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The Status of White Hake (*Urophycis tenuis*, Mitchill) in the Southern Gulf of St. Lawrence (NAFO Division 4T) in 2000

L'état du stock de merluche blanche (*Urophycis tenuis*, Mitchill) dans le sud du golfe du Saint-Laurent (division 4T de l'OPANO) en 2000

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1 - Abstract

The latest survey results indicate that the abundance of white hake in NAFO Div. 4T has increased because of increasing recruitment. However, the low abundance of commercial-size fish, below average estimate of population biomass, and the evidence which suggests that the distribution of white hake has become more concentrated during the 1990's is a concern. The research survey results are consistent with an analysis of the catch rates by longliners participating in the Sentinel Survey Project, which revealed a significant decline in 2000 to the lowest level in the series. Furthermore, the survey and SPA results indicate that the abundance of the 'Strait' component, which has yielded the majority (90%) of the landings of white hake in NAFO Div. 4T, declined to its lowest level in 2000. This resource appears to be in the early stages of a potential recovery but the short-term prospects are not encouraging because it will take a few years for the promising signs of recruitment to contribute significantly to the fishable population. Although the reported landings during the moratorium have been low, estimates of total mortality for 1999 and 2000 were high suggesting that removals from all sources may still be excessive.

1 - Résumé

Les résultats des derniers relevés indiquent que l'abondance de la merluche blanche dans la division 4T de l'OPANO a augmenté en raison d'une hausse du recrutement. En revanche, la faible abondance de poissons de taille commerciale, une valeur estimée de la biomasse de la population inférieure à la moyenne et des indices selon lesquels la distribution de la merluche blanche serait devenue plus concentrée au cours des années 1990 constituent des sources de préoccupation. Les résultats du relevé de recherche corroborent une analyse des taux de captures des palangriers participant au Programme de pêches sentinelles, suivant laquelle il y a eu, en 2000, une baisse marquée de l'abondance, qui a atteint les niveaux les plus bas de la série. De plus, les résultats du relevé et de l'analyse séquentielle de la population (ASP) montrent que l'abondance de la « composante du détroit », dont provenaient la plupart des débarquements de merluche blanche de la division 4T de l'OPANO (90 %), a chuté à son niveau le plus bas en 2000. Cette ressource semble aux premiers stades d'un rétablissement potentiel; cependant, à court terme, les perspectives sont peu encourageantes, car il faudra attendre quelques années avant que les indices prometteurs d'une hausse du recrutement ne contribuent de façon significative à la population exploitable. Même si les débarquements déclarés au cours du moratoire ont été faibles, on estime que la mortalité totale en 1999 et en 2000 a été très élevée; ce qui porte à croire que les prélèvements de toutes sources seraient encore excessifs.

2 - Introduction

White hake (*Urophycis tenuis*, Mitchill) has historically been the third or fourth most important groundfish resource in the southern Gulf of St. Lawrence (NAFO Div. 4T), with annual landings that averaged 5,675 t from 1960-1994 (Table 1). This resource was not managed by a TAC (Total Allowable Catch) until the precautionary quota of 12,000 tonnes was established for the 1982 fishery. The TAC was subsequently reduced on five occasions: to 9,400 t in 1987, to 5,500 t in 1988, to 3,600 t in 1993, to 2,000 t in 1994, and most recently to 0 t (moratorium) in 1995 (Table 1).

The stock structure of white hake in the southern Gulf is not completely understood. The combined evidence from a discriminant function analysis of morphometric and meristic characters (Hurlbut 1990; Hurlbut and Clay 1990A), seasonal and annual distributional studies (Clay 1991; Clay and Hurlbut 1989) and a tagging study (Kohler 1971) suggests that the management unit for white hake in NAFO Div. 4T is composed of two different stock components:

- (1) fish from the shallow, inshore southern Gulf (depths \leq 100m), principally the Northumberland Strait area (the 'Strait' component)
- (2) fish from along the Laurentian Channel in depths in excess of 200 m (the 'Channel' component).

The extent of mixing between these two stock components is presently unknown and there is uncertainty concerning the stock affiliation of the hake that occur in depths between 100-200 m. During the February 2001 Regional Assessment Process meeting, the subcommittee recommended that until these uncertainties concerning stock structure can be resolved, it may be prudent to consider white hake in NAFO Div. 4T as a stock complex.

Clay (1991) inferred the annual migration pattern of white hake in the southern Gulf from six seasonal surveys of the south-eastern Gulf (Sept. 86, Dec. 86, Jan. 87, May 87, June 87 and Sept. 87). His analysis indicated that as the shallow waters of the southern Gulf cool in the fall, the inshore 'Strait' fish, which had been acclimated to warmer waters (10-15°C), migrate into the deep (> 200 m), relatively warm (4-5°C) water of the Laurentian Channel. He suggested that this is the probable overwintering area for three groups of white hake: those from both the inshore and offshore components of the southern Gulf (eg., 'Strait' and 'Channel' groups) and those from the northern Gulf (NAFO Div's. 4R and 4S). Subsequently, six seasonal surveys of the south-western Gulf (Sept. 89, Dec. 89, June 90, Sept. 90, Nov. 90 and Apr. 91) were conducted to describe the seasonal distribution of fish in this area. Like the surveys of the south-eastern Gulf, the results from these surveys indicated that the hake left the shallow south-western Gulf sometime between Nov. and Dec. and returned sometime between April and May.

Morin and Hurlbut (1994) conducted an analysis of the distribution of white hake from survey data for the northern and southern Gulf (fall and winter) which confirmed that hake increasingly occupy the deeper, eastern portion of the Gulf in winter, and that their distribution appears to be continuous with divisions and subareas outside of the Gulf, including NAFO Div's. 4Vn and 3Pn. The results of these studies suggest that any directed fishing for white hake in NAFO 4Vn in late Nov. and Dec., or before mid-June, may result in mortality and unaccounted catches to white hake that originated in NAFO Div. 4T.

After extensive consultations with industry, the Fisheries Resource Conservation Council (F.R.C.C.) recommended "that there be no directed fishing for NAFO Div. 4T white hake in 1995, and that by-catches be kept to the lowest possible level". The council also recommended that "measures be taken to avoid catches of small hake in smelt and eel traps". In response to these recommendations, the Minister of the Department of Fisheries and Oceans (D.F.O.) announced (Dec. 21, 1994) the closure of the fishery for white hake in NAFO Div. 4T in 1995. He also announced conservation measures beyond the F.R.C.C. recommendations, including the closure of directed fishing for white hake in NAFO Div's. 4RS, 3Pn and 4Vn (January to April). The white hake fishery in NAFO Div. 4T has remained under moratorium since 1995, with the only removals occurring as by-catch or landings in the sentinel survey and recreational fishery. The present document reviews the status of white hake in NAFO Div. 4T in 2000.

3 - Description of Fisheries

A) Landings

From 1961-1978, the landings were relatively stable and ranged from 3,600-7,200 t (Table 1 and Figure 1a). The landings rose sharply from 1979 to 1981 and peaked at 14,039 t in 1981. This increase in landings was attributed to increased fishing effort rather than an increase in the abundance of white hake (Anon 1982). Fishing effort increased because of changes in market conditions (Metuzals and Fullerton 1981) and the general expansion of inshore and nearshore fisheries that occurred throughout the Atlantic provinces after 1976 (Anon 1983). Landings declined almost every year after 1981 to 1,036 t in 1994. Since 1991, landings have been lower than the average of 4,878 t for the period from 1960-2000. The TAC has never been exceeded.

Since the moratorium on directed fishing for white hake in NAFO Div. 4T, the nominal landings have ranged in magnitude from 70 t in 1995 to 399 t in 1999 (Tables 1, 2a-4a and Figure 1a). The provisional landings in 2000 were 300 t. During the moratorium, approximately one-third of the total landings in NAFO Div. 4T have been made in the sentinel survey, of which approximately two-thirds were made by longliners in St. George's Bay, N.S. The total landings of white hake in the sentinel survey were 116 t, 88 t and 47 t in 1998, 1999 and 2000 respectively (Tables 2c-4c). The proportion of the total landings attributable to the sentinel survey has declined each year since 1996 (from 68% in 1996 to 16% in 2000), while the proportion attributable to by-catches in other fisheries has increased.

Since 1960, gillnets have accounted for 30% of the landings of white hake in NAFO Div. 4T, and bottom trawls for 26% (Table 1 and Figure 1b). Over the same time period, longlines and seines have accounted for 15% and 11% respectively. However, since 1999, mobile gears have collectively accounted for a greatly reduced proportion of the landings (< 21%), and the proportion taken by gillnets has also declined considerably. Although greater than the historical average, the proportion taken by longlines since 1999 has also decreased. Since 1960, handlines have accounted for only 2% of the reported landings of white hake, but in 1999 and 2000, estimates indicate that the proportion attributable to handlines increased dramatically (to 40% and 45% respectively). This increase, which was reported to have primarily occurred in the recreational fishery off P.E.I., reflects a dedicated effort by DFO field staff to estimate the quantity of landings from this source in 1999 and 2000 (These estimates used the number of registered licenses in the recreational fishery in each fishing port on P.E.I., expanded by estimates of the average quantity of hake caught per week during the recreational fishery). During the February 2001 Regional Assessment Process meeting, industry members expressed considerable skepticism about the reliability and accuracy of these estimates, feeling that they are extreme overestimates. It was reported that the P.E.I. Dept. of Fisheries, Aquaculture and Environment made some cursory estimates of the quantity of groundfish landed in the recreational fishery by the tourist boat industry in 1996 and 1997. They estimated that no more than 20 tonnes of hake per year were landed by tourist boat participants in the recreational groundfish fishery off P.E.I. It was recommended that the estimates for 1999 and 2000 be verified and corrected, if necessary. Since 1999, the majority of the landings (> 60%) have been made in July and August (Tables 2a and 3a).

The DFO statistical system determines the directed species of a fishing trip by the main species landed. A breakdown of the landings from 1998 to 2000, by main species and month, is given in Tables 2b-4b. The majority of the hake landed each year came from trips where hake was the main species landed. Most of the remaining landings were taken on trips where winter flounder, cod or herring were the main species landed.

We allocated the NAFO Div. 4T white hake landings (1985-2000) to the 'Strait' and 'Channel' stock components by the statistical unit areas (Figure 2) in which they were landed. Unit areas in the southern Gulf where the bottom depths were predominately less than 100 m were considered to be occupied by the 'Strait' component, and those bordering the Laurentian Channel with depths that approached and exceeded 200 m were regarded as being occupied by the 'Channel' component.

Since 1985, the majority (90%) of the white hake landings in the southern Gulf of St. Lawrence (NAFO Div. 4T) have been from the 'Strait' component of the stock (unit areas 4Tg, 4Th, 4Tj, 4Ti, 4Tm and 4Tn - Figure 3) and in 2000, 39% of the total landings came from unit area 4Tg alone. From 1985 - 2000, annual landings from the unit areas that encompass the 'Channel' component (unit areas 4Tf, 4Tk, 4To, 4Tp and 4Tq - Figure 3) have averaged less than 10% of the total landings; however, the landings for unit areas 4Tf and possibly 4Tk, probably include hake from the 'Strait' component that were caught while migrating through these unit areas, or were from the shallower parts (eg., < 200 m depth) of these unit areas.

With the exception of NAFO Div. 4X, the reported landings of white hake in most of the neighbouring NAFO divisions in Atlantic Canada have been at a low level, not exceeding 1,000 t since the early 1990's (Figure 4). In NAFO Div. 4X, the reported landings have exhibited a declining trend since 1987, and have not exceeded 3,000 t since 1995.

B) Management Measures Relevant to White Hake in the southern Gulf in 2000

As previously mentioned, the white hake fishery in NAFO Div. 4T has remained under moratorium since 1995, with the only removals occurring as by-catch or landings in the sentinel survey and recreational fishery.

In 1999 and 2000, the daily by-catch level for white hake was 20% for both the fixed and mobile gear sectors in the southern Gulf. In addition to the by-catch protocol, a small fish protocol was enforced. If a fleet sector exceeded 15% in number of "small" fish, the groundfish fishery would be closed. The target fish size agreed to by industry for white hake was 45 cm. The minimum mesh size for mobile gears (<14 m (45 feet) in the Northumberland Strait, Chaleur Bay/Miscou and Magdalen Is. areas was 140 mm (square mesh), and 155 mm (square mesh) in all other areas of NAFO 4T. To further minimize the by-catch of white hake, restrictive fishing seasons for both the fixed and mobile gear sectors directed at other species were implemented. The purpose of this management measure was to permit hake migration to be completed before opening the area to any other groundfish fishing activity. The fishing season for mobile gears in the eastern portion of the Northumberland Strait was adjusted to open on July 15 to allow hake to spawn. Furthermore, aside from the sentinel survey, there has not been a longline fishery in St. George's Bay since the establishment of the moratorium.

The recreational groundfish fishery in the southern Gulf was opened between June 19 and Sept. 8, 2000. Management measures for this fishery were the same as in 1998 and 1999: maximum daily bag limit of 5 fish per person with a vessel limit of 25 fish.

The DFO has also enforced a licensing condition that required fishers directing for smelts in the fall and winter fisheries to sort and release all groundfish (eg. primarily white hake and winter flounder) from their fishing gear.

C) Descriptions from Industry of the Fisheries for White Hake in 2000

i) End of Season Telephone Survey

A telephone survey of harvesters that were active in the groundfish fishery in the southern Gulf in 2000 was conducted from Nov. 20 to Dec. 20, 2000 (Hurlbut & Daigle 2001). The primary purpose of the survey was to obtain their views and opinions on groundfish abundance for inclusion in stock assessments.

The interview subjects were selected from a list of all of the southern Gulf purchase slips that were received and processed by Nov. 15, 2000. This list identified 760 harvesters from New Brunswick, Nova Scotia, Prince Edward Island, Quebec and the Magdalen Islands. Of the 200 respondents that were interviewed (26%), seven (4%) indicated that they directed for white hake to some extent in 2000 (eg. white hake was their second or third priority). None of the respondents identified white hake as their first

priority. Two of the seven respondents (29%) were participants in the 2000 sentinel survey, and 5 of them (71%) indicated that they fished in the recreational fishery.

The geographical distribution of the 7 respondents who indicated that they fished for white hake 'most of the time' in 2000 is shown in Figure 5 (4 of the 7 respondents were from statistical districts located in unit area 4Tg, where the majority of the hake landings occurred in 2000). The preponderance (86%) of these respondents fished fixed gears (4 gillnets, 2 longlines, and 1 otter trawl).

The respondents were asked to compare the abundance of white hake in 2000 with its abundance in three previous time periods (in 1999, from 1995 to 1999, and in all of their years fishing commercially for white hake). Three out of five of the respondents that expressed an opinion regarded the abundance of white hake as higher or much higher in 2000 than in 1999, and two felt that the abundance was the same in both years (2 of the 7 respondents indicated that they had no opinion on this question (Figure 6)). All 4 of the respondents that expressed an opinion described the abundance as higher or much higher in 2000 than during the period from 1995 to 1999 (Figure 7). Two of the 7 respondents indicated they had no opinion on this question and one indicated that it was not applicable to him. When asked to relate the abundance of white hake in 2000 with its abundance during all of the years that they fished for this species, all 5 of the respondents that expressed an opinion considered its abundance as the same or higher in 2000 (Figure 8). Again, 2 of the 7 respondents indicated that they had no opinion on this question. The findings of this survey were generally consistent with those of previous surveys (1996-1999), in which most of the respondents have tended to view the abundance of white hake favourably relative to previous years.

4 - Fishery Data

A) Commercial Samples and Age Determination

Commercial port samples of NAFO Div. 4T white hake have been obtained according to previously established protocols (Clay et al. 1985; Clay and Hurlbut 1989; Clay and Clay 1991). Since the moratorium, it has been considerably difficult to obtain samples of the white hake by-catch in the southern Gulf. Ten samples were obtained by DFO port samplers in 2000 (721 fish measured and 304 otolith pairs), fourteen in 1999 (1,075 fish measured and 346 otolith pairs) and only nine in 1998 (833 fish measured and 283 otolith pairs). The majority of these samples (76% of the fish measured and 67% of the otoliths) were obtained from unit areas occupied by the 'Strait' component.

As a result of the difficulty of obtaining samples of the white hake by-catch during the moratorium, we incorporated sampling data from the 1998-2000 sentinel survey program and the observer program. These data were obtained at sea by trained fishery observers and sentinel harvesters. All of the otolith samples that were aged, were obtained from unit areas occupied by the 'Strait' component. The observer samples were collected on a set-by-set basis, whereas the commercial port samples were collected on a trip-by-trip basis. The set-by-set observer samples were weighted by the catch in the set, then combined within trips and weighted by the observer estimate of the trip catch.

Quality control tests were conducted throughout the period of age determination in 1998, 1999 and 2000. These tests involve the blind ageing of two randomly selected trays (50 otoliths per tray) from the reference collection. Recently assigned ages (commercial or research vessel) are accepted if agreement on the tests exceeds 75% and if age bias plots do not indicate the presence of age estimation bias (Figure 9); otherwise the ages are discarded and the reader re-calibrates with otoliths from the reference collection. Although marginal in 1998, agreement with the reference ager was acceptable each year and age estimation bias was not detected (Table 5 and Figure 9). The coefficient of variation is considered to be a more robust measure of the precision of age determination (Campana et al. 1995). The coefficients of variation averaged 16.0, 12.4 and 9.0 in 1998, 1999 and 2000.

B) *Catch, Weight and Length-at-age in 1998, 1999 and 2000*

Even though samples from the sentinel survey and observer program were included in the analysis, it was not possible to maintain the Jan.-July and Aug.-Dec. stratification by gear, used in previous assessments because of the limited sampling coverage. Whenever possible, the catch-at-age was calculated separately for the by-catch and sentinel survey gear components (eg. lengths from the by-catch fishery and sentinel survey were not combined). However, the complete lack of samples from the longline by-catch fishery in 1998, and the shortage of samples from the same fishery in 1999, necessitated the computation of a combined catch-at-age for this gear component (eg. ages and lengths from the by-catch fishery and sentinel survey were combined). The shortage of samples also required the computation of a combined catch-at-age for the two mobile gears (otter trawls and seines), as was required in previous assessments. A separate catch-at-age was also calculated for mobile gears in the sentinel survey when small mesh (60 mm) liners were used. Age samples were combined within the mobile and fixed gears to augment the age keys.

A summary of the sampling data used in constructing the 1998-2000 catches-at-age is given in Tables 6a-c. The conversion of length to weight was based on the length-weight regression obtained from the annual (Sept.) groundfish survey of NAFO Div. 4T (Tables 6a-c). The catch-at-age, mean weight-at-age and mean length-at-age for 1998-2000 are shown in Tables 7a-c. The time series of catches-at-age, mean weights-at-age and mean lengths-at-age from 1982-2000 are found in Table 8.

Following the establishment of the moratorium in 1995, the landings gradually increased and the total number of white hake landed increased each year until 2000, when it declined with the reduction in landings (Table 8a and Figure 10a). The catch-at-age for 2000 was composed of a limited number of ages (ages 1-9), and was dominated by ages 5 and 6 (the 1994 and 1995 year-classes), as it has been since the mid-1990's (Table 8a and Figure 10a and b). Since 1982, the landings have been composed principally of age 4+ hake, but the proportion of older hake (eg., age 6+) has diminished since 1989, and the unusually high proportion of older hake (eg., age 6+) noted in 1995, did not persist.(Figure 10c).

The mean weights-at-age for ages 4 and 5 declined to minima in 1992, after which they have tended to increase (Figure 11). The mean weight-at-age for age 6 hake reached a minimum in 1991, after which it has also exhibited an increasing trend. If size-at-age varies in a density-dependent manner, we would expect that all of the age classes would exhibit an increasing trend in mean weight-at-age in recent years, as stock size has declined to historical low levels. We would also anticipate an increasing trend in mean weight-at-age for most of the age groups in recent years with the increased mesh sizes in use. The failure to observe this trend is perplexing.

5 - Research Data

A) *Fall Groundfish Survey of 2000*

Research vessel surveys have been conducted every autumn since 1971 in the southern Gulf of St. Lawrence to provide an index of groundfish stock abundance. A stratified random survey design has been maintained, except for the period from 1984-1987, when randomly chosen fixed stations were surveyed. The surveys are conducted in the month of Sept., before groundfish commence their migration out of the Gulf. Survey procedures and protocols are standardized and documented in Hurlbut and Clay (1990B).

The survey strata for the fall groundfish abundance survey are shown in Figure 12. In 1984, three inshore strata (401-403) were added to the 24 strata (415-439) that had been fished since 1971 (Figure 12). However, much of stratum 402 (central portion of the Northumberland Strait) has been unfishable in Sept. due to lobster gear, and this stratum was not occupied in 1989, 1991, 1994 and 1995. Consequently, the abundance index for NAFO Div. 4T white hake was revised in the mid-1990's to include strata 401, 403 and 415-439.

During the 2000 survey (N045), 198 valid sets were made by the research vessel *Alfred Needler* in NAFO Div. 4T. At 21 locations, fishing sets were made both during the day and the night. These sets

were part of a multi-year experiment designed to determine whether daylight affects survey catch rates of American plaice and white hake.

i) Geographic Distribution

During the annual (Sept.) abundance surveys of the southern Gulf, white hake have tended to exhibit a disjunct distribution, with concentrations occurring in warmer waters, either in shallow inshore areas or in deep water along the Laurentian Channel (Figure 13). The constancy of this disjunct distribution pattern from year to year lends support to the contention that there are separate stock components inhabiting the Strait and Channel areas in Sept. In the 2000 survey, four sets in stratum 437 (Cape Breton Trough) yielded the greatest numbers of white hake (range from 99-849 fish). The main areas of concentration in 2000 were the Cape Breton Trough, along the Laurentian Channel (strata 437, 439 and 425) and St. George's Bay (stratum 403). The information from the 1994 and 1995 surveys, which extended into NAFO 4Vn, suggested that the distribution of white hake is continuous between this area and NAFO 4T (Hurlbut et al. 1996). White hake have seldom been caught in the shallow, central zone adjacent to the Magdalen Islands. Previously, hake were usually encountered in the Shediac Valley (strata 420-422), but they were again virtually absent from that area in 2000. Few white hake have been caught in the western part of the southern Gulf since 1991, suggesting that there may have been a contraction of the geographic range.

The proportion of the total survey area occupied by the top 75th and 95th percentiles of the total population has been interpreted as an index of population concentration. Swain and Sinclair (1994) showed, that for cod, this index was positively correlated with changes in overall population abundance (the area occupied by the top 95th percentile of the population was highly correlated with population abundance but the correlation with the area occupied by the top 50th percentile of the population was low). For white hake in NAFO Div. 4T, there has been a declining trend in the proportion of the total survey area occupied by the top 75th and 95th percentiles of the population since 1984, suggesting that this resource has become more concentrated (Figure 14a).

The overall prevalence of white hake in NAFO Div. 4T, as indicated by the proportion of the total number of non-zero survey sets, shows a declining trend from a level around 45% in 1984 to about 22% in 1994, after which it has fluctuated at a low level (< 27%) (Figure 14b).

ii) Length and Age Composition of Survey Catches

Length frequencies and the stratified mean catch per tow-at-age for the entire series of abundance surveys of the southern Gulf were calculated using the research vessel analysis (RVAN) programs written in SAS/IML (SAS Institute Inc. 1989) (Figure 15 and Table 9).

The 2000 length frequency is markedly different from any seen in recent years (Figure 15). The abundance of incoming year-classes (between 30 and 40 cm) appears to be considerably higher than observed since the early-1990's. The modes at 31 and 38 cm likely correspond to the modes at 22 and 32 cm respectively in the 1999 length frequency, but the relationship of the other modes to previous years is not clear. Few or no 0-group fish (< 10 cm) have been caught since the 1996 survey, and the abundance of commercial-size fish (\geq the small fish protocol size of 45 cm) decreased in 2000. Examination of the length frequencies for the two stock components reveals a substantial difference in the numbers of small fish (30-45 cm) and reflects the importance of the four large sets made in stratum 437 in the Cape Breton Trough ('Channel' component).

Since 1984, when the most abundant age groups in the survey were ages 3-5, there has been a tendency for the most abundant age groups in the survey to be younger, so that in the most recent years, the most abundant age groups have been ages 1-4 (Table 9). The catch-at-age for 2000 indicates the greatest abundance of age 2 white hake (1998 year-class) in the history of the survey, and the greatest abundance of ages 3 and 4 (1996 and 1997 year-classes) since 1989 (Table 9 and Figures 16a and b). The abundance of ages 3 and 4 declined sharply from 1992 to 1993 (Figure 16b) and it appears that the abundance of age 5⁺ hake underwent a rapid decline from 1991 to 1992 (Figure 16c).

Figure 16d shows that the proportion (eg., percentage) of large, old white hake (age 5⁺ or 45 cm and longer) has declined to the lowest level observed in the history of this survey.

iii) Size-at-Age

The stratified mean weight-at-age and mean length-at-age were calculated using the research vessel analysis (RVAN) programs written in SAS/IML (SAS Institute Inc. 1989) (Tables 10-11).

In 2000, the mean weight-at-age for age 4 hake reached a minimum (Figure 17). The mean weight-at-age for ages 5 and 6 declined gradually after the mid-1980's until reaching a minimum in 1997. For hake ages 8 and 9, the mean weight-at-age has fluctuated greatly, and minima for the time series were reached in 1996 for both age groups (Note: the weight-at-age for ages 7⁺ may not be well estimated because of the low numbers of these age groups caught).

iv) Abundance Indices and Biomass Estimates

The stratified mean number of white hake (ages 0+) caught per tow (strata 401 and 403-439) during the 2000 survey increased to the highest level observed since 1989 (10.6 in 2000 compared to 12.7 in 1989) (Table 12 and Figure 18). This catch rate (numbers per tow) is greater than the average of 7.4 for the period 1984-2000, but the catch rate in weight per tow (4.2) was below the average (5.5) for the same time period, confirming that the higher catch rate (numbers per tow) in 2000 was mainly due to the catch of small fish (Table 12). In 2000, the estimated population numbers for NAFO Div. 4T increased to the highest level observed since 1989 but the estimated population biomass remains well below the average for the time series (Table 12 and Figure 19).

