

Not to be cited without  
permission of the authors<sup>1</sup>

Canadian Atlantic Fisheries  
Scientific Advisory Committee

CAFSAC Research Document 92/ 63

Ne pas citer sans  
autorisation des auteurs<sup>1</sup>

Comité scientifique consultatif des pêches  
canadiennes dans l'Atlantique

CSCPCA Document de recherche 92/ 63

## **Assessment of 4X Haddock in 1991**

by

P.C.F. Hurley, J. Simon and K.T. Frank

Biological Sciences Branch  
Scotia-Fundy Region  
Marine Fish Division  
Bedford Institute of Oceanography  
P.O. Box 1006, Dartmouth  
Nova Scotia, B2Y 4A2

- 1 This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required, and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author(s).

- 1 Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteur(s) dans le manuscrit envoyé au secrétariat.

### Abstract

The nominal catch of 4X haddock in 1991 was 9690 t. Individual Transferable Quotas were introduced into the mobile gear fleet <65 ft in 1991 and resulted in changes in fishing strategy. The fixed gear fleet <65 ft fished unrestricted until March 1 at which time they were placed on trip limits of 30% haddock bycatch or 1500 kg of haddock. An assessment using sequential population analysis was not attempted as problems with the catch at age and/or the ADAPT formulation had not been resolved. Both the catch at age and the age composition in the July groundfish research vessel survey indicate a reduction in the age range in the population, a sign of continued heavy exploitation. The research vessel survey abundance index has increased twofold since the near record low in 1987. The production of two average yearclasses in 1987 and 1988 has contributed to the recent increase. The 1989 yearclass appears very poor and the 1990 yearclass may also be weak. The research vessel survey biomass has increased to slightly above the long term mean as a result of the increase in abundance and a trend of increasing mean weight at age in recent years. Total mortalities calculated from the research vessel survey indicate that  $F$  has been in excess of 1 since 1985. The Leapfrog procedure for estimating status quo TACs projected catches for 1992 and 1993 in the order of 13,000 and 15,000 t respectively, under the assumption that the present management scheme remains in place and fishing mortality is maintained at present levels over the period. Maintaining the current catch levels of approximately 10,000 t in 1992 and 1993 would result in a decrease in  $F$  to about four times  $F_{0.1}$ . Catches should be reduced to about 6,000 t to lower exploitation to twice  $F_{0.1}$ .

### RÉSUMÉ

Les prises nominales d'aiglefin dans la division 4X se sont établies à 9 690 t en 1991. La flottille des bateaux de moins de 65 pi pêchant aux engins mobiles a adopté un régime de contingents individuels transférables en 1991, ce qui a modifié la stratégie de pêche. La flottille des bateaux de moins de 65 pi pêchant aux engins fixes a pêché sans restriction jusqu'au 1<sup>er</sup> mars, date à laquelle elle s'est vu imposer des limites de 30 p. 100 de prises accidentelles d'aiglefin ou de 1 500 kg d'aiglefin par sortie. On n'a pas procédé à une évaluation par analyse séquentielle de population en raison de problèmes non résolus au sujet des données sur les prises selon l'âge et de la formule ADAPT. Les prises selon l'âge et la composition par âge obtenues lors de la campagne d'évaluation du poisson de fond de juillet révèlent une diminution de la fourchette d'âges de la population, signe que l'exploitation demeure forte. D'après les résultats des missions de recherche, l'indice d'abondance a doublé depuis le niveau de 1987, proche du plus bas de tous. La production de deux classes d'âge moyennes en 1987 et 1988 a contribué à la hausse récente. La classe d'âge de 1989 semble très faible, ce qui pourrait aussi être le cas de celle de 1990. Il ressort également des missions de recherche que la biomasse a atteint un niveau légèrement supérieur à la moyenne à long terme, en raison de la hausse de l'abondance et d'une tendance à l'accroissement du poids moyen selon l'âge ces dernières années. La mortalité totale calculée d'après les résultats des missions de recherche révèle que  $F$  a été supérieur à 1 depuis 1985. Le principe du "Leap-frog" utilisé pour estimer les TPA de statu quo a abouti à des projections de prises de 13 000 t et 15 000 t respectivement pour 1992 et 1993, cela dans l'hypothèse du maintien du régime de gestion et des niveaux de mortalité actuels durant la période considérée. Si les niveaux de prises actuels, soit environ 10 000 t, sont maintenus en 1992 et 1993, on obtiendrait une diminution de  $F$  équivalant à environ quatre fois  $F_{0.1}$ . Les prises seraient ramenées à 6 000 t, c'est-à-dire à un niveau d'exploitation plus bas correspondant à deux fois  $F_{0.1}$ .

## Introduction

This document contains an evaluation of the NAFO Division 4X (Figure 1) haddock stock. As in the past, haddock caught in unit area 4Xs were not included in the analysis because they are believed to be part of the 5Y stock (Halliday 1974).

In a previous assessment of this stock (Frank et al. 1990), it was concluded that problems with the catch at age and/or the ADAPT formulation needed to be resolved before the results of the Sequential Population Analysis (SPA) could be used as the basis for harvest advice. In particular, a strong retrospective pattern in  $F$  exists for this stock (Sinclair et al. 1991) which has been the basis for rejection of the SPA. These problems have not yet been resolved; thus indices and stock parameters derived from research vessel survey and commercial sampling data are examined to estimate trends in stock abundance and exploitation rates.

## The Fishery

### Annual Trends in Reported Landings

The long-term (1930-1988) annual catch of haddock in NAFO Division 4X has averaged about 20,000 t. This level was greatly surpassed once during the 1960s and again during the 1980s when landings peaked above 30,000 t (Figure 2). The former peak, fuelled by the strong 1963 yearclass, resulted in high exploitation rates and low spawning stock biomass and was thus instrumental in the imposition in 1970 of a quota system and a spawning area closure (Halliday 1988) under ICNAF. The 1970 TAC was set at 18,000 t, but was dropped to 9,000 t in 1972 and ICNAF recommended closure of the fishery in 1974 (Table 1). Catches and TACs subsequently increased to a peak in 1981-82. Catches were lower than TACs set during 1982-84. Total catch has been below the long-term average since 1984 with restrictive quotas in place since 1985.

Quota allocations for the stock since 1976 were reviewed in detail by Hurley et al. (1991). Those for 1991 are given in Table 2. There has been a general tendency over time for increasing subdivision of the TAC by fleet sector and season. During 1982-87, the fishery was regulated on the basis of 5 gear sectors: 1) mobile gear <65 ft; 2) mobile gear 65-100 ft; 3) mobile gear >100 ft; 4) fixed gear <65 ft; 5) fixed gear 65-100 ft. In 1988, gear sectors <65 ft were further subdivided into less than and greater than 45 ft. In 1989, mobile gear <45 ft were further subdivided into generalists and specialists. Since 1986, the allocation to mobile gear was further subdivided into three 4-month trimesters to extend the fishery over the year. These fine-scale allocations resulted in significant enforcement problems and led to the implementation of an aggregate cod/haddock/pollock (CHP) allocation in 1989 for the <65 ft mobile fleets; however the mobile and fixed gear sectors <65 ft all exceeded their quotas and were tied up in June and October respectively. In 1990, vessels in the inshore mobile gear fleets again fished in 4X against a combined cod, haddock and pollock (CHP)

quota system that had been introduced in 1989. A combination of CHP trip limits and haddock bycatch allowances kept the fleets fishing throughout most of the year, in contrast to 1989. Landings by gear type, tonnage class and area are shown in Table 3 and are further broken down by quarter for 1984-91 in Table 4.

The 1991 nominal catch of 4X haddock was 9690 t (Table 1). This includes 41 t of foreign bycatch reported by the International Observer Program.

The 1991 Atlantic Groundfish Management Plan stated that the 1991-93 4X haddock fishery would be managed on the basis of bycatch only; however Individual Transferable Quotas were introduced into the mobile gear fleet <65 ft in 1991 and vessels were allocated individual haddock quotas based on historic catches and proportional shares of 4600 t. The implementation of ITQs in the Scotia-Fundy region is described in more detail by Annand (1992). The fishing strategy of this gear sector changed substantially under ITQ management as vessels with small ITQs for 4X haddock avoided catching haddock, while many other ITQ vessels chose to hold their 4X haddock ITQs until later in the year and directed for other species (flatfish, shrimp, silver hake) or fished other areas (5Z). As a result, a number of ITQ vessels approached the end of the year with uncaught 4X haddock quota. Quota monitoring reports indicate that the ITQ fleet landed approximately 1100 t of 4X haddock during December 1991 for an annual total of 3843 t (Table 2, Figure 3). The mobile gear fleet 65-100 ft landed 54 t of 4X haddock as bycatch while the mobile gear fleet >100 ft landed 337 t as bycatch. The non-ITQ mobile gear vessels <45 ft, the remaining Generalist fleet, were restricted by trip limits over most of the year. Quota monitoring reports show 4X haddock landings of 549 t for this fleet of inshore boats that fishes mainly between May and September (Figure 3). The fixed gear fleet <65 ft fished unrestricted in 4X in 1991 until March 1 when they were placed on trip limits of 1500 kg of haddock and 30% haddock bycatch restrictions. Longline landings totalled 5117 t while gillnet landings totalled 275 t.

Reports suggest that misreporting of 4X haddock was still relatively low in 1991. Some dumping of 4X haddock occurred in the ITQ fleet, especially early in the year by vessels with very low 4X haddock ITQs. The Commercial Catch Monitoring Program was implemented along with ITQ management (Annand, 1992) whereby ITQ vessels were required to hail their catch to DFO and arrange to have the catch weighed out by a certified weighmaster. Reports indicate that small amounts of 4X haddock were occasionally being landed by ITQ vessels without being weighed out. Some longline vessels fishing with dual license conditions, for both 4X and 5Z haddock, were misreporting haddock caught in 4X as caught in 5Z. During a short period in the early fall when haddock aggregate on German Bank to feed on herring spawn, haddock catches were transhipped from mobile gear vessels with 4X license conditions to those with 5Z license conditions and misreported as caught in 5Z.

The Browns Bank closure (March 1-May 31) was again extended to June 15 in 1991. New mesh size regulations were also introduced in 1991. The minimum otter trawl mesh size increased from 130 mm diamond to 155 mm diamond or 140 mm square on March 1. Many

mobile gear vessels that participated in the experimental square mesh fishery on Georges Bank in 1990 continued to use the same 130 mm square mesh nets in 1991 while others switched immediately to 140 mm square mesh. The new mesh size regulations met with strong opposition from the offshore fleet and were reduced to 145 mm diamond or 130 mm square in July 1991. Reports suggest there has been some confusion as to which mesh sizes (130 vs 140 mm square) were in use over the period.

### Sampling

As exploitation by the inshore fleet expanded during the 1977-81 period, the landings per sample ratio increased relative to previous levels (Table 3). Since then, sampling has been generally good with rates of approximately one sample per 100-300 t landed.

Although sampling intensity in 1991 was good (119 t per sample) and the number of otoliths collected increased ( $n=1952$ ), the low level of landings created by trip limits and bycatch restrictions made it extremely difficult to obtain samples from the inshore mobile gear fleet fishing in 4Xmnop after the first quarter. As a result, it was not possible to follow the recommendations of O'Boyle et al. (1983) when constructing the catch at age for this fleet sector. The lack of samples from this sector necessitated using keys common to 4Xmnop and 4Xqr rather than separate keys as O'Boyle et al. (1983) recommended. The 1991 catch at age was constructed using the gear and quarter stratification shown in Table 3. A total of 25 keys were used (Table 6).

### Catch Numbers and Weight at Age

The catch at age data for 1970-91 are shown in Table 7 and expressed as both percent numbers and weight at age in Table 8.

In recent years, the landings have been dominated by fewer and fewer age groups. From 1985 to 1989, ages 4-6 comprised >85% of the catch by weight (Table 8). In 1990 and again in 1991, four age groups contributed significantly to the landings, but one of those was age 3. In 1991, age 4 contributed 41% by numbers and 36% by weight.

Since the mid-1980s, there has also been a reduction in the age range present in the catch at age. As in 1990, the oldest fish in the catch at age in 1991 was age 9. Age 8+ fish contributed 4-5% by numbers and 9-10% by weight (excluding the 1963 yearclass) to the catch until 1984; those ages now contribute less than 1%.

