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Assessment of the Status of Division 4X5Y Haddock in 2009

Évaluation de l'état du stock d'aiglefin des divisions 4X5Y en 2009

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ABSTRACT

The status of the southern Scotian Shelf and Bay of Fundy haddock stock (Divs. 4X5Y) was assessed using sequential population analysis. The previously established framework was used to provide advice. The results of several other models were presented to illustrate the degree of uncertainty in stock status and to promote further analysis and discussion of biological reference points. Landings of 4X5Y haddock in the fishing year ending 31 March 2008 were 5,684t, which is less than the quota of 7,000t. The quota in the 2008/09 fishing year remained at 7,000t, and 3,146t had been landed as of 5 November 2009. The summer research vessel (RV) survey mean weight per tow of haddock in the Bay of Fundy was below the long-term average. The weight-at-age of haddock remains low, but condition shows a positive trend over the past five years. Both the population, as sampled by the summer RV survey, and commercial landings are dominated by small fish (<43cm). Recent recruitment, based on model estimates, has been good; the 2003, 2005 and 2006 year-classes are above average. Spawning stock biomass (ages 4+) increased over the past decade, and is still above the long-term average. The recruitment indices, age structure and relative fishing mortality (F) for Scotian Shelf haddock suggest that exploitation is moderate and can allow for some rebuilding of the population. Assuming an $F_{0.1}$ catch of 5,300t in 2009, the catch at $F_{0.1}$ (F=0.25) in 2010 would be projected at 5,400t and zero growth would occur at a catch of approximately 4,200t.

RÉSUMÉ

L'état du stock d'aiglefin du sud du plateau néo écossais et de la baie de Fundy (divisions 4X5Y) a été évalué d'après une analyse séquentielle de population. Le cadre établi précédemment a été utilisé pour formuler l'avis au sujet de ce stock. Les résultats de plusieurs autres modèles ont été présentés pour illustrer le degré d'incertitude quant à l'état du stock et inciter à d'autres analyses et discussions sur les points de référence biologiques. Les débarquements d'aiglefin de 4X5Y pour l'année de pêche ayant pris fin le 31 mars 2008 se sont chiffrés à 5 684 t, ce qui était inférieur au quota de 7 000 t. Le quota de l'année de pêche 2008 2009 est resté de 7 000 t et les débarquements avaient atteint 3 146 t au 5 novembre 2009. Le poids moyen d'aiglefin par trait dans le relevé d'été par navire scientifique (relevé NS) était inférieur à la moyenne à long terme. Le poids selon l'âge reste faible dans ce stock d'aiglefin, mais la condition suit une tendance positive depuis cinq ans. Les petits poissons (< 43 cm) dominent, tant dans la population (d'après l'échantillonnage réalisé dans le relevé NS d'été), que dans les débarquements commerciaux. Les estimations du modèle révèlent que le recrutement a été bon récemment; les classes d'âge de 2003, 2005 et 2006 sont supérieures à la moyenne. La biomasse du stock de reproducteurs (âges 4+) a augmenté au cours de la dernière décennie et elle reste supérieure à la moyenne à long terme. Les indices de recrutement, la structure d'âges et la mortalité relative par pêche (F) de l'aiglefin du plateau néo écossais révèlent que l'exploitation est modérée et propice à un certain degré de rétablissement de la population. Si on se fonde sur des captures hypothétiques à $F_{0.1}$ de 5 300 t en 2009, les projections de captures à $F_{0.1}$ (F = 0,25) en 2010 seraient de 5 400 t et la croissance zéro se produirait à des captures d'environ 4 200 t.

INTRODUCTION

The southern Scotian Shelf and Bay of Fundy haddock stock (Divs. 4X5Y) was last assessed in 2005 (Hurley et al. 2009). This assessment uses the same Sequential Population Analysis (SPA; also known as a virtual population analysis; Gavaris 1988, Deriso 1999) model and data framework as Hurley et al. (2009). The catch is assumed to be known without error and the model is tuned to two surveys; the groundfish research survey (RV survey) and a joint industry/DFO survey (ITQ survey). Because haddock grow faster in the Bay of Fundy than in the southern Scotian Shelf, the landings and catch at age are built separately. Similarly, haddock catches from the summer research vessel (RV) survey strata from the Bay of Fundy (482-495) and the Scotian Shelf (470-481) are handled separately. The RV survey has been conducted every July since 1970, but several gear and vessel changes have occurred (reviewed in the methods). The RV survey has caught 943 haddock on average over the past 5 years. During the same period 1,217 haddock from the summer RV survey and 6,357 haddock from the commercial fishery were aged.

The size-at-age has declined dramatically since 1970 and has affected stock productivity, a pattern that has also been observed on the Eastern Scotian Shelf (Frank et al. 2001, Mohn and Simon 2002). Temperature explains only a small portion of this variation (Neuheimer et al. 2008), and size selection due to fishing is a possible mechanism that was examined (Law 2000).

The assessment model for 4X5Y haddock is based on the calendar year and was run up to 2008. Here, the data are presented from the 2009 summer RV survey and the available 2009 landings data. Both the methods and results are presented in less detail than in Hurley et al. (2009), and it is recommended that readers refer to this earlier assessment as necessary. For most sections, only the most recent data and results are reported.

A base model was used for the assessment of stock status, and three other models were run to show the variation in the estimate of stock status when the ITQ survey was excluded and natural mortality was estimated. The single survey model was used to model production and to estimate biological reference points. These alternative models were not fully reviewed and should be considered as illustrative only.

The Fishery

Hurley et al. (2009) reviewed the history of the fishery in some detail. The statistical unit areas for the stock are shown in Figure 1. The total allowable catch (TAC) has remained the same since 2005, and landings have remained steady over the past three years (2006-2008), averaging 5713t (Table 1, Figure 2). Landings of 4X5Y haddock in the fishing year ending 31 March 2008 were 5,684t relative to a quota of 7,000t. The quota in the 2008/09 fishing year remained the same, and 3,146t had been landed as of 5 November 2009. Over half of the catch comes from the third and fourth quarters (Figure 3). Most of the catch comes from the mobile gear fishery, but there have been some variation over time (Table 2, Figure 4). The allocations of quota to the various fishing sectors in 2009 are shown in Table 3. Landings by month and gear are in Table 4.

The proportion of catches from 4Xp has been increasing in the last 5 years (Table 5, Figure 5). The increase in 4Xp reflects directing for larger haddock in deeper water, which generally returns higher market value, and 4Xp is also an area in which the by-catch of cod is relatively

low. Further, since about 2002, the expansion of the lobster fishery has forced mobile fleet further offshore.

It should be noted that harvesting haddock is in the context of a mixed, multi-species fishery. There is some difficulty defining a 'haddock' fishing trip. Consequently, catch is reported for all groundfish trips for mobile and fixed gear (Table 6a and 6b). To some extent the haddock fishery is limited by the incidental catch of cod. There are strict cod by-catch limits and haddock fishers choose time, location and methods to avoid them. A growing number of fishers are using separator panels to reduce cod by-catch, equipment that is mandatory on Georges Bank (Div. 5Z).

The declining weight-at-age in the catch has been an important issue in the marketability of the haddock and overall stock productivity. The weight-at-age of younger fish (<5 years old) has declined slightly, but decline in the weight at age of older fish has been more dramatic. Currently, the weight of a 7-year old is roughly equivalent to that of a 3-year old in the 1970s and early 1980s (Figure 6a). Similar declines in weights-at-age have been observed for haddock on the Eastern Scotian Shelf (Frank et al. 2001, Mohn and Simon 2002). Declining trends in weight-at-age from 2004 to 2008 are greater in the Bay of Fundy (Figure 6b, 4Xqr).

The catch-at-age was constructed using the same stratification as in Hurley et al. (2009). Port sampling data (Table 7) were used to generate the catch-at-age (Table 8, Figure 7). Since the discarding and high-grading of haddock appear to be negligible (Hurley et al. 2009), it is assumed that the catch at age was well estimated. Mean weights-at-age are reported in Table 9.

A seasonal spawning closure was instituted in 1970. The current closure extends from February 1st to June 15th. The history of this area closure is documented by Halliday (1988).

Research Survey

A bottom trawl research vessel survey of the Scotian Shelf and Bay of Fundy has been conducted every July since 1970. The strata are shown in Figure 8. To date, three vessels and two types of gear have been used. From 1970 to 1981 the *A.T. Cameron* used a Yankee 36, and from 1982 to 2004, 2008 and 2009 the *Alfred Needler* used a Western IIA. In 2005 and 2007, the *Teleost* used a Western IIA. A vessel / gear conversion factor of 1.2 was used for the *A.T. Cameron* surveys (Fanning 1985). No conversion factor was used for the *Teleost*. The distribution of catches aggregated into 10-year periods shows no obvious change in the distribution of summer RV survey catches, and the 2009 appears to be consistent with the historic distribution (Figure 9). The stratified mean numbers-at-age and mean weight-per-tow is shown in Table 10 and Figure 10 respectively. Catches in the Scotian Shelf component (Strata 470-481) have shown an increasing trend over the last decade and are near the long term mean (41 kg/tow) in recent years, while catches in the Bay of Fundy (Strata 482-495) remained relatively stable but are below the long term mean (27 kg/tow) in recent years (Figure 10). Spawning stock biomass (ages 4+) shows similar trends indicating that Scotian Shelf haddock are making up a larger proportion of the population (Figure 11). Spawning stock biomass (SSB) has increased over the past decade and is still above the long-term average. The area expanded age composition, which the SPA tunes to, is shown in Figure 12.

Mean weights-at-age have been decreasing since the early to mid-1990s, particularly at older ages (Table 11, Figure 13). Many ages are at or near the smallest size observed in the RV time series. Condition has improved some over the last 5 years (Figure 14).

The length composition of the summer RV is dominated by smaller (<43cm) haddock. In 2009, 72% of haddock (by number) caught on the Scotian Shelf were <43cm, while 50% of the haddock caught in the Bay of Fundy were <43cm (Clark and Emberley 2010).

Total mortality (Z) estimated for ages 5-9 from the summer RV surveys was relatively stable in recent years (Figure 15).

Joint Industry/DFO Survey (ITQ Survey)

The mobile gear <65 ft (ITQ) fleet has conducted a joint resource survey of the 4X/5Y area with DFO since the summer of 1995. The survey is conducted in July, the same time that the DFO research vessel survey is conducted, by 3 draggers (<65 ft) equipped with standardized gear with the same size codend liner as used in the RV survey. A fixed station design, based on the RV survey strata, is used and standardized tows are made. The survey is designed to cover the entire 4X area, including a large inshore area off southwest Nova Scotia that is not covered by the RV survey. Further details are summarized in O'Boyle et al. 1995 and Hurley et al. 1999. Due to changes in the survey design between 1995, the first year of the survey, and subsequent years, the 1995 survey was not used in the time series here.

The largest catches are on Browns Bank (4Xp, Figure 16). In recent years, there has been a reduction in the numbers of haddock in the western portion of 4X (Gulf of Maine and Bay of Fundy). The q-corrected mean numbers per tow in the ITQ survey and the summer RV survey show a similar pattern, with the exception of the last 2 years when there were relatively higher catches in the ITQ survey (Figure 17).

Estimation of Stock Parameters and Results

As this assessment is in essence an update, the base model is unchanged from the 2005 stock assessment (Hurley et al. 2009), with the exception that the half year's data for the terminal year are not included. The base model is run in ACON and is as follows:

Parameters:
   Population numbers at mid-year $N_{i,2005}$ i = 2-10
   Calibration coefficients $q_{1,i}$ i = ages 2-10 for July RV survey
                            $q_{2,i}$ i = ages 2-10 for ITQ survey

Structure Imposed:
   Error in catch assumed negligible
   Partial recruitment fixed for age 1 in 2008
   F on oldest age (10) set as average F of ages 8-9 adjusted by the partial
        recruitment of age 10 in 2005
   No intercepts were fitted
   M = 0.2 for all ages

Input:
   $C_{i,t}$ i = 1-10; t = 1970 to 2008 - catch-at-age for entire year
   $J_{i,t}$ i = 2-10; t = 1970 to 2008 - July RV survey index
   $ITQ_{i,t}$ i = 2-10; t = 1996 to 2008 - ITQ survey index

Objective function:

Minimise $\{ \sum\sum (\ln J_{i,t} - \ln q_{1,i} N_{i,t})^2 \} + \{ \sum\sum (\ln ITQ_{i,t} - \ln q_{2,i} N_{i,t})^2 \}$

Summary:

Number of observations:	348 for July RV (9 ages by 39 years – 3 zeros)	
	117 for ITQ (9 ages by 13 years)	
Number of parameters:	27, 9 ln Ns estimated by NLLS, 18 qs algebraically	

age	1	2	3	4	5	6	7	8	9	10
partial recruitment	.0001	.033	.118	.452	.884	.972	1.00	1.00	1.00	1.00

The fit of the model to the summer and ITQ survey is shown in Figure 17. Catchability for the summer and ITQ survey are shown in Figure 18. It is interesting to note that the catchability of the RV survey increases with age and that the catchability of the ITQ survey decreases with age. This pattern indicates that each survey is sampling a different part of the population. The ITQ survey may be catching more young haddock because a balloon trawl is used and/or they are fishing in an inshore area with more small haddock. Recruitment and SSB are shown in Figure 19. Recent recruitment has been good; the 2003, 2005 and 2006 year-classes are above average. Exploitation rates for ages 5-7 are below $F_{0.1}$ (Figure 20).

Three additional models were developed to explore some alternative assumptions. An identical model, except that it used only the summer RV survey for tuning, was also run in ACON. This single survey version was required for the Sissenwine-Shepherd production analysis. This model was then ported to AD Model builder (ADMB). The move to ADMB was chosen because of its more powerful parameter and error estimation. The single survey ADMB version was run with M = 0.2 as a test and then with natural mortality estimated as a random walk. A comparison of the base model and the three additional models in terms of SSB is shown in Figure 20. The base (2-index) run has the lowest SSB. The ACON and ADMB one index runs are almost identical. The random walk M has higher peaks (Figure 21). The estimated trend in natural mortality is shown in Appendix A.1.

The one- and two-survey models give very similar estimates of abundance. However, the two-survey base model is preferred because the lower level of uncertainty in the estimate of numbers-at-age in the terminal year. The Coefficient of Variation (CV) of the two-survey base model is about 70% of the CV of the single-survey estimates (Table 12).

The resulting estimates of population numbers, biomass, and fishing mortality from the base model are shown in Table 13a-c. Residuals from the base model fit are shown in Table 13d and Figure 17. As with previous assessments of this resource, the residuals show some strong year effects, with positive residuals at all ages in some years and negative residuals at all ages in other years (Figure 17).

This resource has a strong retrospective pattern (base model: Figure 22), but the pattern was not so bad as to suggest discarding the model. Fitting a random walk Natural Mortality (M) added 39 more parameters but had very little effect of the overall goodness of fit. It did however have a large impact of the retrospective metric, rho (P) (Table 14, Appendix A.2, A.3).

Production Modeling and Biological Reference Points

A Sissenwine-Shepherd production model (Sissenwine and Sheperd 1987) was run using the population estimates from the single survey version of the model. The production model was modified to use moving windows of data in order to estimate time trends in production (Mohn and Chouinard 2004). The brevity of the ITQ survey meant that it could not be used in this analysis and is the reason that the single index models were developed. Figure 23 shows the results of this analysis using the entire time series as an input. Here the weight-at-age were long-term averages and are not representative of recent growth. This analysis using the single survey model gives the familiar biological references of Maximum Sustainable Yield (MSY), Biomass Maximum Sustainable Yield (B_{MSY}), F_{MSY}, $F_{0.1}$ and F_{crash}. MSY was estimated to be 15kt, SSB_{MSY} 42kt and F_{MSY} at 0.32. The base model estimates are very similar: 15kt, 45kt and 0.30, respectively. This F is for fully recruited fish and is 5% above the F5-7 previously used in most of this assessment as those ages were not fully recruited.

The moving window analysis (Figure 24) shows that the MSY was above 20,000t in the 1980s but fell to near 10,000t recently. Thus, the production regime has an impact of more than two fold on MSY. Figure 24 also shows that F_{MSY} and $F_{0.1}$ were similar until the late 1990s and then diverged with recent $F_{0.1}$ the difference becoming quite large as growth decreases. Slower growth and/or increased natural mortality shifts $F_{0.1}$ to higher values.

Figure 25 partitions the contributions of growth, stock-recruitment and natural mortality to production and, therefore, MSY. Reproduction was good up until about 1990 and then fell into a poor regime when recruitment became more sporadic (Figure 25, upper panel). Growth also slowed over this period and in the early years it added about 4,000 t to the MSY, while in recent years it has reduced production by about the same amount (Figure 25, lower panel). Total production, stock-recruitment, and yield are plotted against fishing mortality and SSB in Appendix A.4.

The uncertainty in the reference points was also estimated using bootstrapping (Figure 26). The residuals to the stock-recruit curve were re-sampled and added to the model fit; so-called conditioned bootstrapping. The weight-at-age was randomly sampled from the summer RV series and, finally, natural mortality was assumed to have log normal error with a CV of 0.1 (somewhat conservatively). After 1000 random trials, the distributions of SSBMSY and FMSY were constructed. They show that these reference points could easily be 40% higher or lower to the 10th and 90th percentiles.

Nonetheless, trial references at 40 and 80% SSB_{MSY} for biomass at the lower stock reference (Blsr) and the upper stock reference (Busr) were calculated and are shown with the SSB history (Figure 27). For most of the years, SSB is above the Busr and it was always above Blsr. The trial references are converted into a harvest control rule in Figure 28. This figure also contains the trajectory of the resource and a 3-year projection at 7,000t (in red). The ellipses are the measurement uncertainty from a SPA bootstrap analysis and for the projected SSB.

Figure 29 and 30 were used in pervious assessments to estimate the impacts of harvest levels. Figure 29 shows at an F of 0.2 would correspond to a harvest of 5,400t, while zero growth occurs at about 4,200t. Figure 29 is a risk plot which shows a high probability of falling biomass and that Blsr would be exceeded with a harvest over 5,000t.

CONCLUSIONS

The TAC for Atlantic haddock has been 7,000 t since 2006, and landings have averaged 5,713t during this time.

Using the base model, recent recruitment has been good; the 2003, 2005 and 2006 year-classes are above average. Spawning stock biomass (ages 4+) increased over the past decade and is still above the long-term average.

The recruitment indices, age structure and relative F for Scotian Shelf haddock suggest that exploitation is moderate and can allow for some rebuilding of the population.

Analysis conducted in this assessment suggests that a catch of 7,000 t exceeds $F_{0.1}$; $F_{0.1}$ of 0.25 would correspond to a catch of 5,400 t. Zero growth occurs at a catch of approximately 4,200t.

The ancillary analysis emphasizes the need for a benchmark for this stock. Also, although it has been shown how biological reference points may be estimated, a workshop to review this methodology, at least regionally, is needed.

Sources of Uncertainty

The selectivity of the fishery may have changed as the proportion of the landings from mobile and fixed gear has changed or the as the gear has been modified over time. Changes in the geographic and seasonal distribution of the fishery, resulting from gear conflict with the lobster fishery starting in about 2002, may have affected the catch-at-age.

Models presented here only run to age 10 as opposed to age 16 in previous models. A framework assessment would be needed to fully assess the implications of this change, but the results appear to be consistent.

The production analysis using moving windows identifies a change in the biology, specifically changes in recruitment and growth, but the projection model does not fully incorporate these changes. Furthermore, the reasons for the dramatic changes in growth or recruitment are not fully understood at present.

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Table 1. Reported nominal catch (t) of haddock from NAFO Division 4X (Canadian landings include 5Y).

Year	Catch	TAC	Fishing Year[1] Catch	Fishing Year[1] TAC
1970[3]	18072	18000		
1971	17592	18000		
1972	13483	9000		
1973	13106	9000		
1974	13378	0		
1975	18298	15000		
1976	17498	15000		
1977	21281	15000		
1978	27323	21500		
1979	25193	26000		
1980	29210	28000		
1981	31475	27850		
1982	25729	32000		
1983	27405	32000		
1984	21156	32000		
1985	16131	15000		
1986	15555	15000		
1987	13780	15000		
1988	11272	12400		
1989	6800	4600		
1990	7556	4600		
1991	9826	0		
1992	10530	0		
1993	6968	6000		
1994	4406	4500		
1995	5669	6000		
1996	6245	6500		
1997	6527	6700		
1998	7843	8100		
1999	6621	8100	9291	9800
2000	6961		7761	8100
2001	8466		7411	8100
2002	7997		7930	8100
2003	8706		8617	8100[2]
2004	6553		5964	10000
2005	5633		5142	8000
2006	4746		4687	7000
2007	6876		6767	7000
2008	5372		5684	7000
2009			3146[3]	7000

1 Fishing year in 1999 was extended to March 3, 2000. TAC prorated upwards. Subsequent fishing years begin on April 1st.
2 Quota increased to 10,000t from 8100t during the fishing year.
3 Landings to November 5, 2009

Table 2. Reported nominal catch (t) of haddock from NAFO Division 4X5Y landed in the Maritimes by gear type and tonnage class. MG = mobile gear tonnage class 1-3 and 4+, LL = longline, HL = handline, GN = gillnet.

Year	MG[1] 1-3	MG 4+	LL	HL	GN	Misc[2]	Total of Gear Categories
1970[3]	5519	6503	2961	539	88	402	16012
1971	4743	7716	3227	456	79	183	16404
1972	2942	4755	4048	498	59	268	12570
1973	1929	4233	5853	377	143	145	12680
1974	4113	1628	6211	258	166	58	12434
1975	6183	4406	4944	275	176	75	16059
1976	4390	6157	4642	714	389	46	16338
1977	6290	8346	4032	411	337	177	19593
1978	9588	8099	6072	865	573	198	25395
1979	10293	8638	4349	838	399	63	24580
1980	13131	7444	5723	1281	797	228	28604
1981	14912	6649	7008	923	856	17	30365
1982	11960	3122	6763	875	814	31	23565
1983	12988	2560	7787	786	664	56	24841
1984	12081	615	6307	492	183	4	19682
1985	10244	563	4028	336	110	33	15314
1986	9854	209	4875	469	88	13	15507
1987	8177	511	4572	286	215	3	13763
1988	7269	377	3356	126	81	23	11233
1989	3829	90	2469	221	158	27	6794
1990	3329	110	3391	396	278	0	7504
1991	4182	206	4588	539	257	1	9772
1992	3469	258	5587	974	215	5	10508
1993	2632	123	3227	865	100	1	6947
1994	2081	97	1578	600	48	2	4405
1995	3062	106	2171	250	69	2	5660
1996	3685	151	2053	298	50	0	6237
1997	4238	65	2066	110	58	0	6538
1998	5155	80	2461	141	50	0	7887
1999	4475	120	1955	40	31	0	6621
2000	4129	105	2670	29	28	0	6961
2001	6140	88	2227	11	21	0	8486
2002	5630	37	2252	55	23	0	7997
2003	6616	29	2008	26	26	0	8706
2004	5376		1140	15	22	0	6553
2005	4611	53	950	5	13	0	5633
2006	3255	174	1309	3	6	0	4746
2007	5240	50	1583	0	3	0	6876
2008	4189	0	1176	0	7	0	5372

1 Mobile gears = Otb1, Otb2, PT, SDN, SS, MWT, MWPT, ShrT, Pair Seine.
2 Misc gears = Misc, Trap, UNK, Dredge, Jigger, Pot, Mech sq jig, undef, weir.
3 Years 1970 to 1985 are from NAFO and do not include area 5Y landings. From 1986 to 2002, data are from ZIF files; from 2003 to present, data is from MARFIS; data includes landings from 5Y from both of these sources.

Table 3. Canadian Atlantic Quota Reports. Quota and catch in metric tons.

	Initial Quota	Quota adjustments	Total Caught	%	Remaining
Preliminary final for fishing year 2008/09 as of April 22 2009					
01/04/08 - 31/03/09					
ABORIGINAL FISHERY	574	594	524	88	69
FIXED / FIXE < 45'	2048	2048	1106	54	942
FIXED / FIXE 65' - 100' BY-CATCH	39	39	0	0	39
MOBILE 65' - 100' BY-CATCH	39	39	20	52	19
FIXED & MOBILE GEAR - ITQ/EA FLEET	4300	4280	4015	94	264
TOTAL 4X5Y Haddock	7000	7000	5665	288	1333
Fishing year 2009/10 as of November 5, 2009					
01/04/09 - 31/03/10					
ABORIGINAL FISHERY	574	417	400	96	17
FIXED / FIXE < 45'	2048	2048	720	35	1328
FIXED / FIXE 65' - 100' BY-CATCH	39	39	0	0	39
MOBILE 65' - 100' BY-CATCH	39	39	0	0	39
FIXED & MOBILE GEAR - ITQ/EA FLEET	4300	4452	2426	55	2026
TOTAL 4X5Y Haddock	7000	6995	3546	186	3449

Table 4. Reported landings by month and gear type from NAFO Divisions 4X and 5Y (from ZIF and Marfis).

