B. GULF OF MAINE/GEORGES BANK WHITE HAKE (*UROPHYCIS TENUIS*) STOCK ASSESSMENT FOR 2013, UPDATED THROUGH 2011

The White Hake Working Group (WHWG) prepared the assessment. The working group held two meetings. The meeting dates, locations, and participants are listed below.

WHWG Data Meeting
- December 10-12, 2012
- Northeast Fisheries Science Center (NEFSC), Woods Hole, MA

WHWG Models and Biological Reference Points Meeting
- January 7-11, 2013
- Northeast Fisheries Science Center (NEFSC), Woods Hole, MA

White Hake Working Group:
Gary Shepherd – NEFSC (Chair)
Katherine Sosebee – NEFSC (Lead Scientist)
Liz Brooks – NEFSC
Doug Butterworth – University of Cape Town, South Africa
Chris Legault – NEFSC
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White Hake Data and Model Meeting Participants:
Larry Alade – NEFSC
Jessica Blaylock – NEFSC
Jon Deroba – NEFSC
Bill Duffy – NEFSC
Ed Houde – Chesapeake Biological Lab, Univ. MD
Anna Murex – NEFSC
Julie Nieland - NEFSC
Paul Nitschke – NEFSC
Jim Odlin – Maine commercial fishermen
Paul Rago – NEFSC
Maggie Raymond - Associated Fisheries of Maine
Eric Robillard – NEFSC
Fred Serchuk – NEFSC
Sally Sherman- ME DNR
Michele Traver – NEFSC
Jim Weinberg – NEFSC
Susan Wigley – NEFSC
Tony Wood – NEFSC

TERMS OF REFERENCE (TORs)

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of fishing effort. Characterize the uncertainty in these sources of data. Analyze and correct for any species misidentification in these data. Comment on the consistency of the approach to identify the catch of white hake with respect to that used in the red hake assessment.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

3. Evaluate the utility of pooled age-length keys for development of a stock assessment model.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.

5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.

a. If possible update the ASPM with new data and evaluate stock status (overfished and overfishing) with respect to the relevant BRP estimates.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., the probability density function) of the OFL (overfishing level) and candidate ABCs.

a. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).
b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

8. Evaluate the validity of the current stock definition, taking into account what is known about migration among stock areas. Make a recommendation about whether there is a need to modify the current stock definition for future stock assessments.

9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in the most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

EXECUTIVE SUMMARY

TOR 1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of fishing effort. Characterize the uncertainty in these sources of data. Analyze and correct for any species misidentification in these data. Comment on the consistency of the approach to identify the catch of white hake with respect to that used in the red hake assessment.

Landings of white hake were summarized from 1893-2011.The landings in the early part of the time series are almost double any landings since 1964. Landings from the stock unit in the late 1960s were low at about 1,200 mt, and then increased through the 1970s and 1980s, peaking in 1992 at 9,600 mt. Landings then decreased to about 1,400 mt by 2008, and were about 3,000 mt in 2011. The major gear type is otter trawl followed by sink gill net. The second half of the year generally accounts for higher landings than the first half. A new source of landings (red/white hake market category) was split between red and white hake to better account for removals. For the first time, recreational catch was summarized but have not been included in the stock assessment model since there are no length data available to characterize the length/age composition. Discards were estimated using the SBRM protocol. The approach used to estimate white hake catch using nominal landings and discards is now consistent with the red hake assessment. Spatial distribution of landings, effort, and observer coverage was presented. There appears to be a concentration of landings in the otter trawl fishery in recent years. Length and age composition of landings, discards and total catch were developed.

TOR 2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

Landings per unit effort (LPUE) were analyzed for the otter trawl and gill net fisheries. For the otter trawl fishery, all trips as well as those trips for which white hake accounted for more than forty percent of the landings (directed trips). The LPUE index for all trips showed that LPUE in 2011 was at the time series high. The directed LPUE and the gill net LPUE had increased but were not the highest values in the time series.

Indices of abundance and biomass were presented for the NEFSC spring and autumn surveys, ASMFC shrimp survey, Massachusetts DMF spring and fall surveys, and ME/NH spring and fall surveys. NEFSC spring stratified mean number and weight/tow indices declined from 1990 to 1997 and have slowly increased. The autumn weight per tow index fluctuated around 5 kg/tow in the early 1960s and increased to approximately 12 kg/tow during the 1970s. The autumn weight per tow index fluctuated around 10 kg/tow from 1983 to 1993. The index then declined to below 4 kg/tow in 1999, increased due to a moderately good year class. Following a decline through 2007, the index has since increased. The biomass index from the ASMFC shrimp survey shows a decline through 1997, an increase through 2002 and no trend since 2002. The Massachusetts DMF and ME/NH surveys were very variable. Length compositions were shown for all of the surveys. Age compositions for the NEFSC spring and fsll surveys were developed using survey age-length data while the MA DMF and ME/NH surveys were aged using length-slicing.

TOR 3. Evaluate the utility of pooled age-length keys for development of a stock assessment model.

An evaluation of the utility of pooled ALKs in developing a stock assessment model was conducted. Two stock assessment models were run using four sets of age compositions derived using pooled and non-pooled ALKS. The results of each model were similar under the four options. The differences were more striking between models than between age compositions. Reference points were derived for each of the possibilities and the terminal year stock sizes compared to the reference points. Stock status was the same across models and age composition type.

TOR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catchand fishing mortality.

The ASPM assessment model used for the most recent assessment of white hake (GARM III, 2008) was updated to account for the major changes to the data inputs as well as four additional years of catch and survey data. The major changes to the input data include:

-*Updated length-weight equations.*

-*Updated maturity ogive.*

-*Re-estimated commercial landings-at-age.*

-*Re-estimated discards-at-age.*

-*Updated catch and stock weights-at-age.*

-*Re-estimated survey indices.*

The ASPM (see Appendices B1 and B2) was also modified to include:

1. Baranov catch equation instead of Pope's approximation.
2. Survey season: spring and autumn instead of begin and mid-year.
3. Survey variance: use input CV's and estimate additional variance, instead of estimate year-independent variance.
4. ϕ estimated instead of fixed at 0.2.
5. μ_{spawn}=0.25 instead of 0.1667.
6. Use age-dependent σ_a for CAA.
7. Flat commercial selectivity from age 6.
8. Commercial selectivity blocks (1963-1997, 1998-2011).

The updated ASPM (described above) is not the accepted model for this stock assessment. Rather the SARC56 panel accepted a model known as ASAP (described below).

In this updated assessment a statistical catch-at-age model (ASAP) was developed to estimate stock sizes and fishing mortalities. The reasons for selecting the ASAP model include: the ability to update the model *within the NEFSC and similar results to the ASPM. Based on ASAP, total SSB has ranged from 7,847mt to 34,399 mt during the assessment time period, with SSB in 2011 estimated at 26,877 mt (90% CI = 23,127 – 30,729 mt). Total January 1 biomass is estimated at 31,225 mt (90% CI =27,110 – 35,515 mt). Recent F's are near historic lows, with the 2011 fully recruited Ffull =0.13 (0.11 –0.16).*

A retrospective analysis for the 2004-2011 terminal years indicates small retrospective error in F and SSB with the tendency for the model to underestimate F and overestimate SSB. The F retrospective error ranged from -0.03 in 2010 to -0.24 in 2005. SSB retrospective error ranged from 0.03 in 2010 to 0.28 in 2005. Retrospective error in age 1 recruitment varied from -0.04 in 2007 to 1.56 in 2004.

An historical restrospective indicated that the stock status has been robust to the model type and data changes.

TOR 5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

The existing reference points derived at GARM III from the ASPM for white hake are:

> *Fmsy proxy (= F40%) = 0.125 (on age 6)*
> *SSBMSYPROXY = 56,300 mt*
> *MSY = 5,800 mt*

The new reference points derived at SARC56 based on the ASAP model for white hake are:

> *Fmsy proxy (= F40%) = 0.2 (on age 6)*
> *SSBMSYPROXY = 32,400 mt*
> Overfished threshold = ½ *SSBMSYPROXY = 16,200 mt*
> *MSY = 5,630 mt*

See the BRP section of this report for details about the decision to retain F40% as the F_{MSY} proxy.

TOR 6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.

a. If possible update the ASPM with new data and evaluate stock status (overfished and overfishing) with respect to the relevant BRP estimates.

The ASPM was updated with the new catch and survey data. Because of these data changes, the reference points from the GARM III ASPM are no longer valid for stock status determination.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

Based on the new ASAP model and BRPs recommended by the SARC56 panel, white hake is not overfished and overfishing is not occurring. Spawning stock biomass (SSB) in 2011 is *estimated to be 26,877 mt which is 83% of the revised SSBMSY proxy (32,400 mt). The 2011 fully selected fishing mortality is estimated to be 0.13 which is below (66% of) the revised FMSY proxy (0.20).*

TOR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., the probability density function) of the OFL (overfishing level) and candidate ABCs.

a. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

Short term projections of future stock status were conducted based on the current assessment results without accounting for retrospective bias since the bias was very small. Two sets of recruitment assumptions were used, a long time series (1963-2009) and a short time series (1995-2009). Projections were run under two different F assumptions: FMSY(F40%) = 0.20, and F75%FMSY = 0.15.

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

Uncertainties that were not accounted for by assessment and reference point models were evaluated using model diagnostics. Standard model diagnostics (e.g., residual analyses, retrospective analyses) were used for model validation. A potential source of additional vulnerability is the slightly lower recruitment observed in the last fifteen years when compared with the entire time series. This was accounted for in the projections.

TOR 8. Evaluate the validity of the current stock definition, taking into account what is known about migration among stock areas. Make a recommendation about whether there is a need to modify the current stock definition for future stock assessments.

Information was presented on the distribution of white hake as well as any studies on spawning and larval patterns. Some genetic information exists on Canadian white hake, but does not extend into United States waters. It is likely that there is population structure within the current stock unit. But separate population units were not distinguished based on the information available.. For the purposes of this stock assessment, the current definition is appropriate with a small modification needed to account for different spatial coverage of the new survey vessel.

TOR 9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in the most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

Thirteen previous research recommendations from SARC28 and SARC33 were evaluated. Most have either been addressed or shown to be no longer relevant. Some have been carried forward. A total of nine research recommendations are put forward which either have been combined from previous assessments or are new recommendations.

INTRODUCTION

The white hake, *Urophycis tenuis*, occurs from Newfoundland to Southern New England and is common on muddy bottom throughout the Gulf of Maine (Bigelow and Schroeder 1953; Collette and Klein-MacPhee 2002). Depth distribution of white hake varies by age and season; juveniles typically occupy shallower areas than adults, but individuals of all ages tend to move inshore or shoalward in summer, dispersing to deeper areas in winter (Musick 1974; Markel et al. 1982). Small white hake are difficult to distinguish from red hake, *Urophycis chuss*, likely resulting in a small degree of bias in reported nominal catches of white hake, with potentially red hake being landed as small white hake (Mayo and Terceiro 2005).

Larval distributions indicate the presence of two spawning groups in the Gulf of Maine-Georges Bank-Scotian Shelf region, one which spawns in deep water on the continental slope in late winter and early spring, and a second which spawns on the Scotian Shelf in the summer (Fahay and Able 1989; Lang et al. 1994). Since no spawning has been found to occur within the Gulf of Maine and at least two types of growth patterns are found in the otoliths of white hake in the GOM (Bohan and Burnett, pers. Comm.), the population found in U.S. waters appears to be supported by both spawning events, but spawning groups are not distinguishable in commercial landings. The stock is currently assessed as a single unit in United States waters, although Canadian catch from Georges Bank is included (Figure B1).

The current assessment summarizes all current information on the white hake stock and fishery through 2011. The white hake stock was last assessed and reviewed at the Groundfish Assessment Review Meeting (GARM III) in 2008 (NEFSC 2008). The data for this stock were reviewed at the AOP in 2013, but the model was not updated due to significant changes in the data. The assessment for this stock has evolved over time from index-based in the early 1990s, to a Collie-Sissenwine catch-index model in 1994, and then to an age-structured Virtual Population Analysis (VPA) in 1998. However, the addition of years to the VPA model created a marked retrospective pattern in the assessment in 2001. The assessment moved to a surplus production model which was itself unstable and rejected in 2002. The AIM (catch-index) method was then used to assess the status of the stock relative to biological reference points for the initial Groundfish Assessment Review Panel assessments (GARMs I and II; NEFSC 2002; Mayo and Terceiro 2005). The GARM III Review Panel recommended examining forward projecting length or age-based models to include all sizes of the stock, and suggested a forward projecting age-based model, but with more exploration of the model formulation to mitigate some of the problems encountered in the model. The final GARM III meeting ultimately accepted an Age-Structured Production Model (ASPM). The results of GARM III suggested the stock of white hake was overfished and overfishing was occurring (NEFSC 2008).

[SAW56 Editor's Note: The section headings in this white hake stock assessment report do not correspond directly to the stock assessment Terms of Reference (TORs). To assist readers, the SAW56 Editor has added "TOR #" in various places throughout the report to indicate sections that relate to particular TORs.]

STOCK STRUCTURE (TOR 8)

Little is known about the stock structure of white hake. Studies aimed at determining the existence of more than one stock tend to be confounded with the presence of red hake and the timing and location of sampling. Fahay and Able (1989) used several sources of data to attempt a solution to this problem. The evidence suggests that two groups of white hake exist in the Gulf of Maine-Georges Bank-Scotian Shelf region. The first group arises from a late winter-early spring spawning event which occurs in the deep water of the continental slope from the northeast Gulf of St. Lawrence to Southern New England. The second group spawns in the relatively shallow waters of the Scotian Shelf during the summer. No larvae were found in the Gulf of Maine itself and, therefore, it appears that the Gulf of Maine population is supported by the two spawning events described above. It may be that spawning occurred in the Gulf of Maine in the past (1920s and 1930s) but exploitation in that time period or a change in the environment eliminated some groups which would spawn on bottom structure in the winter (Ames 2012).

A study by Lang et al. (1994) supports the existence of a deep water spring spawning population that recruits to the estuaries in the Gulf of Maine. White hake first appeared as pelagic juveniles occurring in deep, offshore areas. Larger fish (50-80 mm) were found inshore later in the year as demersal juveniles. There was a northward progression of size and age from spring to summer, but no evidence of summer spawned fish recruiting to the Gulf of Maine estuaries was found. The timing of sampling suggests that the study may have missed these fish.

An age validation study (Bohan and Burnett, pers. comm.) revealed that three growth patterns may exist among Gulf of Maine - Southern New England white hake. The predominant pattern indicated winter-spring spawning event and accounted for over 90% of the samples. The second pattern showed a later spawning period because the fish were smaller in size at age and the size of the nucleus of the otolith was much smaller than the predominant pattern. This growth pattern occurred in fish from offshore strata 29, 30, and 36, closest to the Scotian Shelf. The third growth pattern was found in a limited number of white hake caught on the southern slope of Georges Bank. These had poorly defined annuli which made ageing impossible.

A genetic study conducted in Canadian waters concluded that there were three distinct genetic populations, Gulf of St. Lawrence, Grand Bank, and Scotian Shelf (Roy et al. 2012). However, these three genetic groups were caught in all three locations, so they are not spatially separate groups. No data were collected for fish in United States waters, so it is unknown whether the Scotian Shelf group would be separate from the Gulf of Maine. Given that some of the Gulf of Maine stock is supported by spawning on the Scotian Shelf, it is unlikely.

In light of the evidence above, all the white hake found in US waters were treated as one stock. Information from the Northeast Fisheries Science Center (NEFSC) spring and autumn bottom trawl surveys reveals that in the spring (during or just after spawning) white hake are located in deep water and are not found in inshore waters as often as in the autumn surveys (Figures B2 and B3). The fish may be spawning in deeper waters beyond the range of the survey coverage in the spring. Survey indices from various strata sets (Figures B4, B5 and B6) demonstrate that the Gulf of Maine area (Strata 26-30, 36-40) exhibits the same basic distribution pattern of abundance and biomass as the Georges Bank area (Strata 13-25), although the levels of abundance and biomass are quite different between areas. Southern New England (Strata 1-12) did not show the same abundance and biomass distribution pattern but this area (and all other areas, including the Mid-Atlantic (Strata 61-76) and inshore areas) contributes insignificantly to the total stock biomass (Figures B7 and B8). In previous assessments, offshore strata 33-35 were included in the strata setIt should be noted that these strata occur almost entirely in Canadian waters. In 1987, stratum 35 was split into two areas and only the southern area was sampled. In 2009, with the switch to the new survey vessel FRV H.B Bigelow, stratum 33 was discontinued due to the inability to effectively sample the irregular bathymetry of this stratum . To keep the strata set more consistent with the commercial landings, these were eliminated since the overall trend is similar (Figures B9 and B10). Therefore, for the purpose of the current assessment, landings from the Gulf of Maine and south (SA 464, 465, 511- 640) and the survey strata set from the Gulf of Maine to Northern Georges Bank

(21-30, 36-40) were used. This area accounted for over 95% of landings (Table B1) and around 85% of the whole survey swept-area biomass and 80% of the whole survey swept-area abundance.

THE FISHERY (TOR 1)

Commercial Landings

For this stock assessment the landings have been re-compiled and some changes have been made to the previous assessments (Burnett et al. (1984), NEFC (1986), NEFC (1991), NEFSC 1995, NEFSC 1999, NEFSC 2001, 2002, 2008, Mayo and Terceiro 2005). The first change is due to the inclusion of historical data collected by some states but not included in the NEFSC Weighout Database until later years. The data sources for the new landings by state are given in Table B2. The second difference is found between live pounds calculated using current conversion factors and the live pounds retrieved directly from the NEFSC Weighout Database in some years (Table B3). From 1975-1981 and 1985-1990, the market categories did not always have the correct conversion factor applied. All subsequent figures and tables use the calculated live weights.

Total landings of white hake decreased from 2,971 mt in 1964 to a low of 1,147 mt in 1967 (Table B4, Figure B11). Landings then gradually increased and peaked at 8,304 mt in 1985. Landings fluctuated around 5,000 to 6,000 mt until they peaked again in 1992 at 9,582 tons and declined slightly to 9,149 tons in 1993 (Table 4). Landings fell sharply to a 1997 level of 2,513 tons but increased moderately to 4,564 tons in 2003. Landings then declined to a low of 1,372 mt in 2008 followed by an increase in 2011 to 2,983 tons. The US has accounted for the major portion of landings with small amounts landed by Canada. Landings from other countries have been negligible since 1977.

The primary gear type used to catch white hake is the otter trawl, accounting for 37-83 per cent of the total United States landings (Table B5, Figure B12). Historically, line trawls and long-lines were also important, but from 1980 to 1990, this gear accounted for less than 5% of the total. This gear type again increased in importance and averaged 16% of the total landings between 1992 and 1998. Since then the landings from these gear types averaged less than 10 percent and are now less than one per cent of the total. Sink gill nets historically (1960s) accounted for less than 10% of total landings but the share increased in the 1970s to between 20 and 40% of the total.

The primary season for landing white hake is summer or quarter 3 (Table B6, Figure B13). The highest percentage of landings occurs in August, with the months of July, September and October each accounting for around 10% of the annual landings (Table B7). The percentages for September and October have declined slightly over time with the 1994-2011 average being less than the time series average (Table B7).

White hake landings occur primarily in the New England states of Maine and Massachusetts. Landings have been dominated by Maine with average landings between 35 and 70% of the total US landings between 1962 and 2007, however the percentage has declined to less than 20 through 2011 (Table B8, Figure B14). Massachusetts landings exceeded those of Maine from 1968 to 1974 but have accounted for 20 to 40% of the total landings from 1975-2005. Since 2006, Massachusetts landings of white hake have increased to over 80% in 2011. New Hampshire landings have been variable over time but have accounted for over 10 percent of the landings in some years (1980, 1999, and 2000). Other states contributing to landings are Connecticut, Rhode Island, New York, New Jersey, Delaware, Maryland, North Carolina and Virginia.

Under-tonnage vessels (less than 5 GRT) and unknown vessels (trips aggregated together) traditionally accounted for between 20 and 40% of US landings (Table B9). Since mandatory vessel trip reporting was implemented in 1994, these have become less important and have not been represented in the total landings except for a few years after the implementation of electronic dealer reporting in 2004. Tonnage classes 2 and 3 (5-50 GRT and 51-150 GRT, respectively) have accounted for the majority of the landings with tonnage class 3 dominating landings for the last twenty years. The landings of tonnage class 4 vessels (151-500 GRT) increased in importance in the 1980s and 1990s.

In 1986, a market category that combined red and white hake was created in some ports. In previous white hake assessments and the past red hake assessment, these landings were ignored. For this assessment, the landings of this market category were split between red and white hake based on the proportion of the commercial landings of the two species by statistical area (Table B10). These landings will be added to the total white hake landings.

Records of historical landings of white hake from the United States were discovered at ICNAF (1952) and (Table B11, Figure B15). These landings ranged from almost 22,000 mt in 1898 to 5,500 mt in 1950 with many years more than double the largest landings seen since 1964.

Distribution of Landings and Effort

Landings of white hake generally occur throughout the Gulf of Maine in the otter trawl fishery (Figures B16-B19). In the early part of the time series (1975-1980s), the highest concentration of landings appears to be in deeper waters, but this could also be due to more of the data in that time frame reported in quarter-degree squares and not to the current ten-minute square resolution of the maps. In the later part of the time series (2005 and later), there appear to be two areas, one in the western Gulf of Maine and the other towards the Hague Line (International Boundary) in the eastern Gulf of Maine (Figure B19). From 2008-2011, there has been an increase in landings in the Western Gulf of Maine (Figure B20). Landings from the sink gill net vessels generally are more inshore, although these data also suffer from the quarter-degree square reporting issue (Figures B21-B24). In the 1990s, there was an increase in landings in the eastern Gulf of Maine just north of Georges Bank (Figure B22). The later part of the time series does not show the same increase as the otter trawl landings (Figures B24-B25) until a small increase in 2011 (Figure B25).

Effort for otter trawl trips that caught white hake is concentrated in the deeper basins of the Gulf of Maine (Figures 26-29) and has declined over time. The effort has not increased over the last four years to the extent that the landings have (Figure B30). Effort for sink gill net trips is generally concentrated in the western GOM (Figures B31-B32). Reported effort over the last four years has been stable (Figure B33).

Recreational Catches

White hake recreational catches reported in the Marine Recreational Fishery Statistical Survey (MRFSS; now the Marine Recreational Information Program [MRIP]) since 1979 have generally been low, but have been summarized in Table B12. Since some of the recreational fishery takes place in January and February, which are not sampled by MRFSS/MRIP, the reported landings of white hake from the party/charter sector were summarized as well using Vessel Trip Report (VTR) data (Table B12).

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 discard to kept (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), calendar quarter, and region (New England, Mid-Atlantic), 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 white hake.

The discard ratio for hakes in stratum h is the sum of discard weight over all observed trips divided by sum of kept weights over all observed 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 estimated discard ratio R and the total landings for the fishery, defined as stratum h, i.e., $D_h=R_hK_h$.

Values for cells with less than three trips were imputed using annual averages by gear type and region. To hind-cast the discards to 1964, 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. Five-year average rates (1989-1993 and 1992-1996) were used to test the sensitivity of the estimates to the time period chosen for hind-casting. Discard mortality is assumed to be 100% given that white hake usually have everted ('blown') stomachs when they are caught.

The direct discard estimates range from 36 mt in 2007 to almost than 1,500 mt in 1993 (Table B13). The overall CV varied from 12.5% in 2011 to a high of 44% in 2003. The majority of the discards come from both the small and large mesh otter trawl fisheries (Tables B14-B16) with a few high estimates coming from the scallop dredge fisheries. The high values in 1989, 1990, 1993, and 1998 appear in the estimates regardless of the stratification scheme used (Figure B34) and may be related to good year classes. The hind-cast estimates using a three-year average are higher than the five-year average since the rates were higher in 1989 and 1990 than in 1992 (Figure B35).

Discards of white hake generally occur in the same locations as the kept portion of the catch on observed trips (Figures B36-B47). In the large-mesh otter trawl fishery (>= 5.5in mesh), there are some discards that occur in the Mid-Atlantic region, likely on summer flounder trips, in which few, if any, white hake are kept (Figures B36-39). The small-mesh otter trawl fishery occurs only in a few places in the Gulf of Maine and targets mainly silver hake and some squid (Figures B40-B43). In the Mid-Atlantic region, the targeted species are the two squid species, silver hake, scup, and black sea bass. These trips generally do not keep white hake. Most of the white hake caught on sink gill net trips is caught in the Gulf of Maine and not in the Mid-Atlantic (Figures B44-B47).

Total Catch

There was no hind-casting of the discards and foreign catch prior to 1964 (Figure B48). This would generally add another 20 percent to the total using an average proportion for the whole time series or 40% using the first 3-5 years of the time series. The White Hake Working Group (WHWG) decided that either assumption could be used but that neither was sufficiently reliable to put in place. Therefore the raw data were used in certain cases.

Species Composition of Catch

The GARM III Panel (NEFSC 2008) recommended using the ratio of white hake to red hake in the survey to split out white hake catch. This involved estimating red and white hake landings-at-length as well as red and white hake discards-at-length. These estimates were used for the GARM III white hake assessment. The method used has been further refined for the 2008 skate complex assessment (NEFSC 2009) and during the 2011 SAW 51 red hake assessment (NEFSC 2011). The red hake analysis required splitting the length samples for both species by the red hake stock areas to get red hake landings by stock area. The numbers of samples by area were minimal for red hake in the north and not adequate for white hake calculations in the south (Tables B16-B18). Because of this poor coverage and some resulting shifts in historical catches from red hake to white hake, the 2011 SAW 51 decided to use nominal catch for red hake. Therefore, nominal catches are also used for the current white hake assessment. The total catch for white hake is now generally less than that used in the 2008 GARM III assessment (Figure B49) except for the first few years of the time series. The WHWG decided that the catches from 1991-2011 were the best data because the discards were directly estimated and therefore should get a small coefficient of variation (CV) of 0.05 for modeling purposes. The catch from 1989-1991 had partially hind-cast discards and therefore the CV should be higher (0.08 was chosen). The CV on catch with completely hind-cast discards estimates was set at 0.15 while the first year of catch (1963) in which no hind-cast estimates were available was set to 0.25.

Length and Age Composition

Since the majority of white hake are landed in headed and gutted condition, length measurements have not generally been available from port samples. A regression developed to convert dorsal fin-caudal fin length to total length (Creaser and Lyons, 1985),has allowed measurements obtained from landed catch to be used to evaluate overall length composition since 1985. Age samples are still unavailable from port samples since otoliths are the structures used for ageing and are lost when the head is removed.

Commercial length composition during 1985-2011 was estimated by market category (pooling small and medium size categories together) from length frequency samples, pooled on a semiannual basis (Table B19). The sampling intensity overall has been adequate (< 300 mt/sample), except in 1989 and 1995 when only 13 and 12 samples were taken (350 mt/sample and 361 mt/sample). The sampling intensity in 1997 was very good (32 mt/sample), but the unclassified market category had only one sample for the entire year. In 1999 and 2000, there were no samples for the unclassified. The landings for this group were small so the landings were added at the end from 1998-2011. Since the landings of the red/white market category have never been sampled, the mesh size used to land white hake was examined (Table B20). On average, more landings come from small mesh than large mesh (Table B21). The WHWG also discussed whether large white hake would be landed in a mixed market category since these would obviously be white hake. Therefore, the decision was made to include the mixed red/white hake market category with the small/medium white hake market category.

Mean weights were obtained by applying the NEFSC semiannual survey length-weight equations using data from 1992-2012 to the semiannual market category length frequencies (Figure B50), as below:

ln Weight (kg, live) = -12.8621 + 3.2641*ln Length (cm) – Spring
ln Weight (kg, live) = -12.4856 + 3.1906*ln Length (cm) – Autumn

An examination was made of the annual estimates of the spring (Figure B51) and autumn (Figure B52) length-weight relationships, but there was no pattern and the WHWG decided to use a single equation for each season. Mean weight values were then divided into semiannual market category landings to derive estimated numbers landed by market category. These numbers were then summed over market categories and half-years to produce annual length compositions. Age-length keys were derived from NEFSC survey data for 1985-1988 and 2001-2011 (Table B22). Survey data for 1989-2000 were combined with data collected from observed trips. Age structures have been collected on observed trips from 2001-2011but not aged. The autumn survey for 2003 has not been aged and a pooled key using ages from 1982-2004 (without 2003 for fall) and 2011-2012 was used to fill in the year. The other years of survey data did not become available until after the pooled catch-at-age was computed. Commercial landings-at-age were derived by applying these age-length keys to the length composition. Estimates of US landings-at-age in numbers, weight, and mean weight at age are shown in Tables B23-Table25 and in Figure B53. Even with the addition of age data from the observer program, there is a great deal of imputation needed to fill in lengths with missing ages (Tables B26-B27). Most of the imputation occurs at the older ages (9 and 10+) which should have a minimal impact on the assessment.

The length composition of the otter trawl portion of the discards was characterized from the Fishery Observer Program (FOP) length samples by mesh size (Table B28-B29) because the length compositions of the two mesh sizes were different (Figure B54). The sampling in some years was poor to nonexistent and years were required to be pooled together (Table B30). The scallop dredge and shrimp trawl discards (Table B31) were added to the small-mesh otter trawl length composition based on the overall similarity between the length compositions of the gear types (Figure B54). The longline discards were combined with the large-mesh otter trawl discards. The sampling of discards from sink gill nets has not been adequate for characterizing that fleet sector (Table B29), but in looking at the overall length composition (Figure B55), the sink gill net discards were added to the total catch once the landings and discards were combined. The same age-length key used for commercial landings was used to derive the age composition shown in Table B32-Table B33and Figure B56. The amount of imputation needed for the discarded portion of the catch was less than for the landings-at-age since there are fewer old fish in the discards (Tales B35-B36, B40-B41). In a few years, the age zero fish were almost entirely imputed.

The two age compositions were combined to get a catch-at-age for 1989-2011 (Tables B37-B38, Figure B57). Since there are no length samples with which to characterize the recreational component of the fishery, and since the landings were very low, they were not included in the CAA. The mean weights at age do not show much of a trend over the time series, except a possible slight increase in the last three years (Table B39, Figure B58). The mean weight of age 9+ fish is very variable and is due to sparse sampling of the 9+ age classes.

STOCK ABUNDANCE AND BIOMASS INDICES (TOR 2)

Commercial LPUE

United States commercial LPUE (landings per unit effort in metric tons landed per day fished) indices for white hake were calculated for otter trawl trips that landed any white hake. Indices were also derived for trips that 'directed' toward white hake (white hake accounted for > 40%, 60% or 80% of the total landings for the trip, Table B42, Figures B59-B60). Directed trips at these different percentage levels have generally accounted for only 15%, 4% and 1% of the total white hake landings from otter trawls, and so may not provide a very meaningful index of stock abundance. The higher percentage directed trips (60% and 80% trips) also have years in which no trips met these criteria, so the WHWG decided to only use 40% trips as the cutoff for any standardization for directed trips. Total otter trawl LPUE indices were stable or increased through 1985, generally declined through 1997, and increased to a peak in 2003 (Figure B61). After a small decline through 2008, the indices increased to the highest value in the time series by 2011. The three directed LPUE indices generally show similar trends at the beginning of the time period, peaking in the late 1970s and declining through the 1990s (Figures B61-62). After 1996, the three indices all increase, however the magnitude of the subsequent increases after 1996 vary by index.

United States commercial LPUE indices for white hake were calculated for sink gill net trips that landed any white hake. Indices were also derived for trips that 'directed' toward white hake (white hake accounted for > 40%, 60% or 80% of the total landings for the trip, Table B43, Figures B63-B64). The higher percentage directed trips have generally accounted for 47%, 29% and 5% of the total white hake landings from sink gill nets, and so may not provide a very meaningful index of stock abundance. The higher percentage directed trips (60% and 80% trips) also have years in which no trips (or only one trip) met these criteria, so the WHWG decided to only use 40% trips as the cutoff for directed trips. The effort data for sink gill nets appears to be different between 1975-1993 and 1994-2011. The data collection system changed at that time and the way effort is calculated is likely not the same. Therefore, only data from 1994 onwards are used in the standardization. All four sink gill net LPUE indices generally decreased from 1975 through 1993 ((Figures B65-B66). They also increased from 1994-2003, generally declined through 2008, and increased through 2010. The three directed indices decline in 2011.

Fishing effort was standardized by applying a General Linear Model (GLM) to the LPUE data for all otter trawl trips and for the 40% directed trips. A four-factor model (year, calendar quarter, statistical area, tonnage class) was applied to both datasets and an additional model was applied to all trips which includes an area*year interaction term. These GLMs were applied to ln LPUE data derived for all otter trawl trips taking white hake from 1975 through 2011 (Tables B44 and B45). All of the main effects were highly significant. Standardized effort was calculated by multiplying the nominal effort in each cell by the product of the retransformed ln coefficients for each factor (excluding year). The estimated standardized effort was then summed over all categories to give annual totals (Tables B46 and B47). Trends in the two standardized LPUE series are similar to the trends in the two nominal LPUE indices (Figures B67 and B68). The standardized effort suggests that overall effort has declined since 1992 (Figure B67) while the directed effort was higher in the 1980s than in the 1990s and has recently increased (Figure B68).

Fishing effort was standardized by applying a General Linear Model to the LPUE data for all sink gill net trips. This GLM was applied to ln LPUE data derived for all sink gill net trips taking white hake from 1994 through 2011 (Tables B48). All of the main effects were highly significant. Standardized effort was calculated by multiplying the nominal effort in each cell by the product of the retransformed ln coefficients for each factor (excluding year). The estimated standardized effort was then summed over all categories to give annual totals (Tables B49). The standardized LPUE series is similar to the trend in the nominal LPUE indices (Figure B70). The standardized effort suggests that overall effort has declined since 2000 (Figure B70).

The distribution pattern of weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) in otter trawls has the highest LPUE values occurring in the northeast portion of the Gulf of Maine with lower values of LPUE to the west (Figures B71-B74). There has also been an increase from 2008-2011, in agreement with the LPUE indices (Figure B75). Sink gill net LPUE (Figures B76-B77) is higher in the southeast Gulf of Maine and there has also been a slight increase from 2008-2011 (Figure B78).

Research Vessel Abundance and Biomass Indices

The primary sources of biological information for white hake are the annual fishery independent surveys conducted by the Northeast Fisheries Science Center (NEFSC). The surveys are conducted using a random stratified sampling design which allocates samples relative to the size of the strata, defined by depth. The NEFSC has 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, NC, in offshore waters at depths 27-365 meters, and have been conducted in the fall since 1963 and in the spring since 1968. Details on the stratified random survey design and biological sampling methodology may be found in Azarovitz (1981) and Sosebee and Cadrin (2006). The area used for calculating abundance and biomass indices for white hake is the Gulf of Maine to Northern Georges Bank (offshore strata 21-30 and 36-40). Indices of abundance and biomass were calculated following the methods of Cochran (1977). Vessel (Delaware II vs. Albatross IV), door, and gear effects were not found to be significant for white hake (NEFC 1991). Other surveys used in the analysis of white hake are NEFSC shrimp survey (1985-2012), Massachusetts Division of Marine Fisheries (1978-2012), and Maine-New Hampshire (2000-2012) state surveys.

In 2009 the FRV *Henry B. Bigelow* replaced the R/V *Albatross IV* as the primary vessel for conducting spring and fall annual bottom trawl surveys for the NEFSC. There are many differences in the vessel operation, gear, and towing procedures between the new and old research platforms (NEFSC 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. 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),

(1) $\hat{R}_A = \rho R_B$

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 (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.

Since the 2009 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.

For white hake, a suite of beta-binomial models were fit to the calibration data 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 functions of length. The fitted logistic model with parameters constant across all stations had a sharp increase at about 7 cm (Model 4 in Table B50), but there were only 7 observations from 4 tows for fish less than 7 cm. For six of those observations only the *Albatross IV* caught fish and for the other only the *Henry B. Bigelow* caught fish. This resulted in substantial uncertainty of the calibration factor at those sizes with this model.

Although there were not sufficient numbers of ++ stations (i.e. non-zero catches from both vessels) in each of the spring and fall surveys to estimate seasonal effects, there is sufficient information in the site-specific stations and survey stations to split these groups. Doing so provided a very small decrease in the AIC in the constant calibration factor models (Model 2 vs. Model 1 inTable B50). There is a better fit of the model with different parameters for the spring and fall which is due primarily to the differences in dispersion parameters for the two seasons. The variability in the ratio between tows appears to be much less during the spring than the fall. However, there were only 26 ++ tows in the spring.

For the survey and site-specific data separately, there was no information to support the calibration factor changing with length. As such, the logistic models for those data (not shown) provided the same fit as the constant models. A logistic model fit to all data that forced a negative slope (Model 5 in Table B50, Figure B79) provided a poorer fit than the free logistic model that estimated the increasing slope at the smallest size. Finally, a fitted double logistic model that had both the positive and negative slopes of the two logistic models (not shown) converged but variance estimates were not available due to a non-positive hessian matrix at the maximized log-likelihood. Therefore, the WHWG decided to use the constant calibration estimated by Miller et al. (2010).

Spring stratified mean number and weight/tow indices declined from 1990 to 1997 and have slowly increased (Table B51, Figure B80). The autumn weight per tow index fluctuated around 5 kg/tow in the early 1960s and increased to approximately 12 kg/tow during the 1970s (Table B52, Figure B80). The autumn weight per tow index fluctuated around 10 kg/tow from 1983 to 1993. The index then declined to below 4 kg/tow in 1999, increased due to a moderately good year class. Following a decline through 2007, the index has since increased.

The mean, median and 95th percentile of length compositions from the spring survey have largely declined over the survey (Table B51, Figure B81). The maximum length has also followed this pattern. There was a period of increase in the 95th percentile and maximum during the late 1990s into the early 2000s, followed by a decline. Over the last three years, both have increased, but not to the same value as in the 1970s.

The mean of the length composition of the autumn survey has declined slightly from about 50 cm in the 1970s to just above 40 cm in the last decade (Table B52, Figure B82). The 95th percentile decreased from about 80 cm in the 1970s to 70 cm. The maximum length was stable at around 120 cm from the 1960s to the 1980s. In the 1990s and 2000s, the maximum has been around 105 cm. Length compositions of the spring and autumn surveys show the mode of the length composition is around 40 cm in all years and also show the decline of the larger fish (>= 100 cm) from the 1970s to later periods (Figure B83).

The Atlantic States Marine Fisheries Commission (ASMFC) conducts a summer shrimp survey in the Gulf of Maine. Finfish are also weighed and measured on these surveys and white hake are often caught. The biomass index from this survey shows a decline through 1997, an increase through 2002 and no trend since 2002 (Table B53, Figure B84). The mean length from the shrimp survey has been stable and the 95th percentile of length has increased over the time series (Figure B85). The length composition shows most fish caught are between 20 and 40 cm (Figure B86).

The Massachusetts Division of Marine Fisheries (MDMF) has also conducted spring and fall surveys since 1978 (Howe et al., 1981). The survey only covers a portion of the white hake stock area (Figure B87) but can still be useful, particularly for young fish. The spring survey shows a decline over the time series until about 1991 when it dropped to a low level and remained for most of the time series (Table B54, Figures B88-B91). There is a small increase at the end of the time series. The autumn series is more variable, particularly for abundance but has shown a similar decline (Table B55, Figures B88-B91). The length compositions from the spring survey show more fish less than 20 cm until 2003 when that size class disappeared (Figure B92). The autumn survey has the occasional large amount of small fish, but also has a larger number of 30-40 cm fish (Figure B93).

In 2000, a new survey was implemented in the state waters of Maine and New Hampshire (Figure B94, Sherman et al. 2011). Both the spring and autumn surveys show an increase through 2008 or 2009 followed by a decline (Table B56, Figure B95). The spring length composition shows mostly fish between 17 and 40 cm, with a potential strong year class in 2009 (Figure B96, likely Age 1 fish). The autumn length composition shows a similar grouping of fish, but there are signs of smaller fish (around 9-15 cm) in later years (Figure B97).

Research Vessel Age Compositions

The age data from the spring and fall surveys were used to age the NEFSC spring and fall surveys (by survey) using all available age data, even ages from outside the core area (Table B57) and the Massachusetts spring and fall surveys (by survey). If only the ages from the core area were used, there would be many more lengths without ages. For the years without age data, a pooled ALK was applied using 1982-2004 (without 2003 for fall) and 2011-2012 age data. The rest of the ages became available after the pooled key was created. The shrimp survey was not aged at this time. Length slicing was attempted to age the ME/NH survey.

The age compositions do not show many strong or poor year classes (Tables B58-B64, Figures B98-B99) although a few strong cohorts are prominent. There appears to be large 1984, 1989, 1990 and 1998 year classes in the fall survey data (Table B60). Some of the inability to follow year classes may be due to the amount of imputation involved in applying the annual keys (Tables B59, B61). Another reason may be that white hake are not easy to read and quality assurance/quality control tests indicate around 80% agreement between production ageing and quality control checks (http://www.nefsc.noaa.gov/fbp/QA-QC/data/whhk-results.html). The ME/NH spring survey was aged using length-slicing, but given the overlap with the lengths used for age 2 in the fall survey, this method may not work for the spring survey (Table B64). Either using the NEFSC survey to age the data collected in spring or waiting for the otoliths collected during the ME/NH survey to be aged would be more appropriate.

Research Vessel Distributions

In the spring, white hake are located in deeper waters of the Gulf of Maine and off the southern slope of Georges Bank (Figure B100). Over time the white hake located along the Mid-Atlantic slope have decreased. In the 1992, the white hake in the central GOM were reduced in number as well but have increased in the later time blocks, particularly 2008-2012 (Figure B100). Most white hake caught by the Massachusetts survey were in Cape Cod and Massachusetts Bays in the autumn (Figure B101). A few large tows were caught along the islands south of Cape Cod. These large tows were not found in the last time block (Figure B101). The largest tows in the ME/NH survey were located in the eastern portion of the survey in both time blocks for the springs survey (Figure B102). The fall survey is similar, with even less fish found near the Massachusetts border (Figure B103).

STOCK PARAMETERS

Natural Mortality

Natural mortality (M) for most gadid stocks is assumed to be 0.2. Hoenig (1983) developed an empirical relationship between total mortality (Z) and longevity (T_{max}):

$$\ln Z = 1.46 - 1.01 \ln T_{max}$$

Assuming a maximum age of 20 years for white hake (the oldest fish in the samples used in section on total mortality was 16 years and the maximum length in the commercial fishery data is much larger than this fish) this relationship estimates a Z of 0.2. In the absence of fishing mortality Z = M = 0.2.

Maturity

A logistic regression method (O'Brien et al. 1993) was used to fit maturity-at-age from the NEFSC spring survey data. In an attempt to smooth the noise in the data and increase sample sizes for those years with low sampling (Table B65), both 3-year and 5-year centered moving averages were applied (Figure B104).The WHWG examined the 3-year moving average, and determined that the estimated *A50* (the age at which 50% of fish are mature) varied about the time series average *A50*, but without any persistent trends. The WHWG decided to use a single time series average maturity ogive estimated from data in years 1982-2011. The time series *A50* for male white hake was 2.52 and 2.83 for females.

Pooled age-length key (TOR 3)

During the 2008 GARM III assessment review (NEFSC 2008), two differently configured Age Structured Assessment Program models (ASAP; NFT 2008) were presented that both had some diagnostic problems. The GARM III Panel chose the model with the shorter time series (1963-2007) and suggested further exploration of the model to improve the diagnostics. Some of the problems were with the starting conditions, for which the initial fishing mortality was estimated to be almost 3.0 (Figure B105). The recruitment pattern from the model had a large value in 1965 amongst some moderate values (Figure B105). Finally, in trying to get a model to converge, the catchability for the autumn survey had to be constrained, which then caused a residual pattern (Figure B106). Several attempts were made to fix these problems, including providing the model some age structure at the beginning of the time series by using a common ALK, which seemed a reasonable approach since there was already a common key used for the 2001-2007 commercial age data. All of the problems with the original model were minimized (Figures B107-B108). However, the GARM III Panel was not satisfied with the use of a common ALK for the survey years which had no age data. This was one reason why an alternative Age-Structured Production Model (ASPM; Butterworth et al. 2008) was chosen as the basis for the assessment. The GARM III Panel was concerned that estimates of recruitment would be dampened due to the use of a pooled key. The ASPM model did have a common key applied to the commercial length data for the recent years, but the reviewers concluded that there was no choice but to go with that model. This section evaluates the use of a pooled ALK on the results of various models.

The data from the 2008 GARM III ASPM model for white hake (Butterworth et al. 2008) have been re-evaluated in the current assessment using alternative models. Annual age data were available for the commercial catch from 1989-2000 and for survey data from 1982-2000. The catch at age was derived using semiannual age-length keys for 1989-2000. The spring survey age data were augmented with ages from January-June collected by the Northeast Fisheries Observer Program (NEFOP) while the autumn survey age data were augmented with ages from July-December collected by NEFOP. Two seasonal age-length keys were derived from these annual data and pooled across years. The spring and autumn survey numbers at age were derived using annual age-length keys for 1982-2000 for the appropriate survey. A second set of age matrices was developed using a single pooled age-length key for each survey. The percent difference between the two sets of age matrices was calculated.

Two different models have been used to determine whether the use of pooled age-length keys had a major effect on the 2008 GARM III assessments results. The first was a traditional Virtual Population Analysis (VPA) using the ADAPT calibration method (Parrack 1986, Gavaris 1986, and Conser and Powers 1990) as developed in the NOAA Fisheries Toolbox (NFT) ADAPT VPA version 2.7.7 (NFT 2007). The method assumes that the CAA is measured without error and requires data for each year of the analysis. The survey age data are treated as separate indices and only the spring ages 2-7 and autumn ages 1-6 (lagged forward to the beginning of the following year) were used in tuning. Ages 2-7 were estimated and the fishing mortality on the oldest true age was set equal to the Fs for ages 5-7.

The second model, using the Age-Structured Assessment Program (ASAP; NFT 2008), is a forward-projecting statistical catch at age model which assumes error in the CAA and does not require age or survey data for the entire time series (Legault and Restrepo 1999). The CV on the commercial landings was set at 0.01 for the entire time series. The effective sample size for the commercial fishery was set at the number of trips sampled for length composition. The survey age data were treated as proportions and multinomial error structure was assumed. Sample sizes were set at the number of non-zero tows for each survey. The weighting on recruitment was set to zero, which means that recruitment deviations from the Beverton-Holt Stock-Recruitment function were not included in the objective function. Selectivity was estimated by age for the fishery and the surveys, with selectivity set to one at age 5. These may not be the optimal settings for this stock, but they were held constant over the four model runs.

For both models, four separate configurations were examined: 1) using annual age-length keys for both commercial and surveys, 2) using annual ALK for commercial and pooled ALK for survey, 3) using pooled ALK for commercial and annual ALK for survey, and 4) using pooled ALK for both commercial and surveys.

Retrospective analyses, with one year at a time sequentially removed from the end of the data time series, were conducted on all eight model configurations to determine if pooling the ALKs improved or degraded the retrospective pattern. Given the short time series, the retrospective analyses were run back to 1994 and Mohn's rho (Mohn 1999) was calculated as the average of the relative differences between each "peel" from the final model run.

For each of the eight configurations, biological reference points were estimated following the recommendations of the 2008 GARM III Panel (NEFSC 2008) to examine whether stock status would be changed if pooled ALK were used. A yield-per-recruit analysis (Thompson and Bell 1934, NFT 2007b) was run to estimate fishing mortality at 40% SPR. The partial recruitment (i.e. selectivity) (PR) and mean weights at age were set using the last five years of data. The estimate of F40%, along with the same PR and mean weights, was then used in a 50-year projection using AGEPRO (Brodziak and Rago 1994; as developed in the NOAA Fisheries Toolbox; NFT 2010), to determine the biomass that would be achieved (BMSY proxy) in the long-term. The entire time series of recruitment values was used for the projection. ASAP also estimates reference points internally within the model runs using the biological data from the final year of the model and these were also compared.

When the pooled and unpooled age matrices are compared, most of the difference in the commercial

CAA mong the older age classes, while the spring and autumn surveys showed large differences at both young and older ages (Table B66).

The results of the VPA models show somewhat different results in fishing mortality and spawning stock biomass while the recruitment results are very similar (Figure B109). The converged part of the VPA (1989-1991) is the same across models, followed by divergence in both SSB and fishing mortality, suggesting that the older ages are the most variable among the ALKs (Table B67). However, all models pick up the same year classes, mainly the 1988, 1989 and 1998 year classes. The CVs on the stock sizes are the lowest for the pooled commercial data run, and highest for the pooled survey run. The highest CVs on the catchability coefficients are from different runs depending on the survey index.

The various ASAP model runs show more similarity to each other than the VPA runs (Figure B110). The trends in recruitment, SSB and fishing mortality are the same in the four model runs. The year classes in the ASAP runs are the same as in the VPA in addition to a bigger 1983 year class. Most of the terminal year estimates are similar across models (Table B68).

The retrospective analyses for the VPA models all show a very large retrospective bias for fishing mortality and spawning stock biomass (SSB) with a smaller bias for recruitment (Table B69, Figures B111-B116). Pooling the commercial ALKs reduces the bias in F and SSB while pooling the survey ALK increases that bias. For the model run with all the data sets pooled, the result is a reduction in Mohn's rho from using the unpooled data but slightly higher than the commercial only pooled. The bias for recruitment, while already low in the base model, is reduced slightly with more pooling of the data. The retrospective analyses for the ASAP models show a moderate bias in F and SSB but a much larger bias in recruitment (Table B69, Figures B117-B122). As more pooling is done, there is slightly more bias, but still within the range of a small retrospective pattern.

Biomass-based biological reference points from the VPA models are estimated to be between 59,600 mt and 61,200 mt (Table B70). The fishing mortality reference points are also estimated to very similar. While the terminal year estimates differ, the comparison between the reference points and the terminal year estimates indicates the same stock status regardless of the pooling of the data. The externally derived reference points from the ASAP models are also similar (SSB: 73,400 mt – 77,500 mt, F40: 0.2-0.22) and the resulting stock status the same. The difference between the ASAP and VPA derived reference points is largely driven by the slightly lower recruitment estimates in the VPA at the end of the time series (Figure B123). The internally derived reference points are lower (SSB: 38,800 mt-44,700 mt, F40: 0.15), but the stock status does not change.

The results presented in this section show that the results of the white hake stock assessment are more sensitive to the type of model chosen than the pooling of the data being used in the models. Given that the review panel was concerned about dampening of recruitment fluctuations, the results show that this was not an issue (Figure B123) and that the year class strength is very stable over the VPA and ASAP while the GARM III model had lower estimates overall. For white hake, which does not have a large variation in year class strengths, it does seem reasonable to use a pooled ALK when necessary. There is more work planned including the use of different years for the pooling exercise to determine if the years chosen influence the results. Simulation analyses are also needed to see if there are biases between a pooled ALK approach and fitting to length data using a single growth curve (derived from the same age data as the ALK).

ESTIMATES OF STOCK SIZE AND FISHING MORTALITY (TOR 4)

ASPM

The previous stock assessment was conducted using an Age-Structured Production Model (ASPM, now called Statistical Catch-at-Age [SCAA]; Butterworth and Rademeyer 2012). Since there have been substantial changes to the input data, it is important to separate the changes in the data before changing the model formulation or model type.

Spawning biomass, fishing proportion and recruitment trajectories are shown in Figure B124 for the following runs:

a. "2007": GARM III SCAA assessment,

With updated commercial data through 2007:
b. "2007 - new catches": as above, with updated annual catches,
c. "2007 - new catches + comm CAA": as above, with updated commercial catches-at-age,
d. "2007 - new catches + comm CAA + comm WAA": as above, with updated catch mean weight-at-age,

With updated survey data through 2007:
e. "2007 - new indices": GARM III SCAA assessment with updated NEFSC survey indices,
f. "2007 - new indices + CAA (same yr)": as above with updated survey catch-at-age data for the same years as used for the GARM III SCAA assessment,
g. "2007 - new indices + CAA": as above, but also including further years of survey catch-at-age data.

With all updated data through 2007:
h. "2007 - new data": all updated commercial and survey data,

With all updated data through 2011:
i. "2011 - new data": including data through 2011.

The major feature of these models is that the spawning biomasses estimated for the "2011 – new data" assessment are lower in absolute terms than their GARM III counterparts, with corresponding increases in estimates of fishing mortality and decreases in estimates of recruitment (Figures B124-127). This feature seems to arise primarily from the doming of the commercial selectivity now being estimated to be rather less than at the time of GARM III. The data changes having the most impact on the results are the modifications to the annual catches, followed by introducing catch-at-age information for additional years with an average ALK for years when age data were not available at the time of these model runs (Butterworth and Rademeyer 2012).

Further explorations of the SCAA were considered and are summarized in Appendix 1. A final run (RcpEvenNewer) was chosen to compare with the final ASAP run. This final run had three selectivity blocks (1963-1981, 1982-1997, and 1998-2011). The first selectivity block was based on using the results from a two-block model and moving the A50 one age younger.

ASAP

The use of ASAP (Age Structured Assessment Program v3.0.9, Legault and Restrepo 1999), which can be obtained from the NOAA Fisheries Toolbox (http://nft.nefsc.noaa.gov/) was explored further from the work done at GARM III. In developing the base ASAP model configuration over 30 preliminary models configurations were explored. The WHWG eventually set up 3 basic ASAP models with different starting years based on the catch data that were agreed to be of better quality (1963) and with the start of catch age data and survey age data (1982 and 1989). The models used the commercial CAA (1+) from 1989-2011, the NEFSC spring survey abundance index (1+) and age composition (1-9+) from 1968-2011, and the autumn survey index (1+) and age composition (1-9+) from 1963-2011. To compare these models with the SCAA, a two-block commercial selectivity model was set up with the split in 1997/1998. Age at full selectivity was set at 6 for both periods. For initial runs selectivity at ages 7-9+ was allowed to be estimated but when upper bounds were hit at ages 7 and 8, selectivity was forced to be flat-topped. Selectivity for the survey was set to full at age 3 and all other ages were allowed to be freely estimated. The estimates of CV for the surveys were used in initial runs, but increased by 0.15 and 0.05 for the spring and autumn survey, respectively, using the results of the SCAA as a guide.

The effective sample sizes (ESS) for the age compositions were initially set at 50 for all three components from 1982 on and to half of that (25) for the years in which a pooled ALK was used. Two methods of adjusting these were applied. Following Francis (2011), adjustment in the effective sample sizes were informed by the overall fit between the predicted and observed mean age of the catch. However, this resulted in some very small ESS for the spring survey of 6 and 13 for the early and later time periods, respectively. Therefore, the WHWG decided to use the average of the estimated ESS for both the fishery and survey catch-at-age. The final Base model suggests that the ESS for the early survey age data should be higher, but since these were the years for which a pooled ALK was used to derive the age compositions, the WHWG decided not to adjust these values (Figures B128).

In the base runs, the WHWG noted that some of the CVs on the starting stock sizes were very large (Table B71). Therefore a prior was specified for the starting stock sizes so that they followed an exponential decline with a CV of 0.2.

Because the ASAP model run starting in 1963 estimated a higher fishing mortality at the start of the time series than the SCAA, a profile over different fixed values for F(1963) was run (Figure B129). The minimum objective function occurred for F(1963)= 0.3. These runs showed a large range in SSB and fishing mortality values (Figure B130) but recruitment values are relatively stable. There was also convergence of the SSB values after a period of about 10 years. When the starting F(1963) values within 4 points of the minimum objective function are examined, there is less variability in SSB and F (Figure B131). The same profile was run for the model starting in 1989 and these values fit in with the 1963 values (Figure B131). In contrast, the minimum for the SCAA model occurred for higher starting SSB values and a much lower starting F value, and the best estimates of this F value for each model were outside the 95% confidence intervals for the other. This difference was found to arise primarily from contributions to the objective function (negative log-likelihood) from the survey catch at age proportions in the earlier years. The WHWG decided that the consequent uncertainty in the early SSB values which are influential in the estimation of the parameters of a stock recruitment function, therefore did not allow for a stock-recruitment model to be used for reference point estimation at this time.

ASAP BASE model fits to the fishery catches were good, with no strong patterning of residuals over time and generally good agreement between modeled and observed catches (Figure B132). There were reasonable fits to the observed catch-at-age (Figure B133) with no large residual runs or obvious year class effects apparent in the residual patterning. Fishery selectivities show a higher selectivity at younger ages in the first block (Figure B134).

Fits to the NEFSC spring survey index exhibited no strong residual patterning (Figure B135) and the autumn survey fit fairly well, with the exception of the 1982 value which has never fit any model particularly well (Figure B136). There was some residual patterning to the index age composition fits (Figures B137-B138), with age 1 having a run of positive residuals starting around 2002 while age 3 during the same time period are negative. This pattern is stronger for the spring survey than for the fall. There was an age reader and otolith preparation change at that time. The selectivities estimated from the model indicate that the autumn survey catches more younger fish than the spring while the spring catches more older fish, although both surveys have highly domed selectivities (Figure B139)

The ASAP Base model configuration reflects the consensus opinion of the WHWG as the best model with which to evaluate stock status and provide catch advice. The assessment indicates that total SSB has ranged from 7,847 mt to 34,339 mt during the assessment time period, with current SSB in 2011 estimated at 26,877 mt (Table B72, Figure B140). Total biomass in 2011 is estimated at 31,225 mt and F's at the end of the time series are near historic lows (Figure B141) with the 2011 fully recruited, Ffull = 0.13. Fishing mortalities-at-age are presented in Table B73. The low fishing mortality on ages 1 through 3 is notable given that the maturity A50% is between ages 2 and 3. The current fishery selectivity allows one to two spawning events on average prior to entering the fishery. Until the last few years, recruitment over the past decade has been poor (Figure B142). Age-1 recruitment did not exceed 3 million fish between 2000 and 2004. Only three year classes in the time series have exceeded 10 million fish (Table B72). The current population structure is less reliant on fish that have not yet recruited to the fishery (fish age 1-3) than it was in the 1990s, with approximately 40% of the population age 4 and older compared to 20% previously (Table B74 and Figure B143).

MCMC was performed to characterize uncertainty in management quantities (SSB, F). An initial chain of length 200,000 was run with a thinning rate of 200 (resulting in 1000 saved iterations). Examining the trace and the autocorrelation suggested that the beginning of the chain was not well-mixed, and that additional thinning was needed (Appendix Figures B3.1, B3.2). These diagnostics were poorest for parameters at the beginning of the time series. To address this issue, a second chain of length 5 million was run with a thinning rate of 500 (resulting in 10,000 saved iterations). Examination of the trace from this longer chain suggested satisfactory mixing, however the autocorrelation suggested that additional thinning was still needed, particularly for parameters at the beginning of the time series (SSB1963, e.g.; Appendix Figures B3.3, B3.4). Subsequently, from the 10,000 iterations, the first 2000 were dropped (for burn-in) and the remaining 8,000 were thinned by a factor of 8, resulting in a total of 1000 iterations. All parameters had satisfactory diagnostics (Appendix Figures B3.5, B3.6).

In addition to characterizing uncertainty in parameter estimates, the MCMC analysis produces estimates of January 1 numbers at age for initializing projections. Because the diagnostics suggested that the initial chain (200,000) should have been longer, the distributions of numbers at age between that initial chain and the longer chain (after burn-in and further thinning) were compared (Appendix Figure B3.7). The distributions at age are virtually identical, suggesting that any correlation or lack of mixing in the initial chain did not impact the starting values for the projections. This result is not entirely surprising, given that the diagnostics suggested that the parameters at the beginning of the time series were less well-determined than those at the end of the time series.

The 90% probability intervals (PI) were calculated from the original MCMC analysis to provide a measure of uncertainty for the model point estimates. Time series plots of the 90% PIs for January-1Biomass, SSB and Ffull are shown in Figure B144. The distribution of values for the terminal year (2011) are shown in Figure B145 while the ASAP point estimates and the 90% PIs are reported below for the terminal year (2011):

ASAP point estimate for 2011 (90% probability interval)
SSB2011 (mt) 26,877 (23,127 – 30,729)
B2011 (mt) 31,225 (27,110 - 35,515)
Ffull 0.13 (0.11 – 0.16)

Retrospective analysis for the 2004-2011 terminal years indicates very little retrospective error in both F and SSB with the tendency for the model to underestimate F and overestimate SSB with mostly overestimation of recruitment (Figures B146-B148). The F retrospective error ranged from -0.03 in 2010 to -0.24 in 2005 (Table B75). SSB retrospective error ranged from 0.03 in 2010 to 0.28 in 2005. Retrospective error in age 1 recruitment varied from -0.04 in 2007 to 1.56 in 2004.

Sensitivities to the input data were conducted (Appendix B4). The first sensitivity run was to the length of the time series. When the time series starts in 1982, the results are not appreciably different (Appendix Figure B4.1) except that the SSB and recruitment values for the recent years are a little higher. The second sensitivity used a different strata set which included all offshore strata to calculate the survey indices (Appendix Figure B4.2). The differences in this sensiticity run are that the SSB values in the early part of the time series are higher while the recent SSB values are lower. The overall trend is similar.

BIOLOGICAL REFERENCE POINTS (TOR 5 and TOR 6)

Existing Reference Points

The existing reference points for white hake are:

*F*msy = 0.125 (on age 6)
SSBMSY = 56,300 mt
MSY = 5,800 mt

The existing ASPM model was updated, but the data have changed significantly and these reference points are no longer valid for stock status evaluation.

New Reference Points

Ideally the estimation of MSY-related reference points should be based on a fit of a stock-recruitment relationship for the population under consideration. In the case of this white hake stock however, this approach was not possible. Although a time series (1963-2011) of recruitment estimates can be determined with reasonable reliability, estimates of spawning biomass for the early years are sensitive to the different assumptions made in the assessment models evaluated by the WHWG. The consequence was that estimates of the stock recruitment relationship and associated MSY-related reference points ranged too widely to provide a reliable basis for advice. If the values to which a stock-recruitment relationship is to be fit are limited to more recent years that are not subject to this uncertainty in spawning biomass estimation, there is insufficient contrast in the data to allow the parameters of a stock recruitment relationship to be estimated with the necessary precision.

This situation necessitated the use of a proxy to determine F_{MSY} and related reference points. In the 2008 GARM III assessment the F40% SPR-based proxy had been used (NEFSC 2008). In considering the matter of recommending an F_{MSY} proxy on this basis, the WHWG noted that the suggestion of F40%, which has been widely used as this proxy, is based primarily on the work of Clark (1991, 1993). In the first of these papers, Clark considered a range of demographic and selectivity parameters, together with a number of stock recruitment relationships, and based upon deterministic evaluations recommended F35% as the proxy for F_{MSY}. In the second paper, Clark further introduced recruitment variability with ln recruitment residuals with a standard deviation σ_R of 0.6, and based his recommendation to use F40% rather than F35% on the criterion of little chance in forward projections, under a constant F value, that spawning biomass would drop below 20% of its deterministic pristine level (SSB0).

The WHWG decided to examine the application of Clark's approach to white hake in terms of a criterion of no more than a 5% probability (a value selected by the WHWG) that the population would drop below 0.2SSB0. The agreed ASAP assessment model provided values for the demographic and selectivity parameters. Three alternative plausible stock recruitment relationships were considered:

i) The standard basis used for projections of sampling recruitments randomly from the empirical cdf of recruitment estimates in the base case assessment (here ASAP from 1963 to 2011), with the caveat that if spawning biomass in the projections falls below the lowest value in the time series, the recruitment selected is multiplied by the ratio of the projected spawning biomass to the lowest in the series (i.e. corresponding deterministically to a hockey-stick stock-recruitment relationship). Projection under F=0 provided an estimate of median SSB0 from which the target 0.2SSB0 was obtained.

ii) A Beverton-Holt stock-recruitment relationship with steepness h=0.8, and σ_R=0.48 as determined from the ASAP time series of recruitments (with only the values from 1982 onwards being used to avoid the negative bias introduced in earlier estimates through smearing of year classes with the use of an average age-length key to provide the survey catches-at-age input to the assessment). Given a recent five year average of biological and selectivity parameters, relative reference points were calculated. Assuming that R_{MSY} corresponded to the average of the full time series of recruitment estimates, the relative reference points were scaled to calculate the pristine mean recruitment (R_0). Stochastic projections were then performed to determine SSB_{MSY} and SSB_0 (taken as the medians of the projected distributions).

iii) As for ii), except that steepness h=0.7.

The values of fully selected F each giving a probability of 5% of dropping below the corresponding 0.2SSB0 in any one year in each case (once the biomass spawning biomass distribution had stabilized) were: i) F=0.35, ii) F=0.25 and iii) F=0.22.

Based on the demographic and selectivity parameters of the white hake stock, the SPR based F reference points of F40% and F35% correspond respectively to fully selected F values of F=0.20 and F=0.24. Since the risk levels of these two reference points appeared to be similar, the WHWG recommended that F35% (i.e. a fully selected F=0.24) be adopted as the proxy for F_{MSY} as it allowed for higher yield.

Due to time constraints the WHWG interpolated the risk that spawning biomass would drop below 0.2*SSB0, associated with F=0.24 (F35%) for either steepness, to be slightly over 5%. During the course of the stock assessment peer review, the SARC reviewers requested that the lead analyst provide the actual probability at the F=0.24 value to compare the equivalence between the proposed F35% and F40% currently used for management (Table B76). In so doing, it was discovered that the probability under a steepness of 0.7 was actually 9.7% rather than the assumed 5%. Although the original calculations presented were correct, there turned out not to be a linear relationship between steepness and risk, so the 10% risk was unexpected (Figure B149). Since the WHWG had established 5% as the threshold for risk in comparing the F35% and F40%, and the value for F=0.24 exceeded that level, the SARC determined that the two options did not have equivalent risks, counter to what had been originally proposed. Based on that and other considerations, described in their reports and in NEFSC 2013, CRD 13-04, the reviewers decided not to recommend adopting F35%, but instead to retain F40% as the overfishing threshold proxy.

When the F_{MSY} proxy value of 0.2 is used in long-term projections the estimate of SSB_{MSY} is 32,400 mt (Figure B150). The estimate of SSB in 2011 is 26,877 mt and fishing mortality in 2011 is 0.13. Therefore, this assessment indicates that the stock of white hake is not overfished and overfishing is not occurring (Figure B151-Figure B153). Table B77 gives the existing and new (SARC56) reference points and shows the differences in the biological data which give rise to the differences in the reference points.

