D. OFFSHORE HAKE STOCK ASSESSMENT FOR 2010

[SAW-51 Editor's Note: The SARC-51 Review Panel concluded that sufficient information is not available to determine offshore hake stock status with confidence, because fishery data are insufficient and one cannot assume that survey data reflect stock trends. The Panel concluded that it is not possible at this time to provide a reliable definition for overfished and overfishing for this stock. SEINE and AIM modeling is included in this report to show what the Working Group provided to the SARC-51 for peer review.]

Terms of Reference

1. Use models to estimate the commercial catch. Describe the uncertainty in these sources of data.
2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, age-length data, etc.). Describe the uncertainty in these sources of data.
3. Estimate measures of annual fishing mortality, recruitment and stock biomass for the time series, and characterize the uncertainty of those estimates.
4. State the current definitions for overfished and overfishing. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and F_{MSY}; and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs.
5. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from Offshore hake TOR 4).
6. If a model can be developed, conduct single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
    1. Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment.
    2. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
    3. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.
7. Propose new research recommendations.

Executive Summary

Offshore hake (*Merluccius albidus*) is a data-poor stock and very little is known about its biology and life history. They are commonly distributed from southern Georges Bank through the Mid-Atlantic Bight, at depths of 160-550 meters and temperatures ranging between 11-13°C.

They are known to co-occur with silver hake (*Merluccius bilineris*) in the outer continental slopes of the Atlantic Ocean and are easily confused with silver hake because of their strong morphological resemblances.

The primary sources of biological information for offshore hake are based on the annual fishery independent surveys conducted by the Northeast Fisheries Science Center (NEFSC). The NEFSC have conducted both spring and fall bottom trawl surveys off the US continental shelf annually since 1963. The surveys extend from the Gulf of Maine to Cape Hatteras, in offshore waters at depths 27-365 meters, and have been conducted in the fall since 1963 and in the spring since 1968. The winter bottom trawl survey began in 1992 and was specifically designed for flatfish, however, the deeper survey strata were not sampled until 1998. The winter trawl survey does not cover the Georges Bank area because the survey was designed specifically for flatfish in the southern region.

Survey catches are highly variable but the trends in the spring and fall are similar. The higher catchability in the winter survey can be explained by the net configuration (i.e smaller cookies) specifically designed to target flatfish.

Offshore hake are located primarily on the continental shelf and presumably beyond the NEFSC survey area. Offshore hake tend to be concentrated in the southern Georges Bank region in the fall, whereas in the spring, they are found further south in the Mid-Atlantic Bight. They also appear to be more abundant during the winter months at temperatures ranging between 11-13 °C and in deeper waters.

Offshore hake appear to be sexually dimorphic with females slightly larger than males. Females mature at a larger length than males, similar to other gadoid species (O'Brien et al 1993). Length at 50% maturity (L_{50}) also differed significantly between sexes with females maturing at larger sizes (28cm) relative to males (23cm). More fish are found in the developing stage in April than in the other months sampled. There is also more frequency in resting stage in the fall than in the spring, which would also indicate that spawning occurs in the late spring and summer months (Traver et al., in review). We do not have a summer survey to verify these results.

Offshore hake is a trawl based fishery and primarily a bycatch fishery for silver hake, with 95% being caught by otter trawl. They are being caught in deep waters, where they are potentially being mixed with and reported as silver hake. Landings data are a major source of uncertainty for this stock, due to mixed reported landings with silver hake and landings were not reported until 1991. Even those that are reported may not be correctly identified (Garcia-Vazquez et al., 2009), therefore fishing mortality rates remain unknown. Two models were used to estimate the proportion of offshore hake landed as silver hake, a length-based and a depth-based model. The two models give similar estimates that are both much higher than the nominal landings. The data used in the assessment include survey indices from the NEFSC fall survey, landings estimated using two models, and discards estimated using a single model. The length-based model used the catch-at-length for silver hake and used the proportion of offshore hake at length from the survey to apportion catch. The depth-based model used VMS data and depth-based logistic functions from the survey to apportion landings. Two assessment models were attempted, An Index Method (AIM) and Survival Estimation in Non-Equilibrium Situations Model (SEINE). Neither model was considered adequate for management.

The survey data may not be a good index of abundance, and the values may be driven more by environmental changes or fish migrations. The survey likely does not cover the entire stock area and therefore, the survey estimates could potentially be under-representing the population. It also appears that the fishery as estimated by either the length-based model or the depth-based model has not had an impact on the stock. The mortality estimates from the SEINE model are in direct contrast to the catch data. Developing ACLs will be challenging given that the landings are not separated to a great extent. Garcia-Vazquez et al (2009) found 12% of hake sold in Spain as silver hake were actually offshore hake. No alternative reference points are recommended and the existing BRPs should also not be accepted.

Hake Working Group Meetings
Three meetings were held in preparation of the 2010 silver hake assessment.

1. Hake fishermen's/stakeholder's meeting – August 6, 2010 – UMASS School of Marine Science and Technology (SMAST), Fairhaven, MA. Participants include fishermen Dan Farnham and Bill Phoel. Also in attendance were David Goethel (Oversight Committee chair), Andrew Applegate (staff) Steve Cadrin (SSC and WG chair, SMAST), Pingguo He, Klondike Jonas, Yuying Zhang, Tony Wood, and Daniel Goethel (SMAST), Loretta O'Brien, Michele Traver, Kathy Sosebee and Larry Alade (NEFSC), and Dick Allen (advisor at large).

2. Data Meeting – September 7-10, 2010, NEFSC Woods Hole MA. Participants included Steve Cadrin (WG Chair), Assessment leads (Larry Alade, Kathy Sosebee , Michele Traver), Rapporteurs (Jessica Blaylock and Julie Nieland), Mark Showell (DFO), Andy Applegate (NEFMC Staff), NEFSC (Loretta O'Brien, Mark Terceiro, Chris Legault, Tim Miller, Dave Richardson, Ayeisha Brinson, Jiashen Tang, Janet Nye, Mike Palmer, Paul Rago, Josef Idoine, Jon Hare), Moira Kelly (NERO), SMAST (Tony Wood, Yuying Zhang, Saang-Yoon Hyun).

3. Model Meeting – October 25-29, 2010, NEFSC, Woods Hole, MA. Participants included Steve Cadrin (WG chair), Assessment leads (Larry Alade, Kathy Sosebee , Michele Traver), Rapporteurs (Jessica Blaylock and Julie Nieland), Mark Showell (DFO), Andy Applegate (NEFMC Staff), Dan Farnham (Fisherman and Industry Advisor), (Loretta O'Brien, Paul Nitschke, Mark Terceiro, Jay Burnett, Chris Legault, Tim Miller, Jon Deroba, Rich McBride, Jim Weinberg, Paul Rago, Josef Idoine, Jon Hare, Janet Nye, Dave Richardson, Laurel Col, Jason Link), SMAST (Tony Wood, Yuying Zhang, Dan Goethel). The groups met by correspondence after the meetings, including a WebEx meeting on November 5, 2010 to report updates on silver hake analyses, provide guidance on reference points and discuss plans for report development.

This Working Group (WG) report includes products from all three meetings and contributions from all participants.

Fishery Regulations
The following outlines the current small mesh multispecies regulations (based on the small mesh

exemption program) for the New England whiting fishery to provide context for interpreting the fishery and model results.

1. 1994 & 2000 - Exempted fisheries allows vessels to fish for specific species such as whiting or northern shrimp in designated areas using mesh sizes smaller than the minimum mesh size allowed (Gulf of Maine, Georges Bank, Southern New England, Mid-Atlantic : 6.5-inch square or diamond) under the Regulated Mesh Area (RMA) regulations .

2. Permits
a. Open access Category K Multispecies
b. Limited Access Category A-F (non Days-at-Sea fishing)

3. No Size Limits

4. 500 lbs at sea transfer limit.

5. 2003 - Possession limits vary by exemption area
a. 3,500 lbs if mesh < 2.5 inches (63.5mm)
b. 7,500 lbs if mesh <=3.0 inches (76.2mm)
c. 30,000 lbs if mesh > 3.0 inches (76.2mm)
d. No Red Hake possession limit

Introduction
Offshore hake, *Merluccius albidus* belongs to one of the twelve hake species of the genus *Merluccius*, inhabiting the northern and southern hemisphere of the world's oceans (Pitcher and Alheit 1995; Helser 1996). Like other species of the *Merluccius* genus, they are considered to be a 'true hake' species and are morphologically distinct from other gadoid-like hakes (e.g., red and white hake, Helser 1996). Offshore hake are known to be distributed off the continental slope of the northwest Atlantic to the Caribbean and the Gulf of Mexico (Chang et al 1999) (Figures D1-4). They are commonly located off southern Georges Bank through the Mid-Atlantic Bight at depths ranging from 160-550 meters (Bigelow and Schroeder 1953, Klein-MacPhee 2002). Offshore hake and silver hake (*M. bilinearis*) are sympatric species, and they co-exist over a considerable range of the continental slope, but are often separated by depth preferences (Helser 1996). The most distinguishing morphological characteristics between these species are the number of gill rakers and lateral line scales (Chang et al 1999). Due to the similar morphological features and spatial areas where they co-exist, they have been commonly misidentified for many years. The fishing industry did not separate the commercial landings of the two species until 1991, but the extent to which they are still landed as a single species is unknown (Helser 1996).

Offshore hake is currently included in the New England Fishery Management Council's (NEFMC) small mesh multi-species fishery management plan. Unfortunately, very little is known about the biology and population dynamics of offshore hake. They have never been formally assessed before.

Biology
Spawning usually occurs between April and July in the New England area, at depths ranging from 330-550 meters (Cohen et al. 1990). The maximum observed length from all areas is 40cm for males and 70cm for females (Chang et. al. 1999). Maximum observed size in samples from the Northwest Atlantic was approximately 43cm for males and 56cm for females, and fish greater 40cm consist mainly of females, suggesting that they are sexually dimorphic (Traver et al. in review). Length at 50% maturity (L_{50}) also differed significantly between sexes with females maturing at larger sizes (28cm) relative to males (23cm) (Traver et al. in review).

TOR 1. Use models to estimate the commercial catch. Describe the uncertainty in these sources of data.

Nominal commercial landings of offshore hake did not occur until 1991 (Figure D5, Table D1). Offshore hake commercial landings peaked at 120 mt in the early 1990s, then declined sharply to less than 5mt in 2001, the lowest in the time series (Figure D5). Landings have since increased slightly and average around 15 mt. Nominal landings of offshore hake occur in the silver hake northern area even though offshore hake are not found in these areas.

In the north, Massachusetts is the primary state that has nominal offshore hake landings while New Jersey and Rhode Island account for most of the southern area landings (Tables D2-D3). Otter trawl is the dominant fishing gear for offshore hake, accounting for 95% of the total nominal landings in both regions (Tables D4-D5). Other gears such as gillnet or hook and line were very minimal, contributing less than 1% in offshore hake catches.

Nominal landings of offshore hake occur sporadically in the north over time (Table D6). The landings are spread somewhat evenly among months in the south (Table D7-D8). Offshore hake are landed in an unclassified or dressed market category (has been combined in Table D9). King offshore hake are large component of the southern stock landings accounting for more than 50% of the total (Table D9).

There are currently no estimates of CPUE or effort for this species. Given the uncertainties given below with species identification and the major changes in management noted in the introduction, CPUE is not likely to be a good indicator of stock status.

It is thought that landings of offshore hake are likely under-reported or mis-reported and landed as silver hake as well as reported in areas that are not likely. There is no price differential so there is no real incentive to separate the two species when they are landed. Landings from the northern area are assumed to be silver hake. In order to estimate landings of offshore hake from the landings of silver hake from the southern region (Table D10-D13), two alternative methods were developed.

The first method used the port length samples of both species directly. Length samples of silver and offshore hake were combined by stock (Tables D14-D16). In examining the silver hake length samples by market category, it appeared that most of the market categories were similar in length composition to the round category (Figures D6-9). Therefore, only three market categories were used for stratification: round, king, and large. Even with the reduction of market categories, pooling over years was required to get an adequate number of fish (Table D17). The length-weight equations for silver hake by season from Wigley et al. 2003 were applied to the samples and used to estimate the landings numbers at length for each market category.

For the southern stock, length compositions for each species were estimated for the spring and fall surveys from 1968-2009. The species-specific length-weight equations were then applied to determine weight-at-length by species. The proportions at length by species for both number and weight were applied to the commercial landings-at-length to estimate landings-at-length by species. The lengths had to be grouped into intervals to avoid zero cells in the survey. To hind-cast the species proportions back to 1955, the average proportion of offshore hake for the time series was used and applied to the total silver hake landings.

The second method relates survey catch composition to Vessel Monitoring System (VMS) derived commercial landings from 2004-2009 using survey depth as an explanatory factor to develop a model that predicts the hake species landings composition. Offshore and silver hake composition (R_{23}) in the trawl survey tows were modeled as a two parameter logistic function of average depth. Only survey tows with silver hake, offshore hake or both were fitted and mean depth was the dependent variable.

$$R_{23} = \frac{e^{a+b*depth}}{1+e^{a+b*depth}}$$

For each stratum group, survey (winter, spring, and fall), and sets of time series, the catch and depth data were fitted by a non-linear least squares, weighted by the number of positive tows in a stratum, using the Marquardt method (Marquardt 1963) to aide convergence. Data were weighted by the number of positive tows in a stratum group. R^2 and Wald 95% confidence intervals (Cook and Weisberg 1990) were calculated for parameters a, b, D50, and the range to evaluate goodness of fit. Fitting the data with a two parameter logistic non-linear regression using maximum likelihood estimation and iteratively reweighted least squares approaches was attempted, but did not improve the results.

The parameter estimates for 1985-2009 were applied to the depth association with the VMS-derived commercial landings at depth (Applegate 2010). The model ratio of offshore to silver hake were assigned to landings from each group depth zone, survey season, and survey stratum group and summed for the calendar year (Applegate 2010). The final landings from this method were greater than 90% of the total landings reported by dealers in 2004-2009.

Estimates of offshore hake landings ranged between 290 – 893 mt and 5 – 12% of total hake landings (Table D18). These estimates are considerably higher than those reported by either dealers or by fishermen on Vessel Trip Reports (VTR).

Given that VMS data for 2004 – 2009 were deemed acceptable for direct estimation of silver and offshore hake landings composition, landings prior to 2004 (1955 – 2003) were hindcasted to generate longer time series of removal for assessments and for developing biological reference points. Although the hindcast procedure allowed the distribution of catch to vary between statistical areas, the distribution of catch within these intermediate depth statistical areas was assumed to be constant, equal to the average depth distribution observed by VMS during 2004-2009. Details of the hindcasting methodology can be found in Applegate (2010).

Hindcast and model based estimates of offshore hake landings were an order of magnitude greater than that reported by dealers. Landings rose from 951 mt in 1955 (7.0% of the total) to 24,189 mt in 1965 (8% of the total). Offshore hake as a proportion of total hake landings ranged from 2% in 1971, 1976, 1978-1980 to 13% in 1988 and 1996 (Tables D18a-b).

Relative to the length-based approach, the results from the depth-based method for allocating silver hake catches were very similar (<1 – 14% relative difference). Conversely, offshore hake estimates showed substantial differences between both methods. However, these differences are more noticeable on a relative scale because offshore hake consists of a small fraction of the total hake catches (Figure D10).

For assessment purposes, the Working group felt that the length-based estimator was more suitable because of the shorter period in hindcasting analyses. The group also felt that the small differences between the methods for silver hake estimates are likely not to influence assessment model results.

The resulting offshore hake landings for the two methods are given in Tables D18a-b and Figures D11-12. On average, the two methods gave slightly different results, with the length-based model averaging 7% silver hake while the depth-based method averaged 4% silver hake.

Commercial Fishery Discards
Discard estimates were calculated in this assessment. The ratio-estimator used in this assessment is based on the methodology described in Rago et al. (2005) and updated in Wigley et al. 2007. It relies on a d/k ratio where the kept component is defined as the total landings of all species within a "fishery". A fishery is defined as a homogeneous group of vessels with respect to gear type (longline, otter trawl, shrimp trawl, sink gill net, and scallop dredge), quarter, and area fished (GOM-NGBK, SGBK-MA), and for otter trawls, mesh size (<= 5.49", > = 5.5 "). All trips were included if they occurred within this stratification regardless of whether or not they caught hakes.

The discard ratio for hakes in stratum h is the sum of discard weight over all trips divided by sum of kept weights over all trips:

$$\hat{R}_h = \frac{\sum_{i=1}^{n_h} d_{ih}}{\sum_{i=1}^{n_h} k_{ih}} \qquad (1)$$

where d_{ih} is the discards for hakes within trip i in stratum h and k_{ih} is the kept component of the catch for all species. R_h is the discard rate in stratum h. The stratum weighted discard to kept ratio is obtained by weighted sum of discard ratios over all strata:

$$\hat{R} = \sum_{h=1}^{H} \left(\frac{N_h}{\sum_{h=1}^{H} N_h} \right) \hat{R}_h \qquad (2)$$

The total discard within a strata is simply the product of the estimate discard ratio R and the total landings for the fishery defined as stratum h, i.e., $D_h = R_h K_h$. Cells with < three trips were imputed using annual averages by gear type and region. To hind-cast the discards to 1981 (the first year in which there was no industrial fishery), discards/total landings by half year for the first three years (1989-1991 for otter trawl, sink gill net, and shrimp trawl; 1992-1994 for longline and scallop dredge) were averaged and the rate applied to the total landings from the dealer database. For the otter trawl fisheries, the mesh sizes were combined for the hind-cast.

Discards from the longline and sink gill net fishery were minimal for silver and offshore hake in both stock areas (Table D19-D22). Discards from the otter trawl fisheries have been significant and variable for silver hake.

The same problem with species identification that exists in the landings is found in the FOP data. There are discards of offshore hake estimated for the north. The geographical distribution of offshore hake is limited to the southern stock of silver hake and therefore, any discards from the northern stock (Tables D19) are considered to be silver hake. In order to estimate discards of offshore hake from the southern region, only one of the alternative methods was employed.

The observer discard length samples of silver and offshore hake were combined by stock (Tables D23-D26). Enough length samples were available for large and small mesh otter trawls in both regions and sink gill net and shrimp trawl in the north. Pooling over years was still required to get an adequate number of fish (Table D27-D28). The length-weight equations by season from Wigley et al 2003 were applied to the samples and used to estimate the landings numbers at length for each market category. The discards-at-length were raised to the total discards including all the gear types to account for as much of the removals as possible.

For the southern stock, length compositions for each species were estimated for the spring and fall surveys from 1968-2009. The species length-weight equations were then applied to determine weight-at-length by species. The proportions at length by species for both number and weight were applied to the commercial discards-at-length to estimate discards-at-length by species. The lengths had to be grouped into intervals to avoid zero cells in the survey. To hind-cast the species proportions back to 1981, the average proportion of offshore hake for the time series was used and applied to the total silver hake discards (Table D29).

TOR 2. Characterize the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, age-length data, etc.). Describe uncertainty in these sources of data.

Data Source: The primary sources of biological information for offshore hake are based on the annual fishery independent surveys conducted by the Northeast Fisheries Science Center (NEFSC). The surveys were conducted using a random stratified sampling design which allocates samples relative to the size of the strata, defined by depth. The NEFSC have conducted both spring and fall bottom trawl surveys off the US continental shelf annually since 1963. The surveys extend from the Gulf of Maine to Cape Hatteras, in offshore waters at depths 27-365 meters, and have been conducted in the fall since 1963 and in the spring since 1968. The winter bottom trawl survey began in 1992 and was specifically designed for flatfish, however, the deeper survey strata were not sampled until 1998 (Figure D1). The winter trawl survey does not cover the Georges Bank area because the survey was designed specifically for flatfish in the southern region. Details on the stratified random survey design and biological sampling methodology may be found in Grosslein (1969), Azarovitz (1981) and Sosebee and Cadrin (2006).

Survey analysis suggests that offshore hake are distributed within the narrow band of the outer continental shelf from southern Georges Bank to the Mid-Atlantic region (strata 3-4, 7-8, 11-12, 14-15, 17-18, 63-64, 67-68, 71-72, and 75-76). There are seasonal differences in the patterns of distribution with concentrations shifting south of Georges Bank in the winter months and extending to the southern flank of Georges Bank and further south in the spring (Figures D2-4).

Transform: Survey estimates were computed using both delta transformation and arithmetic means for numbers and weight. The Whiting Plan Development Team (PDT) has used the delta mean for assessing stock status. The delta transformation uses only the positive tows for log transformation:

$$\hat{M}_{\delta} = \begin{cases} \frac{m}{n} e^{\bar{y}} \psi_m\left(\frac{1}{2} s_y^2\right) & m > 1, \\ \frac{1}{n} x_1 & m = 1, \\ 0 & m = 0 \end{cases}$$

m = number of non-zero tows

n = total number of tows

$$\hat{V}_{\delta} = \begin{cases} \frac{m}{n} e^{2\bar{y}} \left[\psi(2s_y^2) - \frac{m-1}{n-1} \psi_m\left(\frac{m-2}{m-1} s_y^2\right)\right] & m > 1, \\ \frac{1}{n} x_1^2 & m = 1, \\ 0 & m = 0 \end{cases}$$

Examination of the differences between the delta and arithmetic means revealed that use of the delta transformation did not reduce the variability of the survey (Figure D13). If a survey has a high variance, the back-transformation may be biased high (see Silver Hake Assessment). The delta transformation was also more sensitive to the handling of missing weights. Prior to 2001, the data for weights were recorded to the nearest 0.1 kg and if a tow contained only a single small fish, the weight was entered into the data as zero. Since the delta transform uses the positive tow, how this is handled has an impact on the result. There are three options: taking out the zeros, leaving in the zeros, and filling in zeros using a length-weight equation. Since these options did not affect the arithmetic as much as the delta mean, the decision was made to use the arithmetic and length-weight options for any new analyses (Figure D14).

Calibration: In 2009 the *NOAA SHIP Henry B. Bigelow* replaced the *R/V Albatross IV* as the primary vessel for conducting spring and fall annual bottom trawl surveys for the Northeast Fisheries Science Center (NEFSC). There are many differences in the vessel operation, gear, and towing procedures between the new and old research platforms (NEFSC Vessel Calibration Working Group 2007). To merge survey information collected in 2009 onward with that collected previously, we need to be able to transform indices (perhaps at size and age) of abundance from the *Henry B. Bigelow* into those that would have been observed had the *Albatross IV* still been in service. The general method for merging information from these two time series is to calibrate the new information to that of the old (Pelletier 1998). Specifically we need to predict the relative abundance that would have been observed by the *Albatross IV* ($\hat{R}_A$) using the relative abundance from the *Henry B. Bigelow* (R_B) and a "calibration factor" (ρ),

$$\hat{R}_A = \rho R_B . \qquad (4)$$

To provide information from which to estimate calibration factors for a broad range of species, 636 paired tows were conducted with the two vessels during 2008. Paired tows occurred at many stations in both the spring and fall surveys. Paired tows were also conducted during the summer and fall at non-random stations to improve the number of non-zero observations for some species. Protocols for the paired tows are described in NEFSC Vessel Calibration Working Group (2007).

The methodology for estimating the calibration factors was proposed by the NEFSC and reviewed by a panel of independent scientists in 2009. The reviewers considered calibration factors that could potentially be specific to either the spring or fall survey (Miller et al. 2010). They recommended using a calibration factor estimator based on a beta-binomial model for the data collected at each station for most species, but also recommended using a ratio-type estimator under certain circumstances and not attempting to estimate calibration factors for species that were not well sampled. In the case of offshore hake, the Working Group decided that using silver hake calibration factors as a proxy was better than not using any calibration factors.

Since the review, it has become apparent that accounting for size of individuals can be necessary for many species. When there are different selectivity patterns for the two vessels, the fraction of available fish of a given size taken by the two gears is different. Therefore, the ratio of the mean catches by the two vessels will change with size. Under these circumstances, the estimated calibration factor that ignores size reflects an average ratio weighted across sizes where the weights of each size class are at least in part related to the number of individuals at that size and the number of stations where individuals at that size were caught. Applying calibration factors that ignore size effects to surveys conducted in subsequent years when the size composition is unchanged should not produce biased predictions (eq. 1). However, when the size composition changes, the frequency of individuals and number of stations where individuals are observed at each size changes and the implicit weighting across size classes used to obtain the estimated calibration factor will not apply to the new data. Consequently, the predicted numbers per tow that would have been caught by the *Albatross IV* will be biased.

Calibration coefficients for silver hake were used because an insufficient number of offshore hake were captured during calibration studies to derive a coefficient for offshore hake. For silver hake, a suite of beta-binomial models were fit that made different assumptions on the relationship of the calibration factor to length. The models ranged from those that were constant with respect to length to logistic and double-logistic functions of length. A season-specific model was chosen based on AIC_c for silver hake by the working group where a logistic functional form for the spring and a double-logistic form for the fall provided the best fit (Table D30, Figure D15). Refer to the silver hake chapter of this NEFSC CRD for more details.

Survey Data Results: Swept Area abundance and biomass were calculated by using swept area conversions of 0.0112 for the NEFSC fall and spring surveys and 0.0131 for the NEFSC winter survey. A three-year moving average was calculated for the arithmetic means and swept area abundance and biomass for the fall and spring surveys in order to smooth out the variability of the surveys (Tables 31-32).

The fall survey stayed rather stable with similar trends to the spring survey in the late 1970s and early 1980s. The highest swept area biomass was in 1981, with 577 metric tons. It sharply declined to 17 metric tons in 1982. It stayed fairly low until 2001 and 2003, where the biomass was over 100 metric tons. 2009 has a 28% increase over 2008, with 56 metric tons (Table D34, Figure D17).

The spring survey was low in the early part of the time series and increased steadily to a record high in 1980 at 1,886 metric tons. Like the fall survey, the spring survey then had a sharp decline to 336 metric tons. It has continued to decline, with its lowest value in 2006 at 10 metric tons. It has since increased from 2006 to 30 metric tons (Table D36, Figure D19).

The winter survey abundance and biomass have varied substantially over the entire time series (1998-2007) with no trend (Table D38, Figure D21). Survey catches are highly variable but the trends in the spring and fall are similar. The higher catchability in the winter survey can be explained by the net configuration (i.e. smaller cookies) specifically designed to target flatfish.

Age Data: Growth parameters were calculated from the survey data using the Von Bertalanffy growth equation:

$$L(t) = L\infty * (1 - exp(-k * t - t0))$$

There are 55 ages that were aged by the NEFSC that were used in this analysis. The lengths range from 13cm to 45cm, with ages 1-5. The ages are considered preliminary since there is no published ageing study in the Northwest Atlantic and were based on the same ageing criteria for silver hake. The growth equation with an L_∞ value set to 70cm resulted in a k value of 0.174.

Length Data: Survey length distributions for offshore hake in the spring and the fall do not show any clear modes and were difficult to interpret due to very low sample sizes. However, the general trend indicates that majority of the catches range between 20-40 cm in the fall and spring with very few fish greater than 40 cm. Despite, the higher sampling in the winter survey, the trends in the length distribution remain similar to the fall and spring (Table D39, Figures D22-24). To improve sampling intensity and trends in the length distribution, a three year moving average was calculated for the fall and the spring surveys and there were still no clear trends in the length distributions (Figures D25-26).

TOR 3. Estimate measures of annual fishing mortality, recruitment and stock biomass for the time series, and characterize the uncertainty of those estimates.

Application of Survival Estimation in Non-Equilibrium Situations (SEINE) to Offshore hake

SEINE Method

Gedamke and Hoenig (2006) developed a method to estimate mortality from mean length data in nonequilibrium situations, now called Survival Estimation in Non-Equilibrium Situations Model (SEINE, available at http://nft.nefsc.noaa.gov/). It is an extension of the Beverton-Holt length-based mortality estimator that assumes constant recruitment throughout the time series and mortality at fixed levels for certain periods within the time series. The approach allows for the transitory changes in mean length to be modeled as a function of mortality rate changes. After an increase in mortality, mean length will gradually decrease due to larger animals being less prevalent in the population. After a decrease in mortality, mean length will increase slowly due to growth of the fish in the population. The rates of change in both cases depend on the von Bertalanffy growth parameters and the magnitude of change in the mortality rates. Since the method requires only a series of mean length above a user defined minimum size and the von Bertalanffy growth parameters, it can be applied in many data poor situations. Gedamke and Hoenig (2006) demonstrated the utility of this approach using both simulated data and an application to data for goosefish caught in the NEFSC fall groundfish survey.

The SEINE model requires the growth parameters, L_∞ and k. It also requires mean lengths and sample size (Table D40). Since there are no accepted growth parameters for offshore hake, we used an average of Southern Georges Bank and Southern New England silver hake growth parameters ($L_\infty = 43.91$ and $k = 0.33$) for Lcritical values of 20cm as a base model. We varied the Lcritical values to 17cm and 23cm. The three mortality cut points (17cm, 20cm, and 23cm) were chosen because it is synonymous with fishable biomass.

Sensitivity analyses were run for the fall survey only, as the working group thought one season would be sufficient and it had the best likelihood value compared to the spring. Winter has too short of a time series. The model was run with higher and lower growth parameters at the different cut points. Silver hake growth parameters for the Southern Georges Bank (L_∞ = 43.78 and k = 0.28) and Southern New England (L_∞ = 44.04 and k = 0.37) alone were used. Using the preliminary offshore hake ages, von Bertalanffy growth parameters (L_∞ = 70 and k = 0.174) were estimated, and used in the SEINE model as part of the sensitivity analyses (Tables D41-42, Figure D27).

We set L_∞ to 70cm, as it corresponded with the largest offshore hake seen in both the NEFSC and Canadian DFO surveys. When it wasn't set, Solver gave an L_∞ result of 274cm, which is completely infeasible. The model results showed that using the offshore hake estimated growth parameters at 20cm were the best fit. They had the lowest AIC and likelihood values and realistic z values of all the runs completed.

The model includes an assumption of flat-topped selectivity. The working group felt that there is no correspondence between the mortality rate and the catch (Figures D28-34). For example, in the 1970s, when landings increased substantially, total mortality apparently decreased. Subsequently, when catch declined, mortality increased. Therefore, the results from SEINE are not a reliable basis for management.

Application of An Index Method (AIM) Model to Offshore Hake

AIM Method

The AIM model is a simple approach for examining the relationship between survey data and catch in data poor stock assessments. AIM is designed to address the question of whether a given rate of fishing mortality is likely to increase or decrease the population size. Survey data are used to define a relative rate of increase and the ratio of catch to survey indices provides a measure of relative fishing mortality. Theoretically the model can identify a stable point about which the stock will neither increase nor decrease in response to a fixed harvest rate. The model assumes that the resource dynamics are approximately linear with relatively minor influence of density dependent effects or variable environmental or ecological factors. Such conditions often typify stocks that have been historically harvested at high fishing rates and are therefore at low population sizes. AIM is both an analytic and graphing approach. The analytical methods can be used to define relative Fs for replacement and the graphical methods can be used to identify transient conditions that are relevant to implementation of any model. The details of the methodology are described below.

- ✓ Population biomass at time t can be written as a linear combination of historical population biomasses
- ✓ Recruitment is proportional to population biomass
- ✓ Fishing mortality is proportional to catch divided by an index of population size (relative F).
- ✓ The rate of change in population biomass is a monotonically decreasing function of relative F.
- ✓ Smoothing methods can be used to identify underlying trends.
- ✓ Randomization methods can be used to develop sampling distributions of test statistics
- ✓ Graphical methods can help identify linkages among variables

Relative F is defined as the ratio of catch to an index of population abundance. A three-year centered average of the abundance index is chosen as the measure of average stock size.

$$relF_{j,s,t} = \left(\frac{C_{s,t}}{\frac{I_{j,s,t-1} + I_{j,s,t} + I_{j,s,t+1}}{3}} \right) \qquad (1)$$

Where $relF_{j,s,t}$ = relative F for relative index j for stock s at time t
$C_{s,t}$ = catch or landings of stock s at time t (in units of weight)
$I_{j,s,t}$= Index of abundance j for stock s at time t expressed in terms of average weight per tow

The population size at any given time can be viewed as a weighted sum of previous recruitment events. For a population with a maximum age of A years, the population in year t consists of the recruits from year t-1, t-2, …t-A. At high levels of total mortality, the contributions from the earliest recruitments, say t-k-1 to t-A will diminish in importance such that the population can be viewed as the sum of recruitments from t-1 to t-k years.

Using the linearity assumption defined above, we can employ basic life history theory to write abundance at time t as a function of the biomasses in previous time periods. The number of recruits at time t (R_t) is assumed to be proportional to the biomass at time t (B_t). More formally,

$$R_t = S_o \, Egg \, B_t \qquad (2)$$

where **Egg** is the number of eggs produced per unit of biomass, and $\mathbf{S_o}$ is the survival rate between the egg and recruit stages. Survival for recruited age groups at age a and time t ($S_{a,t}$) is defined as

$$S_{a,t} = e^{-F_{a,t} - M_{a,t}} \qquad (3)$$

where F and M refer to the instantaneous rates of fishing and natural mortality, respectively. We also need to consider the weight at age a and time t ($W_{a,t}$) and the average longevity (A) of the species

Using these standard concepts we now write the biomass at time t as a linear combination of the A previous years. Without loss of generality, we can drop the subscripts on the survival terms and assume that average weight at age is invariant with respect to time. Further, set the product S_o Egg equal to the coefficient α. The biomass at time t can now be written as

$$B_t = R_{t-1} S^1 W_1 + R_{t-2} S^2 W_2 + R_{t-3} S^3 W_3 + .. + . R_{t-(A-1)} S^{A-1} W_{A-1} + R_{t-A} S^A W_A \quad (4)$$

Substituting Eq. (2) into Eq. (4) leads to

$$B_t = \alpha B_{t-1} S^1 W_1 + \alpha B_{t-2} S^2 W_2 + \alpha B_{t-3} S^3 W_3 + .. + .\alpha B_{t-(A-1)} S^{A-1} W_{A-1} + \alpha B_{t-A} S^A W_A \quad (5)$$

If the population is replacing itself, then the left hand side of Eq. 5 will equal the right hand side. The replacement ratio can then be defined as

$$\Psi_t = \frac{B_t}{\alpha B_{t-1} S^1 W_1 + \alpha B_{t-2} S^2 W_2 + \alpha B_{t-3} S^3 W_3 + .. + .alphaB_{t-(A-1)} S^{A-1} W_{A-1} + \alpha B_{t-A} S^A W_A} \quad (6)$$

Substituting observed values of abundance indices into Eq 6 leads to

$$\Psi_t = \frac{\frac{I_t}{q}}{\alpha \frac{I_{t-1}}{q} S^1 W_1 + \alpha \frac{I_{t-2}}{q} S^2 W_2 + \alpha \frac{I_{t-3}}{q} S^3 W_3 + .. + \alpha \frac{I_{t-(A-1)}}{q} S^{A-1} W_{A-1} + \alpha \frac{I_{t-A}}{q} S^A W_A} \quad (7)$$

By noting that the q's cancel out, and letting $\varphi_j = \alpha S^j W_j$, Eq. 6 simplifies to

$$\Psi_t = \frac{I_t}{\sum_{j=1}^{A} \phi_j \quad I_{t-j}} \qquad (8)$$

All of the I_t and φ_j are positive, and at equilibrium $I_t = I_{t+1}$ and $I_t = \sum \varphi_j I_{t-j}$ both hold . Therefore $\sum \varphi_j = 1$. When the population is not at equilibrium the parameter Ψ becomes a measure of the non equilibrium state of the population and a measure of whether the population is increasing or decreasing relative to prevailing fishery and ecosystem conditions.

It would be desirable to express the parameters of φ_j weighting terms as function of the underlying parameters. Analyses of other stocks with more detailed information, such as Georges Bank haddock, has suggested that setting the φ_j to 1/A is a reasonable approximation. Equations 2 to 8 are a long way of justifying that the ratio of current stock size to a moving average of the previous A years of stock size can be used as a measure of population growth rate. This ratio embeds some life history theory into the basis for the ratio and simultaneously provides a way of damping the variations in abundance owing to measurement error. A ratio defined as I_t/I_{t-1} has been found, as expected to be much more noisy measure of population change.

Further details on the AIM methodology may be found in Working Group (2002) and the NOAA

Fisheries Toolbox (NFT) 3.1 (2010a) software package http://nft.nefsc.noaa.gov/AIM.html. The relationship between $\mathbf{\Psi_t}$ and $\mathbf{relF_t}$ can be expressed as

$$\ln(\Psi_t) = a + b\ln(relF_t) \quad (9)$$

The usual tests of statistical significance do not apply for the model described in Eq. 9. The relation between $\mathbf{\Psi_t}$ and $\mathbf{relF_t}$ is of the general form of Y/X vs X where X and Y are random variables. The expected correlation between Y/X and X is less than zero and is the basis for the oft stated criticism of spurious correlation. To test for spurious correlation we developed a sampling distribution of the correlation statistic using a randomization test. The randomization test is based on the null hypothesis that the catch and survey time series represent a random ordering of observations with no underlying association. The randomization test was developed as follows:

1. Create a random time series of length **T** of $\mathbf{C_{r,t}}$ from the set $\{\mathbf{C_t}\}$ and $\mathbf{I_{r,t}}$ from the set $\{\mathbf{I_t}\}$ by sampling with replacement.

2. Compute a random time series of relative F ($\mathbf{relF_{r,t}}$) and replacement ratios ($\mathbf{\Psi_{r,t}}$)
3. Compute the r-th correlation coefficient, say $\boldsymbol{\rho_r}$ between ln($\mathbf{relF_{r,t}}$) and ln($\mathbf{\Psi_{r,t}}$).
4. Repeat steps 1 to 3 K times.
5. Compare the observed correlation coefficient $\mathbf{r_{obs}}$ with the sorted set of $\boldsymbol{\rho_r}$
6. The approximate significance level of the observed correlation coefficient $\mathbf{r_{obs}}$ is the fraction of values of $\boldsymbol{\rho_r}$ less than $\mathbf{r_{obs}}$

It should be emphasized that relF is not necessarily an adequate proxy for Fmsy, since this parameter only estimates the average mortality rate at which the stock was capable of replacing itself. Thus, while relF defined as average replacement fishing mortality is a necessary condition for an F_{msy} proxy, it is not sufficient, since the stock could theoretically be brought to the stable point under an infinite array of biomass states. The relF at replacement does however provide some guidance on the contemporary rate of harvesting and its potential impact on future stock abundance.

Application of AIM to Offshore Hake

AIM was applied to offshore hake using catches derived from the method of Sosebee, and the NEFSC fall and spring bottom trawl survey indices (Table D43). Relative F was defined as the ratio of catch to a centered 3-year average of survey abundance (Eq. 1) and the replacement ratio was defined as a 5-year moving average of previous stock sizes (Eq. 8). The relationship between catch, survey, relative F and the replacement ratio for the fall and spring survey indices are depicted in Figs. D35 and D36, respectively. Neither of the randomization tests resulted in significant statistical relationship between the replacement ratio and relative F (Table D44).

Bootstrap estimation of the relative F at replacement were imprecise (Table D44, Figure D37) and may not be appropriate measures of Fmsy proxies. Graphical results suggest some underlying causes for the absence of a strong statistical relationship. Relative F has been declining continuously for the fall index (Figure D35). For the spring (Figure D36) survey indices relative F declined through the mid 1980 rebounded for a decade and then declined again from the late 1990s onward. Fall and spring survey trends suggest high abundance before 1980 but much lower values (about one order of magnitude) since then. Replacement ratios for offshore hake in the fall survey have been generally below one since 1980 (Figure D35). The spring survey is slightly different with a brief excursion above 1.0 in the late 1990s followed by a general decline since 2001. Catch rates for offshore hake in both surveys is generally low, perhaps reflecting low abundance, low gear efficiency or both factors. Low gear efficiency can make the detection of trends difficult.

The relationship between survey abundance and relative F suggest a temporal trend wherein reductions in relative F do not necessarily induce similar increases in relative abundance (Figure D35 and D36--left middle panel). At a minimum these stanzas suggest major changes in the population abundance indices and exploitation rates. It is not possible from these data alone to identify causal factors but it does suggest that more advanced modeling if possible, will need to account for these changes in apparent productivity and/or natural mortality.

Survey exploitation indices were calculated using the swept area biomass for the fall, spring, and winter surveys, using the length-based total catch (Table D45, Figures 38-40). It was also calculated using the length-based landings, but the Working group decided that the catch was more accurate due to it being total removals (Table D45, Figures 41-43).

TOR 4. State the existing definitions for overfished and overfishing. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, and F_{MSY}; and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs.

Existing BRPs

The current overfishing definition is that:

> offshore hake is in an overfished condition when the three year moving average weight per individual in the fall survey falls below the 25th percentile of the average weight per individual from the fall survey time series 1963-1997 (0.236) **AND** when the three year moving average of the abundance of immature fish less than 30 cm falls below the median value of the 1963-1997 fall survey abundance of fish less than 30 cm (0.33) (NEFMC 2003).

In previous SAFE Reports, the WMC noted problems associated with this overfishing definition. Although the current definition is intended to identify overfished (i.e. low biomass) stock conditions, it is a better indication of overfishing (high exploitation rate). The WMC recommended that the overfishing definition for offshore hake be revisited.

The Hake Working Group noted that the survey data may not be a good index of abundance but may be driven more by the environment. Therefore, the existing BRPs should not be accepted, and no alternative reference points are recommended by SAW/SARC51.

TOR 5. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from Offshore hake TOR 4).

Based on current biological reference points, offshore hake (Figure D44,Table 46) is not overfished and overfishing is unknown. The three year delta individual mean weight index (Figure D44, Table 46), based on NEFSC fall bottom trawl survey data for 2007-2009 (0.16 kg/individual), is below the management threshold (0.24 kg/individual) but the three year average recruitment index (0.89 num/tow) is above the threshold value (0.33 num/tow).

Based on the SAW/SARC51 review, stock status is unknown.

TOR 6. If a model can be developed, conduct single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).

> ***a. Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment***
> ***b. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.***
> ***c. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.***

No model could be developed. Therefore, this term of reference could not be completed.

TOR 7. Propose new research recommendations.

- Studies to estimate discard mortality should be conducted.
- As an alternative to using silver hake calibration coefficients, it may be better to explore depth-based survey calibration coefficients.
- Develop explicit process and criteria for the application of length-based (vs. constant) calibration coefficients (other than purely statistical criteria such as AIC, etc.). It may be useful, if enough data exist, to attempt a cross validation with a subset of data.
- Investigate silver and offshore hake data in deepwater surveys (e.g., monkfish survey).
- Information on consumption by more predators (including mammals, highly migratory species (HMS)) needs to be included.
- Examine diel (day/night) variation in consumption of hakes.
- Identify offshore hake otoliths found in predators' stomachs.
- Validation of the ageing method for offshore hake via tagging, radiocarbon, or tetracyclin research needs to be conducted.
- The extent of the stock covered by the NEFSC needs to be examined.
- Perform a stock reduction analysis.

Sources of Uncertainty

- It appears that the fishery as estimated by either the length-based model or the depth-based model has not had an impact on the stock. The mortality estimates from the SEINE model are in direct contrast to the catch data. Developing ACLs will also be challenging given that the landings are not separated to a great extent. Garcia-Vazquez et al (2009) found 12% of hake sold in Spain as silver hake were actually offshore hake.
- Given that the distribution of offshore hake in the NEFSC survey is very close to the edge of the survey range, the survey index may be more driven by environmental factors than abundance. The survey likely does not cover the entire stock area and therefore, the survey estimates could potentially be under-representing the dynamics of the population.

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D. Offshore Hake-Tables

Table D1. Landings (mt) of offshore hake by region.

Year	North	South
1991		30.246
1992		118.663
1993		98.076
1994		115.069
1995		71.094
1996		66.849
1997		22.333
1998	0.018	5.268
1999	5.257	6.545
2000		3.729
2001	0.338	1.781
2002	0.139	6.281
2003	0.159	10.202
2004	0.207	23.199
2005	1.389	12.135
2006	0.110	36.916
2007	0.051	11.581
2008	0.001	21.070
2009	3.567	16.707

Table D2. Landings (mt) of offshore hake from the northern region by state.

Year	ME	MA	NH	NY	RI	Total
1998					0.018	0.018
1999		5.257				5.257
2001		0.338				0.338
2002		0.139				0.139
2003		0.159				0.159
2004		0.195	0.011			0.207
2005	0.311	1.060			0.018	1.389
2006				0.110		0.110
2007				0.051		0.051
2008					0.001	0.001
2009		3.567				3.567

Table D3. Landings (mt) of offshore hake from the southern region by state.

Year	CT	MD	MA	NJ	NY	RI	VA	Total
1991				30.246				30.246
1992				36.625		82.039		118.663
1993				98.076				98.076
1994				85.887		29.182		115.069
1995	25.261		0.035	23.205	0.027	22.565		71.094
1996				34.833	0.033	31.983		66.849
1997				10.915		11.418		22.333
1998						5.268		5.268
1999						6.545		6.545
2000						3.729		3.729
2001						1.781		1.781
2002					0.027	6.254		6.281
2003			9.185	0.030		0.986		10.202
2004			5.537		12.064	5.523	0.029	23.199
2005		0.015	7.058		0.954	4.109		12.135
2006		0.015			35.126	1.774		36.916
2007		0.091	1.263	0.211	9.856	0.160		11.581
2008	0.412	0.029		0.008	20.077	0.544		21.070
2009			0.097	0.122	15.346	1.142		16.707

Table D4. Landings (mt) of offshore hake from the northern region by gear.

Year	LL	OTF	SGN	OTH	Total
1998		0.018			0.018
1999		5.257			5.257
2001		0.338			0.338
2002		0.035	0.105		0.139
2003		0.159			0.159
2004	0.156		0.049	0.002	0.207
2005	0.012	0.979	0.398		1.389
2006		0.109			0.110
2007		0.051			0.051
2008		0.001			0.001
2009		3.567			3.567

Table D5. Landings (mt) of offshore hake from the southern region by gear.

Year	LL	OTF	SGN	OTH	Total
1991		30.246			30.246
1992		118.663			118.663
1993		98.076			98.076
1994		115.069			115.069
1995	0.029	45.769		25.297	71.094
1996		66.849			66.849
1997		22.333			22.333
1998		5.268			5.268
1999		6.545			6.545
2000		3.729			3.729
2001		1.781			1.781
2002		6.281			6.281
2003		10.202			10.202
2004		22.852	0.064	0.283	23.199
2005		4.243		7.893	12.135
2006		35.846	0.108	0.961	36.916
2007	0.211	11.161		0.210	11.581
2008		20.085		0.985	21.070
2009	0.122	15.445	0.002	1.138	16.707

Table D6. Landings (mt) of offshore hake from the northern region by month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
1998							0.018						0.018
1999									3.569	1.687			5.257
2001									0.034			0.304	0.338
2002			0.098			0.003	0.035		0.005				0.139
2003							0.159						0.159
2004							0.029		0.018	0.047		0.114	0.207
2005	0.027				0.018	0.004		0.337	0.265	0.739			1.389
2006									0.110				0.110
2007										0.051			0.051
2008			0.001										0.001
2009		1.393	1.066	0.349	0.032	0.379	0.011	0.014	0.005	0.304	0.016		3.567

Table D7. Landings (mt) of offshore hake from the southern region by month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
1991						25.778	4.468						30.246
1992				62.859	18.760	0.419	25.850	6.645	4.130				118.663
1993						47.850	23.428	12.980	9.446	4.067	0.306		98.076
1994			1.778	1.437	21.918	52.785	24.538	2.403	6.432	0.091	2.779	0.909	115.069
1995	8.773	1.361	14.232	1.568	15.483	23.245	1.189	0.876	0.987	1.431	1.427	0.524	71.094
1996				2.191	5.312	0.515	17.234	19.287	12.725	3.648	5.191	0.747	66.849
1997	0.446	0.881	1.030	1.148	1.775	1.112	2.392	10.946	2.539	0.042		0.023	22.333
1998	0.075	1.581	2.220	0.109	0.063	0.868	0.007					0.345	5.268
1999	0.229	0.085	1.276	0.276	1.470	3.178						0.032	6.545
2000	0.011	1.216		0.307	2.195								3.729
2001		0.297	1.371	0.113									1.781
2002	0.027				5.408		0.846						6.281
2003		0.015	8.087					0.060	0.443			1.597	10.202
2004	0.449	0.472	0.486	0.068	4.675	1.058	2.535	8.433	2.001	0.386	1.738	0.897	23.199
2005	0.231	0.433	3.834	0.500	0.015		0.064		6.831	0.227			12.135
2006	0.567	0.727	2.004	1.584	7.456	9.480	1.134	0.110	4.441	8.309	0.388	0.716	36.916
2007	0.132	0.024	1.191	1.540	3.103	1.882	0.219	0.428	0.344	0.899	0.844	0.976	11.581
2008	2.886	2.144	2.857	0.590	3.026	0.549	0.399	2.156	1.617	3.183	0.366	1.296	21.070
2009	0.478	0.604	5.022	1.320	1.034	0.988	1.134	0.329	1.394	2.676	0.907	0.820	16.707

Table D8. Nominal landings (mt) of offshore hake by region and half year.

