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Size-at-age and condition of cod in Subdivision 3Ps as determined from research bottom-trawl surveys (1972-1997)

by

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Abstract

The size-at-age and condition of cod in the offshore of Subdivision 3Ps were monitored by sampling catches during research bottom-trawl surveys in the winter/spring of 1972-1997. There are strong year effects in the size-at-age data that have not yet been explained. Peak length-at-age occurred in the mid-1970s for young ages and progressively later to 1980 for older ages. From the mid-1980s to the late 1990s, length-at-age and weight-at-age varied with no trend (younger ages) or declined (older ages). Condition, as measured by somatic (gutted) weight and liver weight relative to length cubed, was low in fish sampled during the 1993-1997 surveys. However, there is no evidence that these values are unusually low because sampling was conducted in April when condition is near the low point of the seasonal cycle. There are few comparable data from previous years. During previous assessments of this stock, weights-at-age on January 1 were estimated from the mean weights-at-age derived from sampling of commercial catches. A preliminary investigation of the utility of using January 1 weights-at-age derived from the research sampling found that the research data were more variable than the commercial data and that estimates from research data tended to be much higher than those from commercial data during the 1970s and early 1980s.

Résumé

La taille selon l'âge et le facteur de condition des stocks de morue dans la zone hauturière de la subdivision 3Ps ont fait l'objet d'un échantillonnage des captures à l'occasion de relevés au chalut de fond au cours de l'hiver et du printemps lors de la période de 1972 à 1997. Il y a de fortes incidences dans les données sur la taille en fonction de l'âge qui n'ont pas encore été expliquées. La longueur maximale en fonction de l'âge a été observée vers le milieu des années 70 pour les jeunes poissons et un peu plus tard jusqu'en 1980 pour les poissons plus âgés. Du milieu des années 80 à la fin des années 90, la longueur et le poids en fonction de l'âge ont varié, sans révéler de tendance (poissons plus jeunes) ou de baisse (poissons plus âgés). Le facteur de condition, mesuré par le poids somatique (éviscéré) et le poids du foie par rapport à la longueur au cube était faible chez le poisson échantillonné au cours des relevés de 1993 à 1997. Toutefois, rien n'indique que ces valeurs étaient anormalement faibles parce que l'échantillonnage a eu lieu en avril, alors que le facteur de condition se situe près du point faible du cycle saisonnier. Il existe peu de données comparables des années précédentes. Au cours d'évaluations antérieures de ce stock, le poids en fonction de l'âge au 1er janvier était estimé d'après le poids moyen selon l'âge dérivé de l'échantillonnage de prises commerciales. Un examen préliminaire de l'utilité d'utiliser le poids selon l'âge au 1er janvier dérivé d'un échantillonnage de recherche a permis de constater que les données de recherche étaient plus variables que les données commerciales et que les estimations à partir des données de recherche étaient beaucoup plus élevées que celles des données commerciales au cours des années 70 et au début des années 80.

Introduction

Cod (Gadus morhua) in several areas of Atlantic Canada experienced pronounced declines in growth and condition during the late 1980s and early 1990s (Sinclair 1996; Sinclair and Murawski 1997). The degree to which such changes occurred in the stock off the south coast of Newfoundland (Subdivision 3Ps) is difficult to assess because the DFO bottom-trawl surveys have varied considerably in timing and there appear to be strong year effects in size-at-age data that have not yet been explained (Lilly MS 1996). The major purpose of this paper is to explore in more detail the size at age and condition data available from cod sampled during the surveys in 1972-1996 and to update the analyses with data collected in 1997.

A second purpose is to document the method used to calculate the January 1 weights-at-age used during the 1998 assessment of 3Ps cod (Stansbury et al. MS 1998). The relative merits of commercial data and research vessel data are discussed, and the reasons for continuing to use commercial weights-at-age at this time are described.

Materials and Methods

Research vessel surveys

Survey design

Cod were caught during stratified-random bottom-trawl surveys conducted in Subdivision 3Ps during winter-spring 1972-1997. The timing of the surveys varied considerably, with the earliest and latest dates of fishing being January 27 in 1988 and June 12 in 1975 (Table 1). The median dates of fishing varied from February 7 to June 6. The number of fishing stations also varied considerably, from a low of 44 in 1978 to a high of 159 in 1983. The number of stations tended to be lower in the 1970s and early 1980s. Note that there were two surveys in 1993, one in February and one in April. Only the latter has been included in the time-series.

The survey gear was changed twice during the period 1972-1997. The 51 m side trawler ‘A. T. Cameron’ (1972-1982) deployed a Yankee 41.5 otter trawl, the sister 50 m stern trawlers ‘Alfred Needler’ (1983, 1984) and 'Wilfred Templeman' (1985-1995) deployed an Engel 145 Hi-Lift otter trawl, and in 1996-1997 the ‘Wilfred Templeman’ deployed a Campelen 1800 shrimp trawl with rockhopper foot gear. In all instances, a 29 mm mesh liner was inserted in the codend. In 1972-1995, tows were made at 3.5 knots for 30 min at each fishing station, whereas in 1996-1997 tows were made at 3.0 knots for 15 min. Catches from the few stations of non-standard duration were appropriately adjusted. Fishing in all years was conducted on a 24-h basis.

Fishing stations were allocated randomly within strata that had been designed by defining depth zones and then subdividing these zones perpendicular to the bathymetry. The number of fishing stations allocated to each stratum was roughly proportional to the size of the stratum, with the constraint that each stratum be allocated no fewer than 2 stations. (There were instances in which the sampling objectives were not realized.) Doubleday (1981) provides illustrations of the strata and information on their areas and depth-ranges. Several additions and modifications to the stratification scheme are described by Bishop (MS 1994) and Murphy (MS 1996). Additional strata were added to the inshore in 1997. Many analyses, including sequential population analysis, make use of only those strata that have been fished over a long time period. These have been termed index strata. Strata 293-300, 709-710, and 776-783 are excluded from the index strata. Only data from sets in the index strata are included in the analyses presented in this paper.

Biological sampling

Sampling of cod for otoliths and various biological attributes was conducted using two distinct procedures (Table 2). The first involved determination of biological attributes (eg. fork length, cm) and the extraction of otoliths at sea. The second, which was started in 1978, involved the determination of body length at sea followed by the freezing of the fish for detailed examination in the laboratory at the Northwest Atlantic Fisheries Centre, St. John’s. These frozen fish were thawed in fresh water and weighed (to the nearest 10 g) before being cut (round weight) and again after removal of the organs from the abdominal cavity (gutted weight). The liver and gonad were also weighed (g) or measured volumetrically (ml).

For each of these two methods of sampling, there were several changes in what constituted a sample and several changes in the biological attributes measured. With respect to the sampling of unfrozen fish, a single sample was obtained for the whole Subdivision during 1972-1984, two samples were obtained during 1985-1987, and a single sample was obtained in 1988-1996. With respect to the sampling of frozen fish, a single sample was obtained for the whole Subdivision during 1978-1984, two samples during 1985-1988, three samples during 1989-1993 (February), four samples in 1993 (April) and five samples in 1994-1997. The boundaries of the sample areas varied over time, and in some years (notably 1985-1988) several strata were not included in any of the samples.

For the period 1978-1984, all information regarding body weight and the size of individual body parts came only from the frozen fish. Additional information was collected at sea starting in 1985. From 1985-1989, the volumes of the liver and gonad were determined with volumetric cylinders for all fish sampled at sea. In 1990, balances for weighing at sea were used to obtain round weight, gutted weight, and weights of large livers and gonads for all fish sampled at sea. The sizes of small (<100 g) livers and gonads continued to be determined volumetrically. In 1991 and subsequent years, weights were obtained for livers and gonads of all sizes. An important change for the frozen fish, initiated in 1991, was the determination of round weight at sea prior to freezing.

The number of aged fish for which body length, body weight and liver size (weight or volume) were determined in each year is recorded in Table 3. The number of fish for which both length and age were determined is given by year and age in Table 4. The number of fish sampled at the older ages declined during the late 1980s and 1990s. The number sampled at age 1 increased dramatically with the introduction of the Campelen trawl in 1996. The number of fish sampled for weight in addition to length and age is given by year and age in Table 5.

Data analysis

All sampling was stratified by length, so calculation of mean length, weight and condition at age included weighting observations by population abundance of the size groups (Morgan and Hoenig 1997), where the abundances were calculated by areal expansion of the stratified arithmetic mean catch at length per tow (Smith and Somerton 1981). Note that weights were not obtained prior to 1978 and that in 1978-1989 the number of aged fish for which weight was recorded was substantially fewer than the number for which length was recorded.

The somatic condition and liver index of each fish were expressed using Fulton's condition factor $((W/L^3)*100)$, where W is gutted weight (kg) or liver weight (kg) and L is length (cm). Note that somatic condition as defined in this paper differs from that proposed by Dutil et al. (MS 1995), who use somatic weight calculated as total weight minus gonads and stomach contents. This formulation cannot be applied directly to data collected from 3Ps cod because the weight of the empty digestive tract was not determined. Note that there may be merit in considering the sizes of the carcass (gutted weight) and the liver separately, since these two body compartments may differ in their responses to food deprivation and intensive feeding. In addition, the liver index used in this paper differs from the hepato-somatic index proposed by Dutil et al. (MS 1995). For the liver index in this paper the liver weight is expressed relative to body length, in a manner identical to the calculation of somatic condition, whereas for the hepato-somatic index of Dutil et al. (MS 1995) the liver weight is expressed relative to somatic weight. A concern with the latter formulation is that body components other than the liver may vary in weight. Hence, for a fish of given length, changes in muscle mass will cause changes in hepato-somatic index (as defined above) even if there is no change in liver weight.

