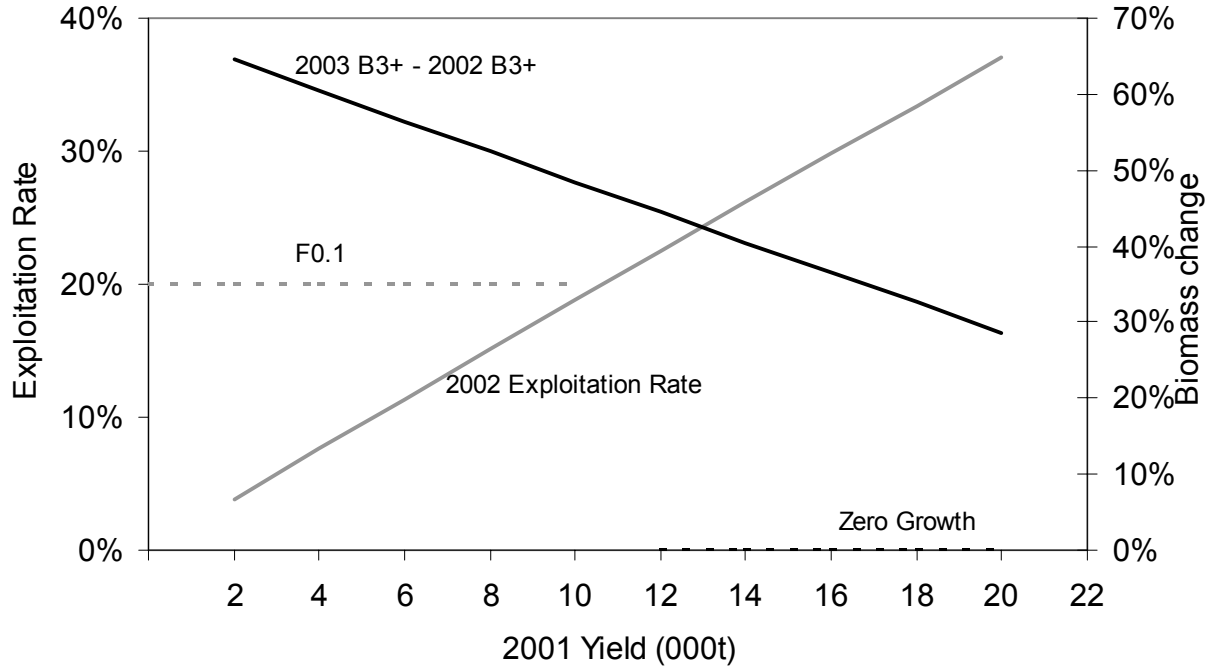

Figure 34. Expected exploitation rate in 2002 and expected change in biomass from 2002 to 2003 for 5Zjm haddock at various quotas.