	North			South		
	Half 1	Half 2	Total	Half 1	Half 2	Total
1991				25.778	4.468	30.246
1992				82.038	36.625	118.663
1993				47.850	50.226	98.076
1994				77.918	37.151	115.069
1995				64.661	6.434	71.094
1996				8.017	58.832	66.849
1997				6.391	15.942	22.333
1998		0.018	0.018	4.916	0.352	5.268
1999		5.257	5.257	6.513	0.032	6.545
2000				3.729		3.729
2001		0.338	0.338	1.781		1.781
2002	0.101	0.039	0.140	5.435	0.846	6.281
2003		0.159	0.159	8.102	2.100	10.202
2004		0.207	0.207	7.209	15.991	23.200
2005	0.049	1.340	1.389	5.013	7.122	12.136
2006		0.110	0.110	21.817	15.099	36.916
2007		0.051	0.051	7.871	3.710	11.582
2008	0.001		0.001	12.053	9.017	21.070
2009	3.218	0.349	3.567	9.447	7.260	16.707

Table D9. Landings (mt) of offshore hake by market category by region.

	Half 1		Half 2		Half 1		Half 2	
	Uncl	King	Uncl	King	Uncl	King	Uncl	King
1991						21.548	4.230	3.697
1992						82.038		30.264
1993						47.850		44.795
1994						66.300	11.617	32.551
1995						60.440	4.221	5.495
1996						7.141	0.876	49.400
1997						5.994	0.398	14.911
1998			0.018		0.018	3.901	1.015	0.304
1999			5.257		5.257	5.815	0.699	0.027
2000			0.000			3.677	0.052	
2001			0.338		0.338	1.755	0.026	
2002	0.101		0.039		0.140	5.408	0.027	0.846
2003			0.159		0.159	8.026	0.076	1.929
2004			0.195	0.012	0.207	5.843	1.366	12.056
2005	0.049		1.212	0.128	1.389	0.911	4.102	6.895
2006			0.110		0.110	16.461	5.355	13.461
2007			0.051		0.051	7.474	0.398	3.637
2008		0.001			0.001	9.227	2.826	6.579
2009	1.524	1.694	0.349		3.567	7.510	1.936	6.875

Table D10. Nominal landings (mt) of silver hake by stock from 1955-2009.

	Northern Stock			Southern Stock			Combined Stock		
Year	US	DWF	Total	US	DWF	Total	US	DWF	Total
1955	53,361		53,361	13,842		13,842	67,203		67,203
1956	42,150		42,150	14,871		14,871	57,021		57,021
1957	62,750		62,750	17,153		17,153	79,903		79,903
1958	49,903		49,903	13,473		13,473	63,376		63,376
1959	50,608		50,608	17,112		17,112	67,720		67,720
1960	45,543		45,543	9,206		9,206	54,749		54,749
1961	39,688		39,688	13,209		13,209	52,897		52,897
1962	42,427	36,575	79,002	13,408	5,325	18,733	55,835	41,900	97,735
1963	36,399	37,525	73,924	19,359	74,023	93,382	55,758	111,548	167,306
1964	37,222	57,240	94,462	26,518	127,036	153,554	63,740	184,276	248,016
1965	29,486	15,793	45,279	23,765	283,366	307,131	53,251	299,159	352,410
1966	33,569	14,239	47,808	11,212	200,058	211,270	44,781	214,297	259,078
1967	26,489	6,882	33,371	9,500	81,749	91,249	35,989	88,631	124,620
1968	30,873	10,506	41,379	9,074	49,422	58,496	39,947	59,928	99,875
1969	16,008	8,047	24,055	8,165	67,396	75,561	24,173	75,443	99,616
1970	15,223	12,305	27,528	6,879	20,633	27,512	22,102	32,938	55,040
1971	11,158	25,243	36,401	5,546	66,344	71,890	16,704	91,587	108,291
1972	6,440	18,784	25,224	5,973	88,381	94,354	12,413	107,165	119,578
1973	14,005	18,086	32,091	6,604	97,989	104,593	20,609	116,075	136,684
1974	6,907	13,775	20,682	7,751	102,112	109,863	14,658	115,887	130,545
1975	12,566	27,308	39,874	8,441	65,812	74,253	21,007	93,120	114,127
1976	13,483	151	13,634	10,434	58,307	68,741	23,917	58,458	82,375
1977	12,455	2	12,457	11,458	47,850	59,308	23,913	47,852	71,765
1978	12,609		12,609	12,779	14,353	27,132	25,388	14,353	39,741
1979	3,415		3,415	13,498	4,877	18,375	16,913	4,877	21,790
1980	4,730		4,730	11,848	1,698	13,546	16,578	1,698	18,276
1981	4,416		4,416	11,783	3,043	14,826	16,199	3,043	19,242
1982	4,664		4,664	12,164	2,397	14,561	16,828	2,397	19,225
1983	5,312		5,312	11,520	620	12,140	16,832	620	17,452
1984	8,289		8,289	12,731	412	13,143	21,020	412	21,432
1985	8,297		8,297	11,843	1,321	13,164	20,140	1,321	21,461
1986	8,502		8,502	9,573	550	10,123	18,075	550	18,625
1987	5,658		5,658	10,121	2	10,123	15,779	2	15,781
1988	6,789		6,789	9,195		9,195	15,984		15,984
1989	4,648		4,648	13,428		13,428	18,076		18,076
1990	6,377		6,377	13,610		13,610	19,987		19,987
1991	6,055		6,055	10,492		10,492	16,547		16,547
1992	5,306		5,306	10,873		10,873	16,179		16,179
1993	4,364		4,364	12,942		12,942	17,306		17,306
1994	3,899		3,899	12,159		12,159	16,058		16,058
1995	2,594		2,594	12,102		12,102	14,696		14,696
1996	3,619		3,619	12,561		12,561	16,180		16,180
1997	2,802		2,802	12,763		12,763	15,565		15,565
1998	2,045		2,045	12,828		12,828	14,873		14,873
1999	3,444		3,444	10,577		10,577	14,021		14,021
2000	2,592		2,592	9,769		9,769	12,361		12,361
2001	3,391		3,391	9,517		9,517	12,908		12,908
2002	2,593		2,593	5,344		5,344	7,937		7,937
2003	1,808		1,808	6,835		6,835	8,643		8,643
2004	1,049		1,049	7,436		7,436	8,485		8,485
2005	827		827	6,670		6,670	7,497		7,497
2006	903		903	4,629		4,629	5,532		5,532
2007	1,014		1,014	5,345		5,345	6,359		6,359
2008	620		620	5,638		5,638	6,258		6,258
2009	1,038		1,038	6,720		6,720	7,755		7,758

Table D11. Nominal landings (mt) of silver hake by region and half year.

	North				South			
Year	1	2	Unknown	Total	1	2	Unknown	Total
1964	5532	30689	1000	37,222	1318	1067	24,133	26,518
1965	2635	26876		29,512	3960	597	19,208	23,765
1966	3928	29641		33,569	2681	1570	6,961	11,212
1967	1180	25045	265	26,489	575	288	8,637	9,500
1968	3356	27502	15	30,873	958	597	7,519	9,074
1969	2332	13677		16,008	1004	706	6,455	8,165
1970	2075	13145	3	15,223	1895	1037	3,947	6,879
1971	624	10526	8	11,158	564	932	4,050	5,546
1972	480	5946	14	6,440	1096	647	4,230	5,973
1973	1305	12700		14,005	697	753	5,154	6,604
1974	652	6255		6,907	1452	893	5,406	7,751
1975	2724	9843		12,566	1294	1159	5,988	8,441
1976	3019	10449	15	13,483	1711	1606	7,117	10,434
1977	2531	9909	15	12,455	912	1560	8,986	11,458
1978	1781	10801	27	12,609	5800	2501	4,478	12,779
1979	245	3158	12	3,415	5297	3898	4,303	13,498
1980	335	4361	34	4,730	5283	3225	3,340	11,848
1981	688	3675	53	4,416	5279	3366	3,138	11,783
1982	376	4288		4,664	6347	3845	1,972	12,164
1983	719	4593		5,312	5053	4255	2,212	11,520
1984	402	7886	1	8,289	6769	3661	2,301	12,731
1985	1133	7159	5	8,297	6914	2862	2,067	11,843
1986	1543	6957	2	8,502	6203	3205	165	9,573
1987	835	4822	1	5,658	6449	3459	213	10,121
1988	1215	5574		6,789	7252	1908	35	9,195
1989	594	4055		4,648	8091	5326	11	13,428
1990	317	6061		6,377	8799	4811		13,610
1991	408	5647		6,055	7530	2951	11	10,492
1992	246	5058	2	5,306	7256	3513	104	10,873
1993	251	4110	3	4,364	7065	5874	3	12,942
1994	335	3564		3,899	7052	5107		12,159
1995	85	2507	2	2,594	6988	5110	4	12,102
1996	114	3505		3,619	7815	4744	2	12,561
1997	280	2520	1	2,802	7919	4834	10	12,763
1998	63	1983		2,045	7581	5246	1	12,828
1999	114	3331		3,444	7562	3015		10,577
2000	319	2272		2,592	5741	4029		9,769
2001	251	3141		3,391	6574	2916	27	9,517
2002	117	2476		2,593	3892	1431	22	5,345
2003	56	1752		1,808	3232	3604		6,835
2004	43	1007		1,049	4391	3045		7,436
2005	83	743		827	3764	2906		6,671
2006	15	888		903	2818	1812		4,629
2007	9	1003		1,014	2718	2625		5,338
2008	30	590		620	2927	2710		5,638
2009	45	994		1,038	3589	3132		6,720

Table D12. Landings (mt) of silver hake by market category from the northern region.

	Half 1							Half 2						
Year	Round	Med	Small	Dressed	Juv	King	Large	Round	Med	Small	Dressed	Juv	King	Large
1964	5350			183				30023			666			
1965	2633			2				26626			225			
1966	3916			11				29510			131			
1967	1179			1				24410			634			
1968	3300			55				26867			634			
1969	2331			<1				13314			362			
1970	2052			23				13095			50			
1971	581			43				10415			113			
1972	471			8				5917			29			
1973	1292			13				12600			99			
1974	648			4				6222			33			
1975	2691			28				9678			168			
1976	3010			8				10447			3			
1977	2530			<1				9847			49			
1978	1779			1				10739			62			
1979	241			4				3125			33			
1980	333			4				4341			19			
1981	667			20		1		3591			28		53	
1982	366			6		3		3986		163	63		74	
1983	414		241	18		46		4047		348	16		183	
1984	199		121	2		81		6436		1234	10		206	
1985	788		232	<1		113		5995		606	61		496	
1986	1147		280	2		114		5826		360	355		418	
1987	680		118	1		35		4234		323	6		260	
1988	1027		167	1		19		5030		344	<1		201	
1989	520		51	<1		22		3818		51	16		166	
1990	258		53	<1		6		5776		17	1		263	
1991	394		5	<1		7		5373		9	<1		263	
1992	236		8			3		4692		40			323	
1993	250		1			1		3913		47			148	
1994	275		49		6	4		2774		521		143	113	
1995	73		5	<1		1		1954		162			36	
1996	84		27			1		2755		442			87	
1997	191		87			2		1825		548			148	
1998	54		3			6		1489		188	16	73	212	
1999	79		35			5		2545		289		236	255	
2000	279		8	<1		31		1890		189			193	
2001	206		5			39		2405		416			302	
2002	94		15			5		1801		501			146	
2003	20		34			2		1177		481			93	
2004	13		8	21		1	<1	359		76	362	24	20	100
2005	71		<1	1		<1	1	363		20	303	<1	4	17
2006	10		1	<1	3	<1	<1	291		110	329	41	12	67
2007	9		<1	1		<1	<1	525	72	169	57	50	20	67
2008	17	<1	2	3	<1	1	3	337	48	18	93	3	13	27
2009	1	<1	<1	4		<1	<1	436	43	3	6		9	35

Table D13. Landings (mt) of silver hake by market category from the southern region.

	Half 1							Half 2						
Year	Round	Med	Small	Dressed	Juv	King	Large	Round	Med	Small	Dressed	Juv	King	Large
1964	1243			76				548			519			
1965	3934			26				540			59			
1966	2449			223				1374			196			
1967	557			17				259			28			
1968	909			48				560			37			
1969	980			24				701			4			
1970	1864			32				1028			10			
1971	536			29				925			7			
1972	1037			59				644			4			
1973	676			20				743			11			
1974	1388			63				879			13			
1975	1265			28				1121			38			
1976	1674			38				1574			32			
1977	907			5				1561			<1			
1978	5791			8				2496			5			
1979	5294			3				3897			1			
1980	5282			<1				3225			1			
1981	5028			107		145		3253			1		112	
1982	6153			35		160		3718		<1	8		120	
1983	4928			3		122		3994			36		225	
1984	6491		1	12		265		3407		1	1		252	
1985	6662			19		232		2667		10	<1		185	
1986	6005		50	<1		147		3094		1			110	
1987	6291		22			137		3387		<1			72	
1988	7135		<1			117		1853		1	<1		54	
1989	7922		<1			61		4763			4		71	
1990	8564			4		110		4542		1	<1		127	
1991	7168		3	2		154		2643		4	<1		121	
1992	6856		12	<1		155		3187		14	<1		65	
1993	6897		<1			124		3447		1197	1	75	114	
1994	3606		2533	1	361	229		2529		1672	<1	277	75	
1995	5142		1375	<1	33	385		4091		680	<1		328	
1996	5999		1474	<1	2	335		3070		1369	1	23	283	
1997	4620		2583		61	606		3210		1369	<1		251	
1998	5411		1542		75	552		3159		1756		45	282	
1999	4817		1989		338	418		2108		767		4	128	
2000	3793		1571	2	44	299		2438		1187		<1	403	
2001	4335		1214		6	908		1905		602			355	
2002	2355		1059	<1	178	228		916		413			88	
2003	1917		1064			248		1959		1524			118	
2004	2403	<1	1101	406	54	206	63	1203		566	410	267	162	150
2005	1587		640	746	293	85	109	1303		443	551	344	38	49
2006	1103		701	445	209	86	92	739	<1	405	260	143	53	43
2007	1153	128	582		163	128	218	996	101	759	228	53	126	153
2008	864	240	652	318	14	127	198	731	378	367	288	3	179	132
2009	955	592	472	144		160	228	684	338	730	75	20	117	166

Table D14. Summary of number of offshore hake measured by port samplers by market category, half and region.

	North	South		
	Round	Round		King
Year	Half 1	Half 1	Half 2	Half 1
1993			103	
1994				
1997		135		
2003				31
2004				337
2005	1			
2006		29		

Table D15. Summary of number of silver hake measured by port samplers by market category and half in the northern region.

	Round		Small		Dressed		King		Large	
Year	1	2	1	2	1	2	1	2	1	2
1969	202	2135								
1970	218	1838								
1971	243	2481				218				
1972		1221								
1973	320	3572			614					
1974	191	1409			84					
1975	799	855								
1976	1789	2126								
1977	878	3795								
1978	1217	1808								
1979	103	1362								
1980		775								
1981	98	1577								
1982		2007		117						
1983	210	3003		200						
1984	433	1829		519						
1985	221	1946	515	1130			125	338		
1986	974	3183	290	586						
1987	367	2717		839				324		
1988	691	2400	300	728			201	519		
1989	763	1146	106					100		
1990	466	1467								
1991	634	1232					114	129		
1992	215							262		
1993		886								
1995	348	344	202							
1997		207		209						
1998		514								
1999	100	45						113		
2000	269	407						102		
2001	1255	800	218				263	217		
2002	103		98				76	106		
2003	19	426						95		
2004	134	488		201				93		
2005		100		100				4		
2006	110	521						9	108	293
2007		547						189		344
2008		200						12		
2009	87	100								

Table D16. Summary of number of silver hake measured by port samplers by market category and half in the southern region.

	Round		Small		Dressed		Juv		King		Large	
Year	1	2	1	2	1	2	1	2	1	2	1	2
1969	50											
1970	316											
1971	98	311										
1972	216											
1975		793										
1976	200	1268			61							
1977	1418	685										
1978	1039	378										
1979	882	1321										
1980	2128	1995										
1981	1270	2570								154		
1982	3159	2699							472	190		
1983	4246	2067							256	541		
1984	3302	1716							323	306		
1985	5048	2025		110					344	186		
1986	3565	3118							201	468		
1987	5004	2539							167	182		
1988	4778	2922							87			
1989	3643	2594							167	104		
1990	5147	4069							201	100		
1991	3004	2397							95	198		
1992	2610	1023							96			
1993	1414	900		212					41	100		
1994	1003		303									
1995	1489		308						236			
1997	2535	236	1396	317					1475	157		
1998	2877	1585	411	32			104		781	410		
1999	2563	603	102	536			413		526	396		
2000	919	542	526	410					223	182		
2001	3598	2131	1178	555					2201	1021		
2002	3243	1274	1139	221			121		958	98		
2003	3088	1536	981	1309					713	618		
2004	1888	2129	1177	319					515	1163		
2005	2646	4512	539	517					1980	526		696
2006	5634	3341							632	461	1503	1256
2007	7499	3575		102					1209	614	1833	2585
2008	5432	3828	109						997	964	2376	1331
2009	4013	2890					100		1498	683	1339	1340

Table D17. Pooling of silver/offshore hake port length samples to estimate length and species composition of the commercial landings by region and market category.

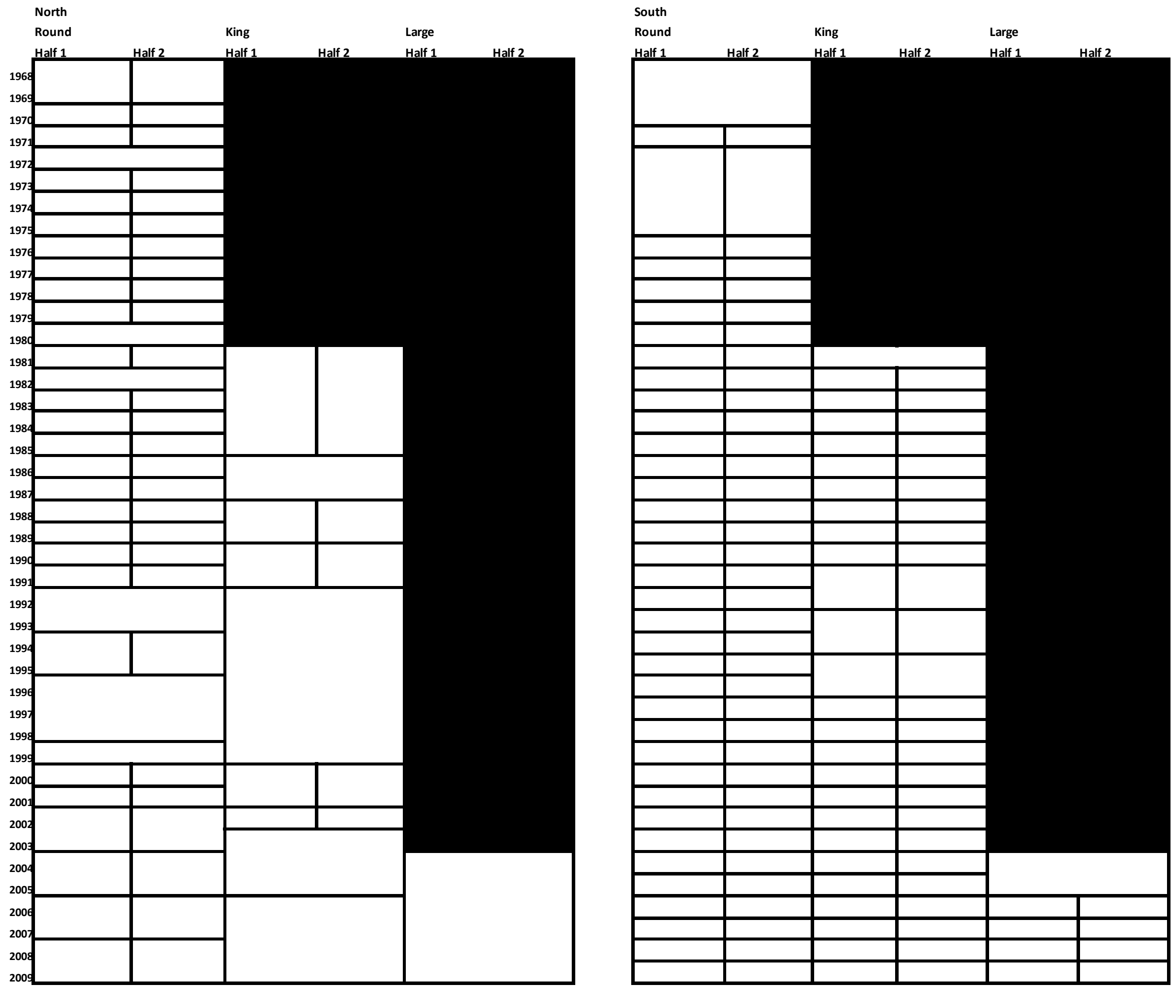


Table D18a. Comparison of estimated and reported offshore and silver hake landings (mt), 2004-2009. Red values reflect revised from the original working paper. Differences are less than 1%.

	Model based estimate			Dealer reported landings			VTR hail weights			
	Offshore hake	Silver hake	Percent offshore	Offshore hake	Silver hake	Percent offshore	Reporting vessels	Offshore hake	Silver hake	Percent offshore
2004	894	6,566	12.00%	18	6,096	0.30%	371	169	6,124	2.70%
2005	819	5,865	12.20%	9	5,886	0.10%	321	213	6,439	3.20%
2006	459	4,207	9.80%	35	3,973	0.90%	405	121	4,170	2.80%
2007	350	5,006	6.50%	11	4,316	0.30%	384	180	4,677	3.70%
2008	290	5,376	5.10%	19	4,127	0.50%	370	194	4,544	4.10%
2009	331	6,406	4.90%	13	4,328	0.30%	382	139	5,363	2.50%

Table D18b. Comparison of alternative methods of landings (mt) estimation for offshore hake.

Year	Nominal	Length-Based	Depth-Based
1955		586.5	951.0
1956		630.1	1021.7
1957		726.8	1178.5
1958		570.9	925.7
1959		725.1	1175.7
1960		390.1	632.5
1961		559.7	907.5
1962		793.8	1287.1
1963		3956.8	6415.9
1964		6506.4	5242.2
1965		13013.8	24189.3
1966		8951.9	18269.9
1967		3866.4	5085.6
1968		339.4	2375.8
1969		670.3	2743.9
1970		680.2	1870.4
1971		1383.7	1431.0
1972		6175.7	5306.5
1973		2514.8	4416.7
1974		7467.5	3958.6
1975		2088.7	2546.9
1976		4132.8	1345.7
1977		2148.1	1757.7
1978		1298.0	477.1
1979		1976.9	323.3
1980		1862.4	251.3
1981		1397.3	509.8
1982		409.2	927.1
1983		279.9	641.4
1984		188.3	612.1
1985		344.4	696.3
1986		425.8	622.8
1987		570.6	903.6
1988		245.2	1178.5
1989		433.2	771.9
1990		590.2	826.5
1991	30.246	783.3	792.2
1992	118.663	460.4	1079.0
1993	98.076	553.1	1523.1
1994	115.069	92.6	1423.1
1995	71.094	181.5	1362.6
1996	66.849	494.0	1703.1
1997	22.333	237.4	1372.0
1998	5.268	275.0	1334.7
1999	6.545	167.3	916.6
2000	3.729	302.2	855.6
2001	1.781	634.7	934.0
2002	6.281	462.8	577.6
2003	10.202	564.6	481.9
2004	23.200	494.3	893.8
2005	12.136	288.1	818.5
2006	36.916	81.7	459.3
2007	11.582	289.5	349.7
2008	21.070	83.9	290.2
2009	16.707	142.2	330.9

Table D19. Offshore hake discards (mt) from the northern region by gear and half. The hind-cast discards for offshore hake are zero.

	Large Mesh Otter Trawl				Small Mesh Otter Trawl				Sink Gill Net				Scallop Dredge		
	1	2	Total		1	2	Total		1	2	Total		1	2	Total
1989	0	0	0		0	0	0		0	0	0		0	0	0
1990	0	0	0		0	0	0		0	0	0		0	0	0
1991	0	0	0		0	0	0		0	0	0		0	0	0
1992	0	0	0		0	0	0		0	0	0		0	0	0
1993	0	0	0		0	0	0		0	0.023	0.023		0	0	0
1994	0	0	0		0	0	0		0	0	0		0	0	0
1995	0	0	0		0	0	0		0	0	0		0	0	0
1996	0	0	0		0	0	0		0	0	0		0	0	0
1997	0	0	0		0	0	0		0	0	0		0	0	0
1998	0	0	0		0	0	0		0	0	0		0	0	0
1999	0	0	0		0	0	0		0	0	0		0	0	0
2000	0	6.544	6.544		0	0	0		0	0	0		0	0	0
2001	0	0.065	0.065		0	0	0		0	0	0		0	0	0
2002	0.428	0.028	0.457		0	0	0		0.272	0	0.272		0.016	0.021	0.038
2003	0.028	0	0.028		0	0	0		0	0.085	0.085		0	0.339	0.339
2004	2.169	0.023	2.192		0	0	0		0	0	0		0	0	0
2005	0.168	0.025	0.192		0	0	0		0	0.032	0.032		0	0	0
2006	0	0.520	0.520		0	0	0		0	0	0		0	0	0
2007	0.089	0.630	0.719		0	0	0		0	0.004	0.004		0	0.027	0.027
2008	0.079	0.007	0.086		0	0	0		0	0	0		0	0	0
2009	0.915	4.311	5.226		0.013	0.089	0.102		0	0	0		0	0	0

Table D20. Offshore hake discards (mt) from the southern region by gear and half. The hind-cast discards for offshore hake are zero.

	Large Mesh Otter Trawl				Small Mesh Otter Trawl				Sink Gill Net				Scallop Dredge		
	1	2	Total		1	2	Total		1	2	Total		1	2	Total
1989	0	0	0		0	0	0		0	0	0		0	0	0
1990	0	0	0		0	0	0		0	0	0		0	0	0
1991	0	0	0		0	0	0		0	0	0		0	0	0
1992	0	0	0		0	0	0		0	0	0		0	0	0
1993	0	0	0		0	0	0		0	0	0		0	0	0
1994	0	0	0		0	0	0		0	0	0		0	0	0
1995	0	0	0		0	0	0		0	0	0		0.064	0.001	0.064
1996	0	0	0		0	0	0		0	0	0		0	0	0
1997	0	0	0		0.019	1.810	1.828		0.028	0	0.028		1.028	0.435	1.463
1998	0	0	0		170.494	0	170.494		0	0	0		3.386	0	3.386
1999	0	0	0		0	1.168	1.168		0	0	0		0	0.571	0.571
2000	0	0.619	0.619		0.183	0.239	0.422		0	0	0		0	0.056	0.056
2001	0	0.065	0.065		0	9.685	9.685		0	0	0		0	0	0
2002	0	0	0		143.674	0	143.674		0	0	0		0	2.563	2.563
2003	0	0	0		0	0	0		0	0	0		2.183	0.015	2.199
2004	0.036	0.030	0.066		2.131	0.909	3.040		0	0	0		1.618	0.219	1.837
2005	0	0	0		0	6.384	6.384		0	0	0		0	0	0
2006	0	0.416	0.416		0	4.109	4.109		0	0	0		0	0.012	0.012
2007	0.510	0.685	1.195		19.386	0	19.386		0	0	0		0	0.036	0.036
2008	0.926	0.176	1.102		0.006	0	0.006		0	0	0		0.001	0.035	0.035
2009	0.440	4.941	5.381		0.025	20.262	20.287		0.050	0	0.050		0	0	0

Table D21. Silver hake discards (mt) from the northern region by gear and half. The discards from 1981-1988 (91 for scallop dredge and longline) are hind-cast using the first three years of available data. The otter trawl discards are hind-cast combining mesh-sizes.

	Longline			Large Mesh Otter Trawl			Small Mesh Otter Trawl			Sink Gill Net			Scallop Dredge			Shrimp Trawl		
	1	2	Total	1	2	Total	1	2	Total	1	2	Total	1	2	Total	1	2	Total
1981	0	0	0	417.9	1898.6	2316.4	Na			13.4	53.2	66.6	2.7	28.4	31.1	223.4	0.6	224.0
1982	0	0	0	411.8	2116.1	2527.9	Na			5.9	47.9	53.7	1.6	21.9	23.6	282.0	17.7	299.7
1983	0	0	0	453.9	1783.5	2237.4	Na			6.2	39.8	46.0	1.4	17.2	18.6	285.6	54.1	339.7
1984	0	0	0	379.2	1640.3	2019.4	Na			5.9	52.4	58.3	0.8	10.3	11.1	372.6	130.1	502.7
1985	0	0	0	331.3	1476.8	1808.2	Na			6.4	44.8	51.2	0.6	9.9	10.5	520.1	171.7	691.8
1986	0	0	0	289.6	1159.9	1449.5	Na			7.8	46.9	54.7	1.0	10.6	11.6	634.7	203.5	838.1
1987	0	0	0	243.7	1031.4	1275.1	Na			7.0	47.7	54.6	1.2	20.4	21.6	642.8	112.5	755.4
1988	0	0	0	227.0	982.0	1209.0	Na			7.8	48.6	56.4	1.5	26.0	27.5	379.9	111.7	491.6
1989	0	0	0	56.2	241.6	297.8	183.2	1005.1	1188.3	17.9	34.5	52.4	1.7	29.9	31.6	612.7	159.0	771.7
1990	0	0	0	271.4	415.8	687.2	18.8	611.2	630.0	6.2	81.8	88.0	0.6	31.9	32.5	420.0	130.9	551.0
1991	0	0	0	19.4	372.9	392.3	28.0	486.5	514.5	3.6	40.1	43.8	2.7	3.5	6.2	262.6	31.6	294.2
1992	0	0	0	99.8	271.9	371.8	28.1	555.0	583.0	5.1	37.4	42.4	0.0	5.2	5.2	378.4	48.7	427.1
1993	0	0	0	94.7	165.3	260.1	9.7	179.2	189.0	5.2	55.2	60.4	1.5	58.5	60.0	62.2	108.4	170.6
1994	0	0	0	29.0	15.6	44.7	3.8	63.0	66.8	2.8	41.0	43.8	0.6	0.5	1.1	25.5	58.3	83.8
1995	0.008	0.010	0.019	56.5	64.2	120.7	2.7	17.6	20.2	5.6	23.5	29.1	1.9	5.7	7.6	216.7	239.5	456.1
1996	0.008	0.008	0.016	55.7	9.3	65.1	1.2	19.5	20.7	3.6	52.9	56.5	0.0	2.1	2.1	576.3	105.0	681.3
1997	0.008	0.008	0.017	28.1	28.8	56.8	1.8	14.3	16.1	14.1	13.3	27.4	0.5	6.9	7.4	126.4	15.1	141.5
1998	0.006	0.010	0.016	116.8	21.5	138.3	23.0	269.3	292.3	4.6	4.4	9.0	19.2	17.3	36.6	206.2	11.2	217.4
1999	0.006	0.008	0.015	26.9	143.1	170.0	20.4	395.6	415.9	8.9	9.3	18.2	8.9	10.6	19.5	93.6	2.2	95.8
2000	0.004	0.009	0.013	102.2	83.3	185.5	0.1	0.7	0.9	9.3	15.1	24.4	1.4	2.7	4.1	137.8	2.3	140.1
2001	0.005	0.006	0.011	182.7	221.2	404.0	3.5	14.3	17.7	3.7	8.9	12.6	1.8	1.4	3.2	39.4		39.4
2002	0	0	0	291.6	95.8	387.4	0	103.0	103.0	3.5	5.7	9.2	1.7	2.2	3.9	9.7		9.7
2003	0	0	0	40.5	34.7	75.2	0.3	90.3	90.6	7.3	2.9	10.2	0	4.4	4.4	22.0		22.0
2004	0	0	0	22.1	44.5	66.5	0.1	29.6	29.6	1.2	1.8	2.9	0.1	0.0	0.1	13.4	0.6	13.9
2005	0	0.019	0.019	5.2	35.4	40.6	0.2	9.1	9.3	0.1	0.9	1.0	0.0	0.6	0.6	10.3	0.5	10.7
2006	0	0	0	3.7	17.3	21.1	0	4.9	5.0	0.7	0.4	1.1	0	1.1	1.1	2.5	7.3	9.8
2007	0.002	0	0.002	4.1	14.9	18.9	42.3	669.7	712.0	0.8	0.6	1.5	0.2	1.9	2.1	11.7	2.8	14.5
2008	0	0.002	0.002	12.6	32.2	44.8	8.1	63.6	71.7	1.4	4.7	6.2	0.2	0.1	0.3	35.1	9.0	44.1
2009	0	0	0	13.9	54.5	68.4	11.9	83.7	95.6	2.0	4.3	6.4	0.1	2.7	2.8	14.6	28.3	42.9

Table D22. Silver hake discards (mt) from the southern region by gear and half. The discards from 1981-1988 (91 for scallop dredge and longline) are hind-cast using the first three years of available data. The otter trawl discards are hind-cast combining mesh-sizes.

	Longline				Large Mesh Otter Trawl				Small Mesh Otter Trawl				Sink Gill Net				Scallop Dredge		
	1	2	Total		1	2	Total		1	2	Total		1	2	Total		1	2	Total
1981	0	0	0		2332.4	1176.2	3508.5		Na				0.0	0.1	0.1		6.1	87.9	94.0
1982	0	0	0		2646.2	2069.8	4716.0		Na				0.0	0.1	0.1		3.6	67.9	71.6
1983	0	0	0		2869.3	2026.3	4895.7		Na				0.0	0.1	0.1		3.1	53.3	56.4
1984	0	0	0		3124.7	1864.3	4989.1		Na				0.0	0.2	0.2		1.8	31.9	33.7
1985	0	0	0		2580.7	1369.7	3950.3		Na				0.0	0.1	0.1		1.2	30.7	31.9
1986	0	0	0		2598.7	1822.2	4420.9		Na				0.0	0.2	0.2		2.3	32.9	35.2
1987	0	0	0		2664.5	1643.3	4307.8		Na				0.0	0.2	0.2		2.7	63.2	65.9
1988	0	0	0		2971.7	1570.4	4542.1		Na				0.0	0.2	0.2		3.4	80.5	83.9
1989	0	0	0		31.1	81.0	112.1		5295.8	1085.1	6380.9		0	0	0		12.5	136.8	149.3
1990	0	0	0		2342.0	420.7	2762.6		1211.4	1961.3	3172.7		0	0	0		20.5	237.5	258.0
1991	0	0	0		201.0	993.0	1194.0		539.8	1480.5	2020.3		0	0.1	0.1		12.8	6.8	19.6
1992	0	0	0		443.9	211.2	655.1		244.7	2559.4	2804.1		0.6	2.7	3.3		9.8	7.4	17.2
1993	0	0	0		250.5	15.7	266.2		3144.5	1475.9	4620.4		1.4	3.4	4.8		6.9	346.2	353.1
1994	0	0	0		549.7	11.0	560.7		3067.1	2335.5	5402.7		0.4	0.3	0.7		15.0	12.4	27.4
1995	0	0	0		136.9	5.8	142.7		83.1	1087.9	1171.0		0.2	0.3	0.4		64.5	60.5	125.0
1996	0.058	0.041	0.099		9.2	10.4	19.6		386.0	52.6	438.6		0.2	0	0.2		19.7	12.7	32.4
1997	0.066	0.057	0.123		26.7	341.4	368.2		220.7	0.1	220.8		1.7	0.4	2.1		33.6	14.5	48.1
1998	0.064	0.044	0.108		2.0	0	2.0		322.0	14.2	336.2		0.3	0.2	0.5		2.5	12.5	15.0
1999	0.049	0.023	0.072		0	18.9	18.9		3461.8	29.5	3491.4		0.9	0	0.9		22.1	18.5	40.6
2000	0.033	0.028	0.061		7.4	1.9	9.4		29.7	161.2	190.9		7.6	0	7.6		80.2	44.7	124.9
2001	0.046	0.046	0.092		2.9	0.3	3.2		25.3	152.0	177.4		0	0	0		6.1	5.7	11.8
2002	0	0	0		5.9	1.3	7.2		160.5	96.8	257.3		0.4	0	0.4		11.4	3.6	14.9
2003	0	0	0		3.8	11.0	14.8		137.2	515.7	652.9		1.2	0.0	1.3		1.7	5.2	7.0
2004	0	0	0		25.2	63.9	89.1		380.4	760.5	1141.0		0.4	0	0.4		4.5	9.0	13.5
2005	0	0	0		19.5	31.2	50.7		825.6	685.9	1511.5		0.1	0.2	0.2		3.4	8.4	11.8
2006	0.045	0.028	0.073		8.9	15.7	24.5		95.7	28.0	123.7		0.0	0	0.0		1.0	11.2	12.2
2007	0.140	0.190	0.331		8.0	13.5	21.5		47.5	53.8	101.3		0	0	0		5.3	3.5	8.8
2008	0.165	0.160	0.325		12.6	12.1	24.7		713.7	299.3	1013.1		0.0	0	0.0		3.7	3.5	7.2
2009	0.121	0.209	0.330		33.2	24.9	58.2		185.9	562.2	748.1		0.1	0.0	0.1		14.5	6.3	20.8

Table D23. Number of discarded offshore hake sampled in all gears from the FOP in the northern region.

	Large Mesh Trawl			Sink Gill Net			
	Half 2			Half 1		Half 2	
Year	ntrips	numlen		ntrips	numlen	ntrips	numlen
2002				1	19		
2004	1	1					
2005	2	3				1	1
2006	1	9					
2009	1	1					

Table D24. Number of discarded offshore hake sampled in all gears from the FOP in the southern region.

	Large Mesh Trawl		Small Mesh Trawl				Scallop Dredge	
	Half 1		Half 1		Half 2		Half 1	
Year	ntrips	numlen	ntrips	numlen	ntrips	numlen	ntrips	numlen
1997					1	7		
2001	1	1						
2002								
2004					1	8	1	3
2007								
2009			1	1	1	1		

Table D25. Number of discarded silver hake sampled from the FOP in the northern region by gear type.

	Large Mesh				Small Mesh				Sink Gill Net				Scallop Dredge				Shrimp Trawl			
	Half 1		Half 2		Half 1		Half 2		Half 1		Half 2		Half 1		Half 2		Half 1		Half 2	
	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len
1989	2	213	10	779	3	1543	23	6445	-	-	-	-	-	-	-	-	16	3590	4	546
1990	-	-	5	362	1	84	7	1130	1	4	-	-	-	-	-	-	8	1221	-	-
1991	1	31	1	150	-	-	27	8063	2	5	4	10	-	-	-	-	8	1055	-	-
1992	1	1	-	-	1	100	19	3888	4	24	5	22	-	-	-	-	-	-	-	-
1993	2	222	1	70	-	-	2	371	2	19	2	7	-	-	-	-	13	2383	2	224
1994	-	-	1	11	-	-	-	-	-	-	6	63	-	-	1	1	9	446	2	459
1995	3	32	1	48	-	-	1	81	1	1	-	-	-	-	-	-	4	404	5	728
1996	1	1	-	-	-	-	4	343	1	3	3	31	-	-	-	-	9	470	1	149
1997	1	1	2	66	1	20	-	-	-	-	-	-	-	-	1	1	9	739	-	-
1998	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	9	218	1	2	6	85	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	6	60	2	22	-	-	-	-	-	-	-	-
2001	-	-	1	14	-	-	-	-	2	2	2	3	-	-	-	-	-	-	-	-
2002	-	-	11	265	-	-	9	542	3	4	3	7	-	-	-	-	-	-	-	-
2003	13	565	13	255	-	-	5	241	11	229	12	39	-	-	1	113	5	372	-	-
2004	4	9	23	749	1	5	9	325	6	12	22	65	-	-	-	-	3	284	-	-
2005	13	105	17	259	2	5	9	97	1	1	10	66	-	-	1	2	2	66	-	-
2006	9	69	5	30	-	-	4	1028	1	1	1	1	-	-	-	-	-	-	-	-
2007	9	127	15	195	-	-	2	733	3	14	3	4	-	-	-	-	4	444	-	-
2008	5	155	16	255	-	-	1	144	6	7	6	62	1	3	-	-	6	206	-	-
2009	7	34	16	260	-	-	3	180	3	15	1	1	-	-	-	-	-	-	-	-

Table D26. Number of discarded silver hake sampled from the FOP in the southern region by gear type.

	Large Mesh				Small Mesh				Sink Gill Net				Scallop Dredge			
	Half 1		Half 2		Half 1		Half 2		Half 1		Half 2		Half 1		Half 2	
Year	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len	trips	len
1989	2	40	1	150	12	2265	10	1659	-	-	-	-	-	-	-	-
1990	2	399	-	-	8	2090	2	95	-	-	-	-	-	-	-	-
1991	-	-	2	29	5	657	7	860	-	-	-	-	-	-	-	-
1992	-	-	-	-	1	20	5	459	1	1	-	-	-	-	-	-
1993	1	127	-	-	-	-	-	-	1	12	-	-	1	2	-	-
1994	2	49	-	-	1	20	5	239	-	-	-	-	2	5	2	6
1995	1	3	1	11	2	73	-	-	-	-	1	3	4	50	-	-
1996	-	-	-	-	4	290	8	494	2	2	-	-	2	31	3	17
1997	-	-	1	216	7	371	1	2	7	69	1	4	2	112	1	1
1998	-	-	-	-	3	656	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	2	309	4	97	-	-	-	-	1	2	-	-
2000	-	-	1	19	1	198	3	88	-	-	-	-	3	456	1	1
2001	-	-	-	-	2	160	3	13	-	-	-	-	-	-	-	-
2002	-	-	-	-	3	139	-	-	-	-	-	-	-	-	-	-
2003	-	-	2	2	3	76	3	40	1	2	-	-	2	3	4	140
2004	6	150	16	359	6	293	24	2007	2	4	-	-	1	17	15	224
2005	9	118	12	471	15	1191	11	1346	-	-	-	-	-	-	5	53
2006	7	48	4	24	10	762	15	764	-	-	-	-	-	-	1	1
2007	3	13	7	106	7	130	14	479	-	-	-	-	4	13	2	10
2008	6	38	10	110	6	580	12	626	-	-	-	-	4	31	7	36
2009	2	19	1	1	10	832	30	1998	1	1	-	-	12	91	6	37

Table D27. Pooling of silver/offshore hake observer length samples to estimate length and species composition of the commercial discards by gear from the north.

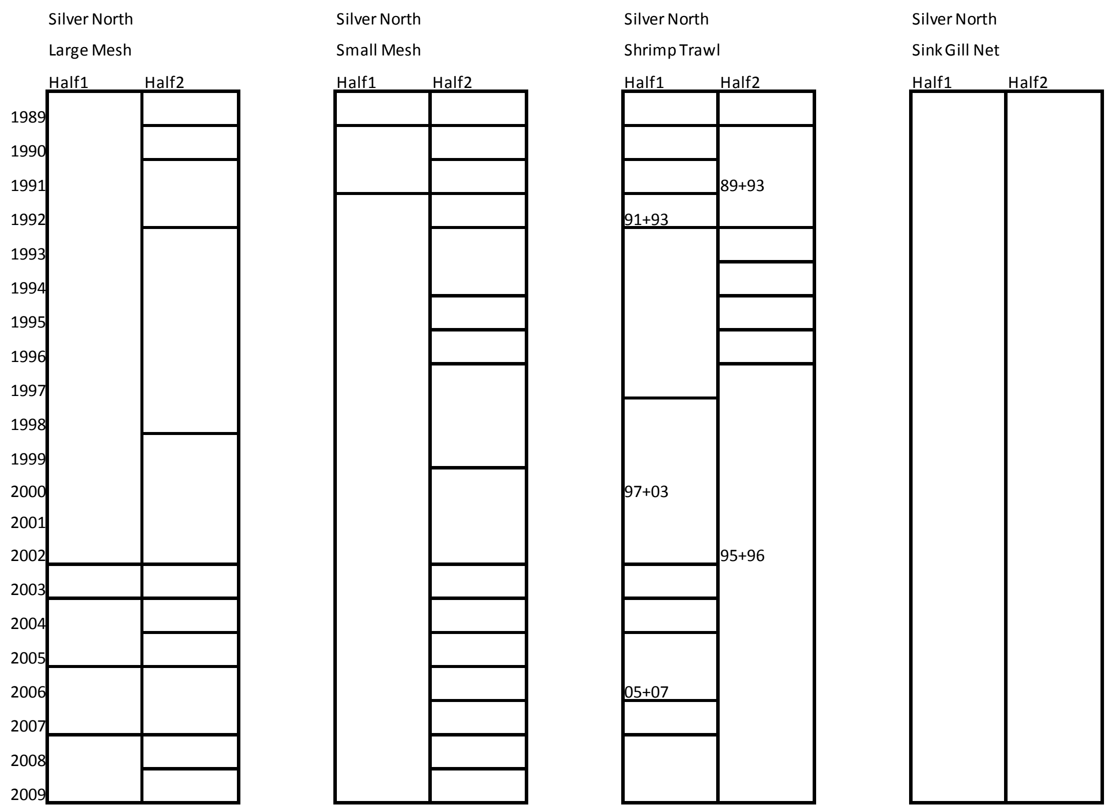


Table D28. Pooling of silver/offshore hake observer length samples to estimate length and species composition of the commercial discards by gear from the south.

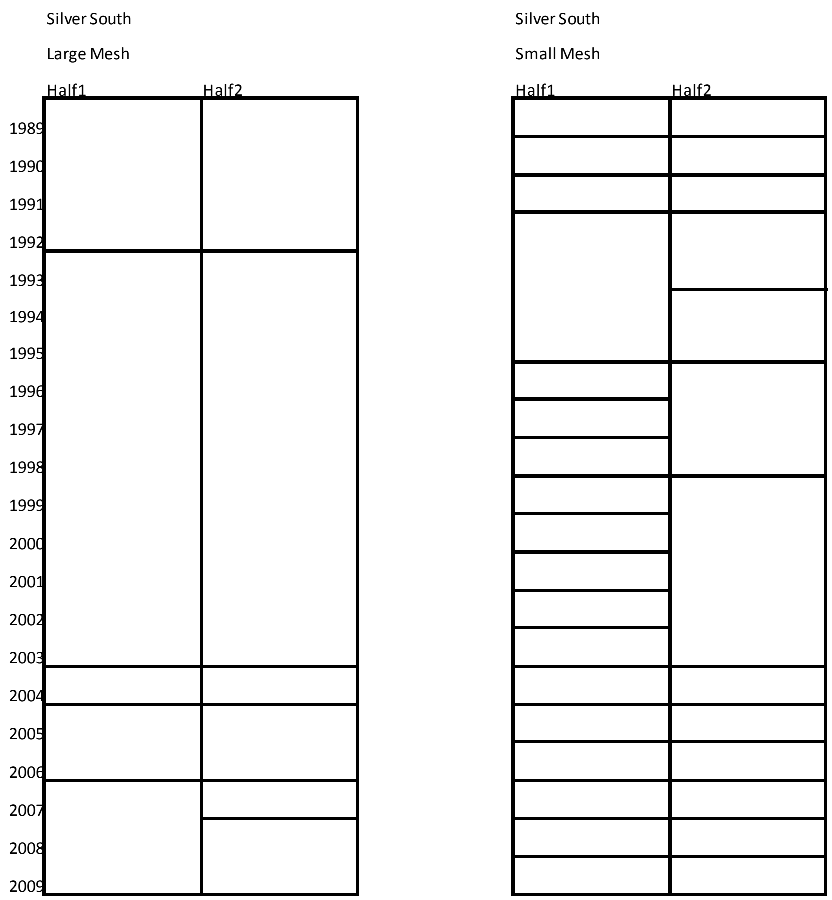


Table D29. Comparison of alternative methods of discard estimation for offshore hake.

Year	Nominal Discards (mt)	Length-Based Estimates (mt)
1981	0	100.3
1982	0	133.2
1983	0	137.8
1984	0	139.8
1985	0	110.8
1986	0	124.0
1987	0	121.7
1988	0	128.7
1989	0	69.6
1990	0	221.0
1991	0	152.7
1992	0	33.7
1993	0	78.1
1994	0	55.2
1995	0.1	37.3
1996	0	12.2
1997	3.3	18.7
1998	173.9	1.7
1999	1.7	5.1
2000	1.1	5.4
2001	10.0	14.5
2002	146.2	16.4
2003	2.2	74.7
2004	4.9	46.2
2005	6.4	5.0
2006	4.5	3.7
2007	20.6	6.8
2008	1.1	13.1
2009	25.7	14.2

Table D30. Negative log-likelihood, number of model parameters, AIC_c measures for beta-binomial models with the specified relationship of the calibration factor to length fit to **silver hake** catch data from the 2008 *Albatross IV*/*Henry B. Bigelow* calibration experiment.

