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Haddock in Division 4TVW in 1994

by

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Abstract

From reported historical annual landings of as high as 55,000t (1965) and up to 20,000t from 1979 to 1987, this fishery was essentially closed in 1994 with reported total landings of just over 100t. Most of these landings were from Divisions 4VW by otter trawl and longline. The current size composition of this stock shows a relatively narrow range of length-classes and a concentration at a single mode probably representing the 1988 year-class.

Our analyses give estimates of exploitation whose patterns over time are consistent with recent events in the fishery. Exploitation of this resource increased steadily from 1979 to 1986 to approximately four times the target level. In 1986, landings of approximately 17,000 t were reported resulting in a significant increase in exploitation over the previous year. In 1987, with the imposition of the Emerald / Western closed area, exploitation declined due to exclusion of the mobile gear fishery from these grounds. From 1987 through 1992, the expansion of fixed gear effort in the closed area, coupled with the significant by-catch fisheries operating outside the closed area, again resulted in an increase in exploiation. The removal of all fishing activity from the closed area in 1993 and a virtual closure of the fishery in 1994 exploitaion has fallen to the lowest observed since 1970.

Under the assumption that the maturity schedules have not shifted, the present spawning stock biomass may be as low as 12,000t. There are indications that the 1993 and 1992 year-classes may be of above average abundance. These year-classes must be protected to promote stock rebuilding. The reduced exploitation which has been achieved over the past two years, if maintained in the near future, may initiate this rebuilding process. At present both the fishery and the reproductive potential of the resource appear to depend to a great extent on the 1988 year-class.

Résumé

Cette pêche dont les débarquements déclarés ont déjà atteint 55 000 t (1965) et qui ont été de l'ordre de 20 000 t de 1979 à 1987 a pratiquement été fermée en 1994 lorsque la valeur totale des débarquements a tout juste été supérieure à 100 t. La plupart des captures étaient faites dans les divisions 4VW par pêche au chalut ou à la palangre. La composition par tailles de la population présente une gamme relativement étroite de classes de longueurs et un même mode y prédomine, sans doute celui de la classe d'âge de 1988.

Nous avons estimé des taux d'exploitation dont l'allure chronologique correspond à la situation récente de cette pêche. L'exploitation s'est accrue de façon constante de 1979 à 1986 pour correspondre à quatre fois environ le niveau cible. Il a été signalé que les débarquements de 1986, de 17 000 t environ, avaient donné lieu à une augmentation appréciable du taux d'exploitation par rapport à l'année précédente. En 1987, les fermetures aux pêcheries dans les zones fermées des bancs Emerald et Western se sont traduites par une baisse de l'exploitation suite à l'exclusion des engins mobiles de ces fonds. De 1987 à 1992, l'accroissement de l'effort de pêche aux engins fixes dans la zone fermée et les importantes prises accessoires de la pêche pratiquée à l'extérieur de la zone fermée a donné lieu à une hausse de l'exploitation. L'interdiction de toute pêche dans la zone fermée en 1993 et la fermeture virtuelle de la pêche en 1994 ont fait chuter le taux d'exploitation à la valeur la plus faible notée depuis 1970.

Si l'on suppose le maintien du régime de maturation, la biomasse actuelle du stock de géniteurs pourrait être aussi faible que 12 000 t. Les classes d'âge de 1993 et 1992 pourraient, selon certains indices, être supérieures à la normale et ces classes doivent être protégées afin de favoriser le rétablissement du stock. Le maintien au cours des prochaines années du taux d'exploitation réduit des deux dernières années pourrait amorcer le rétablissement. Actuellement, tant la pêche que le potentiel reproductif de la ressource reposent en grande partie sur la classe d'âge de 1988.

Description of the Fishery to 1994

Landings averaged 26,500t per year from 1950 to 1969, 5,000t from 1970 to 1979: since then landings have ranged between 8,000 and 20,000t until 1987. The nominal catches for 1987 through 1994, have been taken almost exclusively as by-catch in other groundfish fisheries operating in divisions 4T, 4V and 4W, and totalled just over 100t in 1994 (Table 1). The 1989 nominal catch has been left as provisional due to a large discrepancy between the haddock by-catches reported to NAFO by the former USSR and those reported by the International Observer Program (Zwanenburg et al 1994).

The year-round nursery ground closure (mainly Emerald and Western banks) imposed in 1987 still remains in effect. Throughout the 1987 to 1992 period fixed gear vessels were allowed to fish inside the closed area. In 1993 the closed area was closed to all fishing. Since 1987 the fishery has been regulated through a combination of by-catch restrictions and trip limits. In 1994, the fishery was severely restricted and limited to 10% by-catches in hake, cusk , and pollock fisheries, and to 200 lb trip limits in the restricted fixed gear 4Vn cod fishery (Table 2).

Until 1984, most of the catch from this stock was taken from Division 4W by large otter tralwers (OTBs, TC4 and TC5) in the spring. In 1984, Division 4W was closed to trawlers from May to December to prevent the capture of the abundant early 1980s year-classes. This caused a shift in the fishery to 4Vs. From 1984 to 1986, favourable catch rates resulted in an increase in 4Vs landings to the point where they represented 40-60% of total landings. Following the exclusion of mobile gear from much of Division 4W (as a result of the imposition of the closed area in 1987) landings in 4Vs ranged from 1,500 to 2,500t annually, however landings in this area have declined to just 35t in 1994. Since 1987, landings in 4W increased five-fold (from 991 to 5,261t) due mainly to the development of the fixed gear fishery inside the closed area. In 1993, following the exclusion of all gears from the closed area, landings in 4W fell to just over 800t and then to only 48t in 1994. Landings in Division 4T and Subdivision 4Vn have been negligible since 1989 (Tables 1 and 3).

Given the severely resticted nature of the fishery in 1994 it is dificult to compare this distribution of landings by gear type with previous years. From 1987 to 1992 the proportion of landings taken by trawlers has decreased from 60 to 37%. In 1994 trawler landings represent just under 50% of the total. Longline landings have ranged from 21 to 63% over the period 1987 to 1992 and in 1994 they accounted for about 45% of total landings. Seiner landings represented approximately 4% of the total landings in 1994 (Table 4). The most significant change in the distribution of landings from 1993 to 1994 is the sharp decline in overall landings mainly due to the severe restrictions on fishing activities during the last year. Most of the fishery occurred in the, second, and third quarters of 1994 (Table 5).

Consultation with inshore fishermen in 4W indicated that the inshore haddock landings have declined significantly in recent years. Although a steady decline in landings has been noted over the past 15 to 25 years, declines in the past 3-7 years have been relatively precipitous. In addition to this decline in landings, many independent sources report a change in the 'migratory pattern' of the inshore haddock. In past years the haddock would 'come ashore' in waters westward of Country Harbour, Nova Socita. These fish would then 'migrate' westward throughout the remainder of the summer and fall until the fishermen in the area stopped fishing when the fishery reached Halifax Harbour and approaches. More recently it is reported that the haddock are coming onshore further westward each year, and that the numbers caught has declined substantially. All respondents indicated that these 'inshore haddock' are different from offshore haddock by virtue of colour, shape, taste, and general size composition (larger). We presently have no information by which to judge these observations, but it illustrates our general lack of understanding of inshore resources in general. Plans for cooperative work with the inshore industry to determine the relationship between inshore and offshore haddock are being developed.

The foregoing discussion was not based on recorded information but rather comes from the memories of the fishermen participants.

Sources of Uncertainty

The preceding estimates of landings do not incorporate estimates of misreporting by area, or non-reporting of catches as a result of dumping or discarding. Unquantified, anecdotal information suggests that such practises have been significant sources of error at a number of times in the past. Some of these reports indicate that the amount of dumping and discarding has represented a significant portion of the total reported landings. The effects of these potential errors on catch estimates for the assessment of the status of this resource cannot presently be evaluated.

Composition of the Catch

The age composition of the 1994 landings is not available. Serious concerns have been raised about the accuracy of the ages determined for haddock. A significant bias in the ageing of haddock appears to have been introduced in the early 1980s resulting in over-ageing of young fish in the early 1980s and a subsequent under-ageing of older fish in the late 1980s and early 1990s. The full extent of the bias has not yet been determined. Resolution of this problem will require age validation studies and the establishment and implementation of verified and consistent ageing criteria. It may also require the re-examination of historical otoliths to determine the extent of bias in previous estimates of catch at age. A comparative study of haddock ageing has been initiated. Haddock otoliths aged using a new set of ageing criteria were aged at the Marine Fish Division (MFD) by a number of trained agers and subsequently sent to a number of internationally recognized ageing facilities for re-ageing. The comparison of ages determined by MFD ages and the ages determined by the group of international experts will determine the robustness of the MFD ageing criteria. The landings at age for 1948-1991 as determined by previous ageing criteria are given in Table 6.

The sampling information available for the 1994 landings is given in Table 7. Landings at length for the haddock by-catch from the foreign small mesh gear fishery were estimated from International Observer Program (IOP) data. For landings prior to 1977 no IOP estimates of length-frequencies were available. In the absence of these data it was assumed that the length frequencies of these landings were similar to those observed in the July research surveys conducted in 4W in the same years (Zwanenburg et al 1994).

Estimates of landings at length for 1970-1994 are given in Table 8. Landings at length by the domestic fisheries were estimated using commercial groundfish samples stratified as for the estimation of landings at age outlined in previous documents (see Zwanenburg 1989). The length composition of domestic landings from 1970 to 1978 were estimated as outlined in Mahon et al. (1984). All keys were re-constructed with the length-weight parameters as outlined in Mahon et al. (1984).

The landings at length for 1994 shows modes at 24.5, 30.5, 46.5 and 50.5 cm (Figure 1). The modes at 24.5 and 30.5 cm were the result of catches by the siver hake fishery and likely represent fish from the 1992 and 1993 year-classes (see below). Landings in all length classes were well below the long-term average (1970-1993).

Estimates of lengths at age for haddock from the 1970-1991 July RV surveys (Table 9) were used to determine a likely range of sizes at age as a template for a method of converting landings at length to landings at 'age'. We recognize the limitations of this procedure given the acknowledged problems associated with ageing 4TVW haddock.

Sources of Uncertainty

These estimates of length composition of domestic landings do not take into account any at-sea modification to the size composition. There have been reports of discarding and high-grading that cannot be quantified with presently available information. Dumping would tend to result in underestimation of total landings while selective discarding is likely to result in underestimation of removals at the smaller length classes. The overall effects of these potential sources of error cannot at present be quantified.

The estimation of lenghts at age and therefore the conversion of the landings at length to landings at age depend on the accuracy of the lengths at age used and the distribution of the sizes at any given age. The present estimates are taken from ageing data whose reliability is still being investigated

Commercial Catch Rates

The restrictive nature of this fishery since 1987 does not allow for a comparison of present catch rates to those of earlier years from directed fisheries. We do not consider that by-catch catch rates to be representative of the abundance of this stock.

Research Vessel Survey Results

The July research vessel (RV) catch rates at age for 1970 to 1991, as estimated by previous ageing criteria (see above) are presented in Table 10. Catch rates at length for the full July RV survey times series (1970 - 1994) are given in Table 11.

Summer Surveys

Survey catch rates for 1970-1994 (Figure 2) indicated that overall catch rates declined from 1983-1987 and has fluctuated since, while catch rates in the recruited size groups (36 cm and larger) have declined since 1984. Catch rates of the size-classes representing new pre-recruits show peaks in the early 1980's and again from 1988 to 1991 with the incomng 1988 year-class. This resource is centred in Division 4W with catch rates in subdivisions 4Vn and 4Vs presently negligible. Inputs to the population via recruitment are more or less restricted to Division 4W (Figure 3) which essentially defines the overall dynamics of this resource. Recruitment in Sub-Division 4Vs (Figure 4) has been confined to a single large pulse in 1982 and a lesser peak in 1990. These are likely the result of spill-overs from the recruitment pulses originating in Division 4W. Recruits at lengths up to 36 cm have rarely been seen in Sub-Division 4Vn (Figure 5), the peaks in abundance observed here are likely the result of movement of older fish from both 4Vs and 4W from the recruitment pulse in the early 1980's.

The long-term average length composition (1990-1993) of Subdivision 4Vn shows modes at 20.5, 32.5, and 50.5 cm (Figure 6). Subdivision 4Vn also has the largest mean modal length of the three areas comprising the stock area. It is likely that the 20.5 cm mode represents age 1 fish although we cannot rule out a significantly different growth rate for the haddock in 4Vn relative to other parts of the stock area. If growth rates are similar throughout the stock areas, the interpretation of these fish being age 1 would be consistent with the age structured analysis presented in previous assessments. This indicated that the 4Vn population is composed mainly of fish aged 4+ and that age 0 fish have never been observed in the survey of this area. There are anecdotal reports of haddock spawning in inshore areas of 4Vn in years past, however, we have no observations with which to judge these reports. There is no evidence of the large 1988 year-class in 4Vn. The overall catch rates at length in 4Vn in 1994 remain well below the long-term mean.

The long-term mean (1970 - 1993) catch at length in 4Vs shows modes at 16.5, 28.5 and 42.5 cm (Figure 7). These modes are smaller in all cases than those observed in 4Vn. The modes at 16.5 and 28.5 cm probably represent fish aged 1 and 2, respectively. Overall catch rates at age were well below the long-term average in 1994, however, there is some evidence of above average abundance at modal lengths of 10.5 cm and 24.5 cm. An above averge catch rate at 10.5 cm was also noted in the 1993 survey of this area. The above average mode at 24.5cm differs significantly from the historical average and probably represent the fish observed at 10.5cm in 1993, likely the 1993 year-class

Division 4W has traditionally been the centre of distribution of this resource as evidenced by the significantly higher catch rates observed there. Analysis of the long-term catch at length for 4W shows clear modes at 8.5, 20.5, and 32.5 cm (Figure 8). It is likely that the modal length of 40 cm in 1994 represents the modal length of the survivors of the 1988 year-class at age 6. The 1994 catch rate at length also shows slightly above average modes at 24.5 cm and at 30.5 cm. These would likely represent the 1993 and 1992 year-classes. Again we note a shift in the modal length of these cohorts. At 24.5 cm, the 1993 cohort would be growing significantly faster than the average while at 30.5, the 1992 cohort would be growing rather slower than average.

The overall distribution of catch rates at length are given on Figure 9. The large peak at 40.5 cm in 1994 represents mainly the 1988 year-class at age 6. This was confirmed by ageing a number of fish at lenths of 37-39 cm form the July 1993 survey, since the mode of the population was at 38.5cm in 1993. The results of 3 independent agers agreed that the majority of these fish were 5 years old. These results suggest that these fish belong to the abundant 1988 year-class. It should be noted that these ages were determined using a different ageing technique than that employed in the ageing of the historical survey data. Although this technique is felt to be more reliable because it is consistent with that used in other laboratories that age haddock, the accuracy of the mrthods remains to be verified.

		Age					
		3	**4**	**5**	**6**	**7**	**8**
Length (cm)	**37**		1	6			
	38		1	8	1		
	39			4	3		1
	40	1					

Figure 10 shows the modal length of the 1988 year-class relative to the long-term mean length composition in the survey series. The modal length of this year-class is determined both by growth and exploitation. Comparison of the modal length of this cohort with the mean lenghts at age (as determined by historical ageing conventions) shown on Figure 11 and Table 9 shows that it is well below the 48-58cm range of fish at age 6. As was noted in previous assessments this could be the result of either reduced growth rate, high exploitation of fish reaching fishable sizes (36 cm +) or a combination of the two acting in concert. Final resolution of this question awaits the completion of reliable ageing criteria.

Distribution of Haddock from Summer Surveys

Figure 12a shows the long-term distribution of haddock and bottom temperature over the entire Scotian Shelf as estimated for July survey data. It shows that haddock are more abundant in the warmer shallower areas of the shelf than in either deeper or colder waters. Also presetned in Figure 12a are catch per tow values relative to bottom temperature, depth, and time of day. These indicate that the relationship between haddock catch and bottom temperature is positive, negative with depth, and that there may be some tendency for higher catches during daylight hours. The equivalent information for the July 1994 survey indicates that haddock continue to occupy essentially the same areas with the exception that there were very few haddock on Banquereau Bank.

Spring Surveys

Spring surveys have been conducted on the Eastern Scotian Shelf during March of each year since 1979 (except for 1985) (Table 12). Catch rates in 4VW peaked in 1981 and declined until 1992, since 1992 total numbers per tow have fluctuated (Figure 13a). New pre-recruits entered this area in 1981-82, and again in 1989. There is evidence of some increase in new recruits since 1992. Survey catch rates in Subdivision 4V declined abruptly from the mid 80's and have been relatively low since (figure 13b). In Division 4W survey catch rates peaked in 1981 and declined to 1992, the pattern observed since then is nearly identical to that of 4VW as a whole (Figure 13c)The maximum in both the 4W and 4V catch rates is likely due to the presence of the large early 1980s year-classes. The abrupt decline in 4V in the post-1987 period is probably, in part, related to the cooling trend in the bottom water shown to have occurred from 1984 through 1992, with the lowest temperatures being measured in 1989-1992 (Smith and Page 1994).

The long-term spring survey catch rate at length in Division 4VW, and in Division 4W show modes at 14.5 and 26.5 cm (Figure 14a,b) It is probable that the mode at 14.5 cm represents age 1 fish since the July survey catches age 0 fish at 8.5 cm in the previous year. The fish caught at 26.5 cm probably represent early age 2 fish which are caught later in the year by the July survey at a modal length of 32.5 cm. The 1995 results shows the 1988 year-class at a modal length of 40.5 cm, these fish had a modal length of 40.5 cm in the July survey indicating either no appreciable growth over the year or high mortality for those fish growing fast enough to reach fishable sizes. The 1995 survey show a slightly above average catch at 16.5 cm., however above average catch rates at these small size classes since 1993 have not translated into above average catch rates at larger size classes in the following year.

The long-term mean catch at length for 4Vs shows prominent modes at 14.5 and 32.5 cm (Figure 15). The 1995 results show catches at all lengths well below the mean.

These results do not support the above average abundance of what are assumed to be the 1992 and 1993 year-classes observed at 30.5 and 24.5 cm respectively in the July 1994 survey.

Estimation of Stock Parameters

Fishing Mortality and Stock Abundance

The uncertainties in the landings information and especially in estimating the age structure of this stock, make it problematic to apply the standard population assessment models which assume exact knowledge of both these inputs. However we wished to explore the results of such models knowing the shortcomings in our input data with the aim of evaluating their impact on the model's ability to detect changes in the exploitation pattern of the stock consistent with large-scale well documented events in the fishery.

The results of both the summer and spring surveys indicate that haddock are at low abundance relative to the long-term mean and in particular, larger (presumably older fish) are relatively rare at present. The bulk of the stock is concentrated in Division 4W.

An examination of the commercial catch at length for 1994 shows that significant numbers of fish were caught at sizes less than 42 cm; however with the virtual closure of the fishery in 1994, these landings were well below the long-term average (Figure 1). A comparison of the length composition of removals to the overall length composition of the population estimated from the July 1994 survey (Figure 16) shows that the fishery is exploiting the incoming year-classes at modal lenghts of 24 and 30 cm (almost exclusively in the foreign small-mesh otter trawl fishery) and that the domestic fishery is exploiting the least abundant size-classes in the population (particularly those above 44 cm).

Landings at length (Table 8) were converted to estimates of catch at age using a method developed by Mohn (1991) using the mean lengths at age from all those haddock caught by the July RV surveys from 1970 - 1991 (Table 9). The method assigns fish in length classes to age classes whose mean lengths are provided. All fish at the mean length and all fish in length bins halfway to the next lower and higher limit are included in the age. The mean lengths at age for 1990 and 1991 at age 0 were considered unreliable and were not used in the analyses. The lengths at age for 1992 at all ages was also considered unreliable. The lengths at age for 1992 were replaced by the average lengths at age determined for 1989 through 1991. Lengths at age for 1993 and 1994 were also set to this mean value. Since lengths at age vary significantly between years (Figure 11) and there is some question as to the validity of the ageing criteria we chose to reduce inter-annual variability in size at age by using a three year running mean of length at each age With the wide range of lengths observed at age 7 (58-68 cm)we also implemented a rule which limited the upper bounds of the age 7 size bin to include only those at lengths no greater than a length half-way between the age 7 and the age 8 bins. This rule was implemented to prevent 'overloading' the age 7 bin.

The catch and survey estimates at age resulting from the slicing procedure described by Mohn (1991) was used as input to Qmodel (a modified version of adapt which estimates q's algebraically rather than iteratively)

Parameters

Terminal F estimates F_i, 1994, i = 4-6
Calibration coefficients $K_{1,i}$ = i = 2-6 for July RV survey

Structure Imposed

Error in catch unquantified

Partial selection fixed for ages 1, 2, 3 and 7 in 1993
F for oldest age (7) set as average of "ages" 4-6
No intercept was fitted
M = 0.2 for all ages

Input
$C_{i,t}$ (i = 1,...,7; t = 1977,...,1994) = full catch at age
$J_{i,t}$ (i = 4...,6; t = 1977 to 1994) = July RV index

Objective Function

Minimize $\Sigma \ (\ln J_{i,t} - K_i N_i)^2$ overall i, t

Summary

Number of observations = 75 for July RV (3 ages by 25 years)
Number of parameters = 5 q's and 3 K's

Results

The estimates of landings at age and survey catch at age derived from the length slicing methods are given in Tables 13, note that in both the commercial catch at age and the RV catch at age, the totals are conserved. The final estimates of catch at age and RV numbers at age are given in Table 14. The 'sliced' values are used as the intial input to the analytical model while the final values are those determined to provide the best best fit using the population age structure resulting from cohort analysis to adjust iteratively the sliced age structure.

The analysis was initiated by adjusting the selection vector (partial recruitment) for the last year (1994) until the best 'by-eye' fit between F at ages 3, 4, 5, 6 and population numbers at ages 2+ estimated from the present analysis, and converged estimates of these same parameters from the most recent age based assessment of this resource, were obtained. This selection vector was used to intiate Qmodel

Age 1	**2**	**3**	**4**	**5**	**6**	**7**
0.000179	0.010971	0.0454075	0.111242	0.271362	0.670547	1

The metrics used to determine the intial 'best fit' are given in Figure 17. In determining the initial best fit we tried to minimize the difference between the historical estimates of F and population size. The results shown on Figure were used as our initial best fit to intiate Qmodel.

The final results of Qmodel are shown on Figures 17 and 18 and represent a significant improvement in overall fit of the model to the results obtained in the previous assessment of this resource (Zwanenburg et al 1994).

The overal fit of the model (VPA) population to the observed (q adjusted) RV numbers for ages 2-6 over the period 1970-1994 is shown in Figure 19. The residuals from these analyses are shown in Table 15 and Figure 20. These indicate that the VPA is overestimating the population abundance at ages 2-6 relative to the survey from 1970 - 1981, and underestimating the population in the period 1987 -1993.

Estimates of F and population numbers resulting from this analysis are presented on Table 16. These analyses produce esitmates of exploitation whose patterns are consistent with recent events in the fishery. Just prior to the imposition of the closed area in 1986, landings of approximately 17,000 t were reported from this resource resulting in a significant increase in exploitation. In 1987, with the imposition of the closed area, F declined at all ages but most significantly at young ages since these were now protected (at least from mobile gear fisheries). From 1987 through 1992, the expansion of fixed gear effort in the closed area, coupled with the significant by-catch fisheries operating outside the closed area again resulted in an increase in F. The removal of all fishing activity from the closed area in 1993 and a virtual closure of the fishery in 1994 has resulted in exploitation falling to the lowest observed.

The relative selection at age resulting from these analyses show some distinct patterns over time (Figure 21) especially at younger ages. Selection for ages 1- 3 declined from high values prior to 1977 to lower values through the late 70's and mid 80's. The peak in selection in 1989 is the result of the large catch of small fish in the foreign small-meshed otter trawl fishery. The relative selection at age 5 has remained relatively constant over the entire time period.

Two types of retrospective analyses were carried out. The first accepts the age structure generated by the most recent combination of age-slicing and Qmodel, drops off years sequentiallly and runs Qmodel for each truncated data series. The results of this retrospective analysis (Figure 22) and indicate that F in the current year is generally significantly underestimated relative to the retrospective view. Biomass is therefore significantly overestimated in the current year. The second type of retrospetive analysis, re-estimates the RV catch at age and the commercial landings at age for each of the truncated data sets. The results of this analysis show essentially the same results as the previous one with underestimation of current year F, and overestimation of current year biomass (Figure 23).

Mean lengths of fish captured by the summer RV survey (Figure 24) appear to indicate a gradual decline over the entire 25 year time series. The large declines in 1981 and 1989 are due to recruitment pulses entering the population. The change in the mean weight of a fish caught by the survey shows a similar decline (Figure 25). It could be argued that Figure 24 indicates two distinct time periods rather than a monotonic decline. This would mean that fish through the 1970 were larger than they are now. Again the declines in 1981 and 1989 are the resulting of incoming recruitment. The declines in 1993 and 1994 are likely due to the incoming 1992 and 1993 year classes (see description of the summer surveys above).

The size and age ranges of both the landings and the surveys have narrowed since 1970 (Figure 26) indicating a smaller range of sizes (ages) in the population in recent years relative to the documented history of this resource.

In spite of uncertainties in the input data used in the length based analysis, the resulting pattern of exploitation over time appears to be consistent with known events in the fishery as outlined above. This could indicate that the model is relatively robust to errors in the input data, at least in terms of detecting the relative trends in exploitation. It does not however, allow one to judge whether the precise level of exploitation estimated by the procedure is consistent with reality in any given year. It is imperative that the age structure of the population be reliably estimated before the latter can be evaluated.

Spawning Stock Biomass

Earlier assessments of this resource indicated that the probability of producing a large year-class is related to the general level of spawning stock biomass (Mahon et al 1985.). At a spawning stock biomass below 16,000t the probability of producing an above average year-class is considered low. At present, female spawning stock biomass estimated from surveys is on the order of 2,000 - 6000t. This estimate was derived from survey catch rates at length converted to weight and assumed knife-edged maturity at 42.5 - 46.5 cm (Figure 27). If the maturity schedule of this stock has shifted to maturing at younger ages, these would obviously be understimates of overall SSB

Recruitment

The relationship between recruitment and SSB in the previous year, from the present VPA analysis (Figure 28) indicates the relative abundance of the early 1980's year-classes, but shows the 1988 year-class to be of below average abundance. The large early 80's year-classes and the large 1988 year-class are evident from the survey data.

The 1994 summer survey caught average or above average numbers of fish at 8.5 cm, 24.5, and 30.5 cm. The peaks at 24.5 and 30.5 may indicate relatively abundant 1992 and1993 year-classes respectively. The spring survey revealed above average catch rates at 16.5 cm which are likely the 1994 year class observed at 8.5 cm in July 1994, however, the peaks at 24.5 and 30.5 do not appear above average in the spring survey at 26.5 or 32.5 cm.

Prognosis

The overall abundance of this resource remains below the long-term average as indicated by the results of survey data.