Results and Discussion

Size at age

Mean lengths-at-age (Table 6; Fig. 1) varied over time. For the period 1972-1997, peak length-at-age occurred in the mid-1970s for young ages (3-4) and progressively later to 1980 for older ages. From the mid-1980s to 1997, length-at-age varied with no trend (younger ages) or declined (older ages).

It would be instructive to determine if some of the variability in length-at-age can be accounted for by variability in population size or environmental temperature. However, there are some unexpected year effects in the length-at-age data (Fig. 2; see also Fig. 4 in Lilly MS 1996). There appears to be negative growth for at least 2 cohorts during each of the intervals 1977-1978, 1980-1981, 1989-1990 and 1993-1994. Apparent negative growth could result from under-representation of the larger fish within a cohort. This could be caused by relatively high mortality of larger fish or lower availability of larger fish. The latter could occur either because a higher proportion of the larger fish occur outside the survey area or because larger fish are less susceptible to capture by the gear. Apparent negative growth could also result if the survey area contained different “groups” of fish with different growth rates, and the proportion of each group in the sampling varied from year to year. There is good evidence that the 3Ps stock consists of several stocks or substocks, but it has not yet been determined whether these smaller units experience different growth rates. There is also a possibility that the degree of inclusion of adjacent stocks may vary from year to year. For example, the degree to which 3Pn4RS cod occur within 3Ps probably varies among years (D’Amours et al. MS 1994), and Pinhorn (1969) reported that cod from Burgeo Bank (western 3Ps) grow faster than those from 3Pn. There may also be annual variability in the presence of 3NO cod, which grow relatively quickly (Fleming 1960).

The changes in mean weights-at-age (Table 7; Fig. 3) appear very similar to those for mean lengths-at-age, but will not be examined further in this paper because there is evidence that the weight of both the muscle mass and the liver undergo changes during the winter-spring period.

Cod well-being

Mean somatic (gutted) condition at age (Table 8; Fig. 4) was variable from 1978 to 1986, relatively constant from 1986 to 1992, and dropped suddenly in 1993 before rising to an intermediate level in 1995-1997. Because condition calculated with Fulton’s formula increases with body length, and length-at-age has declined over time, condition at length (Fig. 4B) might be a better indicator of changes in condition over time. As demonstrated by Lilly (MS 1996), much of the annual variability is related to the timing of the surveys. When mean condition in each of three length groups was plotted against the median date of sampling during the survey, there is a gradual decline in condition from the earliest median date (Feb. 7) to approximately mid-April, after which there is an increase. The time course of changes from late April onward is poorly defined because of the paucity of observations.

Mean liver index at age (Table 9; Fig. 5) had a pattern similar to that seen in condition, except that the 1983 values were more clearly at higher levels than other years in the early 1980s and there was a more pronounced peak in the late 1980s and early 1990s. When the values for specific size groups were plotted against the median date of sampling, there was a very pronounced decline in liver index during winter and early spring.

The low condition values observed in recent years (1993-1997) are mainly a consequence of sampling near the low point of the annual condition cycle. They are not indicative of a large and persistent decline in well-being. It is difficult to determine if condition during these years was near normal for the time of year because there are very few data from earlier years with which the recent values can be compared. In the most recent three years there has been some increase from the low values in somatic condition observed in 1993-1994.

Commercial weights-at-age

Mean weights-at-age of the cod caught in the commercial fishery (including food fisheries and sentinel surveys) in Subdivision 3Ps in 1959-1995 are provided in Table 7 of Shelton et al. (MS 1996). Comparable data for 1996 and 1997 are provided in Tables 5 and 8 of Stansbury et al. (MS 1998). The full matrix, including revisions for 1992 and 1994, is provided in Table 10. There are two aspects of these data that should be noted. (1) A single weight-at-age vector has been used for the years 1959-1976. The derivation of this vector is not known at this time. The weight at age 3 in this vector is low compared to all values subsequent to 1976 and may be more representative of the weight of age 3 fish in the population, because the fishery probably selects for the largest fish at age 3. (2) There is a missing value for age 14 fish in 1995. It was arbitrarily decided to set this equal to the mean of the two preceding and two following years.

Exploration of the consequences of various catch options in 1998 requires estimates of the weights-at-age in the commercial catch in 1998 and weights-at-age in the population at the beginning of 1998 and 1999. Since 1997 was the only year since 1993 to see a substantial fishery, it was assumed that the mean weights-at-age in the 1997 fishery would provide the best estimates of the mean weights-at-age in the 1998 fishery (Table 10).

Weights-at-age at the beginning of the year

Estimation of population biomass at the beginning of the year requires an estimate of the mean weight-at-age at the beginning of the year. These mean weights have usually been obtained by adjusting to the beginning of the year those mean weights-at-age calculated from sampling during the commercial fishery (see, for example, Rivard 1982, p. 14). There are several problems associated with this approach. First, the commercial fishery may be conducted with a variety of gears, each with its peculiar selection pattern. The size-at-age determined from sampling the catch from any specific gear may not reflect size-at-age in the population. Second, the relative contribution of each gear to the total catch may vary among years. Third, the temporal pattern of fishing may not centre on the time when the fish attain the mid-point of their annual length increment. Fourth, the temporal and spatial pattern of fishing may vary among years. Prior to preparation of the 1998 assessment of 3Ps cod it was thought that weights-at-age calculated from samples collected during research bottom-trawl surveys should be investigated to determine if they provide a more representative measure of weight-at-age at the beginning of the year.

Data from the surveys are not without problems. First, the weights-at-age are available only since 1978 and are based on small sample sizes for many combinations of year and age (Table 5). Second, the surveys were conducted 2-6 months after January 1 (Table 1) and there is currently no model of seasonal growth from which survey weights-at-age can be extrapolated back to January 1.

Because of these problems with survey weights-at-age, it was decided to explore the possibility of deriving January 1 weights-at-age from information on lengths. This would take advantage of the fact that information on length-at-age is available since 1972 and is often based on larger sample sizes than the corresponding data for weights (compare Tables 4 and 5). The problem of extrapolation back to January 1 was side-stepped by assuming that the cod do not increase in length between January 1 and the date of each survey. The evidence for this is weak. First, Pinhorn (1966) reported that otolith growth of west Newfoundland cod, caught off southwestern Newfoundland, starts in July and continues until December. Second, condition (somatic condition and liver index) of cod both offshore (this paper) and inshore (Lilly MS 1996) decreases during winter-spring, and it is unlikely that linear growth would occur while condition was declining. Third, average spawning time for cod on St. Pierre Bank is mid-May (Hutchings and Myers 1994), and again it is unlikely that linear growth would occur in mature cod at a time when they put considerable energy into reproductive products. Even if length does not change between January 1 and the time of each survey, there is still the problem of the decline in weight at length. For this exercise, it was assumed that the weight at length could be approximated from a weight - length relationship calculated from data collected as close as possible to the start of the year. Data collected in 1988-1991, when the surveys were conducted primarily in February (Table 1), were used to obtain the predictive equation

$$\log_{10}(\text{weight}) = 3.1747*\log_{10}(\text{length}) - 5.3729 ,$$

where weight is in kg and length is in cm. The equation is based on 1907 fish with a length range of 13-141 cm. The weight of each individual fish sampled for length (cm) and age was estimated from this regression equation and mean weight-at-age was estimated as described above.

These research January 1 weights-at-age, which are highly preliminary and merely illustrative, may be compared with January 1 weights-at-age calculated from commercial weights-at-age (Table 10) using formulae in Rivard (1982, p. 14). For ages 4-14, weight-at-age i at the beginning of year t ($W_{i,t}$) was approximated by

$$W_{i,t} = e^{(\ln W_{i-0.5,t-0.5} + \ln W_{i+o.5,t+0.5})/2}$$

For age 3, the $W_{i,\,t}$ were approximated by the relationship

$$W_{i,t} = e^{(2\ln W_{i+0.5,t+0.5} - \ln W_{i+1,t+1})}$$

The resulting estimates of January 1 weights-at-age are provided in Table11.

The degree of similarity between the research and commercial estimates of January 1 weights-at-age was explored visually. On average over the period 1977-1997, the estimates from research sampling were lower than estimates from commercial sampling at ages 3 and 4 and higher than the commercial estimates at older ages (Fig. 6). When temporal changes in the two series were compared on an age by age basis (Fig. 7), it was clear that the research values were more variable. The coefficient of variation of mean weights-at-age at ages 3 to 12 tended to be in the range 15-35% for research data but only 8-17% for commercial data. In addition, there was no consistent relationship between the two series. That is, for a given age, the research estimates were not consistently either above or below the commercial estimates. However, there was a tendency for the research weights-at-age to be considerably greater than those derived from commercial data during the 1970s and early 1980s. This phenomenon requires additional study.

At this time it is not clear that January 1 weights-at-age derived from research vessel samples are more representative than those derived from commercial sampling. There are strong unexplained year effects and there is no model of seasonal changes in weight-at-age that would allow extrapolation from the date of each survey back to January 1. Estimates from commercial data have been used in previous assessments of this stock, and it is prudent to continue to use those until it can be demonstrated that more representative estimates are available.

For exploration of the consequences of various catch options in 1998, mean weights at ages 4-14 at the beginning of 1998 (Table 11) were estimated using the commercial weights-at-age in 1997 and assuming that commercial weights-at-age in 1998 would be identical to those in 1997 (Table 10). The mean weight at age 3 at the beginning of 1998 was assumed to be the same as the mean weight at age 3 at the beginning of 1997. All mean weights-at-age at the beginning of 1999 were assumed to be unchanged from mean weights-at-age at the beginning of 1998.

References

Bishop, C. A. MS 1994. Revisions and additions to stratification schemes used during research vessel surveys in NAFO Subareas 2 and 3. NAFO SCR Doc. 94/43. Serial No. N2413. 23 p.