The trend of increasing mean weight at age observed in the commercial catch in the past three to four years continued in all ages except 2 year olds (Table 9, Figure 4).

## Abundance Indices

### Commercial Catch Rates

Because of high and variable levels of misreporting in recent years, particularly the mid-1980s, and the extent of management changes in the recent period, the commercial C/E is not considered to be a reliable index of haddock abundance in NAFO Division 4X.

### Groundfish Bottom Trawl Survey

The July groundfish research vessel survey on the Scotian Shelf from 1970-91 was examined to evaluate the status of the resource. The stratification scheme used in the survey is shown in Figure 5. Mean numbers per tow by stratum are shown in Table 10. The survey efficiency estimator as calculated by Smith (1991) gives a total efficiency of 56% for the 1991 survey, with an allocation component of 13% and stratum component of 43%, indicating that the allocation of sets to strata was appropriate and that use of the stratified random design was advantageous, relative to a strictly random design.

The arithmetic mean catch rates at age are shown in Table 11 and the associated standard errors and coefficients of variation are shown in Tables 12 and 13 respectively. CVs are relatively low for all ages in 1991, lowest at age 2 (26%) and highest at age 7 (44%). Mean weight per tow is shown in Table 14 and mean individual weights and lengths at age are shown in Tables 15 and 16 respectively.

The arithmetic mean catch rates across strata from 1970-91 for ages 2-5, ages 6-9 and all age groups combined exhibit large inter-annual variability (Figure 6). In general, total abundance was low during the early 1970s, high during the early-mid 1980s, and dropped sharply between 1985 and 1987. Total abundance has increased since 1987 to 39.33 per tow, still below the long term mean of 47.02.

Trends in biomass in general parallel catch rate in numbers per tow (Figure 7), and have increased sharply in the last two years to 44.76 kg per tow, compared to a survey long term mean of 41.32. From 1986 to 1990, there has been a general trend of increasing weights at age in the survey (Figure 8), consistent with the pattern observed in the commercial catch; however survey weights at age declined in 1991 relative to 1990. The sharp increase in survey biomass per tow to a value above the long term mean is a result of this trend in increasing mean weight and several average incoming yearclasses. The same increasing trend can be seen in mean length at age in the survey (Figure 9).

There has also been a reduction in recent years in the number of ages seen in the survey (oldest age=7 since 1989), consistent with the trend seen in the commercial fishery.

A recruitment index was calculated by averaging the survey numbers at age 1 and numbers at age 2 in the subsequent year, both standardized to mean numbers at age for the

series (Figure 10). This suggests the population experienced average recruitment in 1981 to 1984, followed by two poor yearclasses in 1985-86 and then two average yearclasses in 1987-88. The 1989 yearclass is close to the 1970 yearclass, the smallest yearclass in the series.

### Foreign Small Mesh Gear Fishery

Length frequencies of the haddock bycatch from the foreign small mesh gear fishery in 4X were examined to determine whether they could be used to indicate the strength of yearclasses (Figure 12). The 1986 and 1987 length frequencies show little bycatch of the weak 1985 and 1986 yearclasses; however the 1988, 1989 and 1990 length frequencies show the 1987 and 1988 yearclasses at ages 1 and 2. The 1990 and 1991 length frequencies show very little bycatch of the 1989 yearclass, supporting the indication from the research vessel survey that the 1989 yearclass is weak. The low level of bycatch of the 1990 yearclass in the 1991 length frequency suggests that the 1990 yearclass may also be weak.

### **Estimation of Stock Parameters**

Several formulations of the adaptive framework were examined this year. Each resulted in strong retrospective patterns in  $F$  and were considered unreliable. As was concluded previously, problems with the catch at age and/or the ADAPT formulation are causing these patterns and need to be resolved before SPA results can be used.

Total mortality ( $Z$ ) for ages 2-8, 2+, and age groups considered to be fully recruited (5-7/6-8) to the survey gear were calculated from the 1970-91 July research vessel survey data (Table 17) using Paloheimo's method. If natural mortality has been constant at 0.2, then these calculations indicate that exploitation rates (smoothed using a 3 yr running mean) varied around 0.5 during 1970-83, have been in excess of 1 since 1985 and have declined from a high in 1989 (Figure 11).

### **Assessment Results**

The Leapfrog procedure of Pope (1983) for estimating status quo TACs was used to project a catch for 1992 and 1993, from the 1990 and 1991 catch at age and commercial mean weights at age 1990-91.

Age	1	2	3	4	5	6	7	8	9
wt	.000	.491	.932	1.367	1.809	2.369	2.999	4.149	4.810

The geometric mean of the 1970-91 summer RV survey age 1/2 series (Figure 10) was used as a recruitment index (0.637). We assumed that  $F$  in 1990 and 1991 did not change. The

catches at age were:

	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>
1	0	0	0	0
2	259	13	346	346
3	1179	1066	54	1421
4	890	2478	2241	113
5	1236	1417	3946	3568
6	943	831	953	2653
7	182	161	142	163
8	11	8	8	7
9	1	1	1	1
10	0	0	0	0

The projected catches for 1992 and 1993 are 13,133 and 14,899 t respectively, if the present management scheme remains in place and fishing mortality is maintained at present levels over the period. Catches are expected to decline thereafter unless strong recruitment occurs. If fishing mortality is increased over this period, short term yields will increase but the subsequent decline will be more drastic and the chances of stock recovery are reduced.

#### Fishing Mortality and Stock Abundance

The 4X haddock stock has been experiencing very high exploitation rates in recent years. Paloheimo Zs calculated from the research vessel survey indicate  $F_s$  for fully recruited ages in excess of 1 since 1985. Although  $F$  on fully recruited ages declined in the last two years, it is still above  $F_{MAX}$ . The reduction in age range in the population evident in both the research vessel survey and the commercial catch at age is also indicative of very high exploitation.

Research vessel survey catch rates suggest the population was at or near a historical low in 1987. With the exception of the 1991 survey, the 1985 and 1986 yearclasses have looked weak in the survey. The 1987 and 1988 yearclasses, while only average in size, have produced the increase in survey abundance in the last two years, and together with the increase in mean weight, have resulted in a survey biomass that is above the long term mean. The 1989 yearclass appears very poor and the 1990 yearclass may also be weak.

#### **Prognosis**

With the decline in 4X haddock population abundance since 1985 and the reduction of age ranges in the population, this fishery has essentially become a recruitment fishery. Good recruitment has occurred in 1987 and 1988 and these two yearclasses will dominate the catch in the next two to three years. If fishing mortality remains high ( $F=1.2$ ) as it has under the



present management scheme (ie. status quo), catches should increase in the short term. Although maintaining the current catch level of approximately 10,000 t would result in a decrease in  $F$ , fishing mortality would still be in the order of four times  $F_{0.1}$  in 1992 and 1993. To reduce exploitation to twice  $F_{0.1}$ , catches should drop to about 6,000 t. Catches should be reduced even further if greater contribution of these two yearclasses to the spawning stock biomass is to be realized.

### Acknowledgements

The authors wish to thank Peter Comeau for assistance with the analysis, Alan Sinclair for suggesting the use of the Leapfrog procedure and Kees Zwanenburg for reviewing the manuscript.

## References

- Annand, C. 1992. Review of 1991 management measures in Scotia Fundy Region. CAFSAC Res. Doc.: (in prep.)
- Frank, K.T., P.C.F. Hurley, and J. Simon. 1990. Assessment of 4X haddock in 1989. CAFSAC Res. Doc. 90/58: 48p.
- Halliday, R.G. 1974. Current status of the ICNAF Div. 4X haddock stock. ICNAF Res. Doc. 74/91: 24p.
- Halliday, R.G. 1988. Use of seasonal spawning area closures in the management of haddock fisheries in the northwest Atlantic. NAFO Sci. Coun. Studies 12: 27-36.
- Hurley, P.C.F., K.T. Frank, and J. Simon. 1991. Assessment of 4X haddock in 1990. CAFSAC Res. Doc. 91/67: 48p.
- O'Boyle, R.N., L. Cleary, and J. McMillan. 1983. Determination of the size composition of the landed catch of haddock from NAFO Division 4X during 1968-81, pp. 217-234. In: W.G. Doubleday and D. Rivard [eds.] Sampling Commercial Catches of Marine Fish and Invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 66.
- Pope, J.G. 1983. Analogies to the status quo TACs: Their nature and variance, pp. 99-113. In: W.G. Doubleday and D. Rivard [eds.] Sampling Commercial Catches of Marine Fish and Invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 66.
- Sinclair, A., D. Gascon, R. O'Boyle, D. Rivard, and S. Gavaris. 1991. Consistency of some Northwest Atlantic groundfish stock assessments. NAFO Sci. Coun. Studies 16: 59-77.
- Smith, S.J. 1991. Assessing the efficiency of the groundfish survey design for the Scotian Shelf summer trawl surveys - 1980-1990.

Table 1. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding Unit Area 4Xs) by country. The numbers in brackets represent the number of commercial samples collected in that year.

Year	Canada (MQ)	Canada (NFLD)	USA	USSR	Spain	Other	Total	TAC
1970	15560 (26)	-	1638	2	370	12	17582	18000
1971	16067 (29)	-	654	97	347	1	17166	18000
1972	12391 (36)	-	409	10	470	1	13281	9000
1973	12535 (30)	-	265	14	134	6	12954	9000
1974	12243 (25)	-	660	35	97	-	13035	-
1975	15985 (56)	-	2111	39	7	2	18144	15000
1976	16293 (45)	-	972	-	95	5	17365	15000
1977	19555 (79)	-	1648	2	-	12	21217	15000
1978	25299 (62)	114	1135	2	-	27	26577	21500
1979	24275 (49)	268	70	3	-	15	24631	26000
1980	28209 (56)	71	257	38	-	37	28612	28000
1981	30148 (82)	117	466	-	-	15	30746	27850
1982	23201 (92)	28	854	-	-	4	24087	32000
1983	24428 (119)	44	494	17	-	7	24990	32000
1984	19402 (97)	23	206	-	-	-	19631	32000
1985	14902 (86)	-	25	-	-	1	14928	15000
1986	14986 (78)	-	38	10	-	-	15034	15000
1987	13538 (82)	-	17	-	-	-	13555	15000
1988	10921 (79)	-	2	53	-	-	10976	12400
1989	6666 (43)	-	1 <sup>1</sup>	33 <sup>1</sup>	-	-	6700	4600
1990	7297 (71)	-	32 <sup>1</sup>	17 <sup>2</sup>	-	3 <sup>2</sup>	7342	4600
1991	9636 (81)	13	-	38 <sup>2</sup>	-	3 <sup>2</sup>	9690	-

Long-term Averages:      1930 - 60 = 16854 t  
                                  1961 - 83 = 25217 t  
                                  1930 - 83 = 20127 t

1 = NAFO Circular Letters  
 2 = I.O.P data

Table 2. Summary of license conditions and variation orders relating to 4X haddock issued by Fisheries and Habitat Management, Scotia-Fundy Region.