Short-Term Projections (TOR 7)

Projections were run at F_{MSY} proxy (0.2) and 75%$F_{MSY\ p}$roxy (0.15) from 2012 to 2016 using the numbers at age derived from the MCMC, two recruitment options, and assuming that catch in 2012 is 2900 mt (CFDERS value +100 mt for discards and Canadian catch) and are shown in Figures B154-157. The two recruitment options were drawing recruitment from an empirical cumulative distribution using the entire time series of estimates (1963-2009) and a shorter time series of recruitment estimates (1995-2009). The last two years (2010-2011) of the recruitment time series are uncertain and so were not used in the distribution. These results indicate that under 75%F_{MSY} proxy, the stock rebuilds by 2014 . If the short timer series is used, OFL in 2013 and 2014 are 5,457 mt and 5,574 mt (Table B78) while the TACs are 4,177 mt and 4,435 mt (Table B79). In 2013, the difference between the long and short time series of recruitment values for TACs is 4 mt.

Historical assessment retrospective

A comparison between the estimates of stock status for the current and the four previous assessments (SARC 33, GARM I, GARM II and GARM III) is provided in Figure B158. This historical "retrospective" examination of past model performance illustrates that the basic trends are the same for the alternative model, with biomass being above Bmsy in the 1970s and declining to below Bmsy in the 1990s. Even with the major changes in data that have occurred in the most recent update, the current assessment, in terms of relative biomass and fishing mortality, is entirely comparable with previous assessments. The scale differences between the current assessment and the previous GARM III assessment are driven by changes to the underlying catch data and not as a result of the assessment or choice of model (Figure B159).

SOURCES OF UNCERTAINTY

1. Possible mixture of red and white hake in early years of sea sample data may be the cause of high discard estimates in those years.

2. Lack of larger, older fish in survey age/length keys requires considerable augmentation of keys. This may affect mean weight of the plus group and SSB estimates.

3. White hake may move seasonally into and out of the defined stock area.

4. Catch at age information is not well characterized due to possible mis-identification of species in the commercial and sea sampling data, particularly in early years, low sampling of commercial landings in some years, and sparse discard data particularly in early years.

5. Catchability of older ages in the surveys is very low and is likely responsible for the uncertainty in starting numbers at age since there are no commercial catch-at-age data prior to 1989.

6. Mean weights at age in the catch for ages 5-9+ in 2001-2011 may not be well specified due to unaged observer samples.

RESEARCH RECOMMENDATIONS (TOR 9)

From SARC28

1. Investigate the potential utility of stratifying estimates of discard by mesh size in the otter trawl fishery data.
   · *The discard estimates are now stratified by mesh size.*

2. Incorporate all sources of catch in Catch at Age, including Canadian 4X landings and investigate feasibility of including discards throughout the 1985-present period.
   · *Discards have been incorporated into the model from 1963 with direct estimates from 1989. The current stock definition does not include 4X, although sensitivities were run at GARM III (see Stock Structure section for rationale). Recreational catch is not incorporated (see Data Section for rationale).*

3. Investigate stock structure and spawning patterns throughout the Gulf of Maine area, including relationships to areas in 4X and in deeper waters off Georges Bank and the Scotian Shelf.
   · *No new work has been carried out in the Gulf of Maine area. Some genetic analyses were conducted in Canadian waters (Roy et al. 2012).*

4. Further work on the 2-Bin Mass Balance Model should continue particularly as this relates to changes in catchability related to seasonal emigration of white hake during the autumn.
   · *This is no longer relevant because a full statistical catch at age model has been implemented.*

5. Investigate the availability and potential use of sea sample age samples to augment survey age/length keys.
   · *Sea sample ages are included in the ALKs from 1989-2000. The otolithes from 2001-2011 have not yet been aged.*

From SARC 33

1. Explore causes of retrospective pattern, if possible.
   · *This assessment does not have a large retrospective pattern.*

2. Improve species identification in sea sampling.

   · *Efforts are underway to improve training of at-sea observers.*

3. Increase sea sampling coverage for improved estimates of discard rates.

   · *Sea sampling coverage has been expanded.*

4. Expand NEFSC survey coverage into deeper water to better define stock distribution.

   · *Coverage has not been extended, however, with the new survey vessel, there are more tows conducted in deeper waters within the survey area from the southern flank of Georges Bank and south.*

5. Explore the use of 4X landings and Canadian survey data to define stock area.

· *The current stock definition does not include 4X, although sensitivities were run at GARM III.*

6. Continue the collection and ageing of samples from the ASMFC Shrimp survey.

· *Age samples have been collected from all ASMFC Shrimp surveys but have not been aged.*

7. For improved age-based analyses of commercial landings, continue ageing of sea sampling samples from 1991-1994.

· *Ages collected by the Observer Program are included in the ALKs from 1989-2000. The otoliths from 2001-2011 have not yet been aged.*

8. Explore alternative assessment methodology.

· *Three alternative models have been explored (SS2 (GARM III), ASPM (now referred to as SCAA) and ASAP).*

New Research Recommendations

- Further comparison of the SCAA and ASAP models. Perhaps institute a comparison using a simulated population and a common model configuration.
- Review of general SARC working group procedures which could for example include how new models are evaluated, the ability to modify models in real time, and policies for model testing prior to meetings using simulated data.
- Complete ageing of samples collected by the Observer program, the shrimp survey and state surveys (ME/NH survey)
- Continue production ageing of NEFSC Survey samples.
- Conduct sensitivity testing of the ASAP model using the shrimp and ME/NH survey indices.
- Further explore swept area biomass estimation for white hake.

- Develop improved calibration methods to adjust total fish length for fish with heads removed.

- Consider conducting cooperative research to collect intact fish from commercial gear.

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Table B1. Landings (mt, calc. live) of white hake by statistical area with percentages by statistical area (1) NAFO Sub Area 3, (2) Includes Sub Area 4, excluding 464-465, (3) Includes areas 500,510,520,531, 533,534, 536, 541, 542, 543 (4)Includes Sub Area 6 (5) Includes all area except those in notes (1) and (2).

		Statistical Areas																					
Year	Unknown (State waters)	3(1)	4(2)	464	465	511	512	513	514	515	521	522	525	526	537	538	539	561	562	5(3)	6(4)	Total Stock(5)	Total
1962	3178	0	0	0	0	12	0	71	0	0	0	0	0	0	0	0	0	0	0	0	0	3262	3262
1963	2163	0	231	9	29	150	2	128	303	135	240	331	1	1	1	0	0	64	6	0	0	3561	3792
1964	0	0	121	20	44	339	984	339	318	122	419	247	1	14	5	0	1	63	21	0	4	2942	3063
1965	0	0	110	2	9	164	1433	256	156	32	146	320	6	6	15	0	2	70	6	0	3	2625	2735
1966	0	0	62	2	25	36	758	212	116	12	146	158	4	11	23	0	2	58	6	1	2	1569	1631
1967	0	0	144	9	14	141	406	174	53	19	130	95	3	9	11	0	2	55	7	2	0	1131	1275
1968	0	0	66	6	6	97	332	263	76	11	199	98	9	15	17	1	5	63	8	3	4	1214	1280
1969	0	0	35	2	9	26	289	381	102	30	282	108	5	23	32	0	1	44	9	0	2	1347	1381
1970	0	0	46	12	17	21	276	589	190	114	274	179	7	32	42	0	3	46	6	0	5	1812	1859
1971	0	0	56	8	6	56	574	620	277	105	490	279	9	24	43	1	3	45	12	0	29	2580	2636
1972	0	0	70	3	13	62	829	850	314	99	390	222	21	17	18	0	2	49	44	0	18	2953	3023
1973	0	0	20	3	10	141	584	1009	472	189	449	164	6	24	44	0	2	21	11	0	42	3169	3189
1974	0	0	37	8	5	197	493	1567	550	182	525	178	3	13	7	0	3	18	21	0	42	3813	3850
1975	0	0	24	3	20	209	744	1614	262	254	370	123	5	6	4	0	3	22	18	0	32	3689	3714
1976	0	0	28	15	27	206	830	1822	272	392	404	96	6	5	4	0	1	9	15	0	24	4127	4156
1977	0	0	30	84	18	269	538	2428	531	384	350	303	10	5	5	1	0	35	20	0	11	4992	5022
1978	0	0	5	19	16	244	1345	1743	351	334	365	360	4	4	18	2	0	70	14	0	8	4896	4901
1979	0	0	0	14	2	655	957	1035	277	295	408	348	3	5	5	0	2	81	8	0	1	4096	4096
1980	0	0	0	29	22	584	821	1775	253	396	465	372	7	9	15	0	6	98	9	0	5	4868	4868
1981	0	0	0	64	121	59	1360	2258	149	669	306	488	10	8	14	0	1	355	52	3	66	5982	5982
1982	0	0	1	110	85	299	2056	1422	285	842	409	345	21	13	22	4	3	240	17	0	5	6177	6178
1983	0	0	3	52	189	427	1600	1464	264	1295	353	386	9	6	16	0	10	298	35	0	2	6405	6408
1984	0	0	3	50	224	354	1215	1716	319	1392	600	475	11	13	36	0	5	292	39	0	14	6753	6756
1985	0	19	0	10	61	425	1293	1642	439	2031	699	449	24	14	31	0	6	182	40	0	5	7351	7370
1986	0	278	5	56	120	648	1341	1103	261	1525	434	342	60	19	22	0	2	157	13	0	4	6107	6390
1987	0	8	2	44	30	345	965	1194	345	1479	574	509	17	26	33	1	5	206	38	0	5	5817	5828
1988	0	4	0	7	16	308	755	854	321	910	740	489	12	30	30	0	3	248	22	0	37	4782	4786
1989	0	6	0	26	7	209	1151	897	189	996	343	514	5	15	13	0	1	151	27	0	4	4549	4554
1990	0	2	0	82	58	242	1089	1031	210	1095	394	329	15	10	25	0	9	287	44	0	8	4929	4931
1991	0	0	0	21	2	191	1350	1138	247	1364	289	437	47	15	58	0	3	367	50	0	29	5607	5607
1992	0	0	0	6	0	416	1945	1595	285	2090	513	939	127	52	120	0	2	268	35	6	45	8444	8444
1993	0	0	0	0	0	222	1154	1064	221	1774	389	1839	211	38	78	0	4	393	45	0	32	7466	7466
1994	25	0	5	36	2	178	345	799	272	1313	375	576	462	34	57	2	7	155	10	0	83	4732	4737
1995	43	0	0	52	68	147	361	585	351	1457	377	510	127	57	49	17	11	67	10	3	32	4324	4324

1996	8	0	0	45	80	130	289	520	304	1065	350	323	28	28	29	0	5	34	2	0	40	3281	3281
1997	3	0	0	25	56	30	260	307	156	876	204	223	3	1	20	0	3	40	3	1	14	2223	2223
1998	16	0	0	23	47	65	196	206	180	911	291	252	55	5	38	3	1	53	6	2	17	2366	2366
1999	22	0	0	56	11	24	144	314	224	824	361	430	60	5	11	1	0	114	5	0	16	2621	2621
2000	25	0	0	45	36	50	179	455	254	1027	390	331	20	8	13	1	3	112	14	0	22	2984	2984
2001	19	0	0	33	45	82	284	563	183	1042	580	355	41	4	11	0	5	213	15	4	4	3482	3482
2002	14	0	0	40	57	69	301	575	238	929	514	323	25	11	6	1	7	120	32	0	5	3266	3266
2003	45	0	0	15	17	94	449	853	584	1498	411	286	15	4	14	0	4	123	17	1	2	4435	4435
2004	128	0	0	19	9	62	469	551	478	1126	333	176	17	0	11	3	5	71	26	0	26	3511	3511
2005	52	0	0	72	24	35	407	417	325	886	283	102	9	1	27	2	2	16	3	0	7	2670	2670

Table B1. cont.

Year	Unknown (State waters)	3[1]	4[2]	464	465	511	512	513	514	515	521	522	525	526	537	538	539	561	562	5[3]	6[4]	Total Stock[5]	Total
										Statistical Areas													
2006	41	0	0	10	27	4	237	243	195	569	231	103	3	3	12	0	3	3	1	0	15	1700	1700
2007	82	0	0	13	10	3	183	269	157	469	190	92	11	0	4	3	0	20	7	0	14	1529	1529
2008	42	0	0	34	3	2	131	261	208	362	142	79	13	0	7	0	0	29	5	0	13	1333	1333
2009	57	0	0	22	21	11	163	259	210	517	155	120	25	0	7	0	3	100	10	2	15	1696	1696
2010	9	0	0	31	11	7	73	283	343	468	284	173	23	0	10	0	0	67	18	0	8	1808	1808
2011	4	0	0	48	22	0	191	617	492	710	537	152	14	2	6	0	0	84	17	0	1	2897	2897

Table B1. cont.

Year	Unknown (state waters)	3[1]	4[2]	464	465	511	512	513	514	515	521	522	525	526	537	538	539	561	562	5[3]	6[4]
		Statistical Areas																			
1964	0.00	0.00	3.96	0.64	1.44	11.07	32.12	11.07	10.37	4.00	13.70	8.06	0.03	0.47	0.15	0.00	0.04	2.06	0.70	0.00	0.12
1965	0.00	0.00	4.02	0.07	0.33	6.00	52.40	9.35	5.70	1.16	5.33	11.69	0.21	0.22	0.55	0.00	0.08	2.56	0.21	0.01	0.11
1966	0.00	0.00	3.79	0.11	1.53	2.18	46.44	12.98	7.09	0.72	8.94	9.67	0.23	0.69	1.39	0.00	0.13	3.57	0.36	0.05	0.13
1967	0.00	0.00	11.31	0.68	1.13	11.07	31.86	13.65	4.18	1.52	10.22	7.44	0.22	0.72	0.84	0.00	0.19	4.29	0.55	0.12	0.00
1968	0.00	0.00	5.18	0.50	0.50	7.55	25.98	20.53	5.94	0.86	15.56	7.62	0.71	1.20	1.34	0.06	0.43	4.90	0.61	0.27	0.30
1969	0.00	0.00	2.51	0.14	0.65	1.91	20.95	27.58	7.37	2.18	20.45	7.84	0.36	1.65	2.30	0.01	0.09	3.21	0.65	0.00	0.15
1970	0.00	0.00	2.50	0.63	0.89	1.11	14.85	31.70	10.20	6.13	14.72	9.65	0.38	1.72	2.28	0.02	0.14	2.47	0.33	0.00	0.28
1971	0.00	0.00	2.11	0.29	0.25	2.11	21.78	23.53	10.50	3.99	18.59	10.58	0.35	0.89	1.61	0.05	0.12	1.72	0.44	0.00	1.10
1972	0.00	0.00	2.30	0.08	0.44	2.06	27.43	28.13	10.39	3.28	12.89	7.35	0.71	0.58	0.59	0.00	0.08	1.64	1.44	0.01	0.60
1973	0.00	0.00	0.63	0.10	0.31	4.43	18.31	31.63	14.80	5.94	14.07	5.13	0.18	0.74	1.38	0.00	0.06	0.64	0.34	0.00	1.32
1974	0.00	0.00	0.96	0.20	0.13	5.13	12.81	40.70	14.30	4.73	13.63	4.63	0.08	0.35	0.17	0.00	0.08	0.47	0.54	0.00	1.09
1975	0.00	0.00	0.66	0.09	0.55	5.63	20.02	43.46	7.06	6.84	9.96	3.32	0.13	0.15	0.11	0.00	0.09	0.58	0.49	0.00	0.87
1976	0.00	0.00	0.69	0.37	0.65	4.97	19.96	43.83	6.55	9.44	9.72	2.30	0.14	0.13	0.10	0.01	0.01	0.22	0.35	0.00	0.57
1977	0.00	0.00	0.59	1.68	0.37	5.37	10.71	48.34	10.58	7.66	6.96	6.04	0.20	0.10	0.09	0.01	0.01	0.70	0.39	0.00	0.22
1978	0.00	0.00	0.10	0.39	0.33	4.97	27.44	35.56	7.15	6.82	7.45	7.34	0.07	0.08	0.37	0.03	0.01	1.43	0.29	0.00	0.17
1979	0.00	0.00	0.00	0.35	0.05	15.98	23.37	25.28	6.75	7.20	9.95	8.50	0.08	0.13	0.11	0.00	0.05	1.99	0.20	0.00	0.02
1980	0.00	0.00	0.00	0.61	0.44	12.01	16.86	36.47	5.19	8.13	9.56	7.65	0.15	0.19	0.30	0.01	0.12	2.02	0.19	0.00	0.11
1981	0.00	0.00	0.00	1.06	2.03	0.98	22.73	37.74	2.49	11.18	5.12	8.15	0.17	0.13	0.23	0.00	0.02	5.93	0.87	0.05	1.10
1982	0.00	0.00	0.01	1.78	1.37	4.84	33.27	23.02	4.62	13.62	6.62	5.59	0.34	0.20	0.36	0.07	0.05	3.89	0.28	0.00	0.07
1983	0.00	0.00	0.04	0.81	2.94	6.66	24.97	22.84	4.13	20.21	5.51	6.03	0.14	0.10	0.25	0.00	0.15	4.65	0.55	0.00	0.04
1984	0.00	0.00	0.05	0.73	3.31	5.24	17.98	25.40	4.72	20.61	8.88	7.03	0.16	0.20	0.53	0.01	0.07	4.32	0.58	0.00	0.20
1985	0.00	0.26	0.00	0.14	0.83	5.77	17.54	22.28	5.95	27.55	9.49	6.09	0.32	0.19	0.43	0.00	0.08	2.47	0.55	0.00	0.06
1986	0.00	4.35	0.07	0.87	1.88	10.15	20.99	17.26	4.09	23.87	6.80	5.36	0.94	0.30	0.34	0.00	0.03	2.46	0.20	0.00	0.06
1987	0.00	0.15	0.04	0.75	0.51	5.92	16.56	20.49	5.92	25.38	9.85	8.74	0.29	0.45	0.57	0.01	0.09	3.53	0.66	0.00	0.09
1988	0.00	0.09	0.00	0.14	0.33	6.43	15.77	17.85	6.72	19.01	15.45	10.23	0.25	0.63	0.62	0.00	0.07	5.17	0.47	0.00	0.77
1989	0.00	0.12	0.00	0.56	0.16	4.58	25.27	19.70	4.14	21.88	7.54	11.29	0.12	0.32	0.28	0.00	0.03	3.32	0.59	0.00	0.10
1990	0.00	0.04	0.00	1.67	1.17	4.91	22.09	20.91	4.26	22.21	7.99	6.68	0.30	0.20	0.50	0.00	0.18	5.83	0.89	0.00	0.17
1991	0.00	0.00	0.00	0.38	0.04	3.41	24.07	20.29	4.40	24.32	5.15	7.80	0.83	0.26	1.04	0.00	0.06	6.54	0.88	0.00	0.52
1992	0.00	0.00	0.00	0.07	0.00	4.93	23.04	18.90	3.37	24.75	6.07	11.12	1.50	0.61	1.42	0.00	0.03	3.17	0.41	0.07	0.54
1993	0.00	0.00	0.00	0.00	0.00	2.98	15.46	14.25	2.96	23.77	5.21	24.63	2.82	0.50	1.05	0.00	0.05	5.26	0.61	0.00	0.43
1994	0.52	0.00	0.10	0.76	0.05	3.77	7.33	16.96	5.76	27.87	7.95	12.23	9.80	0.73	1.22	0.05	0.15	3.29	0.21	0.01	1.75
1995	1.01	0.00	0.00	1.21	1.59	3.42	8.44	13.67	8.19	34.05	8.82	11.91	2.97	1.33	1.14	0.39	0.25	1.57	0.23	0.08	0.76
1996	0.24	0.00	0.00	1.38	2.45	3.96	8.84	15.89	9.30	32.55	10.70	9.87	0.84	0.86	0.88	0.00	0.14	1.05	0.06	0.01	1.21
1997	0.12	0.00	0.00	1.14	2.51	1.34	11.73	13.82	7.04	39.44	9.19	10.02	0.11	0.05	0.88	0.02	0.13	1.81	0.12	0.04	0.62
1998	0.69	0.00	0.00	0.96	1.98	2.78	8.34	8.77	7.67	38.76	12.38	10.71	2.32	0.22	1.61	0.13	0.05	2.26	0.27	0.07	0.71
1999	0.85	0.00	0.00	2.15	0.42	0.92	5.52	12.08	8.62	31.71	13.91	16.55	2.30	0.19	0.42	0.02	0.02	4.39	0.18	0.01	0.60
2000	0.82	0.00	0.00	1.51	1.23	1.69	6.07	15.37	8.58	34.72	13.19	11.19	0.67	0.25	0.44	0.03	0.09	3.79	0.46	0.00	0.73
2001	0.53	0.00	0.00	0.95	1.31	2.36	8.21	16.24	5.27	30.08	16.75	10.25	1.19	0.10	0.31	0.01	0.13	6.15	0.44	0.12	0.12
2002	0.43	0.00	0.00	1.24	1.74	2.11	9.25	17.69	7.30	28.56	15.79	9.93	0.77	0.33	0.19	0.02	0.21	3.70	1.00	0.01	0.16
2003	1.01	0.00	0.00	0.35	0.39	2.15	10.23	19.44	13.31	34.12	9.37	6.52	0.34	0.08	0.32	0.01	0.09	2.81	0.39	0.02	0.05
2004	3.65	0.00	0.00	0.55	0.26	1.83	13.87	16.30	14.13	33.28	9.86	5.20	0.51	0.01	0.31	0.09	0.15	2.11	0.78	0.00	0.77
2005	1.94	0.00	0.00	2.75	0.92	1.35	15.54	15.91	12.43	33.85	10.81	3.90	0.36	0.05	1.03	0.08	0.06	0.60	0.10	0.01	0.25

Table B1. cont.

Year	Unknown (state waters)	3[1]	4[2]	464	465	511	512	513	514	515	521	522	525	526	537	538	539	561	562	5[3]	6[4]
	Statistical Areas																				
2006	2.42	0.00	0.00	0.62	1.64	0.27	14.29	14.63	11.73	34.28	13.91	6.22	0.19	0.16	0.72	0.02	0.19	0.18	0.06	0.00	0.89
2007	5.35	0.00	0.00	0.90	0.72	0.23	12.66	18.59	10.83	32.42	13.15	6.39	0.76	0.00	0.29	0.22	0.02	1.39	0.48	0.00	0.94
2008	3.19	0.00	0.00	2.65	0.26	0.14	10.18	20.25	16.13	28.05	10.98	6.12	1.00	0.01	0.56	0.02	0.04	2.27	0.36	0.00	0.98
2009	3.38	0.00	0.00	1.32	1.28	0.66	9.93	15.82	12.80	31.54	9.48	7.31	1.52	0.00	0.43	0.01	0.16	6.09	0.63	0.12	0.89
2010	0.47	0.00	0.00	1.71	0.60	0.37	4.08	15.75	19.04	26.01	15.77	9.61	1.28	0.03	0.57	0.01	0.01	3.71	1.01	0.00	0.43
2011	0.14	0.00	0.00	1.65	0.77	0.01	6.62	21.32	17.00	24.53	18.57	5.26	0.48	0.07	0.20	0.00	0.01	2.89	0.57	0.00	0.05
1964-2011 average	0.558	0.10	0.87	0.83	0.93	4.16	18.21	21.94	8.27	19.47	10.87	8.39	0.83	0.39	0.68	0.03	0.09	2.94	0.48	0.02	0.48
1994-2011 average	1.487	0.00	0.01	1.32	1.12	1.63	9.51	16.03	10.84	31.99	12.25	8.85	1.52	0.25	0.64	0.06	0.11	2.78	0.41	0.03	0.66

Table B2. Source of data for white hake by state and year from 1962-1988.

	CT	DE	ME	MD	MA	NH	NJ	NY	RI	VA
1962	gen can	gen can	gen can	gen can	gen can	gen can	gen can	gen can	gen can	gen can
1963	gen can	gen can	gen can	gen can	gen can	gen can	gen can	gen can	gen can	gen can
1964	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1965	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1966	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1967	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1968	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1969	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1970	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1971	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1972	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1973	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1974	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1975	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1976	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1977	gen can	gen can	**weighout**	gen can	**weighout**	gen can	gen can	gen can	**weighout**	gen can
1978	gen can	gen can	**weighout**	gen can	**weighout**	gen can	**weighout**	gen can	**weighout**	gen can
1979	gen can	gen can	**weighout**	gen can	**weighout**	gen can	**weighout**	gen can	**weighout**	gen can
1980	gen can	gen can	**weighout**	gen can	**weighout**	gen can	**weighout**	gen can	**weighout**	gen can
1981	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	gen can	**weighout**	gen can
1982	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	gen can	**weighout**	gen can
1983	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	gen can	**weighout**	**weighout**
1984	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	gen can	**weighout**	**weighout**
1985	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	gen can	**weighout**	**weighout**
1986	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	**weighout**	**weighout**	**weighout**
1987	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	**weighout**	**weighout**	**weighout**
1988	gen can	gen can	**weighout**	gen can	**weighout**	**weighout**	**weighout**	**weighout**	**weighout**	**weighout**

Table B3. US landings (mt, lnd[1]), live weight (mt, live[2]), and calculated live weight (mt, calc live[3]) of white hake by market category. Data are from WO and general canvas according to Table B2.

	Market Category																	
	Unclassified Dressed[4]			Small Round[5]			Small Gutted[6]			Unclassified Gutted[6]			Large Round[5]			Medium Round[5]		
	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live
1962	2434	3262	3262															
1963	2830	3792	3792															
1964	28	37	37															
1965	24	32	32															
1966	24	33	33															
1967	16	22	22															
1968	16	21	21															
1969	9	12	12															
1970	13	17	17															
1971	25	34	34															
1972	22	29	29															
1973	2028	2717	2717															
1974	2873	3850	3850															
1975	2771	2823	3714															
1976	3101	3154	4156															
1977	3748	3812	5022															
1978	3657	3710	4900										1	1	1	0	0	0
1979	3057	3136	4096															
1980	3633	3761	4868															
1981	4459	5946	5976										3	3	3	1	1	1
1982	4317	5785	5785	13	17	13				8	10	9	4	4	4	2	2	2
1983	2935	3933	3933	1	2	1	2	3	2	7	10	8				1	1	1
1984	2428	3254	3254	8	10	8	4	5	4	38	50	43	0	0	0	0	0	0
1985	2783	2783	3729	3	3	3	15	20	17	54	72	61	1	1	1	1	1	1
1986	2780	2780	3725	0	0	0	0	0	0	22	28	25						
1987	1535	1536	2057	3	3	3				28	31	31	0	0	0	0	0	0
1988	554	738	743	3	3	3	3	3	3	40	46	46						
1989	814	1089	1091	1	1	1	0	0	0	8	9	9				2	2	2
1990	713	954	956	2	2	2	0	0	0	13	15	15	0	0	0			
1991	928	1244	1244	0	0	0				22	25	25	0	0	0	0	0	0
1992	1251	1677	1677	0	0	0	1	2	2	48	54	54	1	1	1	2	2	2
1993	1445	1936	1936	1	1	1	10	12	12	28	32	32	2	2	2	3	3	3
1994	913	1223	1223	0	0	0	0	0	0	26	30	30	0	0	0	34	34	34
1995	825	1106	1106				0	0	0	5	6	6	0	0	0	24	24	24
1996	554	742	742	0	0	0				3	4	4	1	1	1	2	2	2
1997	80	107	107	0	0	0	0	0	0	2	3	3	1	1	1	0	0	0
1998	69	93	93	0	0	0	0	0	0	3	3	3	0	0	0	0	0	0

Table B3. cont.

	Market Category																	
		Unclassified Dressed[4]			Small Round[5]			Small Gutted[6]			Unclassified Gutted[6]			Large Round[5]			Medium Round[5]	
	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live	Lnd	Live	Calc. Live
1999	44	59	59	0	0	0	0	0	0	4	5	5	1	1	1	0	0	0
2000	36	48	48	0	0	0	0	0	0	3	3	3	1	1	1	0	0	0
2001	68	92	92				1	1	1	8	9	9	1	1	1	1	1	1
2002	29	39	39	0	0	0				3	4	4	1	1	1	0	0	0
2003	33	44	44	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
2004	163	219	219	4	4	4	13	15	15	13	15	15	35	35	35	38	38	38
2005	467	626	626	5	5	5	7	8	8	19	22	22	23	23	23	24	24	24
2006	250	335	335	7	7	7	7	8	8	8	9	9	205	205	205	26	26	26
2007	133	178	178	1	1	1	12	14	14	5	5	5	279	279	279	29	29	29
2008	44	59	59	2	2	2	16	18	18	9	10	10	267	267	267	42	42	42
2009	44	59	59	1	1	1	27	30	30	6	7	7	231	231	231	81	81	81
2010	56	74	74							0	0	0						
2011	45	60	60	0	0	0	24	27	27	47	53	53	7	7	7	1	1	1

[1] Data Source NEFSC Weighout Landed Pounds+General Canvas Landed Pounds as in Table 1.

[2] Data Source NEFSC Weighout Live Pounds+General Canvas Landed Pounds*Appropriate Conversion Factor as in Table 1.

[3] Data Source NEFSC Weighout Landed Pounds *Appropriate Conversion Factor+General Canvas Landed Pounds*Appropriate Conversion Factor as in Table 1.

[4] Conversion Factor = 1.34

[5] Conversion Factor = 1.00

[6] Conversion Factor = 1.13

Table B3. cont.

						Market Category									
		Large			Medium			Small			Unclassified				
		Dressed[4]			Dressed[4]			Dressed[4]			Round[5]			Total	
			Calc.			Calc.			Calc.			Calc.			Calc.
Year	Lnd	Live	Live	Lnd	Live	Live	Lnd	Live	Live	Lnd	Live	Live	Lnd	Live	Live
1962													2434	3262	3262
1963													2830	3792	3792
1964	1552	2079	2079	707	947	947							2286	3063	3063
1965	1533	2055	2055	484	648	648							2041	2734	2735
1966	790	1059	1059	403	540	540							1217	1631	1631
1967	511	685	685	424	569	569							951	1275	1275
1968	547	733	733	392	525	526							955	1280	1280
1969	594	796	796	428	573	574							1031	1381	1381
1970	772	1034	1034	603	807	807							1387	1859	1859
1971	1288	1726	1726	654	876	876							1967	2636	2636
1972	2045	2741	2741	189	253	253							2256	3023	3023
1973	283	379	379	70	93	93							2380	3189	3189
1974													2873	3850	3850
1975													2771	2823	3714
1976													3101	3154	4156
1977													3748	3812	5022
1978	0	0	0	0	0	0							3658	3712	4901
1979													3057	3136	4096
1980													3633	3761	4868
1981	2	3	3	0	0	0							4465	5953	5982
1982	185	248	248	9	12	12	79	106	106				4617	6184	6178
1983	1215	1628	1628	75	100	100	548	734	734				4784	6410	6408
1984	1851	2480	2480	137	183	183	585	784	784				5050	6768	6756
1985	1821	2440	2440	332	445	445	503	674	674				5512	6439	7370
1986	1460	1957	1957	212	284	284	297	398	398				4772	5447	6390
1987	1355	1816	1816	228	306	306	1204	1614	1614				4354	5307	5827
1988	1111	1489	1489	365	489	489	1503	2015	2015				3579	4782	4786
1989	1519	2035	2035	213	285	285	844	1131	1131				3401	4553	4554
1990	1031	1382	1382	466	625	625	1456	1951	1951				3683	4929	4931
1991	924	1238	1238	566	758	758	1748	2342	2342	0	0	0	4188	5607	5607
1992	1232	1650	1650	1064	1426	1426	2710	3631	3631	1	1	1	6310	8444	8444
1993	1387	1858	1858	1592	2133	2133	1110	1488	1488	2	2	2	5579	7466	7466
1994	1330	1782	1782	1009	1352	1352	236	317	317				3548	4737	4737
1995	1166	1562	1562	1018	1364	1364	183	245	245	18	18	18	3238	4324	4324
1996	919	1231	1231	819	1098	1097	135	181	181	23	23	23	2456	3281	3281
1997	794	1064	1064	560	751	751	220	294	294	4	4	4	1661	2223	2223
1998	1081	1448	1448	375	502	502	235	315	315	4	4	4	1767	2366	2366

Table B3 cont.

					Market Category										
		Large Dressed[4]			Medium Dressed[4]			Small Dressed[4]			Unclassified Round[5]			Total	
			Calc.			Calc.			Calc.			Calc.			Calc.
Year	Lnd	Live	Live	Lnd	Live	Live	Lnd	Live	Live	Lnd	Live	Live	Lnd	Live	Live
1999	1237	1658	1658	432	579	579	236	316	316	2	2	2	1957	2621	2621
2000	1366	1831	1831	602	807	807	213	285	285	8	8	8	2230	2984	2984
2001	1522	2040	2040	608	815	815	391	524	524	0	0	0	2600	3481	3481
2002	1528	2047	2047	681	912	912	197	264	264	0	0	0	2438	3266	3266
2003	2778	3723	3723	400	536	536	95	127	127	1	1	1	3310	4435	4435
2004	1948	2611	2611	347	465	465	73	98	98	12	12	12	2647	3511	3511
2005	1073	1438	1438	317	425	425	67	89	89	10	10	10	2013	2670	2670
2006	602	807	807	181	242	242	39	53	53	10	10	10	1334	1701	1701
2007	511	685	685	160	215	215	63	85	85	38	38	38	1231	1529	1529
2008	406	544	544	205	274	274	84	112	112	4	4	4	1079	1333	1333
2009	595	797	797	249	333	333	114	153	153	4	4	4	1352	1697	1697
2010	850	1138	1138	334	448	448	110	147	147				1349	1808	1808
2011	1456	1951	1951	489	656	656	106	143	143	0	0	0	2175	2897	2897

[1] Data Source NEFSC Weighout Landed Pounds+General Canvas Landed Pounds as in Table 1.

[2] Data Source NEFSC Weighout Live Pounds+General Canvas Landed Pounds*Appropriate Conversion Factor as in Table 1.

[3] Data Source NEFSC Weighout Landed Pounds *Appropriate Conversion Factor+General Canvas Landed Pounds*Appropriate Conversion Factor as in Table 1.

[4] Conversion Factor = 1.34

[5] Conversion Factor = 1.00

[6] Conversion Factor = 1.13

Table B4. Total Landings (mt,calc live)[1] of white hake by country from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6, and 464 and 465), 1964 2011.

	5Y[2]			5Z			6			Total			Grand
Year	Canada	USA[3]	Other[4]	Canada	USA	Other4	Canada	USA	Other4	Canada	USA	Other	Total
1964	3	2166		26	772			4		29	2942		2971
1965		2051			570			3			2625		2625
1966		1160			407			2			1569		1569
1967		819		16	312					16	1131		1147
1968	5	791		80	418			4		85	1214		1299
1969	4	840		30	505	6		2		34	1347	6	1387
1970	12	1218		34	590	222		5	58	46	1812	280	2138
1971	18	1646		82	905	109		29	105	100	2580	214	2894
1972	8	2171		32	764	159		18		40	2953	159	3152
1973	17	2408		100	719	1		42	4	117	3169	5	3291
1974	36	3003		196	768			42		232	3813		4045
1975	17	3106		129	551			32		146	3689		3835
1976		3564		195	539			24		195	4127		4322
1977		4253		170	728	189		11	149	170	4992		5500
1978	20	4051		135	837	1		8	28	155	4896	29	5080
1979	102	3235		149	860	3		1	1	251	4096	4	4351
1980	14	3881		291	982	1		5	1	305	4868	2	5175
1981	21	4680		433	1237			66		454	5982		6436
1982	352	5099		412	1074	1		5	1	764	6177	2	6943
1983	441	5290		369	1112			2		810	6405		7215
1984	479	5269		534	1471			14		1013	6753		7766
1985	452	5901		501	1446			5		953	7351		8304
1986	308	5054		648	1049			4		956	6107		7063
1987		4402		555	1410			5		555	5817		6372
1988		3171		534	1574			37		534	4782		5316
1989		3475		583	1070			4		583	4549		5132
1990		3808		547	1112			8		547	4929		5476
1991		4313		563	1265			29		563	5607		6170
1992		6338		1138	2061			45		1138	8444		9582
1993		4435		1683	2998			32		1683	7466		9149
1994		2970		957	1679			83		957	4732		5689

Table B4. Cont.

	5Y[2]			5Z			6			Total			Grand
Year	Canada	USA	Other[4]	Canada	USA	Other[3]	Canada	USA	Other[3]	Canada	USA	Other[3]	Total
1995		3064		481	1227			32		481	4324		4805
1996		2442		372	799			40		372	3281		3653
1997		1713		290	497			14		290	2223		2513
1998		1644		228	705			17		228	2366		2594
1999		1618		175	987			16		175	2621		2796
2000		2071		224	891			22		224	2984		3208
2001		2250		203	1228			4		203	3482		3685
2002		2222		158	1039			5		158	3266		3424
2003		3556		129	877			2		129	4435		4564
2004		2841		86	643			26		86	3511		3597
2005		2219		85	445			7		85	2670		2755
2006		1327		89	359			15		89	1700		1789
2007		1186		56	329			14		56	1529		1585
2008		1045		39	276			13		39	1333		1372
2009		1260		79	422			15		79	1696		1775
2010		1224		104	576			8		104	1808		1912
2011		2085		86	811			1		86	2897		2983

[1]Canada and Other as reported to ICNAF/NAFO for 1964-2011. USA Landings derived from NEFSC Weighout and General Canvas files.
[2]US 5Y landings include 464 and 465 and 5NK
[3]Includes Japan, Spain, and USSR.

Table B5. US commercial landings (mt,calc. live) and the annual percentage of total landings of white hake by gear type (NAFO Subareas 5 and 6, and 464 and 465), 1962-2011.

	Landings (mt,live)					Percentage of Annual Landings				
		Bottom	Sink				Bottom	Sink		
	Line	Otter	Gill	Other[1]		Line	Otter	Gill	Other[1]	
Year	Trawl	Trawl	Net	Gear	Total	Trawl	Trawl	Net	Gear	Total
1962	1585.3	1676.2	0.0	0.5	3262.1	48.6	51.4	0.0	0.0	100
1963	1800.7	1640.1	118.6	1.6	3561.0	50.6	46.1	3.3	0.0	100
1964	1155.4	1687.3	99.0	0.0	2941.7	39.3	57.4	3.4	0.0	100
1965	1515.7	1044.6	64.3	0.0	2624.5	57.8	39.8	2.4	0.0	100
1966	708.2	762.7	98.6	0.0	1569.4	45.1	48.6	6.3	0.0	100
1967	329.0	734.9	66.8	0.0	1130.6	29.1	65.0	5.9	0.0	100
1968	268.5	829.4	115.6	0.0	1213.5	22.1	68.3	9.5	0.0	100
1969	230.1	1013.7	102.7	0.0	1346.6	17.1	75.3	7.6	0.0	100
1970	204.8	1478.2	129.4	0.0	1812.4	11.3	81.6	7.1	0.0	100
1971	537.4	1921.6	117.7	3.3	2580.1	20.8	74.5	4.6	0.1	100
1972	836.9	1724.4	383.4	8.7	2953.4	28.3	58.4	13.0	0.3	100
1973	824.5	1833.6	505.3	5.9	3169.3	26.0	57.9	15.9	0.2	100
1974	646.5	1866.7	1298.8	0.8	3812.8	17.0	49.0	34.1	0.0	100
1975	989.5	1367.8	1331.9	0.1	3689.3	26.8	37.1	36.1	0.0	100
1976	547.2	1615.1	1964.2	0.8	4127.3	13.3	39.1	47.6	0.0	100
1977	373.3	2321.3	2290.3	7.4	4992.5	7.5	46.5	45.9	0.1	100
1978	317.4	2183.1	2377.4	18.2	4896.0	6.5	44.6	48.6	0.4	100
1979	209.9	2068.2	1802.5	15.5	4096.0	5.1	50.5	44.0	0.4	100
1980	100.4	2674.9	2065.5	27.6	4868.4	2.1	54.9	42.4	0.6	100
1981	110.7	3487.9	2376.3	7.2	5982.1	1.8	58.3	39.7	0.1	100
1982	99.0	3861.7	2201.0	15.8	6177.5	1.6	62.5	35.6	0.3	100
1983	83.1	4866.2	1394.2	61.4	6405.0	1.3	76.0	21.8	1.0	100
1984	33.3	5156.4	1485.9	77.6	6753.0	0.5	76.4	22.0	1.1	100
1985	318.2	5504.4	1417.1	111.7	7351.4	4.3	74.9	19.3	1.5	100
1986	231.9	4670.3	1161.9	43.1	6107.2	3.8	76.5	19.0	0.7	100
1987	86.2	4797.4	910.4	23.2	5817.3	1.5	82.5	15.7	0.4	100
1988	82.4	3655.2	1007.3	37.2	4782.1	1.7	76.4	21.1	0.8	100
1989	50.9	2548.4	1892.3	50.4	4542.0	1.1	56.1	41.7	1.1	100
1990	110.6	3279.8	1508.2	20.8	4919.5	2.2	66.7	30.7	0.4	100
1991	419.6	3547.7	1614.2	18.8	5600.3	7.5	63.3	28.8	0.3	100
1992	957.0	5190.6	2260.9	30.3	8438.9	11.3	61.5	26.8	0.4	100
1993	1207.1	4653.3	1588.4	12.6	7461.4	16.2	62.4	21.3	0.2	100
1994	1178.5	2478.4	1066.1	9.3	4732.3	24.9	52.4	22.5	0.2	100
1995	786.2	2405.7	1109.1	22.9	4323.9	18.2	55.6	25.7	0.5	100
1996	324.8	2036.8	916.0	3.6	3281.2	9.9	62.1	27.9	0.1	100
1997	414.4	1266.1	538.4	4.2	2223.0	18.6	57.0	24.2	0.2	100
1998	344.8	1285.6	730.7	4.9	2366.0	14.6	54.3	30.9	0.2	100
1999	144.0	1481.7	982.9	12.2	2620.8	5.5	56.5	37.5	0.5	100
2000	97.5	1811.0	1065.9	9.7	2984.0	3.3	60.7	35.7	0.3	100
2001	51.5	2421.3	1003.4	5.4	3481.5	1.5	69.5	28.8	0.2	100
2002	88.9	2338.5	823.2	15.6	3266.1	2.7	71.6	25.2	0.5	100
2003	104.3	2860.2	1417.2	52.8	4434.6	2.4	64.5	32.0	1.2	100
2004	63.8	2402.7	958.4	85.7	3510.6	1.8	68.4	27.3	2.4	100
2005	155.6	1883.8	573.3	57.7	2670.3	5.8	70.5	21.5	2.2	100
2006	30.0	1316.8	317.8	35.9	1700.5	1.8	77.4	18.7	2.1	100
2007	47.1	1031.8	392.9	56.7	1528.6	3.1	67.5	25.7	3.7	100
2008	9.0	904.4	399.8	19.6	1332.8	0.7	67.9	30.0	1.5	100
2009	5.9	1200.0	439.7	51.1	1696.6	0.3	70.7	25.9	3.0	100
2010	6.7	1387.9	403.5	9.6	1807.6	0.4	76.8	22.3	0.5	100
2011	7.6	2305.5	581.9	2.4	2897.4	0.3	79.6	20.1	0.1	100

[1] Includes Scottish seine, scallop dredge, Danish seine, pound net, floating trap net, lobster pots, fish pots, purse seine, common seine, diving gear, harpoon, rakes, and trammel net.

Table B6. Landings (mt,calc. live) of white hake by month, 1964-2011.

						Month								
Year	Unk.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1962	3262													3262
1963	3561													3561
1964	37	147	126	125	166	110	221	721	406	364	220	199	99	2942
1965	32	82	105	88	38	25	151	762	550	371	163	134	121	2625
1966	33	37	40	68	47	29	93	90	552	224	169	104	82	1569
1967	22	54	29	50	22	22	33	58	241	234	207	98	61	1131
1968	21	38	52	51	22	28	67	103	301	220	165	79	65	1214
1969	12	55	44	19	24	34	69	82	264	254	217	163	112	1347
1970	17	57	54	50	38	115	160	183	243	259	331	171	133	1812
1971	34	82	39	37	43	99	180	181	453	405	443	400	184	2580
1972	29	123	65	54	45	150	186	379	629	423	495	212	165	2953
1973	143	124	54	65	78	145	191	311	579	415	481	323	261	3169
1974	173	175	50	85	148	164	194	354	529	557	640	416	326	3813
1975	204	105	72	64	98	233	296	464	727	500	312	422	193	3689
1976	208	96	147	152	128	133	316	758	563	667	364	378	217	4127
1977	253	117	92	199	146	191	283	684	852	645	648	612	272	4992
1978	212	105	147	114	131	172	271	370	1084	859	761	480	190	4896
1979	314	102	34	78	106	232	322	642	964	433	379	308	182	4096
1980	502	109	108	106	102	131	441	720	860	636	553	405	195	4868
1981	66	196	86	126	116	129	437	903	1375	797	649	766	336	5982
1982	4	174	180	194	134	190	461	1139	1280	809	693	571	348	6177
1983	1	405	237	284	211	334	630	817	1015	745	744	577	406	6405
1984	9	425	228	221	208	341	537	770	1209	960	934	549	362	6753
1985	2	273	231	292	345	358	705	1097	1030	1114	825	633	445	7351
1986		309	276	288	386	392	619	999	851	723	623	369	272	6107
1987	3	135	188	221	163	270	724	1000	937	804	693	411	267	5817
1988	6	183	100	132	165	287	646	682	761	844	503	314	159	4782
1989	7	149	130	130	137	204	596	795	807	603	540	291	161	4549
1990	10	157	112	172	135	269	595	812	916	635	617	318	181	4929
1991	7	163	162	90	114	457	554	846	1126	871	624	345	247	5607
1992	5	277	247	294	283	344	832	1487	1756	1203	802	595	321	8444
1993	4	272	213	274	307	531	1000	1319	1232	790	744	514	266	7466

Table B6. cont.

							Month							
Year	Unk.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1994		143	275	198	325	348	615	688	717	447	462	293	221	4732
1995		140	180	190	138	261	504	705	597	504	565	366	175	4324
1996		135	149	152	100	243	376	366	553	448	402	235	122	3281
1997		97	116	73	73	62	209	271	344	343	285	206	143	2223
1998		67	92	116	107	101	257	319	308	322	275	213	191	2366
1999		151	141	156	142	181	346	377	330	288	209	175	125	2621
2000		125	160	195	192	294	296	371	358	257	344	222	171	2984
2001		209	205	200	228	259	309	441	373	324	348	300	286	3482
2002		298	301	316	234	173	228	313	324	302	272	241	263	3266
2003		365	289	459	267	465	381	470	457	365	358	311	248	4435
2004		277	354	377	213	236	341	364	393	286	212	219	238	3511
2005		253	303	259	130	193	285	241	301	208	175	176	148	2670
2006		206	215	190	87	67	113	168	153	119	132	127	125	1701
2007		120	104	109	65	101	181	191	175	137	143	120	81	1529
2008		92	93	88	57	39	110	183	175	128	134	138	95	1333
2009		134	122	155	101	91	133	174	169	164	186	176	93	1697
2010		180	184	223	122	126	141	137	138	145	156	118	137	1808
2011		215	313	311	263	167	178	220	258	278	234	206	255	2897

Table B7. The annual percentage of landings of white hake by month, 1964-2011.

							Percentage of total							
Year	Unk.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1964	1.3	5.0	4.3	4.2	5.7	3.7	7.5	24.5	13.8	12.4	7.5	6.8	3.4	100
1965	1.2	3.1	4.0	3.4	1.5	1.0	5.8	29.0	21.0	14.1	6.2	5.1	4.6	100
1966	2.1	2.3	2.5	4.3	3.0	1.9	6.0	5.7	35.2	14.3	10.8	6.6	5.2	100
1967	1.9	4.8	2.5	4.4	2.0	2.0	2.9	5.2	21.3	20.7	18.3	8.7	5.4	100
1968	1.8	3.1	4.3	4.2	1.9	2.3	5.5	8.5	24.8	18.2	13.6	6.5	5.4	100
1969	0.9	4.1	3.2	1.4	1.8	2.5	5.1	6.1	19.6	18.9	16.1	12.1	8.3	100
1970	0.9	3.1	3.0	2.8	2.1	6.4	8.8	10.1	13.4	14.3	18.3	9.4	7.3	100
1971	1.3	3.2	1.5	1.4	1.7	3.8	7.0	7.0	17.5	15.7	17.2	15.5	7.1	100
1972	1.0	4.2	2.2	1.8	1.5	5.1	6.3	12.8	21.3	14.3	16.8	7.2	5.6	100
1973	4.5	3.9	1.7	2.1	2.4	4.6	6.0	9.8	18.3	13.1	15.2	10.2	8.2	100
1974	4.5	4.6	1.3	2.2	3.9	4.3	5.1	9.3	13.9	14.6	16.8	10.9	8.6	100
1975	5.5	2.8	2.0	1.7	2.7	6.3	8.0	12.6	19.7	13.5	8.5	11.4	5.2	100
1976	5.0	2.3	3.6	3.7	3.1	3.2	7.7	18.4	13.7	16.2	8.8	9.2	5.3	100
1977	5.1	2.3	1.8	4.0	2.9	3.8	5.7	13.7	17.1	12.9	13.0	12.3	5.4	100
1978	4.3	2.1	3.0	2.3	2.7	3.5	5.5	7.6	22.1	17.6	15.5	9.8	3.9	100
1979	7.7	2.5	0.8	1.9	2.6	5.7	7.9	15.7	23.5	10.6	9.3	7.5	4.4	100
1980	10.3	2.2	2.2	2.2	2.1	2.7	9.1	14.8	17.7	13.1	11.4	8.3	4.0	100
1981	1.1	3.3	1.4	2.1	1.9	2.2	7.3	15.1	23.0	13.3	10.8	12.8	5.6	100
1982	0.1	2.8	2.9	3.1	2.2	3.1	7.5	18.4	20.7	13.1	11.2	9.2	5.6	100
1983	0.0	6.3	3.7	4.4	3.3	5.2	9.8	12.7	15.8	11.6	11.6	9.0	6.3	100
1984	0.1	6.3	3.4	3.3	3.1	5.1	7.9	11.4	17.9	14.2	13.8	8.1	5.4	100
1985	0.0	3.7	3.1	4.0	4.7	4.9	9.6	14.9	14.0	15.2	11.2	8.6	6.0	100
1986	0.0	5.1	4.5	4.7	6.3	6.4	10.1	16.4	13.9	11.8	10.2	6.0	4.5	100
1987	0.1	2.3	3.2	3.8	2.8	4.6	12.5	17.2	16.1	13.8	11.9	7.1	4.6	100
1988	0.1	3.8	2.1	2.8	3.4	6.0	13.5	14.3	15.9	17.7	10.5	6.6	3.3	100
1989	0.1	3.3	2.9	2.9	3.0	4.5	13.1	17.5	17.7	13.3	11.9	6.4	3.5	100
1990	0.2	3.2	2.3	3.5	2.7	5.5	12.1	16.5	18.6	12.9	12.5	6.5	3.7	100
1991	0.1	2.9	2.9	1.6	2.0	8.2	9.9	15.1	20.1	15.5	11.1	6.1	4.4	100
1992	0.1	3.3	2.9	3.5	3.4	4.1	9.8	17.6	20.8	14.2	9.5	7.0	3.8	100
1993	0.1	3.6	2.9	3.7	4.1	7.1	13.4	17.7	16.5	10.6	10.0	6.9	3.6	100
1994	0.0	3.0	5.8	4.2	6.9	7.3	13.0	14.5	15.2	9.5	9.8	6.2	4.7	100
1995	0.0	3.2	4.2	4.4	3.2	6.0	11.7	16.3	13.8	11.7	13.1	8.5	4.0	100

Table B7.cont.

Year	Unk.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
	Percentage of total													
1996	0.0	4.1	4.5	4.6	3.0	7.4	11.5	11.1	16.8	13.7	12.2	7.2	3.7	100
1997	0.0	4.4	5.2	3.3	3.3	2.8	9.4	12.2	15.5	15.4	12.8	9.3	6.5	100
1998	0.0	2.8	3.9	4.9	4.5	4.3	10.9	13.5	13.0	13.6	11.6	9.0	8.1	100
1999	0.0	5.8	5.4	6.0	5.4	6.9	13.2	14.4	12.6	11.0	8.0	6.7	4.8	100
2000	0.0	4.2	5.3	6.5	6.4	9.8	9.9	12.4	12.0	8.6	11.5	7.4	5.7	100
2001	0.0	6.0	5.9	5.7	6.6	7.4	8.9	12.7	10.7	9.3	10.0	8.6	8.2	100
2002	0.0	9.1	9.2	9.7	7.2	5.3	7.0	9.6	9.9	9.3	8.3	7.4	8.0	100
2003	0.0	8.2	6.5	10.3	6.0	10.5	8.6	10.6	10.3	8.2	8.1	7.0	5.6	100
2004	0.0	7.9	10.1	10.7	6.1	6.7	9.7	10.4	11.2	8.2	6.0	6.2	6.8	100
2005	0.0	9.5	11.3	9.7	4.9	7.2	10.7	9.0	11.3	7.8	6.5	6.6	5.5	100
2006	0.0	12.1	12.6	11.2	5.1	3.9	6.6	9.9	9.0	7.0	7.8	7.4	7.4	100
2007	0.0	7.8	6.8	7.1	4.3	6.6	11.9	12.5	11.4	9.0	9.4	7.9	5.3	100
2008	0.0	6.9	7.0	6.6	4.3	3.0	8.2	13.7	13.2	9.6	10.0	10.4	7.1	100
2009	0.0	7.9	7.2	9.1	6.0	5.4	7.8	10.2	9.9	9.7	10.9	10.3	5.5	100
2010	0.0	9.9	10.2	12.4	6.8	7.0	7.8	7.6	7.6	8.0	8.6	6.5	7.6	100
2011	0.0	7.4	10.8	10.7	9.1	5.8	6.1	7.6	8.9	9.6	8.1	7.1	8.8	100
average 1964-2011	1.3	4.7	4.5	4.8	3.9	5.1	8.7	13.0	16.2	12.7	11.3	8.3	5.6	100.0
average 1994-2011	0.0	6.7	7.3	7.6	5.5	6.3	9.6	11.6	11.8	9.9	9.6	7.8	6.3	100.0

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Table B8. Total US Landings (mt,calc.live) and the annual percentage of landings of white hake by state, 1962-2011.

	Landings (mt, live)												Percentage of total				
Year	CT	DE	Maine	MD	Mass.	NH	NJ	NY	RI	VA	NC	Total	Maine	Mass.	NH	RI	Others
1962	0.85		1817.15	0.06	1363.17	0.30	66.25	2.07	9.24	2.98		3262.07	55.7	41.8	0.0	0.3	2.2
1963	0.61		2163.25	0.06	1301.11	0.30	68.99	3.22	20.42	3.04		3561.00	60.7	36.5	0.0	0.6	2.1
1964			1522.15		1362.49	0.61	35.25	0.97	20.08	0.18		2941.74	51.7	46.3	0.0	0.7	1.2
1965	2.43		1743.32		830.08	0.91	27.29	0.49	19.20	0.79		2624.51	66.4	31.6	0.0	0.7	1.2
1966	2.31		914.04		596.63	0.73	29.48	0.18	26.03			1569.40	58.2	38.0	0.0	1.7	2.0
1967			638.17		453.00	0.61	20.97	0.18	17.71			1130.65	56.4	40.1	0.1	1.6	1.9
1968			568.08		576.09	1.09	18.60	1.58	48.08			1213.52	46.8	47.5	0.1	4.0	1.7
1969	1.09		474.45		818.01	1.22	6.32	2.98	42.51			1346.59	35.2	60.7	0.1	3.2	0.8
1970	0.06		638.66		1088.05	0.55	13.13	3.16	68.64	0.12		1812.36	35.2	60.0	0.0	3.8	0.9
1971	0.18		879.44		1563.73	1.22	26.20	5.53	102.96	0.85		2580.12	34.1	60.6	0.0	4.0	1.3
1972			1328.97		1537.89	2.43	22.49	3.83	57.72	0.06		2953.39	45.0	52.1	0.1	2.0	0.9
1973			1262.75		1699.26	103.82	37.32	1.88	64.29			3169.31	39.8	53.6	3.3	2.0	1.2
1974	0.18		1707.99		1900.65	134.03	35.07	4.19	30.71			3812.83	44.8	49.8	3.5	0.8	1.0
1975			2063.01		1404.54	172.26	29.91	1.64	17.90			3689.26	55.9	38.1	4.7	0.5	0.9
1976	3.53	0.49	2501.51		1401.73	182.47	16.90	4.13	16.56			4127.31	60.6	34.0	4.4	0.4	0.6
1977	1.52		2966.70		1738.29	240.15	9.24	1.88	34.68			4992.47	59.4	34.8	4.8	0.7	0.3
1978	1.09		3046.83		1617.77	207.39	4.35	3.71	14.90			4896.04	62.2	33.0	4.2	0.3	0.2
1979			2403.77		1366.03	313.03	0.75	1.03	11.38			4095.99	58.7	33.4	7.6	0.3	0.0
1980	0.55	3.04	2728.67		1593.46	498.29	3.74	0.30	40.34			4868.39	56.0	32.7	10.2	0.8	0.2
1981	60.78		3755.27		2023.82	100.64	2.53	4.92	34.11			5982.09	62.8	33.8	1.7	0.6	1.1
1982			4252.49		1793.81	76.97	1.01	4.13	49.07			6177.47	68.8	29.0	1.2	0.8	0.1
1983	0.18		4288.97		1870.79	204.23	0.97	0.97	38.69	0.16		6404.96	67.0	29.2	3.2	0.6	0.0
1984	0.30		3876.92		2442.50	313.89	0.56	8.81	110.05			6753.03	57.4	36.2	4.6	1.6	0.1
1985			3695.75		3367.97	162.40	0.80	2.43	122.06			7351.41	50.3	45.8	2.2	1.7	0.0
1986			2954.83		2872.36	189.24	2.91	2.12	85.74			6107.18	48.4	47.0	3.1	1.4	0.1
1987	3.04		3246.01		2253.23	184.74	2.11	5.32	122.81			5817.26	55.8	38.7	3.2	2.1	0.2
1988	6.32		2694.91		1897.79	48.04	40.33	2.23	92.47			4782.09	56.4	39.7	1.0	1.9	1.0
1989	3.16		3127.89		1325.93	49.03	6.85	0.78	40.75			4554.38	68.7	29.1	1.1	0.9	0.2
1990	5.57		2746.41		2109.09	0.69	9.10	0.20	59.99			4931.05	55.7	42.8	0.0	1.2	0.3
1991	3.10		3280.36		2122.07	70.00	5.92	11.82	113.99			5607.26	58.5	37.8	1.2	2.0	0.4
1992	2.65		5356.63		2520.91	287.04	28.79	8.05	239.59			8443.67	63.4	29.9	3.4	2.8	0.5

Table B8.cont.

	Landings (mt, live)												Percentage of total				
Year	CT	DE	Maine	MD	Mass.	NH	NJ	NY	RI	VA	NC	Total	Maine	Mass.	NH	RI	Others
1993	1.16		5041.54		2066.89	130.83	18.00	12.13	195.06			7465.60	67.5	27.7	1.8	2.6	0.4
1994			2938.54		1381.37	244.73	11.40	63.03	93.26			4732.33	62.1	29.2	5.2	2.0	1.6
1995	17.22		2531.77		1517.40	218.07	1.19	15.92	22.36	0.02		4323.94	58.6	35.1	5.0	0.5	0.8
1996	22.89		1949.45	0.12	1123.64	138.24	0.91	22.54	23.35	0.03		3281.16	59.4	34.2	4.2	0.7	1.4
1997	3.63		1427.29		620.48	129.09	0.03	18.68	23.80			2223.01	64.2	27.9	5.8	1.1	1.0
1998	3.99		1357.14		885.38	87.85	0.56	13.77	17.16	0.13	0.03	2366.01	57.4	37.4	3.7	0.7	0.8
1999	1.62		1351.32	0.01	941.27	285.80	0.85	14.43	25.50			2620.81	51.6	35.9	10.9	1.0	0.6
2000	7.01		1702.06		906.11	319.99	0.16	17.95	30.76	0.00		2984.05	57.0	30.4	10.7	1.0	0.8
2001	41.33		1899.32		1272.71	235.83	0.02	3.03	29.29	0.03		3481.55	54.6	36.6	6.8	0.8	1.3
2002	17.08		1964.77		1080.02	173.60		1.16	29.09	0.36		3266.07	60.2	33.1	5.3	0.9	0.6
2003	3.77		2909.78		1241.76	247.66	0.03	3.69	27.92			4434.60	65.6	28.0	5.6	0.6	0.2
2004	1.36		2160.90		1153.94	127.16	0.64	34.58	32.02	0.01		3510.60	61.6	32.9	3.6	0.9	1.0
2005	24.85		1523.78		966.82	122.64	0.07	22.86	9.31	0.00		2670.35	57.1	36.2	4.6	0.3	1.8
2006	9.31		758.83		832.05	68.31	0.44	20.75	10.81			1700.50	44.6	48.9	4.0	0.6	1.8
2007	3.59		598.46		842.48	46.75	1.00	26.31	10.03	0.02		1528.63	39.1	55.1	3.1	0.7	2.0
2008	1.12		357.71	0.01	917.04	19.65	0.17	30.10	6.97	0.05		1332.81	26.8	68.8	1.5	0.5	2.4
2009	0.79		351.70		1260.12	52.81	0.04	26.66	4.53			1696.64	20.7	74.3	3.1	0.3	1.6
2010	1.04		279.46	0.04	1467.03	48.21	3.77	6.77	1.30			1807.61	15.5	81.2	2.7	0.1	0.6
2011	0.49		395.53		2382.35	112.42	0.09	3.92	2.62	0.00		2897.42	13.7	82.2	3.9	0.1	0.2

Table B9. US Landings (mt,calc. live) and the annual percentage of total landings of white hake by tonnage class[1], 1962-2011.

	Tonnage Class (TC)					Percentage of total				
Year	2	3	4	Others[2]	Total	2	3	4	Others[2]	Total
1962	0	0	0	3262	3262	0.0	0.0	0.0	100.0	100
1963	0	0	0	3561	3561	0.0	0.0	0.0	100.0	100
1964	450	991	230	1271	2942	15.3	33.7	7.8	43.2	100
1965	312	510	198	1605	2625	11.9	19.4	7.5	61.2	100
1966	280	404	124	761	1569	17.8	25.7	7.9	48.5	100
1967	206	333	111	481	1131	18.2	29.4	9.8	42.5	100
1968	300	414	162	338	1214	24.7	34.1	13.3	27.9	100
1969	286	531	228	302	1347	21.3	39.5	16.9	22.4	100
1970	520	728	296	268	1812	28.7	40.2	16.3	14.8	100
1971	600	1084	341	555	2580	23.2	42.0	13.2	21.5	100
1972	738	972	303	941	2953	25.0	32.9	10.3	31.8	100
1973	934	913	287	1036	3169	29.5	28.8	9.1	32.7	100
1974	1334	884	338	1259	3814	35.0	23.2	8.9	33.0	100
1975	1302	602	254	1531	3689	35.3	16.3	6.9	41.5	100
1976	1587	837	279	1424	4127	38.5	20.3	6.8	34.5	100
1977	2363	1008	486	1136	4992	47.3	20.2	9.7	22.8	100
1978	2161	1083	534	1118	4896	44.1	22.1	10.9	22.8	100
1979	1687	1055	469	885	4096	41.2	25.8	11.5	21.6	100
1980	1809	1143	730	1187	4868	37.1	23.5	15.0	24.4	100
1981	2346	1492	1348	797	5982	39.2	24.9	22.5	13.3	100
1982	2626	1828	1309	415	6177	42.5	29.6	21.2	6.7	100
1983	1964	2403	1797	241	6405	30.7	37.5	28.1	3.8	100
1984	1966	2746	1621	420	6753	29.1	40.7	24.0	6.2	100
1985	1883	2987	2181	302	7351	25.6	40.6	29.7	4.1	100
1986	1190	2257	2195	465	6107	19.5	37.0	35.9	7.6	100
1987	1078	2517	1905	318	5817	18.5	43.3	32.8	5.5	100
1988	1114	1703	1732	233	4782	23.3	35.6	36.2	4.9	100
1989	1535	1495	1221	298	4549	33.7	32.9	26.8	6.6	100
1990	1330	1696	1702	202	4929	27.0	34.4	34.5	4.1	100
1991	1748	1895	1688	275	5607	31.2	33.8	30.1	4.9	100
1992	2665	2925	2362	491	8444	31.6	34.6	28.0	5.8	100
1993	1994	2563	2704	204	7466	26.7	34.3	36.2	2.7	100
1994	1345	1686	1693	9	4732	28.4	35.6	35.8	0.2	100
1995	1390	1563	1365	6	4324	32.2	36.1	31.6	0.1	100
1996	1218	1161	901	0	3281	37.1	35.4	27.5	0.0	100
1997	850	950	422	1	2223	38.2	42.7	19.0	0.0	100
1998	978	1007	378	4	2366	41.3	42.5	16.0	0.2	100
1999	1171	1019	430	0	2621	44.7	38.9	16.4	0.0	100
2000	1178	1179	628	0	2984	39.5	39.5	21.0	0.0	100
2001	1189	1539	754	0	3482	34.1	44.2	21.7	0.0	100
2002	1010	1557	700	0	3266	30.9	47.7	21.4	0.0	100
2003	1647	1855	932	0	4435	37.1	41.8	21.0	0.0	100
2004	1181	1532	788	10	3511	33.6	43.6	22.4	0.3	100
2005	609	1460	508	94	2670	22.8	54.7	19.0	3.5	100
2006	386	891	394	28	1700	22.7	52.4	23.2	1.7	100
2007	477	797	255	0	1529	31.2	52.1	16.7	0.0	100
2008	417	716	200	0	1333	31.3	53.7	15.0	0.0	100
2009	437	896	361	2	1697	25.8	52.8	21.3	0.1	100
2010	399	913	495	0	1808	22.1	50.5	27.4	0.0	100
2011	569	1474	844	10	2897	19.7	50.9	29.1	0.4	100

[1]TC2 = 5-50 GRT, TC3 = 51-150 GRT, TC4 = 151-500 GRT.
[2]Undertonnage and unknown vessels

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Table B10. Landings of red/white mixed market category. The percentage and mt assumed to be white hake using the ratio of white to white+red by statistical area are also given.