D'Amours, D., Frank, K.T., and Bugden, G. MS 1994. Report of the working group on oceanographic effects on stock migration and mixing - reviewed by the Fisheries Oceanography Committee (FOC). DFO Atl. Fish. Res. Doc. 94/54. 52 p.

Doubleday, W. G. (ed.) 1981. Manual on groundfish surveys in the Northwest Atlantic. NAFO Sci. Coun. Studies 2: 7-55.

Dutil, J.-D., Lambert, Y., Chouinard, G. A., and Fréchet, A. MS 1995. Fish condition: what should we measure in cod (Gadus morhua)? DFO Atlantic Fisheries Res. Doc. 95/11. 26 p.

Fleming, A. M. 1960. Age, growth and sexual maturity of cod (Gadus morhua L.) in the Newfoundland area, 1947-1950. J. Fish. Res. Board Can. 17: 775-809.

Hutchings, J. A., and Myers, R. A. 1994. Timing of cod reproduction: interannual variability and the influence of temperature. Mar. Ecol. Prog. Ser. 108: 21-31.

Lilly, G. R. MS 1996. Growth and condition of cod in Subdivision 3Ps as determined from trawl surveys (1972-1996) and sentinel surveys (1995). DFO Atlantic Fisheries Research Document 96/69. 39 p.

Morgan, M.J., and Hoenig, J. M. 1997. Estimating maturity-at-age from length stratified sampling. J. Northw. Atl. fish. Sci. 21: 51-63.

Murphy, E. F. MS 1996. Corrections to the stratification scheme in 3Ps. NAFO SCR Doc. 96/55. Serial No. N2731. 11 p.

Pinhorn, A. T. 1969. Fishery and biology of Atlantic cod (Gadus morhua) off the southwest coast of Newfoundland. J. Fish. Res. Board Can. 26: 3133-3164.

Rivard, D. 1982. APL programs for stock assessment (revised). Can. Tech. Rep. Fish. Aquat. Sci. 1091: 146 p.

Shelton, P. A., Stansbury, D. E., Murphy, E. F., Brattey, J., and Lilly, G. R. MS 1996. As assessment of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 96/91. 82 p.

Sinclair, A. 1996. Recent declines in cod species stocks in the northwest Atlantic. NAFO Sci. Coun. Studies 24: 41-52.

Sinclair, A. F., and Murawski, S. A. 1997. Why have groundfish stocks declined?, p. 71-93. *In* J. Boreman, B. S. Nakashima, J. A. Wilson and R. L. Kendall [eds.] Northwest Atlantic groundfish: perspectives on a fishery collapse. American Fisheries Society, Bethesda, Maryland.

Smith, S. J., and Somerton, G. D. 1981. STRAP: A user-oriented computer analysis system for groundfish research trawl survey data. Can. Tech. Rep. Fish. Aquat. Sci. 1030: iv + 66 p.

Stansbury, D. E., Shelton, P. A., Brattey, J., Murphy, E. F., Lilly, G. R., Cadigan, N. G., and Morgan, M. J. MS 1998. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 98/19. 92 p.

Table 1. Selected data for bottom-trawl surveys in Subdivision 3Ps in winter-spring 1972-1997. Some entries differ from those in Table 1 of Lilly (MS 1996) because only data from successful survey sets in the index strata are included in the present analyses.

		No. of	Dates of fishing		
Year	Ship/trip	stations	first	median	last
1972	ATC 197	45	21-Mar	26-Mar	29-Mar
1973	ATC 207	55	16-Mar	19-Mar	22-Mar
1974	ATC 221	79	20-Apr	24-Apr	30-Apr
1975	ATC 234	62	03-Jun	06-Jun	12-Jun
1976	ATC 247	69	12-May	15-May	20-May
1977	ATC 261	101	16-Apr	20-Apr	25-Apr
1978	ATC 273	44	23-Feb	25-Feb	28-Feb
1979	ATC 287	79	20-Feb	25-Feb	05-Mar
1980	ATC 302	81	20-Mar	29-Mar	02-Apr
1981	ATC 316	69	09-Mar	14-Mar	26-Mar
1982	ATC 330	92	29-May	04-Jun	08-Jun
1983	AN 9	159	23-Apr	01-May	08-May
1984	AN 26	89	10-Apr	14-Apr	17-Apr
1985	WT 26	107	08-Mar	13-Mar	25-Mar
1986	WT 45	133	06-Mar	15-Mar	23-Mar
1987	WT 55,56	129	13-Feb	09-Mar	22-Mar
1988	WT 68	144	27-Jan	07-Feb	14-Feb
1989	WT 81	144	01-Feb	09-Feb	16-Feb
1990	WT 91	108	01-Feb	09-Feb	19-Feb
1991	WT 103	154	02-Feb	10-Feb	20-Feb
1992	WT 118	136	06-Feb	15-Feb	23-Feb
1993[a]	WT 133	132	06-Feb	13-Feb	23-Feb
1993	WT 135	126	02-Apr	13-Apr	20-Apr
1994	WT 150,151	147	07-Apr	18-Apr	26-Apr
1995	WT 166,167	148	04-Apr	12-Apr	28-Apr
1996	WT 186,187	141	10-Apr	24-Apr	01-May
1997	WT 202,203	127	04-Apr	13-Apr	23-Apr
Total		2900			

[a] This survey is not considered to be part of the time-series. The survey time was changed to April to reduce the chances of catching cod from the 3Pn4RS stock.

Table 2. Instructions for sampling cod during bottom-trawl surveys in Subdivision 3Ps in 1972-1997. The instructions were extracted from unpublished trips reports available in the library of the Northwest Atlantic Fisheries Centre, St. John's, NF. In each of the sample descriptions, the numbers in parentheses are stratum numbers.

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1972	ATC 197	For the Subdivision, collect otoliths from cod < 32 cm; 5 per 3-cm group cod 33-62 cm; 15 per 3-cm group cod 63-101 cm; 30 per 3-cm group cod 102-116 cm; 15 per 3-cm group cod >116 cm; 5 per 3-cm group	
1973	ATC 207	As in 1972	
1974	ATC 221	As in 1972	
1975	ATC 234	As in 1972, except for cod 33-62 cm; 30 per 3-cm group	
1976	ATC 247	For the Subdivision, collect otoliths from 25 specimens per 3-cm group	
1977	ATC 261	As in 1976	
1978	ATC 273	As in 1976	For the Subdivision, freeze 5 specimens per 3-cm group
1979	ATC 287	As in 1976	As in 1978
1980	ATC 302	For the Subdivision, collect otoliths from 25-30 specimens per 3-cm group	As in 1978
1981	ATC 316	As in 1976	As in 1978
1982	ATC 330	As in 1976	Instructions not recorded, but sample obtained
1983	AN 9	As in 1976	As in 1978
1984	AN 26	As in 1976	As in 1978

(cont'd)

Table 2 (cont’d)

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1985	WT 26	For each of two samples, collect otoliths from 25 specimens per 3-cm group. Samples are: (1) Burgeo Bank (306-309) (2) St. Pierre Bank (all other strata, but excluding 714-716) For each sampled fish, also obtain: volume of liver volume of gonad	For each of two samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-312) (2) Halibut Channel (315, 318, 319)
1986	WT 45	As in 1985	As in 1985
1987	WT 55, 56	As in 1985	For each of two samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-314) (2) Burgeo Bank (306-309)
1988	WT 68	For the Subdivision, collect otoliths from 25 specimens per 3-cm group For each sampled fish, also obtain: volume of liver volume of gonad	As in 1987
1989	WT 81	As in 1988	For each of three samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-314) (2) Burgeo Bank (306-309) (3) Green Bank - Halibut Channel (east of 55010' W)
1990	WT 91	For the Subdivision, collect otoliths from 25 specimens per 3-cm group For each sampled fish, also obtain: round weight gutted weight weight of liver (volume if liver <100 g) weight of gonad (volume if gonad <100 g)	As in 1989

(cont’d)

Table 2 (cont'd)

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1991	WT 103	For the Subdivision, collect otoliths from 25 specimens per 3-cm group For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	As in 1989, except that in addition ***determine round weight at sea***
1992	WT 118	As in 1991	As in 1991
1993	WT 133 (February)	As in 1991	As in 1991
	WT 135 (April)	For the Subdivision, collect otoliths from 10 specimens per 3-cm group For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	For each of four samples, freeze 5 specimens per 3-cm group. Samples are: (1) Northwest St. Pierre Bank (310-314, 705, 713) (2) Burgeo Bank (306-309, 714-716) (3) Green Bank - Halibut Channel (318, 319, 707-709) (4) Remaining strata (315-317, 320-326, 706, 711, 712) Determine round weights at sea
1994	WT 150, 151	For the Subdivision, collect otoliths from 2 specimens per cm For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	For each of five samples, freeze 2 specimens per cm Samples are: (1) Northwest St. Pierre Bank (310-314, 705, 713) (2) Burgeo Bank (306-309, 714-716) (3) Green Bank - Halibut Channel (318, 319, 325, 326, 707-710) (4) Placentia Bay (779-783) (5) Remaining strata (315-317, 320-324, 706, 711, 712) Determine round weights at sea
1995	WT 166, 167	As in 1994 (However, instructions for WT. 166 specified 10 specimens per cm, whereas instructions for WT. 167 specified 2 per cm)	As in 1994 (Areas specified in instructions for WT. 167, but not for WT. 166)
1996	WT 186, 187	As in 1994	As in 1994

(cont'd)

Table 2 (cont'd)

Year	Trip	Sampling the unfrozen fish	Sampling of frozen fish
1997	WT 202, 203	For the Subdivision, collect otoliths from 10 specimens per cm (This includes the fish taken in the frozen samples.) For each sampled fish, also obtain: round weight gutted weight weight of liver weight of gonad	For each of five samples, freeze 2 specimens per cm Samples are: (1) Northwest St. Pierre Bank (294-298, 310-314, 705, 713) (2) Burgeo Bank (299-300, 306-309, 714-716) (3) Green Bank - Halibut Channel (318, 319, 325, 326, 707-710) (4) Placentia Bay (293, 779-783) (5) Remaining strata (315-317, 320-324, 706, 711, 712) Determine round weights at sea

Table 3. Sampling of cod caught during bottom-trawl surveys in Subdivision 3Ps in 1972-1997. Number of aged fish for which there are also records of length, body weight and liver size (weight or volume). Some entries differ from those in Table 2 of Lilly (MS 1996) because only data from successful survey sets in the index strata are included in the present analyses.