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Table 1. Nominal catches (t) of eastern Scotian Shelf haddock (4TVW) by NAFO Division and country as reported to NAFO (from NAFO Statistical Bulletin).

	4T					4Vn+					4Vs					4W						
Year	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Total	TAC
1954	5918	1044			40	5549	405		1058	24						12323	1956		17		28334	
1955	3101	31				3339	450		1183	13						12777	1217				22111	
1956	2861					4899	147		1350	12						18273	1661		354		29557	
1957	1740	1				5869	120		747	9						19960	1533		132		30111	
1958	2599			151		3166	71		1343	6						17572	427		1593		26928	
1959	2996	1		64		1594	159		69		3456	111		2870		21156	4804		640		37920	
1960	2041					1317	6		97		1187	18		3926	1	20093	127		1024		29837	
1961	1297			273	2	1055	1		47	1	846			1526	7	22277	23	151	1441	16	28963	
1962	1132			10		1097	1		5	2	1235			1076		15566	51	2567	3224		25966	
1963	1019			46		1213	1	6	64		1061	1		2828	195	11002	60	3295	4915	866	26572	
1964	461			1		958			59	52	677	11		2057	2	9810	42	4391	2884	1889	23294	
1965	432			3	3	402			53	84	1201			1806	47	7007	8	42876	1500	96	55518	
1966	149			1		311		516	30		1494			940	9	8259	19	9985	1885	51	23649	
1967	112			9		203		95	26	31	898			839	9	7180	5	459	1046		10912	
1968	144				4	127			70	6	1128		59	1702	23	8392		195	1458	10	13318	
1969	167				3	245				112	726			631	66	8270		235	864	1	11320	
1970	160					395	2		75	1	620		34	830	16	4754	574	636	1332		9429	
1971	151					466			215	1	1133		11	1114		7940	497	464	1477		13469	
1972	60					362	3		136	19	421		3	599	37	2096	70	103	737	102	4748	
1973	21				2	286			76	164	233			431	9	2830	173	76	95	18	4414	
1974	17				14	161			3	1	147		30	174	196	907	6	102	521	78	2357	0
1975	35				2	67			15	4	107	1		48	3	1393	20	52	63	59	1868	0
1976	12					40				1	52	1	9		1	1198	31	15			1360	2000
1977	8					189				8	144				1	2845	1	14		38	3248	2000
1978	18					119				3	441		3		38	4949	82	139		109	5901	2000
1979	59					194				11	650				2	2339		104		73	3433	2000

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Table 1. (Continued)

	4T					4Vn+					4Vs					4W						
Year	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Can.	USA	USSR	Spain	Other	Total	TAC
1980	81					188				42	1841					12448		209		31	14840	15000
1981	177					119				25	1796					17684		187		21	20009	23000
1982	47					183				23	2373					12498		53		49	15226	23000
1983	30					206				17	1542					7302		149		166	9412	15000
1984	120					299				11	3195		2		1	3992		168		233	8021	15000
1985	498					598				59	7291				2	2862		275		79	11664	15000
1986	531					904				17	8798				4	6277		312		78	16921	17000
1987	438					484				13	1587					994		207		154	3877	0
1988	369					507					2057					1176		332		99	4540	0
1989	80					425				2	3108					3582		1754		177	9128	6700
1990	33					108					2429					4077		265		97	7009	6000
*1991	18					51					978					3740		575		59	5421	0
*1992	9					27					781					5118		63		115	6113	
*1993	4					9					434					730		27		55	1259	
*1994	0					9					35					48				12	104	

+ = Between 1954 and 1958 catches for 4Vn and 4Vs were combined as 4V.
* = Provisional data.

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Table 2.

	Gear Category	Date	Reported Catch	Trip Limits
Fixed Gear <45' - Scotia-Fundy				
4Vn(Dec)	FG < 65'	May 1	Lic. Cond.	200 lbs or 10% bycatch, whichever is greater; 10% haddock bycatch only
4VsW - Halibut, Hake, Cusk	FG <65'	Feb 16	Lic. Cond.	10% bycatch each of cod and haddock; 14 circle hook or larger for halibut; 12 circle hook or larger for hake and cusk
	FG 45'-65'	Jan 1	Lic. Cond.	14 circle hook or larger; 10% combine cod, haddock bycatch
	FG <65'	Apr 15	Lic. Cond.	Cod - 10% or 225 kg whichever is greater; 10% haddock bycatch only
Mobile Gear <65' - Scotia-Fundy				
4VsW Pollock	all MG <65'	Jan 1	Lic. Cond.	130 mm square mesh; 10% daily bycatch level of cod and haddock combined
Vessels Greater than 65'				
4VsW Pollock	All vessels >65'	Jan 1	Lic. Cond.	155 mm diamond mesh or 100 mm square mesh; 10% daily bycatch level of cod and haddock combined
4Vs Pollock	Vessels >100' Etos & Ttoy	Apr 16	Lic. Cond.	1994-035 bycatch closure

Table 3. 4TVW haddock landings (t) by division and subdivision (Canadian catches only from inter-regional data).

Area	1986	1987	1988	1989	1990	1991	1992	1993	1994
4T	553	453	383	79	30	12	9	4	0
4Vn	899	491	506	421	108	52	27	11	9
4Vs	8719	1547	2041	3114	2427	975	776	435	35
4W	6170	991	1150	3580	4078	3999	5261	824	48
TOTAL	16341	3481	4080	7194	6643	5038	6074	1275	92

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Table 4. 4TVW haddock landings by quarter and major gear type 1986-1989 (Canadian landings only).

Gear	1986 Q1	1986 Q2	1986 Q3	1986 Q4	1986 TOTAL	1987 Q1	1987 Q2	1987 Q3	1987 Q4	1987 TOTAL
OTB	3072	4158	3661	3060	13952	356	680	608	433	2077
LL	86	203	535	281	1105	34	135	377	190	736
SNU	121	483	349	226	1179	5	370	175	34	585
Other	1	14	65	26	106	0	19	40	24	83
TOTAL	3280	4858	4611	3592	16341	396	1203	1200	682	3481

Gear	1988 Q1	1988 Q2	1988 Q3	1988 Q4	1988 TOTAL	1989 Q1	1989 Q2	1989 Q3	1989 Q4	1989 TOTAL
OTB	266	852	777	447	2341	763	2022	1062	487	4332
LL	33	177	721	204	1134	285	522	858	657	2322
SNU	11	199	197	17	424	14	283	150	28	475
Other	7	63	53	57	180	0	16	34	14	64
TOTAL	317	1291	1747	725	4080	1062	2842	2104	1186	7194

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Table 4. (Continued)

Gear	1990					1991				
	Q1	Q2	Q3	Q4	TOTAL	Q1	Q2	Q3	Q4	TOTAL
OTB	1092	957	664	258	2971	338	569	396	410	1713
LL	838	474	1341	497	3149	439	668	1413	651	3171
SNU	15	168	223	11	417	3	78	16	6	104
Other	0	7	64	35	106	1	17	34	4	55
TOTAL	1945	1606	2292	800	6643	782	1332	1859	1071	5043

Gear	1992					1993				
	Q1	Q2	Q3	Q4	TOTAL	Q1	Q2	Q3	Q4	TOTAL
OTB	1323	514	217	218	2272	95	140	121	18	375
LL	615	660	1400	855	3530	27	171	597	45	840
SNU	1	123	85	37	246	0	27	20	7	53
Other	0	1	14	12	26	0	0	6	1	7
TOTAL	1940	1298	1716	1122	6074	122	338	753	72	1285

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Table 4. (Continued)

Gear	1994				
	Q1	Q2	Q3	Q4	TOTAL
OTB	15	6	18	6	45
LL	2	8	25	4	39
SNU	0	2	2	0	4
Other	0	4	2	0	4
TOTAL	17	20	46	10	92

Table 5. 4TVW haddock landings by area, quarter and gear type (Canadian landings only).

Year	4T					
	Gear	Q1	Q2	Q3	Q4	Total
1986	OTB	9	71	85	4	169
	LL	0	2	6	5	12
	SNU	0	261	83	16	359
	Other	0	1	10	1	13
	TOTAL	9	336	184	25	554
1987	OTB	4	78	43	9	134
	LL	0	2	6	4	13
	SNU	0	208	75	5	289
	Other	0	11	6	0	17
	TOTAL	4	300	130	19	453
1988	OTB	1	18	199	5	224
	LL	0	1	2	4	8
	SNU	0	57	69	7	132
	Other	0	9	9	2	20
	TOTAL	1	85	279	18	383
1989	OTB	0	9	2	0	11
	LL	0	0	1	2	3
	SNU	0	39	20	1	60
	Other	0	4	1	0	6
	TOTAL	0	52	24	3	79
1990	OTB	1	2	0	1	5
	LL	0	0	1	0	1
	SNU	0	19	3	0	22
	Other	0	1	1	0	2
	TOTAL	1	22	5	2	30
1991	OTB	0	3	0	0	3
	LL	0	0	0	1	2
	SNU	0	10	2	0	12
	Other	0	0	1	0	1
	TOTAL	0	14	3	2	18
1992	OTB	0	0	0	0	1
	LL	0	0	0	2	2
	SNU	0	5	1	0	6
	Other	0	0	0	0	0
	TOTAL	0	6	1	2	9
1993	OTB	0	0	0	0	0
	LL	0	0	0	1	2
	SNU	0	1	0	0	1
	Other	0	0	0	1	1
	Total	0	1	1	3	4
1994	OTB	0	0	0	0	0
	LL	0	0	0	0	0
	SNU	0	0	0	0	0
	Other	0	0	0	0	0
	Total	0	0	0	0	0

Table 5. (Continued)

Year	4Vn					
	Gear	Q1	Q2	Q3	Q4	Total
1986	OTB	67	139	180	18	405
	LL	0	27	87	47	161
	SNU	0	190	134	4	328
	Other	0	1	3	1	6
	TOTAL	67	356	405	71	899
1987	OTB	28	84	32	20	164
	LL	7	28	54	26	115
	SNU	0	142	47	18	207
	Other	0	1	2	3	5
	TOTAL	35	254	135	66	491
1988	OTB	26	113	14	11	164
	LL	0	21	113	52	186
	SNU	0	102	48	3	153
	Other	0	0	2	0	2
	TOTAL	26	236	177	66	506
1989	OTB	24	178	46	1	249
	LL	0	13	32	8	53
	SNU	0	96	17	1	114
	Other	0	1	2	1	4
	TOTAL	25	287	97	12	421
1990	OTB	17	32	12	6	67
	LL	0	6	14	1	21
	SNU	0	15	5	0	20
	Other	0	0	0	0	1
	TOTAL	17	53	31	7	108
1991	OTB	8	8	4	2	21
	LL	0	2	14	3	19
	SNU	0	5	2	0	7
	Other	0	0	3	0	3
	TOTAL	8	14	23	5	50
1992	OTB	8	2	1	1	12
	LL	0	0	10	3	13
	SNU	0	1	0	0	2
	Other	0	0	0	0	0
	TOTAL	8	4	12	4	27
1993	OTB	1	2	0	0	3
	LL	0	2	5	1	8
	SNU	0	0	0	0	0
	Other	0	0	0	0	0
	TOTAL	1	4	5	1	11
1994	OTB	0	0	4	1	5
	LL	1	0	0	0	1
	SNU	0	1	0	0	1
	Other	0	3	0	0	0
	TOTAL	1	3	4	1	6

Table 5. (Continued)

Year	4Vs					
	Gear	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
1986	OTB	810	3666	3093	917	8485
	LL	4	93	115	0	212
	SNU	0	17	3	0	19
	Other	0	0	2	0	2
	TOTAL	814	3775	3212	917	8719
1987	OTB	252	398	412	291	1353
	LL	2	58	98	16	174
	SNU	0	11	7	1	19
	Other	0	0	0	0	0
	TOTAL	254	468	517	308	1547
1988	OTB	188	596	448	385	1617
	LL	14	67	211	27	319
	SNU	0	24	16	0	40
	Other	7	45	11	2	65
	TOTAL	209	732	685	414	2041
1989	OTB	592	1255	538	209	2594
	LL	11	100	193	95	399
	SNU	5	76	34	2	118
	Other	0	3	0	0	4
	TOTAL	608	1434	765	307	3114
1990	OTB	830	639	370	184	2023
	LL	132	84	54	6	276
	SNU	0	64	62	0	126
	Other	0	3	0	0	3
	TOTAL	961	789	486	190	2427
1991	OTB	185	257	104	129	675
	LL	3	120	133	10	267
	SNU	1	28	2	1	31
	Other	0	0	0	0	0
	TOTAL	189	405	239	140	973
1992	OTB	204	195	60	97	555
	LL	1	67	64	5	137
	SNU	0	79	2	2	84
	Other	0	0	0	0	4
	TOTAL	204	342	127	104	776
1993	OTB	81	126	32	5	244
	LL	8	57	84	0	150
	SNU	0	25	10	7	42
	Other	0	0	0	0	0
	TOTAL	90	208	126	12	435
1994	OTB	6	6	7	3	22
	LL	1	3	5	1	10
	SNU	0	1	2	0	3
	Other	0	0	0	0	0
	TOTAL	7	9	15	4	35

Table 5. (Continued)

Year	4W					
	Gear	Q1	Q2	Q3	Q4	Total
1986	OTB	2186	282	302	2122	4893
	LL	82	81	328	229	719
	SNU	121	16	130	206	472
	Other	1	12	50	23	86
	TOTAL	2391	391	810	2579	6170
1987	OTB	72	120	121	113	427
	LL	26	45	219	144	434
	SNU	5	8	47	10	70
	Other	0	7	32	21	60
	TOTAL	103	181	419	288	991
1988	OTB	51	125	116	45	336
	LL	19	88	394	121	622
	SNU	11	16	64	8	99
	Other	0	9	31	53	93
	TOTAL	81	238	605	226	1150
1989	OTB	146	581	476	276	1479
	LL	274	409	633	551	1867
	SNU	9	72	79	24	184
	Other	0	8	31	12	51
	TOTAL	429	1070	1218	863	3580
1990	OTB	245	284	282	66	877
	LL	706	384	1272	489	2851
	SNU	15	70	153	11	249
	Other	0	3	62	34	100
	TOTAL	966	742	1769	601	4078
1991	OTB	145	301	288	280	1064
	LL	436	546	1266	636	2883
	SNU	3	36	11	5	54
	Other	1	16	30	4	50
	TOTAL	584	900	1594	923	4001
1992	OTB	1112	317	155	120	1704
	LL	615	593	1326	845	3378
	SNU	0	37	82	35	154
	Other	0	1	14	12	26
	TOTAL	1727	947	1576	1011	5261
1993	OTB	13	12	89	13	127
	LL	19	112	509	42	682
	SNU	0	1	10	0	10
	Other	0	0	5	0	5
	TOTAL	32	125	612	55	824
1994	OTB	9	0	7	2	18
	LL	0	5	20	3	28
	SNU	0	0	0	0	0
	Other	0	1	0	0	1
	TOTAL	10	7	27	5	48

Table 6.

catch at age

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1	0	0	0	50	0	0	0	0	0	0	0	0
2	0	10	0	0	6	3	12	0	213	0	63	8
3	177	855	83	765	449	349	211	504	1926	647	2115	2938
4	2194	1126	2389	4967	1915	2324	2881	1021	11209	3634	3817	6803
5	3269	4330	2823	6056	6626	4113	10071	2592	2400	13199	2504	5559
6	1297	3090	5018	2216	4654	4445	2159	5132	2539	2045	8128	3388
7	1412	483	3227	1794	1831	1407	2466	1765	2866	1538	1076	7071
8	1088	357	293	1306	1079	457	1318	1642	963	1233	777	809
9	556	303	575	98	405	247	431	620	1334	341	788	528
10	433	228	230	66	96	25	265	313	340	244	276	534
11	253	142	358	79	65	18	68	51	89	92	164	213
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0	2	205	1287	2591	53595	2127	89	5	31	306	268
2	0	31	436	924	3073	32161	9696	181	13	42	129	667
3	455	409	1491	511	4074	24140	9638	1006	398	438	679	888
4	6408	4901	2039	3471	2368	15192	8887	2622	1806	1408	1743	2189
5	7580	8501	7794	3673	6023	7775	4645	2836	2926	2039	1400	2740
6	3339	4298	6190	6594	2069	4057	1217	1113	2494	1955	1365	1208
7	2164	1362	1957	3190	2906	1282	1637	441	793	939	1163	944
8	1964	1062	839	1243	1562	1234	499	597	379	279	389	1177
9	372	727	317	287	403	402	272	212	406	131	88	277
10	157	193	223	126	81	72	89	174	116	118	38	39
11	161	61	59	113	45	54	12	55	78	39	19	21
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	306	487	59	279	431	213	714	1	332	870	530	497
2	288	1178	233	61	676	283	433	268	376	318	433	470
3	671	646	975	470	157	965	811	423	2372	262	1520	1084
4	751	1467	254	805	249	335	2412	1120	4334	5072	764	3207
5	924	811	464	282	323	513	436	675	3238	5081	5629	2040
6	668	723	298	185	189	283	715	159	1702	3010	1957	1677
7	345	342	114	63	132	117	203	149	249	1178	1220	530
8	191	159	47	30	36	80	61	16	129	139	214	235
9	159	60	8	8	8	19	23	5	39	105	48	29
10	9	99	17	4	10	15	8	6	9	30	28	18
11	18	2	16	1	3	6	2	2	7	10	5	19
	1984	1985	1986	1987	1988	1989	1990	1991				
1	10	133	12	30	56	1590	126	12				
2	360	69	50	76	68	774	527	133				
3	1514	411	1289	160	129	519	372	1035				
4	4158	8006	10064	983	1584	2220	1251	1846				
5	2225	4162	5954	1686	1726	2949	3220	1593				
6	821	881	767	377	390	699	533	467				
7	410	232	100	24	39	63	41	47				
8	90	47	13	6	4	2	2	2				
9	30	14	1	1	4	1	3	0				
10	5	2	1	0	1	0	0	0				
11	2	1	1	1	0	0	0	0				

Table 7. Samples available for the ??????? of catch at length for 1994.

	Trawlers 4TVW		Foreign
	1st Half	2nd Half	
No. Samples	4	7	33
Tons Catch	21	24	12
No. Measures	676	889	5567

Table 8 4TVW Haddock Catch at Length

Length (cm)	1970.00	1971.00	1972.00	1973.00	1974.00	1975.00	1976.00	1977.00	1978.00	1979.00	1980.00	1981.00	1982.00	1983.00	1984.00
0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	2.89	8.45	0.00	0.00	0.00	5.11	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00
8.50	8.67	2.82	0.00	0.00	0.00	1.70	27.77	1.57	0.00	0.00	6.33	0.02	0.00	0.00	0.00
10.50	0.00	0.00	0.00	0.00	12.73	1.70	9.26	0.78	0.00	0.00	4.84	2.33	0.02	0.00	0.00
12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.22	0.16	0.95	0.51	0.00
14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.28	0.00	0.78	3.71	62.54	10.25	0.00
16.50	2.89	5.64	8.61	0.00	0.00	0.00	11.57	0.39	27.99	0.12	163.26	44.74	239.55	88.44	0.00
18.50	37.57	14.09	55.99	21.60	0.00	5.11	25.46	1.96	141.77	0.19	286.10	219.37	340.05	498.55	0.00
20.50	127.17	53.54	189.52	75.61	0.00	17.03	164.33	9.03	249.31	0.80	168.19	452.83	204.01	352.55	17.97
22.50	222.54	70.45	167.98	216.04	15.27	37.47	143.50	16.48	157.60	1.75	130.96	286.12	69.26	233.97	796.30
24.50	72.25	39.45	43.07	162.03	10.18	98.80	50.92	14.52	63.03	3.60	97.01	85.82	19.69	141.05	161.14
26.50	34.68	25.36	21.54	86.41	10.18	85.17	20.83	9.03	20.06	13.62	36.54	12.32	61.24	98.28	137.55
28.50	14.45	47.90	21.54	140.42	5.09	28.96	30.09	10.56	45.32	18.43	4.74	14.98	35.28	51.54	62.00
30.50	66.47	159.76	54.87	195.56	17.82	5.11	44.01	12.92	80.41	28.74	2.88	15.69	14.83	17.48	29.96
32.50	76.38	185.79	47.65	413.51	43.27	3.41	148.37	12.56	131.63	35.73	7.34	17.74	19.94	31.06	39.48
34.50	98.85	129.70	64.81	264.85	129.91	6.24	256.56	13.95	126.61	24.75	35.39	25.10	96.56	109.25	160.89
36.50	262.38	173.18	101.08	235.32	157.99	50.23	147.42	33.09	107.65	23.28	153.80	77.12	206.26	189.96	526.78
38.50	322.64	268.91	100.10	287.79	325.44	53.82	40.74	56.72	171.12	63.85	400.55	287.16	452.70	349.67	1101.85
40.50	473.07	431.08	175.97	277.51	225.14	105.36	16.35	113.88	273.33	100.52	751.09	802.64	511.47	742.28	1296.59
42.50	479.32	668.11	210.00	297.49	138.00	123.56	29.63	245.70	387.72	163.33	1227.49	1248.79	639.18	964.17	1169.66
44.50	610.96	732.11	248.97	383.84	84.70	161.71	20.70	283.65	502.38	215.20	1440.72	1690.66	990.02	862.88	951.70
46.50	629.71	920.49	310.39	469.03	132.03	161.16	62.22	324.75	598.71	257.27	1470.65	2130.75	1313.02	842.35	714.08
48.50	669.66	983.74	326.94	351.91	100.70	217.38	108.16	308.11	547.97	321.59	1565.11	2128.57	1629.10	890.70	661.93
50.50	709.20	931.33	332.04	355.23	125.87	170.54	112.31	227.37	470.37	341.81	1266.23	1822.71	1485.96	866.12	421.46
52.50	710.34	950.26	387.75	342.78	158.49	185.31	111.73	186.52	379.23	323.90	1070.79	1533.81	1142.35	653.20	312.00
54.50	480.73	783.43	299.87	313.36	169.91	164.97	133.79	164.61	288.49	181.35	818.33	1143.45	838.48	484.16	275.96
56.50	420.21	724.90	299.01	242.54	127.59	105.60	99.36	151.18	246.95	151.67	578.21	844.11	637.02	317.54	189.73
58.50	343.90	552.90	225.39	268.59	128.18	100.06	84.69	115.57	198.84	98.35	378.13	637.03	459.54	206.24	120.73
60.50	219.43	401.08	178.41	219.25	94.39	68.78	86.19	92.55	169.39	78.82	263.07	376.17	356.00	131.20	81.00
62.50	241.66	381.14	153.45	173.57	85.81	73.06	71.10	55.42	101.40	48.00	167.01	262.69	216.00	93.08	46.00
64.50	132.78	230.20	101.21	87.01	57.11	28.49	46.11	32.13	73.58	31.00	106.00	125.15	124.00	42.28	29.00
66.50	94.76	158.62	55.83	72.57	28.61	24.37	31.66	28.81	33.34	13.01	67.00	93.15	100.00	27.00	19.23
68.50	59.04	85.70	43.83	23.83	25.27	8.53	6.81	16.66	28.94	11.00	19.00	43.05	45.00	11.08	11.00
70.50	26.56	51.59	8.24	20.69	11.67	5.28	4.11	15.93	5.26	3.00	28.00	26.04	44.00	14.16	10.00
72.50	22.88	19.53	13.23	20.42	3.33	5.17	6.42	3.92	3.11	3.00	6.00	10.01	20.00	5.00	3.00
74.50	20.80	14.43	2.45	14.86	2.59	0.00	0.48	2.19	2.17	1.00	4.00	8.01	5.00	5.00	2.00
76.50	7.84	18.66	1.68	1.49	0.74	0.00	0.34	1.52	3.23	1.00	1.00	2.00	5.00	1.00	0.00
78.50	4.19	1.98	2.92	1.13	0.00	0.94	0.00	0.39	0.17	0.00	1.00	2.00	1.00	1.00	0.00
80.50	0.00	0.48	2.92	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	1.00	2.00	0.00	0.00
82.50	3.90	1.72	0.00	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84.50	0.53	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	7711.32	10228.99	4257.23	6037.55	2428.01	2110.12	2152.97	2566.42	5637.38	2559.68	12729.00	16477.00	12387.00	9333.00	9349.00

Table 8 4TVW Haddock Catch at Length

1985.00	1986.00	1987.00	1988.00	1989.00	1990.00	1991.00	1992.00	1993.00	1994.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.01	0.00
0.34	0.01	0.00	0.00	8.73	0.40	0.01	0.00	0.01	0.00
51.47	0.01	0.20	0.18	119.51	0.62	0.01	0.03	0.01	0.00
175.71	0.35	2.96	3.96	467.26	4.82	0.08	0.26	0.20	0.132
354.29	2.90	16.21	33.37	584.73	17.85	0.63	0.53	1.18	1.948
229.68	5.05	25.02	45.84	297.17	36.94	2.24	0.67	1.82	6.341
66.46	5.47	16.53	20.78	74.61	61.80	5.69	0.74	2.44	7.372
20.94	4.65	11.39	9.08	101.31	148.22	16.14	0.84	1.66	3.148
3.50	7.35	20.37	17.33	233.49	189.54	39.15	1.25	4.16	2.856
15.34	22.81	41.94	25.53	277.77	118.31	68.84	2.37	6.75	5.272
2.38	47.45	47.06	22.72	164.42	58.34	118.04	6.69	6.35	4.217
30.30	99.85	40.38	16.56	60.22	70.71	149.47	43.11	7.16	2.264
207.45	271.03	32.99	14.70	52.69	67.77	151.13	169.64	22.03	1.866
783.47	1060.93	51.27	48.36	122.69	47.46	257.29	448.88	58.31	1.539
1748.80	2605.06	124.52	147.23	283.98	129.41	416.70	650.51	125.24	2.309
2230.47	3858.84	253.29	384.91	644.38	239.89	504.55	721.56	171.34	3.864
1982.97	3983.36	382.48	723.51	939.35	528.63	676.64	772.23	159.07	4.252
1567.21	2821.27	610.41	870.84	1175.58	824.68	727.82	757.68	152.26	4.526
1049.08	1511.18	611.55	654.15	1105.70	930.06	596.93	693.09	125.40	4.234
597.13	848.62	458.28	440.97	799.54	907.78	473.58	478.59	95.82	4.621
421.00	460.22	297.29	263.33	539.76	650.55	318.21	314.56	81.46	3.846
277.00	258.27	161.02	149.99	321.25	476.16	219.77	209.14	54.57	2.939
216.00	144.61	96.50	75.34	195.06	241.19	148.07	156.45	38.34	2.125
136.00	90.43	46.15	40.67	104.92	136.54	85.18	101.35	29.93	1.69
87.00	67.92	33.08	26.90	66.45	70.01	65.53	69.85	27.53	1.113
54.00	32.82	16.62	17.43	27.64	33.68	31.41	45.62	14.68	0.592
41.00	24.21	8.36	12.41	18.61	25.32	20.13	31.06	10.98	0.287
24.00	13.23	2.15	5.23	9.00	15.16	7.05	20.50	5.08	0.207
13.00	2.03	0.01	4.15	7.00	11.10	4.05	5.32	1.61	0.068
10.00	4.03	1.03	2.02	3.00	8.01	2.02	1.82	1.26	0.035
4.00	1.02	1.05	1.06	0.00	3.00	1.00	6.61	0.14	0.052
4.00	1.03	0.00	0.02	1.00	0.00	0.00	0.29	0.04	0.015
1.00	0.00	1.00	0.00	0.00	0.01	1.00	0.34	0.03	0.00
0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.16	0.00
1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
12406.00	18256.00	3411.12	4078.59	8807.36	6055.04	5108.35	5711.62	1207.01	73.73