	1550	1551	1552	Total	% White Hake	mt White Hake
1986	76.3		152.2	228.5	87.9	200.8
1987	0.6		285.8	286.4	77.5	222.1
1988	25.9	280.6	347.2	653.7	82.1	536.7
1989	119.9	60.1	389.5	569.5	90.8	517.2
1990	22.5	67.7	160.5	250.7	85.7	214.9
1991	21.9	54.8	97.7	174.4	89.4	155.9
1992	8.5	30.7	35.9	75.1	87.6	65.8
1993	1.1	6.1	32.8	40	93.0	37.2
1994	0.5	50.6	49	100.1	92.5	92.6
1995	0.2	14	9.4	23.6	92.9	21.9
1996	0.8	17	2.6	20.4	73.2	14.9
1997	1.2	19.8	1.3	22.3	72.6	16.2
1998	0.1	17.5	0.1	17.7	21.0	3.7
1999	1.5	6.6	0.1	8.2	73.1	6.0
2000	1.6	14.3	0.6	16.5	86.9	14.3
2001	2.1	0.9	0.1	3.1	8.4	0.3
2002	0.8	0.8	0.8	2.4	70.3	1.7
2003	0.1	0.1		0.2	37.0	0.1
2004	12	3	0.3	15.3	78.3	12.0
2005	0	2.9	0.1	3	11.6	0.3
2006	3.1	1	0	4.1	72.2	3.0
2007	0.9	2.3		3.2	38.4	1.2
2008	2.1	39.1	0	41.2	18.9	7.8
2009	0.4	80.8	0.1	81.3	18.7	15.2
2010	0.9	67.7	0.1	68.7	17.8	12.2
2011	0	5.1		5.1	23.4	1.2

Table B11. Total Commercial Landings of white hake from 1893-2011.

	US White	Foreign White	White from Red/White	Total		US White	Foreign White	White from Red/White	Total
1893	17424			17424	1924	11214			11214
1894	17121			17121	1925	10462			10462
1895	16227			16227	1926	11177			11177
1896	14332			14332	1927	10392			10392
1897	14239			14239	1928	7798			7798
1898	21669			21669	1929	10840			10840
1899	15275			15275	1930	13976			13976
1900	11977			11977	1931	6678			6678
1901	14090			14090	1932	6991			6991
1902	19198			19198	1933	6021			6021
1903	14927			14927	1934	6214			6214
1904	17525			17525	1935	10225			10225
1905	19039			19039	1936	8947			8947
1906	14910			14910	1937	9399			9399
1907	17134			17134	1938	9384			9384
1908	19170			19170	1939	8222			8222
1909	16177			16177	1940	5982			5982
1910	17603			17603	1941	5001			5001
1911	15548			15548	1942	4985			4985
1912	14745			14745	1943	7426			7426
1913	15788			15788	1944	6155			6155
1914	13068			13068	1945	5876			5876
1915	14623			14623	1946	7398			7398
1916	14469			14469	1947	6159			6159
1917	11003			11003	1948	6660			6660
1918	10048			10048	1949	6123			6123
1919	11862			11862	1950	5492			5492
1920	9615			9615	1951	5552			5552
1921	9787			9787	1952	5429			5429
1922	10894			10894	1953	4665			4665

1923	11222			11222	1954	3842			3842

Table B11. Cont.

	US White	Foreign White	White from Red/White	Total
1955	3529			3529
1956	2933			2933
1957	2606			2606
1958	2026			2026
1959	2372			2372
1960	2624			2624
1961	2365			2365
1962	3262			3262
1963	3561			3561
1964	2942	29		2971
1965	2625	0		2625
1966	1569	0		1569
1967	1131	16		1147
1968	1214	85		1299
1969	1347	40		1387
1970	1812	326		2138
1971	2580	314		2894
1972	2953	199		3152
1973	3169	122		3291
1974	3813	232		4045
1975	3689	146		3835
1976	4127	195		4322
1977	4992	508		5500
1978	4896	184		5080
1979	4096	255		4351
1980	4868	307		5175
1981	5982	454		6436
1982	6177	766		6943
1983	6405	810		7215

	US White	Foreign White	White from Red/White	Total
1986	6107	956	201	7264
1987	5817	555	222	6594
1988	4782	534	537	5853
1989	4549	583	517	5649
1990	4929	547	215	5691
1991	5607	563	156	6326
1992	8444	1138	66	9647
1993	7466	1683	37	9186
1994	4732	957	93	5782
1995	4324	481	22	4827
1996	3281	372	15	3668
1997	2223	290	16	2529
1998	2366	228	4	2598
1999	2621	175	6	2802
2000	2984	224	14	3222
2001	3482	203	0	3685
2002	3266	158	2	3426
2003	4435	129	0	4564
2004	3511	86	12	3609
2005	2670	85	0	2756
2006	1700	89	3	1792
2007	1529	56	1	1586
2008	1333	39	8	1380
2009	1696	79	15	1791
2010	1808	104	12	1924
2011	2897	86	1	2985

1984	6753	1013	7766
1985	7351	953	8304

Table B12. Recreational catches of white hake (number) from MRFSS (1981-2011), MRIP (2004-2011) and Vessel Trip Reports of For-Hire vessels (1995-2011).

	MRFSS			MRIP			VTR	
	NoAB1	mt AB1	no b2	NoAB1	mt AB1	no b2	No Kept	No Disc
1981	11,334	22.7	0					
1982	2,507	4.9	0					
1983	7,665	8.8	8,690					
1984	9,317	106.4	12,202					
1985	0	0.0	46					
1986	3,395	34.0	518					
1987	0	0.0	0					
1988	5,258	1.0	2650					
1989	2,457	2.2	3,800					
1990	209	0.2	322					
1991	88,728	82.2	42,295					
1992	0	0.0	0					
1993	295	0.2	0					
1994	393	0.6	555				1,899	242
1995	1,184	1.2	1,264				3,739	84
1996	839	0.9	386				2,388	266
1997	519	0.5	12				2,471	354
1998	2,453	0.7	254				912	313
1999	174	0.2	1,113				908	97
2000	341	0.3	3,280				2,595	312
2001	2,342	3.3	0				1,089	116
2002	5,488	10.7	1,940				1,728	214
2003	9,970	9.5	9,603				1,638	57
2004	3,491	11.3	299	1,888	9.8	277	1,630	31
2005	917	6.2	0	1,449	7.9	0	1,047	33
2006	1,237	7.9	174	688	3.8	175	877	29
2007	494	1.6	0	573	2.0	0	1,564	7
2008	3,240	11.0	11,999	4,067	19.8	7,583	1,370	37
2009	1,489	3.9	174	1,141	2.9	96	1,538	36
2010	2,277	6.1	1,309	1,602	4.7	793	2,170	22
2011	4,437	12.7	465	3,836	12.6	351	4,460	253

Table B13. Total Estimates of discards from 1963-2011. Estimates of the coefficient of variation (CV) are given for 1989-2011. Two estimates of hind-casted discards are given A. 3-year average by gear and B. 5-year average by gear type.

Year	3-Year	5-Year	Year	Discards	CV
1964	1453.7	1274.6	1989	1136.9	
1965	1425.7	1251.0	1990	1895.7	
1966	1323.2	1168.0	1991	392.6	23.2
1967	1177.6	1043.2	1992	766.9	37.4
1968	1147.4	1016.9	1993	1480.6	39.2
1969	1011.0	894.5	1994	309.5	27.3
1970	938.9	833.0	1995	294.7	30.9
1971	862.4	766.9	1996	216.9	13.6
1972	758.9	673.8	1997	136.5	20.2
1973	734.2	654.5	1998	149.2	24.4
1974	703.2	624.3	1999	939.5	21.0
1975	739.9	666.5	2000	216.0	23.3
1976	808.0	707.0	2001	354.7	21.4
1977	954.7	831.5	2002	123.0	18.1
1978	1152.0	984.2	2003	324.0	43.8
1979	1199.7	1036.3	2004	112.6	21.4
1980	1230.8	1085.9	2005	93.2	33.2
1981	1229.2	1077.7	2006	61.8	16.9
1982	1379.4	1213.4	2007	36.0	14.7
1983	1324.2	1156.8	2008	171.4	31.5
1984	1245.3	1097.9	2009	83.5	17.5
1985	1099.4	966.4	2010	90.6	15.5
1986	1142.1	995.7	2011	54.4	12.5
1987	1192.2	1016.6			
1988	1188.9	1002.8			

Table B14. Estimates of discards in the large and small mesh otter trawl fleets from the NEFOP from 1989-2011.

	OT Large Mesh							OT Small Mesh						
	Half 1		Half 2		Total			Half 1		Half 2		Total		
YEAR	trips	discards	trips	discards	trips	discards	CV	trips	discards	trips	discards	trips	discards	CV
1989	28	52.7	29	337.7	57	390.4	41.8	44	110.6	75	149.9	119	260.5	43.6
1990	26	358.1	28	114.5	54	472.6	78.1	41	271.2	43	530.0	84	801.2	47.7
1991	31	7.1	51	107.9	82	115.1	34.5	61	3.2	113	123.5	174	126.7	60.9
1992	64	49.8	18	262.6	82	312.4	74.2	52	192.9	52	9.8	104	202.7	80.2
1993	20	52.0	18	77.3	38	129.3	42.0	17	0.7	11	487.5	28	488.2	94.0
1994	26	80.8	15	15.0	41	95.8	60.5	2	77.7	20	103.1	22	180.8	33.6
1995	54	47.8	66	100.9	120	148.7	36.0	25	5.9	77	12.5	102	18.4	41.5
1996	30	22.3	25	0.3	55	22.6	49.1	36	99.5	91	18.3	127	117.8	9.7
1997	19	15.2	10	58.0	29	73.2	28.0	47	22.1	22	0.0	69	22.1	59.7
1998	18	18.9	6	33.4	24	52.3	42.1	13	0.0	18	0.0	31	0.0	
1999	6	3.3	31	127.9	37	131.1	52.5	20	0.5	32	751.0	52	751.5	24.5
2000	73	69.4	54	79.3	127	148.7	30.1	27	19.4	24	6.8	51	26.2	82.4
2001	61	83.0	135	164.5	196	247.5	27.4	36	48.3	36	0.0	72	48.3	39.6
2002	46	45.6	206	58.8	252	104.4	20.9	26	0.0	70	1.3	96	1.3	78.0
2003	196	33.9	200	33.5	396	67.4	29.4	65	0.7	75	238.7	140	239.4	58.6
2004	217	8.7	404	55.3	621	64.0	33.6	144	17.9	273	10.2	417	28.1	36.3
2005	666	6.4	763	14.4	1429	20.7	16.1	178	3.9	235	43.0	413	47.0	64.6
2006	405	9.8	269	23.7	674	33.5	23.4	122	4.6	103	0.6	225	5.2	38.5
2007	328	10.6	449	9.6	777	20.2	21.8	125	3.2	168	0.7	293	3.9	56.1
2008	412	5.7	469	13.3	881	19.0	18.2	105	86.2	106	31.7	211	117.9	45.5
2009	478	22.7	563	14.8	1041	37.5	30.9	198	0.5	304	20.1	502	20.5	35.0
2010	519	17.0	806	16.4	1325	33.4	13.4	305	11.8	289	1.3	594	13.1	66.4
2011	895	7.0	953	7.9	1848	14.9	12.3	252	7.2	302	0.4	554	7.6	80.1

Table B15. Estimates of discards in the sink gill net and longline fleets from the NEFOP from 1989-2011.

	SGN							Longline						
	Half 1		Half 2		Total			Half 1		Half 2		Total		
YEAR	trips	discards	trips	discards	trips	discards	CV	trips	discards	trips	discards	trips	discards	CV
1989	1	12.2	106	21.8	107	34.0	18.8							
1990	75	10.2	78	78.4	153	88.6	48.3							
1991	194	25.5	763	54.6	957	80.2	18.3	1	1.0	17	0.6	18	1.6	6.0
1992	497	37.3	690	84.0	1187	121.3	12.2	32	7.6		9.2	32	16.8	29.1
1993	348	56.4	422	153.7	770	210.1	20.0	3	3.2	1	2.1	4	5.2	34.4
1994	188	0.5	216	11.5	404	12.0	72.7	2	2.5		2.2	2	4.7	
1995	298	1.2	239	27.2	537	28.4	41.8	1	2.2		2.3	1	4.5	
1996	254	2.8	168	48.1	422	50.9	46.4		2.1		1.9		4.0	
1997	257	4.9	132	27.3	389	32.2	40.3		2.3		2.1		4.4	
1998	267	2.2	136	2.0	403	4.1	47.3		1.8	1	2.2	1	4.0	
1999	88	12.7	101	5.4	189	18.2	52.4		1.7		1.8		3.5	
2000	118	6.2	108	11.1	226	17.3	33.4		1.0		1.9		2.9	
2001	98	1.4	69	47.3	167	48.6	57.9		1.4		1.5		2.9	
2002	67	6.6	106	2.6	173	9.2	43.5		1.6	9	0.9	9	2.5	11.9
2003	162	6.4	330	7.7	492	14.2	30.0	17	0.1	2	0.1	19	0.2	
2004	289	1.0	800	10.6	1089	11.6	21.9	9	0.1	113	1.8	122	1.9	14.6
2005	260	3.9	744	14.2	1004	18.0	22.4	88	0.3	204	3.1	292	3.4	11.2
2006	136	2.0	115	13.0	251	14.9	43.0	46	0.1	56	3.3	102	3.4	25.1
2007	100	2.2	234	2.2	334	4.4	30.8	24	0.1	69	0.8	93	0.8	24.9
2008	115	4.2	194	10.1	309	14.3	27.8	27	0.1	52	2.5	79	2.7	20.1
2009	190	3.4	226	5.3	416	8.7	29.4	35	0.4	55	0.7	90	1.0	30.4
2010	419	16.5	1460	10.8	1879	27.3	32.1	72	0.2	120	2.0	192	2.2	21.9
2011	733	4.5	1326	19.2	2059	23.7	10.2	77	0.1	41	0.4	118	0.6	26.7

Table B16. Estimates of discards in the shrimp trawl and scallop dredge fleets from the NEFOP from 1989-2011.

	Shrimp							Scallop						
	Half 1		Half 2		Total			Half 1		Half 2		Total		
YEAR	trips	discards	trips	discards	trips	discards	CV	trips	discards	trips	discards	trips	discards	CV
1989	31	3.9	9	17.4	40	21.3	36.4							
1990	27	10.3	4	3.7	31	14.0	57.8							
1991	46	21.9	7	46.3	53	68.1	35.2		0.6	2	0.3	2	0.9	
1992	78	68.3	6	1.0	84	69.4	52.2	8	12.1	10	32.3	18	44.4	52.6
1993	78	4.7	4	0.5	82	5.2	36.5	14	8.1	8	634.5	22	642.6	54.2
1994	71	5.2	6	6.0	77	11.2	28.8	11	2.4	12	2.7	23	5.1	18.3
1995	64	11.3	9	1.0	73	12.3	16.6	15	52.3	12	30.2	27	82.5	87.5
1996	30	15.9	5	1.6	35	17.5	41.0	22	0.0	18	4.1	40	4.1	54.8
1997	17	2.3		0.3	17	2.6	24.7	19	0.1	10	2.0	29	2.2	44.4
1998		1.0		0.1		1.0		9	41.6	17	46.2	26	87.8	33.0
1999		0.4		0.0		0.4		15	14.1	56	20.6	71	34.7	39.7
2000		0.6		0.0		0.7		38	11.6	218	8.5	256	20.2	24.3
2001	3	0.0		0.0	3	0.0		58	3.2	48	4.2	106	7.4	13.0
2002		0.1	2	0.0	2	0.1		34	1.6	66	3.9	100	5.5	33.8
2003	15	0.2			15	0.2	86.9	50	0.4	74	2.3	124	2.7	35.6
2004	12	0.4	1	0.5	13	0.9	8.8	85	0.9	212	5.2	297	6.1	36.5
2005	17	0.4		0.0	17	0.4	48.0	128	0.3	206	3.2	334	3.6	85.7
2006	17	1.0	4	0.2	21	1.2	17.5	45	0.3	183	3.2	228	3.5	34.5
2007	14	3.6		0.6	14	4.2	23.3	158	0.6	202	2.0	360	2.6	46.6
2008	16	3.0	3	1.5	19	4.5	44.6	385	5.8	257	7.2	642	13.0	27.6
2009	7	2.9	5	2.1	12	5.0	37.5	373	7.4	117	3.3	490	10.7	38.4
2010	11	4.7	5	0.0	16	4.7	20.3	145	7.6	194	2.4	339	10.0	48.4
2011	1	5.6		0.1	1	5.7		177	0.2	216	1.7	393	2.0	30.1

Table B17. Summary of number of red hake measured by port samplers by region and half.

	North			South		
Year	1	2	Total	1	2	Total
1975					206	206
1976					103	103
1977				159		159
1979					94	94
1980				318		318
1981		101	101			
1982		431	431			
1983	125	1232	1357	182		182
1984	209	546	755	982	200	1182
1985	43	914	957	1139	599	1738
1986	335	1227	1562	948	320	1268
1987		967	967	786	213	999
1988	666	1172	1838	612	100	712
1989	111	410	521	201	309	510
1990	242	607	849	518	275	793
1991	826	214	1040	701	299	1000
1992		111	111	400	404	804
1993		95	95	303	100	403
1994				419	356	775
1995				1067	62	1129
1996					193	193
1997				1730	246	1976
1998		138	138	904	309	1213
1999		47	47	748	795	1543
2000				250	388	638
2001		99	99	1010	720	1730
2002				432	406	838
2003		345	345	1068	509	1577
2004		370	370	755	1195	1950
2005				1030	1208	2238
2006		93	93	1255	1146	2401
2007		37	37	2819	1758	4577
2008				2560	2183	4743
2009				1139	599	1738

Table B18. Summary of number of white hake measured by port samplers by market category and half in the northern region.

	Uncl			Small			Large		
Year	1	2	Total	1	2	Total	1	2	Total
1985	101	397	498	356	640	996	509	790	1299
1986	215	398	613	686	668	1354	332	221	553
1987	245	237	482	443	998	1441	111	754	865
1988	100	41	141	1414	823	2237	233	299	532
1989	100	106	206	185	511	696		410	410
1990		101	101	613	749	1362	214	306	520
1991	207	94	301	674	1118	1792	474	728	1202
1992	97	237	334	1177	1423	2600	94	622	716
1993	214	293	507	1097	616	1713	361	851	1212
1994	236	697	933	397	1063	1460	303	667	970
1995	100		100	191	535	726	221	103	324
1996	199	546	745	101	976	1077	202	1210	1412
1997		58	58	1634	2455	4089	1166	1574	2740
1998		118	118	500	886	1386	897	1226	2123
1999				213	640	853	831	425	1256
2000				1172	1146	2318	229	336	565
2001				881	887	1768	784	1457	2241
2002				1171	1746	2917	1055	761	1816
2003				1637	1500	3137	1945	3285	5230
2004				988	978	1966	3536	1646	5182
2005	28	61	89	1203	1760	2963	1849	1711	3560
2006				1467	1936	3403	1922	1748	3670
2007				1524	1759	3283	1469	1489	2958
2008				1226	1857	3083	1698	1467	3165
2009				981	1691	2672	1248	1920	3168

Table B19. Summary of number of white hake measured by port samplers by market category and half in the southern region.

	Uncl			Small			Large		
Year	1	2	Total	1	2	Total	1	2	Total
1985									
1986									
1987	113		113						
1988				100		100			
1989									
1990				104		104			
1991				151		151			
1992				52	55	107	100		100
1993				50		50	100		100
1994									
1995									
1996									
1997									
1998				100		100			
1999					107	107		104	104
2000									
2001									
2002							85		85
2003				92	96	188			
2004				96		96			
2005	111		111	61		61	106		106
2006									
2007	201		201						
2008				142		142	5		5
2009					101	101	28		28

Table B20. Summary of US commercial white hake landings (mt), number of length samples (n), and number of fish measured (len) by market category and quarter from the Gulf of Maine to the Mid-Atlantic (SA 464,465, 511-515,521-526,533-539,611-626) for all gear types, 1985-2011.

	small					medium					large					unclassified					All	Sampling
	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Total	Intensity
1985 mt	129	162	235	167	694	63	78	181	124	446	237	433	1135	623	2428	367	737	1690	988	3782	7349	272
N		2	4	3	9					0		5	5	3	13		1	3	1	5	27	
# fish		233	323	317	873					0		632	519	271	1422		101	293	104	498	2793	
1986 mt	59	134	105	100	398	86	89	55	54	284	274	422	835	417	1948	455	752	1578	694	3478	6107	235
N	1	3	2	1	7	1	1		2	4	1	3	2	1	7	2	2	3	1	8	26	
# fish	102	263	215	101	681	94	122		229	445	122	315	248	96	781	215	206	292	106	819	2726	
1987 mt	98	300	641	576	1616	13	49	122	123	306	171	326	943	372	1813	262	482	1035	301	2080	5814	194
N		2	4	5	11		2	1	1	4		1	6	3	10	2	1	1	1	5	30	
# fish		240	291	507	1038		203	91	109	403		111	518	236	865	218	140	112	125	595	2901	
1988 mt	181	549	893	397	2020	26	82	262	120	489	136	330	695	325	1486	73	137	437	134	782	4776	165
N	5	6	3	5	19	1	1	1		3	1	1	2	1	5		1		1	2	29	
# fish	558	764	240	478	2040	100	92	105		297	112	121	214	85	532		100		41	141	3010	
1989 mt	149	221	404	358	1132	41	54	124	68	287	188	473	904	470	2035	33	190	774	96	1092	4547	350
N	1	1	2	2	6			1		1			2	2	4	1		1		2	13	
# fish	91	94	213	195	593			103		103			206	204	410	100		106		206	1312	
1990 mt	207	411	885	450	1953	43	108	303	171	625	167	300	596	320	1382	24	182	580	176	962	4922	234
N	3	4	4	2	13			2	1	3	2		1	1	4				1	1	21	
# fish	309	408	399	151	1267			202	99	301	214		101	103	418				101	101	2087	
1991 mt	150	366	1215	612	2342	88	160	381	129	758	126	241	533	338	1238	52	358	714	138	1262	5601	156
N	2	5	6	4	17	1	1	3	1	6	4	1	1	4	10		2	1		3	36	
# fish	151	471	485	244	1351	103	100	382	100	685	375	99	96	539	1109		207	94		301	3446	
1992 mt	424	626	1735	848	3633	102	202	766	358	1428	231	351	699	371	1651	60	280	1246	141	1727	8439	211
N	4	4	8	3	19	1	4	3	3	11		2	3	2	7	1		2		3	40	
# fish	329	432	655	240	1656	80	388	266	317	1051		194	325	297	816	97		237		334	3857	
1993 mt	331	502	453	214	1500	161	397	1117	461	2136	173	476	795	416	1860	94	463	975	433	1965	7462	191
N	2	5	4	1	12	2	3	2	1	8	2	3	7	2	14		2	2	1	5	39	
# fish	150	504	275	50	979	184	309	196	95	784	199	262	676	175	1312		214	196	97	507	3582	
1994 mt	63	82	116	56	317	154	374	593	265	1386	206	481	687	407	1782	193	352	457	251	1252	4737	144
N		2	4	1	7		2	3	3	8		3	4	2	9		2	4	3	9	33	
# fish		167	386	100	653		230	305	272	807		303	363	304	970		236	431	372	1039	3469	
1995 mt	39	43	98	66	245	140	238	616	399	1393	197	398	595	374	1564	134	225	504	268	1130	4333	361
N		1	1	1	3		2	2	1	5		2		1	3		1			1	12	
# fish		107	97	105	309		191	222	111	524		221		103	324		100			100	1257	

Table B20. cont.

	small					medium					large					unclassified					All	Sampling
	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Total	Intensity
1996 mt	23	34	80	43	181	96	207	531	269	1103	208	331	416	280	1234	110	152	339	169	769	3287	122
N					0	1		4	4	9		2	4	5	11	1	1	3	2	7	27	
# fish					0	101		435	541	1077		202	451	759	1412	127	72	326	220	745	3234	
1997 mt	31	58	124	83	295	76	113	370	193	752	146	146	438	335	1066	34	28	26	26	113	2225	32
N	4	2	4	2	12	3	7	6	13	29	5	7	7	9	28				1	1	70	
# fish	458	206	430	261	1355	276	694	564	1200	2734	541	720	678	896	2835				58	58	6982	
1998 mt	31	54	128	105	318	55	77	218	152	502	159	311	571	407	1449	28	23	34	14	100	2370	74
N	1	2	1	1	5	3		3	2	8	7	2	8	1	18			1		1	32	
# fish	53	220	120	59	452	327		402	305	1034	684	213	1311	110	2318			118		118	3922	
1999 mt	50	76	103	87	317	85	110	236	149	580	303	468	633	257	1661	11	14	25	16	66	2624	119
N			1		1	1	1	3	4	9	1	6	2	3	12					0	22	
# fish			119		119	111	102	315	313	841	166	665	202	327	1360					0	2320	
2000 mt	55	70	81	81	286	118	202	289	201	811	293	497	596	446	1833	14	15	20	12	60	2990	120
N	4			1	5	5	1	5	4	15	1	1		3	5					0	25	
# fish	428			123	551	527	106	573	450	1656	103	126		336	565					0	2772	
2001 mt	59	122	167	177	525	131	155	219	310	815	413	497	697	434	2041	10	22	57	12	101	3482	97
N	2	3	2	2	9	2	1	2	2	7	3	4	7	6	20					0	36	
# fish	231	329	213	224	997	221	100	235	215	771	328	456	797	660	2241					0	4009	
2002 mt	124.544	58	51	31	264	330	186	234	163	912	454	378	640	576	2047	7	14	15	6	43	3266	58
N		2	1	11	14	6	4	4	7	21	7	4	7	3	21					0	56	
# fish		154	103	968	1225	626	391	417	629	2063	768	372	665	335	2140					0	5428	
2003 mt	35	20	42	32	129	153	92	158	134	537	918.472	996.55	1065.672	742.897	3724	6	5	26	9	46	4435	46
N	3	6	6	4	19	4	8	4	8	24	6	14	17	17	54					0	97	
# fish	249	424	306	208	1187	355	768	387	796	2306	576	1369	1620	1665	5230					0	8723	
2004 mt	17	17	44	38	116	113	87	180	122	503	869	632	721	420	2642	5	53	98	88	245	3505	42
N	2	3		7	12	5	5	2	6	18	20	14	5	15	54					0	84	
# fish	83	162		445	690	383	456	211	579	1629	2062	1474	524	1213	5273					0	7592	
2005 mt	22	24	33	24	102	79	84	167	120	450	446	352	418	246	1463	270	148	137	104	659	2673	30
N	7	7	8	6	28	3	5	6	5	19	9	10	8	11	38	1	1	1		3	88	
# fish	349	360	400	313	1422	161	494	554	493	1702	825	924	738	973	3460	28	111	61		200	6784	
2006 mt	27	10	14	17	67	69	48	78	76	271	336	163	299	226	1025	193	47	49	66	355	1718	18
N	6	9	5	9	29	5	3	6	6	20	12	13	9	10	44					0	93	
# fish	372	398	254	547	1571	434	263	534	601	1832	958	1013	776	972	3719					0	7122	

Table B20. cont.

	small					medium					large					unclassified					All	Sampling
	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Total	Intensity
2007 mt	11	16	31	41	99	39	53	75	76	244	207	220	338	198	963	75	59	59	28	222	1528	15
N	12	6	7	10	35	5	5	7	7	24	9	8	10	11	38	1	1			2	99	
# fish	478	264	325	388	1455	396	386	428	618	1828	753	716	667	922	3058	100	101			201	6542	
2008 mt	22	20	50	40	132	48	44	110	114	316	176	125	308	203	813	28	18	18	9	73	1335	14
N	5	5	6	7	23	7	5	6	6	24	11	17	8	10	46					0	93	
# fish	283	255	328	385	1251	474	356	528	616	1974	597	1106	790	677	3170					0	6395	
2009 mt	36	32	42	74	184	75	76	120	144	415	270	203	334	220	1028	29	15	11	15	70	1697	20
N	5	5	8	6	24	5	4	7	5	21	10	8	10	13	41					0	86	
# fish	282	279	599	519	1679	385	209	285	506	1385	773	558	1113	1104	3548					0	6612	
2010 mt	59	28	30	31	147	131	83	109	124	447	360	270	267	242	1139	38	9	13	15	75	1807	15
N	11	6	8	9	34	7	8	11	10	36	10	12	17	11	50					0	120	
# fish	500	483	580	428	1991	645	704	866	681	2896	953	1071	1203	898	4125					0	9012	
2011 mt	32	30	45	52	160	147	128	189	190	654	589	436	503	423	1952	56	23	14	18	111	2877	22
N	14	7	10	8	39	7	8	12	7	34	12	16	19	13	60						133	
# fish	542	390	611	418	1961	677	710	1069	700	3156	974	987	1199	1048	4208						9325	

Table B21. Proportion of red/white hake market category by mesh size (large >= 5.5 in, small < 5.5 in).

	LARGE	SMALL	UNK
1986	0.317	0.122	0.561
1987	0.388	0.027	0.584
1988	0.159	0.090	0.751
1989	0.151	0.031	0.817
1990	0.086	0.022	0.892
1991	0.155	0.043	0.802
1992	0.206	0.056	0.738
1993	0.288	0.087	0.625
1994	0.111	0.046	0.843
1995	0.178	0.517	0.304
1996	0.111	0.295	0.594
1997	0.033	0.645	0.322
1998	0.012	0.623	0.366
1999	0.047	0.350	0.603
2000	0.233	0.465	0.302
2001	0.360	0.131	0.508
2002	0.014	0.013	0.973
2003	0.000	0.044	0.956
2004	0.341	0.022	0.637
2005	0.286	0.269	0.445
2006	0.569	0.053	0.378
2007	0.097	0.097	0.806
2008	0.017	0.391	0.593
2009	0.050	0.396	0.554
2010	0.036	0.326	0.638
2011	0.226	0.644	0.131
AVG	0.172	0.223	0.605

Table B22. Number of ages from NEFSC survey and NEFOP data from 1982-2012 used to age the commercial length composition.
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Year	Spring	Obs Half 1	Autumn	Obs Half 2	Grand Total
1982	362		283		760
1983	309		483		792
1984	224		450		716
1985	411		652		1063
1986	686		669		1355
1987	191		443		634
1988	276		476		752
1989	259	36	472	90	731
1990	436	46	717	67	1153
1991	499	197	861	411	1360
1992	360	99	789	244	1149
1993	380	44	686	140	1066
1994	282	26	582	113	864
1995	256	123	542	208	798
1996	199	122	279	269	478
1997	113	136	277	224	390
1998	184	40	359		543
1999	210	57	374	209	584
2000	289	168	424	104	866
2001	323		328		651
2002	249		256		505
2003	235				235
2004	95		186		281
2005	237		207		444
2006	160		253		413
2007	184		488		672
2008	247		469		716
2009	775		822		1597
2010	755		952		1707
2011	697		737		1434
2012	616				616

Table B23. Total commercial landings-at-age (in 000s of fish) of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1985	0.000	0.000	11.985	630.707	1970.224	733.597	155.049	40.955	21.445	19.059	32.482		3615.505	3615.505	51.541
1986	0.000	0.000	13.846	303.056	437.697	324.864	227.450	137.260	78.481	103.849	147.913		1774.417	1774.417	251.762
1987	0.000	0.000	59.514	961.112	781.298	333.479	182.991	91.993	84.136	45.531	65.667		2605.721	2605.721	111.198
1988	0.000	1.308	80.063	1079.134	1264.266	515.114	105.235	15.779	10.526	4.910	28.747		3105.082	3105.082	33.657
1989	0.000	0.000	6.988	657.147	1006.232	593.181	259.583	39.802	22.835	9.927	12.614		2608.309	2608.309	22.542
1990	0.000	0.089	133.434	1226.335	1230.294	385.303	84.582	32.369	13.700	8.114	17.028		3131.248	3131.248	25.141
1991	0.000	0.000	62.055	1151.316	1307.508	750.988	174.022	40.128	14.677	8.691	26.002		3535.388	3535.388	34.693
1992	0.000	0.000	33.645	2022.094	1904.283	802.618	360.416	177.423	40.679	10.546	16.994		5368.698	5368.698	27.539
1993	0.000	0.000	4.165	1471.175	2271.586	866.068	299.926	99.479	12.406	7.356	13.378		5045.539	5045.539	20.734
1994	0.000	0.887	67.590	777.515	1100.425	600.293	257.221	86.974	28.903	8.904	13.158		2941.869	2941.869	22.062
1995	0.000	0.000	271.449	1594.567	765.135	330.931	168.725	29.044	24.406	18.229	5.807		3208.292	3208.292	24.036
1996	0.000	0.000	27.800	334.470	500.437	418.158	255.623	66.991	14.311	7.573	6.949		1632.313	1632.313	14.523
1997	0.000	0.006	0.603	78.054	222.095	314.080	191.734	78.599	21.458	8.417	5.073		920.118	920.118	13.490
1998	0.000	0.000	5.598	75.060	178.858	189.711	167.538	97.550	38.005	15.658	6.466		774.443	774.443	22.123
1999	0.000	0.000	0.289	139.347	188.529	231.910	160.579	97.964	73.340	23.068	12.418		927.443	927.443	35.486
2000	0.000	0.000	0.878	28.333	228.809	250.977	162.903	85.773	91.112	70.400	16.147		935.330	935.330	86.547
2001	0.000	0.000	7.585	250.079	315.558	222.062	204.681	113.895	68.843	39.219	14.379		1236.301	1236.301	53.598
2002	0.000	0.000	42.692	221.180	410.986	228.243	185.552	92.931	41.117	10.522	3.832		1237.054	1237.054	14.354
2003	**0.000**	**0.000**	**0.325**	**30.542**	**145.131**	**232.402**	**268.268**	**210.928**	**115.347**	**58.815**	**17.026**		**1078.784**	**1078.784**	**75.841**
2004	0.000	0.000	1.354	32.100	87.810	195.359	169.930	141.138	84.541	45.334	27.378		784.943	784.943	72.712
2005	0.000	0.000	1.248	18.828	100.608	134.111	103.267	134.709	80.491	26.036	56.430		655.727	655.727	82.465
2006	0.000	0.000	1.651	24.327	51.685	72.473	117.648	57.376	51.869	16.103	27.037		420.167	420.167	43.140
2007	0.000	0.000	3.252	45.931	60.555	55.322	74.157	49.135	31.335	13.865	20.694		354.247	354.247	34.560
2008	0.000	0.000	2.145	52.080	115.263	63.722	85.066	39.859	24.534	10.259	7.665		400.594	400.594	17.925
2009	0.000	0.063	14.525	57.691	123.626	122.091	109.050	62.576	40.220	7.245	24.496		561.583	561.583	31.741
2010	0.000	0.018	2.603	55.548	123.403	122.692	83.355	35.213	27.163	14.516	38.637		503.149	503.149	53.154
2011	0.000	0.037	1.621	57.315	155.066	146.338	147.186	84.948	54.713	27.812	41.755		716.790	716.790	69.567

Table B24. Total commercial landings-at-age (in mt) of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1985	0.000	0.000	7.920	649.196	3743.976	2280.435	678.828	227.944	143.692	157.520	414.960		8304.470	8304.470	572.480
1986	0.000	0.000	8.633	299.996	693.079	964.599	1034.470	798.792	553.717	866.681	2044.191		7264.158	7264.158	2910.872
1987	0.000	0.000	31.832	956.418	1450.867	1028.682	868.012	477.124	545.728	350.326	885.379		6594.367	6594.367	1235.705
1988	0.000	0.229	45.318	1160.849	2236.962	1347.521	409.153	76.339	68.864	37.643	469.701		5852.578	5852.578	507.344
1989	0.000	0.000	4.563	677.234	1778.709	1640.801	989.572	214.376	136.362	78.817	128.653		5649.087	5649.087	207.470
1990	0.000	0.026	75.192	1421.244	2165.320	1127.046	352.163	162.412	92.958	68.275	226.206		5690.843	5690.843	294.481
1991	0.000	0.000	35.287	1268.609	2060.793	1752.400	577.150	166.092	89.219	78.777	297.834		6326.160	6326.160	376.611
1992	0.000	0.000	20.850	1966.298	2821.781	2005.649	1431.817	871.946	237.206	83.103	208.658		9647.308	9647.308	291.761
1993	0.000	0.000	2.102	1492.141	3636.683	2253.250	1099.945	400.805	75.191	53.653	171.983		9185.752	9185.752	225.637
1994	0.000	0.168	24.092	725.870	1662.547	1567.544	973.175	423.867	197.180	65.724	141.713		5781.880	5781.880	207.437
1995	0.000	0.000	158.943	1711.129	1251.512	775.696	503.376	121.964	136.880	96.291	70.993		4826.783	4826.783	167.284
1996	0.000	0.000	16.052	364.174	858.959	1077.509	867.119	275.304	94.596	43.465	70.831		3668.008	3668.008	114.295
1997	0.000	0.002	0.338	77.450	384.894	805.624	674.691	352.793	127.560	57.907	47.902		2529.162	2529.162	105.809
1998	0.000	0.000	2.912	88.818	364.530	574.742	704.401	465.956	234.488	107.919	53.942		2597.709	2597.709	161.862
1999	0.000	0.000	0.172	98.990	304.172	574.899	606.003	476.559	463.662	167.727	109.584		2801.768	2801.768	277.311
2000	0.000	0.000	0.503	29.105	404.468	640.007	546.463	403.142	572.154	480.207	146.269		3222.318	3222.318	626.476
2001	0.000	0.000	3.791	355.662	565.702	573.872	781.287	579.882	421.089	274.174	129.303		3684.760	3684.760	403.477
2002	0.000	0.000	50.462	335.763	927.586	664.689	713.896	414.763	220.306	68.310	29.967		3425.743	3425.743	98.277
2003	**0.000**	**0.000**	**0.311**	**41.643**	**315.988**	**747.426**	**1141.925**	**1102.744**	**677.288**	**390.006**	**146.319**		**4563.649**	**4563.649**	**536.324**
2004	0.013	13.309	139.592	194.463	159.612	475.291	632.555	831.028	574.129	355.713	232.835		3608.541	3608.528	588.549
2005	0.000	0.000	1.031	26.663	198.086	377.565	417.825	624.841	470.623	186.584	452.501		2755.718	2755.718	639.085
2006	0.000	0.000	1.256	33.553	92.758	219.805	473.056	265.231	277.587	132.783	296.427		1792.457	1792.457	429.210
2007	0.000	0.000	3.055	73.113	163.533	242.432	347.499	241.495	171.357	97.023	246.308		1585.816	1585.816	343.332
2008	0.000	0.000	1.737	78.838	262.157	216.079	339.552	192.115	129.937	64.668	94.530		1379.612	1379.612	159.198
2009	0.000	0.023	9.915	73.606	230.131	337.669	439.637	295.412	208.701	49.641	145.865		1790.601	1790.601	195.505
2010	0.000	0.012	2.734	111.384	345.280	351.781	339.757	177.209	160.184	93.660	341.852		1923.854	1923.854	435.513
2011	0.000	0.013	1.090	105.823	396.788	485.390	593.156	424.179	359.902	214.712	403.497		2984.549	2984.549	618.208

Table B25. Total commercial landed mean weights-at-age of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1985			0.661	1.029	1.900	3.109	4.378	5.566	6.700	8.265	12.775		2.297	2.297	11.107
1986			0.623	0.990	1.583	2.969	4.548	5.820	7.055	8.346	13.820		4.094	4.094	11.562
1987			0.535	0.995	1.857	3.085	4.743	5.187	6.486	7.694	13.483		2.531	2.531	11.113
1988		0.175	0.566	1.076	1.769	2.616	3.888	4.838	6.543	7.667	16.339		1.885	1.885	15.074
1989			0.653	1.031	1.768	2.766	3.812	5.386	5.972	7.939	10.199		2.166	2.166	9.204
1990		0.291	0.564	1.159	1.760	2.925	4.164	5.017	6.785	8.415	13.284		1.817	1.817	11.713
1991			0.569	1.102	1.576	2.333	3.317	4.139	6.079	9.064	11.454		1.789	1.789	10.855
1992			0.620	0.972	1.482	2.499	3.973	4.914	5.831	7.880	12.279		1.797	1.797	10.594
1993			0.505	1.014	1.601	2.602	3.667	4.029	6.061	7.293	12.856		1.821	1.821	10.882
1994		0.190	0.356	0.934	1.511	2.611	3.783	4.874	6.822	7.382	10.770		1.965	1.965	9.402
1995			0.586	1.073	1.636	2.344	2.983	4.199	5.609	5.282	12.226		1.504	1.504	6.960
1996			0.577	1.089	1.716	2.577	3.392	4.110	6.610	5.739	10.193		2.247	2.247	7.870
1997		0.259	0.561	0.992	1.733	2.565	3.519	4.489	5.945	6.880	9.443		2.749	2.749	7.844
1998			0.520	1.183	2.038	3.030	4.204	4.777	6.170	6.892	8.343		3.354	3.354	7.316
1999			0.596	0.710	1.613	2.479	3.774	4.865	6.322	7.271	8.825		3.021	3.021	7.815
2000			0.573	1.027	1.768	2.550	3.355	4.700	6.280	6.821	9.059		3.445	3.445	7.239
2001			0.500	1.422	1.793	2.584	3.817	5.091	6.117	6.991	8.992		2.980	2.980	7.528
2002			1.182	1.518	2.257	2.912	3.847	4.463	5.358	6.492	7.820		2.769	2.769	6.847
2003			**0.957**	**1.363**	**2.177**	**3.216**	**4.257**	**5.228**	**5.872**	**6.631**	**8.594**		**4.230**	**4.230**	**7.072**
2004	0.763		0.704	1.346	2.011	3.407	4.279	5.897	6.792	7.847	8.504		4.597	4.597	8.094
2005			0.826	1.416	1.969	2.815	4.046	4.638	5.847	7.167	8.019		4.203	4.203	7.750
2006			0.761	1.379	1.795	3.033	4.021	4.623	5.352	8.246	10.964		4.266	4.266	9.949
2007			0.939	1.592	2.701	4.382	4.686	4.915	5.469	6.998	11.902		4.477	4.477	9.934
2008			0.810	1.514	2.274	3.391	3.992	4.820	5.296	6.303	12.332		3.444	3.444	8.881
2009		0.367	0.683	1.276	1.862	2.766	4.032	4.721	5.189	6.852	5.955		3.188	3.188	6.159
2010		0.651	1.050	2.005	2.798	2.867	4.076	5.033	5.897	6.452	8.848		3.824	3.824	8.193
2011		0.363	0.672	1.846	2.559	3.317	4.030	4.993	6.578	7.720	9.663		4.164	4.164	8.887

Table B26. Percentage by age of landings-at-age (000s of fish) that were filled out to account for missing ages-at-length. The total is the percentage of the entire landings-at-age.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1985	0.00	0.00	0.00	0.00	0.06	1.82	28.79	77.32	80.19	97.97	94.08		4.35	4.35	95.51
1986	0.00	0.00	0.00	0.00	0.79	7.87	21.53	42.47	91.67	73.92	97.08		24.15	24.15	87.52
1987	0.00	0.00	0.00	1.02	9.11	34.04	39.95	46.13	49.55	54.87	93.87		16.82	16.82	77.90
1988	0.00	0.00	0.00	0.88	1.41	9.63	48.42	92.33	95.53	100.00	100.00		6.00	6.00	100.00
1989	0.00	0.00	0.00	0.95	6.19	5.46	14.59	59.87	56.93	100.00	71.65		7.46	7.46	84.13
1990	0.00	0.00	0.00	0.00	0.01	0.48	12.60	27.65	75.74	83.09	88.72		1.72	1.72	86.91
1991	0.00	0.00	0.00	0.00	0.00	0.05	1.46	5.06	43.26	92.10	90.10		1.21	1.21	90.60
1992	0.00	0.00	0.00	0.00	0.00	0.27	2.61	4.30	12.73	63.00	95.97		0.88	0.88	83.34
1993	0.00	0.00	0.00	0.00	0.08	1.64	8.65	29.45	100.00	77.12	100.00		2.04	2.04	91.88
1994	0.00	0.00	0.00	0.04	1.09	6.61	15.28	30.99	80.36	100.00	100.00		5.56	5.56	100.00
1995	0.00	0.00	0.00	0.00	0.00	0.90	6.82	30.81	19.24	1.25	76.47		1.02	1.02	19.42
1996	0.00	0.00	0.00	0.00	0.07	1.25	7.26	16.93	33.03	59.99	76.07		3.06	3.06	67.69
1997	0.00	100.00	11.20	0.05	0.53	3.46	11.68	20.48	42.36	56.87	72.55		7.41	7.41	62.76
1998	0.00	0.00	0.00	0.69	12.65	39.30	62.44	55.11	85.98	100.00	100.00		40.14	40.14	100.00
1999	0.00	0.00	0.00	1.46	4.77	1.07	6.70	13.68	18.30	70.27	80.88		8.34	8.34	73.98
2000	0.00	0.00	0.00	0.00	0.80	7.11	25.13	29.33	18.67	12.76	78.79		13.31	13.31	25.08
2001	0.00	0.00	0.00	0.00	0.83	12.13	33.55	56.67	79.14	86.83	97.90		21.46	21.46	89.80
2002	0.00	0.00	1.05	3.42	2.66	10.90	44.10	68.63	83.65	100.00	100.00		19.26	19.26	100.00
2003	**0.00**	**0.00**	**5.09**	**0.70**	**0.02**	**3.55**	**12.22**	**17.47**	**48.32**	**35.30**	**41.95**		**15.00**	**15.00**	**36.79**
2004	0.00	0.00	0.00	13.64	42.05	32.81	77.59	100.00	91.79	83.91	100.00		66.43	66.43	89.97
2005	0.00	0.00	4.85	30.41	9.79	16.31	51.79	28.81	33.24	68.17	44.95		30.45	30.45	52.28
2006	0.00	0.00	0.00	7.12	23.86	44.36	50.94	74.61	53.99	100.00	92.12		51.88	51.88	95.06
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.64		1.15	1.15	11.76
2008	0.00	0.00	0.00	0.00	0.73	13.74	8.15	2.36	0.71	0.68	18.06		4.77	4.77	8.11
2009	0.00	0.00	0.00	0.00	3.72	11.11	30.45	56.44	58.94	100.00	14.21		21.57	21.57	33.79
2010	0.00	0.00	0.00	0.00	0.00	0.82	6.17	31.22	54.48	54.61	48.02		11.61	11.61	49.82
2011	0.00	0.00	0.00	0.00	0.20	0.00	11.46	35.84	70.61	81.74	69.12		19.23	19.23	74.17

Table B27. Percentage by age of landings-at-age (mt) that were filled out to account for missing ages-at-length. The total is the percentage of the entire landings-at-age.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1985	0.00	0.00	0.00	0.00	0.13	2.44	32.29	78.12	78.31	97.98	95.36		13.49	13.49	96.09
1986	0.00	0.00	0.00	0.00	1.57	9.09	24.10	45.31	90.95	74.63	97.54		53.06	53.06	90.72
1987	0.00	0.00	0.00	2.28	11.50	29.39	35.50	48.54	52.11	53.15	94.45		35.45	35.45	82.74
1988	0.00	0.00	0.00	0.75	1.79	14.07	49.79	93.03	96.06	100.00	100.00		18.56	18.56	100.00
1989	0.00	0.00	0.00	1.12	5.22	5.10	15.81	56.79	61.05	100.00	79.94		12.87	12.87	87.56
1990	0.00	0.00	0.00	0.00	0.04	0.83	16.80	32.15	72.30	80.75	89.67		7.85	7.85	87.60
1991	0.00	0.00	0.00	0.00	0.00	0.10	2.63	8.09	54.42	92.39	92.20		6.74	6.74	92.24
1992	0.00	0.00	0.00	0.00	0.00	0.46	3.26	4.70	15.44	68.39	96.18		4.05	4.05	88.27
1993	0.00	0.00	0.00	0.00	0.17	2.53	10.52	35.28	100.00	78.23	100.00		6.64	6.64	94.82
1994	0.00	0.00	0.00	0.08	1.68	7.45	17.66	33.49	79.27	100.00	100.00		14.23	14.23	100.00
1995	0.00	0.00	0.00	0.00	0.00	1.60	9.64	32.62	23.40	1.63	76.93		3.91	3.91	33.59
1996	0.00	0.00	0.00	0.00	0.14	1.92	9.50	19.82	29.38	77.63	80.73		7.56	7.56	79.55
1997	0.00	100.00	5.17	0.01	1.30	5.29	15.89	25.07	45.14	58.82	74.46		14.65	14.65	65.90
1998	0.00	0.00	0.00	1.28	18.29	45.55	63.28	58.81	84.56	100.00	100.00		54.26	54.26	100.00
1999	0.00	0.00	0.00	2.11	4.07	1.90	11.15	19.38	24.31	70.14	81.96		18.04	18.04	74.81
2000	0.00	0.00	0.00	0.00	1.81	11.00	33.08	32.52	19.86	14.13	78.47		21.28	21.28	29.15
2001	0.00	0.00	0.00	0.00	1.74	19.34	41.49	59.01	79.52	86.98	97.96		40.36	40.36	90.50
2002	0.00	0.00	0.75	2.06	2.24	15.85	51.92	76.79	90.20	100.00	100.00		32.68	32.68	100.00
2003	**0.00**	**0.00**	**2.96**	**0.29**	**0.01**	**4.99**	**13.46**	**18.18**	**48.51**	**33.64**	**42.02**		**20.00**	**20.00**	**35.93**
2004	0.00	0.00	0.00	19.11	45.79	34.56	83.53	100.00	90.34	82.63	100.00		77.72	77.72	89.50
2005	0.00	0.00	8.62	32.43	10.01	21.77	58.40	30.97	36.04	75.51	59.65		40.96	40.96	64.28
2006	0.00	0.00	0.00	7.51	28.91	53.19	56.37	82.64	64.84	100.00	96.44		68.66	68.66	97.54
2007	0.00	0.00	0.00	0.81	16.22	24.30	7.21	0.96	0.59	0.38	23.33		10.86	10.86	16.85
2008	0.00	0.00	0.00	0.00	1.01	12.18	6.56	1.66	0.52	0.32	21.42		5.48	5.48	12.85
2009	0.00	0.00	0.00	0.00	6.06	14.20	34.91	61.89	66.95	100.00	24.90		34.84	34.84	43.97
2010	0.00	0.00	0.00	0.00	0.00	1.47	8.80	38.76	62.66	66.73	75.67		27.31	27.31	73.75
2011	0.00	0.00	0.00	0.00	0.43	0.00	15.12	42.27	72.43	84.93	82.43		35.06	35.06	83.29

Table B28. Number of lengths sampled in the NEFOP data for white hake in small and large mesh otter trawls.

	OT Large						OT Small					
	Half 1		Half 2		Total		Half 1		Half 2		Total	
Year	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc
1989		221	12	715	12	936	1	479	92	698	93	1177
1990	63	8		9	63	17	1	8	138	303	139	311
1991	1		413	43	414	43				2	0	2
1992	206		59	86	265	86	22				22	0
1993	542	51	658	14	1200	65	2			30	2	30
1994	190	26	99	2	289	28			14	2	14	2
1995	852	161	403	166	1255	327			294	106	294	106
1996	144	31	25		169	31		145	306	335	306	480
1997	67	39	84	64	151	103		29			0	29
1998	23	11	12	2	35	13					0	0
1999	23		113	42	136	42					0	0
2000	291	12	454		745	12		107	8	12	8	119
2001	38		391		429	0	7	42			7	42
2002	125		806	128	931	128			22	14	22	14
2003	2071	24	1381	196	3452	220	202	1	827	2	1029	3
2004	1031	190	1694	604	2725	794	276	93	128	185	404	278
2005	3009	489	3010	730	6019	1219	198	91	660	217	858	308
2006	1801	506	1532	415	3333	921	224	19	25		249	19
2007	611	209	1394	219	2005	428	68	39	16	3	84	42
2008	791	126	1739	487	2530	613	2	6	6	36	8	42
2009	1353	100	1227	217	2580	317		1	76	12	76	13
2010	1954	114	1368	85	3322	199	14	2	14	3	28	5
2011	1388	27	921	10	2309	37	75		110	1	185	1
Total 1989-2011	17408	2359	17964	4257	35372	6616	1092	1066	1961	2736	3828	3027

Table B29. Number of lengths sampled in the NEFOP data for white hake in sink gill net and longline fisheries.

	SGN						Longline					
	Half 1		Half 2		Total		Half 1		Half 2		Total	
Year	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc
1989			484	2	484	2						
1990	196		1061	32	1257	32						
1991	2448	135	9973	30	12421	165						
1992	1620		8451	4	10071	4	1				1	
1993	1239	1	3968	13	5207	14						
1994	44		1766	4	1810	4						
1995	167	1	2599	30	2766	31						
1996	70	12	826	3	896	15						
1997	85		427	4	512	4						
1998	36		411	1	447	1						
1999	79		218	20	297	20						
2000	47	9	143		190	9						
2001	16	4	8	2	24	6						
2002	6		74	2	80	2						
2003	182	8	748	52	930	60						
2004	185	6	3108	69	3293	75			23	9	23	9
2005	42	3	4455	35	4497	38	3		165	34	168	34
2006	160	2	683	4	843	6		1	14	10	14	11
2007	339	7	501	5	840	12			8		8	
2008	236	3	509	6	745	9		5	127	125	127	130
2009	147	2	553	3	700	5		4	13	13	13	17
2010	828	3	676	1	1504	4	158	1	37		195	1
2011	329		1274	11	1603	11			4	6	4	6
Total 1989-2011	8501	196	42916	333	51417	529	162	11	391	197	553	208

Table B30. Pooling scheme for otter trawl discards by mesh size and half year.

<table>
<tr><th></th><th colspan="2">Large</th><th colspan="2">Small</th></tr>
<tr><th></th><th>1</th><th>2</th><th>1</th><th>2</th></tr>
<tr><td>1989</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1990</td><td rowspan="4"></td><td rowspan="4"></td><td colspan="2"></td></tr>
<tr><td>1991</td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>1992</td></tr>
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<tr><td>1995</td></tr>
<tr><td>1996</td><td rowspan="2"></td><td rowspan="4"></td></tr>
<tr><td>1997</td><td rowspan="5"></td><td rowspan="8"></td></tr>
<tr><td>1998</td><td rowspan="6"></td></tr>
<tr><td>1999</td></tr>
<tr><td>2000</td><td rowspan="3"></td></tr>
<tr><td>2001</td></tr>
<tr><td>2002</td><td></td></tr>
<tr><td>2003</td><td></td><td rowspan="2"></td></tr>
<tr><td>2004</td><td></td><td></td></tr>
<tr><td>2005</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2006</td><td></td><td></td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>2007</td><td></td><td></td></tr>
<tr><td>2008</td><td></td><td></td></tr>
<tr><td>2009</td><td></td><td></td></tr>
<tr><td>2010</td><td></td><td></td></tr>
<tr><td>2011</td><td>+2012</td><td>+2012</td></tr>
</table>

Table B31. Number of lengths sampled in the NEFOP data for white hake in shrimp trawl and scallop dredge.

	Shrimp						Scallop					
	Half 1		Half 2		Total		Half 1		Half 2		Total	
Year	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc
1989		200				200						
1990		37				37						
1991	52				52							
1992	37	17		58	37	75						
1993		282				282		1	1		1	1
1994		517		256		773		1		3		4
1995		958				958		51	1	73	1	124
1996		325		15		340				1		1
1997		25				25				1		1
1998							1	5		63	1	68
1999										35		35
2000								2				2
2001												
2002												
2003		1				1		2				2
2004			111		111			7		223		230
2005	157	28			157	28			2	67	2	67
2006		131				131		1	1	5	1	6
2007		43				43		13		29		42
2008		31		25		56		8		56		64
2009		13		1		14	1	3		1	1	4
2010								1		15		16
2011										9		9
Total 1989-2011	246	2608	111	355	357	2963	2	95	5	581	7	676

Table B32. Total commercial discards-at-age (in 000s of fish) of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	11.875	701.123	1705.570	655.103	36.284	2.113	0.000	0.000	0.000	0.000	0.000		3112.068	3100.192	0.000
1990	25.958	700.325	3470.954	1260.777	89.526	0.000	0.000	0.000	0.000	0.000	0.000		5547.540	5521.581	0.000
1991	19.508	412.309	343.891	172.150	13.716	0.000	0.000	0.000	0.000	0.000	0.000		961.574	942.066	0.000
1992	59.662	198.594	309.239	746.127	222.685	0.000	0.000	0.000	0.000	0.000	0.000		1536.306	1476.645	0.000
1993	9.849	1417.738	2479.071	655.043	22.670	0.000	0.000	0.000	0.000	0.000	0.000		4584.370	4574.522	0.000
1994	0.889	163.880	281.913	295.930	39.619	5.771	0.609	0.012	0.000	0.000	0.000		788.623	787.734	0.000
1995	0.000	105.129	196.167	259.776	20.981	2.831	1.980	0.000	0.000	0.000	0.000		586.864	586.864	0.000
1996	0.000	43.939	109.216	224.869	21.850	1.309	1.633	0.930	0.089	0.000	0.000		403.835	403.835	0.000
1997	0.000	10.689	149.855	43.065	12.173	6.887	1.453	0.889	0.000	0.000	0.000		225.011	225.011	0.000
1998	5.691	60.696	208.034	67.211	21.588	2.923	0.062	0.000	0.000	0.000	0.000		366.205	360.514	0.000
1999	137.352	1517.289	826.295	220.970	90.048	56.567	11.006	0.000	0.000	0.000	0.000		2859.527	2722.175	0.000
2000	5.532	30.301	112.303	104.140	34.667	19.673	6.091	0.033	0.442	0.000	0.000		313.183	307.651	0.000
2001	0.312	27.429	153.337	133.392	57.965	24.274	11.414	2.373	0.178	0.000	0.000		410.675	410.363	0.000
2002	18.014	18.460	43.552	31.557	25.610	4.906	0.781	0.740	0.064	0.000	0.000		143.685	125.671	0.000
2003	**116.945**	**420.844**	**241.151**	**87.974**	**31.144**	**13.520**	**2.186**	**0.307**	**0.034**	**0.000**	**0.000**		**914.104**	**797.159**	**0.000**
2004	18.371	91.000	73.112	59.531	11.407	1.603	1.295	0.060	0.030	0.000	0.000		256.409	238.038	0.000
2005	289.926	62.779	30.945	30.313	6.962	0.413	0.148	0.062	0.033	0.000	0.000		421.580	131.654	0.000
2006	9.547	78.077	37.466	20.750	4.073	0.406	0.010	0.001	0.066	0.000	0.000		150.395	140.848	0.000
2007	8.083	19.977	22.578	18.417	3.076	1.002	0.060	0.046	0.007	0.000	0.000		73.246	65.163	0.000
2008	71.205	72.768	80.549	111.830	24.451	0.984	0.000	0.000	0.000	0.000	0.000		361.787	290.583	0.000
2009	33.184	44.015	42.534	37.104	16.898	2.759	0.716	0.062	0.018	0.009	0.000		177.299	144.115	0.009
2010	6.219	18.388	31.485	35.780	17.660	3.317	0.529	0.070	0.000	0.000	0.000		113.447	107.229	0.000
2011	3.225	12.739	18.334	17.913	4.732	0.726	0.199	0.000	0.000	0.000	0.000		57.869	54.644	0.000

Table B33. Total commercial discards-at-age (in mt) of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	2.158	99.401	528.085	428.052	40.017	4.876	0.000	0.000	0.000	0.000	0.000		1102.589	1100.431	0.000
1990	1.327	122.669	1095.647	534.377	54.971	0.000	0.000	0.000	0.000	0.000	0.000		1808.991	1807.664	0.000
1991	1.037	59.561	134.247	106.828	10.768	0.000	0.000	0.000	0.000	0.000	0.000		312.441	311.404	0.000
1992	3.308	21.184	112.952	384.409	123.756	0.000	0.000	0.000	0.000	0.000	0.000		645.610	642.302	0.000
1993	0.420	175.750	676.951	394.194	23.237	0.000	0.000	0.000	0.000	0.000	0.000		1270.551	1270.131	0.000
1994	0.040	21.148	81.033	140.101	40.298	12.899	2.019	0.024	0.000	0.000	0.000		297.563	297.523	0.000
1995	0.000	15.951	77.667	139.048	22.753	5.599	5.284	0.000	0.000	0.000	0.000		266.303	266.303	0.000
1996	0.000	5.886	30.221	96.356	20.982	3.010	5.690	3.502	0.375	0.000	0.000		166.022	166.022	0.000
1997	0.000	1.583	41.082	20.078	19.153	14.398	4.418	3.681	0.000	0.000	0.000		104.392	104.392	0.000
1998	0.113	8.370	54.128	39.228	36.365	6.764	0.135	0.000	0.000	0.000	0.000		145.104	144.991	0.000
1999	4.892	163.008	267.435	150.906	165.215	135.546	34.271	0.000	0.000	0.000	0.000		921.273	916.381	0.000
2000	0.236	3.541	24.621	52.895	46.750	50.487	17.738	0.132	2.292	0.000	0.000		198.692	198.456	0.000
2001	0.045	6.494	33.646	85.266	77.114	59.732	33.412	9.487	0.905	0.000	0.000		306.100	306.055	0.000
2002	2.184	5.366	15.534	29.207	45.144	10.883	2.600	2.600	0.325	0.000	0.000		113.844	111.660	0.000
2003	**8.289**	**50.835**	**84.590**	**69.714**	**56.006**	**33.744**	**5.722**	**0.800**	**0.107**	**0.000**	**0.000**		**309.807**	**301.518**	**0.000**
2004	1.438	17.913	29.297	29.635	14.713	4.218	3.464	0.199	0.114	0.000	0.000		100.992	99.554	0.000
2005	20.829	10.770	15.609	18.840	7.438	0.936	0.349	0.236	0.124	0.000	0.000		75.132	54.303	0.000
2006	1.005	16.134	12.252	12.084	4.243	0.897	0.014	0.001	0.220	0.000	0.000		46.851	45.846	0.000
2007	0.660	4.226	8.537	12.326	3.685	1.718	0.205	0.204	0.031	0.000	0.000		31.591	30.931	0.000
2008	6.113	11.046	31.899	77.791	28.802	1.487	0.000	0.000	0.000	0.000	0.000		157.138	151.025	0.000
2009	2.474	7.413	18.328	24.364	15.755	3.927	2.136	0.212	0.067	0.033	0.000		74.710	72.236	0.033
2010	0.620	3.814	13.694	23.128	16.527	4.598	0.829	0.122	0.000	0.000	0.000		63.332	62.712	0.000
2011	0.231	2.183	8.055	13.391	5.502	0.951	0.305	0.000	0.000	0.000	0.000		30.618	30.387	0.000

Table B34. Total commercial discarded mean weights-at-age of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	0.182	0.142	0.310	0.653	1.103	2.308							0.354	0.355	
1990	0.051	0.175	0.316	0.424	0.614								0.326	0.327	
1991	0.053	0.144	0.390	0.621	0.785								0.325	0.331	
1992	0.055	0.107	0.365	0.515	0.556								0.420	0.435	
1993	0.043	0.124	0.273	0.602	1.025								0.277	0.278	
1994	0.045	0.129	0.287	0.473	1.017	2.235	3.316	2.040					0.377	0.378	
1995		0.152	0.396	0.535	1.084	1.978	2.668						0.454	0.454	
1996		0.134	0.277	0.428	0.960	2.299	3.484	3.767	4.227				0.411	0.411	
1997		0.148	0.274	0.466	1.573	2.091	3.041	4.142					0.464	0.464	
1998	0.020	0.138	0.260	0.584	1.684	2.314	2.190						0.396	0.402	
1999	0.036	0.107	0.324	0.683	1.835	2.396	3.114						0.322	0.337	
2000	0.043	0.117	0.219	0.508	1.349	2.566	2.912	3.950	5.191				0.634	0.645	
2001	0.145	0.237	0.219	0.639	1.330	2.461	2.927	3.999	5.094				0.745	0.746	
2002	0.121	0.291	0.357	0.926	1.763	2.218	3.329	3.514	5.094				0.792	0.889	
2003	**0.071**	**0.121**	**0.351**	**0.792**	**1.798**	**2.496**	**2.617**	**2.606**	**3.189**				**0.339**	**0.378**	
2004	0.078	0.197	0.401	0.498	1.290	2.632	2.674	3.351	3.793				0.394	0.418	
2005	0.072	0.172	0.504	0.622	1.068	2.265	2.363	3.835	3.806				0.178	0.412	
2006	0.105	0.207	0.327	0.582	1.042	2.211	1.442	1.244	3.332				0.312	0.326	
2007	0.082	0.212	0.378	0.669	1.198	1.715	3.400	4.402	4.402				0.431	0.475	
2008	0.086	0.152	0.396	0.696	1.178	1.511							0.434	0.520	
2009	0.075	0.168	0.431	0.657	0.932	1.423	2.984	3.431	3.731	3.731			0.421	0.501	3.731
2010	0.100	0.207	0.435	0.646	0.936	1.386	1.567	1.744					0.558	0.585	
2011	0.072	0.171	0.439	0.748	1.163	1.311	1.529						0.529	0.556	

Table B35. Percentage by age of discards-at-age (000s) that were filled out to account for missing ages-at-length. The total is the percentage of the entire discards-at-age.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	100.00	14.08	4.24	0.01	1.11	0.74	0.00	0.00	0.00	0.00	0.00		5.89	5.53	0.00
1990	5.08	1.58	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.27	0.25	0.00
1991	0.00	0.03	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.04	0.00
1992	0.00	2.72	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.85	0.88	0.00
1993	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
1994	0.00	0.46	0.00	0.00	1.11	17.08	7.80	100.00	0.00	0.00	0.00		0.28	0.29	0.00
1995	0.00	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.19	0.19	0.00
1996	0.00	0.00	0.00	0.00	0.00	7.91	37.88	46.50	100.00	0.00	0.00		0.31	0.31	0.00
1997	0.00	0.86	0.66	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.75	0.75	0.00
1998	33.33	10.50	1.58	0.41	20.44	59.10	100.00	0.00	0.00	0.00	0.00		4.92	4.48	0.00
1999	0.00	0.00	0.00	0.04	0.56	0.05	0.00	0.00	0.00	0.00	0.00		0.02	0.02	0.00
2000	35.63	0.55	0.00	0.00	0.07	0.76	3.56	100.00	1.89	0.00	0.00		0.82	0.20	0.00
2001	100.00	8.13	0.62	0.03	0.41	7.19	14.49	25.49	100.00	0.00	0.00		1.94	1.86	0.00
2002	4.10	2.60	2.80	4.65	9.74	5.46	29.59	24.78	100.00	0.00	0.00		4.97	5.10	0.00
2003	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**	**0.00**
2004	15.82	5.81	2.46	0.53	17.58	23.02	21.39	100.00	100.00	0.00	0.00		5.09	4.26	0.00
2005	7.57	9.61	2.68	0.54	5.06	5.88	14.29	53.60	12.50	0.00	0.00		6.98	5.67	0.00
2006	12.66	12.07	2.80	7.96	15.84	13.21	100.00	100.00	0.00	0.00	0.00		9.34	9.11	0.00
2007	0.00	1.73	12.30	3.22	28.82	23.52	100.00	100.00	100.00	0.00	0.00		6.76	7.60	0.00
2008	0.05	0.07	0.36	0.35	0.03	0.00	0.00	0.00	0.00	0.00	0.00		0.21	0.25	0.00
2009	0.00	0.00	0.00	0.00	0.11	2.92	42.54	86.96	100.00	100.00	0.00		0.27	0.34	100.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00

