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**Assessment of the Scotian Shelf silver  
hake population through 2009**

**Évaluation de la population du merlu  
argenté du plateau néo-écossais d'après  
les données recueillies jusqu'à 2009**

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**ABSTRACT**

The last complete assessment of Scotian Shelf silver hake (*Merluccius bilinearis*) was conducted in 2005 and included data to 2005. This assessment includes new information from the commercial fishery and research cruises from 2006 to 2009. Attributes of stock status are generally poor. Survey biomass remains at or near the lowest in the times series. Growth at present is poor, with condition and length-at-age below long-term averages. However, some improvement has been seen in condition and weight-at-age. Total mortality (Z), on ages 2-4 and older fish has been variable, but Z on age 1 fish has increased in recent years. The 2002, 2004 and 2005 year classes were above average, sustained the fishery at ages 1 and 2, but did not result in an increase in biomass. Recent year classes (2006-2008) have been near average, and commercial catch rates may become lower as a result, as well as a decline in abundance at older ages. This exploitation pattern of the Scotian Shelf silver hake fishery may be unsustainable and efforts should be made to reduce the proportion of age 1 fish in the catch through gear modifications or area closures.

**RÉSUMÉ**

La dernière évaluation complète du merlu argenté du plateau néo-écossais a été réalisée en 2005 et comprenait des données d'années antérieures (jusqu'à 2005). La présente évaluation comprend de nouvelles données sur la pêche commerciale et sur les relevés effectués entre 2006 et 2009. En général, les caractéristiques de l'état des stocks sont mauvaises. La biomasse du relevé demeure à son niveau le plus bas de la série chronologique ou près de son niveau le plus bas. À l'heure actuelle, la croissance est mauvaise, puisque la condition et la longueur selon l'âge sont inférieures aux moyennes à long terme. Toutefois, une amélioration a été observée dans la condition et le poids selon l'âge. La mortalité totale (Z) pour les poissons de 2 à 4 ans et les poissons plus âgés a été variable, mais la mortalité totale des poissons âgés d'un an a augmenté au cours des dernières années. Les classes d'âge de 2002, 2004 et 2005 étaient supérieures à la moyenne, ont soutenu les pêches pour les poissons de 1 et 2 ans, mais n'ont pas entraîné d'augmentation de la biomasse. Les classes d'âge récentes (2006 à 2008) ont été près de la moyenne, et par conséquent, il est possible que les taux de captures commerciales diminuent, et que l'abondance à des âges plus avancés diminue. Ce régime d'exploitation du merlu argenté du plateau néo-écossais pourrait ne pas être durable, et des efforts devraient être déployés pour réduire la proportion de poissons d'un an capturés (par l'intermédiaire de modifications des engins ou de la fermeture de certaines zones).



## BIOLOGY

Silver hake (*Merluccius bilinearis*) is a bottom dwelling member of the gadoid family, found from Cape Hatteras to the Grand Banks and the Gulf of St. Lawrence. A population of silver hake occurs on the Scotian Shelf.

Scotian Shelf silver hake are generally found in water between 7 and 10° C, in deeper water on the shelf edge and in the Emerald and LaHave basins. Seasonal movements occur during the summer, as silver hake move into shallow water on Sable and Western banks to spawn. Silver hake feed primarily on invertebrates, with euphausiids the predominant prey item. Older fish are piscivorous and exhibit a high degree of cannibalism.

Silver hake exhibit relatively rapid growth with females growing faster than males. Maximum age is 12 years. Maturity is relatively early, with a majority maturing at age 2.

## THE FISHERY

The silver hake fishery has been conducted on the Scotian Shelf (NAFO [North Atlantic Fisheries Organization] Divisions 4VWX, Figure 1) since the mid-1960's, primarily by the distant water fleets of Russia, Cuba and Japan in the early years. Prior to 1977, fishing on the Scotian Shelf was unrestricted in terms of area, mesh size and season. During this period, fishing was conducted over the entire shelf, and the use of trawl mesh as small as 40 mm was common. Following the extension of jurisdiction to 200 miles by coastal states in 1977, Canada implemented the *Coastal Fisheries Protection Act*, which restricted fishing for this species to the seaward side of the Small Mesh Gear Line (SMGL, Figure 2), west of 60° W longitude, with a minimum mesh size of 60 mm. On an experimental basis, a portion (4-6 vessels) of the fleet was allowed to fish landward of the SMGL during 1978 and 1979. From 1980 through 1983, fishing was permitted by condition of license in an eastern extension of the Silver Hake Box as far as 57° W longitude; from 1984 to present, this eastern extension has been restricted to 59° W longitude. In 1994, further restrictions were introduced to minimize incidental catches of cod, haddock and pollock in the silver hake fishery. These included a repositioning of the SMGL to prevent fishing in depths less than 190 m (Branton, 1998) and the use of a separator grate with 40 mm bar spacing in the lengthening piece of the trawl.

Foreign vessel participation in the silver hake fishery, either through national allocations or Canadian charter agreements, declined through the 1990's, and ended in 2004.

Canadian fishing interests have engaged in experimental harvesting of this species since 1975, although until 1995 these efforts were developmental in nature (Showell and Cooper, 1997). From 1995 to present, a commercial fishery has been conducted by the Canadian tonnage class 3 (< 65') mobile gear fleet in and around Emerald and LaHave basins (Figure 2). Concern was expressed over the harvesting of small fish in these inshore areas, and experimental evidence suggested a change to 55 mm square mesh would be effective in releasing small silver hake (Cooper, 1995). As a result, 55 mm square mesh, rather than the traditional 60 mm diamond, was made mandatory in 1999. Initially, a topside chafer was required to support the codend during haulback, as the tensile strength of the twine used to manufacture the square mesh was lower than that of traditional diamond mesh. It was recognized that gear configured in this manner had the potential to block the meshes, thus mitigating the benefits of the square mesh. To address this, a codend composed of stronger twine was designed, and from 2000 onwards topside chaffers have not been used in this fishery.

Nominal catches from this stock ranged from nearly 300,000 tons in 1973 to under 8,000 tons in 1994 (Table 1). Catches by the foreign fleet were generally high during the mid- to late 1980's, with catches in recent years much lower (Table 1, Figure 3). As the inshore Canadian fishery has developed, proportions of the catch harvested by the inshore (Basin) and offshore (Slope) fleet components have changed, and since 1998 the catch by the inshore fleet has exceeded that of the offshore (Figure 4).

Recent Total Allowable Catches (TACs) and landed catches ('000 tons) are as follows:

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TAC	20	20	20	15	15	15	15	15	15	15
Canada	12.9	18.0	16.7	12.8	12.9	11.8	12.8	12.3	12.1	
Foreign	0	0	0	0	0	0	0	0	0	
Total	12.9	18.0	16.7	12.8	12.9	11.8	12.8	12.3	12.1	

### REMOVALS AT AGE AND SIZE AND WEIGHTS-AT-AGE

While no foreign allocations of silver hake have been made since 1997, the fishery is conducted by two distinct fleets - Canadian flag vessels < 65' fishing in or near to Emerald and LaHave basins, and Cuban flagged tonnage class 7 vessels fishing seaward of the SMGL line under charter arrangements with Canadian partners. Several changes to the SMGL and numerous temporary exemptions have occurred since 1994 to accommodate the Cuban fleet in this area. Details of these changes can be found in Branton (1998).

Sampling for length composition and ageing material from silver hake directed trips from 2005 to 2008 was conducted by both Canadian at-sea observers, as well as Department of Fisheries and Oceans (DFO) and Industry shore samplers. The commercial removals at age were calculated using the standard Population Ecology Division Catch-at-Age application, uncultured length frequency data and quarterly age/length keys, by sex. Regressions of lengths with weights from the Canadian July groundfish research vessel survey were used to calculate yearly alphas (intercepts) and betas (slopes) by sex (Table 2) used in the calculation of length frequency based commercial sample weights and commercial mean weight-at-age. In one case, first quarter foreign catches were added to those of the Canadian fleet as the catch was small and sampling was limited (Table 3). Results from 2003 to 2008 are presented in Table 4.

The removals at age for 1977-2004 were taken from the previous assessment (Showell *et al.*, 2005) to provide estimates for the period 1977-2008 inclusive (Table 5).

The age groups on which the fishery is conducted have changed over time. Until the late 1980's, most of the catch was ages 3 and 4 fish. From 1990 to 1998, the catch shifted to age 2 and 3 year olds, and since 1999 a high proportion of the catch has been age 1 fish (Figure 5, Figure 6). Since 1999, most of the catch of 1 and 2 year old fish have been taken by the Canadian fleet (Figure 7) fishing primarily in Emerald and LaHave basins.

Commercial mean weight-at-age was calculated for the same periods as the catch-at-age for each fleet, weighted by monthly catches, prior to 1999, and quarterly from 1999 onward. An aggregate mean weight-at-age was then calculated, weighting by the catches of each fleet (Table 6). As has been noted in the past for this stock, commercial mean weight-at-age declined from 1977 to 1994, but has stayed relatively stable at a lower level in subsequent years (Figure 8).



## RESEARCH VESSEL SURVEYS

A stratified random design groundfish research vessel (RV) survey has been conducted on the Scotian Shelf (Figure 9) from 1970 using three Canadian research vessels (*A.T. Cameron*, *Lady Hammond* and the CCGS *Alfred Needler*). Based on an analysis of comparative fishing experiments by Fanning (1985) a conversion factor of 2.3 is applied to the abundance series prior to 1982 to account for the effect of vessel and gear changes between the *A.T. Cameron* and the other two vessels. The same conversion factor was used to adjust biomass estimates. No conversion factor is required between the *Lady Hammond* and the CCGS *Alfred Needler* for this period. The survey was conducted by the CCGS *Teleost* in 2004 and 2007. An analysis of comparative fishing experiments showed no conversion factor was required between the two vessels for silver hake (Fowler and Showell, 2009).

Silver hake found in the Bay of Fundy area likely represent a portion of the Gulf of Maine/Northern Georges Bank silver hake stock, rather than the Scotian Shelf stock (Showell, 1998). As was the case in the previous assessment of this resource, survey trends in both total numbers and biomass were therefore calculated for the Scotian Shelf portion of 4VWX only, excluding strata 484 through 495 (Figure 9).

Survey trends in both numbers and biomass show relatively high abundance in the early to mid-1980's, followed by a decline to relatively low levels over the period 1988-94 (Figure 10, Table 7). Abundance and biomass increased in 1995 and 1996, but declined subsequently, particularly in the case of biomass. Recently 2+ biomass, approximating Spawning Stock Biomass (SSB), has been at the lowest levels in the times series since 2002, with the exception of 2004 (Figure 11).

Numbers-at-age for the Scotian Shelf strata only are presented in Table 8 and Figure 12.

## INDUSTRY SURVEY

A standardized groundfish survey has been conducted in 4X by the Individual Transferable Quota (ITQ) mobile gear < 65' fleet since 1995, with sampling since 1996 considered appropriate for abundance estimates. While this survey does not cover the entire stock area for silver hake, it does cover areas in 4X that are not accessible to the Canadian July groundfish research vessel survey (Figure 13), and can provide an additional useful index of abundance, despite the relatively small number of years for which it has been conducted. The survey shows a declining trend in both numbers and biomass from 1999 to 2002, increased between 2002 and 2004, but dropped sharply in 2005 and has remained stable at a lower level subsequently (Figure 14, Table 9). A comparison of ITQ numbers per tow (strata 484-495 excluded) to the July RV total numbers is presented in Figure 15. There is some correspondence between the two indices until 2004, but less so from 2005 to 2009.

## COMMERCIAL CATCH RATES

As in the previous assessment Showell *et al.*, 2005), an analyses of deviance using a generalized linear modeling approach with S-Plus 6.1 was conducted to determine magnitudes of influence of year, month and area on commercial catch rates of Canadian silver hake fishers. Catch-per-unit-effort (CPUE) was calculated as sub-trip tons per fishing day, with the model output predicted catch rates on an annual basis. Preliminary studies were used to examine an extension to the area scheme distinguishing slope and basin fishery locations. NAFO areas

were found to mostly subsume any potential for slope/basin effects, so the NAFO zones were retained as the only area factor. After these preliminary studies, the data were restricted to NAFO unit areas 4Whk14Xmn, the dominant locales of the fishery, and to boats with at least five years experience in the fishery. This latter restriction, intended to reduce the potential for the learning curves of more recent entrants to the fishery to confuse results, left 28 of the 54 Canadian boats known to prosecute this fishery. These 28 boats were considered index fishers.

The index fishers were themselves included as factors in the base model. This explicitly quantifies the intrinsic differences in catch rates between individual boats, this component of the variance being accounted for before attributing variance to other factors (year, month, area). Variable sequencing among year, month and area in models was determined by comparing Akaike Information Criteria (AIC) for different models, which uses  $\chi^2$  tests to determine the best fit from a set of possible models. The relative ranking of a given factor, in terms of explanatory power, is estimated by inclusion in and exclusion from iterative series of possible models, with calculation of AIC statistics, to achieve the likeliest hierarchy of main effects for the model. Two-way interactions are then sequenced according to the main effects (i.e., if the main effects were ordered year, month, area then the interaction terms would be year:month, year:area, month:area).

Annual predictions for month/area combinations most representative of the fishery were reviewed, and it was determined that interaction effects in the model were minor differences of degree, with commonality in trends being apparent. It was also decided that the unit areas within each of 4W and 4X could be combined, for a final two-area model, from which an annual predicted catch rate series for the fishery in 4W during July was selected as a reasonable index of catch rate trends for the fishery as a whole (Table 10, Figure 16). A declining trend is evident from 1997 to 1999, but catch rates have shown a slight increasing trend subsequently.

### RELATIVE FISHING MORTALITY (RELATIVE F)

Relative fishing mortality (F) can be calculated as the ratio of the commercial catch over the stratified total biomass estimates from the July RV survey (Figure 17). This statistic does not give an absolute estimate of the true fishing mortality, but trends over time can be useful in examining exploitation patterns. Relative F was extremely high in the 1970's and high from 1988 to 1991. Since 1994, overall relative F has been low, suggesting that exploitation has been moderate relative to the historical period. Relative F was also calculated by age from 1977 to 2008. Age 1 relative F has shown an increase since 1998, with the exception of 2003 to 2006 (2002-2005 year classes; Figure 18, top). Ages 2-4 show high relative F from 1977 to 1981 and between 1987 and 1993, but have been low for the past decade (Figure 18, bottom).

### RECRUITING YEAR CLASS SIZES

Estimates of age 1 abundance are available from the July RV survey (Table 8). For the most recent year, age data are not available but an approximation of the 2008 year class at age 1 can be made based on abundance of fish <23 cm (Branton *et al.*, 1997). Recruitment in recent years has been variable. The 2000, 2001 and 2003 year classes were well below average in abundance, while those of 2002, 2004 and 2005 are amongst the highest in the time series. The 2006, 2007 and 2008 year classes are close to average (Figure 19).

### ESTIMATES OF TOTAL MORTALITY (Z)

The mean numbers per tow index from the July survey was used to calculate total mortality. To reduce variability in the estimates, the results were grouped into age classes (1, 2-4, 6-8) and smoothed using a three year moving average (Figure 20a and b). Based on this method, total mortality on age 2-4 fish (i.e., the age classes on which the fishery traditionally has been conducted) was high from 1996 to 1998, despite a sharp decline in catches. Z for this age group declined from 1999 to 2003, but has increased since. Total mortality for the oldest ages shows a similar pattern. Z for age 1 fish was stable from 1986 to 2001, but has increased sharply in recent years (Figure 20a).