Table 9. Survey length at age

AGE IN YEARS									
LENGTH	0	1	2	3	4	5	6	7	8
1970	7.80	22.01	32.04	39.76	45.25	50.94	54.45	58.08	62.74
1971	7.30	22.59	31.73	40.05	45.43	50.55	54.05	56.98	62.85
1972		21.07	29.39	36.50	45.11	49.30	56.01	59.61	57.13
1973		23.18	32.18	40.44	47.84	51.36	57.42	58.06	63.71
1974	9.25	23.48	34.59	41.64	47.14	53.50	58.42	57.91	60.52
1975	8.57	25.13	28.22	43.23	48.31	54.71	58.98	60.72	63.36
1976	8.80	21.36	32.20	38.40	47.88	52.44	56.13	61.20	63.22
1977	9.18	23.46	32.94	41.98	47.23	53.53	55.48	60.89	65.11
1978		20.54	33.02	39.83	46.69	52.13	56.78	63.26	56.50
1979	7.51	20.82	32.19	39.10	45.50	50.19	54.75	60.05	64.45
1980	7.48	21.07	28.28	39.58	45.80	49.68	54.93	60.30	64.92
1981	8.43	19.71	30.95	37.03	44.77	49.15	54.27	59.26	60.91
1982	7.57	17.80	28.78	39.56	44.05	48.24	53.81	57.35	62.58
1983	6.60	18.99	25.83	35.82	42.00	48.15	51.47	55.23	59.13
1984		21.35	29.26	35.43	40.52	46.28	51.62	56.56	61.66
1985		22.11	26.30	35.98	41.95	48.93	53.40	61.42	64.09
1986	7.76	21.90	29.68	36.57	41.16	46.29	54.66	57.03	58.93
1987	8.18	20.40	26.24	36.53	42.45	46.78	54.02	58.81	
1988	8.95	22.72	32.64	37.00	42.08	47.43	52.18	61.84	64.50
1989	9.37	19.95	31.91	38.46	44.29	49.60	57.19	63.61	
1990	17.04	22.79	29.79	37.96	44.76	49.43	57.33	62.82	72.50
1991	6.50	24.16	32.39	36.57	44.03	48.71	54.40	68.50	
1992	36.50	33.94	32.01	36.13	39.77	42.71	48.06	48.88	59.94
	9	9	11	12	13	14	15	UNKNOWN	
1970	65.00	67.21	74.04	74.50		78.50		0.00	
1971	60.50							0.00	
1972	58.83	68.50						6.50	
1973	72.50	72.12						0.00	
1974	59.07	67.20	66.05					66.50	
1975	62.20	67.39	0.00	72.50				0.00	
1976	64.50	54.50	64.50	72.50				7.31	
1977		68.50	78.50	0.00	78.50			29.79	
1978			68.50					0.00	
1979						66.50		0.00	
1980	60.50							4.50	
1981	63.19	66.22						0.00	
1982	72.02	64.50	0.00				74.50	0.00	
1983	64.56	60.61	0.00	66.50		72.50		0.00	
1984	64.19	66.50	74.50		80.50			0.00	
1985		80.50						26.55	
1986								68.50	
1987	56.28							7.24	
1988								0.00	
1989								0.00	
1990								0.00	
1991								0.00	
1992	65.83							18.50	

Table 10. HADCPUE_rv

	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0.105	0.062	0	0	0.228	0.074	0.295	0.197	0
2	2.736	1.724	1.319	0.531	0.373	5.073	2.76	6.075	9.899
3	1.004	3.63	0.886	1.733	2.146	0.721	3.13	11.379	11.071
4	1.839	1.197	1.295	0.537	2.903	1.938	0.478	8.969	14.806
5	2.044	1.576	0.585	0.472	0.526	1.734	0.95	1.217	8.32
6	0.993	0.627	0.488	0.169	0.541	0.461	0.931	1.94	0.513
7	0.621	0.355	0.367	0.349	0.27	0.833	0.206	0.722	0.488
8	0.695	0.163	0.15	0.074	0.201	0.22	0.23	0.204	0.124
9	0.348	0.255	0.071	0.096	0.08	0.088	0.052	0.108	0.015
10	0.139	0.012	0.043	0.023	0.045	0.047	0.016	0	0
11	0.044	0	0.019	0.046	0.033	0.054	0.015	0.05	0.011
12	0.038	0	0	0	0.039	0	0.016	0.009	0.014
13	0.033	0	0	0	0	0.018	0.06	0	0
14	0	0	0	0	0	0	0	0.021	0
15	0.009	0	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0	0	0
	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	1.488	1.441	22.353	0.774	0.146	0.276	0	0.137	0.083
2	0.088	3.512	15.615	18.189	21.8	0.302	4.223	0.604	1.929
3	9.133	0.276	9.378	15.752	14.486	10.836	1.04	2.251	1.733
4	9.937	14.882	0.991	14.215	30.222	16.893	11.084	7.777	4.671
5	10.33	13.921	7.375	2.048	11.631	29.115	21.685	26.058	15.57
6	2.895	8.65	4.679	7.212	3.078	5.247	4.731	11.879	6.174
7	0.372	2.09	2.015	3.053	2.742	2.572	1.263	1.299	0.552
8	0.289	0.333	0.308	0.965	0.946	1.361	0.305	0.401	0.092
9	0.098	0.119	0.088	0.227	0.238	0.303	0.062	0.067	0
10	0	0.019	0.095	0.02	0.07	0.108	0	0	0.053
11	0.038	0	0.028	0.016	0.059	0.025	0.002	0	0
12	0.018	0	0	0	0	0.006	0	0	0
13	0	0	0	0	0.045	0	0	0	0
14	0	0	0	0	0	0.003	0	0	0
15	0.007	0	0	0	0.024	0	0	0	0
15+	0	0	0	0.021	0	0	0	0	0
	1988	1989	1990	1991					
1	1.043	0.1	0.054	0.022					
2	4.695	13.863	1.019	0.253					
3	13.432	7.067	16.835	6.449					
4	10.201	3.207	11.515	39.982					
5	16.163	10.79	7.874	12.517					
6	9.257	6.006	4.757	3.63					
7	1.129	0.46	0.332	0.144					
8	0.106	0.03	0.032	0.016					
9	0.032	0	0.005	0					
10	0	0	0	0					
11	0	0	0	0					
12	0	0	0	0					
13	0	0	0	0					
14	0	0	0	0					
15	0	0	0	0					
15+	0	0	0	0					

Table 11. July RV Catch Rates at Length.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0.0108	0	0	0	0.006	0	0	0.0516	0.0432	0.0132	0.075	0.015
6.5	0.03	0.0372	0.0264	0	0	0.024	0.3192	0.06	0	0.516	0.8856	4.4976	0.319	0.1
8.5	0.0744	0.0252	0.0108	0	0.1416	0.0228	0.2508	0.1296	0	0.8664	0.42	14.3148	0.28	0.031
10.5	0	0	0	0	0.0864	0.0264	0.0444	0.0672	0	0.0528	0.1248	3.3396	0.1	0
12.5	0	0	0	0	0	0	0	0	0	0	0.012	0.1884	0.03	0.016
14.5	0	0	0	0	0	0	0	0.024	0.036	0	0.0216	0.312	1.361	0.286
16.5	0.0264	0.018	0.036	0	0	0.0348	0.096	0.024	0.5256	0	0.036	2.31	7.78	4.163
18.5	0.2292	0.15	0.2172	0.0132	0.0276	0.096	0.1404	0.0852	2.9172	0.024	0.5928	5.238	5.809	9.825
20.5	0.792	0.3204	0.5376	0.0792	0.024	0.2196	1.2636	0.8328	4.0608	0.0348	1.476	4.7808	2.548	8.22
22.5	1.2288	0.6696	0.4932	0.2076	0.1392	0.3816	1.014	2.2416	1.7112	0.0228	1.1064	2.0916	0.745	3.071
24.5	0.3408	0.4776	0.1368	0.1848	0.1008	1.9296	0.39	2.2164	0.9084	0.1788	0.3936	1.0956	1.547	2.256
26.5	0.15	0.3396	0.198	0.1548	0.0804	2.3844	0.4452	1.1016	0.4872	0.5112	0.03	0.5868	3.612	2.65
28.5	0.042	0.3204	0.1512	0.2592	0.0384	0.5028	0.3516	1.116	0.3192	1.6212	0.0648	1.7688	4.593	4.014
30.5	0.366	0.9528	0.372	0.2448	0.1308	0.1224	0.2556	2.0184	1.5552	2.3904	0.018	2.724	3.806	4.201
32.5	0.3936	1.1928	0.36	0.5592	0.4584	0.0252	0.546	3.1224	3.4404	2.9352	0.1044	2.5908	2.329	5.154
34.5	0.1932	0.8316	0.264	0.3732	0.9096	0.0432	0.7008	2.9544	4.2552	2.538	0.7716	1.656	0.962	5.174
36.5	0.4212	0.39	0.2376	0.2232	0.7524	0.0888	0.69	2.0832	3.456	1.4832	1.8828	0.5604	1.919	7.836
38.5	0.4704	0.2148	0.222	0.2052	0.6456	0.1056	0.2964	1.3608	3.2088	2.0712	4.3992	0.3144	3.427	9.099
40.5	0.7044	0.372	0.2868	0.1656	0.504	0.4476	0.0816	1.6692	4.7424	3.3876	5.214	0.6972	3.8	5.085
42.5	0.6756	0.6288	0.2004	0.0636	0.6888	0.4848	0.1848	2.4528	3.7956	3.6348	4.4376	1.8192	2.891	3.309
44.5	0.7872	0.5484	0.1524	0.1728	0.642	0.9324	0.1164	2.1756	2.9484	3.4656	5.5668	2.3952	3.269	2.615
46.5	0.5328	0.4164	0.2508	0.15	0.4788	0.5496	0.2568	1.4028	2.274	3.0252	4.8	2.4732	2.37	2.152
48.5	0.4524	0.378	0.1344	0.0468	0.2304	0.4476	0.4008	0.534	2.0508	2.2212	4.698	2.4288	2.196	1.809
50.5	0.5868	0.378	0.3384	0.1632	0.1428	0.438	0.3696	0.6984	1.2696	1.5228	3.6984	1.77	2.039	1.348
52.5	0.498	0.252	0.144	0.1692	0.2412	0.2544	0.3132	0.7128	0.5184	0.828	1.7424	1.0428	1.65	1.177
54.5	0.2112	0.1596	0.1332	0.1524	0.2724	0.4644	0.3204	0.492	0.1632	0.6252	1.3368	0.5952	1.173	0.836
56.5	0.3324	0.1776	0.0864	0.0324	0.2136	0.2508	0.2076	0.4368	0.1656	0.1728	0.432	0.5424	0.645	0.323
58.5	0.2448	0.0864	0.0552	0.15	0.1704	0.2964	0.0708	0.312	0.1152	0.0924	0.3468	0.288	0.476	0.258
60.5	0.1068	0.0564	0.0672	0.048	0.0648	0.2496	0.0252	0.3228	0.1116	0.1548	0.2376	0.2448	0.185	0.091
62.5	0.1692	0.048	0.0912	0.0936	0.0684	0.132	0.1008	0.1128	0.1068	0.096	0.186	0.09	0.287	0.121
64.5	0.2436	0.0204	0.036	0	0.0888	0.1272	0.0792	0.084	0.0744	0.0516	0.1056	0.1332	0.175	0.083
66.5	0.1956	0.1032	0	0.0588	0.0096	0.0792	0.0444	0.0168	0	0.0612	0.0492	0.0324	0.076	0.099
68.5	0.0312	0.0084	0.0468	0	0.0216	0.03	0.0216	0.0624	0.0312	0.036	0.0528	0.0324	0	0.042
70.5	0.0444	0.0252	0	0	0.0048	0.0468	0	0	0.03	0.0192	0	0	0.018	0.002
72.5	0.0432	0	0	0.0228	0.0156	0.036	0.06	0.0324	0.0108	0	0	0	0	0.024
74.5	0.0084	0	0	0.0348	0	0	0.0036	0	0	0	0	0	0.022	0
76.5	0.0084	0	0	0	0	0	0	0	0	0	0	0	0	0
78.5	0.0084	0	0	0	0	0	0	0.03	0	0	0	0	0	0
80.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUM	10.6428	9.5988	5.2968	4.0284	7.3932	11.274	9.4668	30.9852	45.2892	34.692	45.2868	62.9676	62.514	85.485

Table 11. (Continued)

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0.026	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0.012	0
0.018	0	0.086	0.017	0.063	0	0	0.022	0	0.282	0.31
0.258	0.011	0.051	0.061	0.692	0.057	0	0	0	1.13	0.69
0	0	0	0.004	0.28	0.043	0	0	0	1.006	0.35
0	0	0	0	0.008	0	0	0	0	0.063	0.01
0.005	0	0	0	0	0	0.018	0	0	0	0
0	0.023	0	0.174	0	0.741	0.014	0	0.02	0.007	0
0.04	0.155	0.061	0.487	0.075	5.296	0.049	0.017	0.008	0.053	0.06
0.258	1.286	0.179	0.941	1.043	5.627	0.249	0.061	0.323	0.34	0.75
0.339	2.346	0.45	0.871	2.081	1.632	0.387	0.091	0.299	1.06	2.48
0.951	0.677	0.483	0.31	1.306	0.574	0.424	0.035	0.137	0.925	3.24
1.839	0.226	0.178	0.131	0.27	0.217	1.652	0.068	0.049	0.422	1.01
3.119	0.307	0.187	0.211	0.356	0.512	5.874	0.564	0.16	0.217	1.7
5.183	0.834	0.912	0.5	2.704	1.735	7.123	1.969	0.435	0.705	1.94
4.54	1.803	1.567	0.874	8.208	3.2	2.976	7.544	1.248	0.618	0.94
4.238	3.366	2.026	0.888	6.178	1.718	2.035	11.525	4.519	0.981	0.75
7.143	4.235	4.271	1.542	2.738	0.943	3.184	10.256	6.059	2.949	1.32
9.916	4.598	7.598	2.535	3.639	1.053	3.369	8.137	4.78	5.136	2.95
10.563	6.282	9.06	4.557	4.268	1.567	2.489	6.279	3.746	4.535	3.94
6.792	6.288	7.812	5.432	5.336	2.945	2.12	5.037	2.364	3.28	2.79
3.945	4.122	5.611	4.808	6.121	3.965	2.99	3.945	1.478	1.763	1.52
2.184	2.748	3.655	2.913	4.7	3.694	2.72	3.408	1.111	1.045	0.65
1.686	1.595	2.239	1.83	3.012	2.706	1.974	2.487	0.775	0.448	0.37
1.039	1.335	1.559	0.769	1.451	1.504	1.438	0.865	0.528	0.432	0.16
1.066	0.83	0.76	0.515	0.726	0.827	0.597	0.467	0.306	0.167	0.07
0.545	0.425	0.652	0.188	0.318	0.441	0.298	0.095	0.099	0.07	0.03
0.464	0.373	0.498	0.167	0.193	0.275	0.254	0.072	0.107	0.03	0.02
0.302	0.242	0.305	0.07	0.115	0.07	0.065	0.034	0.011	0.023	0
0.238	0.093	0.155	0.032	0.13	0.102	0.093	0.007	0.015	0.008	0.01
0.126	0.073	0.066	0.002	0.056	0.043	0.016	0	0.015	0	0
0.102	0.031	0.038	0.013	0.067	0.019	0.005	0.009	0	0.002	0
0.066	0.093	0.02	0.01	0.016	0.008	0.007	0	0.007	0	0
0.066	0.028	0.007	0.002	0	0.008	0	0.016	0.007	0	0
0	0.024	0.007	0	0	0	0	0	0	0	0
0.014	0.004	0	0	0	0	0.005	0	0	0	0.01
0.006	0	0	0	0	0	0	0	0	0	0
0.026	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0.003	0.002	0	0.008	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
67.08	44.455	50.493	30.888	56.15	41.522	42.425	63.01	28.606	27.709	28.07

Table 12. Spring (March) Research Vessel catch rates per tow at length

length	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2.5	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
8.5	0	0	0.02	0	0	0		0	0	0	0	0	0	0	0	0	0
10.5	0	0	1.88	0.5	0.25	0		0	0.02	0	0.02	0	0	0	0	0	0
12.5	0	0.69	9.16	9.28	2.49	0.64		0.07	0.05	0.08	1.46	0.03	0.02	0.02	0	0.07	0.1
14.5	0.01	3.1	10.33	14.92	6.53	0.97		0.15	1.11	1.5	11.22	0.07	0.01	0.6	0.12	0.17	2.12
16.5	0	1.69	4.83	6.95	4.73	0.1		0.29	1.55	4.13	6.93	0.08	0.1	0.36	0.92	1.44	2.47
18.5	0.02	0.45	1.38	2.2	1.84	0.3		0.99	0.79	2.27	1.06	0.21	0.04	0.01	1.54	1.51	0.56
20.5	0.07	0.17	0.07	2.31	2.62	2.3		0.41	0.11	0.64	0.21	0.09	0	0	0.61	0.68	0.15
22.5	0.23	0.02	0.57	4.76	4.33	3.33		0.09	0.05	0.15	0.08	0.77	0.13	0	0	0.1	0.06
24.5	0.64	0.03	3.67	9.2	5.52	3.72		0.13	0.29	0.88	1.2	3.39	0.18	0.06	0	0.1	0.95
26.5	0.86	0.05	4.45	10	3.49	3.63		0.69	0.7	2.58	4.46	4.77	0.65	0.06	0.04	0.68	1.75
28.5	0.61	0.17	2.64	4.94	2.63	4.65		0.68	0.76	3.09	8.03	2.96	0.97	0.02	0	0.81	1.61
30.5	0.22	0.54	1.38	2.21	4.65	9.27		0.75	0.69	1.28	4.76	0.59	2.4	0.08	0.06	0.56	1.02
32.5	0.43	1.67	0.5	1.46	10.61	15.56		1.45	1.38	0.49	2.18	2.03	3.69	0.32	0.43	0.46	1.38
34.5	0.53	2.52	0.12	2.6	13.01	16.26		3.76	2.56	0.94	3.39	3.11	2.4	0.67	1.06	1.44	1.16
36.5	1.74	3.23	3.14	3.68	8.23	11.27		7.89	3.96	1.5	3.4	2.58	1.85	1.1	3.56	4.18	0.84
38.5	1.29	2.41	11.4	2.57	6.24	10.49		11.51	5.46	2.11	3.06	1.55	1.7	0.79	3.43	9.25	0.56
40.5	1.89	1.44	22.09	2.43	7.68	7.28		11.99	8.86	3.5	3.95	2.9	1.28	1.05	2.57	6.75	0.95
42.5	2.14	0.94	27.89	1.48	6.41	4.14		11.42	9.16	5.85	4.69	3.75	0.99	0.95	1.24	4.4	0.46
44.5	1.97	0.93	21.77	2.62	5.15	4.63		9.35	8.94	5.43	6.07	5.58	0.56	0.78	0.88	2.42	0.47
46.5	1.86	1.04	18.37	3.63	3.82	3.28		5.9	7.7	4.88	3.49	5.08	0.9	0.7	0.42	1.43	0.36
48.5	1.48	0.7	12.95	2.61	3.36	2.49		3.45	4.71	2.87	2.89	4.52	0.83	0.48	0.24	0.76	0.15
50.5	0.85	0.73	9.94	2.59	3.33	2.48		2.27	2.59	1.86	1.76	3.14	0.81	0.48	0.06	0.53	0.11
52.5	0.99	0.72	8.28	1.74	2.51	1.58		1.17	1.61	1.24	0.95	1.61	0.46	0.28	0.07	0.26	0.06
54.5	0.5	0.3	6.22	1.41	2.07	1.36		1.1	0.76	0.7	1.04	0.71	0.31	0.34	0.04	0.15	0.02
56.5	0.51	0.33	3.13	1.29	1.46	0.91		0.52	0.56	0.34	0.58	0.67	0.26	0.11	0.02	0.15	0.02
58.5	0.44	0.39	2.87	0.79	0.7	0.61		0.31	0.35	0.23	0.31	0.32	0.11	0.03	0.07	0.16	0
60.5	0.35	0.3	2.37	0.73	0.48	0.31		0.25	0.18	0.27	0.31	0.15	0.13	0.11	0.01	0.08	0.02
62.5	0.2	0.18	1.12	0.64	0.27	0.36		0.08	0.07	0.09	0.08	0.14	0.03	0.05	0.01	0.06	0
64.5	0.07	0.06	0.37	0.36	0.12	0.22		0.1	0.02	0.1	0.02	0	0.04	0.03	0.01	0.04	0
66.5	0.2	0.11	0.37	0.11	0.14	0.11		0.03	0	0.03	0.04	0.05	0	0	0	0	0.02
68.5	0.04	0.05	0.08	0.1	0.04	0.04		0.03	0	0	0	0	0	0	0	0	0
70.5	0.02	0.02	0	0.06	0.06	0.13		0.02	0.05	0	0	0	0	0	0	0	0
72.5	0.05	0	0	0.03	0.01	0.02		0	0	0.01	0	0	0.02	0	0	0.02	0
74.5	0	0.01	0.02	0.02	0	0.01		0	0	0	0	0	0	0	0	0	0
76.5	0.01	0	0	0	0.01	0.02		0	0	0	0	0	0	0	0	0	0
78.5	0	0	0	0.02	0	0.01		0	0	0.01	0	0	0	0	0	0	0
80.5	0.01	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
82.5	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
84.5	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
sum	20.23	24.99	193.38	100.24	114.79	112.48	0	76.85	65.04	49.05	77.64	50.85	20.87	9.48	17.41	38.66	17.37

Table 13. Catch and RV numbers from slicing.

Sliced Catch Numbers													
	70	71	72	73	74	75	76	77	78	79	80	81	82
1	480	189	473	532	35	222	408	48	652	6	822	1025	905
2	268	472	172	1016	254	75	499	60	420	113	85	128	152
3	1184	949	467	994	822	358	227	402	793	257	1318	1111	903
4	1631	2207	754	1168	315	562	224	955	1552	628	3797	4031	2043
5	1594	2285	832	919	401	439	267	451	1030	784	3273	4779	3533
6	999	1665	624	492	188	175	190	337	625	500	2167	3244	2514
7	929	1487	550	499	185	197	204	240	416	208	1023	1581	1418
sum	7085	9253	3871	5621	2200	2029	2020	2493	5488	2497	12484	15902	11469
	83	84	85	86	87	88	89	90	91	92	93	94	
1	1145	804	848	10	58	100	1575	184	18	3	6	17	
2	354	393	70	38	103	76	764	471	255	22	20	15	
3	597	1075	475	1006	128	92	325	233	722	980	149	6	
4	2159	3532	4714	8121	466	1043	1917	1164	1688	2120	454	11	
5	2187	2016	4471	7421	1586	1992	2976	2583	1613	1747	344	13	
6	1634	873	1206	1319	885	663	1065	1274	704	682	182	9	
7	925	536	469	263	155	87	157	122	100	145	49	2	
sum	9002	9229	12254	18178	3381	4054	8778	6031	5100	5697	1204	74	
Sliced RV Numbers													
70	71	72	73	74	75	76	77	78	79	80	81	82	
1	2.69	1.72	1.49	0.59	0.36	4.45	3.18	6.11	10.44	0.26	3.53	15.16	18.15
2	1.06	3.1	1.15	1.45	1.82	1.31	2.08	10.03	10.65	9.15	0.52	8.55	14.84
3	1.78	1.43	0.93	0.67	2.57	1.31	1.23	6.75	13.16	9.15	11.97	3.13	8.5
4	1.85	1.54	0.57	0.38	1.14	1.87	0.87	4.52	7.63	9.13	13.74	5.46	9.01
5	1.19	0.87	0.54	0.38	0.59	0.94	0.75	1.52	2.55	3.82	9.7	5.21	5.36
6	0.58	0.39	0.24	0.16	0.3	0.45	0.37	0.98	0.41	1.2	3.21	2.1	3.55
7	0.64	0.27	0.16	0.2	0.19	0.55	0.16	0.68	0.3	0.33	0.93	0.9	1.57
sum	9.79	9.33	5.07	3.82	6.96	10.88	8.64	30.59	45.14	33.04	43.59	40.51	60.98
	83	84	85	86	87	88	89	90	91	92	93	94	
1	25.07	0.64	4.18	0.8	2.72	4.27	13.94	1.81	0.24	0.81	2.56	6.95	
2	14.78	9.63	1.85	1.6	1.39	10.94	6.13	17.46	11.77	3.03	2.04	5.36	
3	24.13	20.44	10.6	12.12	4.46	13.68	3.77	9.33	31.05	16.1	11.11	6.82	
4	11.52	25.48	16.18	21.94	11.76	13.72	8.38	7.43	13.76	6.14	7.7	6.52	
5	5.37	6.54	8.21	10.37	8.76	10.3	7.49	5.27	5.6	2.09	1.57	0.95	
6	2.73	2.39	2.41	2.58	1.42	1.81	1.5	1.01	0.54	0.41	0.23	0.1	
7	1.27	1.29	0.75	0.82	0.23	0.31	0.19	0.09	0.01	0.03	0.01	0.01	
sum	84.88	66.4	44.19	50.22	30.74	55.02	41.41	42.4	62.97	28.6	25.22	26.7	

Table 14. ModelKey Catch and RV Numbers.