Model	Model	-LL	# parameters	AIC_c	$\Delta(AIC_c)$	AIC_c Weights
1	All stations, constant (no length effect)	9341.745	2	18687.49	494.4465	0
2	Survey, S-S, constant	9322.744	4	18653.49	460.4489	0
3	S,F,S-S, constant model	9305.244	6	18622.5	429.4549	0
4	All stations, logistic model	9186.488	5	18382.99	189.9405	0
5	Survey, S-S logistic	9163.663	10	18347.36	154.3148	0
6	S, F, S-S, logistic	9146.738	15	18323.55	130.5072	0
7	All stations, double logistic model	9115.248	8	18246.52	53.4731	0
8	Survey, S-S, double-logistic model	9089.773	16	18211.63	18.5858	1.00E-04
9	S,F,S-S, double-logistic model	9073.961	24	18196.11	3.0675	0.1774
10	Spring logistic model	9076.506	21	18195.16	2.1138	NA
11	No minimum of ascending logistic for Fall	9073.981	23	18194.14	1.0926	NA
12	No minima for ascending or descending logistic for Fall	9074.917	22	18194	0.9499	NA
13	Spring logistic, no minima for ascending or descending logistic for Fall	9076.527	19	18193.05	0	0.8225

Table D31. The 3-year moving average of the stratified mean number per tow, stratified mean weight per tow (kg), swept area abundance (millions of fish), and swept area biomass (kg) of offshore hake for the NEFSC fall survey.

Year	Stratified Mean Number per Tow	Stratified Mean Weight per Tow (kg)	Swept Area Abundance (millions)	Swept Area Biomass (mt)
1967				
1968				
1969	0.52	0.15	0.21	59.76
1970	0.58	0.15	0.24	60.02
1971	0.48	0.10	0.19	41.94
1972	1.33	0.29	0.54	117.68
1973	1.29	0.29	0.53	116.74
1974	1.54	0.34	0.63	138.24
1975	0.80	0.20	0.33	80.79
1976	1.15	0.37	0.47	149.72
1977	1.22	0.41	0.50	167.91
1978	1.64	0.50	0.67	204.73
1979	1.39	0.37	0.57	153.00
1980	1.26	0.36	0.51	148.75
1981	1.34	0.66	0.55	267.61
1982	1.15	0.59	0.47	241.92
1983	1.09	0.53	0.45	216.53
1984	0.40	0.09	0.16	38.45
1985	0.76	0.24	0.31	98.51
1986	0.86	0.28	0.35	114.87
1987	0.97	0.31	0.39	126.13
1988	0.62	0.19	0.25	77.40
1989	0.54	0.17	0.22	70.06
1990	1.04	0.24	0.42	96.59
1991	1.13	0.24	0.45	98.23
1992	1.03	0.23	0.41	90.58
1993	0.42	0.13	0.17	52.74
1994	0.29	0.09	0.12	35.96
1995	0.35	0.09	0.14	35.48
1996	0.35	0.09	0.14	35.98
1997	0.42	0.12	0.17	49.17
1998	0.41	0.10	0.17	41.81
1999	0.37	0.07	0.15	30.47
2000	0.34	0.05	0.14	21.46
2001	1.00	0.18	0.41	74.04
2002	1.25	0.24	0.51	98.14
2003	1.74	0.41	0.70	164.87
2004	1.00	0.27	0.41	108.43
2005	0.73	0.21	0.30	85.08
2006	0.48	0.08	0.19	31.59
2007	0.91	0.16	0.37	64.22
2008	1.05	0.18	0.43	74.66

Table D32. The 3-year moving average of the stratified mean number per tow, stratified mean weight per tow (kg), swept area abundance (millions of fish), and swept area biomass (kg) of offshore hake for the NEFSC spring survey.

Year	Stratified Mean Number per Tow	Stratified Mean Weight per Tow (kg)	Swept Area Abundance (millions)	Swept Area Biomass (mt)
1967				
1968				
1969				
1970	0.33	0.15	0.13	62.21
1971	0.40	0.18	0.16	74.96
1972	0.67	0.30	0.28	121.19
1973	1.40	0.47	0.57	193.93
1974	2.12	0.78	0.87	317.51
1975	2.45	0.84	1.00	340.85
1976	3.01	0.88	1.22	358.84
1977	3.15	0.77	1.28	310.76
1978	3.11	1.01	1.27	413.92
1979	3.91	1.27	1.60	520.99
1980	6.12	2.57	2.50	1053.01
1981	6.67	2.40	2.71	976.59
1982	4.92	2.01	2.00	816.40
1983	2.04	0.58	0.82	232.95
1984	0.99	0.34	0.40	139.95
1985	0.90	0.33	0.37	133.32
1986	0.90	0.36	0.37	149.19
1987	1.14	0.50	0.47	202.66
1988	0.78	0.37	0.32	151.99
1989	0.63	0.32	0.26	129.27
1990	0.42	0.21	0.17	84.70
1991	0.99	0.36	0.40	148.19
1992	1.04	0.35	0.42	140.42
1993	1.00	0.31	0.40	122.67
1994	0.39	0.12	0.15	44.88
1995	0.25	0.05	0.10	18.75
1996	0.21	0.04	0.08	16.10
1997	0.24	0.05	0.10	20.03
1998	0.18	0.06	0.07	23.67
1999	0.14	0.05	0.06	20.85
2000	0.18	0.07	0.07	29.94
2001	0.37	0.10	0.15	41.07
2002	0.88	0.20	0.36	82.92
2003	1.04	0.24	0.43	98.02
2004	1.03	0.24	0.42	97.46
2005	0.52	0.14	0.21	58.13
2006	0.29	0.07	0.12	29.21
2007	0.53	0.10	0.22	39.39
2008	0.62	0.10	0.25	42.21

Year	Stratified Mean Number/Tow	Upper CI Mean Number/Tow	Lower CI Mean Number/Tow	Stratified Mean Weight/Tow (Kg)	Upper CI Mean Weight/Tow (Kg)	Lower CI Mean Weight/Tow (Kg)	Average Individual Weight (Kg)	Stratified Mean Temp. (C)	Stratified Mean Depth (M)
1967	0.36	0.49	0.24	0.11	0.20	0.01	0.30	10.02	156.14
1968	0.63	0.99	0.26	0.19	0.30	0.09	0.31	10.79	176.57
1969	0.58	0.91	0.26	0.14	0.24	0.03	0.23	10.51	172.51
1970	0.52	0.92	0.13	0.11	0.19	0.03	0.21	10.51	168.30
1971	0.32	0.54	0.10	0.06	0.10	0.02	0.19	11.49	170.69
1972	3.14	5.49	0.79	0.69	0.96	0.42	0.22	11.34	174.24
1973	0.42	0.66	0.18	0.10	0.16	0.05	0.25	12.11	168.10
1974	1.06	1.91	0.21	0.22	0.33	0.11	0.21	11.61	182.36
1975	0.93	1.25	0.60	0.27	0.35	0.19	0.29	11.28	171.13
1976	1.46	2.05	0.87	0.61	0.91	0.31	0.42	11.49	170.26
1977	1.28	2.04	0.52	0.35	0.53	0.17	0.28	11.92	169.88
1978	2.18	3.35	1.02	0.54	0.87	0.21	0.25	10.71	166.92
1979	0.71	1.17	0.25	0.23	0.36	0.10	0.32	12.01	161.71
1980	0.88	1.61	0.16	0.33	0.61	0.04	0.37	11.54	163.90
1981	2.44	3.06	1.81	1.41	2.28	0.54	0.58	9.88	178.81
1982	0.13	0.26	0.00	0.04	0.08	0.01	0.32	11.05	171.40
1983	0.70	0.98	0.42	0.14	0.18	0.10	0.19	10.91	163.17
1984	0.36	0.48	0.24	0.11	0.15	0.06	0.30	11.84	176.85
1985	1.22	2.57	-0.14	0.48	1.05	-0.09	0.40	6.80	163.89
1986	1.00	1.49	0.51	0.26	0.39	0.12	0.26	7.61	175.11
1987	0.68	0.89	0.47	0.19	********	********	0.28	5.79	176.25
1988	0.19	0.19	0.19	0.12	0.12	0.12	0.65	7.91	167.11
1989	0.76	0.76	0.76	0.20	0.20	0.20	0.27	3.75	161.57
1990	2.15	2.33	1.97	0.39	0.41	0.37	0.18	4.96	174.66
1991	0.47	0.47	0.47	0.14	0.14	0.14	0.29	11.19	158.24
1992	0.46	0.52	0.39	0.15	********	********	0.33	11.91	161.25
1993	0.32	0.50	0.15	0.11	********	********	0.33	11.66	169.89
1994	0.09	0.09	0.09	0.01	0.01	0.01	0.15	11.65	164.73
1995	0.64	0.83	0.44	0.14	0.18	0.10	0.22	12.05	158.05
1996	0.33	0.53	0.12	0.11	0.17	0.05	0.33	9.52	160.96
1997	0.29	0.29	0.29	0.11	0.11	0.11	0.38	11.82	168.27
1998	0.62	0.96	0.27	0.09	********	********	0.14	10.61	156.06
1999	0.19	0.19	0.19	0.03	0.03	0.03	0.13	12.72	162.74
2000	0.21	0.30	0.12	0.04	0.07	0.02	0.21	12.00	154.15
2001	2.61	**********	**********	0.48	0.52	0.44	0.18	11.09	159.32
2002	0.92	0.92	0.92	0.20	0.20	0.20	0.22	11.26	174.43
2003	1.68	1.78	1.59	0.54	**********	********	0.32	11.32	179.30
2004	0.40	0.43	0.36	0.06	0.07	0.05	0.15	10.81	169.33
2005	0.12	0.12	0.12	0.03	0.03	0.03	0.27	11.54	157.59
2006	0.91	2.13	-0.31	0.14	0.27	0.02	0.16	11.75	164.60
2007	1.69	1.75	1.63	0.30	**********	********	0.18	10.05	164.87
2008	0.55	0.78	0.33	0.11	0.17	0.04	0.19	10.54	164.32
2009	1.53			0.14				11.92	167.17

Table D33. Stratified mean number and weight per tow upper and lower confidence intervals, mean individual weight, mean temperature, and mean depth for offshore hake from the NEFSC fall bottom trawl surveys (strata 3-4, 7-8, 11-12, 14-15, 17-18, 63-64, 67-68, 71-72, 75-76). Values from 2009 were converted to Albatross units.

Year	Swept Area (nm)	Swept Area Abundance (millions)	Swept Area Upper CI	Swept Area Lower CI	Swept Area Biomass (mt)	Swept Area Upper CI	Swept Area Lower CI
1967	4583	0.15	0.20	0.10	44.40	83.84	4.95
1968	4583	0.26	0.41	0.11	79.55	123.99	35.11
1969	4583	0.24	0.37	0.10	55.32	98.70	11.91
1970	4583	0.21	0.38	0.05	45.18	76.36	13.95
1971	4583	0.13	0.22	0.04	25.33	42.76	7.86
1972	4583	1.29	2.25	0.32	282.55	394.26	170.88
1973	4583	0.17	0.27	0.07	42.35	64.82	19.85
1974	4583	0.43	0.78	0.09	89.82	134.46	45.13
1975	4583	0.38	0.51	0.24	110.20	143.46	76.97
1976	4583	0.60	0.84	0.36	249.16	371.51	126.81
1977	4583	0.52	0.84	0.21	144.36	218.06	70.67
1978	4583	0.89	1.37	0.42	220.68	355.96	85.40
1979	4583	0.29	0.48	0.10	93.95	147.76	40.10
1980	4523	0.36	0.65	0.06	131.61	245.57	17.61
1981	4583	1.00	1.25	0.74	577.25	932.11	222.44
1982	4583	0.05	0.11	0.00	16.90	30.81	2.99
1983	4583	0.29	0.40	0.17	55.45	72.02	38.87
1984	4497	0.14	0.19	0.10	43.00	60.67	25.38
1985	4583	0.50	1.05	-0.06	197.07	429.04	-34.95
1986	4583	0.41	0.61	0.21	104.55	159.50	49.55
1987	4531	0.27	0.36	0.19	76.78	********	********
1988	4583	0.08	0.08	0.08	50.86	50.86	50.86
1989	4583	0.31	0.31	0.31	82.53	82.53	82.53
1990	4478	0.86	0.93	0.79	156.37	163.25	149.53
1991	4583	0.19	0.19	0.19	55.77	55.77	55.77
1992	4426	0.18	0.21	0.16	59.59	********	********
1993	4523	0.13	0.20	0.06	42.85	********	********
1994	4583	0.04	0.04	0.04	5.44	5.44	5.44
1995	4583	0.26	0.34	0.18	58.15	73.70	42.60
1996	4583	0.13	0.22	0.05	44.36	69.89	18.82
1997	4583	0.12	0.12	0.12	45.01	45.01	45.01
1998	4583	0.25	0.39	0.11	36.05	********	********
1999	4583	0.08	0.08	0.08	10.35	10.35	10.35
2000	4583	0.08	0.12	0.05	17.96	28.97	6.92
2001	4523	1.06	********	********	193.80	211.73	175.83
2002	4583	0.38	0.38	0.38	82.66	82.66	82.66
2003	4523	0.68	0.72	0.64	218.15	********	********
2004	4583	0.16	0.18	0.15	24.47	28.15	20.79
2005	4418	0.05	0.05	0.05	12.62	12.62	12.62
2006	4531	0.37	0.86	-0.12	57.69	108.18	7.24
2007	4583	0.69	0.72	0.67	122.35	********	********
2008	4583	0.23	0.32	0.13	43.95	69.56	18.29
2009	4583	0.63			56.11		

Table D34. Swept area abundance and biomass and upper and lower confidence intervals for offshore hake from the NEFSC fall bottom trawl surveys (strata 3-4, 7-8, 11-12, 14-15, 17-18, 63-64, 67-68, 71-72, 75-76). Values from 2009 were converted to Albatross units.

Year	Stratified Mean Number/Tow	Upper CI Mean Number/Tow	Lower CI Mean Number/Tow	Stratified Mean Weight/Tow (Kg)	Upper CI Mean Weight/Tow (Kg)	Lower CI Mean Weight/Tow (Kg)	Average Individual Weight (Kg)	Stratified Mean Temp. (C)	Stratified Mean Depth (M)
1968	0.15	0.28	0.02	0.06	0.11	0.01	0.42	9.49	165.47
1969	0.17	0.35	-0.02	0.11	0.22	0.01	0.69	10.40	176.23
1970	0.66	1.10	0.22	0.28	0.44	0.12	0.42	10.87	171.62
1971	0.37	0.82	-0.08	0.16	0.35	-0.04	0.42	10.05	175.33
1972	0.99	1.32	0.67	0.45	0.57	0.34	0.46	10.95	176.25
1973	2.83	3.96	1.69	0.81	1.23	0.40	0.29	11.11	160.33
1974	2.53	3.11	1.95	1.06	1.42	0.70	0.42	11.33	170.11
1975	2.00	2.46	1.54	0.65	0.79	0.50	0.32	9.76	163.80
1976	4.50	6.73	2.27	0.94	1.23	0.66	0.21	11.02	172.08
1977	2.95	4.23	1.67	0.71	0.92	0.50	0.24	9.66	172.70
1978	1.88	2.91	0.85	1.38	2.06	0.70	0.73	7.95	161.57
1979	6.90	10.54	3.26	1.73	2.49	0.97	0.25	10.75	153.45
1980	9.58	15.07	4.08	4.61	8.00	1.22	0.48	10.74	164.49
1981	3.55	5.53	1.57	0.85	1.65	0.05	0.24	10.18	155.33
1982	1.65	2.27	1.02	0.55	0.79	0.32	0.34	5.91	166.43
1983	0.93	1.56	0.31	0.33	0.55	0.12	0.36	10.98	175.39
1984	0.39	0.65	0.12	0.14	0.26	0.02	0.36	10.47	163.45
1985	1.38	2.74	0.03	0.51	0.93	0.08	0.37	9.41	163.70
1986	0.93	1.49	0.37	0.45	0.76	0.14	0.48	7.92	177.24
1987	1.12	1.66	0.59	0.53	0.90	0.16	0.47	10.44	172.50
1988	0.27	0.27	0.27	0.14	0.14	0.14	0.50	10.08	179.51
1989	0.49	0.49	0.49	0.28	0.28	0.28	0.58	7.10	167.67
1990	0.50	0.50	0.50	0.21	0.21	0.21	0.42	9.12	168.65
1991	1.97	4.06	-0.12	0.60	1.12	0.08	0.30	11.26	166.32
1992	0.66	0.71	0.61	0.24	********	********	0.36	11.19	163.58
1993	0.36	0.36	0.36	0.08	0.08	0.08	0.21	10.33	157.48
1994	0.14	0.23	0.05	0.03	0.06	0.00	0.22	11.78	157.77
1995	0.24	0.42	0.06	0.03	0.06	0.01	0.14	12.41	164.97
1996	0.24	0.52	-0.04	0.05	0.12	-0.01	0.22	10.38	165.57
1997	0.24	0.34	0.15	0.06	0.08	0.04	0.26	11.11	148.75
1998	0.05	0.05	0.05	0.06	0.06	0.06	1.20	8.12	158.28
1999	0.13	0.22	0.04	0.03	********	********	0.26	11.44	160.65
2000	0.35	0.77	-0.07	0.13	0.23	0.02	0.36	11.85	154.41
2001	0.63	0.66	0.60	0.14	0.14	0.14	0.22	11.11	154.97
2002	1.67	2.02	1.33	0.34	********	********	0.20	11.96	170.39
2003	0.81	0.81	0.81	0.24	0.24	0.24	0.29	8.69	161.19
2004	0.60	0.60	0.60	0.14	0.14	0.14	0.23	8.52	173.98
2005	0.15	0.15	0.15	0.05	0.05	0.05	0.35	9.45	170.79
2006	0.11	0.11	0.11	0.02	0.02	0.02	0.22	11.53	160.94
2007	1.32	1.66	0.98	0.21	0.25	0.18	0.16	9.56	171.19
2008	0.42	0.42	0.42	0.07	0.07	0.07	0.17	10.71	163.60
2009	0.42			0.08				11.26	168.78
2010	0.70			0.07					153.66

Table D35. Stratified mean number and weight per tow upper and lower confidence intervals, mean individual weight, mean temperature, and mean depth for offshore hake from the NEFSC spring bottom trawl surveys (strata 3-4, 7-8, 11-12, 14-15, 17-18, 63-64, 67-68, 71-72, 75-76). Values from 2009 and 2010 were converted to Albatross units.

Year	Swept Area (nm)	Swept Area Abundance (millions)	Swept Area Upper CI	Swept Area Lower CI	Swept Area Biomass (mt)	Swept Area Upper CI	Swept Area Lower CI
1968	4583	0.06	0.11	0.01	25.45	45.54	5.36
1969	4583	0.07	0.14	-0.01	47.02	88.02	5.97
1970	4583	0.27	0.45	0.09	114.17	179.76	48.61
1971	4583	0.15	0.33	-0.03	63.71	142.60	-15.18
1972	4583	0.41	0.54	0.27	185.69	232.38	139.00
1973	4583	1.16	1.62	0.69	332.39	502.58	162.21
1974	4583	1.04	1.27	0.80	434.44	582.90	285.99
1975	4437	0.79	0.98	0.61	255.72	313.88	197.60
1976	4583	1.84	2.75	0.93	386.36	504.13	268.60
1977	4583	1.21	1.73	0.68	290.20	377.32	203.13
1978	4583	0.77	1.19	0.35	565.18	844.58	285.74
1979	4583	2.82	4.31	1.33	707.58	1018.74	396.43
1980	4583	3.92	6.16	1.67	1886.27	3272.02	500.57
1981	4411	1.40	2.18	0.62	335.91	651.06	20.76
1982	4583	0.67	0.93	0.42	227.02	322.24	131.80
1983	4583	0.38	0.64	0.13	135.94	224.16	47.71
1984	4583	0.16	0.27	0.05	56.88	107.33	6.42
1985	4583	0.57	1.12	0.01	207.14	380.59	33.68
1986	4583	0.38	0.61	0.15	183.57	311.36	55.77
1987	4583	0.46	0.68	0.24	217.28	367.05	67.48
1988	4478	0.11	0.11	0.11	55.14	55.14	55.14
1989	4583	0.20	0.20	0.20	115.39	115.39	115.39
1990	4411	0.20	0.20	0.20	83.57	83.57	83.57
1991	4583	0.81	1.66	-0.05	245.60	459.24	31.92
1992	4347	0.25	0.27	0.24	92.10	********	********
1993	4347	0.14	0.14	0.14	30.31	30.31	30.31
1994	4407	0.06	0.09	0.02	12.24	23.25	1.26
1995	4583	0.10	0.17	0.02	13.71	24.76	2.66
1996	4583	0.10	0.21	-0.01	22.34	48.24	-3.60
1997	4302	0.09	0.13	0.06	24.05	31.38	16.67
1998	4523	0.02	0.02	0.02	24.63	24.63	24.63
1999	4583	0.05	0.09	0.02	13.87	********	********
2000	4583	0.14	0.31	-0.03	51.31	94.03	8.59
2001	4583	0.26	0.27	0.25	58.02	58.47	57.57
2002	4583	0.68	0.83	0.54	139.41	********	********
2003	4583	0.33	0.33	0.33	96.61	96.61	96.61
2004	4583	0.25	0.25	0.25	56.35	56.35	56.35
2005	4583	0.06	0.06	0.06	21.44	21.44	21.44
2006	4523	0.04	0.04	0.04	9.85	9.85	9.85
2007	4583	0.54	0.68	0.40	86.87	100.38	73.37
2008	4583	0.17	0.17	0.17	29.91	29.91	29.91
2009	4497	0.169			34.120		
2010	4583	0.287			30.146		

Table D36. Swept area abundance and biomass and upper and lower confidence intervals for offshore hake from the NEFSC spring bottom trawl surveys (strata 3-4, 7-8, 11-12, 14-15, 17-18, 63-64, 67-68, 71-72, 75-76). Values from 2009 and 2010 were converted to Albatross units.

Year	Stratified Mean Number/Tow	Upper CI Mean Number/Tow	Lower CI Mean Number/Tow	Stratified Mean Weight/Tow (Kg)	Upper CI Mean Weight/Tow (Kg)	Lower CI Mean Weight/Tow (Kg)	Average Individual Weight (Kg)	Stratified Mean Temp. (C)	Stratified Mean Depth (M)
1998	4.81	5.45	4.16	0.44	0.49	0.40	0.09	9.26	155.76
1999	3.01	3.01	3.01	0.51	0.51	0.51	0.17	12.77	154.76
2000	3.73	3.78	3.69	0.50	0.50	0.49	0.13	11.63	142.45
2001	15.74	22.80	8.68	2.99	4.12	1.86	0.19	11.45	166.84
2002	7.17	15.53	-1.18	1.67	4.53	-1.19	0.23	12.42	161.12
2003	8.78	15.18	2.39	1.87	3.29	0.46	0.21	9.35	167.52
2004	8.89	16.06	1.72	1.77	3.76	-0.21	0.20	9.37	167.41
2005	19.68	23.46	15.89	2.76	3.18	2.35	0.14	10.66	169.88
2006	3.84	6.49	1.19	0.73	1.28	0.18	0.19	12.17	163.54
2007	17.32	29.42	5.22	2.47	4.27	0.68	0.14	10.60	165.44

Table D37. Stratified mean number and weight per tow upper and lower confidence intervals, mean individual weight, mean temperature, and mean depth for offshore hake from the NEFSC winter flatfish surveys (strata 3-4, 7-8, 11-12, 63-64, 67-68, 71-72, 75-76).

Year	Swept Area (nm)	Swept Area Abundance (millions)	Swept Area Upper CI	Swept Area Lower CI	Swept Area Biomass (mt)	Swept Area Upper CI	Swept Area Lower CI
1998	2977	1.28	1.45	1.11	117.70	130.35	105.05
1999	3165	0.85	0.85	0.85	145.14	145.14	145.14
2000	2759	0.92	0.93	0.91	122.41	123.91	120.88
2001	3165	4.45	6.44	2.45	845.17	1165.57	524.74
2002	3105	1.99	4.30	-0.33	462.34	1254.48	-329.82
2003	3165	2.48	4.29	0.67	529.52	930.48	128.58
2004	3165	2.51	4.54	0.49	501.03	1062.65	-60.59
2005	3105	5.46	6.50	4.41	766.44	881.71	651.19
2006	3165	1.08	1.83	0.34	206.40	361.71	51.09
2007	3165	4.89	8.31	1.47	698.96	1205.98	191.91

Table D38. Swept area abundance and biomass and upper and lower confidence intervals for offshore hake from the NEFSC winter flatfish surveys (strata 3-4, 7-8, 11-12, 63-64, 67-68, 71-72, 75-76).

year	fall n	spring n	winter n	3yr fall n	3yr spring n
1967	24				
1968	71	13			
1969	47	11		47	
1970	39	50		52	25
1971	27	27		38	29
1972	226	81		97	53
1973	33	360		95	156
1974	76	175		112	205
1975	90	112		66	216
1976	118	448		95	245
1977	101	272		103	277
1978	164	144		128	288
1979	48	475		104	297
1980	58	545		90	388
1981	153	171		86	397
1982	16	149		76	288
1983	70	77		80	132
1984	24	26		37	84
1985	65	56		53	53
1986	95	70		61	51
1987	20	103		60	76
1988	7	6		41	60
1989	31	17		19	42
1990	78	14		39	12
1991	14	47		41	26
1992	12	16		35	26
1993	7	11		11	25
1994	4	7		8	11
1995	34	12		15	10
1996	12	14		17	11
1997	8	8		18	11
1998	18	1	123	13	8
1999	7	5	56	11	5
2000	14	7	164	13	4
2001	85	22	824	35	11
2002	35	60	220	45	30
2003	54	24	448	58	35
2004	20	25	379	36	36
2005	10	5	435	28	18
2006	29	4	260	20	11
2007	55	90	1086	31	33
2008	22	20		35	38
2009	700	188			

Table D39. Sample sizes for offshore hake survey length frequencies and 3-year moving average length frequencies.

Year	Fall Mean 20cm	Spring Mean 20cm	Winter Mean 20cm	Fall Sample Size	Spring Sample Size	Winter Sample Size
1967	31.56			9		
1968	31.67	32.89		11	5	
1969	30.58	41.46		9	4	
1970	28.04	37.14		8	9	
1971	31.46	39.12		10	8	
1972	29.76	37.50		21	19	
1973	30.09	31.63		11	11	
1974	30.10	36.44		15	19	
1975	31.37	33.65		15	22	
1976	37.47	29.98		14	15	
1977	33.32	32.39		17	14	
1978	33.03	44.63		11	10	
1979	34.22	32.86		8	10	
1980	36.89	38.16		8	15	
1981	36.65	34.23		17	7	
1982	32.21	36.48		4	18	
1983	27.72	34.59		10	12	
1984	34.48	35.69		11	10	
1985	36.23	35.80		7	10	
1986	33.20	38.45		11	12	
1987	30.27	37.49		7	13	
1988	40.12	38.43		5	3	
1989	31.29	40.35		7	4	
1990	29.29	36.10		7	3	
1991	33.60	33.28		6	5	
1992	36.24	33.91		5	5	
1993	36.09	30.61		4	4	
1994	22.53	30.57		3	4	
1995	29.50	26.96		5	4	
1996	34.65	31.25		6	4	
1997	35.35	31.67		3	5	
1998	25.72	51.00	24.51	4	1	5
1999	27.25	34.97	28.90	2	2	4
2000	30.33	36.71	26.21	3	4	4
2001	27.72	31.25	28.99	7	8	21
2002	30.52	29.47	30.40	6	7	12
2003	32.99	32.63	30.54	7	5	11
2004	28.74	32.32	29.06	5	6	11
2005	32.40	34.21	26.29	1	4	10
2006	26.68	31.97	30.99	7	2	12
2007	28.38	28.23	27.05	8	13	15
2008	29.17	28.79		9	4	
2009	24.92	31.00		17	19	
2010		25.54			10	

Table D40. Mean lengths and sample sizes for fall, spring and winter surveys, as used for input into the SEINE model (base runs). Values from 2009 and 2010 were converted to Albatross units.

Year	Fall Mean 17cm	Fall Mean 23cm	Fall Sample Size
1967	31.56	31.56	9
1968	31.38	31.78	11
1969	30.16	31.21	9
1970	27.80	32.31	8
1971	30.33	31.81	10
1972	29.03	31.81	21
1973	29.75	31.33	11
1974	29.36	32.89	15
1975	30.96	32.24	15
1976	36.93	37.74	14
1977	32.86	34.09	17
1978	30.46	35.96	11
1979	33.91	34.70	8
1980	33.58	37.22	8
1981	36.46	37.11	17
1982	32.21	33.33	4
1983	27.72	27.93	10
1984	34.48	34.48	11
1985	36.23	36.23	7
1986	32.78	33.49	11
1987	30.27	30.27	7
1988	40.12	40.12	5
1989	31.29	32.33	7
1990	28.36	30.93	7
1991	33.60	33.60	6
1992	36.24	36.24	5
1993	36.09	36.09	4
1994	22.53	23.73	3
1995	29.50	30.12	5
1996	34.65	34.65	6
1997	35.35	35.35	3
1998	25.72	27.45	4
1999	27.25	30.37	2
2000	30.33	30.87	3
2001	27.45	29.07	7
2002	30.52	30.52	6
2003	32.99	33.09	7
2004	26.56	29.70	5
2005	32.40	32.40	1
2006	26.68	27.62	7
2007	28.38	28.86	8
2008	29.17	29.55	9
2009	23.72	26.26	17

Table D41. Mean lengths and sample sizes for fall sensitivity analyses as used for input into the SEINE model.

		Growth Parameters						
Run#	Model	L_{inf}	K	L_{crit}	Cut Point	AIC	Liklihood	Comments
1	Fall BASE	43.91	0.33	20	1	327.81	159.91	silver hake average of SNE/SGB
1	Fall BASE	43.91	0.33	20	2	312.68	150.34	silver hake average of SNE/SGB
1	Fall BASE	43.91	0.33	20	3	311.35	147.68	silver hake average of SNE/SGB
2	Spring BASE	43.91	0.33	20	1	321.29	156.65	silver hake average of SNE/SGB
3	Winter BASE	43.91	0.33	20	1	70.75	31.38	silver hake average of SNE/SGB
4	Fall SENSITIVITY	43.78	0.28	20	1	315.57	153.79	silver hake SGB
4	Fall SENSITIVITY	43.78	0.28	20	2	312.98	150.49	silver hake SGB
4	Fall SENSITIVITY	43.78	0.28	20	3	311.29	147.64	silver hake SGB
5	Fall SENSITIVITY	43.78	0.28	23	1	304.08	148.04	silver hake SGB
5	Fall SENSITIVITY	43.78	0.28	23	2	303.33	145.66	silver hake SGB
5	Fall SENSITIVITY	43.78	0.28	23	3	299.51	141.76	silver hake SGB
6	Fall SENSITIVITY	43.78	0.28	17	1	315.04	153.59	silver hake SGB
7	Fall SENSITIVITY	44.04	0.37	20	1	315.57	153.78	silver hake SNE
7	Fall SENSITIVITY	44.04	0.37	20	2	312.43	150.22	silver hake SNE
8	Fall SENSITIVITY	44.04	0.37	23	1	304.09	148.05	silver hake SNE
8	Fall SENSITIVITY	44.04	0.37	23	2	303.11	145.56	silver hake SNE
8	Fall SENSITIVITY	44.04	0.37	23	3	300.39	142.19	silver hake SNE
9	Fall SENSITIVITY	44.04	0.37	17	1	317.29	154.64	silver hake SNE
9	Fall SENSITIVITY	44.04	0.37	17	2	315.07	151.53	silver hake SNE
9	Fall SENSITIVITY	44.04	0.37	17	3	313.35	148.68	silver hake SNE
10	Fall SENSITIVITY	70	0.174	20	1	289.41	140.70	offshore hake VB
10	Fall SENSITIVITY	70	0.174	20	2	280.79	134.39	offshore hake VB
10	Fall SENSITIVITY	70	0.174	20	3	274.62	129.31	offshore hake VB
10	Fall SENSITIVITY	70	0.174	20	4	255.13	117.57	offshore hake VB
11	Fall SENSITIVITY	70	0.174	23	1	304.01	148.01	offshore hake VB (z was over 1)
12	Fall SENSITIVITY	70	0.174	17	1	317.33	154.67	offshore hake VB
13	Fall SENSITIVITY	70	0.174	17	2	314.24	151.12	offshore hake VB (z was over 1 for 3-cut)

Table D42. SEINE base model results and sensitivity analyses for offshore hake. The highlighted values are the lowest AIC values calculated from the SEINE model runs and sensitivity analyses.

Table D43. Summary of catch, NEFSC fall and spring bottom trawl survey indices, replacement ratios and relative fishing mortality rates for offshore hake. Catch is based on method of Sosebee. Survey values from 2009 were converted to Albatross units.

		NEFSC Survey		Replacement Ratio		Relative Fishing Mortality	
Year	Catch(mt)	Fall (kg/tow)	Spring (kg/tow)	Fall	Spring	Relative F Fall (mt/kg)	Relative F Spring (mt/kg)
1963	3956.8	-999	-999				
1964	6506.4	-999	-999				
1965	13013.8	-999	-999				
1966	8951.9	-999	-999				
1967	3866.4	0.11	-999			35149.2	
1968	339.4	0.19	0.06			1786.1	5655.9
1969	670.3	0.14	0.11			4787.5	6093.2
1970	680.2	0.11	0.28			6183.9	2429.4
1971	1383.7	0.06	0.16			23061.6	8648.1
1972	6175.7	0.69	0.45	5.6557		8950.3	13723.8
1973	2514.8	0.1	0.81	0.4202	3.8208	25148.3	3104.7
1974	7467.5	0.22	1.06	1.0000	2.9282	33943.0	7044.8
1975	2088.7	0.27	0.65	1.1441	1.1775	7736.0	3213.4
1976	4132.8	0.61	0.94	2.2761	1.5016	6775.0	4396.6
1977	2148.1	0.35	0.71	0.9259	0.9079	6137.4	3025.5
1978	1298.0	0.54	1.38	1.7419	1.6547	2403.6	940.6
1979	1976.9	0.23	1.73	0.5779	1.8249	8595.2	1142.7
1980	1862.4	0.33	4.61	0.8250	4.2606	5643.7	404.0
1981	1497.6	1.41	0.85	3.4223	0.4536	1062.1	1761.9
1982	542.4	0.04	0.55	0.0699	0.2963	13560.8	986.2
1983	417.7	0.14	0.33	0.2745	0.1809	2983.7	1265.8
1984	328.1	0.11	0.14	0.2558	0.0867	2982.3	2343.2
1985	455.2	0.48	0.51	1.1823	0.3935	948.3	892.5
1986	549.8	0.26	0.45	0.5963	0.9454	2114.7	1221.8
1987	692.4	0.19	0.53	0.9223	1.3384	3644.0	1306.3
1988	373.9	0.12	0.14	0.5085	0.3571	3116.0	2670.9
1989	502.8	0.2	0.28	0.8621	0.7910	2514.0	1795.7
1990	811.2	0.39	0.21	1.5600	0.5497	2080.0	3862.8
1991	936.0	0.14	0.6	0.6034	1.8634	6685.8	1560.0
1992	494.1	0.15	0.24	0.7212	0.6818	3294.2	2058.9
1993	631.1	0.11	0.08	0.5500	0.2721	5737.6	7889.3
1994	147.8	0.01	0.03	0.0505	0.1064	14783.1	4927.7
1995	218.7	0.14	0.03	0.8750	0.1293	1562.4	7291.4
1996	506.2	0.11	0.05	1.0000	0.2551	4601.9	10124.2
1997	256.1	0.11	0.06	1.0577	0.6977	2328.2	4268.3
1998	276.8	0.09	0.06	0.9375	1.2000	3075.2	4612.8
1999	172.5	0.03	0.03	0.3261	0.6522	5748.8	5748.8
2000	307.6	0.04	0.13	0.4167	2.8261	7689.7	2366.1
2001	649.1	0.48	0.14	6.3158	2.1212	1352.3	4636.6
2002	479.2	0.2	0.34	1.3333	4.0476	2395.9	1409.4
2003	639.2	0.54	0.24	3.2143	1.7143	1183.8	2663.5
2004	540.4	0.06	0.14	0.2326	0.7955	9007.1	3860.2
2005	293.1	0.03	0.05	0.1136	0.2525	9768.9	5861.4
2006	85.4	0.14	0.02	0.5344	0.1099	609.9	4269.6
2007	296.3	0.3	0.21	1.5464	1.3291	987.6	1410.9
2008	97.0	0.11	0.07	0.5140	0.5303	881.4	1385.1
2009	156.4	0.14	0.08	1.0938	0.8671	1117.4	1840.9

Table D44. Summary of AIM results offshore hake, both stocks combined, for NEFSC fall and spring bottom trawl surveys and catch estimates based on Sosebee method.

Offshore Hake	***Fall Survey***	***Spring Survey***
Critical value (observed correlation between replacement ratio and relative F	-0.428349	-0.315118
Probability of observing correlation < Critical Value	0.903500	0.999500
Relative F at Replacement (mt/kg)	1963.39	1307.17
90% Confidence Interval for RelF at replacement	(660, 3347)	(125, 2177)

Year	Fall Swept Area Biomass (mt)	Spring Swept Area Biomass (mt)	Winter Swept Area Biomass (mt)	Length based Total Catch (mt)	Fall Exploitation Ratio (catch, mt)	Spring Exploitation Ratio (catch, mt)	Winter Exploitation Ratio (catch, mt)	Length based Landings (mt)	Fall Exploitation Ratio (landings, mt)	Spring Exploitation Ratio (landings, mt)	Winter Exploitation Ratio (landings, mt)
1967	44.40			3866.41	87.09			3866.41	87.09		
1968	79.55	25.45		339.35	4.27	13.33		339.35	4.27	13.33	
1969	55.32	47.02		670.25	12.12	14.26		670.25	12.12	14.26	
1970	45.18	114.17		680.23	15.06	5.96		680.23	15.06	5.96	
1971	25.33	63.71		1383.69	54.63	21.72		1383.69	54.63	21.72	
1972	282.55	185.69		6175.73	21.86	33.26		6175.73	21.86	33.26	
1973	42.35	332.39		2514.83	59.38	7.57		2514.83	59.38	7.57	
1974	89.82	434.44		7467.47	83.14	17.19		7467.47	83.14	17.19	
1975	110.20	255.72		2088.73	18.95	8.17		2088.73	18.95	8.17	
1976	249.16	386.36		4132.77	16.59	10.70		4132.77	16.59	10.70	
1977	144.36	290.20		2148.09	14.88	7.40		2148.09	14.88	7.40	
1978	220.68	565.18		1297.97	5.88	2.30		1297.97	5.88	2.30	
1979	93.95	707.58		1976.90	21.04	2.79		1976.90	21.04	2.79	
1980	131.61	1886.27		1862.43	14.15	0.99		1862.43	14.15	0.99	
1981	577.25	335.91		1497.57	2.59	4.46		1397.32	2.42	4.16	
1982	16.90	227.02		542.43	32.10	2.39		409.20	24.21	1.80	
1983	55.45	135.94		417.72	7.53	3.07		279.91	5.05	2.06	
1984	43.00	56.88		328.05	7.63	5.77		188.27	4.38	3.31	
1985	197.07	207.14		455.19	2.31	2.20		344.36	1.75	1.66	
1986	104.55	183.57		549.82	5.26	3.00		425.81	4.07	2.32	
1987	76.78	217.28		692.36	9.02	3.19		570.64	7.43	2.63	
1988	50.86	55.14		373.92	7.35	6.78		245.19	4.82	4.45	
1989	82.53	115.39		502.80	6.09	4.36		433.20	5.25	3.75	
1990	156.37	83.57		811.19	5.19	9.71		590.21	3.77	7.06	
1991	55.77	245.60		936.01	16.78	3.81		783.28	14.04	3.19	
1992	59.59	92.10		494.13	8.29	5.37		460.41	7.73	5.00	
1993	42.85	30.31		631.14	14.73	20.82		553.06	12.91	18.25	
1994	5.44	12.24		147.83	27.16	12.08		92.61	17.02	7.57	
1995	58.15	13.71		218.74	3.76	15.96		181.48	3.12	13.24	
1996	44.36	22.34		506.21	11.41	22.66		493.99	11.14	22.11	
1997	45.01	24.05		256.10	5.69	10.65		237.45	5.28	9.88	
1998	36.05	24.63	117.70	276.77	7.68	11.24	2.35	275.04	7.63	11.16	2.34
1999	10.35	13.87	145.14	172.46	16.66	12.43	1.19	167.34	16.16	12.06	1.15
2000	17.96	51.31	122.41	307.59	17.12	5.99	2.51	302.16	16.82	5.89	2.47
2001	193.80	58.02	845.17	649.13	3.35	11.19	0.77	634.65	3.27	10.94	0.75
2002	82.66	139.41	462.34	479.18	5.80	3.44	1.04	462.79	5.60	3.32	1.00
2003	218.15	96.61	529.52	639.25	2.93	6.62	1.21	564.58	2.59	5.84	1.07
2004	24.47	56.35	501.03	540.43	22.09	9.59	1.08	494.27	20.20	8.77	0.99
2005	12.62	21.44	766.44	293.07	23.22	13.67	0.38	288.07	22.82	13.43	0.38
2006	57.69	9.85	206.40	85.39	1.48	8.67	0.41	81.71	1.42	8.29	0.40
2007	122.35	86.87	698.96	296.29	2.42	3.41	0.42	289.47	2.37	3.33	0.41
2008	43.95	29.91		96.96	2.21	3.24		83.89	1.91	2.80	
2009	56.108	34.120		156.44	2.79	4.58		142.24	2.54	4.17	
2010		30.146									

Table D45. Exploitation ratios for total catch (total catch/swept area biomass) and landings (landings/swept area biomass) for offshore hake during fall, spring and winter surveys. Note: These data were considered for determining stock status, but the SARC51 panel concluded that status could not be determined from available data.

Table D46. NEFSC fall bottom trawl survey data (delta mean). Note: These data were considered for determining stock status, but the SARC51 panel concluded that status could not be determined from available data.

Year	Individual Mean Weight	3-yr Average Individual Mean Weight	Recruitment Index (< 30 cm)	3-Year Average Recruitment Index (< 30 cm)
1967	0.720		0.017	
1968	0.318		0.304	
1969	0.250	0.429	0.323	0.215
1970	0.260	0.276	0.164	0.264
1971	0.196	0.235	0.095	0.194
1972	0.221	0.226	1.522	0.594
1973	0.263	0.227	0.183	0.600
1974	0.202	0.229	0.599	0.768
1975	0.290	0.252	0.399	0.394
1976	0.420	0.304	0.302	0.433
1977	0.273	0.328	0.410	0.370
1978	0.309	0.334	0.646	0.453
1979	0.324	0.302	0.081	0.379
1980	0.369	0.334	0.317	0.348
1981	0.582	0.425	0.483	0.294
1982	0.319	0.423	0.031	0.277
1983	0.194	0.365	0.526	0.347
1984	0.317	0.277	0.044	0.200
1985	0.391	0.301	0.271	0.280
1986	0.262	0.323	0.507	0.274
1987	0.280	0.311	0.373	0.384
1988	0.646	0.396	0.049	0.310
1989	0.265	0.397	0.292	0.238
1990	0.182	0.364	1.285	0.542
1991	0.291	0.246	0.054	0.544
1992	0.330	0.268	0.064	0.468
1993	0.327	0.316	0.051	0.056
1994	0.152	0.270	0.088	0.067
1995	0.224	0.234	0.350	0.163
1996	0.333	0.236	0.009	0.149
1997	0.377	0.311	0.077	0.145
1998	0.143	0.284	0.559	0.215
1999	0.132	0.217	0.130	0.255
2000	0.212	0.163	0.057	0.249
2001	0.184	0.176	1.855	0.681
2002	0.220	0.205	0.358	0.756
2003	0.321	0.242	0.554	0.922
2004	0.151	0.231	0.268	0.393
2005	0.272	0.248	0.012	0.278
2006	0.156	0.193	0.713	0.331
2007	0.177	0.202	1.076	0.600
2008	0.195	0.176	0.216	0.669
2009	0.095	0.156	1.380	0.891

D.Offshore Hake-Figures

Figure D1. NEFSC survey strata map.

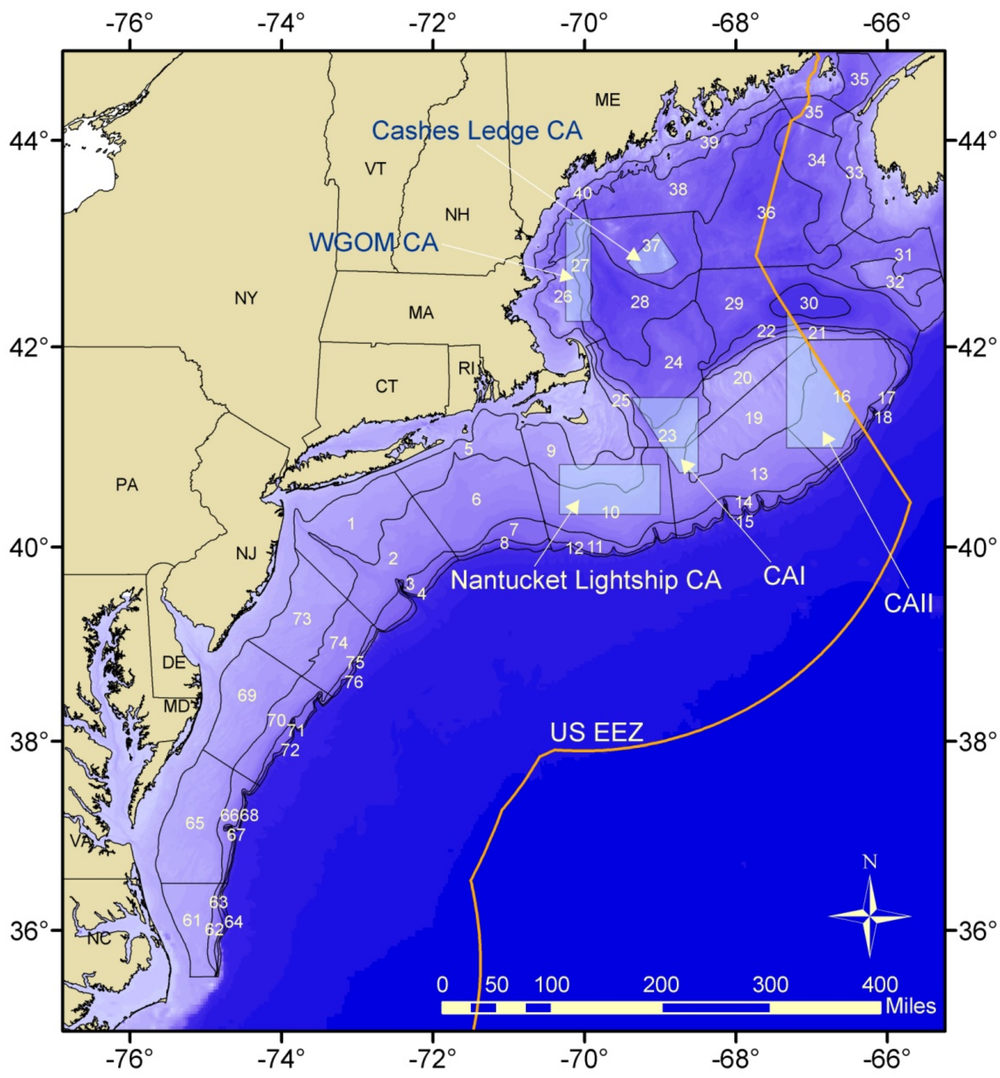


Figure D2. Distribution of offshore hake from the NEFSC fall survey (catch weight per tow, kg), 1967-2009.

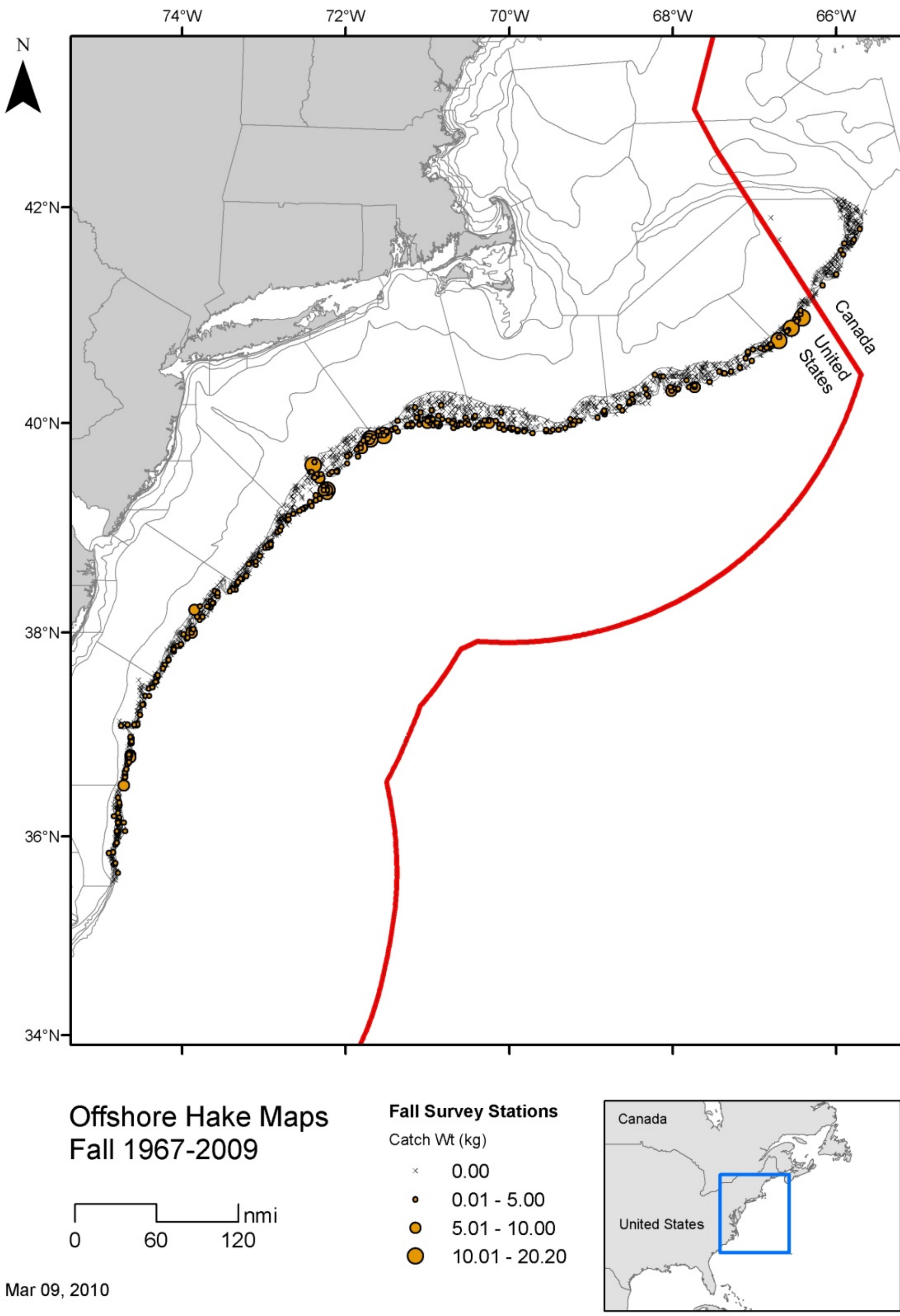


Figure D2a. NEFSC fall survey distribution (catch weight per tow, kg) of offshore hake, 1967-2009, broken up by stratum areas for easier viewing.