Total	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	789	859	1168	2119	996	1371	1057	1519	361	404	539	396	109	419	531	644	1371	982	809	340	402	206	278	150
Feb	3898	2913	2320	1523	1447	1262	1361	1052	924	280	387	463	614	939	526	1129	603	670	398	617	577	589	362	375
Mar	626	1071	2085	216	836	288	318	366	452	139	518	481	572	1103	252	897	1496	772	1190	1351	741	435	531	537
Apr	1000	481	594	637	371	293	241	228	316	209	230	282	439	650	269	146	343	568	277	245	191	82	284	288
May	1164	1109	1363	808	245	429	542	606	676	278	314	273	194	132	324	325	413	361	569	366	176	141	209	90
Jun	2060	1059	1381	1289	906	597	942	1131	897	692	445	539	395	354	420	383	389	599	323	228	178	390	306	142
Jul	1599	1262	961	876	485	739	1086	1297	909	838	697	659	642	743	716	769	606	902	760	397	420	688	313	413
Aug	1291	1254	777	529	504	640	877	1027	1085	366	570	578	664	654	976	745	840	936	903	618	823	570	1059	492
Sep	1585	2652	1458	1697	444	864	978	1127	797	421	572	602	899	1042	1114	788	942	816	1243	855	875	706	1269	727
Oct	1096	1613	1057	790	330	408	742	801	267	289	492	699	867	645	587	609	628	578	898	596	636	370	1384	1008
Nov	436	635	347	231	147	309	585	529	195	220	256	707	598	503	495	344	545	428	832	550	456	409	522	835
Dec	562	599	253	503	83	305	1042	825	69	268	640	559	544	705	412	182	292	388	503	391	157	160	359	314
Total	16105	15507	13763	11217	6794	7504	9772	10508	6947	4405	5660	6237	6538	7887	6621	6961	8466	8000	8705	6553	5633	4746	6876	5372
Mobile	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	331	421	448	1312	614	720	280	578	259	112	246	197	78	319	476	518	1049	780	579	224	371	152	222	79
Feb	2598	1806	1192	1037	1062	794	508	414	232	244	375	450	457	885	494	826	502	598	325	496	569	547	292	359
Mar	439	754	1739	109	667	77	122	225	223	137	518	481	539	1033	229	549	1258	621	1012	1294	724	422	485	513
Apr	792	364	520	555	289	244	159	97	107	155	117	270	399	511	241	123	296	538	252	221	166	77	260	265
May	1067	1021	1207	756	193	379	449	353	396	227	182	203	176	99	296	288	386	347	544	351	164	135	190	86
Jun	1924	900	1142	1185	735	361	589	659	467	195	185	141	249	170	305	217	269	529	257	192	148	356	261	98
Jul	1306	871	549	670	171	315	440	450	320	234	207	267	337	320	349	341	301	541	538	257	292	491	118	204
Aug	856	688	293	117	83	113	195	137	166	141	188	275	277	304	589	316	475	481	560	418	615	217	683	258
Sep	1046	1852	1009	1103	47	154	280	197	209	202	269	364	559	492	733	414	722	432	864	671	704	385	909	510
Oct	713	938	473	469	15	95	235	161	163	160	292	414	502	259	283	282	331	300	607	425	463	250	1160	805
Nov	240	206	75	89	9	100	319	163	147	121	188	453	420	340	291	226	397	221	688	463	321	277	422	733
Dec	290	242	40	248	24	87	811	293	67	252	402	319	311	504	308	133	230	282	420	364	126	119	289	278
Total	11602	10062	8687	7648	3909	3439	4388	3727	2755	2178	3168	3836	4303	5235	4595	4234	6216	5670	6646	5376	4664	3428	5290	4188
Longline	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	457	438	718	807	382	645	777	937	102	292	293	199	31	99	55	126	321	201	229	117	31	54	56	71
Feb	1300	1107	1126	485	385	463	851	638	691	36	11	13	157	54	32	302	101	72	73	120	8	41	70	16
Mar	185	316	342	104	168	205	193	140	227	2	0	0	33	71	23	347	237	150	174	51	15	13	46	23
Apr	207	117	66	81	69	48	77	127	205	53	112	12	40	139	27	22	47	30	24	22	24	5	24	23
May	91	84	138	50	47	33	87	243	275	41	126	64	16	32	27	37	27	13	25	14	11	6	19	4
Jun	99	102	180	83	115	107	236	330	223	236	162	260	102	152	102	149	116	62	55	31	28	34	46	43
Jul	159	186	291	177	229	265	444	506	294	352	363	267	254	352	335	411	297	327	210	128	122	195	194	209
Aug	291	429	367	367	357	382	481	570	608	158	372	249	344	316	377	422	355	427	328	195	203	349	375	233
Sep	448	713	361	538	325	555	524	717	471	180	230	215	323	507	372	370	215	379	376	180	169	320	359	213
Oct	357	621	516	288	266	270	427	507	84	116	197	280	357	378	299	319	295	277	288	170	172	119	223	202
Nov	190	418	259	128	110	202	262	349	45	98	68	254	178	161	202	118	147	207	143	87	135	131	100	102
Dec	271	356	210	254	54	216	229	529	2	16	238	240	232	201	104	49	62	106	83	26	31	42	70	36
Total	4056	4888	4575	3362	2506	3391	4589	5592	3228	1580	2173	2053	2066	2461	1955	2670	2219	2252	2008	1140	950	1309	1583	1176

Table 4. (Continued) Reported landings by month and gear type from NAFO Divisions 4X and 5Y (from ZIF and Marfis).

Handline	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	4	3	3	0	3	3	2	5	2	9	7	4	1	0	1	0	0	0	0	0	0	0	0	0
Jun	35	50	41	10	43	77	97	132	189	256	91	134	40	22	6	15	3	5	9	2	0	0	0	0
Jul	118	188	88	15	75	93	184	315	284	242	117	113	43	56	25	11	2	25	9	9	2	0	0	0
Aug	101	120	94	32	48	114	138	290	297	61	9	44	21	27	5	2	5	25	7	3	2	2	0	0
Sep	54	72	44	38	31	82	77	143	81	26	23	0	3	34	1	0	0	1	0	2	0	0	0	0
Oct	15	29	10	21	15	20	39	70	9	5	3	2	3	1	1	0	0	0	1	0	0	0	0	0
Nov	5	7	2	9	4	4	1	14	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	3	1	1	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	334	469	286	126	221	396	539	974	865	600	250	298	110	141	40	29	10	55	26	15	5	3	0	0
Gillnet	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Jan	0	0	2	1	0	6	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Feb	0	1	1	1	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	2	0	4	3	0	6	2	0	1	0	0	0	0	0	0	1	0	1	4	6	1	1	0	0
Apr	1	0	7	1	12	0	5	5	2	1	1	0	0	0	0	0	0	1	0	2	1	0	0	0
May	1	1	15	1	2	13	5	5	4	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0
Jun	2	7	17	11	13	51	20	10	18	5	6	4	4	10	6	2	1	3	1	3	2	1	0	0
Jul	16	18	32	14	10	66	18	26	11	10	10	12	8	16	6	6	5	9	3	3	3	1	0	1
Aug	43	16	24	14	15	31	63	29	14	7	2	9	23	7	5	5	5	3	8	2	2	2	2	1
Sep	36	15	44	18	41	72	98	69	36	13	49	22	15	9	7	4	5	4	4	2	2	1	1	4
Oct	10	25	58	13	35	23	41	64	12	9	1	2	6	6	4	8	2	0	3	1	1	0	0	2
Nov	0	3	12	4	25	4	2	3	1	1	0	0	0	1	2	0	0	0	1	0	0	0	0	0
Dec	1	2	0	1	4	0	1	0	0	0	0	0	1	1		0	0	0	0	1	0	0	0	0
Total	113	88	215	82	158	278	257	215	100	48	69	50	58	50	31	28	21	23	26	22	13	6	3	7

Table 5. Reported landings by unit area and gear type from NAFO Divisions 4X and 5Y (from ZIF and MARFIS).

Total	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4XL	0	1	10	0	0	0	0	0	0	0	0	0	1	7	0.43	0	0	0	2	3	1	4	1	1
4XM	699	1203	814	673	432	396	515	259	144	58	95	89	90	142	179.9	224.15	227.83	208	124	47	45	73	28	32
4XN	1941	2055	2481	1412	952	698	1349	1402	1642	365	900	1103	1025	2539	1146.7	2059.9	2720.2	1930	1470	1571	1558	1295	1514	1398
4XO	3861	3732	3183	1656	1557	2292	3264	3898	2316	1618	1052	1158	746	877	848.41	855.87	666.97	783	550	244	202	341	355	365
4XP	1928	1023	1297	1212	1324	1108	1452	749	788	298	1473	1127	1477	1696	2120.3	1791.4	2178.7	1915	2516	2175	2229	1653	3707	2573
4XQ	1974	2280	1283	597	599	999	1292	1104	1124	1088	1139	1097	931	943	976.42	998.12	1021.7	691	620	536	343	344	535	348
4XR	1426	982	249	131	228	259	816	862	533	364	493	870	1154	1035	733.49	512.18	792.13	1271	1446	449	291	160	195	81
4XS	295	212	84	46	15	14	91	60	112	113	164	427	638	412	522.31	395.78	735.29	1062	1766	1319	857	732	412	436
4XU	3191	3794	4271	5358	1593	1729	975	2166	276	487	316	274	431	132	51.281	91.572	72.303	79	126	136	67	114	103	120
5Y	791	225	90	132	92	9	12	8	13	15	28	92	25	60	41.689	31.657	51.321	55	85	73	39	30	24	18
Total	16105	15507	13763	11217	6794	7504	9766	10508	6947	4405	5660	6237	6518	7843	6620.9	6960.6	8466.4	7994	8706	6552	5633	4746	6876	5372
Mobile	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4XL	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
4XM	144	295	132	269	41	35	16	32	7	3	7	10	11	25	21	16	22	6	3	1	8	2	0	0
4XN	1455	1624	2194	1007	733	468	786	939	503	187	222	541	407	1954	825	1157	1790	1150	849	1206	1304	949	972	935
4XO	1949	1329	1059	728	454	533	851	735	500	445	275	214	173	108	143	93	181	231	94	102	59	79	99	190
4XP	1401	538	901	963	1047	738	645	427	355	104	1018	758	1063	867	1402	1141	1702	1324	1885	1771	1849	1207	3122	2223
4XQ	1930	2254	1221	559	566	886	1153	912	925	999	975	995	860	803	932	941	980	605	573	482	285	294	480	318
4XR	1330	910	210	107	207	223	739	604	296	311	477	800	1121	1013	709	468	762	1235	1412	427	276	143	178	70
4XS	277	198	63	22	12	5	87	51	108	112	157	413	627	404	516	387	727	1057	1745	1309	842	723	410	435
4XU	2326	2690	2823	3896	761	543	93	21	50	2	8	14	14	4	6	0	2	5	2	8	1	3	5	1
5Y	791	224	83	97	89	7	11	6	12	14	28	92	25	56	41	30	50	54	81	69	35	25	20	12
Total	11602	10062	8687	7648	3909	3439	4382	3727	2755	2178	3168	3836	4303	5234	4595	4234	6216	5667	6646	5375	4664	3428	5290	4188
Longline	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4XL	0	0	10	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	2	2	1	3	1	1
4XM	493	856	552	359	256	275	409	133	113	50	82	68	73	109	150	202	199	199	120	46	37	71	27	31
4XN	485	432	286	403	219	229	561	458	1129	175	672	556	616	583	321	903	930	779	620	365	253	346	542	463
4XO	1545	1924	1798	791	861	1309	1809	2276	994	663	616	678	490	652	678	752	478	506	440	138	141	261	256	170
4XP	528	486	391	247	277	368	801	319	400	171	435	351	380	805	708	636	474	583	621	394	375	444	584	349
4XQ	33	11	54	30	28	30	97	98	178	10	149	84	61	124	31	44	35	73	40	47	52	48	55	30
4XR	86	61	33	18	9	3	45	181	202	39	13	66	30	20	22	40	29	35	33	21	14	17	17	11
4XS	6	6	2	21	1	8	1	2	1	0	3	6	8	6	2	3	5	3	14	6	14	7	2	1
4XU	858	1100	1445	1446	814	1168	863	2119	211	470	200	243	391	112	43	89	70	71	117	117	63	109	99	119
5Y	0	0	2	35	4	1	0	1	0	0	0	0	0	3	1	1	1	1	1	1	0	0	0	1	0
Total	4034	4875	4572	3350	2469	3391	4588	5587	3227	1578	2171	2053	2049	2421	1955	2670	2219	2250	2008	1140	950	1309	1583	1176

Table 5 (Continued) Reported landings by unit area and gear type from NAFO Divisions 4X and 5Y (from ZIF and MARFIS).

Handline	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4XL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4XM	23	17	33	5	4	3	11	13	3	1	0	2	1	1	1	1	0	0	0	0	0	0	0	0
4XN	0	0	0	0	0	0	0	0	7	2	2	5	1	1	1	0	0	1	0	0	0	0	0	0
4XO	294	426	236	111	193	376	460	844	775	486	140	248	72	111	25	9	7	45	15	4	1	1	0	0
4XP	0	0	4	0	0	0	0	1	27	21	13	13	5	2	1	5	1	1	2	2	0	0	0	0
4XQ	11	15	8	2	4	8	30	40	14	75	3	14	6	8	8	9	1	5	2	0	0	0	0	0
4XR	6	10	4	4	12	3	29	74	32	11	0	3	2	0	2	3	0	0	0	0	0	0	0	0
4XS	0	1	1	2	0	0	0	0	3	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0
4XU	0	0	0	3	8	6	9	2	3	4	91	13	23	14	1	2	0	2	5	9	3	0	0	0
5Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	334	469	286	126	221	396	539	974	865	600	250	298	109	137	40	29	10	54	26	15	5	3	0	0

Gillnet	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4XL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4XM	29	31	95	40	96	82	79	79	21	4	5	10	5	7	7	5	7	3	0	0	0	0	1	0
4XN	0	0	0	2	0	1	2	5	3	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0
4XO	67	47	90	26	47	74	144	42	46	21	20	17	12	6	3	1	1	1	1	0	1	1	1	5
4XP	0	0	2	3	0	3	5	1	6	3	7	6	29	22	9	10	2	7	8	9	4	1	0	0
4XQ	0	0	0	0	2	75	12	53	8	4	11	4	4	8	5	4	6	8	5	7	5	2	1	1
4XR	1	1	1	2	0	31	2	3	3	3	3	1	1	2	1	1	1	1	1	1	1	0	0	0
4XS	12	7	18	1	2	1	3	7	1	0	3	7	2	2	4	6	3	2	5	4	2	0	0	0
4XU	4	1	3	8	10	11	10	23	12	11	16	3	4	2	1	0	1	1	2	1	0	1	0	1
5Y	0	1	6	0	0	0	0	1	1	1	0	0	1	1	1	0	0	0	4	0	0	0	0	0
Total	113	88	215	81	158	278	257	215	100	48	69	50	57	51	31	28	21	23	26	22	13	6	3	7

Table 6a. 4X5Y groundfish landings (t) for mobile gear by fishing year. When landings are below 0.05 t they are reported as 0.

Species	MG					
	1997	05/06	06/07	07/08	08/09	09/10*
AMERICAN PLAICE	141	31	32	65	15	14
CATFISH [2]	461	62	38	22	4	2
COD	4857	1789	1588	1745	1604	751
CUSK	23	23	18	16	16	21
DOGFISH	9	3	0	7	2	1
FLOUNDER, UNSPEC	521	173	195	208	201	245
GRENADIER	65					
GREYSOLE/WITCH	365	252	146	118	132	77
GROUNDFISH, UNSPEC	112	1	1	6	3	10
HADDOCK	4294	4121	3306	5243	4551	2337
HALIBUT	31	49	45	54	51	73
LUMPFISH	0	0	0			0
MONKFISH	746	547	179	196	161	165
POLLOCK	6320	2858	2234	3054	3409	1941
RED HAKE	45	8	32	6	66	31
REDFISH	5433	3357	3135	2847	4163	3580
SCULPIN	16	174	186	135	133	318
SILVER HAKE	3675	516	1643	342	788	1020
SKATE	45	15	18	5	4	10
SUMMER FLOUNDER	0			0		
TILEFISH	0	0	0		0	0
TURBOT	5	1	0	0	0	0
WHITE HAKE	428	375	260	261	389	276
WINTER FLOUNDER	774	664	806	1060	922	653
WOLFFISH, UNSPECIFIED [2]						0
YELLOWTAIL	27	22	16	21	5	9
Grand Total	28392	15042	13877	15410	16619	11535

1 Landings Apr-Sept
2 in this area Wolfish or Catfish are Striped Wolfish

Table 6b. 4X5Y groundfish landings (t) for fixed gear by fishing year.

Species	Longline						Handline						Gillnet					
	1997	05/06	06/07	07/08	08/09	09/10*	1997	05/06	06/07	07/08	08/09	09/10*	1997	05/06	06/07	07/08	08/09	09/10*
AMERICAN PLAICE	0	1	0	1	0	0							0	0	0	0	0	
CATFISH [2]	63	30	22	26	24	8	9	0	0	0	0	0	1	0	0	0	0	0
COD	3582	1259	1823	1886	2132	1012	1826	42	27	24	18	17	1271	767	307	295	299	223
CUSK	1401	703	643	800	487	316	11	2	4	1	0	0	22	6	5	6	4	4
DOGFISH	123	1362	1536	1875	1432	112	1	598	359	74	11		107	258	387	425	125	11
FLOUNDER, UNSPEC	4	1	0	2	0	0	0	1	0	0	0	0	29	12	12	13	20	
GRENADIER			0															
GREYSOLE/WITCH	0			1	0	0							0		0	0		0
GROUNDFISH, UNSPEC	1	0	0		1	0	2	0					0	0	0	0	0	0
HADDOCK	2066	1004	1373	1521	1126	519	110	5	3	0	0	0	58	13	5	3	7	6
HALIBUT	293	341	461	394	456	379	5	2	3	1	1	1	2	1	1	1	1	1
LUMPFISH													0	0			0	
MONKFISH	101	33	57	25	21	7	1	0	0	0			49	31	12	9	5	4
POLLOCK	229	57	60	95	113	61	760	73	33	72	33	43	2406	1382	875	1080	971	852
RED HAKE			0	0	0											0		
REDFISH	23	11	18	8	10	5	0	0	0	0	0	0	14	6	2	6	2	1
SCULPIN		1	0	1	7	0				0	0		3	4	4	6	11	8
SILVER HAKE	2	1	0	0	0								0	5	2			0
SKATE	21	18	6	10	4	1	0						0	0	0	0	0	0
TILEFISH	6	1	1	1	3	0	0						0	0		0		
TURBOT	2	3	1	6	1	1							0			0		
WHITE HAKE	904	557	467	429	556	400	11	0	1	0			1349	695	377	221	175	219
WINTER FLOUNDER	0	0	0	0	0	0					0		1	1	1	0	2	1
YELLOWTAIL	6	0	0	0	0	0	0						0	0	0	0	0	
Grand Total	8828	5380	6469	7081	6374	2823	2738	723	431	172	65	61	5313	3182	1991	2066	1622	1332

* half year (Apr-Sept)
1 Landings Apr-Sept
2 in this area Wolfish or Catfish are Striped Wolfish

Table 7. Sampling data that went into the generation of the commercial catch-at-age in Div. 4X5Y haddock by year.

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AIK used
2004			*Annual alpha and beta for 2004 from the Teleost series for 4Xmnop: a = 0.00544 b = 3.15446 4Xqrs5Y: a = 0.00778 b = 3.05032*					
4Xmnop	mobile	1	1759	2965	336	H1mnopMob	ALK made up from first half of the year	364
4Xmnop	mobile	2	252	520	28	H1mnopMob	ALK made up from first half of the year	364
4Xmnop	mobile	3	498	1190	86	H2mnopMob	ALK made up from second half of the year	275
4Xmnop	mobile	4	573	1952	189	H2mnopMob	ALK made up from second half of the year	275
4Xqrs5Y	mobile	1	255	612	85	H1qrMob	ALK made up from first half of the year	293
4Xqrs5Y	mobile	2	512	1957	208	H1qrMob	ALK made up from first half of the year	293
4Xqrs5Y	mobile	3	848	2769	133	H2qrMob	ALK made up from second half of the year	224
4Xqrs5Y	mobile	4	679	1428	91	H2qrMob	ALK made up from second half of the year	224
4Xmnop	fixed	1	288	917	84	mnopFixed	ALK for entire year	268
4Xmnop	fixed	2	44	550	34	mnopFixed	ALK for entire year	268
4Xmnop	fixed	3	465	1257	96	mnopFixed	ALK for entire year	268
4Xmnop	fixed	4	274	755	54	mnopFixed	ALK for entire year	268
4Xqrs5Y	fixed	1	6	0/540		H1qrsyallgear	ALK made up from 1st half of year, all gears for 4Xqrsy5Y; applied LF from 2nd quarter in 4Xqrs5Y (f2qr) to tonnage from this quarter	326
4Xqrs5Y	fixed	2	30	540	33	H1qrsyallgear	ALK made up from 1st half of year, all gears for 4Xqrsy5Y	326
4Xqrs5Y	fixed	3	58	460	23	H2qrsyallgear	ALK made up from 2nd half of year, all gears for 4Xqrsy5Y	269
4Xqrs5Y	fixed	4	9	144	22	H2qrsyallgear	ALK made up from 2nd half of year, all gears for 4Xqrsy5Y	269
2005			*Annual alpha and beta for 2005 from the summer series for 4Xmnop: a = 0.00827 b = 3.05022 4Xqrs5Y: a = 0.01113 b = 2.96388*					
4Xmnop	mobile	1	1533	1010	104	H1mnop	ALK made up from all gears 4Xmnop,1st half of the year	221
4Xmnop	mobile	2	164	965	92	H1mnop	ALK made up from all gears 4Xmnop,1st half of the year	221
4Xmnop	mobile	3	870	626	67	H2mnop	ALK made up from all gears 4Xmnop, 2nd half of the year	381
4Xmnop	mobile	4	653	2215	191	H2mnop	ALK made up from all gears 4Xmnop, 2nd half of the year	381
4Xqrs5Y	mobile	1	131	719	79	H1qrs	ALK made up from all gears 4Xqrs5Y, 1st half of the year	228
4Xqrs5Y	mobile	2	315	1001	118	H1qrs	ALK made up from all gears 4Xqrs5Y, 1st half of the year	228
4Xqrs5Y	mobile	3	741	1250	112	H2qrs	ALK made up from all gears 4Xqrs5Y, 2nd half of the year	163
4Xqrs5Y	mobile	4	256	495	51	H2qrs	ALK made up from all gears 4Xqrs5Y, 2nd half of the year	163
4Xmnop	fixed	1	53	0/493	0	H1mnop	ALK made up from all gears 4Xmnop,1st half of the year; applied LF from 2nd Q to tonnage from this quarter	221
4Xmnop	fixed	2	42	493	25	H1mnop	ALK made up from all gears 4Xmnop,1st half of the year	221
4Xmnop	fixed	3	443	1558	53	H2mnop	ALK made up from all gears 4Xmnop, 2nd half of the year	381
4Xmnop	fixed	4	332	865	70	H2mnop	ALK made up from all gears 4Xmnop, 2nd half of the year	381
4Xqrs5Y	fixed	1	2	0/697	0	H1qrs	ALK made up from all gears 4Xqrs5Y, 1st half of the year; applied LF from 2nd Q to tonnage from this quarter	228

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AlK used
4Xqrs5Y	fixed	2	26	697	31	H1qrs	ALK made up from all gears 4Xqrs5Y, 1st half of the year	228
4Xqrs5Y	fixed	3	63	0/697	0	H2qrs	ALK made up from all gears 4Xqrs5Y, 2nd half of the year	163

2006 *Annual alpha and beta for 2006 from the summer series for 4Xmnop: a = 0.00739 b = 3.07071 4Xqrs5Y: a = 0.00759 b = 3.07407*

