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Halibut on the Scotian Shelf and Southern Grand Banks - Current Estimates of Population Status

État de la population de flétan du plateau néo-écossais et du sud des Grands Bancs

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Abstract

- FRCC recommended increases in TAC in 2000 and 2001, resulting in a current 2002 TAC of 1150t.

- White hake, cusk, cod, dogfish, and a range of other species, are caught in association with halibut. This has management implications in an ecosystem context. In the Industry-DFO halibut longline survey, the average non-halibut by-catch (% weight of all species) has ranged from 76 to 88% in the fixed station phase to between 46 and 69% in the commercial index stations. The latter would be more indicative of bycatch rates in the fishery as a whole.

- According to industry, there has been an increase in the amount of unreported halibut catch, particularly in 2002.

- Adult halibut have a low catchability to the DFO summer RV survey, resulting in highly variable estimates of adult abundance. The RV survey provides information on incoming recruitment (fish < 81cm) and overall spatial distribution. The RV survey shows below average recruitment in 2002; and has been relatively stable over the past decade.

- The halibut longline survey provides the capacity to monitor the halibut population. It has now been in place for five years, is internally consistent (rankings of high, medium and low strata are consistent, fishing grounds are consistently identified, and the commercial and fixed station indices give similar trajectories), and does not suffer from the high variability observed in the RV survey series.

- The halibut longline survey indicates lower recruitment numbers in 2002 for the stock area as a whole. Recruitment estimates for SA3 are relatively high in 2001 and 2002 which suggests that SA3 may be a more important recruitment area than previously thought. However; survey coverage in SA3, particularly 3NO, remains problematic mainly due to the costs involved in getting there and management restrictions related to cod bycatch limits.

- Halibut longline survey commercial index and fixed station estimates of biomass (cpue) show a relatively stable overall population size from 1998 – 2002. Individually, the sub-components of the main survey areas (3Ps4VWX) also appear stable over this period.

- The halibut population biomass appears to be relatively stable even with a 35% increase in TAC and landings since 1998.

- The continued operation of the longline survey to effectively monitor population status, is essential to the management of this fishery.

Résumé

- Le CCRH a recommandé des hausses du TAC en 2000 et en 2001, ce qui a donné un TAC de 1 150 t en 2002.

- La merluche blanche, le brosme, la morue, l'aiguillat ainsi que diverses autres espèces sont capturées en association avec le flétan. Dans un contexte écosystémique, cela a des conséquences pour la gestion de cette pêche. Dans le relevé Industrie-MPO du flétan à la palangre, les prises accessoires moyennes (en pourcentage du poids de toutes les espèces) ont varié de 76 à 88 % aux stations fixes et de 46 à 69 % aux stations d'indice commercial. Ces derniers chiffres seraient plus représentatifs des taux de prises accessoires de l'ensemble de la pêche.

- Selon l'industrie, les prises de flétan non déclarées ont augmenté, particulièrement en 2002.

- Dans le relevé de recherche estival du MPO, le flétan adulte affiche une faible capturabilité, ce qui donne des estimations très variables de l'abondance des adultes. Le relevé de recherche renseigne sur le recrutement prochain (poissons de moins de 81 cm) et la répartition spatiale générale. Selon ce relevé, le recrutement en 2002 était inférieur à la moyenne et a été relativement stable depuis une décennie.

- Le relevé du flétan à la palangre permet de surveiller la population de flétan. Effectué depuis cinq ans, ce relevé présente une cohérence interne (les classements des strates élevées, moyennes et basses sont cohérents, les lieux de pêche sont identifiés de manière consistante et les trajectoires de l'indice commercial et de l'indice aux stations fixes sont semblables) et une variabilité plus petite que celle observée dans la série de données obtenues par le relevé de recherche.

- Pour l'ensemble de l'aire du stock, le relevé à la palangre donne des valeurs de recrutement à la baisse en 2002. Les estimations du recrutement dans la zone SA3 sont relativement élevées pour 2001 et 2002, ce qui semble indiquer qu'il s'agit d'une zone de recrutement plus importante que ce que l'on croyait. Toutefois, la couverture du relevé dans SA3, particulièrement dans 3NO, reste problématique surtout en raison des coûts pour s'y rendre et des restrictions de gestion liées aux limites de prises accessoires de morue.

- L'indice commercial à la palangre et les estimations de la biomasse aux stations fixes (PUE) indiquent que la taille globale de la population était relativement stable de 1998 à 2002. Prises individuellement, les sous-composantes des principales zones de relevé (3Ps4VWX) semblent également stables durant cette période.

- La biomasse de la population de flétan semble relativement stable malgré les hausses de 35 % du TAC et des débarquements depuis 1998.

- La poursuite du relevé à la palangre, qui permet de bien surveiller l'état de la population de flétan, est essentielle à la gestion de cette pêche.

Background

Atlantic halibut (*Hippoglossus hippoglossus*), is the largest of the flatfishes and ranges widely over Canada's East Coast. Halibut are demersal, living on or near the bottom, at temperatures within a few degrees of 5°C. Atlantic halibut are most abundant at depths of 200-500 m in the deep-water channels running between the banks and along the edge of the continental shelf, with larger individuals moving into deeper water in winter. The management unit definition (4VWX3NOPs) was based largely on tagging results which indicated that Atlantic halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish. Migrations of larger fish were thought to be related to spawning. Studies have shown that the Browns Bank area may be an important rearing area for juvenile halibut and that there is a north-eastward movement of fish as they grow. The geographic range of Atlantic halibut in the Northwest Atlantic extends from the coast of Virginia in the south to the waters off Disko Bay, Greenland in the north. Since the early 1990s, there appears to have been a significant reduction in the numbers of halibut in the northern portion of this range, especially along Labrador Shelf.

Although the growth and maturity cycles of Atlantic halibut require further study, it appears that females grow faster than males, and attain a much larger maximum size. Females reach 50% maturity at about 115 cm, while males reach 50% maturity at about 75 cm. In the absence of reliable growth information age at maturity remains uncertain. Present fishing regulations require that all halibut less than 82cm in length be released. Halibut are voracious feeders and up to a length of 30 cm, food consists almost exclusively of invertebrates. Between 30 cm and 66 cm both invertebrates and fish are eaten while halibut over this size eat fish almost exclusively.

The halibut fishery catches halibut as part of a suite of species, which includes most notably, white hake, cusk and cod. The relative proportions of these vary with location and time of year.

The Fishery

Recommendations made by the Fisheries Resource Conservation Council resulted in increases in the TAC for this stock from 850t in 1999 to a current TAC of 1150t. Halibut landings for the 2002 fishing year totalled 1162 t (Figure 1). The bulk of landings from this stock are taken from the Scotian Shelf particularly the eastern portion (NAFO Divisions 4VW, Table 1). Long-term annual landings from this resource (1883 – 2000) have totalled approximately 1900 t.

Comments made by members of the fishing industry indicated that halibut were prevalent across all of the traditional fishing areas of the Scotian Shelf and that significant misreporting took place during the fishing year (2002).

By-catch profiles in the halibut fishery were estimated from commercial catch statistics for NAFO areas 4Vs and 4W which currently represents the bulk of the fishery. These by-catch rates are an estimate of the minimum impact of the halibut fishery on the ecosystem. It is an estimate of minimal impact because it does not take into account

additional impacts such as mortality of non-commercial species, impacts of the bait fishery, impacts on the bottom or other sources of impacts. It is recognized that by-catch rates will be specific for season, area, and gear type. It is presented to put the fishery in its broader ecological context. It shows that halibut are caught as part of a suite of species, most notably, white hake, cusk, and cod. As is the case for other fisheries, management decisions that regulate the overall take of targeted species must recognize the impact of other species caught as by-catch.

By catch profiles were also estimated from the results of the halibut long-line survey (Figure 2, see also Figure 7) and indicate that the commercial index sets consist of 40 to 50+% of halibut on average, while the fixed station sets comprise only 15 – 20% of halibut. Dogfish, white hake and cod are the most common bycatch species in the fixed station sets, while cusk and white hake make up the major portion of the bycatch in the commercial index sets.

Resource Status

Information on the annual spatial distributions and size composition of halibut as estimated from research vessel trawl surveys from 1996 – 2002 are available in Branton and Black (2002)

Research vessel (RV) summer trawl survey results are highly variable from year to year because these surveys have a low catchability for halibut.

In 1995, a number of deep-water strata (>200 fm) were added to the summer RV survey area (Figure 3) Although the survey results including these strata are not comparable to the standard RV otter trawl survey series, the estimates including these strata are higher for halibut. This reflects the relatively deep-water distribution of halibut. This new index will increase in utility as the time series lengthens.

Given the degree of inter-annual variability of halibut abundance estimates from trawl surveys it is problematic to derive any but the most general trends from the results. For the standard time series the weight per standard set in 2002 (Figure 3) is below the long-term average (1970 – 2001 = 0.18 kg) while the numbers per standard set (Figure 4) are well above the long-term average (1970 – 2001 = 0.59). A three-year running average of the time series indicates general stability in both indices over the past 7 or 8 years relative to the remainder of the series.

Fishery recruitment can be estimated from RV survey results since the modal size of halibut caught in the trawl survey is between 40 and 50 cm. The numbers of fish <81 cm caught annually provides an estimate of pre-recruits entering the fishable population. These results indicate that recruitment has been low since 1993 (Figure 5) and that the most recent estimate is slightly below average (0.18 per standard tow, 1970 - 2000). The total number of fish (<81 cm) caught each year in the halibut longline survey (fixed station sets only because of 100% observer coverage to ensure all fish are measured) indicate that numbers of pre-recruits increased from 1998 to 2001. The recruitment estimate declined in 2002 for both the RV survey and the halibut long-line survey.

Population prevalence (the degree to which halibut occupy their historic geographic range within the RV survey area) is currently slightly below average (Figure 6). **Population density** (as measured by catch per unit of effort in those locations where halibut are caught) is currently below average (Zwanenburg et al 2001).

An **industry / DFO longline halibut survey** on the Scotian Shelf and Southern Grand Banks was initiated in 1998. Five years of this survey have now been completed. The survey consists of two phases, a fixed station phase and a commercial index phase. During the fixed station phase, pre-selected locations are fished using prescribed survey fishing protocols (hook-size, number of hooks, and minimum soak times). During the commercial index phase, participants fish with their own fishing protocols and locations of their choosing (see Zwanenburg and Wilson, 2000; Zwanenburg and Wilson 2003; for detailed description of survey protocols and results).

Geographic distributions of halibut survey commercial index, and fixed station catch rates (kg per 1000 hooks and 10 hours soak time) are shown on Figure 7. Note that the most significant alteration of fixed station survey protocol occurred between 1998 and 1999 when survey sets in the approaches to the Bay of Fundy were discontinued due to high cost and very low halibut catch rates. In the commercial index phase, it has been difficult to fish Sub-Area 3. In the first years, this was the result of the strict imposition of by-catch rates for cod, which precludes the conduct of the commercial index phase. More recently it has been due to the high cost of fishing this area (long steaming time for participants). This is also affecting the fixed station phase in that boats are reluctant to undertake the expensive trip to the Grand Banks without the compensating income of the commercial index phase.