	Gear Category	Date	Reported Catch	Trip Limits
<u>Fixed Gear &lt;45' - Scotia-Fundy</u>				
Haddock 4X	A1-A49, A160-A199	Jan 1		4500 kg/20% bycatch
Haddock 4X	A1-A49, A160-A199	Jan 3		No trip limits
Cod, Haddock, Pollock (CHP) 4X,5	A4 (Handlines)	Feb 26		No license conditions to be issued until further notice
Haddock 4X, 5Y	A1-A49, A160-A199	Mar 1		1500 kg/30% bycatch
CHP 4VWX5	A4 (Handlines)	Mar 1		450 kg CHP
Halibut Permit 4VWX5	A1,A3 (Longliners only)	Apr 23		1500kg haddock; 4500 kg cod
All Groundfish 4XWX5	A4 (Handlines)	May 1		2000 kg
CHP 4VWX5	A4 (Handlines)	June 1		2270 kg cod; 1500 kg haddock
Haddock 4X	A1-A300	June 1		1500 kg haddock or 30% bycatch
CHP 4VWX5	A4 (Handlines)	Nov 21		1500 kg cod; 1500 kg haddock
<u>Fixed Gear 45-65' -- Scotia-Fundy</u>				
Haddock 4X	A1-A49, A160-A199	Jan 1		4500 kg/20% bycatch
Haddock 4X	A1-A49, A160-A199	Jan 3		No trip limits
Haddock 4X5Y	A1-A49, A160-A199	Mar 1		1500 kg haddock or 30% by-catch
CHP 4VWX5	A4 (Handlines)	Mar 1		450 kg CHP
Halibut Permit 4VWX5	FG <65' (longliners)	June 1		1500 kg haddock; 4500 kg cod
CHP 4VWX5	A4 (Handlines)	June 1		2270 kg cod; 1500 kg haddock
Haddock 4X	A1-A300	June 1		1500 kg haddock or 30% bycatch
Haddock 4X+5Z	FG <65'	June 1		6800 kg/maximum of 1500 kg or 30% from 4X
Haddock 4X+5Z	FG <65'	Oct 1		6800 kg/maximum of 1500 kg or 30% from 4X; A1s valid until Oct 31st; A2s valid until Nov 14th
Haddock 4X+5Z	FG <65'	Nov 1		6800 kg/maximum of 1500 kg or 30% from 4X; A1s valid until Nov 14th
CHP 4VWX5	A4 (Handlines)	Nov 21		1500 kg cod; 1500 kg haddock
<u>All Fixed Gear</u>			5210	

Table 2. (Continued)

Gear Category		Date	Reported Catch	Trip Limits
<u>Mobile Gear &lt;45' - Scotia-Fundy</u>			549	
CHP 4X5Y	C1 Generalists	Jan 1		Cod 700 kg, Haddock 700 kg, Pollock 10% bycatch, 1 trip/7 days
CHP 4X5Y	C1 Generalists	Feb 6		1500 kg combined CHP; total haddock not to exceed 500 kg per trip; pollock 10% by-catch, 2 trips/7 days
CHP 4X5Y	C1 Generalists	Feb 27		1590 kg CHP per week
CHP 4X5Y	C1 Generalists	Mar 6		No licence conditions to be issued until further notice
CHP 4X5Y	C1 Generalists	Mar 19		1500 kg combined cod & haddock; total haddock not to exceed 500 kg per trip; pollock 10% by-catch, 2 trips/7 days
CHP 4X5Y	C1 Generalists	May 1		3000 kg combined CHP/7 days
CHP 4X5Y	C1 Generalists	July 17		10% by-catch only combined CHP
CHP 4X5Y	C1 Generalists	July 24		1500 kg combined CHP/7 days
CHP 4X5Y	C1 Generalists	Sept 25		680 kg combined CHP/7 days
CHP 4X5Y	C1 Generalists	Nov 6		2270 kg combined CHP/7 days
<u>Mobile Gear 45'-65', ITQ</u>			3843	
<u>All Vessels &gt;65'</u>			391	
Haddock 4X		Jan 1		10% by-catch only

Note: Browns Bank closure was extended for all vessels from June 1 to June 15

Table 3. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding Unit Area 4Xs) landed in the Maritimes split by tonnage class and gear type. The numbers in brackets represent the mean weight landed per age/size sample collected.

Year	Tonnage Class						Total
	TC 1-3			TC 4+			
	MB (OT)	FG (LL)	Misc. <sup>1</sup>	MG (OT)	FG	Misc.	
1970	4894 (1224)	3281	767	6501 (296)	114	3	15560
1971	4289 (858)	3475 (1158)	499	7711 (367)	94	0	16068
1972	2742 (686)	4396 (440)	439	4750 (216)	63	0	12390
1973	1822 (304)	6090 (677)	324	4228 (282)	70	0	12534
1974	3949 (494)	6364 (530)	251	1622 (324)	55	0	12241
1975	6085 (320)	5193 (577)	271	4408 (157)	26	0	15983
1976	4347 (1087)	5305 (884)	445 (223)	6144 (186)	46	6	16293
1977	6178 (1030)	4328 (481)	550	8343 (130)	117	35	19551
1978	9413	6814 (568)	1084 (542)	7888 (164)	97	0	25296
1979	10171 (5086)	5127 (394)	600 (600)	8317 (252)	57	0	24272
1980	13043 (1186)	6911 (384)	1127 (376)	7045 (294)	82	0	28208
1981	14765 (328)	7846 (302)	993 (331)	6475 (809)	70	0	30149
1982	11670 (243)	7581 (345)	945 (79)	2972 (297)	32	0	23200
1983	12563 (224)	8533 (225)	754 (75)	2535 (195)	15	0	24400
1984	11828 (208)	6769 (226)	193 (193)	609 (76)	0	0	19399
1985	9834 (173)	4360 (182)	142	565 (113)	1	0	14902
1986	9201 (192)	5336 (184)	240	209 (209)	0	0	14986
1987	7952 (169)	4854 (270)	231 (21)	501 (84)	0	0	13538
1988	7074 (131)	3353 (152)	118 (118)	376 (188)	0	0	10921
1989	3656 (130)	2699 (245)	222	89 (22)	0	0	6666
1990	3183 (76)	3731 (133)	280 (280)	102	0	1	7297
1991	4061 (94)	5117 (151)	275 (275)	183 (61)	0	0	9636

1 = Gillnets (set, drift), traps, unspecified.

Table 4. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding unit Areas 4Xs) by gear type, tonnage class, area and quarter, 1984-91.

		OTB				LL		Misc		Total
		mnop		qr		mnop	qr	mnop	qr	
		1-3	4+	1-3	4+	1-3	1-3	1-3	1-3	
1991	1	792	37	71	4	1800	20	10	0	9636
	2	305	64	766	3	451	46	27	5	
	3	200	20	627	4	1702	140	168	17	
	4	865	34	435	17	929	29	48	0	
1990	1	1341	42	93	1	1267	8	20	0	7297
	2	229	16	723	0	256	11	9	56	
	3	125	16	427	1	1447	29	115	53	
	4	128	25	117	1	707	6	27	1	
1989	1	2121	34	143	0	916	9	36	0	6666
	2	501	8	587	3	216	59	55	1	
	3	46	2	253	0	1023	36	65	1	
	4	2	42	3	0	440	0	64	0	
1988	1	2203	77	81	0	1368	19	25	0	10921
	2	1476	222	763	16	176	29	22	5	
	3	1126	17	688	4	1075	29	45	2	
	4	612	40	125	0	650	7	19	0	
1987	1	3026	219	108	0	2161	26	31	0	13538
	2	1965	163	667	5	366	58	40	1	
	3	442	42	1271	3	1201	42	85	0	
	4	89	69	384	0	995	5	74	0	
1986	1	2568	147	157	0	1964	5	0	0	14985
	2	830	20	1317	0	329	32	0	0	
	3	794	14	2284	1	1719	62	0	0	
	4	642	27	609	0	1451	13	0	0	
1985	1	2702	522	138	0	1926	11	12	0	15041
	2	2391	21	1226	0	345	46	105	29	
	3	230	17	2212	13	822	59	455	52	
	4	89	17	738	0	815	3	41	4	
1984	1	2280	336	188	0	2931	8	10	0	19675
	2	3249	334	762	0	697	34	161	17	
	3	782	85	3503	12	1350	110	462	74	
	4	164	59	815	5	1155	12	77	3	

Table 5. Summary of commercial sampling for the 4X haddock fishery in 1991. Tonnes landed is followed by sampling information in parentheses. The first number represents the number of fish measured and the second the number of otoliths read. The boxes represent the aggregation used in age/length key formation.

## OTTER TRAWLS

Quarter	4Xmnop		4Xqr	
	TC 1-3	TC 4+	TC 1-3	TC 4+
1	792 (1996-268)	37 (199-31)	71 (421-24)	4 (240-31)
2	305 (624-73)	64 (204-29)	766 (1735-211)	3
3	200	20	627 (1909-221)	4
4	865 (910-68)	34	435 (1687-135)	17

## LONGLINERS/HANDLINERS

Quarter	4Xmnop		4Xqr	
	TC 1-3	TC 4+	TC 1-3	TC 4+
1	1800 (3121-380)	0	20	0
2	451 (1091-150)	0	46 (476-71)	0
3	1702 (1061-103)	0	140 (230-25)	0
4	929 (1113-132)	0	29	0

## MISCELLANEOUS\*

Quarter	4Xmnop		4Xqr	
	TC 1-3	TC 4+	TC 1-3	TC 4+
1	10	0	0	0
2	27	0	7	0
3	168 (18-0)	0	15	0
4	48	0	0	0

\* - Longline samples applied to miscellaneous landings.



Table 6. Individual keys used to construct the catch at age for the 1991 4X haddock fishery by gear, area, and quarter.

GEAR	AREA	QUARTER	NUMBERS AT AGE (000s)												
			1	2	3	4	5	6	7	8	9	10	11	12	13
OT	MNOP	1	0	0	13	161	146	98	35	3	0	0	0	0	0
	QR		0	0	1	15	13	9	3	0	0	0	0	0	0
	MNOP	2	0	1	124	129	35	11	2	0	0	0	0	0	0
	QR		0	3	255	265	71	22	4	0	0	0	0	0	0
	MNOP	3	0	0	55	62	18	8	0	0	0	0	0	0	0
	QR		0	1	151	173	50	22	0	0	0	0	0	0	0
	MNOP	4	0	2	61	290	125	25	2	0	0	0	0	0	0
	QR		0	1	29	138	60	12	1	0	0	0	0	0	0
NFLD	MNOP	2	0	0	4	5	1	0	0	0	0	0	0	0	0
LL	MNOP	1	0	0	24	311	313	289	76	4	0	0	0	0	0
	QR		0	0	0	3	4	3	1	0	0	0	0	0	0
	MNOP	2	0	0	10	85	80	54	13	1	0	0	0	0	0
	QR		0	0	1	9	8	6	1	0	0	0	0	0	0
	MNOP	3	0	0	198	399	322	166	16	0	0	0	0	0	0
	QR		0	0	16	32	26	13	1	0	0	0	0	0	0
	MNOP	4	0	0	63	311	92	65	3	0	1	0	0	0	0
	QR		0	0	2	9	3	2	0	0	0	0	0	0	0
GN	MNOP	1	0	0	0	2	2	2	0	0	0	0	0	0	0
	MNOP	2	0	0	1	5	5	3	1	0	0	0	0	0	0
	QR		0	0	0	1	1	1	0	0	0	0	0	0	0
	MNOP	3	0	0	20	39	32	16	2	0	0	0	0	0	0
	QR		0	0	2	3	3	1	0	0	0	0	0	0	0
	MNOP	4	0	0	3	16	5	3	0	0	0	0	0	0	0
	MNOP	2	0	5	30	14	2	0	0	0	0	0	0	0	0
	MNOP	3	0	0	3	1	0	0	0	0	0	0	0	0	0
TOTAL			0	13	1066	2473	1417	831	161	8	1	0	0	0	0

Table 7. Annual numbers at age of haddock landed (000s) by the commercial fishery in 4X.

ANNUAL LANDINGS (000s) AT AGE OF HADDOCK CAUGHT IN 4Xmnopqr											92/04/22
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0	0	41	150	1	37	18	2	0	0	16
2	1055	788	22	3077	694	2175	1296	1285	75	81	161
3	724	1617	3434	113	4653	4568	1644	3126	3354	1158	2445
4	1502	788	1841	2247	309	5164	4261	2019	7014	6709	3008
5	379	1422	509	1067	1779	485	3682	3193	2094	3881	5413
6	524	404	645	527	509	1103	434	2881	2832	1070	3499
7	4536	69	90	600	189	247	807	360	1040	1244	527
8	1863	3316	57	322	269	172	154	389	137	263	623
9	133	1020	1166	259	186	62	71	107	107	57	169
10	96	163	512	614	269	32	95	72	26	68	34
11	175	181	26	55	552	165	39	23	9	11	21
12	27	146	193	13	24	229	103	8	6	1	3
13+	37	105	92	6	4	11	157	87	48	18	10
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	1	0	0	2	0	0	0	0	0	0	0
2	1182	491	64	708	198	290	39	28	17	259	13
3	2215	3639	3294	1108	1956	1170	913	311	264	1179	1066
4	6219	2474	5476	4680	2261	4378	2868	1342	941	890	2478
5	4199	4628	3733	3439	4516	3923	4186	2854	1644	1236	1417
6	3195	1703	2232	2396	1463	1476	1931	1935	1115	943	831
7	1163	1457	940	948	464	246	252	453	285	182	161
8	357	340	395	340	132	116	56	76	24	11	8
9	323	183	187	110	53	40	2	14	4	1	1
10	97	94	119	77	16	28	2	3	1	0	0
11	14	45	69	36	6	9	5	4	0	0	0
12	23	16	25	20	1	4	0	0	0	0	0
13+	9	14	25	12	1	2	0	0	0	0	0

Table 8. Annual landings of 4X haddock by percent (a) numbers, and (b) weight.