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AlK used
4Xmnop	mobile	1	1089	1415	150	H1mnopMob	ALK made up from 1st half of the year	260
4Xmnop	mobile	2	222	1134	110	H1mnopMob	ALK made up from 1st half of the year	260
4Xmnop	mobile	3	603	900	69	H2mnopMob	ALK made up from 2nd half of the year	198
4Xmnop	mobile	4	326	1407	129	H2mnopMob	ALK made up from 2nd half of the year	198
4Xqrs5Y	mobile	1	32	0	0	H1&H2 qrsallgears	ALK made for entire year all gears; applied LF from 2nd Q in 4Xqrs5Y (m2qr) to tonnage from this quarter	361
4Xqrs5Y	mobile	2	346	715	84	H1&H2 qrsallgears	ALK made for entire year all gears	361
4Xqrs5Y	mobile	3	490	1515	118	H2 4Xqrs5YMob	ALK made up from 2nd half of the year	229
4Xqrs5Y	mobile	4	320	1320	111	H2 4Xqrs5YMob	ALK made up from 2nd half of the year	229
4Xmnop	fixed	1	107	0	0	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year; applied LF from 2nd quarter in 4Xmnop (f2mnop) to tonnage from this quarter	260
4Xmnop	fixed	2	36	352	0	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	260
4Xmnop	fixed	3	796	1752	101	H2mnopallgears	ALK made up from all gears 4Xmnop, 2nd half of year	325
4Xmnop	fixed	4	287	880	26	H2mnopallgears	ALK made up from all gears 4Xmnop, 2nd half of year	325
4Xqrs5Y	fixed	1	2	0	0	4Xqrs5Yallgears	ALK made up for entire year all gears in 4xqrs5Y; applied LF from f2qr to tonnage from this quarter	361
4Xqrs5Y	fixed	2	10	200	22	4Xqrs5Yallgears	ALK made up for entire year all gears in 4Xqrs5Y	361
4Xqrs5Y	fixed	3	72	673	26	4Xqrs5Yallgears	ALK made up for entire year all gears in 4Xqrs5Y	361
4Xqrs5Y	fixed	4	5	0	0	4Xqrs5Yallgears	ALK made up for entire year all gear in 4Xqrs5Y; applied LF from f3qr to tonnage from this quarter	361

2007 *Annual alpha and beta for 2007 from the Teleost series for 4Xmnop: a = 0.00818 b = 3.05329 4Xqrs5Y: a = 0.00861 b = 3.04675*

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AlK used
4Xmnop	mobile	1	869	1420	160	H1mnopMob	ALK made up from 1st half of the year	279
4Xmnop	mobile	2	436	1184	119	H1mnopMob	ALK made up from 1st half of the year	279
4Xmnop	mobile	3	1291	2536	213	H2mnopMob	ALK made up from 2nd half of the year	460
4Xmnop	mobile	4	1600	2680	247	H2mnopMob	ALK made up from 2nd half of the year	460
4Xqrs5Y	mobile	1	130	500	54	H1qrsMob	ALK made up from 1st half of the year	232
4Xqrs5Y	mobile	2	275	1490	178	H1qrsMob	ALK made up from 1st half of the year	232
4Xqrs5Y	mobile	3	418	1475	152	H2qrsMob	ALK made up from 2nd half of the year	264
4Xqrs5Y	mobile	4	271	940	112	H2qrsMob	ALK made up from 2nd half of the year	264
4Xmnop	fixed	1	169	516	29	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	357

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AlK used
4Xmnop	fixed	2	77	435	49	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	357
4Xmnop	fixed	3	874	1593	114	H2mnopallgears	ALK made up from all gears 4Xmnop, 2nd half of year	638
4Xmnop	fixed	4	383	1097	64	H2mnopallgears	ALK made up from all gears 4Xmnop, 2nd half of year	638
4Xqrs5Y	fixed	1	2	0	0	H1qrsallgears	ALK made up from all gears 4Xqrs, 1st half of year; applied LF from 2nd quarter qrs	289
4Xqrs5Y	fixed	2	12	480	57	H1qrsallgears	ALK made up from all gears 4Xqrs, 1st half of year	289
4Xqrs5Y	fixed	3	58	495	37	H2qrsallgears	ALK made up from all gears 4Xqrs, 2nd half of year	325
4Xqrs5Y	fixed	4	10	279	24	H2qrsallgears	ALK made up from all gears 4Xqrs, 2nd half of year	325

2008   *Annual alpha and beta for 2008 from the summer series for 4Xmnop: a = 0.00617 b = 3.12656 4Xqrs5Y: a = 0.00637 b = 3.11535*

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AlK used
4Xmnop	mobile	1	932	1466	149	H1mnopMob	ALK made up from 1st half of the year	199
4Xmnop	mobile	2	321	485	50	H1mnopMob	ALK made up from 1st half of the year	199
4Xmnop	mobile	3	469	522	46	H2mnopMob	ALK made up from 2nd half of the year	424
4Xmnop	mobile	4	1626	4341	378	H2mnopMob	ALK made up from 2nd half of the year	424
4Xqrs5Y	mobile	1	20	230	18	H1& H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	362
4Xqrs5Y	mobile	2	128	485	55	H1& H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	362
4Xqrs5Y	mobile	3	503	1825	203	H2qrsMob	ALK made up from 2nd half of the year	228
4Xqrs5Y	mobile	4	189	450	25	H2qrsMob	ALK made up from 2nd half of the year	228
4Xmnop	fixed	1	107	230	20	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	219
4Xmnop	fixed	2	68	1016	0	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	219
4Xmnop	fixed	3	626	1838	145	H2mnopallgears	ALK made up from all gears 4Xmnop, 2nd half of year	302
4Xmnop	fixed	4	332	1950	157	H2mnopallgears	ALK made up from all gears 4Xmnop, 2nd half of year	302
4Xqrs5Y	fixed	1	4	0/440	0	H1& H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y; applied LF from 3rd quarter	362
4Xqrs5Y	fixed	2	3	0/440	0	H1& H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y; applied LF from 3rd quarter	362
4Xqrs5Y	fixed	3	33	440	41	H2qrsallgears	ALK made up from all gears 4Xqrs, 2nd half of year	289
4Xqrs5Y	fixed	4	10	230	20	H2qrsallgears	ALK made up from all gears 4Xqrs, 2nd half of year	289

Table 8. 4X5Y NAFO Div. haddock commercial catch-at-age (000's). The analysis used data having 1 cm increments and annual a's and b's for each of 4Xmnop and 4Xqrs5Y.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0	0	42	152	1	37	18	2	0	0	16	1	0	0	2	0	0	0	13	13
2	1088	809	22	3114	713	2198	1306	1289	77	83	164	1210	526	70	763	228	294	90	214	190
3	747	1660	3490	114	4783	4617	1657	3137	3453	1184	2497	2268	3895	3621	1195	2105	1153	1043	512	497
4	1549	809	1871	2274	318	5220	4295	2026	7221	6862	3071	6369	2648	6020	5046	2455	4871	3030	1016	499
5	391	1460	517	1080	1829	490	3712	3204	2156	3970	5527	4300	4954	4104	3708	4658	4021	4588	896	936
6	541	415	656	533	523	1115	437	2891	2916	1094	3573	3272	1823	2454	2583	1508	1512	2096	1968	310
7	4679	71	91	607	194	250	813	361	1071	1272	538	1191	1560	1033	1022	509	226	291	871	720
8	1922	3404	58	326	277	174	155	390	141	269	636	366	364	434	367	136	98	58	894	460
9	137	1047	1185	262	191	63	72	107	110	58	173	331	196	206	119	51	36	7	372	504
10	99	167	520	621	277	32	96	72	27	70	35	99	101	131	83	16	31	9	209	255
11	181	186	26	56	567	167	39	23	9	11	21	14	48	76	39	7	11	6	146	57
12	28	150	196	13	25	231	104	8	6	1	3	24	17	27	22	4	6	0	49	81
13	38	108	93	6	4	11	158	87	49	18	10	9	15	27	13	2	3	0	44	30
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	22	12
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	3	8	29	24	3	0	0	0	0	0	0	1	0	0	1	0	1	0
2	313	18	164	139	113	92	24	15	39	38	257	100	46	28	15	34	62	234	149
3	1189	1163	224	567	404	830	912	340	109	462	448	1654	415	673	277	64	923	479	415
4	370	2553	2589	495	564	667	1088	1807	947	563	819	1053	2520	1551	990	482	285	4468	638
5	461	585	2272	1790	312	738	638	1012	1804	1237	558	776	713	2870	1198	1541	679	293	2356
6	459	261	276	1199	974	192	514	478	1188	941	1289	646	563	651	1868	1163	1081	381	368
7	512	340	238	205	306	438	397	269	576	598	980	1326	511	353	553	972	747	713	334
8	628	248	250	111	34	471	523	140	410	230	556	923	752	286	258	320	531	409	579
9	299	305	153	139	14	195	478	192	141	55	224	379	529	230	201	111	174	337	342
10	211	260	300	45	14	40	138	133	220	49	111	124	248	167	171	86	25	77	209
11	55	168	90	53	23	27	18	54	114	54	39	25	114	52	58	72	32	50	91
12	50	146	126	41	11	19	1	41	27	25	9	16	61	22	32	26	6	6	22
13	14	55	34	17	4	7	1	3	5	5	11	4	16	11	19	1	4	10	26
14	9	9	18	11	1	11	3	1	11	0	6	15	3	0	4	0	3	1	1
15	5	6	4	1	0	5	1	0	7	0	5	0	2	0	0	0	0	0	0
16	3	7	1	0	2	2	4	7	3	0	0	0	1	0	0	12	0	0	0

Table 9. 4X5Y NAFO Div. haddock commercial weight-at-age (kg). The analysis used data having 1 cm increments and annual a's and b's for each of 4Xmnop and 4Xqrs5Y.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.29	0.29	0.29	0.27	0.18	0.23	0.23	0.28	0.29	0.29	0.16	0.23			0.25				0.439	
2	0.57	0.5	0.45	0.51	0.46	0.52	0.52	0.46	0.44	0.51	0.522	0.593	0.493	0.394	0.527	0.573	0.522	0.615	0.848	0.81
3	0.9	0.96	0.9	0.75	0.82	0.82	0.81	0.71	0.87	0.87	0.882	0.877	0.907	0.758	0.785	0.83	0.728	0.779	1.085	1.085
4	1.05	1.25	1.35	1.25	1.1	1.2	1.19	1.22	1.33	1.33	1.326	1.26	1.294	1.141	1.069	1.071	1.022	1.005	1.179	1.232
5	1.16	1.4	1.6	1.8	1.7	1.55	1.6	1.72	1.85	1.84	1.777	1.721	1.653	1.714	1.411	1.408	1.38	1.328	1.469	1.35
6	1.43	1.5	1.75	2	2.3	2.25	2.1	2.2	2.33	2.36	2.355	2.219	2.13	2.146	1.932	1.966	1.838	1.796	1.522	1.511
7	1.65	1.75	1.9	2.2	2.5	2.85	2.95	2.94	2.7	2.83	2.906	2.654	2.577	2.607	2.287	2.442	2.506	2.472	1.683	1.69
8	1.95	1.95	2.1	2.3	2.6	3	3.5	3.3	3.39	3.3	3.278	3.134	2.947	2.869	2.683	2.92	2.775	3.123	1.794	1.672
9	2.3	2.3	2.3	2.5	2.8	3.2	3.6	3.57	3.77	4.03	3.811	3.608	3.47	3.108	3.054	3.501	3.396	4.061	2.031	1.815
10	2.82	2.65	2.8	2.7	2.95	3.45	3.8	3.77	4.17	4.15	4.332	3.688	4.033	3.55	3.431	3.313	3.493	3.309	2.256	1.882
11	2.8	3.25	3	3.3	3.2	3.5	4.1	3.69	4.03	4.96	4.2	4.546	3.946	3.63	3.841	4.029	3.299	4.15	2.373	2.256
12	2.85	3	3.7	3.4	3.8	3.7	4	3.94	3.62	6	4.963	4.823	4.033	3.78	4.114	4.424	3.331	4.775	2.57	2.379
13	3.6	3	3.3	4.2	3.9	4.4	4.2	3.91	4.63	5.68	5.711	4.68	4.908	4.064	4	5.468	4.286	5.173	2.329	2.49
14																5.595	4.804	5.827	3.302	2.713
15																		3.767	3.135	
16																		7.526	4.754	6.052

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Mean 70-08	SD
1		0.55	0.671			0.161							0.284			0.192		0.170		0.287	0.129
2	0.666	1.159	0.79	0.796	0.872	0.773	0.906	0.827	0.611	0.965	0.798	0.752	0.824	0.917	0.478	0.560	0.792	0.719	0.652	0.659	0.180
3	1.073	1.104	1.026	0.972	1.139	1.074	1.011	1.03	0.922	1.176	0.947	1.001	1.046	1.076	0.815	0.693	0.780	0.705	0.777	0.910	0.136
4	1.431	1.44	1.232	1.129	1.312	1.369	1.217	1.289	1.029	1.436	1.193	1.096	1.225	1.199	0.972	0.800	0.853	0.872	0.855	1.175	0.164
5	1.809	1.833	1.572	1.392	1.483	1.597	1.396	1.561	1.23	1.407	1.274	1.217	1.317	1.422	0.980	1.061	0.942	0.853	0.989	1.456	0.268
6	1.74	2.016	1.956	1.734	1.793	1.73	1.598	1.869	1.429	1.62	1.32	1.216	1.328	1.427	1.231	1.127	1.153	1.007	0.919	1.740	0.403
7	2.001	2.088	1.887	2.132	2.08	1.976	1.614	2.048	1.676	1.966	1.532	1.318	1.367	1.443	1.346	1.318	1.138	1.119	0.990	2.029	0.566
8	2.05	2.234	1.963	2.098	2.493	2.013	1.86	2.069	1.88	2.198	1.776	1.502	1.399	1.493	1.459	1.399	1.246	1.101	1.046	2.253	0.701
9	2.108	2.24	2.158	2.365	2.101	2.355	2.136	2.199	2.08	2.1	2.201	1.696	1.601	1.473	1.366	1.653	1.288	1.155	1.070	2.502	0.851
10	2.351	2.228	2.167	2.242	2.775	2.286	2.042	2.357	2.122	2.154	2.45	2.094	1.852	1.822	1.574	1.693	1.416	1.405	1.226	2.687	0.860
11	2.316	2.274	2.1	2.377	2.204	2.584	2.75	2.648	2.433	2.678	2.09	2.41	2.074	2.278	1.866	1.616	1.507	1.310	1.222	2.893	0.939
12	2.613	2.339	1.968	2.148	2.381	2.305	3.373	2.55	2.939	2.49	3.405	2.484	1.828	2.486	1.858	1.811	1.913	1.729	1.471	3.110	1.055
13	2.373	2.327	2.66	2.521	2.899	2.623	3.027	3.072	3.537	2.141	2.525	2.579	3.177	2.576	2.001	2.937	2.184	1.201	1.314	3.374	1.160
14	3.126	2.654	2.919	2.887	4.51	2.902	3.271	4.481	3.604	5.7	3.477	1.788	4.459		2.946		2.029	1.995	1.803	3.491	1.243
15	3.204	3.421	3.218	4.777	4.308	3.095	3.49		2.348	5.184	2.645	3.167	4.737							3.607	0.841
16	4.546	3.787	5.541	5.628	2.486	3.224	3.286	3.674	3.081				5.56			1.111			3.894	4.277	1.616

Table 10. 4X5Y NAFO Div. haddock mean numbers-at-age per standard tow from the 1970-2008 summer RV survey.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	4.31	0.09	3.93	4.7	8.16	5.03	4.05	4.85	4.23	1.46	14.35	17.36	8.99	3.2	2.66	6.09	2.82	1.13	5.64	5.45
2	3.47	8.43	0.17	17.26	17.19	2.88	5.29	38.87	4.35	10.36	5.2	21.18	21.83	3.55	17.98	8.51	9.86	1.62	2.39	8.44
3	1.05	3.67	2.61	0.45	24.86	3.95	2.96	41.74	9.65	5.77	11.75	7.41	14.25	12.57	14	20.98	8.92	2.75	1.21	2.03
4	1.95	1.62	1.13	2.34	0.82	5.87	3.27	12.41	2.85	8	6.66	7.77	4.85	6.55	18.23	9.8	13.46	2.75	2.04	0.89
5	0.84	2.22	0.64	1.12	3.19	0.3	5.55	12.05	1.23	4.09	9.45	2.89	7.18	3.46	5.16	12.99	4.23	3.56	2.65	1.54
6	1.95	1.09	0.74	0.44	0.72	1.35	0.36	6.41	2	1.73	3.03	3.02	3.12	2.23	2.75	3.3	4.07	2.79	2.8	0.71
7	4.34	1.63	0.48	0.61	0.39	0.36	0.5	0.72	0.92	2.57	1.05	0.98	3.68	0.88	1.38	1.6	1.52	2.03	1.35	1.4
8	0.62	4.5	0.77	0.45	0.45	0.27	0.09	1.03	0.07	1.1	0.88	0.17	0.69	0.31	0.56	1.01	0.78	0.85	1.11	0.51
9	0.26	0.65	1.19	0.32	0.26	0.11	0.08	0.16	0	0.22	0.46	0.32	0.43	0.29	0.37	0.54	0.57	0.29	0.71	0.5
10	0.22	0.07	0.05	0.45	0.19	0.07	0.02	0.13	0	0.07	0.16	0.19	0.21	0.27	0.08	0.21	0.3	0.33	0.41	0.16
11	0.06	0.04	0.01	0.02	0.29	0.25	0.02	0.05	0.02	0	0.03	0.1	0.16	0.14	0.03	0.06	0.05	0.07	0.15	0.12
12	0.02	0.08	0.01	0	0	0.21	0.15	0.09	0.03	0	0	0.04	0	0.11	0.02	0.03	0.13	0.01	0.02	0.11
13	0	0	0.01	0.01	0	0	0.07	0.06	0.02	0	0	0	0	0.07	0.03	0.03	0.06	0	0	0
14	0	0	0	0	0	0	0	0.2	0.11	0.04	0	0	0	0	0	0.05	0	0.04	0	0.01
15	0	0	0	0	0	0	0	0	0.05	0.1	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4X5Y Total	19.09	24.09	11.74	28.17	56.52	20.65	22.41	118.77	25.53	35.51	53.02	61.43	65.39	33.63	63.25	65.2	46.77	18.22	20.48	21.87
SS Total	27.59	40.34	20.79	46.8	89.2	35.15	31.01	216.54	41.11	39.05	77.33	49.61	72.99	49.02	63.38	103.18	83.4	28.07	26.69	32.94
BoF Total	10.71	7.98	2.8	9.8	24.36	6.31	14.29	22.08	10.99	32.89	30.96	88.05	58.54	23.74	63.94	27.9	12.3	8.53	14.58	11.03

Note: there is no unknown age (row following age 17 row) in this new extraction

Note: 2004 and 2007 com from Teleost survey series

Table 10. (Continued) 4X5Y NAFO Div. haddock mean numbers-at-age per standard tow from the 1970-2008 summer RV survey.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	AVG
0	0	0	0	0	2.55	0.18	2.27	0.12	1.63	24.78	24.73	4.32	0.01	0.52	0.26	0.02	9.37	0.07	0.07	0.00
1	0.07	3.84	2.79	4.17	18.45	41.97	4.6	7.79	8.99	36.11	25.02	27.62	4.69	2.15	7.25	2.16	5.18	9.44	0.5	5.43
2	8.45	1.64	2.21	0.96	5.69	21.09	24.13	7.3	8.66	16.62	38.06	31.57	18.1	5.88	3.5	13.26	4.45	10.21	10.03	10.44
3	9.32	10.61	0.93	1.6	1.99	10.88	19.7	18.87	4.09	9.75	7.82	38.51	20.43	12.56	5.27	3.26	15.97	4.65	7.66	9.63
4	1.46	9.48	6.93	0.63	1.64	3.99	10.42	10.41	10.81	4.98	4.64	8.75	22.61	13.35	10.14	4.79	5.32	16.9	4.3	5.66
5	0.98	2.27	4.56	1.54	0.39	1.97	5.25	3.57	5.35	8.54	3.42	3.85	4.19	10.26	7.26	8.19	2.71	2.21	11.18	4.22
6	1.51	1.43	0.97	0.97	1.93	0.85	2.13	1.64	1.89	4.93	4.49	1.6	2.4	2.18	6.08	7.73	5.59	2.4	1.1	2.23
7	1.13	1.29	0.46	0.21	1.13	1.66	1.96	0.67	1.69	2.45	1.63	4.28	1.84	2.81	2.11	4.34	3.47	5.19	1.41	1.42
8	1.32	1.15	0.49	0.14	0.15	0.43	2.72	0.29	1.11	1.04	0.77	1.75	2.58	1.77	1.34	2.33	4.9	3.47	2.79	0.81
9	0.67	0.89	0.26	0.09	0.06	0.11	0.69	0.54	0.5	0.9	0.32	0.99	1.47	3.4	0.57	0.84	1.45	2.29	2.28	0.39
10	0.58	0.85	0.23	0.05	0.1	0	0.62	0.35	0.58	0.23	0.09	0.61	0.87	1.71	0.7	0.76	0.75	0.69	1.27	0.18
11	0.35	0.14	0.08	0.13	0.01	0	0.13	0.05	0.29	0.23	0.04	0.09	0.55	0.7	0.35	0.35	0.58	0.55	0.73	0.08
12	0.1	0.15	0.05	0.05	0.07	0.02	0.16	0.02	0.05	0.15	0.02	0	0.03	0	0.16	0.15	0.1	0.12	0.06	0.05
13	0.05	0.02	0.02	0.03	0.1	0	0.12	0	0	0.07	0	0.03	0.03	0.03	0.02	0	0.02	0.1	0.13	0.02
14	0.03	0.02	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0.02	0	0	0.05	0.02
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0.01
16	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0.00
17	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
4X5Y Total	26.02	33.8	19.98	10.57	34.26	83.15	74.9	51.64	45.64	110.8	111.05	123.97	79.8	57.32	45.01	48.22	59.86	58.29	43.56	40.59
SS Total	31.13	42.85	28.34	17.12	36.5	105.61	81.96	70	65.1	191.54	152.85	212.87	120.29	79.35	67.82	79.91	91.05	93.32	56.82	58.71
BoF Total	21.38	24.81	11.76	4.17	32.06	60.92	67.91	33.6	26.38	30.87	69.73	36.03	39.79	35.54	22.46	16.88	29	23.68	30.42	24.09

Note: there is no unknown age (row following age 17 row) in this new extraction

Note: 2004 and 2007 com from Teleost survey series

Table 11a. 4X5Y NAFO Div. haddock summer RV survey strata 470-481 - mean weight-at-age (kg).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0																				
1	0.08	0.102	0.078	0.093	0.09	0.101	0.085	0.1	0.072	0.082	0.083	0.04	0.068	0.048	0.039	0.071	0.067	0.067	0.051	0.086
2	0.389	0.246	0.203	0.288	0.307	0.324	0.319	0.44	0.377	0.266	0.347	0.262	0.143	0.167	0.143	0.259	0.273	0.273	0.343	0.296
3	0.768	0.702	0.638	0.472	0.639	0.709	0.594	0.823	0.798	0.538	0.644	0.768	0.499	0.393	0.337	0.395	0.487	0.535	0.6	0.671
4	1.062	1.039	1.255	1.255	0.942	1.195	1.108	1.219	1.311	1.162	1.164	1.114	1.029	0.908	0.688	0.683	0.607	0.749	0.797	0.78
5	1.352	1.39	1.614	1.694	1.663	1.8	1.39	1.693	1.828	1.539	1.61	1.626	1.349	1.438	1.105	0.914	0.946	0.878	0.969	1.143
6	1.665	1.575	1.952	2.276	2.117	2.147	1.899	1.908	2.208	2.136	2.001	2.014	1.817	1.683	1.594	1.192	1.103	1.117	1.014	1.311
7	2.057	1.701	2.053	2.292	2.557	2.828	2.266	2.801	2.571	2.41	2.499	2.394	2.21	2.188	1.843	1.618	1.372	1.321	1.245	1.299
8	2.457	2.035	2.427	2.492	2.639	3.013	2.35	2.855		2.726	2.678	3.137	2.645	2.253	2.046	1.707	1.69	1.431	1.353	1.38
9	2.688	2.533	2.782	2.567	2.871	3.251		4.36		3.514	3.384	3.049	3.292	2.454	2.15	1.853	1.924	1.687	1.629	1.411
10	3.255	4.041	3.057	2.932	2.651	3.501		2.775			3.319	3.425		2.275		2.109	1.899	1.721	1.477	1.648
11	3.594	3.516	3.7	3.386	3.144	3.516			2.6		3.4	3.9	3.1	2.353			2.803	2.1	2.203	1.658
12	2.225	3.294	4.6			3.06	2.35	3.354						3.89		3.352			2.9	1.31
13							2.5	4						3.4			2			
14								3.213								2.7				2.4
15										3.1										
17										0										