The research vessel stratified mean catch per tow, estimates of population abundance and biomass, and associated variances were also calculated for the 'Strait' and 'Channel' stock components (Tables 13a and b and Figures 20a and b). As in past assessments, the 'Strait' component was represented by a subset of shallow-water (< 100m) strata (403, 420-422, 432 and 433), located off the western and eastern coasts of P.E.I. As previously mentioned, the 'Channel' component is considered to include all hake caught in the deep-water (> 200m) along the Laurentian Channel and there is uncertainty concerning the stock affiliation of the hake captured at depths between 100-200m. This makes the selection of strata to represent the 'Channel' component problematic, because some of the strata bordering the Laurentian Channel where significant concentrations of hake occur (eg. 437, 438 and 439), have some depths between 100-200m. As in past assessments, the 'Channel' component was represented by the following subset of strata: strata 415 and 425, where the majority of the survey sets (1984-2000) have been at depths greater than 200m, stratum 437 where the majority of the sets have been at depths between 100-200m, stratum 438 where most (>75%) of the sets have been at depths between 100-200m with the balance at depths greater than 200m, and stratum 439 where most (>85%) of the sets have been at depths greater than 200m with the balance at depths between 100-200m. These subsets of the survey strata were selected because they have produced 96% of the hake caught in the surveys conducted from 1984-2000.

Since 1984, the abundance indices for the 'Strait' and 'Channel' stock components have occasionally varied in an inverse manner (i.e., one going up and the other going down, and vice-versa - Figure 20a). This tendency was most pronounced in 1988, 1989, 1996 and most recently in 2000, when the indices for the 'Strait' and 'Channel' components reached their respective historical minima and maxima. During the February 2001 Regional Assessment Process meeting, it was suggested that this inverse tendency may indicate that the two components are not distinct stocks but it was pointed out that there are almost as many instances in the time series when the indices vary in a parallel manner. A consensus was not reached on this issue but it was stressed that the most important point to be made is that the abundance estimates for the 'Strait' component, which has yielded the majority (90%) of the landings of white hake in NAFO Div. 4T since 1985, has declined to its lowest level in the time series. Similar trends are seen for the two stock components in the estimates of trawlable biomass (ages 3+), but the increase in the

trawlable biomass of the 'Channel' component in 2000 was not as pronounced as the increase in abundance (Figure 20b).

Throughout the moratorium, representatives of the fishing industry from Cape Breton and P.E.I. have frequently expressed skepticism concerning the survey estimates of abundance for white hake in NAFO Div. 4T. The industry representatives have contended that white hake were more abundant in the south-eastern Gulf than the research survey data indicated, especially in St. Georges Bay. The research vessel estimates of the mean catch per tow for the area in question (survey strata 403 and 433 - Figure 12) reveal the considerable importance of these two strata, in terms of the local abundance (density) of white hake (Figure 21 and Table 14). From 1989-1992, the local abundance of white hake in the area represented by strata 403 and 433 was well above average, but in 1993 the local abundance declined sharply and reached a minimum in 1996. The local abundance remained below average from 1997-1998, increased to above average in 1999, but declined to the second lowest level observed in the time series in 2000.

Since 1984, survey catch rates in NAFO Div's. 4Vn and 4X have been considerably higher than in NAFO Div. 4T, but in the late 1990's catch rates in all areas covered during the summer Scotian Shelf survey declined to a low level (Figure 22).

B) 2000 Sentinel Survey Program

a) General Description of the Program

Sentinel surveys (also referred to as sentinel fisheries) have been conducted in the southern Gulf of St. Lawrence since 1994. Essentially, the sentinel surveys consist of limited removals from the stock following a scientific protocol established in consultation with the industry. The objective of the program is to provide additional abundance indices for stocks under moratoria such as southern Gulf of St. Lawrence cod (4T-Vn) and southern Gulf white hake (4T). At first, the surveys were limited to a few sites and were of little value to monitor abundance trends for white hake. In 1996, following the recommendations of the F.R.C.C., the program in the southern Gulf of St. Lawrence was expanded to cover more sites, gear types and seasons. On each fishing trip, detailed information is collected by fisheries observers on the catch composition, length frequency, as well as material for age determination. A detailed description of the protocols and the results of the surveys from 1994-1998 are summarized in Chouinard et al. (1999).

In 2000, 12 sentinel survey projects were conducted in the southern Gulf. There were 6 fixed gear projects and 6 mobile gear projects involving a total of 30 and 9 vessels respectively. The amount of fishing effort (number of fishing trips) directed to the sentinel survey was approximately the same as in 1999 (617 vs. 621 trips). The total landings of white hake in the sentinel survey were 115.7 t, 87.6 t and 46.8 t in 1998, 1999 and 2000 respectively (Tables 2c-4c). The geographic distribution of fishing effort in the sentinel surveys is concentrated in traditional fishing areas that were identified by fishers. In 2000, all of the projects were underway in late July and were completed by early Oct. in Gaspé or by mid-Nov. in Nova Scotia.

The white hake catch rates for the mobile gears in the sentinel survey have typically been very low, and generally less than 10 kg/set (Hurlbut et al. 1997 and 1998). As previously mentioned, since the moratorium approximately one third of the landings of white hake in NAFO Div. 4T have been made in the sentinel survey, of which almost 75% were made by longliners. Although the sentinel surveys have been conducted in the southern Gulf of St. Lawrence since 1994, longlines have only been consistently used in the program since 1996. As a result, we decided to restrict the analysis of catch rates in the sentinel survey to those of longliners during the period since 1996.

The survey protocol has required each vessel participating in the longline project to fish at two traditional fishing areas selected by the participating fishermen (or association). Figure 23 shows the location of all of the fixed gear sentinel survey sites in 1999 (Note: New sites have been incorporated each year since 1996 and several have been discontinued. In 2000, two new sites were added off of St.

Peter's Bay on the north coast of P.E.I.). The fishing locations were 2.5 miles in radius and at least 5 miles apart. Once the locations were determined, they remained constant throughout the fishing season. Each vessel fished its gear a maximum of 18 times with a maximum frequency of twice per week, during the fishing season. The fishing days could be consecutive within each 7-day period. The protocol required the vessels in the longline project to set a maximum of 1,250 hooks (size 12 circle -1 fathom apart) at both of their sites. The soak time for longlines was a minimum of 4-6 hours and a maximum of 24 hours.

b) Catch Rate Analysis in the Longline Sentinel Survey Project

The catch rates were analyzed using a multiplicative analysis (Robson 1966; Gavaris 1980) with the SAS GLM procedure (SAS Institute Inc. 1989) to obtain chronological standardized indices of catch rates. The approach was similar to that used by Chouinard et al. (2000) in the 2000 cod assessment. Observations of catch and effort for each individual site were aggregated on a monthly basis to remove some of the variability associated with individual fishing days, yet allowing for seasonal trends in CPUE. Data cells (eg. monthly aggregates) where the catch was 0 or effort was less than one complete fishing day were eliminated from the analysis.

The model was as follows:

$$\ln A_{ijk} = B_0 + B_1 I + B_2 J + B_3 K + \varepsilon$$

where

A_{ijk} = the catch rate for year i during month j at site k

I = a matrix of 0 and 1 indicating year

J = a matrix of 0 and 1 indicating month

K = a matrix of 0 and 1 indicating site

c) Results

The model explained 85% of the variation observed (Table 15). The residuals were normally distributed.

The resulting catch rates (Figure 24) show an increasing trend from 1996 –1999 followed by a significant decline in 2000 to the lowest level in the time series. These results are consistent with the reports from some participants in the 2000 sentinel survey longline project who indicated that “the amount of white hake available (in St. George’s Bay) was much lower versus previous years” (Anon 2001). These findings are also consistent with the results of the 2000 groundfish survey, in which the catch rate for the area represented by strata 403+433 declined to its second lowest level (Figure 21).

6 - Estimation of Stock Parameters

A) Sequential Population Analysis (SPA)

Before there was evidence suggesting the existence of two stock components in the southern Gulf, SPA was conducted on all hake in the NAFO 4T management unit. Each of the previous SPA's was calibrated with a commercial catch rate series derived from purchase slip data (Clay et al. 1985 and 1986; Clay 1987; Clay and Hurlbut 1988 and 1989) and the research vessel abundance index was not used for calibration. However, with the evidence indicating separate inshore ('Strait') and offshore ('Channel') stock components in NAFO Div. 4T (Hurlbut 1990; Hurlbut and Clay 1990A), SPA's have been conducted on the 'Strait' component only, using the research vessel abundance index for the 'Strait' component as the calibration index (Hurlbut et al. 1996, 1997 and 1998). This abundance index includes strata 403, 420-422, 432 and 433 for the years 1984-2000 (Note: Earlier surveys were not included in these analyses because sample sizes were judged to be insufficient and because they did not include stratum 403 an important area for hake). For this assessment, we had hoped to include an index from the

sentinel survey catch rate analysis but were unable to because of difficulties in estimating an index for the 'Strait' component separately.

The catch-at-age for the 'Strait' component was computed as in previous assessments (Hurlbut et al. 1997 and 1998) by adjusting the catch-at-age for the whole management unit ('Strait' + 'Channel' components) by the ratio: 'Strait' Landings / 'Strait' + 'Channel' Landings

Table 16 shows the catch-at-age matrices for the 'Strait' component and the whole NAFO 4T management unit.

Several formulations of the adaptive framework (ADAPT) (Gavaris 1988) were attempted to determine the stock size in 2000, but the best fit was obtained with the following formulation:

Parameters

- Terminal N estimates: $N_{i,2000}$ $i = 3$ to 8
- Calibration coefficients for RV numbers: K_i $i = 3$ to 8
- Structure Imposed:
 - Natural Mortality = 0.2
 - Error in the catch-at-age assumed negligible
 - F on ages 9 and 10 was set equal to the average for ages 6 - 8
 - Fitted without an intercept
- Input:

$C_{i,t}$	$i = 3$ to 10 , $t = 1985 - 2000$
$RV_{i,t}$	$i = 3$ to 10 , $t = 1985 - 2000$
- Objective Function: - Minimize sum of squared residuals
- Summary:
 - Number of observations = 96
 - Number of parameters = 12

The input data to the ADAPT calibration are given in Table 17 and the parameter estimates are shown in Table 18a. The residual pattern (Figure 25) is unbalanced, with predominately negative residuals for 1986-1989 and 2000, and positive residuals for 1991, 1994-1995 and 1999. There is a distinct retrospective pattern for ages 6-8 that would tend to overestimate population numbers in 2000 (Figure 26). Furthermore, there was substantial bias about the estimates for most ages (Table 18a).

The fishing mortalities and population numbers (beginning of year) from the ADAPT calibration are given in Table 18b and shown in Figures 27 and 28. This analysis indicates that fishing mortality began an increasing trend in 1989 and remained at a high level until 1992, declined in 1993, but increased sharply to a peak in 1994, after which it dropped to a minimum in 1995 (moratorium). Following the closure of the fishery, the estimates of fishing mortality increased in 1996 and 1997, declined in 1998 and 1999, but increased again in 2000. This analysis also indicates that population abundance was relatively stable from 1985-1989 (12.1-13.5 million fish), but declined rapidly from 1990-1993 and reached a minimum in 1995 at just over 0.5 million fish. The estimates of population size increased marginally from 1996-1999 but declined in 2000 to a level comparable to 1998.

The estimates of beginning of year population numbers from the ADAPT calibration were compared with the population estimates for the 'Strait' component from the research vessel survey (Figure 29). These estimates, which were not adjusted for differences in catchability, were dissimilar from 1985-1988, converged in 1989 and 1990, and then remained divergent from 1991-1992. From 1993-1999, the research vessel estimates were consistently higher than the estimates from ADAPT, but the estimates converged in 2000, both indicating a beginning of year population size of approximately 1.0 to 1.5 million fish.

B) Estimation of Mortality Rates by Alternate Methods

Relative trends in fishing mortality-at-age (R_a), were estimated using a variation of the method described by Sinclair (1998) and the ratio of the commercial catch-at-age (C_a) to the RV catch-at-age (A_a):

$$R_a = C_a/A_a$$

The results were compiled for the whole management unit (NAFO 4T) and for the 'Strait' component (Figure 30). From 1984-1994, the estimates of relative fishing mortality for NAFO 4T white hake (ages 5-7) were quite high and variable, relative to the period since. Maxima were reached for ages 4-7 in 1992, after which the estimates declined rapidly to near minimum values in 1995, coincident with the beginning of the moratorium. The estimates remained at a low level from 1996 to 1999 but increased sharply in 2000 for ages 6 and 7. For the same age groups from the 'Strait' component, the estimates of relative fishing mortality were considerably higher from 1984-1994 but were also quite variable. In contrast to the pattern seen for NAFO 4T hake, the estimates for the 'Strait' component tended to reach their maxima before 1992 (age 5 in 1987, age 7 in 1988, and age 6 in 1990) but there were modes in 1992 for ages 6 and 7. However, as with NAFO 4T hake, the estimated values declined rapidly after 1993 to near minimum values in 1995. The estimates of relative F increased again in 1996, and fluctuated at low levels until 2000, when the estimates for ages 5, 6 and 7 increased sharply.

The research vessel abundance index data were also analysed using a multiplicative model to obtain information on trends in total mortality, similar to that described by Sinclair (1992). The model with age and year-class as effects was of the form:

$$\ln(C_{ij}) = \beta_0 J + \beta_1 I + \varepsilon$$

where: C_{ij} is the catch of hake (standardised to a 1.75 nautical mile tow) of age i of year-class j .
 I = age category
 J = year-class category

Analyses used the GLM procedure of SAS (SAS Institute 1989). The research vessel time series was analysed in successive 3 or 4 year blocks (eg., 1985-87, 1986-88, etc.) and included ages 5 to 8.

Again, results were compared for the whole management unit (NAFO 4T) and for the 'Strait' component (Figure 31). The estimates of Z tended to fluctuate more erratically using only the 6 'Strait' strata than when all (26) NAFO 4T strata were used. Most of the estimates were near or greater than 1. There were modes for both stratum groupings in the period ending in 1993 and they both declined to minimum values in the period ending in 1998. The estimates of Z for both stratum groupings increased dramatically in the periods ending in 1999 and 2000 but there is much uncertainty about the estimates for these two years (the data are too sparse to quantify the magnitude of the increase with any certainty). For the 'Strait' component, the highest values occurred in the period ending in 1993, but the values for the period ending in 2000 were almost as high. Conversely, for NAFO 4T hake, the highest value occurred in the period ending in 2000, but the values for the period ending in 1993 were almost as high. These results are extremely surprising in view of the very low landings reported in recent years.

7 - Assessment Results

There was considerable uncertainty in the results of the sequential population analysis (SPA) conducted on the 'Strait' component. The SPA was characterized by an unbalanced residual pattern, very high bias about the parameter estimates for most of the age groups, and a pronounced retrospective pattern for ages 6-8, that would tend to overestimate population numbers in 2000. The SPA suggested

that fishing mortality was high from the late 1980's into the early 1990's, and peaked in 1994, and that the population declined rapidly in the early 1990's to a very low level where it remains in 2000. The estimates of fishing mortality from the SPA increased in 1996 and 1997, declined in 1998 and 1999, and increased again in 2000. The high SPA estimates of fishing mortality in the late 1980's and early 1990's for the 'Strait' component are consistent with the high estimates of relative F for this period, and with the disappearance of old and large fish from the population in the 1990's. The estimates of relative F fluctuated at low levels after the moratorium but increased sharply in 2000 for the oldest ages. In contrast, the estimates of total mortality (Z) suggest that it began declining in the late 1980's but increased to maximum or near-maximum values in 1993, after which it declined again to moderate values throughout the mid-1990's. In 1998, the estimates of Z reached minimum values for the 1990's after which they increased sharply in 1999 and 2000, to near-maximum values, but there is much uncertainty about the magnitude of the increase in these years. Despite the very low reported landings of white hake during the moratorium (average = 227 t), the estimates of total mortality were unexpectedly high for the most recent years. The very low indices of abundance throughout most of the 1990's (for both the 'Strait' component and for NAFO 4T as a whole), coupled with an apparent concentration of the resource also points to a very low population size in recent years.

8 - Future Prospects

The stratified mean number of white hake caught per tow (all ages) during the 2000 research survey increased to the highest level observed since 1989 (10.6 in 2000 compared to 12.7 in 1989). The catch rate in weight per tow has increased each year since 1996, when it reached a historical low for the time series (1984-2000), but it remains below the average for the time series. The length frequency from the 2000 research survey suggests that the abundance of incoming year-classes (between 30 and 40 cm, ages 2-4) may be considerably higher than observed since the early-1990's, but few or no '0-group' fish (< 10 cm) have been caught since 1996, and the abundance of commercial-size fish (≥ 45 cm and ages 5⁺) declined to the lowest level seen since 1984. The increase in the abundance index in 2000 was largely due to four sets made in a confined area of the Cape Breton Trough that yielded a relatively large number of hake between 30-40 cm. The survey abundance estimates did not increase for both of the stock components found in NAFO Div. 4T. The abundance estimate for the 'Channel' component increased sharply in 2000 to the highest level observed in the time series, but the estimate for the 'Strait' component, which has yielded the majority (90%) of the landings of white hake in NAFO Div. 4T since 1985, declined to its lowest level. Furthermore, there are indications that the distribution of the white hake resource in NAFO Div. 4T has become more concentrated during the 1990's. In addition, the analysis of the catch rates by longliners participating in the Sentinel Survey Project revealed an increasing trend from 1996 –1999, followed by a significant decline in 2000 to the lowest level in the series.

Although there was much uncertainty in the results of the sequential population analysis (SPA), it suggested that fishing mortality was high from the late 1980's into the early 1990's, peaking in 1994, and that population abundance declined rapidly in the early 1990's to a very low level where it remained in 2000. The high SPA estimates of fishing mortality in the late 1980's and early 1990's for the 'Strait' component are consistent with the high estimates of relative fishing mortality (F) for this period, and with the disappearance of old and large fish from the population in the 1990's. The estimates of relative F fluctuated at low levels after the moratorium but increased sharply in 2000 for the oldest ages. Estimates of total mortality (Z) suggest that it declined to moderate values throughout the mid-1990's reaching a minimum for the 1990's in 1998, after which they increased sharply in 1999 and 2000 to near-maximum values. Even though the directed fishery has been closed since 1995, the estimates of mortality were unexpectedly high for the most recent years.

In summary, the latest survey results indicate that the abundance of white hake in NAFO Div. 4T has increased because of increasing recruitment. However, the low abundance of commercial-size fish, below average estimates of population biomass, and the evidence which suggests that the distribution of white hake has become more concentrated during the 1990's, is a concern. The research survey results are consistent with the analysis of catch rates by longliners participating in the Sentinel Survey Project, which revealed an increasing trend from 1996 –1999, followed by a significant decline in 2000 to the lowest level in the series. Furthermore, the survey and SPA results indicate that the abundance of the

'Strait' component, which has yielded the majority of the landings of white hake in NAFO Div. 4T, declined to a very low level in 2000. While some of the indicators for this resource are showing improvement, the short-term prospects are not encouraging because it will take a few years for the promising signs of recruitment to become a fishable size.

9 - Acknowledgements

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Table 1. Nominal landings (tonnes) of white hake from NAFO Division 4T by gear, with the yearly TAC's. All data from 1998 to present are preliminary statistics.

<u>Year</u>	<u>Trawl</u>	<u>Seines</u>	<u>Gillnet</u>	<u>Longline</u>	<u>Handline</u>	<u>Other</u>	<u>Total</u>	<u>TAC</u>
1960	479	21	3	1085	87	333	2008	
1961	1430	79	309	2834	664	7	5323	
1962	1141	97	889	3827	715	575	7244	
1963	1444	71	48	0	0	4987	6550	
1964	1508	82	N/S	1	0	4615	6206	
1965	N/S	N/S	N/S	N/S	N/S	N/S	4706	
1966	2267	205	375	1870	0	2307	7024	
1967	2295	128	809	841	107	2370	6550	
1968	795	84	1734	320	146	1182	4261	
1969	1030	50	1802	467	31	828	4208	
1970	1463	382	2149	310	75	1289	5668	
1971	1523	632	1622	599	103	1228	5707	
1972	1139	863	1190	1526	79	960	5757	
1973	2468	204	1265	962	83	720	5702	
1974	1454	305	1098	264	81	414	3616	
1975	1574	306	1279	241	83	642	4125	
1976	1429	398	1147	141	42	601	3758	
1977	1227	408	1300	185	46	818	3984	
1978	1303	737	1829	314	142	500	4825	
1979	2826	912	3189	305	174	704	8110	
1980	3430	1615	4831	604	228	1715	12423	
1981	4733	1922	6174	751	48	411	14039	
1982	2885	994	4625	937	90	245	9776	12000
1983	2141	906	2959	662	91	546	7305	12000
1984	1734	588	3789	808	57	74	7050	12000
1985	1639	1008	2480	714	85	88	6014	12000
1986	1094	898	1884	979	89	4	4948	12000
1987	820	1505	2200	1692	155	0	6372	9400
1988	388	817	1923	672	76	11	3887	5500
1989	868	1689	1830	806	137	24	5354	5500
1990	771	1216	2022	1003	115	48	5175	5500
1991	1094	959	1292	1027	129	0	4501	5500
1992	955	926	914	1096	40	0	3931	5500
1993	175	98	469	711	44	0	1497	3600
1994	79	45	218	580	114	0	1036	2000
1995	30	6	27	5	2	0	70	Moratorium
1996	24	6	41	84	0	0	155	Moratorium
1997	56	13	48	74	4	0	195	Moratorium
1998*	48	27	64	97	5	0	241	Moratorium
1999*	47	36	59	96	161	0	399	Moratorium
2000*	26	28	32	79	134	0	300	Moratorium
				<u>1960-1994</u>				
Average	1518	622	1807	857	122	831	5675	
Percent	26	11	30	15	2	14	100	
				<u>1960-2000</u>				
Average	1264	519	1461	721	109	689	4878	
Percent	26	11	30	15	2	14	100	
				<u>2000</u>				
Percent	9	9	11	27	45	0	100	

N/S = Gear Type Not Specified

* = Preliminary Statistics

Table 2a. Nominal landings (tonnes) of white hake from NAFO Division 4T in 2000 by gear and month. All data are preliminary statistics.

<u>Month</u>	<u>Trawl</u>	<u>Seine</u>	<u>Gillnet</u>	<u>Line</u>	<u>H-Line</u>	<u>Total</u>	<u>Percent</u>
April	0.1	0.0	0.0	0.2	0.0	0.3	0.1
May	0.4	9.0	0.7	2.3	0.0	12.4	4.2
June	0.8	11.9	3.0	1.6	1.8	19.1	6.4
July	3.8	1.3	15.6	9.7	53.9	84.3	28.2
Aug.	7.1	0.6	1.8	27.3	63.2	99.9	33.4
Sept.	7.8	3.4	7.5	31.2	15.2	65.1	21.7
Oct.	5.8	1.7	3.2	7.2	0.0	18.0	6.0
Nov.	0.1	0.2	0.0	0.0	0.0	0.3	0.1
<u>Grand Total</u>	26.1	28.1	31.8	79.4	134.2	299.6	100.0
<u>Percent</u>	8.7	9.4	10.6	26.5	44.8	100.0	

Table 2b. Nominal landings (tonnes) of white hake from NAFO Division 4T in 2000 by main species and month. All data are preliminary statistics.

<u>Main Species</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Total</u>	<u>Percent</u>
Cod	0.3	2.9	12.3	33.1	12.4	10.4	3.6	0.2	75.2	25.1
Redfish	0.0	0.0	0.1	2.4	0.0	0.3	0.0	0.0	2.7	0.9
Halibut	0.0	0.2	0.1	0.3	0.1	0.2	0.0	0.0	1.0	0.3
Plaice	0.0	1.2	1.1	0.2	0.2	0.7	0.7	0.0	4.1	1.4
Yellowtail	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.1
Witch	0.0	6.6	0.7	0.2	0.1	2.2	0.6	0.0	10.4	3.5
Winter Fl.	0.0	0.0	0.2	3.7	3.2	4.6	2.8	0.0	14.5	4.9
Turbot	0.0	0.6	1.0	0.6	0.7	0.1	0.0	0.0	2.9	1.0
Sp. Dogfish	0.0	0.0	0.0	0.1	0.2	0.4	1.0	0.0	1.6	0.5
W. Hake	0.0	0.9	1.6	12.7	34.9	31.2	9.4	0.0	90.8	30.3
Herring	0.0	0.0	1.8	28.8	34.7	8.0	0.0	0.0	73.3	24.5
Mackerel	0.0	0.0	0.0	0.3	3.1	0.9	0.0	0.0	4.3	1.4
Soft Shell Clams	0.0	0.0	0.0	0.4	0.8	0.0	0.0	0.0	1.1	0.4
Quahaugs	0.0	0.0	0.0	1.6	0.3	0.1	0.0	0.0	2.1	0.7
Oysters	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.1
Lobster	0.0	0.0	0.1	0.0	9.3	5.6	0.0	0.0	15.0	5.0
<u>Grand Total</u>	0.3	12.4	19.1	84.3	100.0	65.1	18.0	0.3	299.6	100.0
<u>Percent</u>	0.1	4.2	6.4	28.1	33.4	21.7	6.0	0.1	100.0	

Table 2c. Nominal landings (tonnes) of white hake from NAFO Division 4T in 2000 in the Sentinel Survey. All data are preliminary statistics.