### BIOLOGICAL INDICES

Previous analysis (Showell, 1997, Showell *et al.*, 2005) has shown both condition (weight for given length, males and females averaged) (Figure 21), and mean length-at-age (Table 11a and b, Figure 22) to have declined from 1971 to 1995, with the two factors combining to produce very low mean weights-at-age relative to the early period in the time series (Table 12a and b, Figure 23). Since the mid-1990's, condition and length-at-age have stabilized at this lower level. However, since 2002 improvement has been seen in condition, while length-at-age has remained stable. As a result, increases in weight-at-age can be seen for most ages.

In recent years, attempts have been made to qualify survey abundance estimates for many stocks with indices of spatial distribution. Two such indices were applied to silver hake for this assessment (Figure 24). One, the proportion of the historical stock area encompassing 75% of the annual estimated survey biomass, serves as a measure of resource concentration. A second index, the proportion of annual survey sets where the species occurs (non-zero sets), is a measure of the area occupied by the species. While noisy, neither of these indices show a trend over the time series, indicating that the distribution of silver hake has been relatively stable.

### ECOSYSTEM CONSIDERATIONS

Although a small mesh fishery, the Scotian Shelf silver hake activity is restricted to deeper water, in the inshore basins or off the edge of the shelf, which limits bycatch. In addition, a separator grate that restricts the catch of larger fish is mandatory.

DFO at-sea fishery observers are routinely deployed to the silver hake fleet, to monitor catches and discards of the directed species, as well as bycatch. While observer coverage levels can be calculated in several ways (% trips, % days fished), the proportion of the main species observed to landed catches is most representative. Using this method, observer coverage on the silver hake fleet in recent years (2000–2009) ranged from approximately 2% to 20%, with an average of 9%.

Based on observer records (Table 13), 96% of the catch silver hake trips was of the directed species. Discarding of silver hake was minimal, at less than 0.1 of the total catch. Red hake, herring and dogfish were the most common bycatch species, at 0.9, 0.8 and 0.4%, respectively. Other species of possible concern are a rare bycatch, such as basking shark (0.1%) and pilot whales (0.02%).

## SUMMARY

The Scotian Shelf silver hake stock continues to be in poor condition.

Survey biomass remains at or near the lowest in the times series. Growth at present is poor, with condition and length-at-age below long-term averages. However, some improvement has been seen in condition and weight-at-age.

Total mortality (Z), on ages 2-4 and older fish has been variable, but Z on age 1 fish has increased in recent years.

The 2002, 2004 and 2005 year classes were large, and sustained the fishery at ages 1 and 2. However, recent year classes (2006-2008) have been average, and may lower commercial catch rates, as well as reduce abundance at older ages.

Changes have been seen in the catch-at-age of the commercial fishery, with age 1 fish now making up an important component of the catch. Helser *et al.* (1996) investigated the implications of harvesting such a high proportion of age 1 silver hake in US stocks. The conclusion from this work was that a fishery with a 50%-at-age-1 exploitation pattern could jeopardize the health of these stocks due to a decline in spawning stock biomass. The exploitation pattern of the Scotian Shelf silver hake fishery may be unsustainable and efforts should be made to reduce the proportion of age 1 fish in the catch through gear modifications or area closures.

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## TABLES

Table 1: Nominal catches (mt) for 4VWX silver hake, 1970-2009.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Bulgaria	0	0	0	0	0	1722	3088	862	606	4639	817	0	0
Canada	0	0	0	0	11	101	26	10	26	13	104	6	38
Cuba	0	0	201	0	0	1724	12572	1847	3436	1798	2287	642	11969
France	0	0	0	0	0	0	0	15	0	0	0	0	2
FRG	0	0	10	0	296	106	97	684	0	0	0	0	0
GDR	0	0	0	0	0	0	0	0	3	0	0	0	0
Ireland	0	0	0	0	0	108	106	0	0	9	0	0	0
Italy	0	0	0	0	0	0	0	38	106	5	0	541	37
Japan	129	8	63	88	67	54	78	19	161	219	239	120	937
Poland	0	0	0	0	0	0	0	295	2	0	0	1	31
Portugal	0	0	0	0	0	0	0	0	0	0	56	2044	2
Romania	0	0	0	0	0	0	0	10	0	1	0	0	0
Spain	0	15	0	0	0	6	0	0	2	0	40	0	0
USA	0	1	1	1	1	7	1	14	0	0	0	3	2
USSR	168916	128633	113774	298533	95371	112566	81216	33301	44062	45076	40982	41243	47261
Total	169045	128657	114048	298621	95745	116394	97184	37095	48404	51760	44525	44600	60251

Table 1 (continued): Nominal catches (mt) for 4VWX silver hake, 1970-2009.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Bulgaria	0	0	0	0	0	0	0	88	0	0	0	0	0
Canada	15	10	2	9	13	9	337	10	34	4	73	57	300 <sup>1</sup>
Cuba	7418	14496	17683	16041	20219	9016	14541	13888	23708	16528	22018	7788	16835
France	0	0	0	0	0	0	0	0	0	0	0	0	0
FRG	0	0	0	0	0	0	0	0	0	0	0	0	0
GDR	0	93	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	2 <sup>2</sup>	0	0	0	0	0	0	0	0	0	0	0	0
Japan	649	530	120	66	144	0	194	315	781	547	0	0	0
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	378	1714	1338	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0
USA	0	0	0	1	0	0		0	0	0	0	0	0
USSR	27377	57423	56337	66571	41329	65349	72917	55429	40786	14716	7139	0	0
Total	35839	74266	75480	82688	61705	74374	87989	69730	65309	31795	29230	7845	17835

Table 1(continued): Nominal catches (mt) for 4VWX silver hake, 1970-2009.

Country	1996	1997	1998	1999*	2000**	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	3473	4203	9979	16700	12900	18000	16700	12122	12911	11799	12258	12953	12055
Cuba	21773	11961	6083	0	0	0	0	0	0	0	0	0	0
France	0	0	0	0	0	0	0	2	0	0	0	0	0
FRG	0	0	0	0	0	0	0	0	0	0	0	0	0
GDR	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	0	0
Japan	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0
USA	0	0	0	0	0	0	0	0	0	0	0	0	0
USSR	669	0	168	0	0	0	0	666	0	0	0	0	0
Total	25927	16,164	16062	16700	12900	18000	16700	12790	12911	11799	12258	12953	12055

\*January 1, 1999 to March 31, 2000.

\*\*Commencing in 2000, fishing year, landings refer to the period from April 1 of the current year to March 31 of the following year.



Table 2: Length/weight regressions: Male and female alpha (intercepts) and betas (slopes) from the Canadian July groundfish research vessel survey of the Scotian Shelf.

Year	Male - Alpha	Female - Alpha	Male - Beta	Female - Beta
1970	0.000001153	0.000001953	3.5527	3.3849
1971	0.000004751	0.000006121	3.1382	3.0654
1972	0.000004408	0.000003823	3.1365	3.1865
1973	0.000004242	0.000004353	3.1584	3.1467
1974	0.000004817	0.000004308	3.1169	3.1479
1975	0.000013241	0.000006844	2.8346	3.0375
1976	0.000014429	0.000006401	2.7841	3.0354
1977	0.000006260	0.000006930	3.0626	3.0350
1978	0.000004630	0.000003070	3.1366	3.2531
1979	0.000010200	0.000005880	2.9001	3.0675
1980	0.000002330	0.000001800	3.3417	3.3989
1981	0.000006830	0.000005080	3.0206	3.1172
1982	0.000011600	0.000006740	2.8575	3.0232
1983	0.000006480	0.000003320	2.9935	3.2034
1984	0.000018300	0.000006490	2.7052	3.0284
1985	0.000013500	0.000004530	2.7848	3.1235
1986	0.000007970	0.000003820	2.9384	3.1685
1987	0.000009990	0.000004240	2.8798	3.1456
1988	0.000014300	0.000004800	2.7942	3.1241
1989	0.000006750	0.000004440	3.0114	3.1416
1990	0.000034320	0.000021000	2.5234	2.6958
1991	0.000007773	0.000003488	2.9582	3.2036
1992	0.000003938	0.000003157	3.1824	3.2533
1993	0.000003461	0.000003089	3.178	3.2202
1994	0.000003336	0.000003147	3.2009	3.2228
1995	0.000003340	0.000002367	3.2151	3.3233
1996	0.000002548	0.000002460	3.2909	3.3040
1997	0.000002939	0.000002479	3.2511	3.3050
1998	0.000003682	0.000003049	3.1783	3.2390
1999	0.000002822	0.000002998	3.2564	3.2392
2000	0.000003240	0.000002430	3.1958	3.2920
2001	0.000002840	0.000002230	3.2513	3.3270
2002	0.000002920	0.000002250	3.2531	3.3220
2003	0.000002820	0.00000196	3.2507	3.3769
2004	0.00000185	0.00000180	3.3912	3.3998
2005	0.000002230	0.000002370	3.3385	3.3166
2006	0.000003000	0.000002720	3.2384	3.2719
2007	0.000003010	0.000002640	3.2510	3.2932
2008	0.000002620	0.000002530	3.2889	3.3011
2009	0.000002780	0.000002430	3.2659	3.3088

Table 3: Sampling history for silver hake, 1999-2002.

Year	Quarter	Keys	# Samples	# Measured	# Aged	Catch (t)
1999	1	Domestic	51	11684	240	974
		Foreign	102	22044	145	1374
	Total		153	33728	385	2348
	2	Domestic	126	26229	323	4845
		Foreign	301	72564	296	3080
	Total		427	98793	619	7925
	3	Domestic	40	9101	240	2336
		Foreign	52	11381	86	383
	Total		92	20482	326	2719
	4	Domestic	16	3377	162	3659
		Foreign	12	2691	58	50
	Total		28	6068	220	3709
Total			700	159071	1550	16701
2000	1	Domestic	90	19155	95	3177
		Foreign	110	24456	89	546
	Total		200	43611	184	3723
	2	Domestic	96	17040	114	3950
		Foreign	71	15981	70	486
	Total		167	33021	184	4436
	3	Domestic	87	18406	163	1560
		Foreign	47	10185	29	216
	Total		134	28591	192	1776
	4	Domestic	43	8534	115	2966
		Foreign	---	---	---	---
	Total		43	8534	115	2966
Total			544	113757	675	12901
2001	1	Domestic	52	9974	173	3886
		Foreign	16	3474	56	126
	Total		68	13448	229	4012
	2	Domestic	100	18584	205	5926
		Foreign	120	25793	133	1651
	Total		220	44377	338	7577
	3	Domestic	34	6326	123	2526
		Foreign	17	3633	33	194
	Total		51	9959	156	2720
	4	Domestic	39	6842	169	3691
		Foreign	---	---	---	---
	Total		39	6842	169	3691
Total			378	74626	892	18000
2002	1	Domestic	96	17186	200	3399
		Foreign	---	---	---	(650 - added to Q2)
	Total		96	17186	200	3399
	2	Domestic	53	9306	157	4074
		Foreign	82	17035	113	2556 (1906+650)
	Total		135	26341	270	6630
	3	Domestic	44	8149	126	3025
		Foreign	---	---	---	---
	Total		44	8149	126	3025
	4	Domestic	30	4760	104	3647
		Foreign	---	---	---	---
	Total		30	4760	104	3647
Total			305	56436	700	16701

Table 4: Sampling history for silver hake, 2003-2008.

Year	Quarter	Keys	# Samples	# Measured	# Aged	Catch (t)
2003	1	Domestic	57	9946	175	2786
		Foreign	61(+3)	12520(+645)	---	314(+117)
	Total		121	23111	175	3217
	2	Domestic	58	9497	279	3627
		Foreign	(3)	(645)	---	(117)*
	Total		58	9497	279	3627
	3	Domestic	22	3657	130	1088
		Foreign	11	2435	---	17
	Total		33	6092	130	1105
	4	Domestic	19	3183	110	3629
		Foreign	---	---	---	---
	Total		19	3183	110	3629
Total			231	41883	694	11578
2004	H1	H1	101	20320	257	8481**
	H2	H2	28	1924	80	5400
	Total		129	22244	337	12911
Total			231	41883	694	11578
2005	1	Domestic	20	4736	---	3302
	2	Domestic	23	6714	481	3404
	3	Domestic	16	7109	312	1547
	4	Domestic	19	3960	279	3113
	Total		78	22519	1072	11364
2006	1	Domestic	31	14081	530	3726
	2	Domestic	23	6487	505	1037
	3	Domestic	15	2952	213	2348
	4	Domestic	19	4202	224	2977
	Total		88	27722	1472	10089
2007	1	Domestic	21	4189	254	3657
	2	Domestic	13	4407	319	3351
	3	Domestic	18	4706	128	2452
	4	Domestic	16	4006	234	2599
	Total		68	17308	935	12059
2008	1	Domestic	24	8607	291	3551
	2	Domestic	27	9622	293	3753
	3	Domestic	18	4213	181	2636
	4	Domestic	14	2495	150	2524
	Total		83	24937	915	12464

\*added to Quarter 1 Foreign.

\*\*in 2004, Russia was included in the Canadian catch. Catch by this fleet occurred only in March 2004, (334 t).

Table 5: Catch-at-age ('000's) for Scotian Shelf silver hake, 1977-2008.

Year	Age								
	1	2	3	4	5	6	7	8	9
1977	17911	72529	59862	15070	2218	725	97	91	4
1978	20940	70302	80196	35025	12709	5227	1906	1168	338
1979	20569	57893	72891	36669	22380	9970	3168	495	374
1980	16588	70696	70391	32032	14465	5184	1431	451	98
1981	2358	25214	109035	37573	11928	3234	1201	290	141
1982	20189	52976	75876	68400	31752	5945	2042	465	64
1983	5849	96852	56158	29282	11388	3395	819	253	88
1984	59588	45828	206900	82911	19344	4268	1038	183	10
1985	14970	130814	98346	128365	34110	9327	2344	226	85
1986	45598	70269	229126	84097	28635	8760	1436	497	111
1987	6804	214235	114417	54211	13063	6045	347	156	117
1988	5110	62791	265307	39242	21303	3106	2133	208	143
1989	24264	85846	158745	145105	20025	9369	1569	1166	39
1990	6516	209620	142862	41215	11741	1648	640	107	40
1991	5738	117305	201243	46414	12154	3954	290	181	50
1992	7461	74491	73526	27777	3461	1247	159	33	5
1993	31572	83140	70735	35222	5511	595	71	30	3
1994	1651	13265	35250	8847	1283	150	18	8	0.1
1995	3500	35925	45615	31316	5183	457	58	41	3
1996	33501	92030	43686	23234	4928	888	148	75	0.1
1997	16132	34018	37497	25384	3579	339	29	27	2
1998	14232	44018	40311	11447	1690	235	22	4	0.1
1999	77953	44851	28690	9436	609	176	29	0.2	0
2000	90579	54947	13791	2253	385	31	4	1	0
2001	50803	130923	21905	4375	420	121	30	9	0.1
2002	43064	79296	50459	4594	549	134	16	0.3	0
2003	54508	44136	20357	3906	456	58	63	7	0
2004	21350	82264	25909	5117	681	290	29	24	1
2005	18428	52458	26221	3359	1306	263	160	2	2
2006	55987	41325	18057	3485	395	15	27	24	0
2007	80550	62525	13342	3454	475	147	15	8	0
2008	60407	50173	17108	4439	553	129	35	0.1	1

Table 6: Commercial mean weight-at-age (kg) for Scotian Shelf silver hake, 1977-2008.