ModelKey Catch Numbers													
	70	71	72	73	74	75	76	77	78	79	80	81	82
1	480	189	473	532	35	222	408	48	652	6	822	1025	905
2	268	472	172	1016	254	75	499	60	420	113	85	128	152
3	1184	949	467	994	822	358	227	402	793	257	1318	1111	903
4	1631	2207	754	1168	315	562	224	955	1552	628	3797	4031	2043
5	1594	2285	832	919	401	439	267	451	1030	784	3273	4779	3533
6	999	1665	624	492	188	175	190	337	625	500	2167	3244	2514
7	929	1487	550	499	185	197	204	240	416	208	1023	1581	1418
sum	7085	9253	3871	5621	2200	2029	2020	2493	5488	2497	12484	15902	11469
	83	84	85	86	87	88	89	90	91	92	93	94	
1	1145	804	848	10	58	100	1575	184	18	3	6	17	
2	354	393	70	38	103	76	764	471	255	22	20	15	
3	597	1075	475	1006	128	92	325	233	722	980	149	6	
4	2159	3532	4714	8121	466	1043	1917	1164	1688	2120	454	11	
5	2187	2016	4471	7421	1586	1992	2976	2583	1613	1747	344	13	
6	1634	873	1206	1319	885	663	1065	1274	704	682	182	9	
7	925	536	469	263	155	87	157	122	100	145	49	2	
sum	9002	9229	12254	18178	3381	4054	8778	6031	5100	5697	1204	74	
ModelKey RV Numbers													
	70	71	72	73	74	75	76	77	78	79	80	81	82
1	2.69	1.72	1.49	0.59	0.36	4.45	3.18	6.11	10.44	0.26	3.53	15.16	18.15
2	1.06	3.1	1.15	1.45	1.82	1.31	2.08	10.03	10.65	9.15	0.52	8.55	14.84
3	1.78	1.43	0.93	0.67	2.57	1.31	1.23	6.75	13.16	9.15	11.97	3.13	8.5
4	1.85	1.54	0.57	0.38	1.14	1.87	0.87	4.52	7.63	9.13	13.74	5.46	9.01
5	1.19	0.87	0.54	0.38	0.59	0.94	0.75	1.52	2.55	3.82	9.7	5.21	5.36
6	0.58	0.39	0.24	0.16	0.3	0.45	0.37	0.98	0.41	1.2	3.21	2.1	3.55
7	0.64	0.27	0.16	0.2	0.19	0.55	0.16	0.68	0.3	0.33	0.93	0.9	1.57
sum	9.79	9.33	5.07	3.82	6.96	10.88	8.64	30.59	45.14	33.04	43.59	40.51	60.98
	83	84	85	86	87	88	89	90	91	92	93	94	
1	25.07	0.64	4.18	0.8	2.72	4.27	13.94	1.81	0.24	0.81	2.56	6.95	
2	14.78	9.63	1.85	1.6	1.39	10.94	6.13	17.46	11.77	3.03	2.04	5.36	
3	24.13	20.44	10.6	12.12	4.46	13.68	3.77	9.33	31.05	16.1	11.11	6.82	
4	11.52	25.48	16.18	21.94	11.76	13.72	8.38	7.43	13.76	6.14	7.7	6.52	
5	5.37	6.54	8.21	10.37	8.76	10.3	7.49	5.27	5.6	2.09	1.57	0.95	
6	2.73	2.39	2.41	2.58	1.42	1.81	1.5	1.01	0.54	0.41	0.23	0.1	
7	1.27	1.29	0.75	0.82	0.23	0.31	0.19	0.09	0.01	0.03	0.01	0.01	
sum	84.88	66.4	44.19	50.22	30.74	55.02	41.41	42.4	62.97	28.6	25.22	26.7	

Table 15. ModelKey residuals.

Residuals													
	70	71	72	73	74	75	76	77	78	79	80	81	82
2	-0.64	0.52	-0.31	-0.28	0.04	-0.87	-0.92	0.33	0.21	0.23	-2.13	0.7	0.82
3	-0.97	-0.71	-1.11	-1.17	-0.03	-0.74	-1.45	-0.25	0.09	-0.47	0.02	-0.79	0.22
4	-1.16	-0.79	-1.5	-1.79	-0.53	-0.25	-1.21	-0.17	-0.15	-0.37	-0.03	-0.64	0.38
5	-1.34	-1.19	-1.15	-1.21	-0.84	-0.34	-0.87	-0.4	-0.39	-0.6	0.04	-0.39	0.06
6	-1.52	-1.39	-1.46	-1.39	-0.62	-0.53	-0.67	-0.05	-0.98	-0.59	-0.05	-0.47	0.45
4-6	-0.93	-0.33	-0.97	-1.08	-0.17	-0.62	-1.2	-0.03	0.05	-0.2	-0.72	-0.24	0.47
	83	84	85	86	87	88	89	90	91	92	93	94	
2	0.49	0.38	-0.51	-0.87	-0.95	1.46	0.87	2.09	1.08	-0.29	-0.16	-1.27	
3	0.79	0.32	-0.03	0.93	-0.37	0.81	-0.1	0.82	2.26	0.94	0.49	0.51	
4	0.64	0.94	0.17	1.3	0.88	0.71	0.38	0.64	1.38	1.22	0.15	-0.19	
5	0.55	0.74	0.76	1.1	1.52	1.36	0.84	0.86	1.16	0.86	0.71	-1.84	
6	0.67	0.88	1.25	1.59	1.47	1.48	1.3	0.94	0.33	0.6	0.34	-1.59	
4-6	0.64	0.54	-0.12	0.45	-0.15	0.99	0.38	1.19	1.58	0.63	0.16	-0.31	

Table 16. Fishing mortality and population numbers from ModelKey.

Fishing Mortality													
	70	71	72	73	74	75	76	77	78	79	80	81	82
1	0.07	0.04	0.06	0.09	0	0.01	0.02	0	0.03	0	0.06	0.05	0.03
2	0.05	0.09	0.04	0.19	0.05	0.01	0.04	0	0.02	0.01	0.01	0.01	0.01
3	0.19	0.25	0.13	0.35	0.24	0.1	0.03	0.04	0.05	0.01	0.09	0.12	0.1
4	0.3	0.67	0.32	0.54	0.18	0.25	0.08	0.19	0.19	0.05	0.29	0.41	0.35
5	0.42	0.89	0.58	0.82	0.36	0.4	0.18	0.24	0.33	0.14	0.42	0.72	0.8
6	0.42	1.08	0.65	0.82	0.38	0.26	0.3	0.37	0.62	0.26	0.7	1	1.12
7	1.08	2.51	1.47	2.07	0.87	0.87	0.54	0.77	1.09	0.43	1.33	2.02	2.15
3-6	0.33	0.72	0.42	0.63	0.29	0.25	0.15	0.21	0.3	0.12	0.37	0.56	0.59
	83	84	85	86	87	88	89	90	91	92	93	94	
1	0.05	0.08	0.07	0	0.01	0.01	0.19	0.01	0	0	0	0	
2	0.01	0.02	0.01	0	0.01	0.01	0.11	0.08	0.02	0	0	0	
3	0.04	0.06	0.03	0.16	0.02	0.01	0.06	0.04	0.17	0.12	0.02	0	
4	0.38	0.38	0.37	1.26	0.1	0.17	0.36	0.32	0.51	1.12	0.08	0	
5	0.8	0.74	1.23	1.96	0.93	0.85	1.01	1.23	1.01	1.85	0.52	0	
6	1.16	0.92	1.6	2.07	2.18	1.5	2.13	2.43	1.65	2.34	1.13	0.02	
7	2.23	1.94	3.04	5.02	3.05	2.4	3.32	3.78	3.01	5.04	1.64	0.03	
3-6	0.6	0.52	0.81	1.36	0.81	0.63	0.89	1.01	0.84	1.36	0.44	0.01	
ModelKey Population Numbers													
	70	71	72	73	74	75	76	77	78	79	80	81	82
1	7579	5991	8310	7120	11451	19617	26591	31669	26992	15799	16414	24966	33995
2	6139	5771	4734	6376	5348	9344	15860	21401	25884	21510	12929	12695	19513
3	7422	4784	4298	3720	4301	4148	7583	12533	17468	20813	17508	10509	10277
4	7029	5006	3058	3096	2147	2777	3072	6002	9898	13583	16807	13142	7598
5	5157	4279	2102	1821	1478	1473	1765	2312	4050	6699	10553	10325	7112
6	3205	2780	1436	968	660	847	808	1204	1485	2384	4775	5678	4129
7	1525	1720	770	611	348	370	535	490	681	651	1500	1949	1713
sum	38056	30330	24707	23712	25731	38576	56214	75612	86458	81439	80487	79264	84338
	83	84	85	86	87	88	89	90	91	92	93	94	
1	25396	12111	14817	13133	9281	10027	9907	14780	14608	8652	68912	0	
2	27014	19756	9189	11364	10743	7547	8118	6686	11935	11944	7081	56415	
3	15838	21797	15819	7460	9270	8703	6110	5956	5048	9541	9759	5779	
4	7597	12427	16873	12522	5197	7474	7042	4709	4665	3480	6925	7855	
5	4373	4266	6979	9549	2904	3834	5176	4031	2802	2292	931	5259	
6	2625	1601	1669	1668	1103	942	1336	1545	963	834	296	451	
7	1106	671	520	275	172	102	171	131	112	151	66	78	
sum	83949	72629	65866	55970	38671	38628	37861	37837	40132	36894	93970	75838	

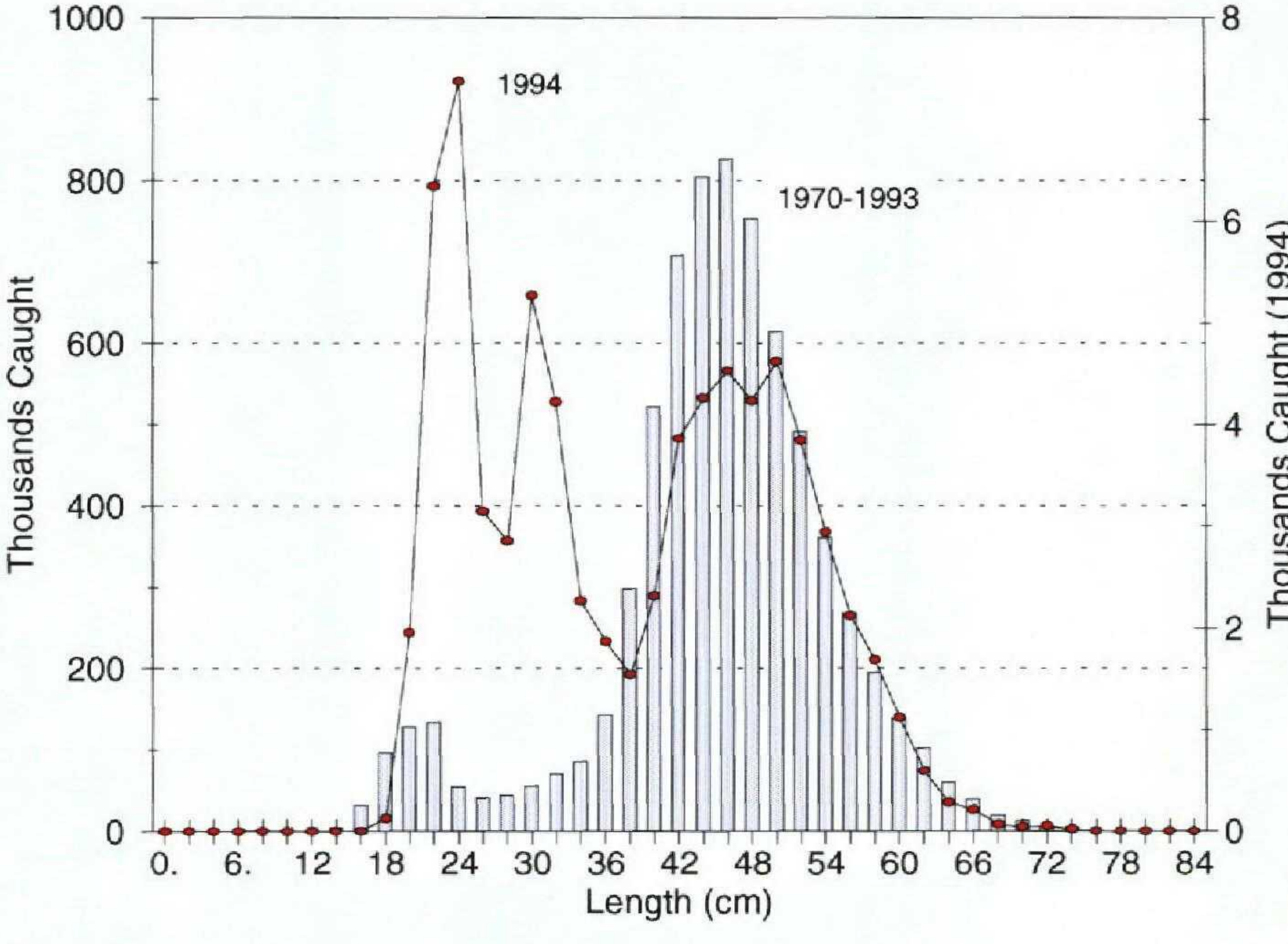

Figure 1. Mean length composition of commercial landings for 1994 and for the period 1990-1993 for comparison.

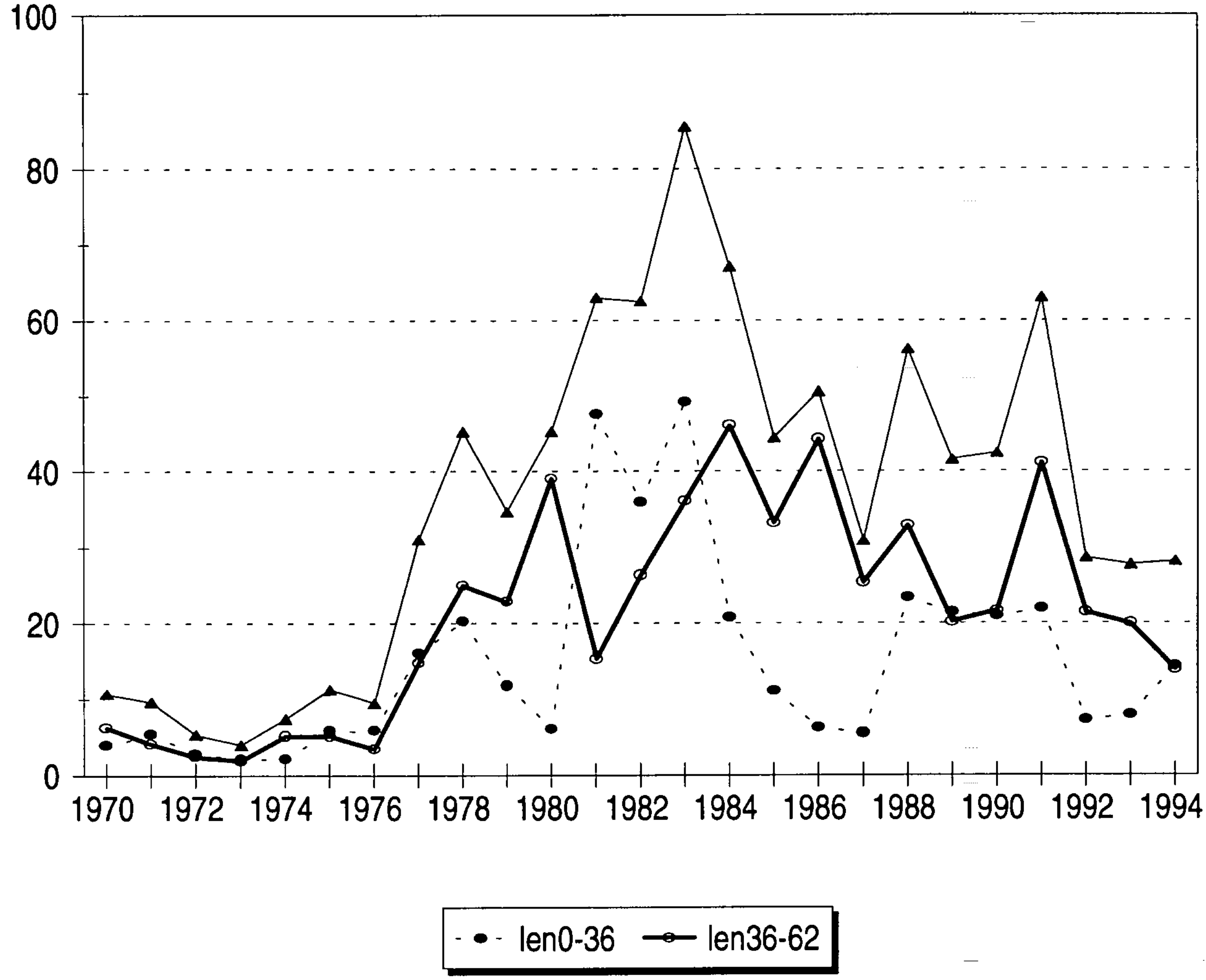

Figure 2. Summer (July) Research Vessel catch rates of haddock in Divisions 4VW. The thin solid line shows results for all length classes while the dotted line show catch rates for fish with lengths from 0-36 cm (pre-recruits) and the thick solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

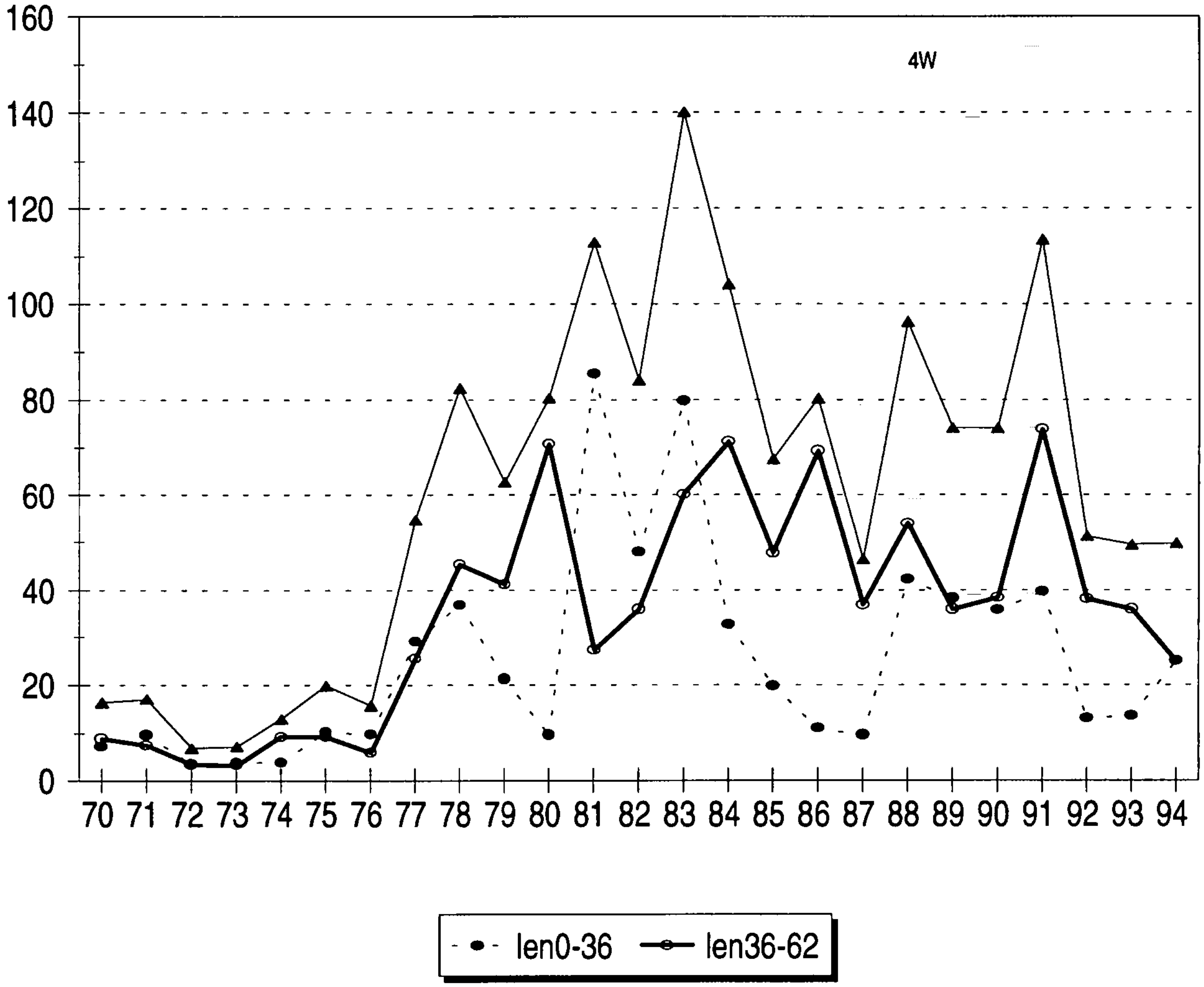

Figure 3. Summer (July) Research Vessel catch rates of haddock in Division 4W. The thin solid line shows results for all length classes while the dotted line show catch rates for fish with lengths from 0-36 cm (pre-recruits), and the thick solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

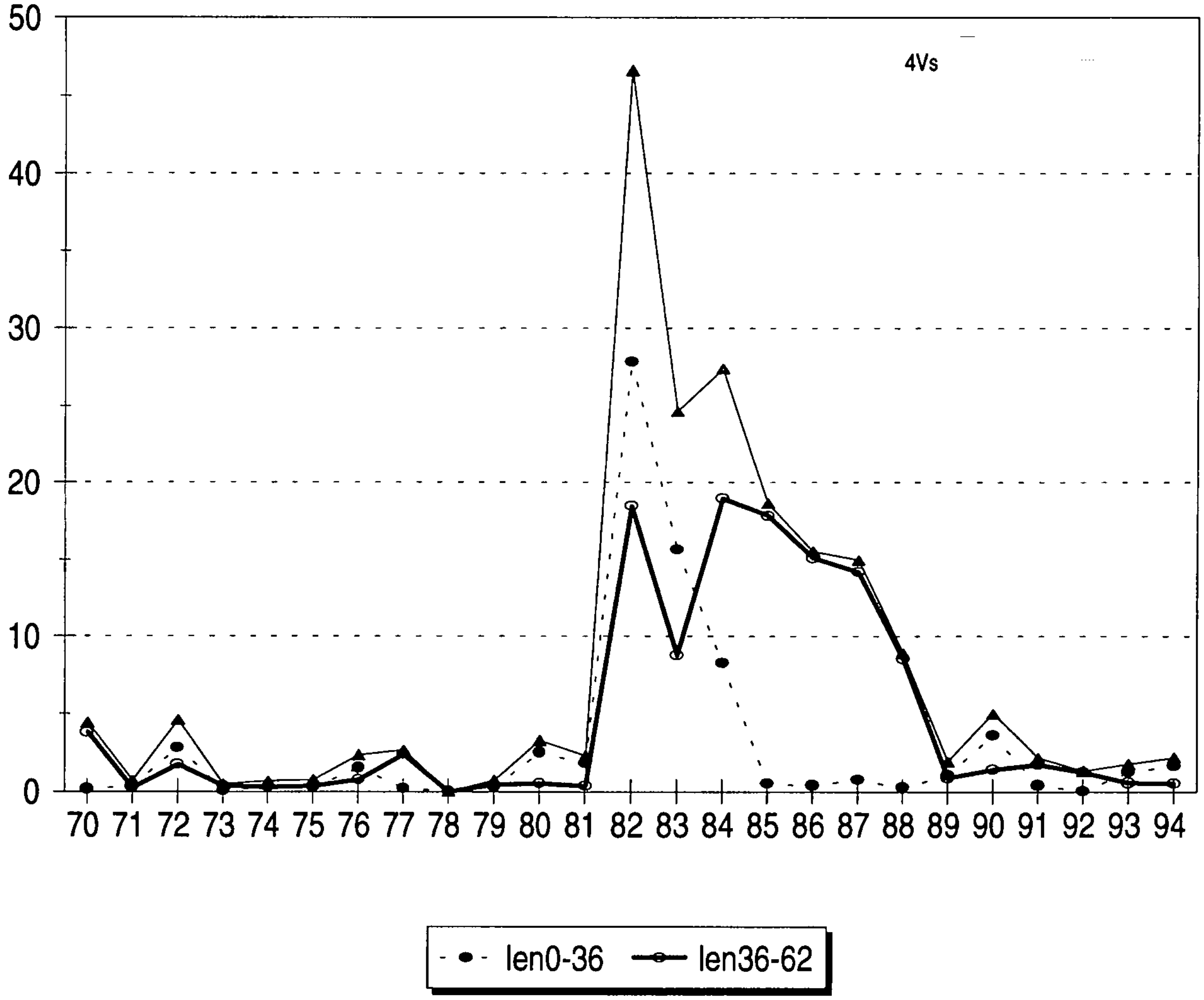

Figure 4. Summer (July) Research Vessel catch rates of haddock in Sub-Division 4Vs. The thin solid line shows results for all length classes while the dotted line show catch rates for fish with lengths from 0-36 cm (pre-recruits), and the thick solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

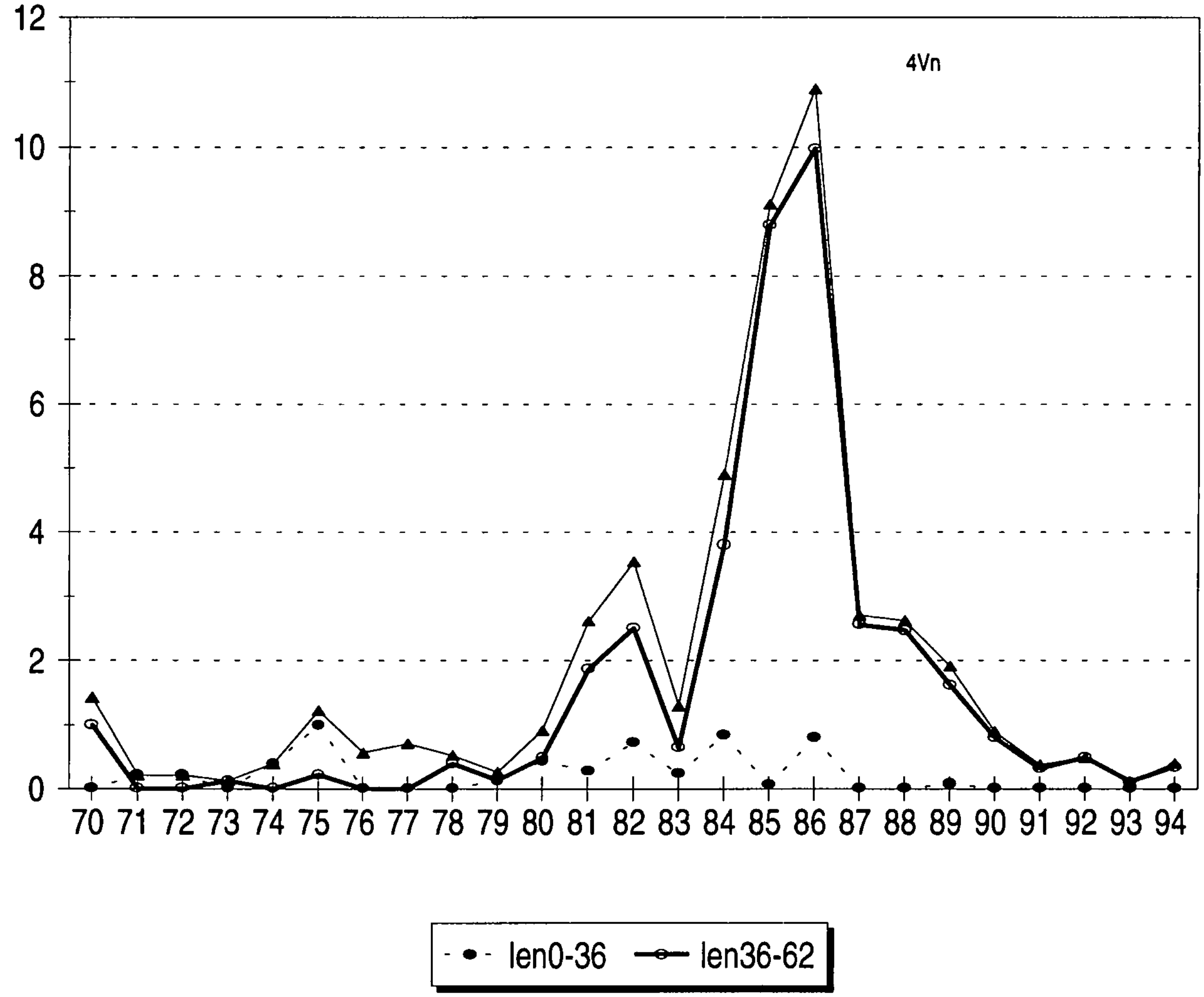

Figure 5. Summer (July) Research Vessel catch rates of haddock in Sub-Division 4Vn. The thin solid line shows results for all length classes while the dotted line show catch rates for fish with lengths from 0-36 cm (pre-recruits), and the thick solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