<u>Month</u>	<u>Sentinel Survey</u>							<u>Total</u>	<u>Percent</u>
	<u>Gear</u>								
	<u>Gillnet</u>	<u>Longline</u>	<u>Trawl-Unlined</u>	<u>Trawl-Lined</u>	<u>Seine-Unlined</u>	<u>Seine-Lined</u>			
June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.18
July	1.5	4.7	0.0	0.0	0.1	0.0	0.0	6.3	13.46
Aug.	1.6	16.1	0.0	0.5	0.0	0.0	0.0	18.2	39.03
Sept.	2.5	17.0	0.0	0.0	0.0	0.0	0.0	19.5	41.70
Oct.	0.2	2.0	0.1	0.1	0.1	0.1	0.1	2.5	5.39
Nov.		0.0		0.1	0.0	0.0	0.0	0.1	0.24
Dec.								0.0	0.00
<u>Total</u>	5.7	39.8	0.1	0.7	0.3	0.2	0.2	46.8	100.00
<u>Percent</u>	12.3	85.1	0.3	1.4	0.6	0.4	0.4	100.0	

Table 3a. Nominal landings (tonnes) of white hake from NAFO Division 4T in 1999 by gear and month. All data are preliminary statistics.

<u>Month</u>	<u>Trawl</u>	<u>Seine</u>	<u>Gillnet</u>	<u>Line</u>	<u>H-Line</u>	<u>Total</u>	<u>Percent</u>
April	0.0	0.0	0.0	0.1	0.0	0.1	0.0
May	0.5	0.8	0.0	1.1	0.0	2.4	0.6
June	1.7	13.7	5.6	4.6	12.5	38.1	9.5
July	7.1	3.4	22.3	10.8	57.7	101.3	25.4
Aug.	13.1	0.9	19.0	40.4	74.2	147.6	37.0
Sept.	18.4	10.8	8.0	32.4	16.5	86.1	21.6
Oct.	5.7	6.2	3.8	6.6	0.0	22.4	5.6
Nov	0.5	0.2	0.1	0.2	0.0	1.0	0.2
Dec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<u>Grand Total</u>	46.9	36.1	58.7	96.2	160.9	398.9	100.0
<u>Percent</u>	11.8	9.1	14.7	24.1	40.3	100.0	

Table 3b. Nominal landings (tonnes) of white hake from NAFO Division 4T in 1999 by main species and month. All data are preliminary statistics.

<u>Main Species</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov</u>	<u>Total</u>	<u>Percent</u>
Cod	0.1	1.4	4.9	16.4	19.0	11.2	10.2	0.5	63.7	16.0
Redfish			1.6	2.7	0.2				4.5	1.1
Halibut			0.0	0.0	0.2	0.0			0.2	0.1
Plaice		0.1	4.0	0.9	0.9	5.2	0.8	0.0	11.9	3.0
Witch		0.6	7.2	0.1	0.7	6.2	0.2		15.0	3.8
Winter Fl.		0.0	0.1	6.5	13.0	16.4	4.7		40.7	10.2
Turbot		0.5	4.8	4.0	0.1	0.1	0.0	0.3	9.8	2.5
Sp. Dogfish			0.1	0.0	0.0	0.8	2.4	0.1	3.4	0.9
W. Hake			15.4	70.6	113.6	45.9	4.0		249.5	62.5
Herring						0.1			0.1	0.0
Mackerel					0.0	0.1			0.1	0.0
<u>Grand Total</u>	0.1	2.6	38.1	101.2	147.7	86.0	22.3	0.9	398.9	100.0
<u>Percent</u>	0.0	0.7	9.6	25.4	37.0	21.6	5.6	0.2	100.0	

Table 3c. Nominal landings (tonnes) of white hake from NAFO Division 4T in 1999 in the Sentinel Survey. All data are preliminary statistics.

<u>Month</u>	<u>Sentinel Survey</u>						<u>Total</u>	<u>Percent</u>
	<u>Gillnet</u>	<u>Longline</u>	<u>Gear</u>		<u>Seine-Unlined</u>	<u>Seine-Lined</u>		
			<u>Trawl-Unlined</u>	<u>Trawl-Lined</u>				
June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July	1.9	9.4	0.0	0.0	0.2	0.0	11.5	13.2
Aug.	1.9	33.7	0.1	0.1	0.0	0.0	35.7	40.7
Sept.	5.6	28.7	0.7	0.1	0.0	0.1	35.3	40.2
Oct.	1.4	3.1	0.1	0.0	0.3	0.0	4.9	5.6
Nov.	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.3
Dec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<u>Total</u>	10.7	74.9	0.9	0.2	0.5	0.4	87.6	100.0
<u>Percent</u>	12.2	85.4	1.0	0.3	0.6	0.4	100.0	

Table 4a. Nominal landings (tonnes) of white hake from NAFO Division 4T in 1998 by gear and month. All data are preliminary statistics.

<u>Month</u>	<u>Trawl</u>	<u>Seine</u>	<u>Gillnet</u>	<u>Line</u>	<u>H-Line</u>	<u>Total</u>	<u>Percent</u>
April							0.0
May	0.5	4.6		2.9		8.1	3.3
June	1.9	8.6	1.7	2.4		14.6	6.1
July	13.6	0.4	8.2	8.7	1.7	32.5	13.5
Aug.	16.3	0.9	13.5	33.3	2.6	66.7	27.6
Sept.	8.9	0.9	26.5	41.6	0.2	78.1	32.4
Oct.	6.7	11.1	14.5	7.8		40.1	16.6
Nov	0.1	0.9	0.0	0.0		1.1	0.4
Dec.	0.0					0.0	0.0
<u>Grand Total</u>	48.1	27.4	64.4	96.8	4.5	241.2	100.0
<u>Percent</u>	19.9	11.4	26.7	40.1	1.9	100.0	

Table 4b. Nominal landings (tonnes) of white hake from NAFO Division 4T in 1998 by main species and month. All data are preliminary statistics.

<u>Main Species</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov</u>	<u>Total</u>	<u>Percent</u>
Cod	1.3	2.5	1.4	5.8	17.4	10.2	0.9		39.5	16.4
Redfish			11.5	6.1		0.0			17.6	7.3
Halibut	1.5	1.0	0.0	0.0	0.1	0.5			3.1	1.3
Plaice	0.2	2.9	0.3	1.4	0.2	0.6	0.0		5.6	2.3
Witch	4.2	5.8	0.1	0.2	0.2	0.2			10.7	4.4
Winter Fl.	0.6	0.2	3.4	8.7	9.2	5.1	0.0		27.2	11.3
Turbot	0.3	0.1	1.8	0.1	0.0	0.1	0.1		2.5	1.0
W. Hake		2.1	14.1	44.3	50.9	17.7	0.0	0.0	129.1	53.5
Sp. Dogfish			0.0	0.0	0.1	5.7	0.0		5.8	2.4
Snow Crab				0.1					0.1	0.0
<u>Grand Total</u>	8.1	14.6	32.6	66.7	78.1	40.1	1.0	0.0	241.2	100.0
<u>Percent</u>	3.4	6.1	13.5	27.7	32.4	16.6	0.4	0.0	100.0	

Table 4c. Nominal landings (tonnes) of white hake from NAFO Division 4T in 1998 in the Sentinel Survey. All data are preliminary statistics.

<u>Month</u>	<u>Sentinel Survey</u>						<u>Total</u>	<u>Percent</u>
	<u>Gillnet</u>	<u>Longline</u>	<u>Trawl-Unlined</u>	<u>Trawl-Lined</u>	<u>Seine-Unlined</u>	<u>Seine-Lined</u>		
June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July	0.8	8.6	0.0	0.0	0.1	0.0	9.5	8.2
Aug.	13.3	32.3	0.1	0.0	0.0	0.2	45.9	39.7
Sept.	12.6	33.0	0.1	0.1	0.0	0.0	45.8	39.6
Oct.	2.1	5.0	0.1	0.7	6.2	0.4	14.5	12.5
Nov.	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1
Dec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<u>Total</u>	28.9	78.9	0.3	0.8	6.3	0.6	115.7	100.0
<u>Percent</u>	24.9	68.2	0.2	0.7	5.4	0.6	100.0	

Table 5. Results of white hake ageing consistency tests conducted in 1998, 1999 and 2000.

Test Date	% Agreement With Reference Ager	Ave. C.V. Over All Ages	Age Estimation Bias
Dec. 22, 1998 (Beginning of Ageing)	69.1	16.15	No
Jan. 4, 1999 (After Ageing Research Otoliths)	77.7	12.64	No
Jan. 18, 1999 (Completion of Ageing)	71.9	19.18	No
Dec. 10, 1999 (Beginning of Ageing)	74.4	9.68	No
Jan. 4, 2000 (After Ageing Research Otoliths)	76.8	10.58	No
Jan. 20, 2000 (Completion of Ageing)	75.3	16.9	No
Nov. 24, 2000 (Beginning of Ageing)	81.4	11.72	No
Dec. 11, 2000 (After Ageing Research Otoliths)	83.0	6.23	No

Table 6a. Age-length keys that were used in the calculation of the 2000 catch-at-age for white hake in NAFO Division 4T.

<u>Key</u>	<u>Fishery</u>	<u>Samples</u>	<u>Total</u>	<u>Landings (t)</u>
1	GN - By-catch: Jan. - Dec.	GN - By-catch: Jan. - Dec. Lengths	297	26.066
		GN - By-catch & Sentinel Survey: Jan. - Dec. Ages	367	
2	GN - Sentinel Survey: Jan. - Dec.	GN - Sentinel Survey: Jan. - Dec. Lengths	2694	5.729
		GN - By-catch & Sentinel Survey: Jan. - Dec. Ages	367	
3	LL - By-catch: Jan. - Dec.	LL - By-catch: Jan. - Dec. Lengths	344	173.811
		LL - By-catch & Sentinel Survey: Jan. - Dec. Ages	516	
4	LL - Sentinel Survey: Jan. - Dec.	LL - Sentinel Survey: Jan. - Dec. Lengths	21206	39.8
		LL - By-catch & Sentinel Survey: Jan. - Dec. Ages	516	
5	OTB/SNU - By-catch: Jan. - Dec. No Liners	OTB/SNU - By-catch: Jan. - Dec. Lengths No Liners	697	52.9
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages	1088	
6	OTB/SNU - Sentinel Survey: Jan. - Dec. No Liners	OTB/SNU - Sentinel Survey: Jan. - Dec. Lengths No Liners	204	0.4
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages	1088	
7	OTB/SNU - Sentinel Survey: Jan. - Dec. Liners	OTB/SNU - Sentinel Survey: Jan. - Dec. Lengths Liners	1321	0.8
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages	1088	
			Totals:	299.6

Gear Type Abbreviations

OTB = Otter Trawl SNU = Seine GN = Gillnet LL = Longline

Length/Weight Coefficients (sexes combined) from Mission N045 (Sept. 2000)

a = 0.006216 b = 3.04872

Table 6b. Age-length keys that were used in the calculation of the 1999 catch-at-age for white hake in NAFO Division 4T.

<u>Key</u>	<u>Fishery</u>	<u>Samples</u>	<u>Total</u>	<u>Landings (t)</u>
1	GN - By-catch: Jan. - Dec.	GN - By-catch: Jan. - Dec. Lengths	389	48.016
		GN - By-catch & Sentinel Survey: Jan. - Dec. Ages	392	
2	GN - Sentinel Survey: Jan. - Dec.	GN - Sentinel Survey: Jan. - Dec. Lengths	3968	10.731
		GN - By-catch & Sentinel Survey: Jan. - Dec. Ages	392	
3	LL - By-catch & Sentinel Survey: Jan. - Dec.	LL - By-catch & Sentinel Survey: Jan. - Dec. Lengths	30922	257.142
		LL - By-catch & Sentinel Survey: Jan. - Dec. Ages	390	
4	OTB/SNU - By-catch: Jan. - Dec. No Liners	OTB/SNU - By-catch: Jan. - Dec. Lengths	1007	80.975
		OTB/SNU (By-catch + Sentinel): Jan. - Dec. Ages	436	
		No Liners		
5	OTB/SNU - Sentinel Survey: Jan. - Dec. No Liners	OTB/SNU - Sentinel Survey: Jan. - Dec. Lengths	568	1.398
		OTB/SNU (By-catch + Sentinel): Jan. - Dec. Ages	436	
		No Liners		
6	OTB/SNU - Sentinel Survey: Jan. - Dec. Liners	OTB/SNU - Sentinel Survey: Jan. - Dec. Lengths	584	0.620
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages Lined & Unlined	1218	
			Totals:	398.882

Gear Type Abbreviations

OTB = Otter Trawl SNU = Seine GN = Gillnet LL = Longline

Length/Weight Coefficients (sexes combined) from Mission N941 (Sept. 1999)

a = 0.004426 b = 3.140833

Table 6c. Age-length keys that were used in the calculation of the 1998 catch-at-age for white hake in NAFO Division 4T.

<u>Key</u>	<u>Fishery</u>	<u>Samples</u>	<u>Total</u>	<u>Landings (t)</u>
1	GN - By-catch: Jan. - Dec.	GN - By-catch: Jan. - Dec. Lengths	206	35.6
		GN - By-catch & Sentinel Survey: Jan. - Dec. Ages	379	
2	GN - Sentinel Survey: Jan. - Dec.	GN - Sentinel Survey: Jan. - Dec. Lengths	11511	28.9
		GN - By-catch & Sentinel Survey: Jan. - Dec. Ages	379	
3	LL - By-catch & Sentinel Survey: Jan. - Dec.	LL - By-catch & Sentinel Survey: Jan. - Dec. Lengths	28467	101.3
		LL - By-catch & Sentinel Survey: Jan. - Dec. Ages	550	
4	OTB/SNU - By-catch: Jan. - Dec. No Liners	OTB/SNU - By-catch: Jan. - Dec. Lengths	875	67.5
		No Liners		
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages	1264	
5	OTB/SNU - Sentinel Survey: Jan. - Dec. No Liners	OTB/SNU - Sentinel Survey: Jan. - Dec. Lengths	810	6.5
		No Liners		
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages	1264	
6	OTB/SNU - Sentinel Survey: Jan. - Dec. Liners	OTB/SNU - Sentinel Survey: Jan. - Dec. Lengths	1280	1.4
		Liners		
		All Gears (By-catch + Sentinel): Jan. - Dec. Ages	1264	
			Totals:	241.2

Gear Type Abbreviations

OTB = Otter Trawl SNU = Seine GN = Gillnet LL = Longline

Length/Weight Coefficients (sexes combined) from Mission N846 (Sept. 1998)

a = 0.004510 b = 3.140022

Table 7a. The catch, weight and length-at-age for white hake in NAFO Division 4T as estimated from observer and port sampling of the by-catch and sentinel surveys in 2000.

<u>2000 CATCH #S AT AGE (1,000's)</u>								L*=Liner NoL*=No Liner	
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comm</u>	<u>KEY 4</u> <u>LLS-Sent</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 6</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 7</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>SUM</u>	<u>CV</u>
1					0.00	0.00	0.02	0.02	173.21
2			0.00	0.11	0.02	0.00	0.48	0.61	168.92
3			0.00	1.44	0.17	0.00	0.33	1.94	155.86
4	0.05	0.05	6.82	7.08	3.61	0.03	0.57	18.21	124.20
5	2.02	0.38	20.29	9.80	12.74	0.09	0.14	45.46	122.40
6	6.23	1.26	36.25	6.74	12.19	0.08	0.05	62.79	142.84
7	2.64	0.54	20.83	3.46	3.62	0.03	0.02	31.12	166.20
8	0.69	0.20	3.51	0.52	0.71	0.01	0.00	5.65	152.53
9	0.33	0.10	0.83	0.15	0.18	0.00	0.00	1.60	126.10
10	0.06	0.02			0.00	0.00	0.00	0.08	152.48
11			0.21	0.00	0.02	0.00	0.00	0.23	196.95
12			0.05	0.02	0.00	0.00	0.00	0.07	159.34
13-16									
SUM	12.02	2.55	88.78	29.33	33.27	0.23	1.61	167.78	

<u>2000 AVERAGE WEIGHT AT AGE (KG)</u>								
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comm</u>	<u>KEY 4</u> <u>LLS-Sent</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 6</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 7</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>WEIGHTED</u> <u>AVE.WGT.</u>
1							0.11	
2				0.35			0.21	
3				0.52	0.58	0.61	0.44	
4	1.02	0.96		0.69	0.86	0.83	0.58	
5	1.73	1.70	1.32	1.15	1.32	1.28	0.97	1.30
6	2.08	2.14	2.09	1.91	1.87	1.91	1.77	2.03
7	2.54	2.64	2.55	2.33	2.26	2.55	2.14	2.50
8	2.80	2.88		2.85	2.68	3.14	2.88	
9	3.01	3.09			2.74	2.96	2.47	
10								
MEAN	2.18	2.25	2.04	1.44	1.66	1.71	0.54	

<u>2000 AVERAGE LENGTH AT AGE (KG)</u>								
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comm</u>	<u>KEY 4</u> <u>LLS-Sent</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 6</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 7</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>WEIGHTED</u> <u>AVE.LT.</u>
1							24.74	
2				35.81			30.69	
3				40.92	42.42	43.24	38.82	
4	46.07	49.67		44.78	48.00	47.56	42.16	
5	60.17	59.73	55.21	52.69	55.14	54.38	49.64	54.89
6	63.87	64.40	64.00	61.78	61.65	61.92	60.37	63.29
7	68.10	68.78	68.35	65.68	65.50	67.65	63.93	67.70
8	70.12	70.73		70.40	69.34	72.47	70.10	
9	71.76	72.24			69.98	71.56		
10								
MEAN	64.68	65.15	62.69	55.00	58.72	58.83	39.48	

Table 7b. The catch, weight and length-at-age for white hake in NAFO Division 4T as estimated from observer and port sampling of the by-catch and sentinel surveys in 1999.

<u>1999 CATCH #S AT AGE (1,000's)</u>							L*=Liner NoL*=No Liner	
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comb.</u>	<u>KEY 4</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 6</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>SUM</u>	<u>CV</u>
1				0.00	0.00	0.06	0.06	173.21
2			0.11	0.00	0.00	0.34	0.45	143.72
3			3.01	0.50	0.02	0.15	3.68	153.04
4	0.30	0.02	29.30	11.82	0.05	0.23	41.72	171.16
5	4.21	1.47	70.52	33.23	0.23	0.17	109.84	156.18
6	9.61	2.41	51.59	11.24	0.34	0.04	75.23	157.20
7	3.73	0.70	10.51	1.21	0.04	0.01	16.20	150.56
8	0.41	0.10	1.46	0.12	0.01	0.00	2.10	160.86
9	0.82	0.06	0.21	0.12	0.00	0.00	1.22	154.09
10	0.12	0.01		0.02	0.00	0.00	0.15	171.65
11				0.02	0.00	0.00	0.02	173.21
SUM	19.19	4.78	166.71	58.28	0.71	1.01	250.68	

<u>1999 AVERAGE WEIGHT AT AGE (KG)</u>							
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comb.</u>	<u>KEY 4</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 6</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>WEIGHTED</u> <u>AVE. WGT.</u>
1						0.16	
2						0.22	
3			0.56		0.55	0.48	
4		0.93	0.84		0.86	0.72	
5	1.86	1.83	1.38	1.33	1.53	1.11	1.39
6	2.63	2.33	2.03	1.96	2.36	1.93	2.11
7	2.90	2.76	2.72	2.91		2.28	2.77
8	3.12	3.03	3.36			2.71	
9	2.90	2.97				2.40	
10							
MEAN	2.52	2.26	1.66	1.43	2.00	0.63	

<u>1999 AVERAGE LENGTH AT AGE (CM.)</u>							
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comb.</u>	<u>KEY 4</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 6</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>WEIGHTED</u> <u>AVE. LT.</u>
1						28.14	
2						30.88	
3			41.92		41.39	39.98	
4		49.22	47.57		48.02	45.13	
5	61.44	60.86	55.55	54.99	57.19	51.92	55.68
6	68.55	65.74	62.78	62.17	66.04	61.66	63.53
7	70.79	69.45	68.78	70.75		65.39	69.23
8	72.01	71.43	73.59			68.71	
9	70.75	71.07				66.80	
10							
MEAN	67.30	64.98	58.02	55.73	61.60	40.69	

Table 7c. The catch, weight and length-at-age for white hake in NAFO Division 4T as estimated from observer and port sampling of the by-catch and sentinel surveys in 1998.

<u>1998 CATCH #S AT AGE (1,000's)</u>							L*=Liner NoL*=No Liner	
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comb.</u>	<u>KEY 4</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 6</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>SUM</u>	<u>CV</u>
1				0.00	0.00	0.01	0.01	173.21
2			0.11	0.04	0.00	0.07	0.22	82.62
3			0.78	0.31	0.00	0.12	1.22	112.30
4	0.02	0.07	11.59	4.54	0.37	0.34	16.93	164.24
5	2.14	3.32	26.52	16.84	1.94	0.50	51.26	124.81
6	7.85	7.06	16.91	13.58	1.24	0.19	46.83	84.57
7	2.48	1.81	4.68	3.04	0.30	0.04	12.35	84.87
8	0.97	0.55	1.80	0.79	0.07	0.01	4.19	94.69
9	0.45	0.16	0.22	0.15	0.01	0.00	1.00	99.34
10	0.19	0.09	0.04	0.06	0.01	0.00	0.39	103.86
11	0.17	0.05		0.00	0.00	0.00	0.22	164.00
12	0.00	0.00		0.00	0.00	0.00	0.00	223.61
13-16			0.02		0.00	0.00	0.02	173.21
SUM	14.27	13.12	62.67	39.35	3.94	1.30	134.65	

<u>1998 AVERAGE WEIGHT AT AGE (KG)</u>							<u>WEIGHTED</u>
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comb.</u>	<u>KEY 4</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 6</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>AVE.WGT.</u>
1							
2							
3			0.56	0.59		0.46	
4	1.04	0.95	0.81	0.90	1.05	0.72	0.84
5	1.95	1.78	1.42	1.49	1.40	1.05	1.48
6	2.51	2.25	2.08	2.05	2.00	1.91	2.17
7	2.79	2.56	2.67	2.46	2.65	2.24	2.62
8	2.64	2.66	3.06	2.92	2.85	2.50	2.88
9	2.77	4.74		3.29	3.20	2.89	
10	2.52	3.48		3.57	3.53	3.24	
11	2.81						
12							
MEAN	2.49	2.21	1.72	1.77	1.70	1.11	

<u>1998 AVERAGE LENGTH AT AGE (CM.)</u>							<u>WEIGHTED</u>
<u>AGE</u>	<u>KEY 1</u> <u>GNS-Comm</u>	<u>KEY 2</u> <u>GNS-Sent</u>	<u>KEY 3</u> <u>LLS-Comb.</u>	<u>KEY 4</u> <u>OTB/SNU-</u> <u>NoL-Comm</u>	<u>KEY 5</u> <u>OTB/SNU-</u> <u>NoL-Sent</u>	<u>KEY 6</u> <u>OTB/SNU-L-</u> <u>Sent</u>	<u>AVE.LT.</u>
1							
2							
3			41.88	42.45		39.28	
4	51.00	49.32	46.78	48.49	51.04	44.98	47.31
5	62.07	60.20	55.78	56.69	55.74	49.59	56.57
6	67.17	64.85	63.09	62.92	62.19	61.32	63.96
7	69.43	67.58	68.16	66.42	67.77	64.46	67.88
8	68.36	68.47	71.29	70.28	69.83	67.12	70.02
9	69.44	82.23		73.31	72.77	70.53	
10	67.53	74.77		75.39	75.05	72.53	
11	69.86						
12							
MEAN	66.96	64.32	58.35	59.33	58.69	49.58	

Table 8. Commercial fishery catch, weight and length-at-age for white hake in NAFO Division 4T: 1982-2000.

a. Commercial Fishery Catch-at-Age (in 1,000's) for NAFO 4T White Hake: 1982-2000.

AGE	Year																			
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
1-2	0	43	2	3	0	0	0	5	0	0	0	0	0	0	0	0	0	1	1	
3	5	86	58	64	2	30	0	11	34	28	127	79	25	0	2	1	1	4	2	
4	159	220	319	216	204	531	39	114	604	409	1000	312	134	1	16	15	17	42	18	
5	648	740	787	608	496	1357	476	574	1170	1048	1028	400	185	2	26	41	51	110	45	
6	1210	939	788	592	477	900	648	810	992	859	554	217	201	10	24	34	47	75	63	
7	1232	712	542	391	330	411	513	689	427	507	270	87	86	12	14	14	12	16	31	
8	665	535	275	227	233	149	109	224	80	79	61	27	28	4	7	6	4	2	6	
9	198	142	142	108	77	68	15	76	18	17	26	10	5	0	2	1	1	1	2	
10	89	42	69	51	45	18	6	11	8	5	11	1	1	0	1	0	0	0	0	
11	24	8	22	16	21	4	2	13	2	2	4	2	0	0	0	0	0	0	0	
12	16	6	16	18	14	2	1	5	1	1	0	1	0	0	0	0	0	0	0	
13+	16	3	7	12	9	3	1	6	1	5	1	0	0	0	0	0	0	0	0	
Sum	4261	3477	3028	2306	1908	3473	1809	2537	3337	2961	3082	1137	664	30	91	113	135	251	168	

b. Commercial Fishery Mean Weight-at-Age (kg) for NAFO 4T White Hake: 1982-2000.