PERCENT LANDINGS AT AGE BY NUMBER

a	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	10	8	0	34	7	15	10	9	0	1	1	6	3	0	5	2	2	0	0	0	6	0
3	7	16	40	1	49	32	13	23	20	8	15	12	24	20	8	18	10	9	4	6	25	18
4	14	8	21	25	3	36	33	15	42	46	19	33	16	33	34	20	37	28	19	22	19	41
5	3	14	6	12	19	3	29	24	13	27	34	22	31	23	25	41	34	41	41	38	26	24
6	5	4	7	6	5	8	3	21	17	7	22	17	11	13	17	13	13	19	28	26	20	14
7	41	1	1	7	2	2	6	3	6	9	3	6	10	6	7	4	2	2	6	7	4	3
8	17	33	1	4	3	1	1	3	1	2	4	2	2	2	2	1	1	1	1	1	0	0
9	1	10	14	3	2	0	1	1	1	0	1	2	1	1	1	0	0	0	0	0	0	0
10	1	2	6	7	3	0	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0
11	2	2	0	1	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	1	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13+	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PERCENT LANDINGS BY WEIGHT

b	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	4	2	0	13	2	7	4	3	0	0	0	2	1	0	2	1	1	0	0	0	2	0
3	4	10	24	1	29	22	7	11	11	4	8	6	14	10	4	10	6	5	2	3	15	10
4	10	6	19	23	3	36	27	12	35	36	14	25	13	25	25	16	31	21	14	17	16	36
5	3	12	6	16	23	4	32	27	14	29	34	23	32	26	25	42	36	42	39	37	30	27
6	5	4	9	9	9	14	5	31	25	10	29	23	15	19	24	19	18	26	33	31	30	21
7	46	1	1	11	4	4	13	5	10	14	5	10	16	10	11	8	4	5	9	10	7	5
8	22	40	1	6	5	3	3	6	2	4	7	4	4	5	5	3	2	1	2	1	1	0
9	2	14	21	5	4	1	1	2	2	1	2	4	3	2	2	1	1	0	0	0	0	0
10	2	3	11	14	6	1	2	1	0	1	1	1	2	2	1	0	1	0	0	0	0	0
11	3	4	1	2	14	3	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
12	0	3	5	0	1	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13+	1	2	2	0	0	0	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9. Annual weights (kg) at age of haddock landed by the commercial fishery in 4X.

MEAN ANNUAL WEIGHT (kg) AT AGE CAUGHT IN 4Xmnopqr											
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	.290	.290	.290	.270	.180	.230	.230	.280	.290	.290	.160
2	.570	.500	.450	.510	.460	.520	.520	.460	.440	.510	.522
3	.900	.960	.900	.750	.820	.820	.810	.710	.870	.870	.882
4	1.050	1.250	1.350	1.250	1.100	1.200	1.190	1.220	1.330	1.330	1.326
5	1.160	1.400	1.600	1.800	1.700	1.550	1.600	1.720	1.850	1.840	1.777
6	1.430	1.500	1.750	2.000	2.300	2.250	2.100	2.200	2.330	2.360	2.355
7	1.650	1.750	1.900	2.200	2.500	2.850	2.950	2.940	2.700	2.830	2.906
8	1.950	1.950	2.100	2.300	2.600	3.000	3.500	3.300	3.390	3.300	3.278
9	2.300	2.300	2.300	2.500	2.800	3.200	3.600	3.570	3.770	4.030	3.811
10	2.820	2.650	2.800	2.700	2.950	3.450	3.800	3.770	4.170	4.150	4.332
11	2.800	3.250	3.000	3.300	3.200	3.500	4.100	3.690	4.030	4.960	4.200
12	2.850	3.000	3.700	3.400	3.800	3.700	4.000	3.940	3.620	6.000	4.963
13	3.600	3.000	3.300	4.200	3.900	4.400	4.200	3.910	4.630	5.680	5.711
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	.230	.000	.000	.250	.000	.000	.000	.000	.000	.000	.000
2	.593	.493	.394	.527	.553	.523	.615	.491	.566	.535	.446
3	.887	.907	.758	.785	.787	.726	.733	.789	.877	.927	.936
4	1.260	1.294	1.141	1.069	1.043	1.050	1.003	1.125	1.214	1.320	1.413
5	1.721	1.653	1.714	1.411	1.392	1.397	1.356	1.488	1.492	1.752	1.866
6	2.219	2.130	2.146	1.932	1.942	1.867	1.800	1.877	1.858	2.325	2.412
7	2.654	2.577	2.607	2.287	2.460	2.480	2.473	2.296	2.379	2.856	3.141
8	3.134	2.947	2.869	2.683	2.901	2.615	3.077	3.001	3.068	3.841	4.456
9	3.608	3.470	3.108	3.054	3.341	3.399	4.095	3.614	4.268	5.130	4.490
10	3.688	4.033	3.550	3.431	3.244	3.540	4.410	3.287	3.410	.000	.000
11	4.546	3.946	3.630	3.841	4.162	3.037	3.980	4.495	.000	.000	.000
12	4.823	4.033	3.780	4.114	4.300	3.110	.000	.000	.000	.000	.000
13	4.680	4.908	4.064	4.000	5.700	4.410	.000	.000	.000	.000	.000

Table 10. 4X haddock mean numbers per standard tow by stratum in the 1970-1991 summer RV surveys.

SUMMER SURVEY-MEAN NOS. PER TOW BY STRATA								
I	1970	1971	1972	1973	1974	1975	1976	1977
70 I	3.938	.583	5.678	5.134	.412	4.200	.700	273.933
71 I	.000	.000	2.471	.000	.000	.553	.000	.437
72 I	13.718	37.800	15.864	12.563	28.858	49.180	35.250	14.917
73 I	89.870	9.975	82.215	51.917	53.905	11.500	111.883	169.737
74 I	55.725	25.608	28.958	39.500	75.434	88.725	75.743	26.003
75 I	78.138	53.879	21.969	57.627	105.675	27.125	136.381	36.580
76 I	.000	80.500	12.385	.000	41.533	39.528	1.313	554.500
77 I	45.401	34.125	24.515	31.914	132.000	25.236	66.938	31.068
78 I	1.750	1.750	.700	.583	2.524	3.208	10.111	4.678
80 I	100.653	240.457	98.510	191.432	262.160	179.521	64.126	628.144
81 I	63.262	30.888	31.687	146.873	271.842	49.718	56.217	7.875
82 I	2.333	3.316	.000	.000	5.833	3.062	4.690	9.750
83 I	2.527	.000	4.083	.000	1.853	2.100	30.333	9.963
84 I	.000	.525	.000	.368	.350	.389	6.115	.412
85 I	52.162	11.776	3.111	31.924	9.291	12.000	14.775	34.484
90 I	30.429	56.875	.525	70.774	323.400	48.120	109.148	188.873
91 I	4.156	.000	11.392	3.917	21.050	3.014	2.580	21.302
95 I	16.800	13.557	9.329	4.000	20.189	1.733	4.873	33.919
I	1978	1979	1980	1981	1982	1983	1984	1985
70 I	5.750	38.250	3.281	6.088	.000	35.790	12.578	.972
71 I	.457	.553	2.917	2.864	2.945	3.889	.461	.000
72 I	10.526	32.552	248.912	192.033	141.201	39.749	49.034	73.403
73 I	26.390	81.259	31.419	10.600	135.882	33.811	60.703	189.097
74 I	96.785	303.429	27.176	119.461	134.865	57.810	.000	134.501
75 I	81.000	77.824	71.197	44.979	47.982	53.936	254.509	100.854
76 I	53.783	.000	23.100	14.841	5.499	62.337	8.750	369.873
77 I	45.019	44.471	35.917	53.200	94.152	86.471	150.809	92.132
78 I	6.153	2.522	1.750	.667	2.941	16.771	16.728	20.417
80 I	192.549	88.416	224.056	180.808	73.738	93.049	172.055	117.448
81 I	72.484	84.583	169.201	35.109	170.296	41.817	70.772	18.678
82 I	8.400	20.545	14.749	9.923	23.333	8.578	20.903	1.458
83 I	1.750	9.740	23.500	32.225	70.037	5.662	33.424	14.583
84 I	.583	14.868	2.333	1.667	6.043	1.279	4.118	2.936
85 I	13.878	10.871	65.917	15.014	24.849	10.942	26.443	80.435
90 I	63.480	384.721	311.149	1478.690	485.533	234.973	773.650	159.637
91 I	11.103	5.205	15.371	15.481	30.463	32.012	29.262	16.342
95 I	48.000	31.461	6.750	8.683	37.082	14.843	3.088	5.219
I	1986	1987	1988	1989	1990	1991		
70 I	38.603	6.611	6.462	4.791	1.544	.000		
71 I	.515	2.574	.000	.000	.000	.000		
72 I	73.088	28.209	34.725	37.785	17.465	19.112		
73 I	174.074	80.294	12.010	12.324	41.512	92.361		
74 I	52.610	3.153	1.544	1.797	31.111	6.319		
75 I	159.044	14.126	13.897	22.104	54.473	22.475		
76 I	22.390	25.032	9.096	9.206	5.023	8.507		
77 I	120.409	43.994	59.482	42.016	24.374	38.583		
78 I	9.479	25.392	11.324	.000	13.825	.000		
80 I	97.597	52.541	84.961	175.585	251.538	360.130		
81 I	167.923	31.931	25.591	29.104	18.030	37.650		
82 I	2.059	31.633	22.733	17.843	39.565	20.855		
83 I	12.517	11.484	20.074	1.544	36.842	41.780		
84 I	.686	.000	1.367	.972	.972	.000		
85 I	35.573	2.970	9.680	1.863	13.125	87.062		
90 I	31.216	29.117	124.802	129.291	174.019	79.274		
91 I	2.745	.772	.257	.000	.667	1.296		
95 I	.000	.000	.975	.000	18.047	.000		





Table 13. 4X haddock coefficients of variation of the mean numbers at age per standard tow from the 1970-1991 summer RV surveys.

SUMMER SURVEY-COEFFICIENTS OF VARIATION																						
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0	0	0	0	0	0	0	0	0	47	0	74	97	67	40	0	45	0	0	0	0	0
1	22	48	39	35	57	41	25	29	35	47	63	64	39	33	46	26	12	24	40	22	56	32
2	28	25	46	38	36	24	27	36	30	12	41	44	29	36	46	20	28	26	56	29	32	26
3	23	31	28	34	32	29	16	62	29	24	38	49	27	31	42	33	27	22	24	22	25	23
4	29	33	17	22	26	29	17	60	27	25	30	17	23	18	34	46	23	17	16	16	19	25
5	40	33	15	18	26	33	15	44	31	28	31	12	20	16	25	34	21	15	13	20	19	34
6	40	34	14	29	29	32	14	38	31	26	29	13	17	15	20	16	27	17	22	33	26	37
7	33	37	15	26	27	32	12	29	25	25	25	18	21	15	20	20	39	23	36	0	35	44
8	36	33	14	30	30	32	18	34	0	25	20	23	27	18	17	29	37	0	59	0	0	0
9	37	34	15	35	29	36	75	24	0	46	21	27	32	24	21	0	66	0	95	0	0	0
10	47	56	24	29	28	57	31	35	0	25	22	43	39	25	36	48	71	0	0	0	0	0
11	34	39	56	40	21	31	0	38	33	0	42	36	41	24	51	0	71	0	0	0	0	0
12	40	45	0	0	0	29	33	59	54	0	0	52	0	38	42	62	0	0	0	0	0	0
13	0	0	0	0	0	0	24	40	0	0	0	0	0	58	35	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	32	0	50	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	33	40	0	0	0	0	0	0	0	0	0	0	0	0





Table 15. 4X haddock mean weight (kg) at age from the 1970-1991 summer RV surveys.