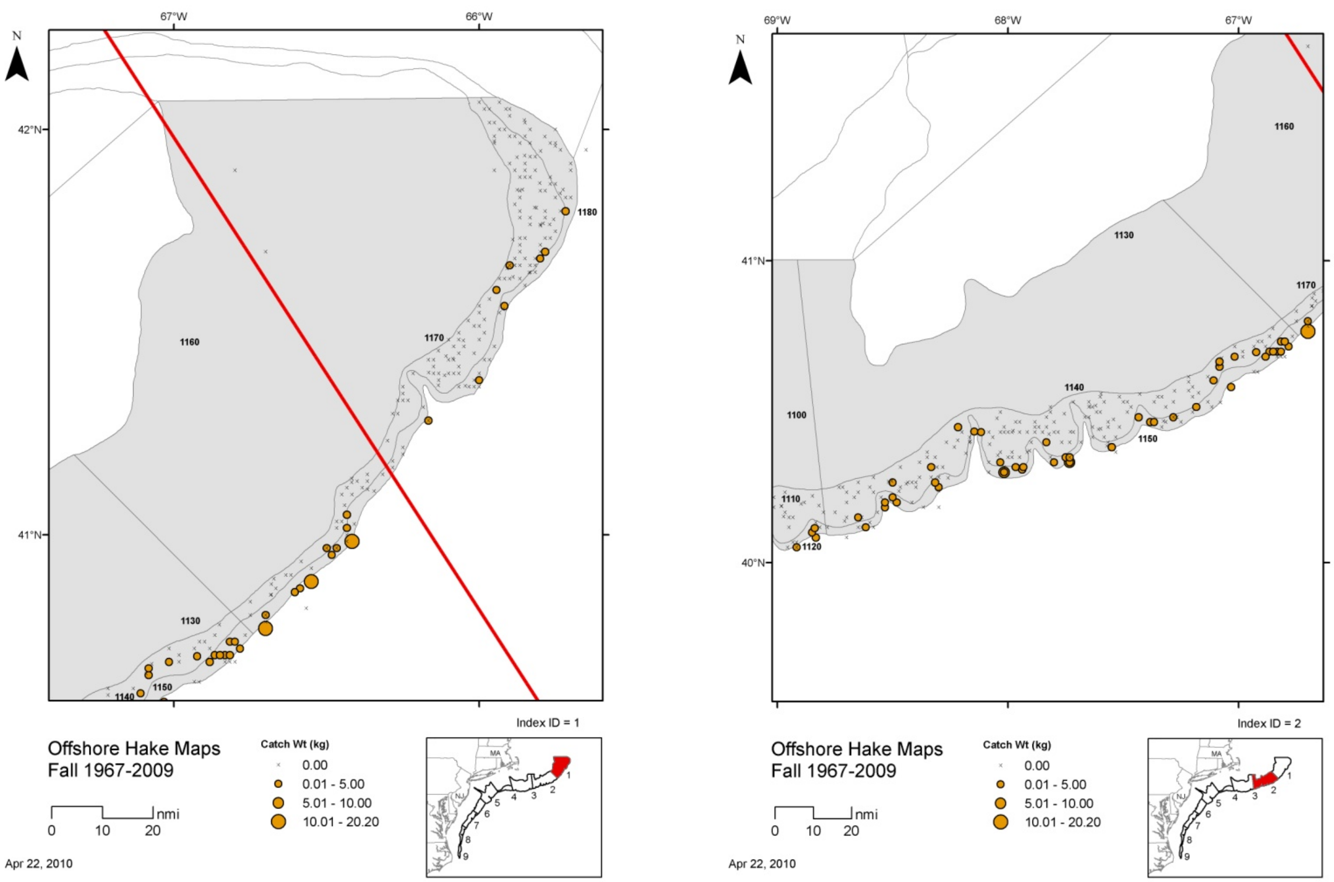
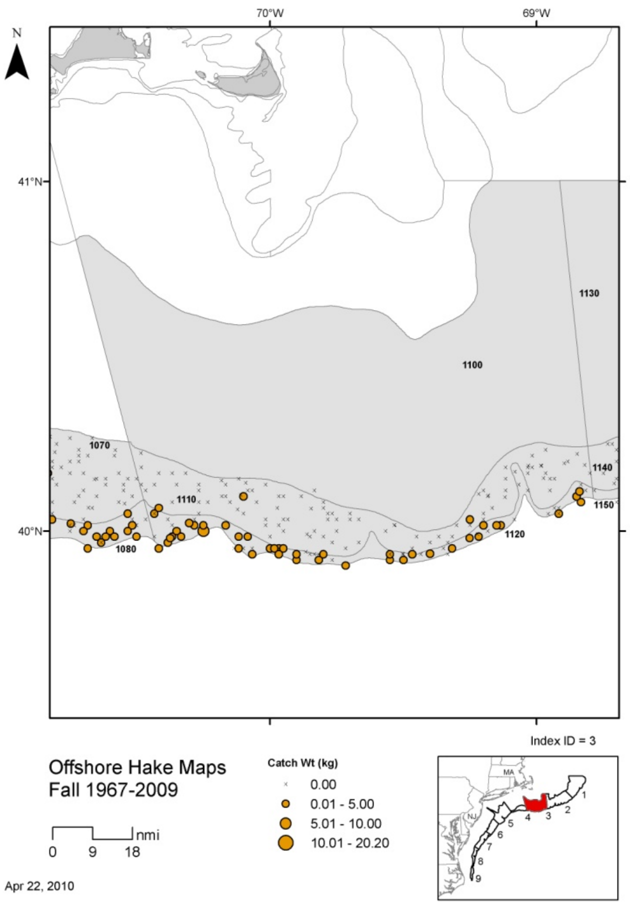


Figure D2b. NEFSC fall survey distribution (catch weight per tow, kg) of offshore hake, 1967-2009, broken up by stratum areas for easier viewing.



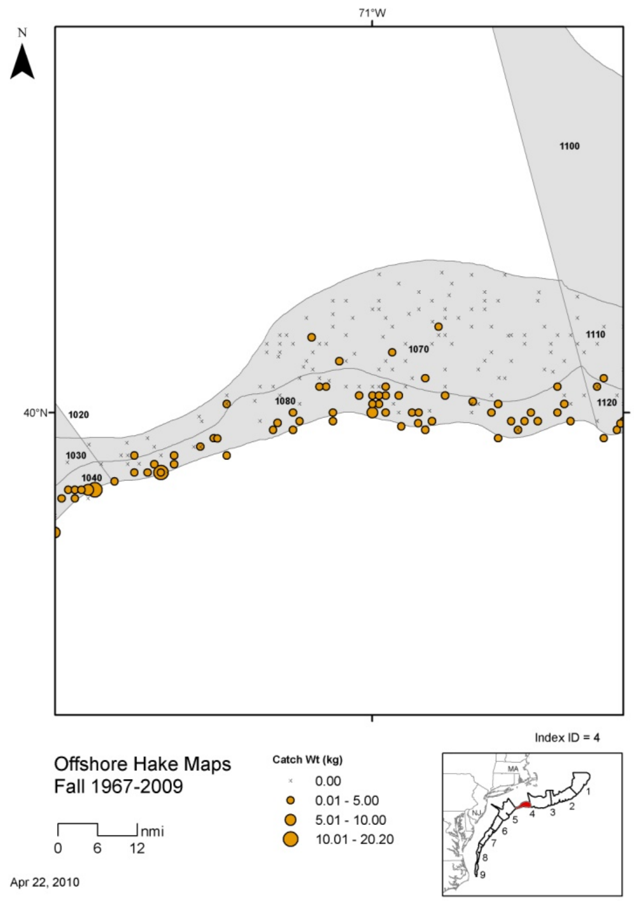
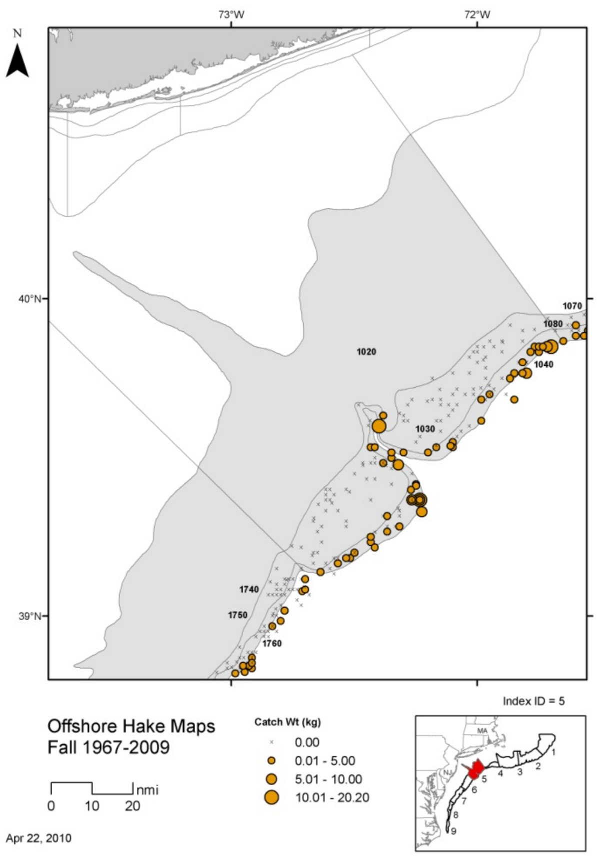


Figure D2c. NEFSC fall survey distribution (catch weight per tow, kg) of offshore hake, 1967-2009, broken up by stratum areas for easier viewing.



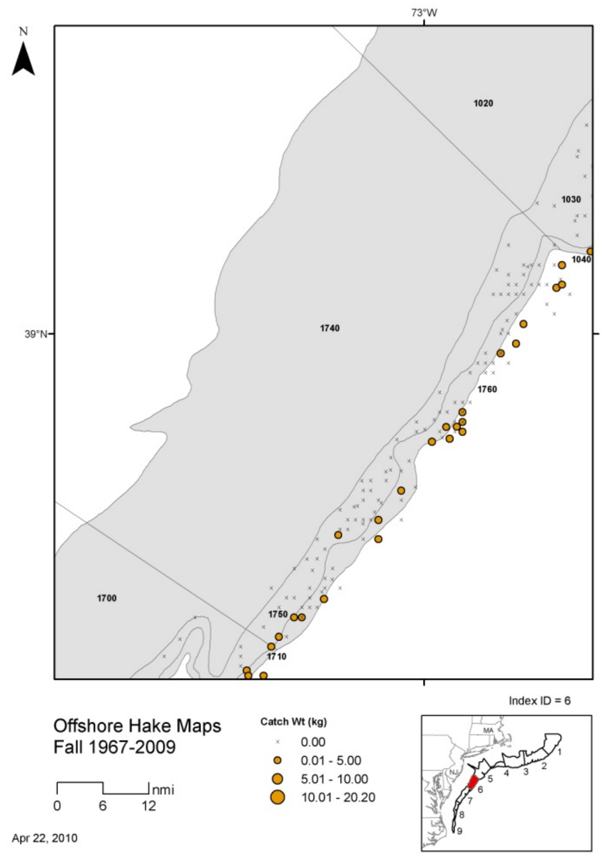
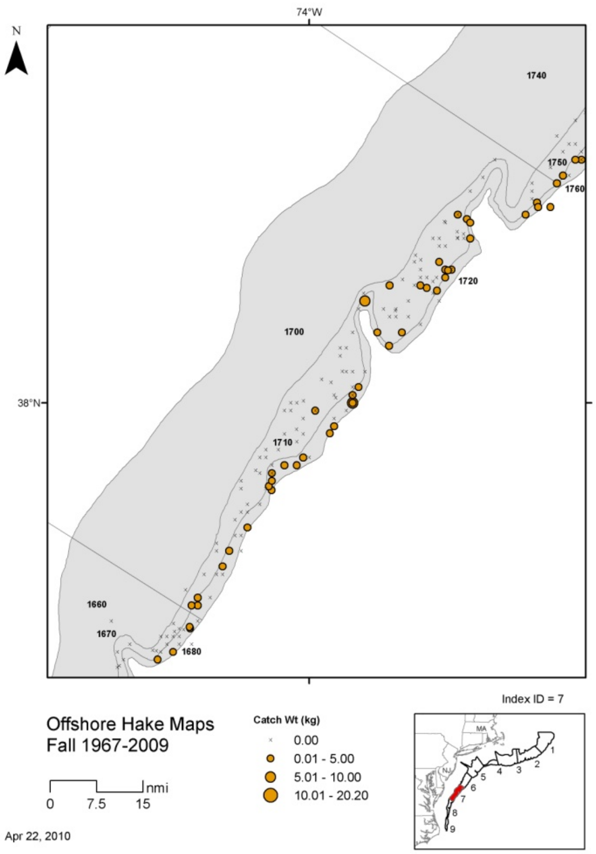


Figure D2d. NEFSC fall survey distribution (catch weight per tow, kg) of offshore hake, 1967-2009, broken up by stratum areas for easier viewing.



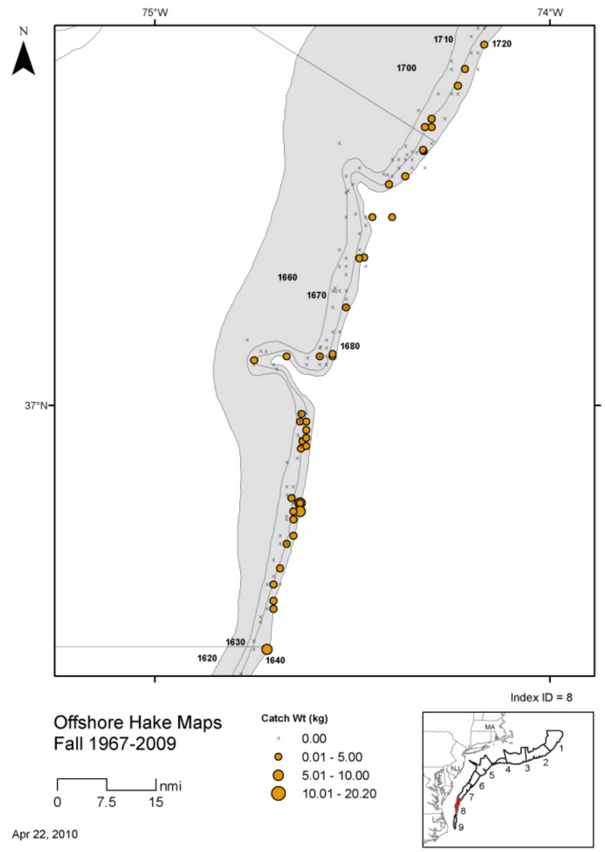


Figure D2e. NEFSC fall survey distribution (catch weight per tow, kg) of offshore hake, 1967-2009, broken up by stratum areas for easier viewing.

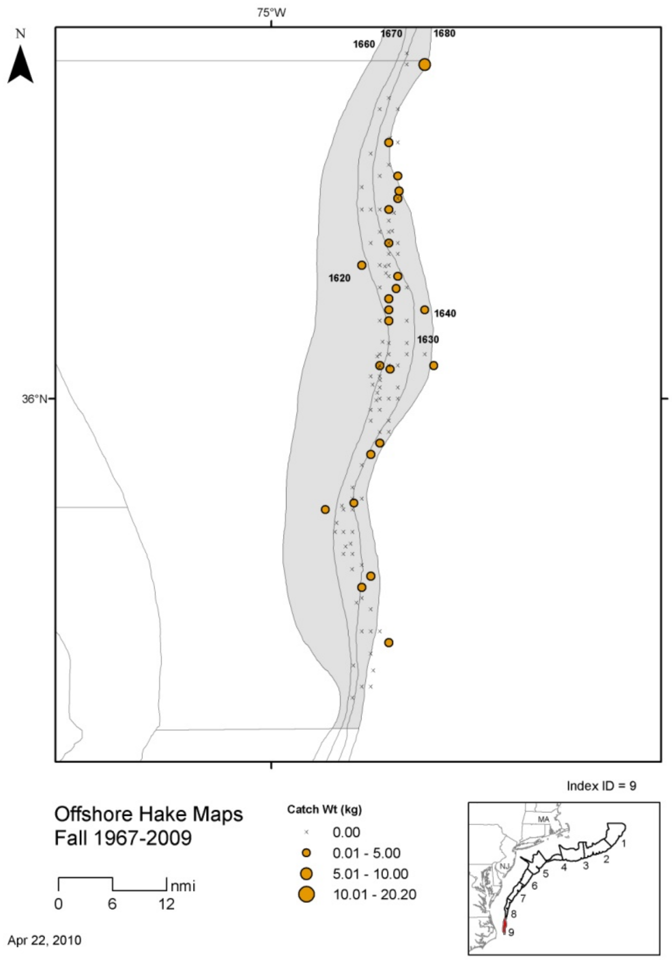


Figure D3. Distribution of offshore hake from the NEFSC spring survey (catch weight per tow, kg), 1968-2009.

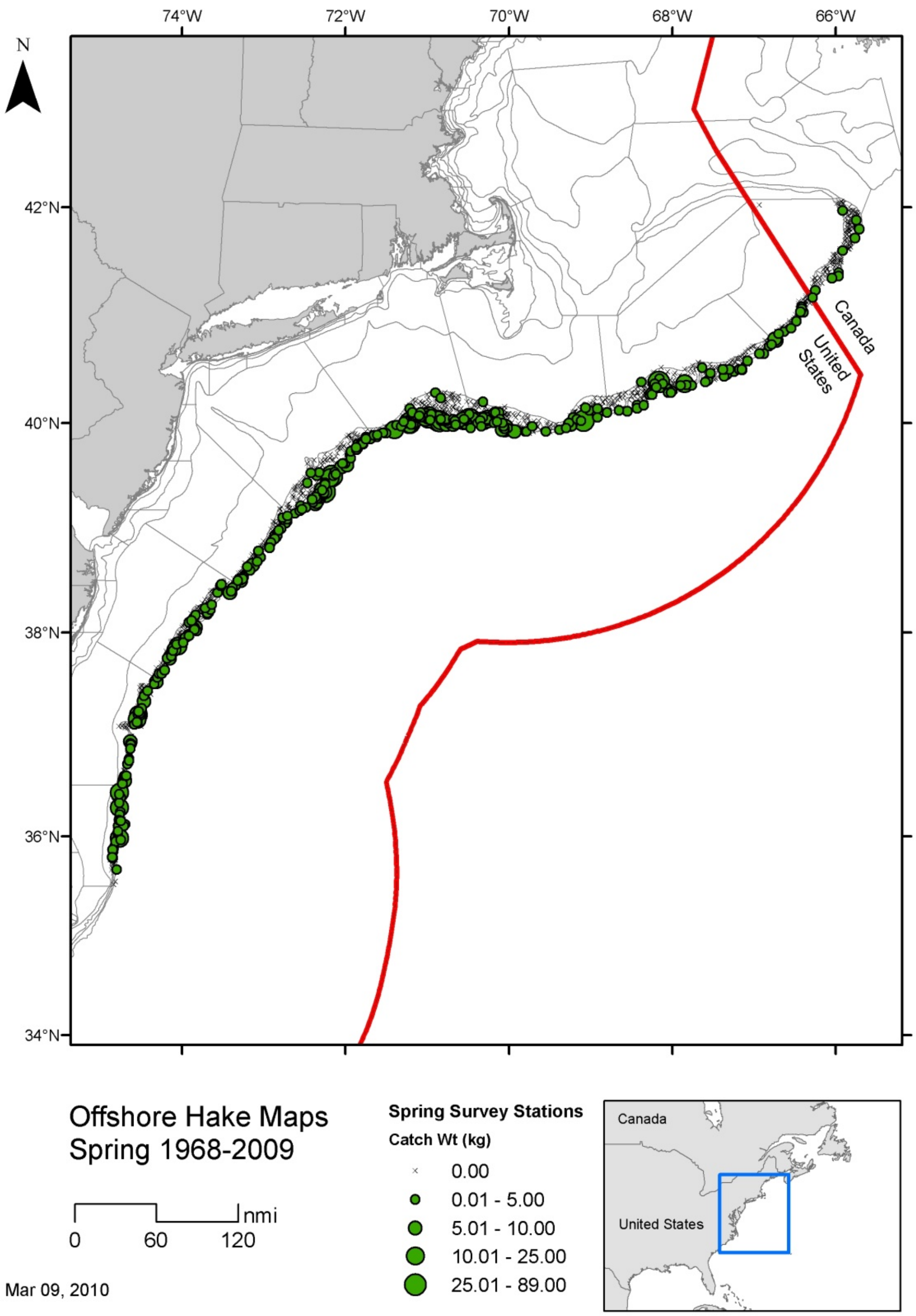
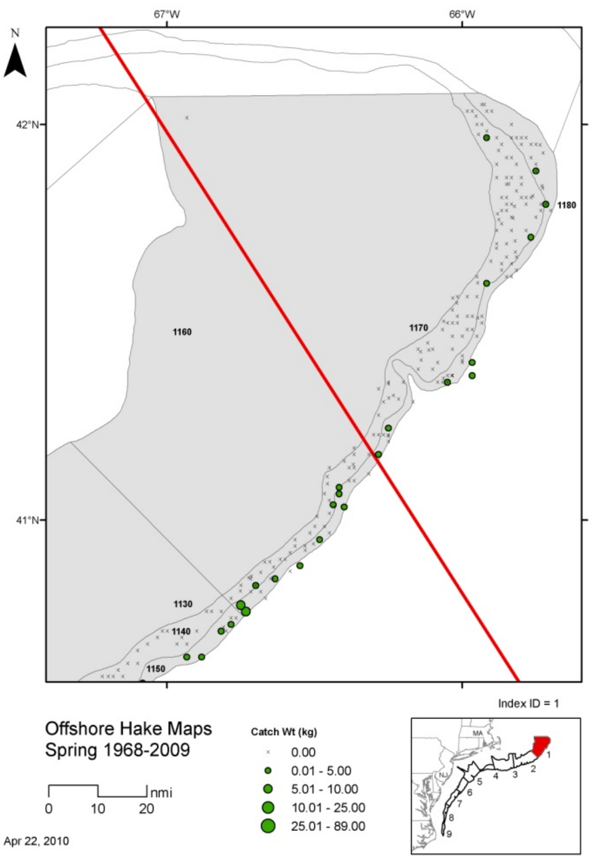


Figure D3a. NEFSC spring survey distribution (catch weight per tow, kg) of offshore hake, 1968-2009, broken up by stratum areas for easier viewing.



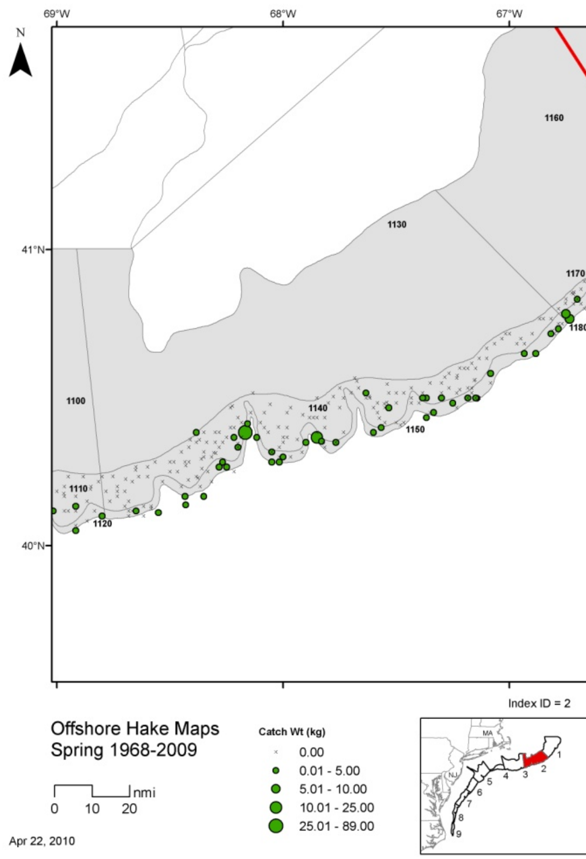
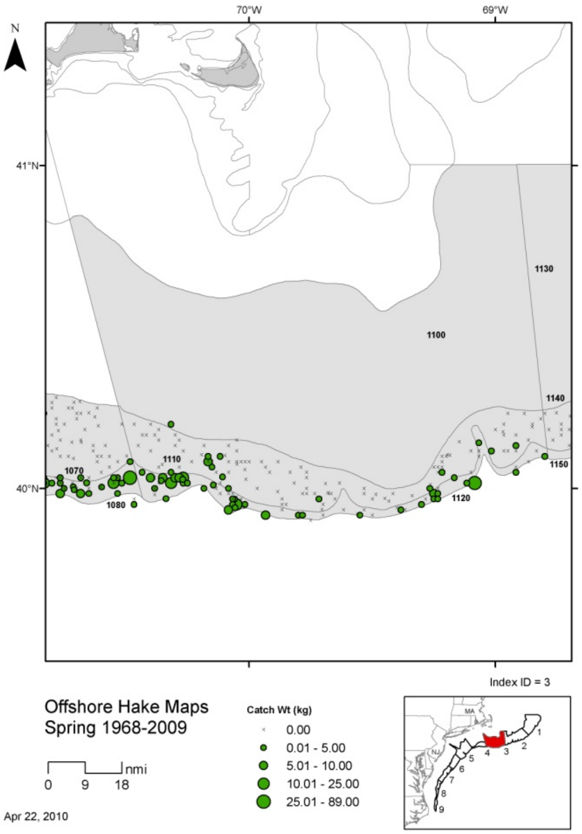


Figure D3b. NEFSC spring survey distribution (catch weight per tow, kg) of offshore hake, 1968-2009, broken up by stratum areas for easier viewing.



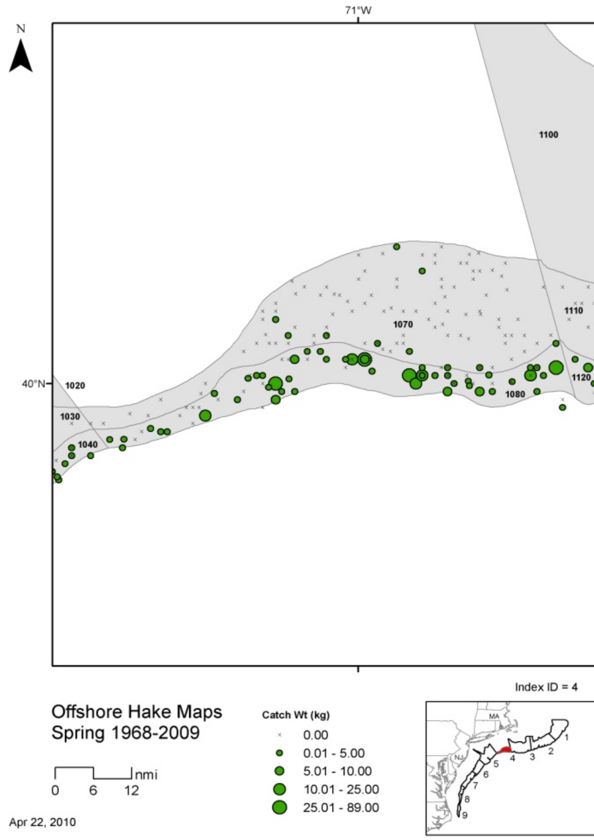
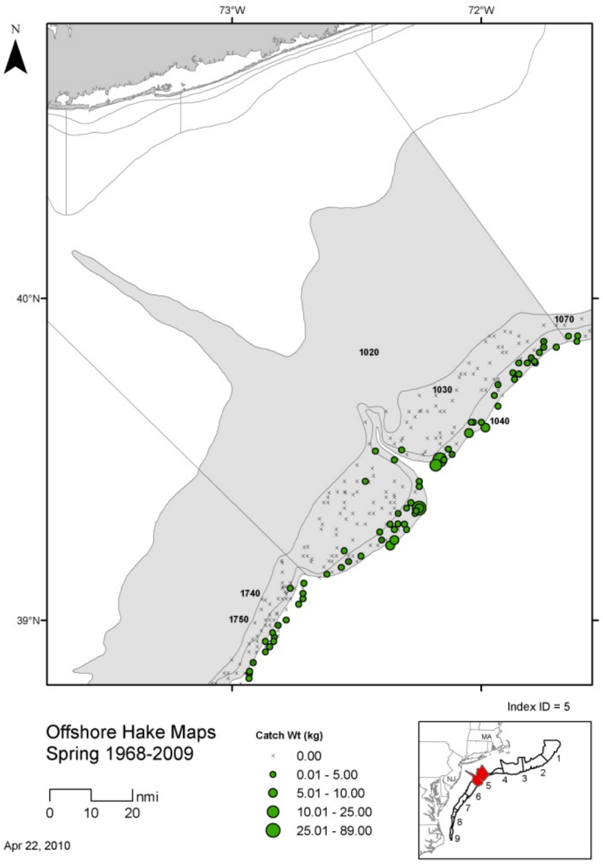


Figure D3c. NEFSC spring survey distribution (catch weight per tow, kg) of offshore hake, 1968-2009, broken up by stratum areas for easier viewing.



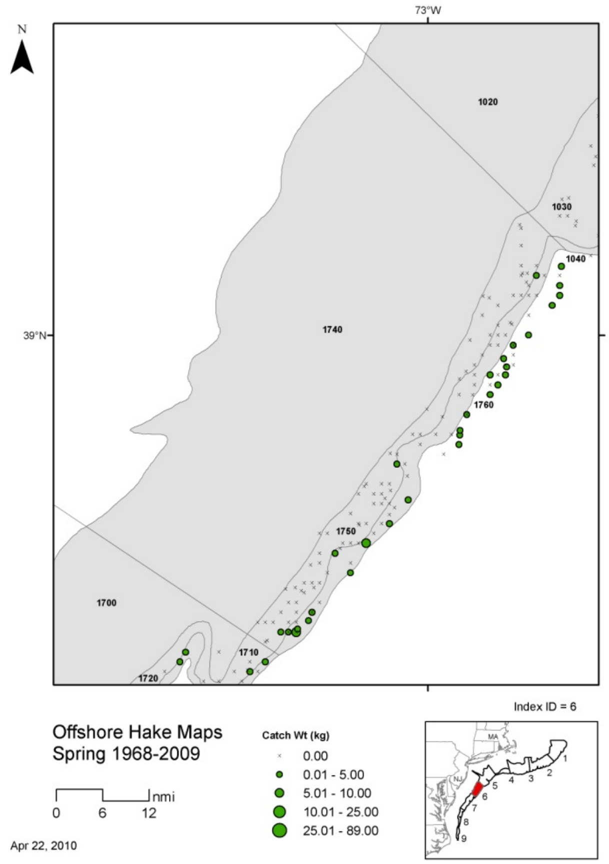


Figure D3d. NEFSC spring survey distribution (catch weight per tow, kg) of offshore hake, 1968-2009, broken up by stratum areas for easier viewing.

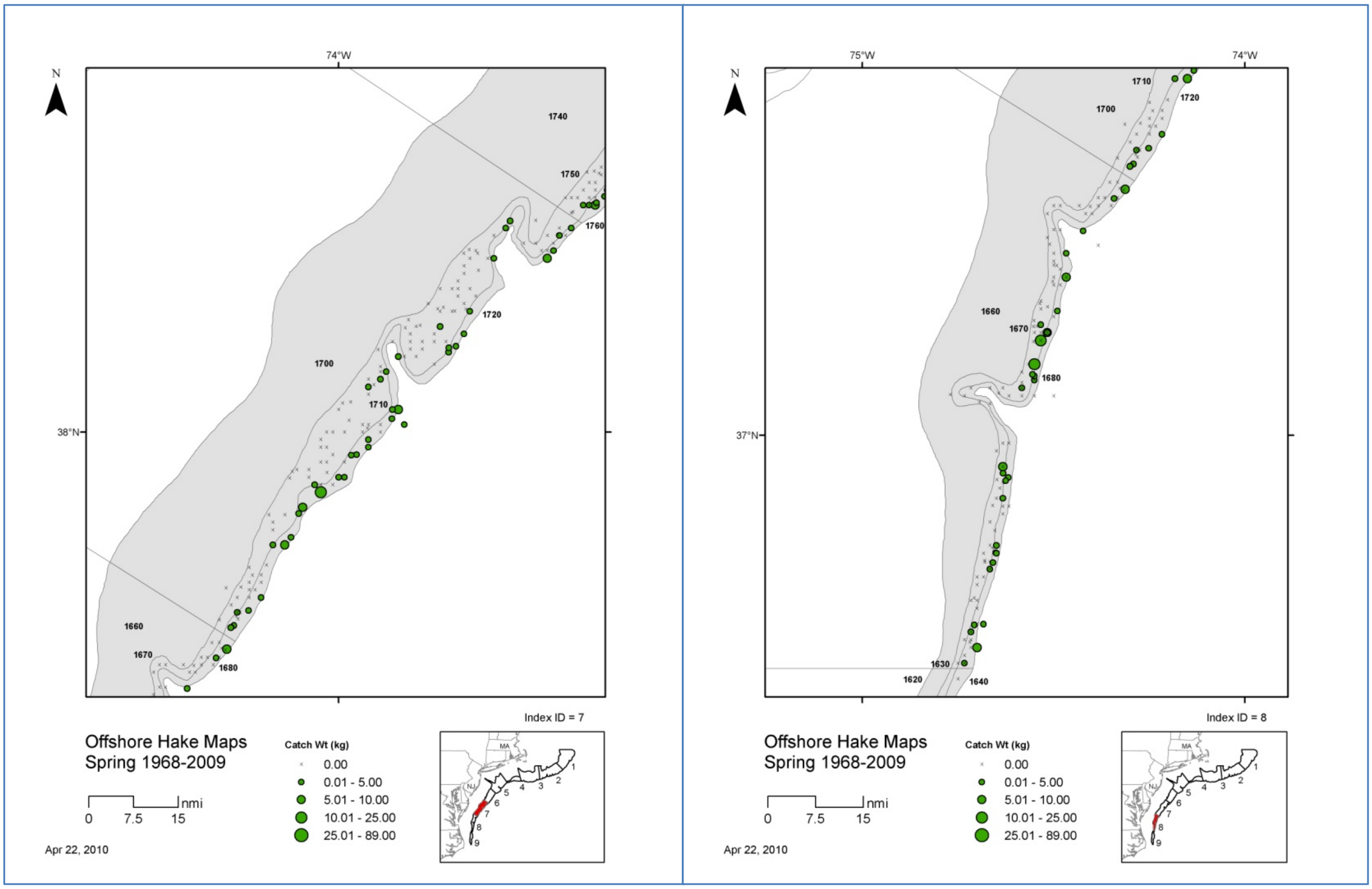


Figure D3e. NEFSC spring survey distribution (catch weight per tow, kg) of offshore hake, 1968-2009, broken up by stratum areas for easier viewing.

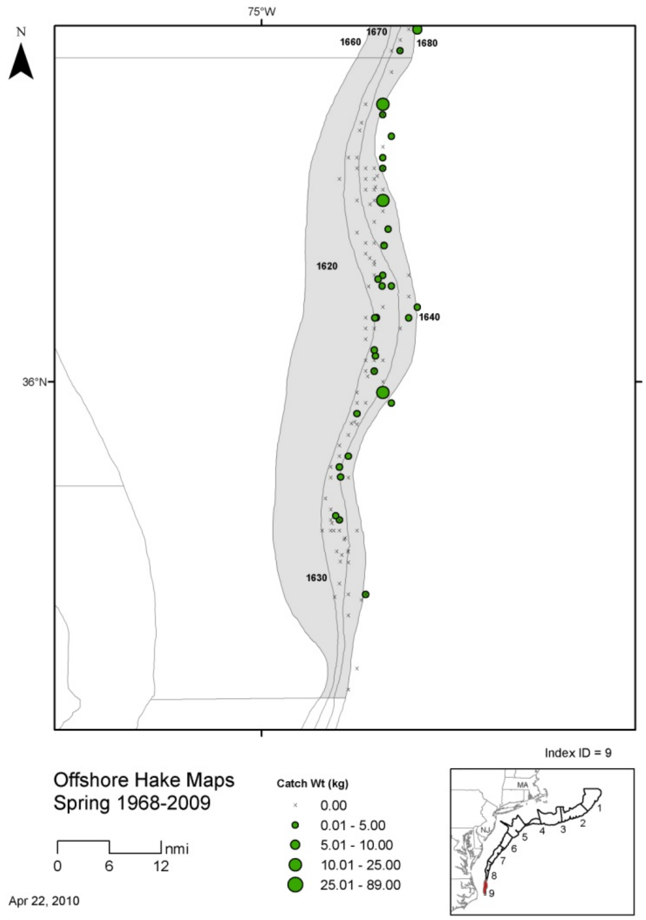


Figure D4. Distribution of offshore hake from the NEFSC winter survey (catch weight per tow, kg), 1998-2007.

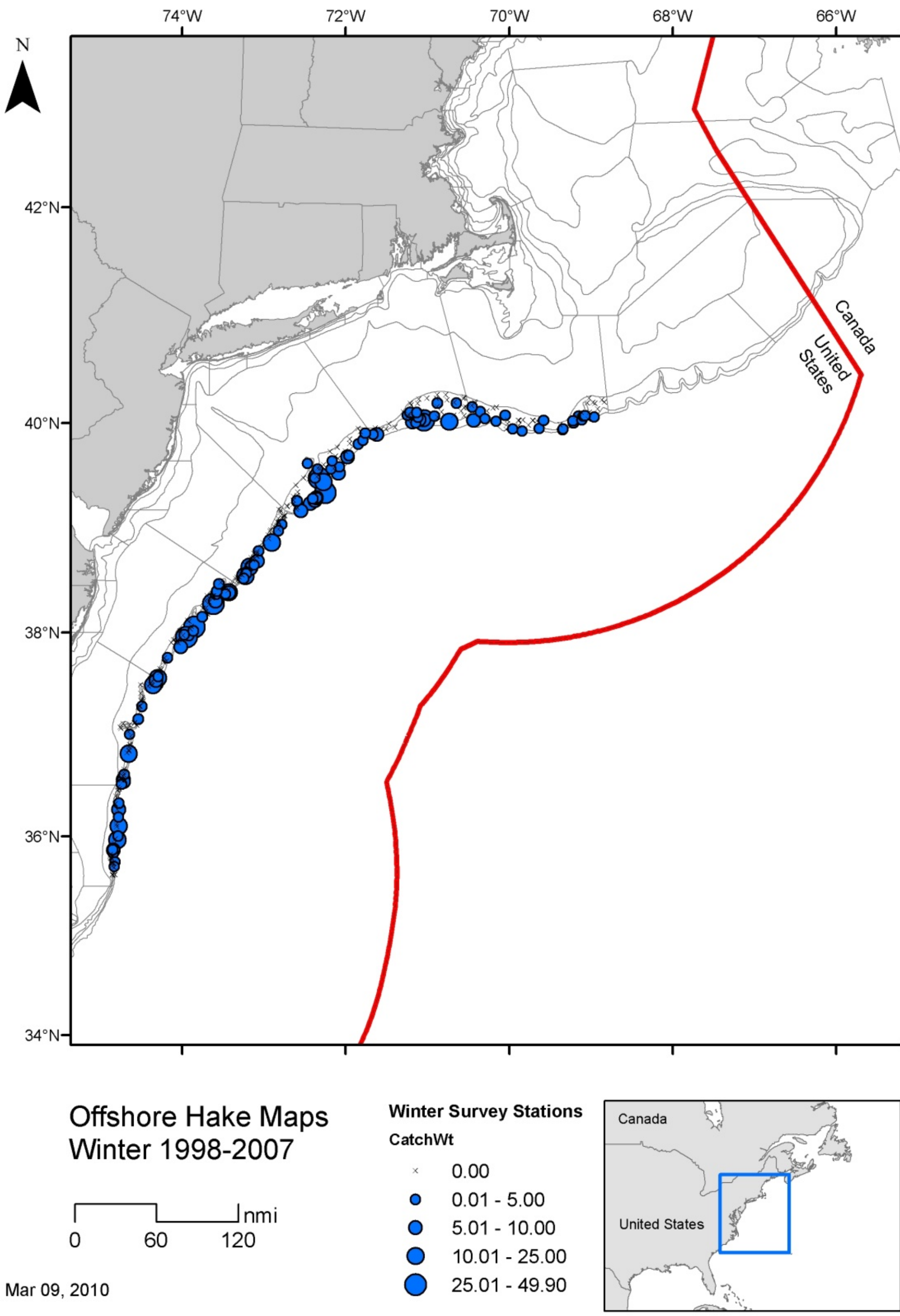
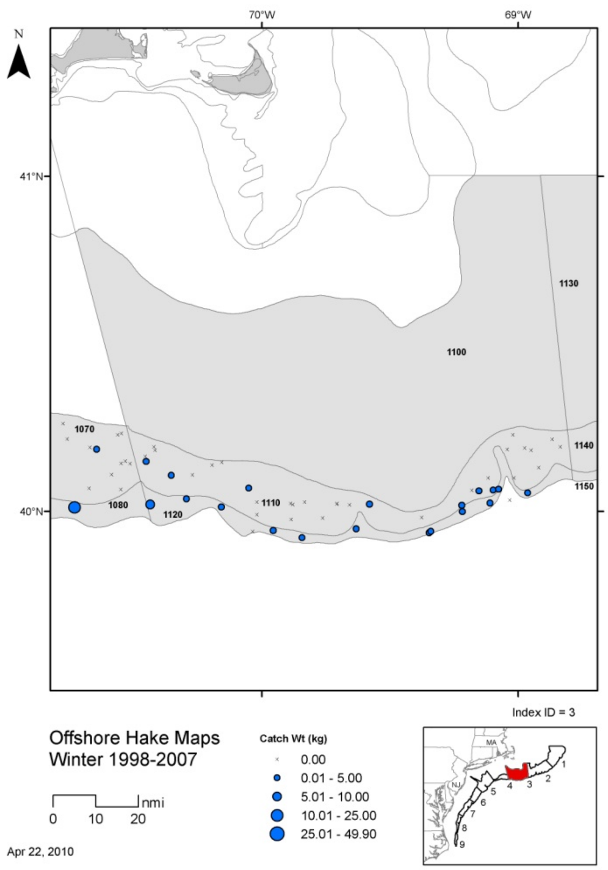


Figure D4a. NEFSC winter survey distribution (catch weight per tow, kg) of offshore hake, 1998-2007, broken up by stratum areas for easier viewing.



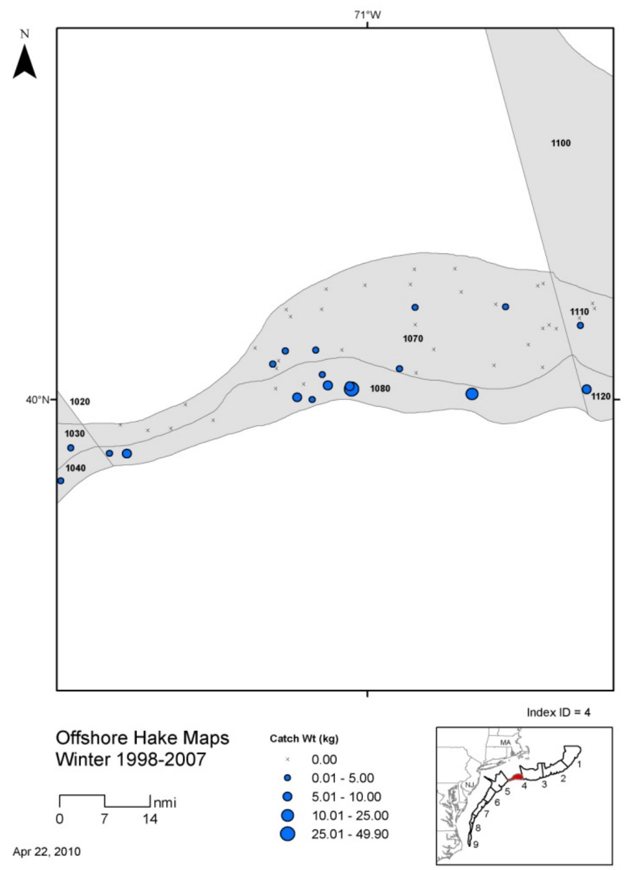
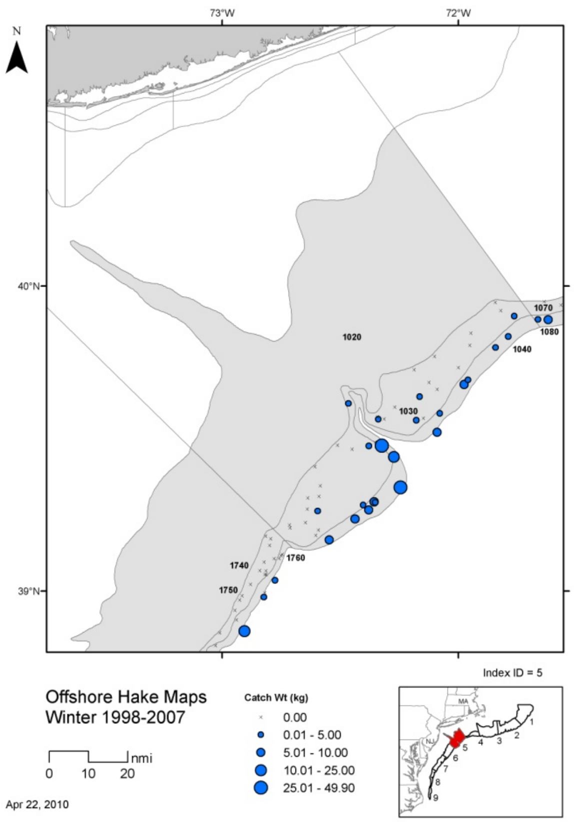


Figure D4b. NEFSC winter survey distribution (catch weight per tow, kg) of offshore hake, 1998-2007, broken up by stratum areas for easier viewing.



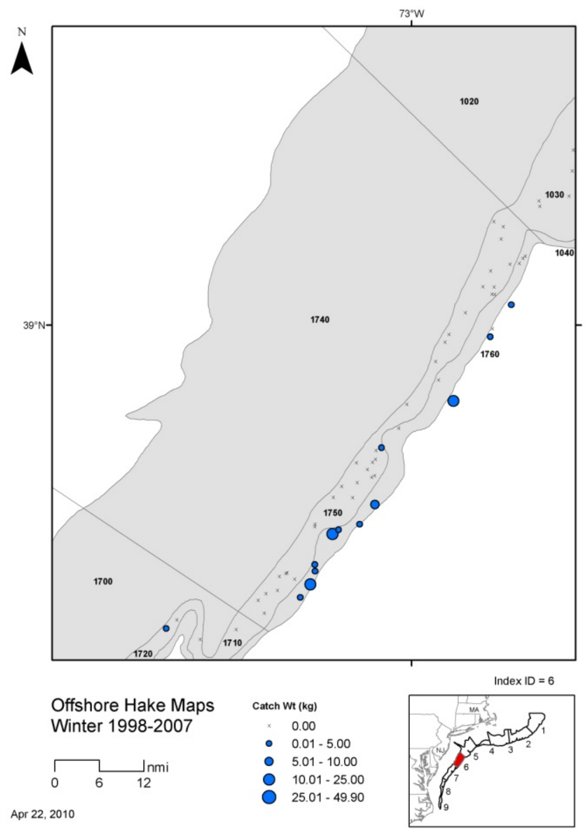


Figure D4c. NEFSC winter survey distribution (catch weight per tow, kg) of offshore hake, 1998-2007, broken up by stratum areas for easier viewing.