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0					0.007	0.007	0.01	0.005	0.009	0.009	0.011	0.007	0.003	0.007	0.005	0.002	0.005	0.004	0.005	0.007
1	0.109	0.079	0.076	0.098	0.11	0.059	0.053	0.089	0.065	0.1	0.096	0.083	0.061	0.066	0.077	0.08	0.074	0.074	0.072	0.112
2	0.315	0.435	0.282	0.322	0.36	0.271	0.181	0.219	0.21	0.18	0.299	0.227	0.174	0.19	0.176	0.201	0.174	0.175	0.247	0.247
3	0.693	0.668	0.63	0.63	0.629	0.613	0.491	0.36	0.38	0.445	0.466	0.472	0.342	0.335	0.417	0.346	0.371	0.387	0.395	0.45
4	0.989	1.038	0.984	0.984	0.942	0.946	0.777	0.655	0.514	0.544	0.689	0.567	0.547	0.507	0.513	0.54	0.441	0.546	0.588	0.61
5	1.322	1.282	1.238	1.211	1.158	1.172	0.976	0.959	0.742	0.694	0.759	0.821	0.625	0.693	0.616	0.613	0.553	0.707	0.669	0.712
6	1.434	1.603	1.64	1.564	1.282	1.29	1.248	1.014	0.975	0.861	0.912	0.879	0.831	0.791	0.736	0.713	0.72	0.754	0.861	0.951
7	1.357	1.627	1.811	1.702	1.466	1.483	1.41	1.27	1.22	0.958	1.101	0.99	0.885	0.866	0.813	0.811	0.798	0.825	0.961	0.935
8	1.545	1.687	1.513	1.695	1.748	1.812	1.467	1.532	1.537	1.166	1.205	1.067	0.927	0.974	0.843	0.939	0.841	0.947	0.885	0.902
9	1.851	1.55	1.63	1.396	1.567	2.153	1.77	1.592	1.439	1.153	1.263	1.259	1.022	0.984	1.004	1.046	0.985	0.99	0.922	1.012
10	1.343	1.213	2.719	2.226	1.705		1.234	1.535	1.581	1.349	1.482	1.08	1.083	1.042	1.077	1.068	0.962	1.208	0.955	1.034
11	2.186	2.763	2.1	1.621	2.195		2	2.045	2.058	1.645	1.858	1.644	0.747	1.235	1.203	1.132	1.173	1.142	1.005	1.144
12	1.816	2.322	2.76	1.995	1.274	1.51	2.019	1.358	1.465	1.642	2.2		1.74		1.164	1.204	0.988	1.378	1.655	1.289
13			3.5	1.682	1.406		1.31			1.347		1.45			1.304	0	1.765	1.491	1.26	
14	3.3	3.4		4.54								3.81				1.83			1.867	1.382
15																2.205				
17		2.945																		

Table 11b. 4X5Y NAFO Div. haddock summer RV survey strata 482-495 - mean weight-at-age (kg).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0																				
1	0.105		0.063	0.125	0.096	0.12	0.134	0.126	0.088	0.097	0.116	0.112	0.098	0.102	0.144	0.138	0.14	0.17	0.164	0.119
2	0.478	0.333		0.331	0.336	0.535	0.426	0.642	0.604	0.432	0.518	0.423	0.365	0.401	0.358	0.512	0.555	0.536	0.686	0.519
3	0.763	0.954	0.995	0.689	0.85	1.1	0.896	1.164	1.202	0.964	0.967	0.895	0.822	0.836	0.574	0.879	1.041	1.093	1.198	0.824
4	1.134	1.283	1.553	1.565	1.299	1.53	1.311	1.597	1.727	1.624	1.514	1.434	1.437	1.39	1.131	1.17	1.466	1.496	1.445	1.441
5	1.43	1.637	1.867	2.074	2.236	1.8	1.752	2.212	2.176	2.242	1.998	2.349	1.977	1.961	1.572	1.554	1.658	1.728	1.884	1.572
6	1.53	1.778	2.221	2.679	2.648	3.006	2.1	2.539	2.487	2.688	2.617	2.758	2.6	2.552	2.149	2.451	1.998	2.233	2.275	1.937
7	2.017	1.814	2.942	2.577	2.344		3.068	3.335	2.83	3.047	2.414	3.219	3.074	2.87	2.424	2.744	1.903	2.575	3.038	2.11
8	2.251	2.468	2.706	2.419	3.049		2.6	3.37	3.422	3.771	3.031	3	3.461	3.117	2.846	2.889	1.9	2.246	2.392	1.864
9	2.038	2.692	3.024	2.995	2.528		2.685	3.738		4.204	3.775	3.663	3.482	3.221	3.055	2.678	2.781	2.906	3.23	2.9
10	2.626	4.2	4.704	2.849	3.182	2.7	2.6	3.099		3.477			4.209	4.212	4.013	3.769	3.25	2.809	4.1	2.981	2.575
11	3.7				3.664	3.121	3.5	3.5					3.8	4.643	3.875	2.35	2.635		2.675		2.601
12		5.418				3.383	3.292	4.2	4.2				4		3.4	3.5	3.2	2.611	6	
13			6.2	4			3.897	3.592	3.9						4.7	2.3	3.1	2.4		
14								4.315	4.195	3.6							3.3	0	2.87	
15									4.237	5.123										
17																				

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0					0.006	0.005	0.005	0.004	0.007	0.006	0.005	0.005	0	0.004	0.005	0	0.005	0.003	0.005	0.004
1		0.155	0.119	0.115	0.163	0.077	0.083	0.13	0.093	0.135	0.183	0.137	0.127	0.106	0.105	0.075	0.099	0.098	0.159	0.143
2	0.591	0.93	0.477	0.599	0.522	0.432	0.291	0.305	0.399	0.375	0.468	0.313	0.312	0.317	0.173	0.357	0.235	0.33	0.38	0.402
3	1.127	1.158	0.4	1.014	1.183	0.967	0.796	0.643	0.703	0.886	0.69	0.775	0.569	0.649	0.589	0.666	0.674	0.657	0.599	0.672
4	1.744	1.672	1.576	1.521	1.71	1.376	1.416	1.053	1	1.127	1.029	0.955	0.824	1.048	0.857	0.817	0.664	0.977	0.651	0.81
5	1.842	1.77	2.183	1.77	3.482	1.878	1.829	1.574	1.321	1.248	1.12	1.161	1.155	1.349	0.983	0.962	0.974	1.041	0.945	1.052
6	2.296	2.552	2.184	2.093	2.596	2.091	2.183	2.222	1.805	1.442	1.241	2.055	1.246	1.51	1.303	1.243	1.239	1.259	1.405	1.152
7	2.425	2.531	2.868	2.319	2.86	2.339	2.246	2.228	2.029	1.702	1.806	1.461	1.321	1.551	1.407	1.312	1.287	1.387	1.022	0.945
8	2.873	2.918	2.789	2.14	3.146	2.551	2.257	3.331	2.285	2.115	2.075	1.635	1.535	1.453	1.47	1.37	1.345	1.554	1.679	1.271
9	3.176	3.27	3.716			3.101	2.733	3.767	2.601	2.472	2.641	1.904	1.725	1.665	2.23	1.854	1.404	1.688	1.42	1.266
10	2.853	2.206	2.495				3.221			4.171	4.445	1.996	1.849	1.832	1.64	2.362	1.876	1.716	1.45	1.509
11	2.937	4.535	3.775	3.173			2.255		2.35	2.265			2.228	1.576	1.555	1.086	1.349	2.705	1.304	1.204
12	3.2	3.42											2.025		2.501			3.296	1.188	1.117
13	3.513	3.555			3.856		5.905						2.43	2.802				16.71		
14										3.26										
15																				
17								2.054												

Table 12. Estimates of abundance (N) and the coefficients of variation of the estimates of abundance (CV) for the two-survey base model and the single-survey model.

Age	Base model Log(N)	CV	Single index Log(N)	CV	Ratio of CV's
1	10.135	0.455	10.165	0.668	0.68
2	9.589	0.328	9.490	0.482	0.68
3	8.491	0.294	8.559	0.428	0.69
4	9.378	0.293	9.485	0.420	0.70
5	7.690	0.249	7.803	0.357	0.70
6	7.677	0.246	7.734	0.354	0.69
7	8.378	0.233	8.483	0.331	0.70
8	8.591	0.185	8.765	0.255	0.73
9	8.649	0.178	8.864	0.241	0.74

Table 13a. - SPA results - Population Numbers.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	25933	6201	48008	45079	24756	50547	53865	32835	44182	34198	42891	45994	35529	43713	16249	12707	6376	8803	26966	24085
2	12185	21232	5077	39268	36770	20267	41351	44085	26882	36173	27999	35102	37656	29089	35789	13302	10403	5220	7207	22066
3	5728	8992	16651	4137	29332	29459	14605	32674	34927	21939	29541	22775	27644	30354	23752	28611	10684	8252	4192	5707
4	7861	4014	5860	10475	3284	19687	19942	10458	23913	25472	16891	21926	16594	19109	21575	18366	21520	7704	5812	2969
5	2619	5035	2554	3105	6519	2401	11395	12441	6729	13044	14645	11050	12189	11190	10198	13098	12815	13212	3566	3839
6	2723	1790	2801	1624	1565	3682	1522	5971	7286	3558	7087	6990	5156	5497	5448	4994	6509	6854	6666	2109
7	15119	1740	1090	1700	847	808	2006	851	2273	3327	1924	2570	2762	2572	2280	2124	2724	3961	3715	3677
8	7375	8145	1360	810	842	518	435	907	370	892	1573	1088	1026	850	1171	942	1278	2026	2980	2253
9	750	4299	3588	1061	368	439	267	216	389	175	487	712	560	511	303	627	648	958	1606	1631
10	442	490	2572	1865	632	129	302	153	80	219	91	242	284	281	232	140	467	498	778	979
Sum 3-10	80735	61937	89563	109123	104914	127938	145690	140590	147030	138997	143128	148449	139400	143165	116998	94911	73426	57487	63488	69315

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	7532	11162	12006	20855	27905	23039	11942	12977	23693	71703	48664	36639	13994	9765	48513	13001	27597	37807	22296
2	19707	6167	9136	9822	17048	22825	18860	9778	10625	19398	58705	39843	29997	11457	7995	39719	10643	22594	30953
3	17894	15852	5033	7332	7916	13856	18604	15420	7992	8664	15848	47831	32530	24518	9355	6533	32488	8658	18287
4	4223	13575	11926	3918	5490	6116	10593	14407	12317	6444	6675	12569	37664	26258	19465	7422	5299	25764	6655
5	1979	3123	8804	7422	2760	3984	4404	7689	10160	9227	4767	4724	9338	28557	20095	15057	5749	4081	17051
6	2296	1203	2027	5152	4457	1977	2594	3028	5379	6686	6436	3398	3166	7000	20783	15392	11035	4092	3076
7	1446	1465	749	1410	3133	2767	1445	1659	2047	3329	4623	4103	2197	2082	5142	15370	11746	8056	3006
8	2359	721	892	398	969	2289	1869	824	1115	1154	2185	2898	2159	1337	1385	3680	11779	8941	5951
9	1429	1363	366	504	225	763	1448	1057	548	542	737	1285	1538	1087	836	878	2465	9163	6950
10	879	899	840	161	287	172	448	753	692	321	394	401	710	780	682	479	430	1861	7197
Sum 3-10	59745	55529	51778	56973	70190	77788	72208	67591	74567	127469	149032	153691	133293	112841	134251	117531	119232	131019	121422

Table 13b. - SPA results – Biomass.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	1178	282	3471	1805	1243	2135	2897	1303	2273	1010	1518	1433	1545	907	241	528	236	184	1061	1126
2	3426	2991	731	5967	6200	3631	8001	8999	5544	5500	5318	6006	4870	3096	3855	2205	1501	703	1585	3993
3	3654	4914	6742	1331	13428	14267	7396	18120	22546	12460	15451	14042	14414	10630	7951	11416	4773	3358	2035	3557
4	7373	3644	5839	9884	2359	18639	18712	9779	26495	28274	17078	21398	17654	16525	14630	10686	14046	5886	4401	2352
5	3352	6238	3397	4776	9911	3240	15823	17831	10542	20928	22681	17261	17401	16130	12084	12036	11027	12503	4074	4335
6	4228	2679	4716	3197	3140	7269	2834	10444	14577	7673	13650	14067	10735	9834	9325	6619	7100	7377	8424	3009
7	29675	2893	2031	3712	2070	2023	4693	2000	5234	8232	4691	6204	7113	6054	4508	4105	3828	5152	5099	5373
8	16371	17150	2822	1863	2134	1426	1038	2404	1159	2659	4264	3031	3117	2265	2828	1862	2164	3123	4580	3632
9	1368	10576	9019	2766	965	1296	716	669	1887	651	1659	2134	1832	1440	832	1214	1343	1802	2919	2536
10	1221	1528	8244	5382	1748	383	786	433	258	762	302	895	1059	892	756	349	964	905	1480	1760
Sum 4-10	63590	44708	36068	31580	22327	34275	44602	43560	60153	69179	64325	64991	58912	53139	44963	36870	40473	36746	30976	22998

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	307	519	518	809	1316	1451	412	329	1540	2740	2604	2683	786	459	2056	699	1471	2276	825
2	3828	1577	1458	1702	3471	5056	2169	1082	1833	2144	11868	6347	4045	1484	872	5724	1278	2988	4704
3	9662	9455	3079	3565	4454	8205	9115	4623	2456	3252	5183	22075	9923	6688	2932	1746	10545	2430	5467
4	4222	14173	11669	3259	5351	6118	10610	10579	6350	3208	4622	7597	22096	13525	8761	3912	2368	14483	3484
5	2456	4428	13110	9360	3365	5304	5704	9126	9355	6585	3323	4281	6309	23605	13791	9234	3581	2527	12292
6	3578	2258	3524	8865	6773	2838	4148	4215	7052	6459	5865	2939	2897	6034	18019	11331	8094	3084	2571
7	2595	2885	1639	2737	5797	4770	2454	2734	3231	3898	5244	4211	2101	2098	4875	13883	9622	7043	2821
8	4333	1530	1570	740	2056	4708	3449	1557	2092	1517	2966	3510	2144	1409	1276	3567	10882	8851	5439
9	2886	2733	733	703	353	1890	3395	2004	1075	744	1192	1831	1764	1230	869	901	2647	9429	8538
10	1406	1510	1894	340	442	310	1099	1155	1094	607	723	458	828	959	767	511	442	2394	8852
Sum 4-10	21475	29516	34139	26004	24138	25937	30857	31370	30248	23018	23936	24827	38139	48858	48358	43339	37637	47811	43996

Table 13c. - SPA results - fishing mortality.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.1	0.04	0	0.09	0.02	0.13	0.04	0.03	0	0	0.01	0.04	0.02	0	0.02	0.02	0.03	0.02	0.03	0.01
3	0.16	0.23	0.26	0.03	0.2	0.19	0.13	0.11	0.12	0.06	0.1	0.12	0.17	0.14	0.06	0.08	0.13	0.15	0.14	0.1
4	0.25	0.25	0.44	0.27	0.11	0.35	0.27	0.24	0.41	0.35	0.22	0.39	0.19	0.43	0.3	0.16	0.29	0.57	0.21	0.21
5	0.18	0.39	0.25	0.49	0.37	0.26	0.45	0.33	0.44	0.41	0.54	0.56	0.6	0.52	0.51	0.5	0.43	0.48	0.33	0.31
6	0.25	0.3	0.3	0.45	0.46	0.41	0.38	0.77	0.58	0.42	0.81	0.73	0.5	0.68	0.74	0.41	0.3	0.41	0.39	0.18
7	0.42	0.05	0.1	0.5	0.29	0.42	0.59	0.63	0.74	0.55	0.37	0.72	0.98	0.59	0.68	0.31	0.1	0.08	0.3	0.24
8	0.34	0.62	0.05	0.59	0.45	0.46	0.5	0.65	0.55	0.41	0.59	0.46	0.5	0.83	0.43	0.17	0.09	0.03	0.4	0.26
9	0.23	0.31	0.45	0.32	0.85	0.17	0.35	0.79	0.37	0.46	0.5	0.72	0.49	0.59	0.57	0.09	0.06	0.01	0.3	0.42
10	0.28	0.47	0.25	0.45	0.65	0.32	0.43	0.72	0.46	0.43	0.55	0.59	0.49	0.71	0.5	0.13	0.08	0.02	0.35	0.34
ave 5-7	0.28	0.24	0.22	0.48	0.37	0.36	0.47	0.58	0.59	0.46	0.57	0.67	0.69	0.6	0.65	0.4	0.27	0.33	0.34	0.25

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.02	0	0.02	0.02	0.01	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.01
3	0.08	0.08	0.05	0.09	0.06	0.07	0.06	0.02	0.02	0.06	0.03	0.04	0.01	0.03	0.03	0.01	0.03	0.06	0.03
4	0.1	0.23	0.27	0.15	0.12	0.13	0.12	0.15	0.09	0.1	0.15	0.1	0.08	0.07	0.06	0.06	0.06	0.21	0.11
5	0.3	0.23	0.34	0.31	0.13	0.23	0.17	0.16	0.22	0.16	0.14	0.2	0.09	0.12	0.07	0.11	0.14	0.08	0.17
6	0.25	0.27	0.16	0.3	0.28	0.11	0.25	0.19	0.28	0.17	0.25	0.24	0.22	0.11	0.1	0.07	0.11	0.11	0.14
7	0.5	0.3	0.43	0.18	0.11	0.19	0.36	0.2	0.37	0.22	0.27	0.44	0.3	0.21	0.13	0.07	0.07	0.1	0.13
8	0.35	0.48	0.37	0.37	0.04	0.26	0.37	0.21	0.52	0.25	0.33	0.43	0.49	0.27	0.26	0.2	0.05	0.05	0.11
9	0.26	0.28	0.62	0.36	0.07	0.33	0.45	0.22	0.33	0.12	0.41	0.39	0.48	0.27	0.36	0.51	0.08	0.04	0.06
10	0.31	0.38	0.5	0.37	0.06	0.3	0.41	0.22	0.43	0.18	0.37	0.41	0.48	0.27	0.31	0.36	0.07	0.05	0.03
ave 5-7	0.35	0.27	0.31	0.26	0.17	0.18	0.26	0.18	0.29	0.18	0.22	0.29	0.2	0.14	0.1	0.08	0.11	0.1	0.15

Table 13d. SPA results – residuals.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Summer RV																				
2	-0.07	0.22	-2.24	0.35	0.38	-0.82	-0.99	0.77	-0.79	-0.13	-0.54	0.64	0.54	-1.03	0.44	0.53	0.76	-0.38	-0.36	0.03
3	-0.67	0.19	-0.77	-1.04	0.91	-0.92	-0.5	1.39	-0.32	-0.27	0.08	-0.46	0.03	0	0.04	0.51	0.39	-0.35	-0.67	-0.34
4	-0.45	0.05	-0.56	-0.5	-0.59	-0.18	-0.83	1.2	-0.99	-0.16	-0.1	-0.1	-0.51	-0.33	0.54	0.07	0.34	0.03	-0.36	-0.54
5	-0.39	0.14	-0.46	0	0.2	-1.18	0.26	0.96	-0.68	-0.23	0.58	-0.3	0.43	-0.36	0.16	0.83	-0.1	-0.46	0.43	-0.12
6	0.38	0.31	-0.49	-0.48	0.12	-0.11	-0.27	1.29	-0.08	0.14	0.45	0.29	0.27	-0.08	0.19	0.32	0.51	-0.27	-0.16	-0.51
7	-0.38	0.54	-0.18	-0.21	0	-0.05	-0.3	1.07	0.15	0.59	0.38	0.05	1.17	-0.36	0.2	0.33	0.14	-0.33	-0.46	-0.39
8	-1.57	0.44	0.11	0.38	0.38	0.23	-0.44	1.29	-0.74	1.08	0.53	-1.17	0.21	-0.05	-0.05	0.7	0.32	-0.42	-0.33	-0.84
9	-0.22	-1.09	-0.12	-0.42	0.88	-0.59	-0.6	0.69	0	1.02	1.01	0.08	0.43	0.31	1.03	0.52	0.47	-0.85	-0.2	-0.54
10	0.33	-0.98	-3.24	-0.36	-0.07	0.58	-1.91	0.89	0	0.02	1.8	0.61	0.54	0.68	-0.22	1.08	0.28	0.03	-0.01	-1.27
ITQ																				
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 13d. (Continued) - SPA results – residuals.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Summer RV																			
2	0.23	-0.66	-0.45	-1.39	-0.22	0.93	1.19	0.33	0.52	0.89	0.56	0.62	0.27	0.07	0.07	-0.14	-0.25	0.13	0.01
3	0.09	0.49	-0.94	-0.71	-0.57	0.55	1.01	1.01	0.16	0.82	-0.14	0.55	0.34	0.15	0.14	0.07	-0.1	0.18	-0.36
4	-0.29	0.5	0.25	-1.16	-0.43	0.22	0.79	0.5	0.7	0.59	0.27	0.55	0.18	0.06	0.01	0.19	0.56	0.31	0.17
5	0.28	0.31	0.15	-0.74	-1.42	-0.17	0.7	-0.13	0.26	0.7	0.3	0.53	0.06	-0.23	-0.4	0	-0.06	0.04	0.13
6	0.14	0.63	-0.2	-0.95	-0.3	-0.5	0.1	-0.12	-0.5	0.38	0.33	0.07	0.51	-0.55	-0.64	-0.15	0.04	0.18	-0.31
7	0.56	0.23	-0.13	-1.63	-0.67	-0.17	0.29	-0.61	0.21	0.31	-0.46	0.85	0.5	0.73	-0.38	-0.8	-0.62	0.12	-0.29
8	-0.1	0.99	-0.21	-0.43	-1.44	-1.2	0.47	-0.98	0.58	0.53	-0.5	0.33	1.15	0.76	0.61	0.1	-0.2	-0.4	-0.1
9	-0.47	-0.02	0.55	-1.57	-0.94	-1.41	-0.57	-0.67	-0.06	0.98	-0.13	0.59	0.91	1.55	0.22	0.64	-0.07	-0.88	-0.49
10	-0.13	0.66	-0.64	-0.62	-0.69	0	0.4	-0.75	-0.66	0.03	-1.11	1.4	1.09	0.91	0.59	1.09	1.36	-0.65	-1.07
ITQ																			
2	0	0	0	0	0	0	0.42	-0.39	0.66	0.36	-0.11	-0.05	-0.38	0.04	0.11	-0.46	-0.56	0.38	-0.01
3	0	0	0	0	0	0	0.17	0.62	-0.12	0.62	-0.45	0.03	-0.22	0.08	0.13	-0.62	-0.46	0.38	-0.15
4	0	0	0	0	0	0	-0.21	0.26	0.49	0.03	0.08	0.01	-0.31	-0.08	-0.28	-0.55	0.22	0.3	0.03
5	0	0	0	0	0	0	0.05	-0.17	0.06	0.45	0.64	0.35	-0.14	-0.48	-0.49	-0.43	-0.24	0.19	0.2
6	0	0	0	0	0	0	-0.37	0.02	-0.8	0.27	0.85	0.2	0.62	-0.47	-0.5	-0.22	0.06	0.59	-0.25
7	0	0	0	0	0	0	-0.06	-0.45	-0.27	0.12	-0.05	0.97	0.63	0.72	-0.32	-0.96	-0.63	0.46	-0.16
8	0	0	0	0	0	0	-0.18	-0.84	-0.26	-0.05	-0.24	0.29	1.07	0.51	0.54	-0.14	-0.41	-0.21	-0.08
9	0	0	0	0	0	0	-1.2	-0.61	-0.3	0.5	-0.14	0.49	0.83	1.28	0.39	0.43	-0.56	-0.63	-0.49
10	0	0	0	0	0	0	-0.16	-0.79	-0.59	-0.65	-0.75	1.2	0.92	0.59	0.45	0.66	0.93	-0.59	-1.21

Table 14. Comparison of the retrospective analysis of the single-survey model runs with different parameterization of natural mortality (M).