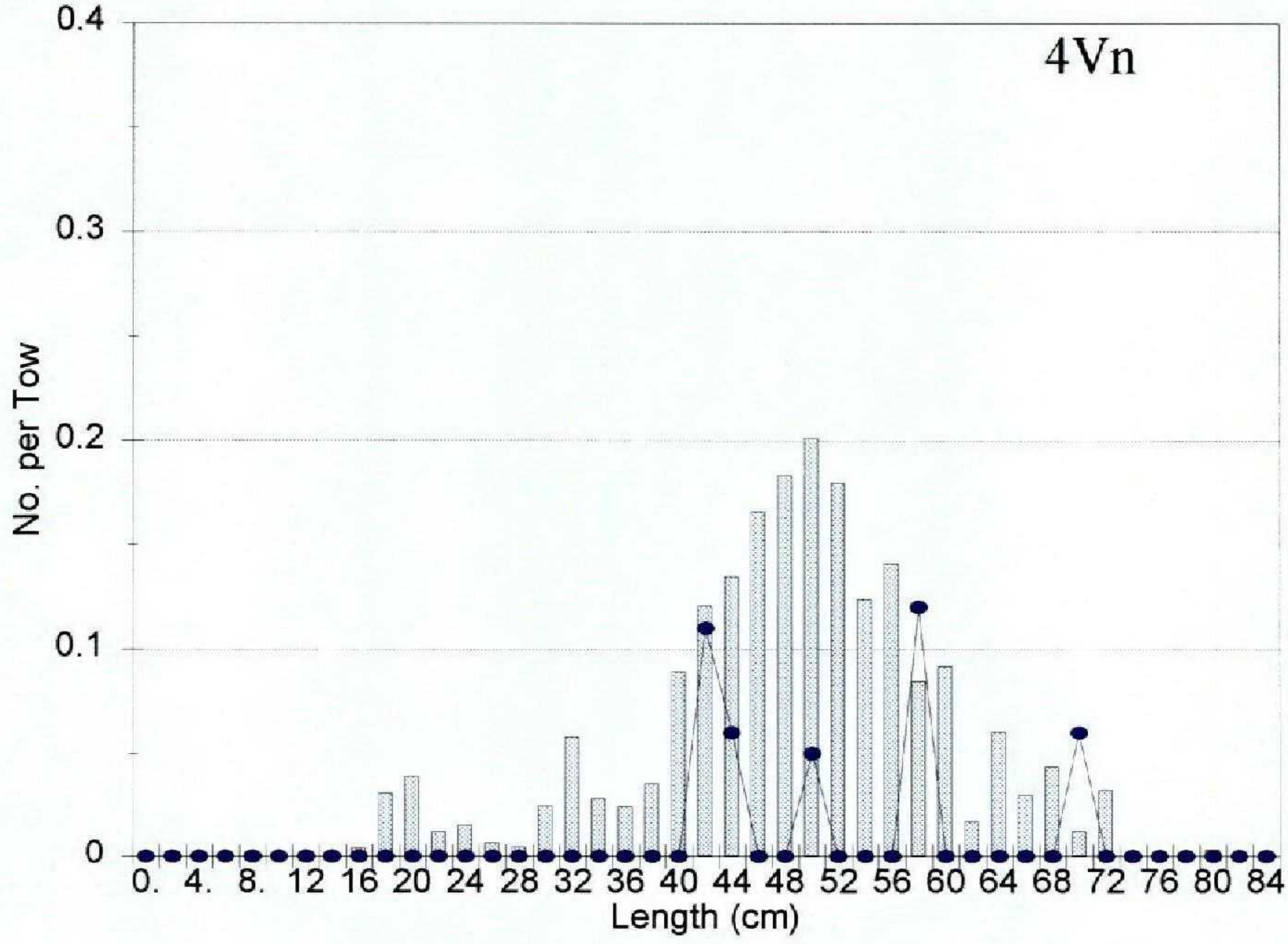

Figure 6. Catch rates by haddock length group observed during the summer (July) research vessel surveys conducted in Sub-Division 4Vn. The bars represent the mean catch rates at length for the period 1970-1993, while the line represents catch rates at length observed in 1994.

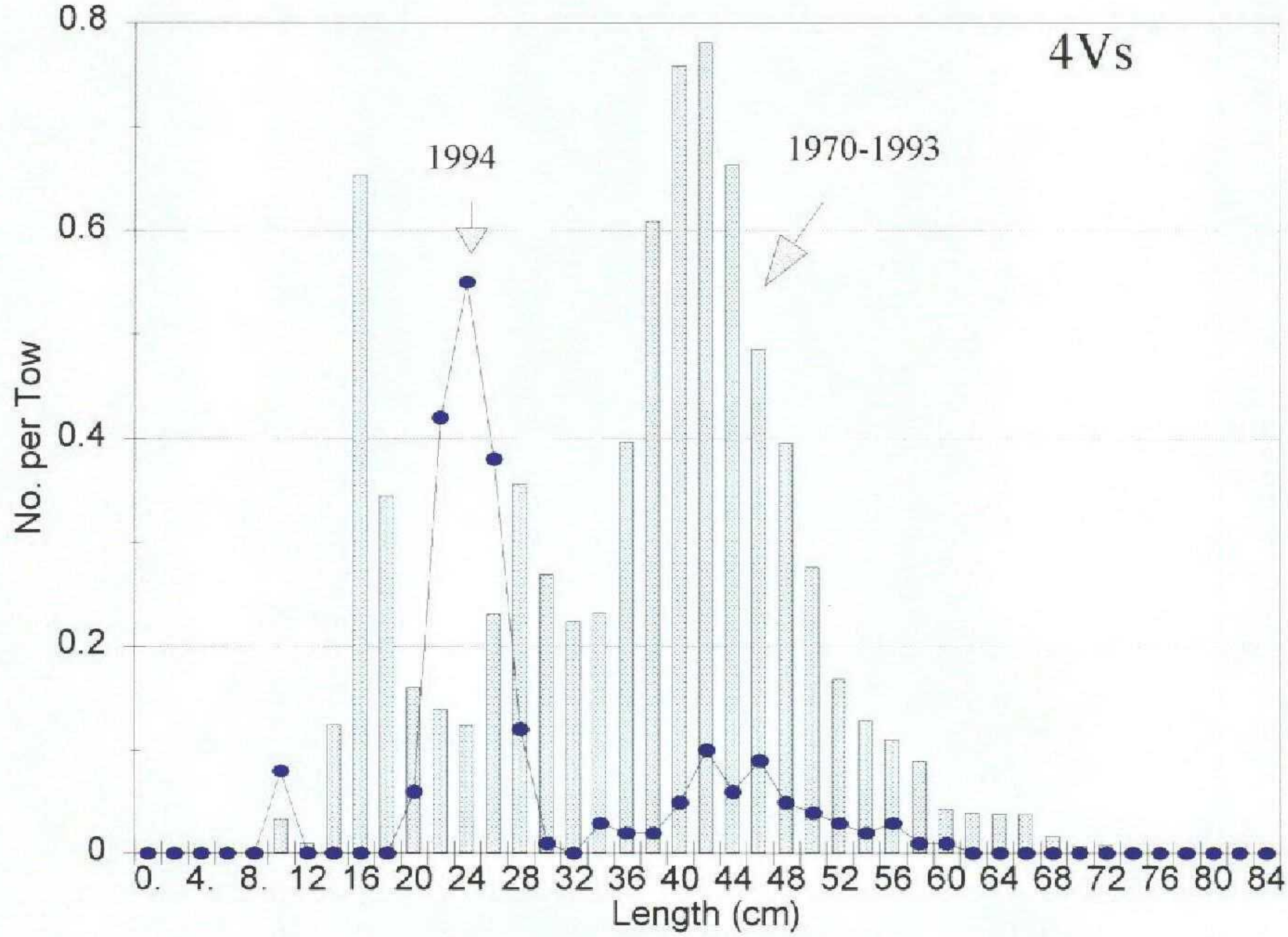

Figure 7. Catch rates by haddock length group observed during the summer (July) research vessel surveys conducted in Sub-Division 4Vs. The bars represent the mean catch rates at length for the period 1970-1993, while the line represents catch rates at length observed in 1994.

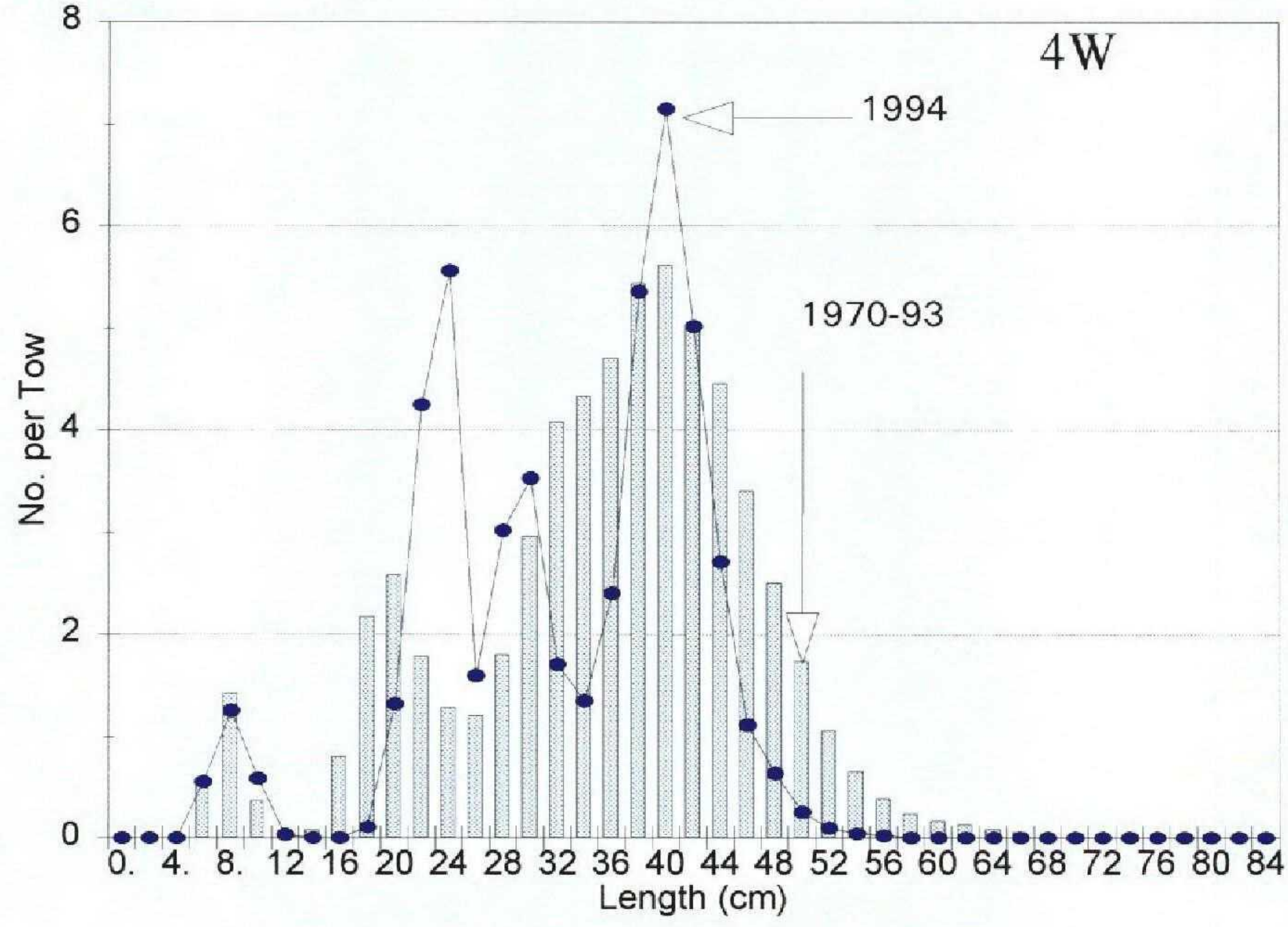

Figure 8. Catch rates by haddock length group observed during the summer (July) research vessel surveys conducted in Division 4W. The bars represent the mean catch rates at length for the period 1970-1993, while the line represents catch rates at length observed in 1994.

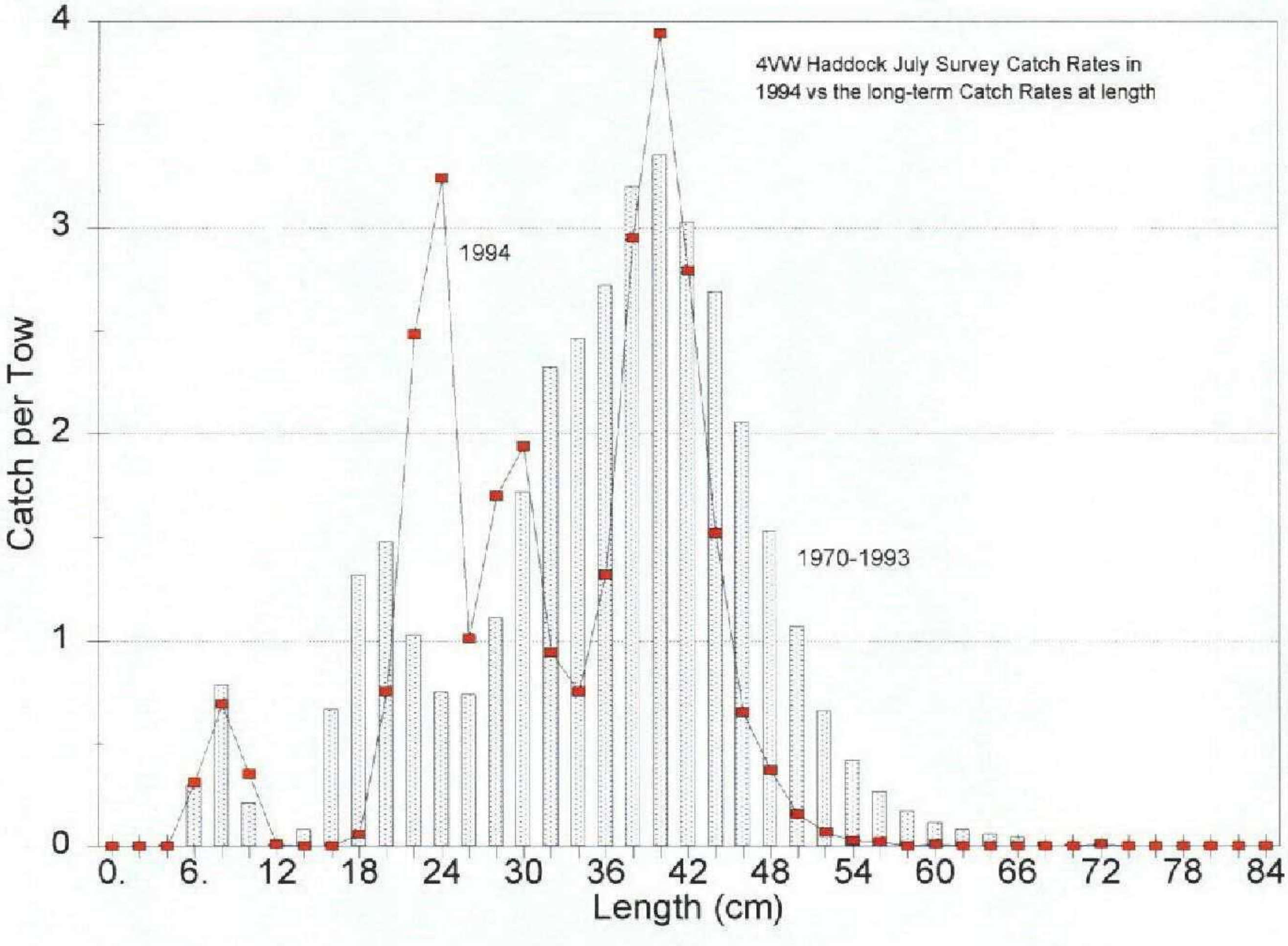

Figure 9. Catch rates by haddock length group observed during the summer (July) research vessel surveys conducted in Divisions 4VW. The bars represent the mean catch rates at length for the period 1970-1993, while the line represents catch rates at length observed in 1994.

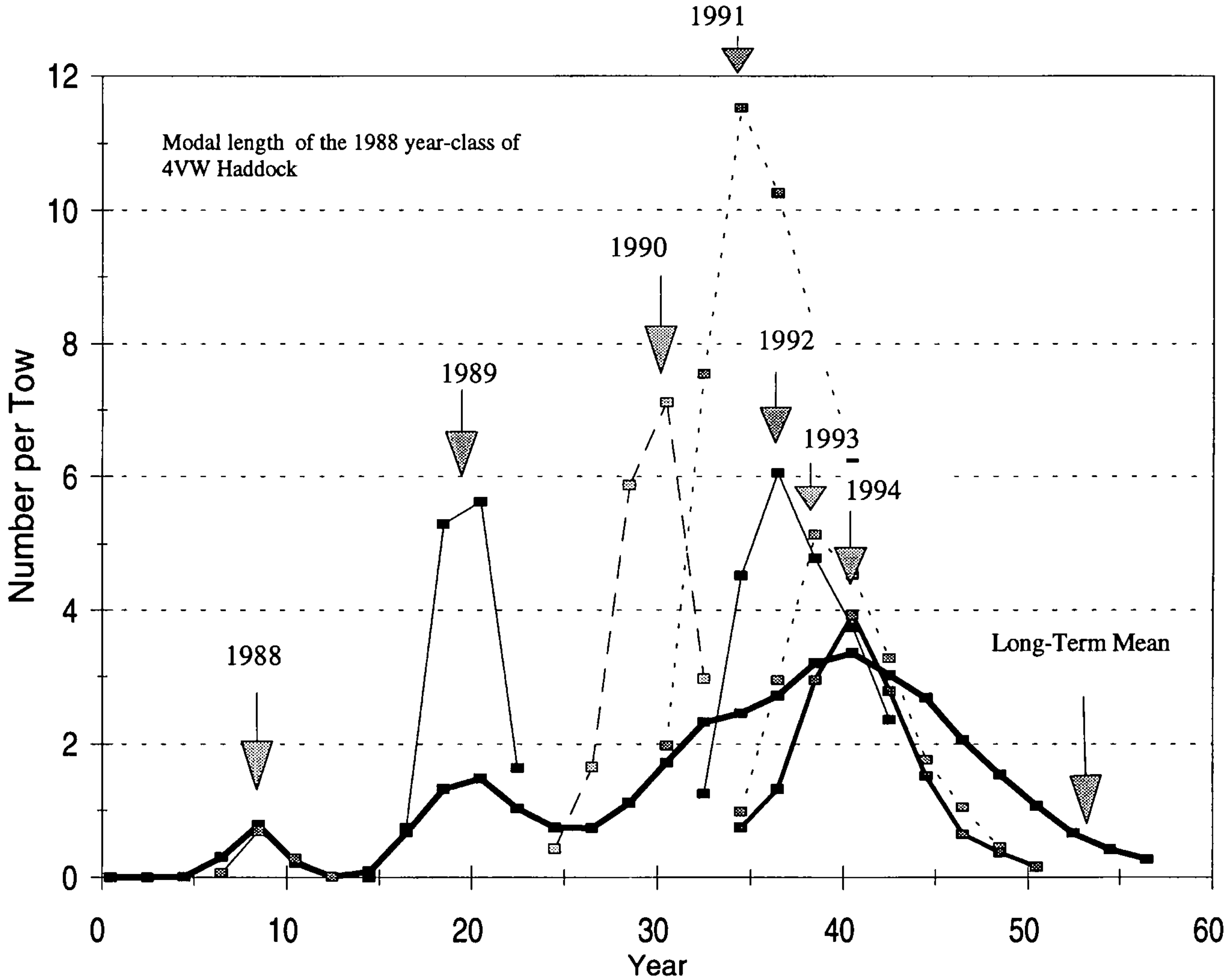

Figure 10. Modal length of the assumed 1988 year-class relative to the long-term mean length composition of the stock.

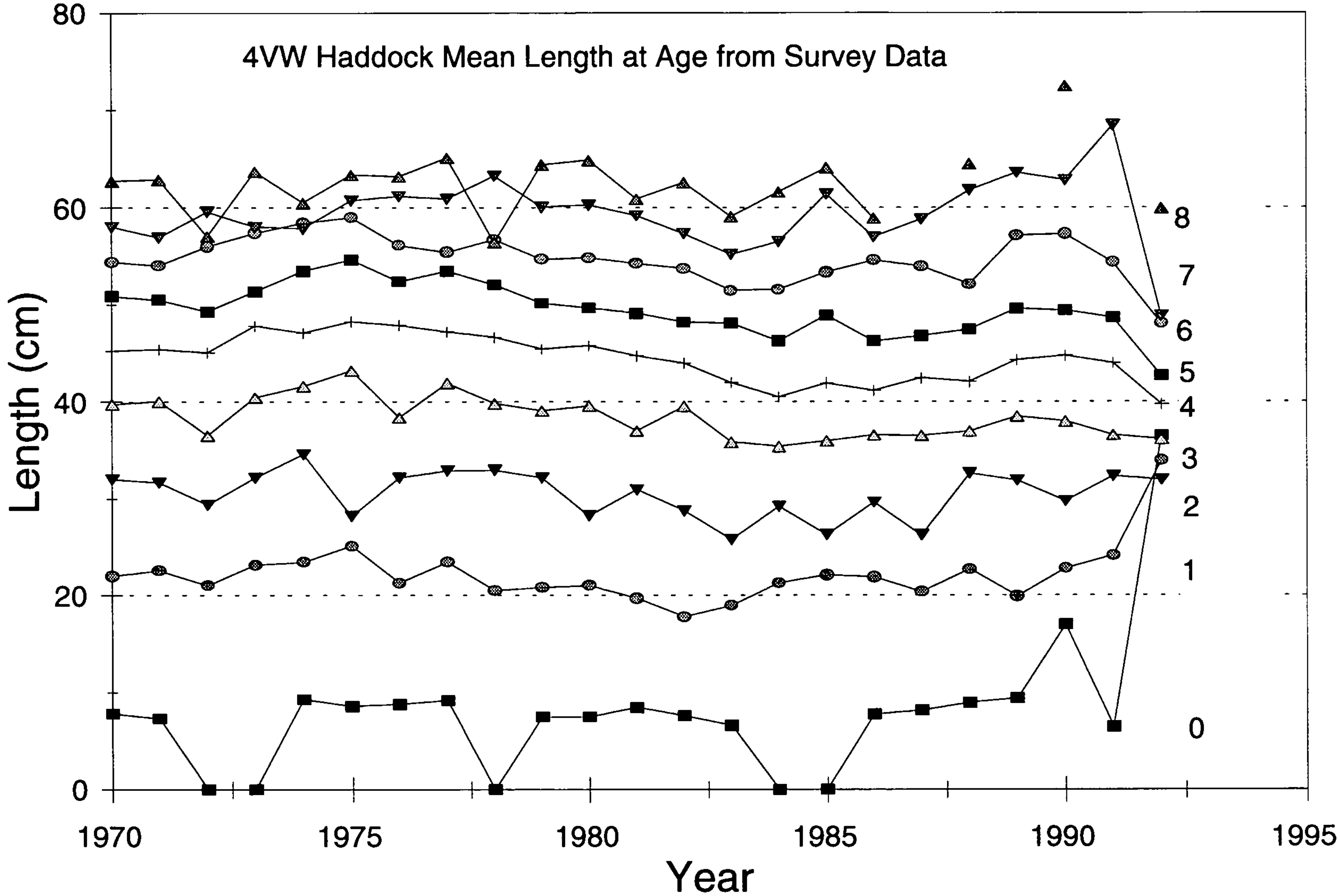

Figure 11. Mean lengths at age (as determined by historical ageing conventions) of haddock caught during the summer (July) surveys of Divisions 4VW.

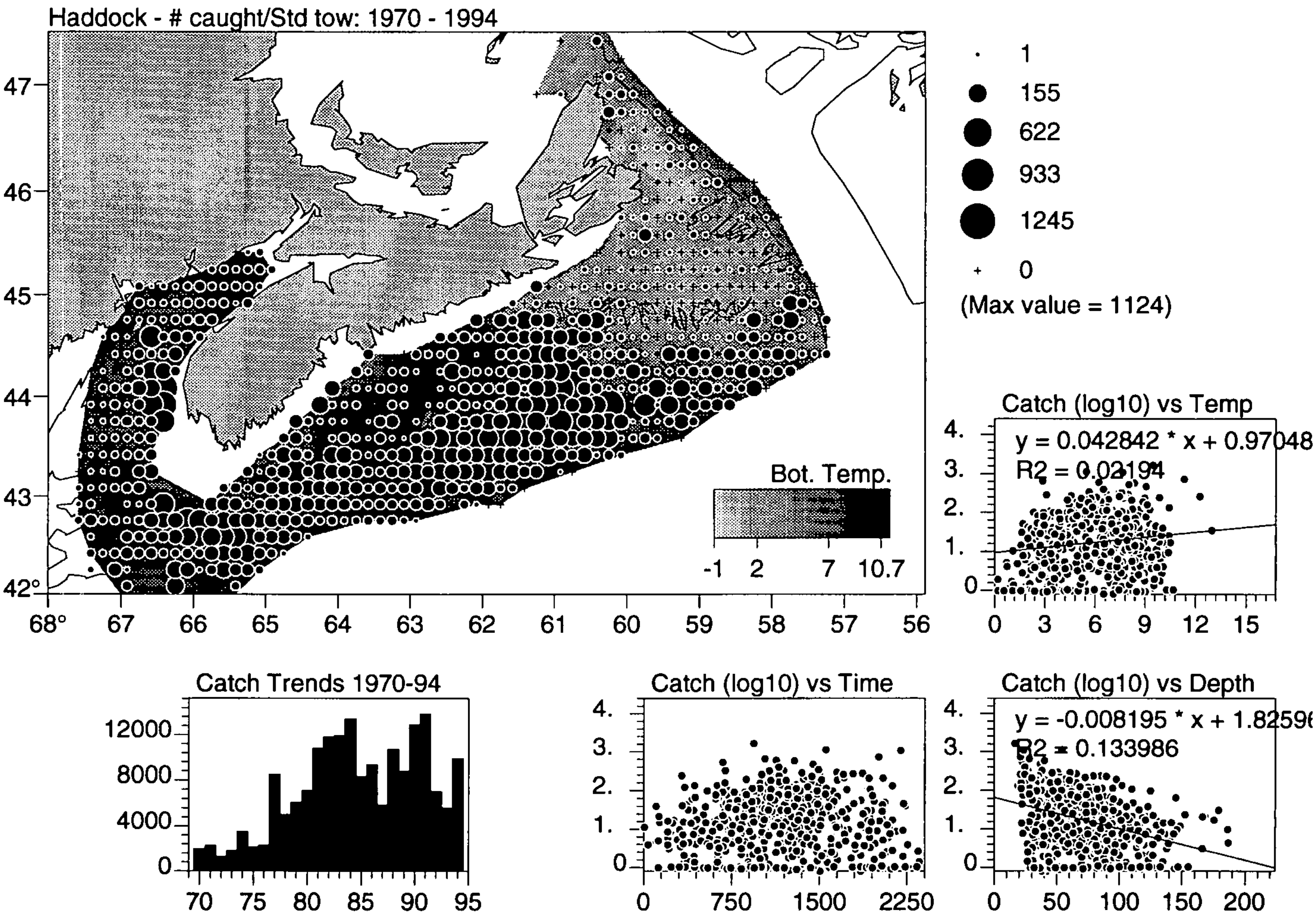

Figure 12a. Long-term geographic distribution of haddock on the Scotian Shelf during the summer (June-August) months. The distribution is overlayed on the mean bottom temperature of estimated at the time and location of the survey. Both haddock abundance and bottom temperature were averaged within 10 minute squares. Also shown on the inset panels are the overall mean catch rates per year for each year of the survey, the mean catch per survey tow versus time of day, the mean catch per survey tow versus (ln) depth, and mean (ln) catch per survey tow versus bottom temperature.