Table B36. Percentage by age of discards-at-age (mt) that were filled out to account for missing ages-at-length. The total is the percentage of the entire discards-at-age.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	100.00	19.29	2.84	0.02	1.11	0.35	0.00	0.00	0.00	0.00	0.00		3.35	3.16	0.00
1990	3.17	0.44	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.04	0.00
1991	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.01	0.00
1992	0.00	1.20	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.15	0.15	0.00
1993	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
1994	0.00	0.06	0.00	0.02	2.23	15.60	4.80	100.00	0.00	0.00	0.00		1.03	1.03	0.00
1995	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.01	0.00
1996	0.00	0.00	0.00	0.00	0.00	13.96	44.91	51.37	100.00	0.00	0.00		3.10	3.10	0.00
1997	0.00	1.50	0.62	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.42	0.42	0.00
1998	13.30	3.47	0.38	1.55	26.57	55.93	100.00	0.00	0.00	0.00	0.00		10.13	10.13	0.00
1999	0.00	0.00	0.00	0.07	0.37	0.03	0.00	0.00	0.00	0.00	0.00		0.08	0.08	0.00
2000	27.38	0.18	0.00	0.00	0.21	1.17	4.82	100.00	1.44	0.00	0.00		0.90	0.87	0.00
2001	100.00	5.20	1.05	0.02	1.12	10.64	18.89	30.60	100.00	0.00	0.00		5.91	5.89	0.00
2002	1.05	1.55	2.56	4.56	5.84	6.60	38.63	35.58	100.00	0.00	0.00		6.54	6.65	0.00
2003	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**	**0.00**
2004	10.83	3.75	0.68	1.67	21.95	21.33	28.38	100.00	100.00	0.00	0.00		6.88	6.82	0.00
2005	2.04	8.49	0.84	1.27	6.43	5.75	25.19	66.32	16.49	0.00	0.00		3.34	3.83	0.00
2006	13.52	5.40	1.83	5.11	18.60	8.51	100.00	100.00	0.00	0.00	0.00		5.83	5.66	0.00
2007	0.00	1.21	5.59	1.53	37.87	23.28	100.00	100.00	100.00	0.00	0.00		9.35	9.54	0.00
2008	0.03	0.06	0.26	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00		0.13	0.13	0.00
2009	0.00	0.00	0.00	0.00	0.42	7.66	53.19	94.56	100.00	100.00	0.00		2.42	2.50	100.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00

Table B37. Total commercial catch-at-age (in 000s of fish) of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	11.935	704.657	1721.190	1318.864	1047.771	598.294	260.891	40.002	22.950	9.977	12.678		5749.209	5737.274	22.655
1990	26.265	708.689	3646.970	2516.495	1335.412	389.855	85.581	32.752	13.861	8.209	17.229		8781.319	8755.054	25.438
1991	19.743	417.288	410.848	1339.447	1337.178	760.057	176.123	40.613	14.854	8.796	26.316		4551.264	4531.521	35.112
1992	60.365	200.935	346.926	2800.851	2152.040	812.078	364.664	179.515	41.159	10.670	17.194		6986.396	6926.031	27.864
1993	10.046	1446.219	2533.121	2168.931	2340.345	883.467	305.951	101.477	12.655	7.504	13.647		9823.362	9813.315	21.151
1994	0.891	165.092	350.192	1075.562	1142.291	607.259	258.338	87.157	28.960	8.921	13.184		3737.847	3736.956	22.106
1995	0.000	105.715	470.224	1864.686	790.500	335.624	171.658	29.206	24.542	18.331	5.839		3816.325	3816.325	24.170
1996	0.000	44.522	138.835	566.763	529.220	425.035	260.671	68.822	14.591	7.674	7.041		2063.176	2063.176	14.715
1997	0.000	10.826	152.295	122.597	237.128	324.886	195.546	80.458	21.720	8.520	5.135		1159.110	1159.110	13.654
1998	5.700	60.787	213.954	142.486	200.748	192.924	167.853	97.697	38.063	15.681	6.475		1142.368	1136.669	22.157
1999	138.022	1524.689	830.616	362.074	279.935	289.884	172.422	98.442	73.698	23.181	12.478		3805.441	3667.419	35.659
2000	5.560	30.455	113.754	133.143	264.809	272.019	169.849	86.240	92.016	70.757	16.228		1254.829	1249.269	86.985
2001	0.316	27.763	162.883	388.145	378.075	249.338	218.729	117.685	69.861	39.697	14.554		1667.046	1666.730	54.252
2002	18.061	18.508	86.469	253.395	437.733	233.756	186.818	93.915	41.288	10.549	3.842		1384.334	1366.273	14.391
2003	**117.285**	**422.069**	**242.179**	**118.860**	**176.789**	**246.638**	**271.241**	**211.850**	**115.717**	**58.986**	**17.075**		**1998.690**	**1881.404**	**76.062**
2004	18.428	91.284	74.699	91.917	99.526	197.577	171.760	141.639	84.835	45.475	27.464		1044.604	1026.176	72.939
2005	291.773	63.178	32.398	49.454	108.255	135.381	104.074	135.628	81.036	26.201	56.789		1084.168	792.395	82.991
2006	9.625	78.710	39.434	45.442	56.210	73.470	118.612	57.842	52.356	16.233	27.257		575.190	565.566	43.490
2007	8.105	20.031	25.900	64.523	63.804	56.477	74.419	49.315	31.427	13.903	20.751		428.655	420.550	34.654
2008	71.867	73.445	83.463	165.434	141.013	65.308	85.857	40.229	24.762	10.355	7.736		769.470	697.604	18.091
2009	33.339	44.284	57.326	95.238	141.180	125.434	110.279	62.931	40.426	7.288	24.610		742.334	708.995	31.898
2010	6.304	18.658	34.556	92.582	143.000	127.740	85.036	35.767	27.536	14.716	39.168		625.064	618.760	53.884
2011	3.250	12.877	20.112	75.819	161.054	148.220	148.544	85.615	55.143	28.031	42.083		780.748	777.498	70.114

Table B38. Total commercial catch-at-age (in mt) of white hake. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	2.17	99.90	535.33	1110.86	1827.89	1653.97	994.56	215.46	137.05	79.21	129.30		6785.707	6783.538	208.516
1990	1.34	124.14	1184.67	1978.73	2246.52	1140.36	356.32	164.33	94.06	69.08	228.88		7588.437	7587.094	297.960
1991	1.05	60.28	171.58	1392.05	2096.58	1773.56	584.12	168.10	90.30	79.73	301.43		6718.766	6717.716	381.159
1992	3.35	21.43	135.38	2378.42	2980.26	2029.29	1448.69	882.22	240.00	84.08	211.12		10414.245	10410.897	295.200
1993	0.43	179.28	692.69	1924.23	3733.44	2298.51	1122.04	408.86	76.70	54.73	175.44		10666.357	10665.929	230.169
1994	0.04	21.36	105.33	867.68	1706.20	1583.56	977.12	424.73	197.57	65.85	141.99		6091.430	6091.389	207.846
1995	0.00	16.04	237.93	1860.50	1281.37	785.65	511.50	122.64	137.64	96.83	71.39		5121.494	5121.494	168.217
1996	0.00	5.96	46.89	466.64	891.62	1094.86	884.39	282.51	96.23	44.04	71.77		3884.922	3884.922	115.812
1997	0.00	1.60	41.93	98.72	408.98	830.03	687.40	360.83	129.12	58.61	48.49		2665.708	2665.708	107.101
1998	0.11	8.38	57.13	128.24	401.50	582.38	705.60	466.66	234.84	108.08	54.02		2746.950	2746.836	162.106
1999	4.92	163.80	268.91	251.11	471.68	713.91	643.40	478.88	465.92	168.55	110.12		3741.200	3736.284	278.664
2000	0.24	3.56	25.25	82.41	453.50	693.99	567.06	405.31	577.35	482.64	147.01		3438.314	3438.076	629.645
2001	0.05	6.57	37.89	446.30	650.65	641.32	824.63	596.55	427.14	277.51	130.88		4039.492	4039.446	408.393
2002	2.19	5.38	66.17	365.92	975.26	677.33	718.36	418.45	221.21	68.49	30.05		3548.803	3546.613	98.533
2003	**8.31**	**50.98**	**85.15**	**111.68**	**373.08**	**783.44**	**1150.99**	**1106.76**	**679.37**	**391.14**	**146.74**		**4887.641**	**4879.328**	**537.885**
2004	1.44	17.97	30.34	73.08	191.85	671.87	732.87	835.14	576.14	356.84	233.56		3721.118	3719.676	590.404
2005	20.96	10.84	16.75	45.79	206.83	380.91	420.84	629.06	473.75	187.77	455.38		2848.879	2827.917	643.155
2006	1.01	16.26	13.62	46.01	97.79	222.49	476.91	267.38	280.06	133.86	298.83		1854.229	1853.215	432.692
2007	0.66	4.24	11.62	85.67	167.67	244.81	348.65	242.36	171.85	97.29	246.98		1621.803	1621.141	344.265
2008	6.17	11.15	33.95	158.09	293.66	219.59	342.71	193.90	131.15	65.27	95.41		1551.040	1544.870	160.678
2009	2.49	7.47	28.38	98.43	247.03	343.19	443.84	297.01	209.74	49.91	146.55		1874.024	1871.539	196.452
2010	0.63	3.88	16.65	136.36	366.78	361.27	345.26	179.77	162.38	94.95	346.55		2014.478	2013.850	441.494
2011	0.23	2.21	9.22	120.15	405.45	490.16	598.13	427.51	362.73	216.40	406.67		3038.871	3038.638	623.068

Table B39a. Total commercial mean weights-at-age of white hake. The values in bold were computed using a pooled ALK. The 1989-2011 average was used for 1963-1988.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	0.182	0.142	0.311	0.842	1.745	2.764	3.812	5.386	5.972	7.939	10.199		1.180	1.182	9.204
1990	0.051	0.175	0.325	0.786	1.682	2.925	4.164	5.017	6.785	8.415	13.284		0.864	0.867	11.713
1991	0.053	0.144	0.418	1.039	1.568	2.333	3.317	4.139	6.079	9.064	11.454		1.476	1.482	10.855
1992	0.055	0.107	0.390	0.849	1.385	2.499	3.973	4.914	5.831	7.880	12.279		1.491	1.503	10.594
1993	0.043	0.124	0.273	0.887	1.595	2.602	3.667	4.029	6.061	7.293	12.856		1.086	1.087	10.882
1994	0.045	0.129	0.301	0.807	1.494	2.608	3.782	4.873	6.822	7.382	10.770		1.630	1.630	9.402
1995		0.152	0.506	0.998	1.621	2.341	2.980	4.199	5.609	5.282	12.226		1.342	1.342	6.960
1996		0.134	0.338	0.823	1.685	2.576	3.393	4.105	6.595	5.739	10.193		1.883	1.883	7.870
1997		0.148	0.275	0.805	1.725	2.555	3.515	4.485	5.945	6.880	9.443		2.300	2.300	7.844
1998	0.020	0.138	0.267	0.900	2.000	3.019	4.204	4.777	6.170	6.892	8.343		2.405	2.417	7.316
1999	0.036	0.107	0.324	0.694	1.685	2.463	3.732	4.865	6.322	7.271	8.825		0.983	1.019	7.815
2000	0.043	0.117	0.222	0.619	1.713	2.551	3.339	4.700	6.274	6.821	9.059		2.740	2.752	7.239
2001	0.145	0.237	0.233	1.150	1.721	2.572	3.770	5.069	6.114	6.991	8.992		2.423	2.424	7.528
2002	0.121	0.291	0.765	1.444	2.228	2.898	3.845	4.456	5.358	6.492	7.820		2.564	2.596	6.847
2003	**0.071**	**0.121**	**0.352**	**0.940**	**2.110**	**3.176**	**4.243**	**5.224**	**5.871**	**6.631**	**8.594**		**2.445**	**2.593**	**7.072**
2004	0.078	0.197	0.406	0.795	1.928	3.401	4.267	5.896	6.791	7.847	8.504		3.562	3.625	8.094
2005	0.072	0.172	0.517	0.926	1.911	2.814	4.044	4.638	5.846	7.167	8.019		2.628	3.569	7.750
2006	0.105	0.207	0.345	1.012	1.740	3.028	4.021	4.623	5.349	8.246	10.964		3.224	3.277	9.949
2007	0.082	0.212	0.449	1.328	2.628	4.335	4.685	4.914	5.468	6.998	11.902		3.783	3.855	9.934
2008	0.086	0.152	0.407	0.956	2.083	3.362	3.992	4.820	5.296	6.303	12.332		2.016	2.215	8.881
2009	0.075	0.169	0.495	1.033	1.750	2.736	4.025	4.720	5.188	6.848	5.955		2.525	2.640	6.159
2010	0.100	0.208	0.482	1.473	2.565	2.828	4.060	5.026	5.897	6.452	8.848		3.223	3.255	8.193
2011	0.072	0.172	0.458	1.585	2.518	3.307	4.027	4.993	6.578	7.720	9.663		3.892	3.908	8.887
1989-2011 average		0.163	0.385	0.987	1.873	2.856	3.863	4.777	6.010						8.565

Table B39b. January 1 weights at age calculated using the Rivard method. The 1989-2011 average was used for the 1963-1988 values.

	0	1	2	3	4	5	6	7	8
1989	0.094	0.196	0.596	1.348	2.252	3.323	4.799	5.671	9.204
1990	0.113	0.215	0.494	1.190	2.259	3.393	4.373	6.045	11.713
1991	0.088	0.271	0.581	1.110	1.981	3.115	4.152	5.523	10.855
1992	0.067	0.237	0.596	1.200	1.980	3.045	4.037	4.913	10.594
1993	0.080	0.171	0.588	1.164	1.898	3.027	4.001	5.457	10.882
1994	0.065	0.193	0.469	1.151	2.040	3.137	4.227	5.243	9.402
1995	0.102	0.256	0.548	1.144	1.870	2.788	3.985	5.228	6.960
1996	0.094	0.227	0.645	1.297	2.044	2.818	3.498	5.262	7.870
1997	0.110	0.192	0.522	1.192	2.075	3.009	3.901	4.940	7.844
1998	0.090	0.199	0.498	1.269	2.282	3.277	4.098	5.261	7.316
1999	0.074	0.212	0.431	1.232	2.220	3.357	4.522	5.496	7.815
2000	0.083	0.154	0.448	1.090	2.073	2.868	4.188	5.525	7.239
2001	0.132	0.165	0.505	1.032	2.099	3.101	4.114	5.361	7.528
2002	0.267	0.426	0.580	1.601	2.233	3.145	4.099	5.212	6.847
2003	0.038	0.318	0.830	1.736	2.660	3.509	4.483	5.115	7.072
2004	0.240	0.376	0.751	1.467	2.732	3.838	5.007	5.958	8.095
2005	0.121	0.400	1.049	1.762	2.592	3.802	4.639	5.873	7.750
2006	0.141	0.244	0.723	1.269	2.406	3.364	4.324	4.981	9.949
2007	0.153	0.305	0.677	1.631	2.746	3.767	4.445	5.028	9.934
2008	0.088	0.294	0.655	1.663	2.972	4.160	4.752	5.101	8.881
2009	0.097	0.263	0.634	1.305	2.393	3.679	4.340	5.001	6.158
2010	0.140	0.283	0.818	1.591	2.245	3.341	4.498	5.275	8.193
2011	0.096	0.309	0.874	1.926	2.913	3.375	4.502	5.750	8.887
2012	0.111	0.285	0.775	1.607	2.517	3.465	4.447	5.342	7.746
1989-2011 average	0.112	0.258	0.637	1.374	2.312	3.321	4.310	5.357	8.531

Table B39c. Rivard weights at age interpolated for the time of spawning (April)..

	1	2	3	4	5	6	7	8	9+
1989	0.108	0.228	0.669	1.469	2.411	3.479	4.987	5.770	9.204
1990	0.131	0.247	0.577	1.336	2.462	3.632	4.578	6.282	11.713
1991	0.103	0.313	0.705	1.246	2.092	3.181	4.147	5.702	10.855
1992	0.078	0.280	0.670	1.259	2.139	3.327	4.311	5.202	10.594
1993	0.092	0.200	0.675	1.293	2.109	3.227	4.010	5.652	10.882
1994	0.082	0.224	0.562	1.256	2.214	3.339	4.432	5.724	9.402
1995	0.116	0.321	0.669	1.285	2.016	2.850	4.055	5.352	6.960
1996	0.105	0.259	0.700	1.415	2.208	2.998	3.689	5.674	7.870
1997	0.122	0.216	0.603	1.348	2.224	3.169	4.087	5.255	7.844
1998	0.104	0.219	0.606	1.477	2.505	3.561	4.313	5.548	7.316
1999	0.084	0.244	0.505	1.367	2.298	3.477	4.634	5.758	7.815
2000	0.093	0.174	0.499	1.268	2.222	3.017	4.352	5.764	7.239
2001	0.160	0.185	0.665	1.224	2.246	3.310	4.411	5.601	7.528
2002	0.274	0.518	0.786	1.787	2.436	3.363	4.215	5.260	6.847
2003	0.055	0.327	0.853	1.847	2.821	3.740	4.719	5.355	7.072
2004	0.261	0.552	0.971	1.725	2.988	4.089	5.289	6.224	8.095
2005	0.136	0.436	1.007	1.811	2.664	3.881	4.639	5.864	7.750
2006	0.160	0.274	0.809	1.410	2.597	3.570	4.421	5.101	9.949
2007	0.171	0.347	0.847	1.912	3.198	4.051	4.596	5.170	9.934
2008	0.106	0.327	0.743	1.793	3.097	4.103	4.775	5.166	8.881
2009	0.116	0.315	0.735	1.448	2.507	3.791	4.463	5.062	6.158
2010	0.160	0.338	0.995	1.866	2.425	3.566	4.668	5.475	8.193
2011	0.117	0.352	1.066	2.106	3.039	3.580	4.660	6.014	8.887
1989-2011 average	0.128	0.300	0.736	1.519	2.475	3.491	4.454	5.564	8.565

Table B40. Percentage by age of catch-at-age (000s) that were filled out to account for missing ages-at-length. The total is the percentage of the entire catch-at-age.

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	100.00	14.08	4.23	0.49	6.09	5.46	14.59	59.87	56.93	100.00	71.65		6.91	6.78	84.13
1990	5.08	1.58	0.08	0.00	0.01	0.48	12.60	27.65	75.74	83.09	88.72		1.01	1.00	86.91
1991	0.00	0.03	0.08	0.00	0.00	0.05	1.46	5.06	43.26	92.10	90.10		1.05	1.06	90.60
1992	0.00	2.72	2.31	0.00	0.00	0.27	2.61	4.30	12.73	63.00	95.97		0.88	0.88	83.34
1993	0.00	0.01	0.00	0.00	0.08	1.64	8.65	29.45	100.00	77.12	100.00		1.36	1.36	91.88
1994	0.00	0.46	0.00	0.03	1.09	6.65	15.27	30.99	80.36	100.00	100.00		4.92	4.92	100.00
1995	0.00	1.00	0.01	0.00	0.00	0.90	6.80	30.81	19.24	1.25	76.47		0.93	0.93	19.42
1996	0.00	0.00	0.00	0.00	0.06	1.26	7.32	17.03	33.09	59.99	76.07		2.79	2.79	67.69
1997	0.00	0.87	0.68	0.55	0.51	3.43	11.65	20.43	42.36	56.87	72.55		6.87	6.87	62.76
1998	33.33	10.50	1.56	0.57	13.08	39.40	62.45	55.11	85.98	100.00	100.00		35.79	35.79	100.00
1999	0.00	0.00	0.00	0.48	3.81	0.98	6.58	13.68	18.30	70.27	80.88		4.14	4.24	73.98
2000	35.63	0.55	0.00	0.00	0.74	6.92	24.89	29.33	18.66	12.76	78.79		12.20	12.17	25.08
2001	100.00	8.13	0.61	0.01	0.79	11.93	33.27	56.54	79.15	86.83	97.90		19.51	19.50	89.80
2002	4.10	2.60	1.86	3.53	2.85	10.86	44.09	68.56	83.66	100.00	100.00		18.68	18.75	100.00
2003	**0.00**	**0.00**	**0.01**	**0.23**	**0.02**	**3.49**	**12.19**	**17.47**	**48.32**	**35.30**	**41.95**		**12.50**	**12.77**	**36.79**
2004	15.82	5.81	2.42	5.12	39.24	32.73	77.17	100.00	91.79	83.91	100.00		51.32	51.96	89.97
2005	7.57	9.61	2.75	14.52	9.63	16.30	51.78	28.82	33.24	68.17	44.95		27.34	29.32	52.28
2006	12.66	12.07	2.71	7.44	23.52	44.31	50.94	74.61	53.98	100.00	92.12		48.58	48.76	95.06
2007	0.00	1.73	10.83	0.65	0.53	0.10	0.02	0.02	0.00	0.00	19.64		1.40	1.40	11.76
2008	0.05	0.07	0.35	0.21	0.67	13.68	8.15	2.36	0.71	0.68	18.06		3.82	3.98	8.11
2009	0.00	0.00	0.00	0.00	3.47	11.05	30.47	56.44	58.94	100.00	14.21		19.65	19.99	33.80
2010	0.00	0.00	0.00	0.00	0.00	0.81	6.16	31.21	54.48	54.61	48.02		10.96	11.00	49.82
2011	0.00	0.00	0.00	0.00	0.20	0.00	11.45	35.84	70.61	81.74	69.12		18.87	18.89	74.17

Table B41. Percentage by age of catch-at-age (mt) that were filled out to account for missing ages-at-length. The total is the percentage of the entire catch-at-age

	0	1	2	3	4	5	6	7	8	9	10+		Total	1+	9+
1989	100.00	19.29	2.81	0.69	5.13	5.08	15.81	56.79	61.05	100.00	79.94		11.32	11.29	87.56
1990	3.17	0.44	0.01	0.00	0.04	0.83	16.80	32.15	72.30	80.75	89.67		5.97	5.97	87.60
1991	0.00	0.01	0.01	0.00	0.00	0.10	2.63	8.09	54.42	92.39	92.20		6.42	6.42	92.24
1992	0.00	1.20	0.53	0.00	0.00	0.46	3.26	4.70	15.44	68.39	96.18		3.81	3.81	88.27
1993	0.00	0.00	0.00	0.00	0.17	2.53	10.52	35.28	100.00	78.23	100.00		5.83	5.83	94.82
1994	0.00	0.06	0.00	0.07	1.70	7.52	17.63	33.49	79.27	100.00	100.00		13.59	13.59	100.00
1995	0.00	0.21	0.00	0.00	0.00	1.59	9.54	32.62	23.40	1.63	76.93		3.71	3.71	33.59
1996	0.00	0.00	0.00	0.00	0.13	1.95	9.73	20.21	29.66	77.63	80.73		7.37	7.37	79.55
1997	0.00	1.60	0.66	0.17	1.24	5.20	15.78	24.81	45.14	58.82	74.46		14.09	14.09	65.90
1998	13.30	3.47	0.36	1.36	19.04	45.67	63.29	58.81	84.56	100.00	100.00		51.93	51.93	100.00
1999	0.00	0.00	0.00	0.88	2.77	1.54	10.55	19.38	24.31	70.14	81.96		13.60	13.61	74.81
2000	27.38	0.18	0.00	0.00	1.65	10.28	32.19	32.54	19.78	14.13	78.47		20.10	20.10	29.15
2001	100.00	5.20	0.94	0.00	1.66	18.52	40.56	58.55	79.57	86.98	97.96		37.72	37.72	90.50
2002	1.05	1.55	1.17	2.26	2.40	15.71	51.88	76.54	90.22	100.00	100.00		31.84	31.86	100.00
2003	**0.00**	**0.00**	**0.01**	**0.11**	**0.00**	**4.77**	**13.39**	**18.17**	**48.50**	**33.64**	**42.02**		**18.73**	**18.76**	**35.93**
2004	10.83	3.75	0.66	12.02	43.96	34.48	83.27	100.00	90.35	82.63	100.00		75.79	75.81	89.50
2005	2.04	8.49	1.32	19.53	9.88	21.73	58.37	30.98	36.03	75.51	59.65		39.96	40.24	64.28
2006	13.52	5.40	1.66	6.87	28.46	53.01	56.37	82.64	64.79	100.00	96.44		67.06	67.09	97.54
2007	0.00	1.21	4.12	0.91	16.69	24.29	7.27	1.04	0.61	0.38	23.33		10.83	10.84	16.85
2008	0.03	0.06	0.24	0.07	0.91	12.10	6.56	1.66	0.52	0.32	21.42		4.93	4.95	12.85
2009	0.00	0.00	0.00	0.00	5.70	14.12	35.00	61.91	66.96	100.00	24.90		33.54	33.59	43.98
2010	0.00	0.00	0.00	0.00	0.00	1.45	8.78	38.74	62.66	66.73	75.67		26.44	26.44	73.75
2011	0.00	0.00	0.00	0.00	0.43	0.00	15.11	42.27	72.43	84.93	82.43		34.70	34.70	83.29

Table B42. Otter trawl landings (MT), days fished (DF) and landings per unit effort (LPUE for all trips landings white hake that had effort, trips for which white hake accounted for 40% of the landings, 60% of the landings and 80% of the landings.

		All Trips				40% Trips				60% Trips				80% Trips	
Year	MT	DF	LPUE		MT	DF	LPUE		MT	DF	LPUE		MT	DF	LPUE
1975	678	2,737	0.25		29	11	2.62		13	5	2.63		5	1	7.57
1976	749	2,304	0.32		43	7	6.39		35	4	9.62		35	4	9.62
1977	877	2,664	0.33		14	5	3.08		3	1	5.93				
1978	898	2,819	0.32		21	3	8.54								
1979	888	3,761	0.24		31	7	4.20		15	1	11.28				
1980	1,025	4,352	0.24		14	5	3.08		6	2	3.50		6	2	3.50
1981	1,535	4,444	0.35		87	31	2.85		32	5	6.34				
1982	1,922	6,125	0.31		75	35	2.17		3	1	2.62				
1983	2,449	6,778	0.36		328	144	2.29		75	13	5.62				
1984	2,700	7,760	0.35		205	144	1.42		32	14	2.28		5	3	2.03
1985	3,587	9,194	0.39		605	353	1.72		110	46	2.37				
1986	2,995	8,819	0.34		509	349	1.46		56	28	2.00		17	3	6.46
1987	2,912	8,957	0.33		662	620	1.07		134	91	1.47		19	15	1.26
1988	2,463	8,258	0.30		688	701	0.98		106	72	1.49		15	8	1.83
1989	1,312	6,319	0.21		268	274	0.98		53	38	1.41		19	7	2.75
1990	1,760	6,540	0.27		490	321	1.53		212	78	2.72		10	8	1.20
1991	1,924	7,021	0.27		441	227	1.94		232	41	5.68		176	6	29.40
1992	2,638	7,788	0.34		814	808	1.01		268	166	1.62		7	3	2.58
1993	2,423	7,524	0.32		791	757	1.05		218	129	1.69		35	17	2.09
1994	1,296	6,887	0.19		113	128	0.88		13	9	1.45		1	2	0.76
1995	1,481	8,583	0.17		230	260	0.88		52	32	1.64		1	4	0.28
1996	1,304	7,141	0.18		119	127	0.93		16	19	0.82		2	8	0.19
1997	751	5,256	0.14		30	28	1.06		7	5	1.45				
1998	801	5,420	0.15		75	68	1.10		11	2	4.41		11	2	4.41
1999	946	5,977	0.16		62	45	1.39		8	1	9.97		6	1	12.71
2000	1,153	5,519	0.21		152	102	1.50		27	6	4.68		6	1	7.35
2001	1,716	6,227	0.28		172	99	1.74		50	16	3.20		24	4	6.03
2002	1,657	5,482	0.30		227	118	1.93		35	11	3.12		13	5	2.80
2003	2,056	5,145	0.40		414	160	2.59		177	31	5.79		84	7	12.17
2004	1,735	4,849	0.36		379	174	2.18		151	69	2.19		43	25	1.71
2005	1,348	4,307	0.31		274	137	2.00		77	23	3.28		0	0	2.19
2006	977	4,029	0.24		41	45	0.91		5	8	0.69		2	3	0.76
2007	796	3,774	0.21		26	37	0.72		2	7	0.30		1	1	0.77
2008	650	3,206	0.20		16	19	0.84		5	4	1.38		1	2	0.38
2009	873	3,265	0.27		45	65	0.69		3	11	0.31		2	6	0.30
2010	1,049	2,753	0.38		110	71	1.55		25	14	1.79		1	3	0.26
2011	2,063	3,657	0.56		425	248	1.72		87	53	1.64		12	20	0.63
average	1,578	5,558	0.28		244	182	1.97		65	29	3.29		19	6	4.28

Table B43. Sink gill net landings (MT), days fished (DF) and landings per unit effort (LPUE for all trips landings white hake that had effort, trips for which white hake accounted for 40% of the landings, 60% of the landings and 80% of the landings.

		All Trips				40% Trips				60% Trips				80% Trips	
Year	MT	DF	LPUE		MT	DF	LPUE		Year	MT	DF		MT	DF	LPUE
1975	119	72	1.64		72	27	2.70		28	8	3.42		12	3	4.79
1976	131	95	1.37		87	24	3.62		49	12	4.09		13	3	4.08
1977	158	150	1.05		96	36	2.67		33	9	3.72		2	1	2.63
1978	204	183	1.12		136	40	3.44		117	29	4.01		10	3	3.11
1979	95	132	0.72		27	12	2.27		23	10	2.36		1	0	4.94
1980	13	31	0.42		5	2	3.02		1	0	2.23				
1981	31	22	1.42		28	7	4.06		27	5	5.44		23	4	5.95
1982	101	115	0.87		67	24	2.82		43	13	3.35		21	5	4.21
1983	117	280	0.42		57	27	2.11		34	12	2.82		12	3	4.87
1984	162	334	0.49		90	44	2.06		40	11	3.82				
1985	154	283	0.54		74	51	1.45		26	13	2.07		8	3	2.58
1986	86	341	0.25		43	33	1.29		22	17	1.26		7	6	1.23
1987	74	371	0.20		3	13	0.26		1	2	0.30				
1988	177	500	0.35		90	57	1.56		35	16	2.19		5	1	10.45
1989	273	372	0.73		226	123	1.83		156	60	2.59		50	16	3.21
1990	350	573	0.61		221	162	1.37		80	56	1.43		5	3	1.76
1991	228	554	0.41		85	88	0.96		23	15	1.59		3	1	3.24
1992	355	842	0.42		218	206	1.06		75	53	1.43		4	1	3.45
1993	240	823	0.29		132	157	0.84		46	44	1.03		0	2	0.09
1994	319	2033	0.16		111	87	1.28		36	24	1.48		7	9	0.72
1995	611	4146	0.15		277	127	2.19		133	49	2.70		25	14	1.72
1996	519	3487	0.15		244	128	1.90		106	51	2.07		14	10	1.52
1997	358	2971	0.12		107	99	1.08		56	21	2.61		19	6	3.36
1998	430	2406	0.18		157	85	1.84		49	21	2.38		7	5	1.44
1999	642	3161	0.20		322	123	2.63		126	31	4.11		35	7	5.15
2000	701	3782	0.19		303	91	3.35		142	32	4.39		26	8	3.29
2001	733	4702	0.16		368	119	3.09		155	33	4.76		15	3	4.29
2002	586	4020	0.15		347	173	2.00		110	39	2.79		25	7	3.57
2003	1027	4434	0.23		693	340	2.04		399	146	2.73		99	26	3.82
2004	659	3869	0.17		342	227	1.51		167	74	2.26		54	14	3.97
2005	318	3595	0.09		94	128	0.73		39	63	0.63		9	40	0.22
2006	209	2990	0.07		37	71	0.52		15	38	0.40		1	17	0.06
2007	298	3828	0.08		33	74	0.44		6	14	0.43		0	1	0.61
2008	286	3787	0.08		30	49	0.60		14	17	0.83		2	9	0.26
2009	303	3747	0.08		88	92	0.96		17	39	0.43		3	26	0.13
2010	311	2529	0.12		134	77	1.75		68	41	1.68		23	17	1.36
2011	544	3673	0.15		164	214	0.77		35	50	0.69		2	4	0.54
average	322	1871	0.43		152	93	1.63		93	43	2.08		16	8	2.84

Table B44. White hake otter trawl effort (days fished) GLM standardization Standard: Year = 75; Area = 515; Qtr = 3; TC = 32. Area 522 includes 521,522,523(561), Area 525 includes 524(562) 525,526.

whhake glm log(cpue) using df 13:58 Wednesday, January 23, 2013 1

Factors are year area qtr tc

The GENMOD Procedure

Model Information

Data Set	WORK.A2
Distribution	Normal
Link Function	Identity
Dependent Variable	lncpuedf

Number of Observations Read	77369
Number of Observations Used	77369

Class Level Information

Class	Levels	Values
year	37	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 9999
AREA	7	511 512 513 514 522 525 999
qtr	4	1 2 4 99
tc	3	2 4 99

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	77E3	160425.5716	2.0748
Scaled Deviance	77E3	77369.0000	1.0006
Pearson Chi-Square	77E3	160425.5716	2.0748
Scaled Pearson X2	77E3	77369.0000	1.0006
Log Likelihood		-137992.2919	
Full Log Likelihood		-137992.2919	
AIC (smaller is better)		276082.5838	
AICC (smaller is better)		276082.6472	
BIC (smaller is better)		276536.1446	

Algorithm converged.

Analysis Of Maximum Likelihood Parameter Estimates

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.6764	0.0414	-0.7576	-0.5952	266.60	<.0001
year	1976	1	0.1707	0.0545	0.0639	0.2776	9.81	0.0017
year	1977	1	0.3718	0.0516	0.2706	0.4729	51.87	<.0001
year	1978	1	0.0080	0.0526	-0.0950	0.1110	0.02	0.8790
year	1979	1	-0.2458	0.0507	-0.3451	-0.1464	23.51	<.0001

Table B44. Cont.

Factors are year area qtr tc

The GENMOD Procedure

Analysis Of Maximum Likelihood Parameter Estimates

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
year	1980	1	-0.2848	0.0493	-0.3813	-0.1882	33.43	<.0001
year	1981	1	-0.2130	0.0523	-0.3154	-0.1105	16.61	<.0001
year	1982	1	-0.3104	0.0486	-0.4057	-0.2152	40.80	<.0001
year	1983	1	-0.2374	0.0480	-0.3314	-0.1434	24.50	<.0001
year	1984	1	-0.1745	0.0481	-0.2688	-0.0802	13.15	0.0003
year	1985	1	-0.2314	0.0466	-0.3228	-0.1401	24.65	<.0001
year	1986	1	-0.5602	0.0474	-0.6530	-0.4673	139.82	<.0001
year	1987	1	-0.3763	0.0471	-0.4686	-0.2839	63.74	<.0001
year	1988	1	-0.6073	0.0480	-0.7013	-0.5132	160.21	<.0001
year	1989	1	-0.9120	0.0511	-1.0121	-0.8119	318.73	<.0001
year	1990	1	-0.9208	0.0505	-1.0198	-0.8219	332.61	<.0001
year	1991	1	-0.7914	0.0501	-0.8897	-0.6932	249.29	<.0001
year	1992	1	-0.4431	0.0493	-0.5397	-0.3464	80.76	<.0001
year	1993	1	-0.6836	0.0496	-0.7809	-0.5864	189.87	<.0001
year	1994	1	-1.2138	0.0493	-1.3105	-1.1171	605.42	<.0001
year	1995	1	-1.3145	0.0479	-1.4083	-1.2206	753.13	<.0001
year	1996	1	-1.2266	0.0487	-1.3221	-1.1311	633.60	<.0001
year	1997	1	-1.3391	0.0508	-1.4388	-1.2395	694.26	<.0001
year	1998	1	-1.3828	0.0494	-1.4796	-1.2860	783.43	<.0001
year	1999	1	-1.2827	0.0481	-1.3770	-1.1884	710.05	<.0001
year	2000	1	-0.9925	0.0481	-1.0867	-0.8983	426.17	<.0001
year	2001	1	-0.7195	0.0472	-0.8120	-0.6269	232.17	<.0001
year	2002	1	-0.8022	0.0476	-0.8956	-0.7089	283.54	<.0001
year	2003	1	-0.7670	0.0474	-0.8600	-0.6740	261.48	<.0001
year	2004	1	-0.8454	0.0488	-0.9409	-0.7498	300.59	<.0001
year	2005	1	-0.8721	0.0496	-0.9693	-0.7748	308.65	<.0001
year	2006	1	-0.8869	0.0518	-0.9885	-0.7853	292.86	<.0001
year	2007	1	-0.9806	0.0519	-1.0824	-0.8788	356.45	<.0001
year	2008	1	-1.0704	0.0523	-1.1729	-0.9679	419.10	<.0001
year	2009	1	-0.8597	0.0517	-0.9611	-0.7584	276.53	<.0001
year	2010	1	-0.2796	0.0528	-0.3830	-0.1761	28.07	<.0001
year	2011	1	0.0182	0.0471	-0.0742	0.1106	0.15	0.6993
year	9999	0	0.0000	0.0000	0.0000	0.0000	.	.
AREA	511	1	0.5010	0.0482	0.4065	0.5955	108.00	<.0001
AREA	512	1	0.3985	0.0242	0.3510	0.4460	270.40	<.0001
AREA	513	1	-0.7858	0.0184	-0.8219	-0.7496	1814.78	<.0001
AREA	514	1	-1.1818	0.0199	-1.2208	-1.1429	3535.11	<.0001
AREA	522	1	-0.9262	0.0162	-0.9581	-0.8944	3251.09	<.0001
AREA	525	1	-2.5033	0.0273	-2.5568	-2.4498	8409.97	<.0001
AREA	999	0	0.0000	0.0000	0.0000	0.0000	.	.
qtr	1	1	-0.3469	0.0156	-0.3775	-0.3164	496.44	<.0001
qtr	2	1	-0.5313	0.0142	-0.5591	-0.5035	1398.32	<.0001
qtr	4	1	-0.0254	0.0140	-0.0528	0.0019	3.32	0.0683
qtr	99	0	0.0000	0.0000	0.0000	0.0000	.	.
tc	2	1	-0.8871	0.0144	-0.9154	-0.8588	3770.56	<.0001
tc	4	1	0.4565	0.0133	0.4304	0.4825	1179.82	<.0001
tc	99	0	0.0000	0.0000	0.0000	0.0000	.	.
Scale		1	1.4400	0.0037	1.4328	1.4472		

NOTE: The scale parameter was estimated by maximum likelihood.

Table B45. White hake otter trawl effort (days fished) GLM standardization for directed (>40% white hake) trips. Standard: Year = 75; Area = 515; Qtr = 3; TC = 32. Area 522 includes 521,522,523(561), Area 525 includes 524(562) 525,526.

```
                         whhake glm log(cpue) using df               14:00 Wednesday, January 23, 2013   1
                          Factors are year area qtr tc

                              The GENMOD Procedure

                               Model Information

                         Data Set                 WORK.A2
                         Distribution              Normal
                         Link Function           Identity
                         Dependent Variable      lncpuedf


                    Number of Observations Read        2284
                    Number of Observations Used        2284


                           Class Level Information

          Class      Levels    Values

          year           37    1976 1977 1978 1979 1980 1981 1982 1983 1984 1985
                               1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
                               1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
                               2006 2007 2008 2009 2010 2011 9999
          AREA            7    511 512 513 514 522 525 999
          qtr             4    1 2 4 99
          tc              3    2 4 99


                     Criteria For Assessing Goodness Of Fit

              Criterion                     DF           Value        Value/DF

              Deviance                    2236       1392.8360          0.6229
              Scaled Deviance             2236       2284.0000          1.0215
              Pearson Chi-Square          2236       1392.8360          0.6229
              Scaled Pearson X2           2236       2284.0000          1.0215
              Log Likelihood                        -2676.0380
              Full Log Likelihood                   -2676.0380
              AIC (smaller is better)                5450.0760
              AICC (smaller is better)               5452.2694
              BIC (smaller is better)                5731.0265


        Algorithm converged.


                     Analysis Of Maximum Likelihood Parameter Estimates

                                         Standard     Wald 95% Confidence          Wald
Parameter            DF     Estimate        Error           Limits            Chi-Square    Pr > ChiSq

Intercept             1       1.1361       0.1977      0.7485      1.5236          33.01        <.0001
year         1976     1      -0.0963       0.3124     -0.7086      0.5160           0.10        0.7578
year         1977     1      -0.0501       0.3527     -0.7414      0.6411           0.02        0.8870
year         1978     1       0.4493       0.3975     -0.3298      1.2285           1.28        0.2584
year         1979     1       0.1197       0.3983     -0.6609      0.9003           0.09        0.7637
```

Table B45. Cont.

whhake glm log(cpue) using df 14:00 Wednesday, January 23, 2013 2

Factors are year area qtr tc

The GENMOD Procedure

Analysis Of Maximum Likelihood Parameter Estimates

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
year	1980	1	-0.3040	0.3716	-1.0323	0.4243	0.67	0.4133
year	1981	1	-0.1595	0.2902	-0.7283	0.4093	0.30	0.5826
year	1982	1	-0.6389	0.2516	-1.1320	-0.1459	6.45	0.0111
year	1983	1	-0.3558	0.2190	-0.7851	0.0734	2.64	0.1042
year	1984	1	-0.7963	0.2167	-1.2210	-0.3715	13.50	0.0002
year	1985	1	-0.7181	0.2047	-1.1192	-0.3170	12.31	0.0005
year	1986	1	-1.0421	0.2059	-1.4457	-0.6385	25.61	<.0001
year	1987	1	-1.1782	0.2001	-1.5704	-0.7859	34.65	<.0001
year	1988	1	-1.2395	0.2002	-1.6319	-0.8472	38.34	<.0001
year	1989	1	-1.4026	0.2110	-1.8161	-0.9890	44.19	<.0001
year	1990	1	-1.1866	0.2109	-1.5999	-0.7734	31.67	<.0001
year	1991	1	-1.0046	0.2132	-1.4225	-0.5868	22.20	<.0001
year	1992	1	-1.1598	0.1998	-1.5514	-0.7683	33.71	<.0001
year	1993	1	-1.3369	0.2010	-1.7310	-0.9429	44.23	<.0001
year	1994	1	-1.5927	0.2199	-2.0237	-1.1617	52.45	<.0001
year	1995	1	-1.5311	0.2150	-1.9526	-1.1097	50.71	<.0001
year	1996	1	-1.6208	0.2297	-2.0711	-1.1706	49.79	<.0001
year	1997	1	-1.7507	0.2892	-2.3175	-1.1840	36.66	<.0001
year	1998	1	-1.5643	0.2480	-2.0504	-1.0782	39.78	<.0001
year	1999	1	-0.9009	0.2640	-1.4184	-0.3834	11.64	0.0006
year	2000	1	-0.9647	0.2333	-1.4220	-0.5074	17.10	<.0001
year	2001	1	-1.0613	0.2305	-1.5131	-0.6096	21.20	<.0001
year	2002	1	-0.7079	0.2279	-1.1546	-0.2612	9.65	0.0019
year	2003	1	-0.6812	0.2187	-1.1099	-0.2526	9.70	0.0018
year	2004	1	-0.8403	0.2177	-1.2669	-0.4136	14.90	0.0001
year	2005	1	-0.7150	0.2183	-1.1428	-0.2871	10.73	0.0011
year	2006	1	-1.7002	0.2709	-2.2312	-1.1692	39.38	<.0001
year	2007	1	-1.7494	0.2683	-2.2753	-1.2235	42.50	<.0001
year	2008	1	-1.3713	0.2740	-1.9083	-0.8343	25.05	<.0001
year	2009	1	-1.8557	0.2429	-2.3318	-1.3796	58.36	<.0001
year	2010	1	-1.0894	0.2208	-1.5222	-0.6565	24.33	<.0001
year	2011	1	-1.1862	0.2032	-1.5845	-0.7879	34.07	<.0001
year	9999	0	0.0000	0.0000	0.0000	0.0000	.	.
AREA	511	1	0.2372	0.0743	0.0916	0.3828	10.19	0.0014
AREA	512	1	0.0661	0.0530	-0.0377	0.1699	1.56	0.2122
AREA	513	1	-0.0131	0.0609	-0.1326	0.1063	0.05	0.8293
AREA	514	1	0.0705	0.0600	-0.0472	0.1882	1.38	0.2403
AREA	522	1	-0.1382	0.0505	-0.2371	-0.0393	7.50	0.0062
AREA	525	1	-0.5964	0.1883	-0.9655	-0.2274	10.03	0.0015
AREA	999	0	0.0000	0.0000	0.0000	0.0000	.	.
qtr	1	1	0.3289	0.0621	0.2072	0.4506	28.07	<.0001
qtr	2	1	0.2157	0.0472	0.1231	0.3082	20.86	<.0001
qtr	4	1	-0.1543	0.0434	-0.2394	-0.0692	12.64	0.0004
qtr	99	0	0.0000	0.0000	0.0000	0.0000	.	.
tc	2	1	-0.3968	0.0528	-0.5002	-0.2934	56.57	<.0001
tc	4	1	0.2021	0.0398	0.1240	0.2801	25.75	<.0001
tc	99	0	0.0000	0.0000	0.0000	0.0000	.	.
Scale		1	0.7809	0.0116	0.7586	0.8039		

NOTE: The scale parameter was estimated by maximum likelihood.

Table B46. White hake landings (mt) used in the GLM, total landings, nominal and standardized effort (days fished-raised to total landings) and landings per day fished (LPUE) for the otter trawl fleet.

			Nominal		Standardized	
year	Landings in GLM	Total OT Landings	Effort	LPUE	Effort	LPUE
1975	658	1368	5469	0.250	2332	0.586
1976	735	1615	4975	0.325	2171	0.744
1977	838	2321	7135	0.325	2901	0.800
1978	881	2183	6819	0.320	2851	0.766
1979	881	2068	8627	0.240	3739	0.553
1980	1003	2675	11248	0.238	5559	0.481
1981	1400	3488	9352	0.373	5233	0.667
1982	1797	3862	11815	0.327	7437	0.519
1983	2288	4866	13134	0.371	8498	0.573
1984	2415	5156	14205	0.363	8934	0.577
1985	3370	5504	14056	0.392	9894	0.556
1986	2786	4670	13779	0.339	9993	0.467
1987	2832	4797	14775	0.325	9405	0.510
1988	2456	3655	12255	0.298	7118	0.514
1989	1312	2548	12275	0.208	6879	0.370
1990	1761	3280	12183	0.269	7335	0.447
1991	1924	3548	12946	0.274	7828	0.453
1992	2638	5191	15325	0.339	8809	0.589
1993	2423	4653	14453	0.322	7876	0.591
1994	1161	2478	13362	0.185	7820	0.317
1995	1349	2406	13846	0.174	8349	0.288
1996	1196	2037	11079	0.184	6600	0.309
1997	684	1266	9004	0.141	4876	0.260
1998	747	1286	8782	0.146	4659	0.276
1999	889	1482	9284	0.160	4348	0.341
2000	1107	1811	8719	0.208	3818	0.474
2001	1649	2421	8788	0.276	4064	0.596
2002	1589	2338	7689	0.304	3311	0.706
2003	1993	2860	7095	0.403	3321	0.861
2004	1652	2403	6710	0.358	3597	0.668
2005	1294	1884	5966	0.316	3090	0.610
2006	927	1317	5439	0.242	3005	0.438
2007	764	1032	4861	0.212	2772	0.372
2008	611	904	4432	0.204	2242	0.403
2009	791	1200	4551	0.264	2369	0.506
2010	975	1388	3630	0.382	1644	0.844
2011	1973	2306	4099	0.562	2002	1.152

Table B47. White hake landings (mt) used in the GLM for directed (>40% white hake) trips, total landings, nominal and standardized effort, and landings per day fished (LPUE) for the otter trawl fleet.

		Nominal		Standardized	
year	Landings in GLM	Effort	LPUE	Effort	LPUE
1975	29	11	2.620	11	2.637
1976	43	7	6.361	7	6.445
1977	14	5	3.075	5	3.021
1978	21	3	8.540	3	7.651
1979	31	7	4.204	6	4.878
1980	14	5	3.075	5	2.917
1981	87	31	2.847	31	2.852
1982	75	35	2.169	38	1.990
1983	328	144	2.286	145	2.257
1984	205	145	1.420	149	1.378
1985	605	353	1.716	370	1.637
1986	509	349	1.458	435	1.170
1987	663	621	1.068	650	1.019
1988	688	701	0.982	747	0.921
1989	269	274	0.981	312	0.861
1990	490	321	1.527	374	1.310
1991	441	227	1.943	225	1.963
1992	814	808	1.008	799	1.020
1993	791	757	1.045	765	1.034
1994	114	128	0.891	154	0.737
1995	254	263	0.967	288	0.883
1996	119	128	0.932	154	0.770
1997	30	28	1.061	33	0.895
1998	75	68	1.106	79	0.950
1999	62	45	1.388	54	1.153
2000	152	102	1.499	126	1.212
2001	172	99	1.742	123	1.393
2002	228	118	1.931	148	1.542
2003	446	160	2.785	205	2.176
2004	379	173	2.186	229	1.652
2005	274	137	2.002	174	1.571
2006	41	45	0.911	51	0.806
2007	26	36	0.722	38	0.689
2008	20	20	1.037	18	1.159
2009	45	65	0.695	76	0.598
2010	110	70	1.568	87	1.262
2011	425	247	1.725	313	1.360

Table B48. White hake sink gill net effort (days fished) GLM standardization Standard: Year = 75; Area = 515; Qtr = 3; TC = 32. Area 522 includes 521,522,523(561), Area 525 includes 524(562) 525,526.

```
whhake glm log(cpue) using df                  13:07 Friday, January 25, 2013   1
        Factors are year area qtr tc

            The GENMOD Procedure

             Model Information

       Data Set               WORK.A2
       Distribution            Normal
       Link Function         Identity
       Dependent Variable    lncpuedf


  Number of Observations Read       44884
  Number of Observations Used       44884


          Class Level Information

Class      Levels    Values

YEAR           18    1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
                     2005 2006 2007 2008 2009 2010 2011 9999
AREA            7    511 512 513 514 522 525 999
qtr             4    1 2 4 99
tc              2    2 99


            Criteria For Assessing Goodness Of Fit

    Criterion                   DF           Value        Value/DF

    Deviance                  45E3     145467.0081          3.2430
    Scaled Deviance           45E3      44884.0000          1.0006
    Pearson Chi-Square        45E3     145467.0081          3.2430
    Scaled Pearson X2         45E3      44884.0000          1.0006
    Log Likelihood                     -90076.4652
    Full Log Likelihood                -90076.4652
    AIC (smaller is better)            180210.9304
    AICC (smaller is better)           180210.9691
    BIC (smaller is better)            180463.5736


Algorithm converged.


          Analysis Of Maximum Likelihood Parameter Estimates

                                 Standard     Wald 95% Confidence          Wald
Parameter          DF    Estimate       Error           Limits          Chi-Square    Pr > ChiSq

Intercept           1      0.4827      0.0698      0.3459      0.6194         47.86        <.0001
YEAR         1995   1     -0.3698      0.0583     -0.4840     -0.2556         40.26        <.0001
YEAR         1996   1     -0.3584      0.0611     -0.4783     -0.2386         34.37        <.0001
YEAR         1997   1     -0.3029      0.0617     -0.4238     -0.1820         24.11        <.0001
YEAR         1998   1     -0.4484      0.0640     -0.5738     -0.3229         49.09        <.0001
YEAR         1999   1     -0.1309      0.0628     -0.2540     -0.0078          4.34        0.0372
YEAR         2000   1     -0.3017      0.0596     -0.4186     -0.1848         25.60        <.0001
```

Table B48 Cont.

Factors are year area qtr tc

The GENMOD Procedure

Analysis Of Maximum Likelihood Parameter Estimates

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
YEAR	2001	1	-0.4643	0.0595	-0.5809	-0.3477	60.91	<.0001
YEAR	2002	1	-0.2926	0.0600	-0.4102	-0.1751	23.81	<.0001
YEAR	2003	1	0.3013	0.0583	0.1871	0.4155	26.73	<.0001
YEAR	2004	1	0.2172	0.0603	0.0990	0.3354	12.98	0.0003
YEAR	2005	1	-0.2902	0.0600	-0.4078	-0.1725	23.35	<.0001
YEAR	2006	1	-0.4876	0.0611	-0.6074	-0.3679	63.68	<.0001
YEAR	2007	1	-0.4147	0.0591	-0.5305	-0.2990	49.31	<.0001
YEAR	2008	1	-0.2561	0.0578	-0.3693	-0.1429	19.65	<.0001
YEAR	2009	1	-0.1863	0.0579	-0.2999	-0.0728	10.35	0.0013
YEAR	2010	1	-0.0664	0.0620	-0.1878	0.0551	1.15	0.2841
YEAR	2011	1	0.5362	0.0577	0.4230	0.6494	86.22	<.0001
YEAR	9999	0	0.0000	0.0000	0.0000	0.0000	.	.
AREA	511	1	-1.1472	0.1147	-1.3720	-0.9224	100.03	<.0001
AREA	512	1	-1.2005	0.1023	-1.4011	-1.0000	137.68	<.0001
AREA	513	1	-2.9205	0.0371	-2.9931	-2.8478	6204.93	<.0001
AREA	514	1	-3.6273	0.0373	-3.7004	-3.5542	9461.06	<.0001
AREA	522	1	-3.2538	0.0382	-3.3286	-3.1789	7257.86	<.0001
AREA	525	1	-3.3579	0.2178	-3.7848	-2.9309	237.64	<.0001
AREA	999	0	0.0000	0.0000	0.0000	0.0000	.	.
qtr	1	1	-0.5281	0.0487	-0.6236	-0.4327	117.57	<.0001
qtr	2	1	-0.5335	0.0264	-0.5853	-0.4818	408.81	<.0001
qtr	4	1	-0.2776	0.0204	-0.3176	-0.2375	184.72	<.0001
qtr	99	0	0.0000	0.0000	0.0000	0.0000	.	.
tc	2	1	-0.9883	0.0474	-1.0813	-0.8954	434.36	<.0001
tc	99	0	0.0000	0.0000	0.0000	0.0000	.	.
Scale		1	1.8003	0.0060	1.7885	1.8121		

NOTE: The scale parameter was estimated by maximum likelihood.

Table B49. White hake landings (mt) used in the GLM for directed trips, total landings, nominal and standardized effort, and landings per day fished (LPUE) for the sink gill net fleet.

			Nominal		Standardized	
year	Landings in GLM	Total SGN Landings	Effort	LPUE	Effort	LPUE
1994	277	1066	7319	0.146	304	3.503
1995	577	1109	7582	0.146	286	3.879
1996	476	916	6234	0.147	321	2.855
1997	329	538	4601	0.117	228	2.359
1998	389	731	4195	0.174	190	3.850
1999	622	983	4680	0.210	209	4.694
2000	683	1066	5696	0.187	248	4.293
2001	707	1003	6500	0.154	333	3.012
2002	571	823	5710	0.144	196	4.208
2003	973	1417	6344	0.223	179	7.926
2004	617	958	5877	0.163	163	5.881
2005	303	573	6670	0.086	178	3.217
2006	187	318	4990	0.064	149	2.127
2007	272	393	5399	0.073	110	3.562
2008	276	400	5332	0.075	124	3.218
2009	277	440	5786	0.076	132	3.340
2010	278	403	3564	0.113	87	4.659
2011	538	582	3932	0.148	100	5.845

Table B50. AIC values for models fit to **white hake** length data.

Model	Model	-LL	# parameters	AIC_c	$\Delta (AIC_c)$	AIC_c Weights
1	All stations, constant (no length effect)	1586.674	2	3177.354	12.415	0.0017
2	Survey, S-S, constant	1584.259	4	3176.541	11.6022	0.0026
3	S,F,S-S, constant model	1576.446	6	3164.939	0	0.856
4	All stations, logistic model (free slope)	1579.413	5	3168.859	3.9203	0.1206
5	All stations, logistic model (declining slope)	1581.257	5	3172.547	7.6079	0.0191

Table B51. Stratified mean catch per tow in numbers and weight (kg) for white hake from NEFSC offshore spring research vessel bottom trawl surveys (strata 21-30,36-40), 1968-2012.

																		Number of				
		Number				Biomass			Individual			Length				Number	Nonzero				
Year	Mean	L80%CI	U80%CI	CV	Mean	L80%CI	U80%CI	CV	Mean Wt	Min	5%	50%	Mean	95%	Max	of Tows	Tows	Area	Temp	Depth	Average Day
1968	1.631	1.144	2.117	21.2	1.937	1.229	2.645	27.0	1.188	10	23	43	45.2	83	118	74	29	22745	5.0	172.1	102
1969	4.018	2.723	5.313	23.6	5.848	4.325	7.372	19.6	1.455	17	26	41	47.7	89	127	74	37	22745	5.5	174.9	93
1970	6.651	4.323	8.980	21.1	13.813	3.659	23.967	39.8	2.077	22	27	50	53.3	78	114	75	42	22745	6.5	181.1	86
1971	3.683	2.780	4.586	18.5	5.930	4.291	7.568	21.0	1.610	17	27	50	52.1	82	121	81	40	22745	6.4	173.2	99
1972	11.553	8.804	14.301	17.8	14.583	9.232	19.934	27.0	1.262	18	28	39	47.6	77	112	80	54	22745	6.4	177.6	102
1973	10.544	7.157	13.931	24.1	14.016	10.127	17.904	20.9	1.329	18	28	46	50.0	77	120	71	49	22745	6.6	175.9	118
1974	8.809	6.865	10.752	16.5	16.068	12.150	19.985	18.2	1.824	13	31	58	56.6	80	126	68	47	22745	6.6	177.6	116
1975	9.313	6.802	11.824	19.8	11.591	8.935	14.247	17.1	1.245	9	14	42	45.2	76	115	75	43	22015	6.7	169.0	120
1976	11.202	8.790	13.615	16.2	19.616	13.416	25.817	23.4	1.751	10	27	48	53.4	82	122	87	64	22745	7.1	179.9	106
1977	6.961	5.130	8.792	19.6	12.008	8.682	15.334	20.6	1.725	22	29	52	55.2	83	128	91	51	22745	5.6	169.0	126
1978	3.367	2.521	4.214	19.2	6.254	4.422	8.086	22.1	1.857	20	26	45	51.2	82	131	94	42	22745	5.7	171.4	127
1979	5.856	4.414	7.298	18.7	5.693	3.776	7.609	25.1	0.972	16	25	40	43.4	74	113	117	61	22745	5.4	174.1	115
1980	11.896	9.440	14.352	15.5	15.607	12.113	19.101	16.7	1.312	10	28	45	49.5	76	123	71	51	22745	5.5	174.1	118
1981	17.888	13.308	22.467	15.4	21.612	5.453	37.772	30.1	1.208	11	25	42	46.8	78	124	74	57	22745	5.5	177.3	131
1982	6.635	4.399	8.871	24.3	10.031	6.756	13.306	23.9	1.512	19	29	46	51.4	77	122	77	45	22745	5.8	178.7	120
1983	3.226	2.525	3.926	16.5	3.232	2.511	3.953	16.9	1.002	15	24	41	43.8	73	102	75	48	22745	5.9	175.4	112
1984	2.714	2.004	3.424	19.7	4.605	2.823	6.386	26.8	1.697	15	30	50	54.0	77	118	73	34	22745	6.2	179.1	104
1985	4.707	3.629	5.785	16.9	6.056	4.273	7.839	22.1	1.287	26	30	47	49.4	73	117	66	33	22745	6.1	179.7	96
1986	8.821	7.406	10.236	12.1	6.083	4.868	7.297	15.1	0.690	14	25	35	40.2	69	96	75	54	22745	7.2	179.2	107
1987	7.695	6.297	9.092	13.7	7.079	5.663	8.494	15.2	0.920	12	27	42	45.4	68	128	70	46	22745	5.7	180.3	112
1988	4.711	3.999	5.423	11.3	4.103	3.434	4.773	12.4	0.871	20	24	38	42.9	70	95	76	43	22745	6.5	176.2	100
1989	3.532	2.363	4.702	24.8	3.440	1.934	4.946	32.6	0.974	16	28	39	44.7	74	92	71	36	22745	5.7	178.4	95
1990	12.323	3.894	20.753	48.4	20.805	-1.111	42.720	74.5	1.688	22	26	55	53.8	77	119	75	45	22745	4.1	181.3	96
1991	9.015	7.400	10.630	13.4	6.813	5.158	8.468	17.8	0.756	9	24	39	42.1	68	131	72	48	22745	6.1	185.5	97
1992	7.872	5.958	9.787	18.4	7.485	4.391	10.579	26.3	0.951	22	27	44	45.2	66	105	74	46	22745	6.4	177.7	100
1993	8.124	6.341	9.908	16.3	7.584	5.712	9.457	18.0	0.934	17	25	45	46.6	68	85	73	42	22745	5.4	173.8	109
1994	4.513	3.554	5.473	15.8	3.415	1.983	4.847	25.3	0.757	18	25	38	41.2	65	96	74	49	22745	6.6	176.1	107
1995	4.185	3.306	5.064	15.8	4.283	3.168	5.398	19.5	1.023	14	27	42	45.5	73	100	74	39	22745	6.6	177.1	109
1996	3.009	2.485	3.532	12.9	3.426	2.732	4.119	14.3	1.139	12	19	45	47.0	69	104	70	42	22745	6.7	175.8	113
1997	1.875	1.439	2.311	17.6	0.893	0.668	1.117	18.7	0.476	18	24	38	38.6	57	67	75	29	22745	6.7	169.2	99
1998	2.233	1.747	2.719	16.3	1.168	0.873	1.464	19.0	0.523	18	25	34	38.7	61	74	101	49	22745	6.1	177.4	101
1999	3.344	2.210	4.477	25.4	3.095	1.533	4.658	37.0	0.926	10	26	41	45.1	69	89	75	39	22745	6.2	179.5	105
2000	5.366	4.359	6.373	14.0	3.692	2.906	4.477	15.9	0.688	16	25	37	41.4	65	75	75	47	22745	6.8	171.8	113
2001	4.912	4.063	5.760	13.1	5.210	4.160	6.260	15.2	1.061	12	28	46	48.4	69	108	75	39	22745	6.5	185.9	109
2002	5.342	3.794	6.890	21.1	6.605	4.137	9.073	25.3	1.236	17	25	52	49.6	70	105	77	42	22745	6.9	176.6	106
2003	5.337	4.368	6.306	13.4	6.203	4.902	7.503	15.4	1.162	16	27	43	47.9	75	92	74	37	22745	5.9	183.7	107
2004	4.747	3.303	6.191	22.2	5.477	2.449	8.505	39.2	1.154	19	24	43	47.0	76	99	73	35	22745	5.2	181.3	102
2005	3.752	2.975	4.529	15.7	5.763	3.767	7.760	26.0	1.536	15	22	45	50.0	92	106	73	34	22745	5.8	177.1	104
2006	2.504	2.114	2.894	11.7	1.586	1.153	2.019	20.4	0.633	17	21	32	37.8	70	97	82	49	22745	7.0	174.4	99
2007	2.656	1.992	3.320	17.0	3.099	1.829	4.369	29.5	1.167	19	27	44	48.0	78	110	72	34	22745	5.9	172.3	105
2008	6.877	4.406	9.348	23.6	4.246	2.219	6.274	32.3	0.618	12	23	39	40.1	61	84	72	48	22745	5.6	177.6	111
2009	6.759	5.195	8.322	18.8	4.767	3.285	6.249	25.0	0.705	13	21	38	40.8	63	89	95	69	22745	5.9	176.0	112
2010	5.411	4.631	6.191	13.1	5.652	4.311	6.992	19.6	1.044	12	25	43	45.8	69	91	87	70	22745	6.8	175.4	109
2011	5.095	4.360	5.831	13.3	5.521	4.597	6.445	16.0	1.084	8	28	44	47.4	72	93	77	61	22745	7.7	177.2	118
2012	4.204	3.677	4.731	12.2	4.209	3.468	4.950	16.5	1.001	20	29	41	45.4	73	96	95	66	22745	7.6	175.3	111

Table 52. Stratified mean catch per tow in numbers and weight (kg) for white hake from NEFSC offshore autumn research vessel bottom trawl surveys (strata 21-30,36-40), 1963-2012.