		Body weight		Liver		
Year	Length	Round	Gutted	Weight	Volume[a]	Total
1972	427					
1973	382					
1974	389					
1975	611					
1976	675					
1977	546					
1978	372	108	108	107		107
1979	559	132	143	143		143
1980	608	162	162	162		162
1981	575	148	148	148		148
1982	727	154	154	154		154
1983	820	198	189	189		189
1984	580	139	139	139		139
1985	704	84	84	84	627	711
1986	878	139	139	139	739	878
1987	853	210	210	210	638	848
1988	903	235	235	235	667	902
1989	825	335	335	335	488	823
1990	579	578	577	253	325	578
1991	739	739	735	735		735
1992	547	547	545	547		547
1993	399	398	397	398		398
1994	546	546	540	545		545
1995	584	584	575	583		583
1996	833	833	801	802		802
1997	316	316	316	314		314
Total	15977	6585	6532	6222	3484	9706

[a] Instances where liver volume was measured but not liver weight.

Table 4. Sampling of cod caught during bottom-trawl surveys in Subdivision 3Ps in 1972-1997. Number of fish for which there are records for age and length, by age and year. Sample sizes in a few cells are different from those in Table 4 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
1	3	8	11	25	15	1		13	3	2	25	24	1		1	6	3	3		8					52	22	226
2	16	20	21	37	126	21	24	24	99	30	119	59	19	35	29	27	61	39	9	70	11		15	3	76	70	1060
3	24	28	38	101	122	137	22	31	85	120	73	103	32	75	48	55	93	95	89	66	99	42	40	29	143	67	1857
4	62	44	35	117	167	101	119	57	54	70	139	48	63	94	115	74	91	130	117	106	52	94	98	41	120	34	2242
5	40	68	38	88	103	117	71	151	93	58	70	117	48	106	154	165	63	80	85	108	108	53	166	101	43	22	2316
6	32	19	60	82	50	73	45	98	123	82	44	56	171	69	180	148	107	67	56	77	92	85	57	181	120	19	2193
7	75	71	38	78	31	31	31	87	46	100	85	26	66	100	94	121	109	130	47	62	73	72	82	55	184	33	1927
8	72	34	57	31	32	15	23	48	49	33	103	67	32	48	93	74	89	86	60	50	40	24	47	73	37	28	1345
9	35	48	32	23	10	23	12	21	14	42	36	132	41	29	58	58	64	49	38	56	22	10	12	51	33	14	963
10	22	17	27	15	6	9	11	17	12	14	13	76	65	33	21	21	55	34	26	53	25	4	11	21	12	5	625
11	9	4	7	6	6	2	5	5	10	4	8	49	15	35	19	17	49	42	17	34	11	8	4	12	11	2	391
12	6	5	6	2	2	4	2	2	11	6	3	20	12	39	24	18	35	16	12	15	7	1	6	2	2		258
13	3	1	4	3		6	2	2	4	5	2	10	5	18	15	20	24	14	8	10	1	1	3	6			167
14	7	2	6			1		3		3	2	9	3	11	11	17	22	7	7	6	1	1	3	6			128
15	3	1	1	1	2	2	2		2	1	3	7		3	7	6	17	12	1	7	4	2		2			86
16	5	3	3						2	2	2	6	3	2	5	6	15	7	4	5	1	1	1				73
17	7	3	2	1	1		1		1	1		1		3	3	6	2	6	1	3		1	1				44
18	3	5	1		1	1						3	3	1		5	1	3	1	2							30
19	1		1		1		1					2				2	1	2	1	1							13
20	1			1		2				2		2			1	2	2	2									15
21	1											2	1	2		2											8
22			1				1							1		1											4
23												1				1								1			3
24		1																1									2
25																1											1
Total	427	382	389	611	675	546	372	559	608	575	727	820	580	704	878	853	903	825	579	739	547	399	546	584	833	316	15977

Table 5. Sampling of cod caught during bottom-trawl surveys in Subdivision 3Ps in 1972-1997. Number of fish for which there are records for age and round weight, by age and year. Sample sizes in a few cells are different from those in Table 5 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
1		7	3		1	9								8					52	22	102
2	12	13	14	7	24	12	6		7		13	11	9	70	11		15	3	76	70	373
3	9	12	21	26	13	22	12	10	10	18	20	43	89	66	99	42	40	29	143	67	791
4	27	15	7	14	20	12	19	18	13	26	22	47	117	106	52	94	98	41	120	34	902
5	17	24	20	13	8	17	8	18	26	34	22	35	85	108	108	53	166	101	43	22	928
6	10	16	21	12	5	10	24	10	29	24	22	23	56	77	92	84	57	181	120	19	892
7	11	22	18	20	14	3	9	16	16	28	30	46	47	62	73	72	82	55	184	33	841
8	5	12	25	7	27	9	5	7	7	17	23	43	59	50	40	24	47	73	37	28	545
9	6	4	9	21	14	31	8	3	5	23	11	24	38	56	22	10	12	51	33	14	395
10	5	6	4	7	10	21	20	1	6	12	13	15	26	53	25	4	11	21	12	5	277
11	3	1	7	4	7	12	7		3	7	14	16	17	34	11	8	4	12	11	2	180
12	1		7	3	3	8	10	1	8	8	15	6	12	15	7	1	6	2	2		115
13			3	5	1	5	2		3	7	8	7	8	10	1	1	3	6			70
14				3	2	8	2		3	3	7	2	7	6	1	1	3	6			54
15			2	1	3	6			1		5	5	1	7	4	2		2			39
16			1	2	2	5	3		2		6	2	4	5	1	1	1				35
17				1		1				1	1	3	1	3		1	1				13
18						3	3			1	1	3	1	2							14
19	1					1				1		2	1	1							7
20				2		1					1	1									5
21						1	1														2
22	1																				1
23						1												1			2
24												1									1
Total	108	132	162	148	154	198	139	84	139	210	234	335	578	739	547	398	546	584	833	316	6584

Table 6. Mean length-at-age (cm) of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1972-1997. Entries in boxes are based on fewer than 5 aged fish. Some entries are different from those in Table 6 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	1972	1973	1974	1975	1976	1977
1	14.0	11.6	12.2	12.7	13.2	11.0
2	23.2	22.6	21.7	23.1	22.8	20.3
3	31.5	31.7	33.4	35.3	35.4	31.7
4	41.0	39.3	43.1	44.4	48.2	43.2
5	51.9	50.1	50.8	55.4	57.4	55.6
6	58.5	56.6	55.6	61.0	64.6	63.5
7	63.0	62.1	63.6	66.5	68.1	73.9
8	74.1	66.1	71.2	74.3	71.6	75.2
9	81.8	68.4	69.3	74.2	78.5	88.0
10	90.4	81.1	79.0	75.2	81.6	83.8
11	95.0	88.2	93.3	76.2	94.8	77.6
12	88.3	87.1	95.6	107.2	110.5	87.9

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1		10.8	14.6	14.6	13.2	10.3	12.0		11.0	10.7	9.2	12.0		9.5					12.6	12.7
2	19.6	22.1	21.0	22.4	22.0	20.2	19.2	17.9	18.7	19.9	19.7	19.2	20.0	19.2	20.7		19.1	21.2	20.6	24.1
3	28.0	32.2	28.1	32.4	33.3	31.2	30.6	29.0	26.8	29.5	29.0	30.1	29.9	29.5	30.5	30.9	32.3	30.1	30.0	31.7
4	35.9	42.6	42.9	44.4	44.9	43.0	42.1	40.3	40.3	39.4	40.8	41.6	40.0	38.5	40.9	41.1	39.2	41.4	38.6	40.8
5	48.0	47.4	50.6	50.6	53.4	52.6	51.8	50.9	48.6	48.1	47.5	47.9	48.0	46.9	47.1	48.0	48.0	50.3	44.0	47.9
6	59.0	56.3	58.2	58.6	59.3	57.8	60.6	60.0	55.5	53.9	56.2	56.0	53.7	53.3	55.1	52.6	50.2	56.4	52.9	51.5
7	65.6	70.5	71.3	63.2	66.4	65.4	66.2	66.3	62.1	61.1	61.9	63.9	56.6	57.4	61.1	62.2	53.6	58.2	60.9	60.6
8	70.1	76.8	84.8	69.9	70.1	71.4	70.6	74.0	72.1	67.3	66.7	71.8	62.2	62.7	62.4	70.3	59.1	57.9	61.1	65.2
9	84.1	85.8	94.9	72.6	75.6	73.3	75.6	74.3	76.4	77.8	74.6	75.9	70.1	68.1	66.6	77.1	68.0	63.0	63.3	66.9
10	86.3	95.3	98.0	83.2	90.6	79.4	78.9	79.3	82.6	85.4	79.7	84.4	76.1	73.7	73.4	80.5	88.0	79.8	76.7	67.3
11	88.3	94.3	97.2	97.6	98.7	89.6	84.1	89.1	93.3	83.1	79.7	88.5	79.4	73.8	83.6	96.0	79.3	81.2	74.7	82.5
12	79.3	116.0	106.6	90.1	104.6	94.1	98.2	93.0	93.8	89.9	87.5	96.5	88.7	77.2	81.8	106.0	90.3	83.6	86.1	