[illegible]

Table 16. 4X haddock mean length (cm) at age from the 1970-1991 summer RV surveys.

SUMMER SURVEY-MEAN LENGTH AT AGE												
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	1	.00	.00	.00	.00	.00	.00	.00	8.50	.00	8.29	6.50
1	1	21.56	23.00	20.51	24.59	22.27	22.32	21.43	22.85	19.32	21.49	19.68
2	1	34.89	30.64	25.29	31.86	31.81	33.99	31.46	35.34	35.41	33.35	35.88
3	1	42.16	40.82	40.00	35.84	40.62	42.76	42.43	43.36	44.93	41.75	43.24
4	1	46.01	48.83	47.73	48.73	44.86	48.41	49.33	49.85	50.82	51.06	50.99
5	1	49.37	51.39	52.50	54.62	56.32	53.79	53.57	56.99	56.52	54.35	55.92
6	1	51.99	55.36	55.52	59.66	59.09	59.74	55.89	59.01	58.08	59.10	58.87
7	1	56.06	56.33	56.19	59.45	60.70	64.74	62.44	62.60	60.80	61.35	61.89
8	1	57.86	58.18	58.76	61.44	61.71	64.91	61.17	61.37	.00	62.66	62.82
9	1	59.69	61.30	60.96	62.10	62.14	66.17	67.11	68.06	.00	68.91	66.53
10	1	64.39	71.19	65.38	61.76	62.90	64.40	66.50	64.63	.00	66.47	67.95
11	1	67.35	68.28	68.50	66.73	67.00	66.38	72.50	66.50	62.50	.00	70.50
12	1	60.50	64.63	76.50	.00	.00	66.47	68.03	67.18	68.50	.00	.00
13	1	.00	.00	.00	70.50	.00	.00	69.78	71.34	72.50	.00	.00
14	1	.00	.00	.00	.00	.00	.00	.00	65.02	74.50	72.50	.00
15	1	.00	.00	.00	.00	.00	.00	.00	.00	62.50	69.94	.00
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	1	9.24	6.50	7.76	8.30	.00	6.50	.00	6.50	10.50	8.50	.00
1	1	21.28	20.11	19.29	21.79	20.51	21.52	20.18	20.60	20.82	22.92	21.96
2	1	36.08	29.48	29.62	31.99	31.49	30.95	27.93	32.44	30.90	35.03	30.91
3	1	45.83	40.55	41.14	37.03	38.51	37.59	36.65	43.16	40.52	42.43	42.81
4	1	48.46	48.63	47.08	44.16	42.55	43.80	44.10	47.97	49.41	49.01	48.25
5	1	56.10	53.92	53.53	50.65	51.15	50.77	50.23	52.24	53.06	55.93	53.86
6	1	59.57	58.04	57.82	54.99	58.64	53.03	54.55	55.29	56.77	60.55	57.49
7	1	61.93	60.02	60.64	56.69	61.91	61.53	56.49	58.26	68.50	65.76	65.54
8	1	64.20	63.54	61.35	58.54	63.77	64.65	60.50	65.94	.00	.00	.00
9	1	66.50	67.17	63.12	62.25	.00	68.50	.00	68.85	.00	.00	.00
10	1	67.95	76.99	61.73	67.66	66.50	74.50	.00	.00	.00	.00	.00
11	1	71.41	66.50	59.39	70.50	.00	74.50	.00	.00	.00	.00	.00
12	1	74.50	.00	68.67	72.50	70.50	.00	.00	.00	.00	.00	.00
13	1	.00	.00	70.50	66.50	.00	.00	.00	.00	.00	.00	.00
14	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
15	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Table 17. Total mortality estimates (Z) for 4X haddock ages 2 to 7, 2+ and fully recruited ages (5-7/6-8) from 1970-1991 summer RV survey.

Estimates of Total Mortalities (Z)

Zs	70-71	71-72	72-73	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81
2-3	-0.019	1.219	-1.121	-0.435	1.494	-0.106	-1.878	1.008	-0.431	-0.119	-0.094
3-4	-0.362	1.208	0.033	-0.310	1.414	0.248	-1.097	2.339	0.198	-0.015	0.597
4-5	-0.074	0.816	-0.116	-0.257	0.807	0.046	-1.058	1.862	-0.271	-0.223	0.927
5-6	-0.198	1.064	0.430	0.537	0.839	-0.253	0.083	1.276	-0.069	0.141	1.247
6-7	0.255	0.743	0.253	0.091	0.652	0.955	-0.368	1.722	0.051	0.196	1.251
7-8	0.107	0.715	0.189	0.189	0.358	1.386	-0.440	0.000	0.091	0.895	1.817
2+	-0.048	0.961	-0.055	-0.031	0.928	0.379	-0.793	1.641	-0.072	0.146	0.957
5-7/6-8	0.103	0.866	0.295	0.338	0.750	0.684	-0.006	1.462	0.023	0.334	1.285

Zs	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91
2-3	0.783	0.688	-1.163	-0.151	-0.355	0.882	-0.776	-0.420	-0.088	-0.153
3-4	0.542	0.775	-0.193	-0.273	0.409	0.397	-0.136	-0.224	-0.117	-0.342
4-5	0.246	0.273	0.041	0.399	0.698	1.160	0.236	0.262	-0.489	-0.720
5-6	0.261	1.045	0.070	0.600	1.537	1.678	1.002	2.181	0.570	0.611
6-7	0.371	0.978	0.439	1.224	1.702	1.766	1.902	4.452	0.613	1.495
7-8	1.277	2.091	0.508	2.785	1.374	4.256	1.756	0.000	0.000	0.000
2+	0.580	0.975	-0.050	0.764	0.894	1.690	0.664	1.250	0.098	0.178
5-7/6-8	0.414	1.175	0.242	0.922	1.556	1.738	1.194	2.489	0.583	0.867

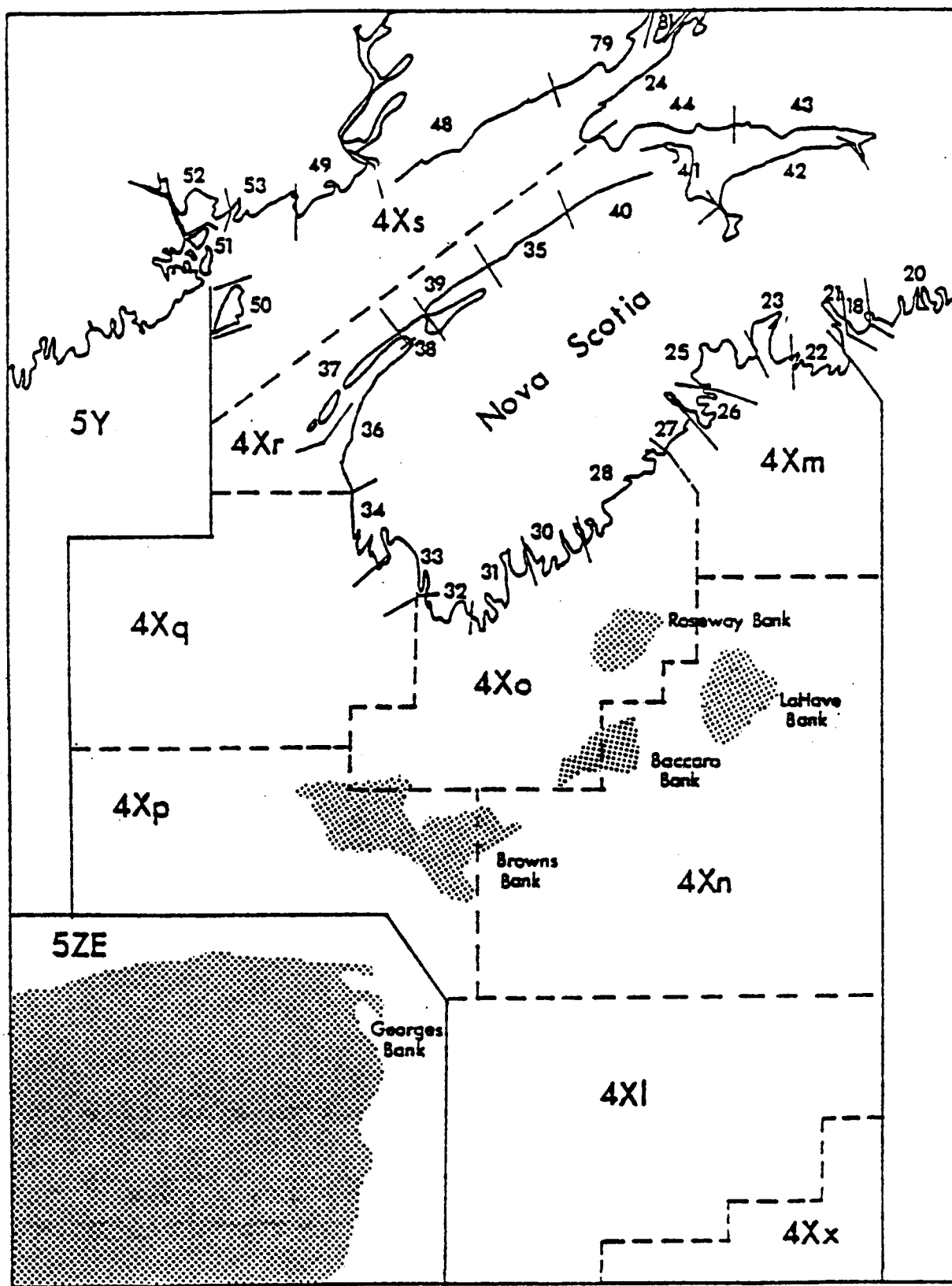


Figure 1. Canadian fisheries statistical unit areas in NAFO Division 4X

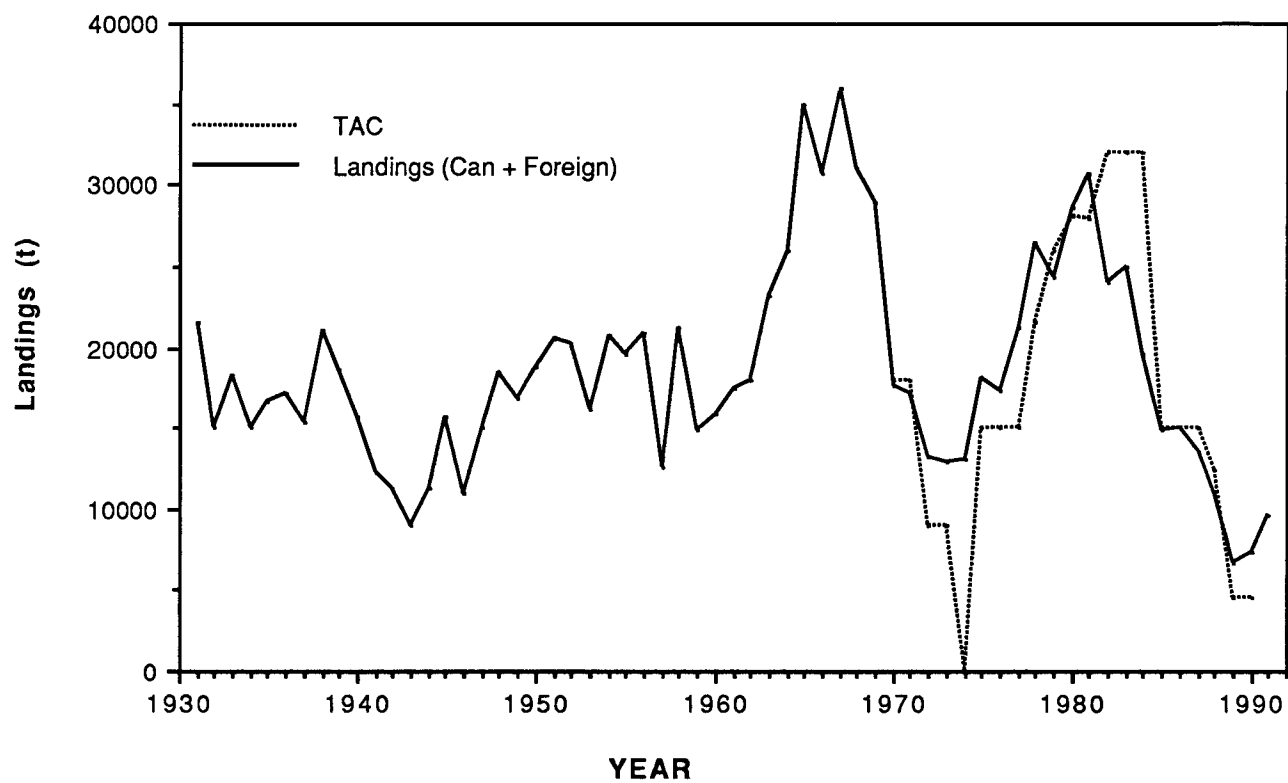


Figure 2. Long-term trends in 4X haddock landings, along with TACs since 1970.