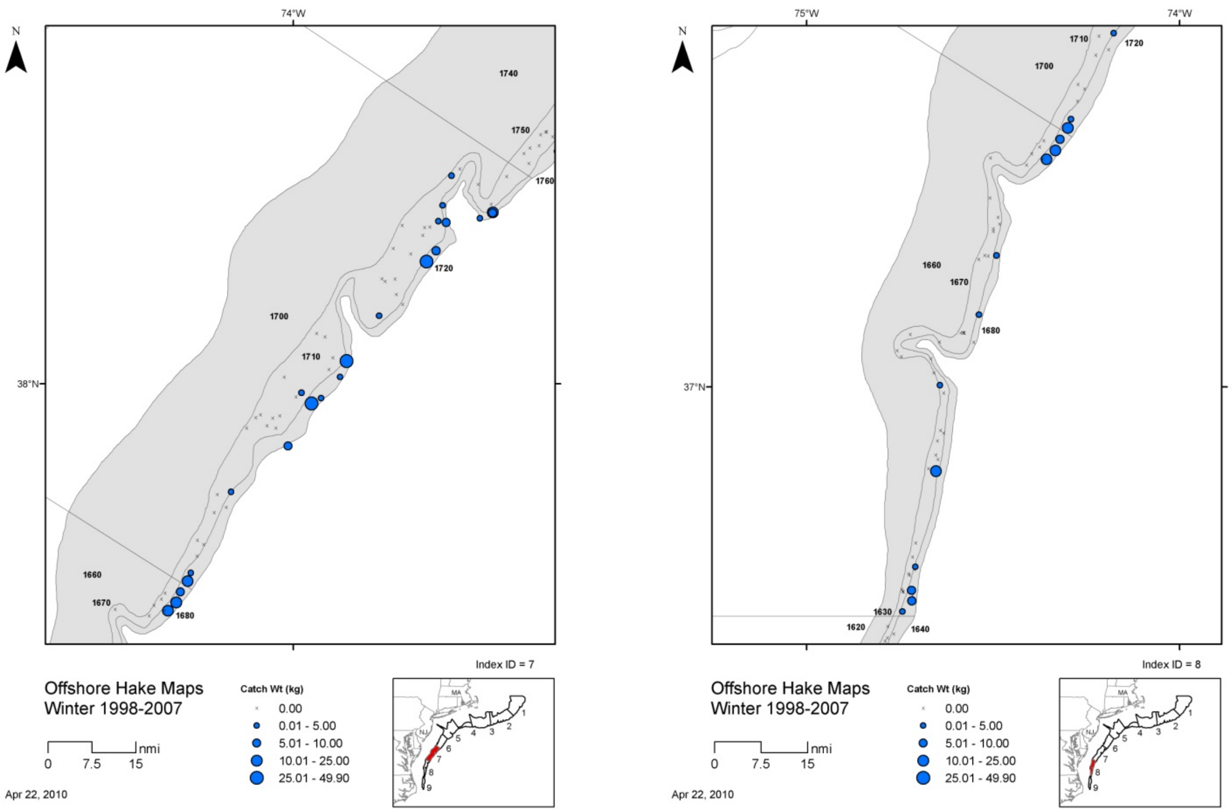
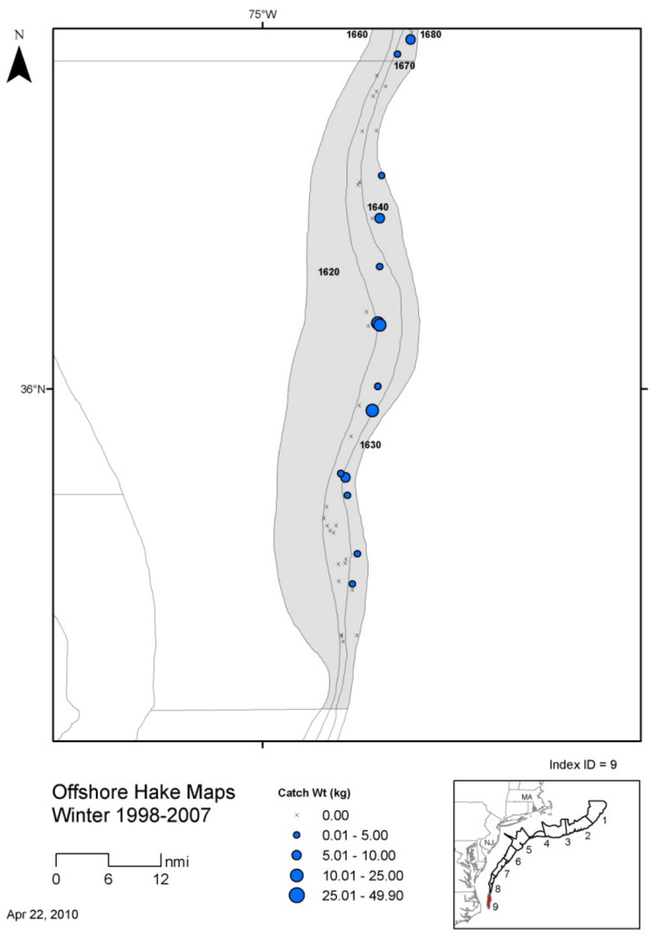


Figure D4d. NEFSC winter survey distribution (catch weight per tow, kg) of offshore hake, 1998-2007, broken up by stratum areas for easier viewing.



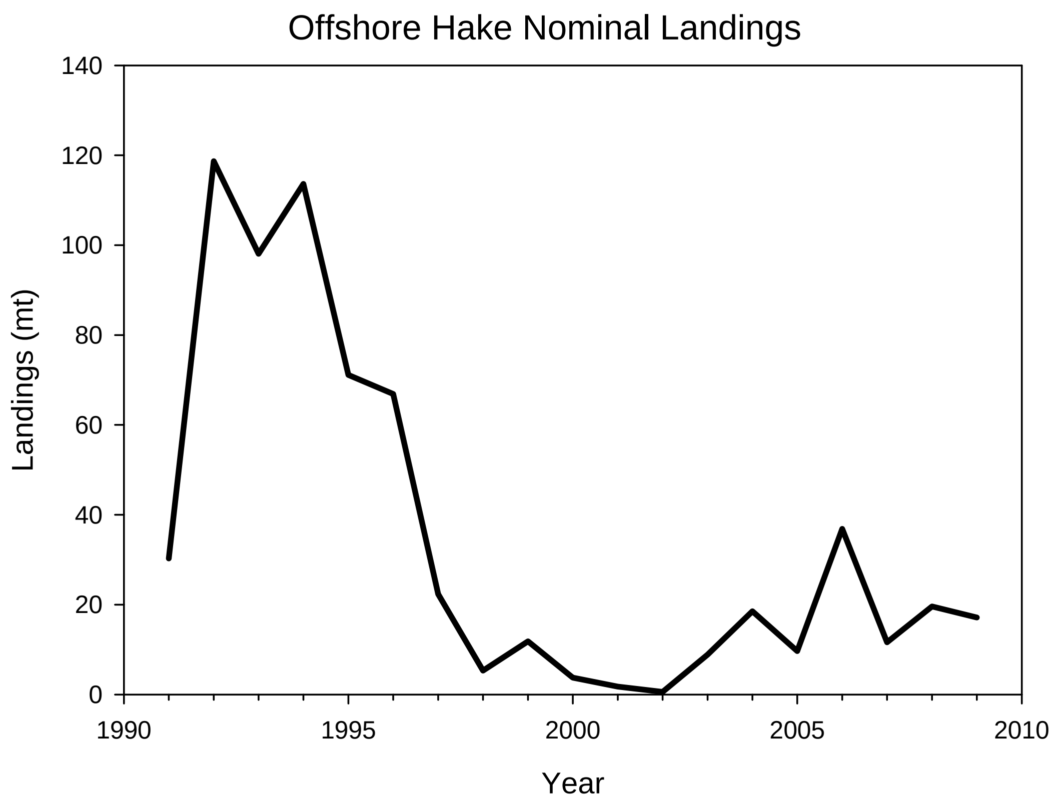


Figure D5. Nominal landings (mt) of offshore hake.

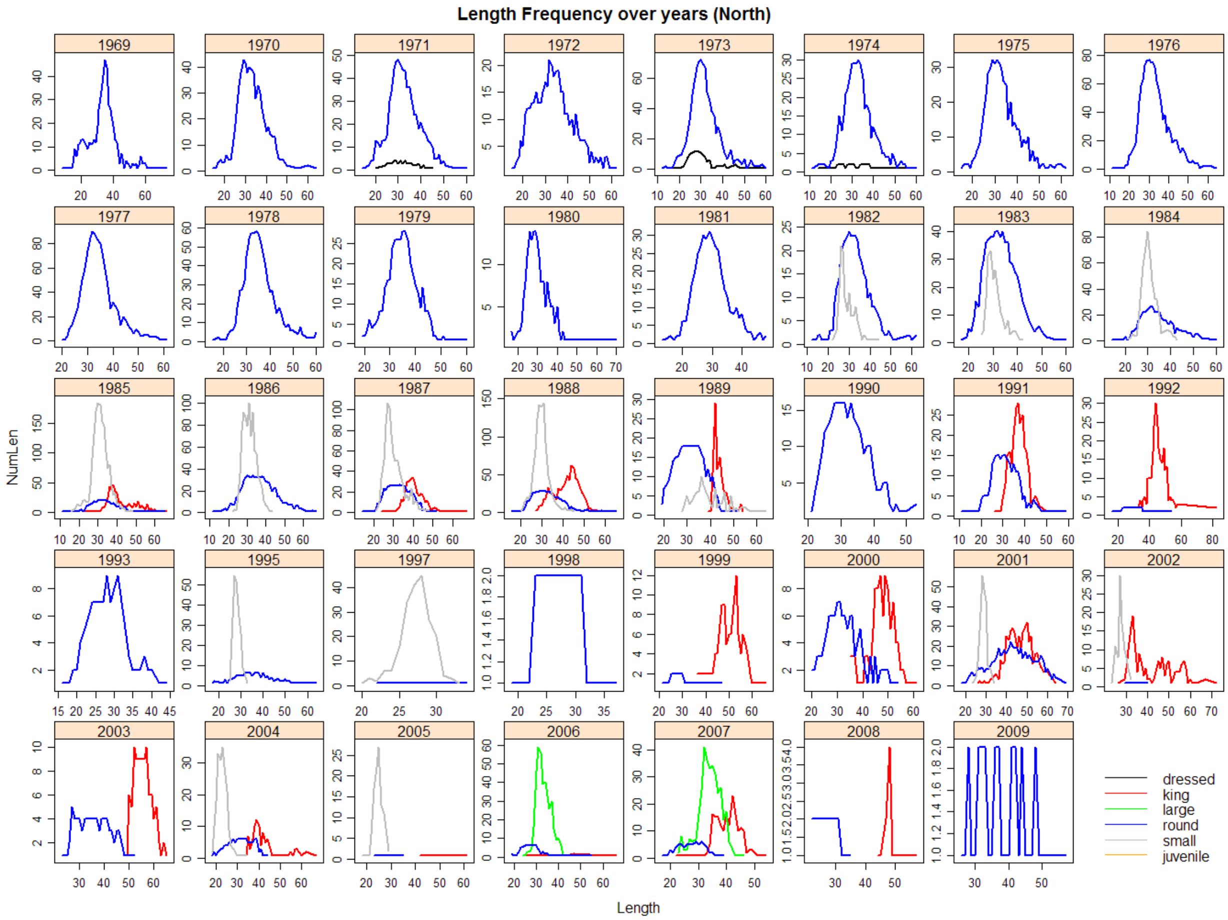


Figure D6. Length frequencies for silver hake for the northern region, before pooling, by all market categories.

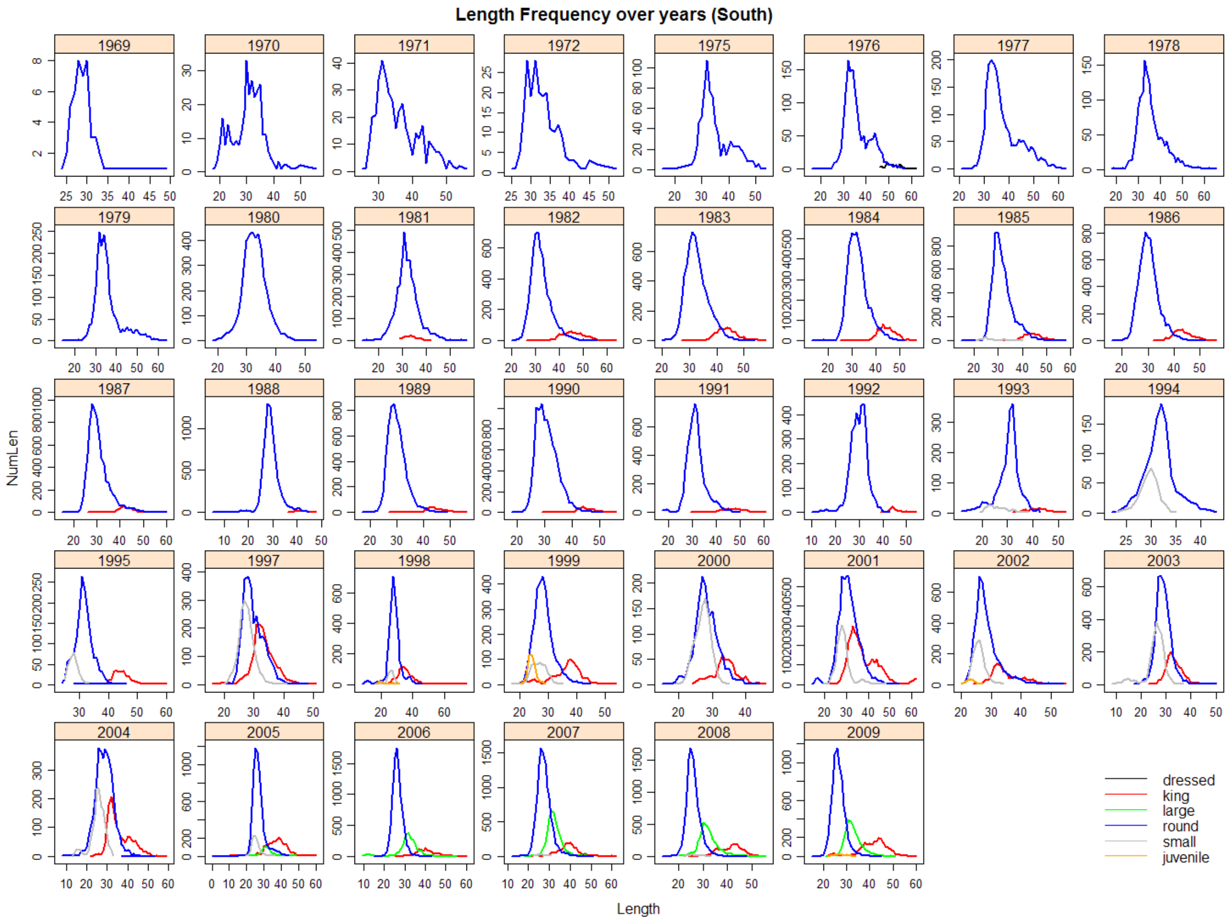


Figure D7. Length frequencies for silver hake for the southern region, before pooling, by all market categories.

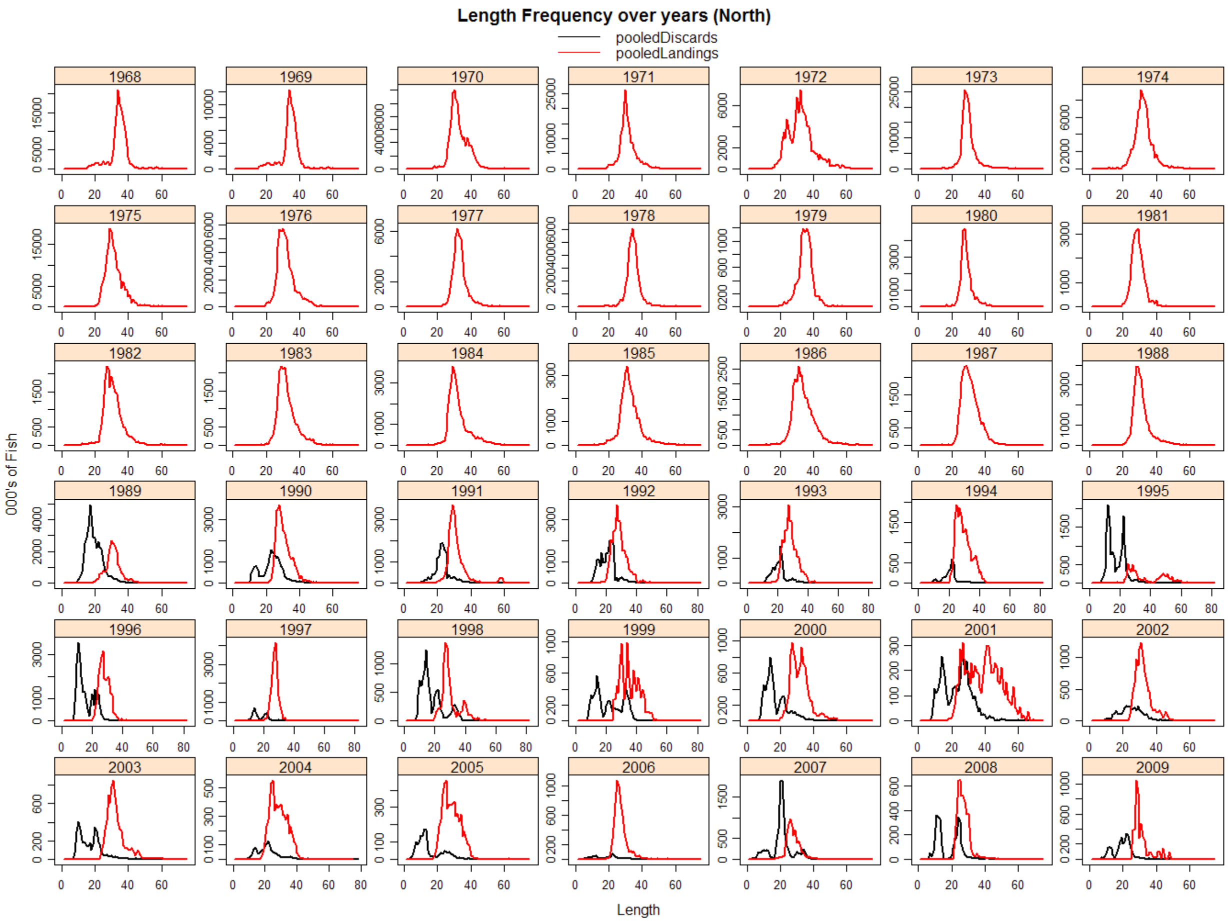


Figure D8. Length frequencies for silver hake for the northern region, landings and discards.

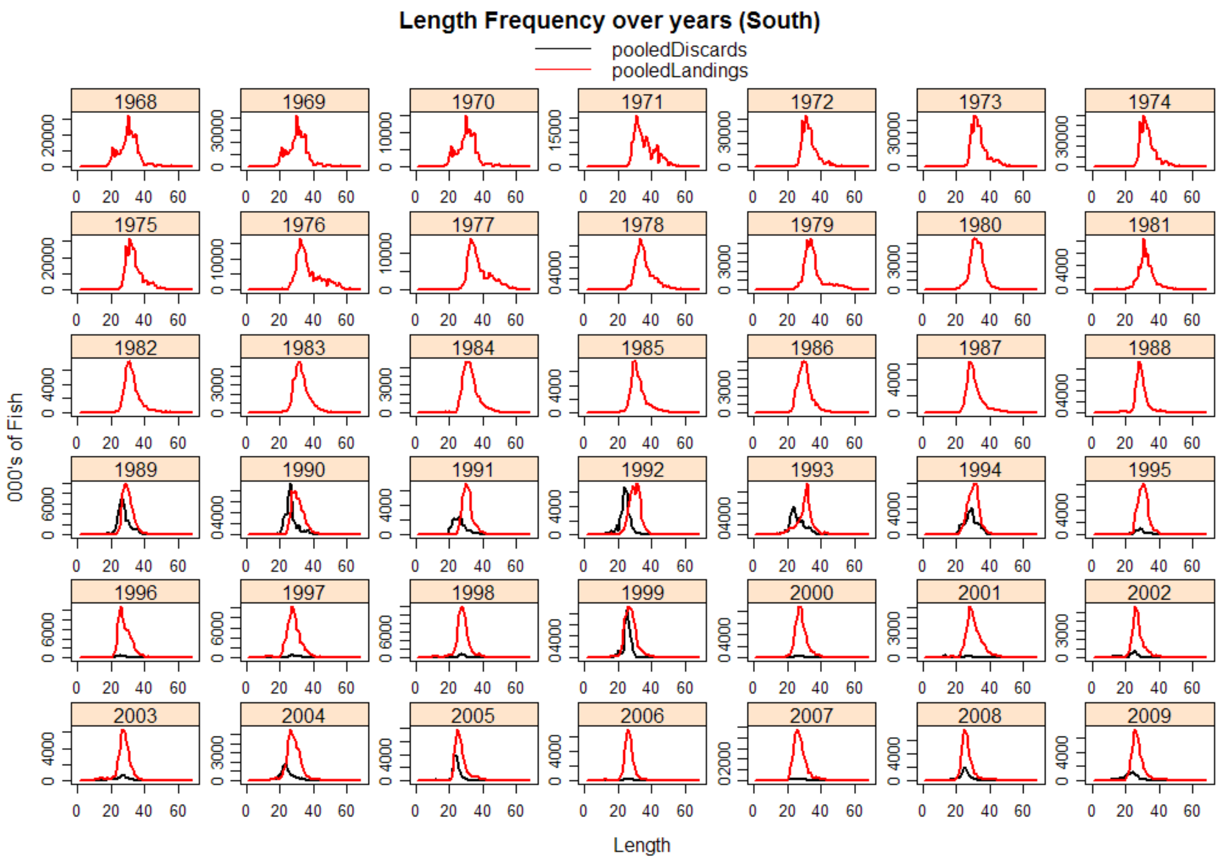


Figure D9. Length frequencies for silver hake for the southern region, landings and discards.

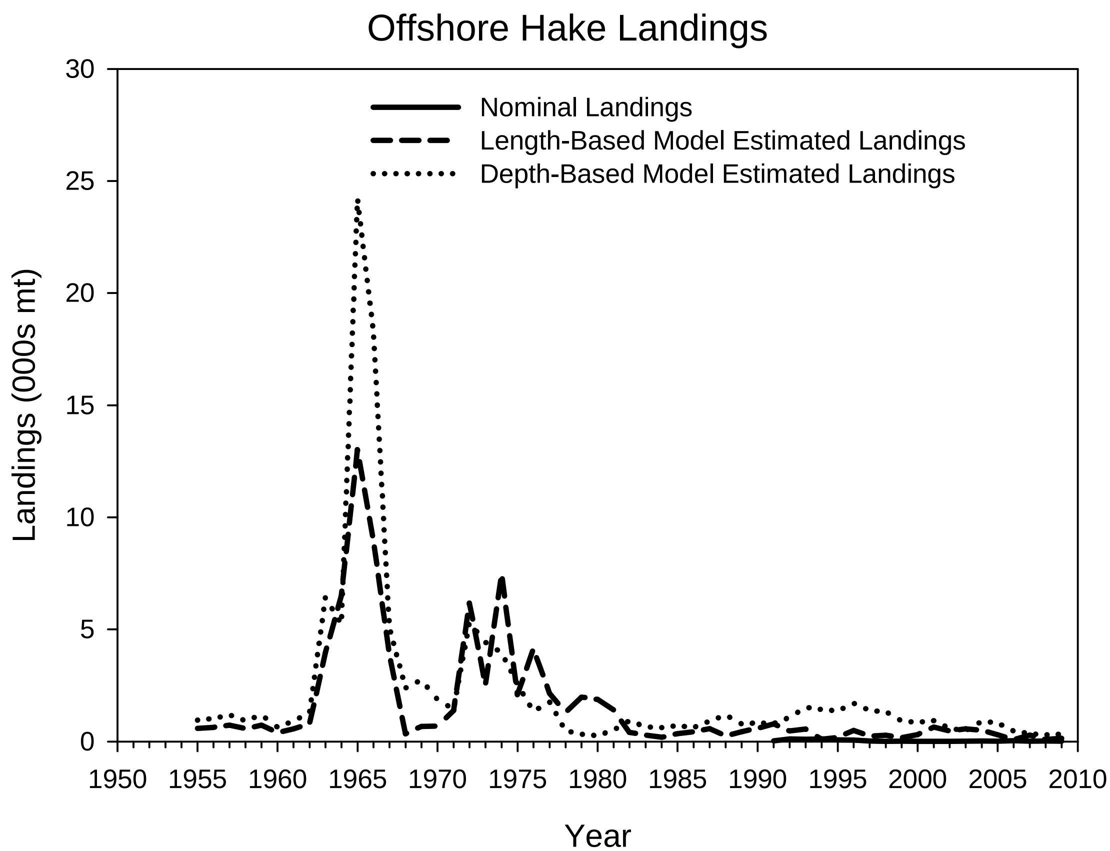
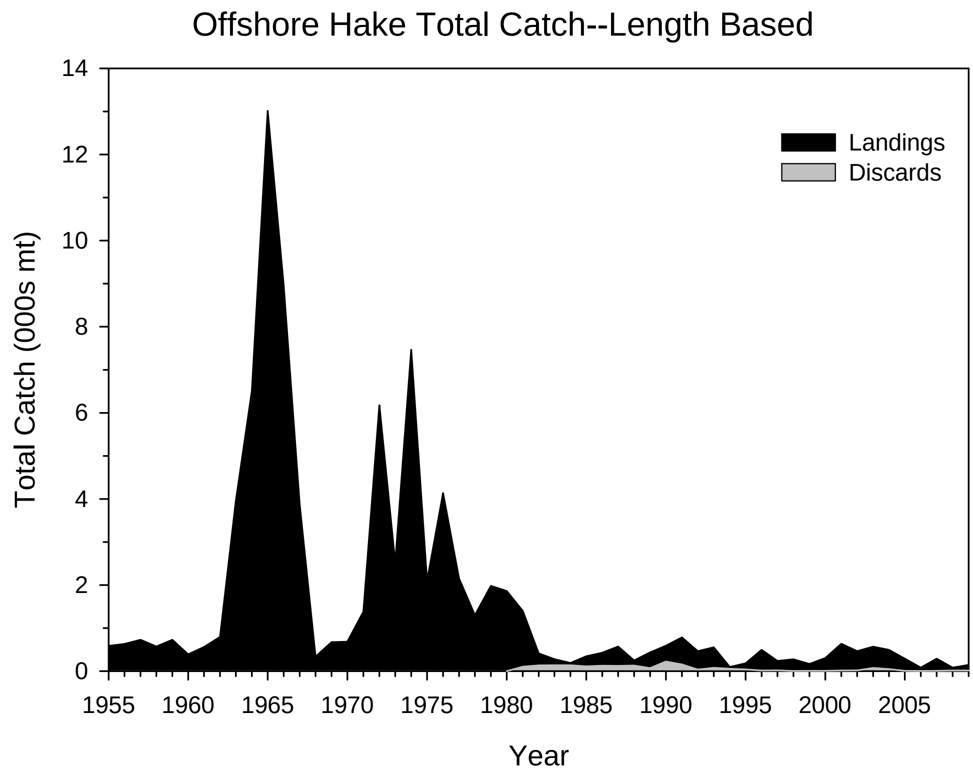


Figure D10. Comparison of nominal landings with the two model-based estimates for offshore hake from the southern stock.

Figure D11. Length-based total catch landings and discards for offshore hake, 1955-2009.



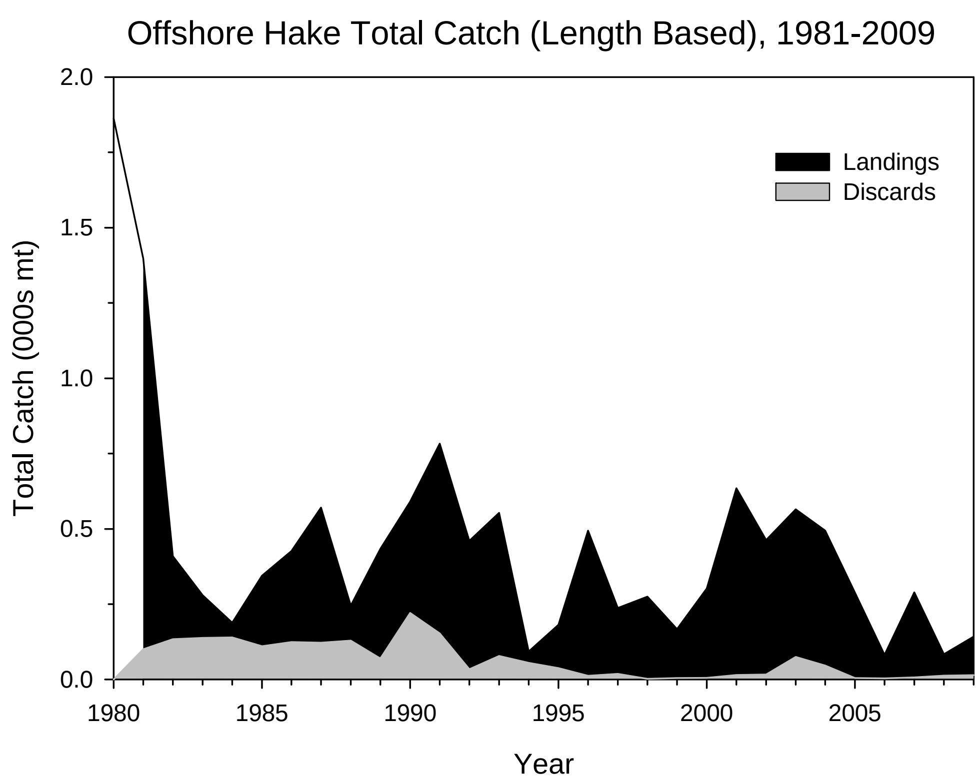
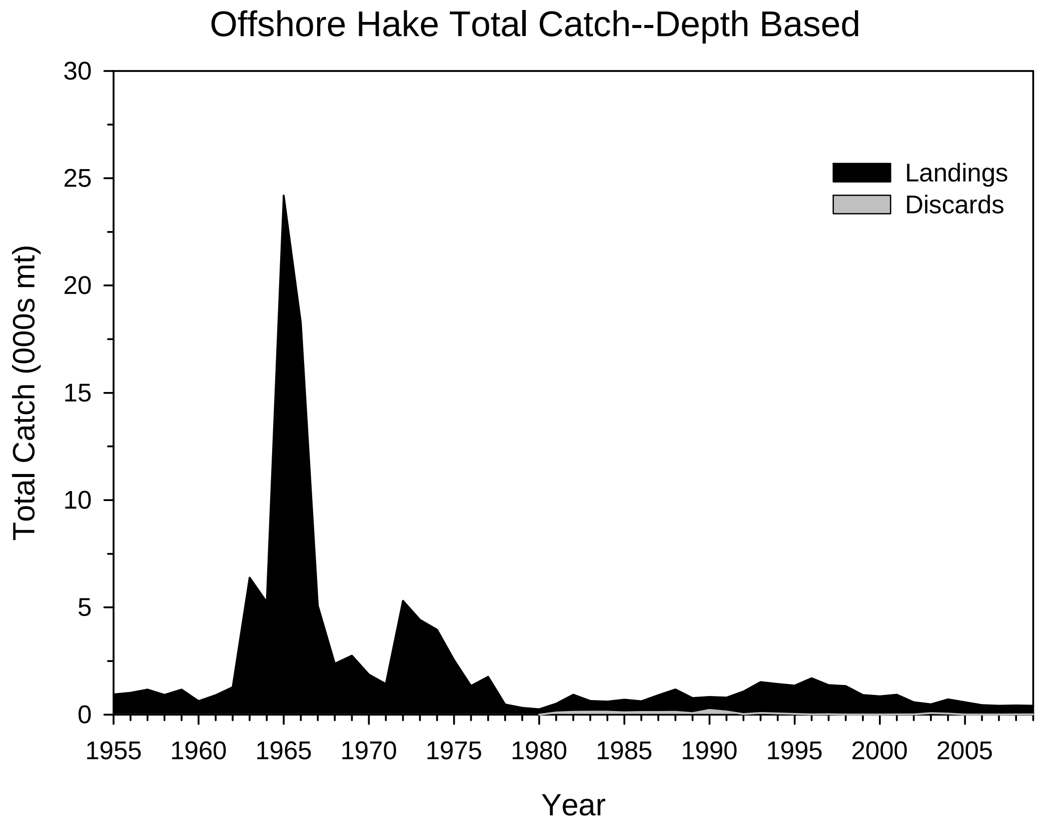


Figure D12. Depth-based total catch landings and discards for offshore hake, 1955-2009.



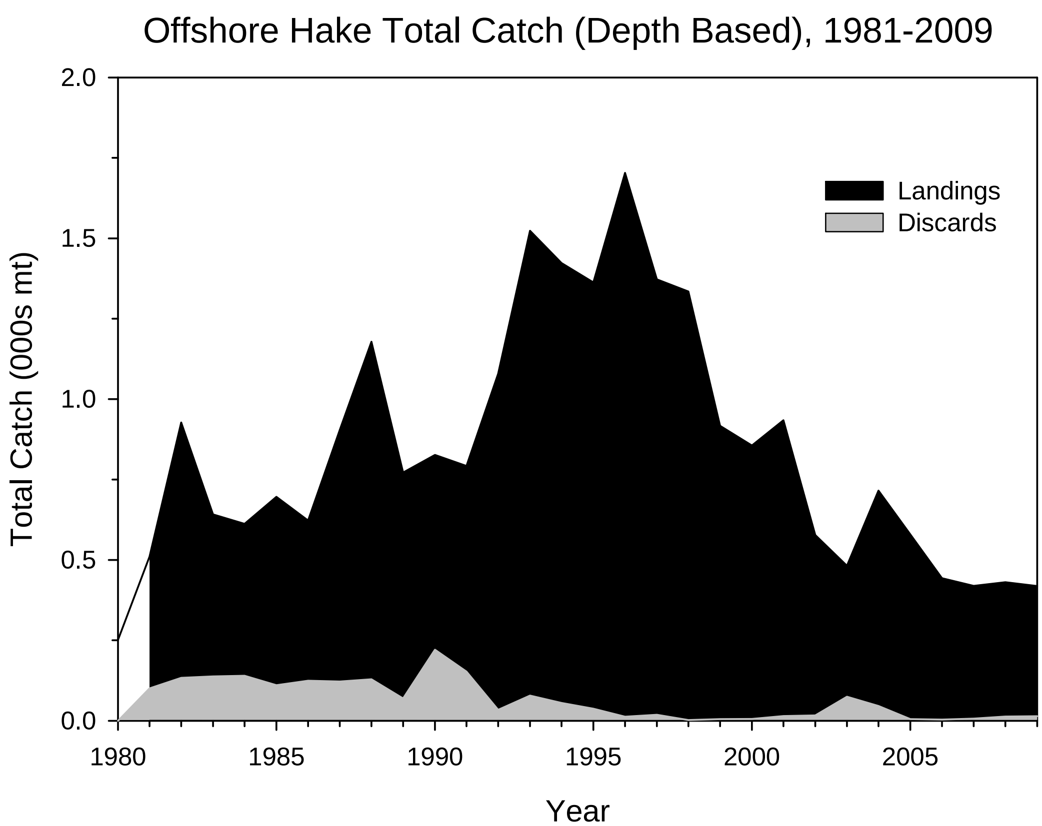


Figure D13.Comparison of the arithmetic and delta transformed mean weight per tow from the fall survey.

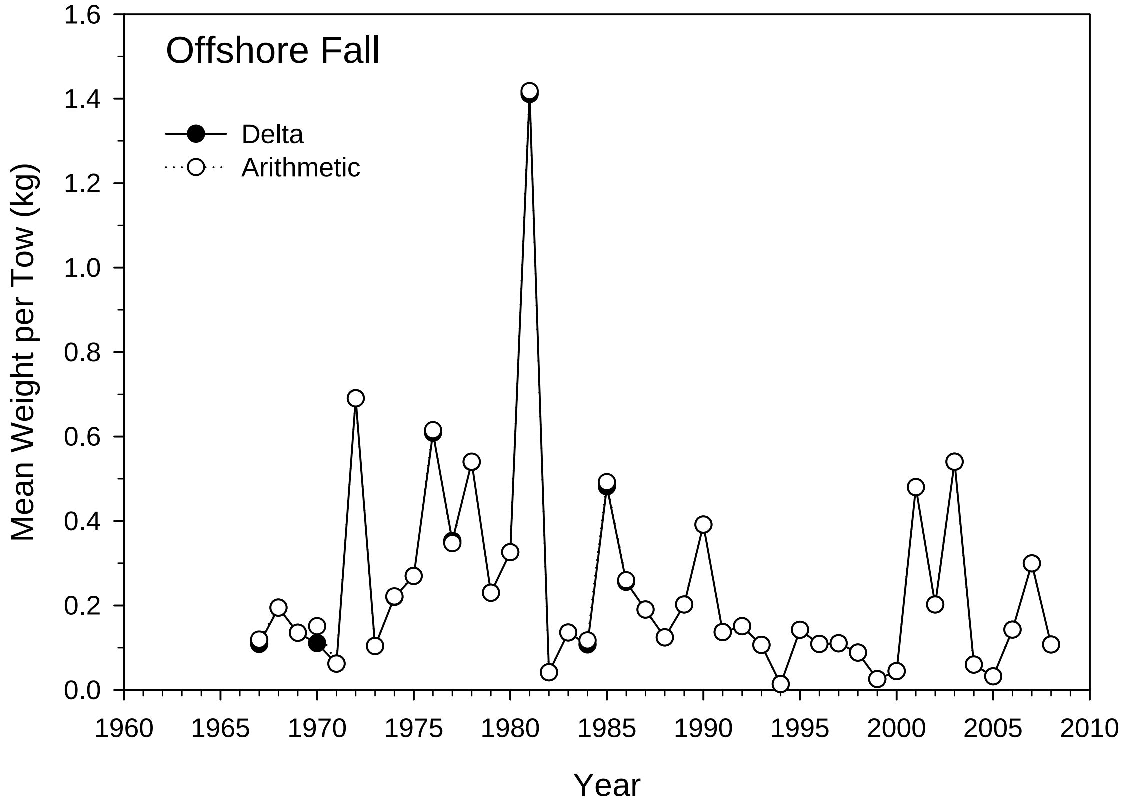
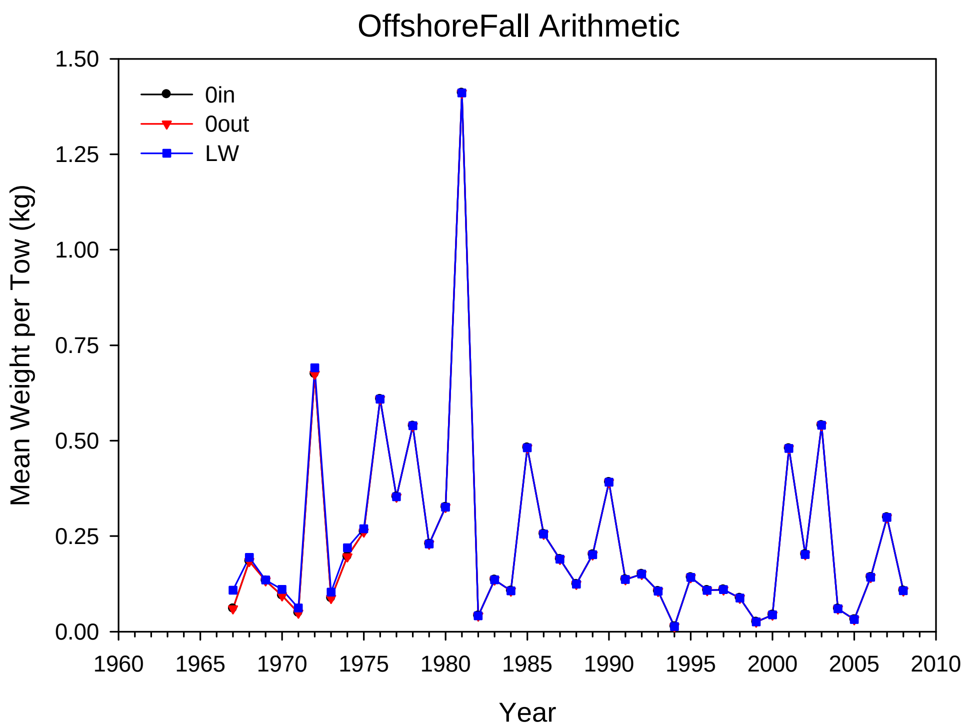
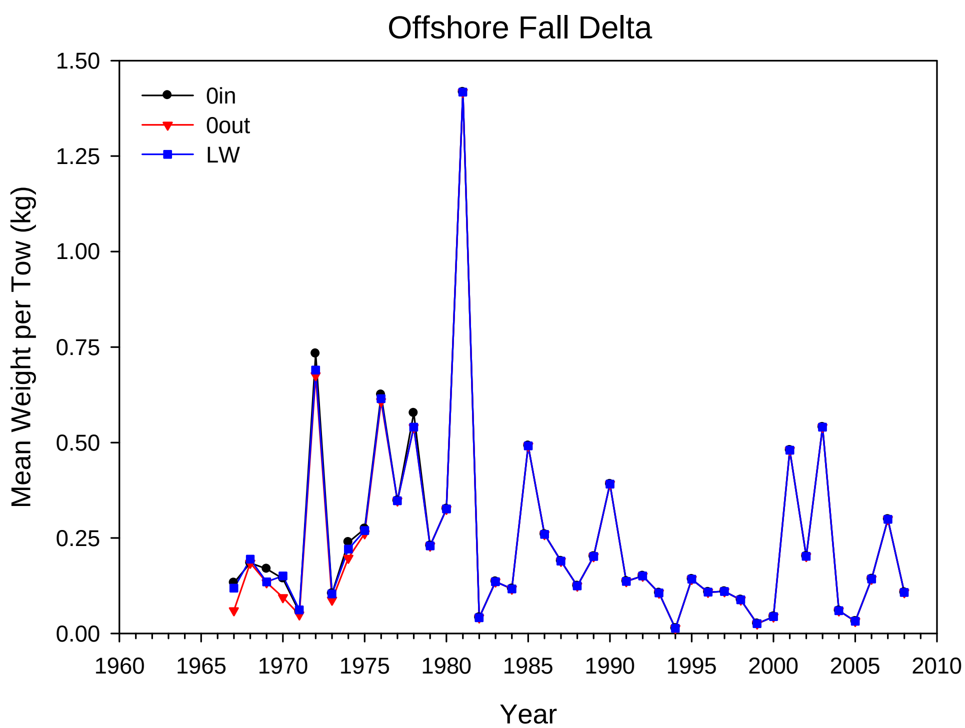


Figure D14. Comparison of the arithmetic and delta transformed mean weight per tow from the fall survey with three methods of handling missing weight data.





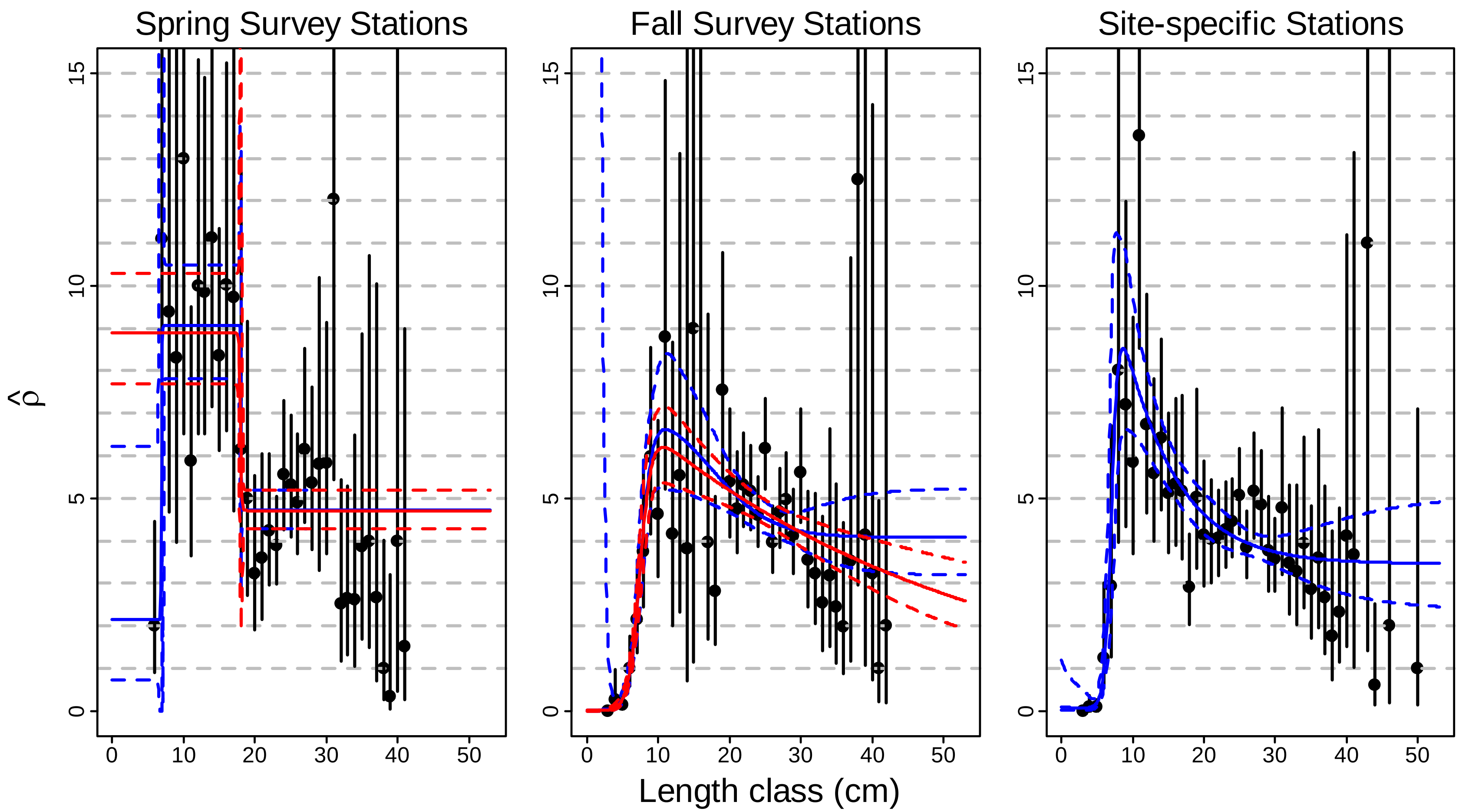


Figure D15. Beta-binomial based estimates of calibration factors and corresponding 95% confidence intervals by length class (1 cm bins) for **silver hake**. The black points and vertical bars represent results where different calibration factors are estimated for each length class. The blue lines represent results from fully parameterized double-logistic models. For the spring, the red lines represent results for a (single) logistic model whereas they represent results for a double logistic model with no minima for the ascending or descending logistic function for the fall.

Figure D16. Stratified mean number (top) and weight (kg) per tow of offshore hake for the NEFSC fall surveys, 1967-2009.

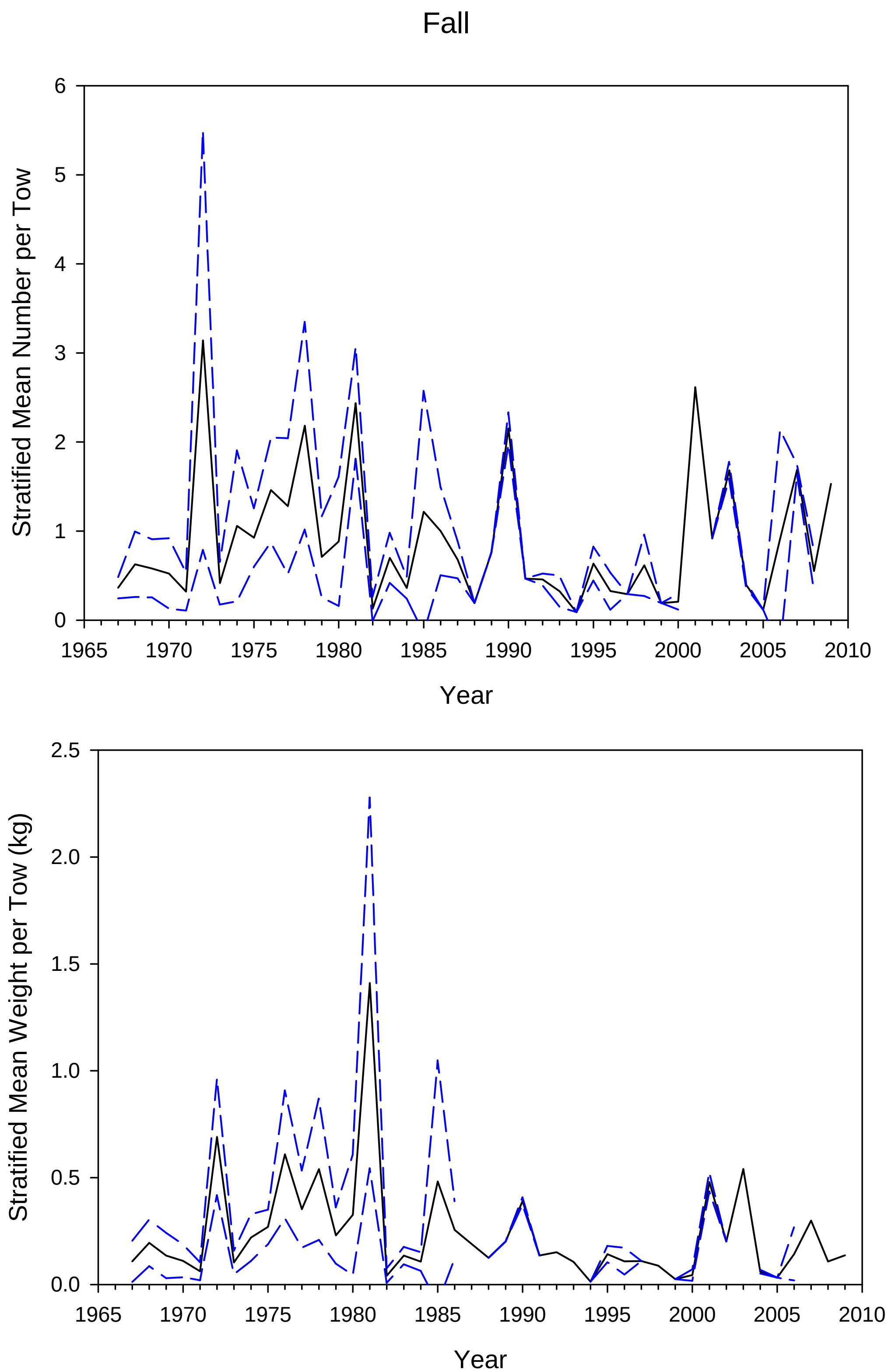


Figure D17. Swept area abundance (millions, top) and biomass (kg, bottom) of offshore hake for the NEFSC fall surveys, 1967-2009.