Table 7. Mean weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-1997. Entries in boxes are based on fewer than 5 aged fish. Some entries are different from those in Table 7 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1		0.011	0.027		0.040	0.010								0.012					0.018	0.016
2	0.057	0.070	0.068	0.060	0.103	0.068	0.073		0.045		0.057	0.060	0.062	0.054	0.064		0.053	0.062	0.072	0.108
3	0.177	0.258	0.147	0.265	0.420	0.232	0.268	0.214	0.168	0.248	0.193	0.239	0.208	0.217	0.230	0.220	0.254	0.212	0.218	0.257
4	0.396	0.633	0.618	0.704	0.829	0.718	0.632	0.505	0.462	0.538	0.582	0.613	0.538	0.465	0.574	0.550	0.460	0.540	0.461	0.552
5	0.979	0.879	1.005	1.079	1.299	1.301	1.212	1.039	0.905	0.950	0.915	0.901	0.954	0.865	0.865	0.894	0.898	1.017	0.673	0.878
6	1.735	1.565	1.634	1.673	1.539	1.652	1.853	1.566	1.332	1.273	1.494	1.331	1.348	1.324	1.461	1.150	1.044	1.514	1.283	1.076
7	2.368	3.029	3.457	2.081	2.555	1.861	2.790	2.279	2.384	1.885	2.214	2.361	1.621	1.702	2.032	1.987	1.236	1.687	2.009	1.904
8	3.192	5.666	5.791	3.496	2.612	3.555	3.828	3.206	3.337	2.297	2.423	3.778	2.185	2.346	2.258	3.003	1.814	1.585	2.084	2.608
9	4.676	5.798	8.459	4.890	4.007	4.042	4.225	3.143	5.023	4.483	3.943	4.505	3.060	3.087	2.859	4.281	2.891	2.209	2.136	2.867
10	5.711	7.108	8.333	7.591	6.441	4.896	5.029	3.760	4.654	6.344	4.839	5.820	4.225	3.956	3.983	4.470	6.450	4.767	4.464	3.083
11	4.901	9.030	9.085	8.374	8.885	8.848	7.866		6.633	6.616	4.262	8.285	4.934	4.050	5.796	8.673	4.470	5.446	3.897	5.456
12	5.760		10.158	11.463	13.068	10.270	9.818	3.970	8.867	5.945	9.103	9.061	7.365	4.906	5.240	13.20	6.748	5.544	6.793	

Table 8. Mean gutted condition at age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-1997. Entries in boxes are based on fewer than 5 aged fish. Some entries are different from those in Table 9 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1																			0.754	0.727
2	0.702	0.629	0.595	0.599	0.660	0.632	0.651		0.699		0.644	0.681	0.623	0.641	0.598		0.627	0.630	0.697	0.674
3	0.745	0.678	0.620	0.718	0.731	0.742	0.734	0.706	0.698	0.736	0.713	0.725	0.680	0.706	0.711	0.657	0.675	0.687	0.706	0.717
4	0.733	0.715	0.680	0.748	0.740	0.777	0.735	0.704	0.704	0.725	0.739	0.739	0.726	0.710	0.732	0.711	0.677	0.690	0.709	0.725
5	0.753	0.702	0.703	0.724	0.722	0.766	0.703	0.680	0.733	0.735	0.731	0.734	0.744	0.720	0.716	0.700	0.705	0.702	0.695	0.702
6	0.730	0.712	0.709	0.745	0.676	0.794	0.711	0.714	0.709	0.717	0.731	0.741	0.743	0.746	0.733	0.663	0.680	0.708	0.713	0.683
7	0.744	0.699	0.724	0.729	0.699	0.737	0.728	0.739	0.721	0.735	0.736	0.748	0.735	0.741	0.735	0.677	0.660	0.703	0.715	0.693
8	0.716	0.775	0.734	0.763	0.690	0.725	0.726	0.714	0.717	0.720	0.736	0.780	0.726	0.738	0.727	0.698	0.676	0.665	0.722	0.714
9	0.737	0.749	0.765	0.748	0.731	0.744	0.730	0.733	0.676	0.768	0.777	0.793	0.735	0.753	0.738	0.758	0.687	0.701	0.671	0.713
10	0.793	0.803	0.715	0.810	0.751	0.793	0.741	0.740	0.719	0.770	0.789	0.834	0.764	0.777	0.732	0.684	0.732	0.725	0.758	0.751
11	0.681	0.648	0.784	0.790	0.758	0.819	0.808		0.798	0.779	0.783	0.827	0.794	0.765	0.766	0.786	0.691	0.750	0.725	0.785
12	0.725		0.759	0.843	0.833	0.865	0.834	0.681	0.789	0.774	0.813	0.852	0.793	0.794	0.744	0.852	0.717	0.753	0.760	

Table 9. Mean liver index at age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-1997. Entries in boxes are based on fewer than 5 aged fish. Some entries are different from those in Table 10 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1																				
2	0.0175	0.0142	0.0150	0.0118	0.0229	0.0247	0.0120	0.0236	0.0230	0.0304	0.0250	0.0279	0.0292	0.0250	0.0301		0.0304	0.0139	0.0252	0.0244
3	0.0223	0.0160	0.0114	0.0146	0.0244	0.0280	0.0167	0.0168	0.0233	0.0233	0.0227	0.0216	0.0213	0.0213	0.0200	0.0106	0.0144	0.0111	0.0160	0.0208
4	0.0203	0.0181	0.0143	0.0188	0.0228	0.0323	0.0179	0.0175	0.0196	0.0225	0.0275	0.0266	0.0293	0.0280	0.0242	0.0154	0.0138	0.0131	0.0161	0.0199
5	0.0227	0.0194	0.0189	0.0169	0.0230	0.0275	0.0142	0.0176	0.0214	0.0240	0.0281	0.0269	0.0335	0.0287	0.0315	0.0180	0.0197	0.0209	0.0168	0.0201
6	0.0253	0.0218	0.0204	0.0194	0.0163	0.0348	0.0144	0.0217	0.0230	0.0241	0.0280	0.0300	0.0357	0.0309	0.0309	0.0187	0.0221	0.0201	0.0201	0.0183
7	0.0256	0.0293	0.0262	0.0213	0.0207	0.0277	0.0195	0.0217	0.0237	0.0273	0.0279	0.0303	0.0376	0.0362	0.0263	0.0184	0.0170	0.0211	0.0219	0.0230
8	0.0323	0.0359	0.0370	0.0322	0.0203	0.0303	0.0191	0.0233	0.0268	0.0291	0.0312	0.0341	0.0334	0.0337	0.0368	0.0206	0.0211	0.0179	0.0231	0.0240
9	0.0284	0.0319	0.0381	0.0418	0.0225	0.0326	0.0188	0.0268	0.0303	0.0362	0.0357	0.0412	0.0349	0.0386	0.0400	0.0280	0.0208	0.0189	0.0194	0.0273
10	0.0326	0.0362	0.0328	0.0470	0.0258	0.0327	0.0328	0.0301	0.0383	0.0462	0.0439	0.0432	0.0411	0.0410	0.0379	0.0182	0.0423	0.0265	0.0303	0.0379
11	0.0256	0.0276	0.0381	0.0277	0.0356	0.0445	0.0330	0.0405	0.0435	0.0404	0.0495	0.0519	0.0471	0.0419	0.0473	0.0346	0.0232	0.0343	0.0314	0.0396
12	0.0379		0.0385	0.0415	0.0539	0.0462	0.0451	0.0435	0.0463	0.0482	0.0545	0.0689	0.0477	0.0373	0.0376	0.0379	0.0326	0.0247	0.0202	

Table 10. Mean annual weights-at-age (kg) calculated from lengths-at-age based on samples from commercial fisheries (including food fisheries and sentinel surveys) in Subdivision 3Ps in 1959-1997. The weights-at-age from 1976 are extrapolated back to 1959. The 1997 data are extrapolated to 1998.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1960	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1961	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1962	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1963	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1964	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1965	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1966	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1967	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1968	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1969	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1970	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1971	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1972	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1973	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1974	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1975	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1976	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1977	0.55	0.68	1.30	1.86	2.67	3.42	4.19	4.94	5.92	6.76	8.78	10.90
1978	0.45	0.70	1.08	1.75	2.45	2.99	4.10	5.16	5.17	7.20	7.75	8.72
1979	0.41	0.65	1.01	1.65	2.55	3.68	4.30	6.49	7.00	8.20	9.53	10.84
1980	0.52	0.72	1.13	1.66	2.48	3.60	5.40	6.95	7.29	8.64	9.33	9.58
1981	0.48	0.79	1.32	1.80	2.30	3.27	4.36	5.68	7.41	9.04	8.39	9.56
1982	0.45	0.77	1.17	1.78	2.36	2.88	3.91	5.28	6.18	8.62	8.64	11.41
1983	0.58	0.84	1.33	1.99	2.58	3.26	3.77	5.04	6.56	8.45	10.06	11.82
1984	0.66	1.04	1.40	1.97	2.64	3.77	4.75	5.56	6.01	9.04	11.20	10.40
1985	0.63	0.85	1.23	1.79	2.81	3.44	5.02	6.01	6.11	7.18	9.81	10.48
1986	0.54	0.75	1.18	1.84	2.43	3.15	4.30	5.50	6.19	8.72	8.05	11.91
1987	0.56	0.77	1.21	1.63	2.31	3.02	4.33	5.11	6.20	6.98	7.08	8.34
1988	0.63	0.82	1.09	1.67	2.17	2.92	3.58	4.98	5.61	6.60	7.46	8.92
1989	0.63	0.81	1.16	1.63	2.25	3.37	4.11	5.18	6.29	7.30	7.75	8.73
1990	0.58	0.86	1.27	1.85	2.45	3.00	4.22	5.09	6.35	7.60	8.31	10.37
1991	0.60	0.75	1.17	1.74	2.37	2.91	3.69	4.23	6.34	7.68	8.64	9.72
1992	0.46	0.69	1.04	1.56	2.23	2.89	4.14	5.54	6.42	7.82	10.40	11.88
1993	0.36	0.68	1.08	1.48	2.13	2.82	4.34	4.30	4.68	7.49	6.85	8.24
1994	0.62	0.82	1.30	1.86	2.05	2.75	3.59	4.38	6.29	7.77	6.78	8.07
1995	0.52	0.85	1.57	2.03	2.47	2.78	3.46	4.30	4.27	4.16	5.59	9.24
1996	0.67	0.98	1.48	2.05	2.53	2.94	3.23	4.03	4.82	4.68	7.26	9.92
1997	0.62	0.90	1.30	1.87	2.51	3.24	3.47	3.52	4.59	6.37	8.58	10.73
1998	0.62	0.90	1.30	1.87	2.51	3.24	3.47	3.52	4.59	6.37	8.58	10.73