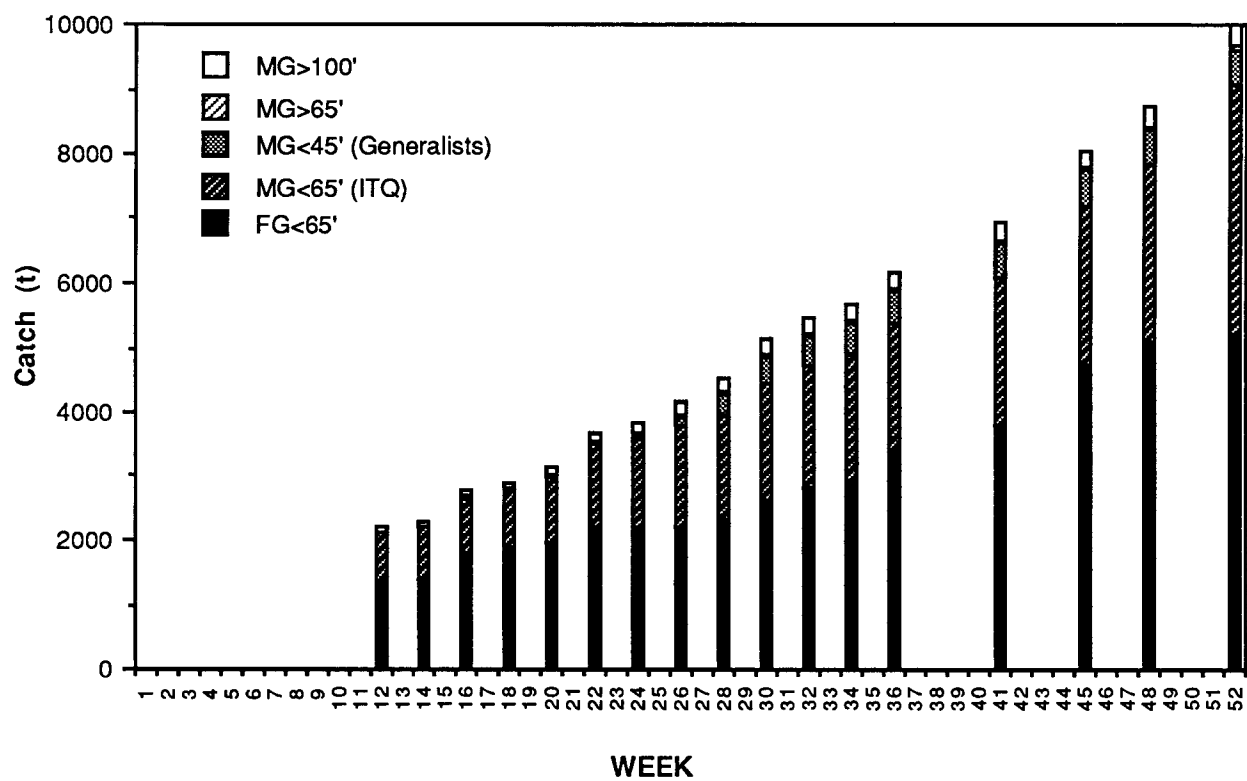


Figure 3. Weekly cumulative landings by gear sector of 4X haddock. (from 1991 quota reports)

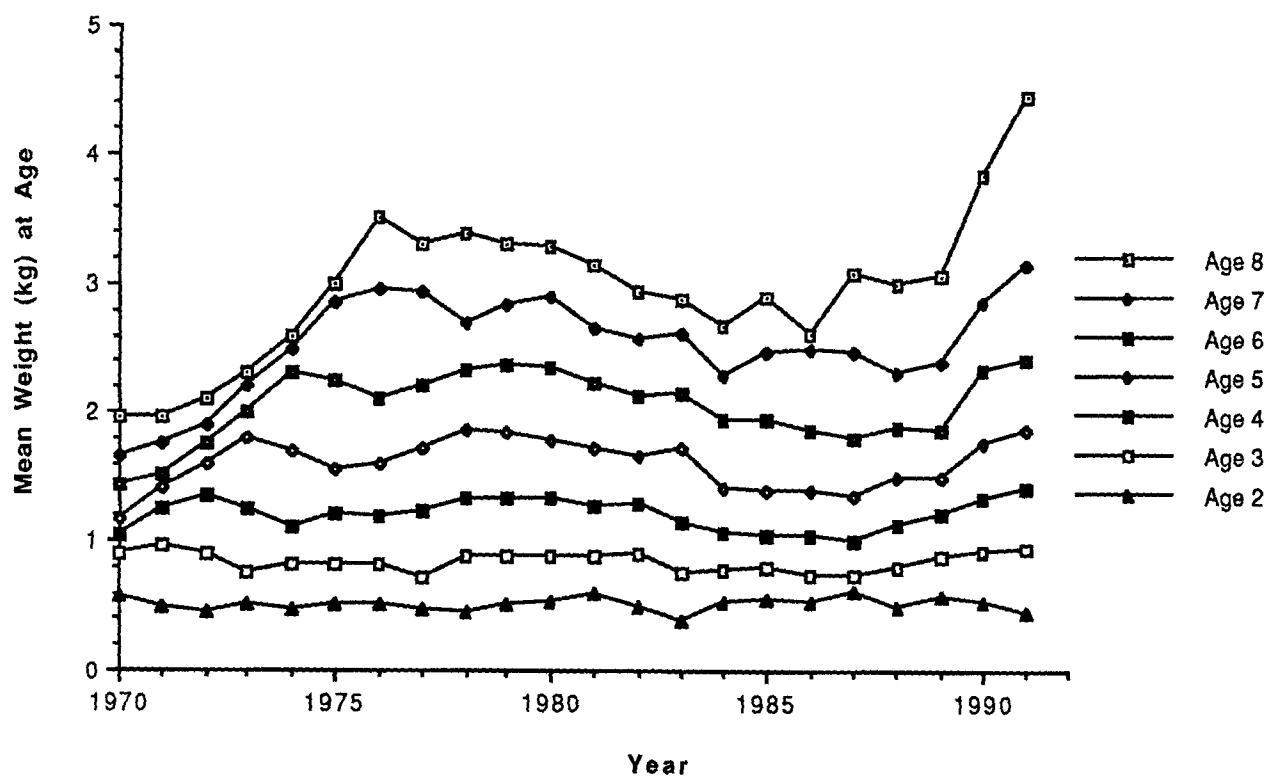


Figure 4. Mean weight at age of haddock in the commercial catch from NAFO Division 4X.



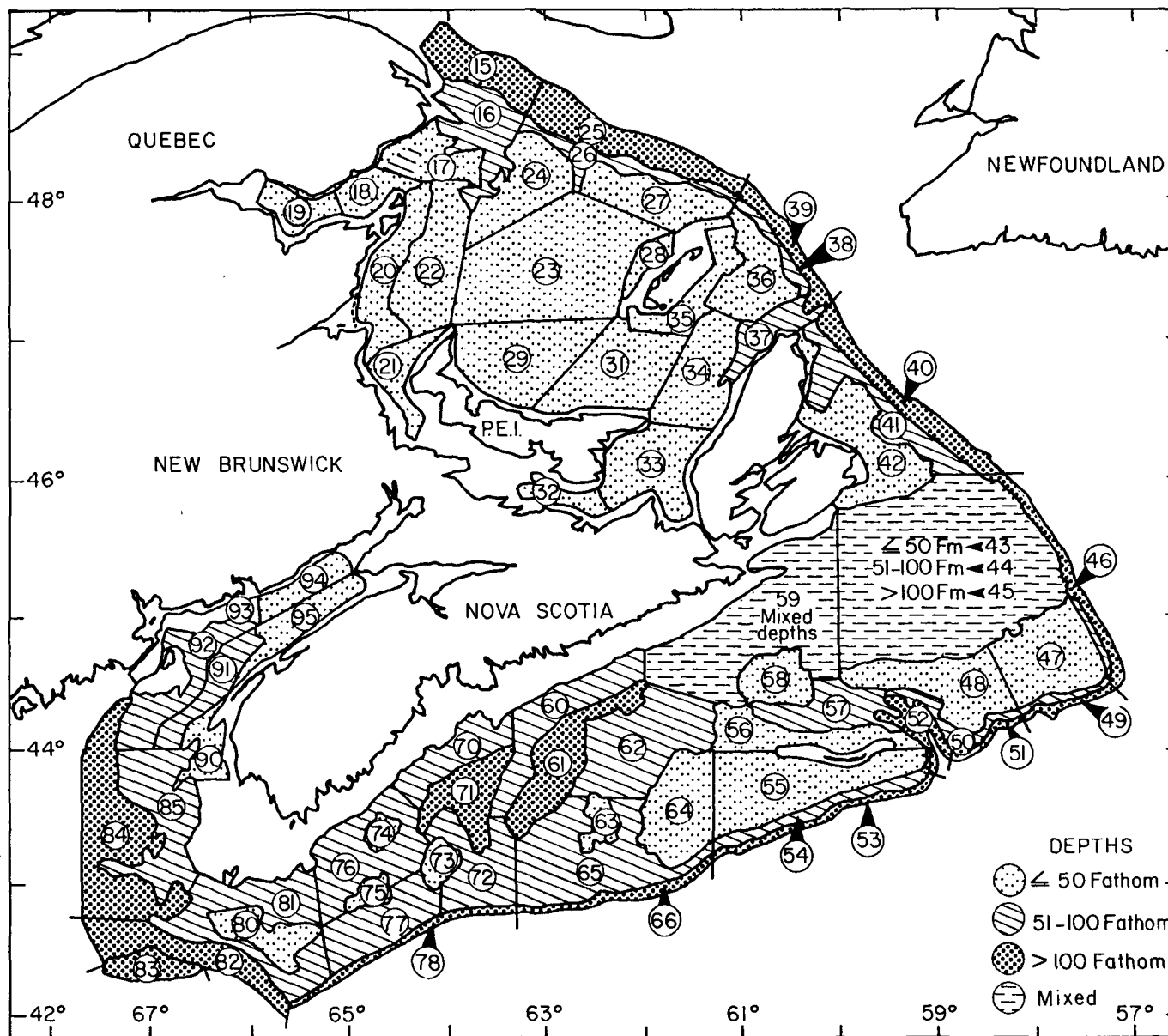


Figure 5. Stratification scheme used for the Canadian bottom-trawl surveys.