Year	Age								
	1	2	3	4	5	6	7	8	9
1977	0.065	0.183	0.264	0.340	0.446	0.632	0.886	0.922	2.120
1978	0.074	0.153	0.229	0.266	0.335	0.405	0.438	0.540	0.892
1979	0.076	0.178	0.227	0.274	0.304	0.389	0.455	0.838	0.838
1980	0.040	0.151	0.223	0.287	0.341	0.391	0.531	0.839	0.859
1981	0.061	0.168	0.215	0.276	0.326	0.401	0.553	0.923	1.137
1982	0.066	0.169	0.231	0.275	0.317	0.394	0.446	0.513	0.506
1983	0.067	0.128	0.196	0.239	0.289	0.365	0.395	0.457	0.444
1984	0.070	0.146	0.181	0.224	0.272	0.353	0.405	0.624	0.650
1985	0.068	0.136	0.177	0.210	0.244	0.295	0.410	0.582	0.669
1986	0.053	0.145	0.184	0.250	0.250	0.274	0.392	0.514	0.644
1987	0.045	0.119	0.168	0.211	0.248	0.286	0.453	0.422	0.518
1988	0.045	0.139	0.185	0.227	0.260	0.292	0.401	0.497	0.688
1989	0.060	0.135	0.195	0.224	0.278	0.349	0.403	0.511	0.820
1990	0.063	0.139	0.184	0.217	0.240	0.315	0.370	0.401	0.545
1991	0.047	0.139	0.189	0.215	0.263	0.314	0.471	0.511	0.568
1992	0.080	0.14	0.190	0.210	0.260	0.280	0.370	0.410	0.690
1993	0.060	0.11	0.150	0.190	0.230	0.280	0.380	0.320	0.960
1994	0.050	0.100	0.130	0.170	0.190	0.270	0.380	0.420	0.717
1995	0.060	0.100	0.140	0.170	0.210	0.310	0.410	0.440	0.620
1996	0.040	0.100	0.139	0.169	0.207	0.293	0.505	0.433	0.717
1997	0.050	0.100	0.136	0.170	0.202	0.291	0.432	0.431	0.685
1998	0.070	0.105	0.140	0.175	0.210	0.295	0.280	0.730	0.674
1999	0.067	0.096	0.137	0.165	0.230	0.321	0.347	0.567	
2000	0.060	0.095	0.129	0.165	0.237	0.338	0.283	0.495	
2001	0.063	0.086	0.127	0.159	0.223	0.282	0.445	0.419	0.759
2002	0.068	0.100	0.131	0.174	0.237	0.281	0.439	0.751	
2003	0.051	0.108	0.134	0.172	0.230	0.304	0.524	0.373	
2004	0.054	0.094	0.140	0.200	0.248	0.304	0.464	0.542	0.680
2005	0.069	0.103	0.137	0.185	0.248	0.290	0.346	0.582	0.789
2006	0.055	0.094	0.133	0.17	0.222	0.254	0.444	0.368	
2007	0.050	0.086	0.135	0.186	0.268	0.351	0.498	0.421	
2008	0.065	0.101	0.151	0.159	0.262	0.332	0.557		0.780

Table 7: Scotian Shelf silver hake Canadian July groundfish research vessel survey total stratified numbers ( $\times 10^{-6}$ ) and biomass ( $t \times 10^{-3}$ ), Strata 484-495 excluded, 1970 to 1981, corrected for vessel effect.

Year	Biomass	Numbers
1970	45.6	275.4
1971	14.0	81.1
1972	29.4	164.1
1973	73.1	438.5
1974	64.0	319.7
1975	13.0	65.7
1976	30.1	152.2
1977	14.6	56.5
1978	21.4	84.0
1979	69.3	329.8
1980	19.0	77.3
1981	75.9	333.3
1982	107.8	654.8
1983	33.3	214.8
1984	79.8	512.9
1985	62.8	346.1
1986	48.4	454.4
1987	56.5	469.0
1988	43.3	276.2
1989	27.3	254.2
1990	37.4	284.5
1991	26.0	178.5
1992	20.9	148.7
1993	30.2	298.1
1994	23.0	235.3
1995	42.8	324.0
1996	44.7	379.5
1997	30.9	339.0
1998	19.9	181.9
1999	16.9	220.7
2000	23.1	268.2
2001	29.1	276.4
2002	11.3	116.7
2003	17.6	292.3
2004	44.9	343.2
2005	12.2	227.8
2006	20.0	302.5
2007	15.5	199.1
2008	18.3	189.7
2009	37.8	311.0

Table 8: Scotian Shelf silver hake Canadian July groundfish research vessel survey numbers ( $\times 10^6$ ) at age, Strata 484-495 excluded, 1971 to 1981, corrected for vessel effect.

Year	Age								
	1	2	3	4	5	6	7	8	9
1971	23.5	33.2	12.1	4.1	1.9	0.3	0.0	0.3	0.0
1972	46.6	82.6	12.5	7.4	3.0	1.9	0.4	0.6	0.1
1973	128.2	237.6	15.4	13.2	12.4	6.5	2.6	1.7	0.1
1974	58.1	168.7	57.7	6.2	6.6	5.8	1.3	0.5	0.0
1975	18.9	28.3	4.8	3.8	1.5	0.9	0.3	0.4	0.0
1976	35.2	86.0	13.6	6.3	2.6	1.1	0.3	0.2	0.2
1977	4.5	22.1	18.9	4.4	1.3	1.2	0.9	0.3	0.3
1978	22.4	21.5	15.6	8.6	6.4	2.9	1.3	0.5	0.8
1979	66.9	140.0	62.8	21.3	12.0	5.4	2.6	0.9	0.3
1980	11.0	19.0	25.6	7.2	4.6	3.6	1.5	0.8	0.4
1981	30.2	81.8	116.4	59.8	18.8	6.3	2.5	0.8	0.7
1982	178.0	297.3	73.5	55.6	32.0	10.0	4.7	3.2	0.3
1983	42.0	100.3	36.8	18.0	11.1	3.3	1.4	0.5	0.3
1984	174.7	64.6	203.3	42.9	14.3	8.5	3.2	1.2	0.5
1985	38.3	177.4	36.3	61.1	21.8	6.7	2.7	1.2	0.2
1986	262.5	71.8	70.7	25.5	15.4	4.5	2.1	0.7	0.5
1987	140.1	252.2	42.4	18.4	6.9	4.6	1.4	0.8	0.5
1988	68.4	84.1	83.0	17.6	15.4	2.8	2.9	0.5	0.1
1989	128.4	60.4	22.4	13.5	3.6	1.8	0.7	0.3	0.1
1990	89.9	113.4	47.0	13.9	4.6	1.2	0.4	0.2	0.1
1991	39.6	80.8	34.1	13.5	6.7	3.0	0.5	0.1	0.1
1992	25.8	59.2	42.2	12.1	5.3	3.0	0.7	0.1	0.2
1993	112.2	90.2	65.0	26.7	2.9	0.8	0.6	0.1	0.0
1994	86.0	59.0	55.4	23.2	9.6	1.4	0.3	0.2	0.1
1995	92.7	72.7	76.4	59.5	15.7	3.7	1.6	0.6	0.7
1996	92.6	179.8	53.1	40.2	9.2	1.9	0.3	0.6	0.2
1997	142.6	122.4	53.3	6.5	3.5	0.6	0.1	0.1	0.0
1998	34.3	92.7	35.7	12.8	2.0	1.5	0.3	0.0	0.0
1999	130.7	56.0	21.0	6.1	2.0	0.3	0.1	0.0	0.0
2000	158.9	73.7	23.6	6.1	1.3	0.6	0.2	0.2	0.0
2001	53.4	172.5	34.9	8.4	2.3	0.3	0.5	0.2	0.3
2002	48.7	33.2	24.3	6.3	0.8	0.4	0.1	0.1	0.1
2003	239.2	22.9	19.5	8.5	1.0	0.3	0.4	0.1	0.1
2004	59.5	155.2	73.9	38.9	12.0	1.40	0.2	0.1	0.2
2005	177.2	26.5	17.3	3.0	1.7	0.3	0.14	0.1	0.0
2006	228.0	52.9	13.7	4.2	2.3	0.7	0.3	0.1	0.0
2007	114.4	62.0	13.2	5.1	1.1	0.5	0.1	0.1	0.1
2008	68.8	87.4	16.4	6.3	2.4	0.6	0.5	0.2	0.04

Table 9: Silver hake abundance (number per tow) and biomass (weight per tow) estimates from the ITQ survey, 1996-2009, for Scotian Shelf Strata 440-483 (excludes Bay of Fundy).

Year	#/tow	Wt/tow (kg)
1996	46.4	7.0
1997	43.1	6.3
1998	11.9	1.2
1999	64.8	7.6
2000	55.7	5.4
2001	29.4	4.5
2002	13.1	1.8
2003	55.9	2.6
2004	104.9	12.2
2005	29.7	3.9
2006	21.4	2.4
2007	28.7	3.9
2008	38.3	4.6
2009	22.7	3.5

Table 10: Predicted catch rates (tons/day) for silver hake in NAFO Div. 4W, in July, 1996-2008.

Year	t/day
1996	4.79
1997	13.32
1998	9.26
1999	2.41
2000	3.03
2001	4.33
2002	5.05
2003	2.11
2004	6.51
2005	3.24
2006	5.01
2007	4.55
2008	6.40



Table 11a: Mean length-at-age (cm) for **male** Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data, 1971-2008.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		18.77	19.56	19.93	19.90	20.51	21.69	17.29	16.05	19.94
2		27.56	26.72	27.58	27.77	28.97	28.06	27.04	25.90	27.69
3		29.29	29.62	30.53	30.28	30.55	31.58	29.97	30.37	29.30
4		31.88	31.37	31.39	34.00	30.43	32.83	33.04	31.95	32.61
5		33.00	33.02	32.06	33.12		35.00		32.58	33.39
6			34.66	34.10		32.00	38.00	34.82	37.23	34.53
7			31.00	34.00	36.00				36.00	36.07
8										
9										40.00
AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	16.96	18.02	17.17	18.27	19.60	18.90	18.00	18.32	16.41	18.40
2	25.98	27.24	26.90	25.49	26.99	27.12	27.19	25.29	26.41	25.72
3	29.94	29.33	30.56	30.18	28.76	29.85	29.33	29.09	28.45	28.16
4	31.07	31.11	31.13	31.82	30.97	30.61	30.75	30.83	30.37	29.64
5	32.76	32.34	33.34	33.02	32.20	31.61	31.97	31.24	31.17	31.63
6	33.79	33.98	34.00	34.3	34.03	33.01	33.01	32.91	31.63	32.54
7	34.51	39.06	35.76	36.69	35.88		34.09	39.77	32.71	34.76
8			35.06	40.00	36.11			37.32		33.00
9		38.00					33.00			
AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	18.42	18.3	18.04	18.03	15.96	18.62	18.57	16.37	15.98	18.19
2	26.41	25.90	25.71	25.96	24.16	23.12	25.69	24.71	24.19	23.99
3	28.62	28.54	27.56	27.97	26.60	26.16	27.40	27.92	27.74	27.50
4	31.00	30.82	29.78	29.36	27.78	28.47	29.02	29.75	29.62	28.89
5	32.09	30.65	30.68	32.20	29.54	30.90	27.74	31.00	31.00	28.69
6		32.95	30.56		31.94	36.00	30.42		32.00	
7		35.00	33.11			33.00				
8										
9										
AGE	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1	20.62	18.41	18.00	18.03	19.53	16.48	19.22	17.44	18.31	
2	25.37	24.59	25.10	25.37	25.09	23.30	24.17	24.74	24.40	
3	27.53	27.52	27.12	27.38	27.77	27.09	26.85	27.46	27.88	
4	29.17	29.13	28.43	28.97	28.50	28.02	29.32	29.44	28.93	
5	31.00	30.32	29.26	31.00	30.25	29.00	29.48	31.16	32.00	
6		36.00	34.00		33.00		36.00			
7						34.00				
8									37.00	
9										

Table 11b: Mean length-at-age (cm) for **female** Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data, 1971-2008.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		18.89	20.36	19.82	20.49	20.54	21.23	17.65	17.26	18.97
2		28.59	27.99	28.84	28.75	30.40	29.90	27.97	26.29	28.85
3		31.54	32.99	32.90	33.05	33.73	35.09	33.10	31.97	31.71
4		33.72	35.24	35.85	37.24	34.76	37.10	36.50	35.49	35.34
5		36.51	36.32	38.56	42.20	40.81	39.81	39.79	37.78	38.76
6		47.00	45.61	41.58	45.82	45.50	47.94	42.15	40.40	44.49
7			42.48	46.31	51.31	53.42	47.12	50.59	48.71	47.63
8		45.00	56.29	51.02	56.76	54.98	50.35	47.15	51.81	55.03
9			50.00	57.00		61.00	52.33	57.24	52.82	53.25
AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	17.23	17.56	17.18	18.34	19.79	19.81	18.11	18.51	16.66	18.75
2	26.35	27.50	28.82	26.60	28.05	27.98	28.01	26.07	27.36	27.00
3	31.92	31.37	32.76	31.62	30.17	31.50	30.76	30.82	30.38	29.99
4	33.85	33.99	34.75	34.74	33.19	33.46	33.16	33.08	32.11	31.32
5	38.53	37.24	36.03	37.80	36.09	34.96	34.80	35.64	34.05	33.81
6	42.83	40.99	37.80	41.13	38.60	37.75	36.62	38.60	37.43	38.18
7	45.61	44.61	45.46	44.37	41.66	41.46	41.53	42.48	40.10	40.06
8	45.34	46.63	50.61	45.52	46.52	47.39	45.04	46.41	43.54	43.78
9	51.62	54.32	50.64	51.26	48.97	51.14	47.72	48.10	49.18	52.68
AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	18.62	18.67	18.24	17.59	16.63	18.99	17.98	17.32	16.52	17.49
2	27.38	26.85	26.47	26.35	24.63	24.09	26.47	25.61	25.09	25.58
3	29.56	30.16	29.57	29.07	28.22	27.69	29.17	29.70	29.72	29.10
4	32.37	32.80	31.49	30.97	30.10	30.45	30.23	32.61	31.02	31.49
5	34.82	34.66	33.18	34.13	32.00	33.37	31.71	35.40	33.58	33.35
6	37.84	36.13	34.61	36.01	37.84	36.88	37.74	36.91	37.72	37.42
7	40.01	40.67	40.16	36.75	40.47	40.43	40.02	51.78	38.15	37.89
8	43.60	49.20	46.75	38.44	43.73	43.77	44.97	53.15		45.00
9	41.64	44.59	46.28	45.00	43.67	47.16	51.44	46.00		46.00
AGE	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1	20.82	17.92	18.16	18.09	20.17	16.56	19.55	17.77	18.31	
2	26.88	25.52	26.36	26.65	26.10	26.41	25.95	25.84	25.42	
3	29.52	29.70	28.28	29.55	29.11	28.84	28.89	29.08	30.50	
4	31.50	31.88	31.05	31.06	31.50	31.53	32.07	32.52	32.31	
5	37.08	33.86	33.02	34.15	32.92	32.34	33.57	35.55	35.37	
6	39.94	37.92	34.56	38.46	35.30	36.30	36.78	37.94	40.57	
7	37.83	44.14	41.92	39.35	41.10	39.42	39.94	39.41	40.86	
8	41.66	45.51	45.09		39.42	40.00	40.64	44.58	43.17	
9	50.78	43.99	42.5	46.66				46.32	49.00	