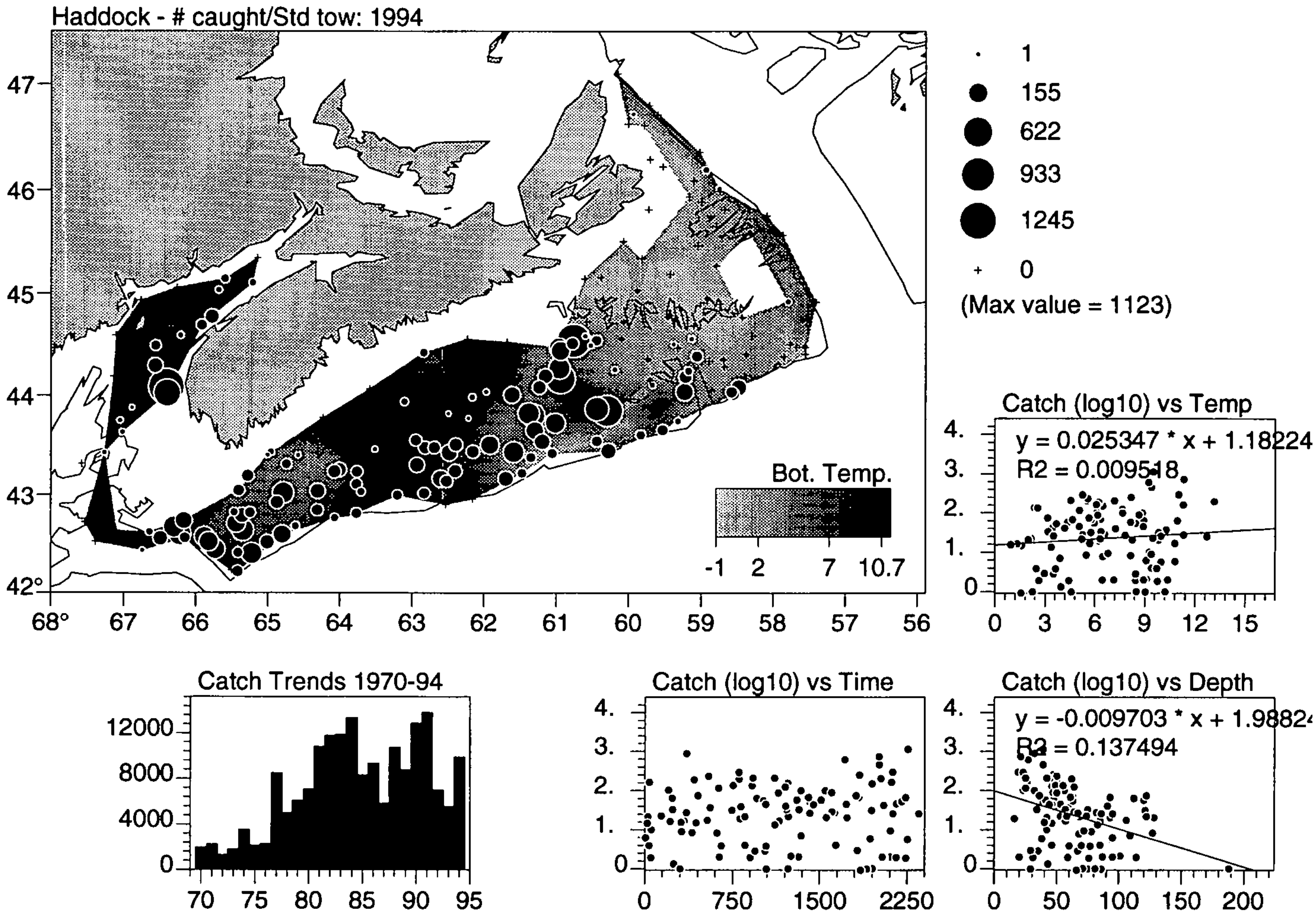

Figure 12b. Geographic distribution of haddock on the Scotian Shelf during the summer of 1994 The distribution is overlayed on the mean bottom temperature of estimated at the time and location of the survey. Also shown on the inset panels are the overall mean catch rates per year for each year of the survey, and for 1994, the mean catch per survey tow versus time of day, the mean catch per survey tow versus (ln) depth, and mean (ln) catch per survey tow versus bottom temperature.

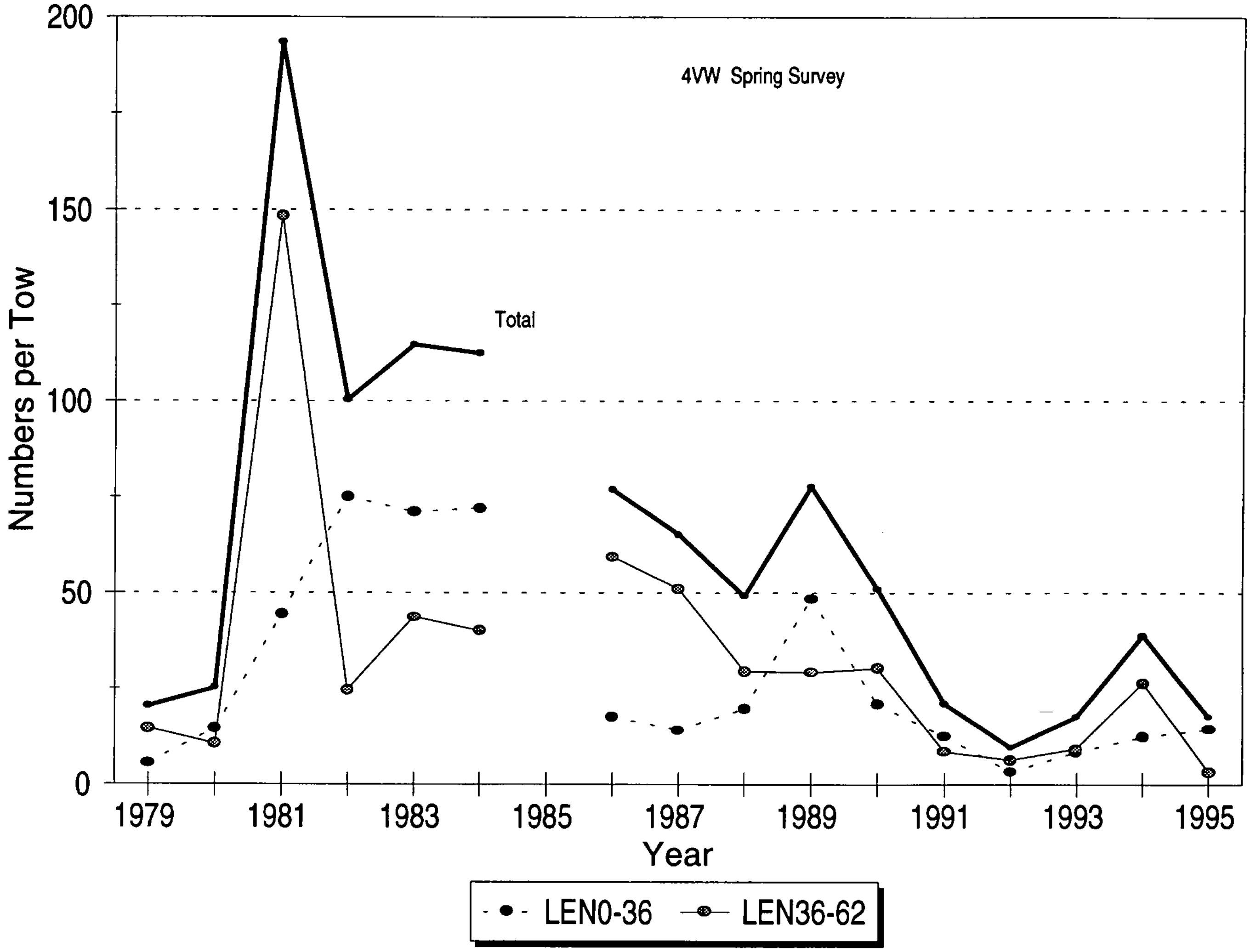

Figure 13a. Spring (March) Research Vessel catch rates of haddock in Divisions 4VW. The thick solid line shows results for all length classes while the dotted line shows catch rates for fish with lengths from 0-36 cm (pre-recruits), and the thin solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

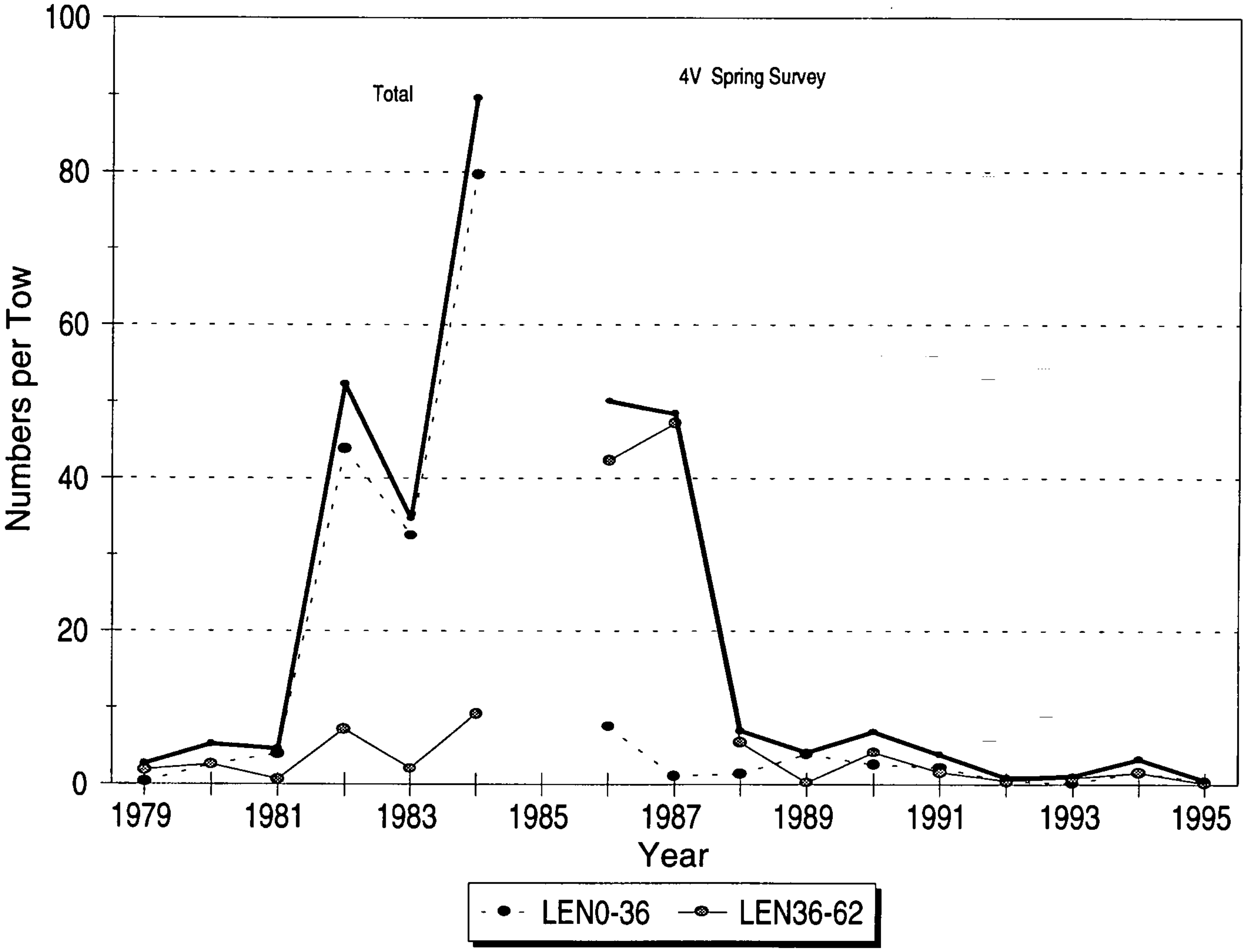

Figure 13b. Spring (March) Research Vessel catch rates of haddock in Sub-Division 4Vs. The thick solid line shows results for all length classes while the dotted line shows catch rates for fish with lengths from 0-36 cm (pre-recruits), and the thin solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

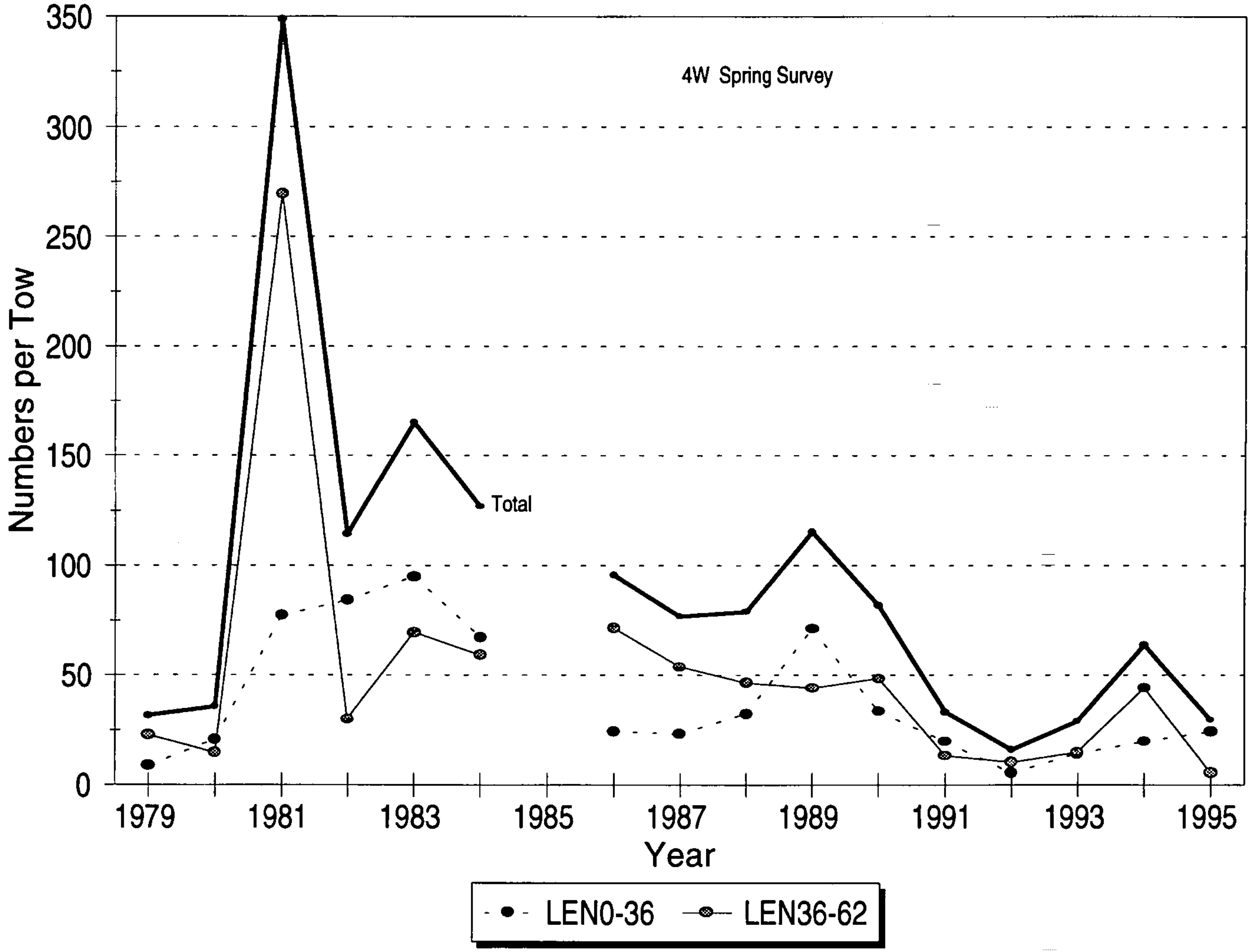

Figure 13c. Spring (March) Research Vessel catch rates of haddock in Division 4W. The thick solid line shows results for all length classes while the dotted line shows catch rates for fish with lengths from 0-36 cm (pre-recruits), and the thin solid line shows results for fish with lengths from 36-62 cm, this being the recruited portion of the population.

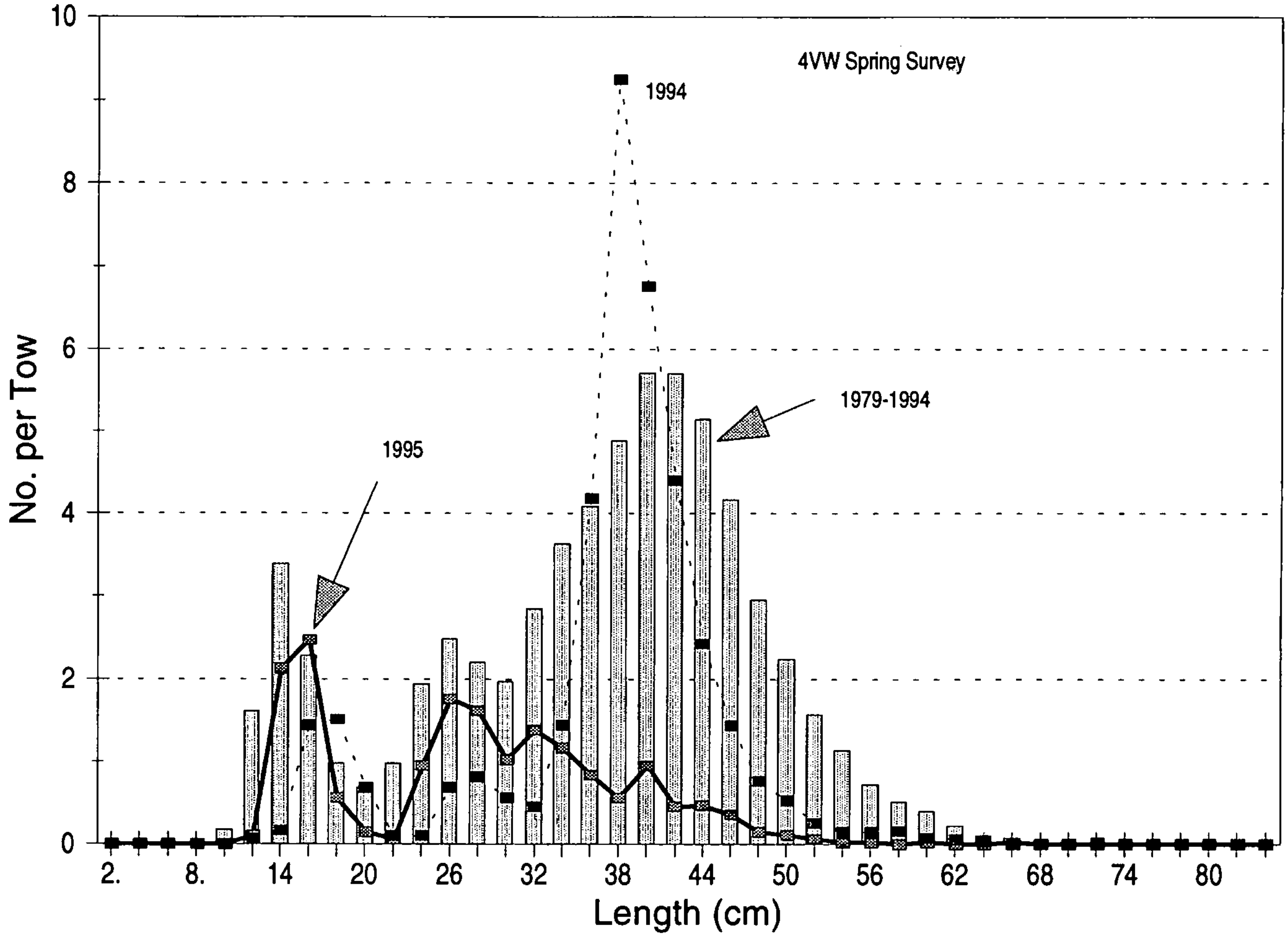

Figure 14a. Catch rates by haddock length group observed during the spring (March) research vessel surveys conducted in Divisions 4VW. The bars represent the mean catch rates at length for the period 1979-1994, while the line represents catch rates at length observed in 1995.

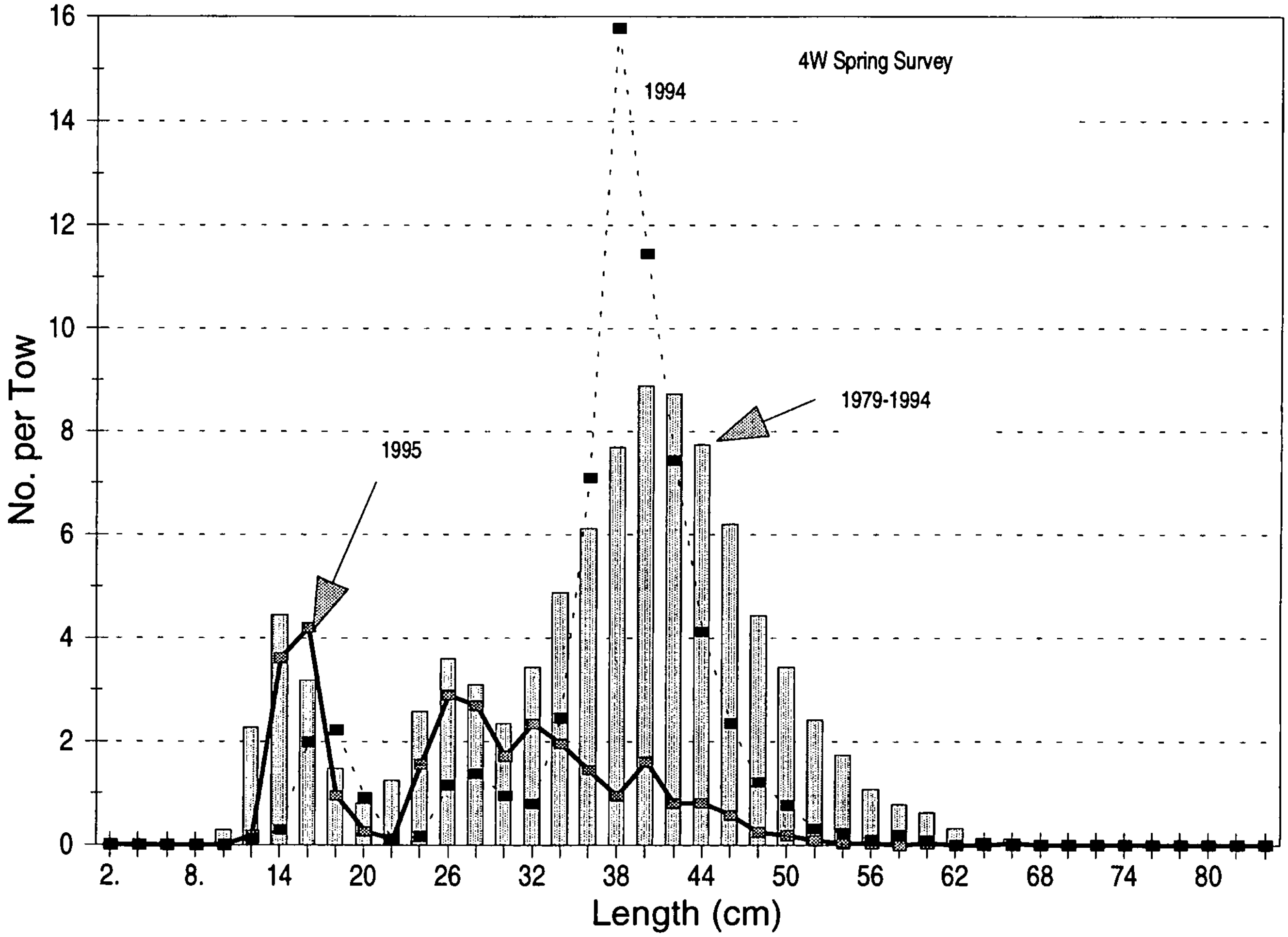

Figure 14b. Catch rates by haddock length group observed during the spring (March) research vessel surveys conducted in Division 4W. The bars represent the mean catch rates at length for the period 1979-1994, while the line represents catch rates at length observed in 1995.