		Number				Biomass			Individual			Length				Number	Number of Nonzero				
Year	Mean	L95%CI	U95%CI	CV	Mean	L95%CI	U95%CI	CV	Mean Wt	Min	5%	50%	Mean	95%	Max	of Tows	Tows	Area	Temp	Depth	Average Day
1963	5.468	4.435	6.501	13.0	7.523	5.601	9.446	19.0	1.376	13	23	45	48.0	74	121	81	48	22745	7.1	166.5	325
1964	1.761	1.327	2.195	18.5	4.089	2.903	5.276	22.1	2.322	24	28	51	56.3	104	123	72	31	22745	5.8	172.3	320
1965	4.160	3.037	5.284	19.8	6.609	5.109	8.110	16.7	1.589	15	27	46	50.8	80	125	74	51	22745	6.1	171.3	286
1966	7.563	6.154	8.973	13.7	8.405	6.892	9.917	13.6	1.111	18	26	40	45.1	72	121	68	53	22745	5.7	163.0	291
1967	4.023	3.175	4.870	15.9	4.122	3.079	5.166	18.8	1.025	20	22	40	43.6	71	117	72	46	22745	6.0	175.1	322
1968	4.397	2.902	5.891	22.3	4.886	3.105	6.667	25.1	1.111	11	23	42	45.3	71	120	73	48	22745	6.9	178.6	318
1969	10.147	8.433	11.861	12.5	13.404	10.613	16.195	15.2	1.321	14	23	43	47.3	74	112	74	54	22745	7.3	178.2	318
1970	8.848	7.397	10.300	12.5	14.174	11.178	17.169	16.0	1.602	21	26	50	51.6	77	119	77	59	22745	7.6	168.9	314
1971	11.196	7.637	14.755	21.7	13.468	11.355	15.580	11.6	1.203	12	25	40	44.5	74	130	79	65	22745	8.3	174.9	308
1972	14.029	7.994	20.065	28.4	14.556	10.648	18.464	18.4	1.038	9	24	42	45.4	72	116	78	62	22745	8.2	166.1	311
1973	9.863	7.684	12.041	15.9	14.800	11.362	18.238	17.2	1.501	8	26	49	51.8	81	119	78	62	22745	8.1	175.2	310
1974	5.400	4.463	6.337	13.1	12.121	9.748	14.495	14.8	2.245	19	27	54	56.6	85	130	80	59	22745	8.3	179.2	297
1975	5.146	4.227	6.066	13.1	7.826	6.385	9.267	13.5	1.521	15	25	45	50.0	82	116	89	61	22745	7.9	167.5	299
1976	6.742	5.167	8.316	17.2	11.695	9.219	14.172	15.9	1.735	8	33	51	54.5	81	123	75	61	22745	8.6	172.9	314
1977	10.575	9.038	12.113	11.0	13.872	11.839	15.905	11.2	1.312	10	21	43	47.0	79	123	112	87	22745	7.9	173.7	323
1978	8.343	7.107	9.578	11.2	13.323	11.097	15.549	12.3	1.597	12	25	45	50.0	82	131	176	133	22745	7.2	172.8	301
1979	5.561	4.685	6.436	12.0	10.568	8.269	12.868	16.1	1.901	22	33	47	53.5	83	127	193	137	22745	7.6	173.2	310
1980	12.001	9.302	14.700	17.1	18.410	12.081	24.739	25.3	1.534	4	8	49	48.8	78	118	81	66	22745	7.4	170.2	307
1981	8.428	6.734	10.123	12.3	11.870	9.987	13.753	11.7	1.408	22	32	44	50.5	79	96	74	51	22745	7.1	172.2	304
1982	1.876	1.427	2.325	17.8	1.954	1.392	2.516	21.8	1.042	12	24	43	45.9	75	93	79	41	22745	7.9	171.1	303
1983	8.991	7.369	10.613	13.3	11.513	9.560	13.466	12.9	1.281	22	29	43	48.6	71	117	71	53	22745	8.0	172.8	303
1984	5.173	4.483	5.862	10.1	8.152	6.969	9.335	10.8	1.576	22	26	49	52.3	76	123	72	57	22745	8.1	182.9	298
1985	9.460	7.489	11.431	15.7	9.795	7.280	12.309	19.3	1.035	9	21	39	42.4	75	128	73	56	22745	8.3	171.7	306
1986	15.181	12.743	17.618	12.0	11.450	9.951	12.949	9.9	0.754	10	17	40	41.2	66	108	75	66	22745	8.4	174.3	299
1987	7.852	6.815	8.888	10.1	9.801	7.644	11.957	16.2	1.248	17	24	46	48.7	76	113	73	54	22745	7.6	176.0	293
1988	8.540	7.219	9.861	11.7	10.430	8.076	12.785	16.7	1.221	19	27	41	46.1	69	136	75	61	22745	7.1	174.9	293
1989	12.538	9.577	15.499	17.7	9.255	7.867	10.642	11.4	0.738	9	19	39	39.8	68	90	73	60	22745	6.9	179.0	296
1990	13.861	11.307	16.415	13.8	10.895	7.966	13.823	19.6	0.786	5	12	39	41.2	64	83	75	61	22745	5.8	174.4	288
1991	13.672	11.047	16.298	14.6	12.541	9.314	15.767	18.8	0.917	16	24	41	44.5	68	94	75	66	22745	7.8	170.3	286
1992	10.746	9.547	11.946	8.5	11.843	10.178	13.509	10.5	1.102	16	30	46	47.7	67	115	73	59	22745	7.3	183.1	292
1993	10.504	8.721	12.287	12.0	12.039	9.910	14.168	12.9	1.146	14	24	47	47.8	68	86	72	63	22745	7.6	180.7	285
1994	7.381	6.334	8.427	10.6	5.924	5.114	6.735	10.4	0.803	3	20	40	41.3	66	88	73	62	22745	8.7	183.0	289
1995	10.072	8.751	11.393	9.9	8.439	7.106	9.772	11.9	0.838	3	4	40	40.1	65	126	79	62	22745	7.9	174.5	285
1996	4.684	4.046	5.322	10.0	6.651	5.407	7.896	13.8	1.420	10	24	51	51.2	70	97	74	50	22745	8.0	173.8	290
1997	5.031	4.179	5.884	12.7	4.896	3.923	5.868	14.8	0.973	18	22	37	41.3	70	118	76	56	22745	7.9	174.9	290
1998	4.958	4.339	5.577	9.6	4.737	4.000	5.475	11.8	0.956	12	25	41	44.3	67	97	90	68	22745	6.9	174.4	299
1999	6.154	4.507	7.800	20.0	3.648	2.939	4.357	14.8	0.593	11	17	30	36.0	62	92	93	65	22745	8.4	169.6	303
2000	7.569	6.459	8.678	11.2	6.800	5.752	7.847	11.8	0.898	5	24	40	43.7	66	110	73	52	22745	8.2	169.5	284
2001	5.704	4.851	6.557	11.3	7.852	6.764	8.939	10.5	1.377	19	34	51	52.4	69	97	77	51	22745	7.7	171.7	285
2002	6.861	4.203	9.519	25.3	6.720	5.273	8.167	16.3	0.979	18	22	37	42.2	71	110	72	49	22745	8.8	174.5	290
2003	4.031	3.226	4.835	14.7	4.531	3.507	5.556	17.1	1.124	20	22	42	44.8	78	87	74	43	22745	7.6	179.6	293
2004	3.550	2.915	4.184	13.1	3.695	2.947	4.442	15.4	1.041	17	24	39	44.7	72	116	71	52	22745	6.7	171.5	292
2005	3.585	2.960	4.211	13.3	3.837	3.039	4.634	15.8	1.070	18	21	41	45.1	73	114	73	42	22745	8.0	173.0	296
2006	4.751	4.127	5.375	9.9	4.272	3.646	4.897	11.1	0.899	9	25	38	43.0	71	111	80	58	22745	8.3	167.2	286
2007	6.636	5.537	7.735	12.5	7.222	5.801	8.643	15.0	1.088	10	25	46	47.6	64	118	76	58	22745	7.2	177.2	292
2008	7.345	6.024	8.666	13.5	7.056	5.470	8.642	16.6	0.961	4	11	42	43.3	71	92	76	56	22745	4.9	175.7	295
2009	5.327	4.654	6.000	12.3	4.760	4.034	5.485	15.2	0.893	13	22	41	43.1	65	98	73	65	22745	8.1	177.3	312
2010	7.951	6.764	9.139	13.5	7.854	6.390	9.317	17.0	0.988	12	24	42	44.8	67	96	68	62	22745	8.9	174.2	314
2011	6.945	5.885	8.006	13.6	9.020	7.375	10.666	16.8	1.299	8	25	45	48.6	71	101	66	58	22745	8.6	184.2	305
2012	5.380	4.846	5.913	10.8	7.739	6.934	8.543	12.7	1.344	19	25	46	49.2	74	111	85	70	22745	na	181.1	295

Table B53. Stratified mean catch per tow in numbers and weight (kg) for white hake from ASMFC shrimp surveys from 1985-2012. White hake were not counted or measured on every tow from 1985-1989.

Year	Number Mean	Number L80%CI	Number U80%CI	Number CV	Biomass Mean	Biomass L80%CI	Biomass U80%CI	Biomass CV	Individual Mean Wt	Length Min	Length 5%	Length 50%	Length Mean	Length 95%	Length Max	Number of Tows	Number of Nonzero Tows	Area	Temp	Depth	Average Day
1985					11.120	6.634	15.603	28.6								44	37	6147	4.0	187.8	221
1986					12.520	9.328	15.716	17.8								40	38	6147	6.3	184.3	214
1987					20.070	16.920	23.215	11.2								41	40	6147	6.0	151.5	221
1988					14.100	11.862	16.340	11.5								41	41	6147	6.5	200.7	222
1989					7.981	6.576	9.386	13.4								43	40	6147	5.6	183.7	217
1990	16.210	11.240	21.174	22.6	9.641	6.857	12.425	21.5	0.595	21	27	34	38.2	54	84	43	37	6147	3.6	192.0	216
1991	17.850	15.004	20.704	12.1	10.460	8.508	12.416	13.9	0.586	15	28	37	39.7	56	69	43	43	6147	6.1	145.3	214
1992	15.550	13.638	17.464	9.4	12.510	11.023	14.000	9.0	0.805	12	29	42	43.3	58	116	45	45	6147	6.3	191.7	220
1993	8.593	7.257	9.929	11.8	9.146	7.898	10.393	10.2	1.064	14	29	44	46.7	67	119	46	42	6147	5.8	193.8	219
1994	8.234	6.155	10.314	18.2	6.462	5.409	7.516	12.2	0.785	17	26	38	41.0	66	95	43	40	6147	6.8	177.2	218
1995	14.030	11.384	16.682	13.6	10.390	8.745	12.043	11.5	0.741	12	31	40	42.9	63	88	35	33	6147	6.6	178.3	218
1996	8.132	5.851	10.414	19.7	6.676	4.428	8.924	23.8	0.821	9	27	42	43.3	61	72	32	30	6147	7.1	172.8	216
1997	4.322	3.357	5.286	16.6	3.252	2.451	4.052	18.3	0.752	10	30	38	41.8	65	81	40	33	6147	6.8	188.0	213
1998	6.027	4.864	7.191	14.5	4.418	3.540	5.296	14.6	0.733	3	29	38	41.4	60	71	35	31	6147	6.3	175.5	214
1999	8.321	5.573	11.069	23.8	7.162	5.256	9.067	19.9	0.861	23	28	40	43.2	65	93	42	37	6147	6.1	180.6	212
2000	16.570	10.602	22.532	26.8	8.854	6.882	10.825	16.8	0.534	16	25	35	37.5	55	88	35	32	6147	6.7	178.8	210
2001	9.636	6.809	12.463	20.8	10.560	6.966	14.152	24.0	1.096	28	34	47	48.5	61	104	36	31	6147	6.5	176.8	209
2002	10.670	8.086	13.255	17.9	14.240	9.601	18.870	18.1	1.334	25	30	49	50.4	71	83	38	37	6147	7.1	178.1	208
2003	11.200	8.865	13.525	15.7	10.290	7.883	12.699	17.0	0.919	15	28	36	43.2	74	90	37	35	6147	5.6	167.5	213
2004	14.780	5.602	23.951	44.7	9.781	7.179	12.383	19.8	0.662	21	25	32	38.7	66	93	35	29	6147	4.7	187.7	214
2005	8.705	7.540	9.871	10.2	7.618	6.235	9.002	13.6	0.875	23	26	39	42.8	69	99	46	43	6147	4.9		212
2006	10.390	7.802	12.969	18.4	10.290	8.471	12.112	13.2	0.991	16	24	36	41.3	69	106	29	29	6147	7.1		213
2007	10.300	8.258	12.349	15.1	8.947	7.059	10.836	15.8	0.868	17	27	38	42.5	67	100	43	39	6147	5.9		213
2008	9.291	6.593	11.989	21.9	7.353	5.768	8.937	16.2	0.791	19	26	37	41.7	65	112	37	36	6147	5.9	176.1	216
2009	10.900	7.763	14.034	21.1	11.570	7.254	15.895	27.6	1.062	10	25	42	45.4	73	117	49	49	6147	6.0	168.7	205
2010	13.050	10.345	15.760	15.4	10.430	8.386	12.475	14.5	0.799	19	29	40	44.0	64	80	49	48	6147	7.4	172.8	203
2011	13.610	11.156	16.066	13.6	12.790	10.642	14.938	12.9	0.940	25	29	39	44.6	72	96	47	46	6147		169.2	203
2012	8.801	7.263	10.340	13.3	9.626	8.215	11.037	11.2	1.094	17	30	42	46.8	69	91	49	48	6147		170.7	217

Table B54. Abundance and biomass indices of white hake from the MDMF Spring Survey, Regions 1-5.

		Number				Biomass			Individual			
Year	Mean	L95%CI	U95%CI	CV	Mean	L95%CI	U95%CI	CV	Mean Wt	Temp	Depth	Average Day
1978	2.255	-1.188	5.698	49.3	0.243	-0.042	0.528	42.5	0.108	10.5	19.4	148
1979	2.400	0.576	4.225	31.8	0.367	-0.243	0.978	61.4	0.153	9.4	21.3	130
1980	2.129	-0.371	4.629	41.7	0.082	0.021	0.143	30.4	0.038	9.5	21.4	135
1981	4.285	2.361	6.210	21.5	0.242	0.081	0.403	29.5	0.057	8.6	21.4	133
1982	0.375	0.132	0.619	31.3	0.029	-0.002	0.061	44.1	0.078	8.1	19.6	132
1983	1.087	0.344	1.831	31.3	0.080	0.020	0.140	33.1	0.073	9.0	21.6	136
1984	1.068	-1.215	3.350	75.3	0.048	-0.050	0.147	70.2	0.045	8.6	22.2	135
1985	1.633	-0.543	3.808	49.7	0.025	-0.008	0.058	38.8	0.016	9.2	22.3	134
1986	2.612	1.310	3.914	21.3	0.614	0.236	0.993	24.4	0.235	8.6	21.9	133
1987	0.242	0.044	0.439	34.4	0.040	-0.005	0.086	40.6	0.167	8.8	22.5	131
1988	0.426	0.184	0.669	25.4	0.038	0.009	0.067	29.8	0.090	8.5	22.0	138
1989	0.620	0.242	0.998	24.4	0.110	0.046	0.174	22.4	0.178	6.7	21.4	136
1990	1.082	0.672	1.492	16.7	0.202	0.117	0.287	17.6	0.187	8.2	22.1	135
1991	0.378	-0.050	0.806	43.5	0.043	-0.016	0.102	50.9	0.114	10.4	21.4	134
1992	0.630	-0.471	1.731	65.3	0.019	-0.007	0.045	52.4	0.031	8.4	21.6	134
1993	0.350	-0.240	0.940	63.8	0.004	-0.014	0.023	100.0	0.012	8.7	22.1	132
1994	0.438	0.120	0.756	31.9	0.014	-0.002	0.029	50.6	0.031	8.3	22.2	137
1995	0.562	0.031	1.092	38.8	0.028	-0.127	0.183	63.9	0.050	8.7	22.3	136
1996	1.080	-0.848	3.009	65.4	0.001	-0.002	0.004	100.0	0.001	8.3	22.2	135
1997	0.552	0.191	0.914	30.0	0.029	0.013	0.045	22.7	0.052	8.3	22.3	133
1998	0.369	0.155	0.582	27.2	0.009	-0.001	0.019	42.6	0.024	8.5	22.4	133
1999	0.199	0.051	0.348	33.4	0.007	-0.002	0.015	50.5	0.033	10.3	22.1	138
2000	0.698	0.015	1.381	37.0	0.021	0.010	0.033	21.3	0.031	10.0	22.1	137
2001	0.366	0.022	0.710	39.6	0.003	-0.003	0.009	73.1	0.009	9.2	22.7	135
2002	1.602	-6.734	9.938	64.9	0.020	-0.081	0.121	42.4	0.013	9.5	21.8	134
2003	0.718	0.051	1.385	40.6	0.001	-0.001	0.002	100.0	0.001	8.3	22.7	133
2004	0.090	0.016	0.164	36.7	0.004	0.000	0.009	42.0	0.049	8.4	21.9	132
2005	0.066	-0.041	0.173	64.2	0.003	-0.011	0.016	76.6	0.039	8.1	22.9	139
2006	0.740	-1.575	3.055	47.0	0.088	-0.159	0.334	31.6	0.119	9.5	22.3	137
2007	0.382	-3.129	3.893	75.6	0.063	-0.645	0.771	89.7	0.165	8.8	22.3	136
2008	0.134	-0.422	0.690	40.7	0.014	-0.081	0.109	53.8	0.103	8.2	22.5	134
2009	0.203	-0.074	0.479	48.2	0.015	-0.006	0.036	50.8	0.074	8.9	21.9	132
2010	0.266	-0.156	0.689	42.1	0.031	-0.028	0.090	45.4	0.116	9.2	22.2	130
2011	0.031	-0.124	0.185	76.0	0.004	-0.023	0.031	80.2	0.125	8.9	21.7	131
2012	0.105	-1.068	1.278	91.8	0.034	-0.377	0.444	96.9	0.320	10.9	22.0	135

Table B55. Abundance and biomass indices of white hake from the MDMF Autum Survey, Regions 1-5.

		Number				Biomass			Individual			
Year	Mean	L95%CI	U95%CI	CV	Mean	L95%CI	U95%CI	CV	Mean Wt	Temp	Depth	Average D
1978	13.610	7.510	19.710	16.6	0.840	0.468	1.212	17.5	0.062	13.0	20.9	261
1979	5.720	3.329	8.110	19.0	0.613	0.364	0.862	18.8	0.107	13.0	21.0	265
1980	13.590	10.312	16.868	11.4	0.959	0.704	1.213	12.6	0.071	14.7	21.2	262
1981	9.217	2.911	15.524	27.2	0.863	0.408	1.317	21.7	0.094	15.6	21.2	268
1982	5.202	1.388	9.016	28.0	0.579	0.243	0.915	25.9	0.111	13.7	21.4	260
1983	1.465	0.845	2.084	19.2	0.299	0.145	0.453	22.2	0.204	13.6	21.2	258
1984	0.638	-1.261	2.536	47.4	0.056	-0.093	0.206	45.7	0.089	13.8	21.8	262
1985	11.747	-13.249	36.743	77.0	0.184	0.068	0.301	27.8	0.016	15.6	22.1	253
1986	1.254	0.792	1.716	17.6	0.211	0.070	0.352	24.5	0.168	14.0	22.1	258
1987	3.705	-5.836	13.246	65.0	0.073	-0.046	0.192	55.3	0.020	12.3	22.5	260
1988	1.546	0.260	2.833	22.2	0.189	0.099	0.279	20.1	0.122	12.5	22.0	259
1989	4.470	0.027	8.913	37.9	0.238	0.096	0.380	18.8	0.053	13.9	21.8	255
1990	3.153	1.411	4.895	24.7	0.514	0.196	0.831	26.7	0.163	15.9	21.8	254
1991	1.528	0.503	2.553	26.7	0.249	0.081	0.416	28.0	0.163	16.1	21.9	255
1992	4.391	-21.570	30.353	61.2	0.227	-1.404	1.857	64.9	0.052	13.7	22.0	261
1993	5.036	-5.090	15.162	64.5	0.327	-0.334	0.987	64.9	0.065	13.7	22.3	258
1994	3.483	0.667	6.298	22.9	0.324	0.197	0.451	16.9	0.093	15.9	22.2	257
1995	15.219	-43.272	73.710	89.4	0.089	0.033	0.145	27.9	0.006	10.4	22.0	256
1996	4.122	0.957	7.287	31.3	0.149	0.055	0.242	24.9	0.036	15.2	22.4	255
1997	1.036	0.469	1.603	12.9	0.090	0.007	0.174	27.1	0.087	15.3	21.6	259
1998	1.195	0.215	2.176	30.7	0.045	0.003	0.088	34.3	0.038	13.5	22.2	261
1999	6.058	-8.898	21.014	38.5	0.192	0.080	0.304	25.6	0.032	15.2	22.3	258
2000	0.794	0.081	1.508	36.3	0.060	0.013	0.108	31.4	0.076	15.9	21.9	257
2001	1.698	-2.703	6.100	61.3	0.073	-0.008	0.154	34.2	0.043	14.2	22.4	255
2002	0.555	0.126	0.985	29.8	0.097	-0.631	0.825	66.8	0.174	16.4	22.0	254
2003	0.835	0.534	1.136	17.0	0.017	0.008	0.027	26.4	0.021	14.4	22.3	253
2004	1.217	-0.997	3.431	70.2	0.023	-0.004	0.050	43.5	0.019	13.0	22.3	265
2005	0.893	-0.554	2.340	59.9	0.067	0.005	0.129	34.7	0.075	14.5	23.1	256
2006	0.524	0.187	0.862	28.0	0.118	-0.031	0.266	45.3	0.224	15.2	22.2	259
2007	0.536	-0.055	1.128	39.1	0.064	-0.330	0.458	56.1	0.120	14.4	22.1	254
2008	0.198	0.015	0.381	32.6	0.061	-0.459	0.580	70.7	0.306	15.8	22.2	255
2009	4.440	2.202	6.678	22.5	0.275	0.149	0.401	20.8	0.062	15.9	21.8	259
2010	0.907	0.576	1.237	15.2	0.081	0.018	0.144	27.1	0.089	15.1	21.5	258
2011	5.898	2.004	9.791	26.6	0.360	0.111	0.610	27.1	0.061	15.6	21.8	257
2012	0.097	-0.037	0.230	51.2	0.019	-0.114	0.153	65.3	0.200	15.2	21.3	257

Table B56. Abundance and biomass indices of white hake from the ME/NH survey.

SPRING					AUTUMN				
	Number		Weight			Number		Weight	
	Mean	SE	Mean	SE		Mean	SE	Mean	SE
					2000	13.03	1.22	1.63	0.16
2001	0.65	0.15	0.04	0.01	2001	18.90	2.75	2.83	0.33
2002	2.10	0.40	0.28	0.06	2002	23.65	1.88	2.71	0.27
2003	1.94	0.47	0.36	0.11	2003	25.41	2.99	3.70	0.45
2004	2.39	0.41	0.17	0.03	2004	17.81	2.56	2.77	0.35
2005	4.23	0.77	0.62	0.13	2005	44.82	3.11	2.35	0.22
2006	6.12	0.72	0.55	0.08	2006	31.06	3.68	2.05	0.21
2007	4.11	0.91	0.48	0.17	2007	32.90	2.82	4.12	0.51
2008	6.79	0.78	0.76	0.12	2008	99.93	8.38	5.00	0.33
2009	15.38	1.34	1.16	0.14	2009	35.54	2.22	4.65	0.37
2010	2.49	0.35	0.37	0.14	2010	24.20	2.47	2.37	0.27
2011	3.85	0.51	0.44	0.06	2011	40.23	2.63	4.30	0.39
2012	3.02	0.35	0.48	0.08					

Table B57. Number of ages available for survey ALKs for all areas and for the stock area.

Year	Spring Stock	Spring Total	Autumn Stock	Autumn Total	Total Stock	Total Total
1982	228	362	189	283	417	645
1983	200	309	396	483	596	792
1984	152	224	325	450	477	674
1985	259	411	395	652	654	1063
1986	426	686	486	669	912	1355
1987	171	191	373	443	544	634
1988	233	276	399	476	632	752
1989	158	259	408	472	566	731
1990	379	436	539	717	918	1153
1991	388	499	545	861	933	1360
1992	285	360	591	789	876	1149
1993	339	380	530	686	869	1066
1994	222	282	370	582	592	864
1995	198	256	480	542	678	798
1996	178	199	229	279	407	478
1997	80	113	245	277	325	390
1998	148	184	330	359	478	543
1999	174	210	321	374	495	584
2000	248	289	353	424	601	713
2001	275	323	278	328	553	651
2002	211	249	213	256	424	505
2003	205	235			205	235
2004	64	95	134	186	198	281
2005	182	237	166	207	348	444
2006	140	160	209	253	349	413
2007	145	184	338	488	483	672
2008	226	247	348	469	574	716
2009	562	775	564	822	1126	1597
2010	598	755	779	952	1377	1707
2011	556	697	622	737	1178	1434
2012	512	616			512	616

Table B58. Stratified mean number per tow at age of white hake in the NEFSC spring bottom trawl surveys (Strata 21-30,36-40), 1968-2012. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+	1+ Biomass
1968	**0.0000**	**0.1054**	**0.3564**	**0.6468**	**0.3118**	**0.0920**	**0.0548**	**0.0216**	**0.0182**	**0.0050**	**0.0185**	**1.6306**	**0.0235**	**1.6306**	**1.937**
1969	**0.0000**	**0.1497**	**1.0233**	**1.4013**	**0.6956**	**0.3596**	**0.1174**	**0.0864**	**0.0516**	**0.0535**	**0.0796**	**4.0181**	**0.1332**	**4.0181**	**5.848**
1970	**0.0000**	**0.1457**	**1.2249**	**1.7268**	**1.3533**	**1.2801**	**0.6096**	**0.1204**	**0.0704**	**0.0383**	**0.0817**	**6.6512**	**0.1199**	**6.6512**	**13.813**
1971	**0.0000**	**0.1133**	**0.5923**	**1.0283**	**1.0065**	**0.5378**	**0.2012**	**0.0877**	**0.0686**	**0.0051**	**0.0423**	**3.6831**	**0.0474**	**3.6831**	**5.930**
1972	**0.0000**	**0.3619**	**3.1629**	**3.6084**	**1.8274**	**1.4844**	**0.6803**	**0.1993**	**0.1177**	**0.0433**	**0.0669**	**11.5526**	**0.1102**	**11.5526**	**14.583**
1973	**0.0000**	**0.2031**	**1.4711**	**4.2293**	**2.7303**	**1.0648**	**0.4546**	**0.1574**	**0.1056**	**0.0331**	**0.0948**	**10.5441**	**0.1279**	**10.5441**	**14.016**
1974	**0.0000**	**0.1132**	**0.8389**	**2.0964**	**2.6523**	**1.9021**	**0.7792**	**0.1849**	**0.1164**	**0.0188**	**0.1063**	**8.8085**	**0.1251**	**8.8085**	**16.068**
1975	**0.0031**	**1.1411**	**1.9486**	**2.8729**	**1.4396**	**1.0646**	**0.5664**	**0.1425**	**0.0749**	**0.0090**	**0.0508**	**9.3133**	**0.0598**	**9.3102**	**11.591**
1976	**0.0000**	**0.2579**	**1.6218**	**3.5215**	**2.3277**	**1.8245**	**1.0120**	**0.2732**	**0.1561**	**0.0694**	**0.1383**	**11.2024**	**0.2077**	**11.2024**	**19.616**
1977	**0.0000**	**0.0985**	**0.7411**	**1.9635**	**2.1551**	**1.0247**	**0.5553**	**0.1575**	**0.0746**	**0.0778**	**0.1129**	**6.9611**	**0.1908**	**6.9611**	**12.008**
1978	**0.0000**	**0.1176**	**0.8397**	**0.8637**	**0.4970**	**0.5621**	**0.2865**	**0.0748**	**0.0396**	**0.0284**	**0.0579**	**3.3673**	**0.0863**	**3.3673**	**6.254**
1979	**0.0000**	**0.3146**	**1.8406**	**2.0077**	**0.9113**	**0.4282**	**0.2457**	**0.0602**	**0.0199**	**0.0053**	**0.0224**	**5.8557**	**0.0277**	**5.8557**	**5.693**
1980	**0.0000**	**0.4296**	**1.4291**	**4.9698**	**2.7324**	**1.2775**	**0.6862**	**0.1749**	**0.1078**	**0.0341**	**0.0542**	**11.8956**	**0.0883**	**11.8956**	**15.607**
1981	**0.0000**	**0.9692**	**5.8239**	**3.6857**	**3.6138**	**2.0111**	**1.1795**	**0.3302**	**0.1188**	**0.0253**	**0.1301**	**17.8876**	**0.1554**	**17.8876**	**21.612**
1982	0.0000	0.0488	0.8058	2.9733	0.9815	1.3927	0.2529	0.0614	0.0369	0.0004	0.0810	6.6347	0.0814	6.6347	10.031
1983	0.0000	0.0592	1.0397	1.2285	0.5433	0.1752	0.0968	0.0453	0.0378	0.0000	0.0000	3.2257	0.0000	3.2257	3.232
1984	0.0000	0.0225	0.2616	0.9816	0.6932	0.4667	0.1749	0.0723	0.0323	0.0000	0.0091	2.7141	0.0091	2.7141	4.605
1985	0.0000	0.0234	0.7502	1.9720	1.2366	0.5065	0.1234	0.0364	0.0127	0.0008	0.0452	4.7073	0.0460	4.7073	6.056
1986	0.0000	0.1082	3.3372	3.5906	1.0397	0.5213	0.2059	0.0000	0.0178	0.0000	0.0000	8.8208	0.0000	8.8208	6.083
1987	0.0000	0.0106	1.4080	4.5032	1.2079	0.3526	0.1287	0.0120	0.0265	0.0078	0.0372	7.6944	0.0449	7.6944	7.079
1988	0.0000	0.0917	1.6294	1.4568	0.8363	0.4970	0.1153	0.0410	0.0361	0.0071	0.0000	4.7108	0.0071	4.7108	4.103
1989	0.0000	0.0282	1.1084	1.4652	0.3083	0.4127	0.1848	0.0247	0.0000	0.0000	0.0000	3.5323	0.0000	3.5323	3.440
1990	0.0000	0.0698	1.8186	2.4924	4.9384	2.2076	0.3334	0.1450	0.1170	0.0671	0.1342	12.3233	0.2013	12.3233	20.805
1991	0.0411	0.1428	2.9593	2.4882	2.0192	0.9302	0.3375	0.0395	0.0170	0.0224	0.0181	9.0153	0.0405	8.9742	6.813
1992	0.0000	0.0056	0.9796	2.9314	3.4555	0.3591	0.0942	0.0376	0.0095	0.0000	0.0000	7.8724	0.0000	7.8724	7.485
1993	0.0000	0.0402	1.6917	3.3089	2.5792	0.4750	0.0258	0.0023	0.0011	0.0000	0.0000	8.1242	0.0000	8.1242	7.584
1994	0.0000	0.0388	1.4473	1.9586	0.7251	0.2224	0.0862	0.0093	0.0256	0.0000	0.0000	4.5133	0.0000	4.5133	3.415

Table B58. cont.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+	1+ Biomass
1995	0.0000	0.1125	0.7682	1.9574	0.7850	0.2755	0.1753	0.0386	0.0726	0.0000	0.0000	4.1850	0.0000	4.1850	4.283
1996	0.0000	0.2299	0.4709	1.0625	0.5774	0.4682	0.0973	0.0248	0.0365	0.0409	0.0000	3.0084	0.0409	3.0084	3.426
1997	0.0000	0.0429	0.7240	0.7884	0.2650	0.0545	0.0000	0.0000	0.0000	0.0000	0.0000	1.8748	0.0000	1.8748	0.893
1998	0.0000	0.0144	1.0234	0.9315	0.1752	0.0717	0.0163	0.0000	0.0000	0.0000	0.0000	2.2325	0.0000	2.2325	1.168
1999	0.0000	0.0449	0.6021	1.5300	0.5961	0.4177	0.0898	0.0538	0.0091	0.0000	0.0000	3.3435	0.0000	3.3435	3.095
2000	0.0000	0.0885	1.5095	2.5822	0.8024	0.2790	0.0900	0.0141	0.0000	0.0000	0.0000	5.3658	0.0000	5.3658	3.692
2001	0.0000	0.0582	0.4947	2.1425	1.4781	0.4575	0.1815	0.0182	0.0361	0.0224	0.0224	4.9115	0.0447	4.9115	5.210
2002	0.0000	0.6856	1.0976	0.7497	1.7406	0.8154	0.1171	0.0684	0.0537	0.0000	0.0141	5.3423	0.0141	5.3423	6.605
2003	0.0000	0.9350	1.2200	1.0798	0.7800	0.6762	0.4278	0.1588	0.0387	0.0205	0.0000	5.3368	0.0205	5.3368	6.203
2004	0.0000	0.6236	0.5035	1.7796	1.0232	0.5166	0.1262	0.0926	0.0496	0.0311	0.0011	4.7471	0.0323	4.7471	5.477
2005	0.0450	0.5568	0.5242	0.8372	0.7524	0.3382	0.2083	0.1459	0.2331	0.0460	0.0647	3.7518	0.1107	3.7068	5.762
2006	0.0000	0.7503	0.8169	0.5001	0.1844	0.0838	0.0686	0.0440	0.0520	0.0037	0.0000	2.5039	0.0037	2.5039	1.586
2007	0.0000	0.2510	0.5549	1.0447	0.4319	0.1272	0.0432	0.0540	0.0424	0.0540	0.0531	2.6563	0.1071	2.6563	3.099
2008	0.0185	1.6148	1.7130	2.2225	1.0906	0.0639	0.0465	0.0325	0.0000	0.0605	0.0141	6.8769	0.0746	6.8583	4.246
2009	0.0000	1.0778	2.0058	1.4987	1.2658	0.6445	0.1697	0.0396	0.0254	0.0000	0.0312	6.7586	0.0312	6.7586	4.767
2010	0.0000	0.4098	1.3778	1.2609	1.2286	0.7656	0.2570	0.0531	0.0184	0.0052	0.0348	5.4112	0.0400	5.4112	5.652
2011	0.0057	0.6882	1.2204	1.4323	0.9760	0.3904	0.2724	0.0761	0.0251	0.0084	0.0000	5.0952	0.0084	5.0894	5.521
2012	0.0000	0.1836	1.3185	1.2180	0.8760	0.3688	0.1384	0.0565	0.0361	0.0080	0.0000	4.2039	0.0080	4.2039	4.209

Table B59. Proportion of the spring survey catch at age of white hake that was imputed. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+
1968	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1969	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8.62**	**14.45**	**13.92**	**23.63**	**1.02**	**19.73**	**1.02**
1970	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1971	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**75.55**	**0.87**	**67.40**	**0.87**
1972	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**41.57**	**54.66**	**0.47**	**49.51**	**0.47**
1973	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**28.39**	**76.61**	**0.78**	**64.11**	**0.78**
1974	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**80.52**	**0.97**	**68.41**	**0.97**
1975	**100.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**48.33**	**0.30**	**41.08**	**0.26**
1976	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**26.73**	**56.98**	**0.87**	**46.88**	**0.87**
1977	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.33**	**4.91**	**30.25**	**46.12**	**1.19**	**39.65**	**1.19**
1978	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**84.73**	**83.61**	**2.15**	**83.98**	**2.15**
1979	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1980	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**9.21**	**0.04**	**5.65**	**0.04**
1981	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**27.42**	**0.20**	**22.95**	**0.20**
1982	0.00	100.00	4.87	0.01	0.08	0.72	5.44	22.50	42.76	100.00	11.20	2.29	11.65	2.29
1983	0.00	0.00	0.00	0.22	3.65	9.33	4.94	16.20	9.43	0.00	0.00	1.69	0.00	1.69
1984	0.00	0.00	0.00	0.00	0.00	0.39	3.37	14.43	43.79	0.00	0.00	1.19	0.00	1.19
1985	0.00	0.00	0.00	0.00	0.27	8.46	48.60	50.15	28.35	100.00	100.00	3.70	100.00	3.70
1986	0.00	12.37	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16
1987	0.00	100.00	5.07	0.53	6.12	15.57	34.00	100.00	100.00	100.00	100.00	4.70	100.00	4.70
1988	0.00	0.00	0.00	1.56	2.81	2.93	35.60	77.90	24.67	100.00	0.00	3.18	100.00	3.18
1989	0.00	100.00	0.24	0.61	26.07	6.15	9.12	9.37	0.00	0.00	0.00	4.66	0.00	4.66
1990	0.00	0.00	0.00	0.00	0.01	0.15	2.32	35.26	19.40	100.00	0.00	1.24	33.33	1.24
1991	100.00	79.74	0.59	0.00	0.00	0.27	3.21	8.93	7.42	100.00	0.00	2.36	55.21	1.92
1992	0.00	100.00	3.24	0.00	0.01	2.01	9.36	3.56	4.08	0.00	0.00	0.70	0.00	0.70
1993	0.00	44.36	0.06	0.00	0.00	0.48	30.81	100.00	100.00	0.00	0.00	0.40	0.00	0.40
1994	0.00	0.00	0.00	0.01	1.01	4.41	0.73	2.25	0.00	0.00	0.00	0.40	0.00	0.40

Table B59 cont.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+

1995	0.00	0.00	0.00	0.00	0.00	1.80	6.78	2.56	0.00	0.00	0.00	0.43	0.00	0.43
1996	0.00	0.00	0.00	0.26	1.89	0.10	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.47
1997	0.00	4.27	2.67	1.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.76	0.00	1.76
1998	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	0.00	0.00	0.00	1.41	1.88	0.21	0.00	0.00	0.00	0.00	0.00	0.84	0.00	0.84
2003	0.00	1.83	2.00	3.42	0.63	0.00	0.00	0.00	0.00	0.00	0.00	1.56	0.00	1.56
2004	0.00	2.74	15.36	0.44	17.72	39.11	82.28	100.00	100.00	28.17	100.00	15.62	30.69	15.62
2005	0.00	0.00	0.00	0.36	4.44	0.79	0.36	0.26	2.42	18.42	0.00	1.45	7.66	1.47
2006	0.00	0.95	0.11	0.17	4.95	0.87	0.30	8.57	7.04	100.00	0.00	1.20	100.00	1.20
2007	0.00	3.63	2.77	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	1.26
2008	0.00	0.40	1.45	1.51	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.95
2009	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.08
2010	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.12
2011	100.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.07
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B60. Stratified mean number per tow at age of white hake in the NEFSC autumn bottom trawl surveys (Strata 21-30,36-40), 1963-2011. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+	1+ Biomass
1963	**0.1483**	**0.9163**	**1.3741**	**1.4625**	**0.9796**	**0.3664**	**0.0749**	**0.0051**	**0.0112**	**0.0103**	**0.1197**	**5.4682**	**0.1299**	**5.3200**	**7.510**
1964	**0.0116**	**0.1195**	**0.4005**	**0.5308**	**0.3294**	**0.1365**	**0.0799**	**0.0314**	**0.0107**	**0.0084**	**0.1023**	**1.7610**	**0.1107**	**1.7495**	**4.088**
1965	**0.0394**	**0.3594**	**1.2753**	**1.2198**	**0.5949**	**0.3685**	**0.1976**	**0.0356**	**0.0174**	**0.0071**	**0.0454**	**4.1605**	**0.0525**	**4.1211**	**6.606**
1966	**0.1134**	**0.9573**	**3.1449**	**1.9368**	**0.8422**	**0.3313**	**0.1005**	**0.0604**	**0.0118**	**0.0038**	**0.0611**	**7.5634**	**0.0648**	**7.4500**	**8.394**
1967	**0.0990**	**0.7867**	**1.4079**	**1.0458**	**0.4231**	**0.1518**	**0.0617**	**0.0057**	**0.0020**	**0.0036**	**0.0353**	**4.0227**	**0.0389**	**3.9237**	**4.111**
1968	**0.1315**	**0.8621**	**1.1342**	**1.3397**	**0.6417**	**0.1696**	**0.0534**	**0.0168**	**0.0048**	**0.0000**	**0.0429**	**4.3968**	**0.0429**	**4.2653**	**4.872**
1969	**0.2438**	**1.7227**	**2.8094**	**2.5698**	**1.7583**	**0.6351**	**0.2271**	**0.0838**	**0.0419**	**0.0132**	**0.0417**	**10.1466**	**0.0549**	**9.9029**	**13.378**
1970	**0.0906**	**0.7893**	**1.9781**	**2.9890**	**2.0001**	**0.5626**	**0.2600**	**0.0576**	**0.0225**	**0.0306**	**0.0681**	**8.8484**	**0.0986**	**8.7578**	**14.162**
1971	**0.3838**	**2.9745**	**2.8858**	**2.2704**	**1.7146**	**0.4887**	**0.2189**	**0.0726**	**0.0350**	**0.0116**	**0.1402**	**11.1960**	**0.1518**	**10.8122**	**13.419**
1972	**0.2959**	**2.0370**	**4.5116**	**4.7995**	**1.2971**	**0.6470**	**0.2319**	**0.0580**	**0.0293**	**0.0464**	**0.0754**	**14.0291**	**0.1218**	**13.7332**	**14.525**
1973	**0.1568**	**0.9754**	**2.1076**	**3.5616**	**1.7131**	**0.6334**	**0.3390**	**0.0666**	**0.0539**	**0.0313**	**0.2238**	**9.8626**	**0.2551**	**9.7057**	**14.788**
1974	**0.0632**	**0.4037**	**0.8835**	**1.5748**	**1.3019**	**0.6457**	**0.2650**	**0.0718**	**0.0331**	**0.0059**	**0.1516**	**5.4001**	**0.1574**	**5.3369**	**12.114**
1975	**0.0877**	**0.5518**	**1.4646**	**1.6073**	**0.6914**	**0.3484**	**0.2253**	**0.0806**	**0.0212**	**0.0111**	**0.0570**	**5.1464**	**0.0681**	**5.0587**	**7.818**
1976	**0.0293**	**0.2125**	**1.2977**	**2.8008**	**1.3331**	**0.6003**	**0.2681**	**0.0610**	**0.0335**	**0.0070**	**0.0983**	**6.7417**	**0.1052**	**6.7124**	**11.694**
1977	**0.3862**	**1.8781**	**2.7485**	**2.8406**	**1.5926**	**0.5216**	**0.2906**	**0.1053**	**0.0554**	**0.0160**	**0.1405**	**10.5755**	**0.1565**	**10.1893**	**13.842**
1978	**0.1900**	**0.8696**	**2.5364**	**2.3629**	**1.1517**	**0.5905**	**0.3003**	**0.1228**	**0.0512**	**0.0305**	**0.1368**	**8.3427**	**0.1673**	**8.1526**	**13.312**
1979	**0.0122**	**0.2136**	**1.5249**	**1.9599**	**0.9664**	**0.4154**	**0.2372**	**0.0783**	**0.0255**	**0.0370**	**0.0901**	**5.5605**	**0.1272**	**5.5483**	**10.566**
1980	**1.0489**	**1.6777**	**1.4929**	**3.6967**	**2.3634**	**1.0263**	**0.3539**	**0.1359**	**0.0609**	**0.0154**	**0.1293**	**12.0013**	**0.1446**	**10.9524**	**18.400**
1981	**0.0414**	**0.5467**	**3.1291**	**1.9866**	**1.4891**	**0.7266**	**0.3310**	**0.1083**	**0.0511**	**0.0176**	**0.0008**	**8.4283**	**0.0184**	**8.3869**	**11.865**
1982	0.0070	0.3266	0.5433	0.6321	0.1867	0.1013	0.0589	0.0199	0.0000	0.0000	0.0000	1.8759	0.0000	1.8689	1.954
1983	0.0007	0.5977	3.1534	2.8528	1.8063	0.2370	0.2625	0.0028	0.0000	0.0000	0.0777	8.9909	0.0777	8.9902	11.513
1984	0.0000	0.3504	0.9706	2.1758	1.1276	0.3465	0.1040	0.0422	0.0116	0.0037	0.0402	5.1726	0.0439	5.1726	8.152
1985	0.2881	3.2732	1.7677	2.0369	1.3962	0.4317	0.1232	0.0748	0.0082	0.0000	0.0602	9.4601	0.0602	9.1720	9.784
1986	0.9522	1.2570	7.0940	4.3420	0.8370	0.4845	0.1536	0.0076	0.0024	0.0327	0.0178	15.1807	0.0505	14.2284	11.423
1987	0.0544	0.5487	1.8369	3.7714	1.0967	0.2195	0.1118	0.0633	0.0743	0.0208	0.0535	7.8514	0.0743	7.7970	9.799
1988	0.0076	0.5593	3.9489	2.1881	1.3588	0.3180	0.1032	0.0043	0.0003	0.0000	0.0511	8.5397	0.0511	8.5321	10.430
1989	0.4012	3.3810	3.3155	3.7846	0.9140	0.3685	0.3513	0.0100	0.0084	0.0036	0.0000	12.5381	0.0036	12.1369	9.242

Table B60. cont.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+	1+ Biomass
1990	1.0209	1.9769	5.3091	3.8259	1.3655	0.3219	0.0382	0.0000	0.0013	0.0012	0.0000	13.8610	0.0012	12.8401	10.883
1991	0.1828	1.1574	6.1843	4.3646	1.3777	0.3424	0.0479	0.0000	0.0075	0.0000	0.0075	13.6721	0.0075	13.4894	12.533
1992	0.1600	0.4178	2.5760	5.8455	1.3604	0.1712	0.1117	0.0447	0.0365	0.0000	0.0224	10.7462	0.0224	10.5862	11.837
1993	0.0503	0.6632	2.3969	4.3012	2.5471	0.4324	0.1128	0.0000	0.0000	0.0000	0.0000	10.5040	0.0000	10.4537	12.038
1994	0.3155	1.0167	2.5558	2.4494	0.7570	0.1554	0.1116	0.0191	0.0000	0.0000	0.0000	7.3805	0.0000	7.0650	5.924
1995	1.3309	0.5887	4.2878	2.8038	0.7044	0.1883	0.0035	0.1312	0.0024	0.0000	0.0309	10.0719	0.0309	8.7410	8.438
1996	0.0272	0.3366	1.0406	1.5485	1.2708	0.3642	0.0314	0.0224	0.0283	0.0000	0.0141	4.6840	0.0141	4.6568	6.651
1997	0.0000	1.7997	1.2606	0.9787	0.6282	0.2034	0.0606	0.0141	0.0224	0.0000	0.0635	5.0312	0.0635	5.0312	4.896
1998	0.0385	0.4267	1.9725	1.6966	0.5376	0.1581	0.0839	0.0258	0.0181	0.0000	0.0000	4.9577	0.0000	4.9193	4.736
1999	0.3680	2.4981	1.2990	1.1923	0.5449	0.1790	0.0686	0.0040	0.0000	0.0000	0.0000	6.1538	0.0000	5.7858	3.637
2000	0.1343	0.5037	3.6025	2.0934	0.6905	0.3064	0.0994	0.0425	0.0418	0.0284	0.0256	7.5686	0.0539	7.4343	6.796
2001	0.0554	0.2809	0.9877	2.0550	1.7167	0.3762	0.1513	0.0807	0.0000	0.0000	0.0000	5.7039	0.0000	5.6485	7.848
2002	2.6038	1.1791	0.7503	1.0023	1.0124	0.1883	0.0744	0.0365	0.0000	0.0000	0.0141	6.8612	0.0141	4.2574	6.404
2003	**0.1663**	**1.1062**	**0.7510**	**0.9807**	**0.6469**	**0.1889**	**0.1391**	**0.0468**	**0.0040**	**0.0008**	**0.0000**	**4.0307**	**0.0008**	**3.8644**	**4.513**
2004	0.1156	0.7650	1.2654	0.6742	0.3438	0.2193	0.1342	0.0042	0.0103	0.0178	0.0000	3.5497	0.0178	3.4341	3.685
2005	0.5378	0.9182	0.5663	0.5928	0.4060	0.3008	0.0554	0.1180	0.0380	0.0085	0.0432	3.5850	0.0517	3.0472	3.791
2006	0.3114	1.8079	1.0044	0.8612	0.2523	0.2030	0.1421	0.0607	0.0836	0.0000	0.0246	4.7511	0.0246	4.4396	4.238
2007	0.3002	0.7998	1.9491	2.3556	0.8915	0.1891	0.0079	0.0188	0.0461	0.0727	0.0050	6.6358	0.0777	6.3356	7.202
2008	1.4540	0.8485	1.5986	2.0292	0.9903	0.1900	0.0872	0.0815	0.0455	0.0201	0.0000	7.3448	0.0201	5.8908	6.977
2009	0.5664	0.9923	1.5266	1.2441	0.6367	0.2524	0.0608	0.0220	0.0073	0.0000	0.0184	5.3270	0.0184	4.7606	4.709
2010	0.8141	1.6021	2.6998	1.9203	0.6548	0.1672	0.0581	0.0100	0.0139	0.0074	0.0037	7.9514	0.0111	7.1373	7.761
2011	0.3397	0.6251	2.1497	2.0349	1.1169	0.4062	0.1619	0.0590	0.0341	0.0069	0.0109	6.9454	0.0178	6.6056	8.991

Table B61. Proportion of the autumn survey catch at age of white hake that was imputed. The values in bold were computed using a pooled ALK.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+
1963	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**13.23**	**0.29**	**12.18**	**0.30**
1964	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**56.02**	**3.25**	**51.75**	**3.28**
1965	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**98.37**	**1.07**	**85.02**	**1.08**
1966	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**86.13**	**0.70**	**81.14**	**0.71**
1967	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1968	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**64.79**	**0.63**	**64.79**	**0.65**
1969	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**63.37**	**0.26**	**48.14**	**0.27**
1970	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**29.21**	**0.22**	**20.16**	**0.23**
1971	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**60.95**	**0.76**	**56.28**	**0.79**
1972	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**18.74**	**0.10**	**11.60**	**0.10**
1973	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**64.72**	**1.47**	**56.78**	**1.49**
1974	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**67.47**	**1.89**	**64.95**	**1.92**
1975	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**34.85**	**0.39**	**29.20**	**0.39**
1976	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**55.41**	**0.81**	**51.74**	**0.81**
1977	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**51.22**	**0.68**	**45.98**	**0.71**
1978	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**43.09**	**0.71**	**35.23**	**0.72**
1979	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**68.30**	**1.11**	**48.42**	**1.11**
1980	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**66.74**	**0.72**	**59.65**	**0.79**
1981	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1982	28.95	53.04	50.42	50.32	57.59	54.33	50.86	50.00	0.00	0.00	0.00	51.69	0.00	51.78
1983	100.00	0.66	0.00	0.00	0.10	5.95	7.51	100.00	0.00	0.00	0.00	0.48	0.00	0.47
1984	0.00	0.00	0.00	0.00	0.07	4.00	27.99	39.04	32.00	100.00	0.00	1.31	8.49	1.31
1985	10.42	0.00	0.00	0.00	0.00	0.74	32.20	54.81	100.00	0.00	37.42	1.53	37.42	1.25
1986	77.59	18.35	0.00	0.00	0.00	0.49	2.30	77.97	100.00	0.00	0.00	6.48	0.00	1.72
1987	3.28	2.15	0.02	0.00	0.99	4.80	6.62	9.38	28.00	14.29	33.33	1.15	28.00	1.13
1988	100.00	2.45	0.00	0.00	0.19	5.23	28.88	100.00	100.00	0.00	0.00	0.88	0.00	0.79
1989	100.00	5.08	2.10	0.00	0.11	1.71	4.37	100.00	100.00	100.00	0.00	5.48	100.00	2.36

Table B61. cont.

	0	1	2	3	4	5	6	7	8	9	10+	0+	9+	1+
1990	16.30	0.60	0.00	0.00	0.68	8.16	41.30	0.00	100.00	100.00	0.00	1.68	100.00	0.51
1991	0.00	0.00	0.00	0.00	0.00	0.00	15.56	0.00	100.00	0.00	100.00	0.16	100.00	0.17
1992	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1993	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	0.00	0.00	0.00	0.00	0.00	1.25	100.00	4.49	100.00	0.00	0.00	0.14	0.00	0.16
1996	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.19	0.44	35.19	0.44
1998	0.00	0.00	0.00	0.00	0.54	8.02	2.91	1.89	0.00	0.00	0.00	0.37	0.00	0.38
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	29.55	0.00	0.00	0.00	0.00	0.00	2.84	6.65	13.51	9.96	0.00	0.71	5.24	0.19
2001	1.79	3.14	2.54	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.62
2002	0.00	0.21	1.66	0.71	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.53	100.00	0.85
2003	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2004	2.16	2.37	0.06	0.79	2.73	0.05	5.79	100.00	13.67	0.00	0.00	1.40	0.00	1.37
2005	0.28	1.07	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.37
2006	5.43	3.15	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.70	0.00	1.44
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	30.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.02	0.00	0.00
2009	3.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	1.64	0.26	0.00	0.00	0.00	0.00	0.35	0.96	3.32	8.22	0.00	0.14	3.18	0.07

Table B62. Age composition of the Massachusetts spring survey using NEFSC age-length keys.

	0	1	2	3	4	5
1982	0.07516	0.207814	0.071543	0.020022	0.000591	0
1983	0.4288	0.203524	0.436186	0.01888	0	0
1984	0.06611	0.94927	0.01091	0.04146	0	0
1985	1.51467	0.034927	0.069231	0.013652	0	0
1986	0.21808	0.063285	1.836168	0.494817	0	0
1987	0	0.042213	0.194027	0.00532	0	0
1988	0.13093	0.073923	0.220568	0.000709	0	0
1989	0.06601	0.139311	0.298507	0.116062	0	0
1990	0.05455	0.266413	0.72946	0.026377	0	0.00546
1991	0.04092	0.078934	0.242576	0.015354	0.000266	0
1992	0.46427	0.041836	0.097148	0.024963	0.001773	0
1993	0.34278	0	0	0.006617	0.000473	0
1994	0.30418	0.069568	0.049602	0.01488	0	0
1995	0.34242	0.058177	0.1432	0.017733	0	0
1996	1.08034	0	0	0	0	0
1997	0.30772	0.084093	0.149117	0.01146	0	0
1998	0.29569	0.004077	0.068487	0.000546	0	0
1999	0.10481	0.051394	0.043086	0	0	0
2000	0.47073	0.053475	0.167861	0.005624	0	0
2001	0.34396	0.012	0.01026	0	0	0
2002	1.51688	0.023349	0.047584	0.007803	0.004256	0.002128
2003	0.70017	0.01146	0.00618	0	0	0
2004	0.02094	0.048504	0.020523	5.28E-05	0	0
2005	0.04928	0.01042	0.006	0	0	0
2006	0.04834	0.556437	0.114454	0.017142	0.003547	0
2007	0	0.212179	0.157751	0.00647	0.00532	0
2008	0	0.120205	0.003015	0.00912	0.00152	0
2009	0	0.194623	0.008047	0	0	0
2010	0	0.166931	0.093366	0.005943	0	0
2011	0	0.020243	0.010307	0	0	0
2012	0	0.015739	0.063917	0.025094	0	0

Table B63. Age composition of the Massachusetts autumn survey using NEFSC age-length keys.

	0	1	2	3	4	5
1982	1.434322	3.259932	0.383718	0.117087	0.007081	0
1983	0.242258	0.777131	0.429525	0.015566	0	0
1984	0.184489	0.420558	0.032423	0	0	0
1985	11.0301	0.634931	0.073998	0.005625	0.00269	0
1986	0.686212	0.254491	0.264147	0.04153	0.00753	0
1987	3.438198	0.148237	0.118555	0	0	0
1988	0.720909	0.527342	0.287022	0.010887	0	0
1989	3.409851	0.939125	0.115098	0.006126	0	0
1990	1.295296	0.805554	1.051204	0.000945	0	0
1991	0.595138	0.549544	0.345681	0.037797	0	0
1992	3.22495	1.072206	0.083106	0.010795	0.000273	0
1993	2.494101	2.446865	0.093193	0.002191	0	0
1994	1.30706	1.662072	0.498832	0.014836	0	0
1995	14.73499	0.397407	0.085654	0.000692	0	0
1996	2.46074	1.61933	0.04172	0	0	0
1997	0.40524	0.51648	0.11423	0	0	0
1998	0.876202	0.310138	0.009	0	0	0
1999	4.353209	1.627061	0.071804	0.006207	0	0
2000	0.505006	0.138872	0.148588	0.001794	0	0
2001	1.596072	0.080838	0.00456	0.010364	0.005389	0.000967
2002	0.376809	0.083735	0.064719	0.023053	0.007093	0
2003	0.756828	0.076554	0.001288	0	0	0
2004	1.125531	0.084843	0.006506	0	0	0
2005	0.723108	0.154428	0.010024	0.00532	0	0
2006	0.210005	0.212323	0.050486	0.051585	0	0
2007	0.334401	0.159162	0.042066	0.000651	0	0
2008	0.089972	0.051948	0.022606	0.027284	0.006029	0
2009	3.901106	0.500478	0.027169	0.011267	0	0
2010	0.701364	0.180642	0.024624	0	0	0
2011	5.567023	0.219195	0.093404	0.015108	0.00304	0

Table B64. Age composition of the ME/NH surveys using length-slicing.

Spring

	Age 0	Age 1	2+	1+	1+ Biomass
	<=9 CM	10-33 CM	>35 CM	>=19	
2001	0	0.656	0	0.656	0.044
2002	0.123	1.897	0.085	1.981	0.281
2003	0	1.801	0.141	1.942	0.363
2004	0	2.376	0.012	2.388	0.174
2005	0	3.698	0.533	4.231	0.619
2006	0	5.930	0.184	6.114	0.553
2007	0	3.790	0.316	4.106	0.478
2008	0.010	6.515	0.267	6.782	0.763
2009	0.190	15.027	0.167	15.194	1.157
2010	0.013	2.191	0.284	2.476	0.373
2011	0.084	3.717	0.048	3.765	0.439
2012	0	2.688	0.330	3.018	0.481

Autumn

Fall	Age 0	Age 1	Age 2	Age 3+	1+	1+ Biomass
	<=18 CM	19-29 CM	30-41 CM	>41CM	>=19	
2000	10.489	6.782	2.234	0.191	9.207	1.543
2001	15.430	12.744	2.721	0.554	16.019	2.769
2002	0	18.264	1.422	0.220	19.907	2.628
2003	0.109	18.964	3.230	0.544	22.738	3.646
2004	0.174	8.596	3.637	0.298	12.531	2.665
2005	0.041	14.593	1.627	0	16.220	1.981
2006	0.415	7.946	2.644	0.186	10.776	1.859
2007	0.058	15.294	6.230	0.700	22.224	3.991
2008	0.501	16.967	6.273	0.671	23.911	4.392
2009	0.063	24.819	6.066	0.486	31.371	4.558
2010	0.760	10.085	2.453	0.374	12.911	2.187
2011	2.457	20.007	2.707	0.792	23.506	4.045

Table B65. Summary of the number of white hake maturity samples taken from Northeast Fisheries Science Center (NEFSC) spring survey from 1982 to 2011 by year and the resulting maturity at age vector for females used in the assessment.

Year	Males	Females		Age	Proportion mature
1982	42	70		1	0.06
1983	67	73		2	0.22
1984	18	50		3	0.57
1985	74	97		4	0.86
1986	117	149		5	0.97
1987	72	73		6	0.99
1988	60	74		7	1.00
1989	43	54		8	1.00
1990	65	147		9	1.00
1991	100	143			
1992	50	97			
1993	66	90			
1994	52	48			
1995	39	57			
1996	42	48			
1997	32	23			
1998	40	49			
1999	51	55			
2000	72	83			
2001	62	63			
2002	36	69			
2003	64	76			
2004	31	23			
2005	35	39			
2006	53	42			
2007	25	24			
2008	64	70			
2009	170	190			
2010	152	174			
2011	138	180			

Table B67. Percent difference between the age composition of the commercial catch (A), spring survey (B) and autumn survey (C) used in the pooled ALK study.

A.	1	2	3	4	5	6	7	8	9
1989	4.1	-0.6	-3.1	17.7	-12.1	-24.6	18.4	-139.2	24.0
1990	15.3	-5.6	3.5	0.8	13.6	18.8	-69.0	4.6	4.8
1991	-13.4	1.2	1.8	-2.0	6.9	-15.6	-43.0	-44.2	18.5
1992	16.3	20.2	-8.5	-39.4	35.8	27.1	-54.8	4.7	43.5
1993	11.9	-7.4	3.8	-12.9	20.8	-0.9	41.7	40.5	23.3
1994	6.6	11.9	-5.9	-1.5	7.3	-34.2	4.3	4.7	44.5
1995	-2.1	-10.4	8.8	14.3	-17.6	-63.0	-103.5	-48.1	-264.8
1996	-11.5	10.1	1.1	20.7	-7.1	-67.4	-151.9	-145.8	16.9
1997	-1.3	-0.3	3.7	35.5	-6.5	-43.2	-213.6	-223.8	-53.9
1998	1.7	-6.8	8.7	26.0	28.0	-13.0	-178.5	-63.1	91.6
1999	1.4	25.2	-23.7	30.6	-6.5	-9.7	-64.0	-89.5	-145.2
2000	29.9	0.4	-1.4	34.4	-3.5	1.5	-15.9	-101.1	-175.4

B.	1	2	3	4	5	6	7	8	9
1982	-18.9	-12.6	-9.4	29.6	-25.7	42.0	69.2	32.8	2.7
1983	13.8	-7.9	-7.3	9.2	40.6	-17.9	-3.5	-15.6	100.0
1984	5.0	-0.7	-21.2	20.8	7.7	0.7	16.8	-77.7	-21.2
1985	-219.4	-8.4	-5.8	8.1	14.7	18.2	12.3	10.0	7.4
1986	4.8	-1.8	-0.5	5.5	-17.5	20.7	100.0	-4.9	100.0
1987	20.3	-18.2	-8.8	26.1	19.9	24.4	100.0	-60.6	16.0
1988	-112.2	5.1	2.4	1.6	1.4	-3.2	54.2	-407.2	-169.2
1989	-51.4	-4.2	-5.4	37.0	-13.2	6.2	31.3	100.0	100.0
1990	-233.3	5.2	1.7	-17.5	15.9	47.6	-12.0	-49.5	8.0
1991	-83.2	1.6	20.9	-23.8	-44.3	-47.4	-112.6	-100.0	7.0
1992	100.0	40.2	32.4	-105.9	25.2	43.6	-51.8	47.4	100.0
1993	40.6	-9.7	-2.9	-9.3	41.1	80.5	100.0	100.0	100.0
1994	43.9	6.8	-9.8	1.0	0.1	-10.1	52.7	14.4	100.0
1995	-59.2	17.9	-13.9	5.1	20.6	-52.0	41.9	-108.5	100.0
1996	-74.8	6.5	-6.3	18.3	-13.8	-42.2	-23.4	11.0	-17.1
1997	-174.8	-1.2	0.3	3.6	-8.8	100.0			100.0
1998	-30.0	-12.9	3.9	31.5	13.6	28.2	100.0	100.0	100.0
1999	-346.8	14.0	-11.4	11.1	-5.1	11.5	-203.0	-105.1	100.0
2000	-320.6	5.2	-13.1	16.2	27.6	-63.2	-650.0		100.0

C.	1	2	3	4	5	6	7	8	9
1982	-13.7	1.1	0.7	18.0	-13.4	-34.5	-33.6	100.0	100.0
1983	-19.0	3.5	0.3	-8.0	30.9	-58.0	88.7	100.0	0.1
1984	-7.6	0.4	-1.8	-6.0	15.6	14.0	47.7	38.9	5.2
1985	-1.3	6.8	13.1	-26.6	-2.2	31.4	12.4	-21.9	0.0
1986	4.6	-3.0	5.5	7.5	-31.2	26.9	-68.2	100.0	-83.1
1987	1.2	12.0	-10.7	11.5	13.9	-5.8	3.0	-20.9	-13.7
1988	12.8	-6.0	7.7	0.7	-24.7	-6.5	100.0	100.0	5.1
1989	-1.1	8.0	-5.5	-3.5	8.2	-85.1	-7.6	-81.5	-83.9
1990	-2.3	-7.1	2.8	10.1	8.3	80.6	100.0		
1991	-8.7	-1.9	-4.3	8.6	39.5	67.8	100.0	-201.5	100.0
1992	12.8	15.4	-13.8	8.6	38.0	10.6	37.1	-128.2	11.3
1993	12.7	12.4	-5.4	-19.7	-4.0	-26.8	100.0	100.0	
1994	19.8	1.4	-8.9	-4.2	12.9	-40.5	-28.3	100.0	
1995	-13.2	-17.5	15.3	12.5	-8.1	81.8	-48.4	100.0	12.7
1996	-1.7	-8.6	1.7	7.7	-26.1	40.9	5.5	-16.4	-64.9
1997	-2.9	-4.8	9.2	-0.6	1.1	-48.5	29.9	-600.0	0.0
1998	10.6	5.5	-9.7	10.8	-25.1	-79.9	-31.3	-48.6	100.0
1999	-11.6	11.4	-5.4	9.5	-109.6	-193.6	10.3	100.0	
2000	-7.2	-1.6	6.8	9.4	-82.7	-90.8	-31.0	-61.0	1.2

Table B67. Results and diagnostics from the VPA model configurations.

Age	Unpooled ALK Stock Size	CV	Pooled Commercial ALK Stock Size	CV	Pooled Survey ALK Stock Size	CV	Pooled Commercial and Survey ALKs Stock Size	CV
2	4,199	0.75	4,143	0.70	4,026	0.93	3,985	0.85
3	7,954	0.49	7,779	0.46	7,370	0.61	7,235	0.56
4	1,373	0.55	1,308	0.52	1,386	0.68	1,326	0.64
5	721	0.48	634	0.48	692	0.60	608	0.59
6	147	0.58	137	0.55	113	0.76	108	0.71
7	68	0.63	49	0.62	38	0.85	27	0.81
INDEX	Catchability	CV	Catchability	CV	Catchability	CV	Catchability	CV
Spring Age 2	0.00015	0.11	0.00016	0.11	0.00017	0.09	0.00017	0.09
Spring Age 3	0.00040	0.10	0.00042	0.10	0.00041	0.08	0.00042	0.08
Spring Age 4	0.00042	0.21	0.00043	0.21	0.00044	0.17	0.00045	0.16
Spring Age 5	0.00036	0.30	0.00040	0.28	0.00040	0.31	0.00044	0.29
Spring Age 6	0.00025	0.34	0.00033	0.33	0.00021	0.45	0.00029	0.40
Spring Age 7	0.00021	0.33	0.00034	0.32	0.00010	0.59	0.00016	0.57
Fall Age 1	0.00012	0.16	0.00012	0.16	0.00013	0.16	0.00013	0.16
Fall Age 2	0.00057	0.11	0.00059	0.10	0.00059	0.10	0.00060	0.09
Fall Age 3	0.00131	0.06	0.00135	0.07	0.00132	0.06	0.00136	0.06
Fall Age 4	0.00117	0.10	0.00132	0.09	0.00124	0.09	0.00140	0.07
Fall Age 5	0.00073	0.18	0.00099	0.15	0.00075	0.21	0.00101	0.17
Fall Age 6	0.00048	0.34	0.00078	0.29	0.00059	0.31	0.00096	0.27

Table B68. Results of the ASAP model formulations

Run		Unpooled ALK	Pooled survey ALk	Pooled Commercial ALK	Pooled Commercial and Survey ALK
SSB1982 (mt)		10971	11904	10174	11043
SSB2000 (mt)		4641	4555	4789	4677
Fmult, 2000		0.98	1.01	0.98	1.02
Selectivity					
Spring Survey	1	0.01	0.01	0.01	0.01
	2	0.19	0.20	0.17	0.17
	3	0.54	0.55	0.49	0.49
	4	0.73	0.72	0.66	0.66
	5	1.00	1.00	1.00	1.00
	6	0.96	1.00	1.00	1.00
	7	0.62	0.66	0.71	0.76
	8	1.00	1.00	1.00	1.00
	9	1.00	1.00	1.00	1.00
Fall Survey	1	0.07	0.08	0.06	0.07
	2	0.28	0.31	0.25	0.27
	3	0.68	0.71	0.59	0.63
	4	0.80	0.83	0.73	0.76
	5	1.00	1.00	1.00	1.00
	6	0.93	0.85	1.00	0.94
	7	0.70	0.76	0.76	0.83
	8	0.77	0.77	0.78	0.79
	9	1.00	1.00	1.00	1.00
Commercial	1	0.07	0.07	0.06	0.06
	2	0.27	0.27	0.26	0.26
	3	0.60	0.59	0.54	0.54
	4	0.77	0.75	0.74	0.73
	5	1.00	1.00	1.00	1.00
	6	0.73	0.74	0.73	0.75
	7	0.61	0.68	0.49	0.58
	8	0.69	0.70	0.58	0.59
	9	0.50	0.53	0.44	0.46

Table B69. Results from the retrospective analyses for the eight model configurations for fishing mortality (F), spawning stock biomass (SSB) and recruitment. The relative differences by year are given as well as the average for the model.