AGE	Year																			
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
1		0.46																		
2		0.60	0.53	0.95			0.21	0.21						0.31						
3	0.55	0.92	0.87	1.39	3.19	0.62	0.33	0.42	0.59	0.54	0.55	0.55	0.61	0.46						
4	0.90	1.39	1.15	1.53	0.98	0.81	0.96	0.96	0.81	0.80	0.77	0.90	0.83	0.87	0.94	0.86	0.84			
5	1.20	1.68	1.66	2.01	1.53	1.29	1.29	1.23	1.19	1.13	1.10	1.20	1.22	1.37	1.40	1.39	1.48	1.39	1.30	
6	1.74	2.03	2.17	2.35	2.39	2.06	1.91	1.77	1.75	1.60	1.69	1.74	1.83	1.99	1.92	1.97	2.17	2.11	2.03	
7	2.11	2.47	2.74	2.84	3.01	2.95	2.82	2.53	2.56	2.34	2.36	2.11	2.49	2.65	2.48	2.53	2.62	2.77	2.50	
8	3.13	2.59	3.31	3.70	3.90	3.92	3.72	3.47	3.45	2.90	3.08	3.12	3.03	3.38	2.61	2.77	2.88			
9	3.06	3.27	3.73	4.05	4.69	4.57	5.31	4.31	4.94	4.15	4.45	3.06	3.48	5.27		3.70				
10	3.37	4.09	5.63	5.00	5.65	6.06	6.01	6.15	5.58	6.91	5.55	3.37	4.07			3.22				
11	4.36	5.99	5.05	6.70	6.90	8.75	8.56	6.16	7.54	5.95	5.54	4.35				4.27				
12	4.03	7.52	7.11	6.96	6.92	9.57	10.41	9.65	9.26	7.18	6.06	4.03								
13									6.83	10.04			9.55							
14																				
15																				

c. Commercial Fishery Mean Length-at-Age (cm) for NAFO 4T White Hake: 1982-2000.

AGE	Year																			
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
1		39.7																		
2		43.8	41.9	50.0			31.6	31.0						35.1						
3	49.0	50.1	47.8	55.6	70.8	44.0	36.2	38.7	43.4	42.0	42.5	42.0	43.6	39.3						
4	54.9	57.0	52.3	57.4	49.6	48.2	50.5	50.0	47.8	47.8	47.5	49.6	48.0	48.7	49.2	48.1	47.3			
5	58.7	60.7	58.8	62.1	57.1	55.5	55.4	54.6	54.3	53.4	53.4	54.4	54.3	56.1	55.9	56.1	56.6	55.7	54.9	
6	65.2	64.3	63.6	65.2	66.0	64.0	62.4	61.2	61.6	59.5	61.7	61.8	61.9	63.4	62.0	62.6	64.0	63.5	63.3	
7	67.8	68.4	68.2	68.9	70.8	71.4	70.5	68.6	70.0	67.4	68.9	65.8	68.4	69.4	67.6	67.9	67.9	69.2	67.7	
8	72.1	68.7	72.2	74.7	76.8	77.8	76.9	76.0	76.8	72.1	74.9	74.6	72.8	74.8	68.4	66.9	70.0			
9	74.8	74.7	74.5	76.3	81.0	80.5	85.7	81.0	86.7	81.3	84.9	74.0	76.1	86.5		76.1				
10	79.0	78.9	84.3	81.0	85.5	87.0	89.2	89.8	89.6	96.3	91.4	76.7	80.5			70.1				
11	77.9	91.6	81.7	89.1	92.1	100.1	99.9	89.2	99.8	92.0	91.5	83.7				64.0				
12	76.9	99.1	91.2	88.9	90.9	102.7	106.4	105.9	107.0	97.8	94.6	81.5								
13	81.7								96.4	109.0			106.0							
14																				
15																				

Table 9. Stratified mean catch per tow (numbers) -at-age for white hake caught during research vessel surveys of the southern Gulf of St. Lawrence (NAFO Division 4T).
(Note: The totals do not include catches of hake for which the age could not be determined).

(Strata: 415-439)

Survey	<u>P091</u>	<u>P106</u>	<u>P122</u>	<u>P143</u>	<u>P157</u>	<u>P172</u>	<u>P188</u>	<u>P204</u>	<u>P229</u>	<u>P244</u>	<u>P260</u>	<u>P278</u>	<u>P296</u>
Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
age 0													
age 1	0.02	0.02	0.02	0.14	0.08	0.07	0.02	0.06			0.05	0.06	0.09
age 2	0.73	0.21	0.45	1.99	3.42	3.09	0.87	2.15	0.28	0.11	0.46	0.27	0.81
age 3	0.69	0.22	0.47	1.53	2.13	1.98	1.24	1.50	2.04	1.11	1.11	0.61	0.81
age 4	0.79	0.37	2.13	2.61	1.48	1.30	1.46	2.52	2.08	1.90	2.47	0.96	0.80
age 5	0.35	0.32	1.81	2.06	0.73	0.55	0.56	2.01	1.82	2.11	3.15	0.79	0.44
age 6	0.14	0.37	0.63	1.38	0.27	0.19	0.18	0.98	1.28	1.31	2.39	0.72	0.28
age 7	0.04	0.14	0.21	0.59	0.07	0.06	0.07	0.30	0.48	0.46	1.45	0.31	0.14
age 8	0.01	0.02	0.03	0.18	0.01	0.01	0.02	0.03	0.13	0.14	0.47	0.14	0.07
age 9	0.01	0.02	0.01	0.04	0.01	0.01	0.01	0.02	0.02	0.01	0.23	0.02	0.07
age 10	0.01	0.03	0.05	0.11	0.03	0.01	0.02	0.07	0.03	0.05	0.01	0.04	0.01
age 11									0.04	0.06	0.02		
age 12	0.03	0.01			0.02		0.01	0.04	0.06	0.05	0.01		
age 13											0.04		
age 14											0.02		
age 15													
age 16													
Totals:	2.80	1.70	5.81	10.63	8.26	7.26	4.45	9.67	8.25	7.29	11.88	3.90	3.52

(Strata: 401, 403, 415-439)

Survey	<u>P312</u>	<u>P327</u>	<u>H159</u>	<u>H179</u>	<u>H192</u>	<u>H204</u>	<u>H219</u>	<u>H232</u>	<u>N178</u>	<u>N192</u>	<u>N210</u>	<u>N230</u>	<u>N249</u>	<u>N746</u>	<u>N846</u>	<u>N941</u>	<u>N045</u>
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
age 0	0.01	0.02	0.04		0.01	0.41	0.44	0.08	0.09	0.08	0.21	0.60	0.30	0.41	0.03	0.35	0.07
age 1	0.05	0.11	0.24	0.04	0.16	1.08	0.66	0.54	0.31	0.26	0.18	0.52	0.42	0.83	0.56	1.22	0.46
age 2	0.47	0.67	1.72	0.46	1.59	2.10	2.39	2.05	1.33	0.71	0.81	1.53	1.09	0.85	1.51	2.25	4.23
age 3	1.11	2.40	2.62	1.75	2.65	4.26	2.59	2.87	2.74	0.80	0.72	0.59	0.76	0.61	0.70	0.97	3.04
age 4	1.42	2.93	4.27	2.16	3.13	2.34	1.65	1.80	2.12	0.98	0.84	0.48	0.54	0.88	0.59	0.89	2.31
age 5	1.14	0.93	2.58	1.50	2.32	1.46	1.65	1.27	0.71	0.54	0.39	0.17	0.19	0.43	0.40	0.55	0.40
age 6	0.53	0.67	0.92	0.70	0.74	0.80	0.53	0.60	0.17	0.17	0.13	0.13	0.07	0.14	0.24	0.21	0.08
age 7	0.27	0.52	0.43	0.21	0.30	0.22	0.35	0.19	0.04	0.06	0.02	0.03	0.03	0.04	0.04	0.05	0.02
age 8	0.17	0.31	0.24	0.05	0.05	0.03	0.08	0.06	0.01	0.00	0.02	0.01	0.01	0.01	0.03		0.00
age 9	0.06	0.26	0.11	0.03	0.01	0.03	0.02	0.01		0.02			0.01		0.00		
age 10	0.06	0.10	0.04	0.03	0.02	0.02		0.02							0.00		0.00
age 11	0.01	0.03	0.04			0.01		0.02									
age 12	0.01	0.04	0.03	0.03													
age 13		0.02	0.01			0.01											
age 14		0.02															
age 15		0.01															
age 16																	
Totals:	5.31	9.05	13.29	6.95	10.97	12.76	10.37	9.51	7.51	3.62	3.33	4.06	3.41	4.19	4.11	6.48	10.61

Research Vessels: E.E. Prince (P) from 1971-1985
Lady Hammond (H) from 1986-1991
Alfred Needler from 1992-Present (N)

Table 10. Mean weight-at-age (kg) for white hake caught during research vessel surveys of the southern Gulf of St. Lawrence (NAFO Division 4T).

(Strata: 415-439)

Survey	P091	P106	P122	P143	P157	P172	P188	P204	P229	P244	P260	P278	P296
Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
age 0													
age 1	0.21	0.06	0.12	0.08	0.27	0.25	0.19	0.17			0.06	0.10	0.16
age 2	0.33	0.31	0.37	0.26	0.33	0.31	0.39	0.25	0.31	0.44	0.25	0.37	0.34
age 3	0.48	0.52	0.62	0.48	0.42	0.42	0.53	0.42	0.45	0.65	0.48	0.64	0.62
age 4	0.85	1.11	1.10	0.96	0.86	0.84	0.81	0.95	0.81	0.96	0.91	1.07	1.11
age 5	1.47	2.09	1.49	1.70	1.42	1.42	1.49	1.53	1.40	1.38	1.41	1.39	1.91
age 6	2.13	2.76	1.94	2.08	1.95	2.01	1.81	2.10	1.84	1.76	1.86	1.83	2.14
age 7	2.14	2.89	2.62	2.81	2.04	2.26	2.38	2.51	2.22	2.17	2.27	2.41	3.13
age 8	2.34	3.68	4.15	4.71	2.31	2.46	4.86	3.40	2.37	2.83	2.98	2.97	3.88
age 9	2.34	2.51	2.48	2.40	2.31	2.46	2.36	2.47	3.17	3.11	3.19	3.13	4.03
age 10	2.18	2.48	2.07	2.21	2.16	2.29	1.99	2.12	2.74	4.13	3.58	3.63	5.96
age 11									5.01	4.69	12.28		
age 12	7.53	7.28			6.83		6.02	8.29	2.74	2.67	3.58		
age 13											9.74		
age 14											12.28		
age 15													
age 16													

(Strata: 401, 403, 415-439)

Survey	P312	P327	H159	H179	H192	H204	H219	H232	N178	N192	N210	N230	N249	N746	N846	N941	N045
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
age 0	0.07	0.04	0.06		0.06	0.05	0.03	0.06	0.07	0.06	0.05	0.01	0.01	0.04	0.04	0.05	0.07
age 1	0.15	0.08	0.15	0.11	0.10	0.09	0.07	0.18	0.16	0.12	0.13	0.11	0.14	0.07	0.14	0.10	0.13
age 2	0.30	0.23	0.25	0.19	0.24	0.22	0.21	0.25	0.28	0.26	0.25	0.24	0.25	0.23	0.25	0.25	0.25
age 3	0.59	0.42	0.47	0.43	0.42	0.44	0.35	0.46	0.45	0.45	0.51	0.46	0.50	0.43	0.43	0.45	0.39
age 4	0.94	0.75	0.77	0.68	0.71	0.61	0.63	0.67	0.62	0.67	0.81	0.72	0.66	0.62	0.67	0.68	0.56
age 5	1.46	1.24	1.24	1.19	1.08	1.06	0.99	1.06	0.94	0.94	1.13	1.10	1.04	0.90	1.10	1.13	0.94
age 6	2.04	1.85	1.94	2.00	1.74	1.62	1.45	1.56	1.48	1.29	1.68	1.77	1.42	1.28	1.73	1.91	1.54
age 7	2.48	2.45	2.74	2.91	2.71	2.40	2.04	2.16	1.88	1.45	2.40	2.89	1.68	2.02	2.00	2.98	2.18
age 8	3.02	3.28	3.30	3.71	3.78	3.44	3.80	3.69	2.90	2.58	3.13	3.29	1.86	2.36	2.70		2.68
age 9	2.65	4.34	4.51	6.43	6.08	5.36	4.10	4.34		4.71			1.78		2.33		
age 10	5.63	3.13	6.36	6.44	9.04	6.87		6.56							4.27		2.40
age 11	3.64	4.08	7.13			9.16		7.20									
age 12	6.13	9.21	7.72	7.98													
age 13		8.04	10.01			9.16											
age 14		9.64															
age 15		10.83															
age 16																	

Research Vessels: E.E. Prince (P) from 1971-1985
 Lady Hammond (H) from 1986-1991
 Alfred Needler from 1992-Present (N)

Table 11. Mean length-at-age (cm) for white hake caught during research vessel surveys of the southern Gulf of St. Lawrence (NAFO Division 4T).

(Strata: 415-439)

Survey	P091	P106	P122	P143	P157	P172	P188	P204	P229	P244	P260	P278	P296
Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
age 0													
age 1	29.7	20.1	23.4	21.8	31.3	31.4	28.2	29.5			20.8	23.3	27.8
age 2	34.8	33.8	35.3	32.4	34.1	33.9	36.6	33.6	34.8	37.6	32.5	35.7	35.5
age 3	39.4	40.0	42.2	39.6	37.0	37.2	40.6	38.6	38.6	41.7	40.0	43.0	42.8
age 4	47.3	50.2	51.4	49.3	47.0	46.5	46.5	49.8	47.2	49.5	49.0	51.3	52.5
age 5	56.4	62.3	56.4	59.3	55.2	54.6	56.6	57.3	55.8	55.6	56.2	56.2	62.6
age 6	64.3	68.3	61.5	63.6	62.9	62.3	61.2	63.1	60.8	60.3	61.5	61.8	65.2
age 7	64.8	69.4	67.2	69.3	64.0	64.9	66.2	66.3	64.7	64.1	65.2	67.4	73.8
age 8	67.0	74.2	77.8	81.9	67.0	67.0	83.7	72.4	65.5	68.2	70.5	72.6	78.4
age 9	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	73.0	73.0	72.2	73.3	80.2
age 10	65.3	66.7	63.0	65.1	65.3	65.2	63.0	63.7	67.4	77.7	76.0	76.2	91.0
age 11									83.9	83.2	112.0		
age 12	98.4	94.0			97.0		91.0	95.6	69.7	69.4	76.0		
age 13												103.1	
age 14												112.0	
age 15													
age 16													

(Strata: 401, 403, 415-439)

Survey	P312	P327	H159	H179	H192	H204	H219	H232	N178	N192	N210	N230	N249	N746	N846	N941	N045
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
age 0	22.0	16.7	19.7		20.8	19.2	16.5	18.5	21.7	19.3	18.4	11.6	9.9	18.1	16.6	19.3	20.9
age 1	26.9	22.8	26.9	25.7	23.8	22.9	20.4	29.0	27.8	25.3	26.3	24.9	26.1	21.3	26.4	23.8	25.7
age 2	33.8	31.1	32.0	30.6	32.3	30.9	30.8	32.7	33.9	32.6	32.4	32.0	31.8	31.7	32.3	32.2	32.0
age 3	42.2	37.6	39.0	39.5	38.6	39.0	36.3	39.8	39.7	39.4	41.0	39.6	40.1	38.9	38.2	39.0	37.1
age 4	48.9	45.8	46.0	45.3	45.6	43.6	44.2	44.9	44.2	45.1	47.5	45.8	44.2	43.6	44.1	44.6	41.9
age 5	56.6	53.9	53.6	54.1	52.1	52.0	51.1	52.0	50.7	50.3	52.9	52.3	51.4	49.1	51.5	52.3	49.6
age 6	62.9	61.7	62.0	63.6	60.4	59.7	58.1	59.0	58.8	55.9	60.2	61.0	56.9	55.0	59.6	61.9	58.2
age 7	66.8	67.2	69.2	71.6	69.6	67.7	64.9	65.7	63.9	58.2	67.5	71.1	60.2	62.3	62.2	71.4	65.1
age 8	71.2	73.3	73.2	76.7	77.1	76.2	79.5	78.0	74.1	71.0	73.6	74.2	61.1	66.4	68.7		69.9
age 9	68.6	80.0	80.0	91.9	89.7	88.2	82.0	83.0		86.6			61.7		66.0		
age 10	84.9	72.6	90.1	92.0	101.7	95.6		94.9							80.0		68.0
age 11	76.4	78.8	93.8			105.0		97.6									
age 12	88.2	103.1	96.0	98.4													
age 13		99.0	106.0			105.0											
age 14		104.9															
age 15		108.8															
age 16																	

Research Vessels: E.E. Prince (P) from 1971-1985
 Lady Hammond (H) from 1986-1991
 Alfred Needler from 1992-Present (N)

Table 12. Research vessel estimates of the mean catch per tow (numbers and weight), population numbers and population biomass for white hake (ages 0+) in the southern Gulf of St. Lawrence (NAFO Division 4T).
 (Note: From 1971-1983 the survey indices included strata 415-439 and since 1984 the survey indices have included strata 401, 403 and 415-439).

Year	Stratified Mean Number		Stratified Mean Wt. (kg.)		Estimated Population Numbers (000's) in NAFO 4T		Estimated Population Biomass (t) in NAFO 4T	
	Per Tow	Variance	Per Tow	Variance		Variance		Variance
1971	2.80	1.20	2.33	0.52	4838	3583318	4028	1552919
1972	1.73	0.23	3.24	1.59	2995	695312	5596	4758931
1973	5.83	17.46	7.60	28.98	10090	52212572	13134	86660015
1974	10.68	21.55	14.10	45.49	18470	64458299	24385	136048571
1975	8.26	15.57	5.11	1.60	14283	46551665	8837	4790655
1976	7.27	8.84	4.49	1.28	12576	26440912	7771	3823445
1977	4.47	1.59	3.77	0.84	7727	4745806	6515	2515284
1978	9.68	10.85	10.25	8.36	15711	28584269	16637	22038177
1979	8.28	6.95	9.97	8.94	14326	20794088	17243	26741492
1980	7.37	1.28	10.25	2.57	12747	3826823	17732	7688792
1981	11.88	13.55	17.89	33.68	20551	40514792	30937	100721146
1982	3.90	1.62	5.32	3.71	6743	4845348	9204	11092682
1983	3.58	0.39	4.11	0.40	6092	1130786	6989	1158737
1984	5.31	1.38	6.26	1.49	9395	4314411	11075	4658036
1985	8.99	7.61	10.60	11.23	15887	23780718	18738	35113495
1986	13.29	7.00	14.20	5.63	23492	21871241	25104	17588823
1987	6.95	2.11	7.57	2.40	12280	6588713	13381	7497788
1988	10.97	5.70	9.45	2.65	19096	17265929	16439	8019952
1989	12.73	6.74	8.03	1.71	22508	21055050	14195	5345043
1990	10.36	4.28	7.27	1.33	18320	13379505	12849	4157874
1991	9.51	9.83	6.80	3.01	16819	30727948	12021	9407318
1992	7.48	6.97	4.36	1.78	13231	21798588	7707	5578221
1993	3.62	0.71	2.31	0.34	6402	2207207	4089	1055358
1994	3.33	0.74	2.13	0.28	5892	2321388	3758	863747
1995	4.07	0.67	1.65	0.09	7196	2101322	2923	275990
1996	3.41	0.44	1.56	0.10	6025	1377045	2765	313495
1997	4.19	1.33	1.78	0.22	7406	4170707	3148	701844
1998	4.11	0.49	2.25	0.16	7259	1522442	3974	512670
1999	6.49	4.33	2.99	0.93	11467	13542152	5287	2919695
2000	10.61	13.57	4.21	1.56	18765	42407693	7436	4889323
<u>MIN.</u>	1971-2000	1.73		1.56	2995		2765	
<u>MAX.</u>	"	13.29		17.89	23492		30937	
<u>AVERAGE</u>	"	7.04		6.40	12286		11130	
<u>MIN.</u>	1984-2000	3.33		1.56	5892		2765	
<u>MAX.</u>	"	13.29		14.20	23492		25104	
<u>AVERAGE</u>	"	7.38		5.50	13026		9699	

Research Vessels: E.E. Prince (P) from 1971-1985
 Lady Hammond (H) from 1986-1991
 Alfred Needler from 1992-Present (N)

Table 13a. Research vessel estimates of the mean catch per tow (numbers and weight), population numbers and population biomass for white hake from the 'Strait' component.
(Note: Only those strata corresponding to the 'Strait' component (i.e., 403, 420, 421, 422, 432 and 433) are included).

Year	Stratified Mean Number		Stratified Mean Wt. (kg.)		Estimated Population Numbers (000's)		Estimated Population Biomass (t)	
	Per Tow	Variance	Per Tow	Variance	for 'Strait' Comp.	Variance	for 'Strait' Comp.	Variance
1984	8.54	25.35	11.49	26.65	2858	2840266	3846	2985351
1985	17.34	40.26	26.08	226.97	5804	4509717	8730	25425154
1986	23.55	75.00	26.82	89.68	7883	8401666	8976	10045613
1987	14.61	28.34	14.45	31.52	4889	3175050	4836	3530635
1988	12.51	37.71	8.63	19.00	3838	3549662	2647	1788625
1989	46.41	157.22	22.36	25.83	15532	17612182	7485	2893357
1990	33.23	99.27	15.55	17.71	11121	11119903	5204	1984085
1991	36.36	269.27	22.16	76.19	12168	30164381	7417	8534517
1992	29.00	189.59	15.68	47.80	9705	21237889	5249	5354791
1993	5.67	2.07	3.76	0.78	1899	231667	1258	86960
1994	12.51	17.09	8.21	6.56	4186	1914096	2747	734925
1995	13.91	14.88	5.94	2.12	4655	1667369	1987	237025
1996	4.80	0.54	1.50	0.09	1606	61022	501	10403
1997	9.41	13.51	2.04	0.25	3150	1513961	684	27610
1998	6.18	1.40	4.17	1.28	2070	157031	1394	142919
1999	17.42	68.51	7.48	15.16	5829	7674522	2502	1698138
2000	4.41	0.52	1.82	0.23	1476	57974	609	25532

Table 13b. Research vessel estimates of the mean catch per tow (numbers and weight), population numbers and population biomass for white hake from the 'Channel' component.
(Note: Only those strata corresponding to the 'Channel' component (i.e., 415, 425, 437, 438 and 439) are included).

Year	Stratified Mean Number		Stratified Mean Wt. (kg.)		Estimated Population Numbers (000's)		Estimated Population Biomass (t)	
	Per Tow	Variance	Per Tow	Variance	for 'Channel' Comp.	Variance	for 'Channel' Comp.	Variance
1984	28.79	33.11	30.96	37.47	5881	1382093	6325	1563934
1985	44.80	459.36	36.88	199.40	9153	19174945	7534	8323678
1986	70.35	318.43	63.76	135.48	14373	13292264	13027	5655133
1987	33.12	79.22	36.19	80.28	6767	3306891	7393	3351082
1988	69.06	323.41	59.95	134.82	14110	13499851	12249	5627639
1989	28.70	81.01	22.47	46.04	5864	3381403	4590	1921916
1990	30.35	52.70	26.95	32.08	6200	2199699	5506	1339279
1991	17.73	9.23	12.21	3.82	3623	385487	2496	159563
1992	16.05	13.26	10.23	4.96	3280	553644	2090	206946
1993	19.76	47.01	11.89	22.75	4038	1962490	2429	949542
1994	7.93	9.71	4.42	3.01	1621	405295	902	125552
1995	8.07	6.14	2.85	0.50	1650	256149	582	21037
1996	21.32	31.51	10.51	7.20	4357	1315426	2147	300618
1997	20.16	63.59	11.48	16.07	4119	2654462	2345	670628
1998	22.57	31.06	10.70	8.01	4612	1296658	2186	334420
1999	25.64	138.86	11.66	27.11	5239	5796239	2383	1131842
2000	83.77	1014.49	32.57	116.39	17116	42347343	6654	4858251

(Note: Tables 13a and b will not sum to Table 12 because Table 12 includes additional strata).

Table 14. Research vessel estimates of the mean catch per tow (numbers) for strata 403 (St. Georges Bay) and 433 (Eastern Northumberland Strait) (separated and combined).

Year	Mean No./Tow Strat. 403 (St. Georges Bay)	Mean No./Tow Strat. 433 East North. Strait	Mean No./Tow (Combined Areas) Strat. 403+433	Mean No./Tow "Rest" of NAFO 4T	Mean No./Tow Total Survey Area All of NAFO 4T
1984	6.93	20.31	19.15	4.41	5.31
1985	26.67	46.75	45.01	6.65	8.99
1986	65.11	61.93	62.21	10.11	13.29
1987	21.58	36.14	34.88	5.13	6.95
1988	58.58	17.98	21.51	10.28	10.97
1989	532.66	81.68	120.85	5.70	12.73
1990	186.67	52.34	64.01	6.87	10.36
1991	80.27	77.93	78.13	5.05	9.51
1992	131.57	75.68	80.53	2.73	7.48
1993	79.93	5.16	11.65	3.10	3.62
1994	23.16	33.40	32.51	1.43	3.33
1995	189.41	14.68	29.86	2.39	4.07
1996	44.94	2.67	6.34	3.22	3.41
1997	28.81	15.06	16.25	3.41	4.19
1998	127.11	4.14	14.82	3.41	4.11
1999	269.02	29.48	50.29	3.64	6.49
2000	53.32	5.36	9.53	10.68	10.61

Table 15. General linear model results for the standardization of longline sentinel survey catch rates (1996-2000).

```

The GLM Procedure
Class Level Information
Class      Levels  Values
year       5      1996 1997 1998 1999 2000
month      4      7 8 9 10
site       27     17 19 22 23 24 25 28 29 30 31 34 35 45 50 51 52 53 60 61 65
              68 103 104 109 110 113 114
Number of observations      276

The GLM Procedure
Dependent Variable: cat_eff
Source      DF      Sum of Squares      Mean Square      F Value      Pr > F
Model              33      1554.348824      47.101480      41.12      <.0001
Error             237      271.492575      1.145538
Corrected Total   270      1825.841399

R-Square      Coeff Var      Root MSE      cat_eff Mean
0.851305      35.76050      1.070298      2.992962

Source      DF      Type I SS      Mean Square      F Value      Pr > F
year              4      47.614554      11.903638      10.39      <.0001
month            3      7.368304      2.456101      2.14      0.0954
site             26     1499.365966      57.667922      50.34      <.0001

Source      DF      Type III SS      Mean Square      F Value      Pr > F
year              4      17.339528      4.334882      3.78      0.0053
month            3      10.773503      3.591168      3.13      0.0262
site             26     1499.365966      57.667922      50.34      <.0001

Least Squares Means
cat_eff
LSMEAN
year
1996      1.85380955
1997      2.15451494
1998      2.11924542
1999      2.32813671
2000      1.59261416
    
```

Table 16. Comparison of the commercial catch-at-age for the 'Strait' component with the catch-at-age (thousands) for NAFO Div. 4T.