Table 12a: Mean weight-at-age (g) for **male** Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data, 1971-2008.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		52.5	52.6	56.4	58.3	77.8	78.8	61.2	53.2	67.7
2		153.7	135.5	154.3	147.1	189.6	162.5	155.4	128.1	158.9
3		175.2	178.9	202.9	182.7	217.1	209.4	209.3	211.7	192.6
4		183.2	218.6	236.9	300.0	206.6	239.6	279.2	245.6	238.3
5		325.0	244.2	245.4	222.1		250.0		258.2	280.7
6			280.5	303.8		225.0	275.0	323.6	377.0	311.0
7			225.0	250.0	400.0				300.0	351.7
AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	70.5	59.3	52.7	62.8	63.9	60.7	53.7	52.3	54.4	56.2
2	119.7	148.0	137.7	105.2	138.3	133.0	132.1	110.3	132.4	119.6
3	199.1	186.1	215.9	171.8	160.2	178.9	168.7	174.7	166.7	146.6
4	225.0	228.6	235.9	216.7	211.9	184.7	202.9	197.7	189.2	160.0
5	260.5	263.6	275.3	262.5	228.0	224.0	233.0	223.6	252.9	222.6
6	285.2	306.8	291.1	272.2	267.4	282.8	258.7	249.4	235.5	227.0
7	274.3	409.5	315.8	326.9	269.5		253.9	469.1	241.5	288.9
AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	58.7	42.4	42.1	39.4	24.9	38.8	43.2	28.2	23.8	41.4
2	129.9	119.1	123.0	116.0	89.8	84.2	114.5	100.1	94.8	93.2
3	155.4	161.5	149.3	133.9	120.7	124.0	132.5	150.1	138.3	135.9
4	219.4	201.7	198.5	174.7	139.0	165.9	165.5	206.7	181.1	160.5
5	251.1	214.7	238.6	214.2	173.5	194.1	148.4	205.9	200.0	160.6
6		266.7	218.3		200.9	340.0	226.6		218.0	
7		275.0	241.1			235.0				
AGE	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1	56.0	38.7	37.4	35.6	56.0	27.5	43.04	35.4	38.78	
2	101.1	99.2	104.8	107.1	101.1	115.36	94.59	100.98	101.91	
3	132.5	136.8	132.5	139.6	150.8	141.84	128.81	152.20	150.67	
4	166.8	159.5	154.1	190.7	157.0	128.67	153.11	174.45	175.63	
5	180.0	141.1	176.0	242.0	196.9	180.00	185.22	200.97	225.00	
6		310.0	296.0		296.0		310.00			
7						266.00				

Table 12b: Mean weight-at-age (g) for **female** Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data, 1971-2008.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		52.2	55.8	40.2	43.0	67.1	67.3	24.2	9.5	38.7
2		181.1	163.1	173.1	166.6	219.7	203.6	172.8	130.2	173.5
3		228.1	271.1	256.3	267.1	301.9	308.5	289.2	253.3	239.4
4		299.3	334.4	340.8	388.3	363.5	367.3	387.1	350.3	303.0
5		386.2	371.0	428.9	579.8	575.3	493.6	488.5	424.2	449.0
6		925.0	789.6	557.9	713.5	768.6	973.6	639.6	526.7	683.2
7			609.5	810.8	1169.4	1238.9	784.6	1173.9	971.8	786.7
AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	4.0	19.3	15.4	22.5	42.2	44.3	12.7	27.4	7.1	32.4
2	124.6	159.9	174.7	125.6	156.1	149.8	148.6	118.4	150.0	126.0
3	246.9	241.3	248.4	215.7	205.4	214.3	199.1	207.1	208.1	157.3
4	285.9	300.2	319.9	283.0	262.8	256.7	253.2	264.5	241.5	177.2
5	453.8	404.4	361.7	387.0	327.1	311.1	300.9	340.9	302.8	274.5
6	659.8	548.9	431.0	514.3	426.2	408.9	372.1	432.6	396.2	432.4
7	793.3	691.8	796.9	717.7	562.7	524.3	550.0	624.8	503.6	549.2
AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	33.3	34.3	41.3	32.5	27.8	45.2	36.5	34.4	27.1	32.7
2	141.8	135.1	131.7	121.2	96.6	96.0	129.1	117.0	107.1	112.8
3	179.7	207.5	196.3	162.0	149.3	146.0	173.1	183.0	183.2	165.1
4	228.3	250.8	242.8	209.4	183.1	201.4	191.8	271.5	213.9	224.4
5	323.2	301.2	294.5	271.5	228.8	275.1	218.9	335.2	274.7	267.8
6	415.2	355.3	374.8	335.2	403.6	374.7	446.0	427.5	440.1	380.7
7	523.3	500.5	633.6	337.3	563.7	545.7	484.7	1296.8	417.6	420.3
AGE	2000	2001	2002	2003	2004	2005	2006	2007	2008	
1	57.4	34.7	38.4	36.6	50.2	28.33	47.37	36.95	41.40	
2	127.5	109.2	122.6	128.3	121.5	127.95	118.25	123.47	111.98	
3	175.0	174.5	148.8	188.2	173.2	165.61	166.81	180.73	207.07	
4	213.1	231.4	206.7	221.9	236.6	215.86	228.18	254.56	235.66	
5	378.0	298.3	251.4	298.1	267.3	237.9	271.54	337.68	337.30	
6	490.1	441.2	297.3	473.0	341.6	395.39	398.23	466.00	539.43	
7	400.2	798.7	543.9	536.4	642.7	551.58	484.92	515.16	518.20	

Table 13: Catches (kept and discarded) in the silver hake fishery from observer data, 2000-2009.

Species	Kept (t)	Kept %	Disc (t)	Disc %	Total (t)	Total %
SILVER HAKE	11665.91	96.50	8.631	0.07	11674.54	95.77
SQUIRREL OR RED HAKE	104.311	0.86	1.027	0.01	105.34	0.86
HERRING(ATLANTIC)	89.187	0.74	8.9	0.07	98.09	0.80
SPINY DOGFISH	0.36	0.00	50.051	0.41	50.41	0.41
REDFISH UNSEPARATED	31.551	0.26	0.157	0.00	31.71	0.26
MACKEREL(ATLANTIC)	27.605	0.23	0.55	0.00	28.16	0.23
HAKE (NS)	24.5	0.20	0.005	0.00	24.51	0.20
HADDOCK	22.358	0.18	0.129	0.00	22.49	0.18
WHITE HAKE	21.296	0.18	0.084	0.00	21.38	0.18
SHORT-FIN SQUID (ILLEX)	17.324	0.14	1.148	0.01	18.47	0.15
WITCH FLOUNDER	15.363	0.13	0.254	0.00	15.62	0.13
ALEWIFE	9.692	0.08	3.321	0.03	13.01	0.11
BASKING SHARK	0	0.00	12.1	0.10	12.10	0.10
LONGFIN SQUID (LOLIGO)	11.352	0.09	0.021	0.00	11.37	0.09
ARGENTINE(ATLANTIC)	8.705	0.07	0.185	0.00	8.89	0.07
BUTTERFISH	8.599	0.07	0.269	0.00	8.87	0.07
ROSEFISH(BLACK BELLY)	6.131	0.05	0.248	0.00	6.38	0.05
POLLOCK	4.387	0.04	0.032	0.00	4.42	0.04
AMERICAN PLAICE	3.963	0.03	0.017	0.00	3.98	0.03
WINTER SKATE	0.713	0.01	2.636	0.02	3.35	0.03
SHAD AMERICAN	2.826	0.02	0.144	0.00	2.97	0.02
SQUID (NS)	0.698	0.01	2.124	0.02	2.82	0.02
ATLANTIC PILOT WHALE	0	0.00	2.7	0.02	2.70	0.02
OFF-SHORE HAKE	2.57	0.02	0.001	0.00	2.57	0.02
YELLOWTAIL FLOUNDER	2.073	0.02	0	0.00	2.07	0.02
MONKFISH,GOOSEFISH,ANGLER	1.721	0.01	0.197	0.00	1.92	0.02
LONGFIN HAKE	1.579	0.01	0.001	0.00	1.58	0.01
AMERICAN LOBSTER	0.003	0.00	1.096	0.01	1.10	0.01
THORNY SKATE	0.111	0.00	0.863	0.01	0.97	0.01
WINTER FLOUNDER	0.879	0.01	0	0.00	0.88	0.01
COD(ATLANTIC)	0.786	0.01	0.031	0.00	0.82	0.01
OCEAN SUNFISH	0	0.00	0.75	0.01	0.75	0.01
HALIBUT(ATLANTIC)	0.276	0.00	0.337	0.00	0.61	0.01

## FIGURES

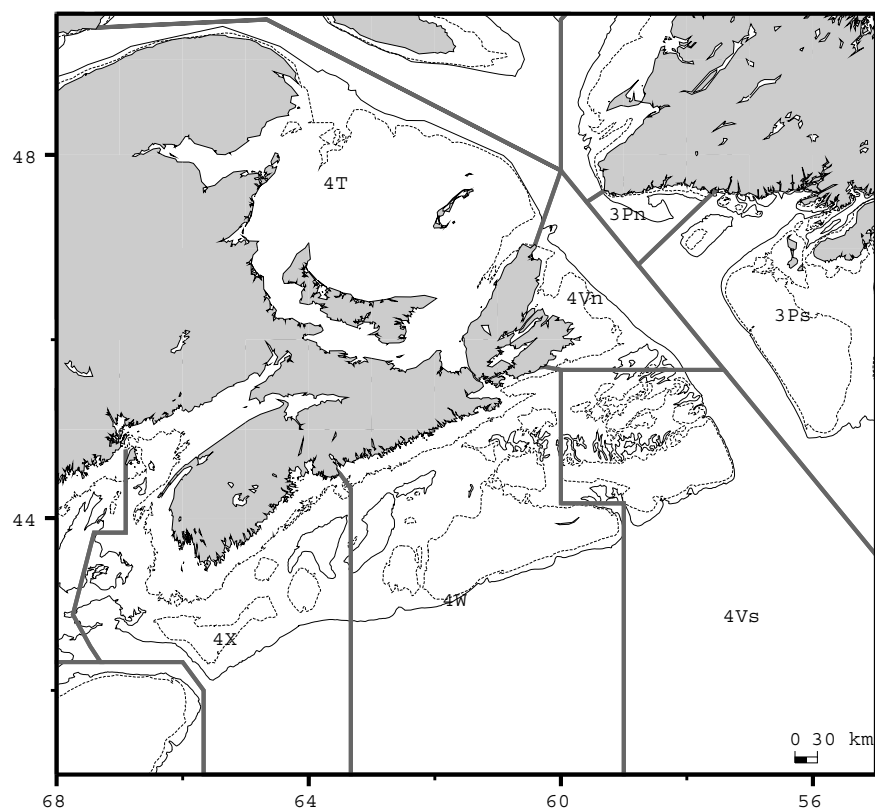


Figure 1: North Atlantic Fisheries Organization (NAFO) statistical areas.

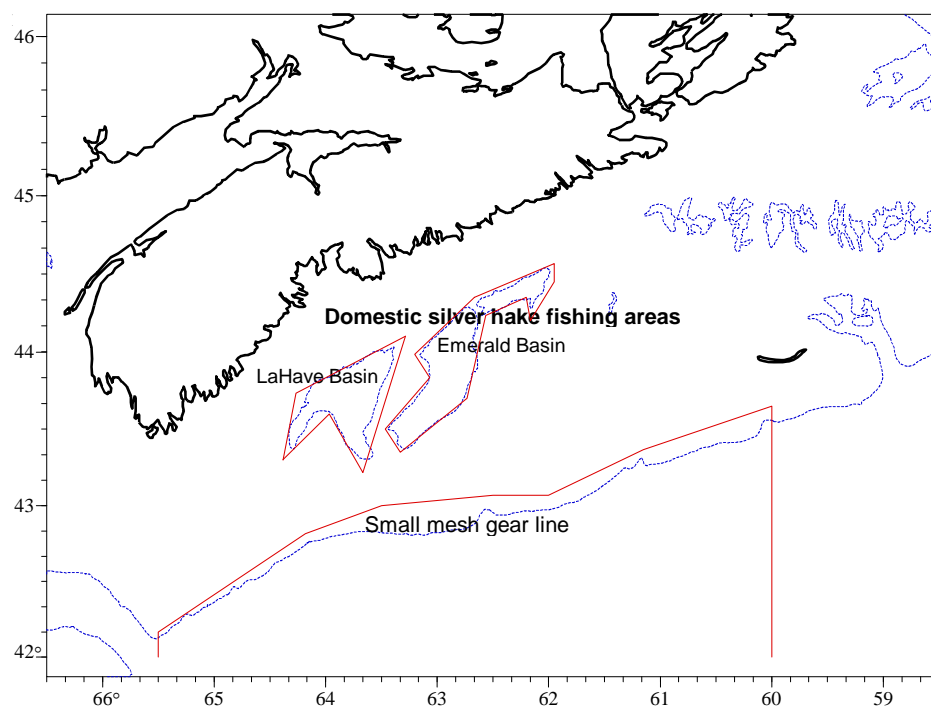


Figure 2: Scotian Shelf silver hake fishing areas.

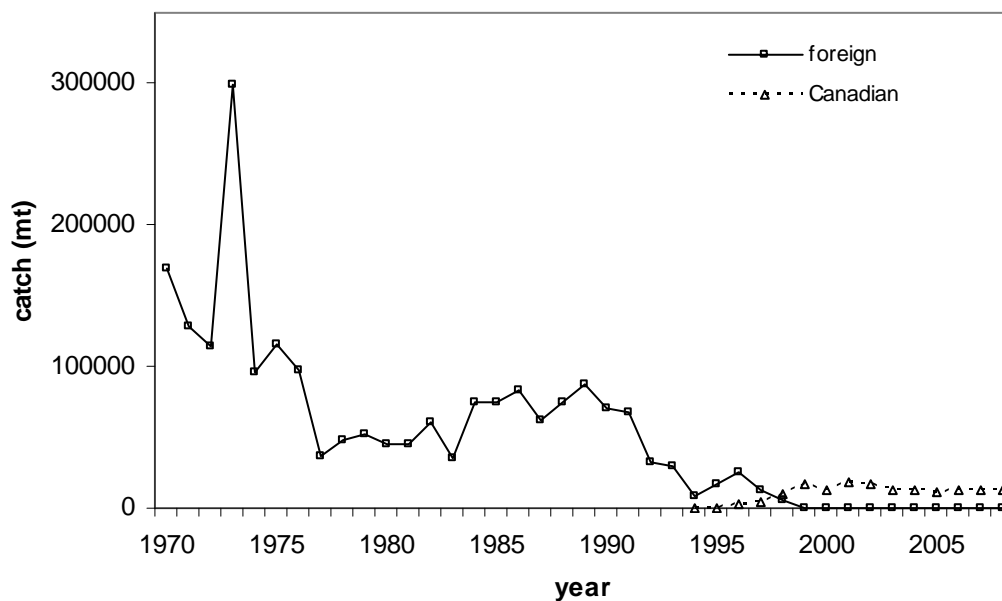


Figure 3: Historical catches of Scotian Shelf silver hake, 1970-2008.