VPA				ASAP			
Unpooled	F	SSB	Recruitment		F	SSB	Recruitment
1994	0.61	-0.24	0.70	1994	-0.35	0.38	1.18
1995	1.84	-0.37	0.27	1995	-0.38	0.42	0.76
1996	2.19	-0.48	0.06	1996	-0.34	0.39	0.69
1997	2.25	-0.60	0.40	1997	-0.07	0.04	1.73
1998	1.00	-0.36	-0.24	1998	0.19	-0.17	0.30
1999	0.68	-0.27	0.16	1999	0.02	-0.03	0.53
Average	1.43	-0.38	0.23	Average	-0.15	0.17	0.87
Pooled Commercial ALK							
1994	-0.01	0.04	0.68	1994	-0.40	0.52	1.17
1995	0.58	-0.10	0.20	1995	-0.43	0.59	0.78
1996	1.01	-0.27	-0.01	1996	-0.41	0.56	0.71
1997	1.75	-0.51	0.52	1997	-0.17	0.15	1.89
1998	0.97	-0.34	-0.27	1998	0.11	-0.11	0.32
1999	0.69	-0.23	0.17	1999	-0.04	0.02	0.60
Average	0.83	-0.24	0.21	Average	-0.22	0.29	0.91
Pooled Survey ALK							
1994	0.75	-0.27	0.97	1994	-0.39	0.49	2.12
1995	1.61	-0.34	0.17	1995	-0.41	0.53	0.43
1996	3.14	-0.57	-0.02	1996	-0.37	0.46	0.43
1997	3.54	-0.63	0.25	1997	-0.09	0.07	1.70
1998	1.64	-0.43	-0.21	1998	0.19	-0.16	0.28
1999	1.42	-0.36	0.13	1999	0.07	-0.07	0.41
Average	2.01	-0.43	0.21	Average	-0.17	0.22	0.90
Pooled Commercial and Survey ALK							
1994	0.08	0.00	0.93	1994	-0.43	0.64	2.09
1995	0.46	-0.07	0.10	1995	-0.47	0.71	0.45
1996	1.81	-0.43	-0.09	1996	-0.44	0.64	0.44
1997	2.74	-0.54	0.35	1997	-0.19	0.18	1.86
1998	1.51	-0.39	-0.24	1998	0.11	-0.11	0.30
1999	1.46	-0.32	0.13	1999	0.00	-0.01	0.47
Average	1.34	-0.30	0.20	Average	-0.24	0.34	0.93

Table B70. Biological reference points estimated from VPA and ASAP models.

VPA	Unpooled ALK	Pooled Commercial ALK	Pooled Survey ALK	Pooled Commercial and Survey ALKs
F40	0.13	0.16	0.13	0.16
SSBMSY	60,400	61,200	59,600	60,500
F2000	0.94	1.07	1.22	1.36
SSB2000	5,922	5,260	5,204	4,731
F/Fmsy	6.96	6.86	9.05	8.50
SSB/SSBmsy	0.10	0.09	0.09	0.08
External ASAP				
F40	0.20	0.22	0.20	0.22
SSBMSY	75,600	77,500	73,400	75,600
F2000	0.74	0.70	0.78	0.74
SSB2000	4,641	4,789	4,555	4,677
F/Fmsy	3.75	3.17	4.01	3.43
SSB/SSBmsy	0.06	0.06	0.06	0.06
Internal ASAP				
F40	0.15	0.15	0.15	0.15
Fmsy	0.24	0.24	0.24	0.25
SSBmsy	39,645	44,679	38,753	43,582
F2000	0.74	0.70	0.78	0.74
SSB2000	4,641	4,789	4,555	4,677
F/F40	5.11	4.72	5.38	4.96
F/Fmsy	3.07	2.85	3.24	3.00
SSB/SSBmsy	0.12	0.11	0.12	0.11

Table B71. Coefficient of Variation in Starting Numbers-at-age from an early ASAP run.

Age	CV
2	0.16
3	0.17
4	0.19
5	0.30
6	0.39
7	0.57
8	1.00
9	0.19

Table B72. Results of the Base ASAP Model.

	SSB (mt)	Jan 1 Biomass (mt)	Fishing mortality	Numbers at Age 1 (000s)
1963	16,736	20,085	0.31	3,410
1964	16,157	19,181	0.29	2,837
1965	15,574	18,460	0.27	3,947
1966	15,298	18,024	0.20	4,505
1967	15,999	18,872	0.15	4,807
1968	17,541	20,773	0.14	5,745
1969	19,600	23,005	0.12	4,948
1970	22,119	25,937	0.14	6,460
1971	24,444	28,803	0.16	7,867
1972	26,504	31,018	0.15	5,025
1973	29,261	33,685	0.14	4,652
1974	31,960	36,382	0.16	5,673
1975	33,441	37,690	0.14	4,666
1976	34,399	38,831	0.15	4,819
1977	34,117	39,023	0.19	6,439
1978	32,932	37,992	0.19	6,369
1979	32,197	37,036	0.18	3,587
1980	31,565	36,514	0.20	6,571
1981	30,073	35,268	0.27	5,315
1982	27,260	32,789	0.33	6,192
1983	24,104	29,141	0.34	3,797
1984	21,532	26,475	0.41	5,620
1985	18,594	24,072	0.49	10,827
1986	15,507	21,057	0.54	5,768
1987	13,775	19,558	0.64	8,792
1988	13,033	18,573	0.64	8,553
1989	12,313	17,715	0.62	12,468
1990	12,491	18,480	0.65	13,072
1991	12,724	18,933	0.57	8,109
1992	13,700	20,355	0.89	6,998
1993	11,570	16,975	1.07	6,673
1994	8,894	12,289	0.76	4,492
1995	7,896	11,025	0.71	2,781
1996	7,891	10,485	0.55	3,520
1997	7,847	9,873	0.36	4,596
1998	9,043	11,010	0.35	4,630
1999	9,413	12,254	0.50	6,231
2000	9,192	11,519	0.46	2,670
2001	10,438	12,599	0.47	2,332
2002	12,556	15,275	0.35	2,506
2003	13,322	16,098	0.46	2,458
2004	12,999	15,423	0.35	2,296
2005	11,577	14,897	0.31	3,841
2006	11,134	13,579	0.19	4,946
2007	14,205	16,744	0.13	4,047
2008	15,888	19,225	0.12	5,053
2009	16,017	19,148	0.14	5,672
2010	21,106	24,626	0.11	5,898
2011	26,877	31,225	0.13	4,006

Table B73. Fishing mortality by age from the Base ASAP model.

	1	2	3	4	5	6	7	8	9+
1963	0.02	0.06	0.14	0.23	0.27	0.31	0.31	0.31	0.31
1964	0.02	0.05	0.13	0.21	0.26	0.29	0.29	0.29	0.29
1965	0.02	0.05	0.12	0.20	0.24	0.27	0.27	0.27	0.27
1966	0.01	0.04	0.09	0.14	0.17	0.20	0.20	0.20	0.20
1967	0.01	0.03	0.07	0.11	0.13	0.15	0.15	0.15	0.15
1968	0.01	0.03	0.06	0.10	0.12	0.14	0.14	0.14	0.14
1969	0.01	0.02	0.05	0.09	0.11	0.12	0.12	0.12	0.12
1970	0.01	0.03	0.06	0.10	0.12	0.14	0.14	0.14	0.14
1971	0.01	0.03	0.07	0.11	0.14	0.16	0.16	0.16	0.16
1972	0.01	0.03	0.07	0.11	0.13	0.15	0.15	0.15	0.15
1973	0.01	0.03	0.06	0.10	0.12	0.14	0.14	0.14	0.14
1974	0.01	0.03	0.07	0.11	0.13	0.16	0.16	0.16	0.16
1975	0.01	0.03	0.06	0.10	0.12	0.14	0.14	0.14	0.14
1976	0.01	0.03	0.07	0.11	0.13	0.15	0.15	0.15	0.15
1977	0.01	0.04	0.09	0.14	0.17	0.19	0.19	0.19	0.19
1978	0.01	0.04	0.09	0.14	0.17	0.19	0.19	0.19	0.19
1979	0.01	0.03	0.08	0.13	0.15	0.18	0.18	0.18	0.18
1980	0.01	0.04	0.09	0.15	0.18	0.20	0.20	0.20	0.20
1981	0.02	0.05	0.12	0.20	0.23	0.27	0.27	0.27	0.27
1982	0.02	0.06	0.15	0.24	0.29	0.33	0.33	0.33	0.33
1983	0.02	0.06	0.15	0.25	0.30	0.34	0.34	0.34	0.34
1984	0.02	0.08	0.18	0.30	0.35	0.41	0.41	0.41	0.41
1985	0.03	0.09	0.22	0.36	0.43	0.49	0.49	0.49	0.49
1986	0.03	0.10	0.24	0.39	0.47	0.54	0.54	0.54	0.54
1987	0.04	0.12	0.29	0.47	0.56	0.64	0.64	0.64	0.64
1988	0.04	0.12	0.29	0.47	0.56	0.64	0.64	0.64	0.64
1989	0.04	0.11	0.28	0.45	0.54	0.62	0.62	0.62	0.62
1990	0.04	0.12	0.29	0.47	0.56	0.65	0.65	0.65	0.65
1991	0.03	0.11	0.26	0.42	0.50	0.57	0.57	0.57	0.57
1992	0.05	0.16	0.40	0.65	0.77	0.89	0.89	0.89	0.89
1993	0.06	0.20	0.48	0.78	0.93	1.07	1.07	1.07	1.07
1994	0.05	0.14	0.34	0.56	0.66	0.76	0.76	0.76	0.76
1995	0.04	0.13	0.32	0.52	0.61	0.71	0.71	0.71	0.71
1996	0.03	0.10	0.25	0.40	0.47	0.55	0.55	0.55	0.55
1997	0.02	0.07	0.16	0.26	0.31	0.36	0.36	0.36	0.36
1998	0.04	0.05	0.09	0.17	0.23	0.35	0.35	0.35	0.35
1999	0.05	0.07	0.13	0.24	0.33	0.50	0.50	0.50	0.50
2000	0.05	0.07	0.12	0.23	0.31	0.46	0.46	0.46	0.46
2001	0.05	0.07	0.12	0.23	0.31	0.47	0.47	0.47	0.47
2002	0.04	0.05	0.09	0.17	0.23	0.35	0.35	0.35	0.35
2003	0.05	0.07	0.12	0.23	0.31	0.46	0.46	0.46	0.46
2004	0.04	0.05	0.09	0.17	0.23	0.35	0.35	0.35	0.35
2005	0.03	0.04	0.08	0.15	0.21	0.31	0.31	0.31	0.31
2006	0.02	0.03	0.05	0.09	0.13	0.19	0.19	0.19	0.19
2007	0.01	0.02	0.03	0.06	0.08	0.13	0.13	0.13	0.13
2008	0.01	0.02	0.03	0.06	0.08	0.12	0.12	0.12	0.12
2009	0.02	0.02	0.04	0.07	0.09	0.14	0.14	0.14	0.14
2010	0.01	0.02	0.03	0.05	0.07	0.11	0.11	0.11	0.11
2011	0.01	0.02	0.04	0.06	0.09	0.13	0.13	0.13	0.13

Table B74. Numbers at age (000s) from the Base ASAP model.

	1	2	3	4	5	6	7	8	9+
1963	3410	2883	2558	2145	1415	849	511	327	509
1964	2837	2740	2226	1817	1396	882	507	306	500
1965	3947	2282	2124	1596	1201	886	538	310	491
1966	4505	3178	1775	1536	1069	774	551	335	498
1967	4807	3645	2509	1330	1089	738	520	370	560
1968	5745	3900	2902	1919	975	782	519	366	655
1969	4948	4664	3111	2230	1418	707	557	370	727
1970	6460	4022	3733	2411	1671	1045	513	404	795
1971	7867	5245	3208	2869	1783	1212	744	365	853
1972	5025	6381	4171	2447	2096	1274	848	521	853
1973	4652	4078	5081	3192	1797	1507	898	598	968
1974	5673	3777	3253	3905	2360	1302	1073	639	1115
1975	4666	4602	3004	2483	2855	1688	913	752	1230
1976	4819	3789	3671	2309	1835	2070	1202	650	1410
1977	6439	3910	3017	2809	1695	1320	1459	847	1452
1978	6369	5211	3088	2263	1997	1173	890	985	1551
1979	3587	5154	4115	2316	1608	1381	791	600	1709
1980	6571	2906	4085	3113	1669	1131	949	543	1587
1981	5315	5314	2291	3050	2196	1144	755	634	1422
1982	6192	4282	4139	1661	2053	1424	716	473	1287
1983	3797	4969	3296	2917	1068	1260	837	421	1034
1984	5620	3046	3818	2313	1862	650	733	487	846
1985	10827	4490	2312	2600	1406	1070	354	399	726
1986	5768	8605	3354	1515	1486	750	535	177	563
1987	8792	4571	6373	2152	837	761	358	255	353
1988	8553	6927	3323	3908	1105	393	329	155	263
1989	12468	6736	5031	2034	2001	517	169	141	179
1990	13072	9836	4916	3115	1061	957	228	75	141
1991	8109	10295	7142	3006	1592	496	411	98	93
1992	6998	6415	7581	4519	1624	794	229	190	88
1993	6673	5432	4454	4158	1938	615	268	77	94
1994	4492	5123	3644	2246	1557	625	172	75	48
1995	2781	3513	3640	2114	1055	658	239	66	47
1996	3520	2182	2522	2166	1034	468	266	96	46
1997	4596	2789	1614	1613	1190	526	222	126	67
1998	4630	3682	2136	1124	1017	714	301	127	111
1999	6231	3652	2869	1593	775	659	412	174	137
2000	2670	4839	2787	2058	1022	455	329	206	155
2001	2332	2081	3710	2017	1342	614	235	169	186
2002	2506	1816	1594	2681	1312	803	315	120	182
2003	2458	1977	1415	1189	1848	850	463	182	175
2004	2296	1916	1516	1025	777	1112	439	240	184
2005	3841	1812	1494	1132	708	504	645	255	246
2006	4946	3041	1419	1124	794	469	302	385	299
2007	4047	3967	2422	1103	837	571	317	204	462
2008	5053	3270	3190	1918	849	630	412	229	481
2009	5672	4084	2632	2529	1480	641	457	299	515
2010	5898	4574	3277	2075	1932	1102	456	325	579
2011	4006	4774	3688	2607	1610	1471	810	335	664

Table B75. Results of the retrospective analysis.

Year	2004	2005	2006	2007	2008	2009	2010	Mohn's rho
Ffull	-0.10	-0.24	-0.20	-0.17	-0.12	-0.05	-0.03	-0.13
SSB	0.11	0.28	0.22	0.22	0.14	0.06	0.03	0.15
Recruitment	1.56	0.76	1.29	-0.04	0.43	0.26	0.21	0.64

Table B76. Analysis of the probability of falling below twenty percent Bzero using long-term projections under different recruitment assumptions.

				fraction of draws below 0.2*SSB0		
steepness	SSB0	0.2*SSB0	SSBmsy	F35%	F40%	F that results in ~5% draws below 0.2*SSB0
0.6	139,200	27,840	51,300	26	7	0.19
0.7	128,100	25,620	42,960	10	2	0.22
0.8	119,200	23,840	36,940	4	1	between 0.24-0.25
emp.cdf (hockey stick)	81,700	16,340	28,450 (F35) or 32,400 (F40)	0	0	between 0.35-0.36

Table B77. Comparison of the existing biological reference points with the new biological reference points.

	GARM III	SARC 56
*F*msy proxy (F40%)	0.125 (on age 6)	0.2 (on age 6)
SSB/R	5.94	6.19
Mean R	8.0 million	5.5 million
SSBMSY proxy	56,300 mt	32,400 mt
F pattern	Domed	Asymptotic at age 6
MSY	5,800 mt	5,630 mt

Table B78**.** Short term projections of total fishery yield and spawning stock biomass for Gulf of Maine-Georges Bank white hake based on a harvest scenario of fishing at FMSY between 2013 and 2016. Catch in 2012 has been estimated at 2,900 mt.

Long Time Series of Recruitment (1963-2009)

Year	**Catch**	**5%**	**95%**	**SSB**	**5%**	**95%**	**F**
2012	2.900			28.886	24.659	33.166	0.12
2013	5.462	4.697	6.309	31.669	27.017	36.719	0.20
2014	5.594	4.797	6.482	32.108	27.573	37.385	0.20
2015	5.587	4.849	6.484	31.843	27.677	36.930	0.20
2016	5.516	4.779	6.428	31.815	27.516	37.213	0.20

Short Time Series of Recruitment (1995-2009)

Year	**Catch**	**5%**	**95%**	**SSB**	**5%**	**95%**	**F**
2012	2.900			28.886	24.659	33.166	0.12
2013	5.457	4.642	6.302	31.654	26.976	36.708	0.20
2014	5.574	4.774	6.459	32.010	27.440	37.284	0.20
2015	5.504	4.777	6.393	31.276	27.238	36.238	0.20
2016	5.287	4.616	6.112	30.178	26.448	34.627	0.20

Table B79**.** Short term projections of total fishery yield and spawning stock biomass for Gulf of Maine-Georges Bank white hake based on a harvest scenario of fishing at 75% FMSY between 2013 and 2016. Catch in 2012 has been estimated at 2,900 mt.

Long Time Series of Recruitment (1963-2009)

Year	**Catch**	**5%**	**95%**	**SSB**	**5%**	**95%**	**F**
2012	2.900			28.886	24.659	33.166	0.12
2013	4.181	3.313	5.205	31.999	27.297	37.095	0.15
2014	4.450	3.566	5.567	33.656	28.911	39.175	0.15
2015	4.595	3.704	5.742	34.473	29.952	39.951	0.15
2016	4.668	3.803	5.830	35.371	30.641	41.248	0.15

Short Time Series of Recruitment (1995-2009)

Year	**Catch**	**5%**	**95%**	**SSB**	**5%**	**95%**	**F**
2012	2.900			28.886	24.659	33.166	0.12
2013	4.177	3.552	4.823	31.986	27.255	37.085	0.15
2014	4.435	3.796	5.137	33.559	28.765	39.087	0.15
2015	4.532	3.929	5.266	33.893	29.505	39.269	0.15
2016	4.490	3.919	5.193	33.683	29.521	38.663	0.15

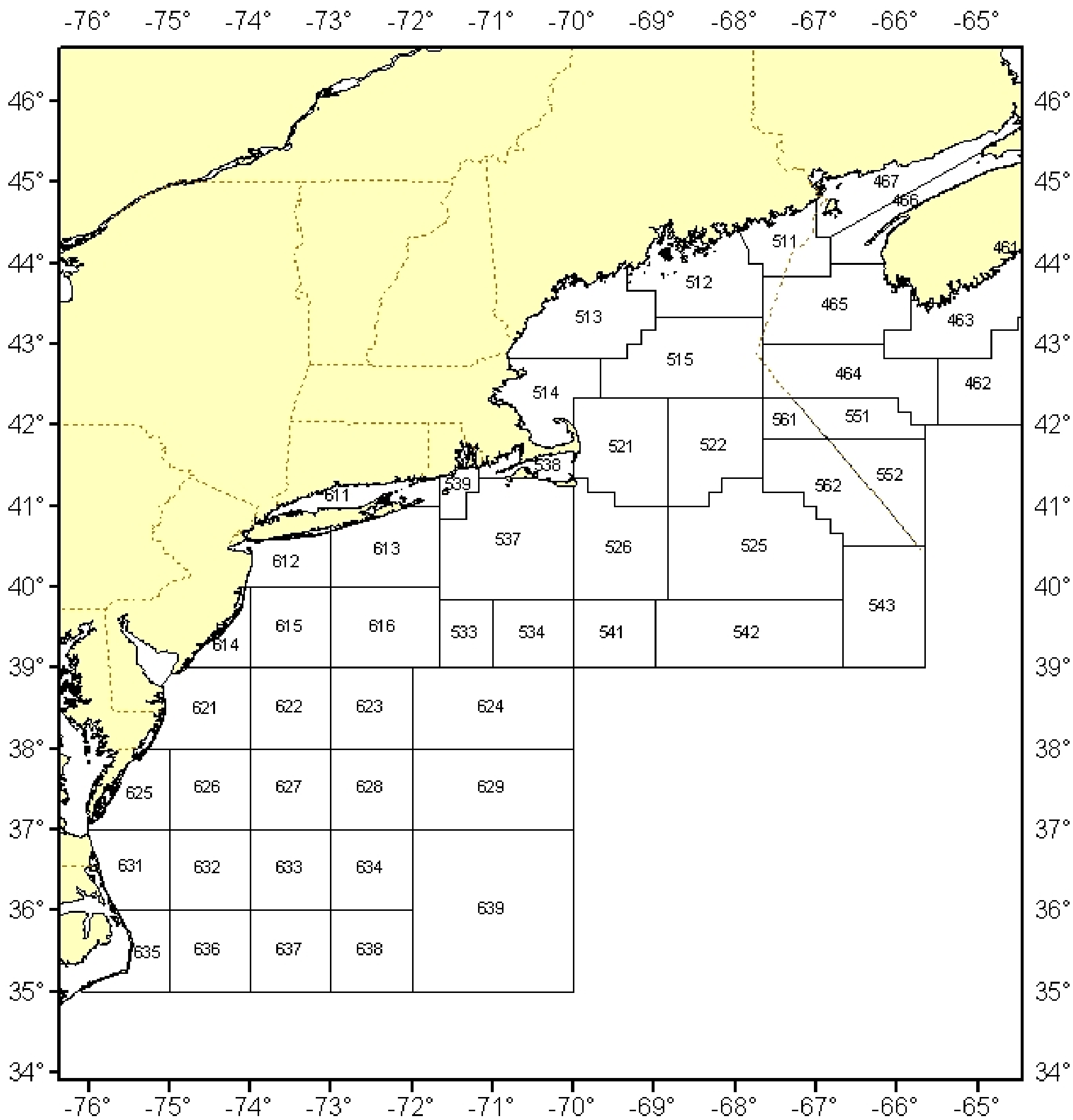


Figure B1. Statistical areas used for reporting United States commercial landings.

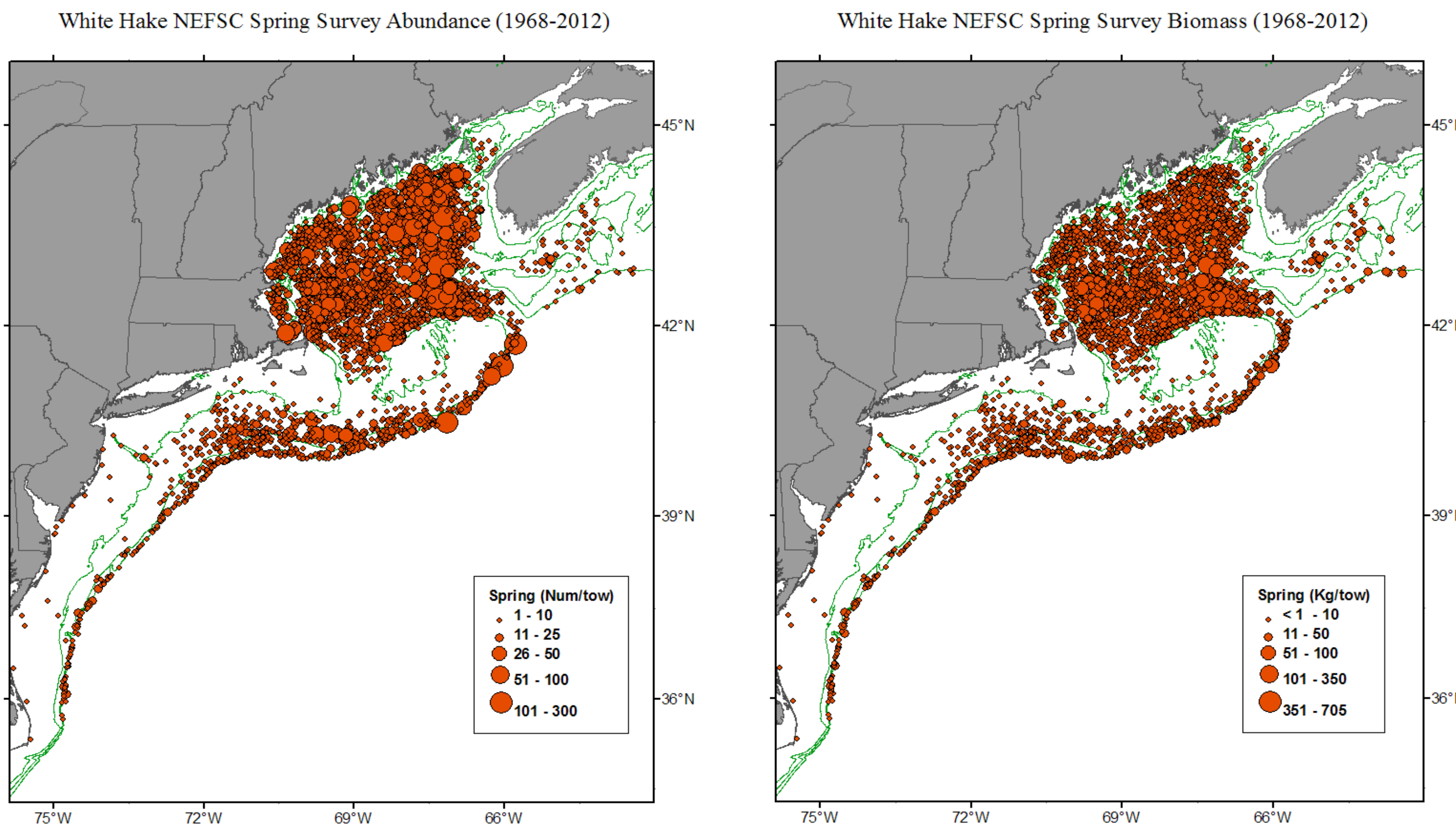


Figure B2. Distribution of white hake from the NEFSC spring survey in number/tow (left panel) and weight/tow (right panel) from 1968-2012.

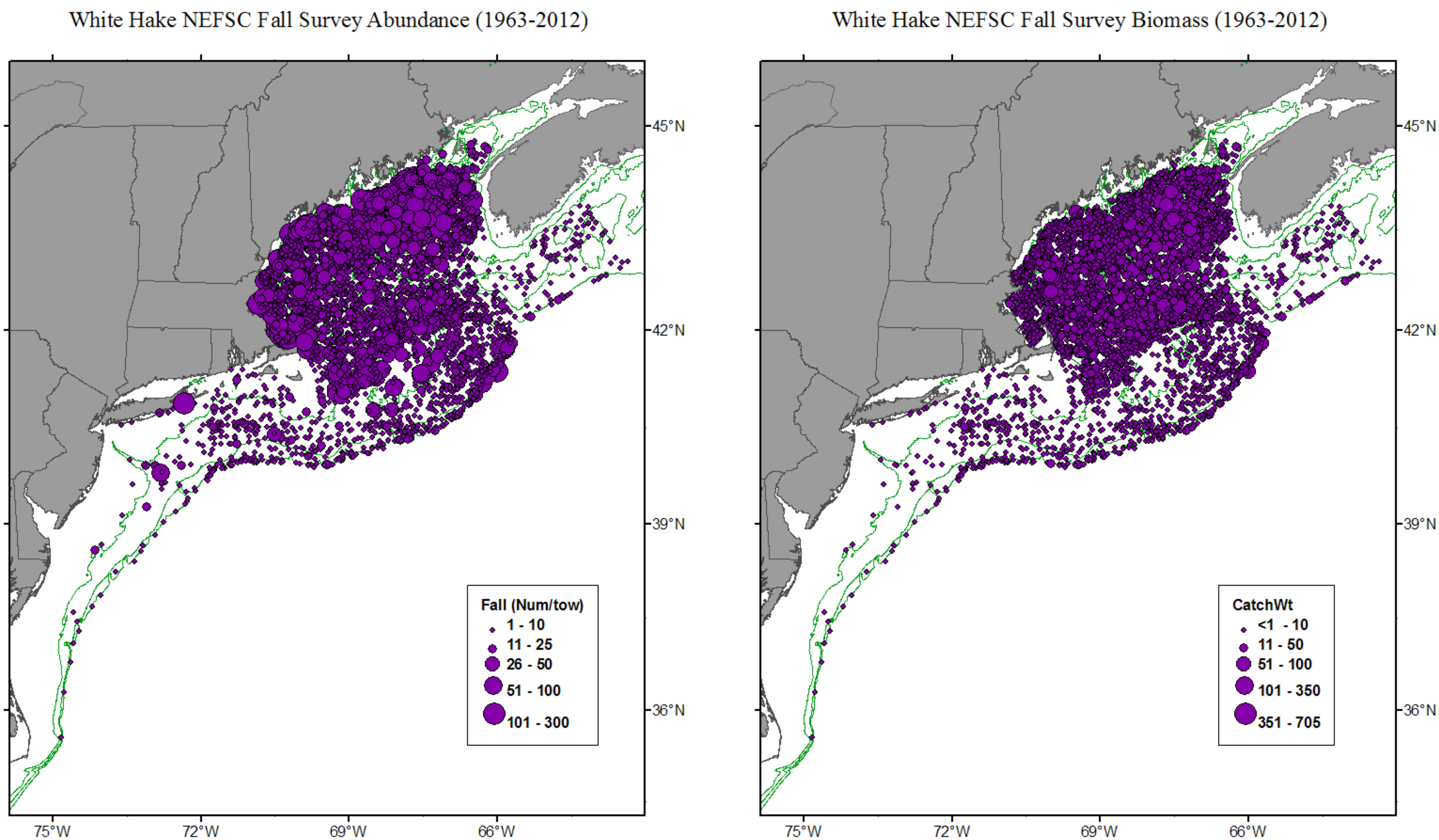


Figure B3a. Distribution of white hake from the NEFSC autumn survey in number/tow (left panel) and weight/tow (right panel) from 1963-2012.

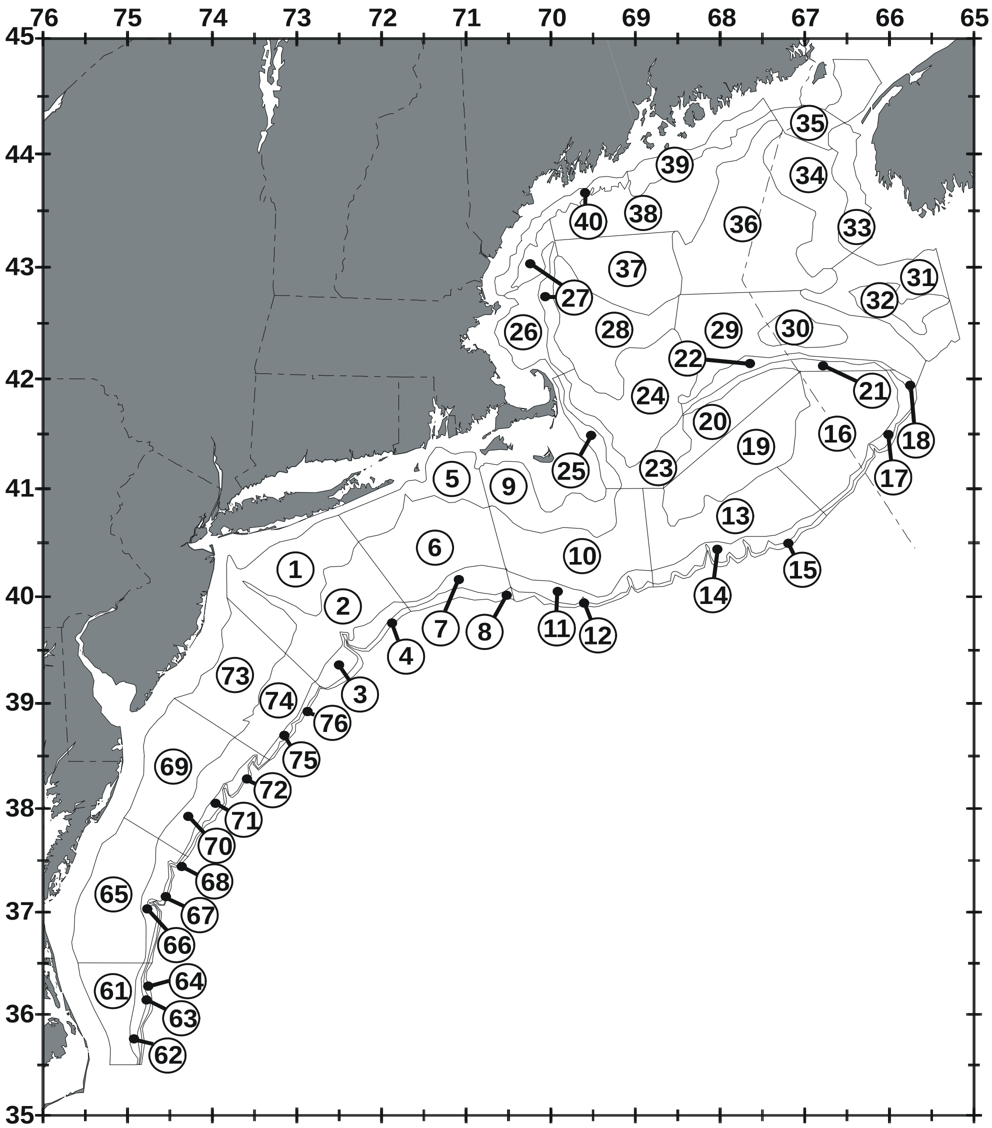


Figure B4. Offshore survey strata for the NEFSC survey.

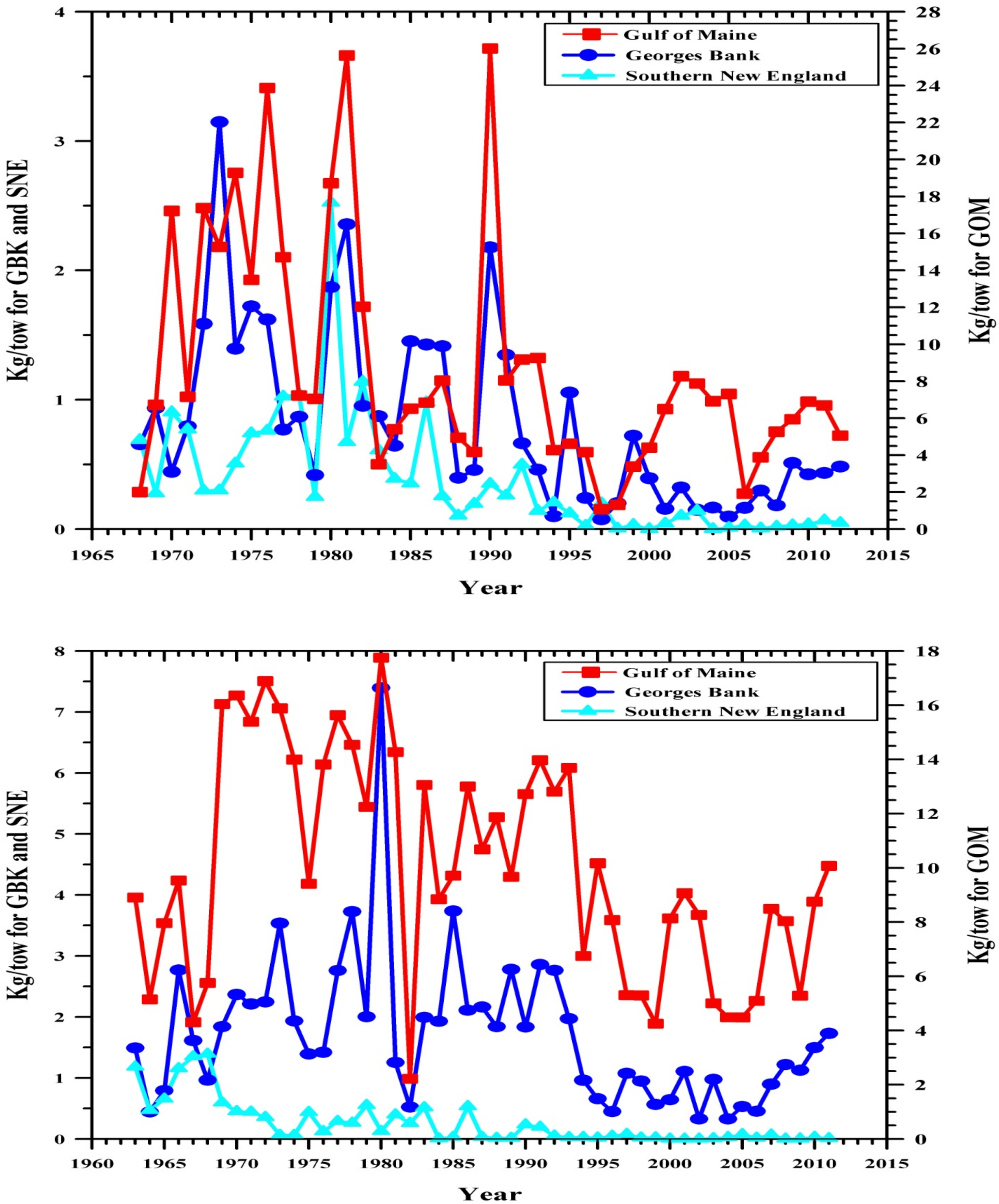


Figure B5. Biomass indices of white hake from the spring (top) and fall (bottom) surveys from Gulf of Maine (offshore strata 26-30, 36-40, GOM), Georges Bank (offshore strata 13-25, GB) and Southern New England (offshore strata 1-12,SNE).

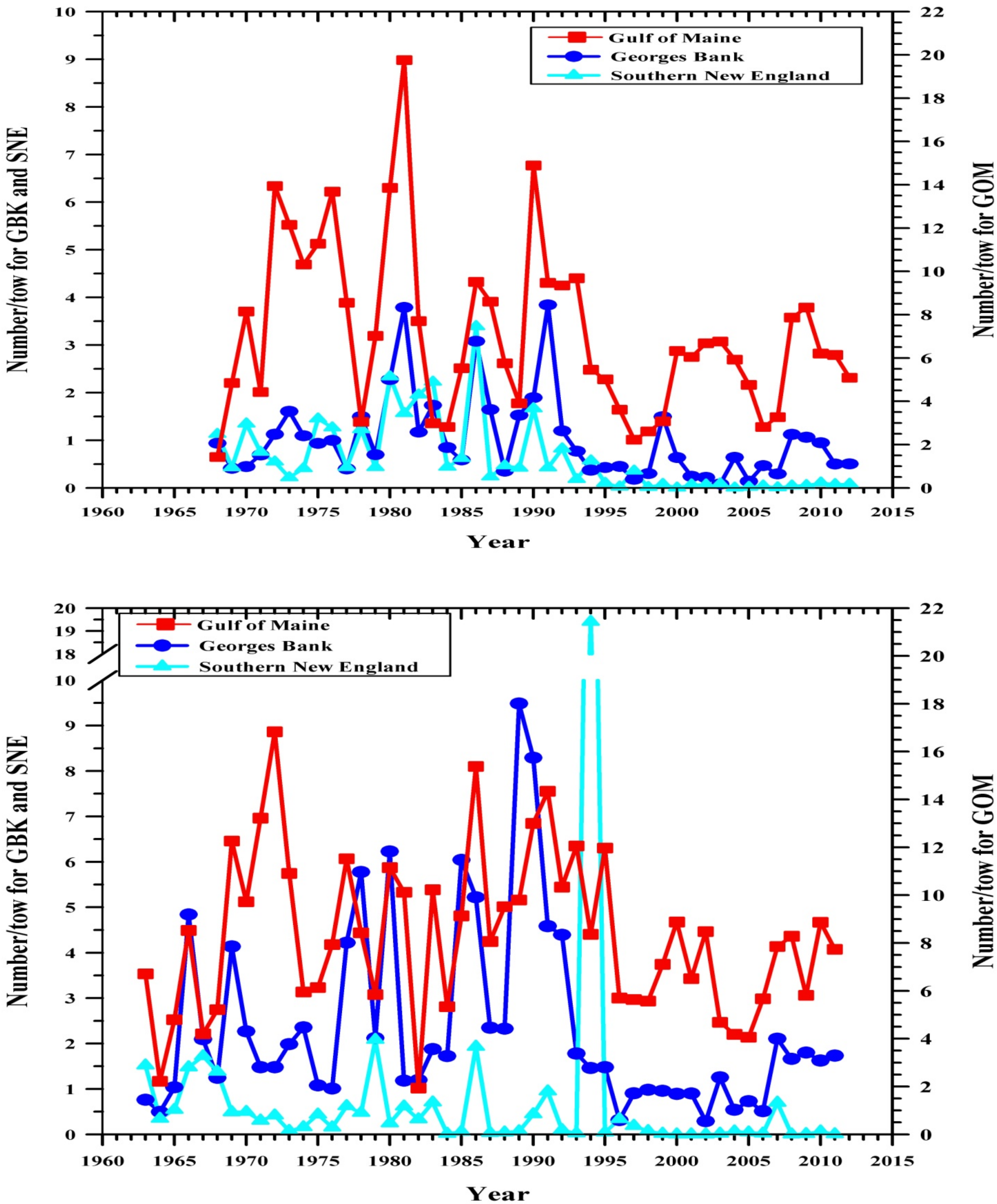


Figure B6. Abundance indices of white hake from the spring (top) and fall (bottom) surveys from Gulf of Maine (offshore strata 26-30, 36-40, GOM), Georges Bank (offshore strata 13-25, GB) and Southern New England (offshore strata 1-12,SNE).

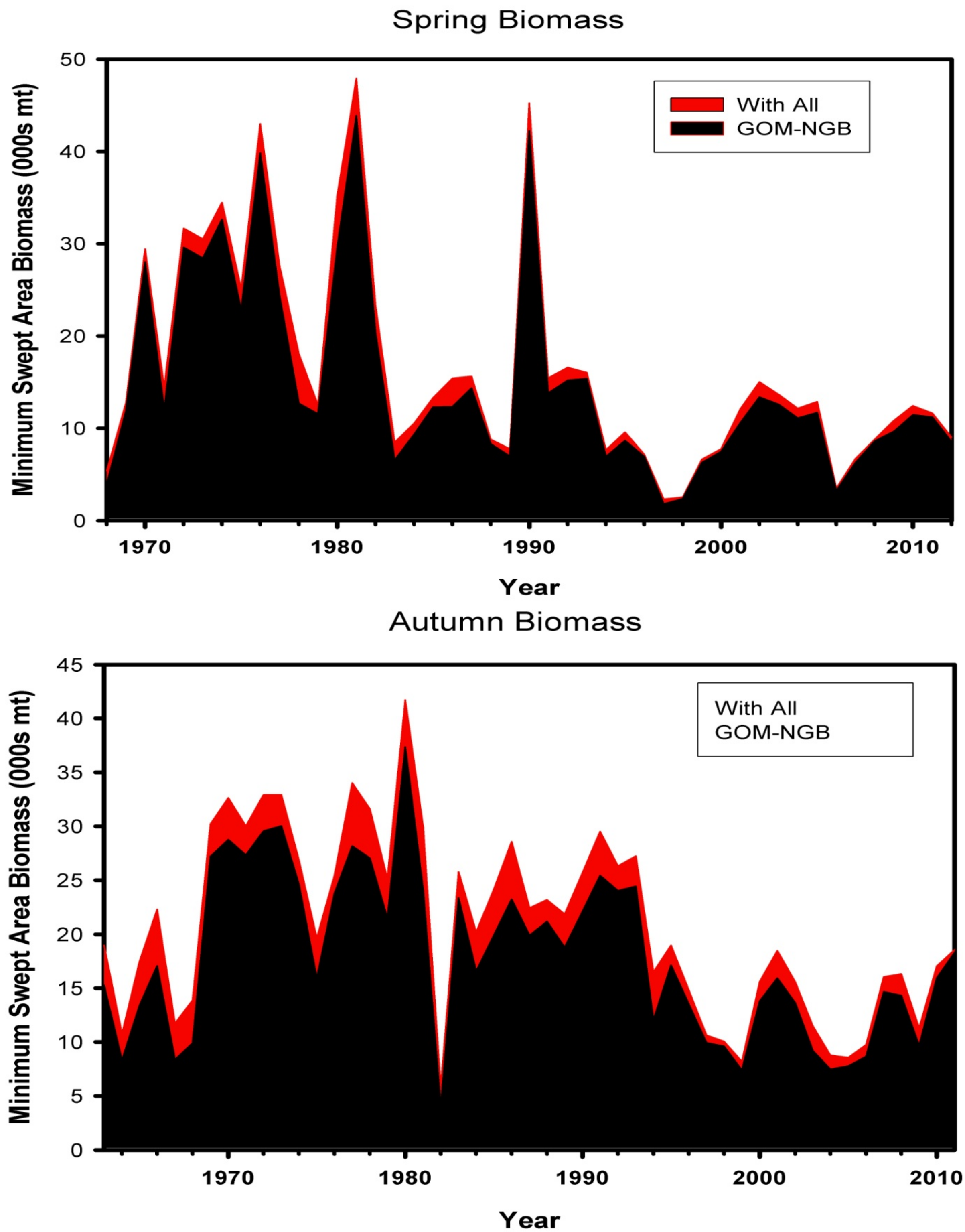
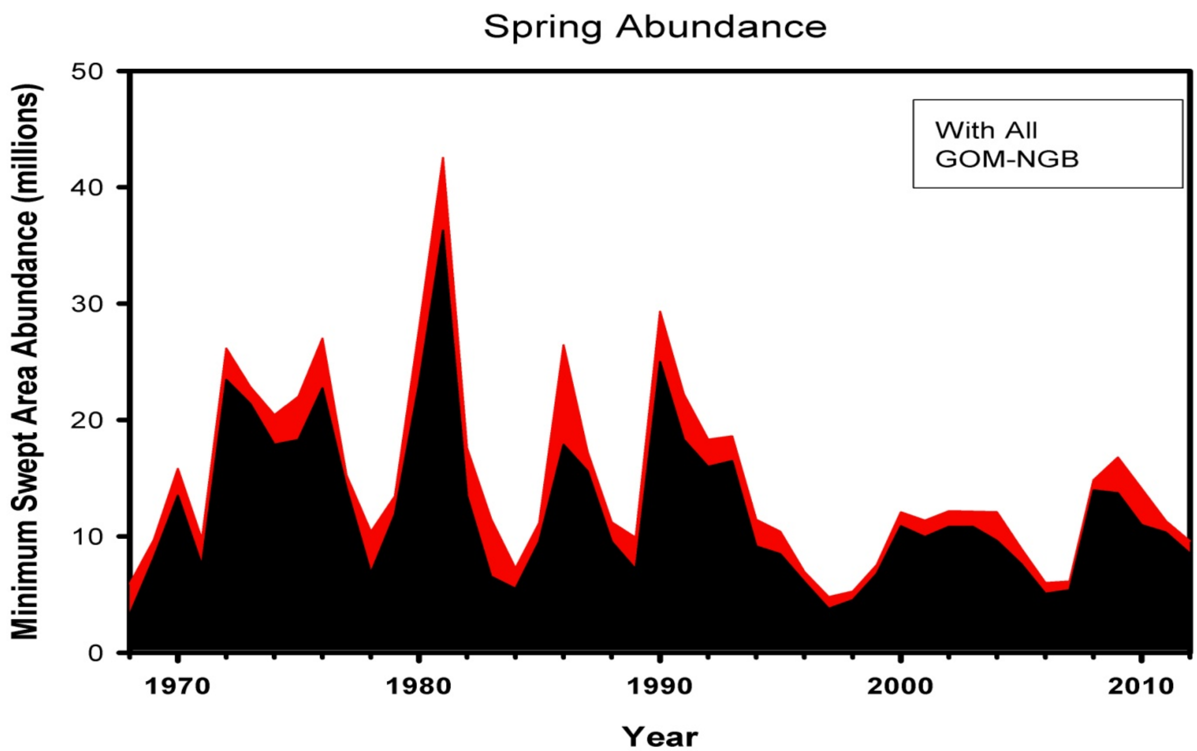


Figure B7. Swept-area biomass of white hake from the spring (top) and fall (bottom) surveys using the current stock definition (offshore strata 21-30, 33-40) and all strata (offshore strata 1-30, 33-40, 61-76, Inshore strata 1-66).



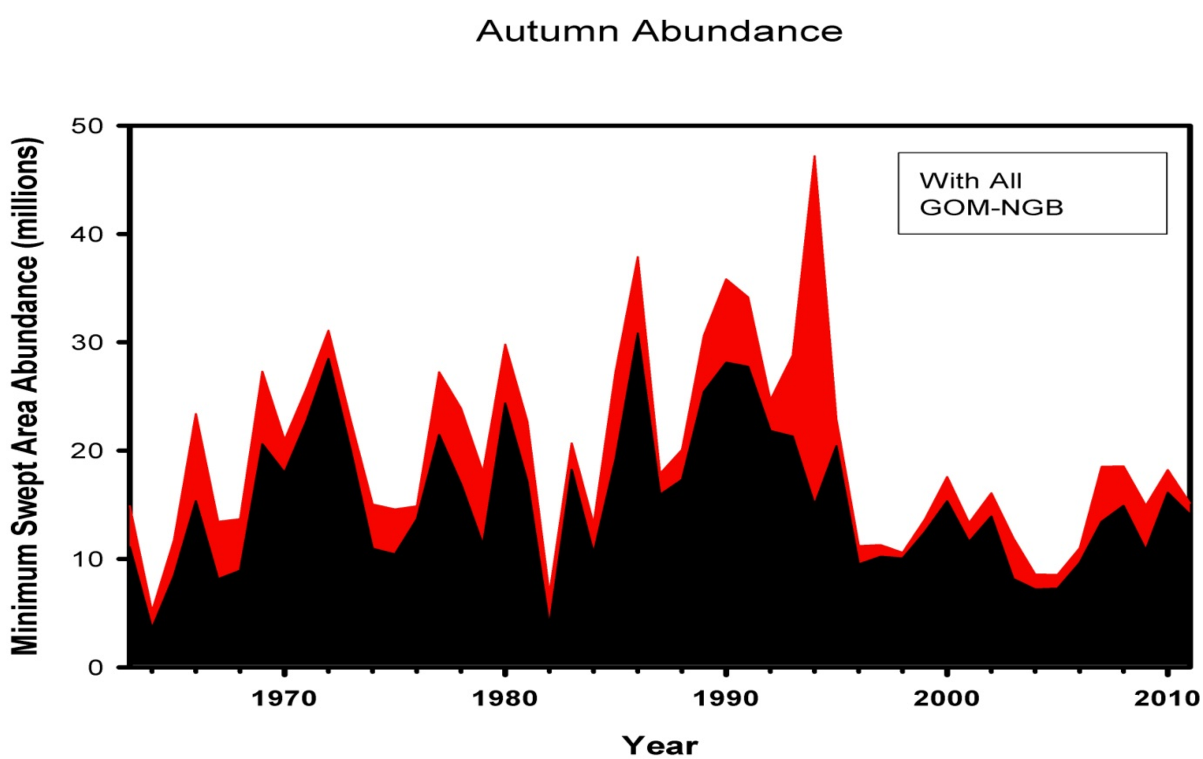
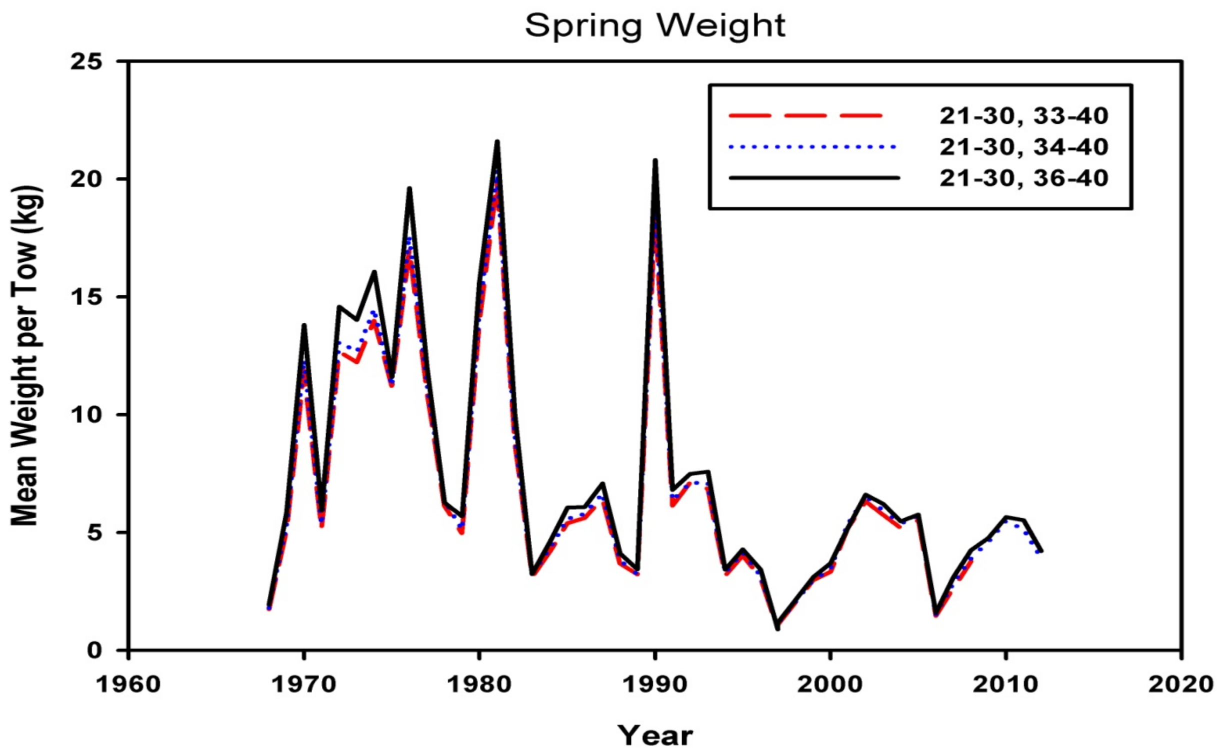


Figure B8. Swept-area abundance of white hake from the spring (top) and fall (bottom) surveys using the current stock definition (offshore strata 21-30, 33-40) and all strata offshore strata 1-30, 33-40, 61-76, Inshore strata 1-66).



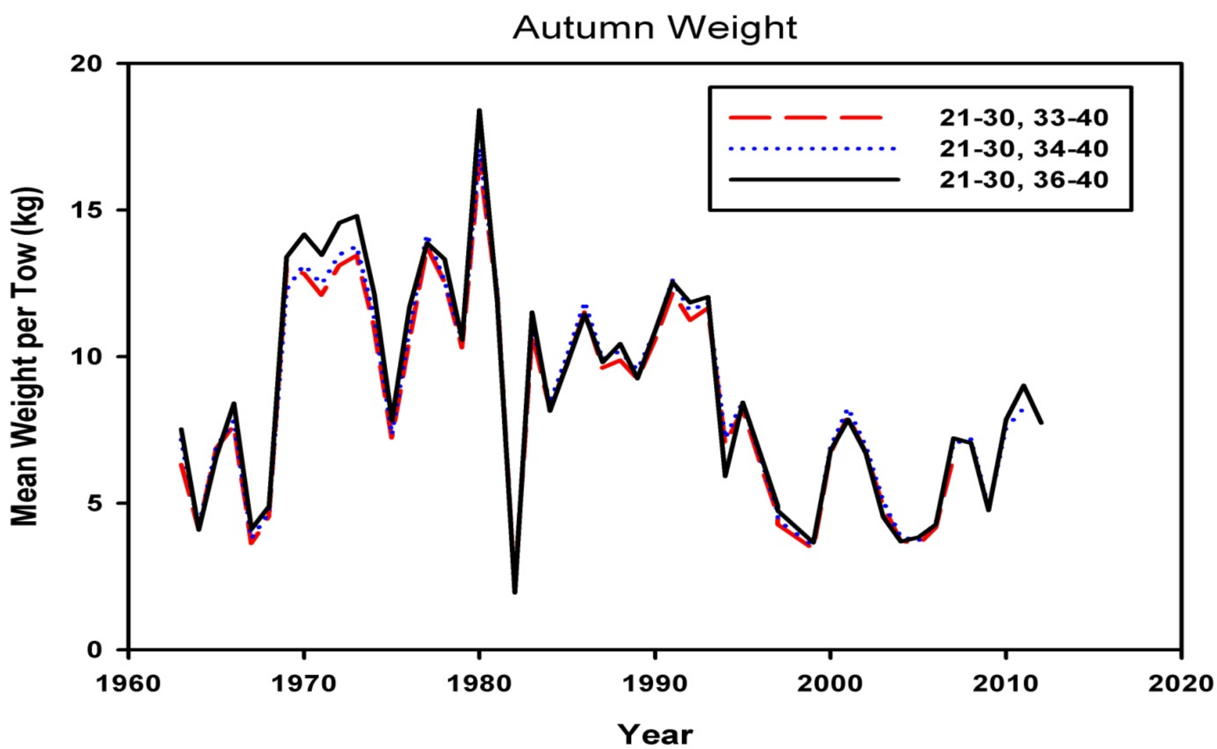


Figure B9. Biomass indices of white hake from the spring (top) and fall (bottom) surveys using the current stock definition (offshore strata 21-30, 33-40), dropping stratum 33 which is no longer sampled (offshore strata 21-30, 34-40) and no Scotian Shelf strata (offshore strata 21-30, 36-40).

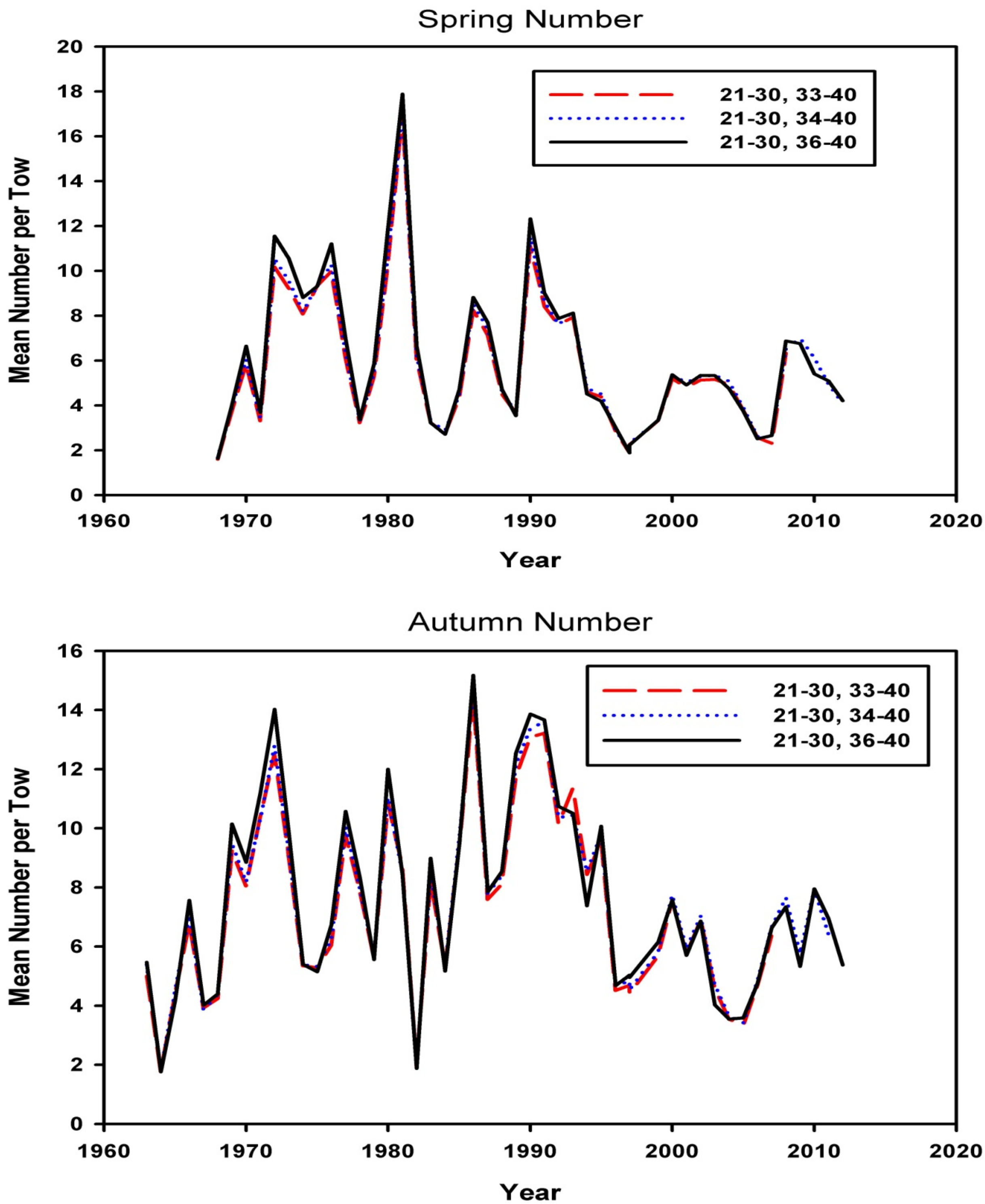


Figure B10. Abundance indices of white hake from the spring (top) and fall (bottom) surveys using the current stock definition (offshore strata 21-30, 33-40), dropping stratum 33 which is no longer sampled (offshore strata 21-30, 34-40) and no Scotian Shelf strata (offshore strata 21-30, 36-40).

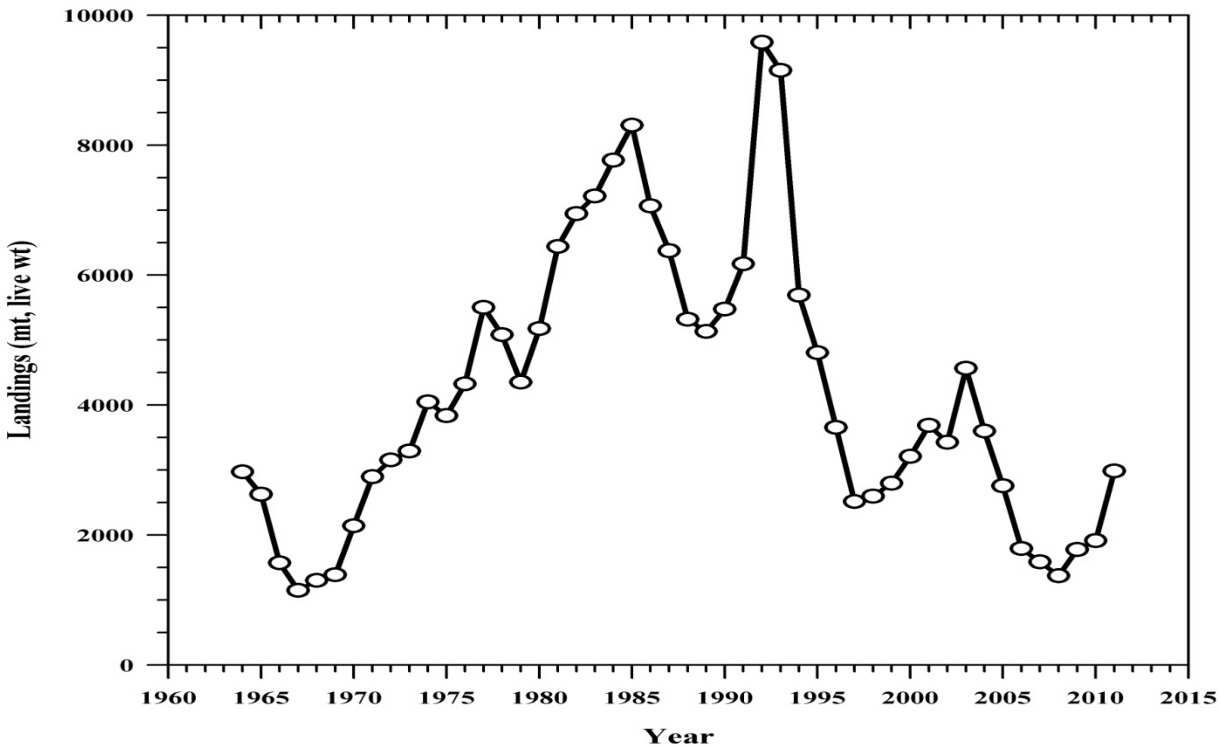


Figure B11. Total nominal commercial landings (mt, live weight) of white hake from 1964-2011.

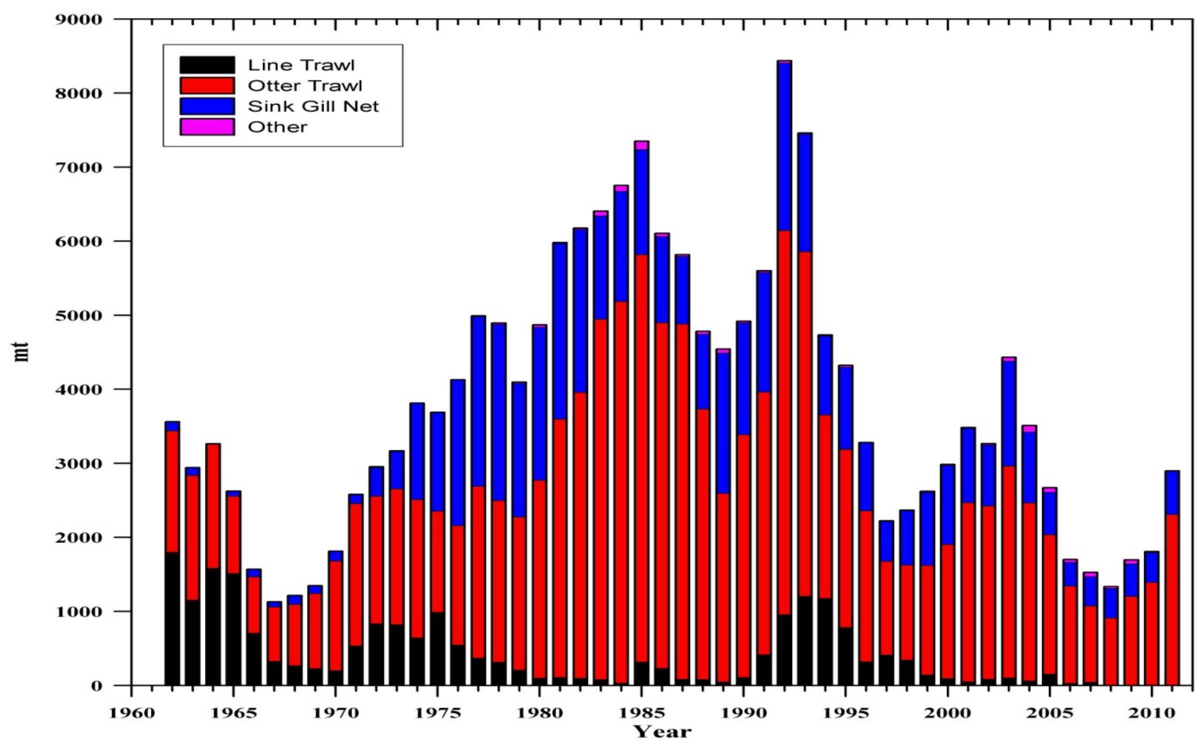


Figure B12. Nominal U.S. commercial landings (mt, live weight) of white hake by gear type from 1964-2011.