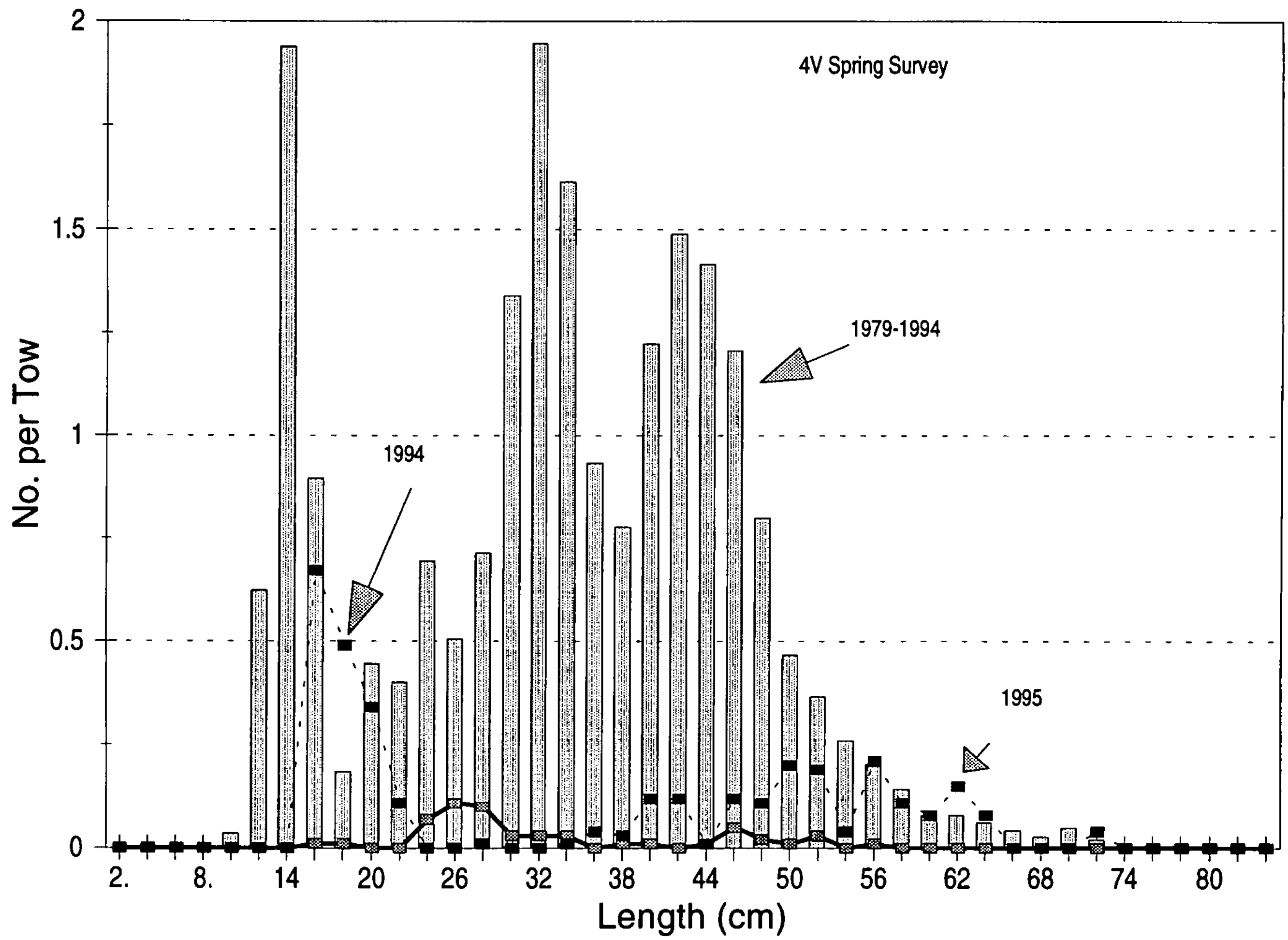

Figure 15. Catch rates by haddock length group observed during the spring (March) research vessel surveys conducted in Division 4V. The bars represent the mean catch rates at length for the period 1979-1994, while the line represents catch rates at length observed in 1995.

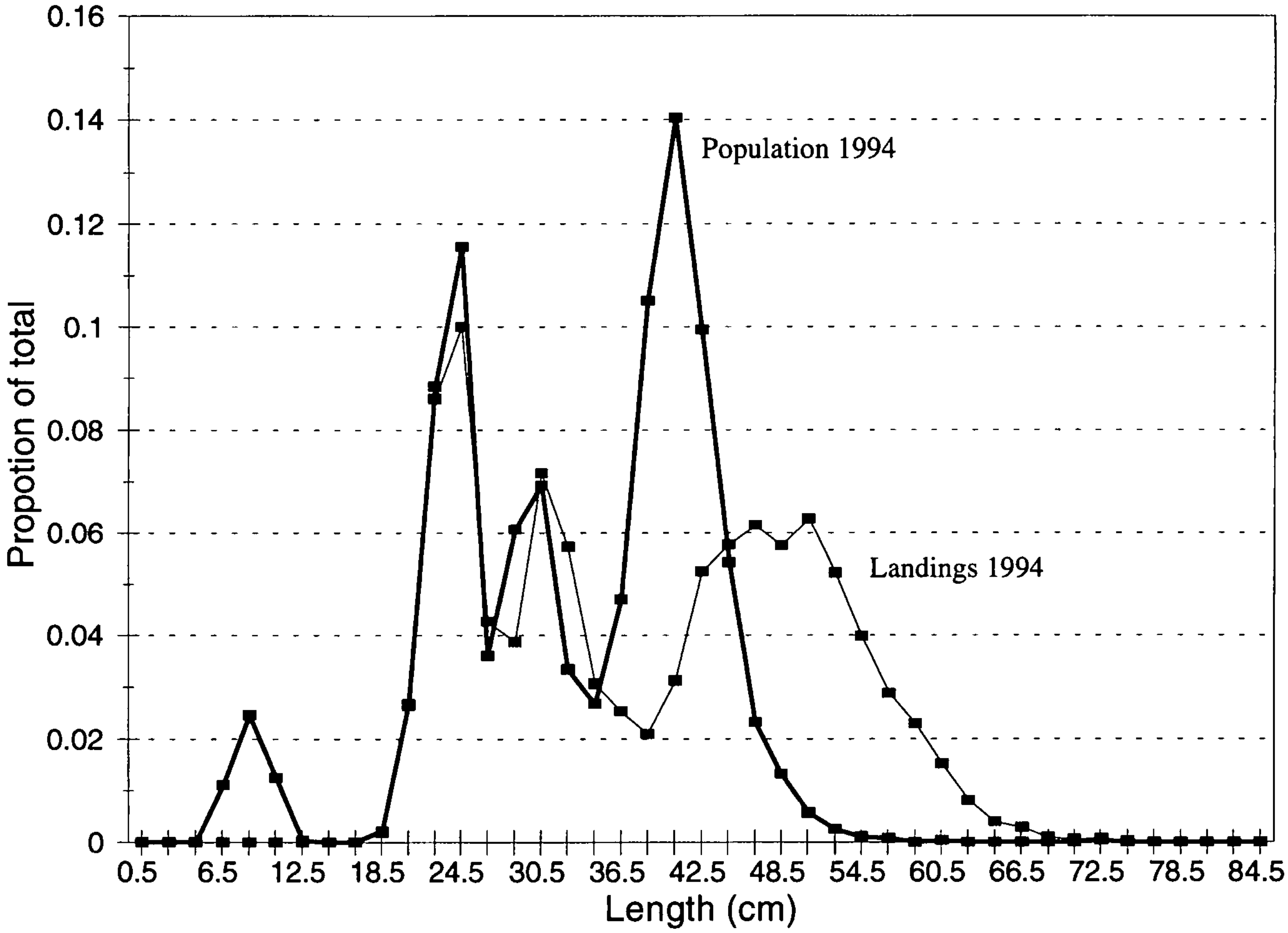

Figure 16. Length composition of haddock landings estimated for 1994 (thin line) versus the length composition of the entire 4VW haddock stock as determined from the summer (July) survey.

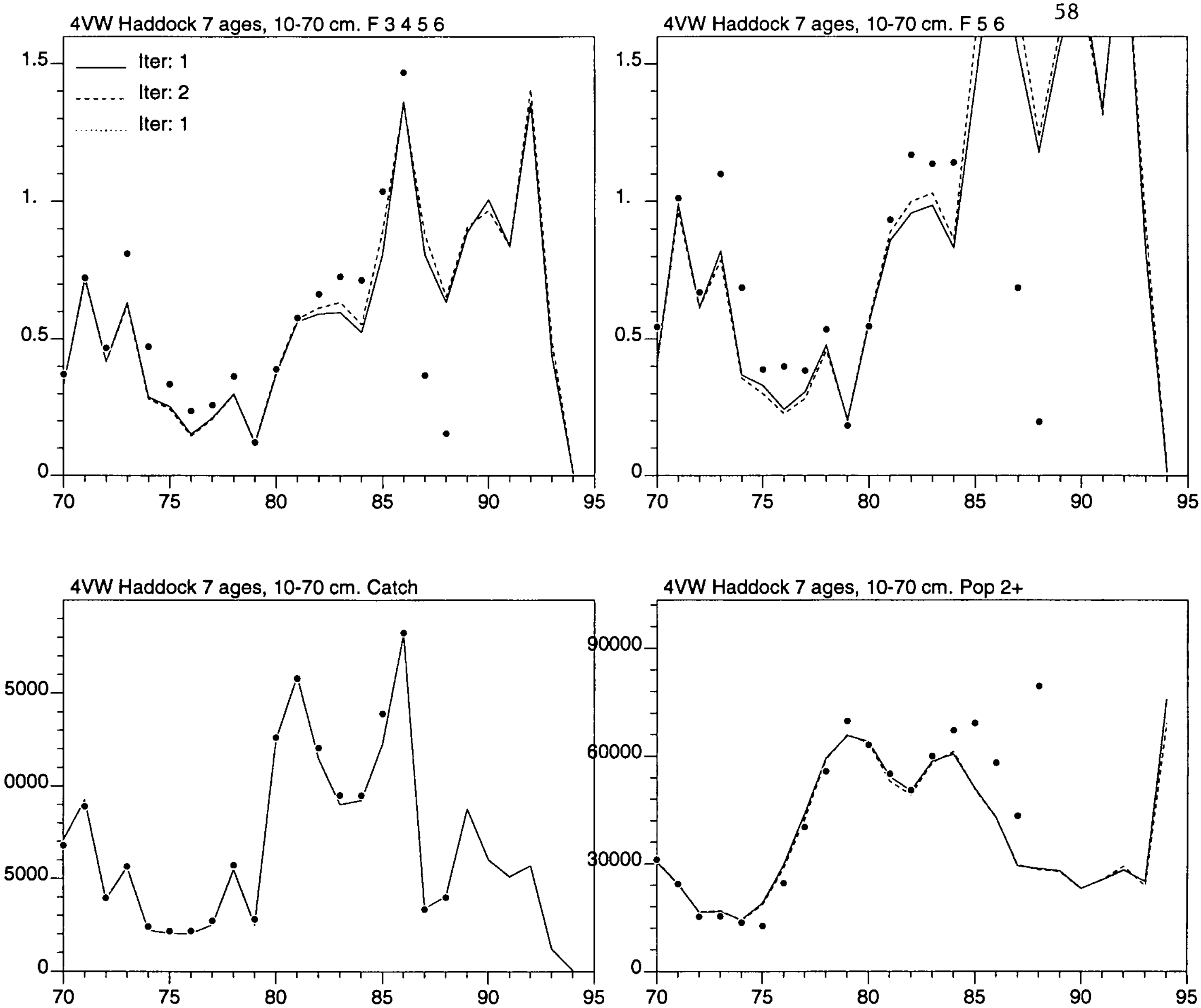

Figure 17. Tuning plots from the initial length based analysis. Points are the estimates derived from the most recent VPA based assessment of this stock, and the lines are the results of the best three iterations of the model. The results are shown for F at 'ages' 3-6, F at 'ages' 5 and 6, catch (as a check on data integrity), population numbers.

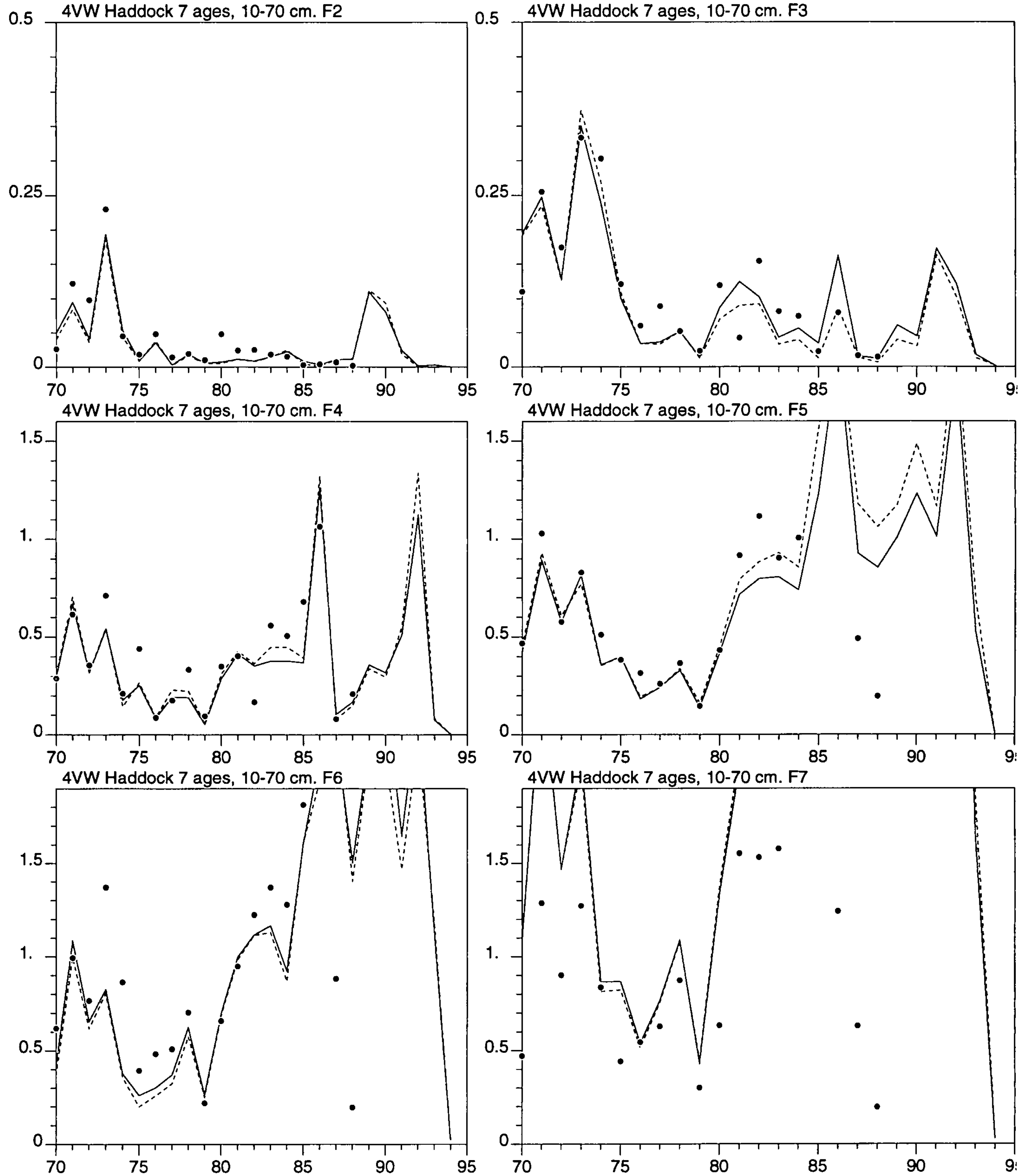

Figure 18. "Age by age" results of Qmodel. Points are the estimates derived from the most recent VPA based assessment of this stock. Results are shown for F at 'ages' 2 through 7.

MACINTOSH HD:ASSESSMENTS:4VW Had:Out95:tune2-6F4-6FTem20:94A7_10-70f2-7 F_Pop Tue Apr 11 12:06:44 1995

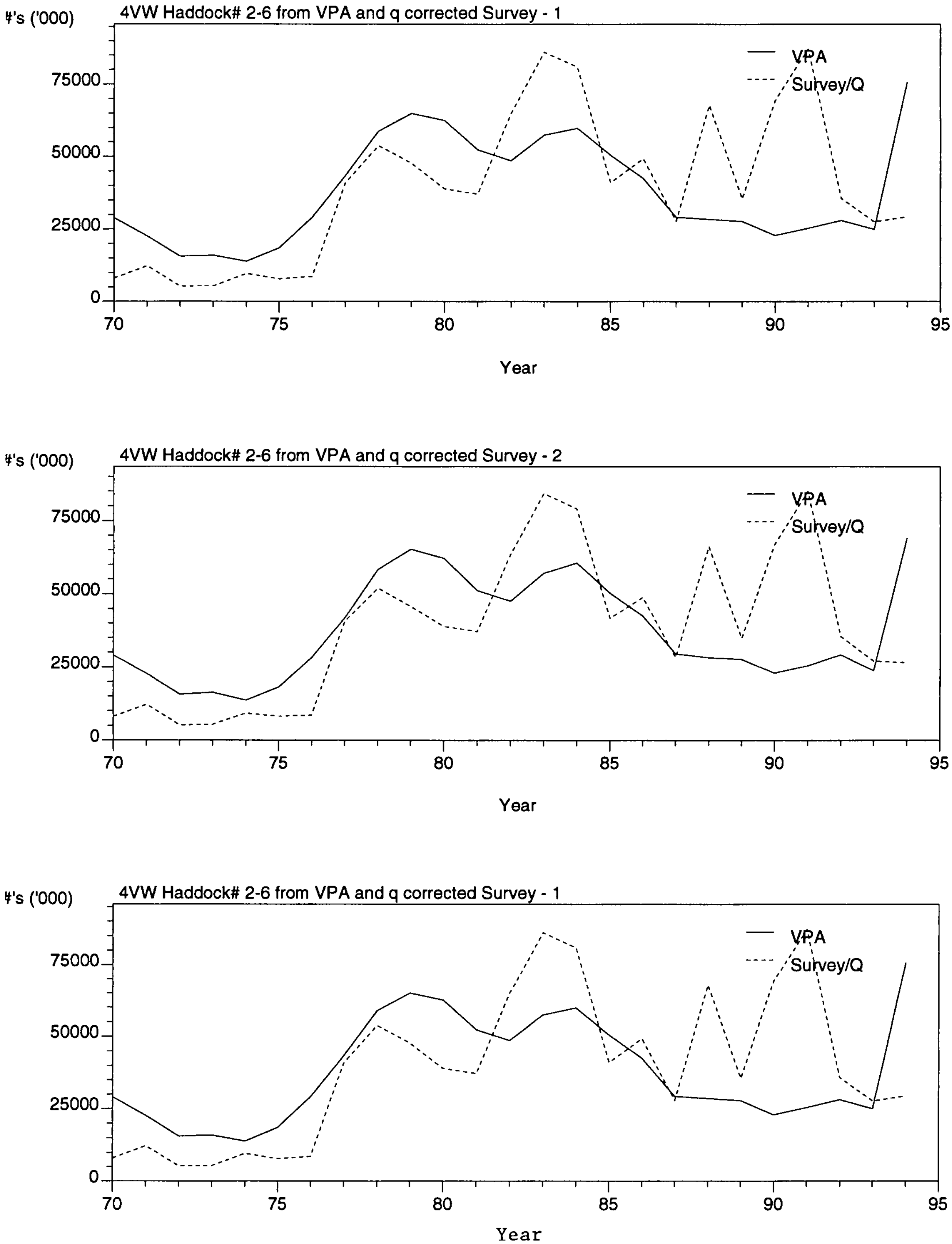

Figure 19. Overall fit of the Qmodel population estimates to q-adjusted RV numbers for ages 2-6. The top panel shows the converged results, the middle panel, the first iteration of model, and the bottom panel, results of slicing only, with no adjustment to 'age' bin boundaries.

MACINTOSH HD:ASSESSMENTS:4VW Had:Out95:tune2-6F4-6FTem20:VPASurv94A7_10-70SM2-6 Tue Apr 11 12:06:41 1995

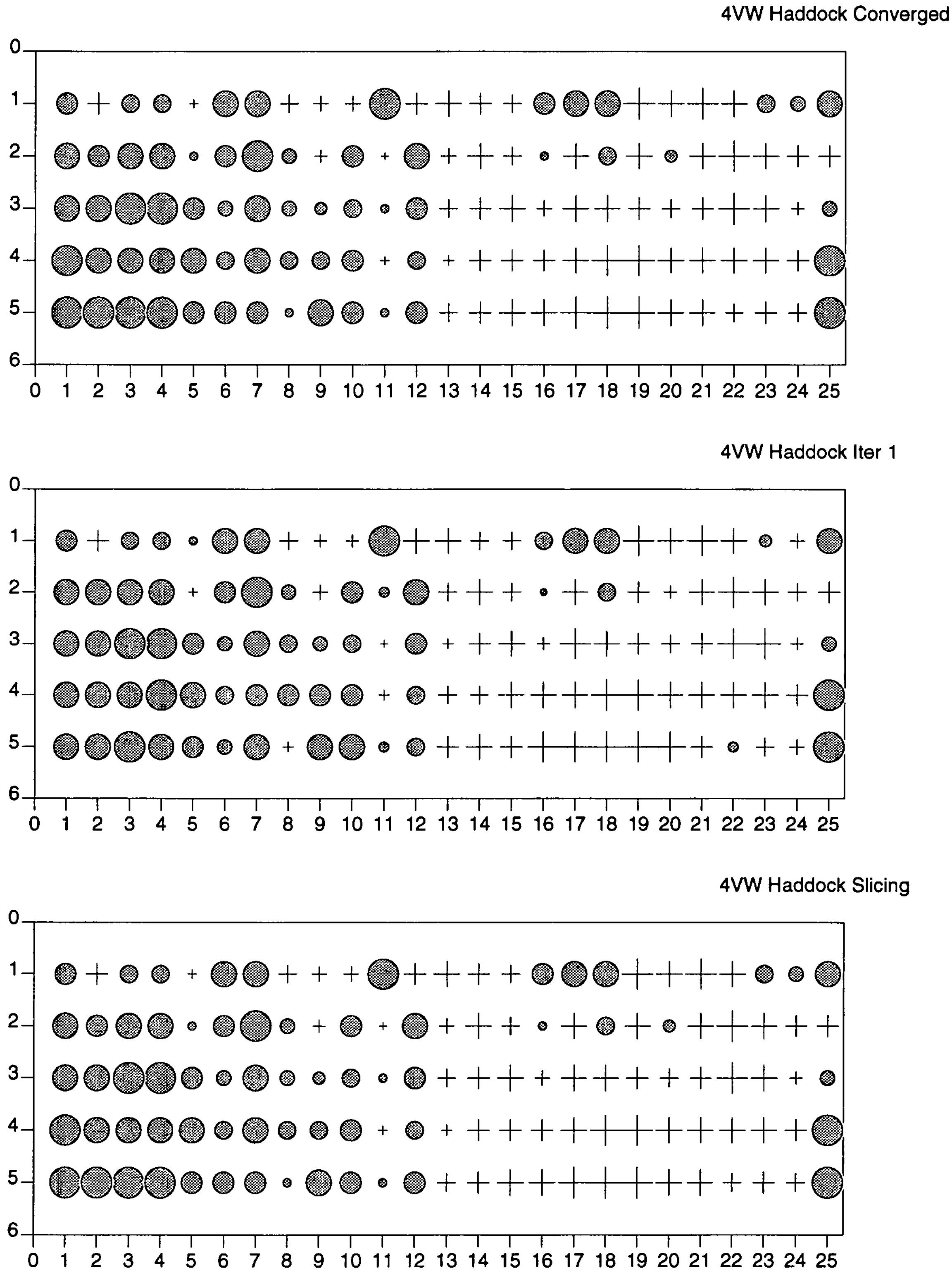

Figure 20. Residuals from the analysis shown in Figure 19. The size of the symbol indicates its relative magnitude.

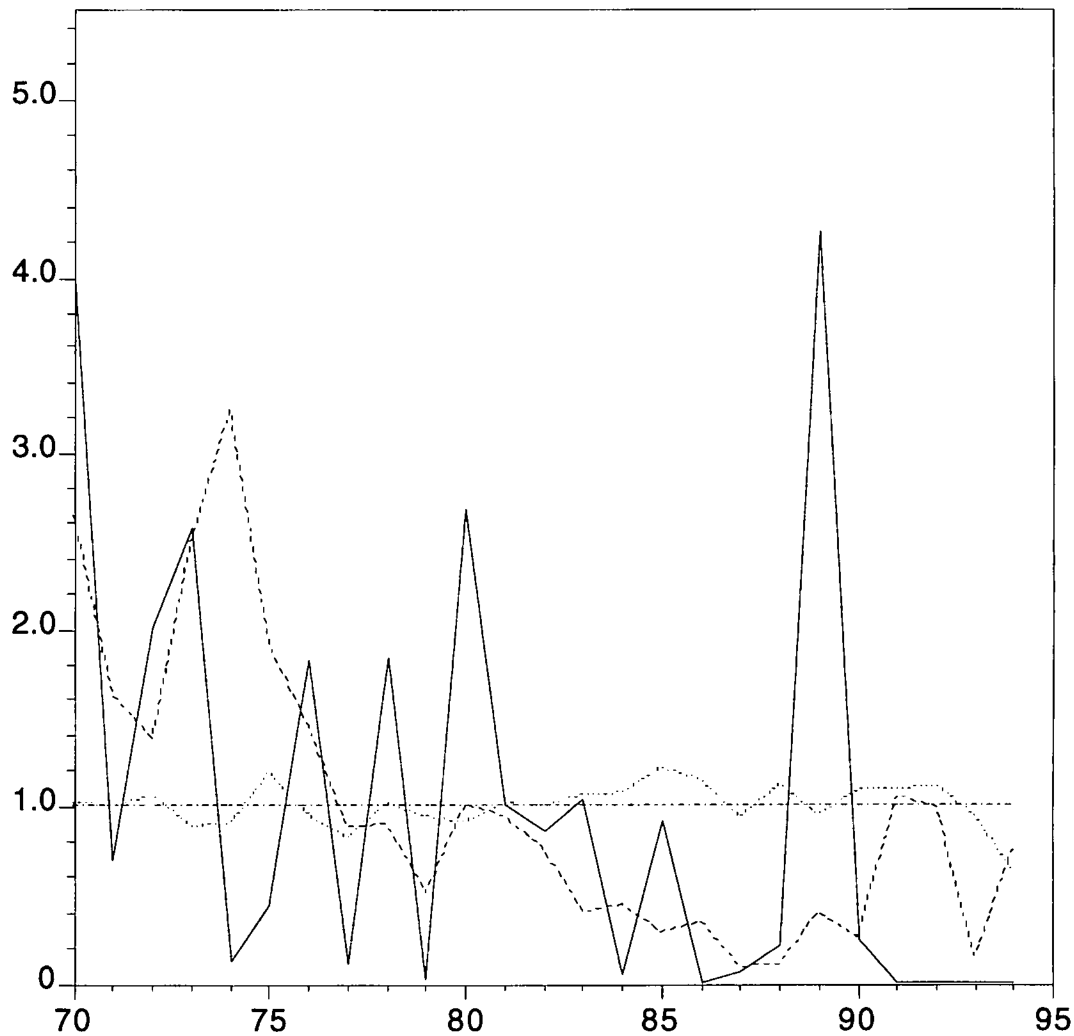

Figure 21. Mean selection at 'age' for 4VW haddock from 1970 to 1994. The solid line indicates the selection of 'age' 2 fish while the heavy dashed line shows the selection of age 3 fish. The thin dotted line shows the selection for 'age' 5 fish.