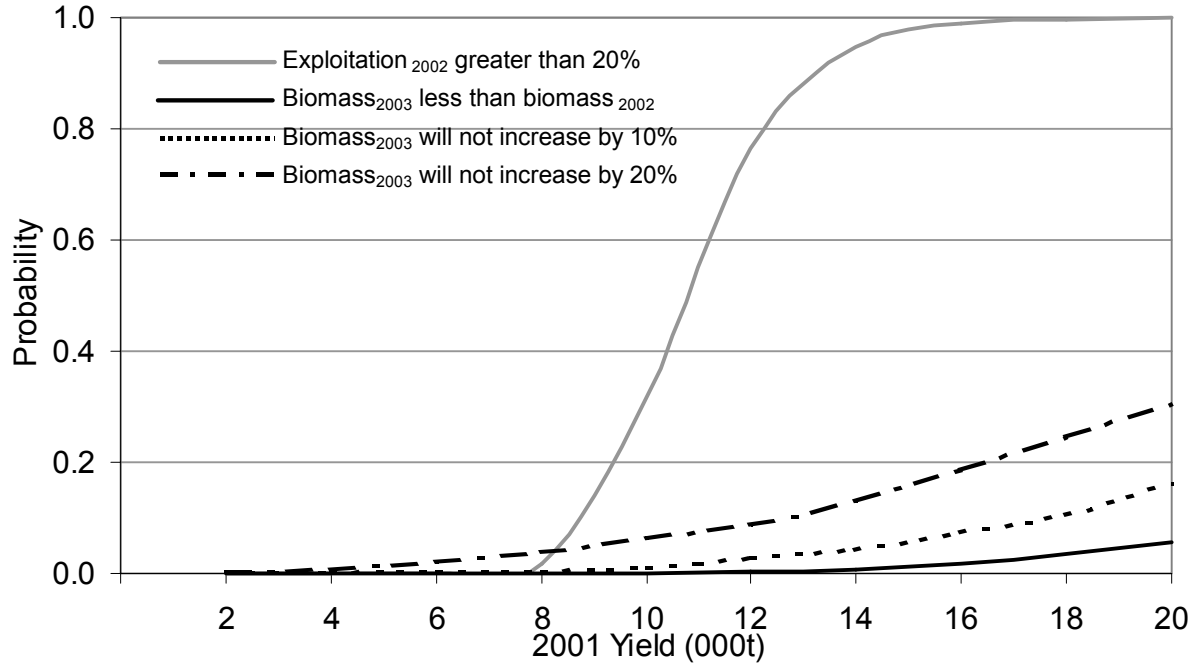

Figure 35. Probability of 2002 explopitation rate exceeding 20%, the $F_{0.1}$ reference level, and of the 2003 ages 3+ biomass being less than the 2002 biomass by 0%, 10% and 20% for 5Zjm haddock at various quotas.

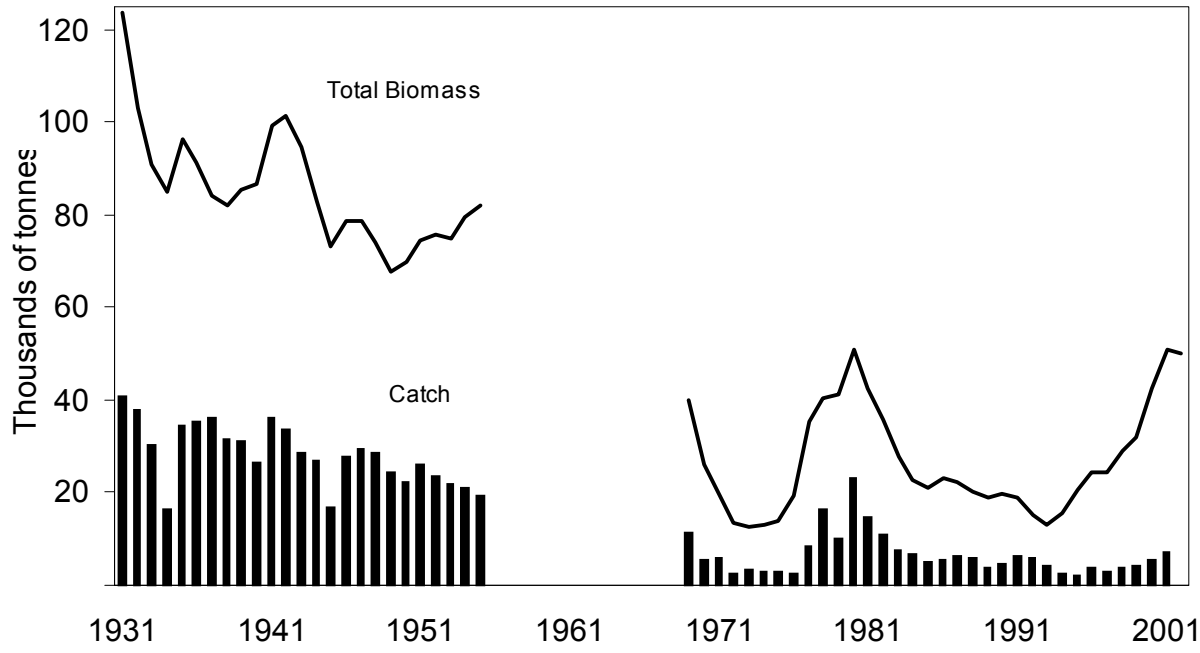

Figure 36. Historical catch and total biomass of haddock in 5Zjm compared to recent catches and biomass.