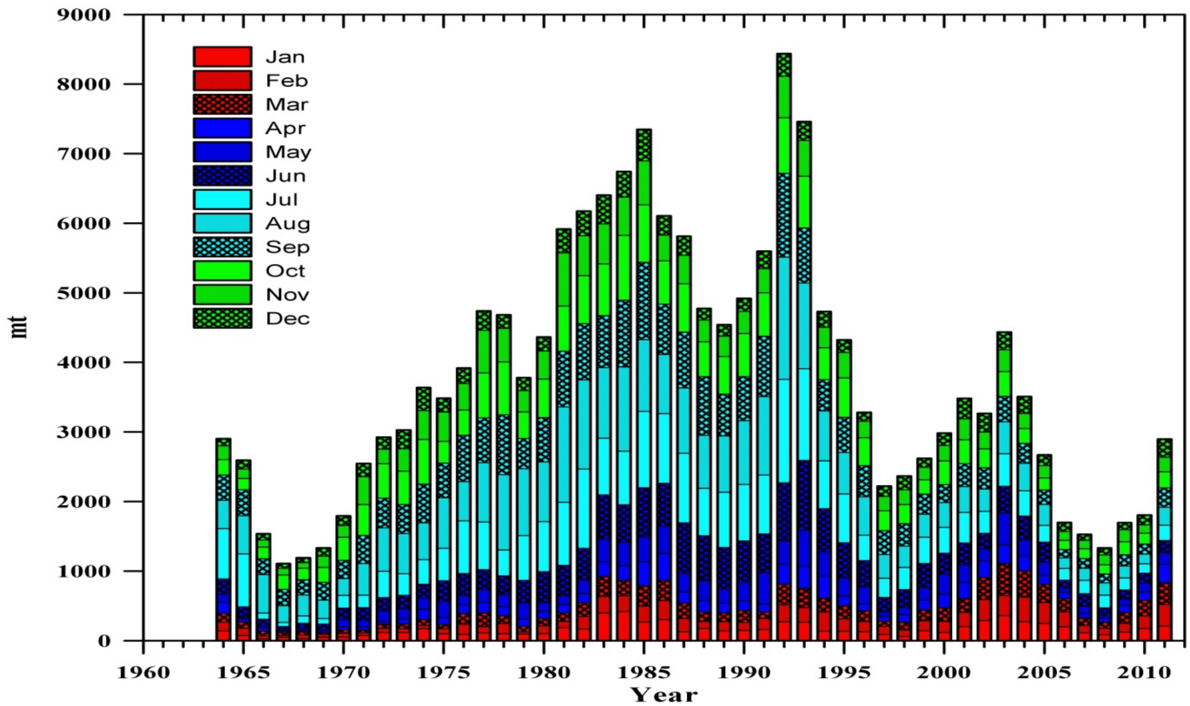


Figure B13. Nominal U.S. commercial landings (mt, live weight) of white hake by month from 1964-2011.

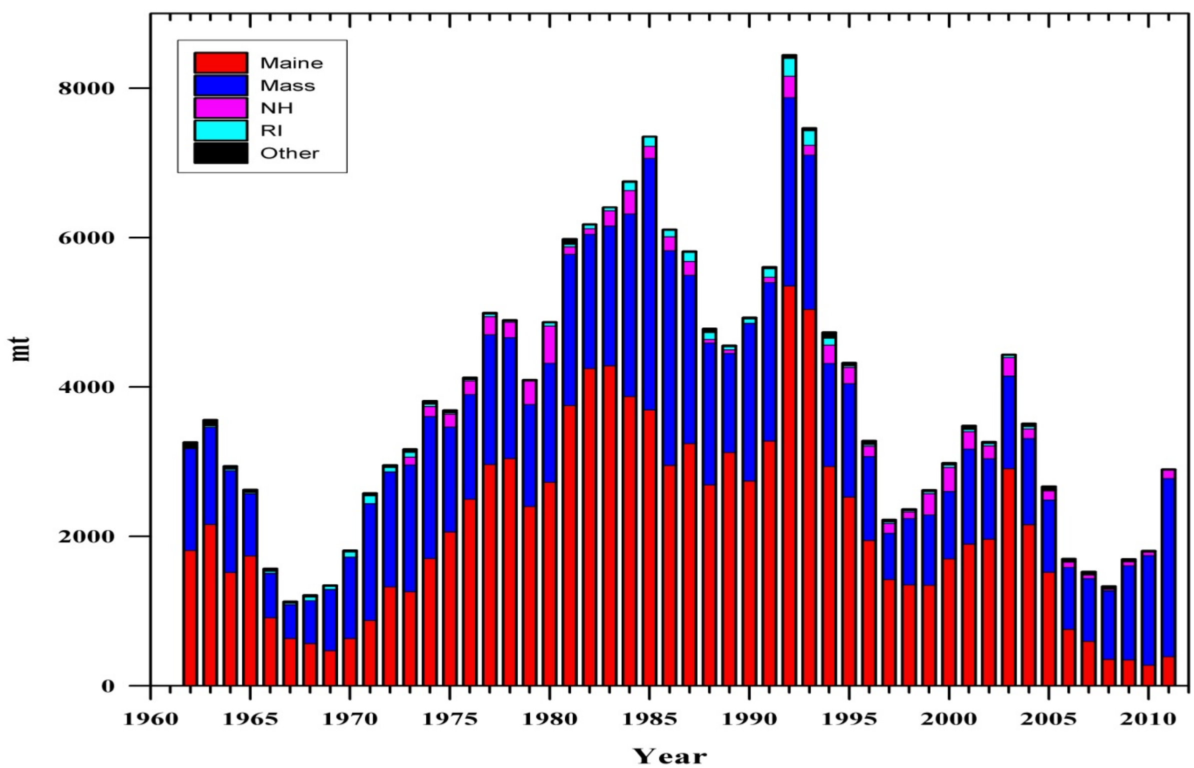


Figure B14. Nominal U.S. commercial landings (mt, live weight) of white hake by state from 1964-2011.

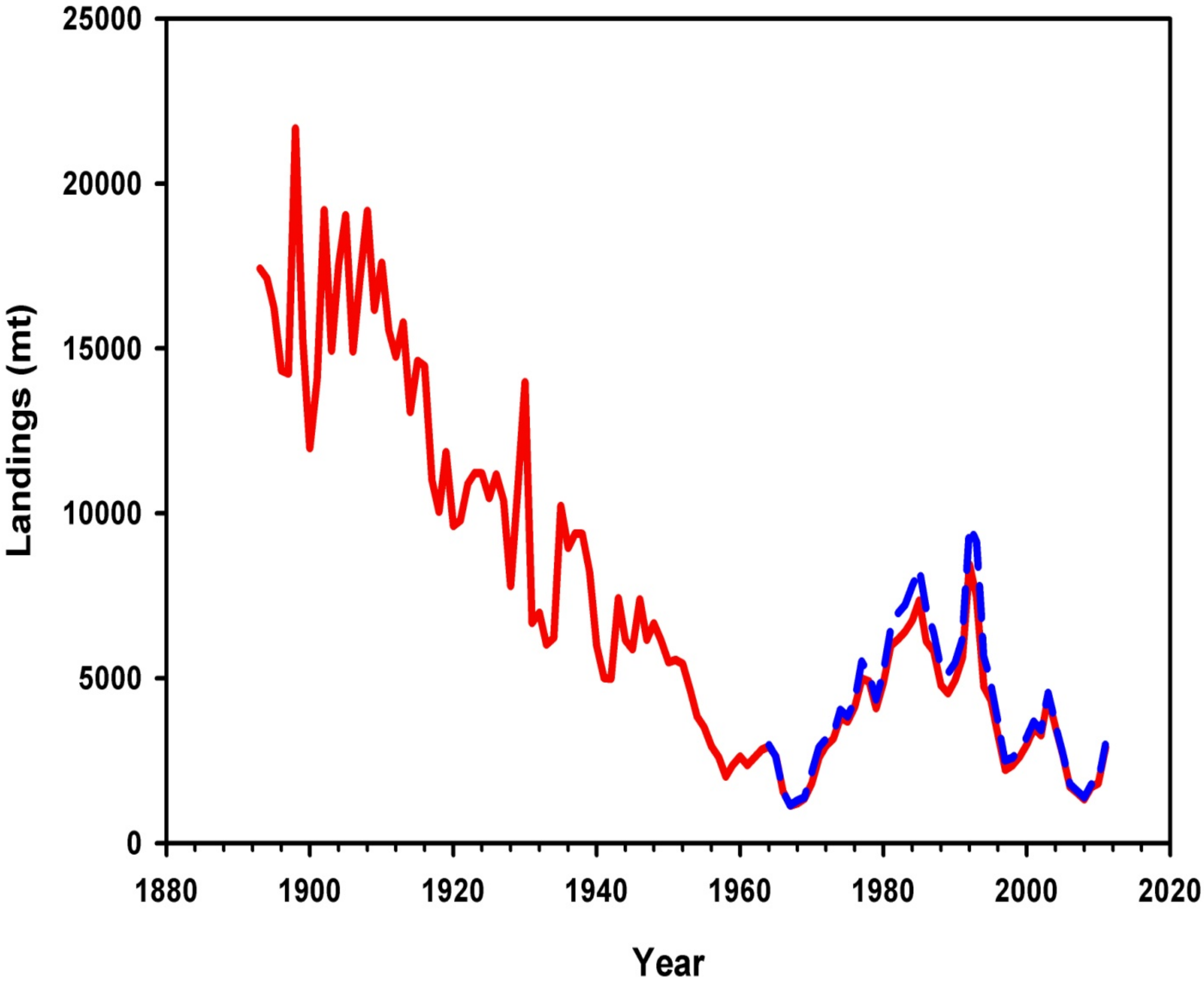
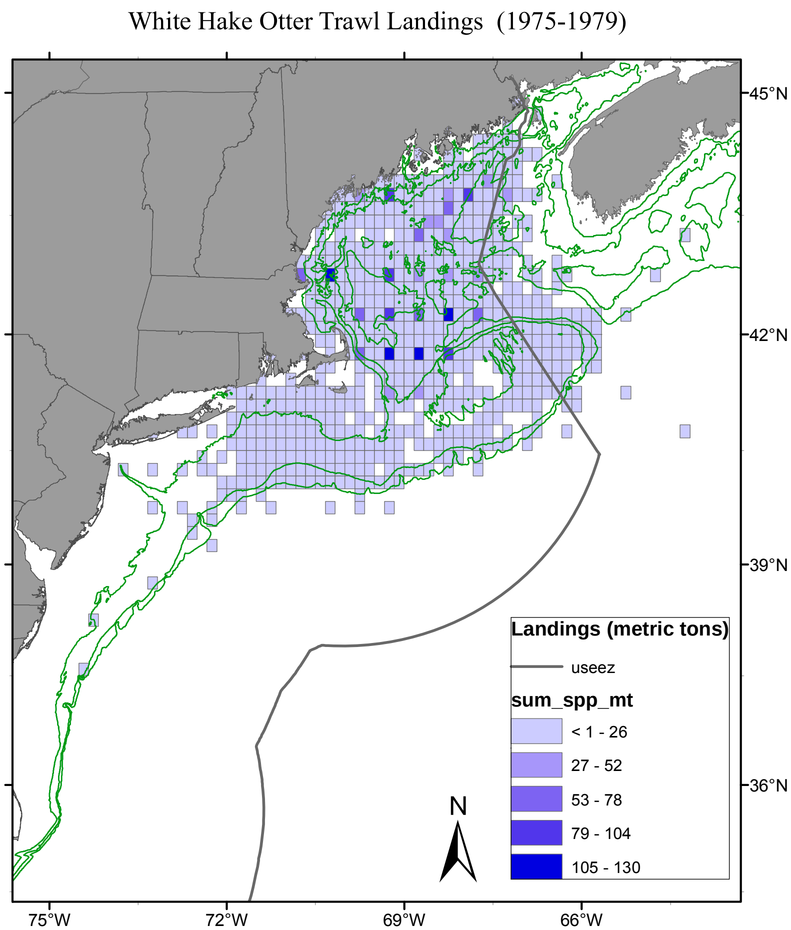


Figure B15. Total landings of white hake. The red line is US landings while the blue dashed line is the total landings including Canada and other countries.



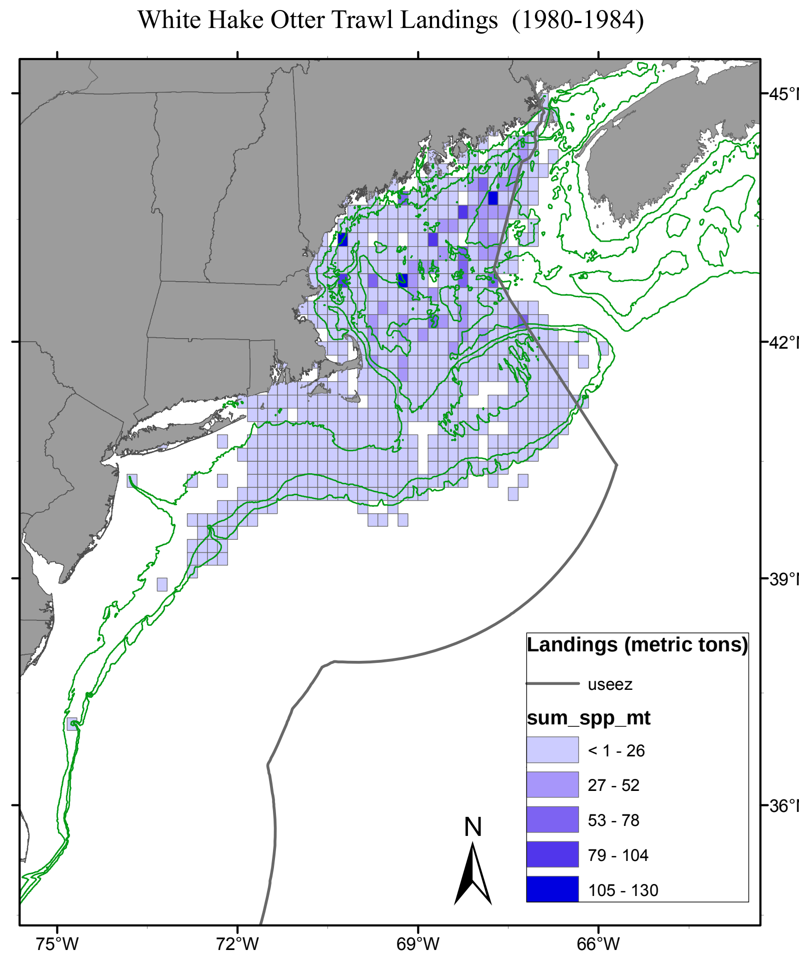


Figure B16. Landings of white hake from the otter trawl fishery from 1975-1979 and 1980-1984.

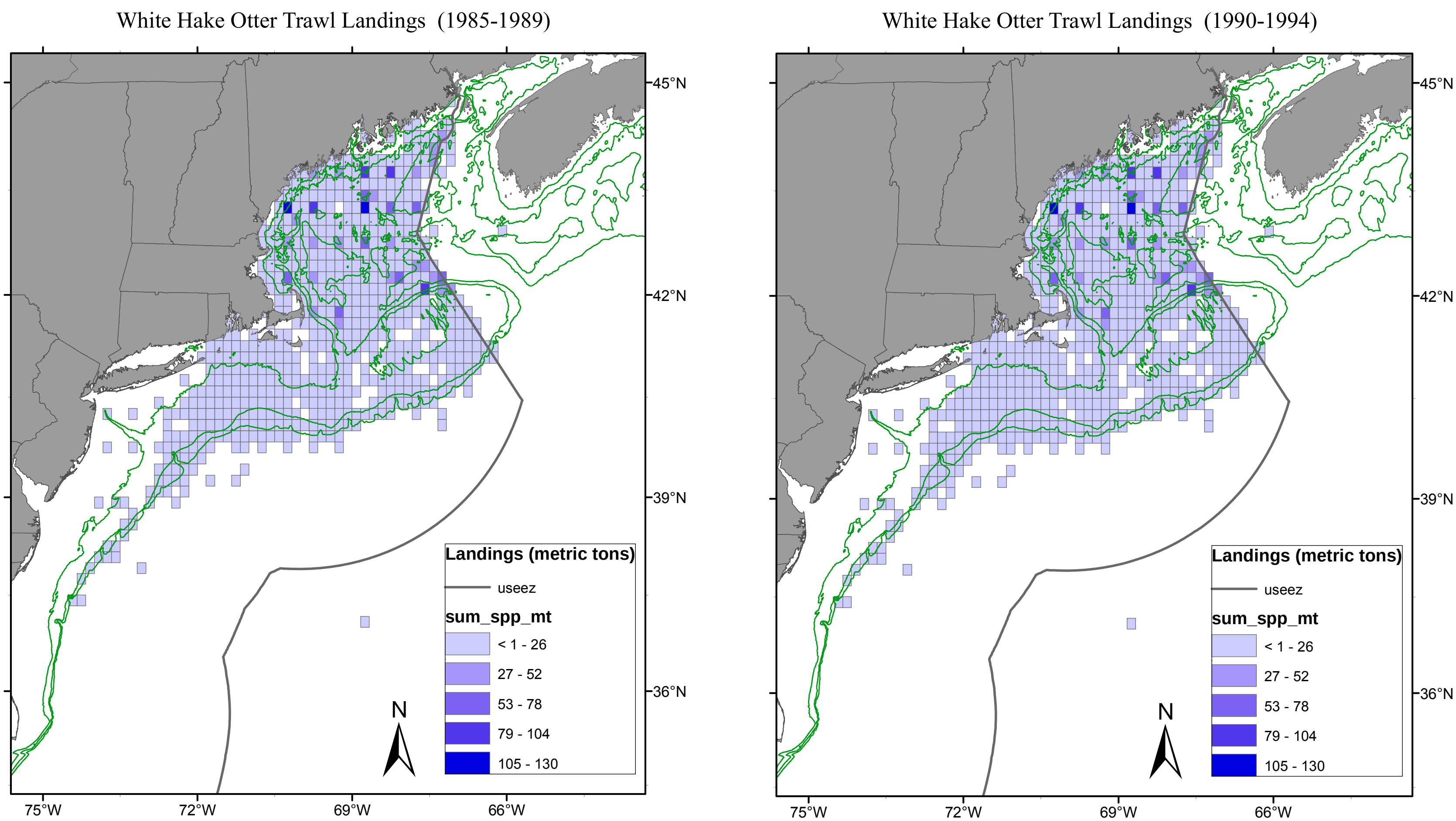
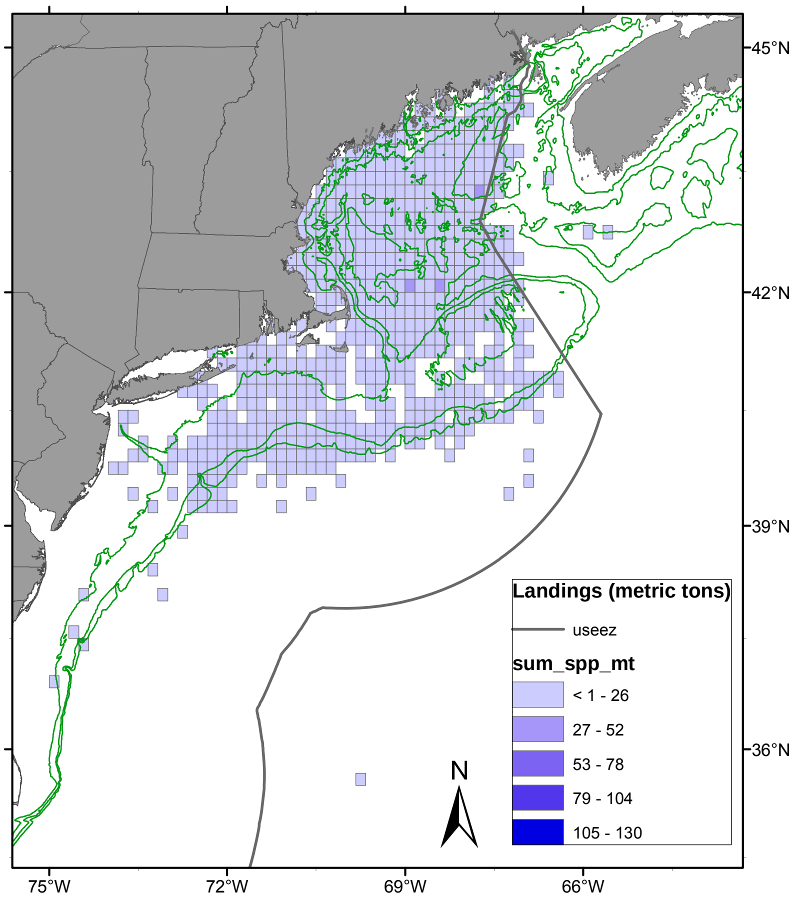


Figure B17. Landings of white hake from the otter trawl fishery from 1985-1989 and 1990-1994.

White Hake Otter Trawl Landings (1995-1999)



White Hake Otter Trawl Landings (2000-2004)

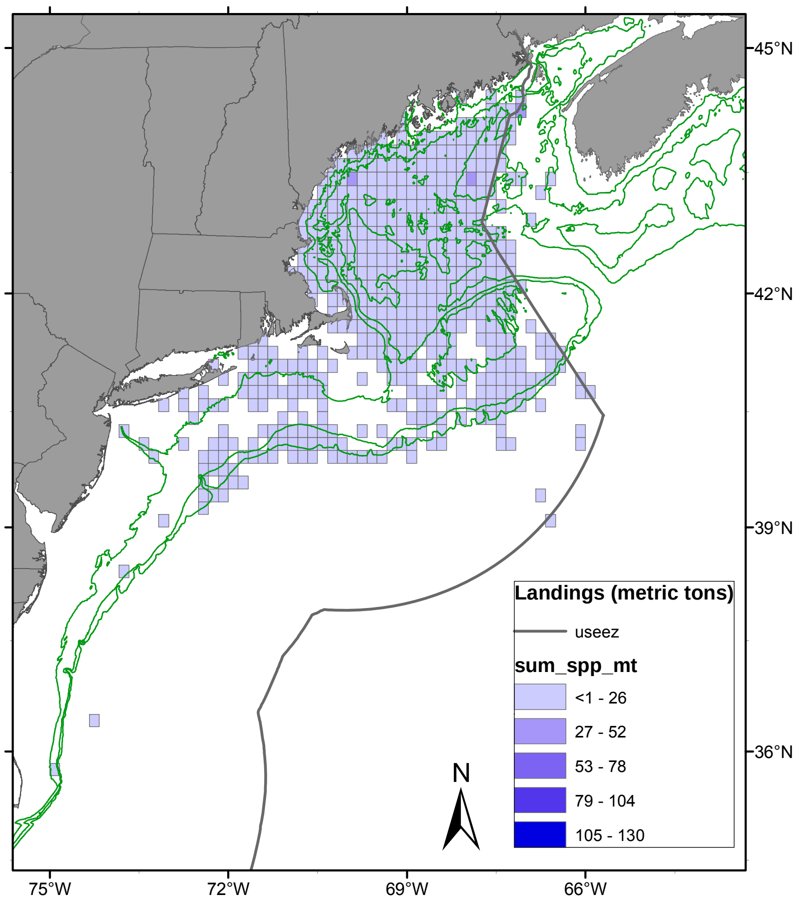


Figure B18. Landings of white hake from the otter trawl fishery from 1995-1999 and 2000-2004.

White Hake Otter Trawl Landings (2005-2009)

White Hake Otter Trawl Landings (2010-2011)

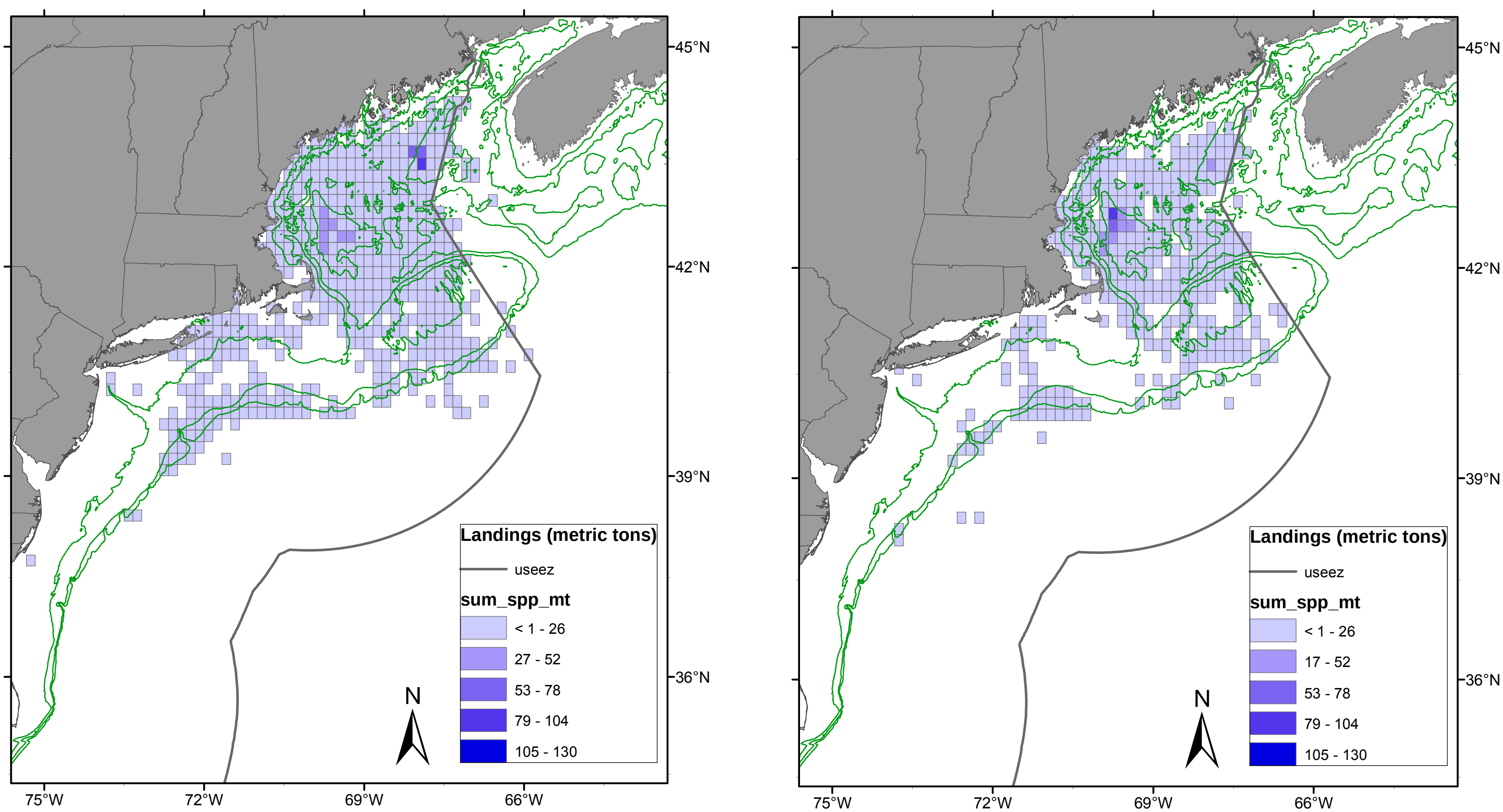
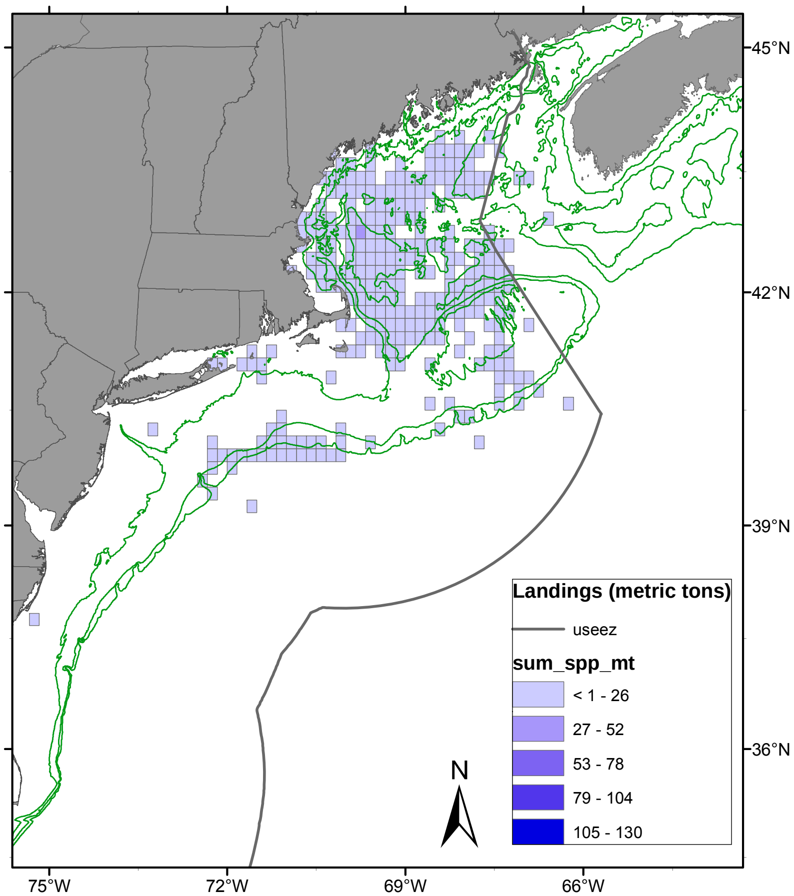


Figure B19. Landings of white hake from the otter trawl fishery from 2005-2009 and 2010-2011.

White Hake Otter Trawl Landings (2008)



White Hake Otter Trawl Landings (2009)

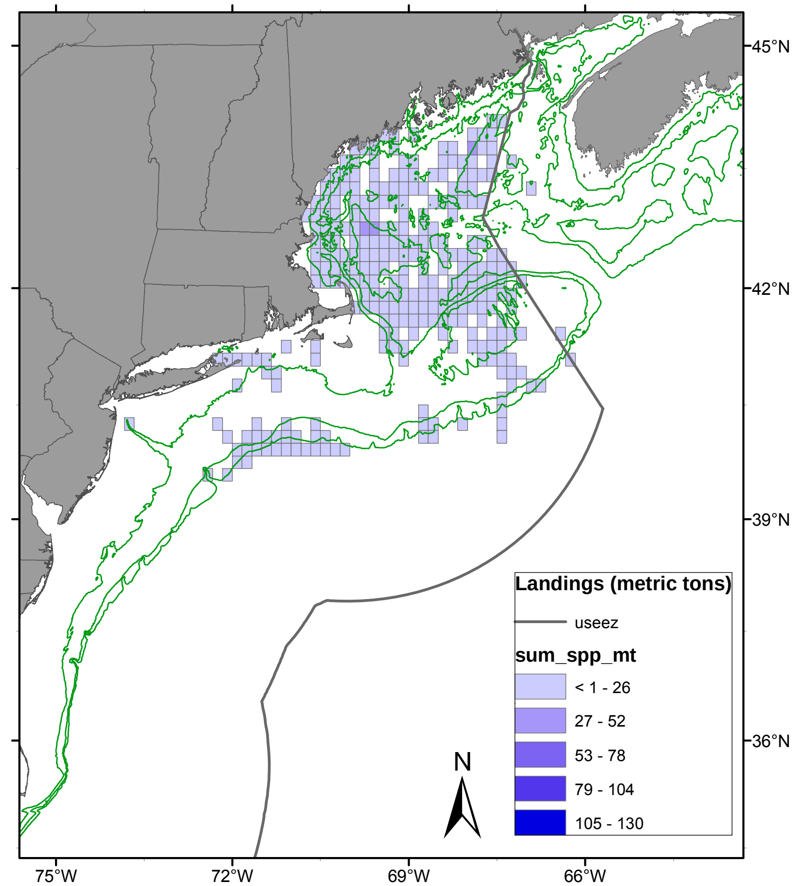
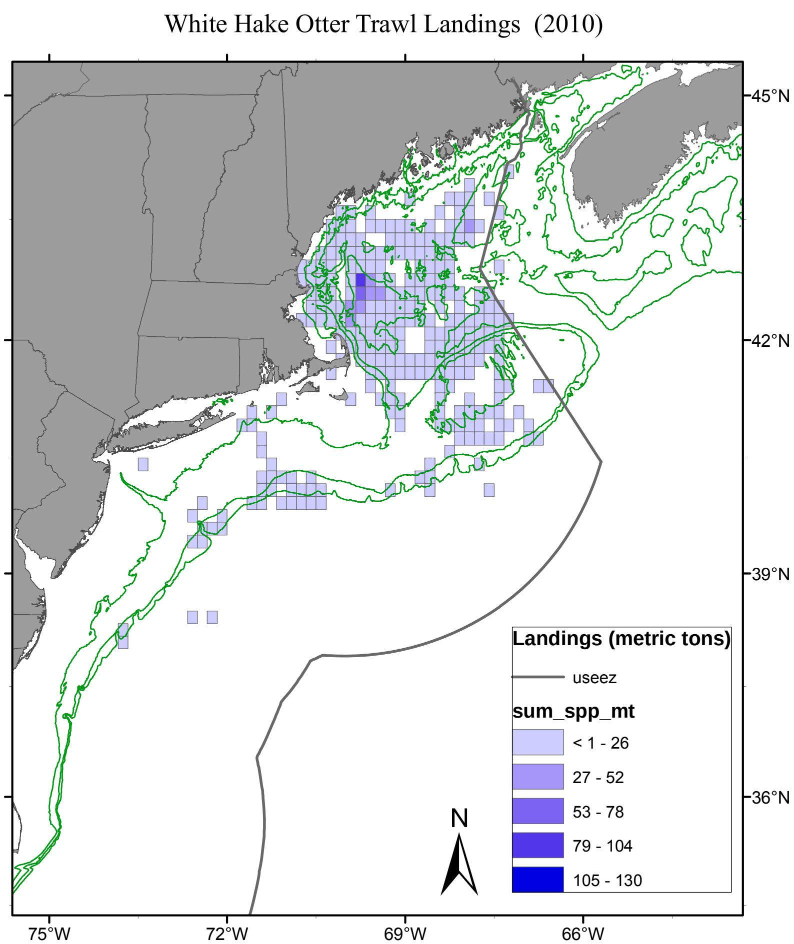


Figure B20a. Landings of white hake from the otter trawl fishery from 2008-2011.



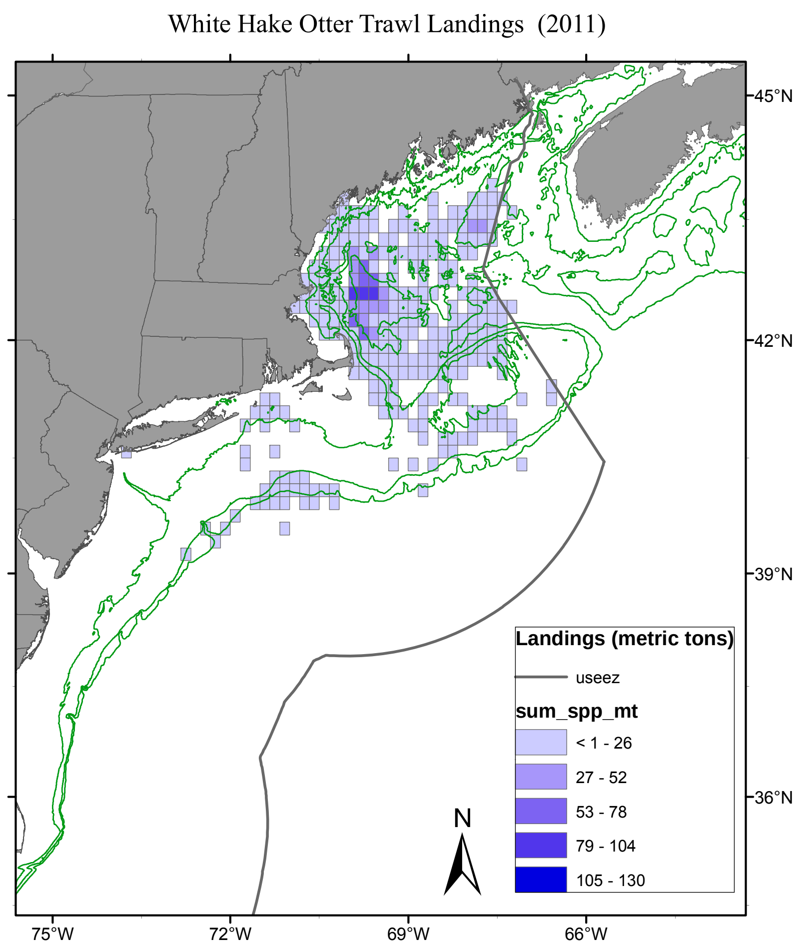
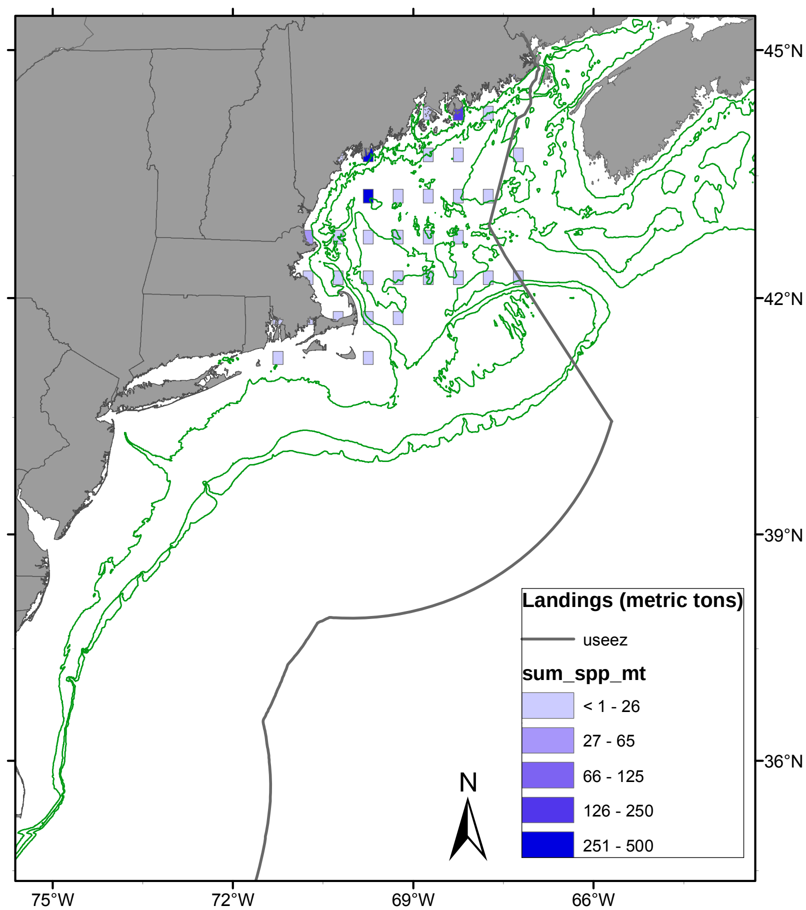


Figure B20b. Landings of white hake from the otter trawl fishery from 2008-2011.

White Hake Gillnet Landings (1975-1979)



White Hake Gillnet Landings (1980-1984)

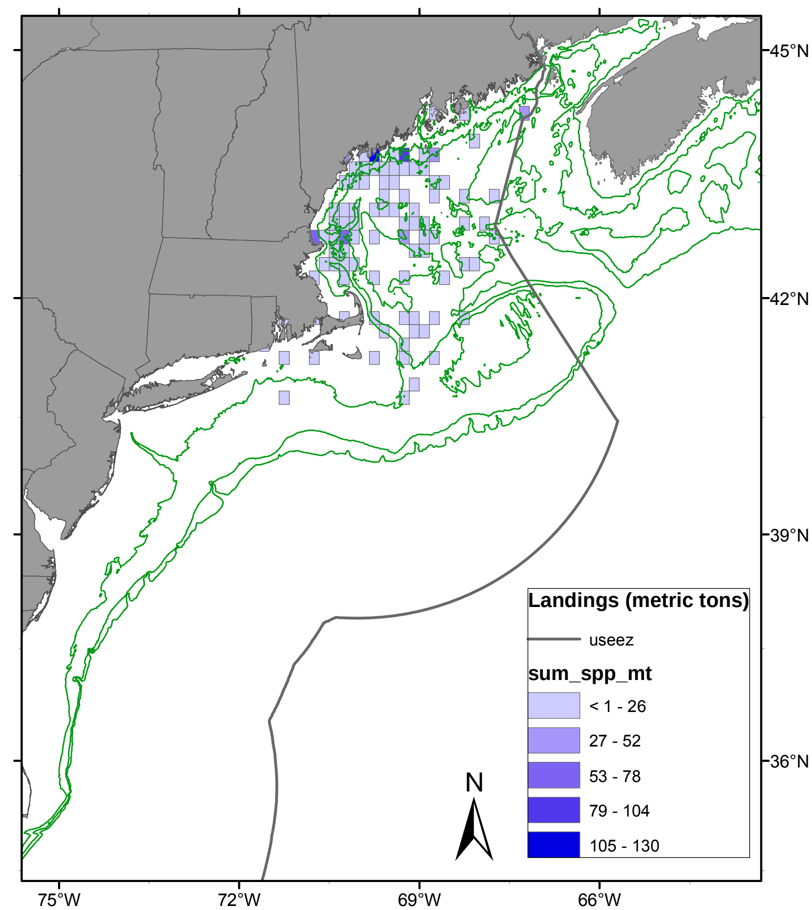


Figure B21. Landings of white hake from the sink gill net fishery from 1975-1979 and 1980-1984.

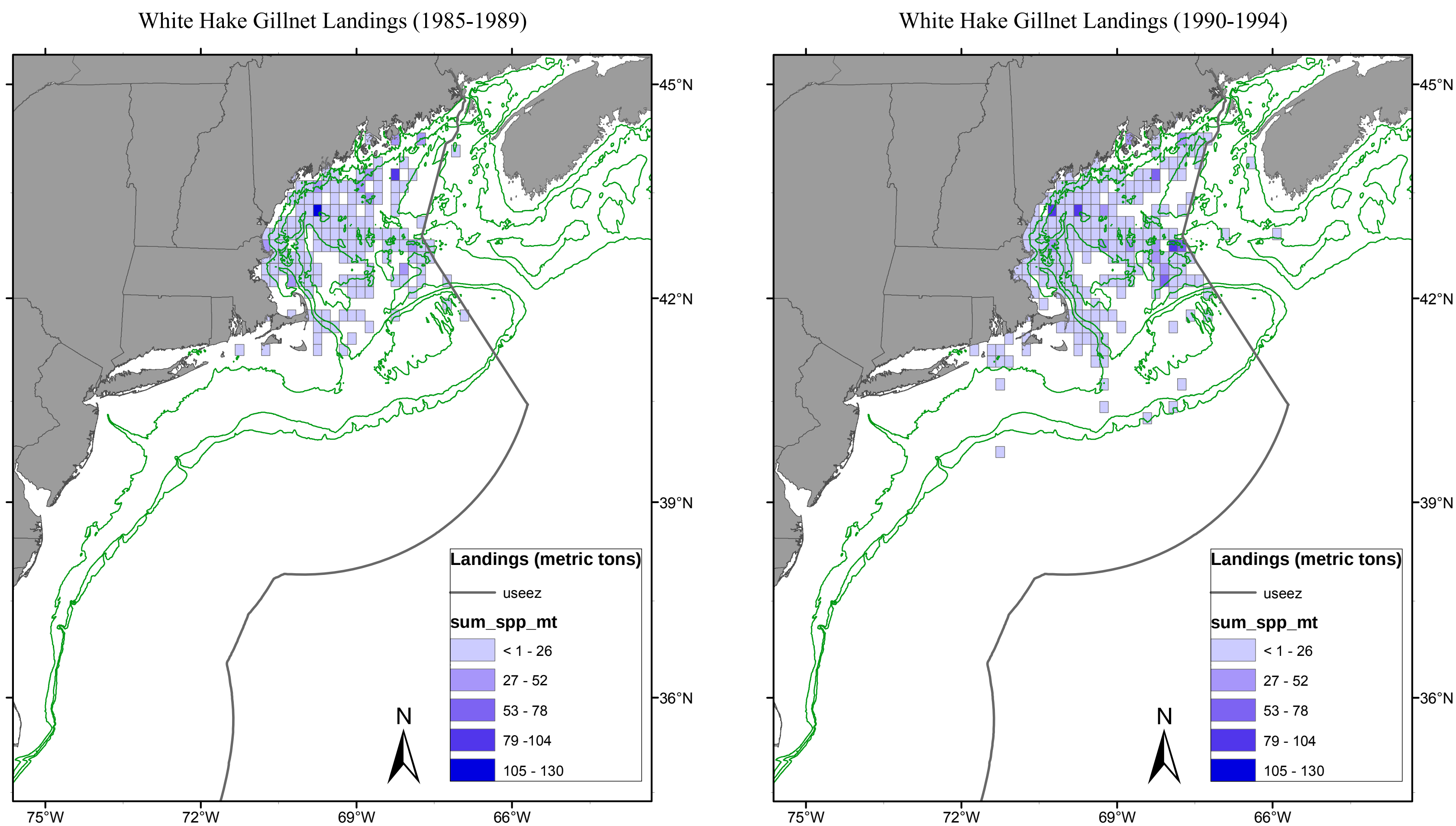


Figure B22. Landings of white hake from the sink gill net fishery from 1985-1989 and 1990-1994.

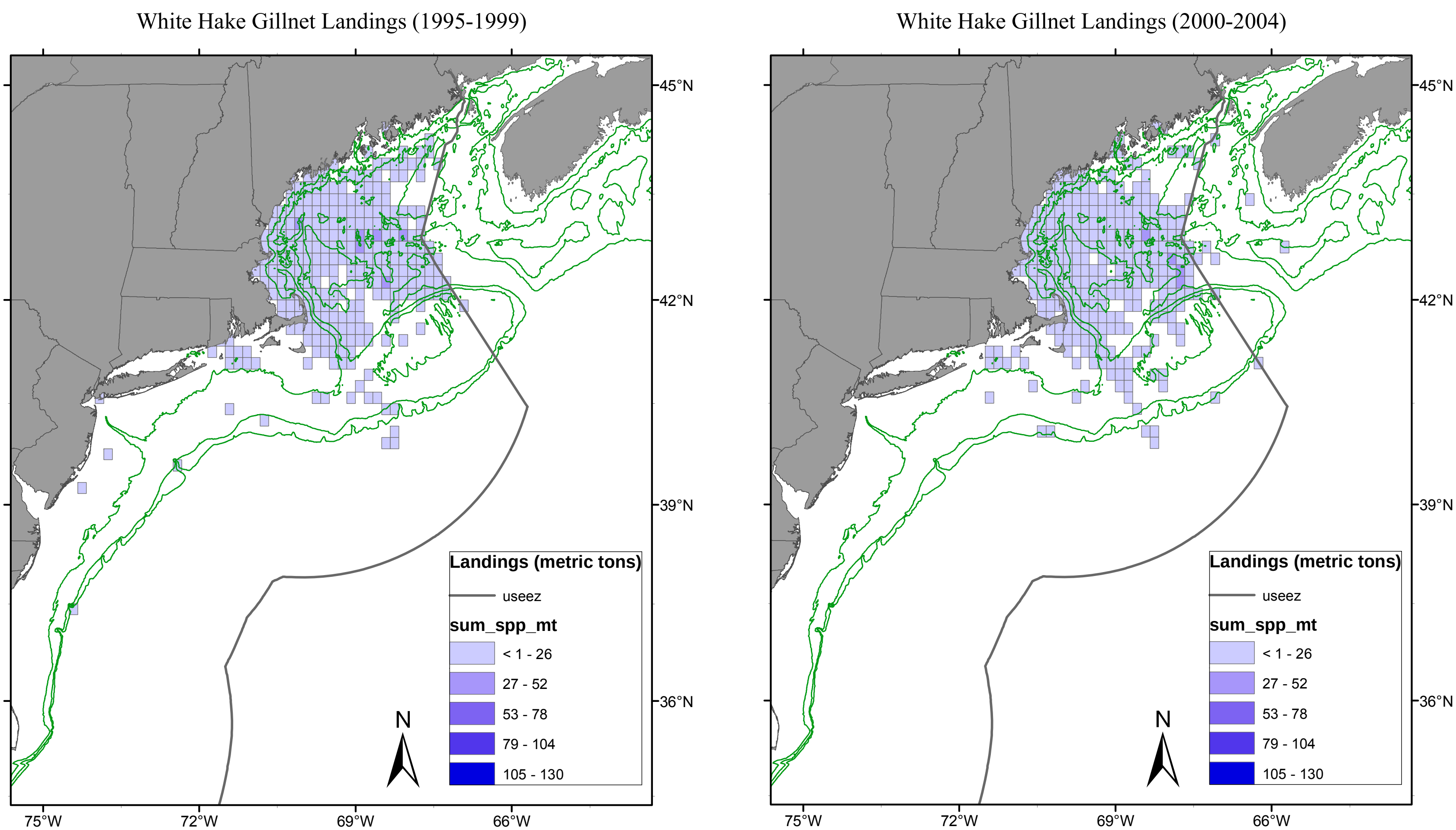
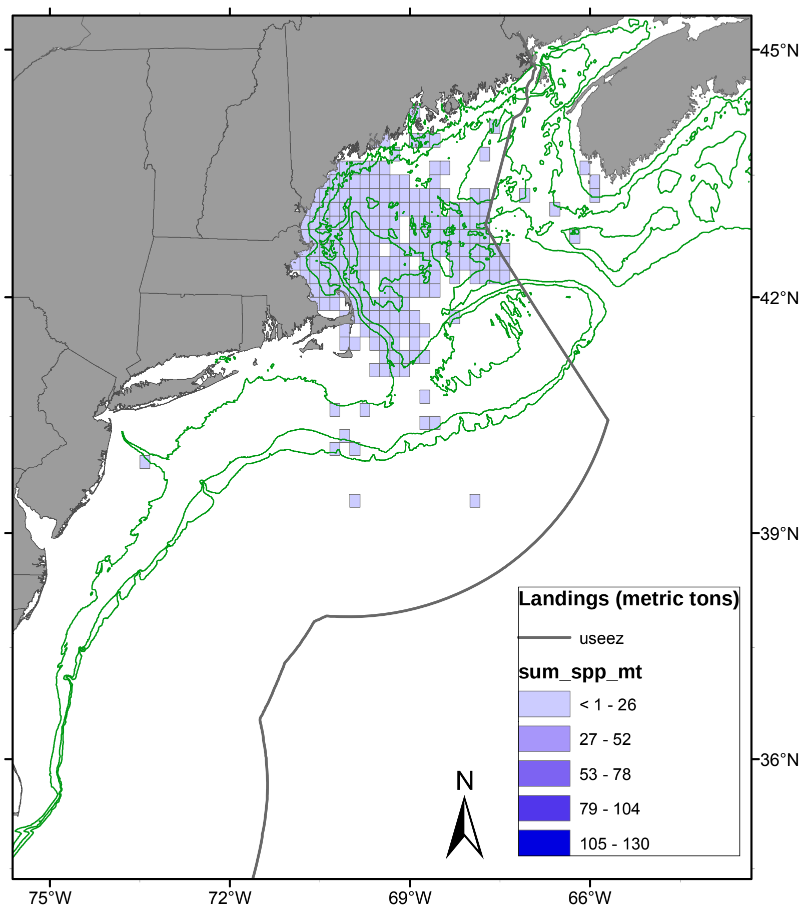


Figure B23. Landings of white hake from the sink gill net fishery from 1995-1999 and 2000-2004.

White Hake Gillnet Landings (2005-2009)



White Hake Gillnet Landings (2010-2011)

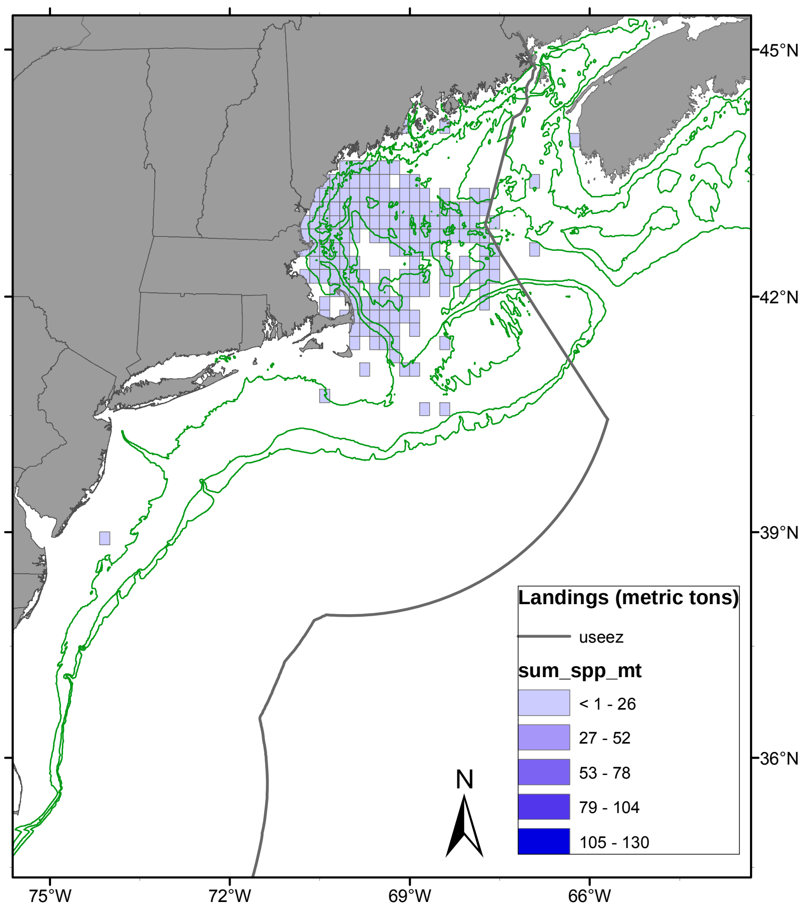
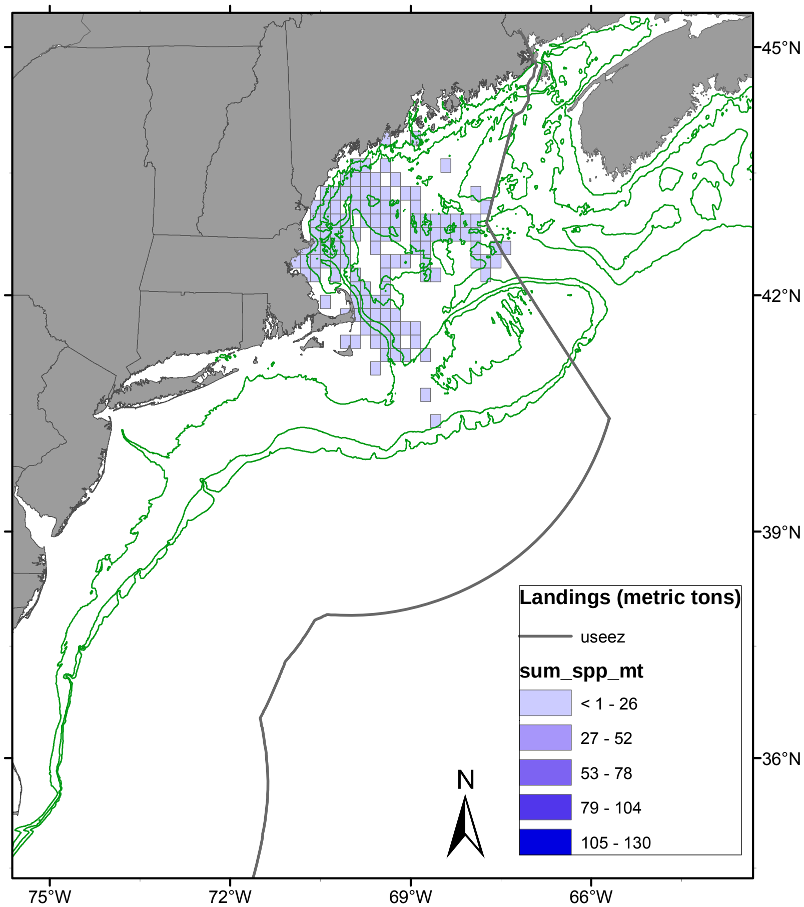


Figure B24. Landings of white hake from the sink gill net fishery from 2005-2009 and 2010-2011.

White Hake Gillnet Landings (2008)



White Hake Gillnet Landings (2009)

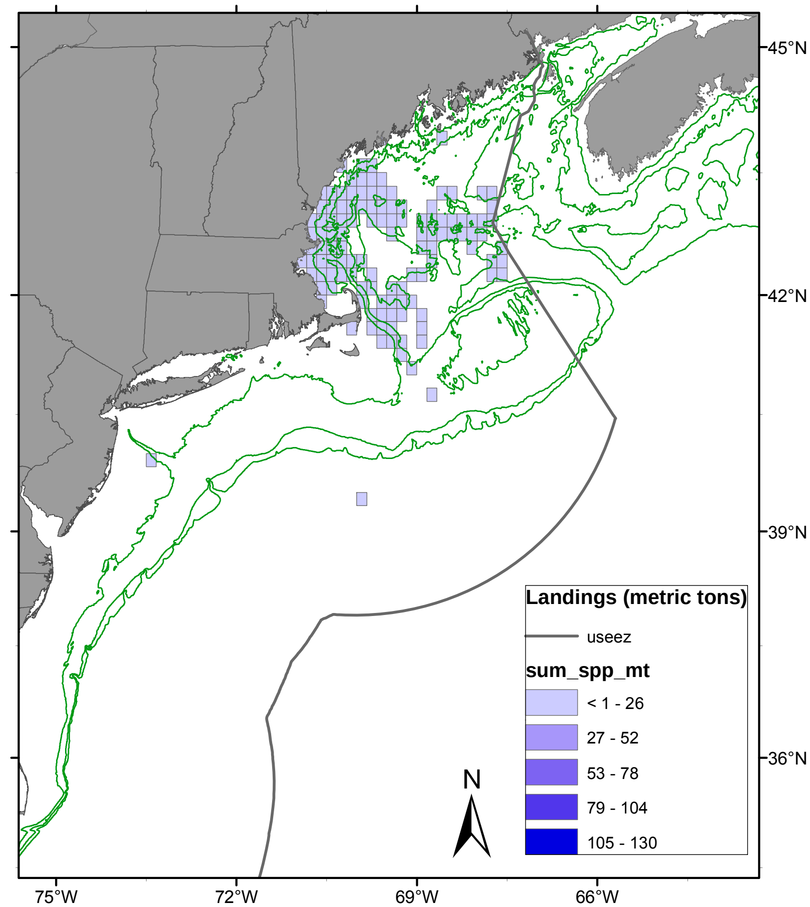
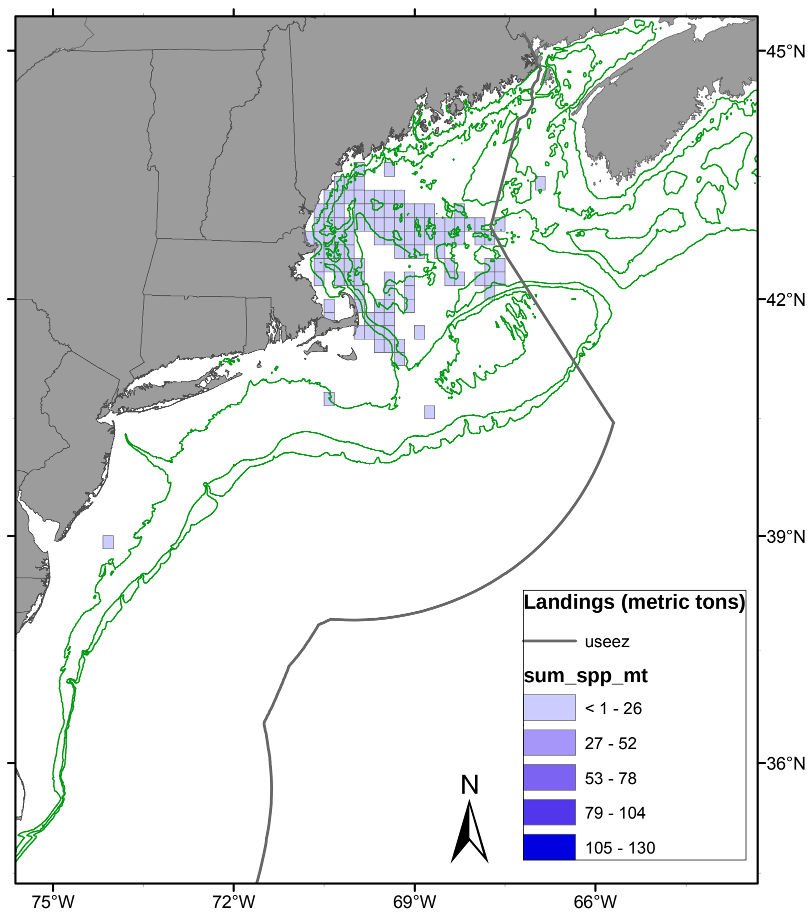


Figure B25a. Landings of white hake from the sink gill net fishery from 2008-2011.

White Hake Gillnet Landings (2010)



White Hake Gillnet Landings (2011)

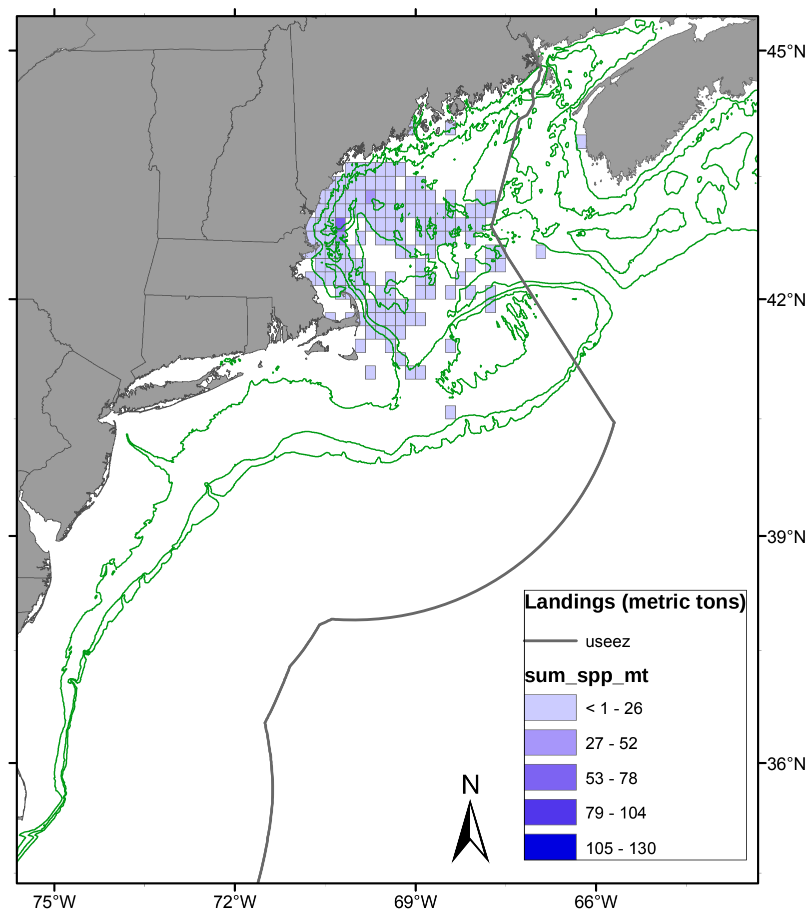


Figure B25b. Landings of white hake from the sink gill net fishery from 2008-2011.