Model	# parameters	Std resid	rho
M = .2	Base	2.22	0.44
M estimated	Base + 1	2.21	0.36
M random walk	Base + 39	2.09	0.11
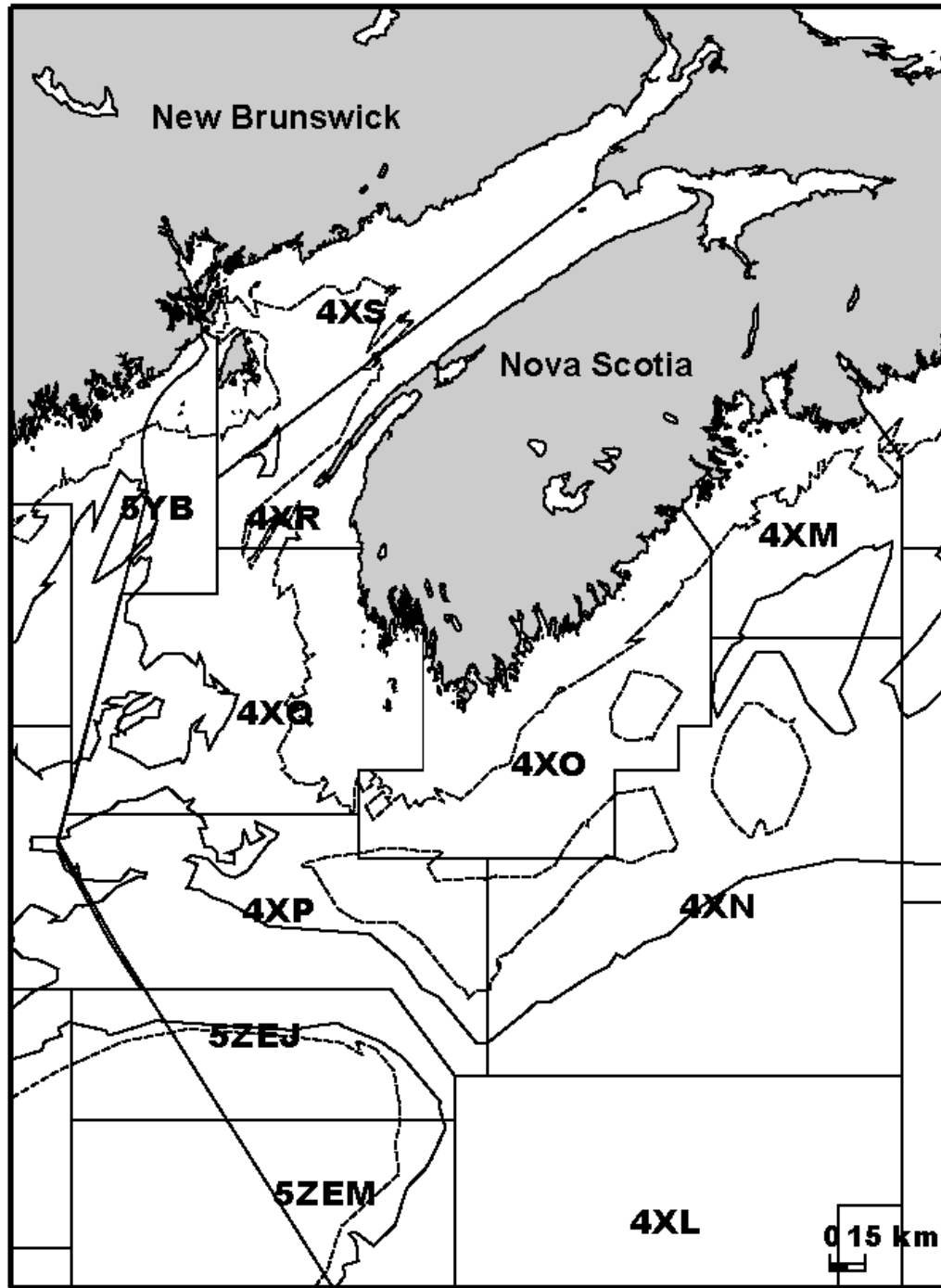
Figure 1. Statistical unit areas in NAFO Divisions 4X, 5Y and 5Z.
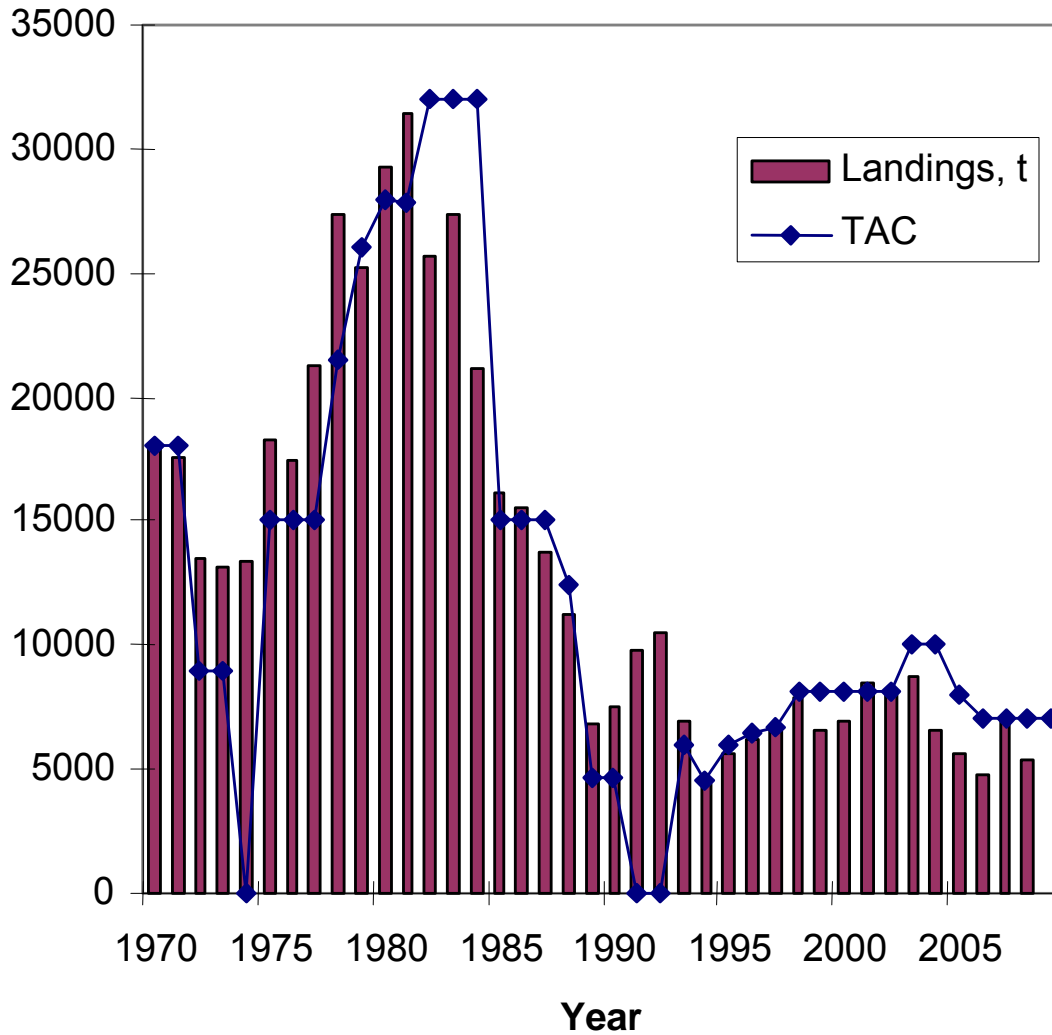
Figure 2. NAFO Divs. 4X5Y haddock landings and TAC. The fishing year in 1999 was extended to March 3, 2000, and the TAC was prorated upwards. Subsequent fishing years begin on April 1st. In 2003, quota increased to 10,000t from 8100t during the fishing year.

4X5Y Haddock landings by quarter
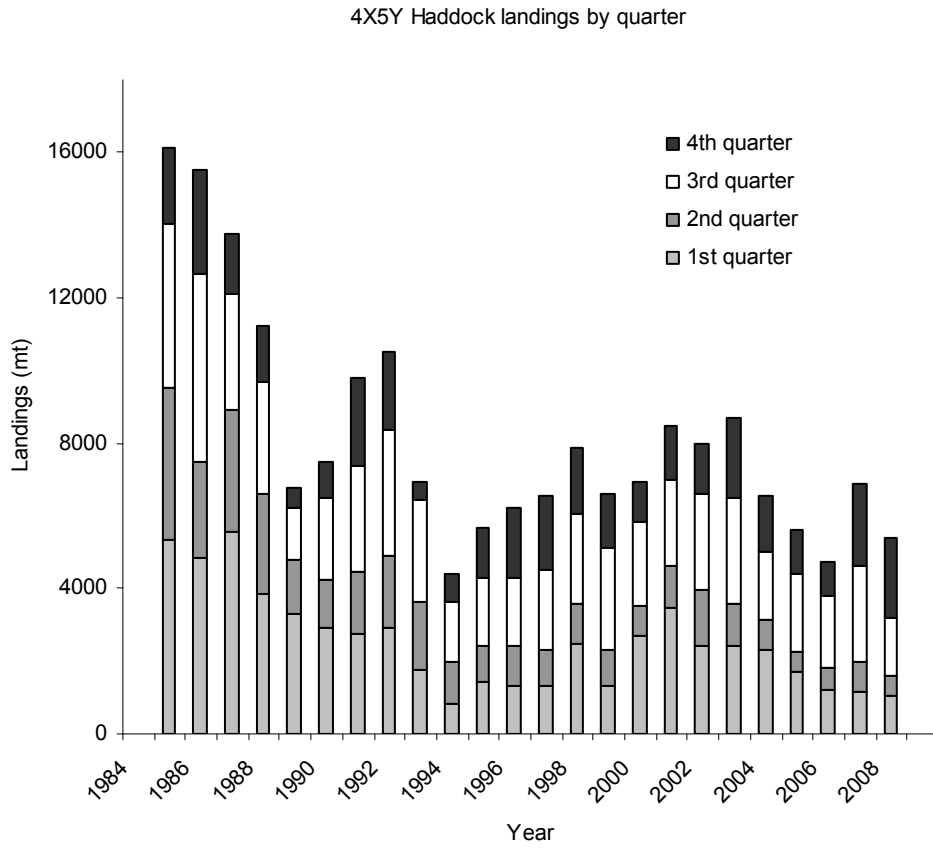
Figure 3. NAFO Divs. 4X5Y haddock landings by quarter, 1985-2008. The fishing year in 1999 was extended to Mar 3, 2000, and the TAC was prorated upwards. Subsequent fishing years begin on April 1st.
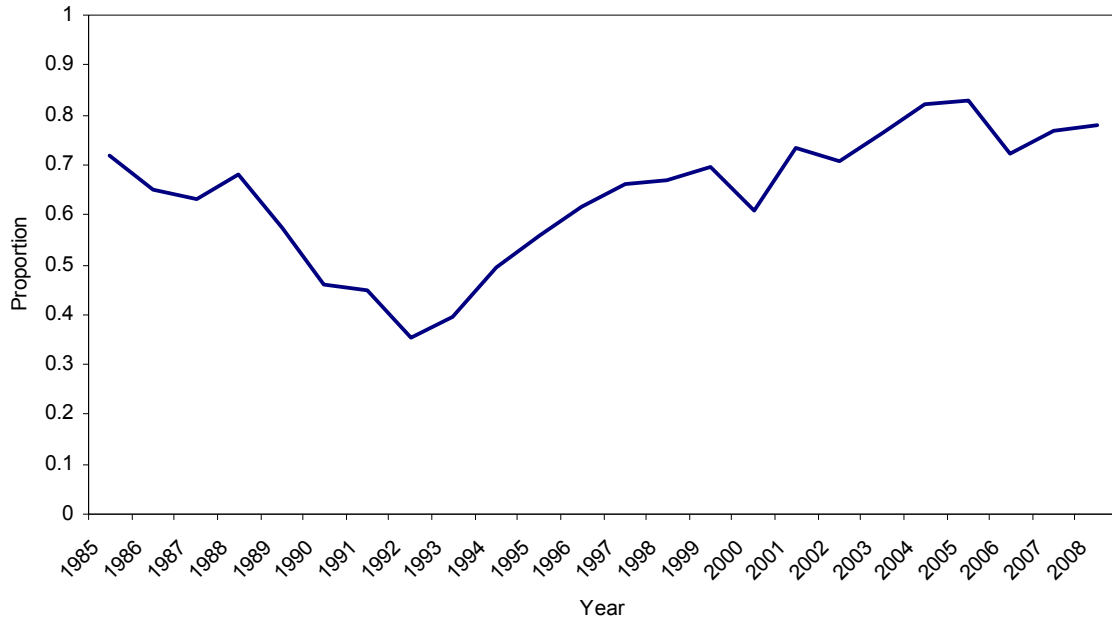
Figure 4. Portion of landings in NAFO Divs. 4X5Y haddock caught by mobile gear (tonnage class 1-3 and 4+). The fishing year in 1999 was extended to March 3, 2000, and the TAC was prorated upwards. Subsequent fishing years begin on April 1st.
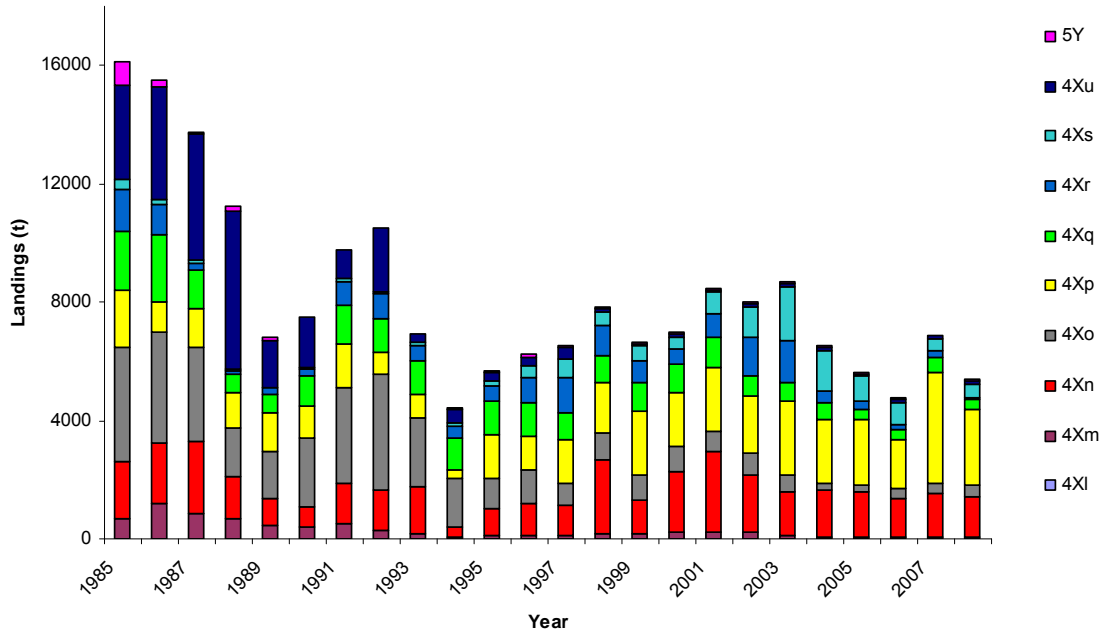
Figure 5. NAFO Divs. 4X5Y haddock landings by unit area, 1985-2008. The fishing year in 1999 was extended to March 3, 2000, and the TAC was prorated upwards. Subsequent fishing years begin on April 1st.

4X5Y Haddock Commercial mean weight at age
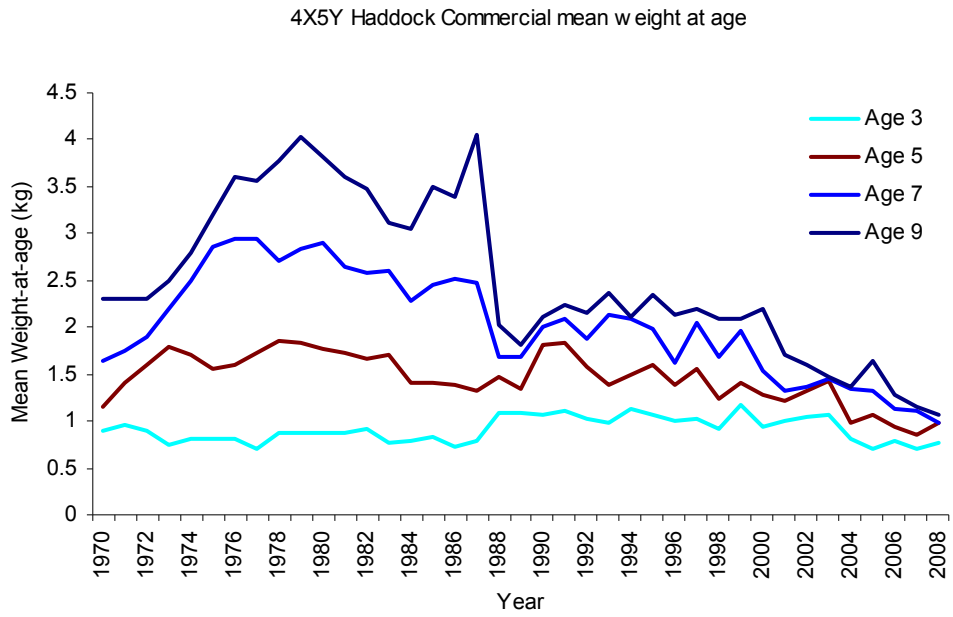
Figure 6a. Commercial mean weight-at-age (kg) in NAFO Divs.4X5Y between 1997 and 2008.

4Xmnop Haddock Commercial mean weight at age

4Xqr Haddock Commercial mean weight at age
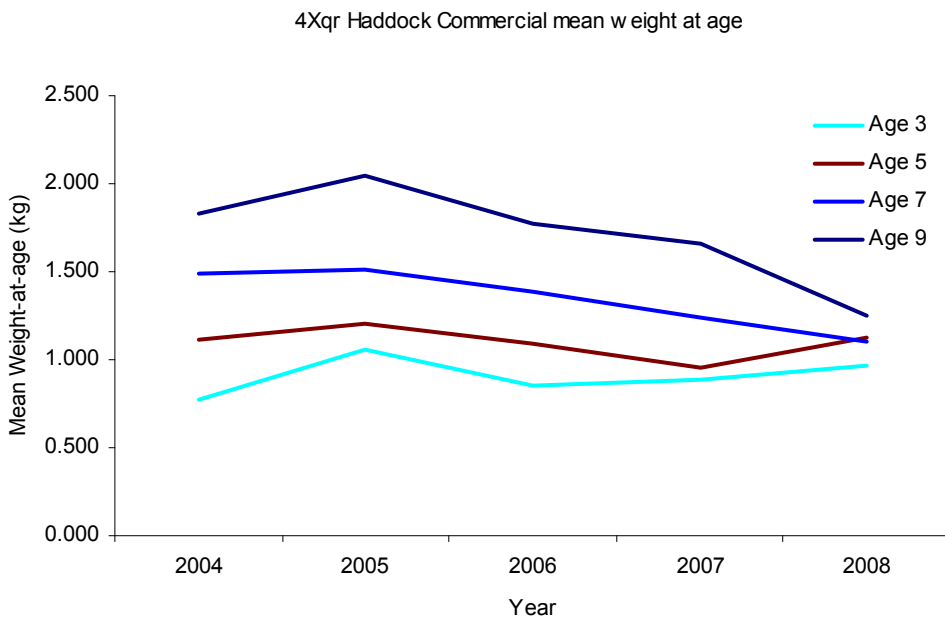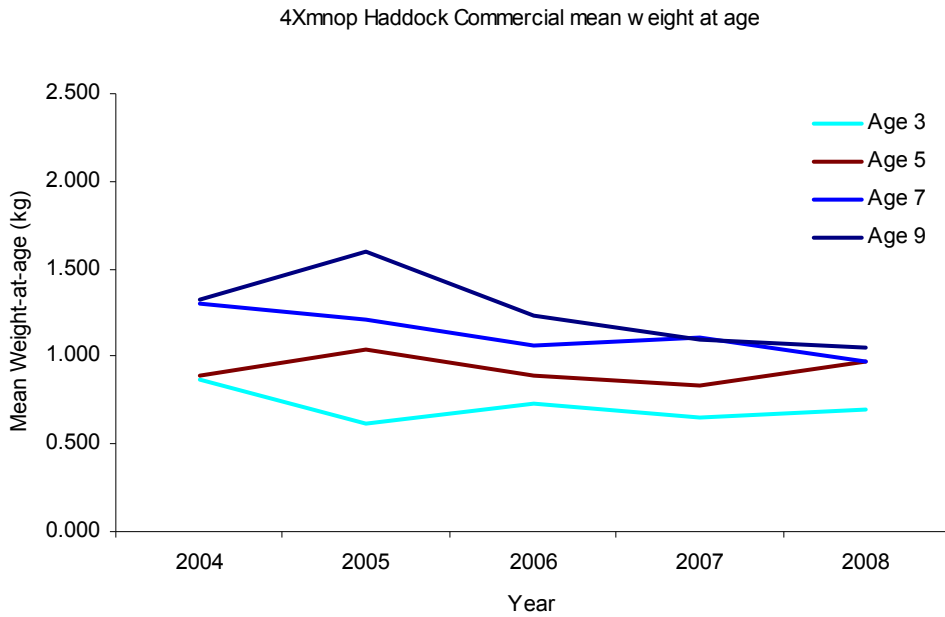
Figure 6b. Commercial mean weight-at-age (kg) on the Scotian Shelf (4Xmnop) and the Bay of Fundy (4Xqr) between 2004 and 2008.
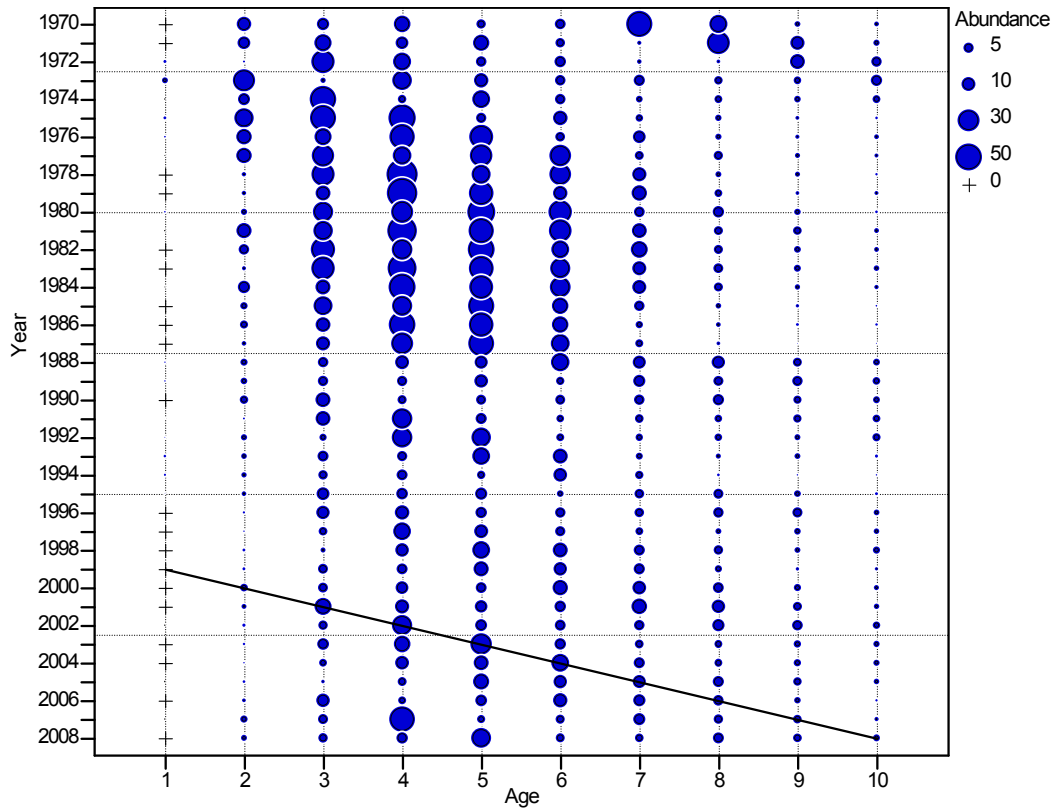
Figure 7. Recent trends in commercial catch-at-age. Abundance is in 10,000s.
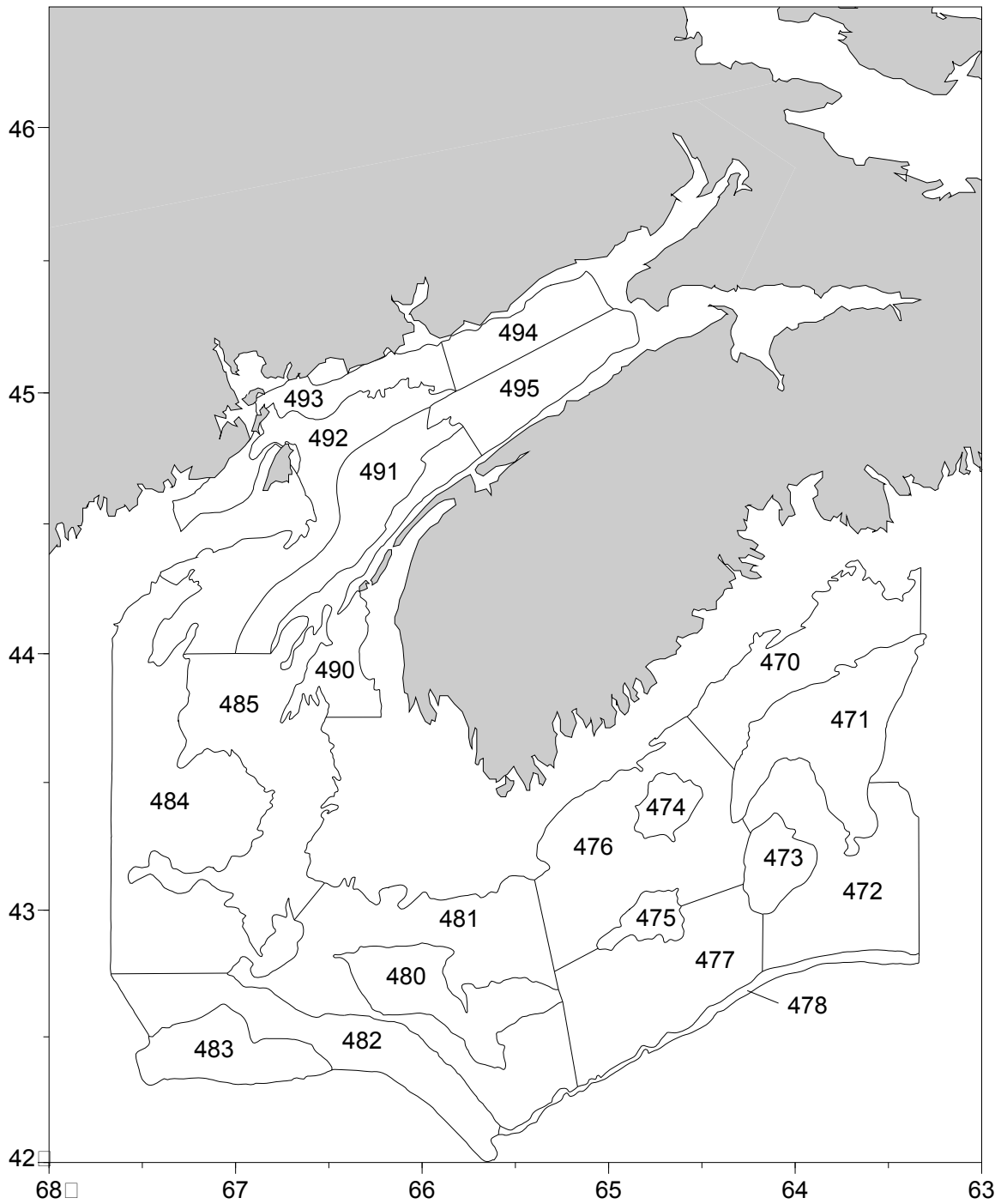
Figure 8. Stratification scheme for the summer research vessel survey in NAFO Div. 4X.
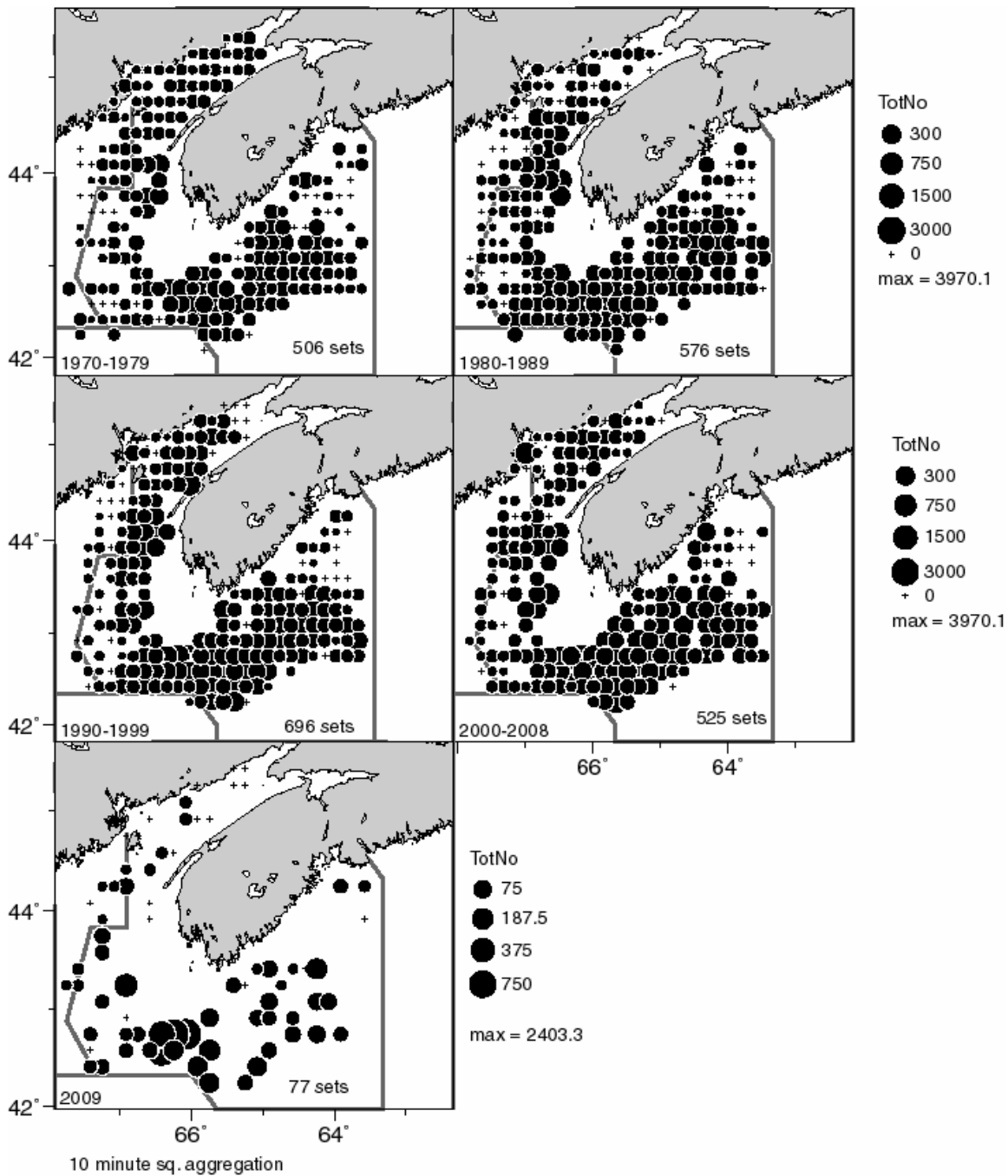
Figure 9. NAFO Divs. 4X5Y Haddock average number caught per tow on the summer RV survey plotted by decade with 2009 plotted separately. Note the difference in scale between 2009 and the decade averages.