NAFO Div. 4T																
AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1-2	3	0	0	0	5	0	0	0	0	0	0	0	0	0	1	1
3	64	2	30	0	11	34	28	127	79	25	0	2	1	1	4	2
4	216	204	531	39	114	604	409	1000	312	134	1	16	15	17	42	18
5	608	496	1357	476	574	1170	1048	1028	400	185	2	26	41	51	110	45
6	592	477	900	648	810	992	859	554	217	201	10	24	34	47	75	63
7	391	330	411	513	689	427	507	270	87	86	12	14	14	12	16	31
8	227	233	149	109	224	80	79	61	27	28	4	7	6	4	2	6
9	108	77	68	15	76	18	17	26	10	5	0	2	1	1	1	2
10+	97	89	27	9	35	12	13	16	4	1	0	1	0	1	0	0

'Strait' Component																
AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1-2	3	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1
3	56	2	25	0	9	30	25	112	48	24	0	2	1	1	3	2
4	189	194	454	34	97	541	367	879	317	128	0	15	14	15	38	16
5	532	458	1159	413	490	1047	941	904	368	176	2	25	39	44	99	41
6	518	421	769	563	691	888	771	487	184	192	10	23	33	40	68	57
7	342	278	351	445	588	382	455	238	71	82	11	13	13	11	15	28
8	199	215	127	94	191	72	71	53	22	27	3	6	5	4	2	5
9	95	59	58	13	64	16	15	22	7	5	0	2	1	1	1	1
10+	85	73	23	8	30	10	12	14	3	1	0	1	0	1	0	0

Table 17. Input data for the ADAPT calibration of SPA for the 'Strait' component.

W. Hake Commercial Fishery Catch-at-Age Matrix for the 'Strait' Component: 1985-2000.

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	56	2	25	1	9	30	25	112	48	24	1	2	1	1	3	2
4	189	194	454	34	97	541	367	879	317	128	1	15	14	15	38	16
5	532	458	1159	413	490	1047	941	904	368	176	2	25	39	44	99	41
6	518	421	769	563	691	888	771	487	184	192	10	23	33	40	68	57
7	342	278	351	445	588	382	455	238	71	82	11	13	13	11	15	28
8	199	215	127	94	191	72	71	53	22	27	3	6	5	4	2	5
9	95	59	58	13	64	16	15	22	7	5	1	2	1	1	1	1
10+	85	73	23	8	30	10	12	14	3	1	1	1	1	1	1	1
Sum	2014	1701	2967	1570	2161	2986	2657	2708	1021	635	30	87	107	115	227	152

W. Hake Research Vessel Catch-at-Age for the 'Strait' Component: 1985-2000

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	4.457	3.975	4.573	2.204	17.316	9.023	10.936	10.728	0.832	1.877	2.028	0.266	0.324	0.461	1.150	0.723
4	2.269	7.144	5.036	2.681	9.490	4.138	7.537	9.117	1.207	3.217	2.119	0.256	0.677	0.615	1.249	0.628
5	1.740	4.346	2.897	2.374	3.741	2.912	4.295	2.774	1.123	1.641	0.638	0.229	0.492	0.905	1.857	0.324
6	1.926	1.598	0.893	0.612	1.618	0.562	1.781	0.626	0.324	0.578	0.466	0.157	0.161	0.787	0.853	0.139
7	1.898	0.790	0.278	0.194	0.305	0.672	0.623	0.133	0.127	0.122	0.117	0.074	0.038	0.140	0.192	0.028
8	1.425	0.446	0.125	0.066	0.055	0.223	0.106	0.014	0.000	0.098	0.065	0.018	0.049	0.092	0.000	0.011
9	1.065	0.326	0.120	0.018	0.029	0.094	0.000	0.000	0.063	0.000	0.000	0.014	0.000	0.009	0.000	0.000
10+	0.426	0.448	0.120	0.077	0.000	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.006
Sum	15.206	19.073	14.042	8.226	32.554	17.624	25.305	23.392	3.676	7.533	5.433	1.014	1.741	3.016	5.301	1.859

Table 18a. Parameter estimates from the ADAPT SPA calibration for white hake using the research survey index for the 'Strait' component.

Parameter	Estimate	Std. Error	C.V.	T-Stat.	Bias	% Bias	Mean Square Residual
Age 3 Abund.	243.189237	290.393188	1.194104	0.837448	178.250607	73.297079	1.327310
Age 4 Abund.	220.388913	193.330196	0.877223	1.139961	85.897987	38.975639	
Age 5 Abund.	93.585590	85.718298	0.915935	1.091781	33.543771	35.842881	
Age 6 Abund.	34.897220	41.944036	1.201931	0.831995	20.808867	59.629010	
Age 7 Abund.	8.326836	11.316427	1.359031	0.735818	6.860664	82.392213	
Age 8 Abund.	14.843108	13.639738	0.918927	1.088225	4.935705	33.252505	
Age 3 Q	0.002827	0.000865	0.306035	3.267596	0.000079	2.804091	
Age 4 Q	0.003556	0.001057	0.297167	3.365106	0.000101	2.829957	
Age 5 Q	0.003915	0.001156	0.295223	3.387270	0.000121	3.097857	
Age 6 Q	0.003726	0.001110	0.297953	3.356235	0.000137	3.669305	
Age 7 Q	0.003809	0.001154	0.303041	3.299883	0.000178	4.682519	
Age 8 Q	0.002995	0.000891	0.297366	3.362857	0.000144	4.815322	

Table 18b. Estimates of fishing mortality and beginning of year population numbers for southern Gulf white hake ('Strait' Component) from the ADAPT calibration of SPA.

Fishing mortality estimates for NAFO 4T ('Strait') White Hake from ADAPT

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.15	0.18	0.16	0.00	0.01	0.00	0.00	0.01	0.01
4	0.06	0.05	0.17	0.01	0.03	0.23	0.21	0.76	0.78	1.00	0.01	0.08	0.06	0.06	0.20	0.06
5	0.32	0.21	0.51	0.23	0.23	0.57	0.81	1.26	0.87	1.60	0.03	0.33	0.30	0.28	0.62	0.33
6	0.64	0.46	0.63	0.50	0.75	0.86	1.20	1.55	0.98	2.16	0.32	0.64	0.99	0.59	0.93	0.91
7	0.63	0.89	0.92	0.98	1.80	1.40	1.91	2.06	1.08	2.39	0.77	0.92	0.98	1.16	0.46	1.40
8	0.94	1.11	1.64	0.68	2.08	1.40	1.18	1.68	1.47	2.36	0.58	1.46	1.25	0.97	0.67	0.27
9	0.74	0.82	1.06	0.72	1.54	1.22	1.43	1.76	1.18	2.30	0.56	1.01	1.07	0.91	0.69	0.86
10	0.74	0.82	1.06	0.72	1.54	1.22	1.43	1.76	1.18	2.30	0.56	1.01	1.07	0.91	0.69	0.86
Age 4+	0.58	0.62	0.86	0.55	1.14	0.99	1.17	1.55	1.08	2.02	0.40	0.78	0.82	0.70	0.61	0.67
Age 6+	0.74	0.82	1.06	0.72	1.54	1.22	1.43	1.76	1.18	2.30	0.56	1.01	1.07	0.91	0.69	0.86

Beginning of year population estimates for NAFO 4T ('Strait') White Hake from ADAPT (1,000's)

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	5102	3935	3984	4082	3537	2612	2258	915	327	175	267	320	374	289	353	299
4	3528	4126	3220	3239	3341	2887	2111	1826	648	224	121	218	260	305	236	286
5	2119	2717	3203	2225	2621	2648	1874	1396	700	244	68	99	165	200	236	158
6	1207	1254	1810	1573	1448	1703	1220	683	325	240	40	54	58	100	124	104
7	812	520	646	786	779	561	591	302	119	100	23	24	23	18	45	40
8	360	355	174	211	241	106	113	72	32	33	7	9	8	7	5	24
9	199	115	96	28	88	25	21	28	11	6	3	3	2	2	2	2
10	178	142	38	17	41	15	17	18	5	1	3	2	2	2	2	2
Sum	13505	13164	13171	12161	12096	10557	8205	5240	2167	1023	532	729	892	923	1003	915

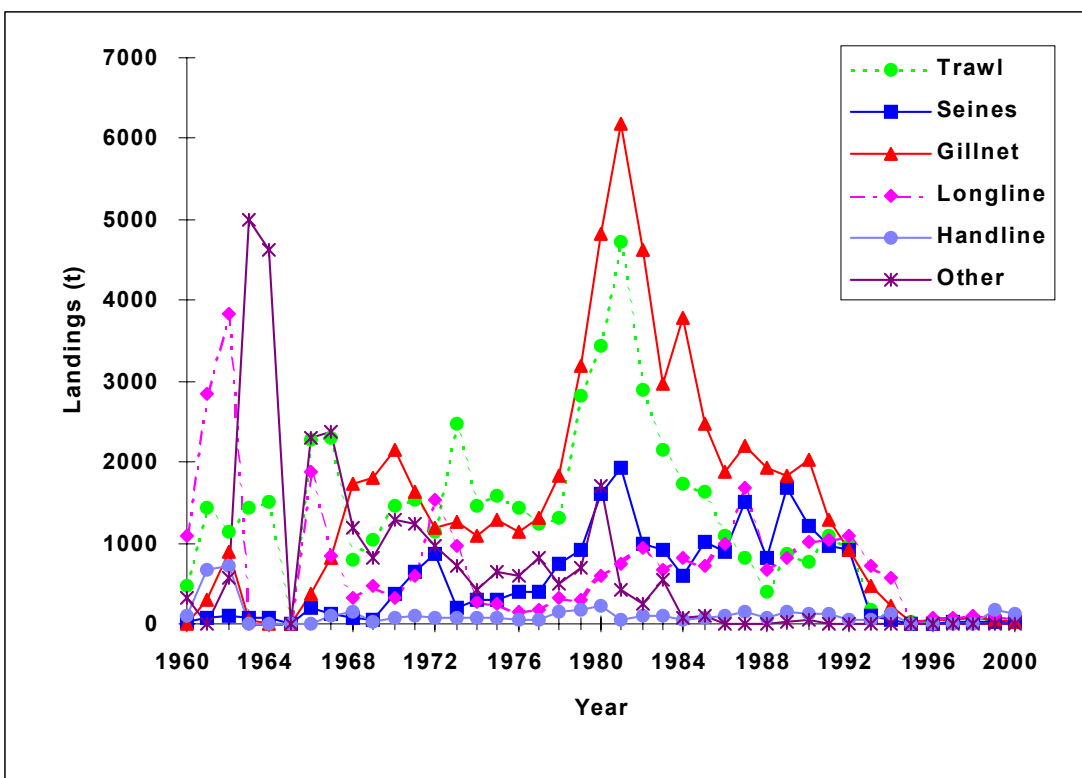
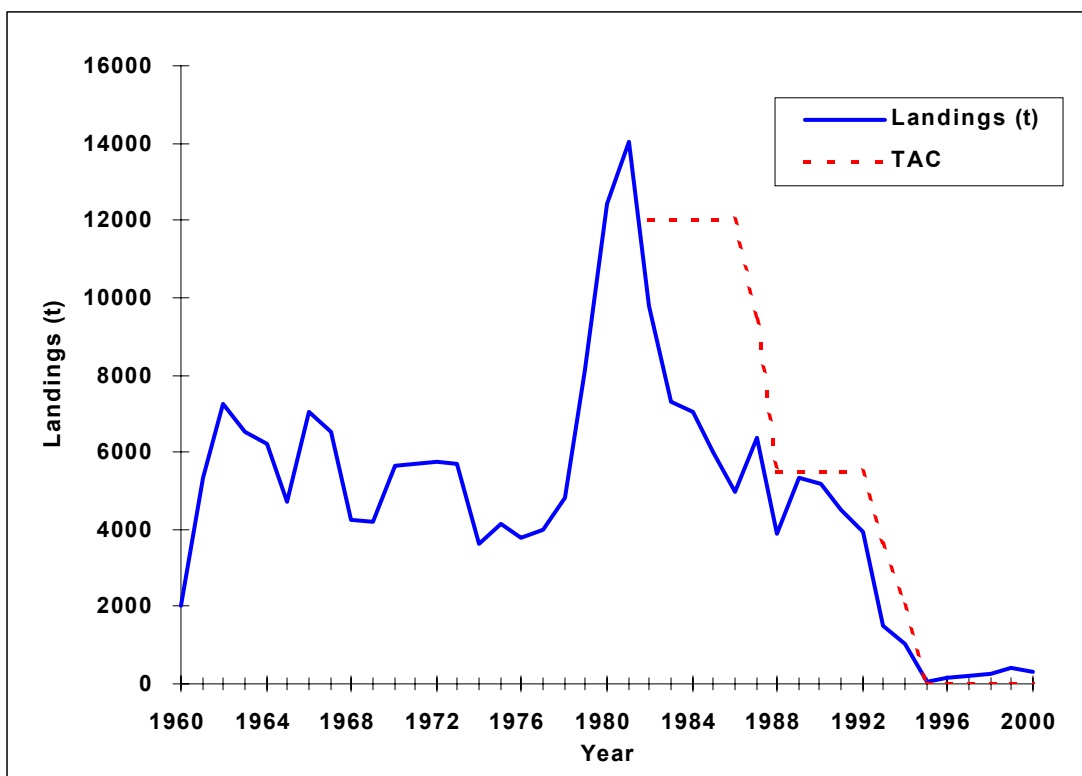


Figure 1 a. Nominal landings and TAC's for white hake in NAFO Division 4T.
 b. Nominal landings by gear category for white hake in NAFO Division 4T.

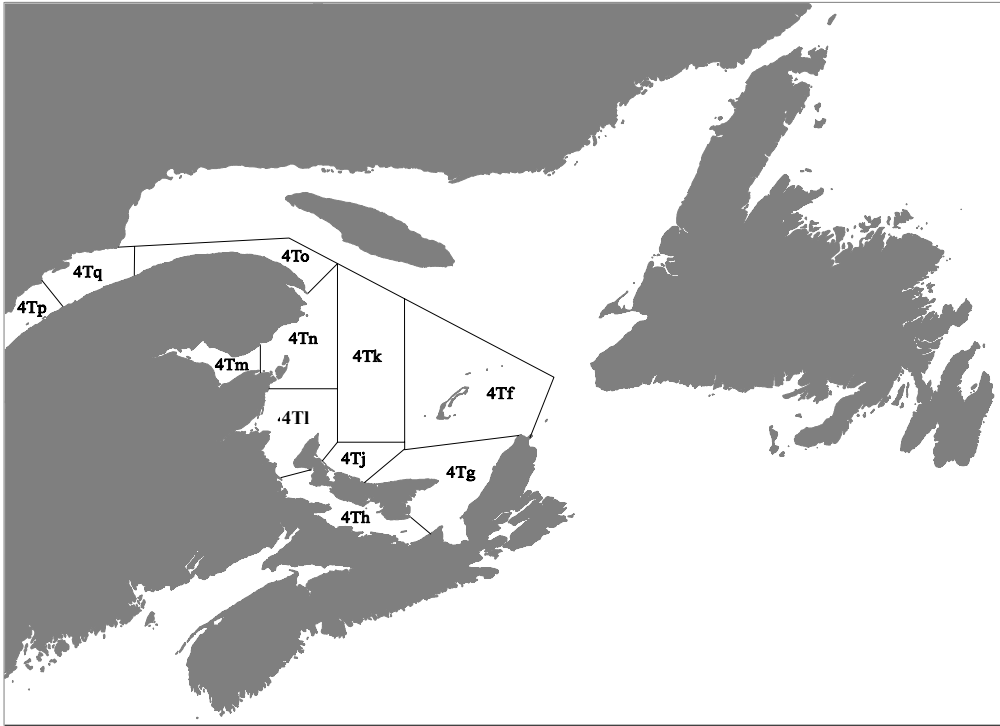


Figure 2. Statistical unit areas in the southern Gulf of St. Lawrence (NAFO Division 4T).

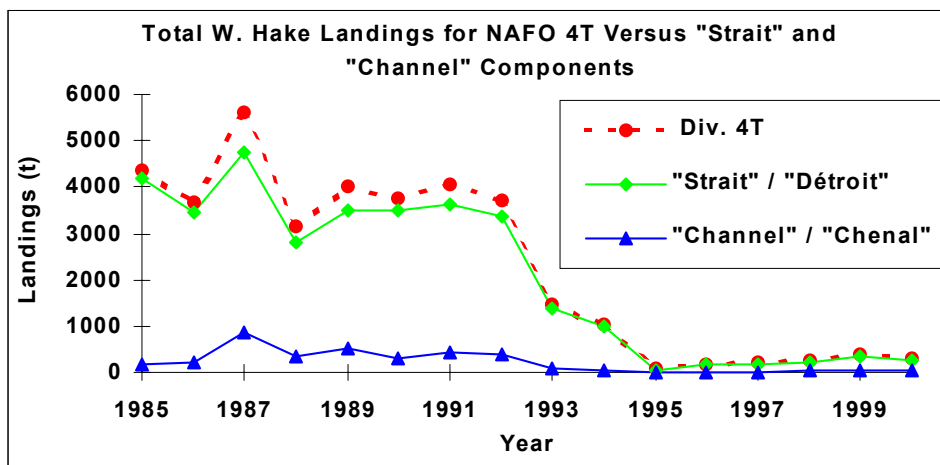
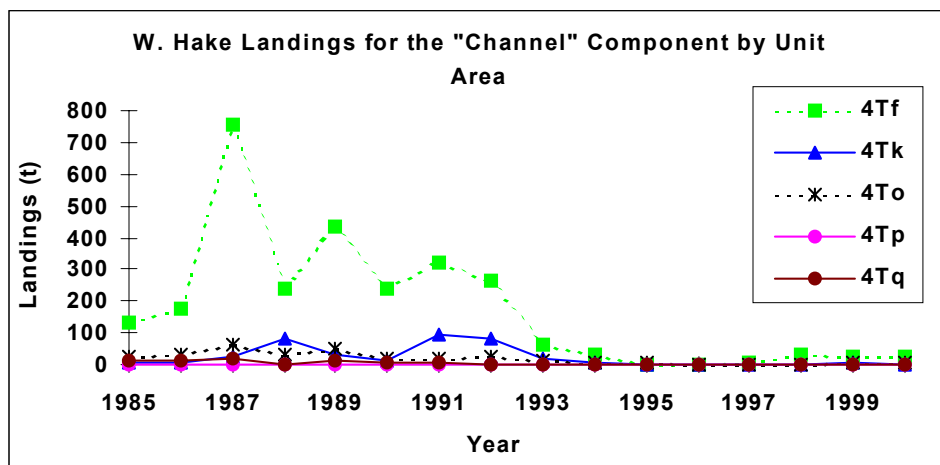
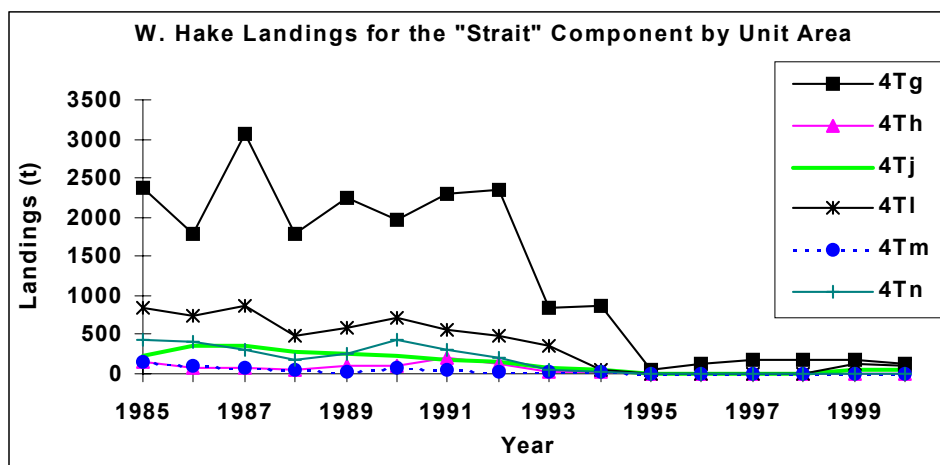


Figure 3. Comparison of landings of white hake in NAFO Division 4T by statistical unit area and stock component: 1985-2000.

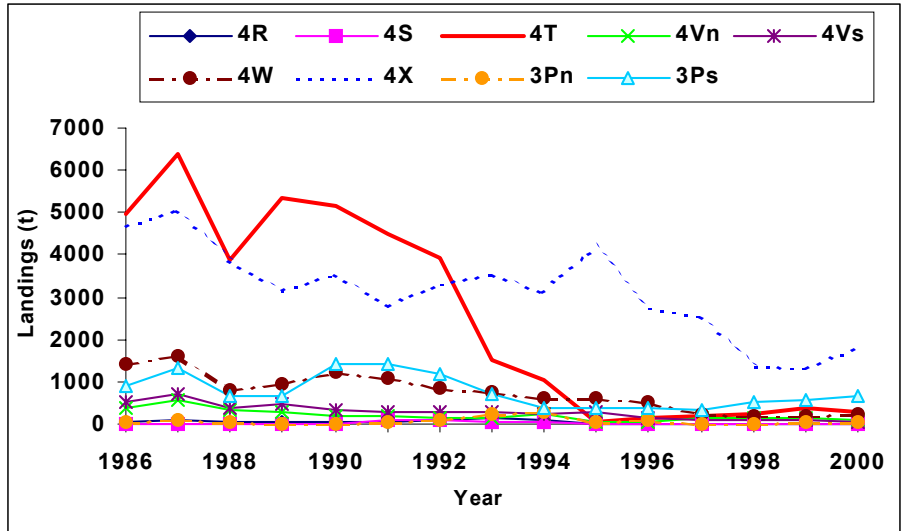


Figure 4. Comparison of reported (ZIF) landings of white hake in NAFO Div. 4T with those in other NAFO divisions in Atlantic Canada.

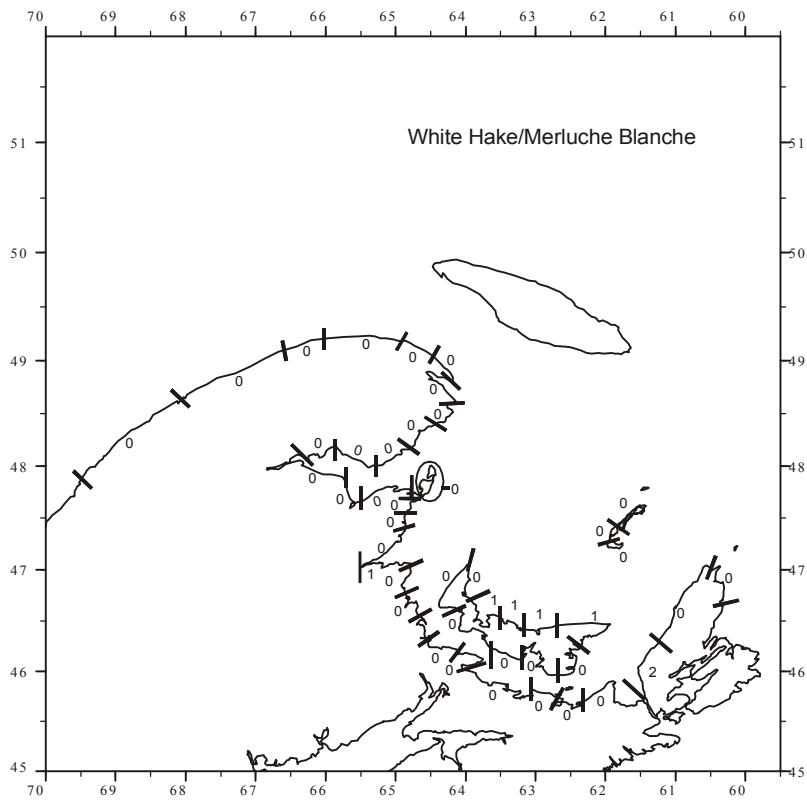


Figure 5. The geographical distribution of respondents that fished for white hake 'most of the time' in 2000 (These respondents identified white hake as either their second or third priority of the species of groundfish that they targeted in 2000). The lines delimit the boundaries of statistical districts bordering the southern Gulf of St. Lawrence.