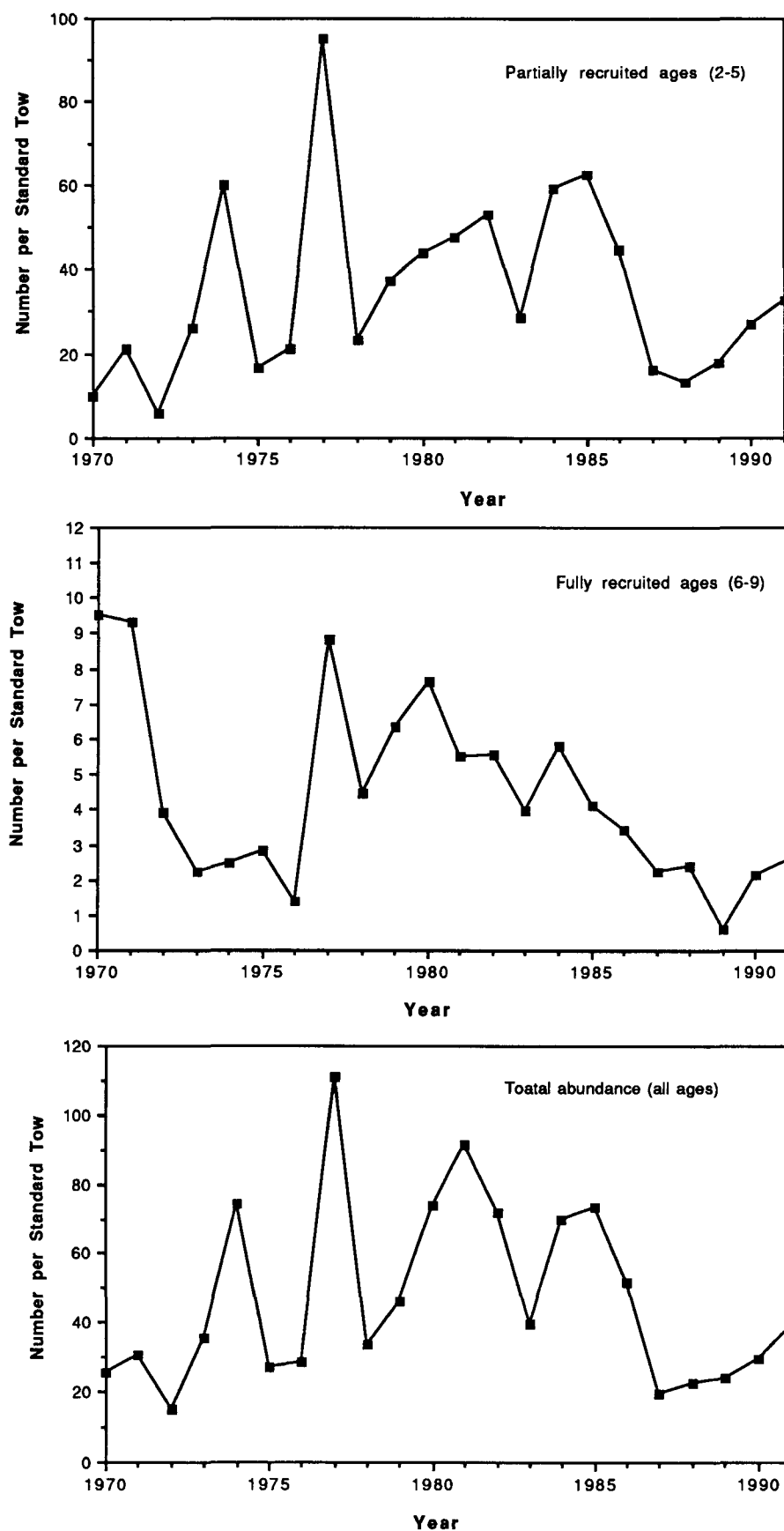


Figure 6. Survey arithmetic mean catch rate (nos./tow) of haddock from 4X during 1970-1991 for ages (a) 2-5, (b) 6-9, and (c) all age groups combined.

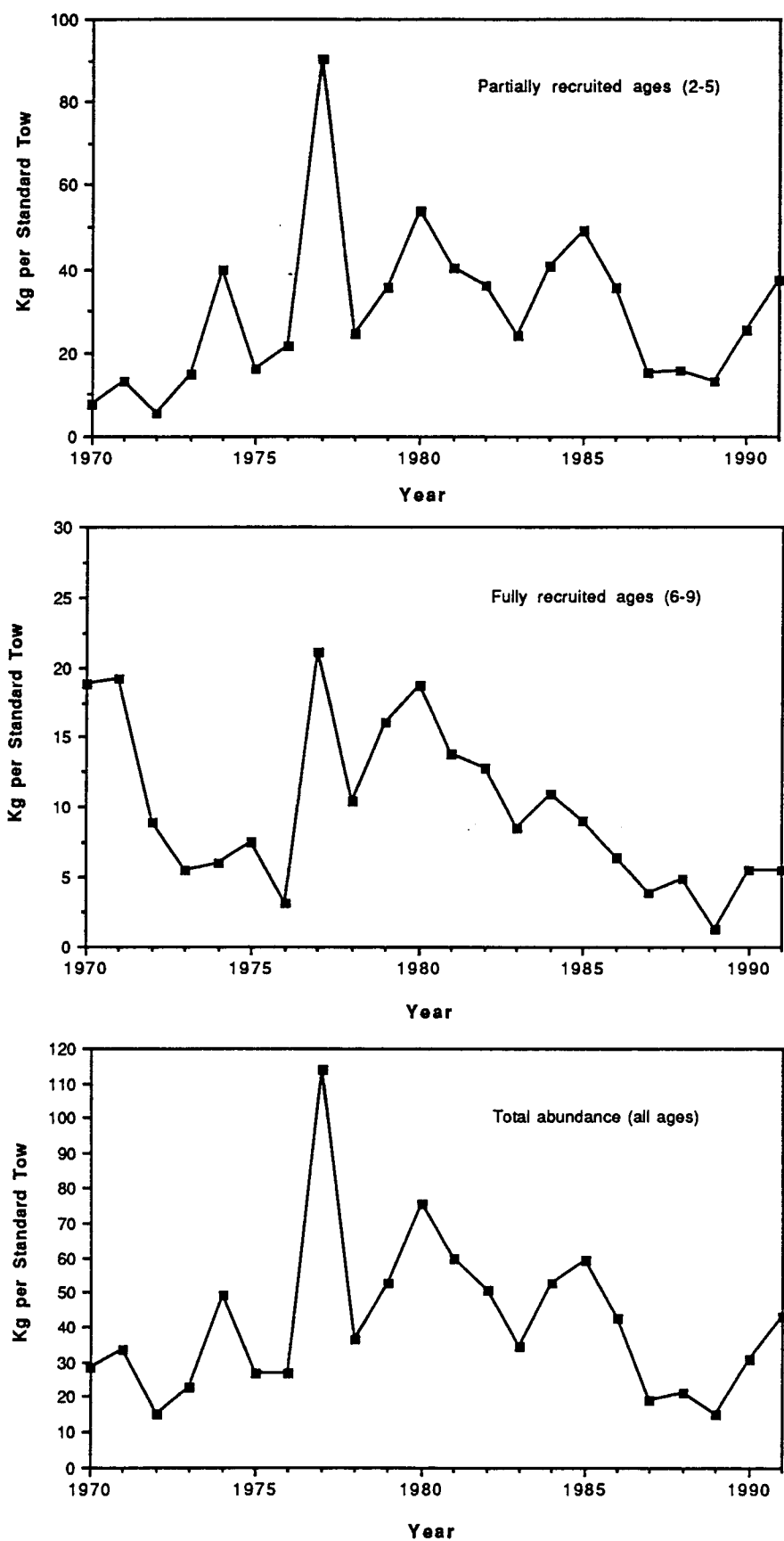


Figure 7. Survey arithmetic mean catch rate (biomass/tow) of haddock from 4X during 1970-1991 for ages (a) 2-5, (b) 6-9, and (c) all age groups combined.

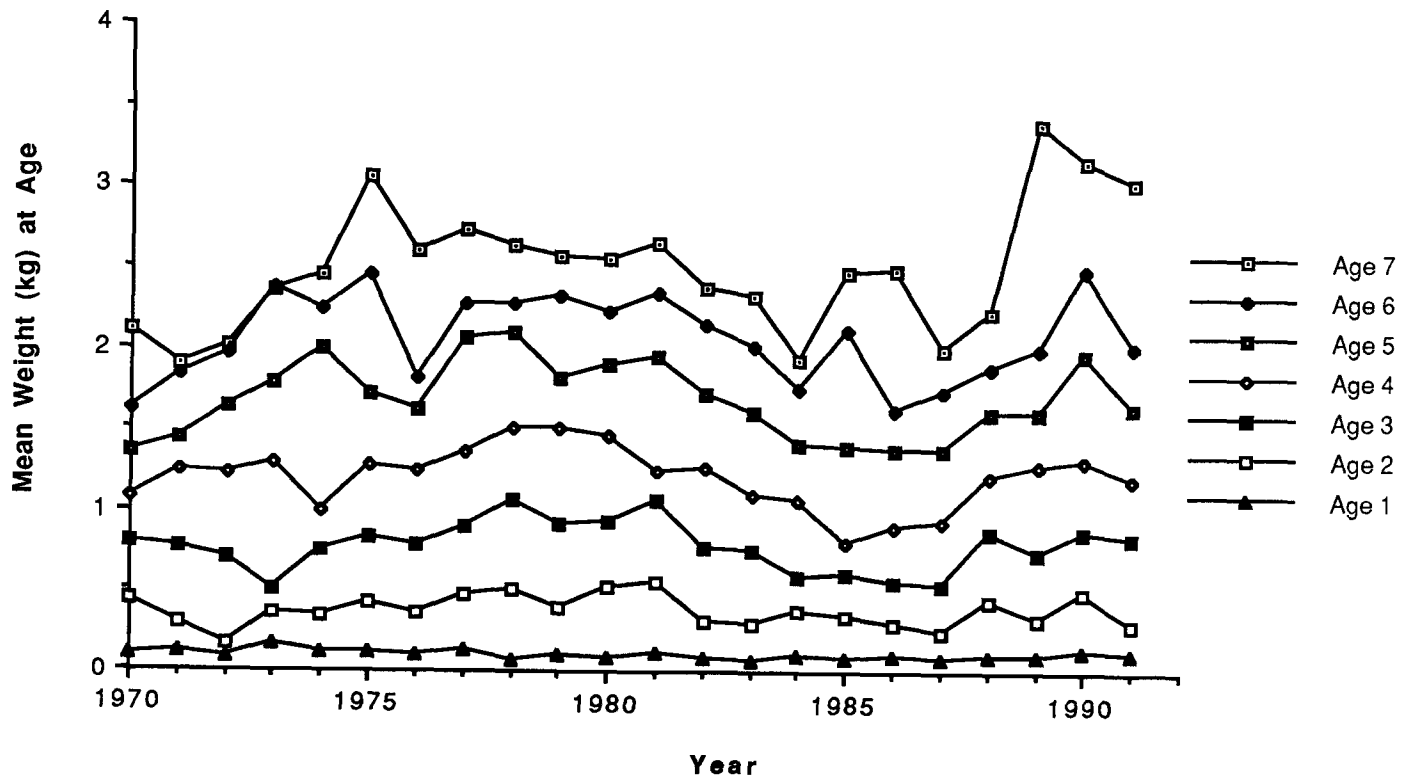


Figure 8. Mean weight at age of haddock from the groundfish research survey in NAFO Division 4X.

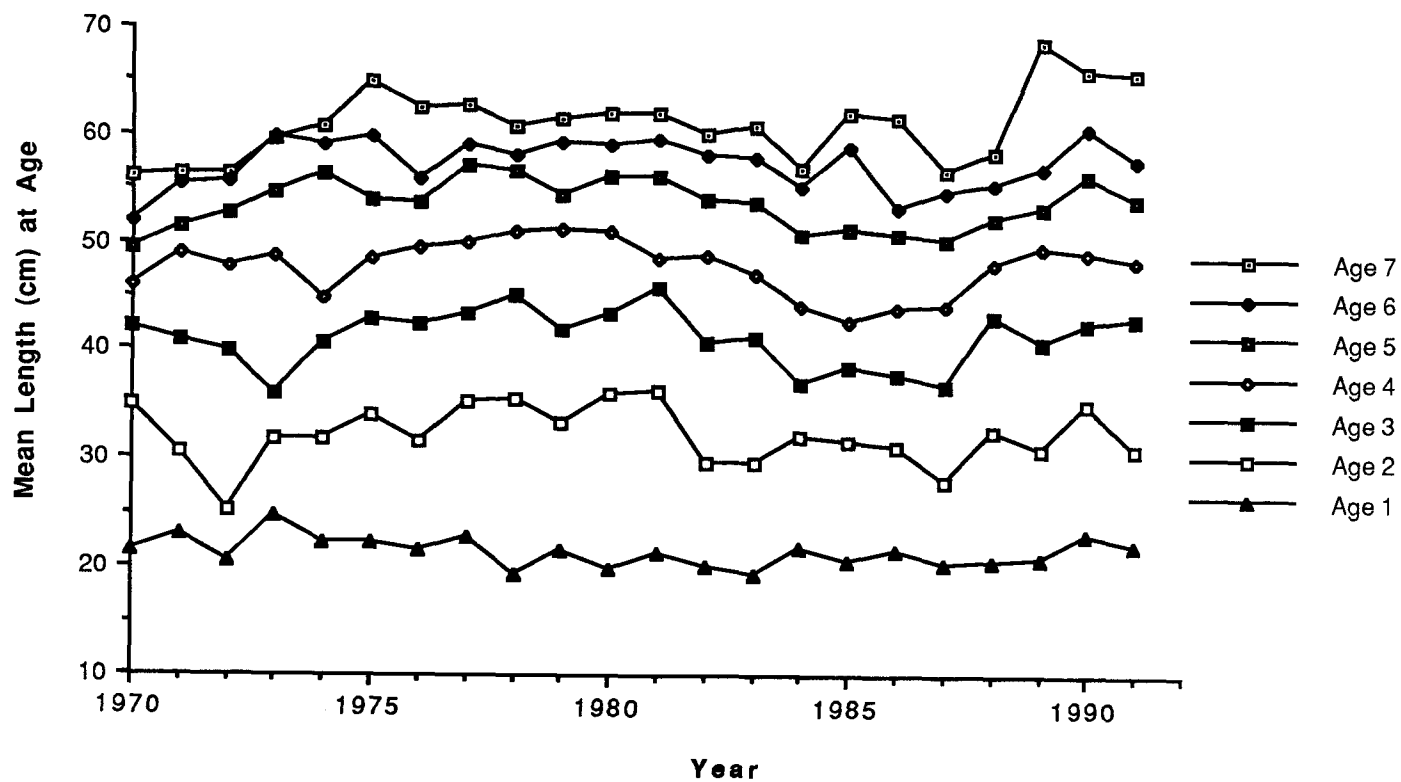


Figure 9. Mean length at age of haddock from the groundfish research survey in NAFO Division 4X.