Summer RV mean weight per tow
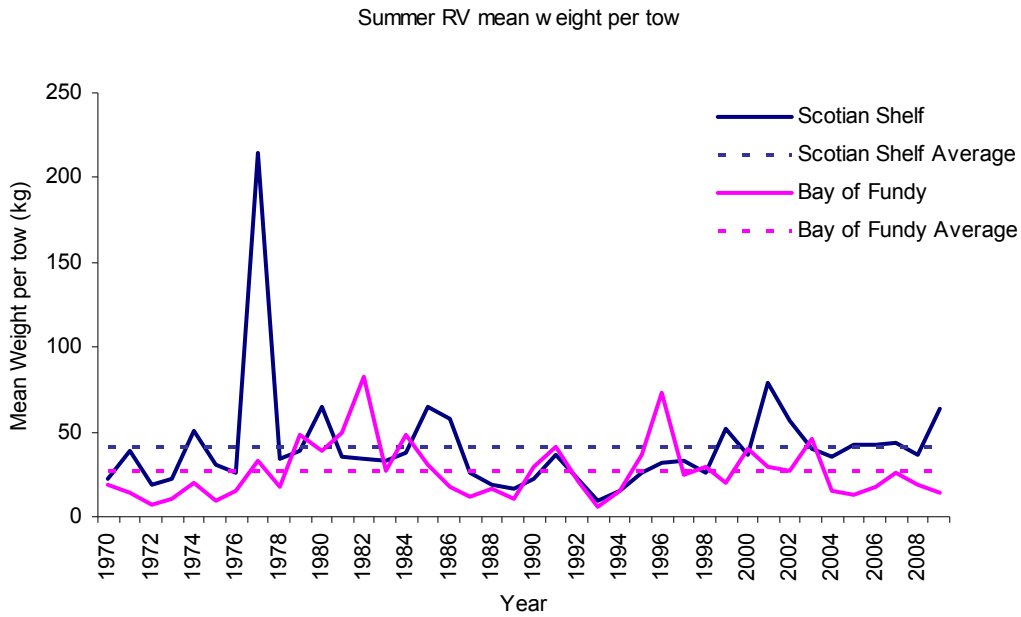
Figure 10. Summer RV survey stratified mean weight per tow between 1970 and 2009.
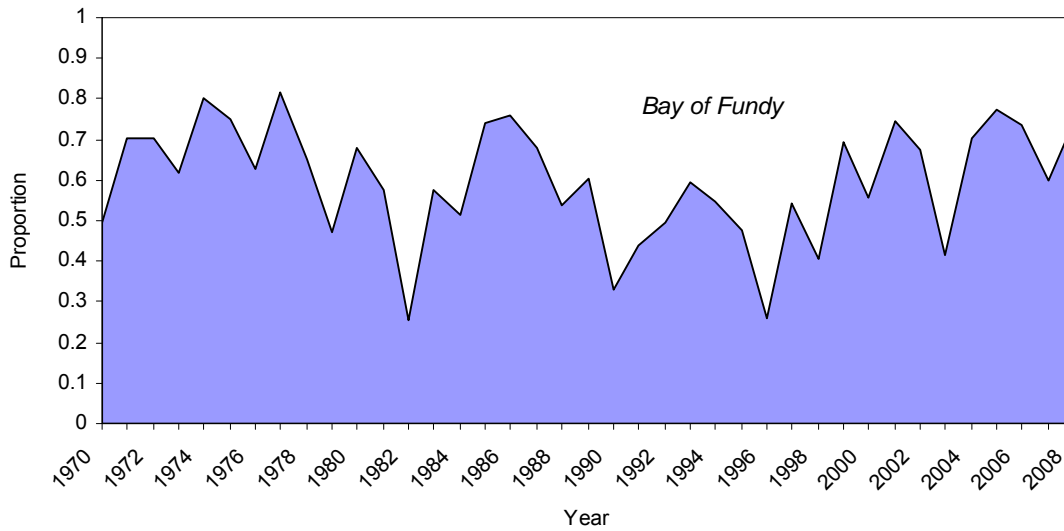
Figure 11. Proportion of 4+ biomass in the summer RV survey in the Bay of Fundy and Scotian Shelf.
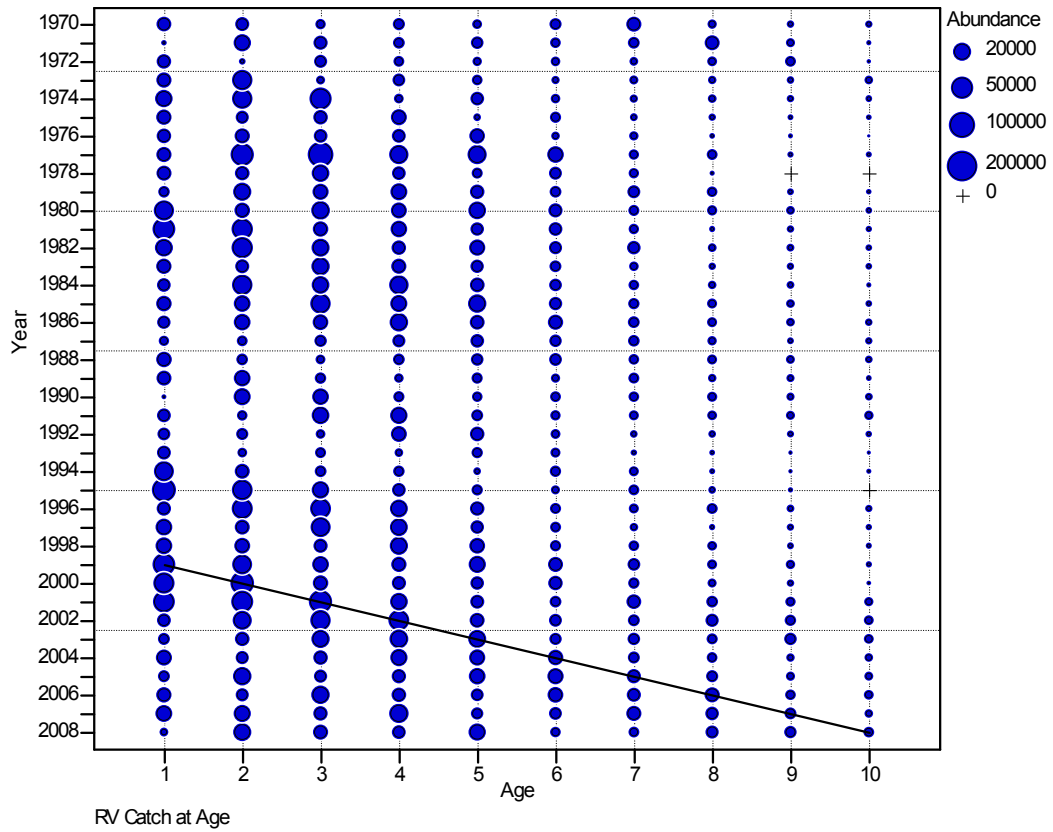
Figure 12. Age composition of summer RV survey indices by area for NAFO Divs. 4X5Y haddock. Solid line tracks 1998 year-class.

4X5Y Haddock Summer RV Survey Scotian Shelf (Strata 470-481)

4X5Y Haddock Summer RV Survey Bay of Fundy (Strata 482-495)
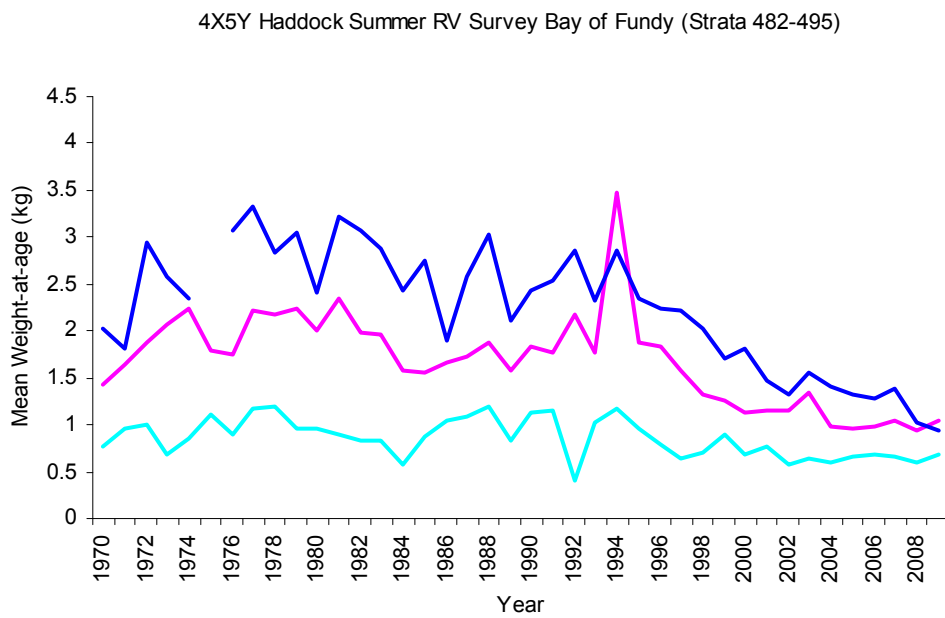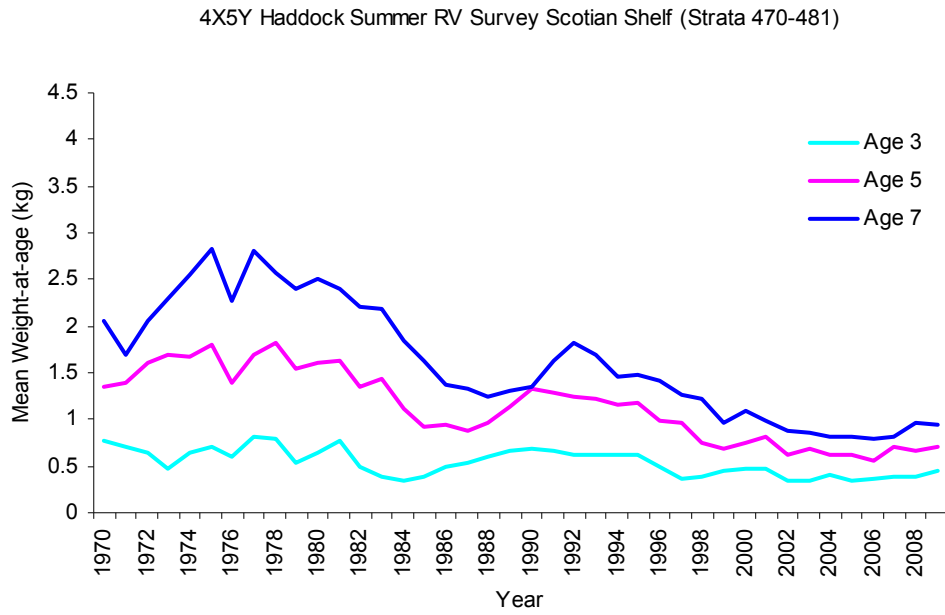
Figure 13. Summer RV survey mean weight-at-age, by area.