Table 11. Beginning of the year weights-at-age calculated from commercial mean annual weights-at-age. The 1998 estimates are extrapolated to 1999.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1960	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1961	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1962	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1963	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1964	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1965	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1966	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1967	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1968	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1969	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1970	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1971	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1972	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1973	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1974	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1975	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1976	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.88
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.51	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.51	0.74	1.08	1.56	2.17	2.85	3.35	3.50	4.02	5.40	7.39	9.60
1999	0.51	0.74	1.08	1.56	2.17	2.85	3.35	3.50	4.02	5.40	7.39	9.60

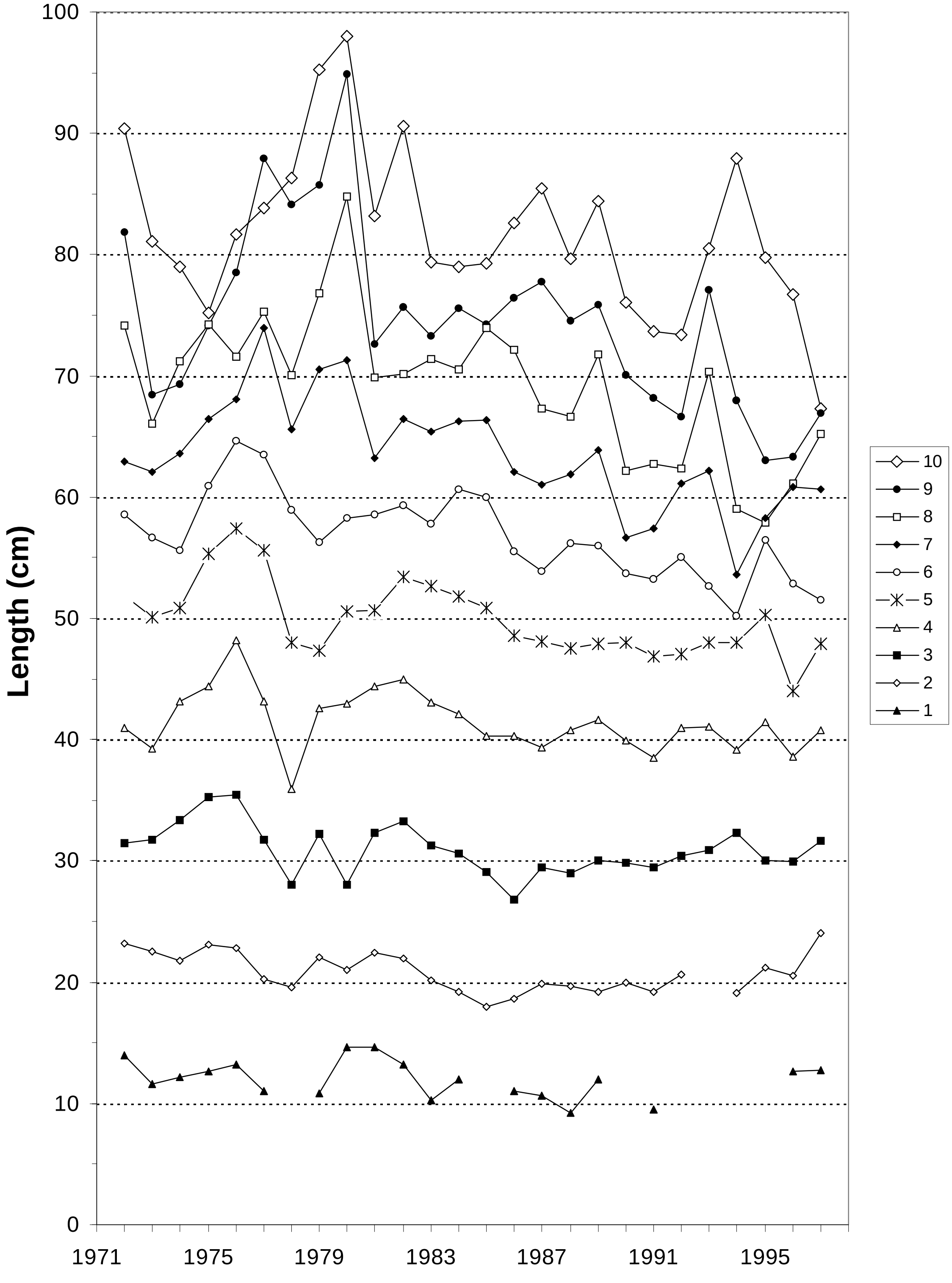

Fig. 1. Mean lengths at ages 1-10 of cod in Subdivision 3Ps in 1972-1997, as determined from sampling during DFO bottom-trawl surveys in winter-spring.

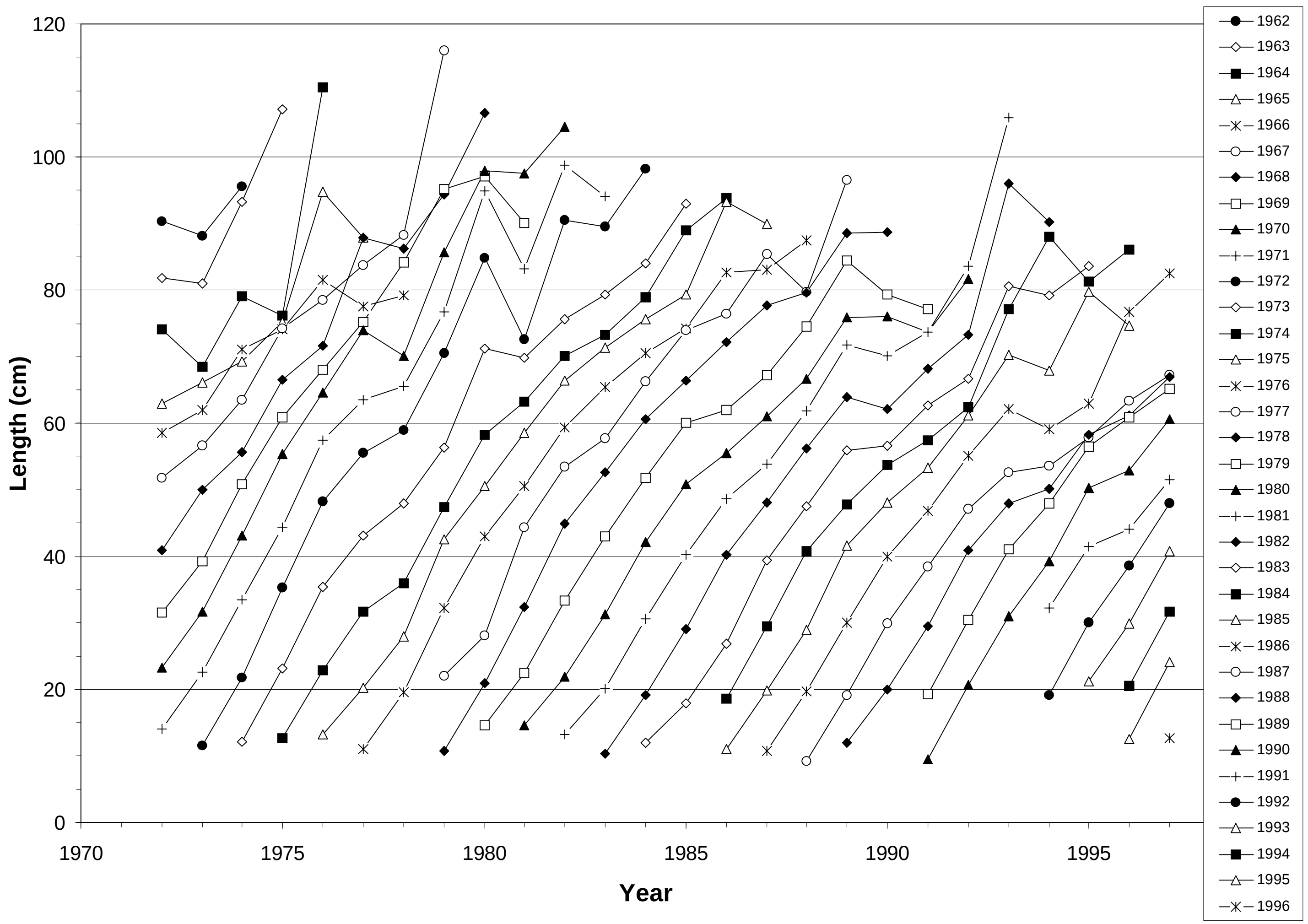

Fig. 2. Mean length (cm) at ages 1-12 of the 1962-1996 cohorts of Subdivision 3Ps cod, as determined from sampling during DFO bottom-trawl surveys in winter-spring.