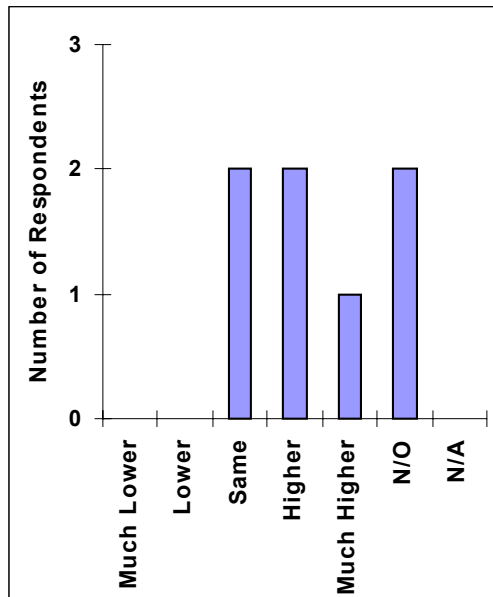


Figure 6. Opinions of respondents asked to compare the abundance of white hake in 2000 with its abundance in 1999 (These results reflect the opinions of respondents for whom white hake was either their second or third priority) (N/O = No Opinion and N/A = Not Applicable).

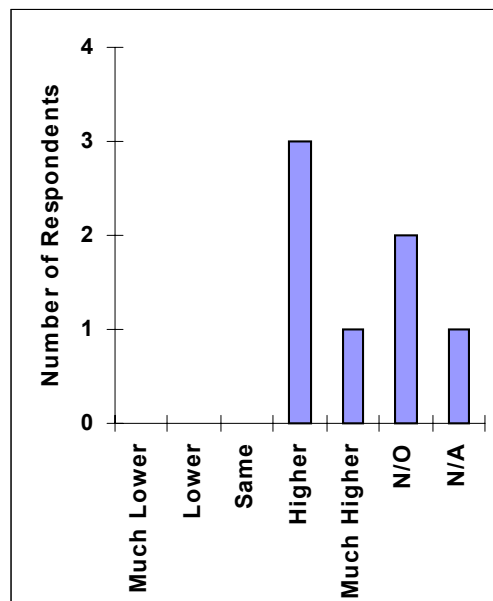


Figure 7. Opinions of respondents asked to compare the abundance of white hake in 2000 with its abundance from 1995 to 1999 (These results reflect the opinions of respondents for whom white hake was either their second or third priority) (N/O = No Opinion and N/A = Not Applicable).

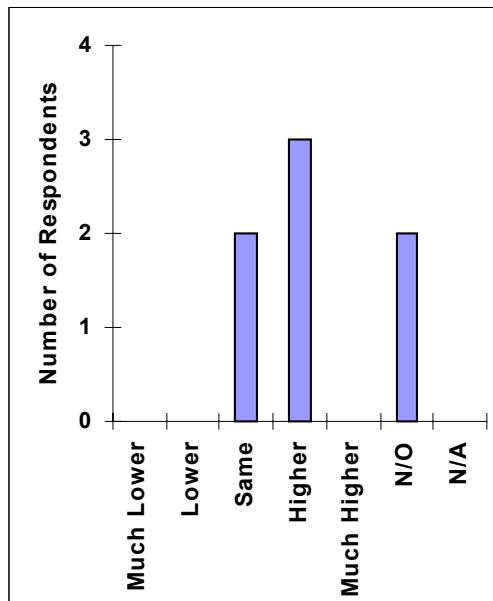


Figure 8. Opinions of respondents asked to compare the abundance of white hake in 2000 with its abundance during all of the years that they fished for this species (These results reflect the opinions of respondents for whom white hake was either their second or third priority)(N/O = No Opinion and N/A = Not Applicable).

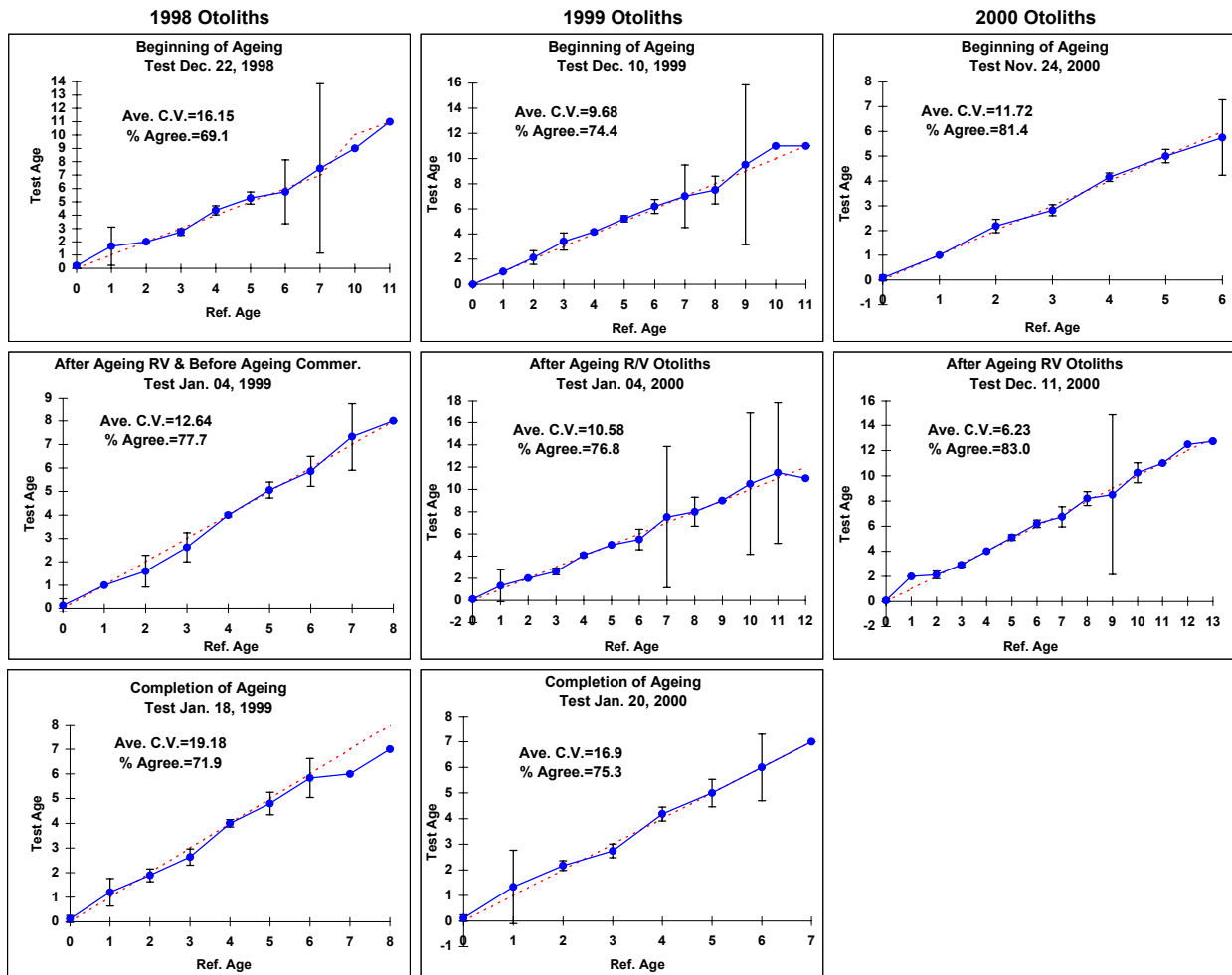


Figure 9. Age bias plots for tests of ageing consistency conducted in 1998, 1999 and 2000. Error bars indicate the 95% confidence interval about the mean age assigned by one ager for all fish assigned a given age by a second reader. The 1:1 equivalence line (dashed) is also indicated.

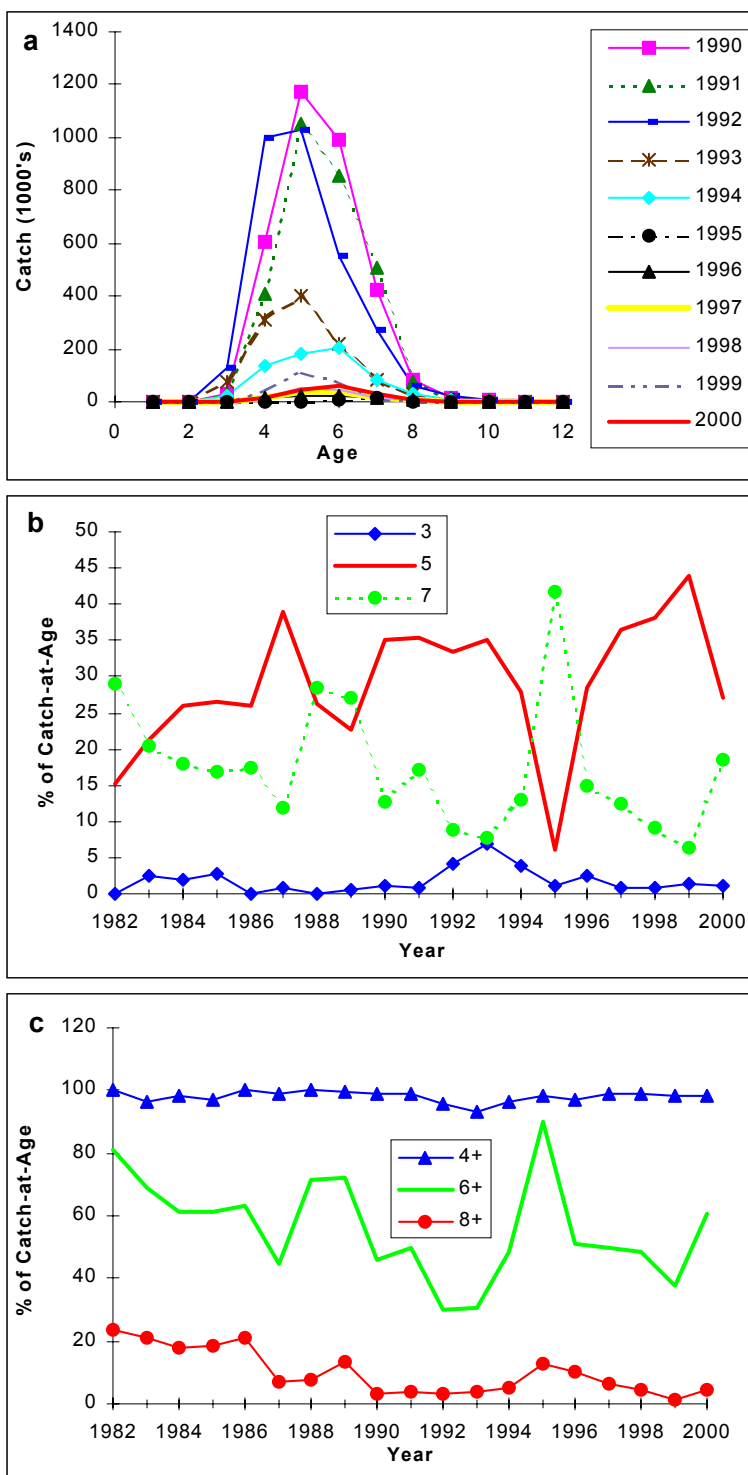


Figure 10. a. Commercial fishery catch-at-age for white hake in NAFO Division 4T: 1990-2000. b and c. Percentage composition of the commercial fishery catch-at-age for white hake: ages 3, 5 and 7 and age groups 4+, 6+ and 8+.

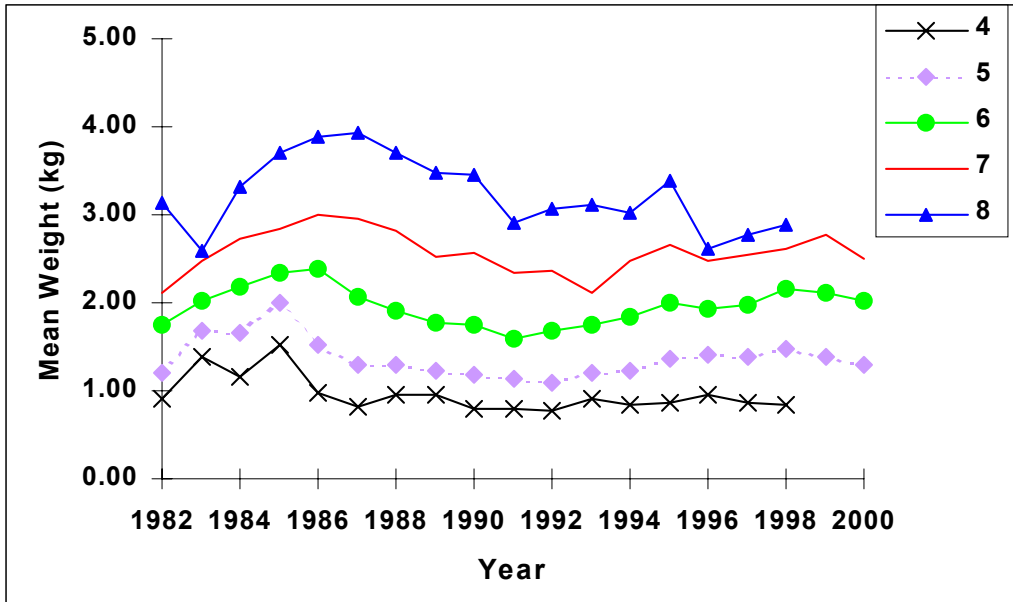


Figure 11. Trends in mean weights-at-age (kg) for white hake (ages 4-8) from the commercial fishery in the southern Gulf of St. Lawrence.

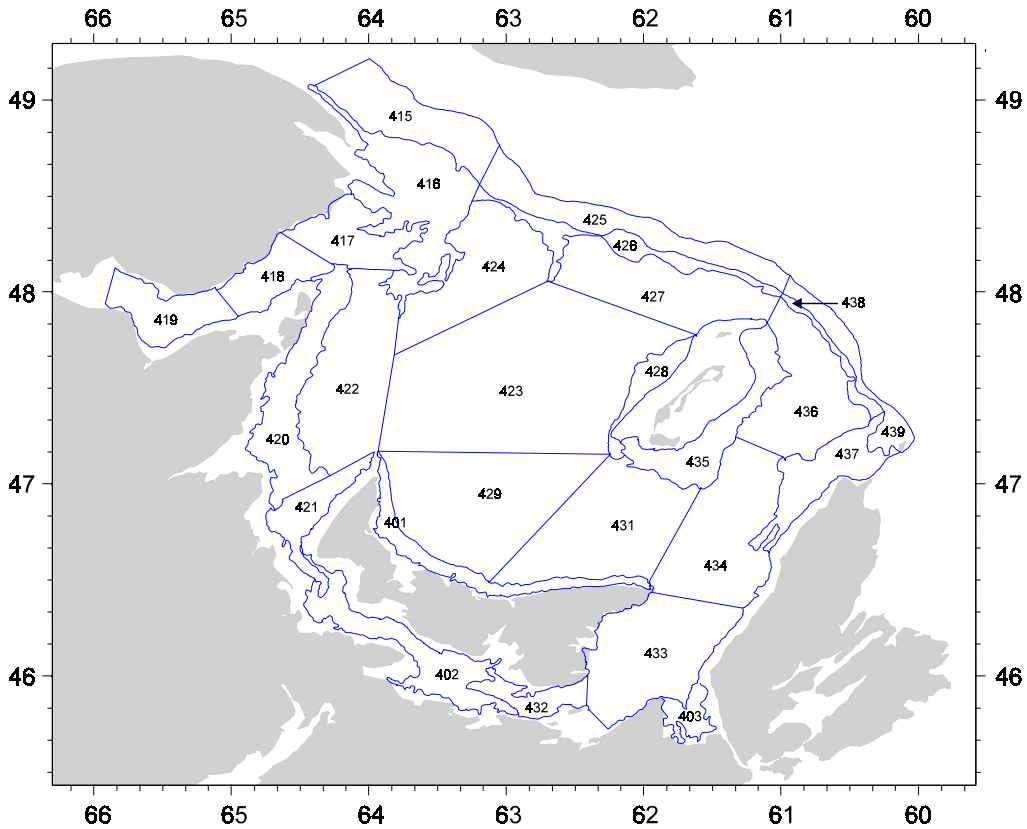


Figure 12. Stratification scheme for the annual (September) groundfish abundance survey of the southern Gulf of St. Lawrence.

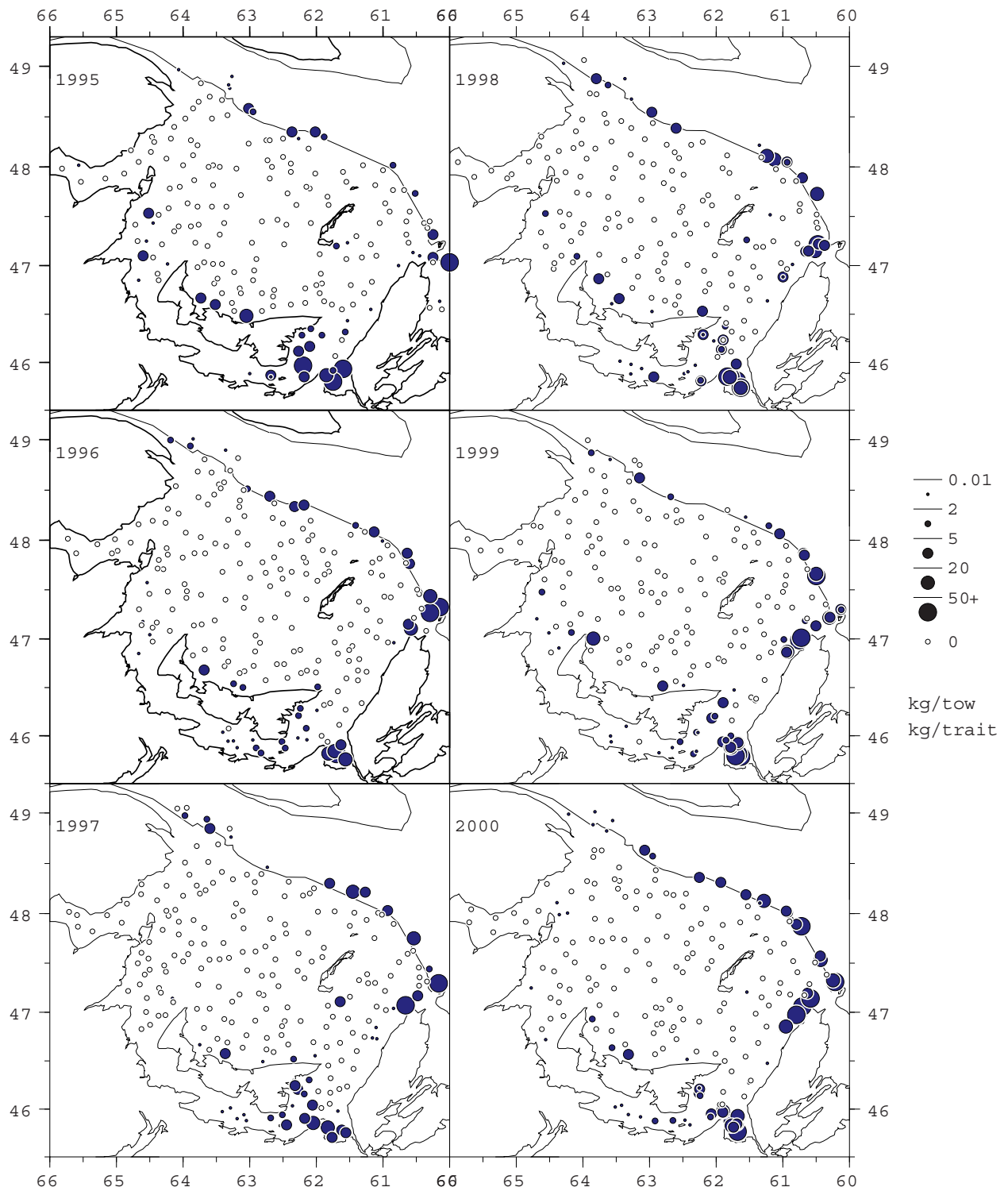


Figure 13. Location of white hake catches (kg) during the annual (September) groundfish surveys of the southern Gulf of St. Lawrence conducted from 1995 to 2000.

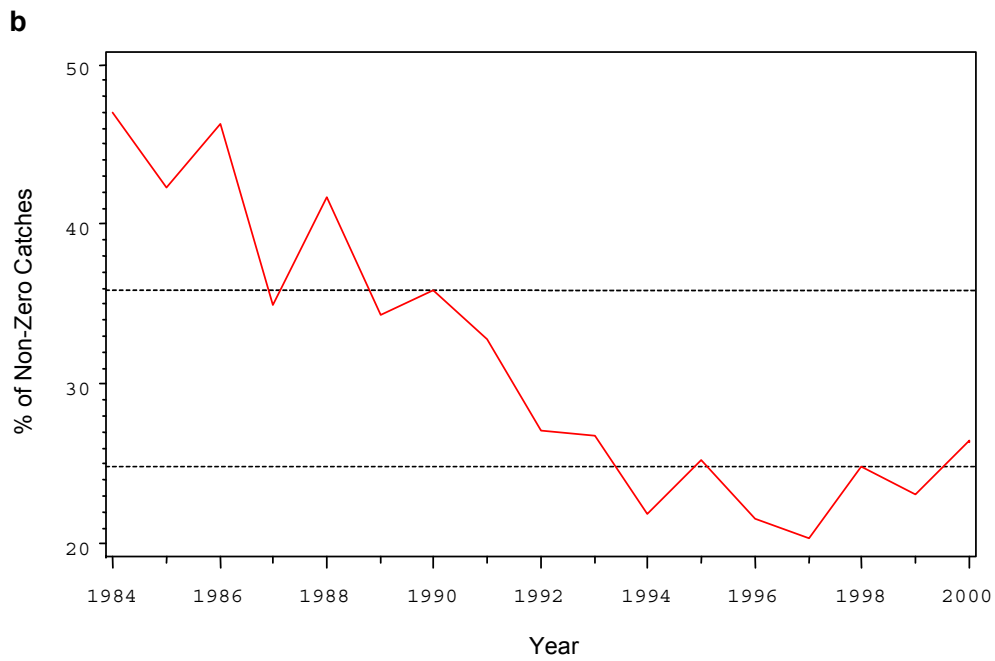
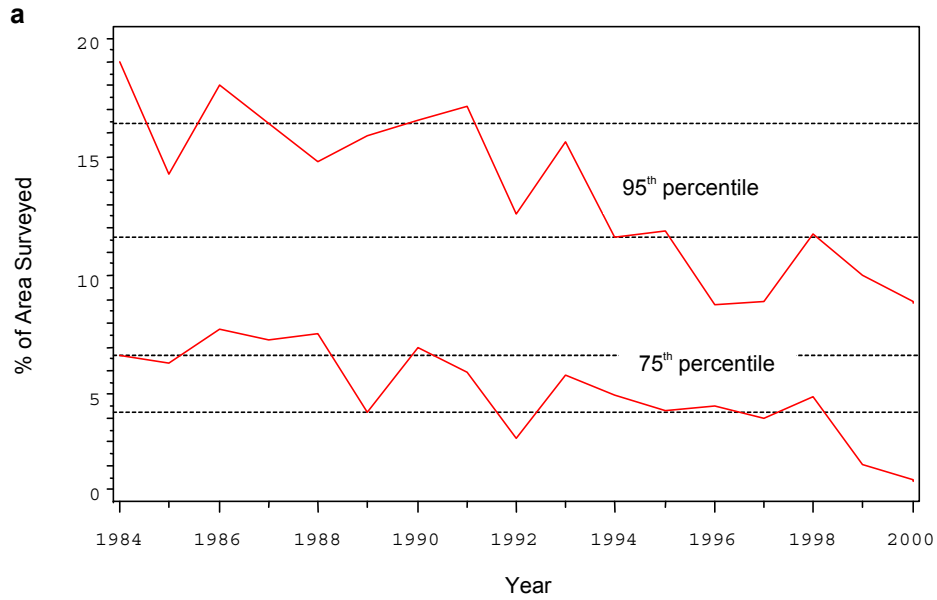


Figure 14. a. Percentage of the total survey area occupied by the top 75th and 95th percentiles of the white hake population in NAFO Div. 4T (an index of population concentration).
 b. Percentage of the total number of survey sets made each year containing white hake (an index of prevalence or how widely white hake are distributed within the survey area).