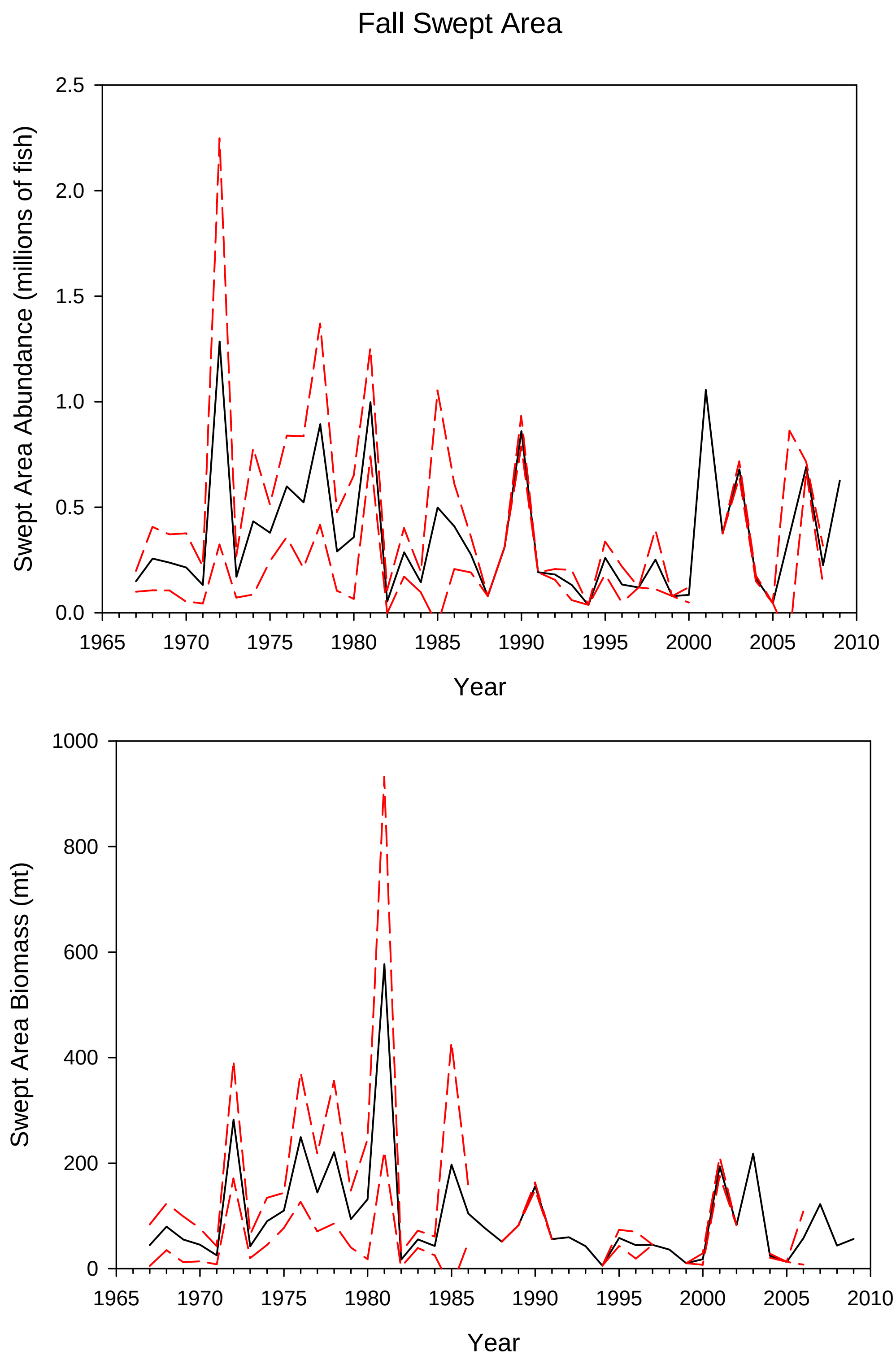
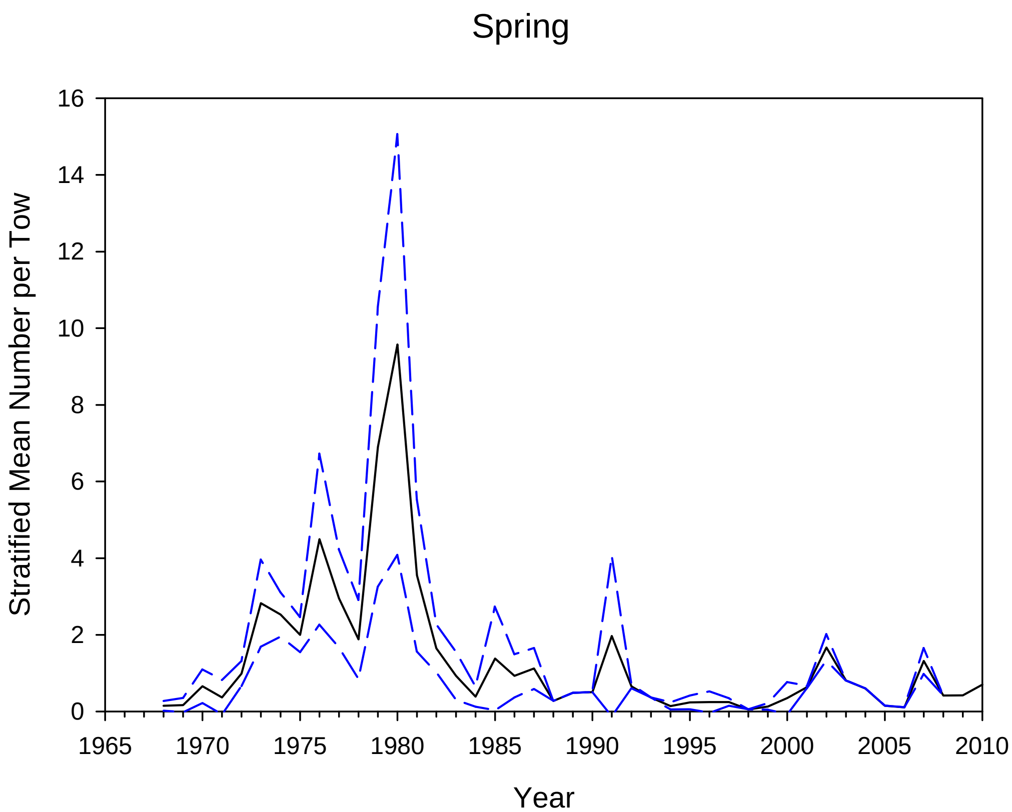


Figure D18. Stratified mean number (top) and weight (kg) per tow of offshore hake for the NEFSC spring surveys, 1968-2010.



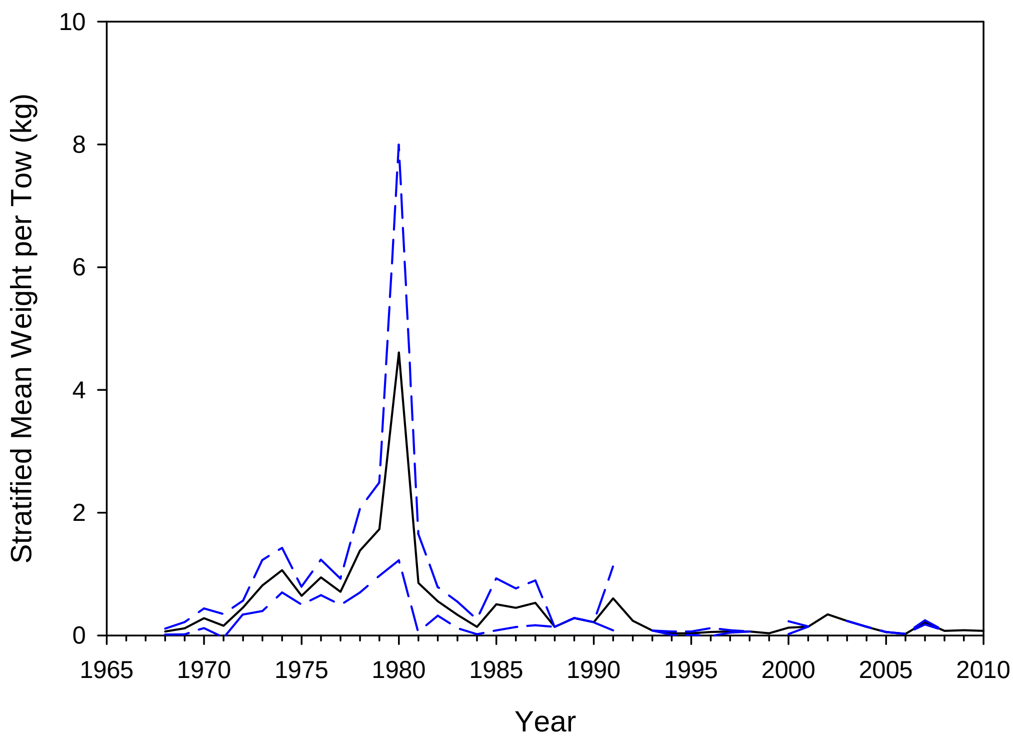


Figure D19. Swept area abundance (millions, top) and biomass (kg, bottom) of offshore hake for the NEFSC spring surveys, 1968-2010.

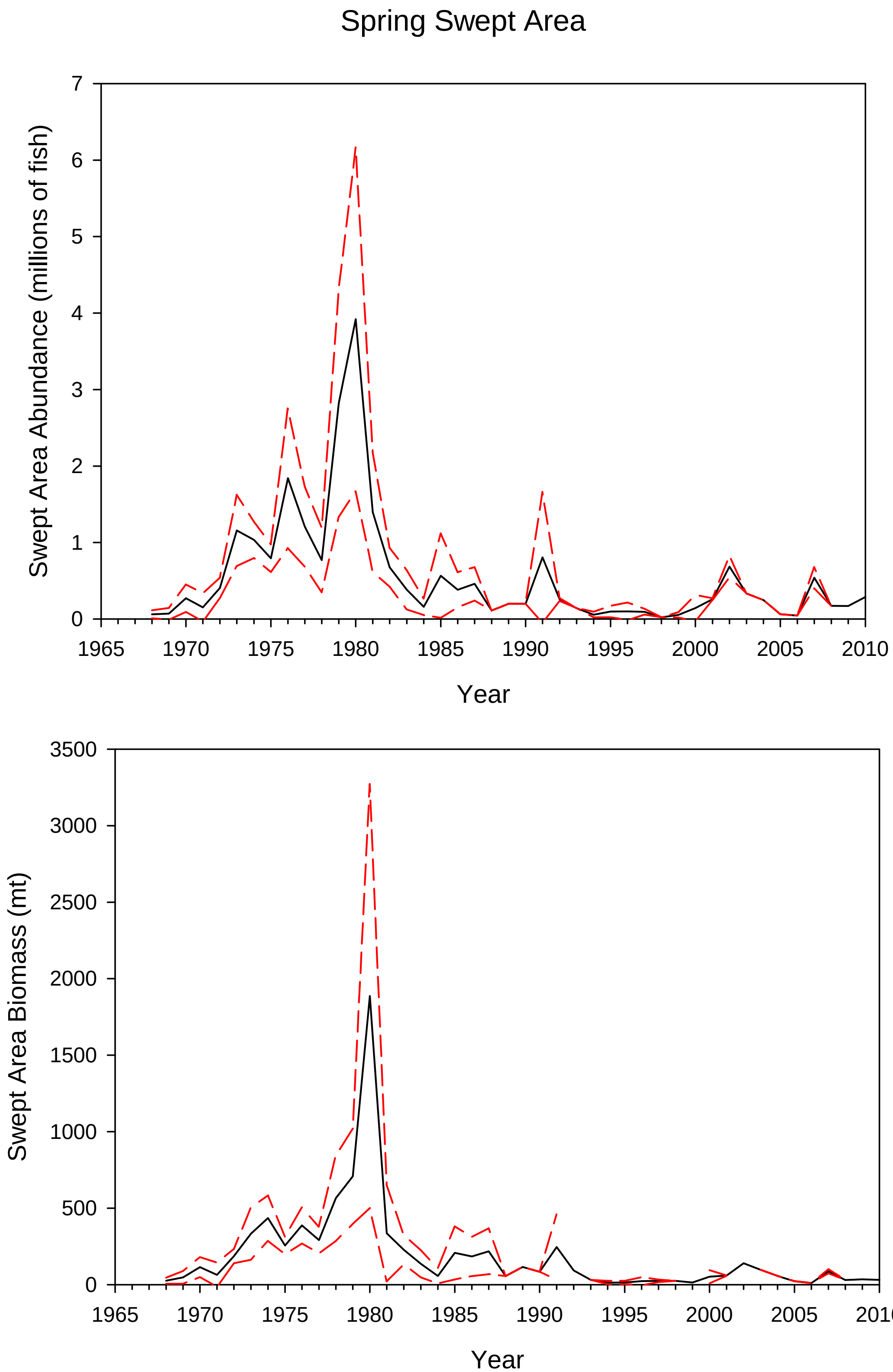


Figure D20. Stratified mean number (top) and weight (kg) per tow of offshore hake for the NEFSC winter surveys, 1998-2007.

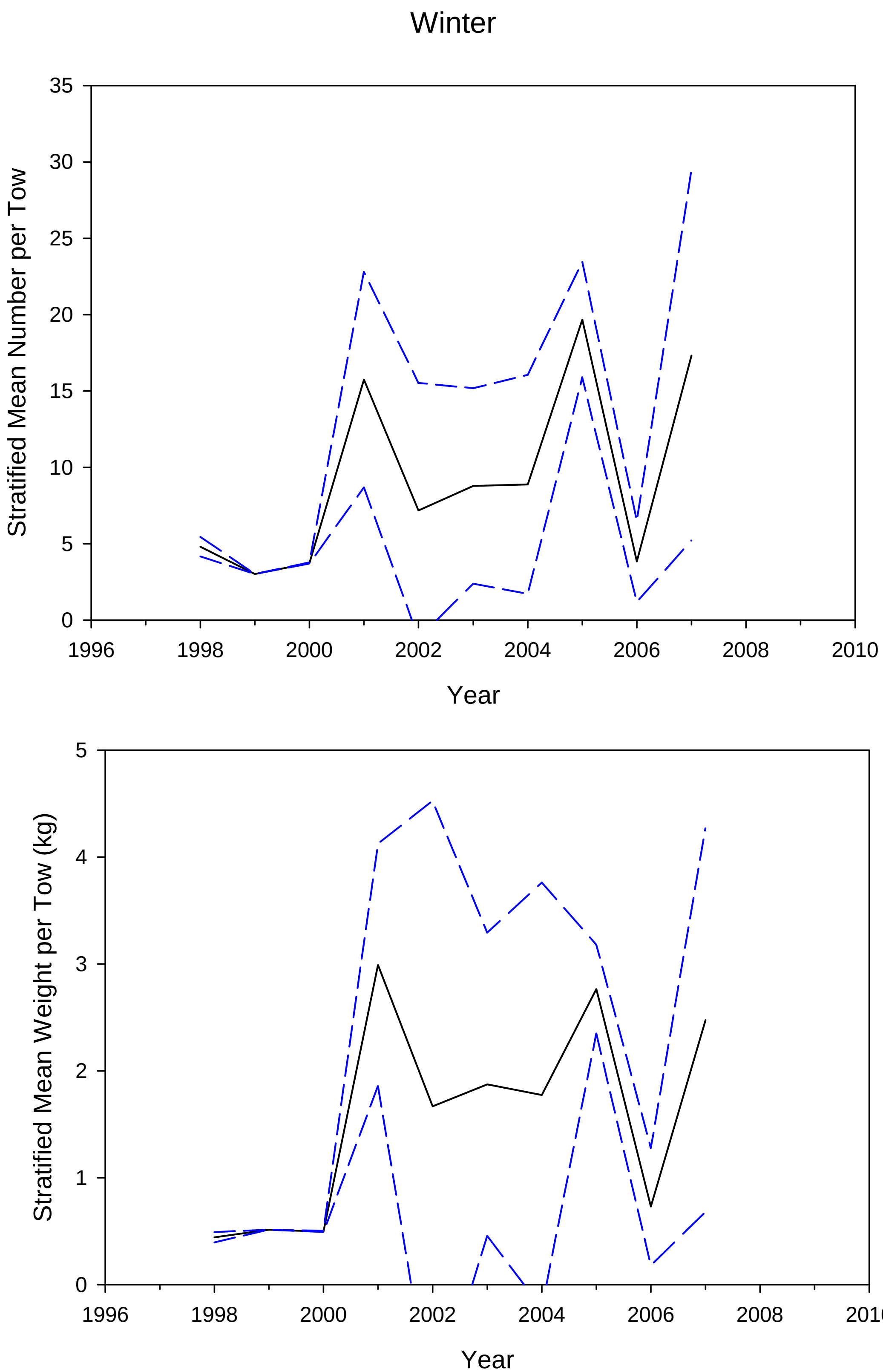
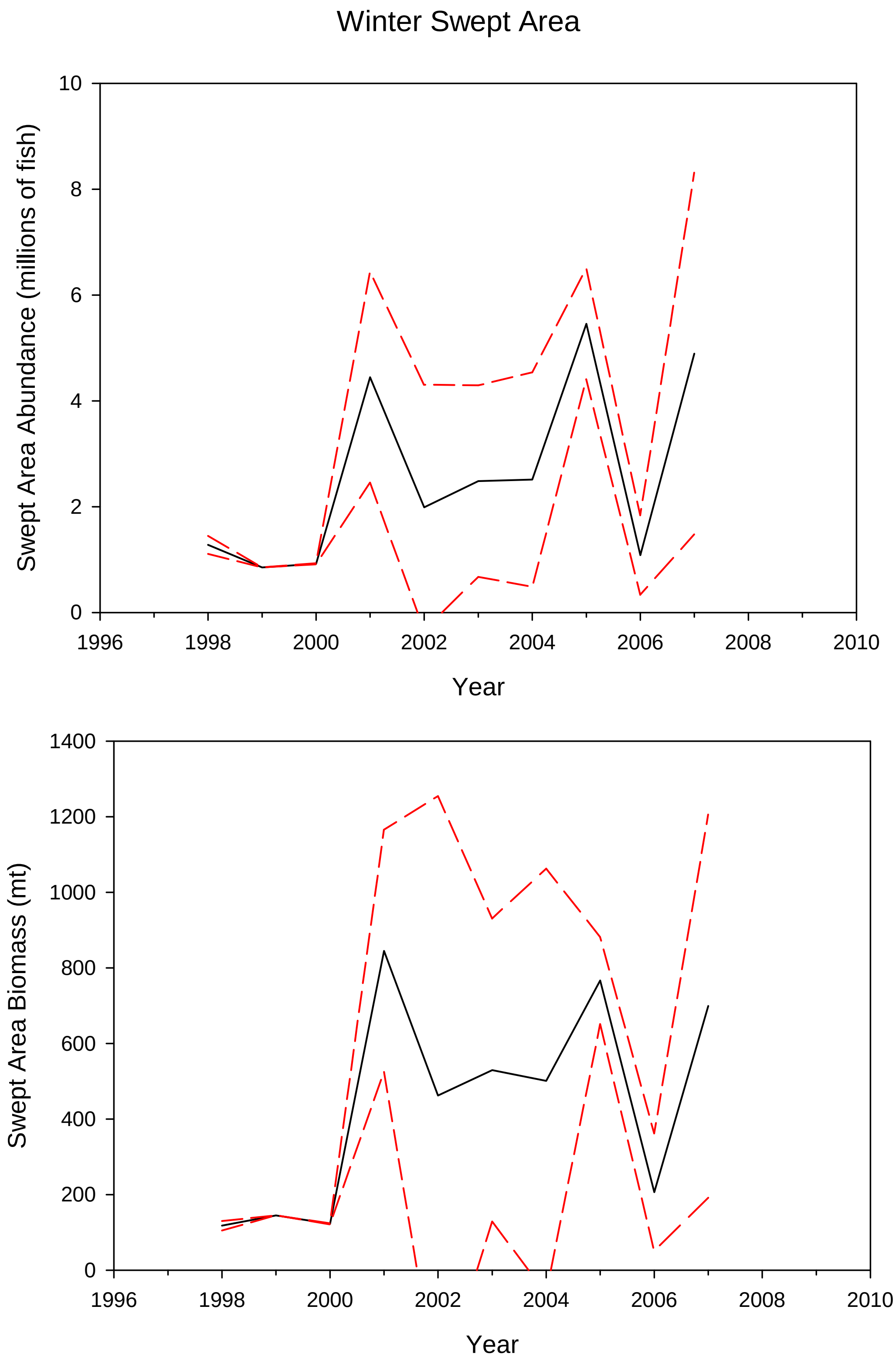


Figure D21. Swept area abundance (millions, top) and biomass (kg, bottom) of offshore hake for the NEFSC winter surveys, 1998-2007.



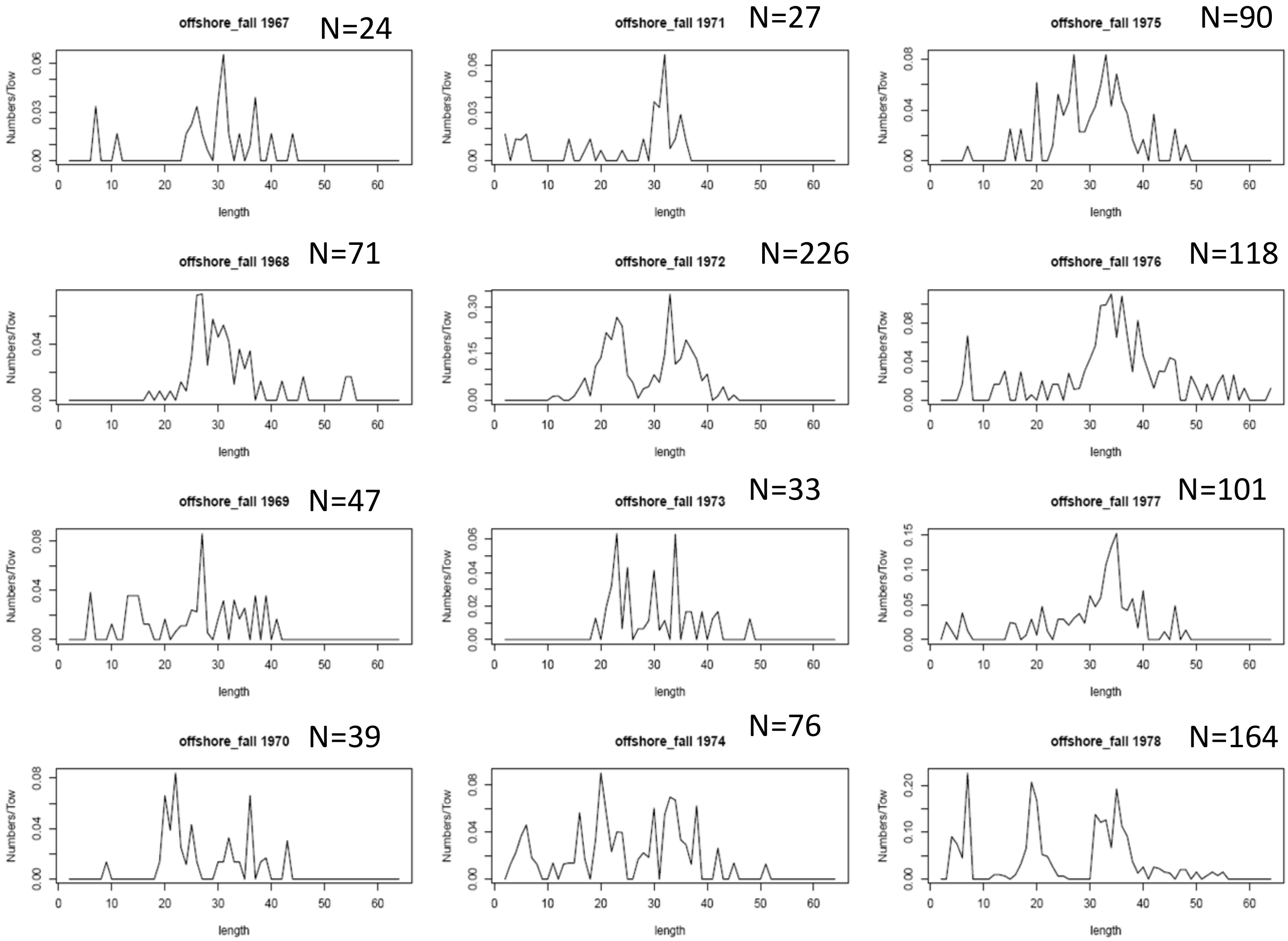


Figure D22a. Length composition (stratified mean number per tow) of offshore hake for the fall survey, 1967-2009.

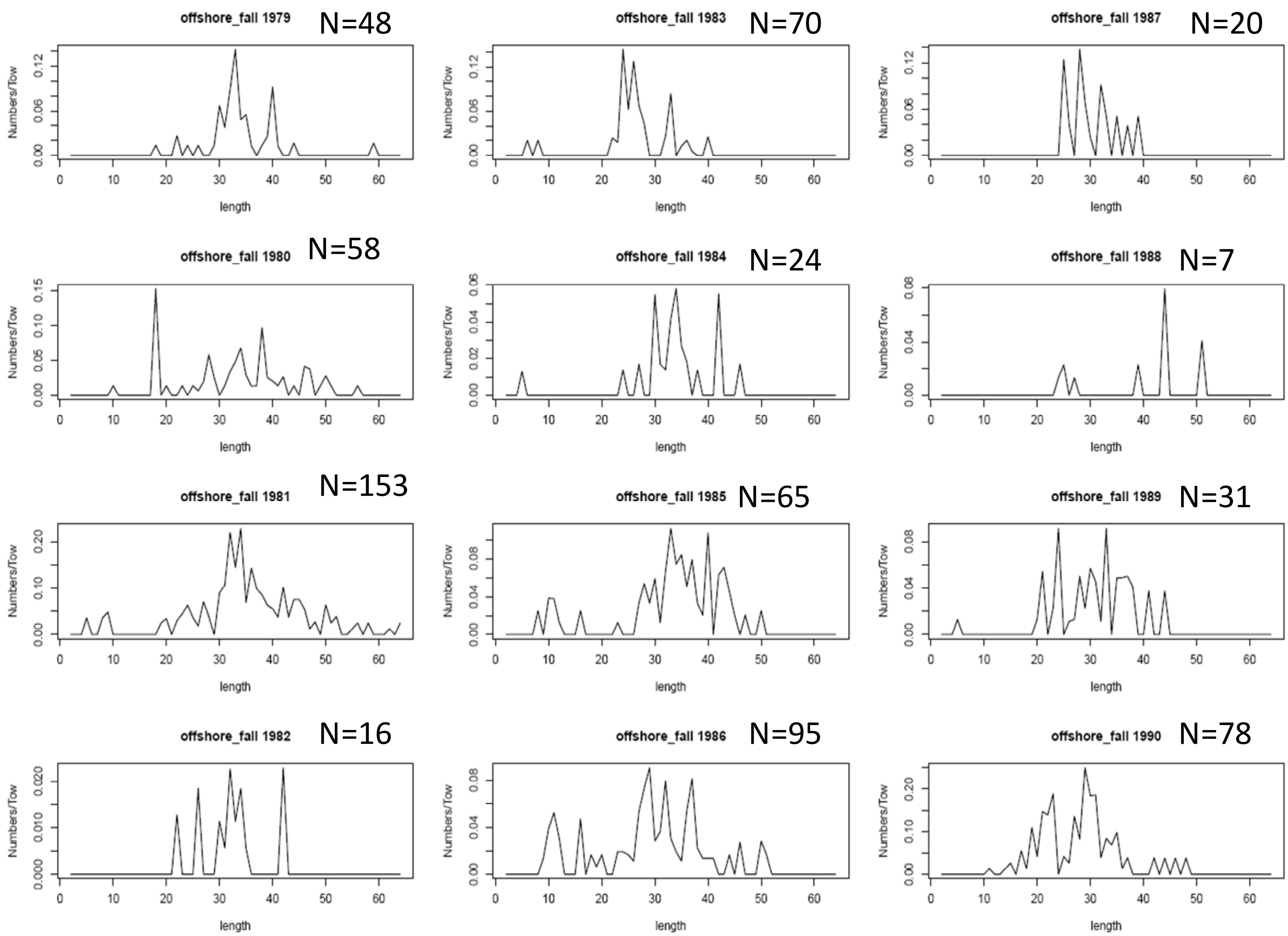


Figure D22b. Length composition (stratified mean number per tow) of offshore hake for the fall survey, 1967-2009.

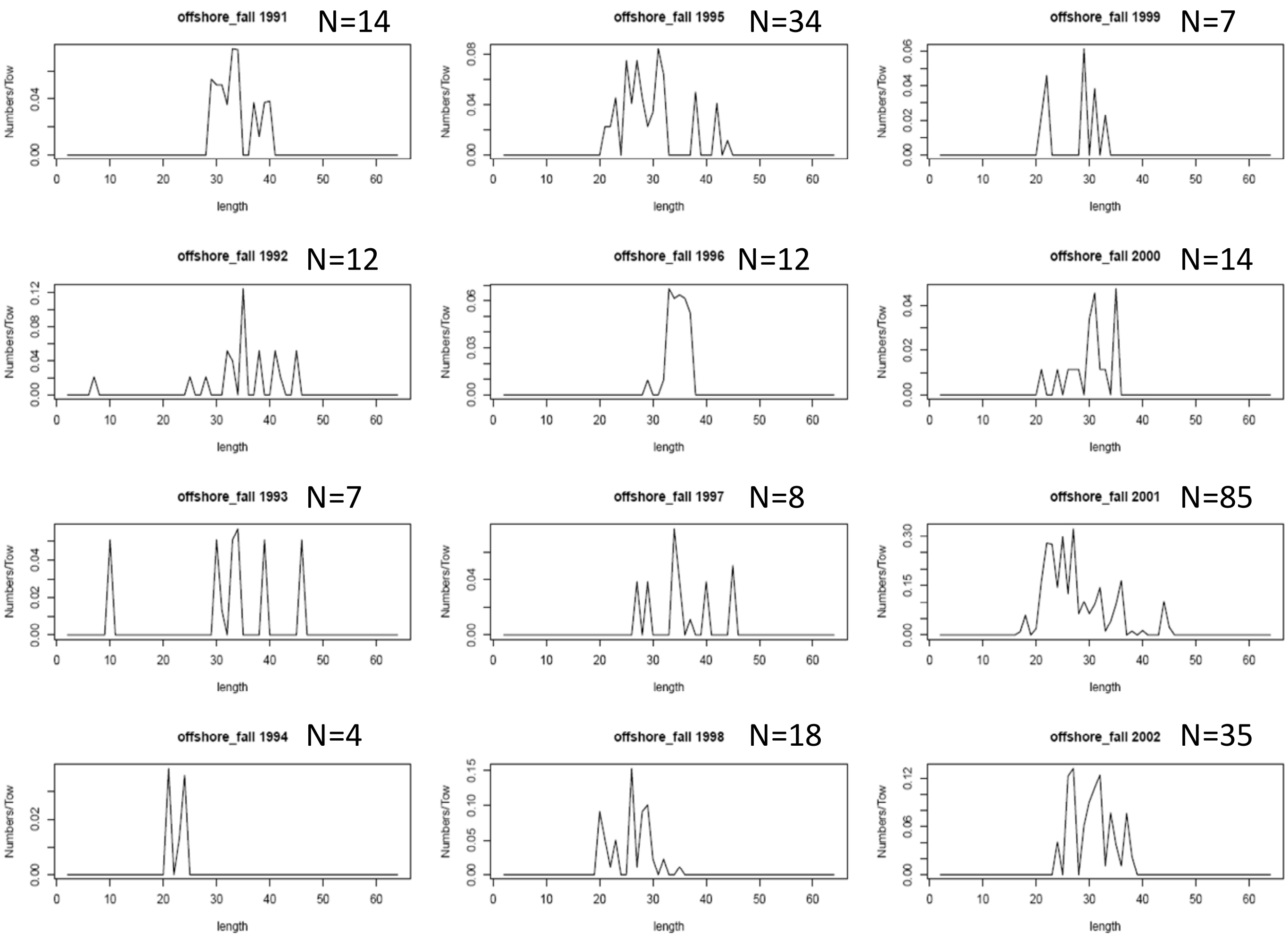


Figure D22c. Length composition (stratified mean number per tow) of offshore hake for the fall survey, 1967-2009.

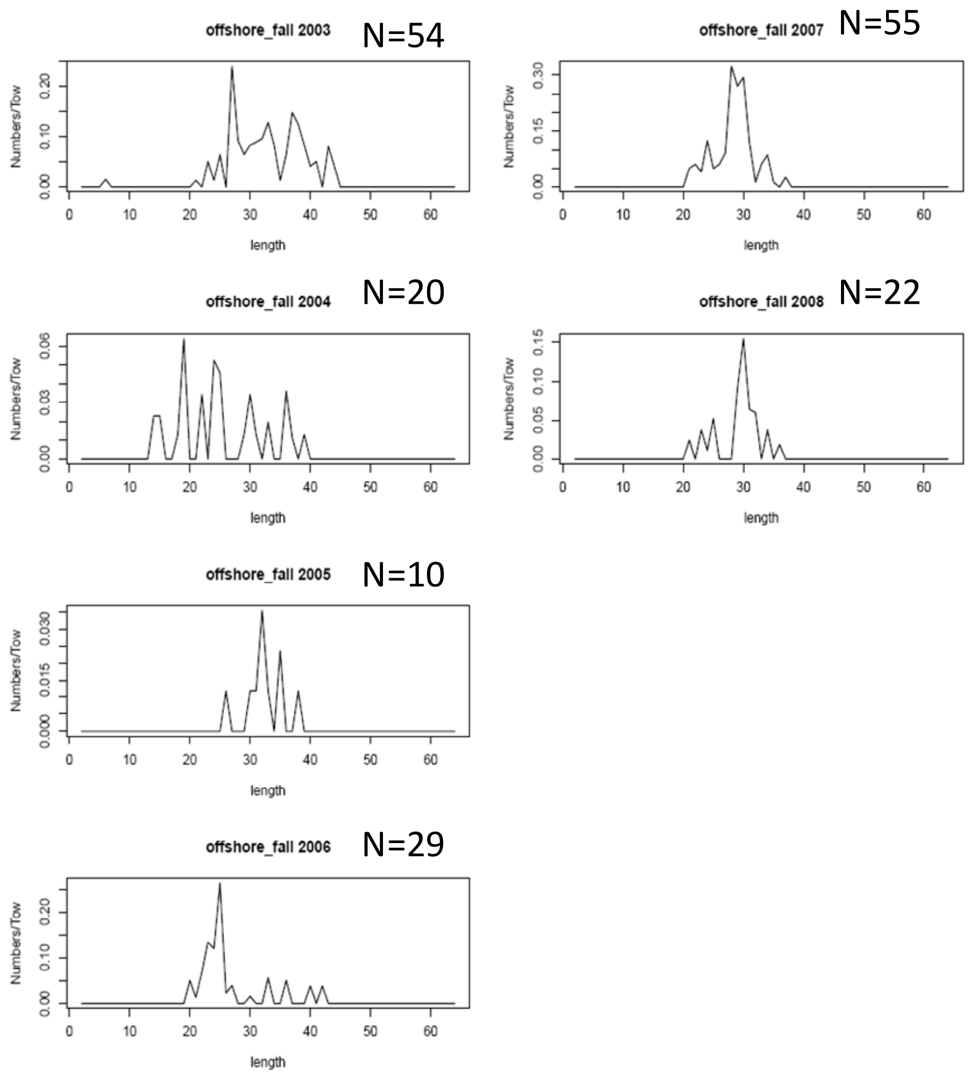


Figure D22d. Length composition (stratified mean number per tow) of offshore hake for the fall survey, 1967-2009.

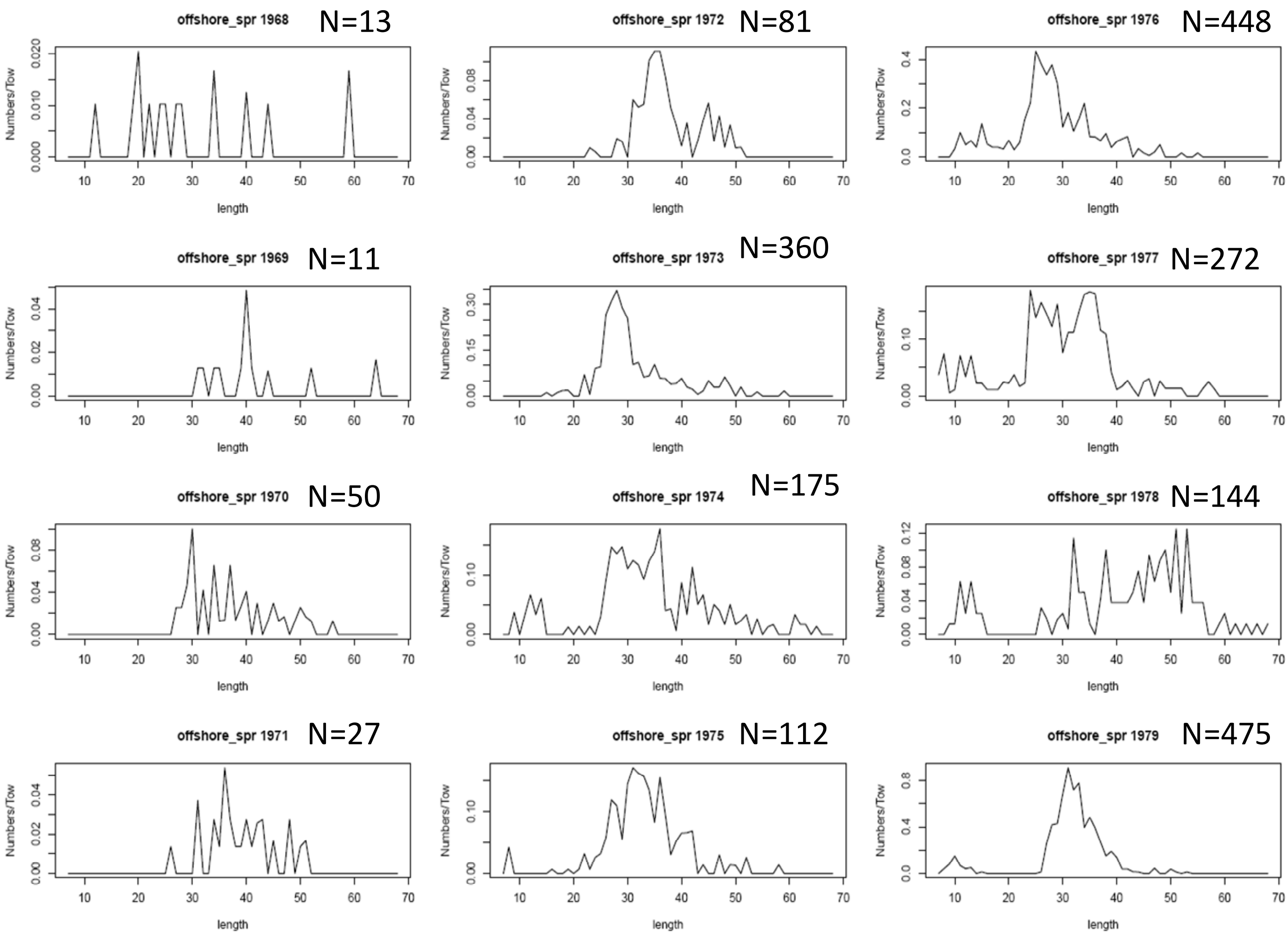


Figure D23a. Length composition (stratified mean number per tow) of offshore hake for the spring survey, 1968-2009.

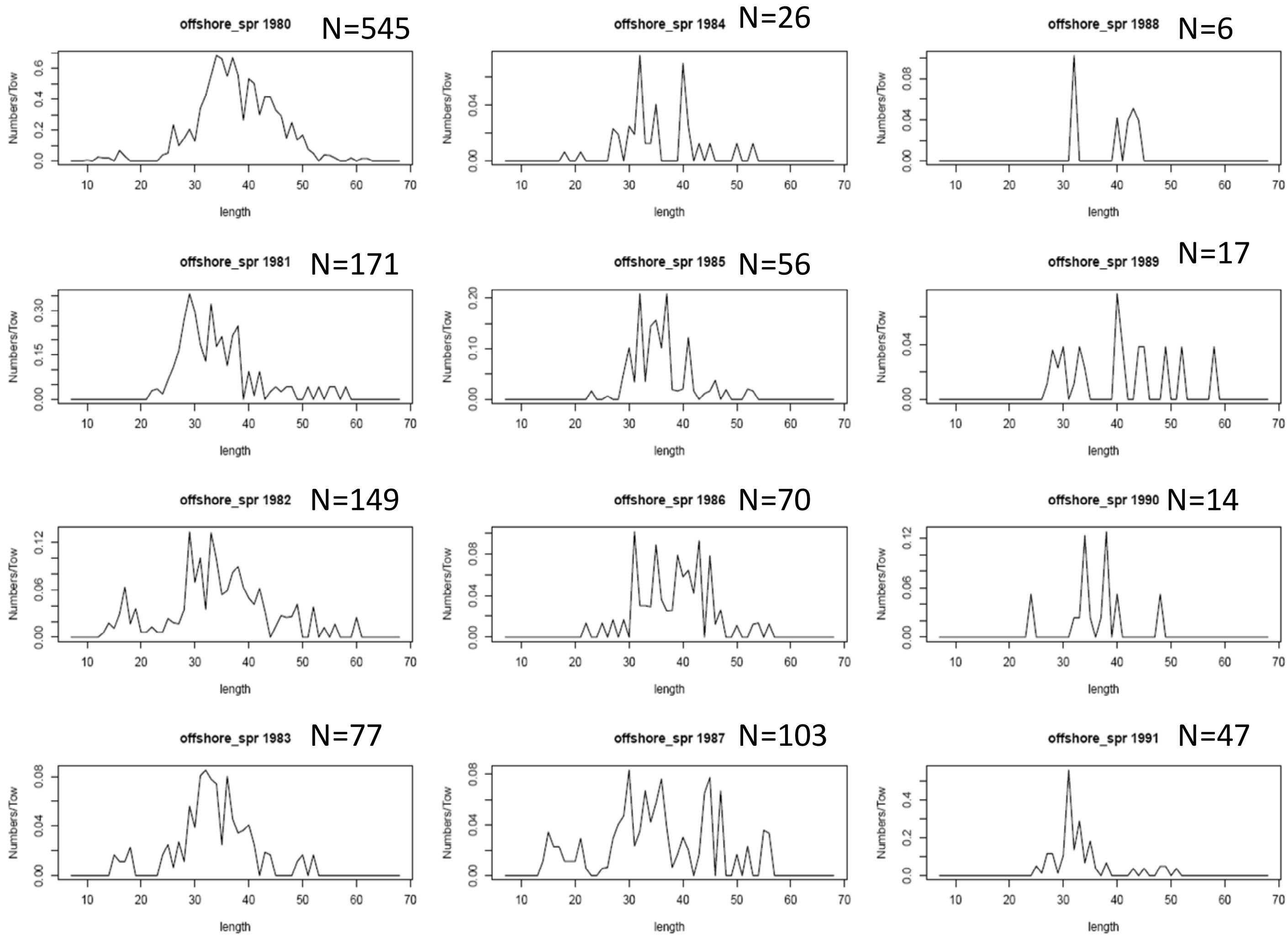


Figure D23b. Length composition (stratified mean number per tow) of offshore hake for the spring survey, 1968-2009.

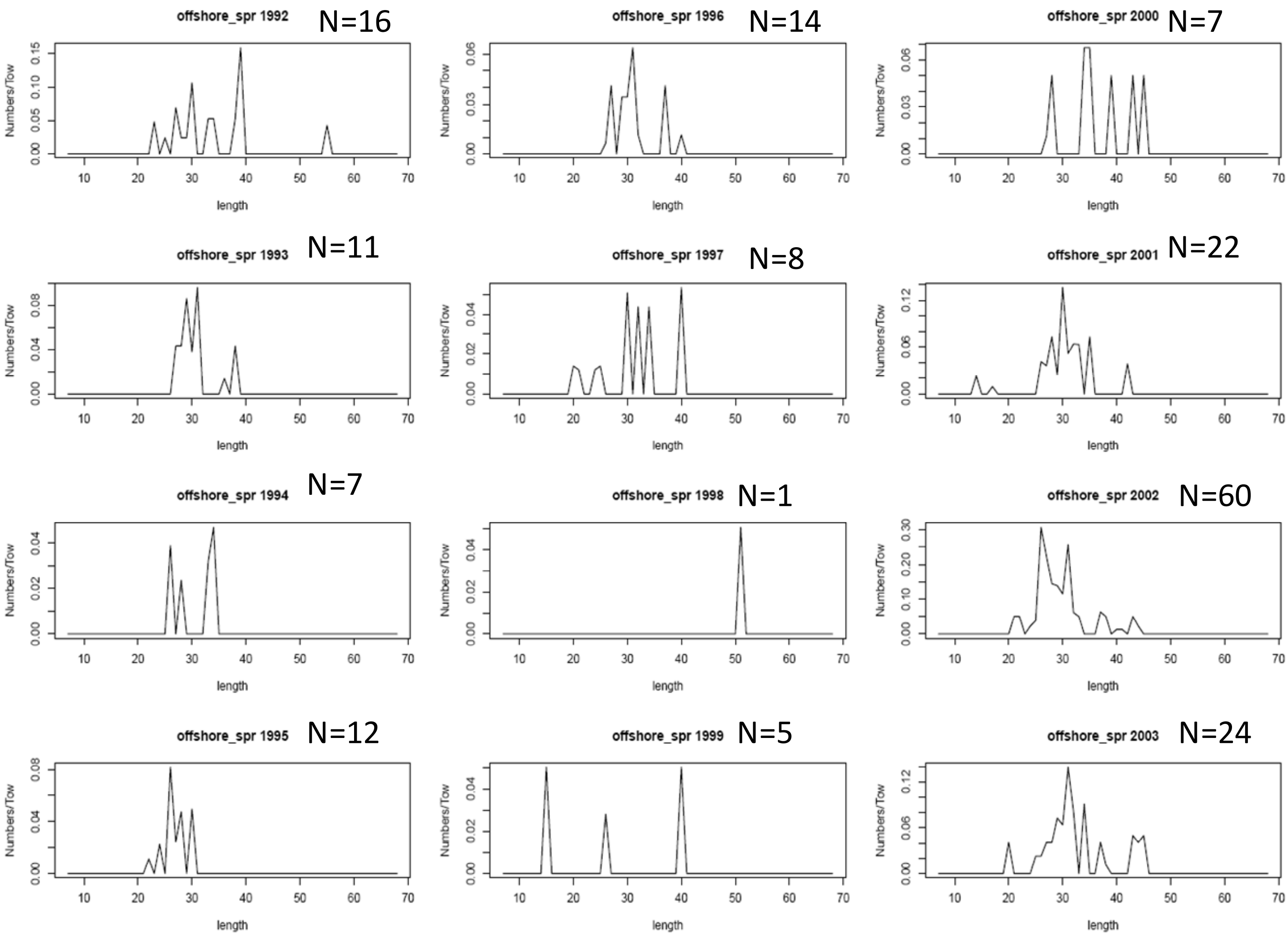


Figure D23c. Length composition (stratified mean number per tow) of offshore hake for the spring survey, 1968-2009.