A number of estimates of abundance can be derived from the halibut survey results. All of the estimates are based on catch rates per standardised longline set. Standardised sets are defined as 1000 hooks set for 10 hours. All catch rates were adjusted to standard catch rates using

(1) Adjusted catch = (Raw catch x (1000 / Hooks set)) x (600/ Minutes soaked)

The **fixed station** portion of the survey was designed to yield a stratum-weighted estimate of mean catch rate where strata were based on the distribution of observed landings by trip for the period 1993 – 1997. Three strata were defined using high (> 250 kg), medium (50 – 249 kg) and low (<49 kg) landings. The area of each stratum was estimated using potential mapping with a radius of influence for each observation sufficient to define a stratum for all areas of the survey area. Weighted catch rate estimates were then estimated as

(2) $\sum_{i=1}^{i=3}$ (Mean standard catch for stratum i) x (area of stratum i / total area of all strata)

The overall weighted mean catch rates estimated for the entire stock area for the fixed portion of the survey show little change over the course of the survey (Figure 8). Because

Divisions 3NO, especially, were not covered consistently by the fixed station survey we also estimate the catch rate (unweighted) for the most consistently occupied survey area (4VWX3Ps). The high value for 1998 is likely due to the fact that there were only 7 observations in 3P in that year. This shows a trajectory similar to the overall index (Figure 8). Fixed station catch rates were also estimated for each stratum individually (Figure 9). These results indicate that the relative catch rates observed between strata support the original stratification in that the high catch rate strata consistently show the highest catch rates and the medium and low catch rate strata follow in order. Catch rates by stratum are also relatively consistent, especially for the last 4 years. The increase in catch rate for the low catch stratum from 1998 to 1999 was likely influenced by the exclusion of the Bay of Fundy sets (which showed very low catch rates) in 1999.

Fixed station catch rates were also estimated by NAFO Division to provide an index of abundance comparable to fishing grounds. Catch rates for NAFO Divisions 3NOP are the least well estimated in that we have the smallest number of observations in these areas and they are not consistent between years (See table below). Fixed station catch rates are not weighted because the proportion of each stratum area by NAFO Division has not been estimated.

Year	3N	3O	3P	4V	4W	4X	Total
1998	0	3	7	42	55	48	155
1999	3	25	13	22	50	49	162
2000	6	24	20	43	70	51	214
2001	6	12	21	30	68	53	190
2002	0	7	18	45	65	58	193
Total	15	71	79	182	308	259	914

Number of fixed station sets completed each year by NAFO Division.

Fixed station catch rates are consistently highest in Division 4V (Figure 10) followed by 4W and then 4X. The decrease in catch rates in 4X observed since 2000 may be due to large catches of dogfish that steal bait and saturate hooks. Dogfish have become significantly more widespread in 4X especially in 2002 (Figure 10A). Catch rates in SA3 are less well estimated with fewer sets and less consistent coverage (Figure 11) but indicated that catch rates there could be higher than in SA4. Catch rates in 3N are highest but based on relatively few observations.

Catch rates derived from **commercial index sets** are significantly higher than fixed station sets and show a similar stability for the stock area as a whole (Figure 12) over the course of the survey. Commercial index catch rates are consistently highest in NAFO Divisions 4V and 4W and lower in 4X (Figure 13). Commercial index catch rates are not well estimated for SA3 because of a paucity of observations. These results are consistent with those observed for the fixed station catch rates and support the inference that these catch rates are a reflection of underlying population abundance.

Year	3O	3P	4V	4W	4X	Total
1998	20		216	231	100	567
1999	33		213	211	38	495
2000	88		244	297	55	684
2001			211	226	78	515
2002		1	337	202	80	620
Total	141	1	1221	1167	351	2881

Number of commercial index sets completed each year by NAFO Division.

The halibut longline survey has now been in place for 5 years. Catch rates derived from the survey appear reliable in that they are relatively consistent from year to year. They show no inter-annual variations that could not be accounted for biologically (as is the case for the trawl survey estimates). They are consistent in that the relative rankings of various areas have remained similar for the entire time series (at least for the well sampled areas). They make sense in that the commercial index catch rates are consistently higher than the fixed station surveys. Given this we can place some reliance on our inferences of stock trajectory. From this we conclude that neither the commercial indices nor the fixed station indices show any significant change in population size in the past 5 years. Estimates of abundance from these surveys will continue to increase in value as the survey time series lengthens.

The halibut survey allows for a detailed estimation of **population size structure**. There are essentially three sources of information on halibut size frequency. The first are the fish measured during the fixed station phase (where all halibut are measured, including the undersized (<81cm) fish that are released). The second are fish measured during the commercial index sets where an observer was present. Again the sampling protocol states that all halibut caught are measured (including those < 81cm and discarded). The final source is from those commercial index sets where no observer was present and the fish were measured on shore for the whole trip combined. This latter source only contains information on fish over the legal limit (> 81cm), and does not provide detailed information on the location of each fish caught.

Fixed stations results do not show any obvious changes in the overall size structure of the population (Figure 14). Length-frequencies by sex for the entire stock area show the increase in numbers of fish <81cm (unsexed) from 1998 to 2001 and the subsequent decline in 2002 as observed in the RV survey series (Figure 15). Size structure in NAFO Divisions 4VW (Figure 16), which coincides with the areas of highest catch rates and where most of the fish are caught, is therefore similar to the overall stock. The size structure of Division 4X (Figure 17) indicates a greater proportion of small fish than in the eastern shelf. The size structure for SA3 (Figure 18), although based on fewer observations than SA4, indicates a relative paucity of small fish especially in 1999 and 2000 (in 1998 there were very few observations in SA3) and a significant increase in small fish in the last two years. This could be indicative of good recruitment in SA3 in the most recent 2 years.

	1998	1999	2000	2001	2002
4X	0.39	0.41	0.35	0.33	0.21
4VW	0.07	0.21	0.28	0.22	0.12
SA3	0.00	0.04	0.04	0.28	0.28

Proportion of fish <81 cm caught in fixed station sets by NAFO Divisions.

Estimates of population size structure from commercial index sets are derived from observed trips. The estimated size structure most resembles that derived from the fixed station sets in 4VW (Figure 19). This is encouraging since this is where most of the commercial sets were taken (see above). The proportion of observed commercial index sets has declined from 100% in 1998 to approximately 25% in 2002 but remains highest in the most frequently occupied fishing grounds (4VW). There is presently no observer coverage in either 4X or SA3. In SA3 this is obviously due to a lack of any commercial index activity while in 4X the reason is less obvious.

Year	3O	3P	4V	4W	4X	Total
1998	20 (1)		216 (1)	231 (1)	100 (1)	567 (1)
1999	33 (1)		91 (0.42)	35 (0.16)	6 (0.15)	165 (0.33)
2000	88 (1)		144 (0.59)	10 (0.03)	18 (0.32)	260 (0.38)
2001			77 (0.36	8 (0.04)		85 (0.16)
2002			133 (0.39)	18 (0.09)		151 (0.24)
Total	141		661	302	124	1228

Number of observed commercial index sets by NAFO Division (number in brackets is the proportion of commercial index sets observed.

We observe that the commercial index sets observed in 4VW give a nearly identical estimate of size-frequency as the fixed sets (Figure 20) indicating that the fixed stations provide a good indicator of the size frequency in the most important fishing grounds.

Sources of Uncertainty

The halibut longline survey provides a reliable indicator of the direction of change in abundance for the Scotian Shelf and Southern Grand Banks halibut population. This survey has now been in place for five years, is internally consistent and provides spatially consistent and reasonable estimates of relative population abundance over time. The survey also provides internally consistent and reliable estimates of population size structure including indications of incoming recruits. The problem remains one of estimating absolute population size, and the conversion of size structure to age structure to allow for estimation of overall mortality rates.

The traditional method of using sequential population analysis, which uses a relationship between survey abundance at age and known removals at age to reconstruct population trajectories and estimate absolute population size, is not applicable. This method will not

be applicable in the foreseeable future because of the requirement for long time series of aged removal information coupled with equally long-time series of survey estimates of abundance at age. Conversion of length structure to age structure will allow for estimation of mortality rates to help pin down fishing impacts. This work is in progress.

Outlook

Recruitment estimates from RV surveys have been relatively constant for the past decade. Numbers of pre-recruits are below average in the RV survey results for 2002 but the variability in these estimates precludes interpretation of annual results. Density and prevalence of halibut as estimated from trawl survey are currently slightly below the long-term average.

There are currently no estimates of mortality available for this stock. The first phase of a study confirming the presence of annual growth rings in halibut is now complete. This knowledge will be used to estimate halibut population age structure and **mortality rates** in future assessments**.**

According to industry sources there has been an increase in the amount of unreported halibut landed especially in 2002.

The implementation of the halibut longline survey has provided the capacity to monitor changes in **abundance and biomass** of this population. The longline survey has a much higher catchability for halibut than the RV survey and covers most of the stock area. The longline survey has now been in place for 5 years and provides internally consistent estimates of relative abundance and population size structure. The two phases of the survey cover most of the stock area although there has been some difficulty in covering the southern Grand Banks, especially 3NO. This is due to the high cost of getting to these areas by Nova Scotia based survey participants, and the strict enforcement of cod by-catch rates in SA3 which precludes conduct of the commercial index phase in this area. Since it is the latter that funds the former, it becomes economically non-viable. Measures to facilitate this coverage, by relaxing bycatch limits, would improve the survey's overall utility.

After increasing from 1998 and 2002, the halibut longline survey results show a decrease in the number of pre-recruits in 2002 for the stock as a whole. Although NAFO Division 4X shows the most consistently high estimates of pre-recruits, SA3 shows the highest proportion of recruits in 2002, however sampling of SA3, especially 3NO remains problematic.

Halibut longline survey commercial index and fixed station estimates of biomass (cpue) show a relatively stable overall population size from 1998 – 2002. Individually, the main survey areas (3Ps, 4V, 4W, and 4X) also appear stable over this period. It is not yet possible to determine absolute population size or the size of the population relative to historical abundance.

The halibut population biomass appears to be relatively stable even with a 35% increase in TAC and landings since 1998.

The continued operation of the longline survey to effectively monitor population status is essential to the management of this fishery.