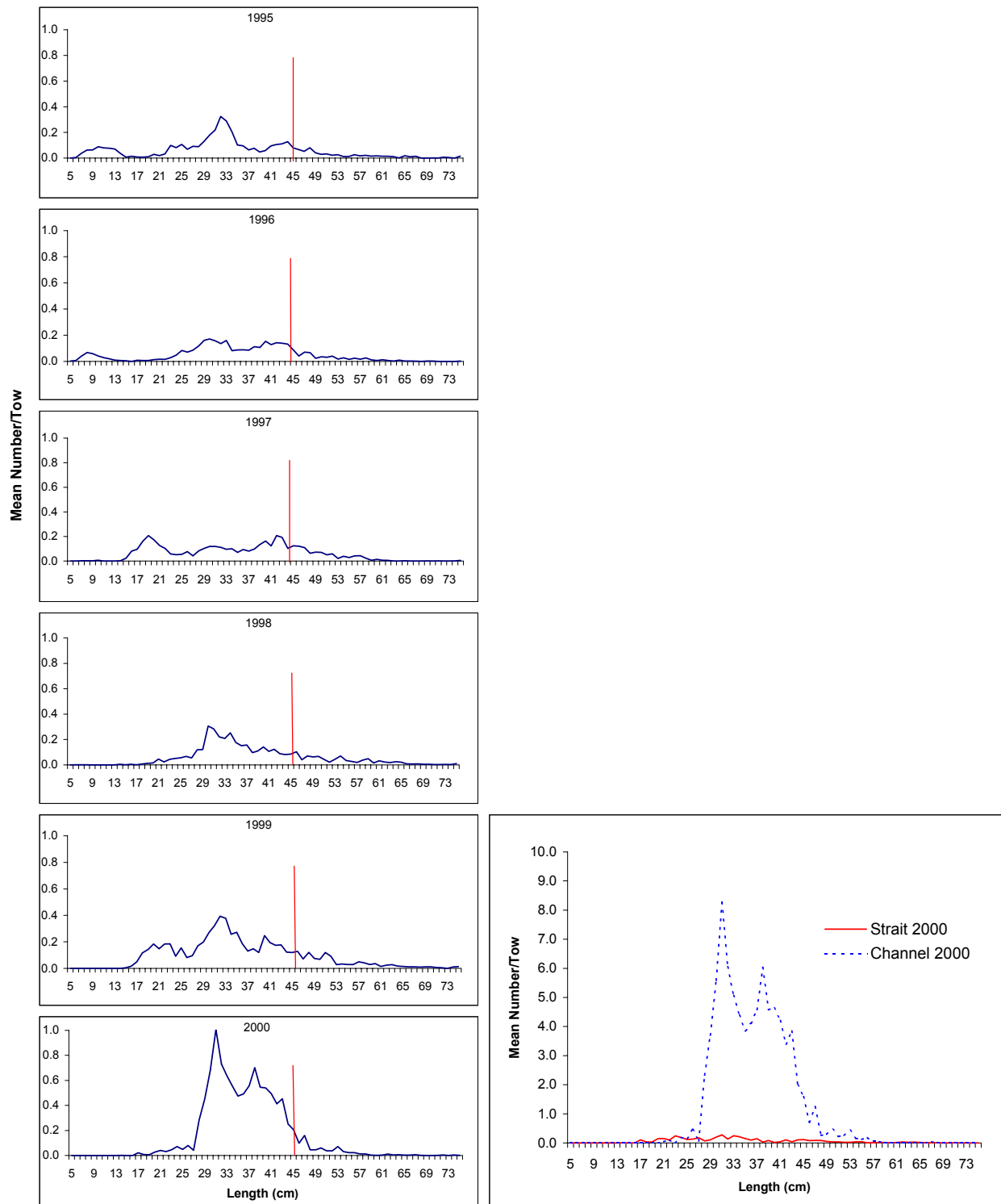


Figure 15. Annual length frequencies for white hake from September groundfish surveys of the southern Gulf of St. Lawrence: 1995-2000 (Note: Strata 401, 403, 415-439 for 1984-1997). The vertical line indicates the regulated minimum commercial size (45 cm). The panel on the right shows the 2000 length frequencies for the 'Strait' and 'Channel' components separately.

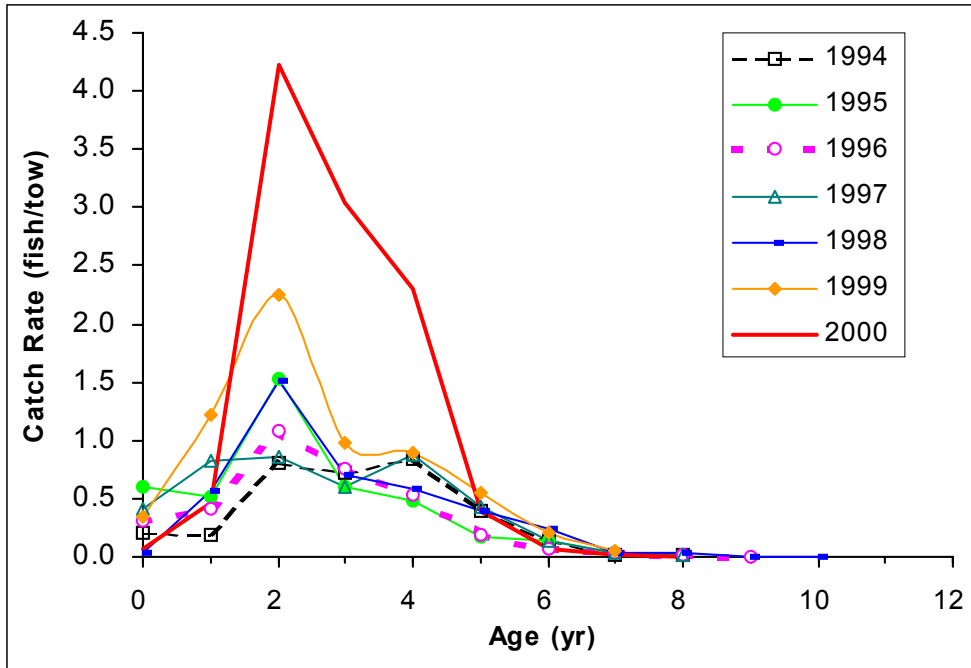


Figure 16 a. Research vessel stratified mean catch per tow-at-age for white hake in NAFO Division 4T: 1994-2000.

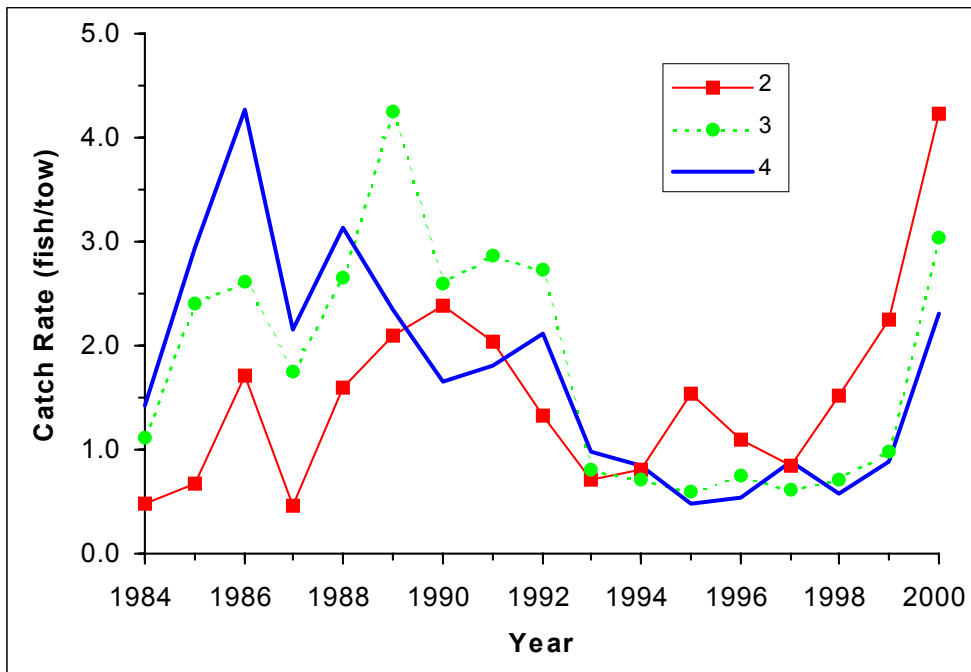


Figure 16 b. Research vessel stratified mean catch per tow-at-age for white hake in NAFO Division 4T: Ages 2, 3 and 4, 1984-2000.

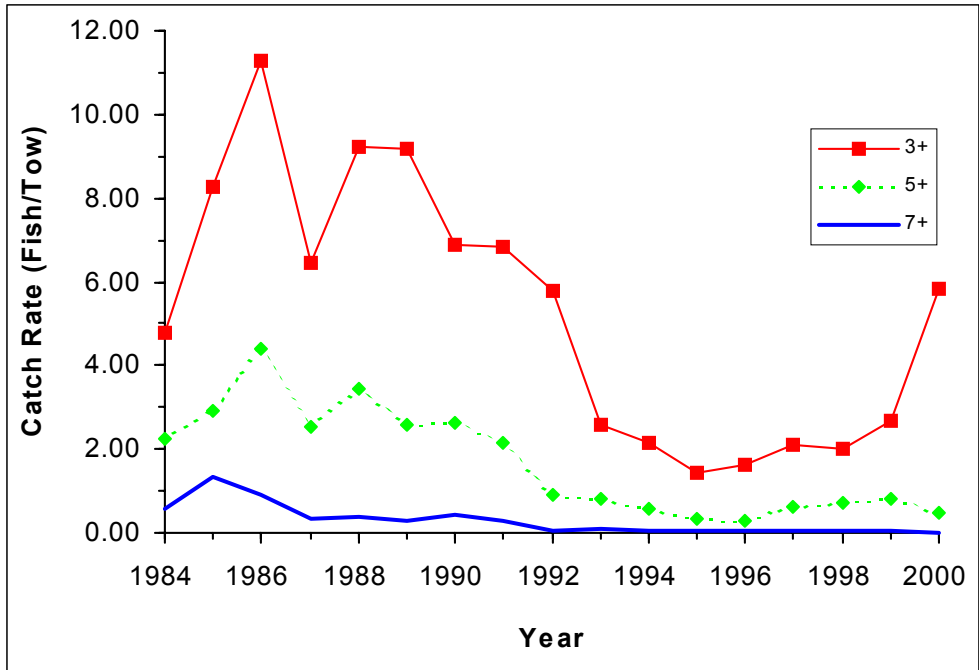


Figure 16 c. Research vessel stratified mean catch per tow-at-age for white hake in NAFO Division 4T: Ages 3+, 5+ and 7+, 1984-2000.

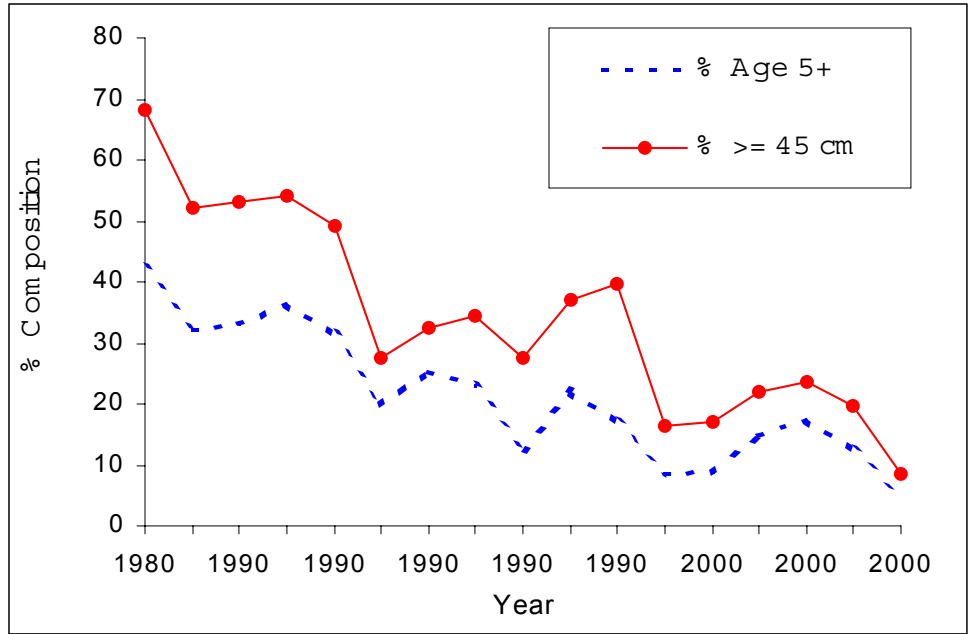


Figure 16 d. Percentage composition of white hake 5 years and older or 45 cm and longer from research vessel surveys in NAFO Div. 4T.

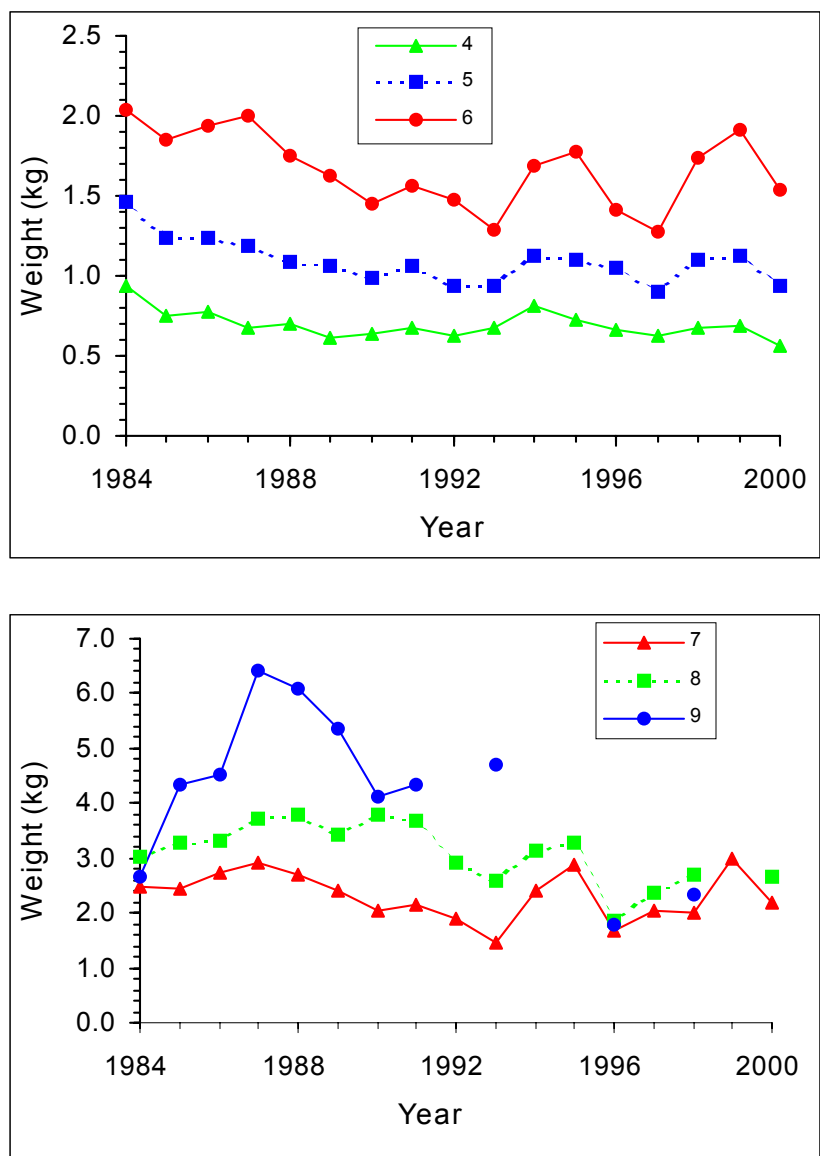


Figure 17. Trends in mean weights-at-age (kg) for white hake (Ages 4-9) from the annual (September) surveys of the southern Gulf of St. Lawrence.

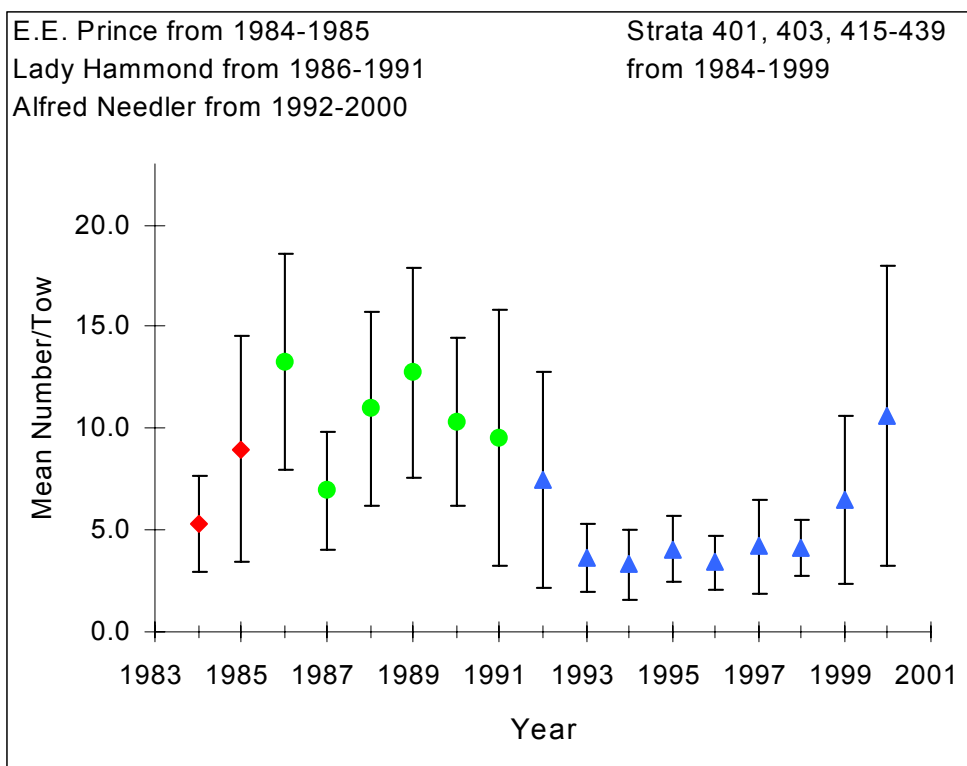


Figure 18. Stratified mean catch rate (fish/tow) of white hake (ages 0+) in the September bottom trawl survey of the southern Gulf of St. Lawrence (NAFO Division 4T). Vertical bars show +/- 2 S.D. The research vessels used in each of the surveys are indicated by different symbols. Since 1984 the survey index includes strata 401,403 and 415-439.

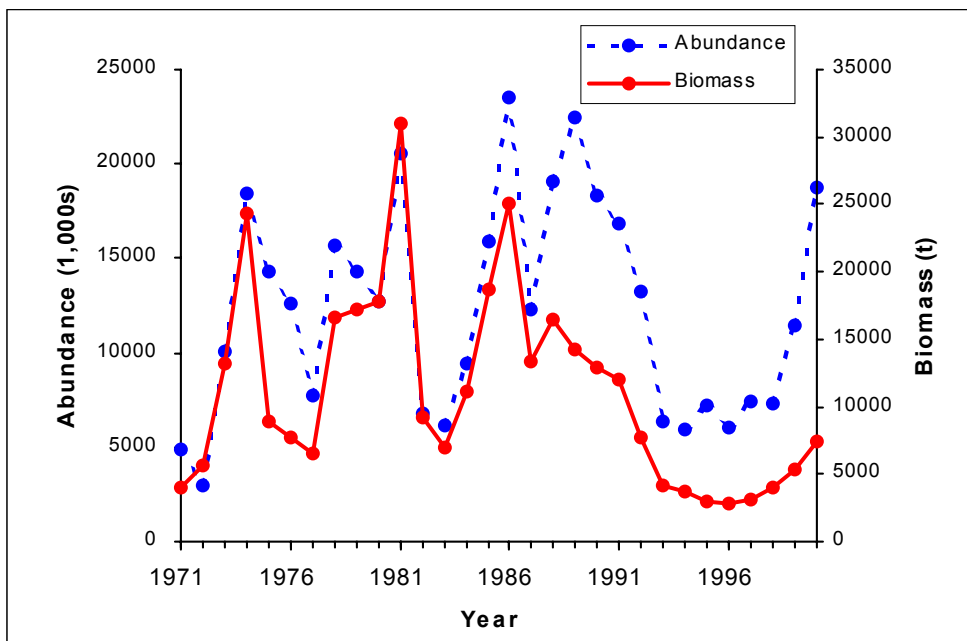


Figure 19. Estimated population numbers (1,000's) and biomass (t) for white hake in NAFO Division 4T.

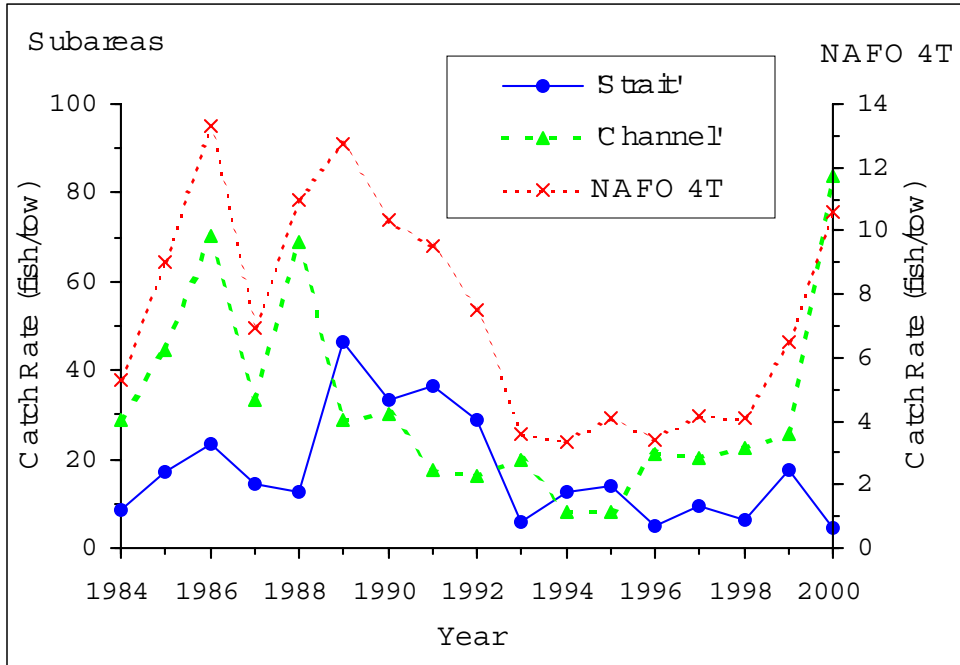


Figure 20a. Comparison of research vessel abundance indices (stratified mean catch per tow) for all of NAFO Division 4T and for the 'Strait' and 'Channel' subareas (Note the difference in scale between the subarea indices and the overall NAFO 4T index).

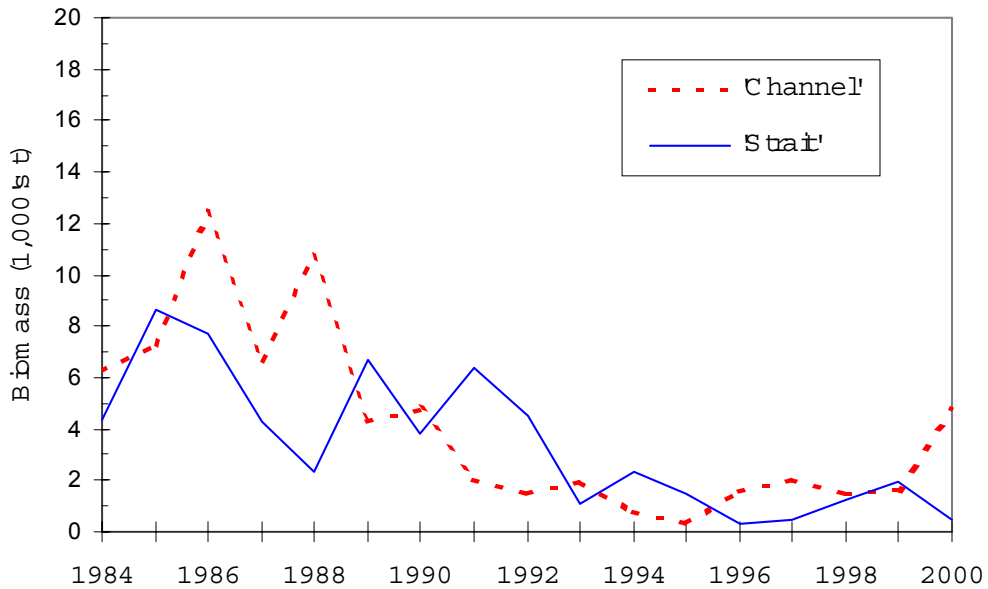


Figure 20b. Comparison of research vessel estimates of the trawlable biomass (ages 3+) for the 'Strait' and 'Channel' stock components.

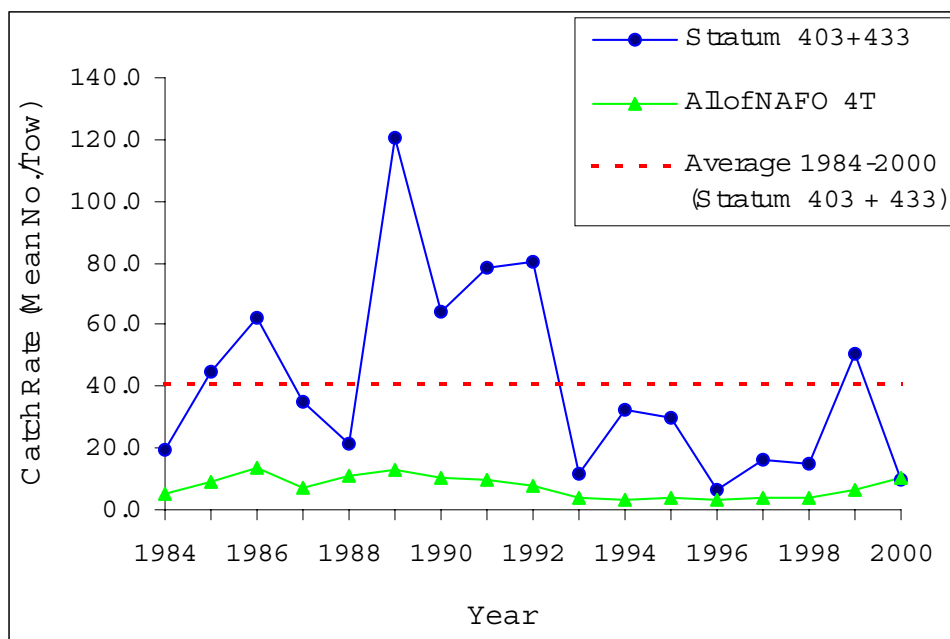


Figure 21. Comparison of the research vessel stratified mean catch per tow of white hake in NAFO Div. 4T and in two strata in the southeastern Gulf (403 and 433) .