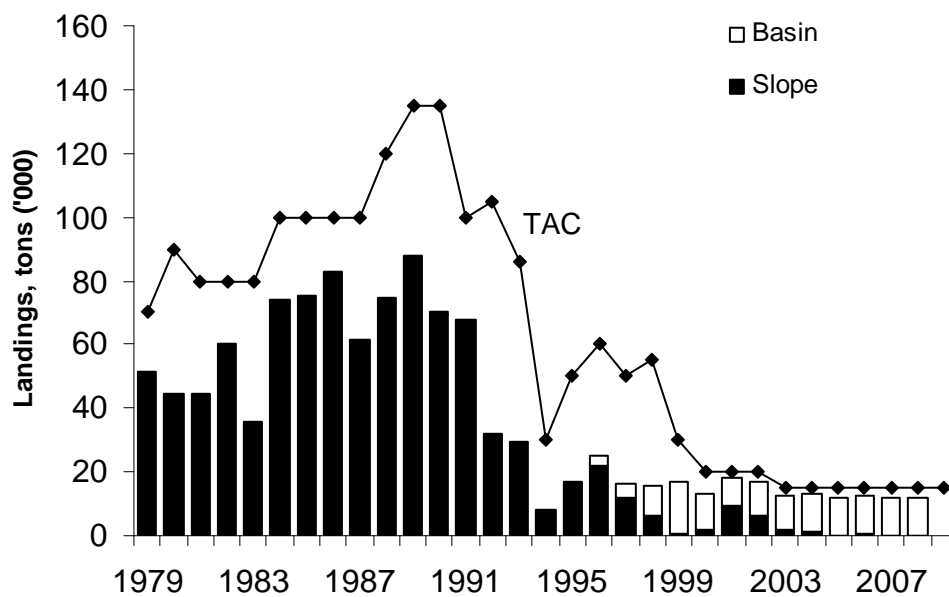


Figure 4: Silver hake Total Allowable Catch (TAC) and catches by fishing area, 1979-2008.

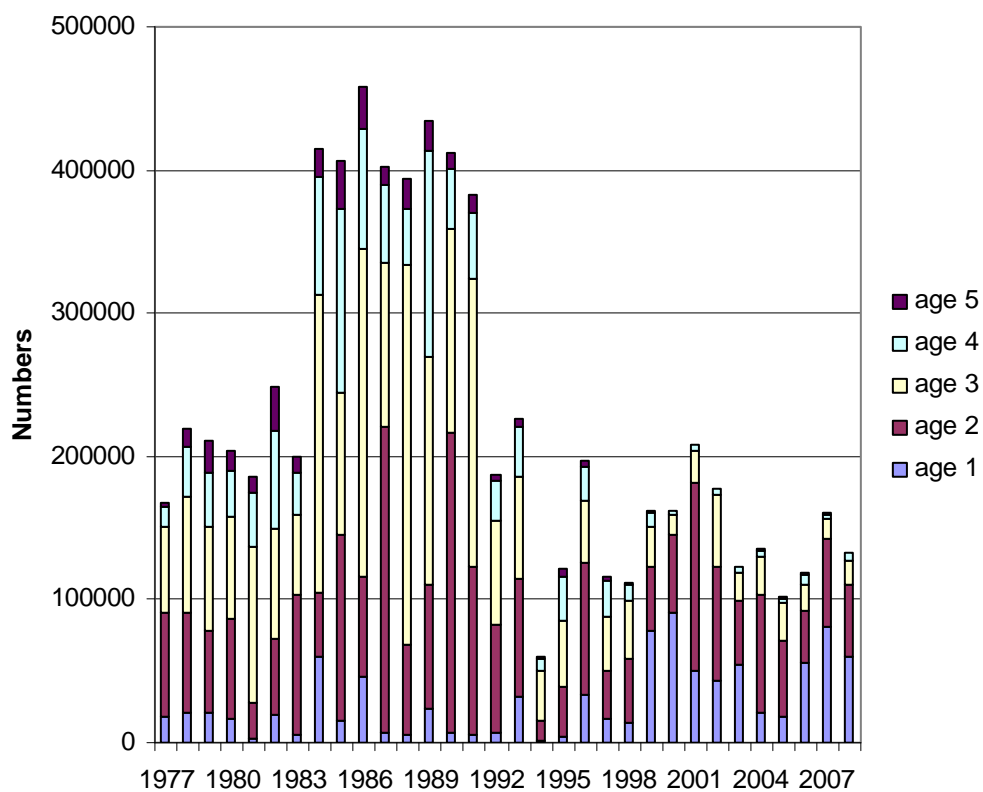


Figure 5: Silver hake catch-at-age comparison for all fleets, ages 1-5 from 1977 to 2008.

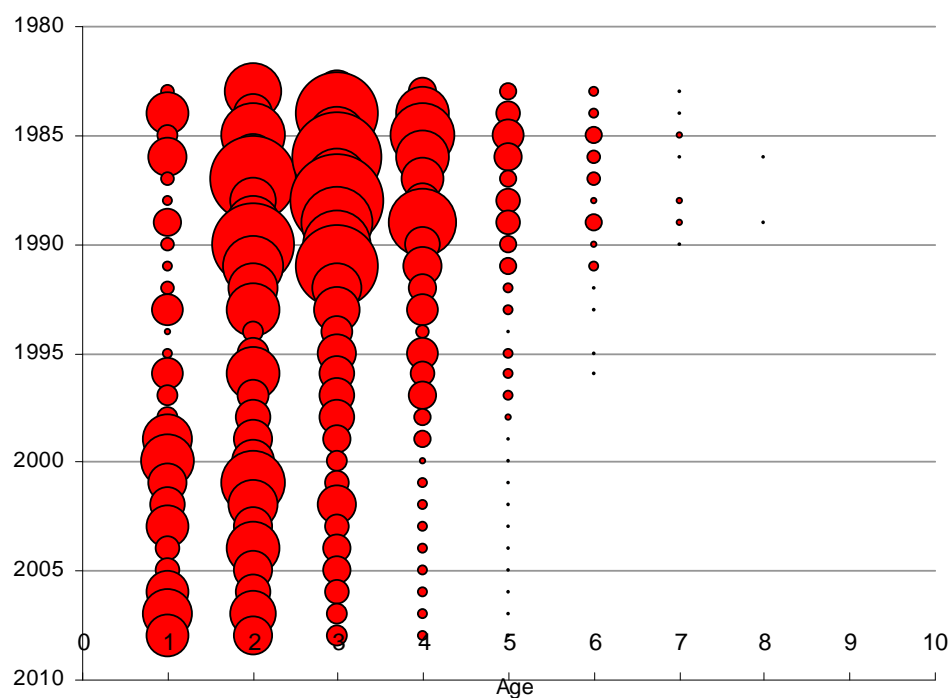


Figure 6: Bubble plot of silver hake commercial catch numbers by age, 1983-2008.



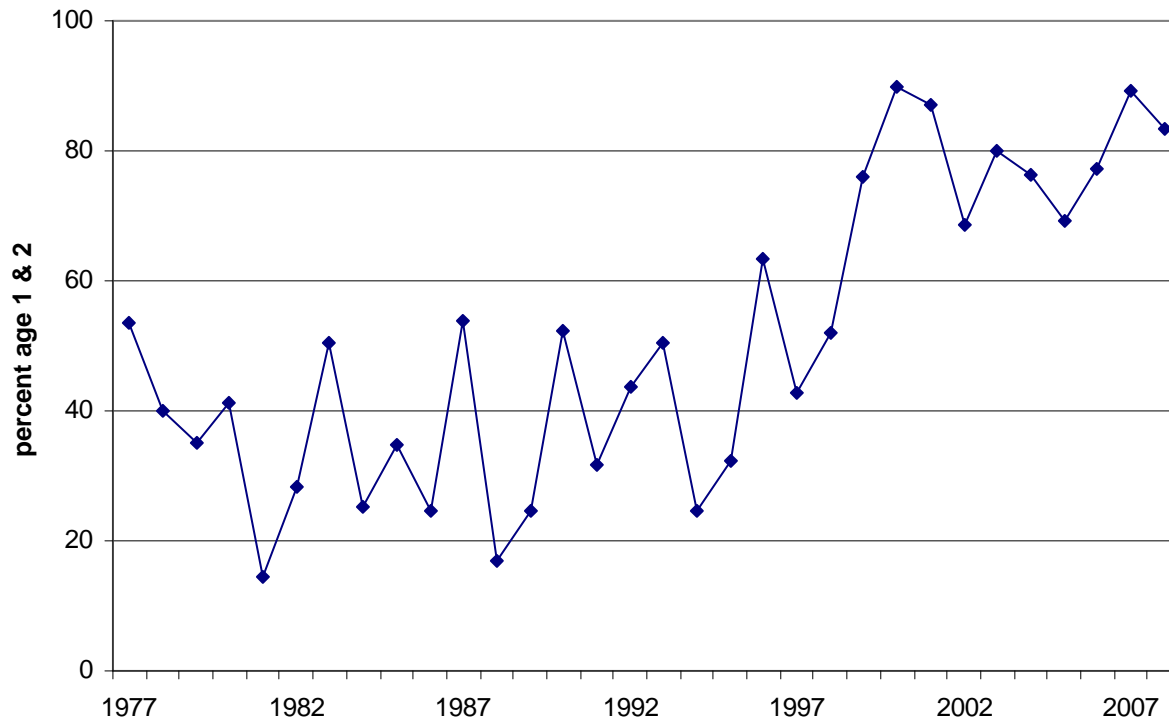


Figure 7: Silver hake catch-at-ages 1 and 2 as a proportion of the total catch, 1977-2008.

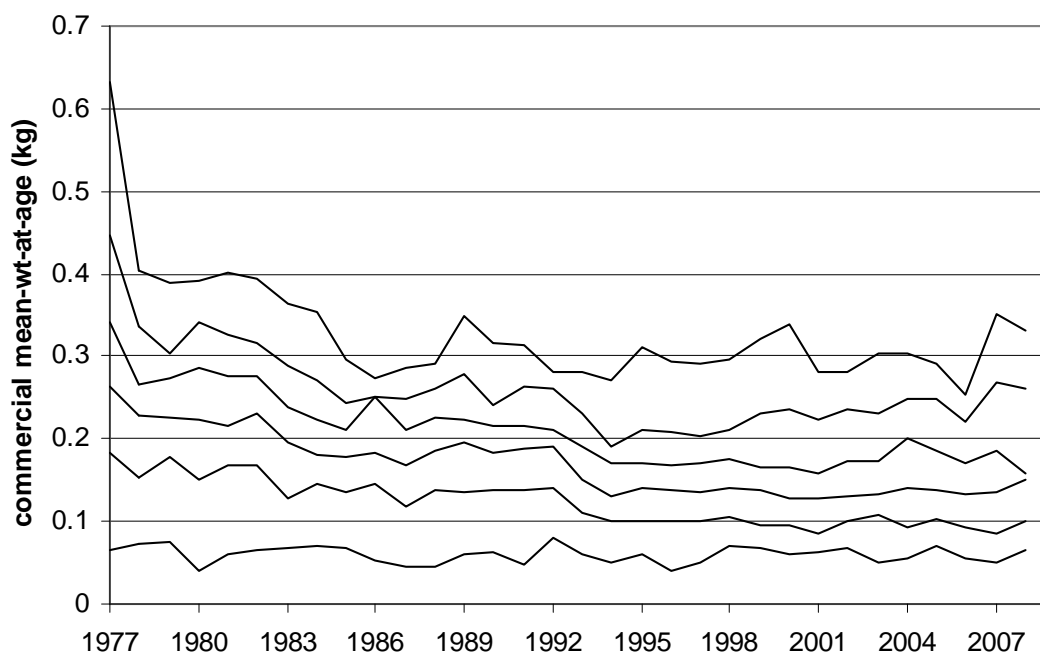


Figure 8: Silver hake weight-at-age comparison for all fleets, ages 2-6 from 1979 to 2008.

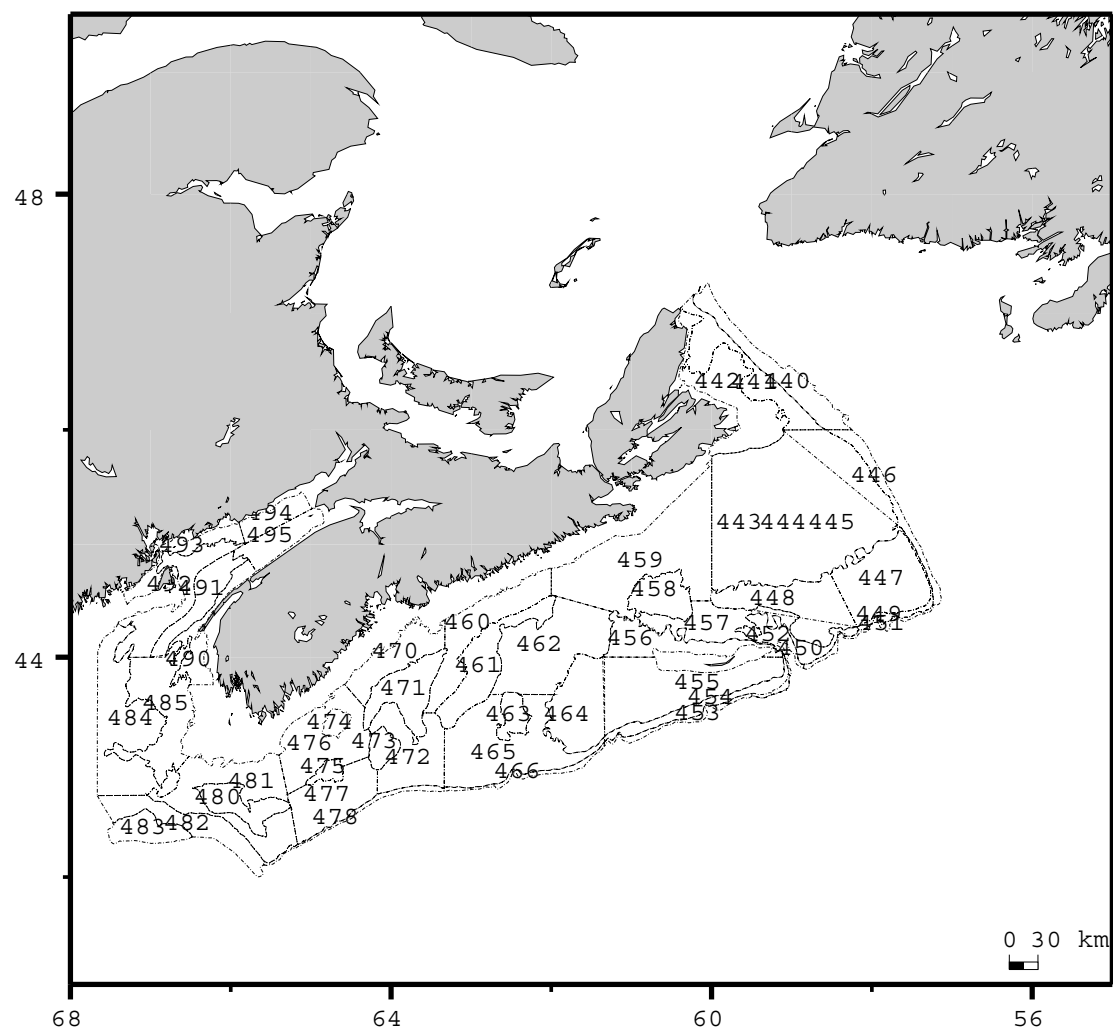


Figure 9: Stratification scheme for the Canadian July groundfish research vessel survey on the Scotian Shelf.