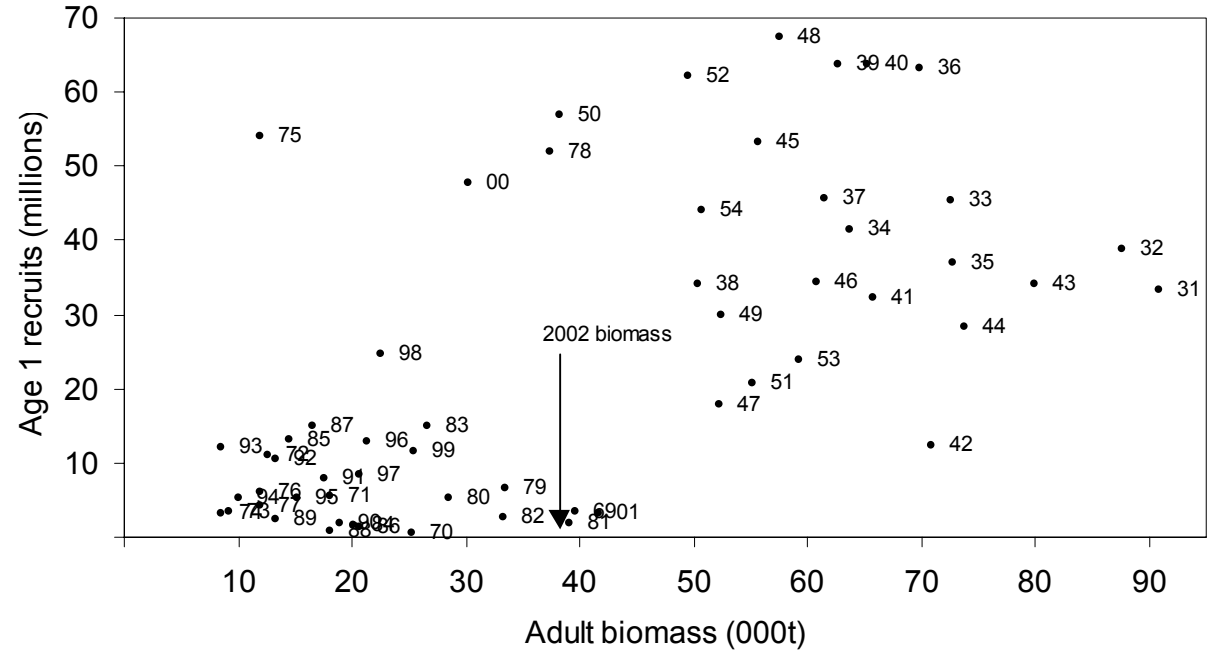

Figure 37. Relationship between adult (ages 3+) 5Zjm haddock biomass and recruits at age 1 from 1931 to 1955 and 1969 to 2001.

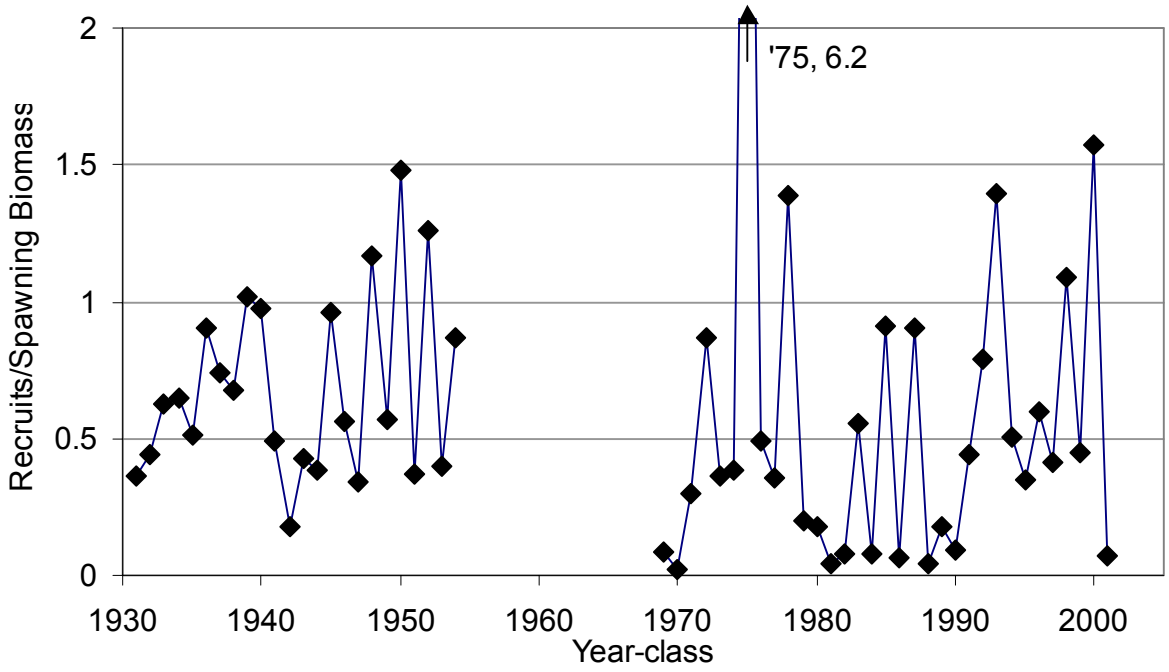

Figure 38. Ratio of recruits (numbers at age 1) to spawning biomass (kg) for 5Zjm haddock suggests that, except for 2001, present survivorship appears comparable to that of the 1930s to 1950s.