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Year	Avg 1960 -69	Avg 1970 -79	Avg 1980 -89	Avg[2] 1990 -99	2000[3]	2001	2002[1]
TAC	na	na	na	1855	1000	1150	1150
3N	144	80	327	193	89	65	13
3O	490	212	390	181	92	159	138
3Pn	69	22	33	27	29	33	45
3Ps	362	196	240	113	146	261	256
3NOP Total	1065	510	990	515	356	518	452
4Vn	50	14	34	24	17	34	25
4Vs	302	147	361	177	137	153	122
4W	446	240	467	293	246	267	256
4X	666	449	699	326	228	271	296
5ZE	183	66	87	29	6	11	10
4VWX5ZE Total	1647	916	1648	850	634	736	709
TOTAL	2713	1426	2626	1355	989	1255	1162

Table 1. Reported landings (tonnes) of halibut on the Scotian Shelf and Southern Grand Banks.

1. Landings as of April 09, 2003
2. Landings prior to 1999 based on Jan-Dec calendar year
3. Landings 1999 based on 15 month Jan 1999 - Mar 2000 year
4. Landings for 2000 onwards are based on April-Mar fishing year

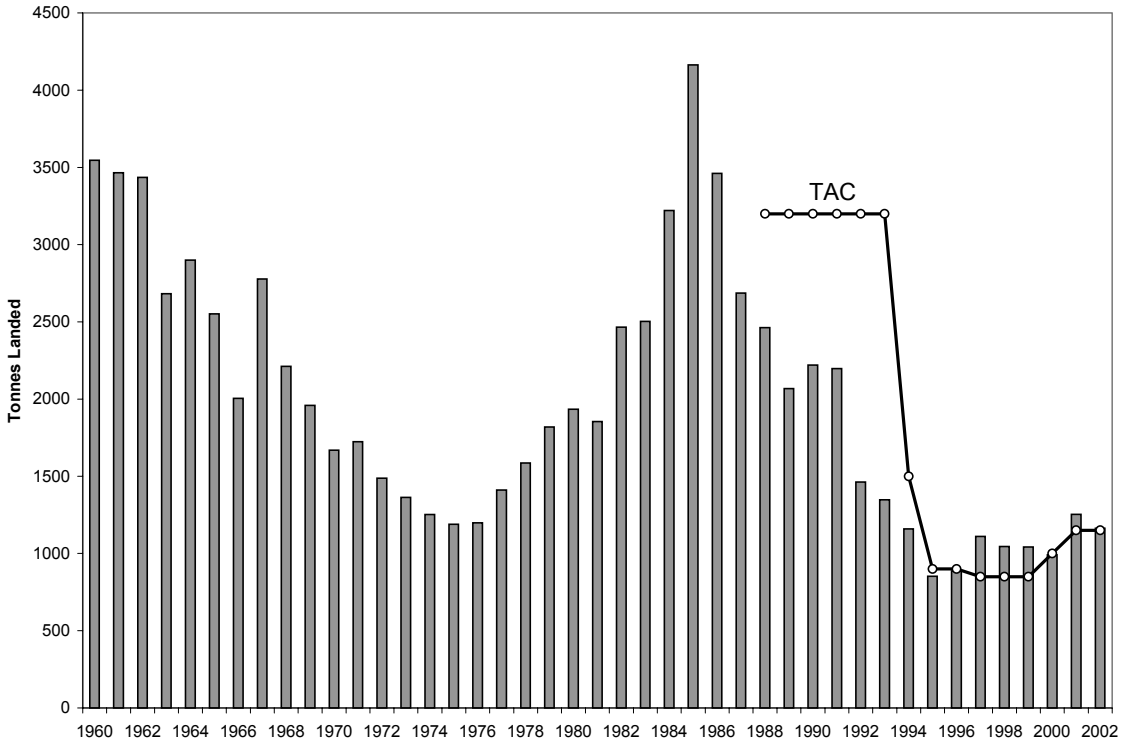

Figure 1. Landings and TACs for Scotian Shelf and Southern Grand Banks halibut.

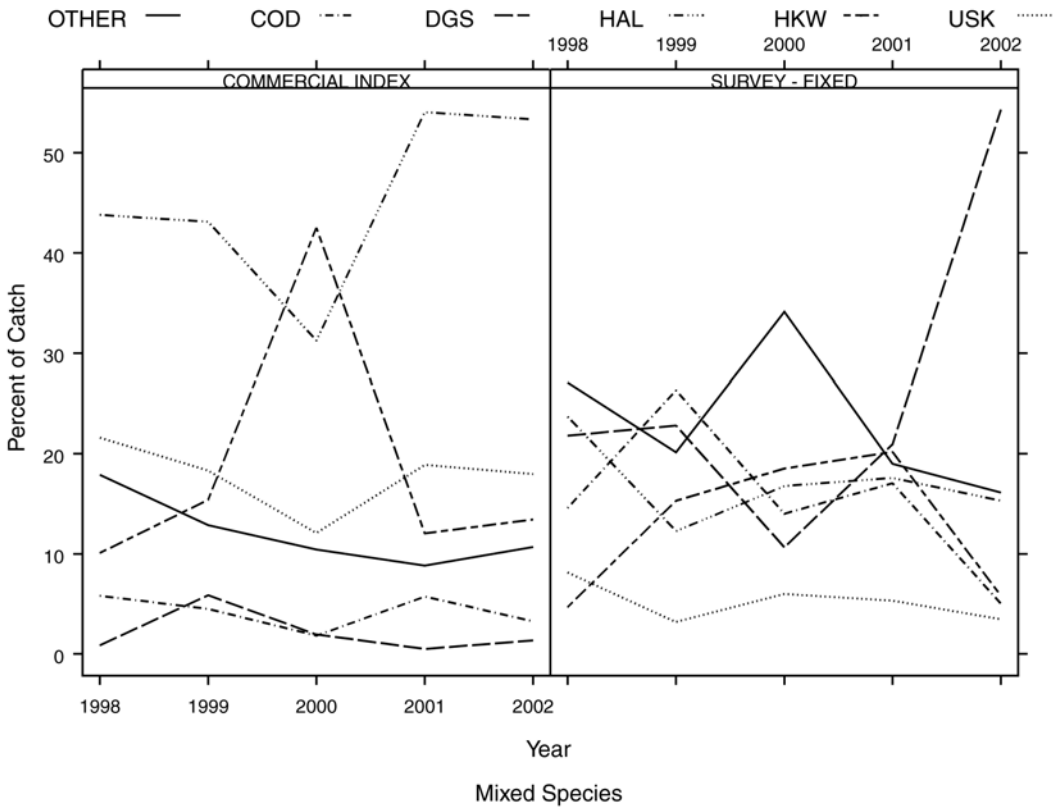

Figure 2. Catch profiles for the commercial index and fixed station index portions of the Scotian Shelf Southern Grand Banks halibut longline survey. The lines represent the proportions (by weight) that each of the indicated species comprise of the average total catch per standard set in that year. (Cod = cod, DGS = Spiny dogfish, HAL = Atlantic halibut, HKW = White hake, and USK = Cusk)

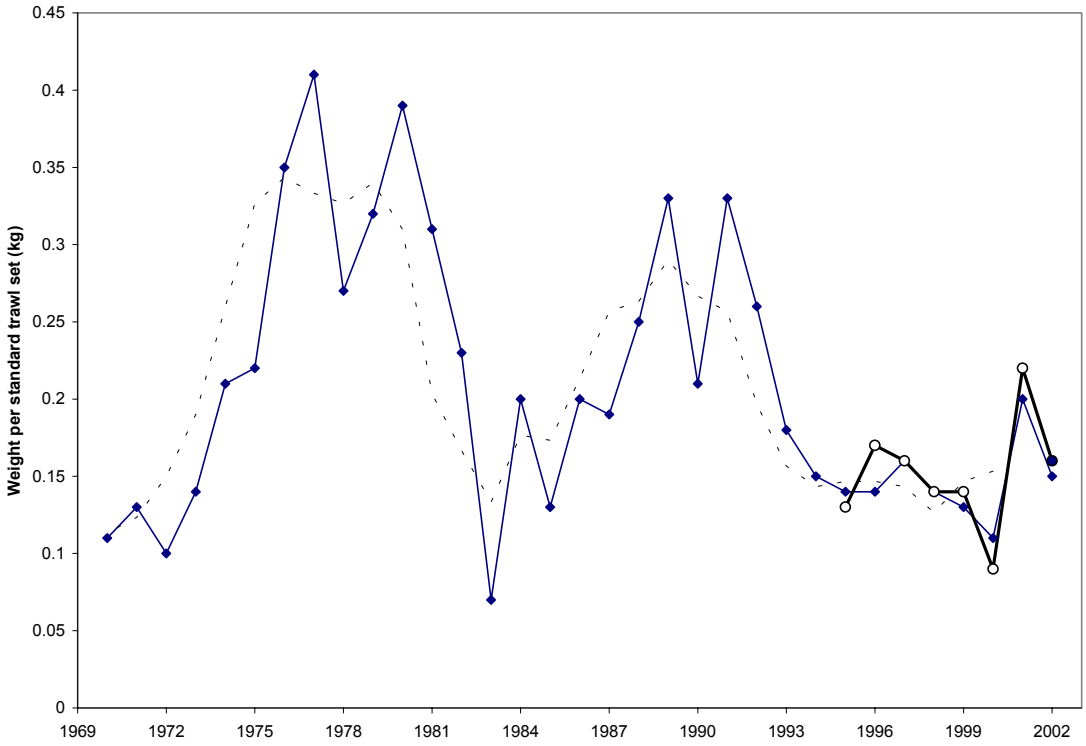

Figure 3. Summer trawl survey weight per standard set. Closed diamonds represent results for the standard survey strata in place since 1970, while the open circles show the impact of including a number of deepwater strata along the Scotian Slope (implemented in 1995). The dashed (or dark in print) line is a 3-year running mean of the standard survey estimates to illustrate general trends.