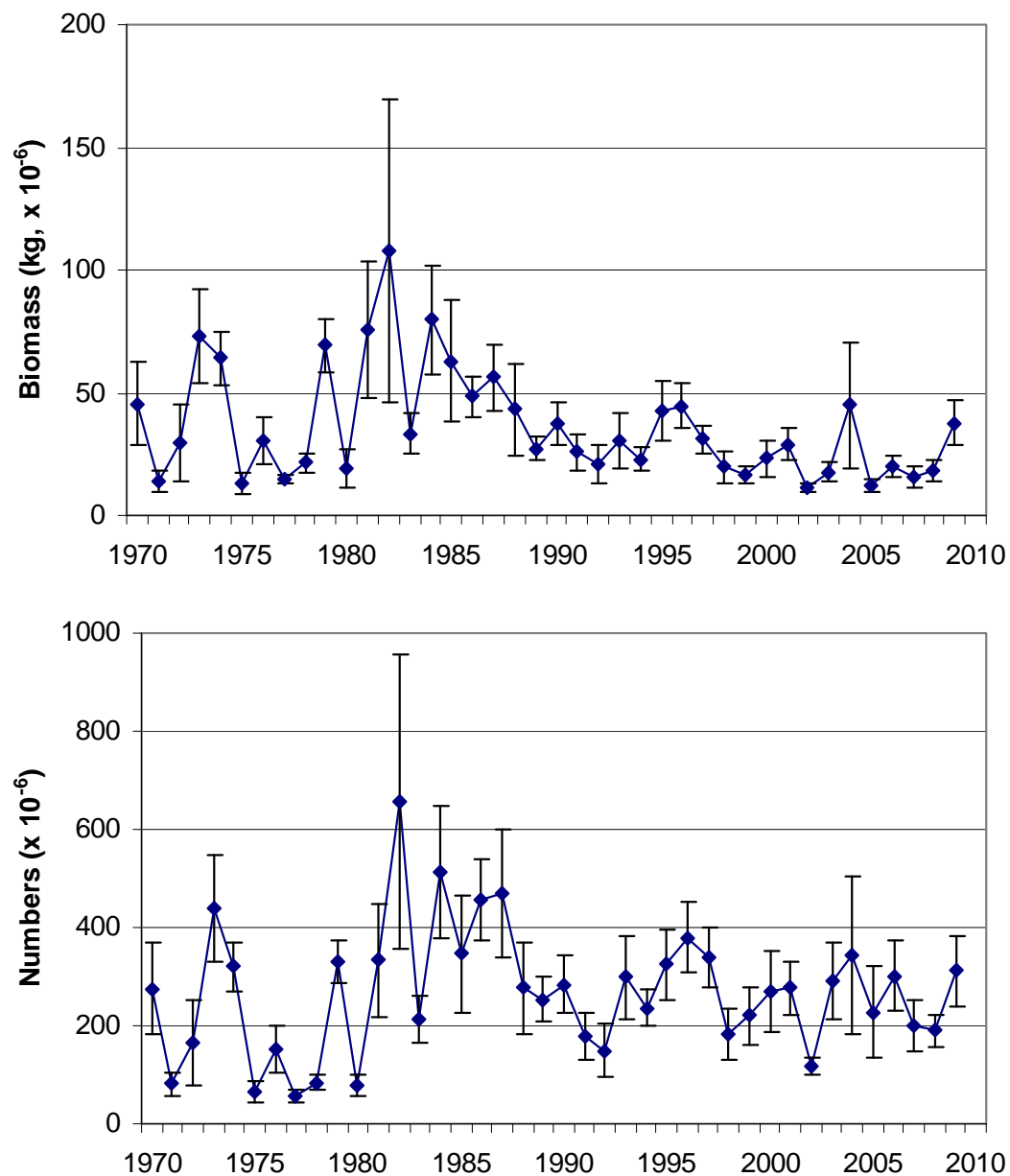


Figure 10: Silver hake biomass and abundance estimates from the Canadian July groundfish research vessel survey, 1970-2009, for Scotian Shelf Strata 440-483 (excludes Bay of Fundy). Years 1970-1981 corrected for survey vessel effect.

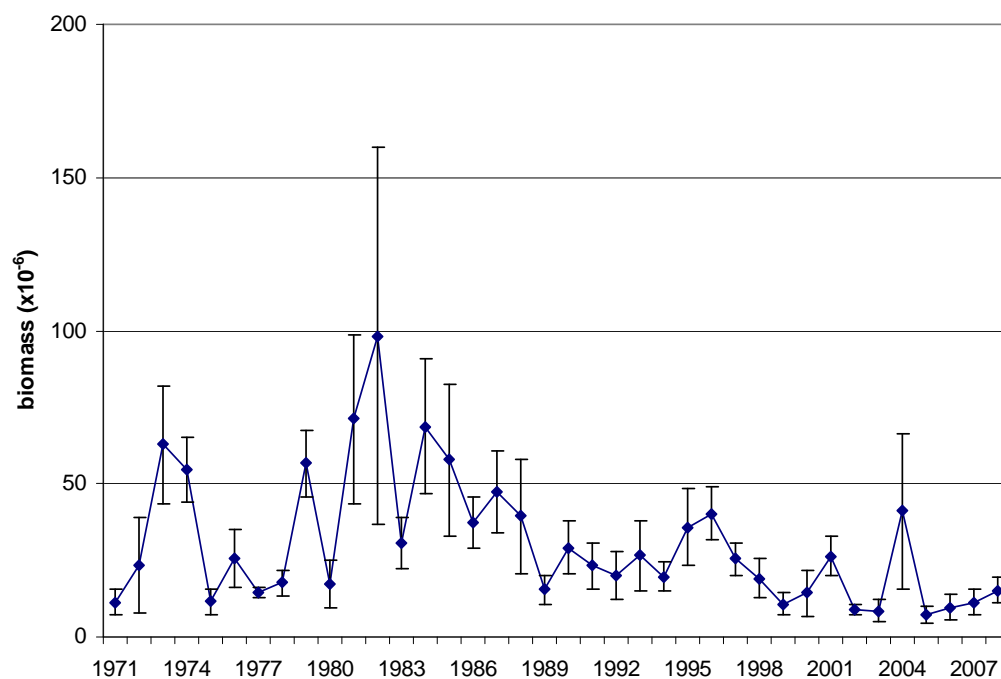


Figure 11: Silver hake age 2+ biomass (kg) from the Canadian July groundfish research vessel survey, 1971-2008.

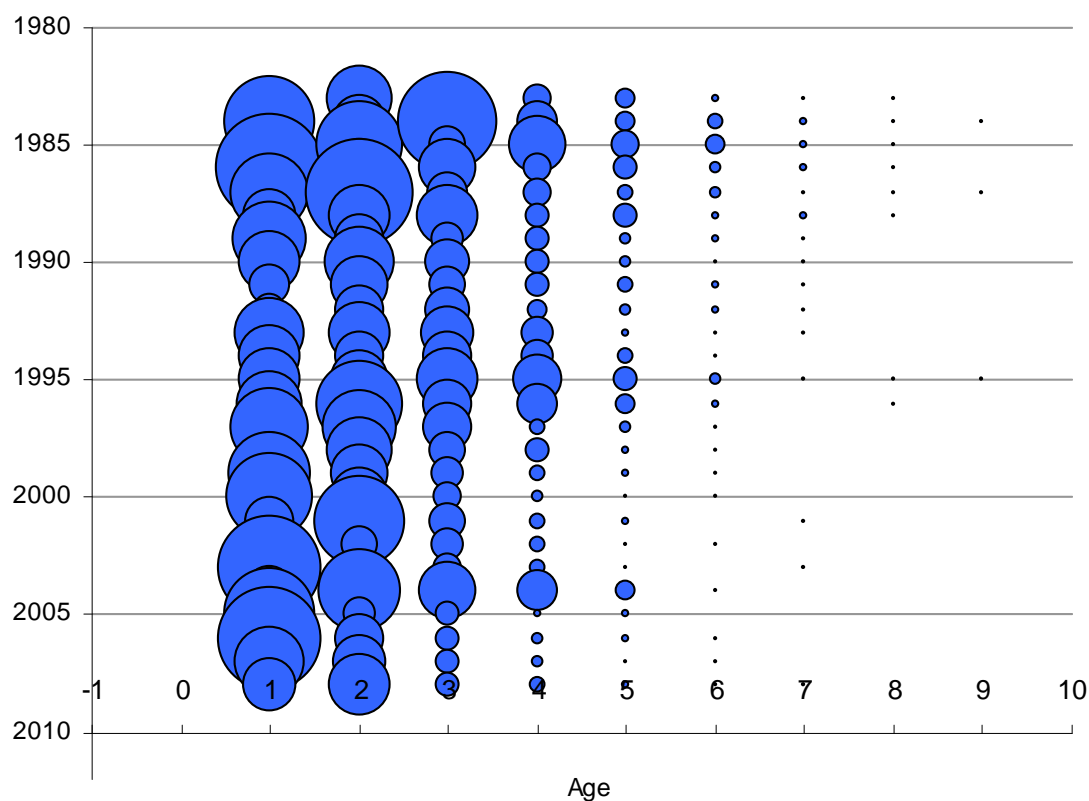


Figure 12: Bubble plot of silver hake abundance by age from the Canadian July groundfish research vessel survey, 1983-2008.

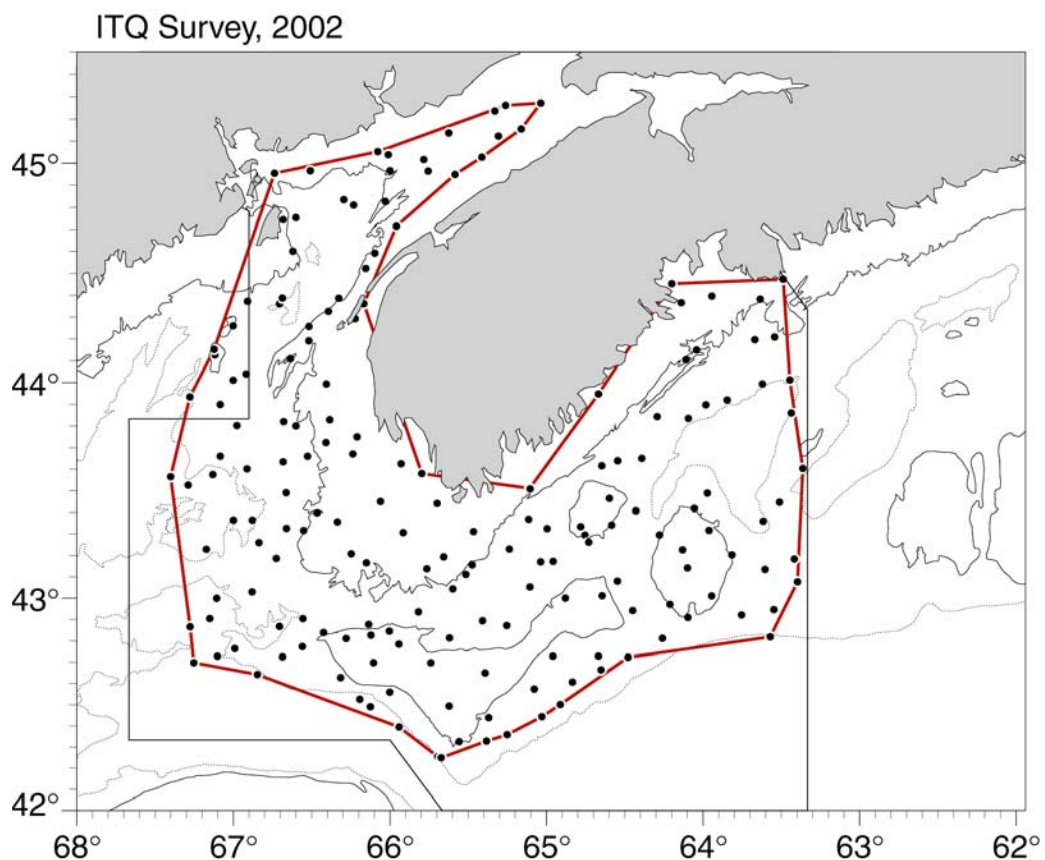


Figure 13: Distribution of fixed station locations in Individual Transferable Quota (ITQ) survey.

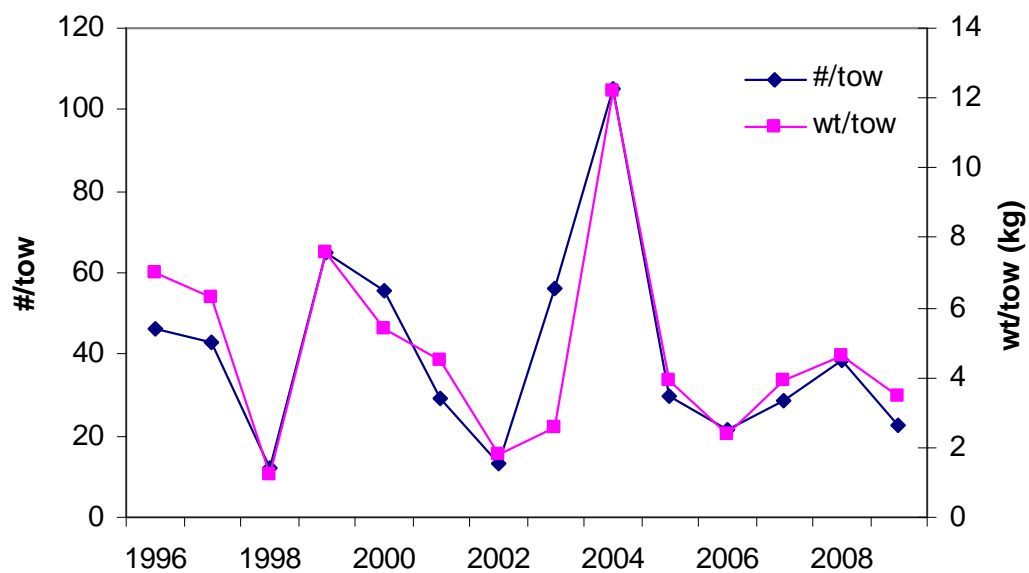


Figure 14: Silver hake abundance and biomass estimates from ITQ survey, 1996-2009, for Scotian Shelf Strata 440-483 (excludes Bay of Fundy).

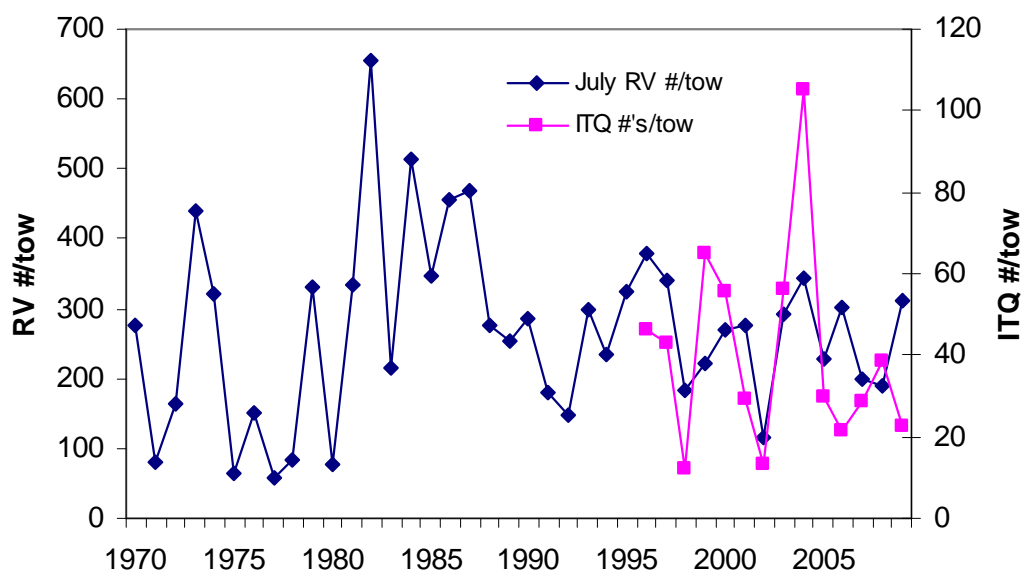


Figure 15: Comparison of the Canadian July groundfish research vessel survey and ITQ numbers per tow (Strata 484 to 495 excluded).