4X5Y Haddock Summer RV Survey Fish Condition
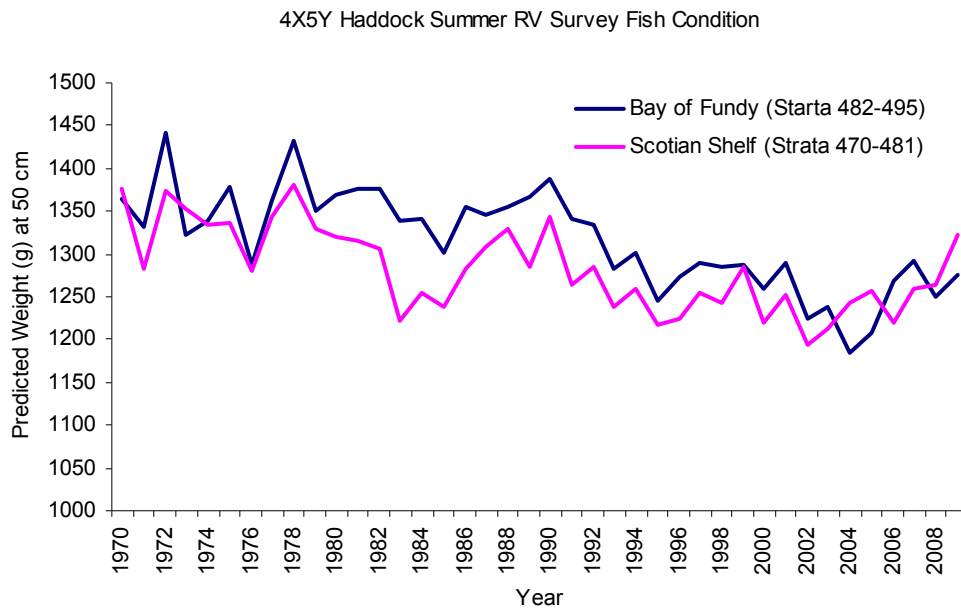
Figure 14. Summer RV survey condition index, predicted weight at 50 cm.
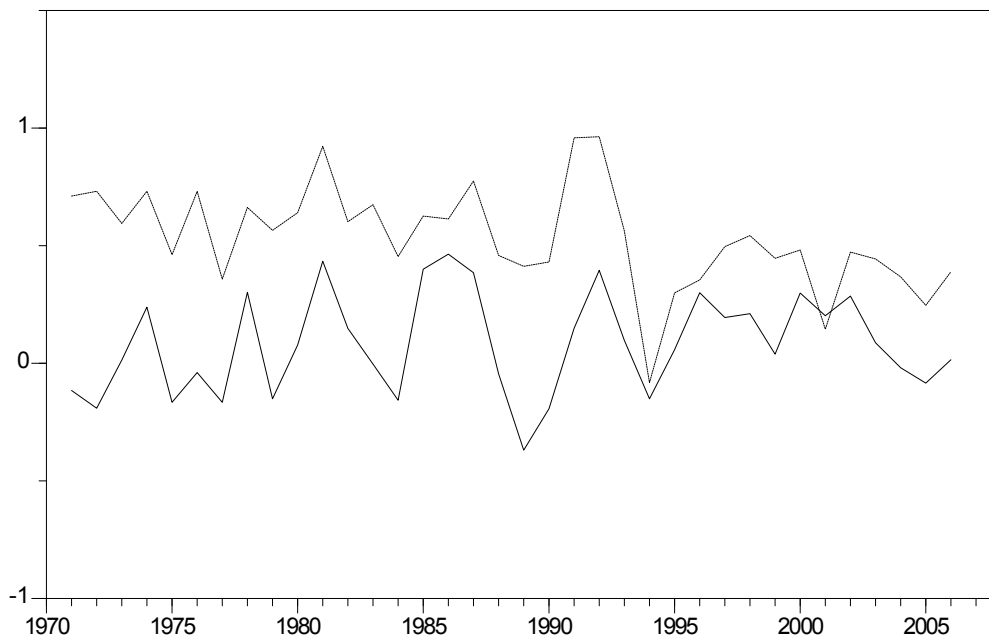
Figure 15. Total mortality (Z) calculated from the RV survey. The lower line is for ages 1-4 and the upper line is for ages 5-9. These have not been corrected for the catchability at age.
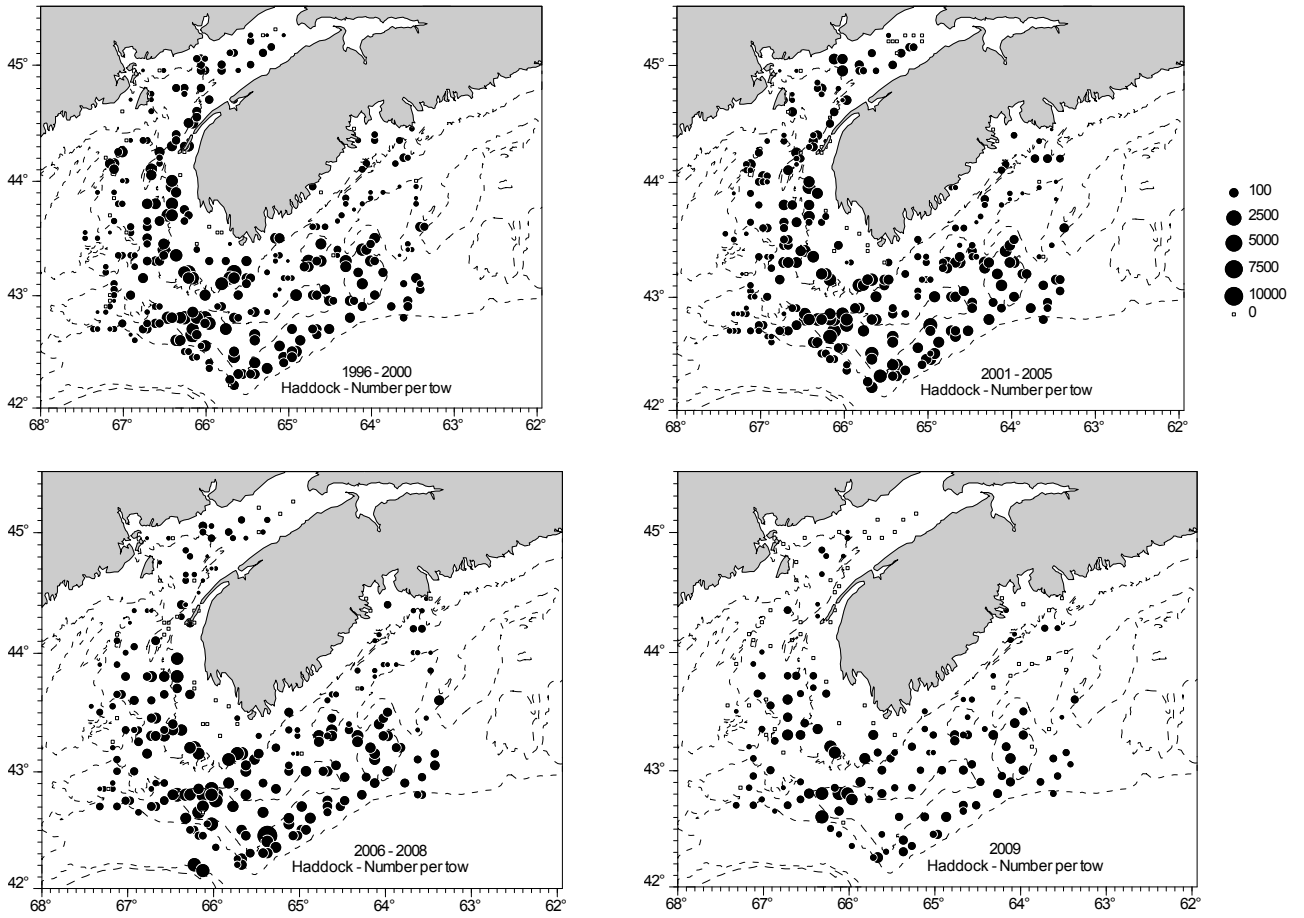
Figure 16. Haddock numbers per tow caught in the ITQ survey.
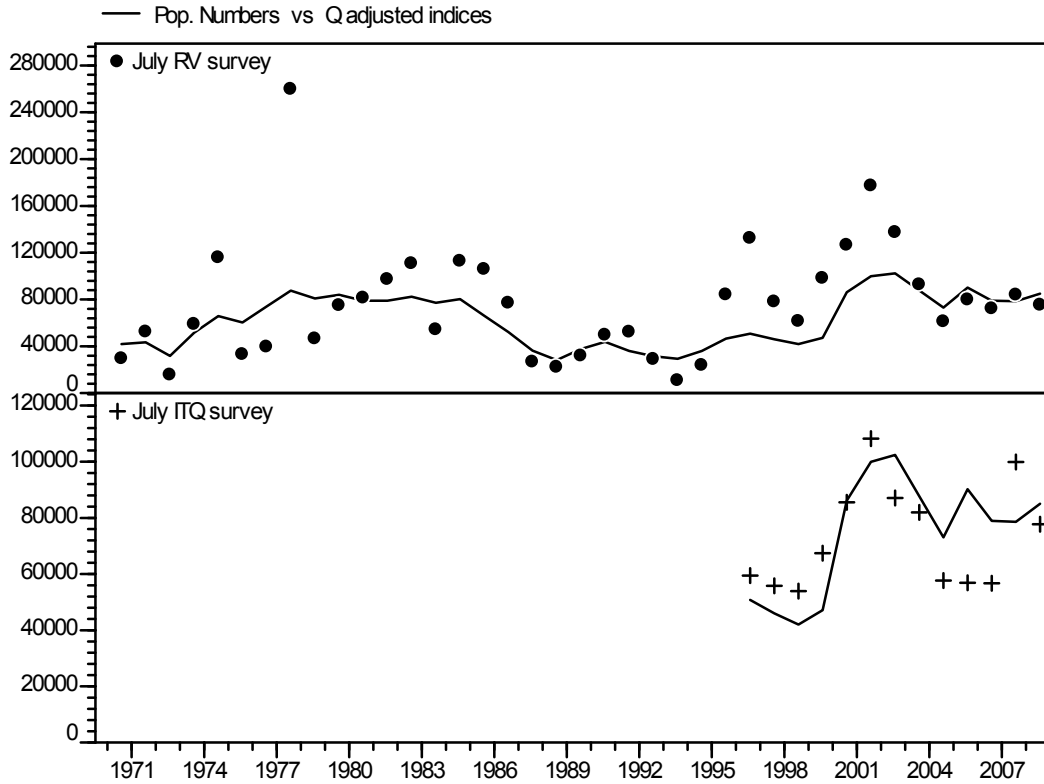
Figure 17. Population numbers (ages 2-10) estimated from the base model and the q-adjusted RV (upper) and ITQ (lower) surveys.
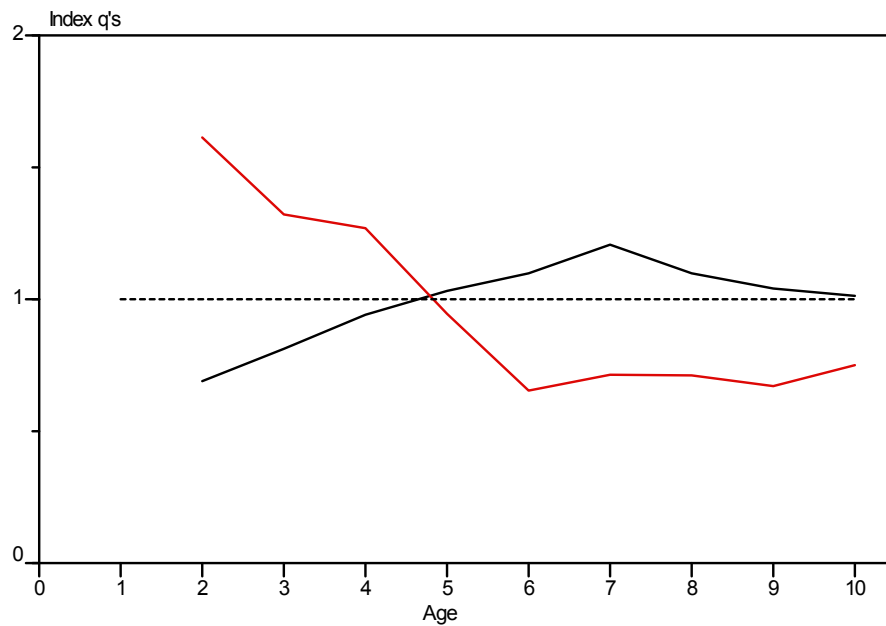
Figure 18. Catchability at age for the summer survey (black) and ITQ survey (red) from the base model.
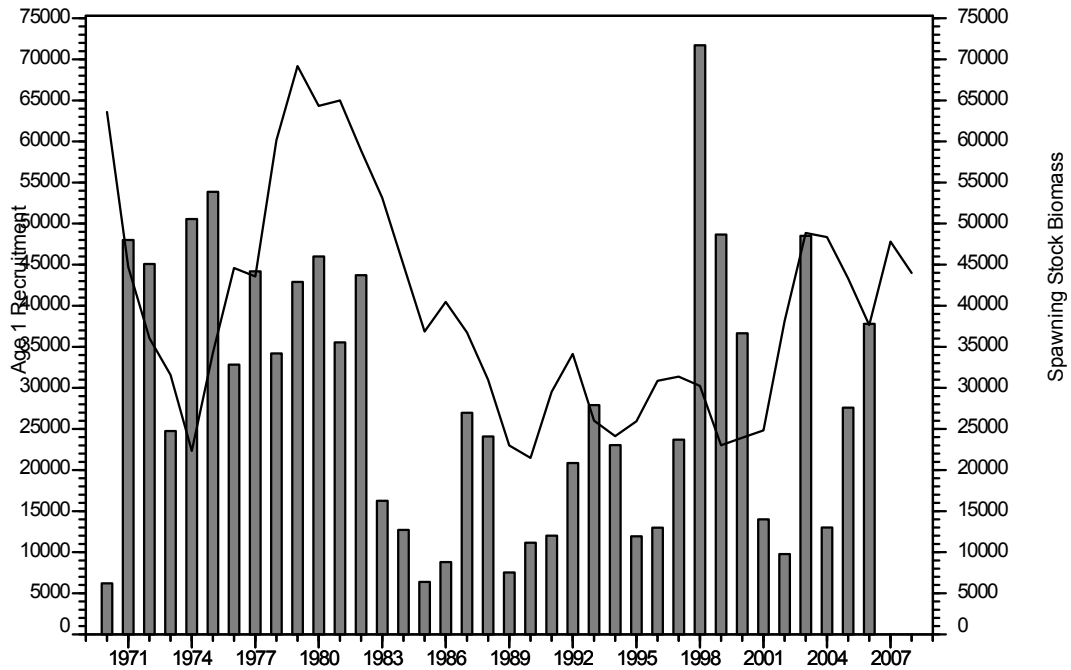
Figure 19. Spawning stock biomass (ages 4+) (line) and age 1 recruitment (bars) from the base model.
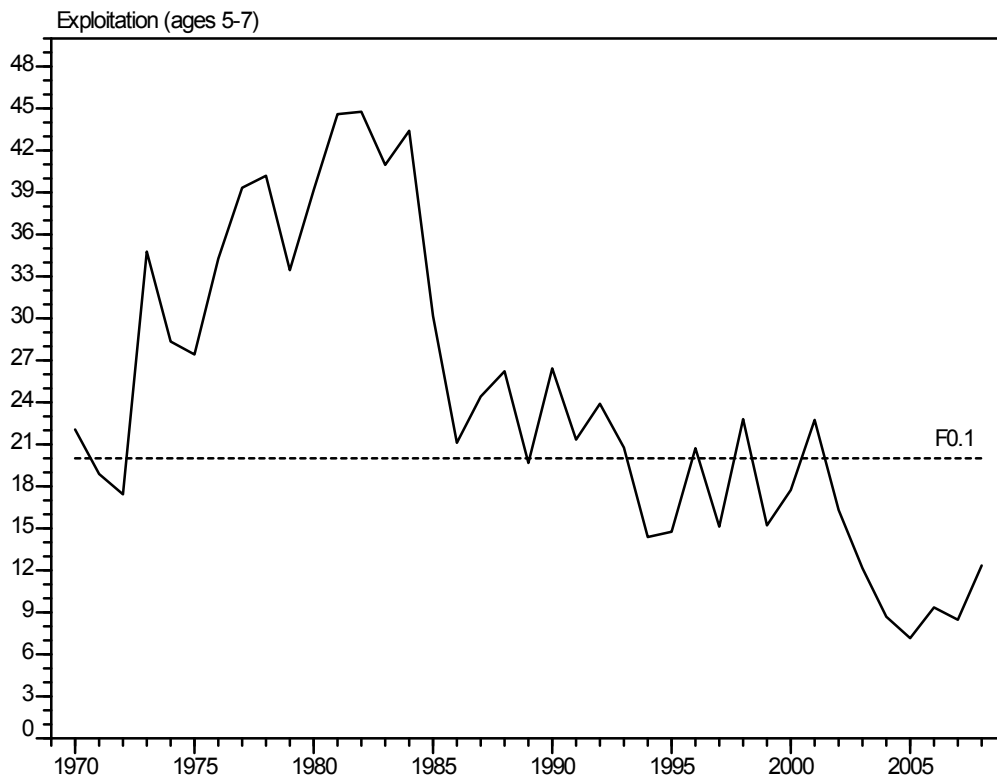
Figure 20. Exploitation rate (ages 5-7) for NAFO Div. 4X Haddock 1970-2008 from the base model.
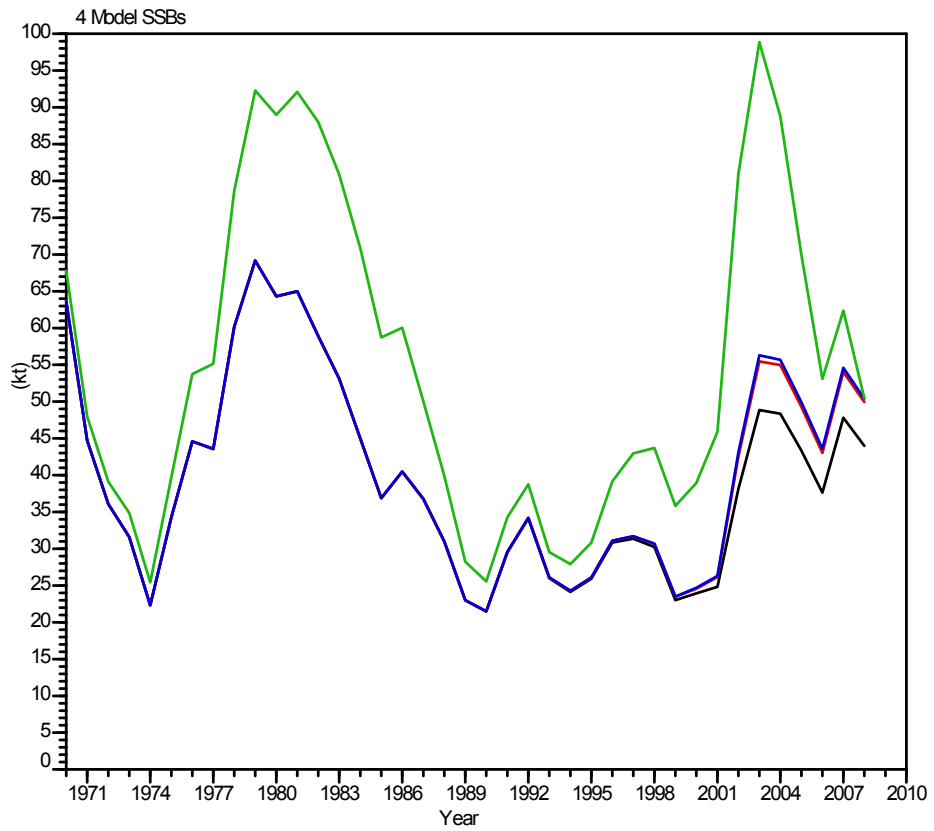
Figure 21. Comparison of four SPA models in terms of SSB. The lowest line (black) is the base model. The middle lines (blue and red) use a single tuning to the RV survey; one was done in ACON, the other in ADMD. The upper most line (green) is a random walk M model.
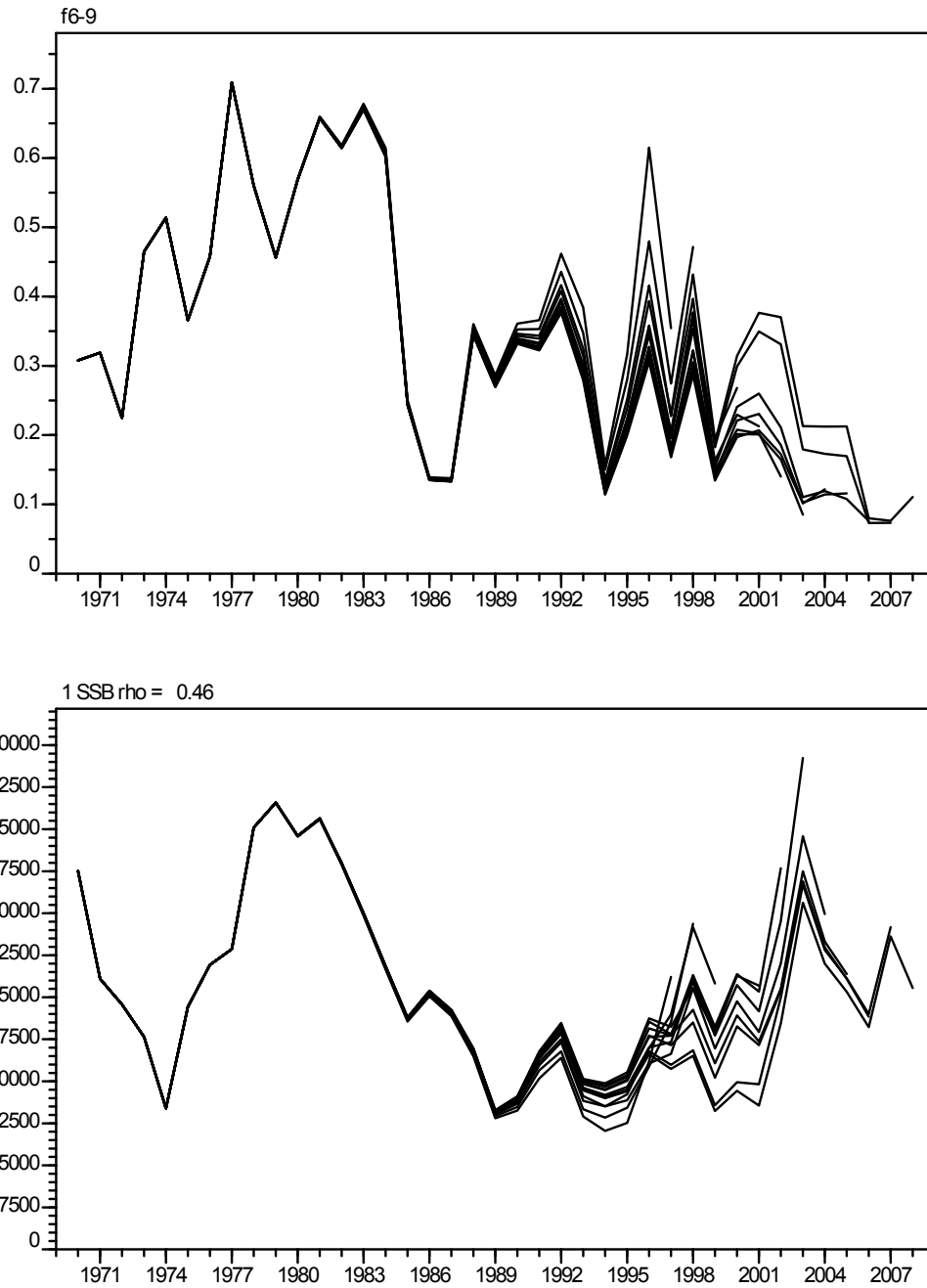
Figure 22. Retrospective analysis of SPA results. The top panel is F for ages 6-9 and the bottom panel is the SSB.
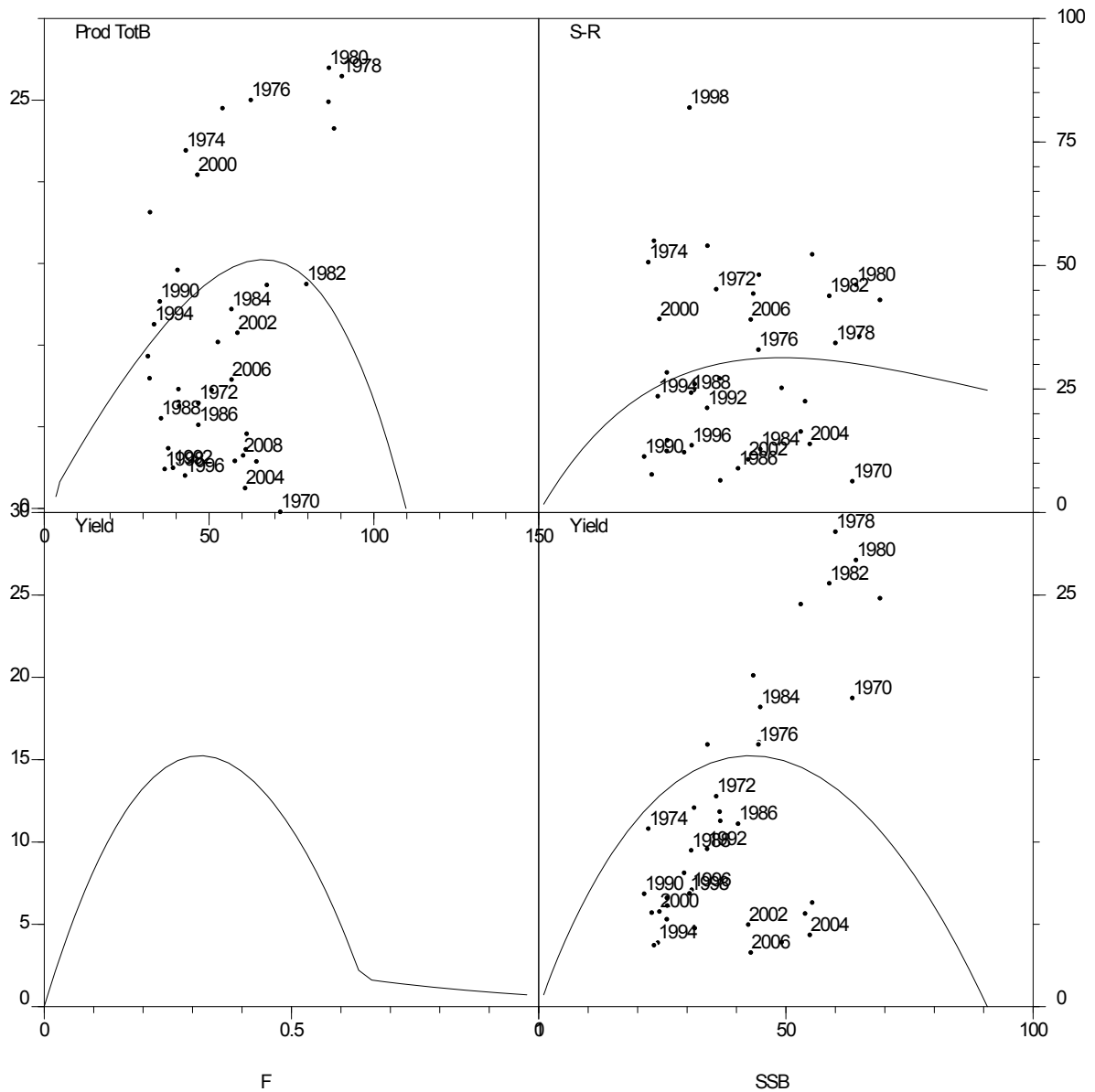
Figure 23. Sissenwine-Shepherd production model. The upper left plot is production as a function of total biomass with the equilibrium line shown. The peak of this line at about 1500 Mt is MSY. The upper right plot is a stock-recruit relationship showing a Ricker curve. The lower left plot is yield (1000 Mt) as a function of fishing mortality, and it shows Fmsy at about 0.32. And the lower right plot is yield as a function of spawning stock biomass. Only the labels for even years are plotted.
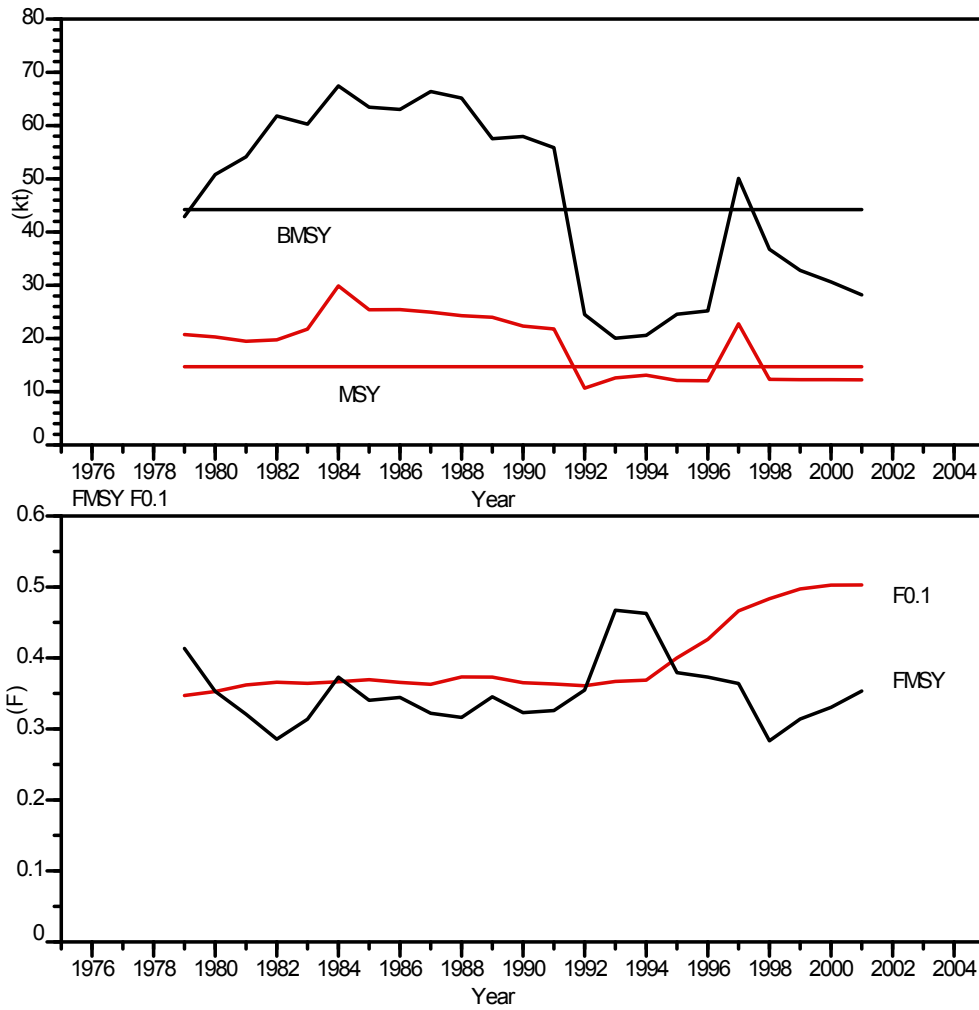
Figure 24. NAFO Div. 4X haddock MSY and production estimated using 10 year windows.
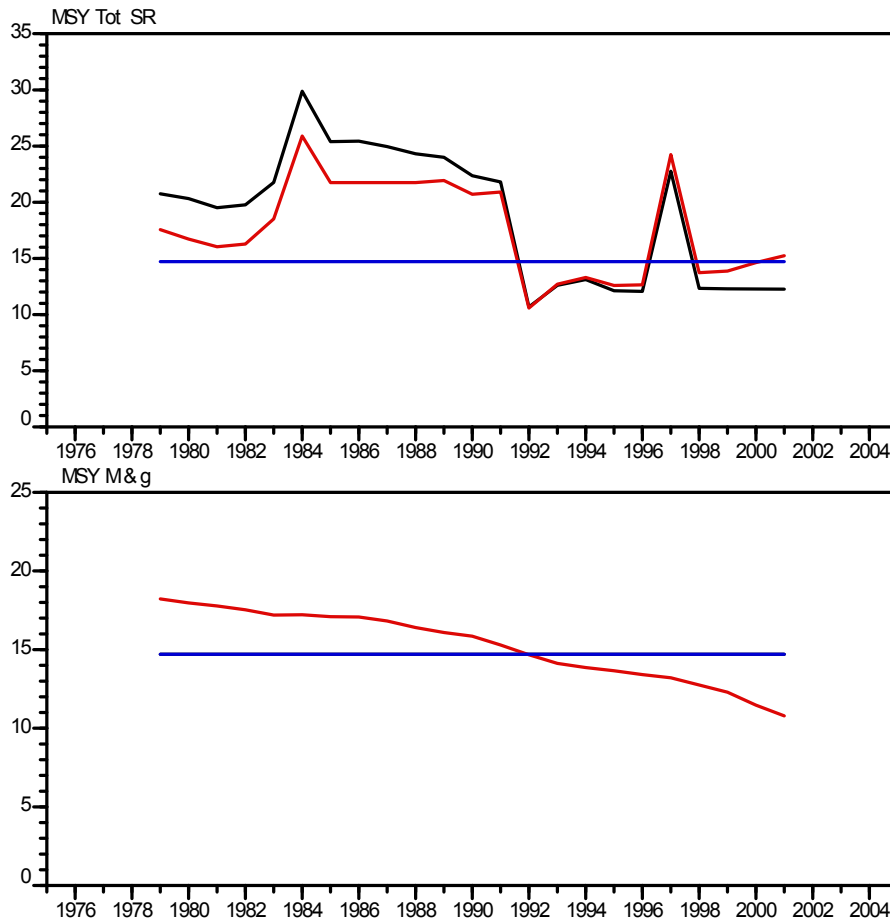
Figure 25. Contribution to time varying production (t) of NAFO Divs. 4X5Y Haddock. Top plot is sum of all effects (black line), stock recruit component (red line) and average over entire data period (blue line). Lower plot is the growth component (red line) and average over entire data period (blue line).