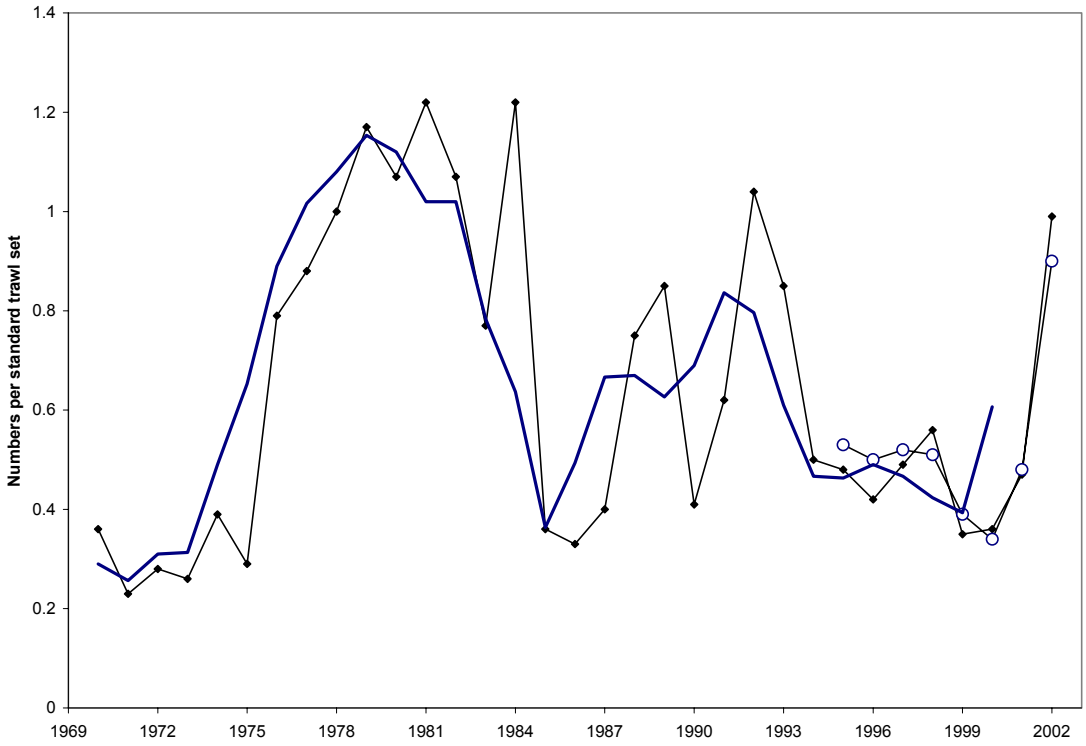

Figure 4. Summer trawl survey numbers per standard set. Closed diamonds represent results for the standard survey strata in place since 1970, while the open circles show the impact of including a number of deepwater strata along the Scotian Slope (implemented in 1995). The dashed (or dark in print) line is a 3-year running mean of the standard survey estimates to illustrate general trends.

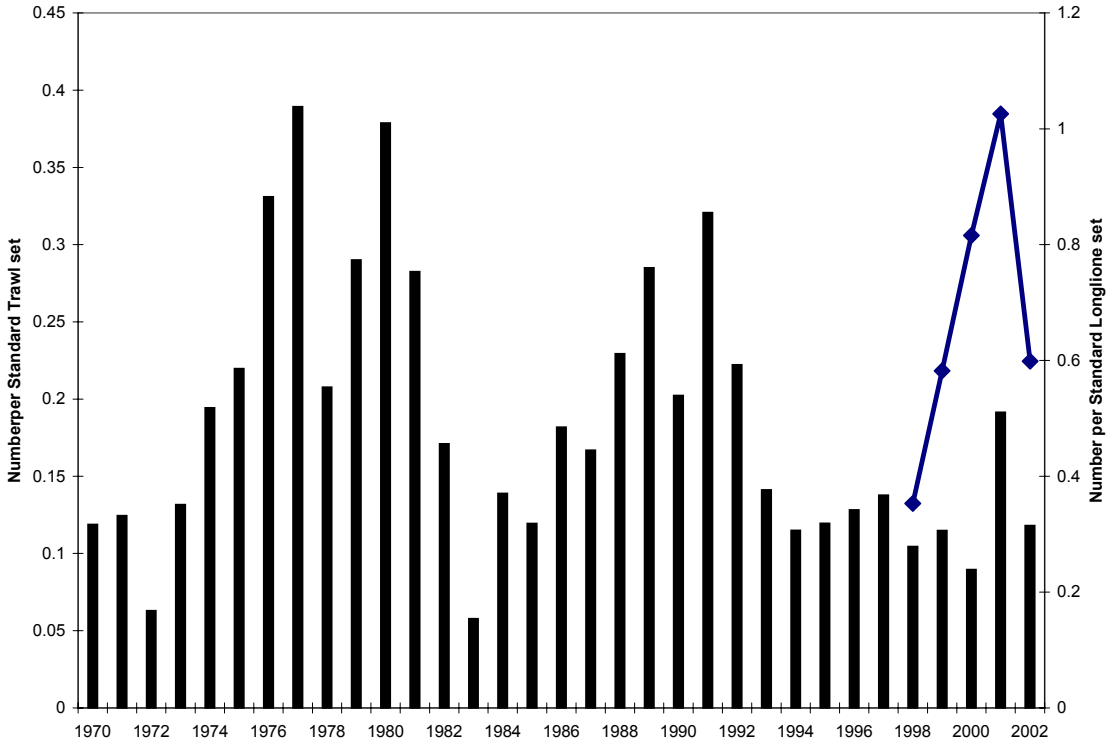

Figure 5. Halibut recruitment indices expressed as number of fish < 81 cm caught per standard tow (bars) or numbers per standard longline set (per 1000 hooks per 10 hours).

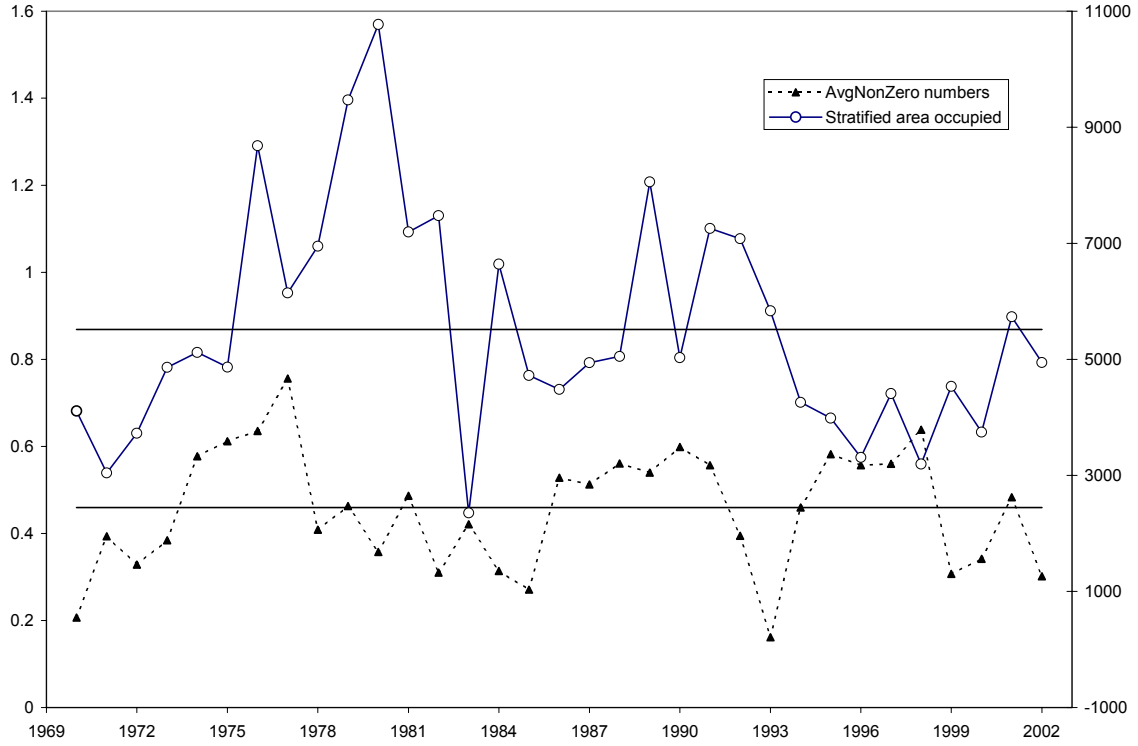

Figure 6. Measures of halibut population distribution. The solid triangles show the local density of halibut as encountered by the summer RV survey, estimated as the average number of halibut caught whenever halibut are encountered (average of all non-zero catches within a year). The open circles represent the proportion of stratified estimate of non-zero sets observed each year by the summer trawl survey. For each series the solid horizontal line represent the time series average (1970 – 2001).

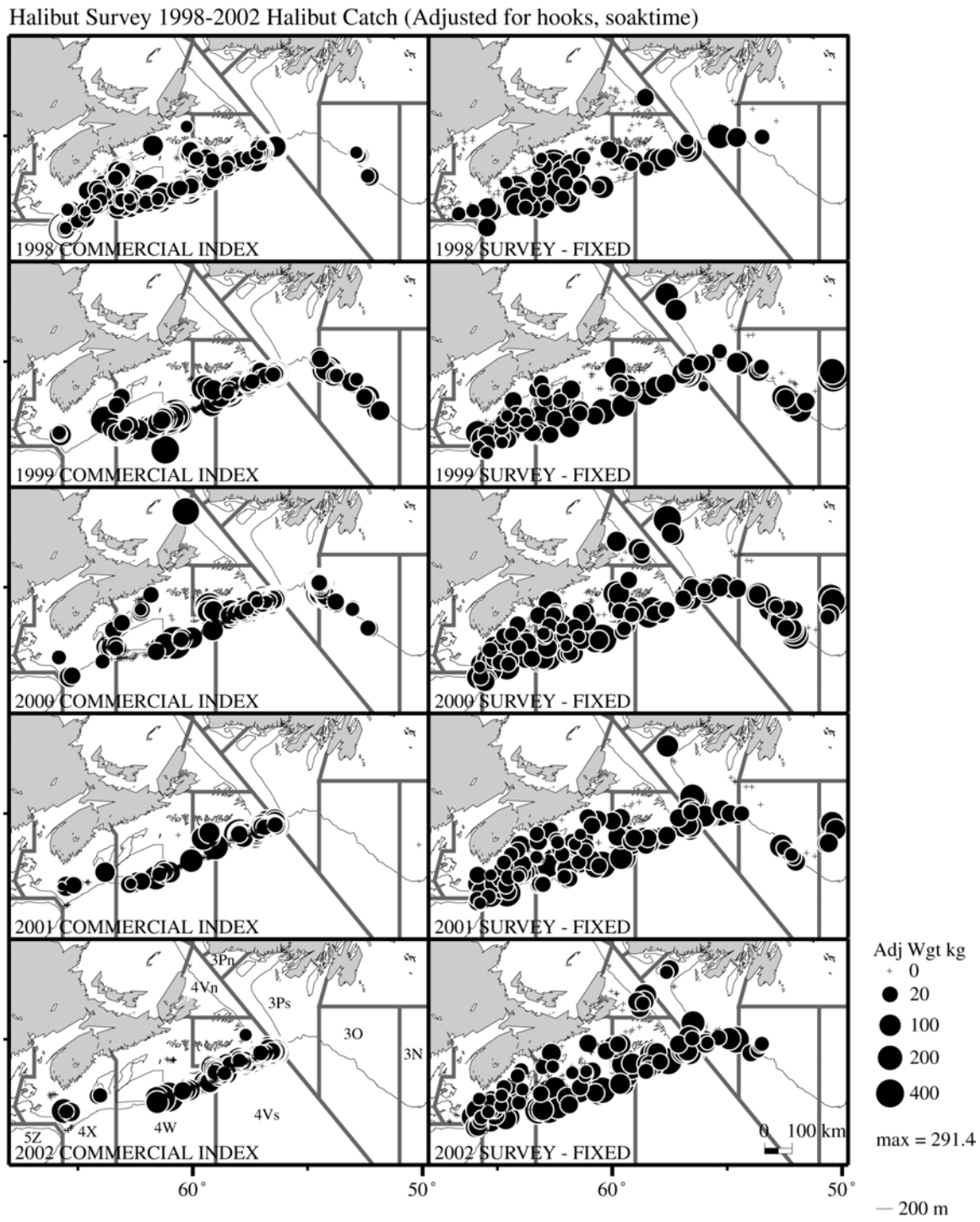

Figure 7 Standardized (kg per 1000 hooks per 10 hours) catch rates from the fixed station and commercial index portions of the halibut longline survey