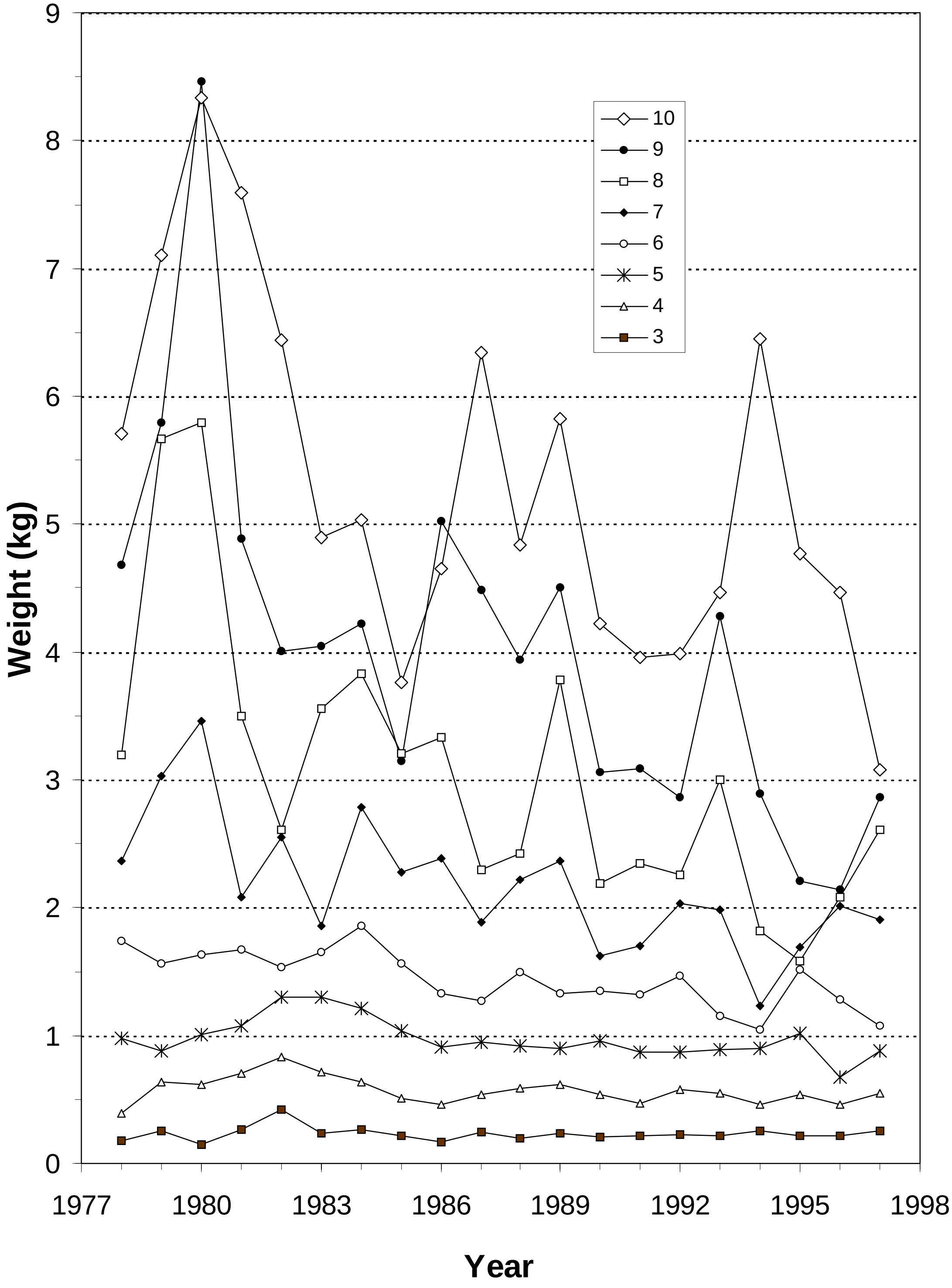

Fig. 3. Mean round weight (kg) at ages 3-10 of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-1997.

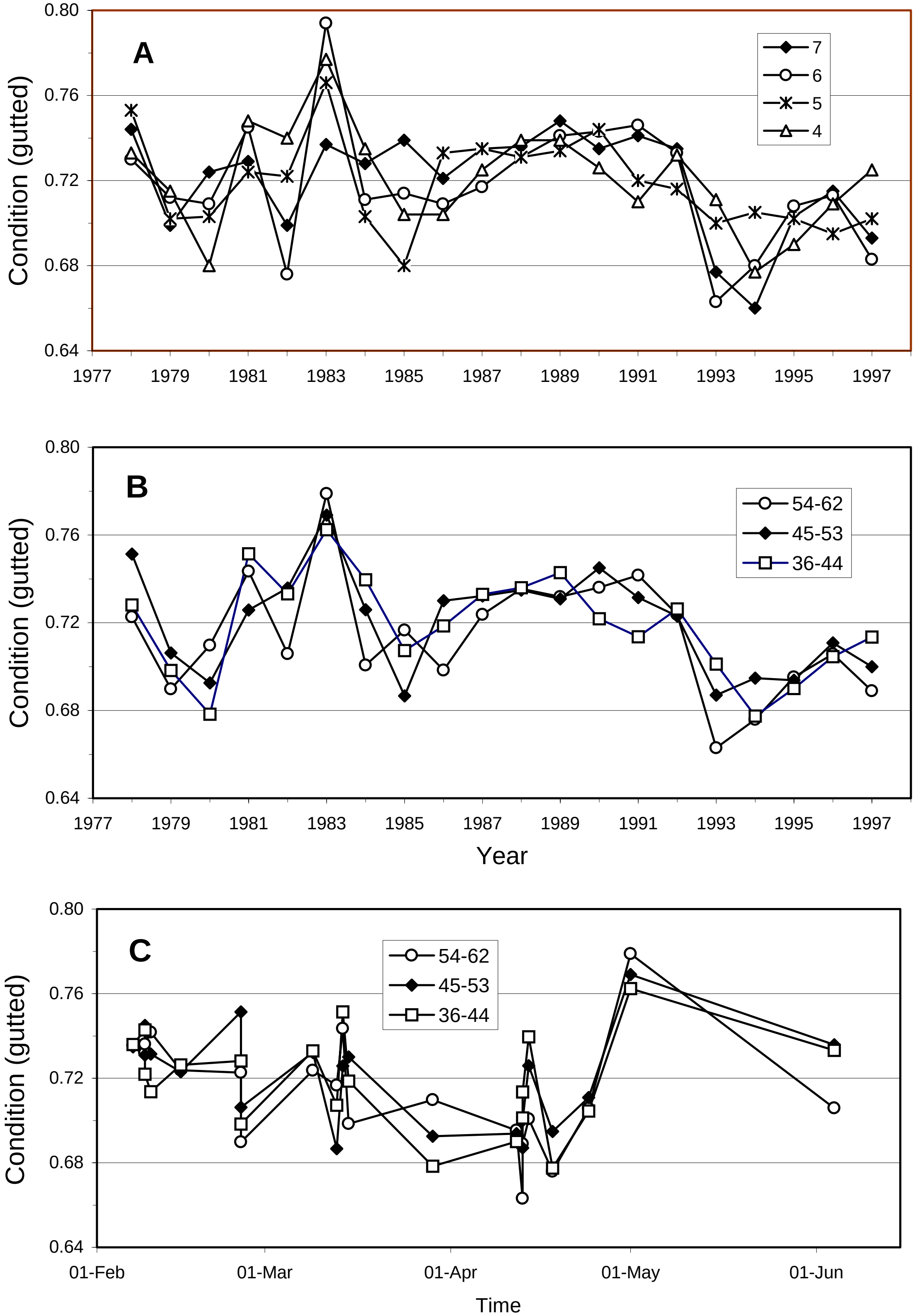

Fig. 4. Mean gutted condition of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in 1978-1997; (A) by age and year, (B) by length-group and year, and (C) by length-group and median date of collection.