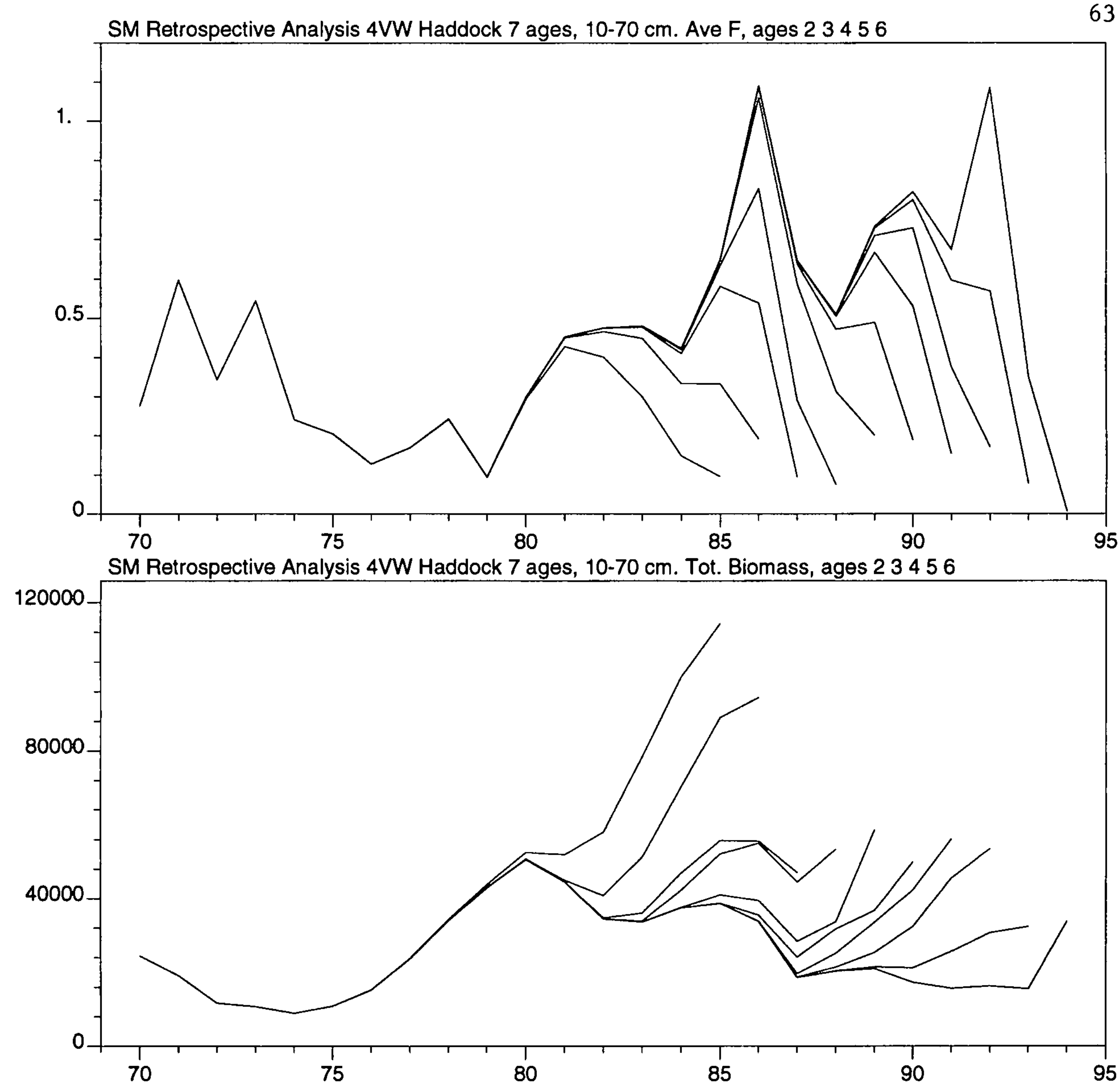

Figure 22. Retrospective analysis using 'age' structure generated by the most recent Qmodel / slicing results.

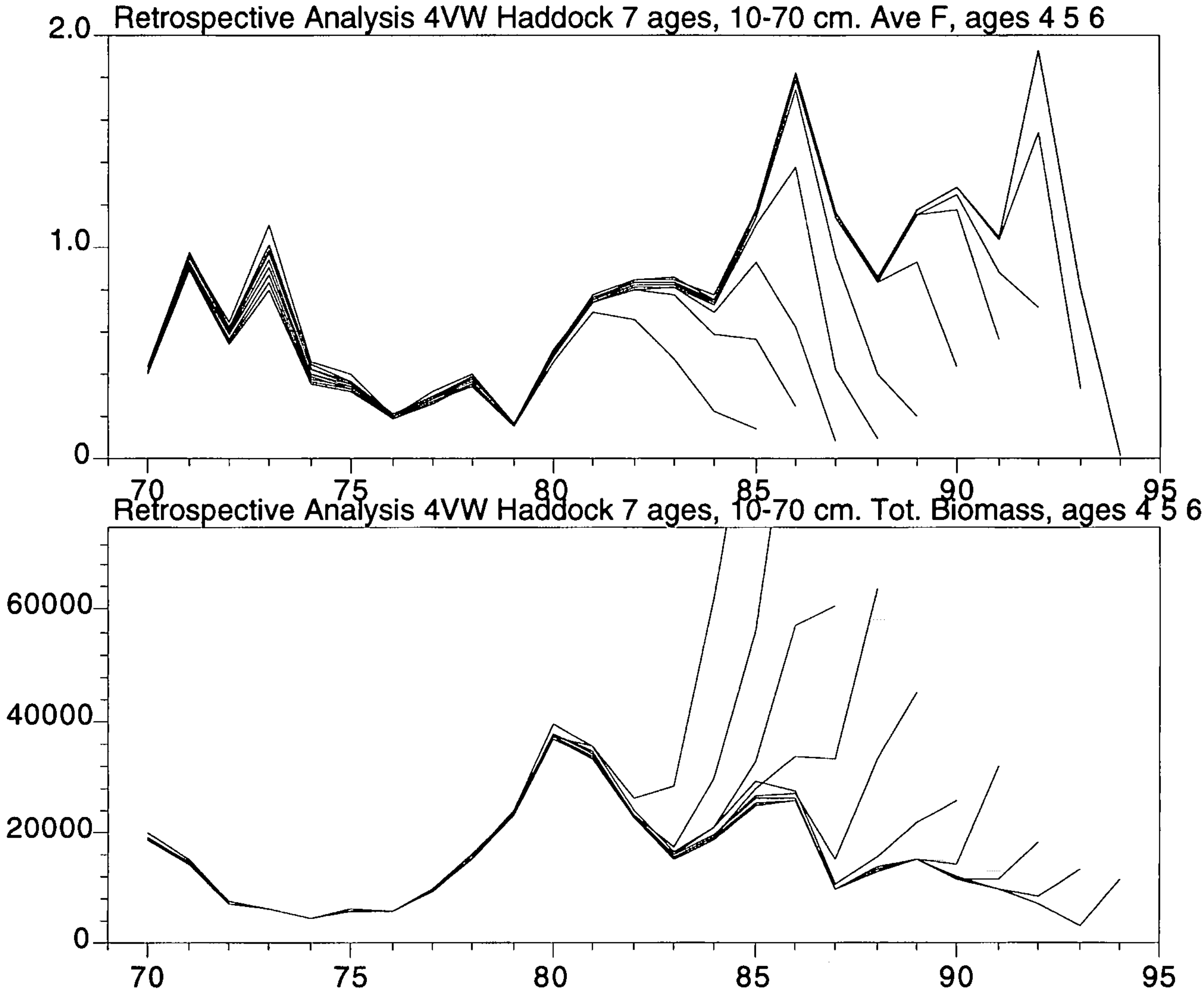

Figure 23. Retrospective analysis using 'age' structure updated for each of the truncated data sets generated for the retrospective analysis.

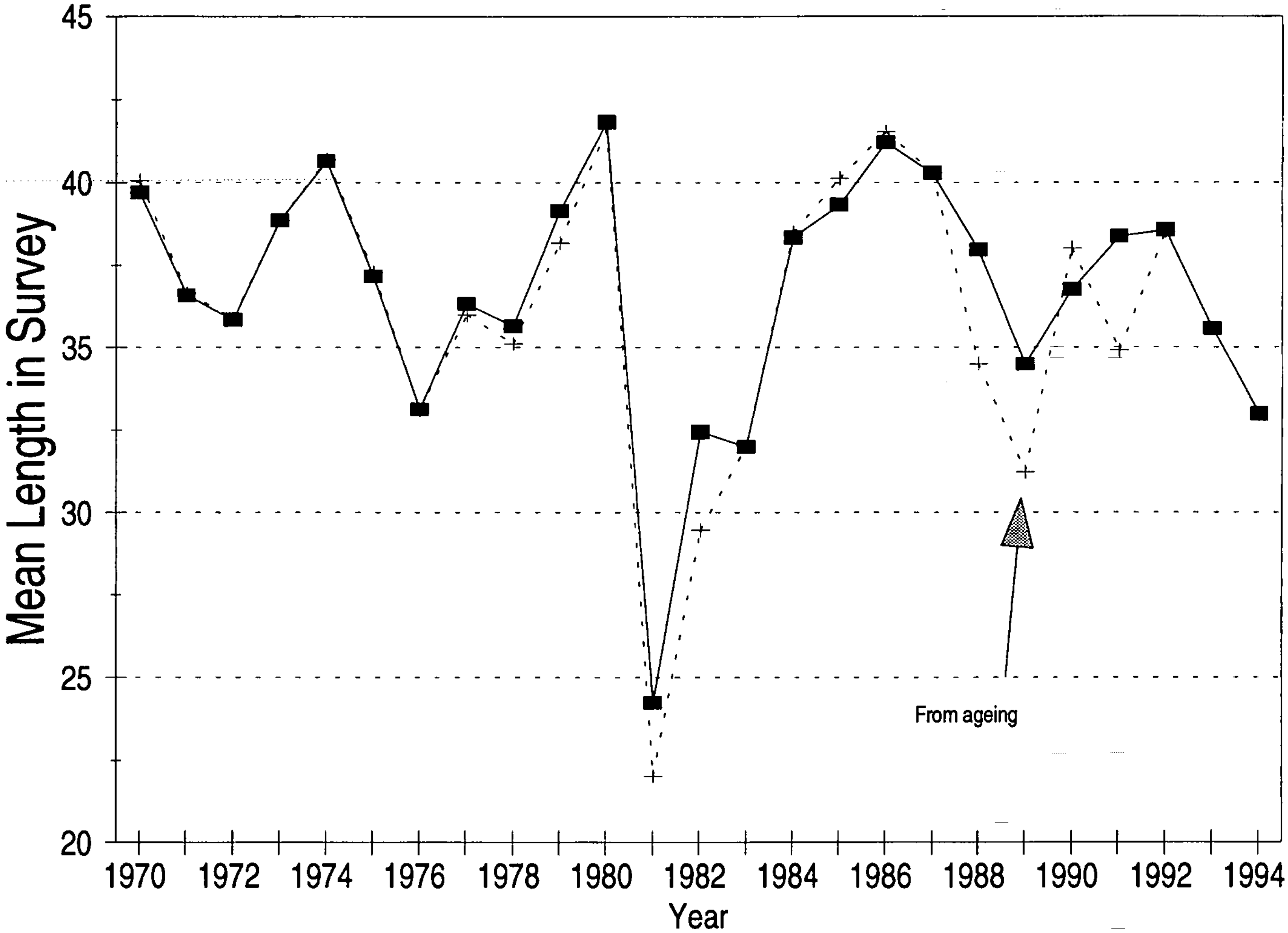

Figure 24. Mean length of haddock caught during the summer (July) surveys conducted between 1970 and 1994. The solid line are the results from the survey measurements, while the dotted line are those lengths derived from the aging of haddock caught in the survey.

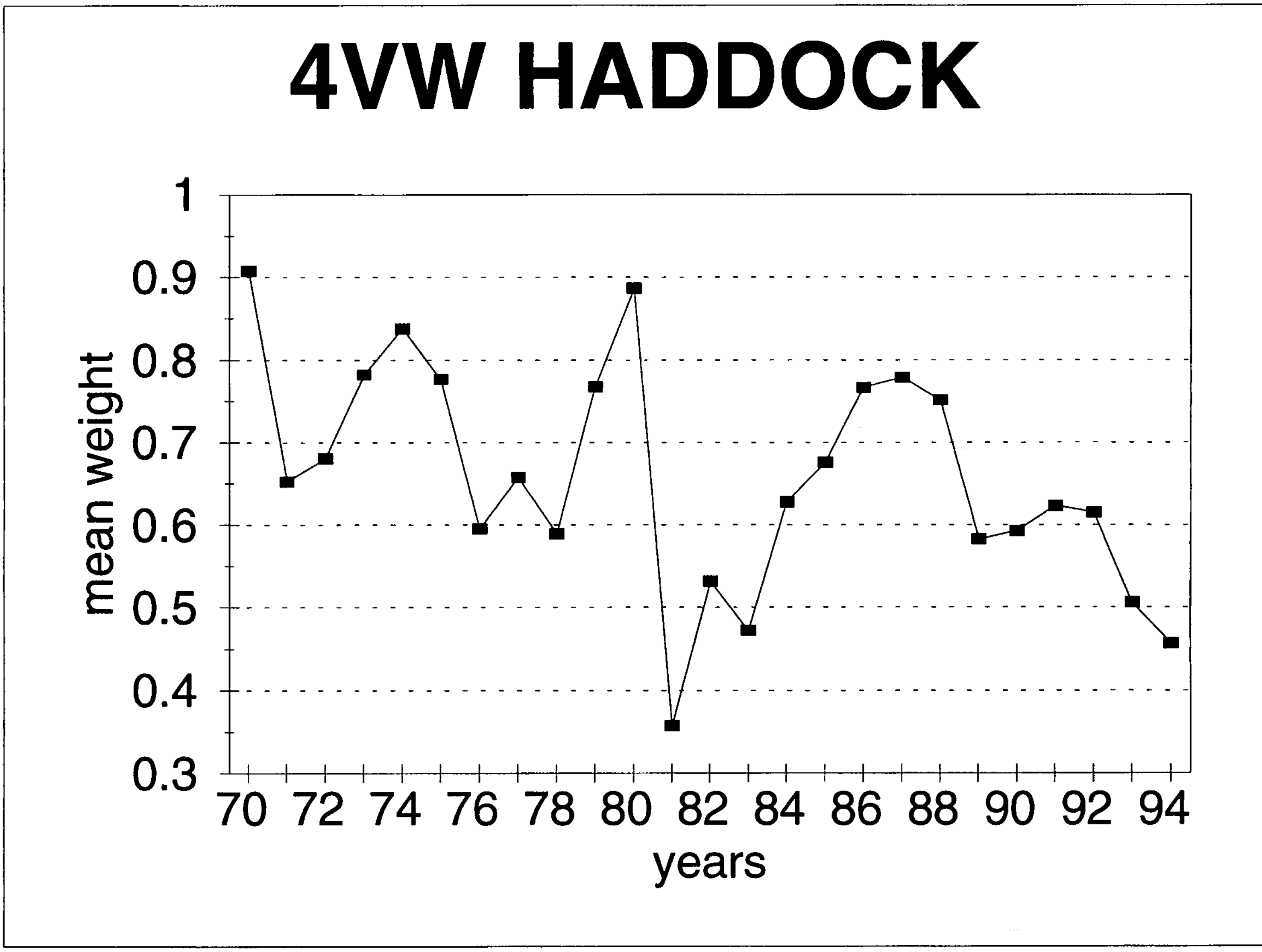

Figure 25. Mean weight of haddock caught in the summer (July) surveys.

4VW Haddock

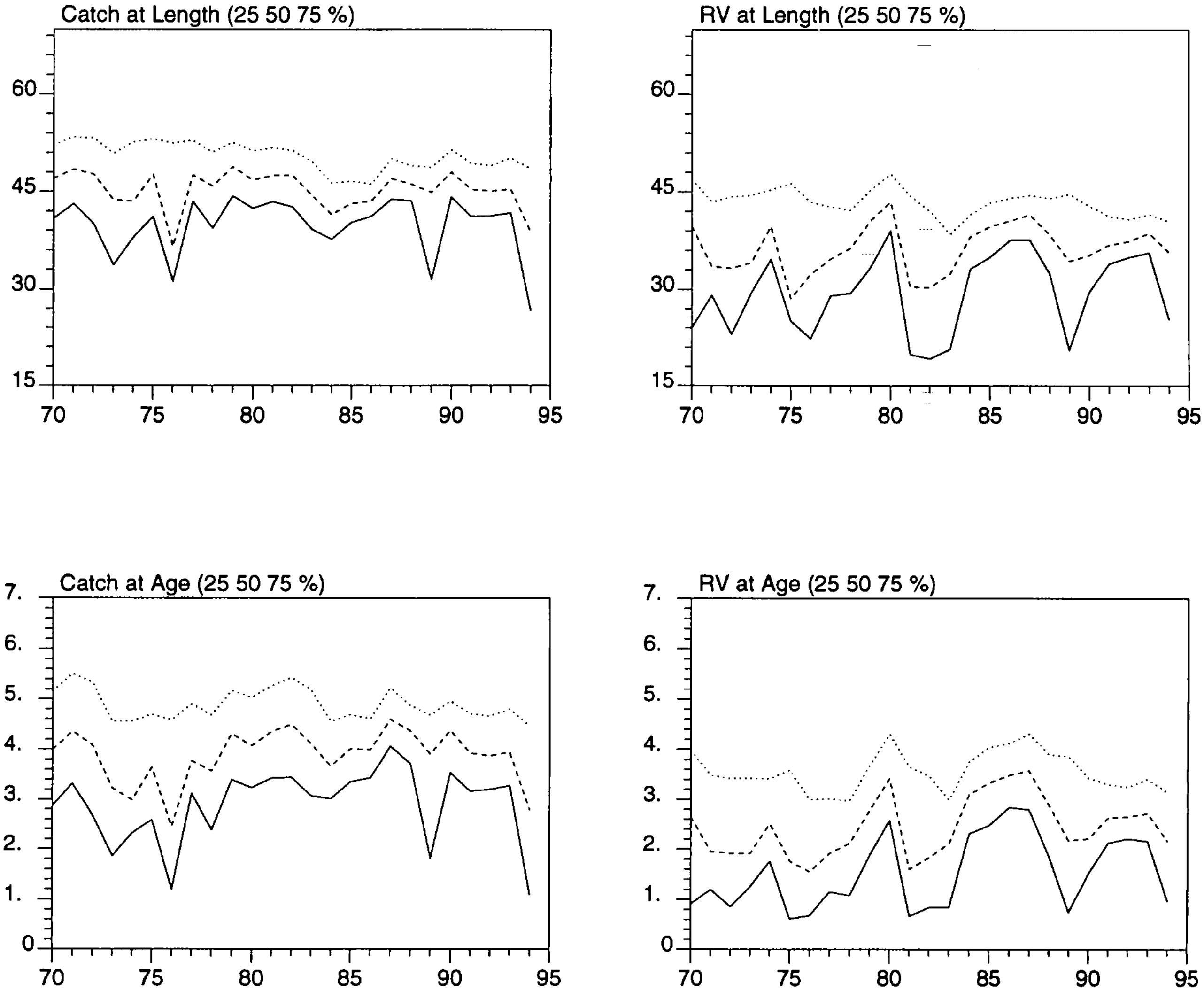

Figure 26. Mean and ranges of lengths and ages of haddock in the catch and in the summer (July) surveys.

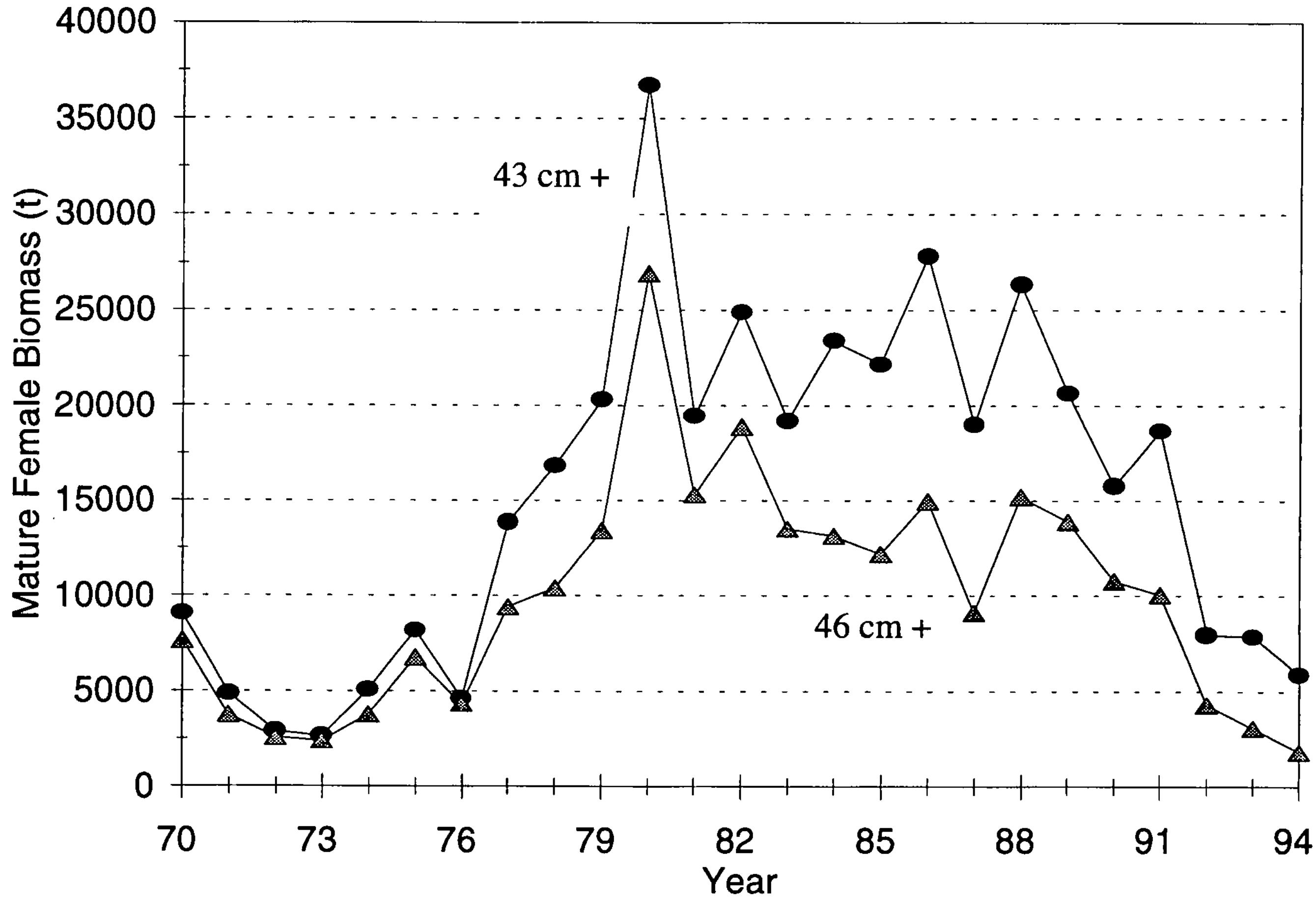

Figure 27. Estimates of Spawning Stock Biomass derived from survey estimates of population abundance, and assuming knife-edged maturity schedules.

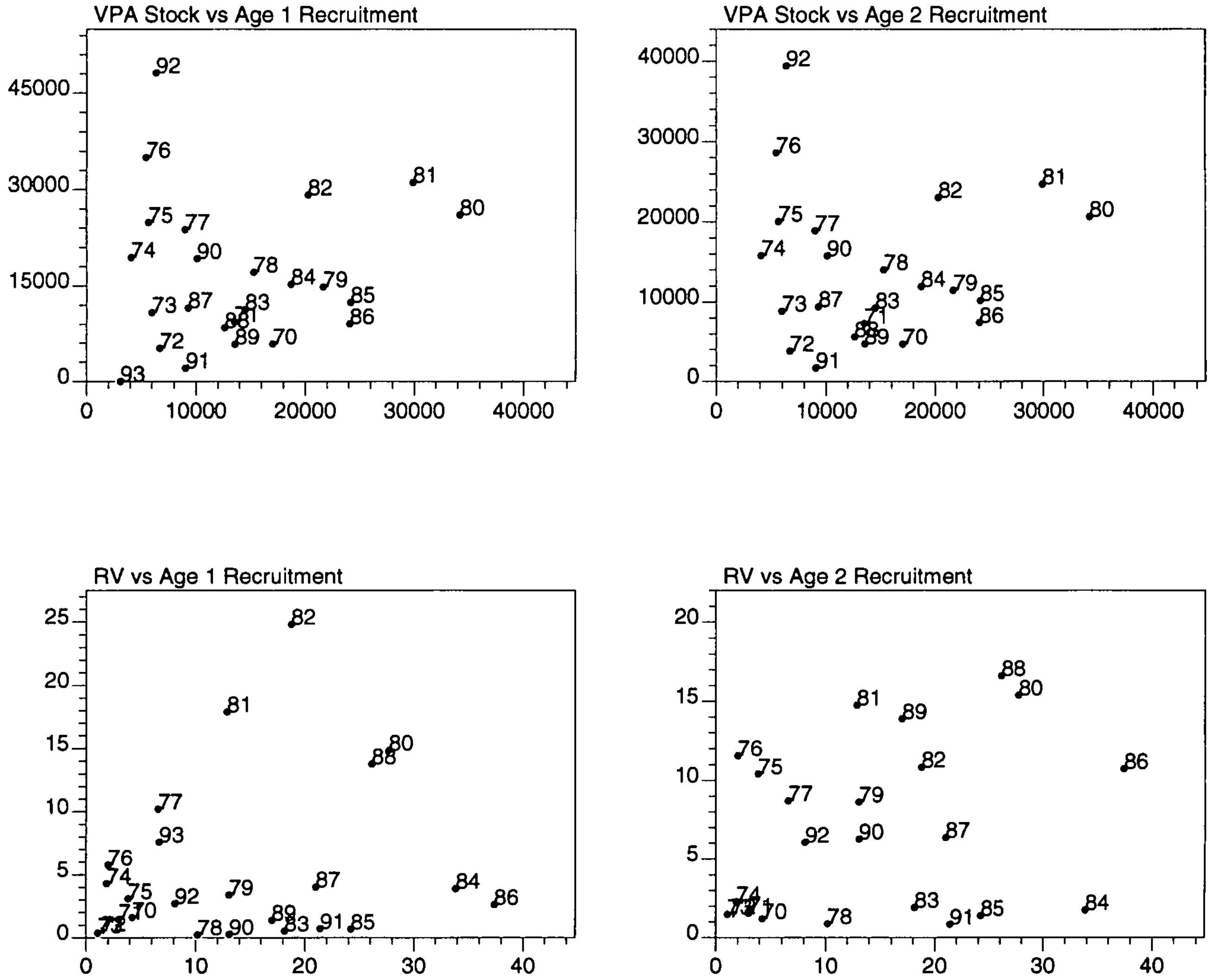

Figure 28. Stock and recruitment relationships as derived from VPA and from survey data for 4VW haddock.