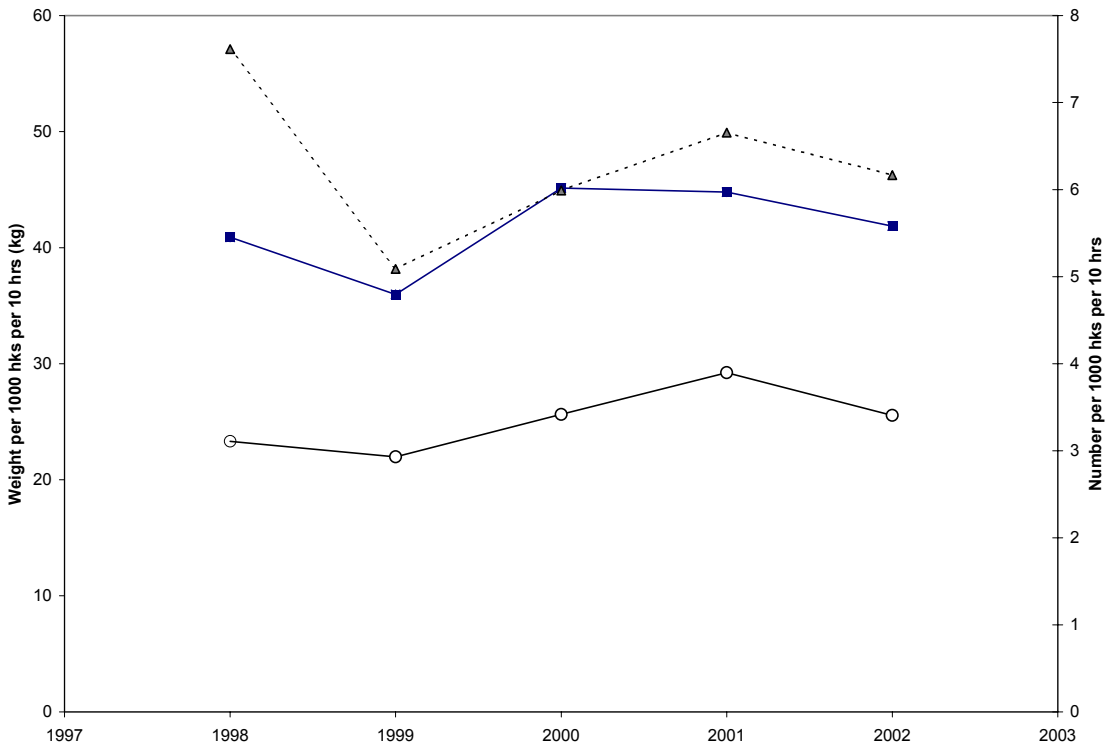

Figure 8. Stratum weighted estimate of average weight (solid squares) and number (open circles) of halibut caught (per standard long-line set) annually during the Scotian Shelf and Southern Grand Banks halibut longline survey. The solid triangles are the estimates of unweighted average weight caught in that portion of the survey most consistently occupied (4VWX3Ps).

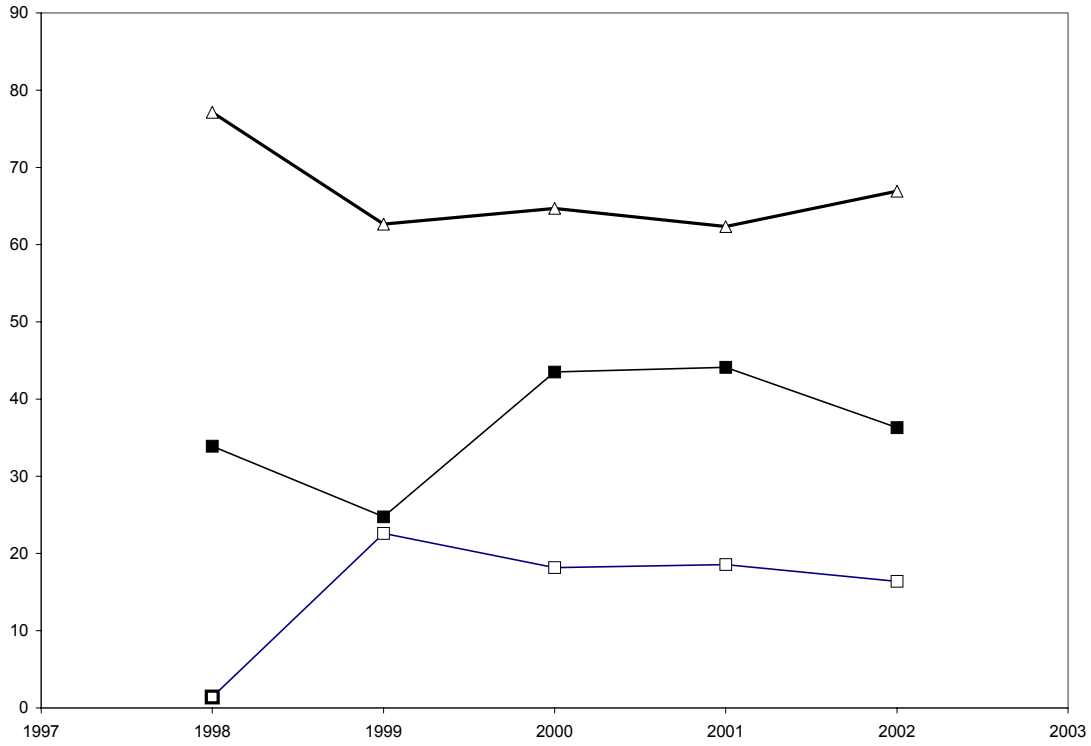

Figure 9. Average catch by stratum (open triangles = 3, ■ = 2, open squares = 1) from the fixed station portion of the halibut survey. Note that for stratum 1 a number of sets in the Bay of Fundy, used in 1998, were abandoned for subsequent years.

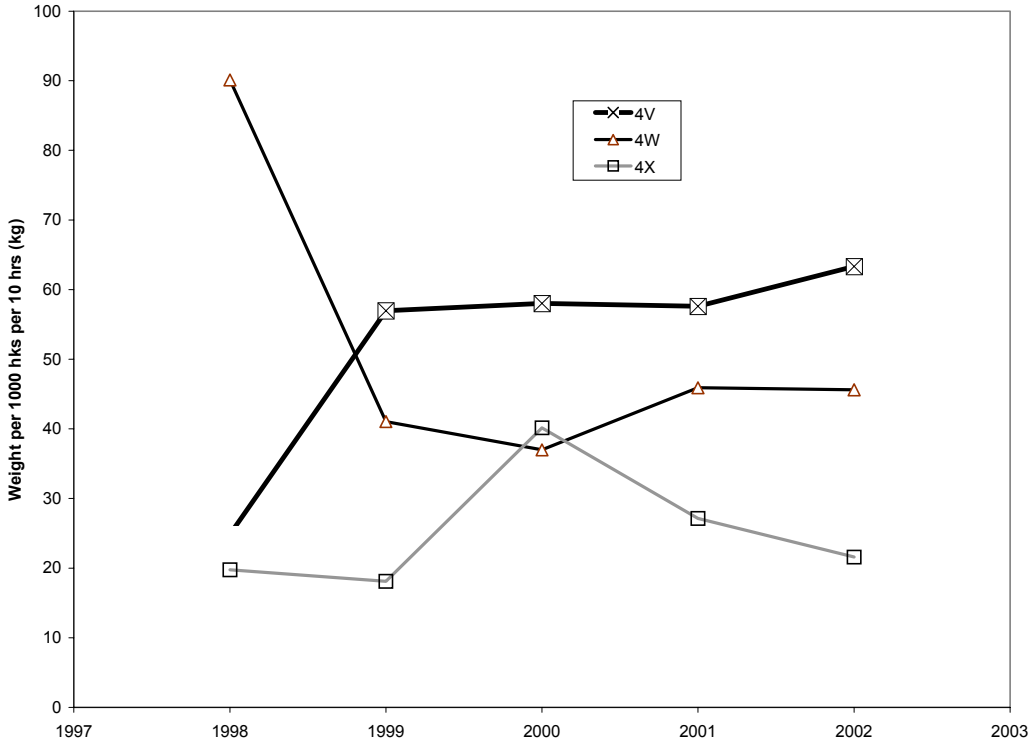

Figure 10. Halibut survey fixed station catch rates by NAFO Division for the Scotian Shelf.

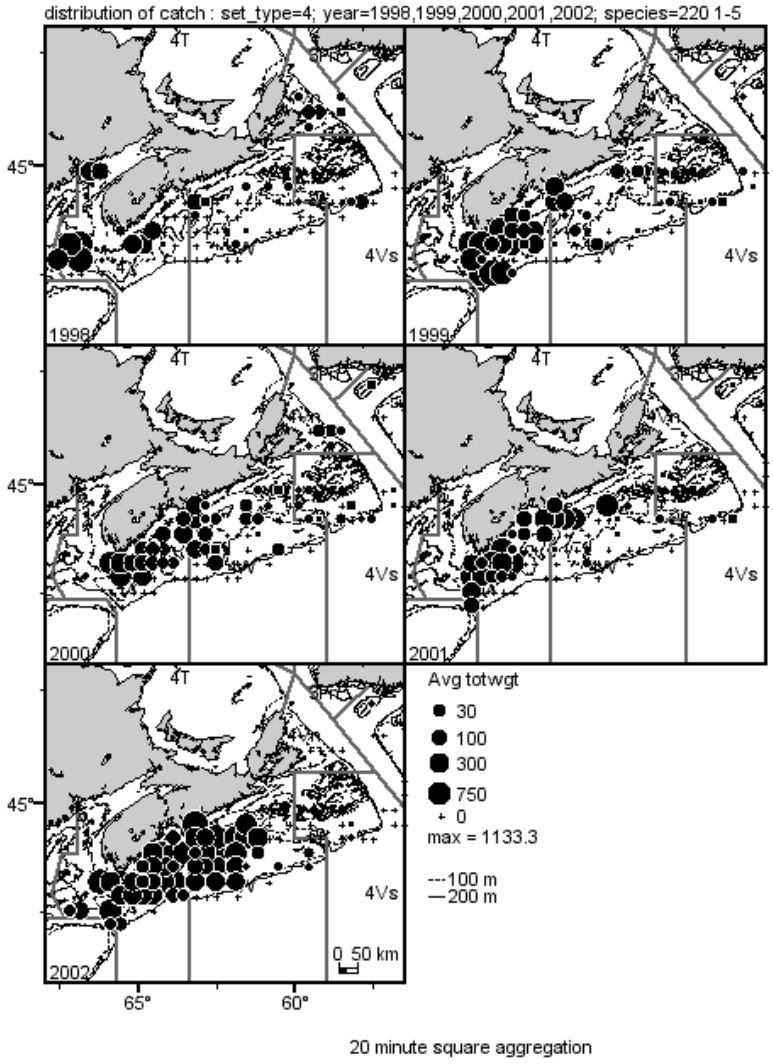

Figure 10A. Distribution and catch rates of spiny dogfish (*Sqaulus acanthias*) from halibut longline fixed station sets.