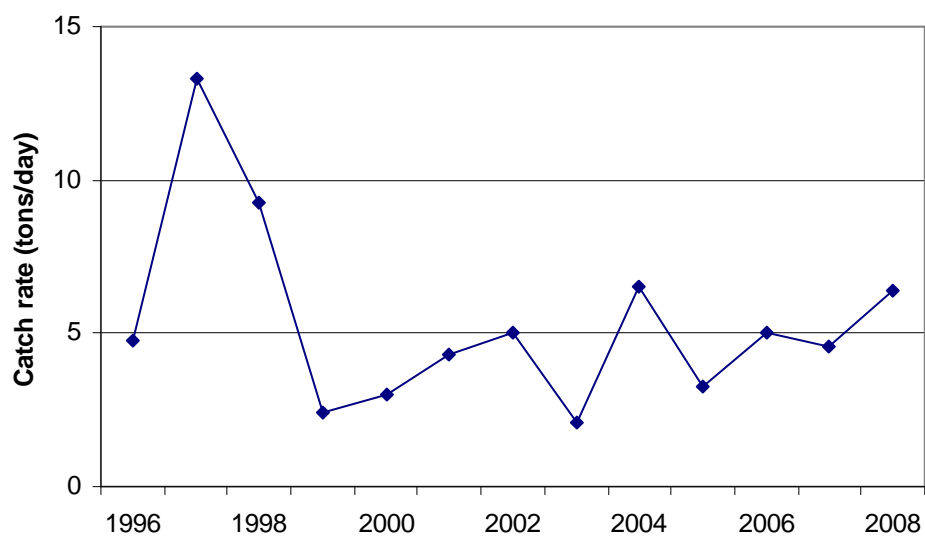


Figure 16: Predicted catch rates (tons/day) for silver hake in NAFO Division 4W, in July, 1996-2008.

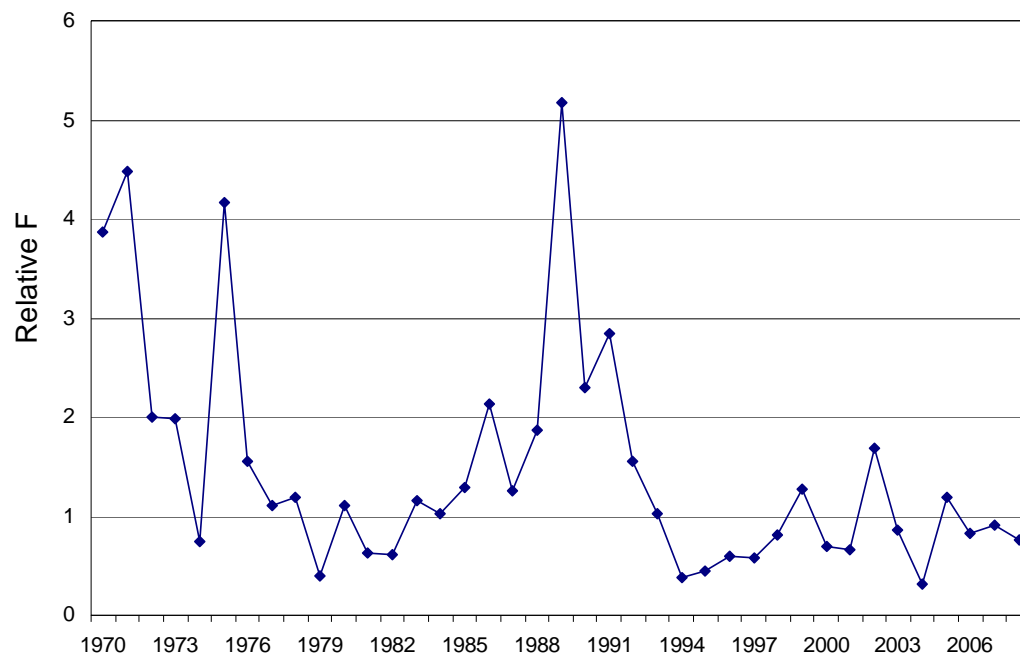


Figure 17: Relative  $F$  for Scotian Shelf silver hake from the Canadian July groundfish research vessel survey biomass and commercial catch weight, 1970–2008.

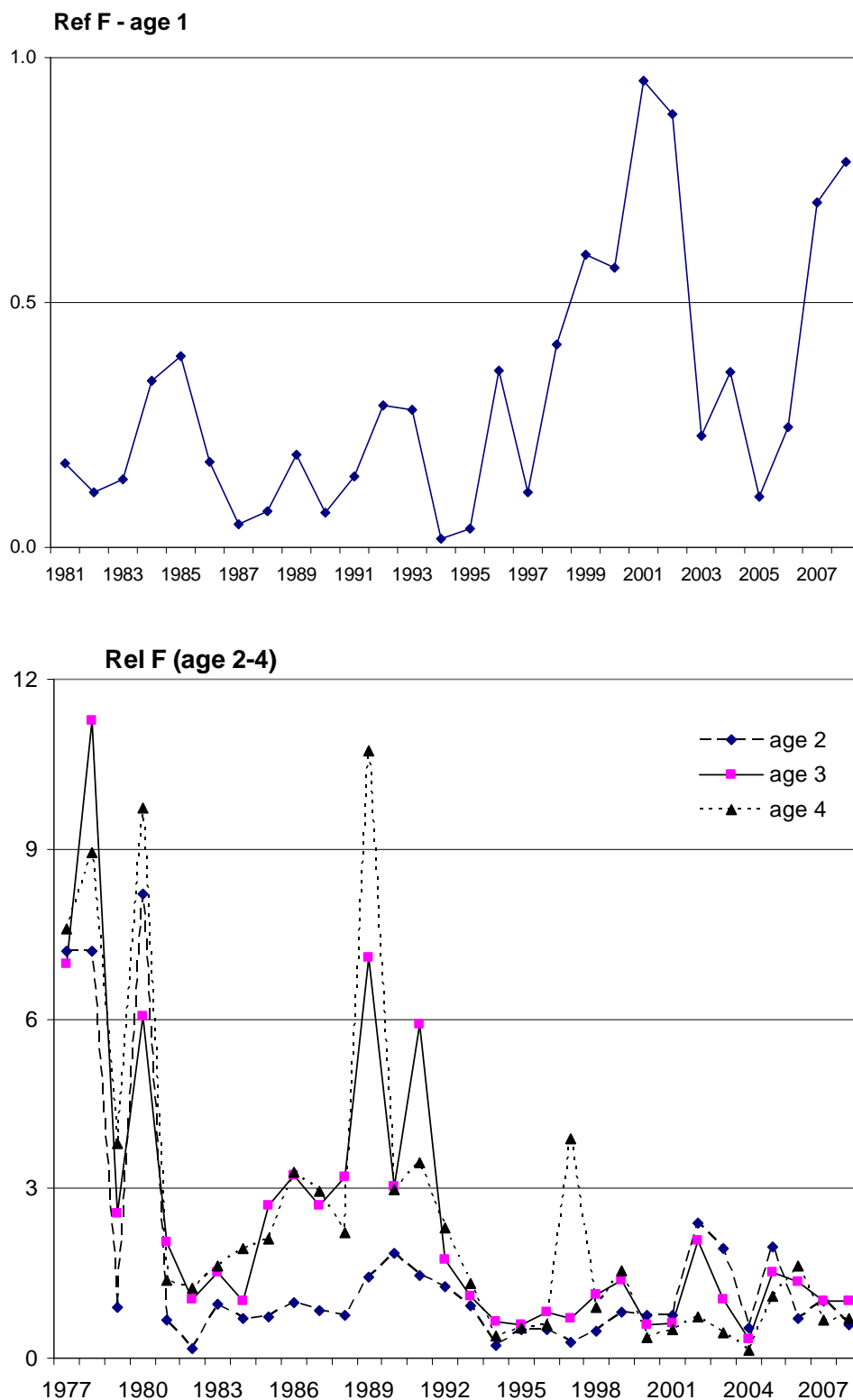


Figure 18: Relative F for Scotian Shelf silver hake from from the Canadian July groundfish research vessel survey abundance and commercial catch-at-age, 1977-2008. (Note: scales are not comparable between age 1 and the other ages.)



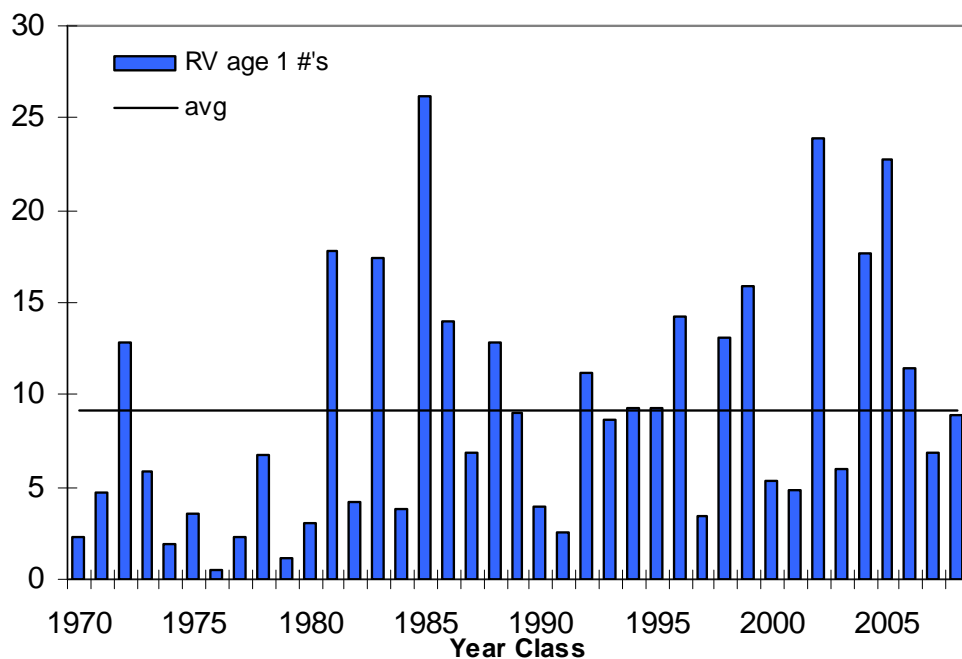


Figure 19: Recruitment estimates for Scotian Shelf silver hake from age 1 Canadian July groundfish research vessel survey abundance (2008 year class estimated from length data).

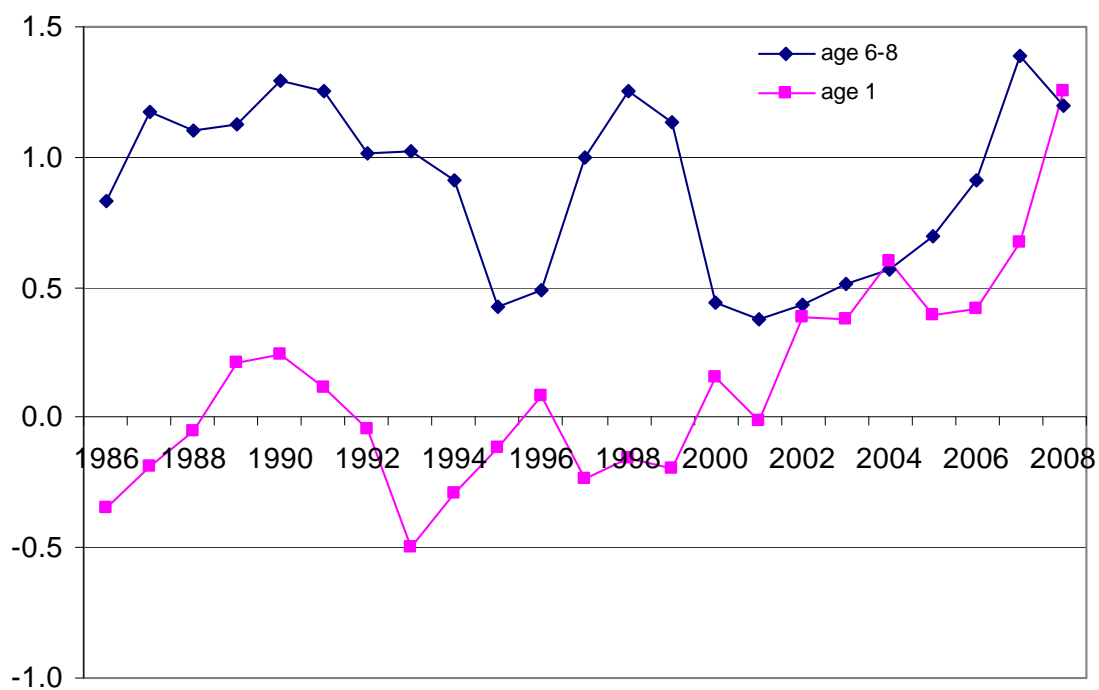


Figure 20a: Smoothed estimates of total mortality for Scotian Shelf silver hake from the Canadian July groundfish research vessel survey numbers, 1986-2008.

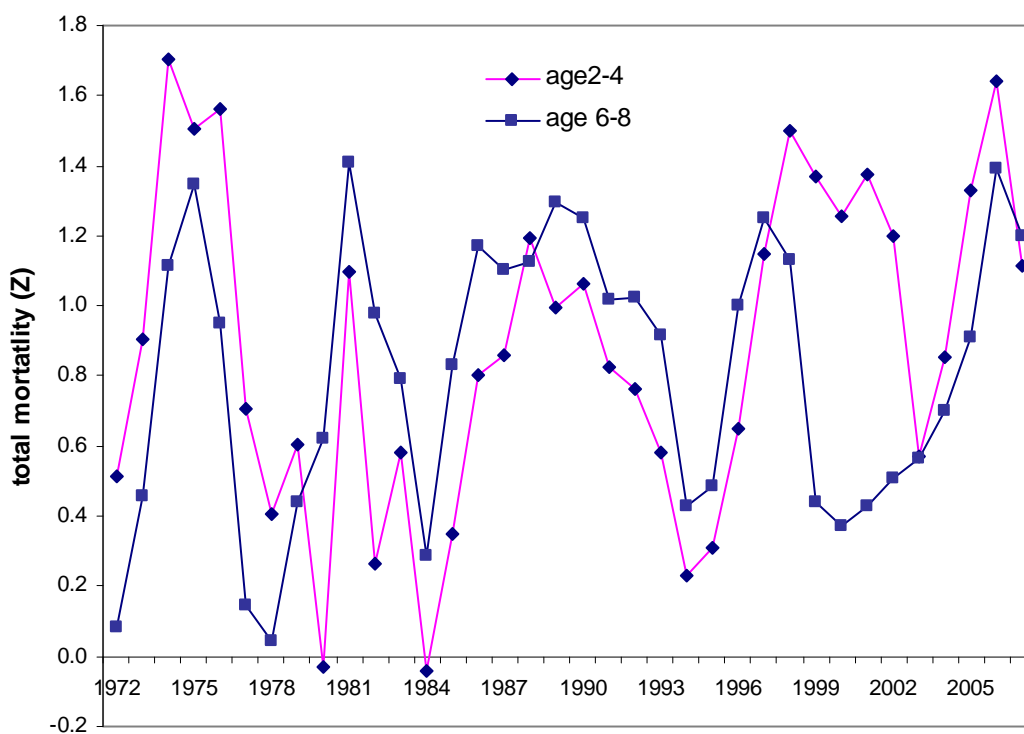


Figure 20b: Smoothed estimates of total mortality for Scotian Shelf silver hake from the Canadian July groundfish research vessel survey numbers, 1972-2008.