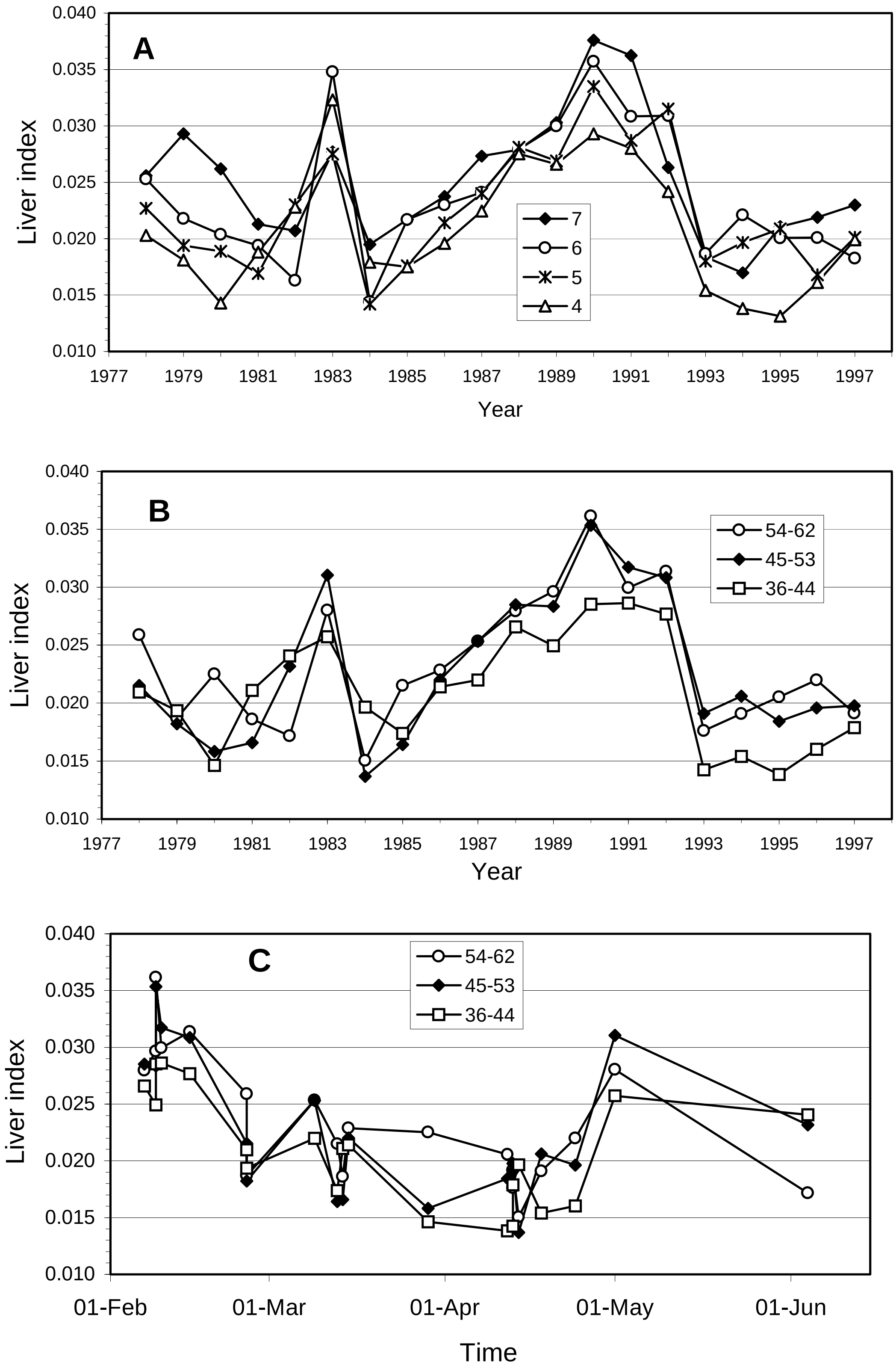

Fig. 5. Mean liver index of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in 1978-1997; (A) by age and year, (B) by length-group and year, and (C) by length-group and median date of collection.

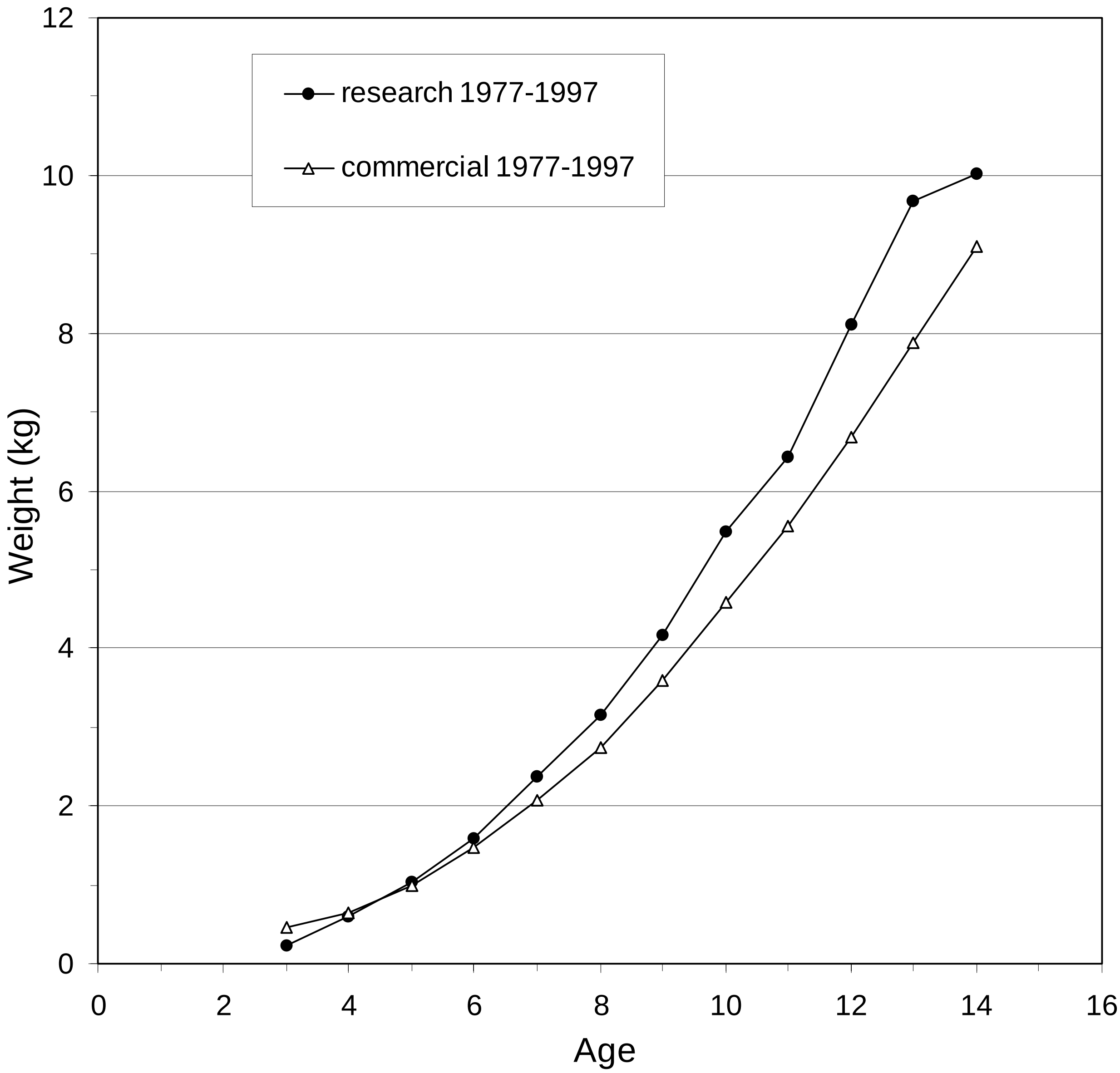

Fig. 6. January 1 weights-at-age calculated from research and commercial sampling. (See text for details.) The values illustrated are the means of annual means for the years 1977-1997.

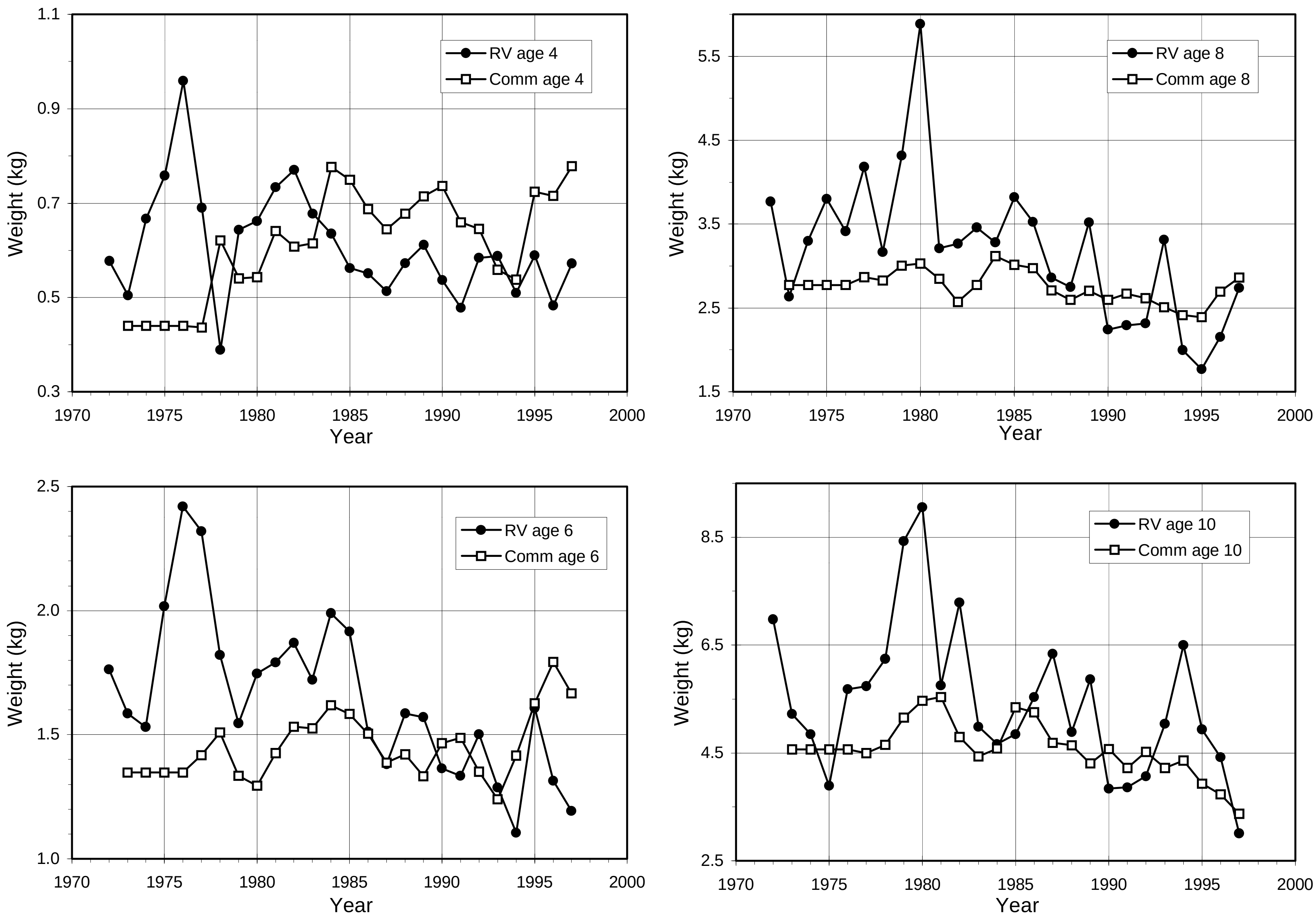

Fig. 7. Mean January 1 weights at ages 4, 6, 8 and 10 calculated from research and commercial sampling in the years 1972-1997.