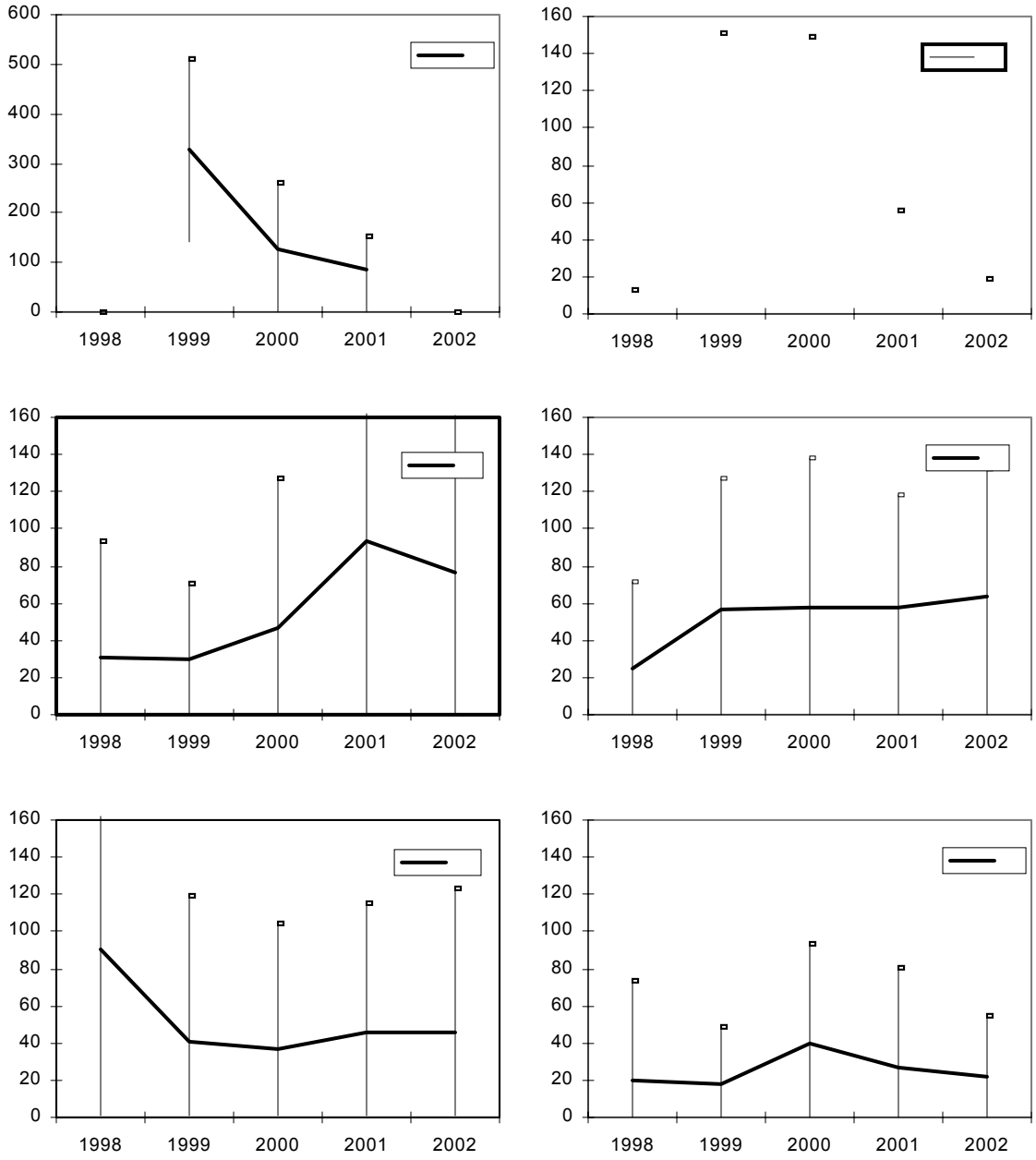

Figure 11. Halibut survey fixed station catch rates by NAFO Division. For each division the vertical lines represent 1 standard deviation above and below the mean (truncated to 0).

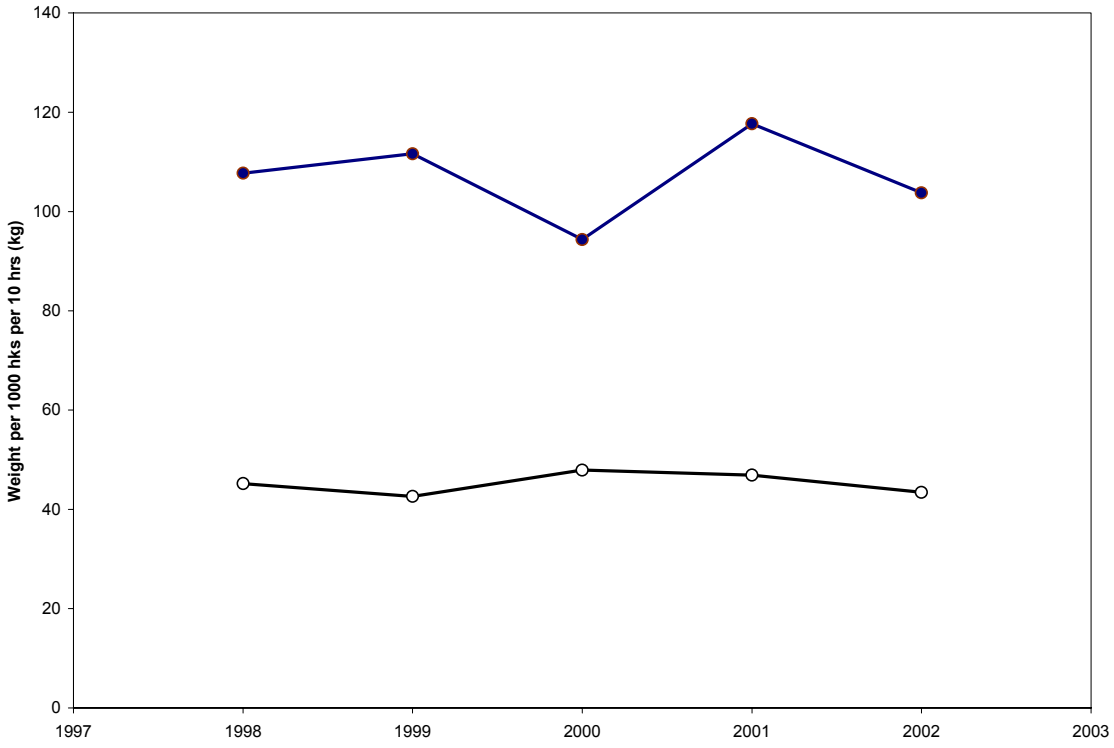

Figure 12. Average (unweighted) weight caught by the halibut long-line survey commercial index (closed circles) and fixed station (open circles) sets.

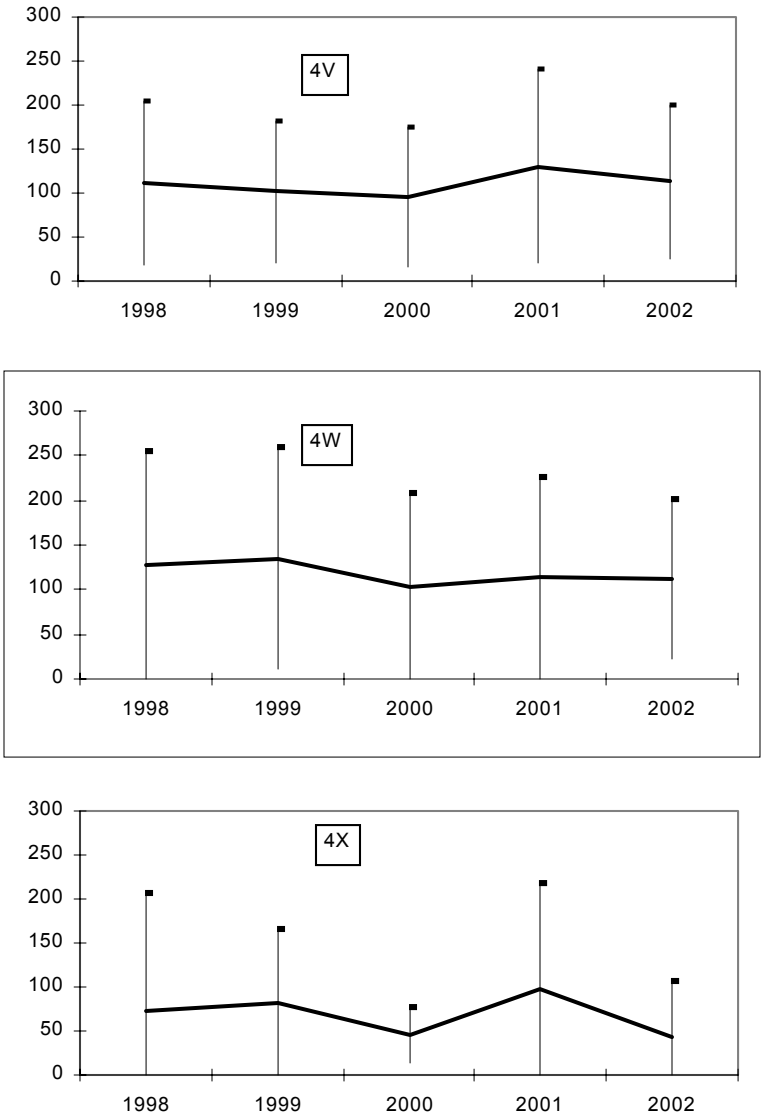

Figure. 13. Halibut survey commercial index catch rates by NAFO Division for the Scotian Shelf. Bars for each annual value represent 1 standard deviation.