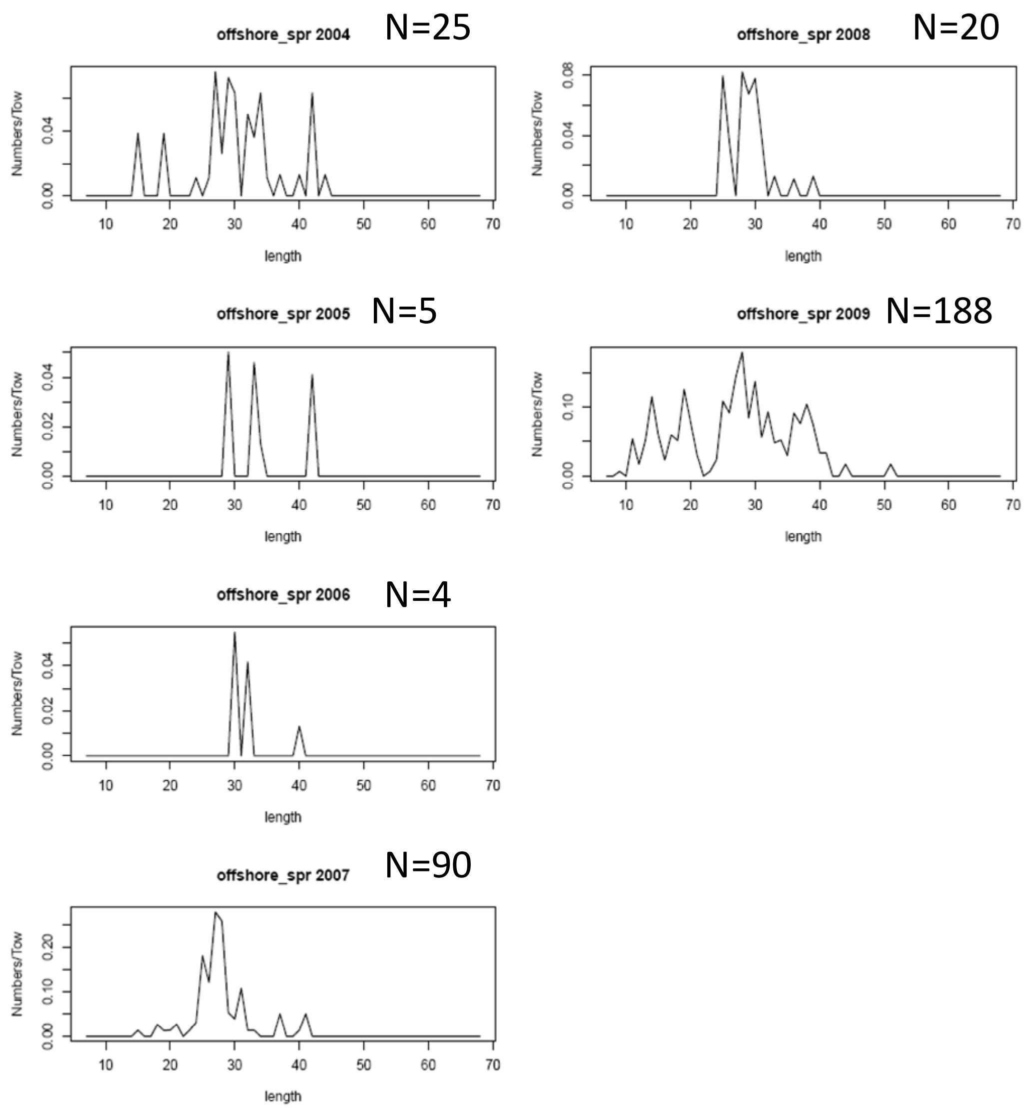


Figure D23d. Length composition (stratified mean number per tow) of offshore hake for the spring survey, 1968-2009.

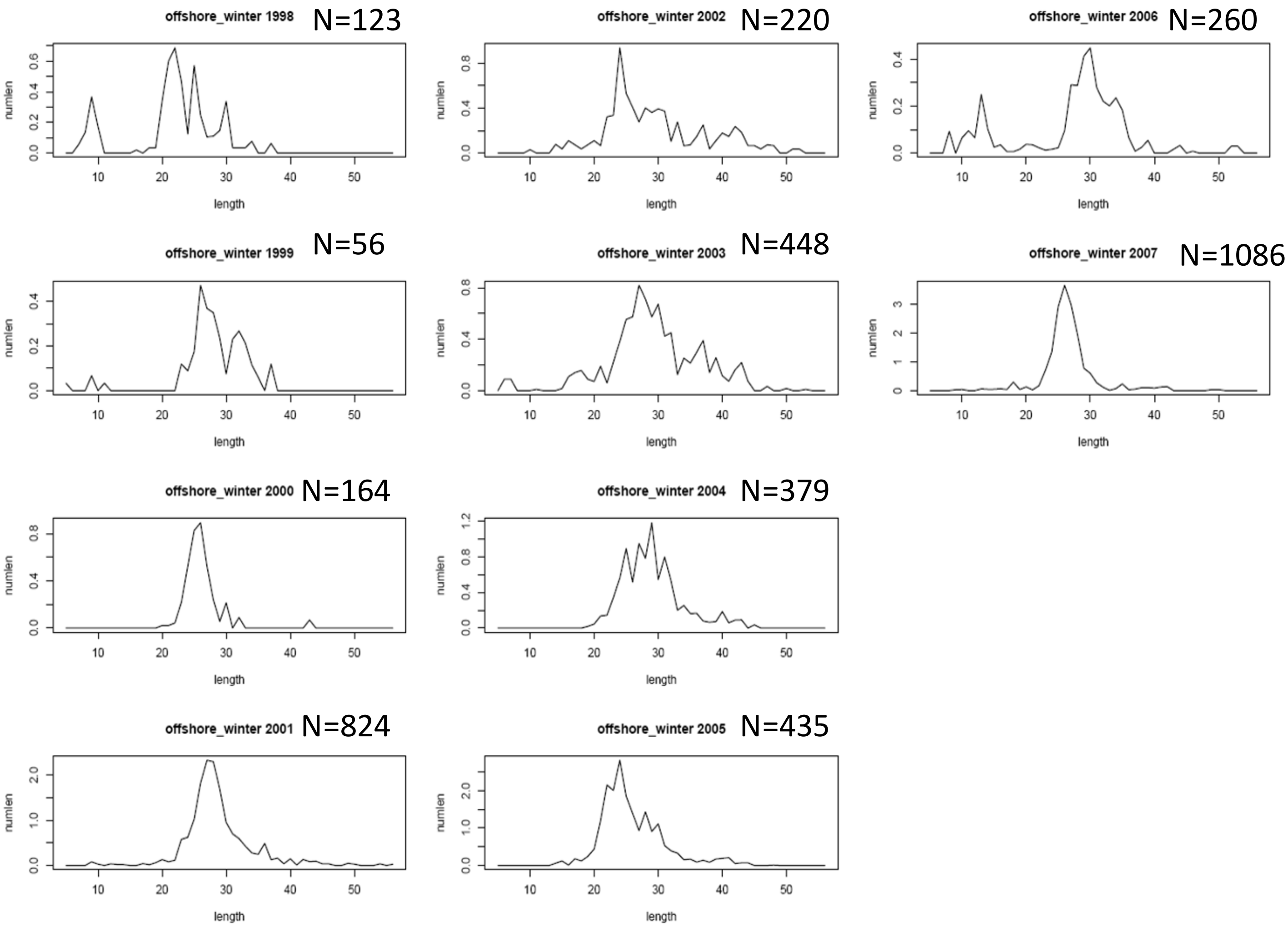


Figure D24. Length composition (stratified mean number per tow) of offshore hake for the winter survey, 1998-2007.

Figure D25a. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the fall survey, 1969-2008.

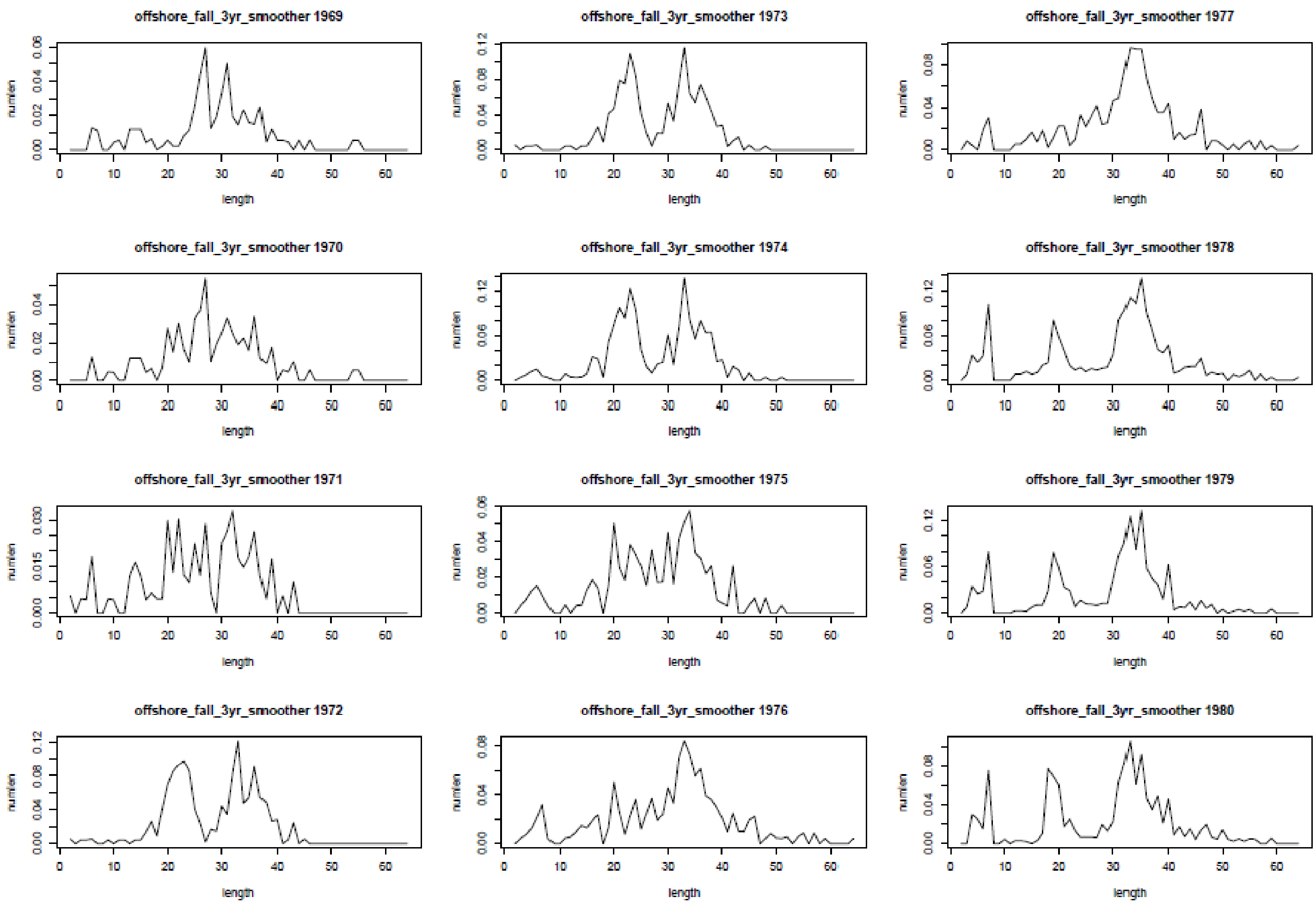


Figure D25b. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the fall survey, 1969-2008.

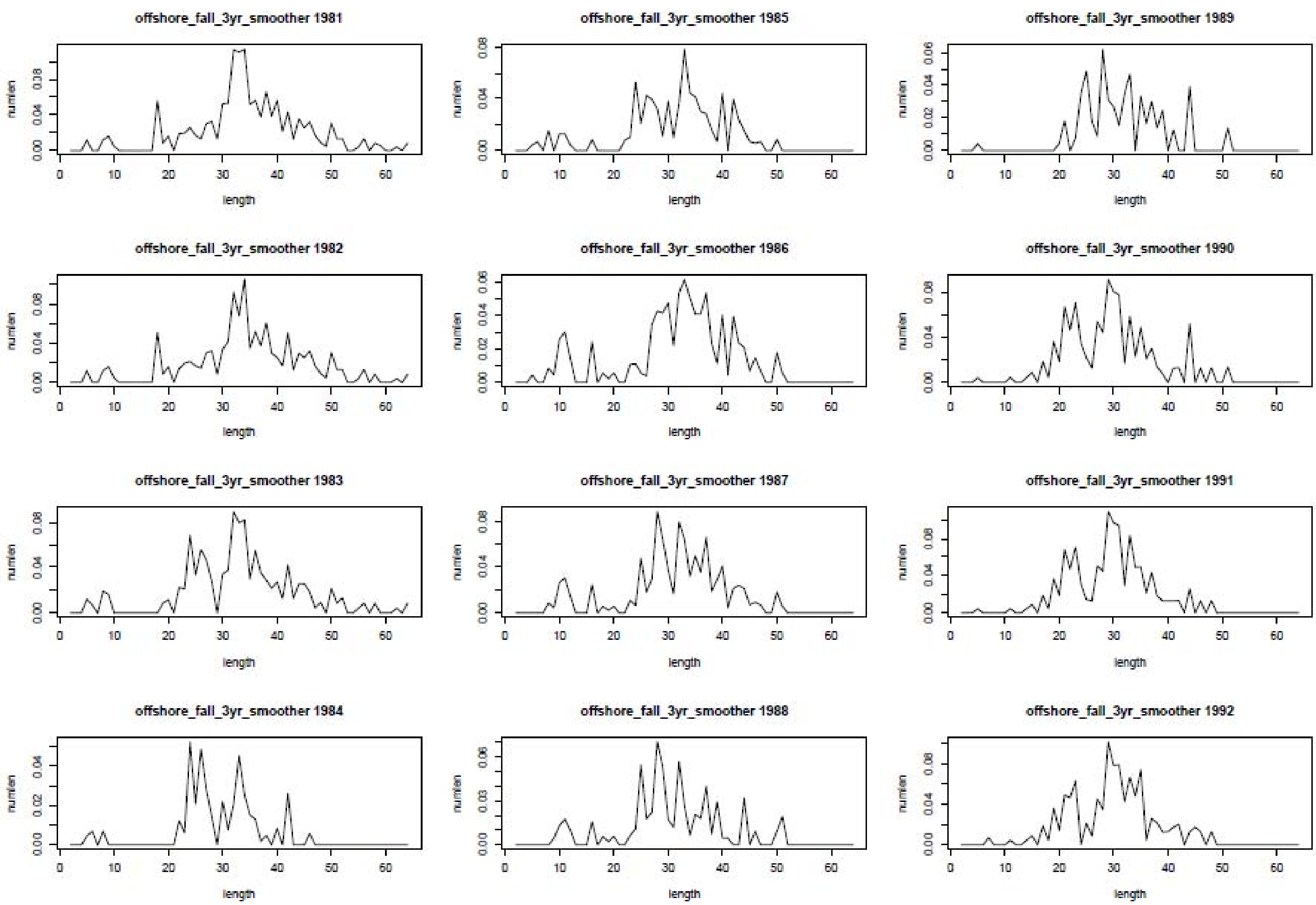


Figure D25c. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the fall survey, 1969-2008.

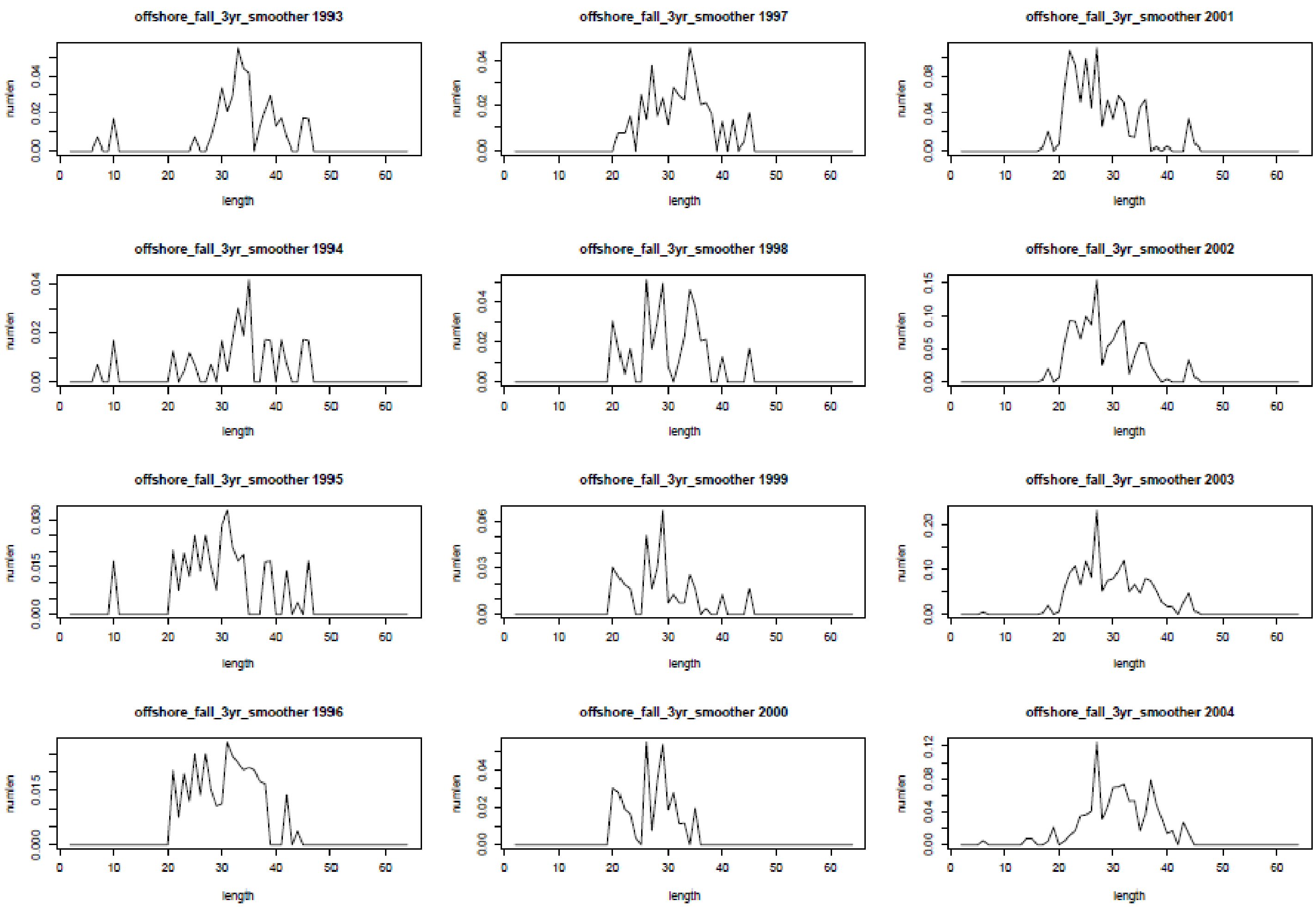
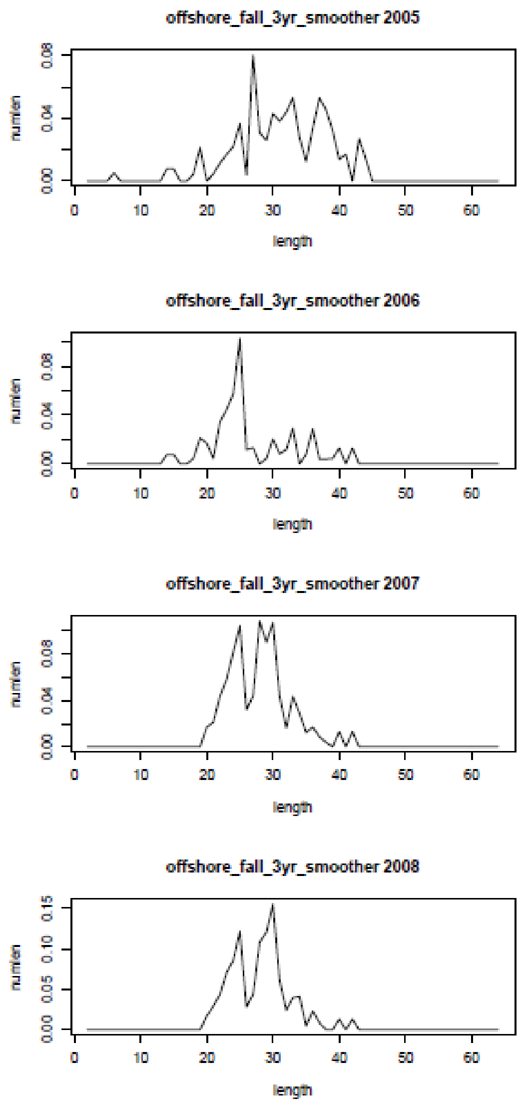


Figure D25d. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the fall survey, 1969-2008.



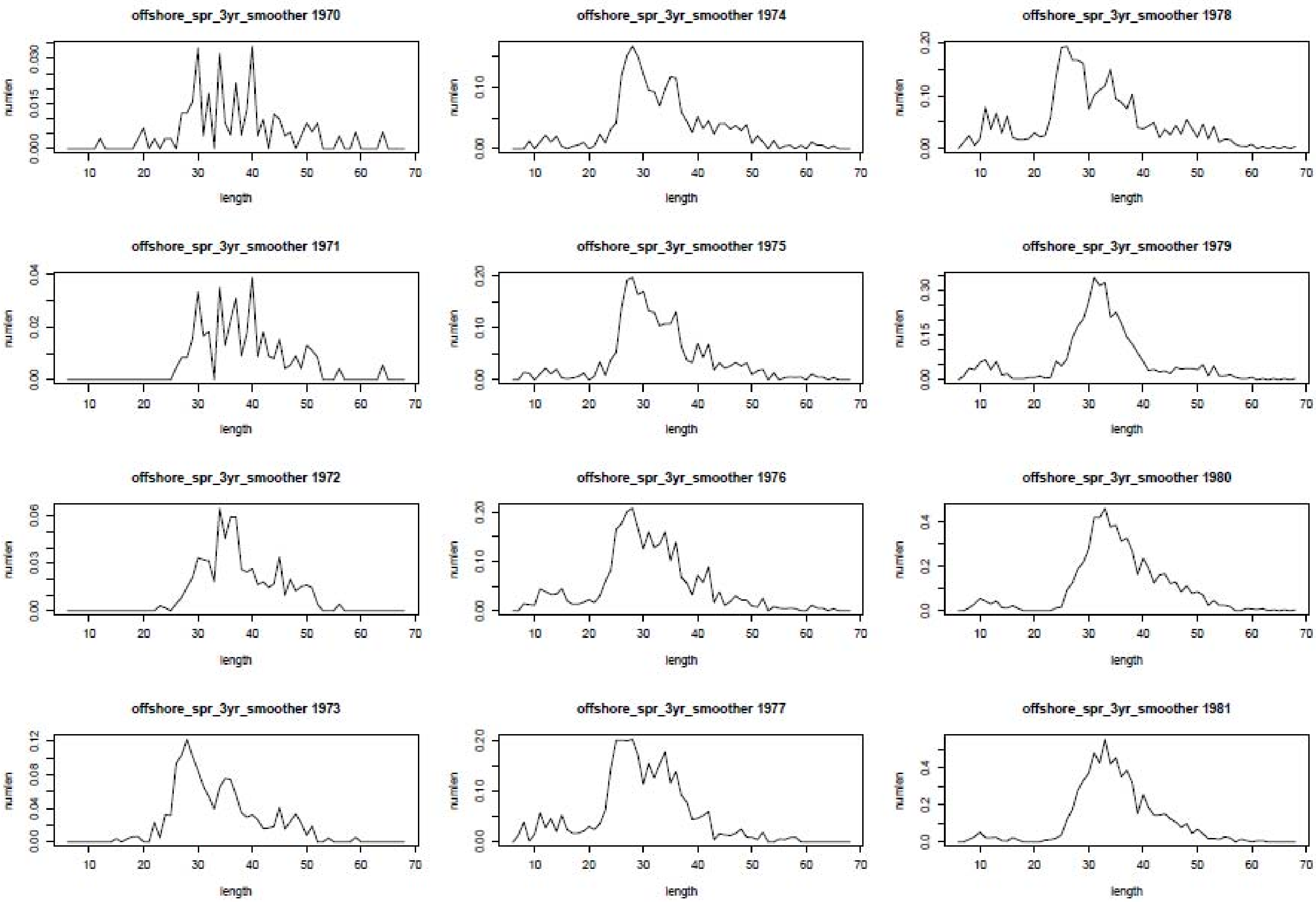


Figure D26a. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the spring survey, 1970-2008.

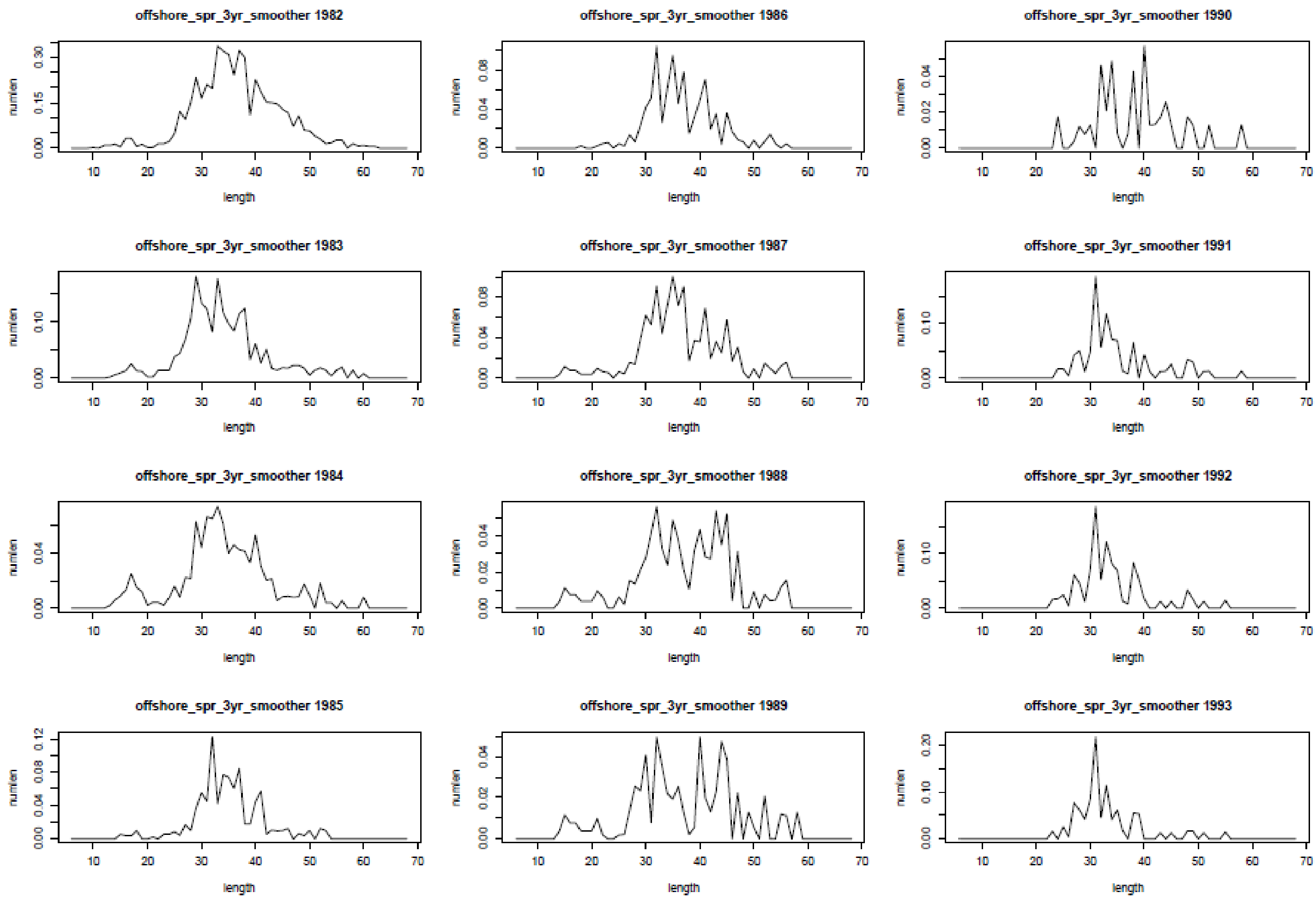


Figure D26b. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the spring survey, 1970-2008.

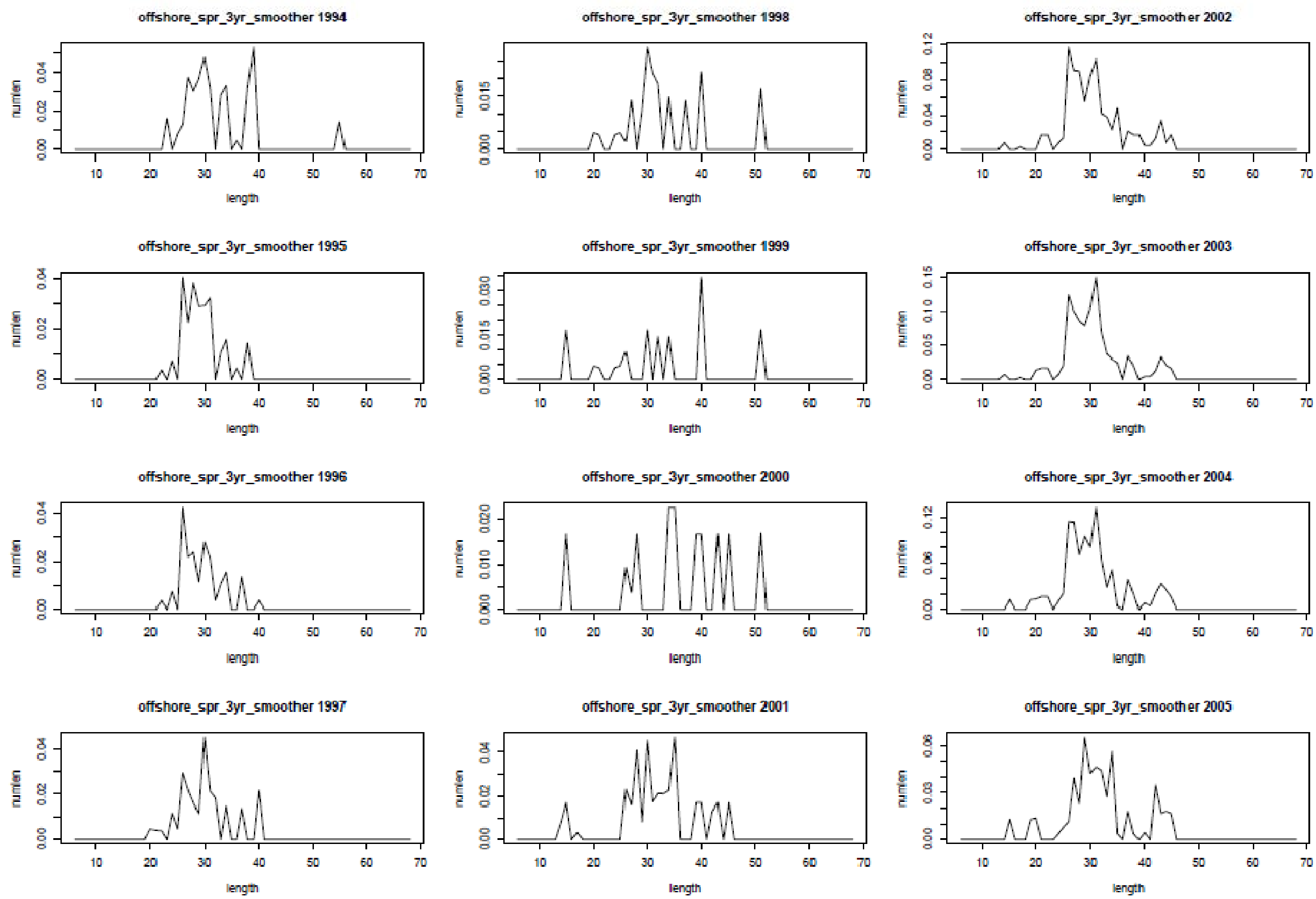


Figure D26c. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the spring survey, 1970-2008.

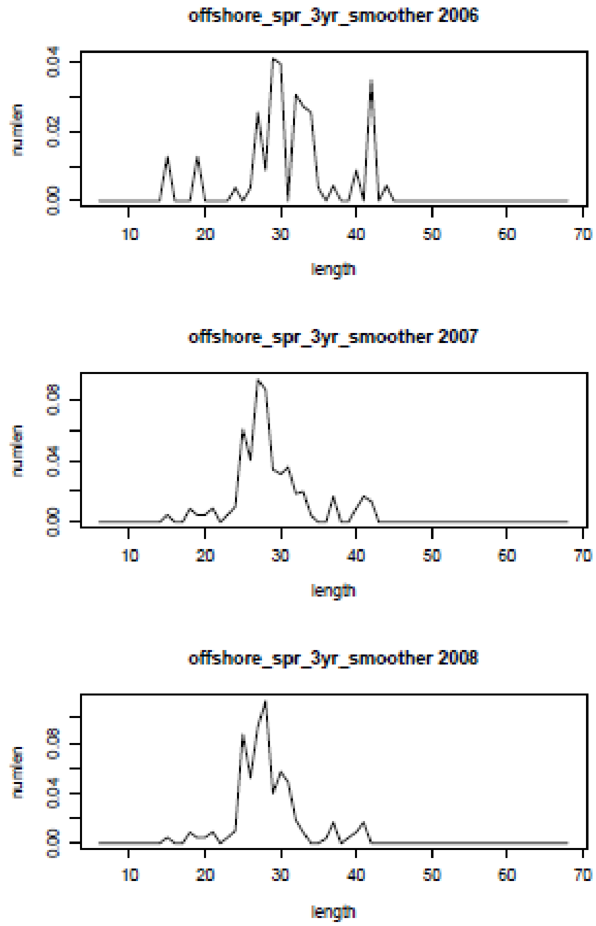


Figure D26d. Three-year moving average length composition (stratified mean number per tow) of offshore hake for the spring survey, 1970-2008.

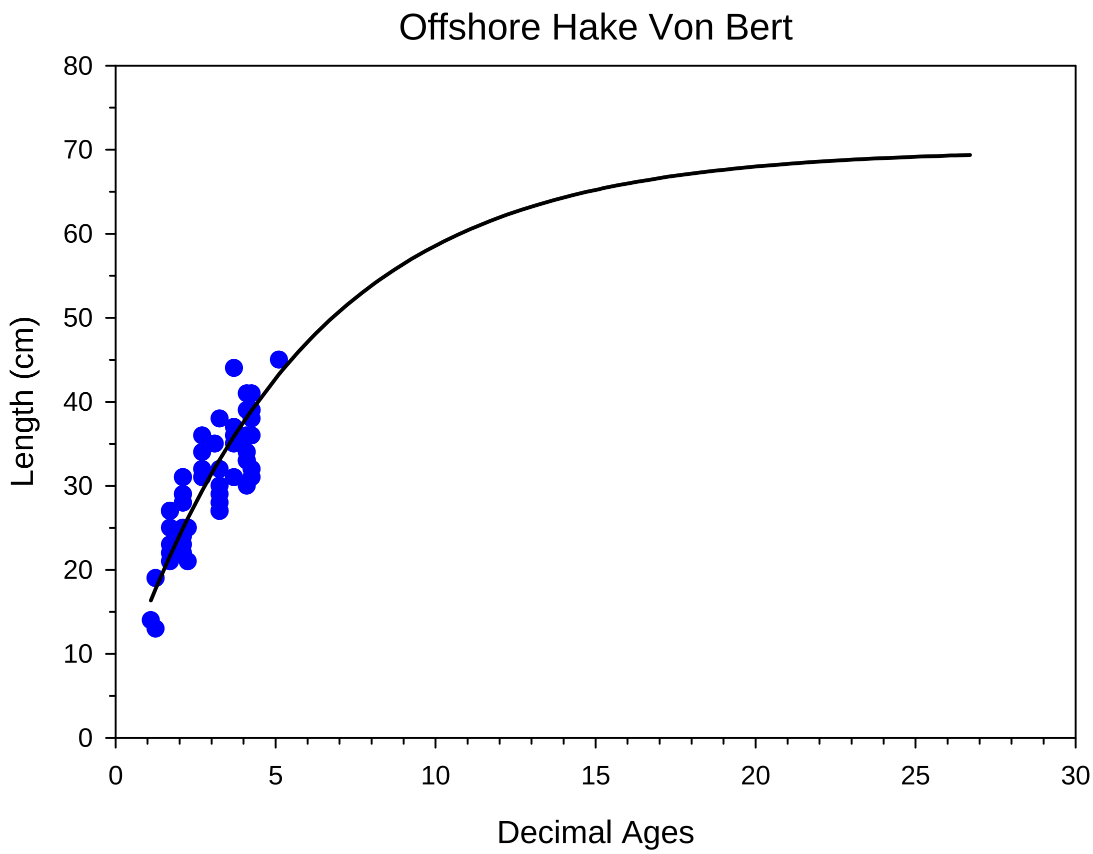


Figure D27. Von Bertalanffy estimates for offshore hake, using the NEFSC preliminary ages.

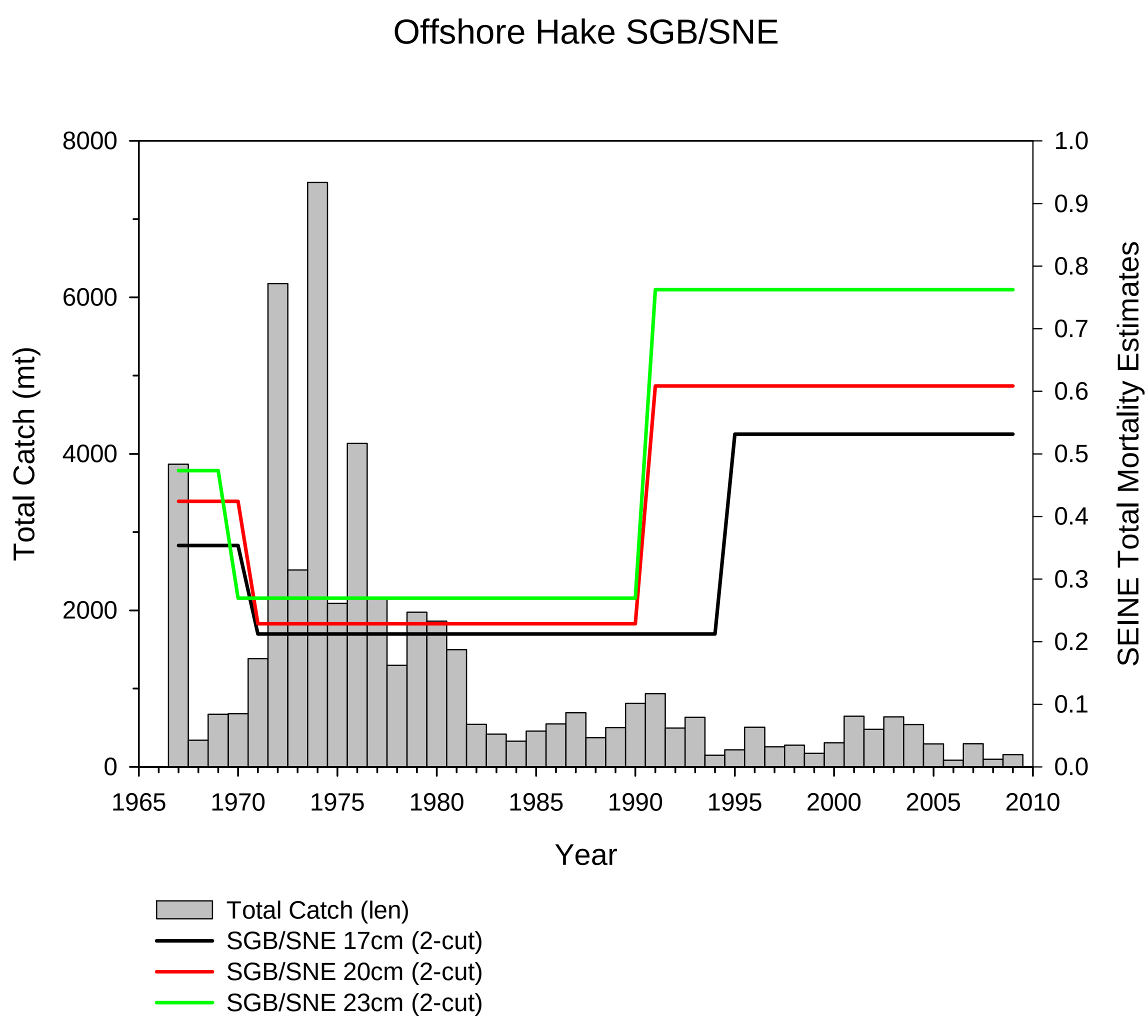


Figure D28. Offshore hake SEINE model results using silver hake average of Southern Georges Bank and Southern New England growth parameters, laid over total catch (metric tons). Lines indicate mortality estimates.

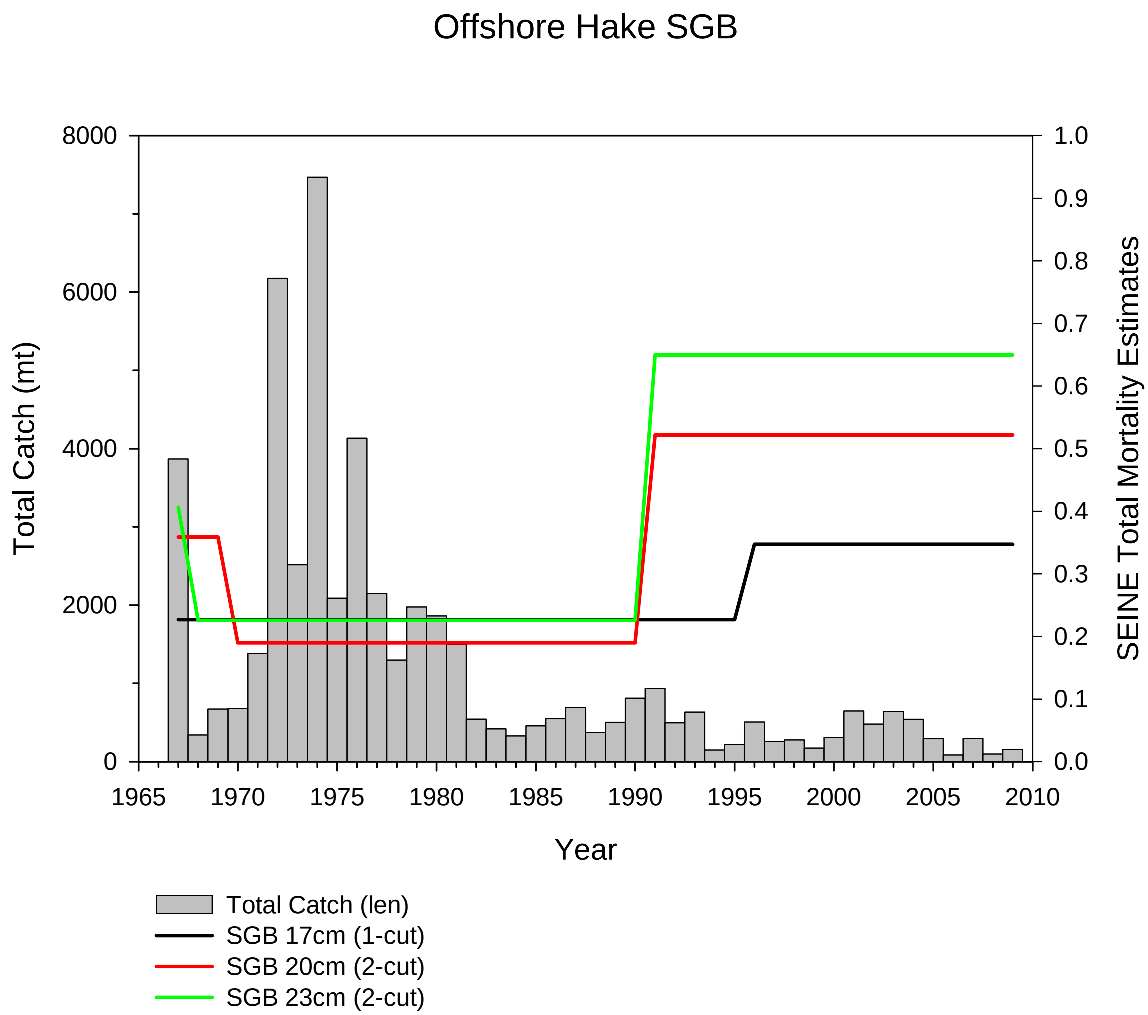


Figure D29. Offshore hake SEINE model results using silver hake Southern Georges Bank growth parameters, laid over total catch (metric tons). Lines indicate mortality estimates.

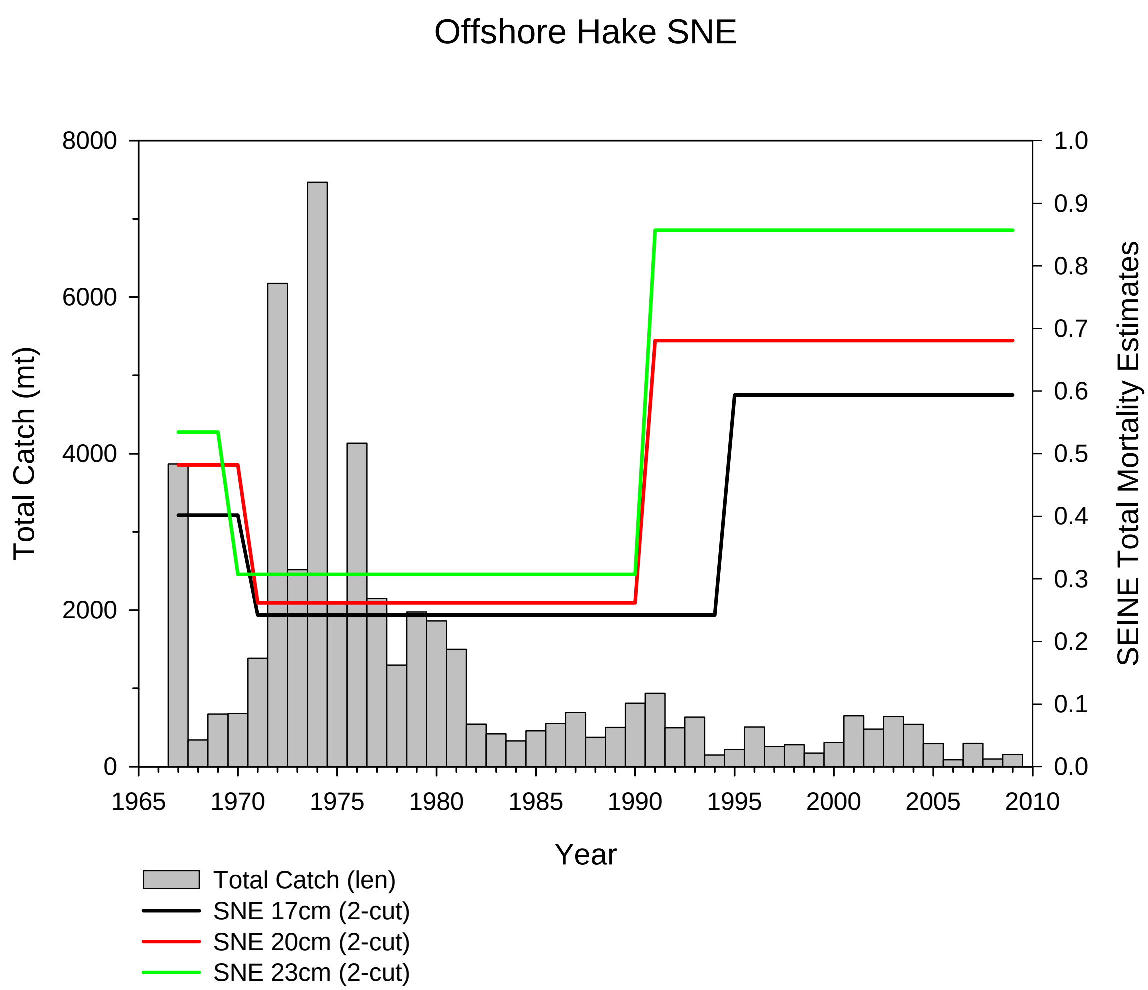


Figure D30. Offshore hake SEINE model results using silver hake Southern New England growth parameters, laid over total catch (metric tons). Lines indicate mortality estimates.