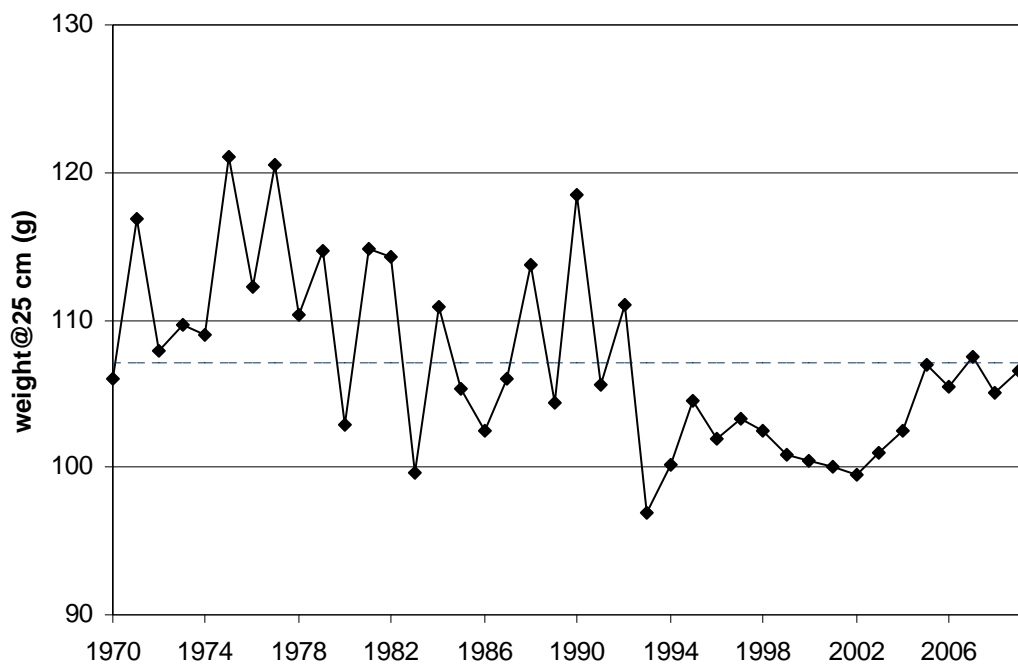


Figure 21: Condition factor (predicted weight at 25 cm) for Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data. (Note: Dotted line is average for the time series.)

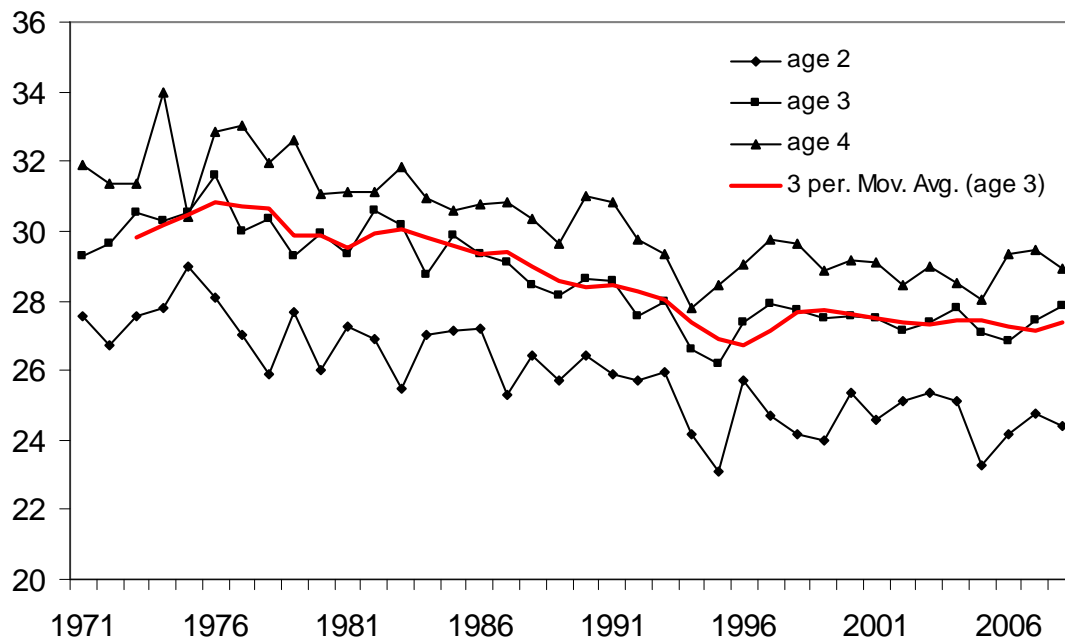
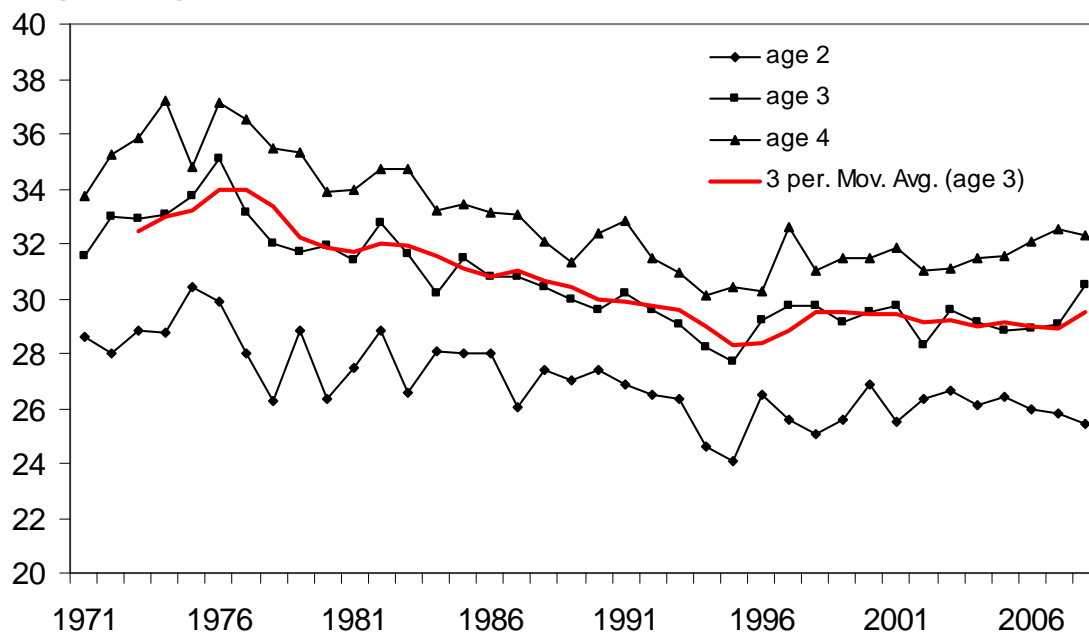
**Length at age (cm) - male****Length at age (cm) - female**

Figure 22: Mean length-at-age for Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data, 1971-2008.

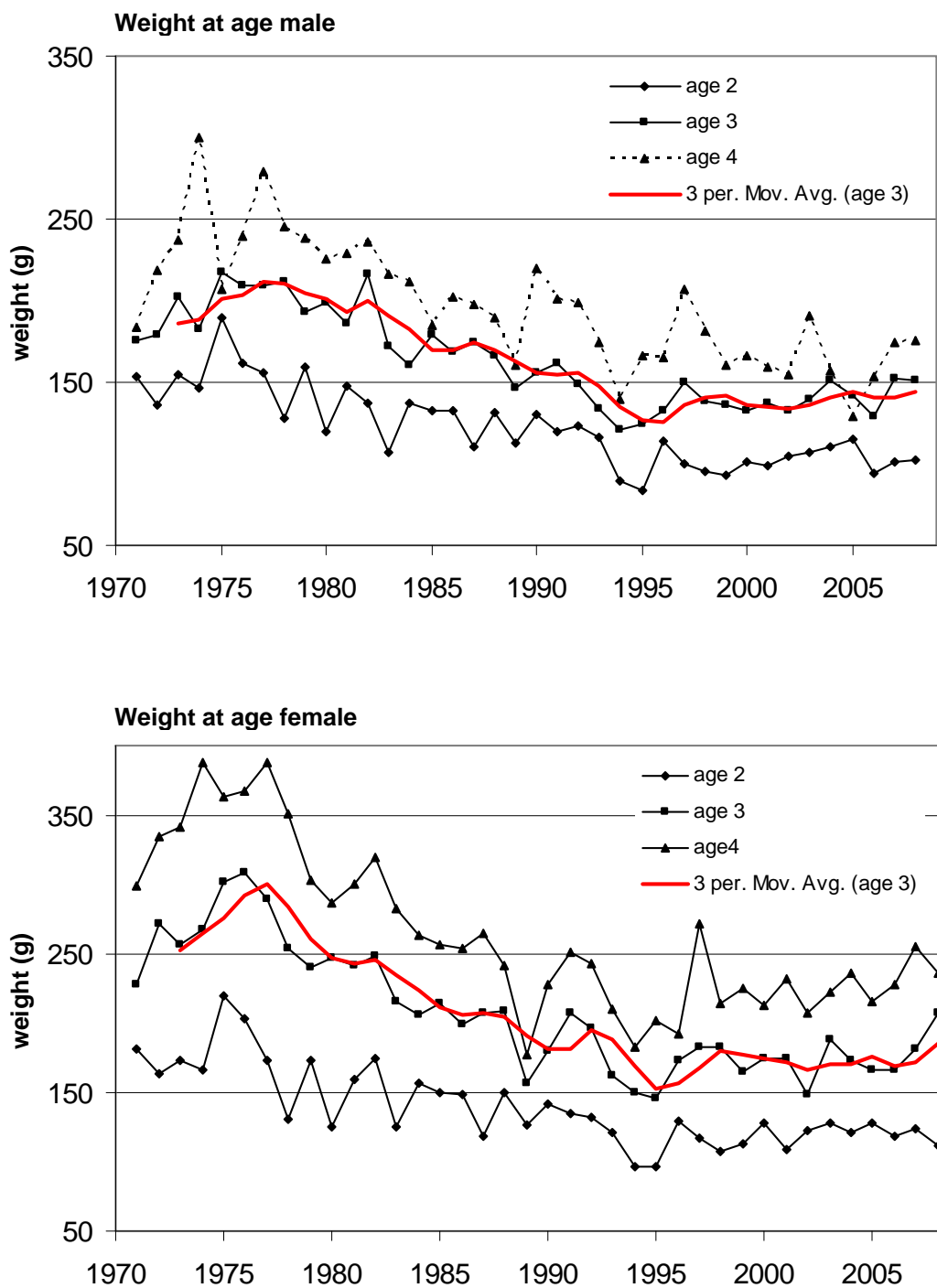


Figure 23: Mean weight-at-age for Scotian Shelf silver hake from the Canadian July groundfish research vessel survey data, 1971-2008.

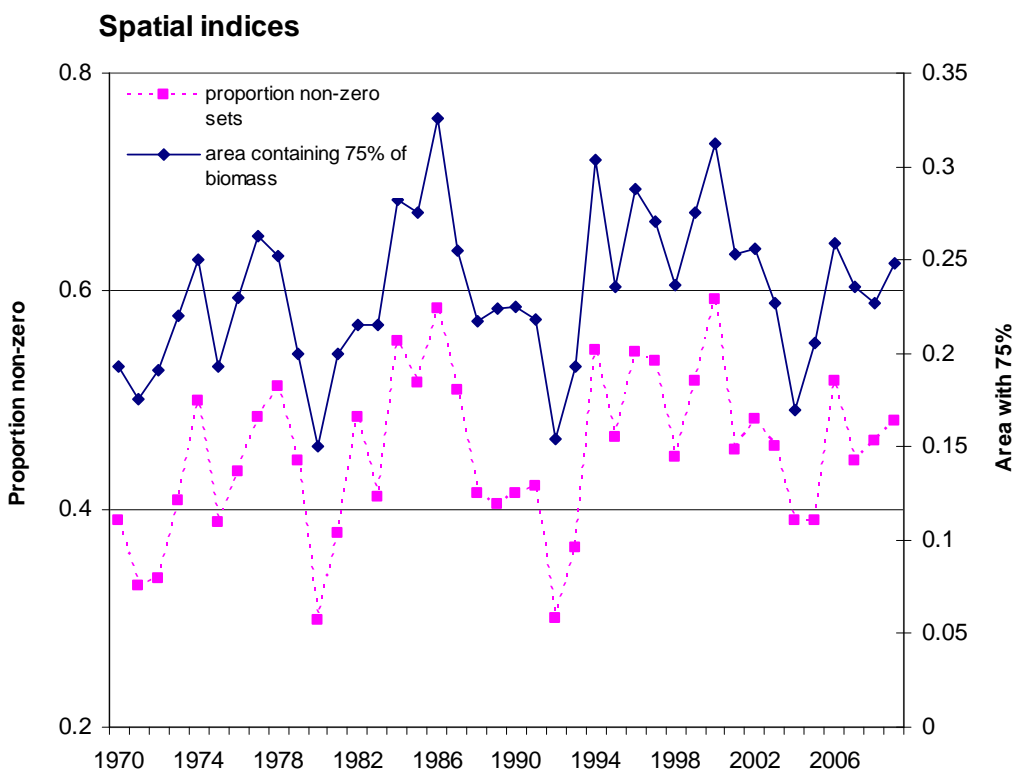


Figure 24: Indices of spatial distribution Scotian Shelf silver hake from the Canadian July groundfish research vessel survey, 1971-2009.

## APPENDIX

Appendix A: Results of age comparison between 2009 and previous 3 years.

Ager1 (x)	Ager2 (y)											
	0	1	2	3	4	5	6	7	8	9	10	Total
0	6	0	0	0	0	0	0	0	0	0	0	6
1	0	64	1	0	0	0	0	0	0	0	0	65
2	0	0	38	2	0	0	0	0	0	0	0	40
3	0	0	3	26	8	0	0	0	0	0	0	37
4	0	0	0	6	18	1	1	0	0	0	0	26
5	0	0	0	0	4	11	3	0	0	0	0	18
6	0	0	0	0	0	0	2	0	0	0	0	2
7	0	0	0	0	0	0	0	2	0	0	0	2
8	0	0	0	0	0	0	0	0	1	1	0	2
9	0	0	0	0	0	0	0	0	0	1	0	1
10	0	0	0	0	0	0	0	0	0	0	1	1
Total	6	64	42	34	30	12	6	2	1	2	1	200

Ager 1 Versus Ager 2