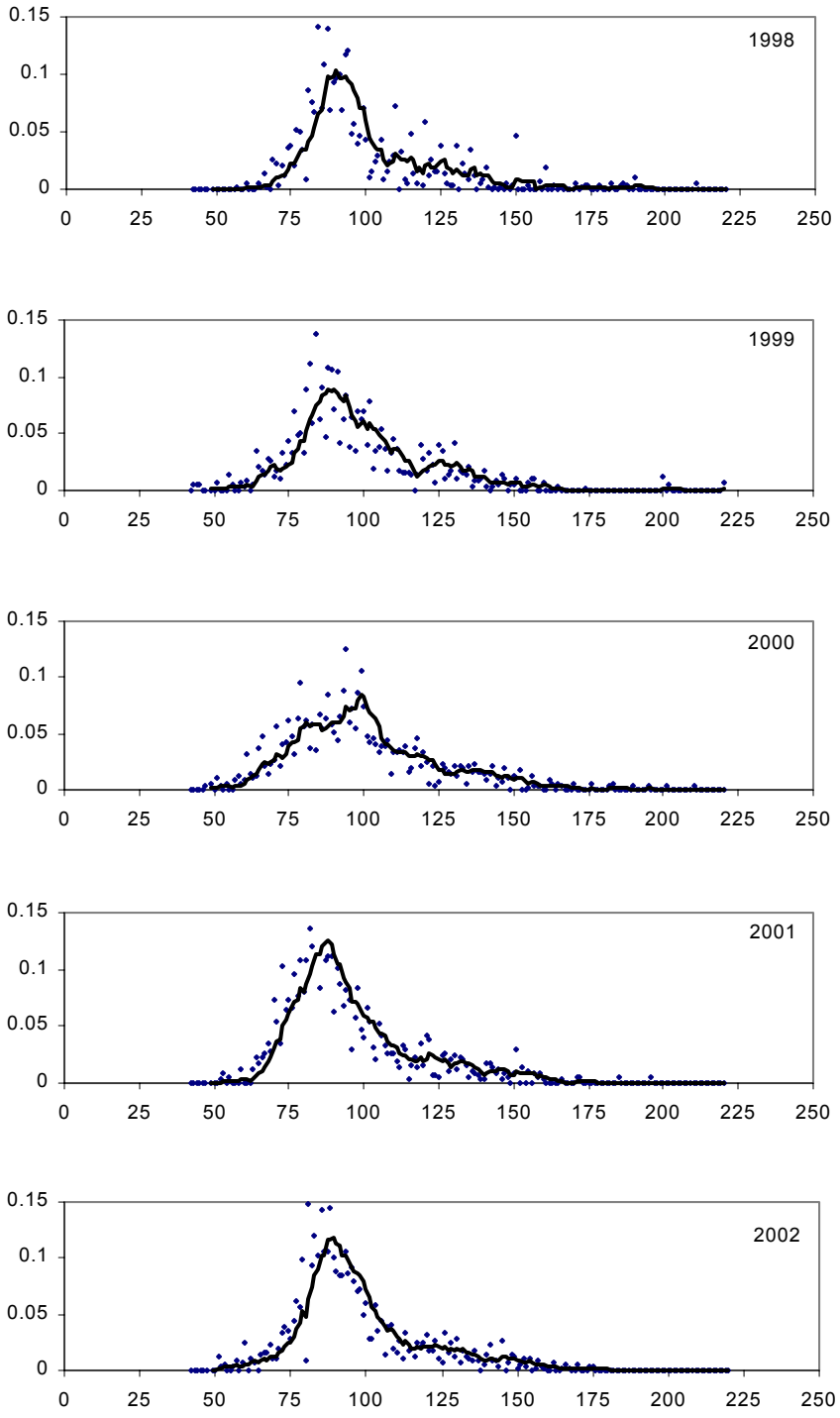

Figure 14. Size frequency (average numbers per 1000 hooks per 10 hrs) of halibut caught in the fixed station portion of the halibut longline survey. The diamonds represent the average numbers at each length group while the line is a 7-length group running average.

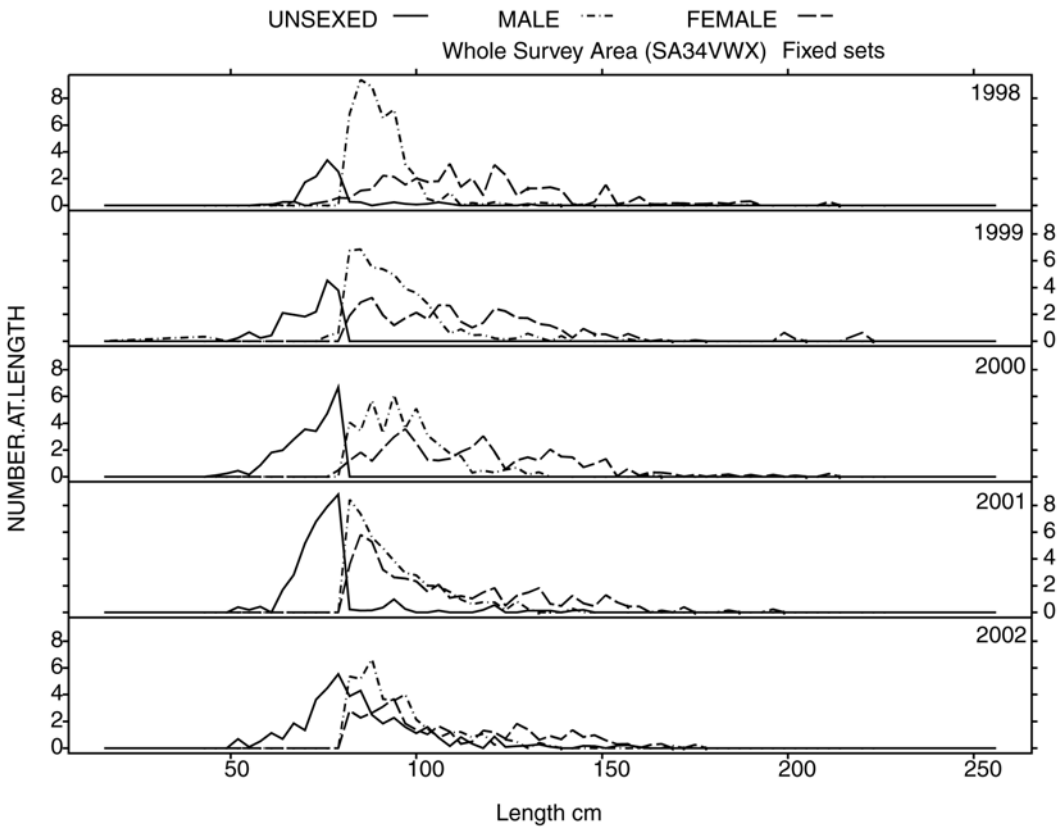

Figure 15. Size frequency by sex of halibut caught (average number per 1000 hooks per 10 hours) during the fixed station portion of the halibut longline survey (whole survey area). Note numbers have been multiplied by 100).

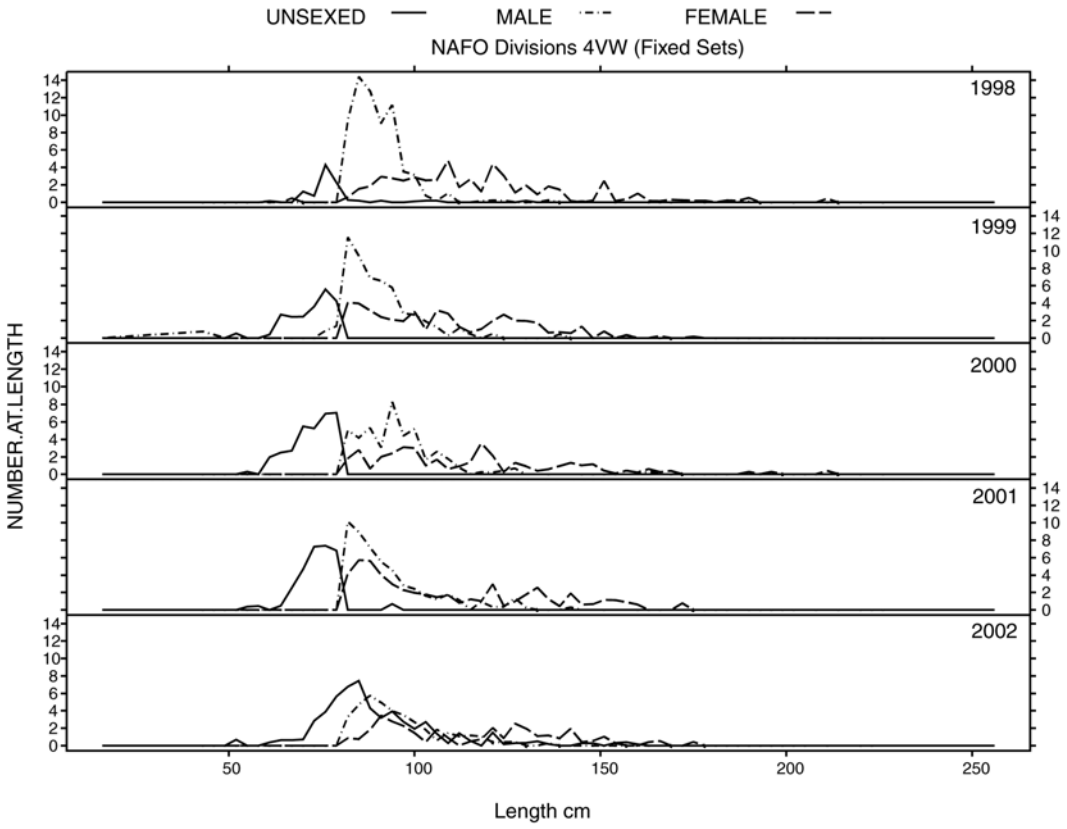

Figure 16. Size frequency by sex of halibut caught (average numbers per 1000 hooks per 10 hours) during the fixed station portion of the halibut longline survey (NAFO Divisions 4VW). Note numbers have been multiplied by 100).