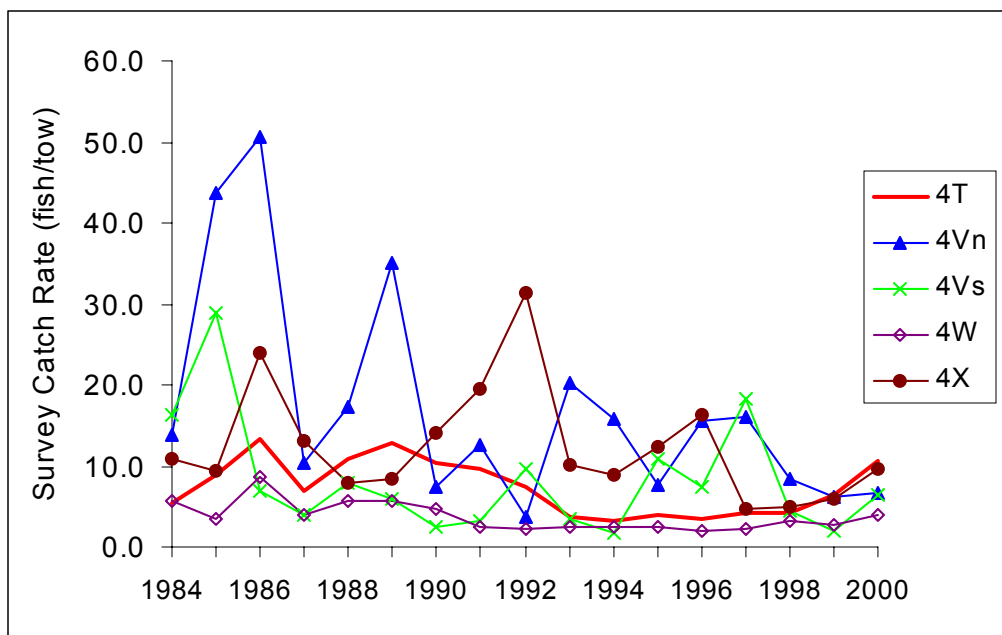


Figure 22. Comparison of the research vessel stratified mean catch rates (numbers/tow) of white hake in the southern Gulf (NAFO Div. 4T), northern Gulf (NAFO Div's. 4RST) and Scotian Shelf/Bay of Fundy (NAFO Div's. 4VWX) surveys.

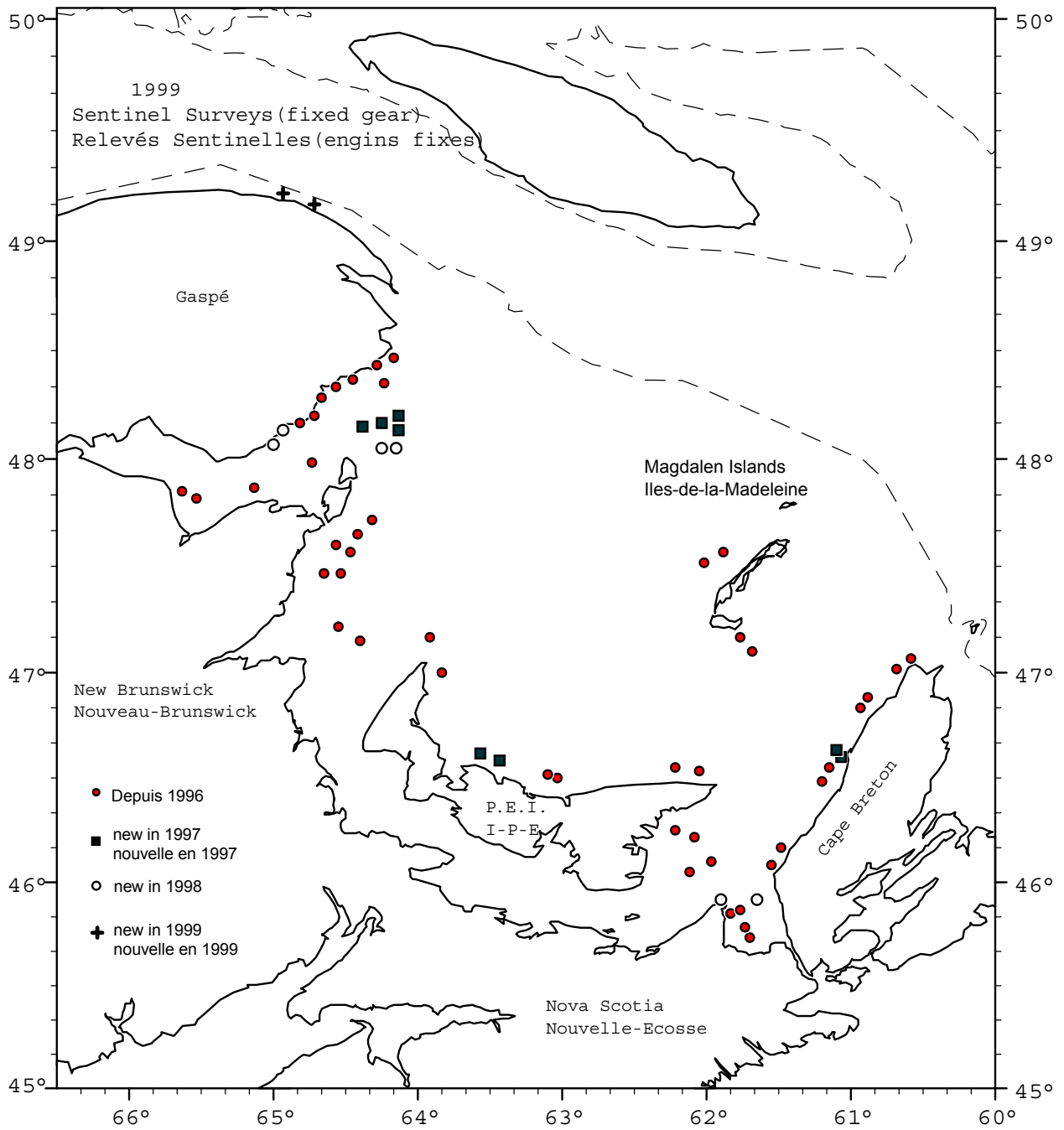


Figure 23: Locations of the fishing sites for the fixed gear sentinel survey program conducted in the southern Gulf from 1996-2000.

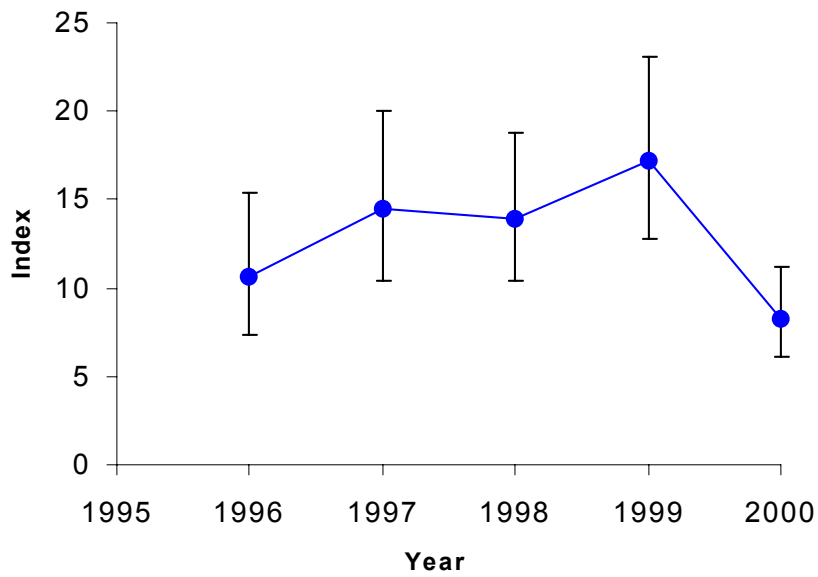


Figure 24: Standardized catch rates for longlines in the southern Gulf sentinel survey program (1996-2000). Error bars indicate approximate 95% confidence intervals.

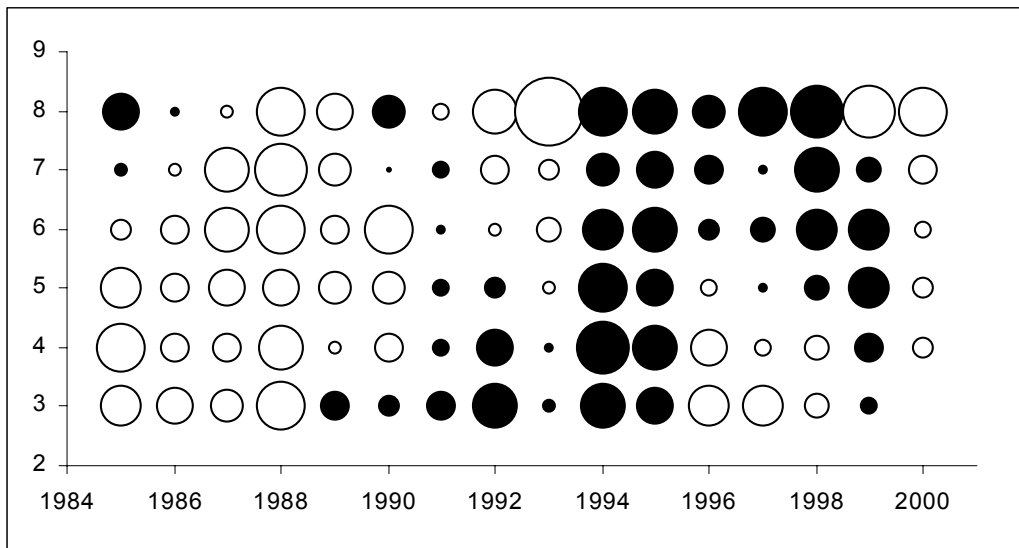


Figure 25. Residual patterns from SPA calibrations using the ADAPT tuning method and the research survey abundance index for the 'Strait' component (Ages 3-8). (Note: not bias corrected).

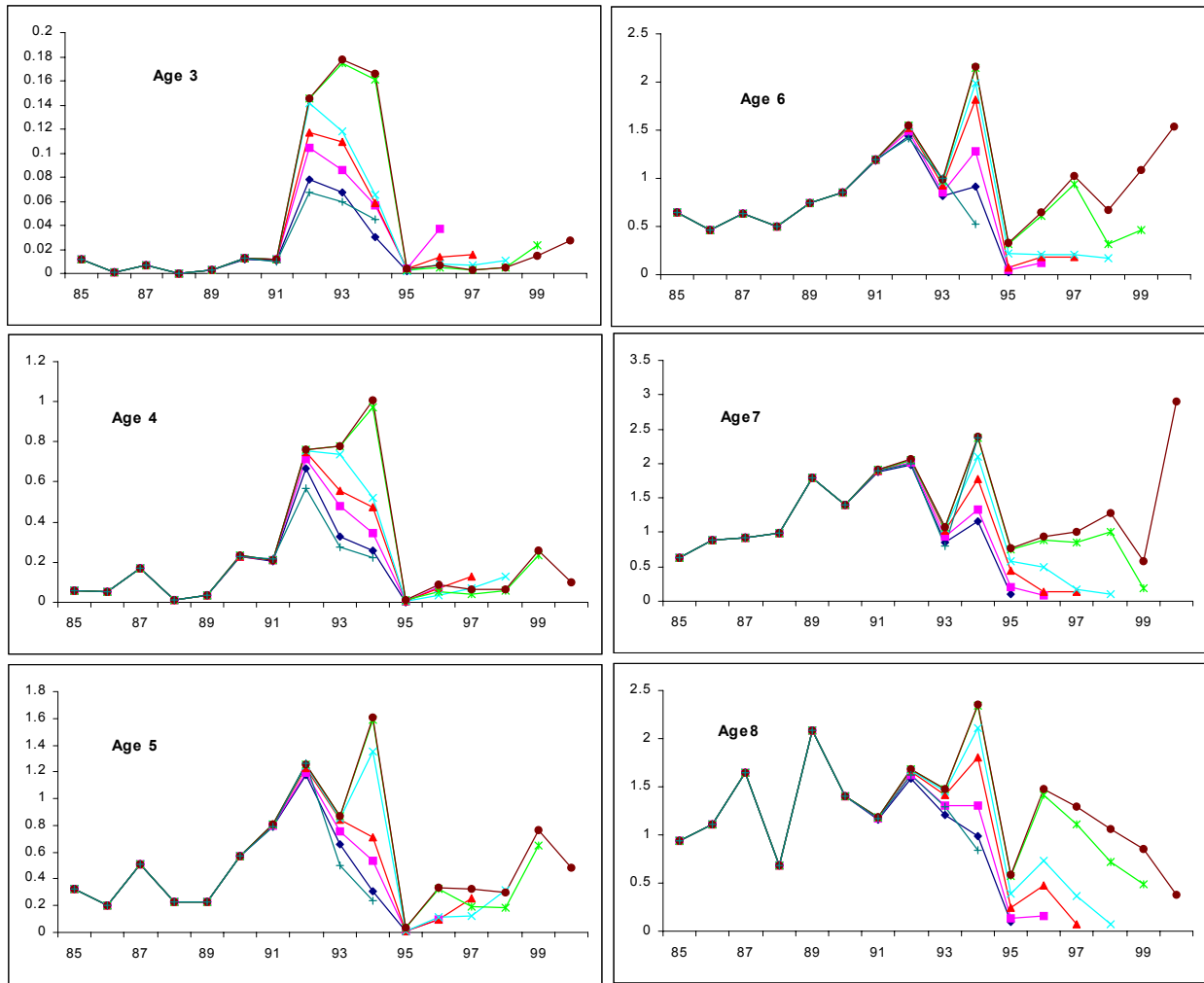


Figure 26. Retrospective patterns in fishing mortality from the ADAPT SPA calibration for white hake from the 'Strait' component (Ages 3-8). (Note: Bias corrected).

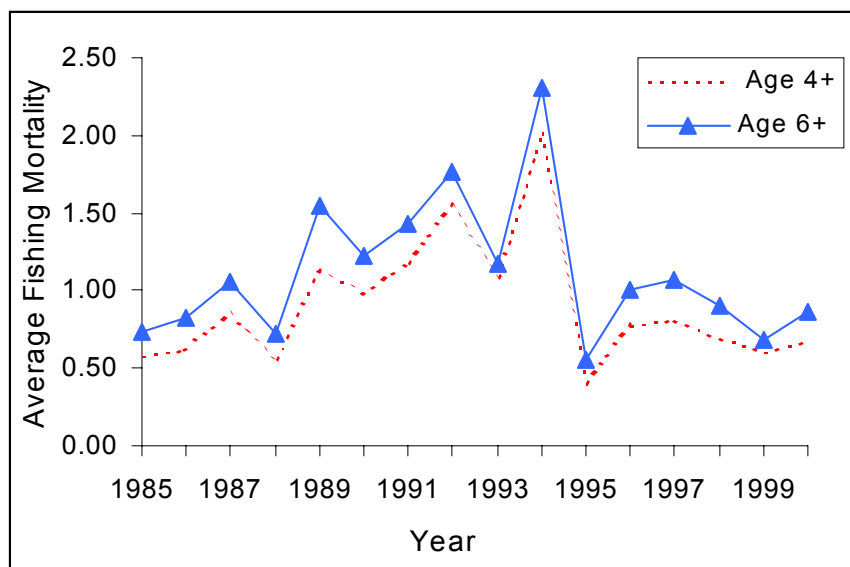


Figure 27. Estimates of fishing mortality (F) for white hake from the 'Strait' component from SPA calibrations using the ADAPT tuning method.

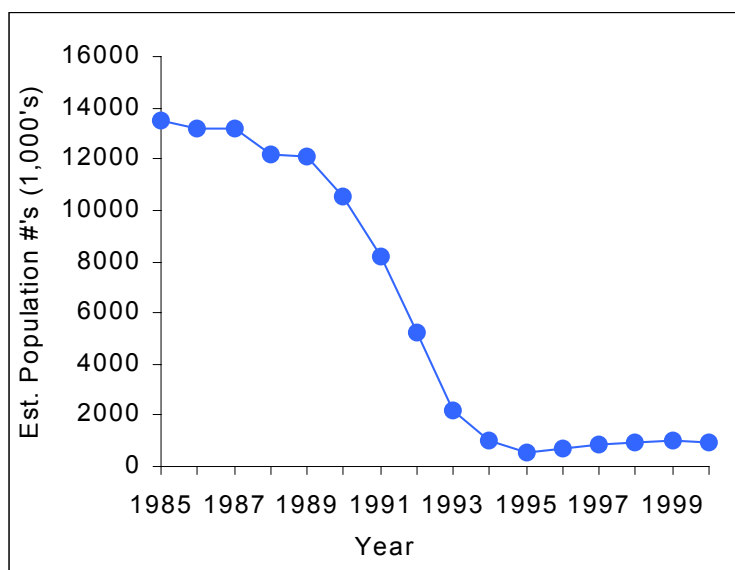


Figure 28. Beginning of the year population estimates for white hake from the 'Strait' component from SPA calibrations using the ADAPT tuning method.

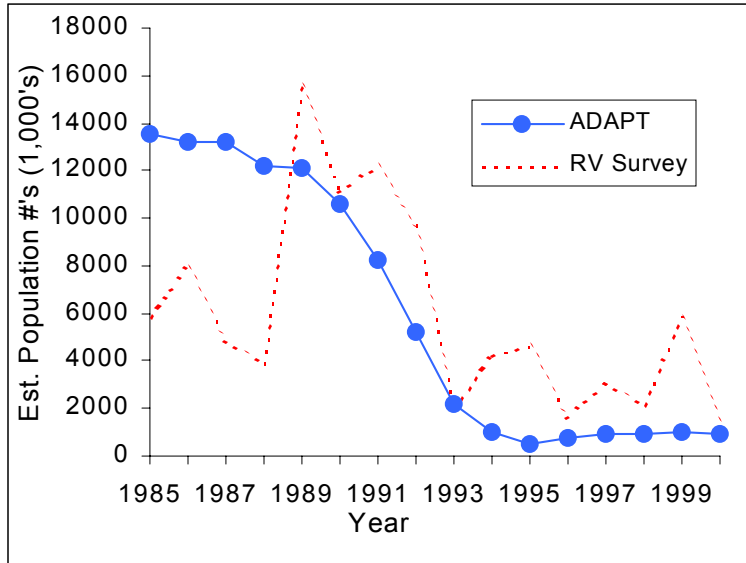


Figure 29. Comparison of beginning of year population estimates from ADAPT with population estimates for the 'Strait' component from the research vessel survey (strata 403, 420-422, 432, 433 (number of WIIA trawlable units = 334,575)). Note: Neither of the population estimates were adjusted for differences in catchability.

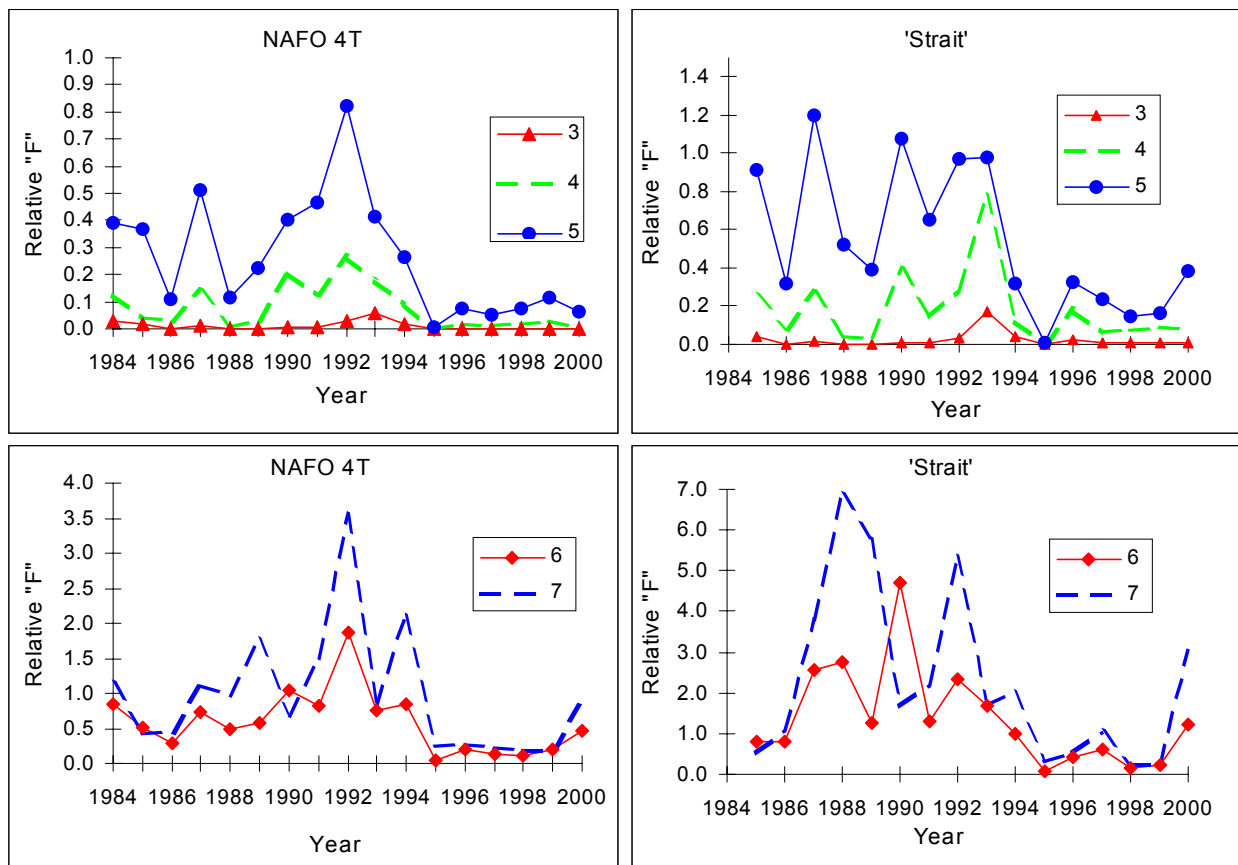


Figure 30. Trends in the estimates of relative fishing mortality (F) for white hake from NAFO Div. 4T and the 'Strait' component.

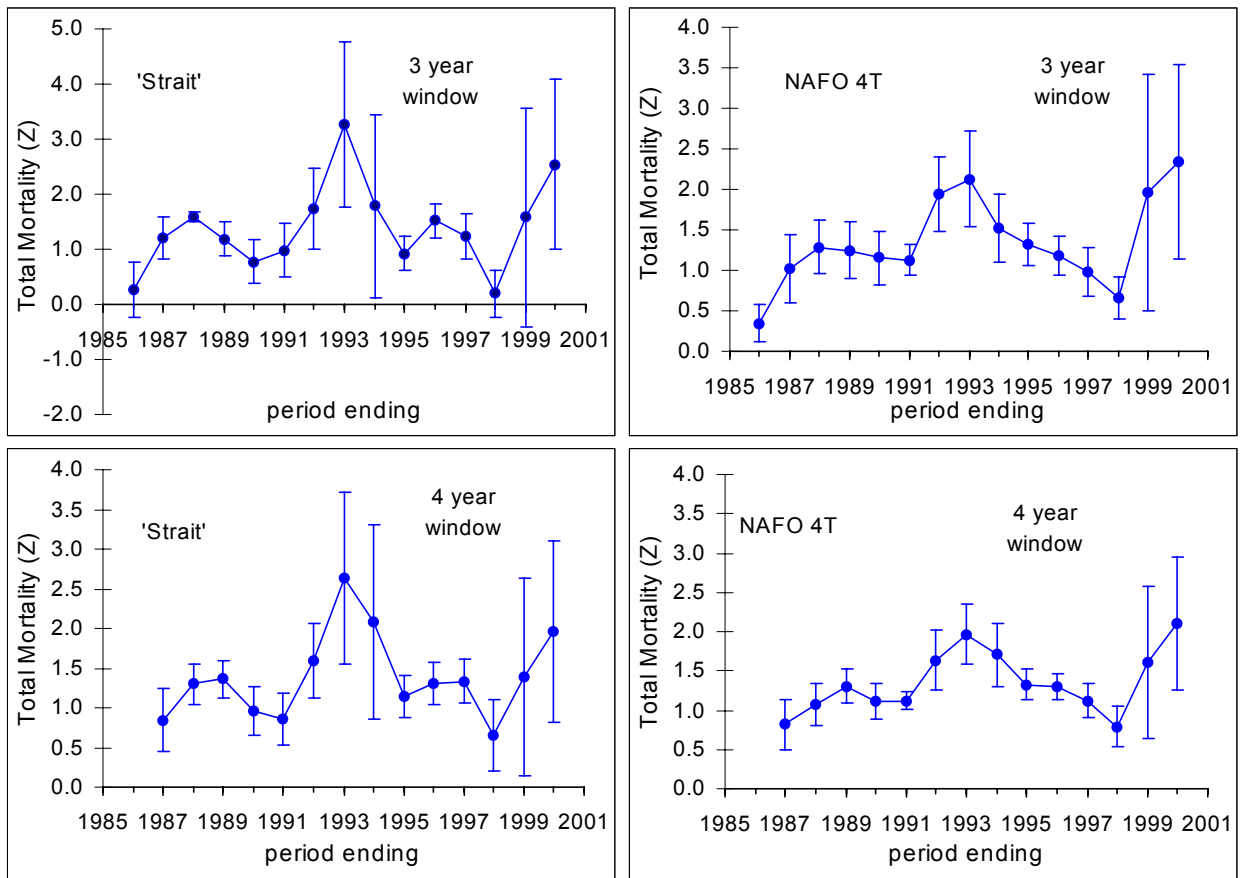


Figure 31. Estimates of total mortality (Z) for white hake in NAFO 4T (strata 401,403, 415-439) and the 'Strait' component of NAFO 4T (403, 420-422, 432, 433). Estimates are for 3 or 4 year windows ending in the year shown on the X-axis. Error bars are 2 SE.