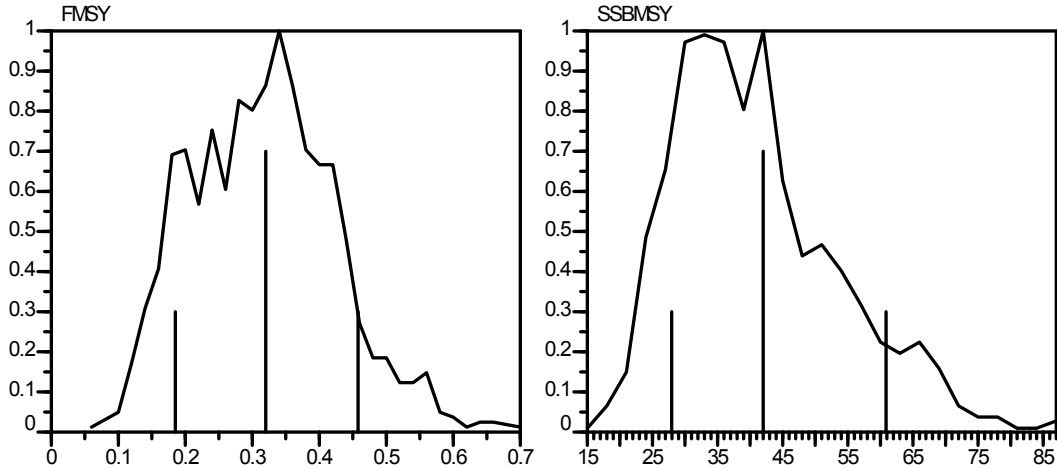
Figure 26. Bootstrap estimate of Fmsy and SSBmsy error. The higher vertical marks the point estimate, the lower lines the 10th or 90th percentiles.
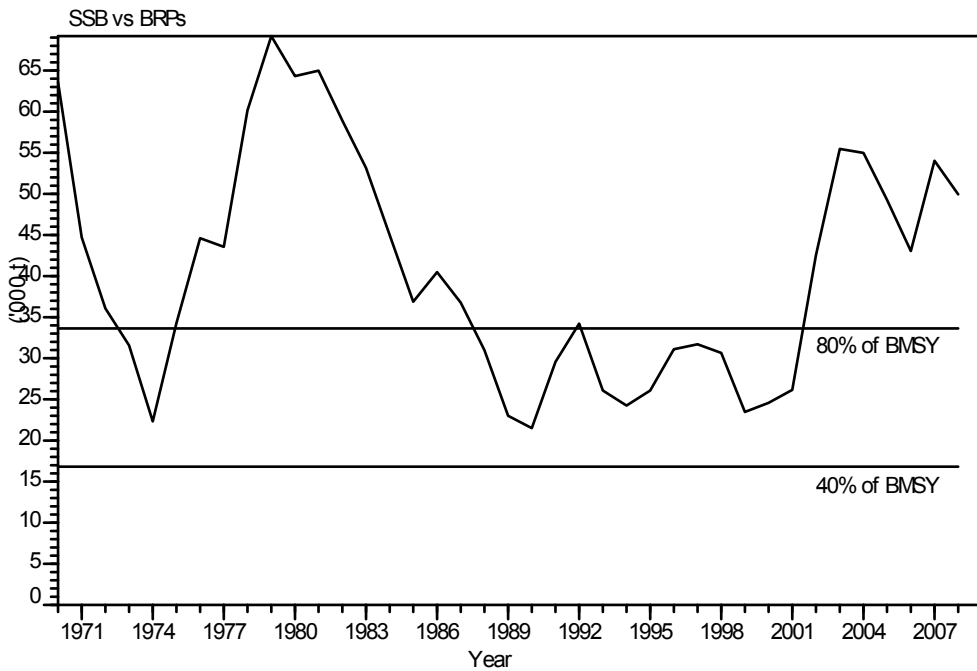
Figure 27. History of spawning stock biomass with biological reference levels shown. The upper line is 0.8 of Bmsy and is the upper stock reference (USR). The lower line is the 0.4 Bmsy is the lower limit reference point.
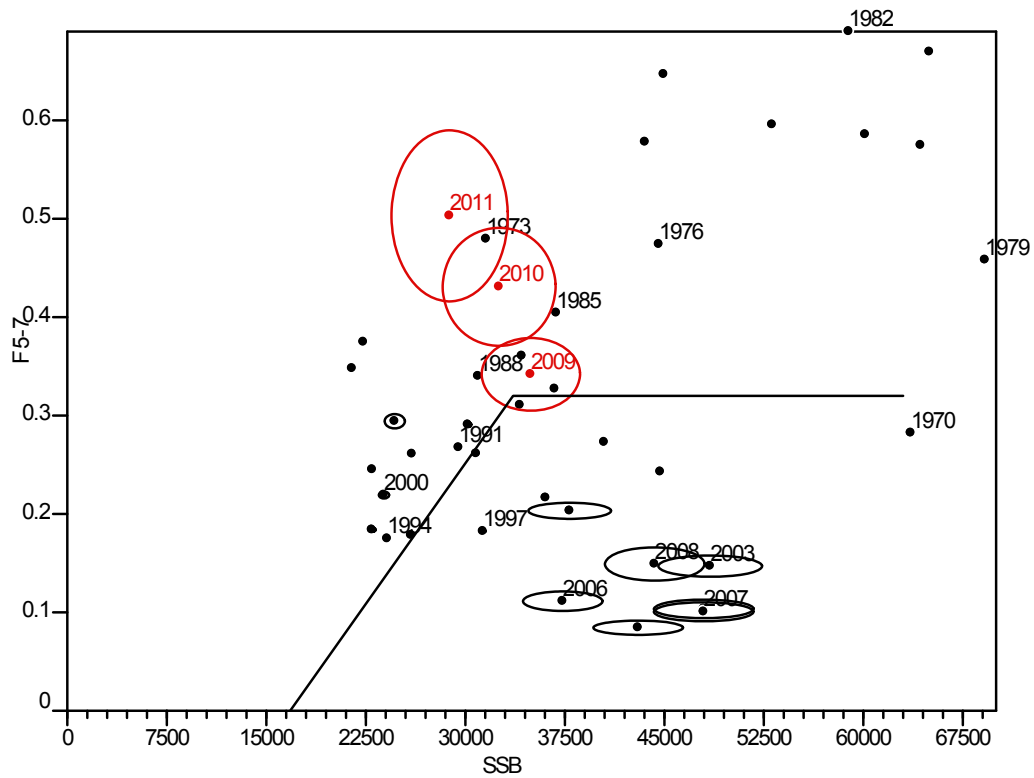
Figure 28.   Harvest control rule for NAFO Divs. 4X5Y Haddock assuming no error is indicated in black. The uncertainty of the reference points estimated by bootstrap (Fig. 25) which would result in a shift in the vertex is represented by the light grey shading with the other most probable vertices indicated by dark grey shading. The black dots trace the trajectory of the stock and the ellipses are 1 SD estimated by bootstrapping.   The three red dots are sample projection at 7000 Mt.
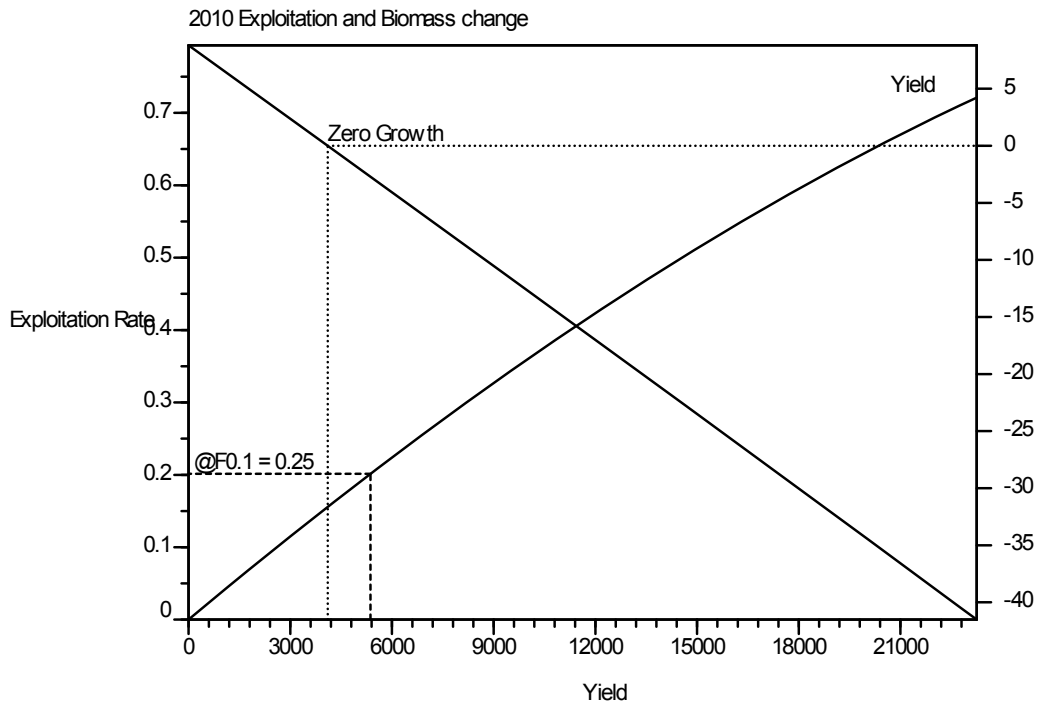
Figure 29. NAFO Div. 4X Haddock projection showing trajectories of exploitation rate and change in spawning stock biomass at various levels of yield in 2010.
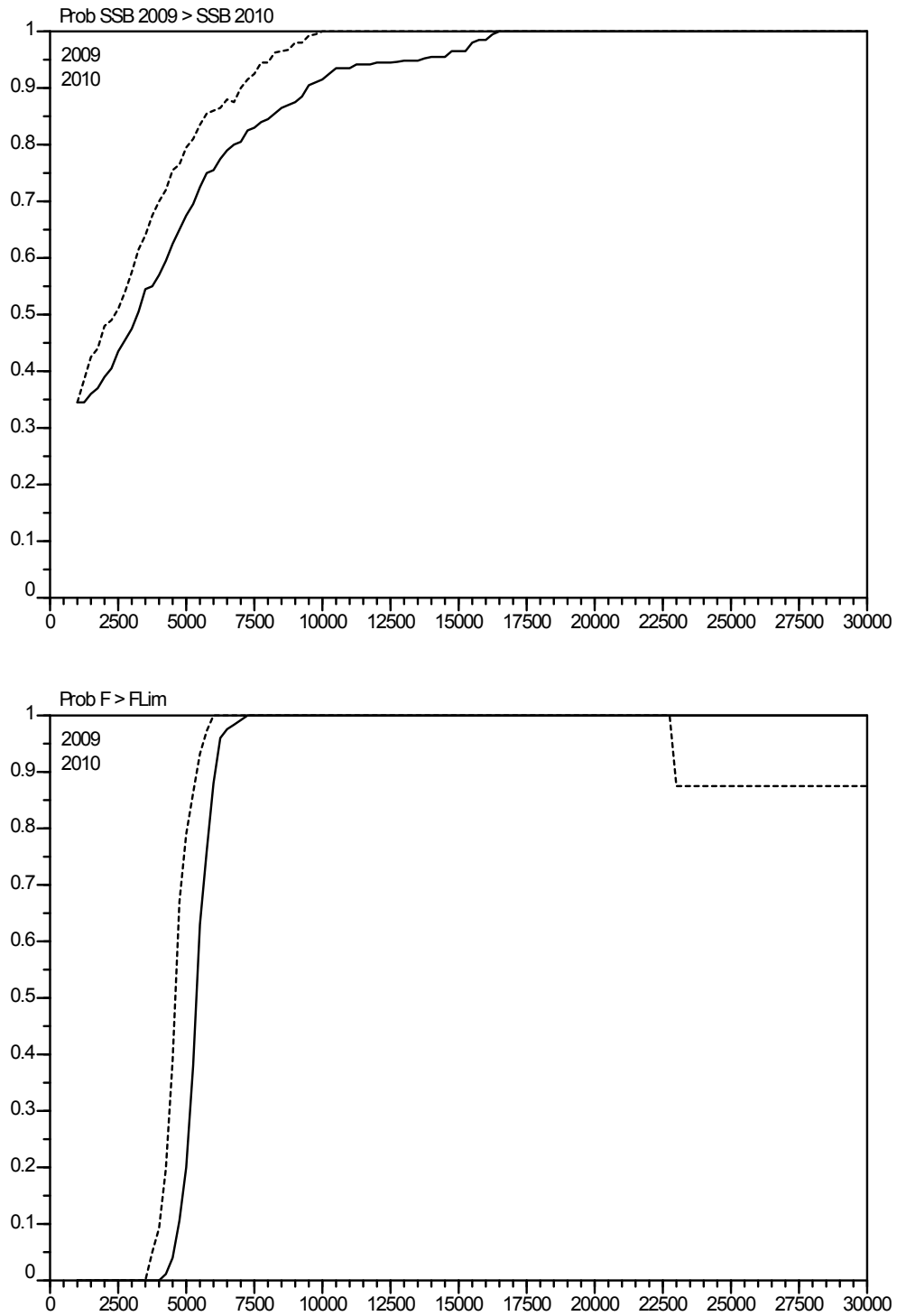
Figure 30. Probability that spawning stock biomass (ages 4+) will decrease (top) and that $F_{0.1}$ will be exceeded (bottom) at levels of yield in 2009 (solid line) and 2010 (dashed line).
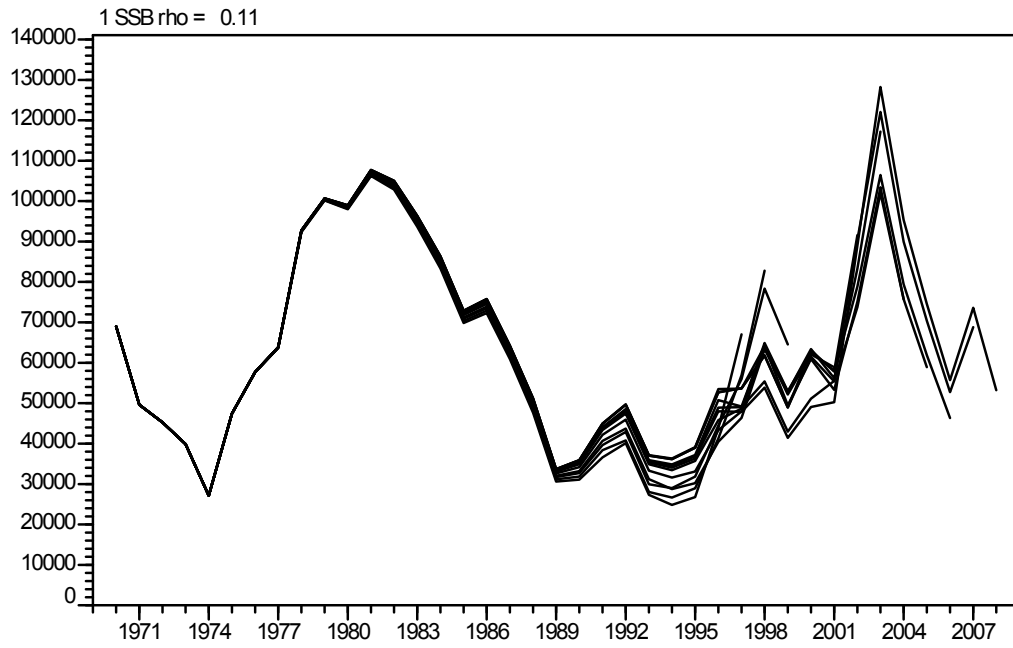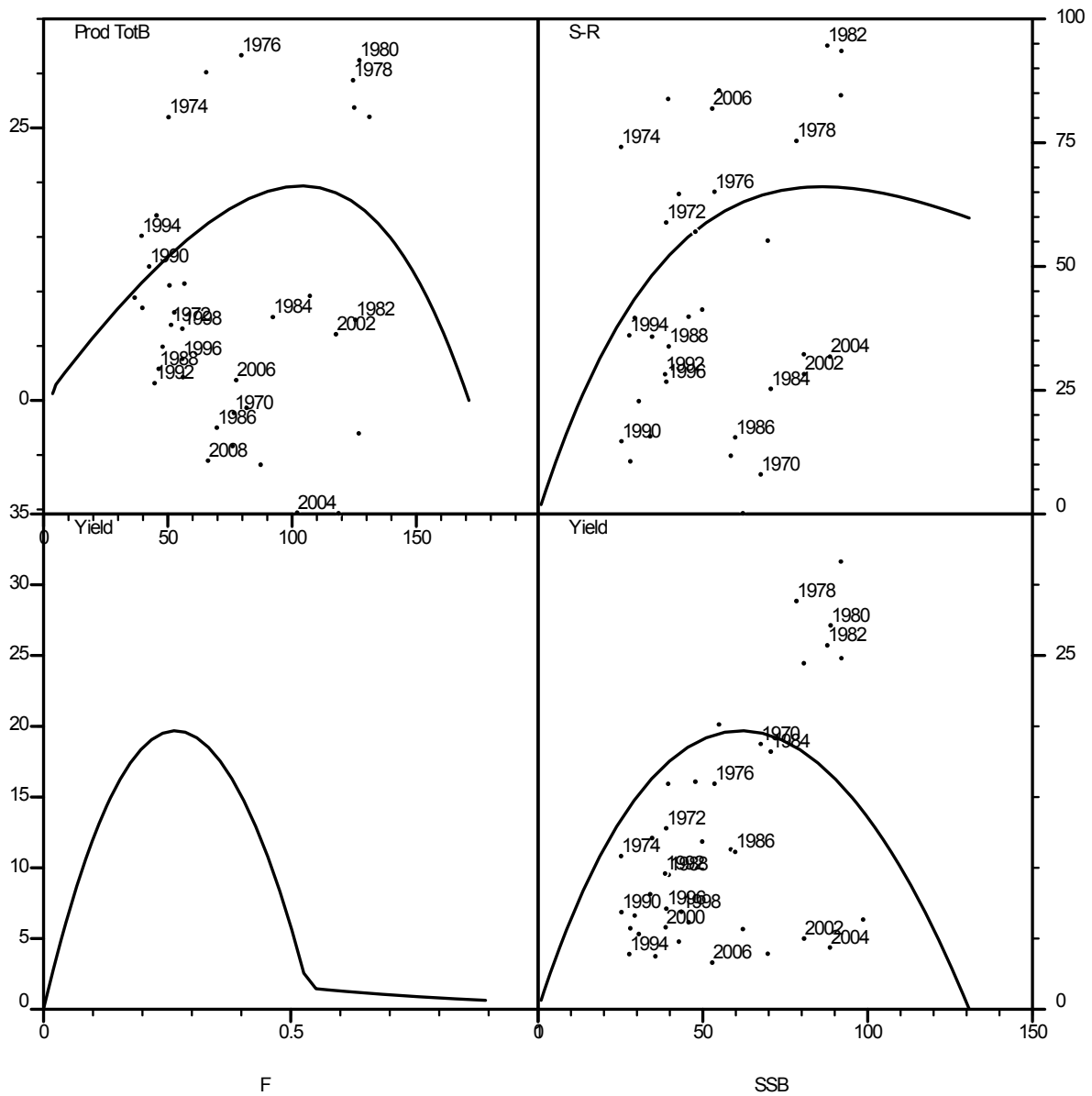
APPENDICES
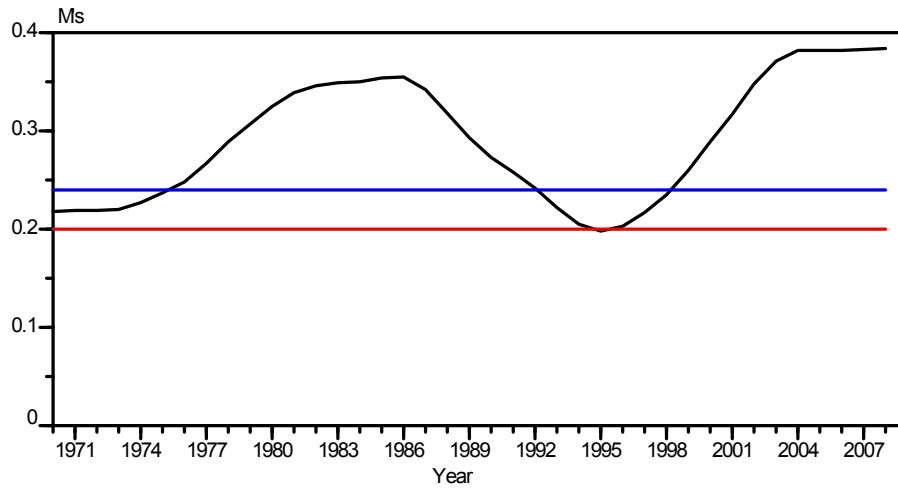
Appendix A.1. Estimates of natural mortality (M) from 3 models. Lower (red) line is fixed at 0.2, blue line is estimated at 0.24 and the black line is the random walk M model.
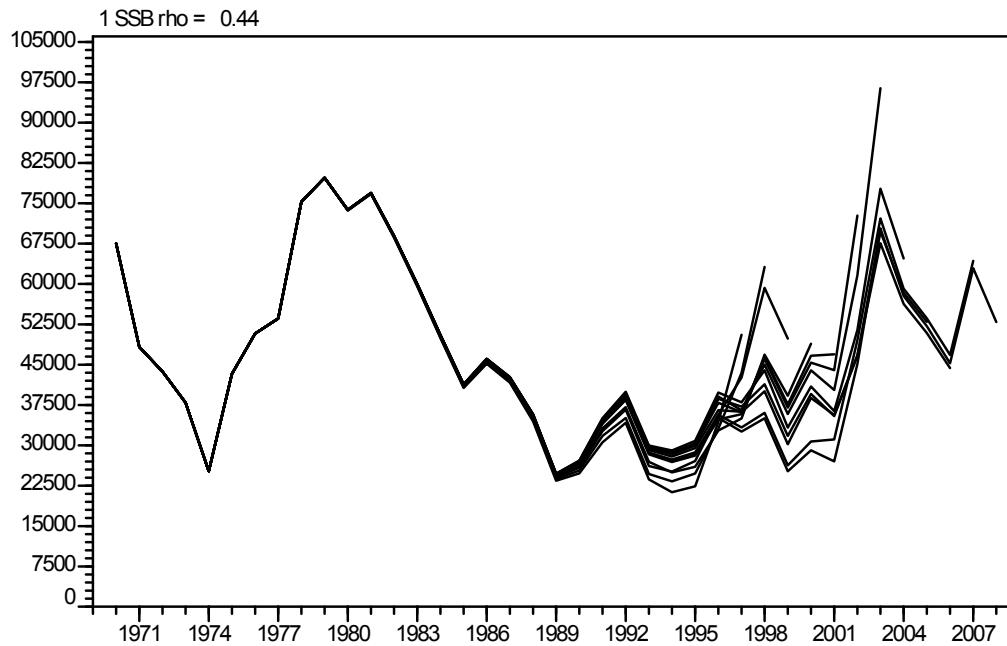
Appendix A.2. Retrospective analysis of SSB from the M=0.2 model

Appendix A.3. Retrospective analysis of SSB from the ranom walk M model.

Appendix A.4. Sissenwine-Shepherd production model for the random walk M model. The upper left plot is production as a function of total biomass with the equilibrium line shown. The peak of this line at about 2000 Mt is MSY. The upper right plot is a stock-recruit relationship showing a Ricker curve. The lower left plot is yield (1000 Mt) as a function of fishing mortality, and it shows Fmsy at about 0.25. And the lower right plot is yield as a function of spawning stock biomass. Only even years are labeled.