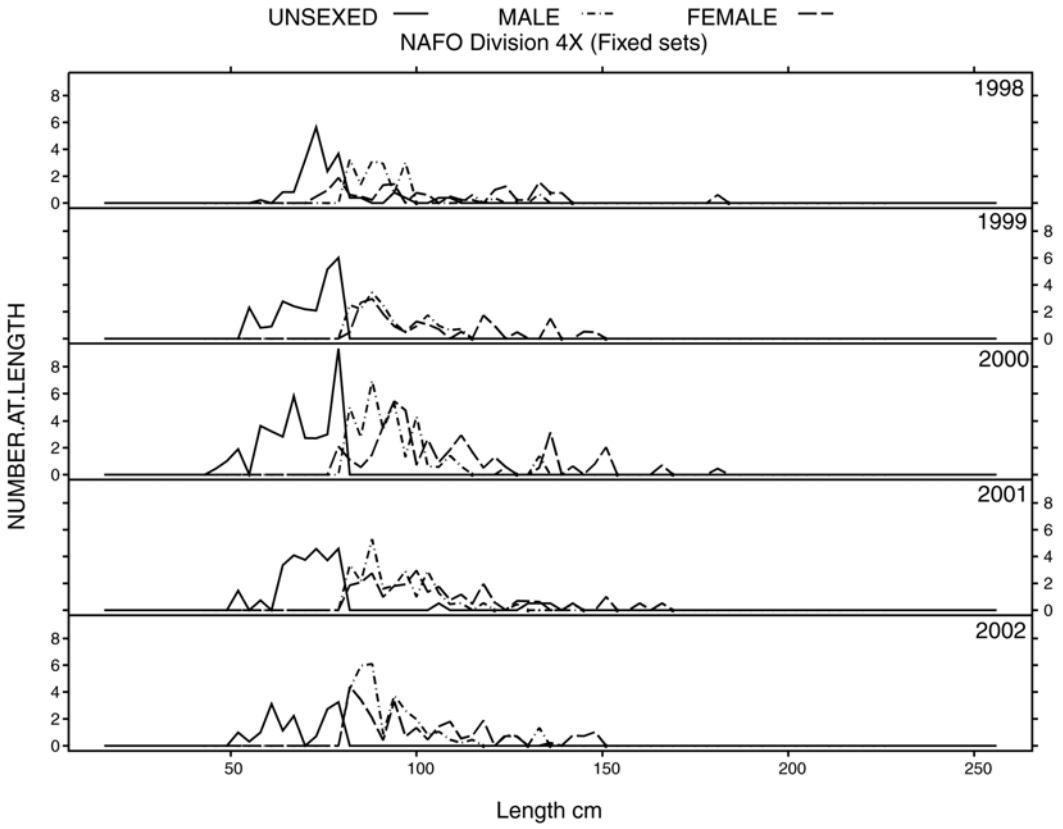

Figure 17. Size frequency by sex of halibut caught (average number per 1000 hooks per 10 hours) during the fixed station portion of the halibut longline survey (NAFO Division 4X). Note numbers have been multiplied by 100).

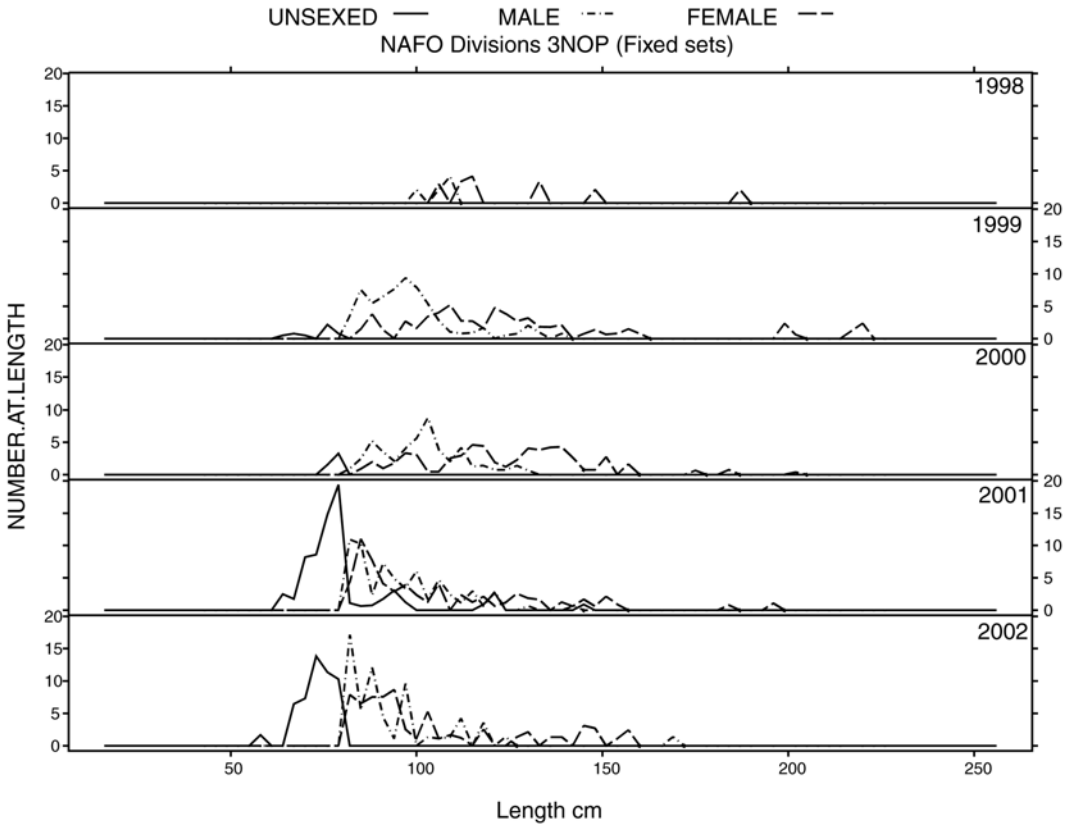

Figure 18. Size frequency by sex of halibut caught (average number per 1000 hooks per 10 hours) during the fixed station portion of the halibut longline survey (NAFO Divisions 3NOP). Note numbers have been multiplied by 100).

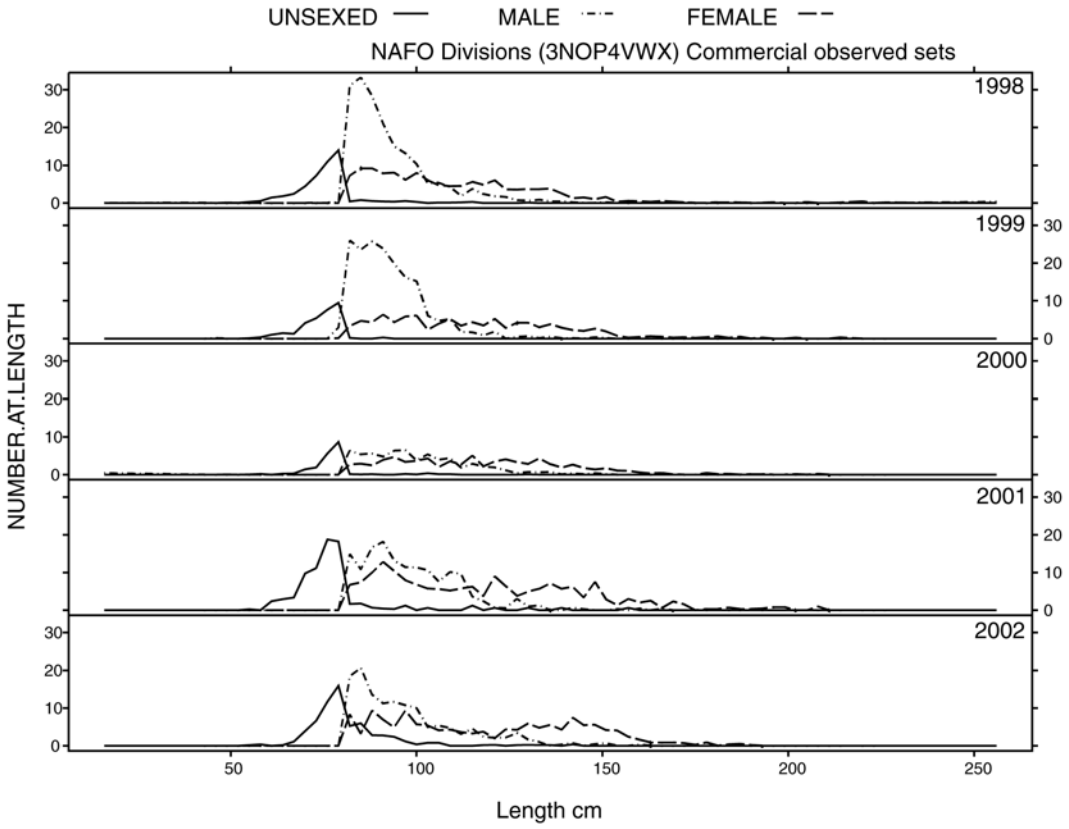

Figure 19. Size frequency by sex of halibut caught (average number per 1000 hooks per 10 hrs) during the observed commercial index (set type 7057) portion of the halibut longline survey. Note numbers have been multiplied by 100).

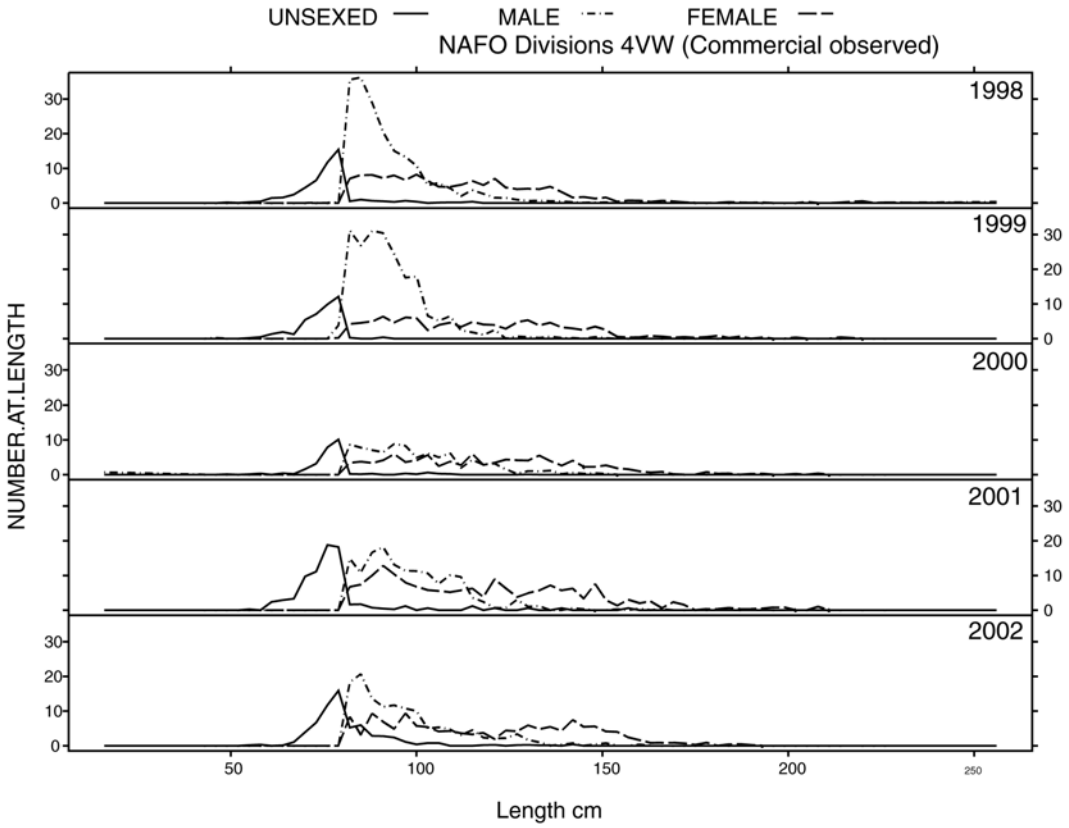

Figure 20. Size frequency by sex of halibut caught (number per 1000 hooks per 10 hours) during the commercial index portion (observed sets) of the halibut longline survey for NAFO Divisions 4VW. Note the numbers have been multiplies by 100.