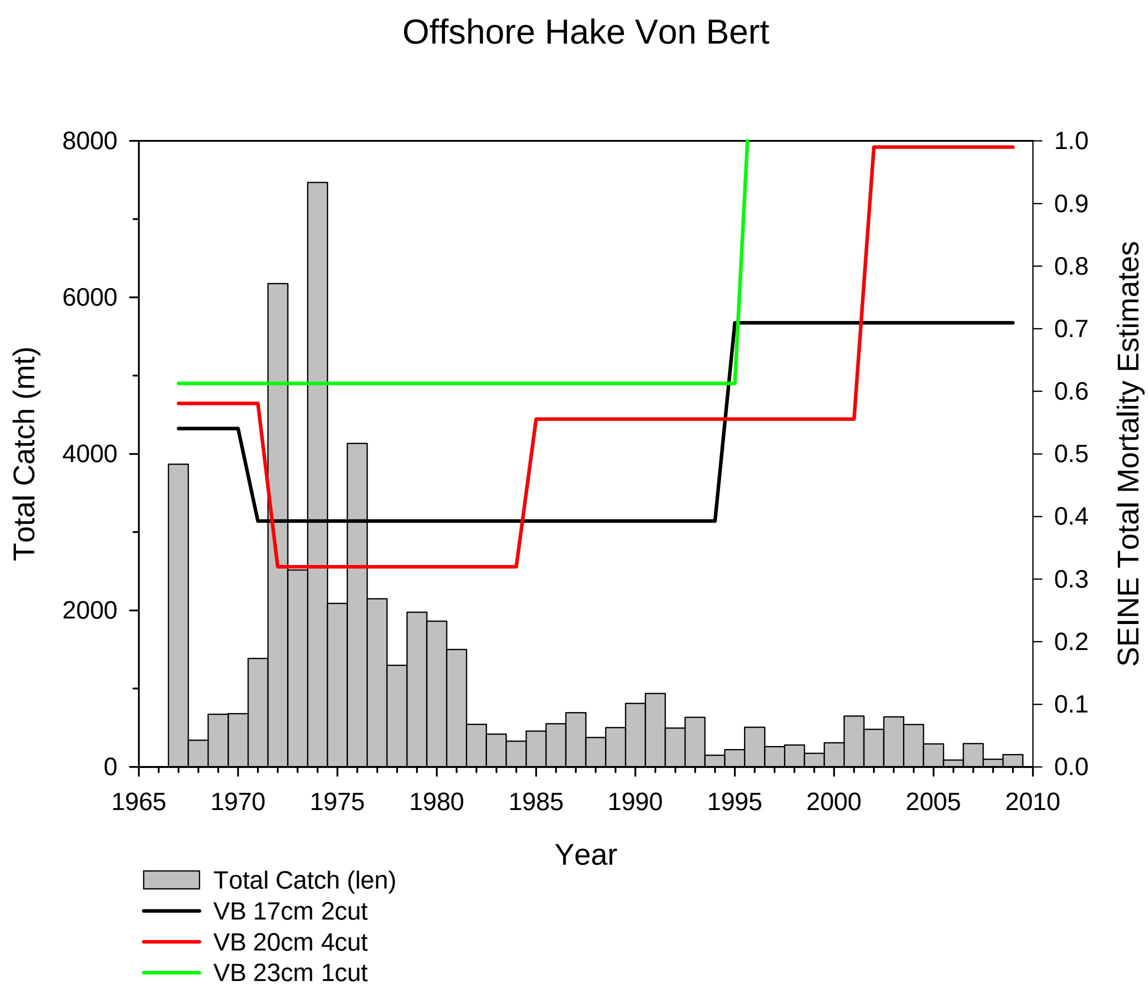


Figure D31. SEINE model results using the estimated von Bertalanffy growth parameters for offshore hake, laid over total catch (metric tons). Lines indicate mortality estimates.

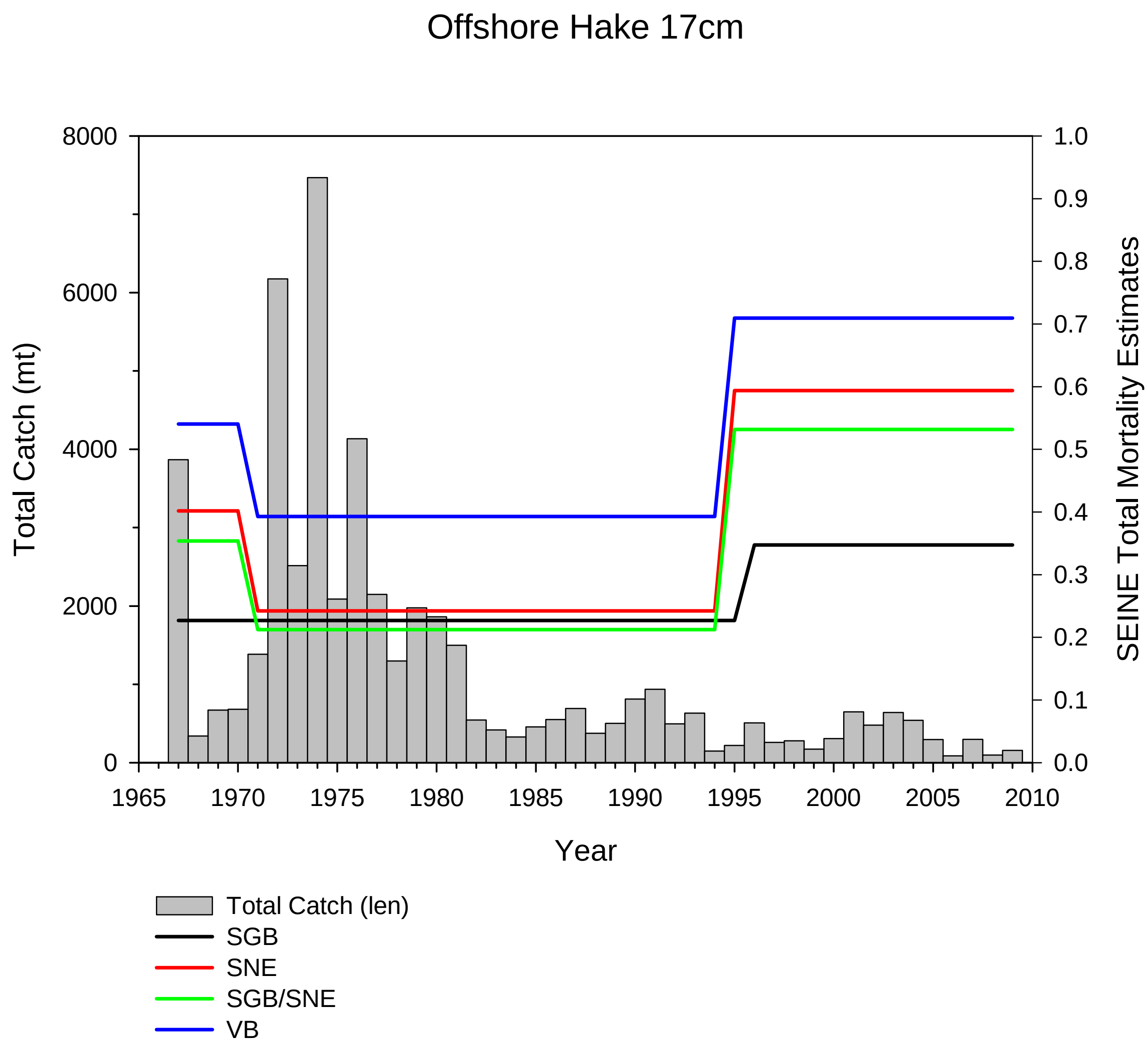


Figure D32. Offshore hake SEINE model results for the 17cm mortality cut, laid over total catch (metric tons). Lines indicate mortality estimates.

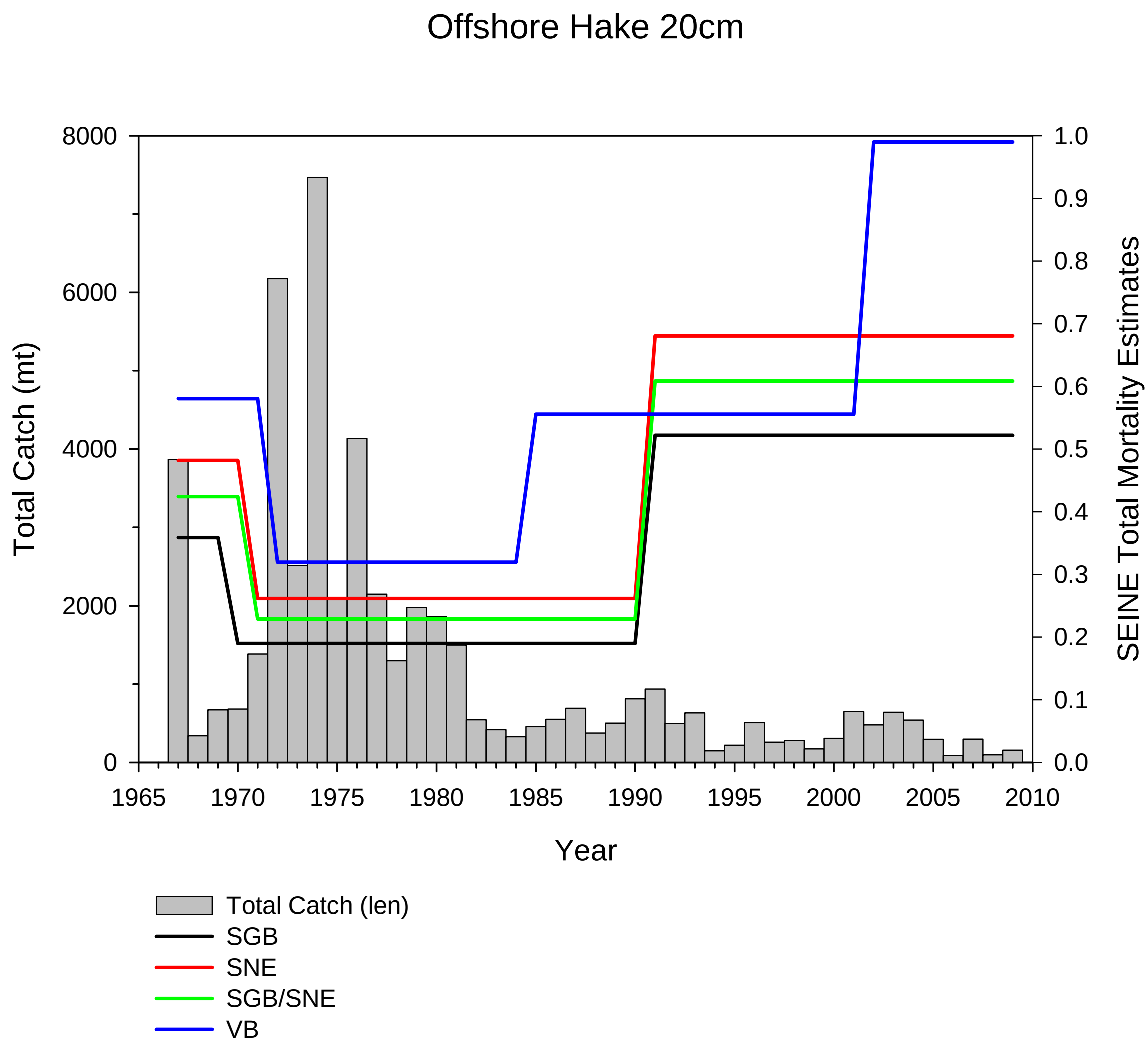


Figure D33. Offshore hake SEINE model results for the 20cm mortality cut, laid over total catch (metric tons). Lines indicate mortality estimates.

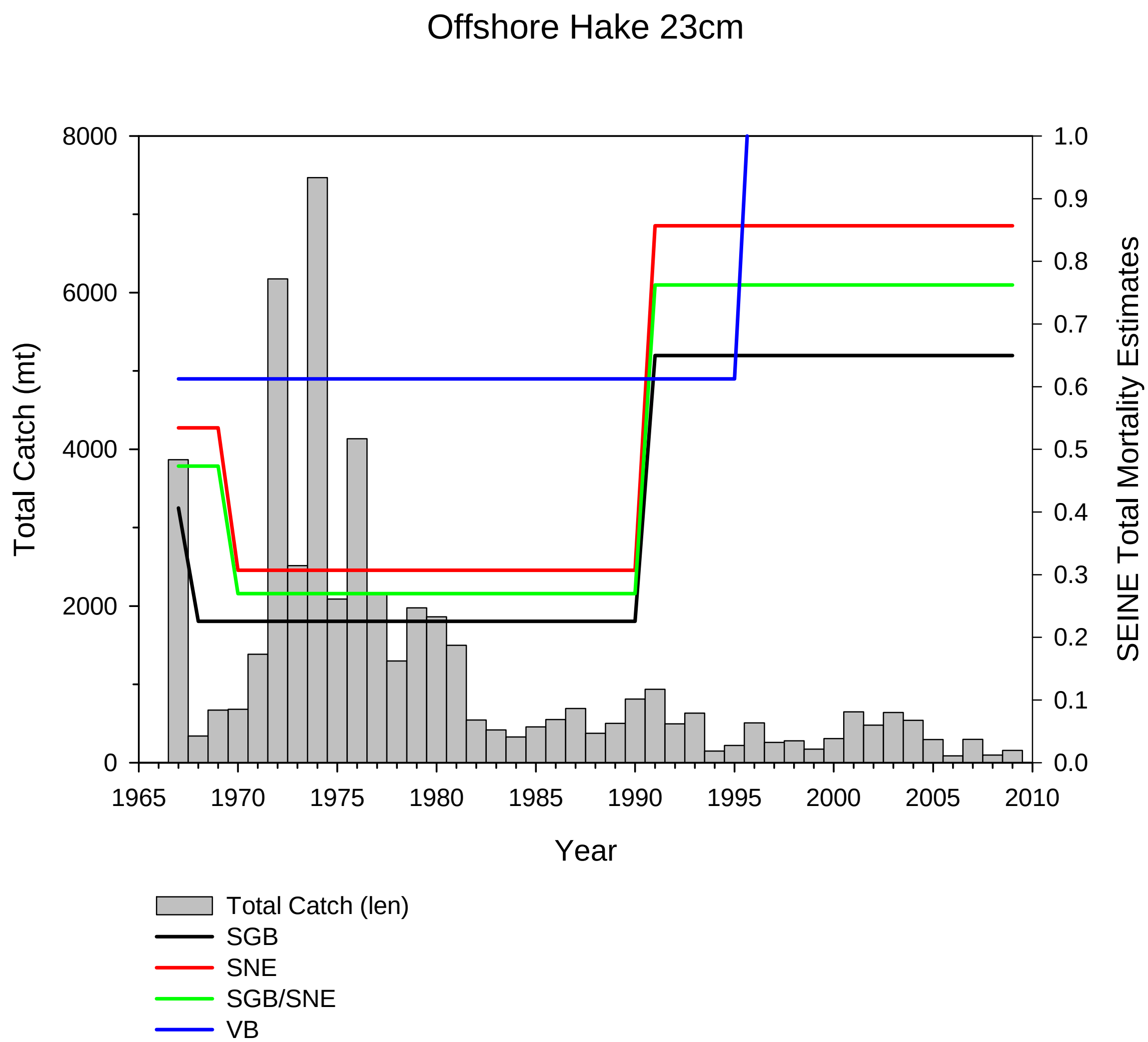


Figure D34. Offshore hake SEINE model results for the 23cm mortality cut, laid over total catch (metric tons). Lines indicate mortality estimates.

Figure D35. Six panel plot for offshore hake depicting trends in relative biomass, landings, relative fishing mortality and replacement ratios for the NEFSC Fall bottom trawl survey index and landings based on the Sosebee method. Horizontal dashed lines (---) represent replacement ratios in the top two panels and the replacement F in the lower right panel. Smooth lines represent Lowess smooths (tension =0.3). The confidence ellipse in the top left panel has a nominal probability level of 0.68. The regression line in the top left panel is a robust regression using bisquare downweighting of residuals.

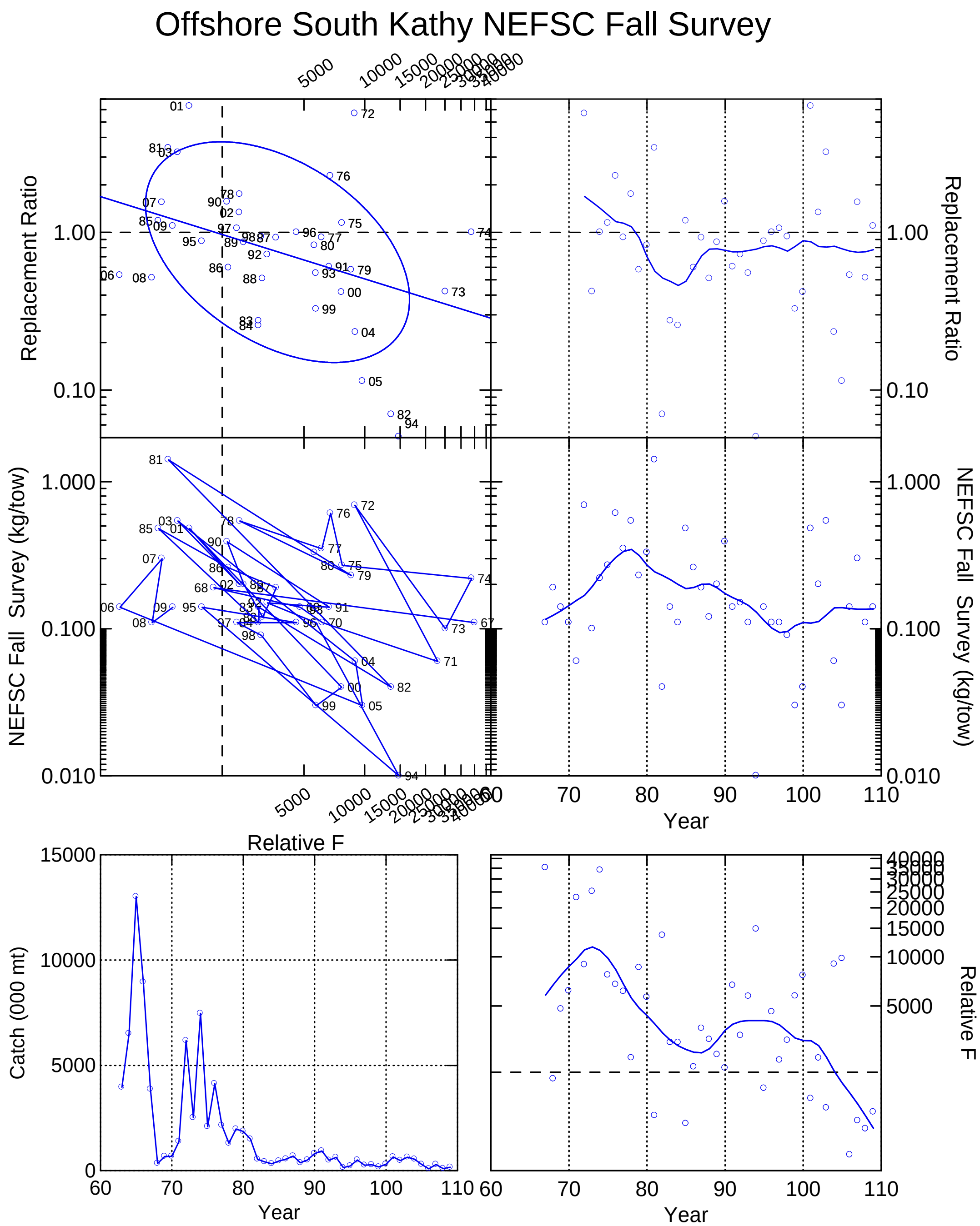


Figure D36. Six panel plot for offshore hake depicting trends in relative biomass, landings, relative fishing mortality and replacement ratios for the NEFSC spring bottom trawl survey index and landings based on the Sosebee method . Horizontal dashed lines (---) represent replacement ratios in the top two panels and the replacement F in the lower right panel. Smooth lines represent Lowess smooths (tension =0.3). The confidence ellipse in the top left panel has a nominal probability level of 0.68. The regression line in the top left panel is a robust regression using bisquare downweighting of residuals.

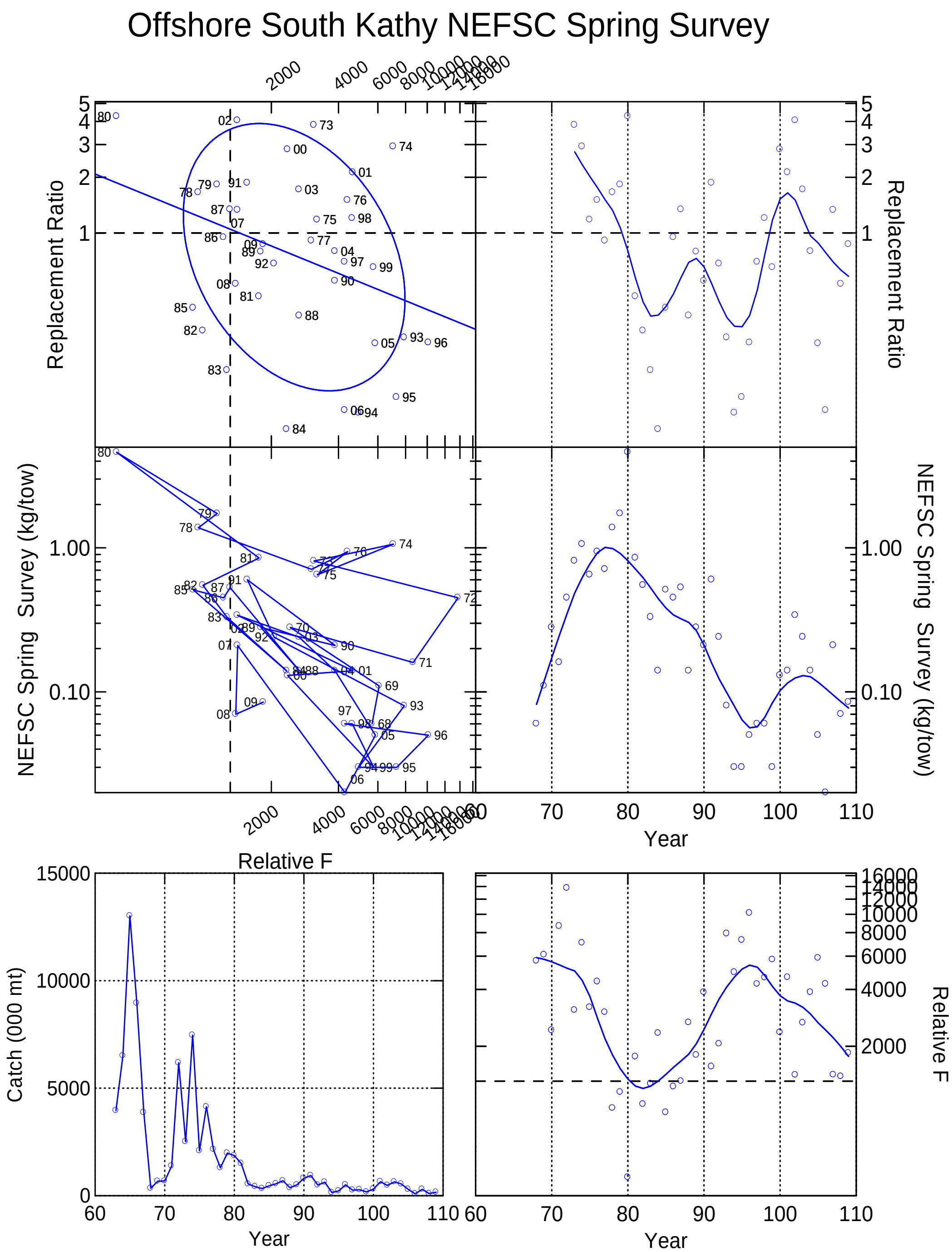
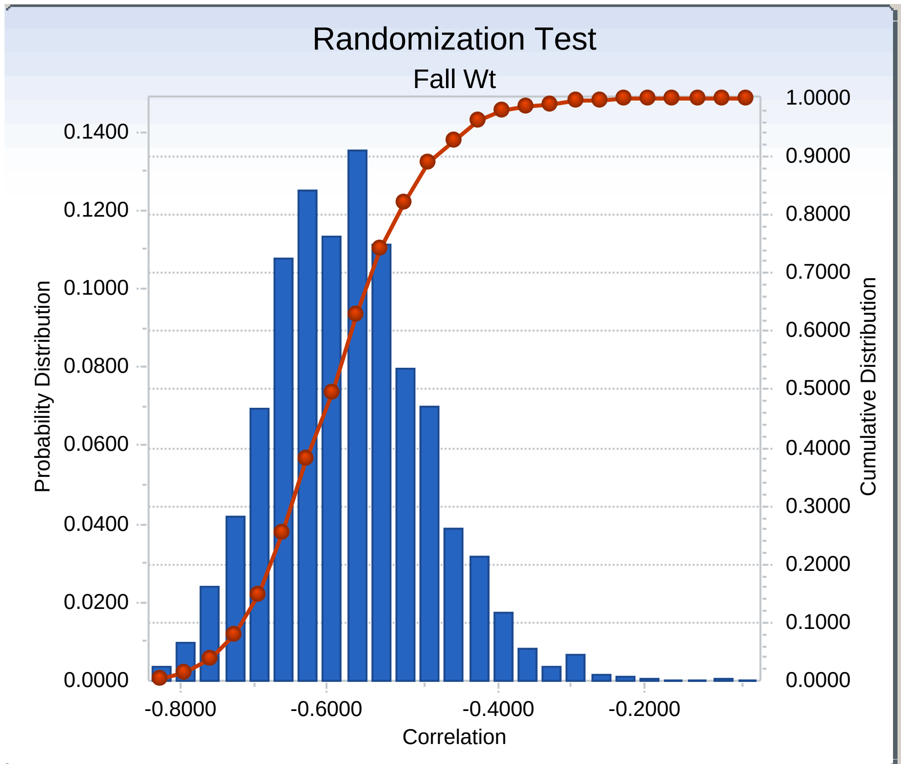


Figure D37. Randomization tests summary of sampling distribution of correlation coefficient between replacement ratio and relative F for fall (top) and spring (bottom) survey indices.



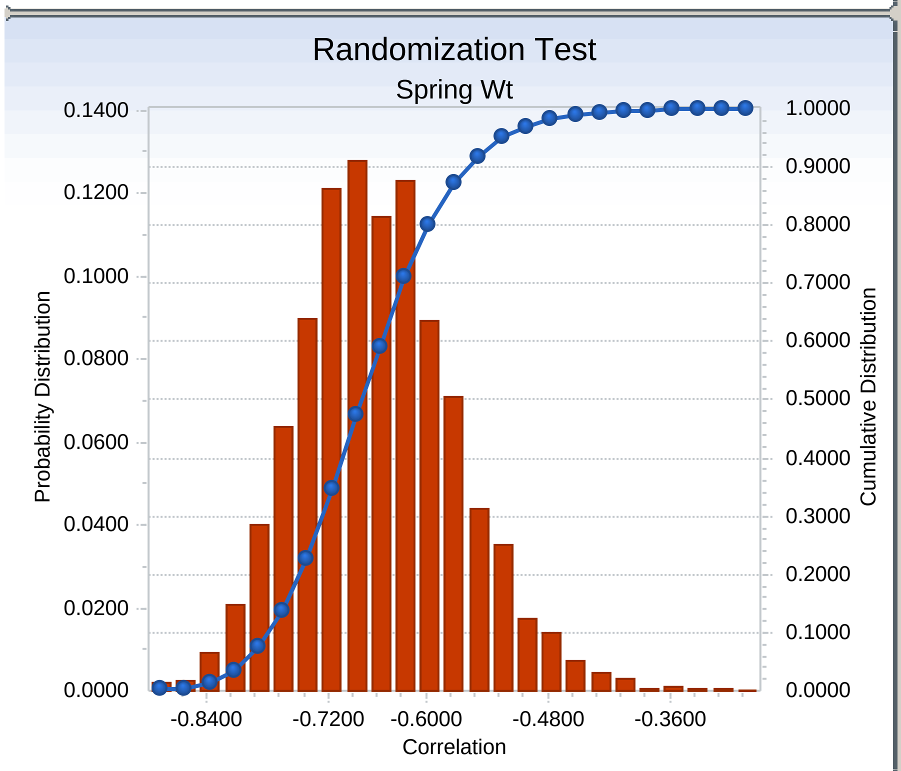


Figure D38. Exploitation ratios for total catch (total catch/swept area biomass) for offshore hake during fall surveys.

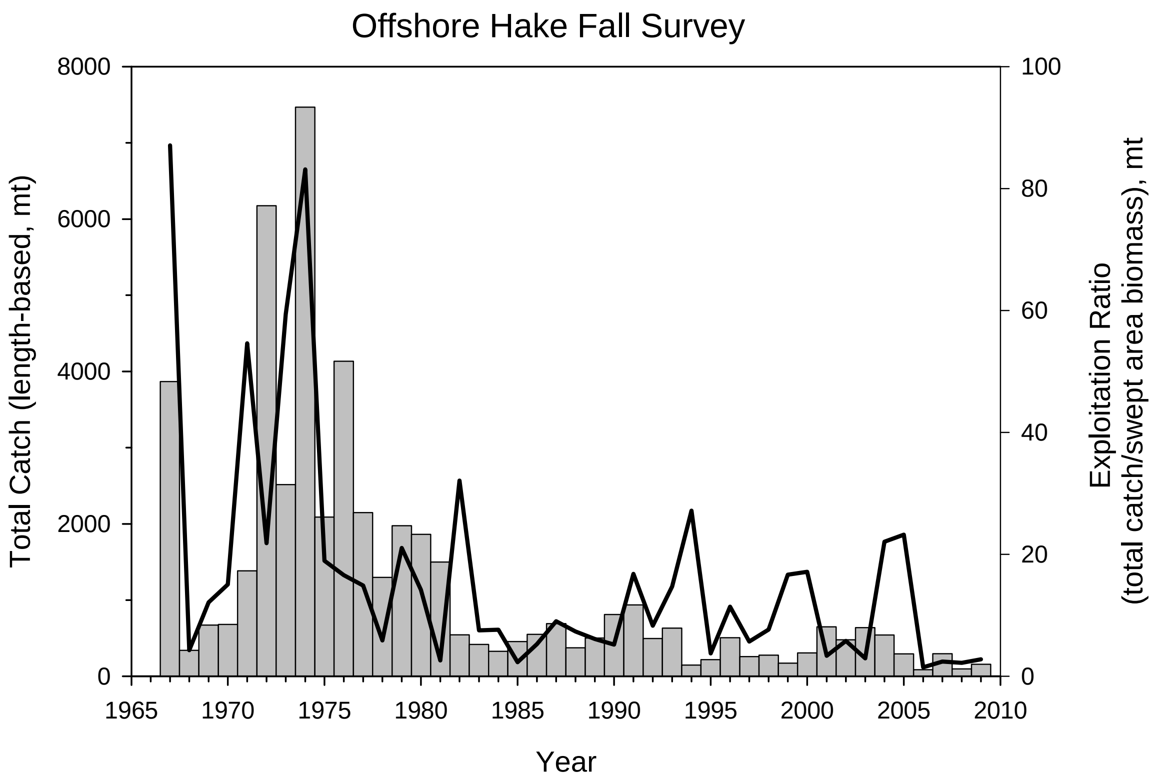


Figure D39. Exploitation ratios for total catch (total catch/swept area biomass) for offshore hake during spring surveys.

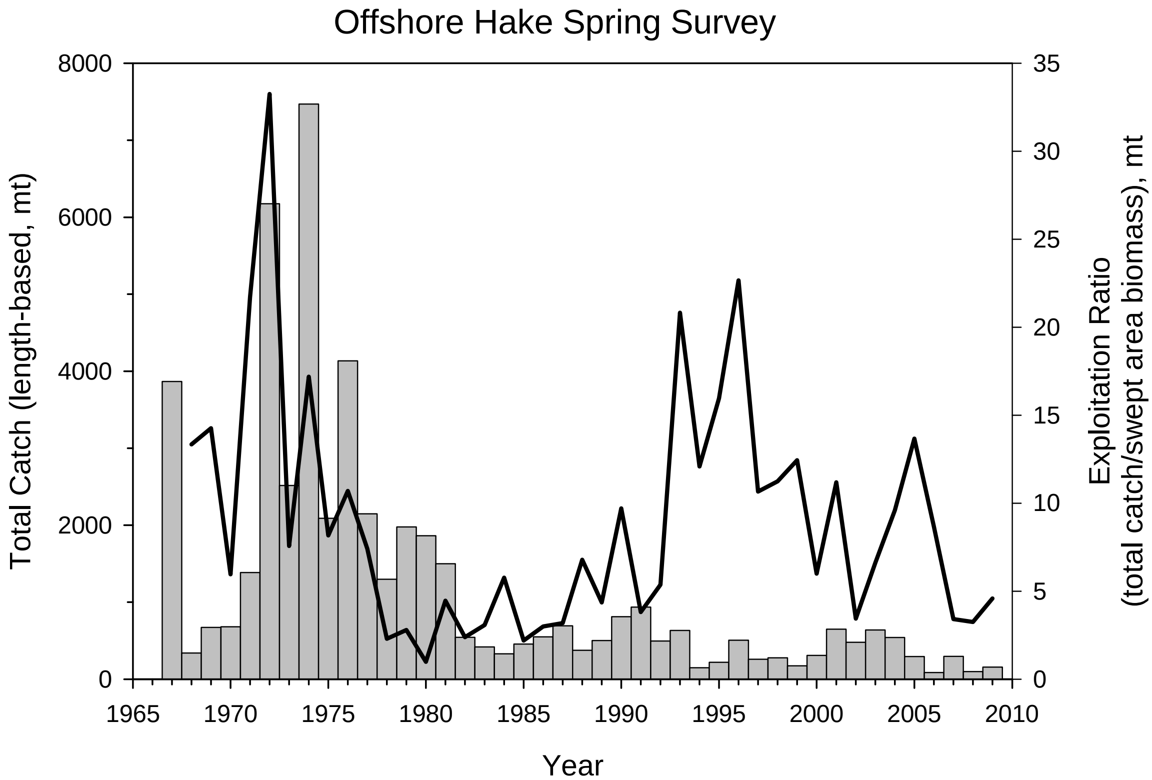


Figure D40. Exploitation ratios for total catch (total catch/swept area biomass) for offshore hake during winter surveys.

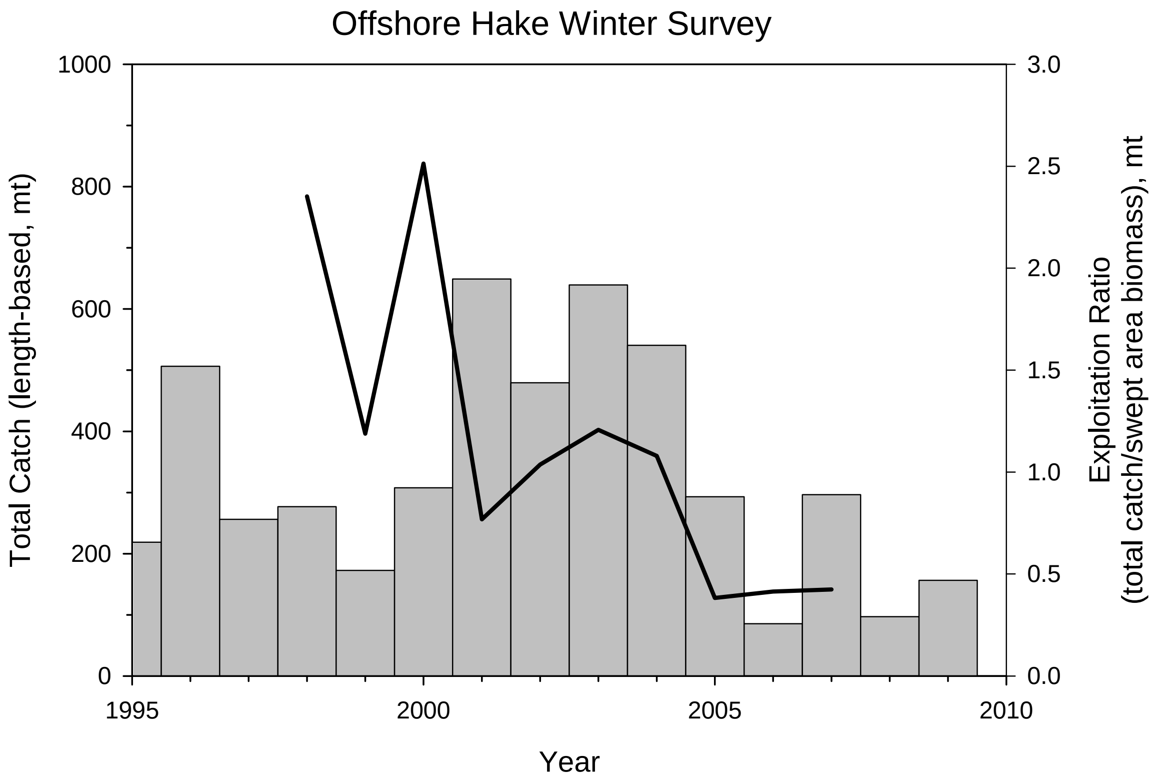


Figure D41. Exploitation ratios for landings (landings/swept area biomass) for offshore hake during fall surveys.

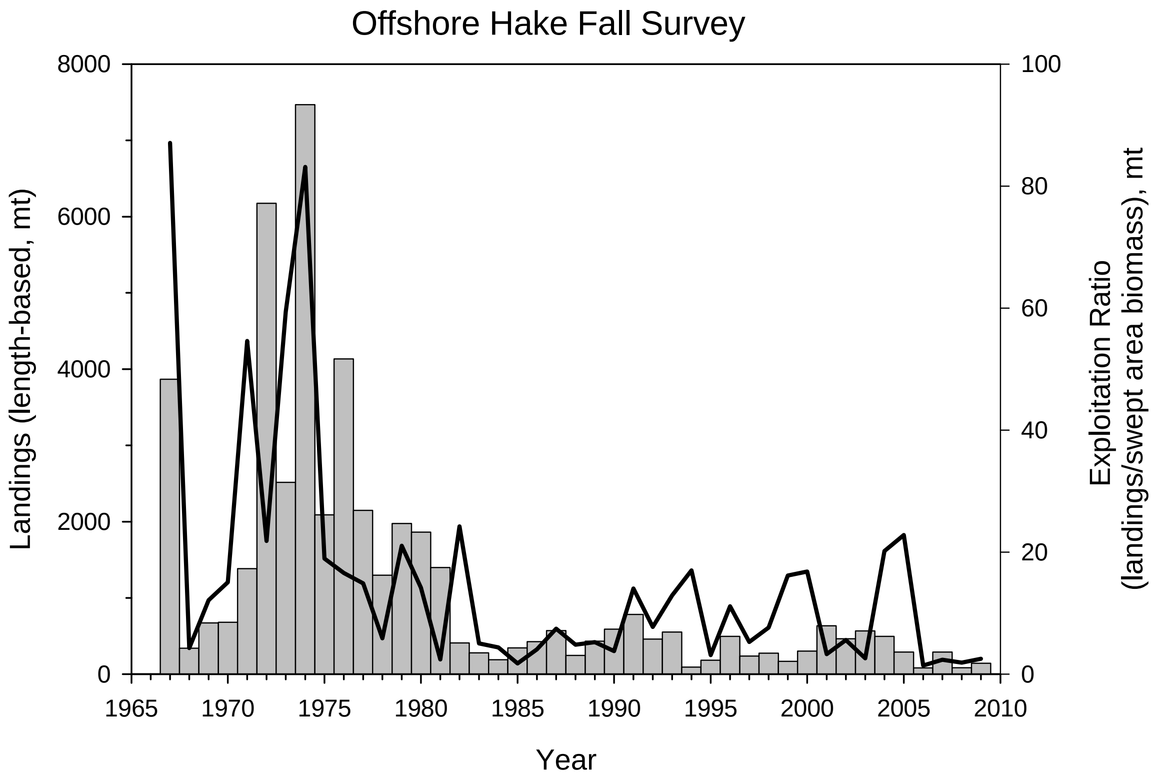


Figure D42. Exploitation ratios for landings (landings/swept area biomass) for offshore hake during spring surveys.

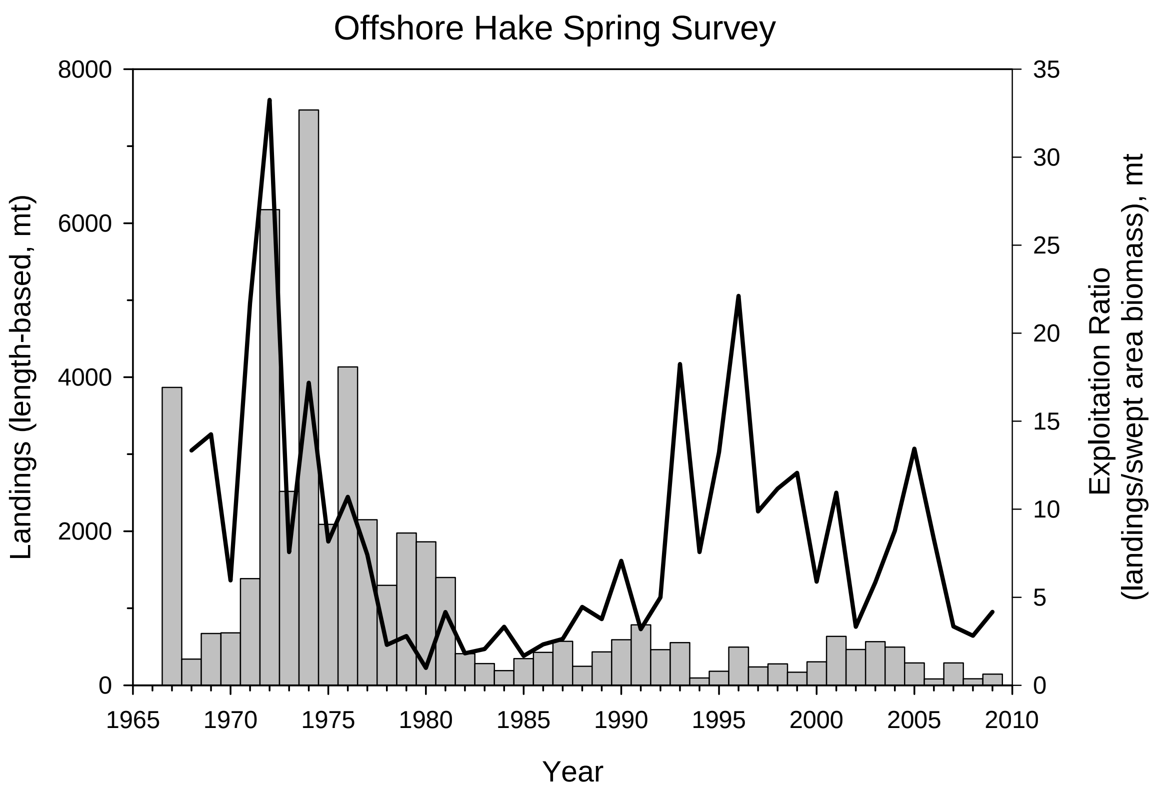
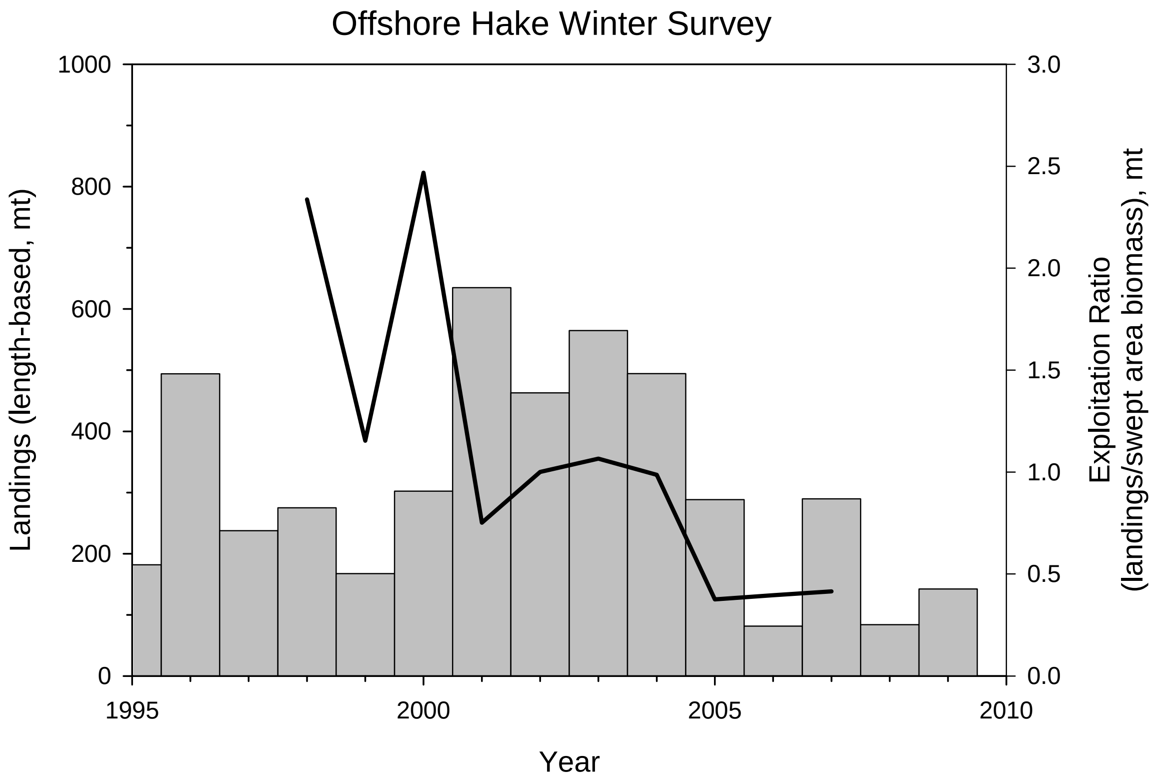


Figure D43. Exploitation ratios for landings (landings/swept area biomass) for offshore hake during winter surveys.



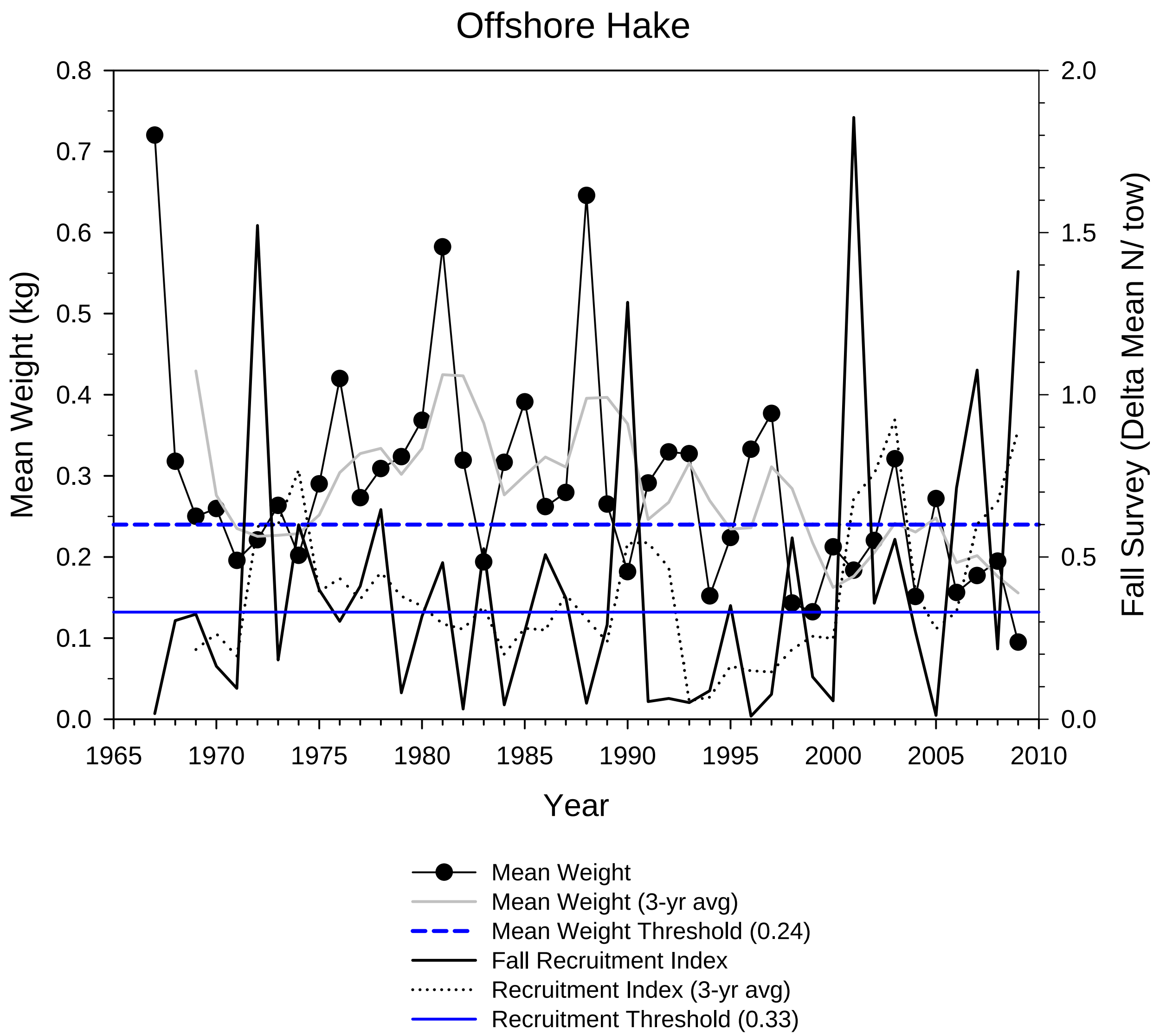


Figure D44. Comparison of current stock status indicators to existing biological reference points for offshore hake.