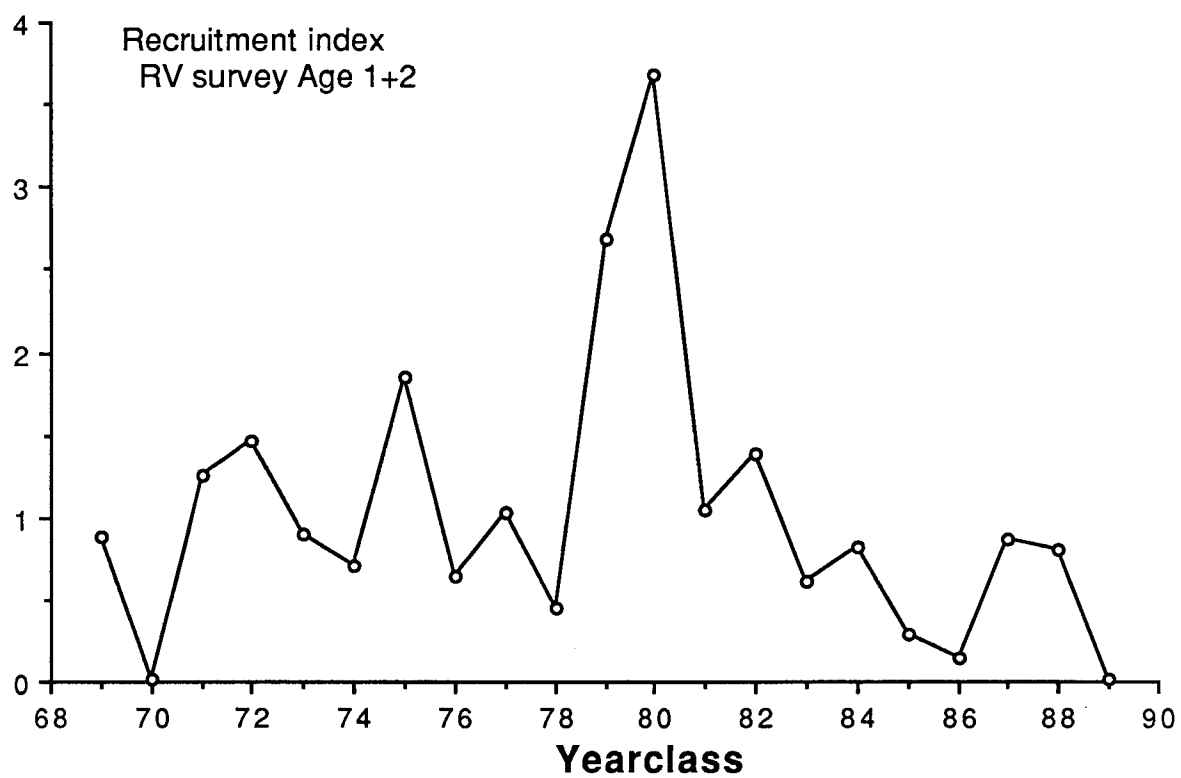


Figure 10. Recruitment index for 4X haddock calculated from ages 1 and 2 in summer RV survey 1970-91.

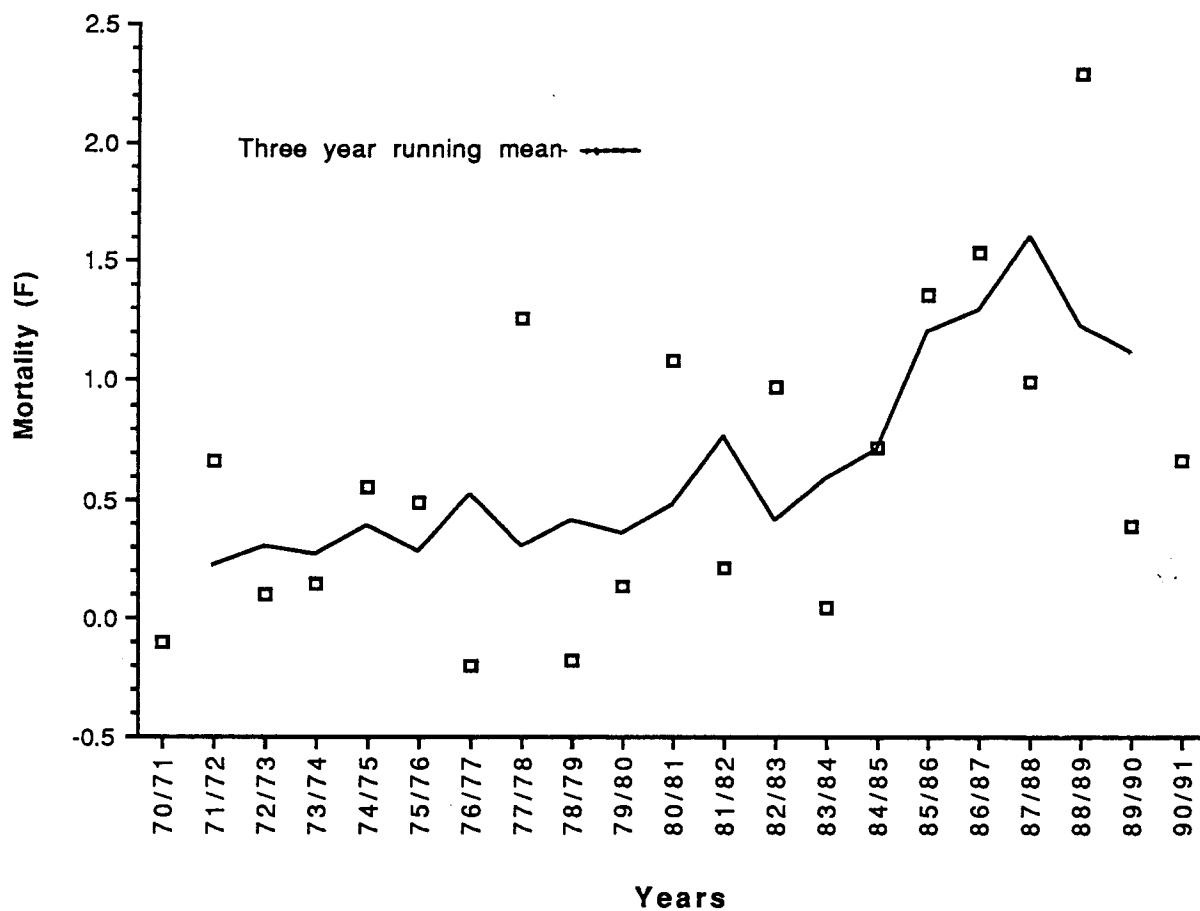


Figure 11. Mortality (F) estimated for fully recruited ages (5-7/6-8) from the summer RV survey, 1970-1991. Natural mortality assumed equal to 0.2. Squares are annual estimates.

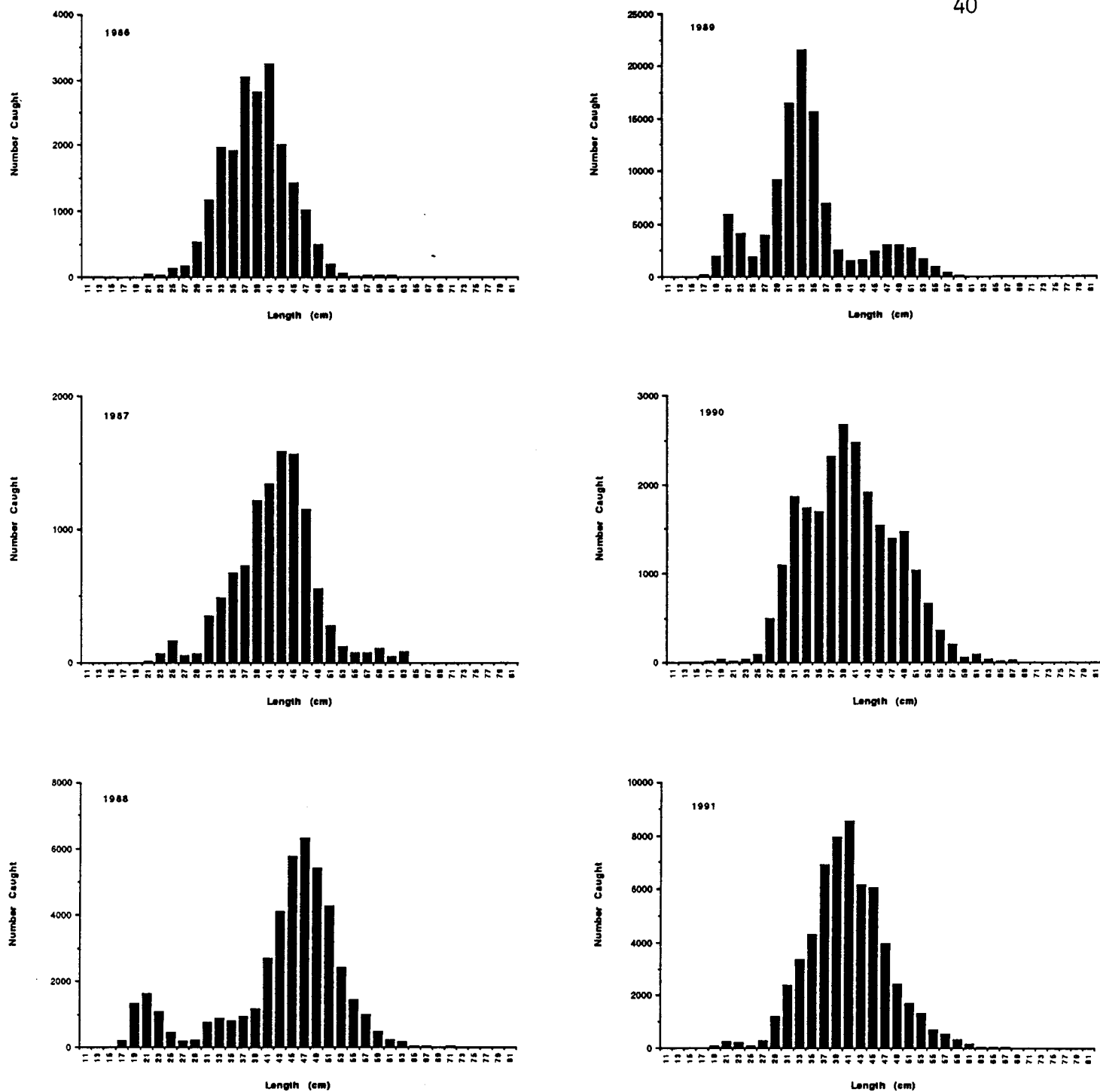


Figure 12. Length frequency of 4X haddock bycatch in the foreign small mesh gear fishery, 1986-1991.