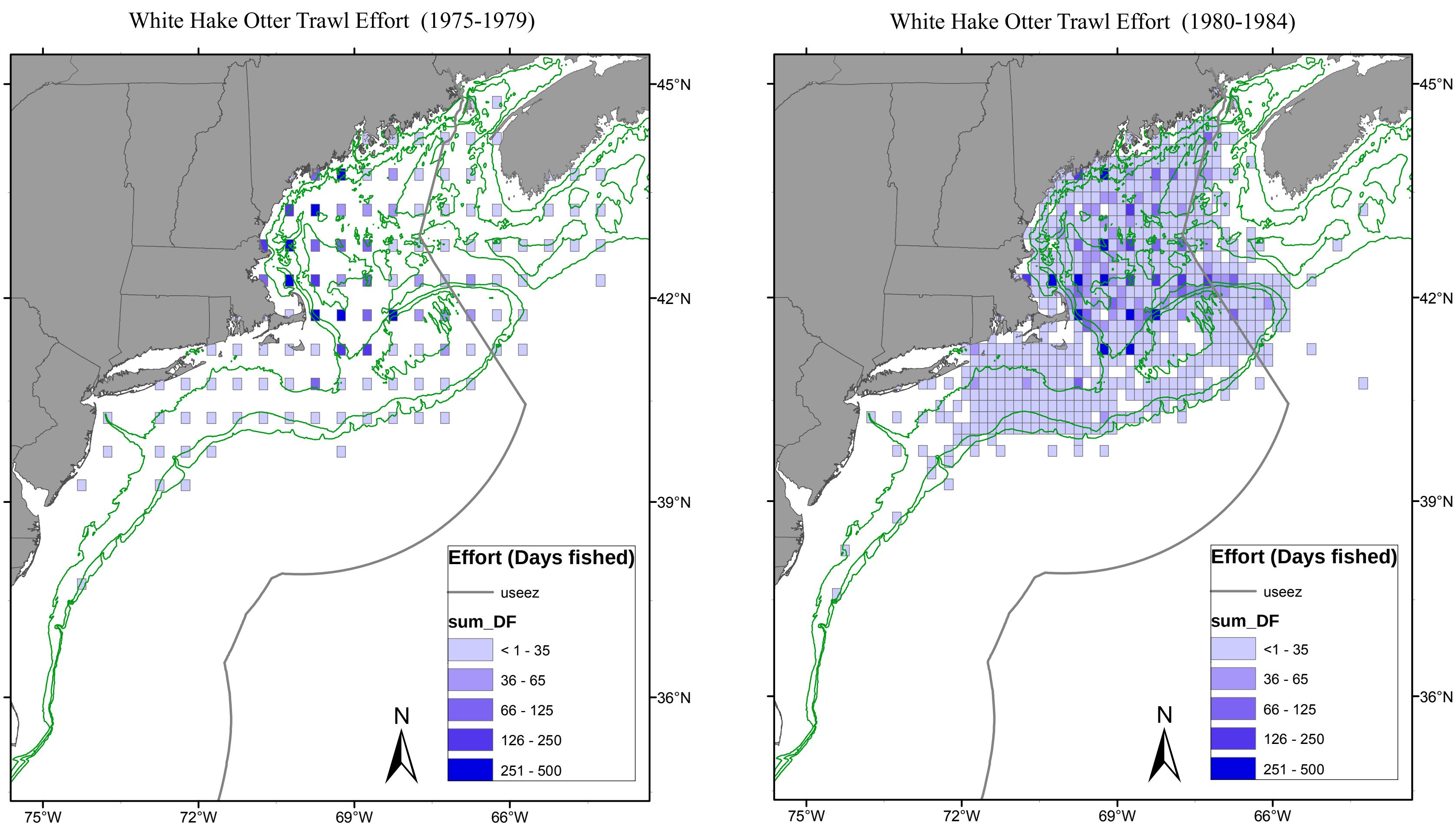
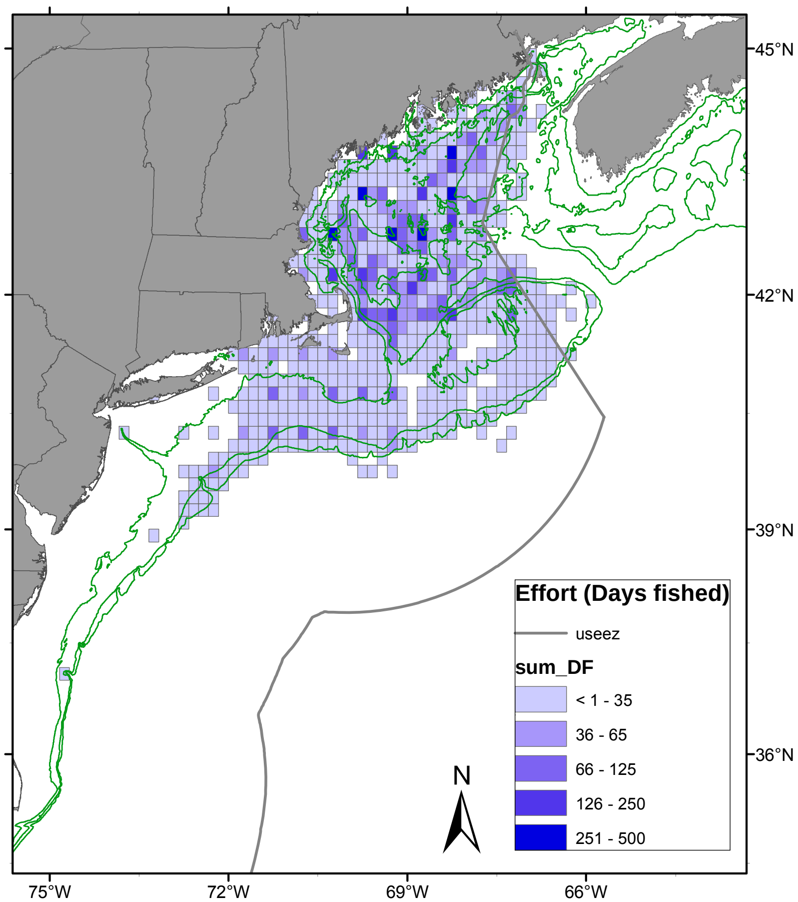


Figure B26. Days fished for trips that landed white hake from the otter trawl fishery from 1975-1979 and 1980-1984.

White Hake Otter Trawl Effort (1985-1989)



White Hake Otter Trawl Effort (1990-1994)

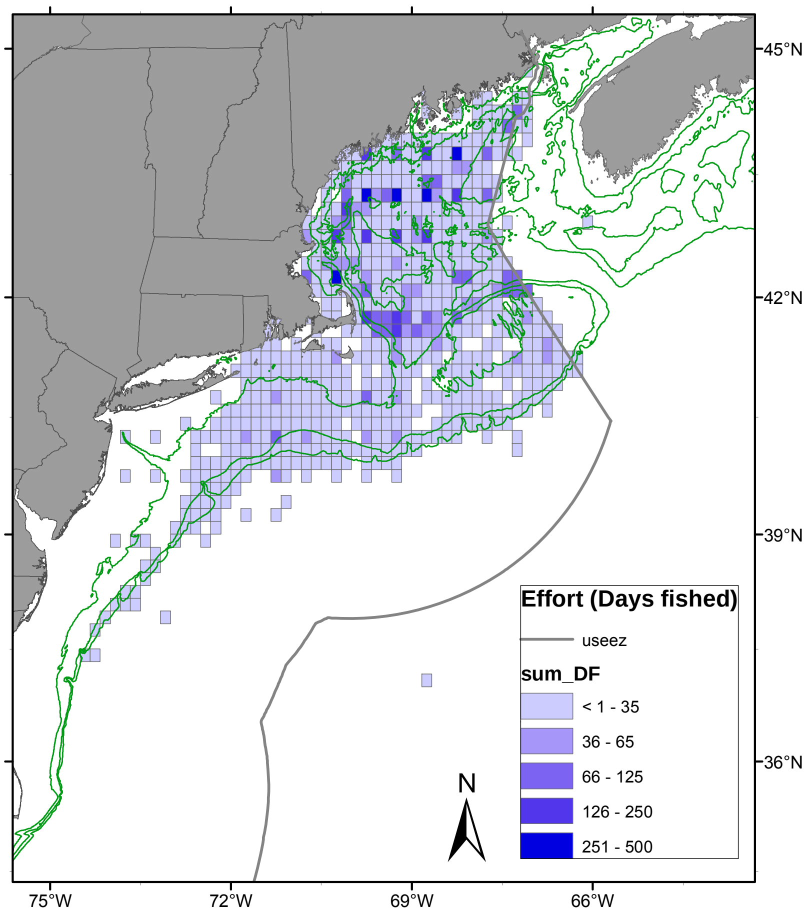


Figure B27. Days fished for trips that landed white hake from the otter trawl fishery from 1985-1989 and 1990-1994.

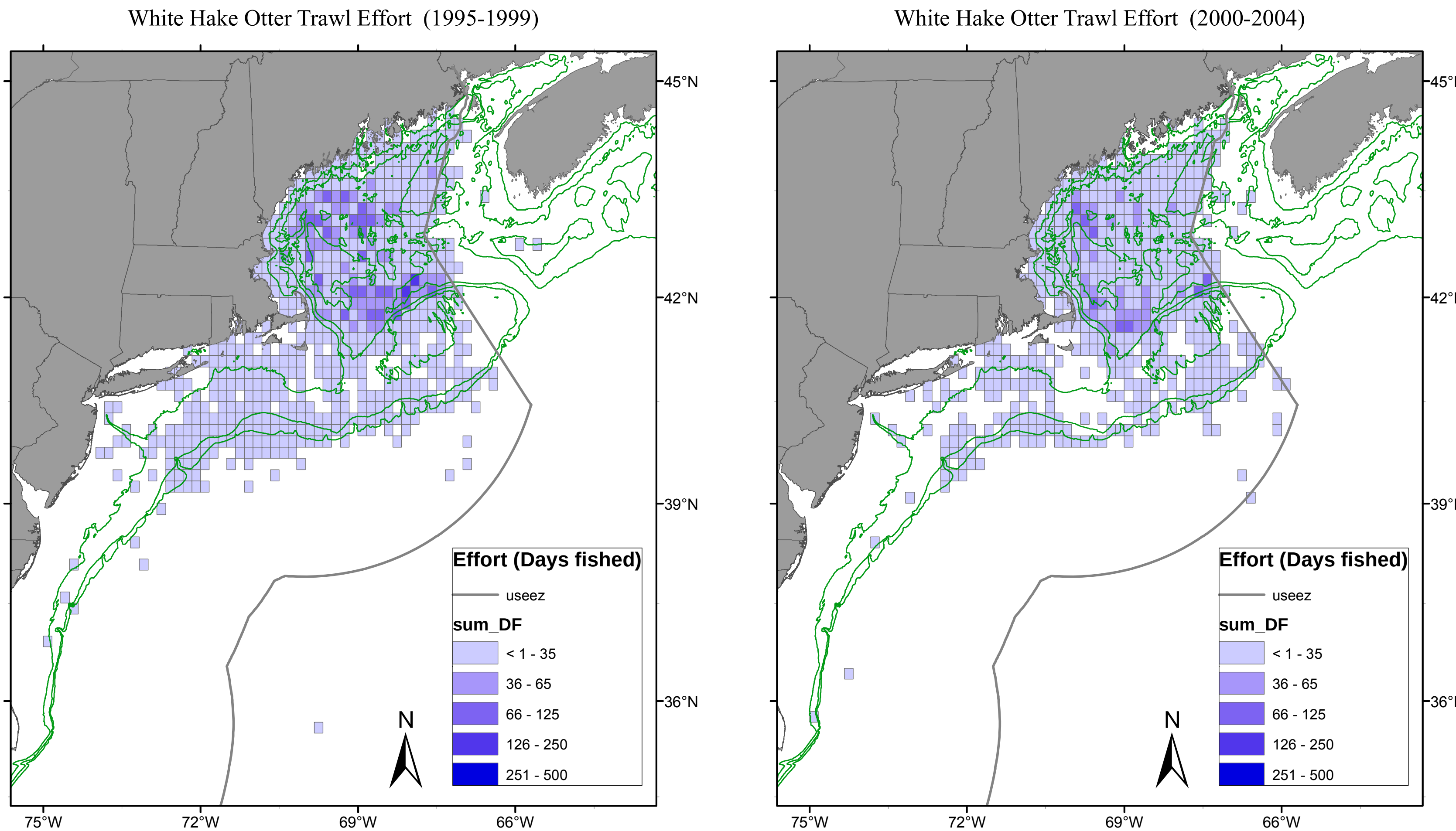
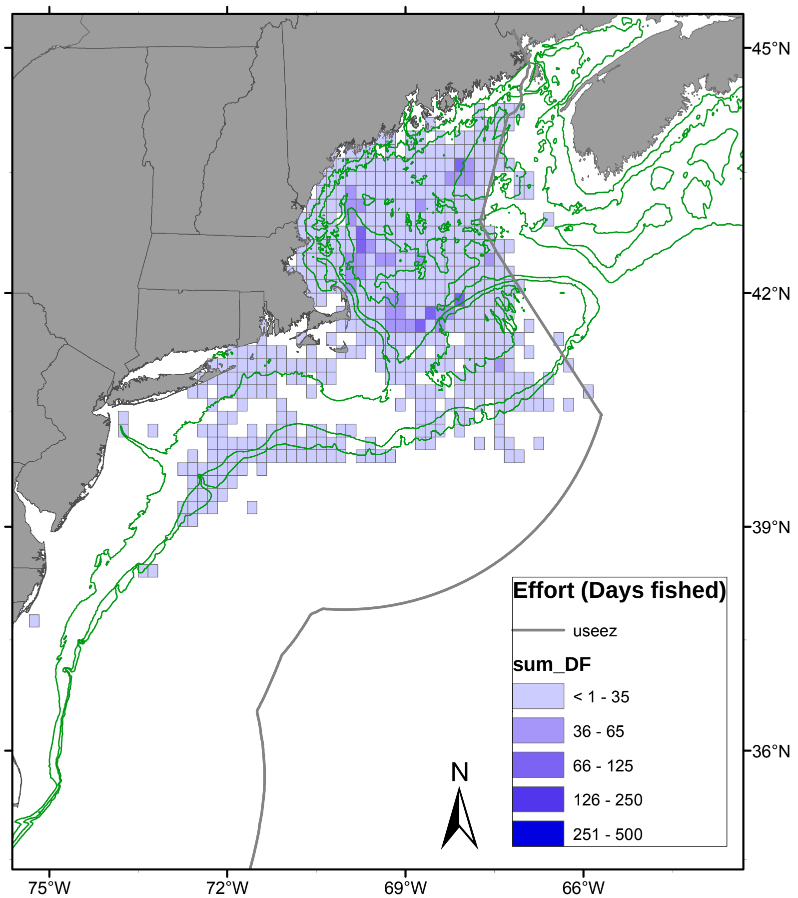


Figure B28. Days fished for trips that landed white hake from the otter trawl fishery from 1995-1999 and 2000-2004.

White Hake Otter Trawl Effort (2005-2009)



White Hake Otter Trawl Effort (2010-2011)

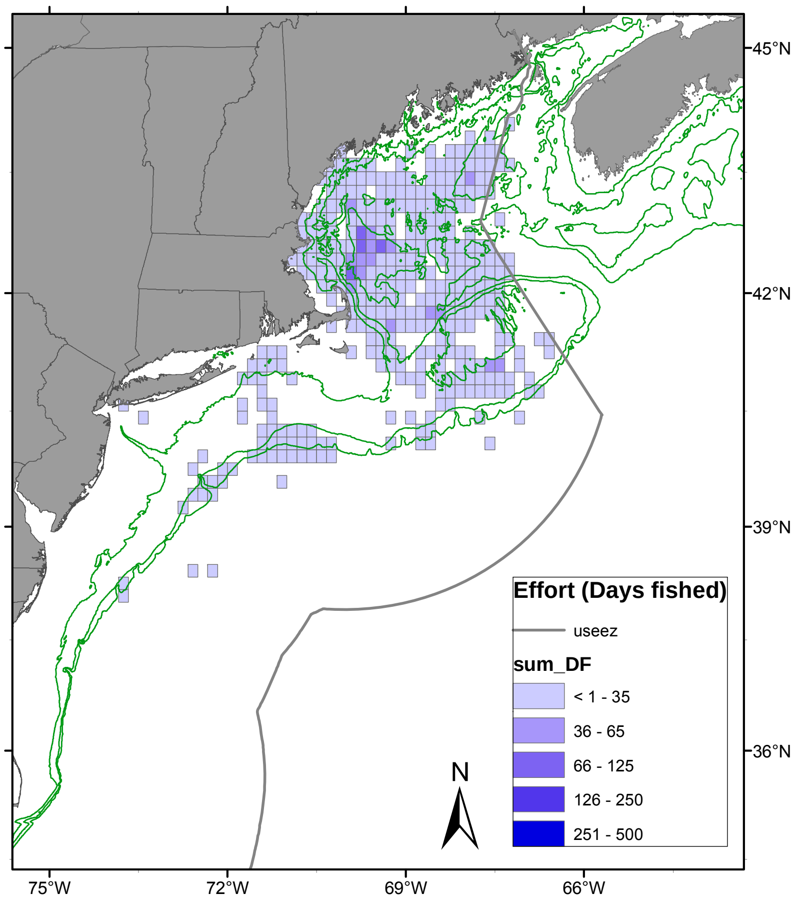
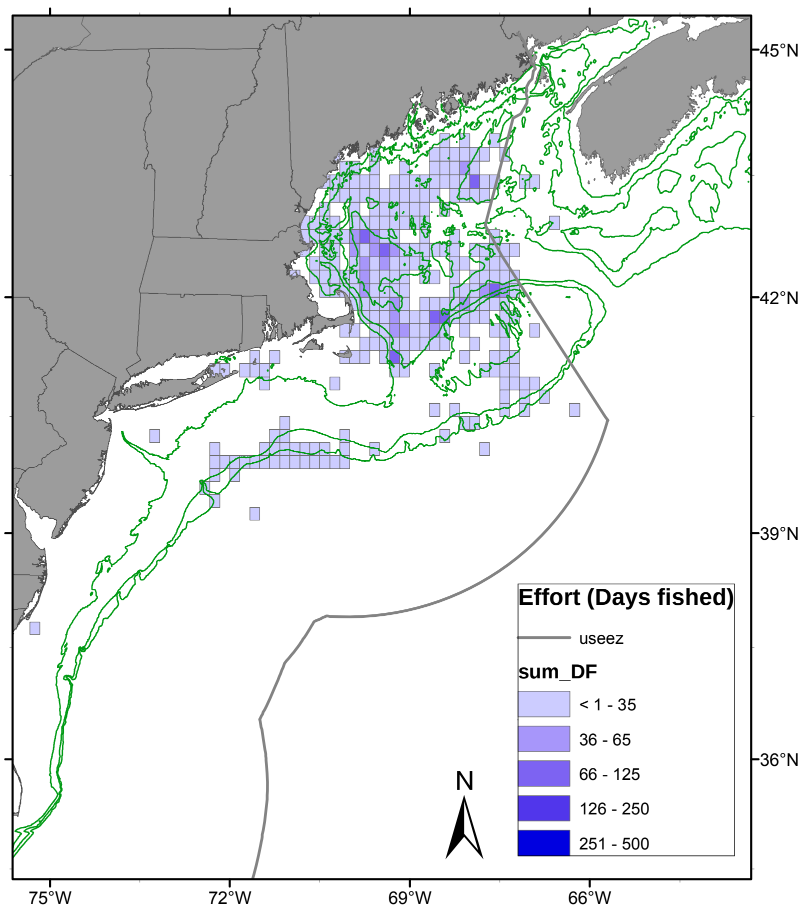


Figure B29. Days fished for trips that landed white hake from the otter trawl fishery from 2005-2009 and 2010-2011.

White Hake Otter Trawl Effort (2008)



White Hake Otter Trawl Effort (2009)

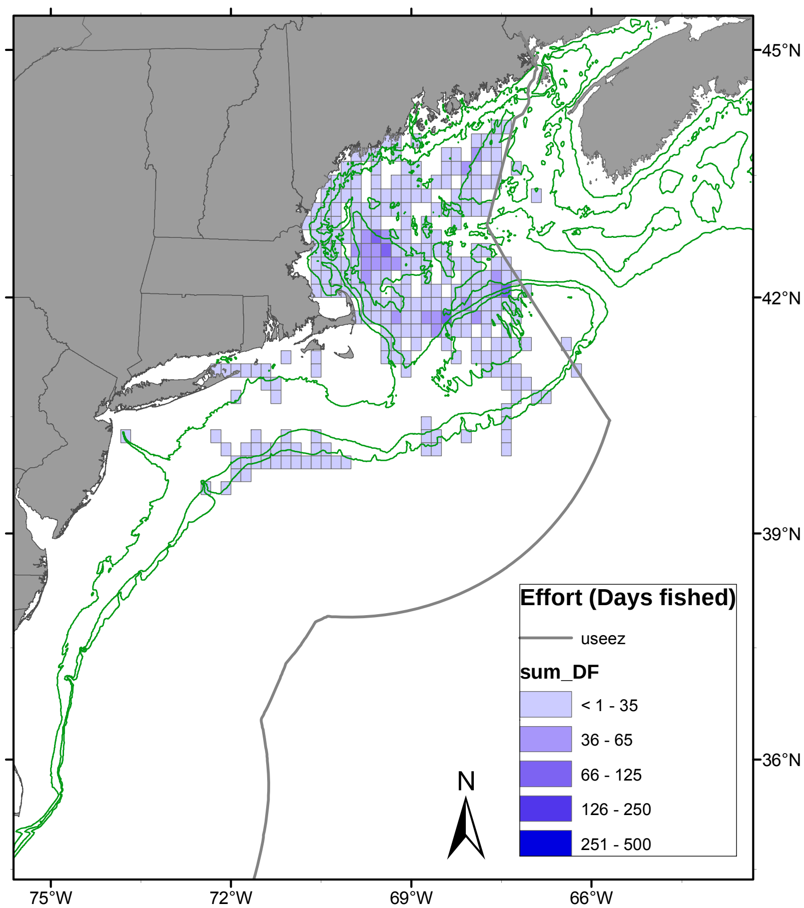
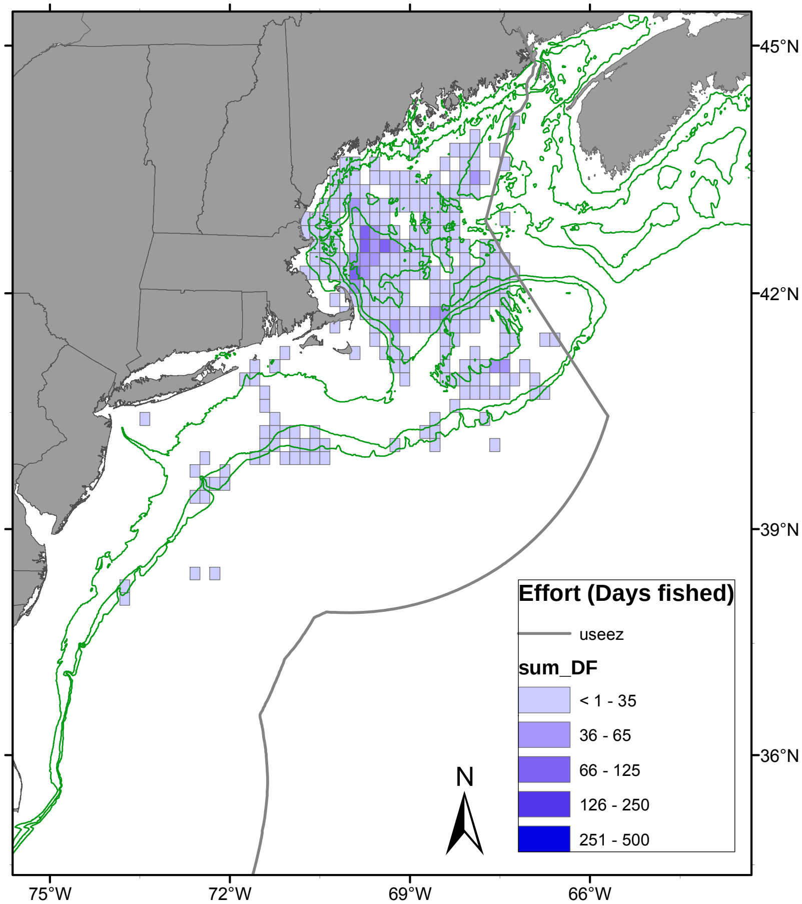


Figure B30a. Days fished for trips that landed white hake from the otter trawl fishery from 2008-2011.

White Hake Otter Trawl Effort (2010)



White Hake Otter Trawl Effort (2011)

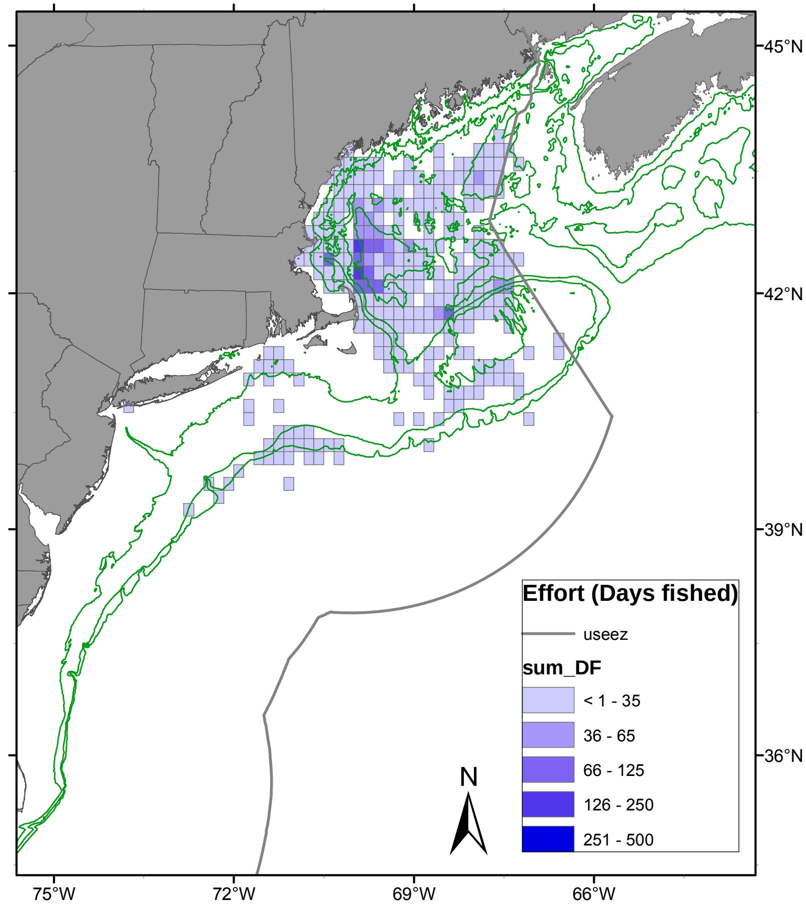


Figure B30b. Days fished for trips that landed white hake from the otter trawl fishery from 2008-2011.

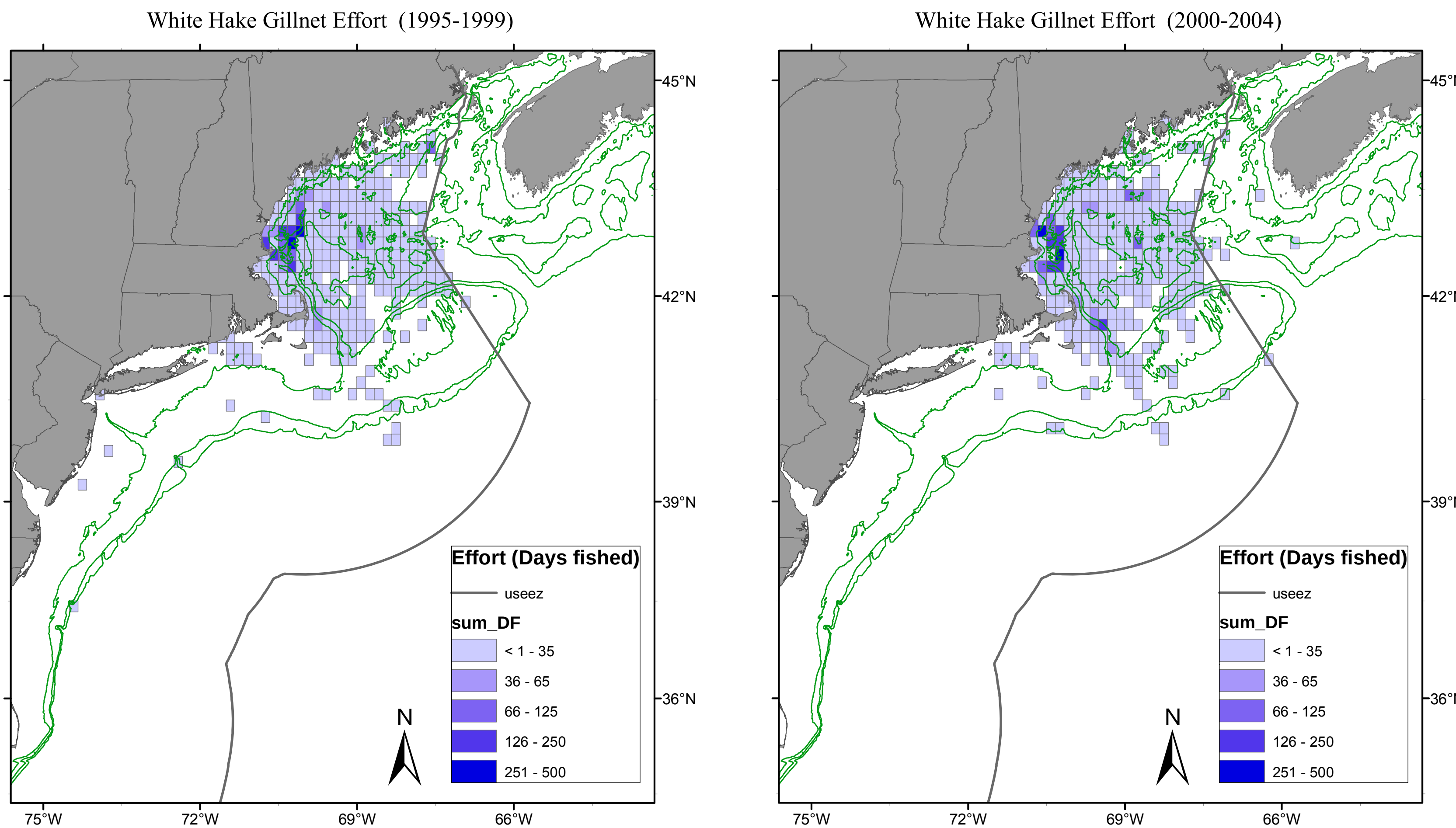
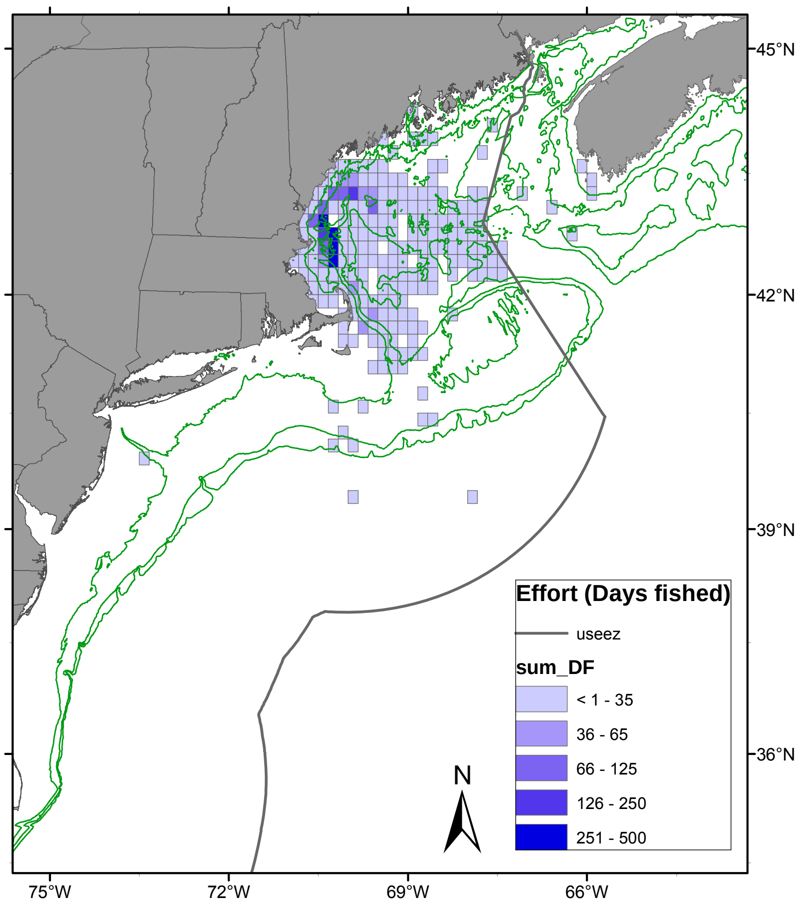


Figure B31. Days fished for trips that landed white hake from the sink gill net fishery from 1995-1999 and 2000-2004.

White Hake Gillnet Effort (2005-2009)



White Hake Gillnet Effort (2010-2011)

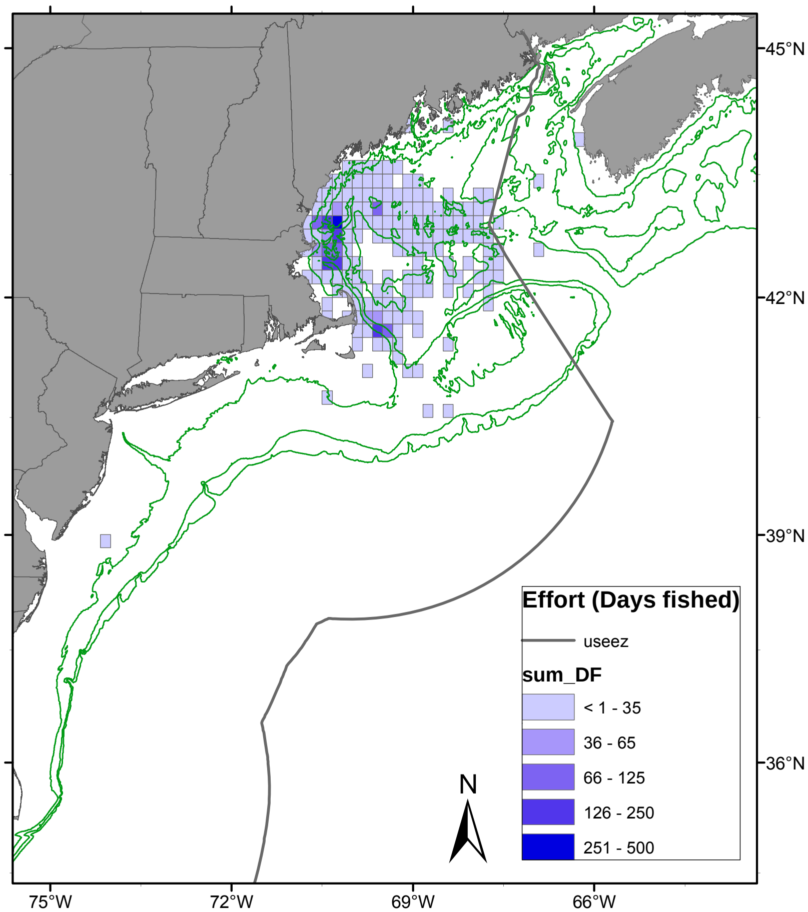
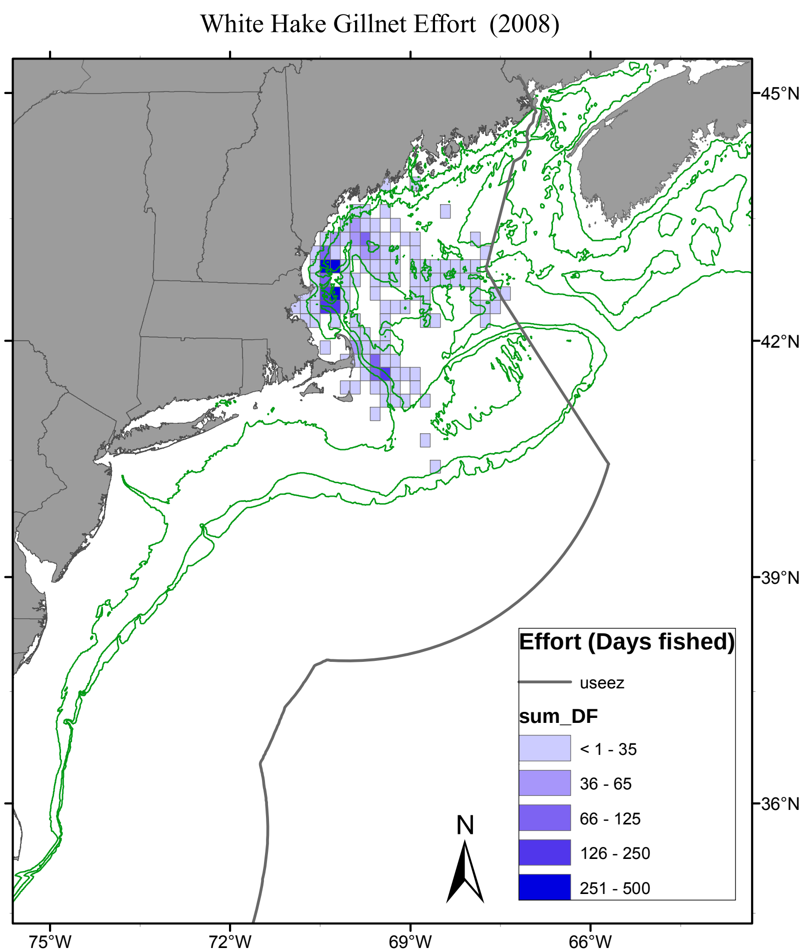


Figure B32. Days fished for trips that landed white hake from the sink gill net fishery from 2005-2009 and 2010-2011.



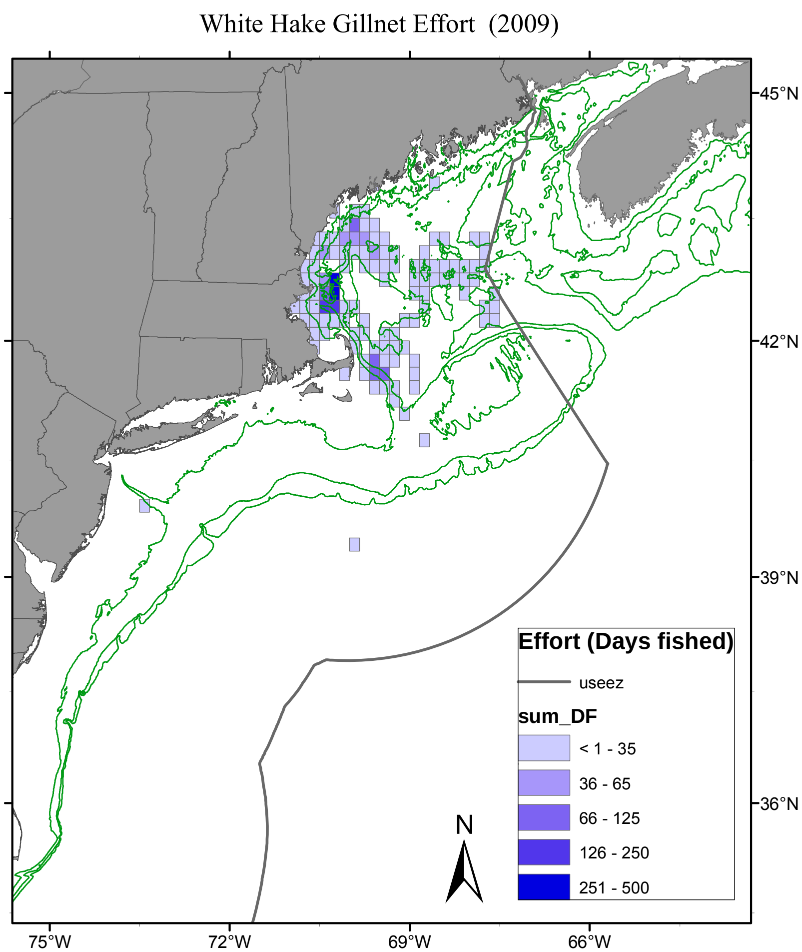
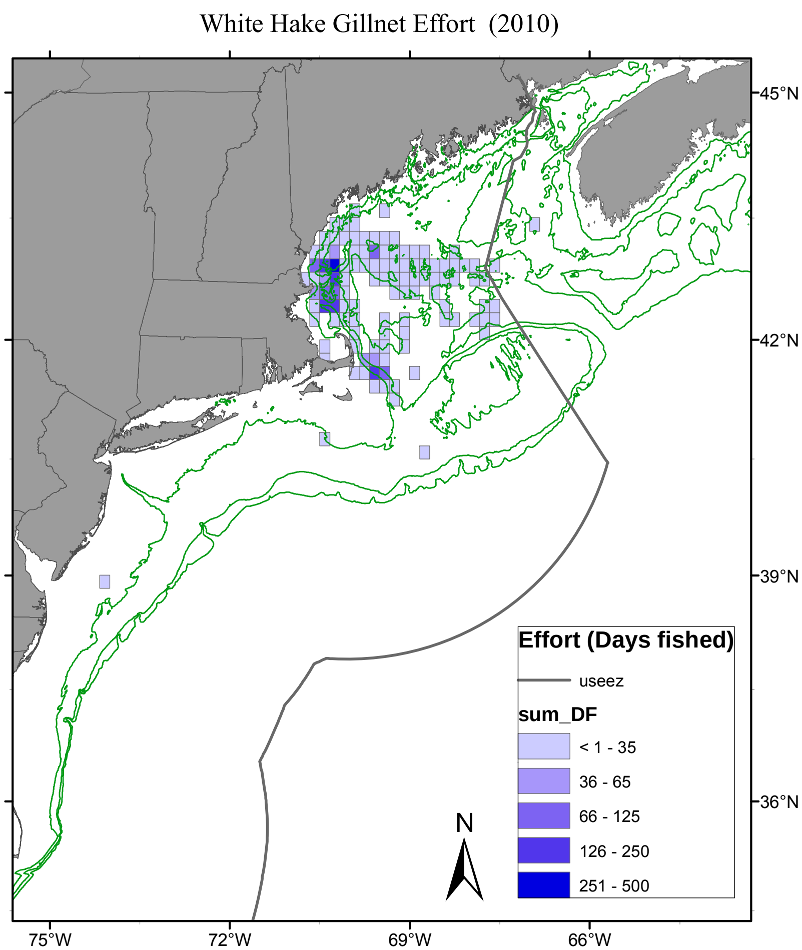


Figure B33a. Days fished for trips that landed white hake from the sink gill net fishery from 2008-2011.



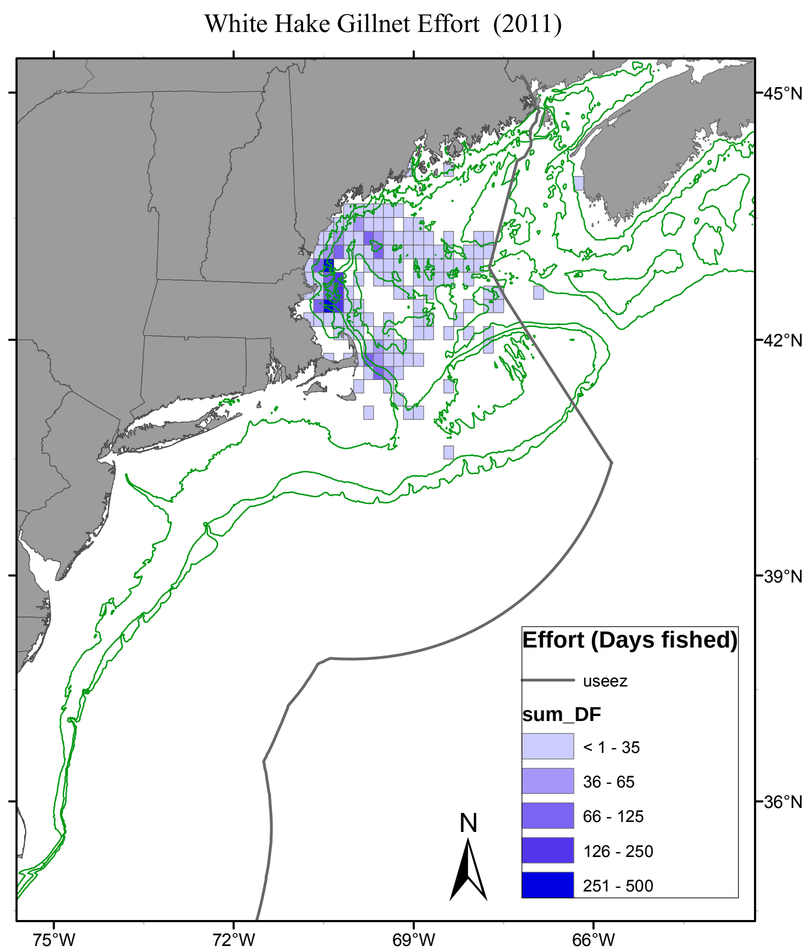


Figure B33b. Days fished for trips that landed white hake from the sink gill net fishery from 2008-2011.

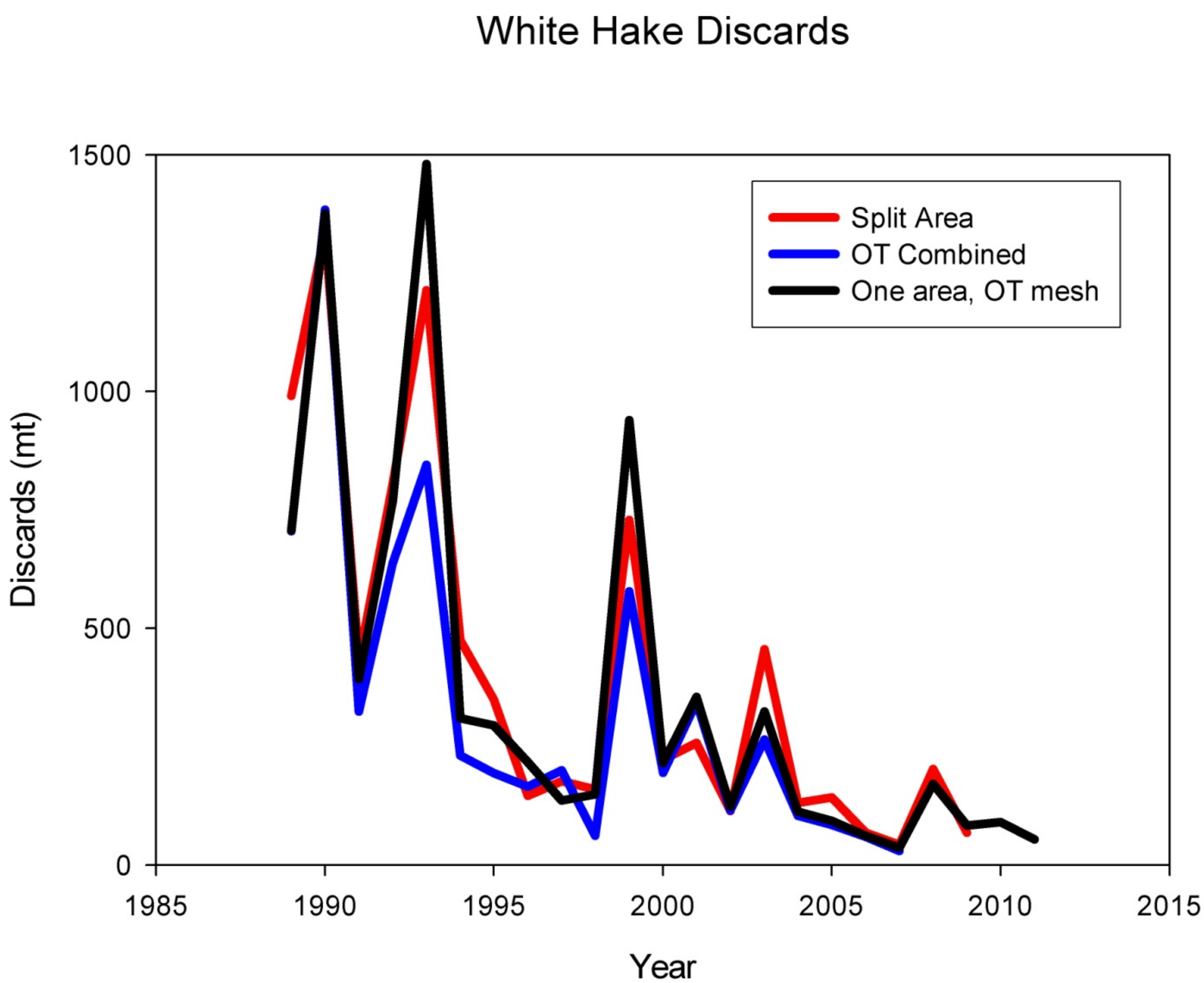


Figure B34. Discards of white hake using three different stratification schemes. The red line uses two areas as in the red hake assessment (NEFSC 2011), the blue line combines otter trawl small and large mesh (Butterworth et al 2008), and the black line uses one fishing area and splits mesh size (this assessment).

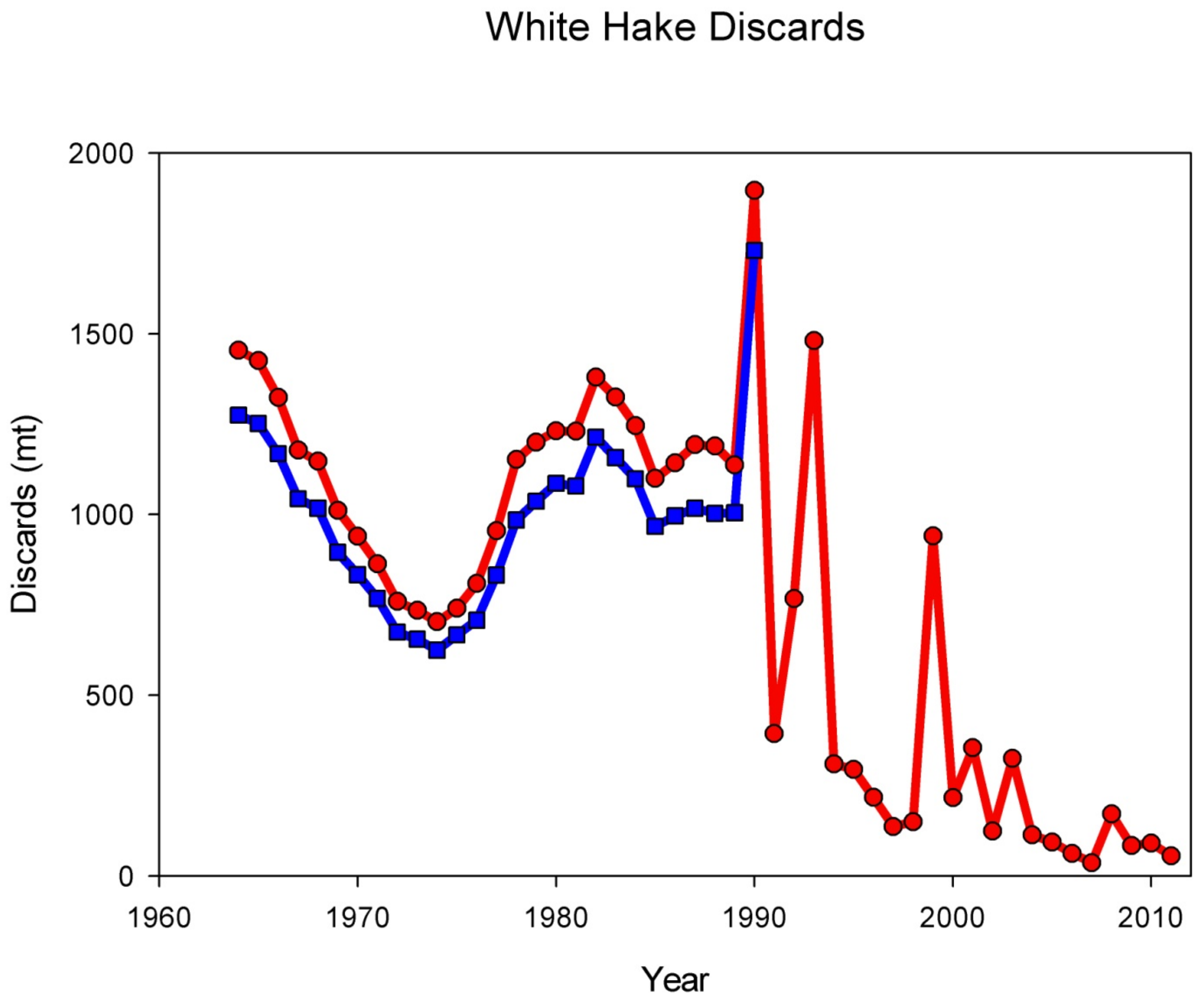


Figure B35. Discards of white hake using two time periods for hind-casting. A three-year average was used for the red circles and a five-year average for the blue squares.

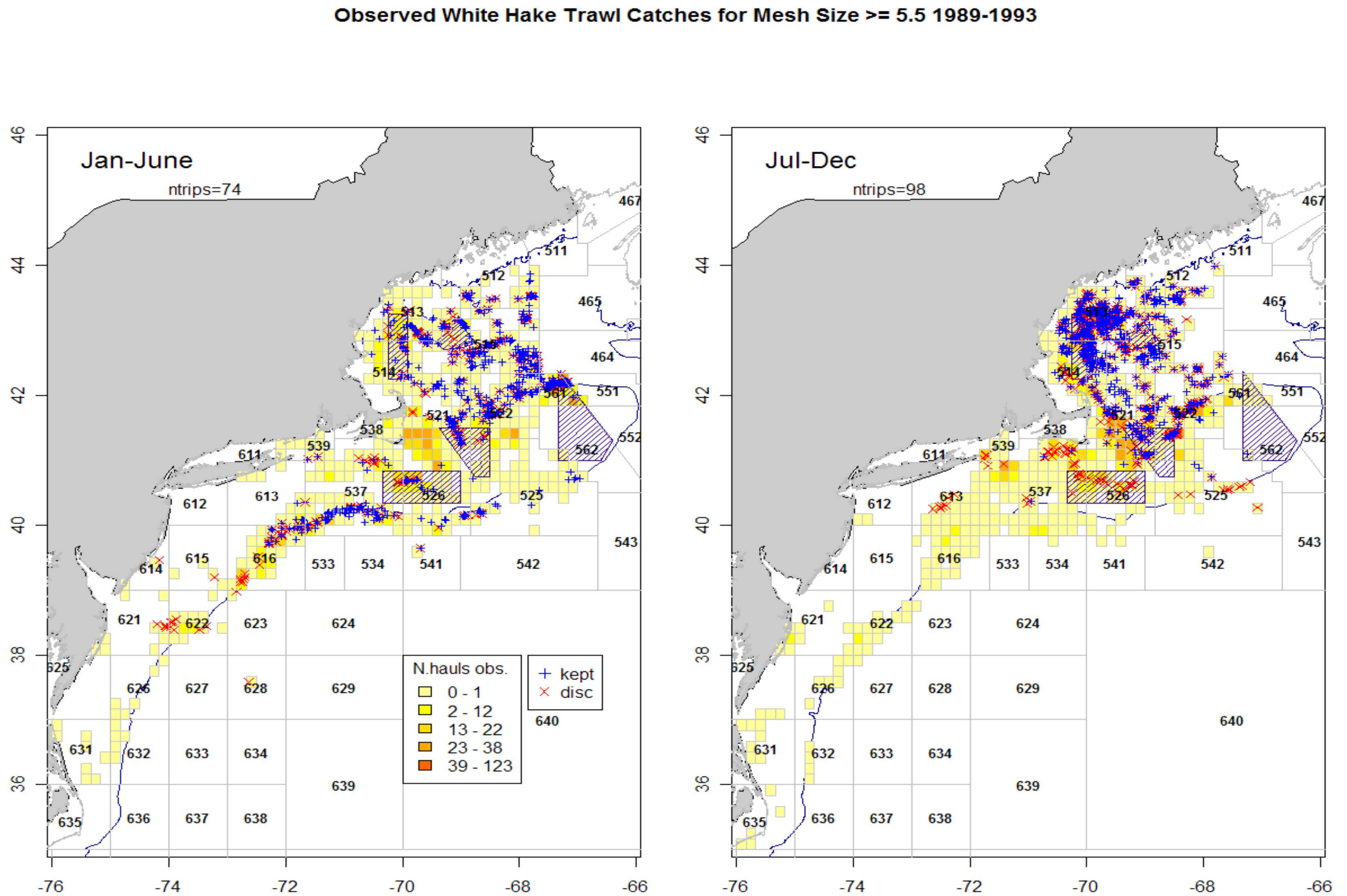


Figure B36. Observed kept and discarded white hake from 1989-1993 in the large-mesh otter trawl fishery.

Observed White Hake Trawl Catches for Mesh Size >= 5.5 1995-1999

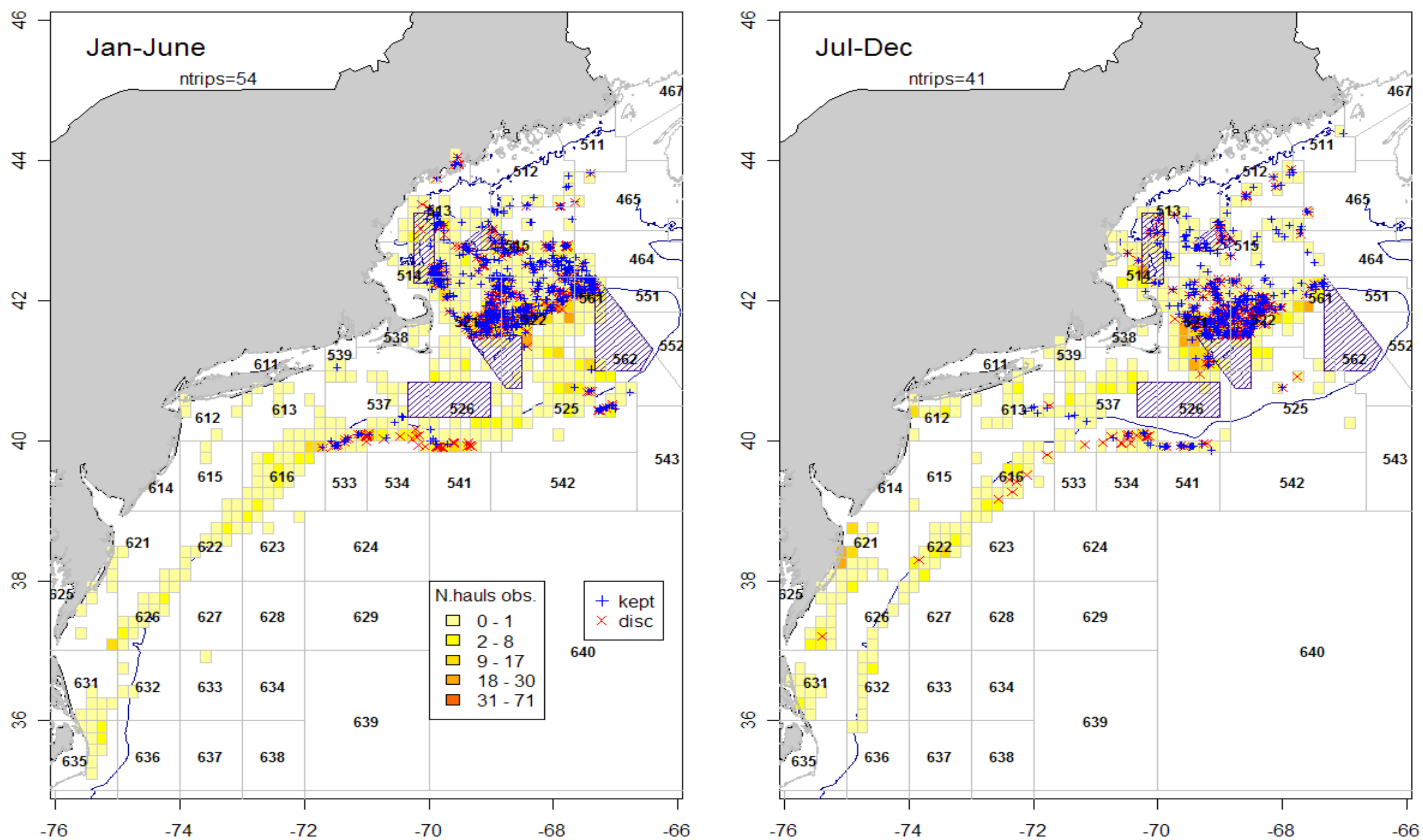


Figure B37. Observed kept and discarded white hake from 1995-1999 in the large-mesh otter trawl fishery.

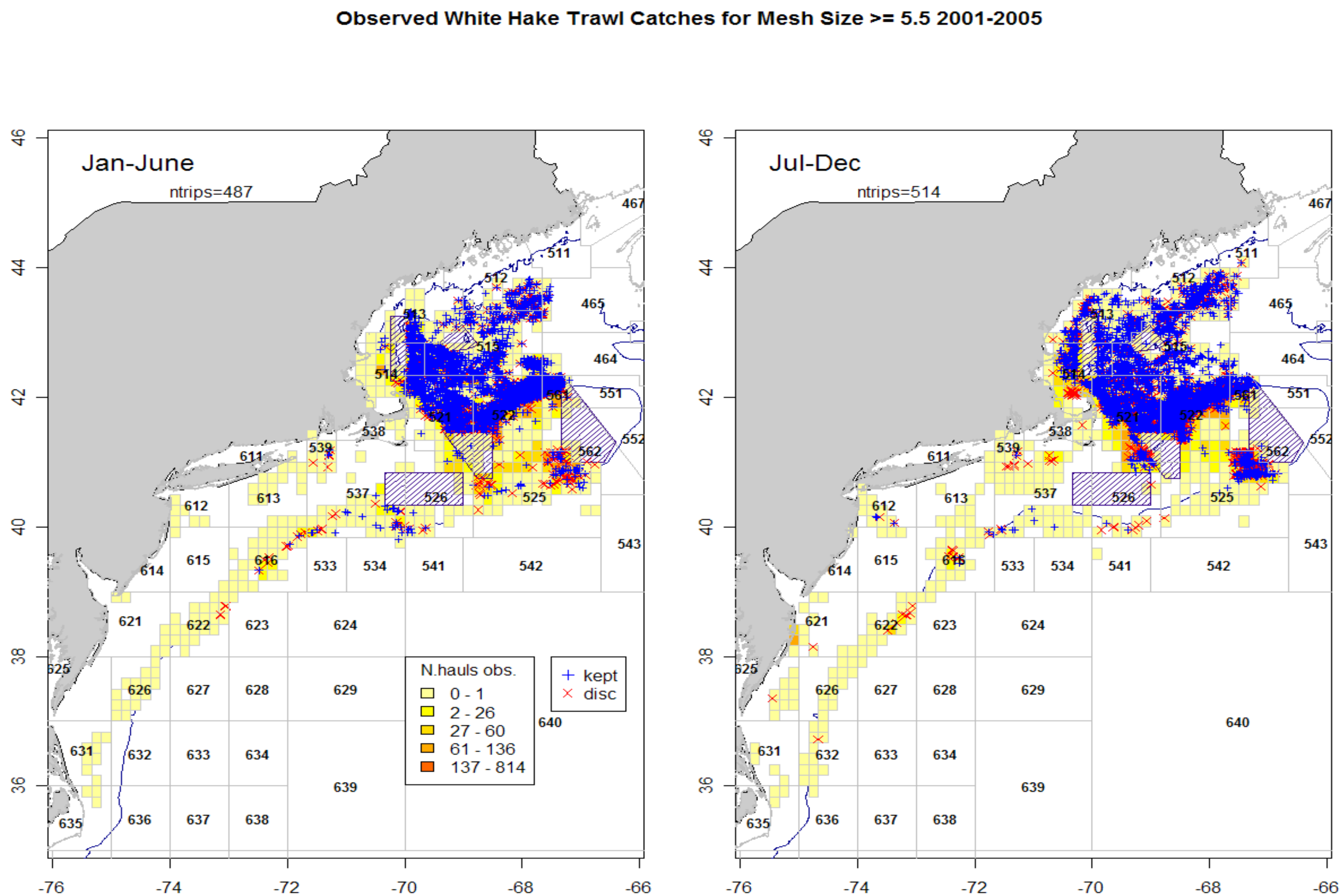


Figure B38. Observed kept and discarded white hake from 2001-2005 in the large-mesh otter trawl fishery.

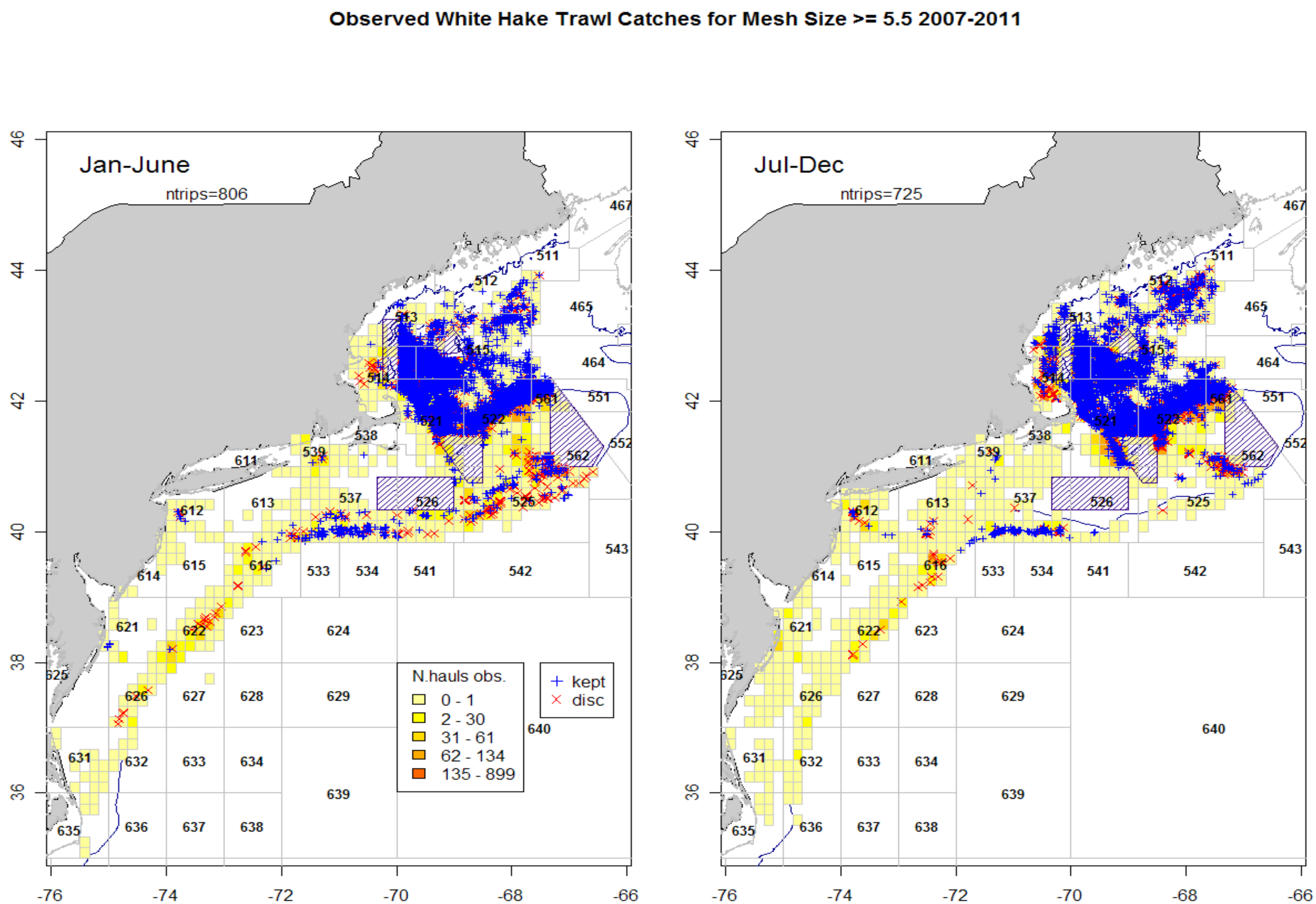


Figure B39. Observed kept and discarded white hake from 2007-2011 in the large-mesh otter trawl fishery.

Observed White Hake Trawl Catches for Mesh Size < 5.5 1989-1993

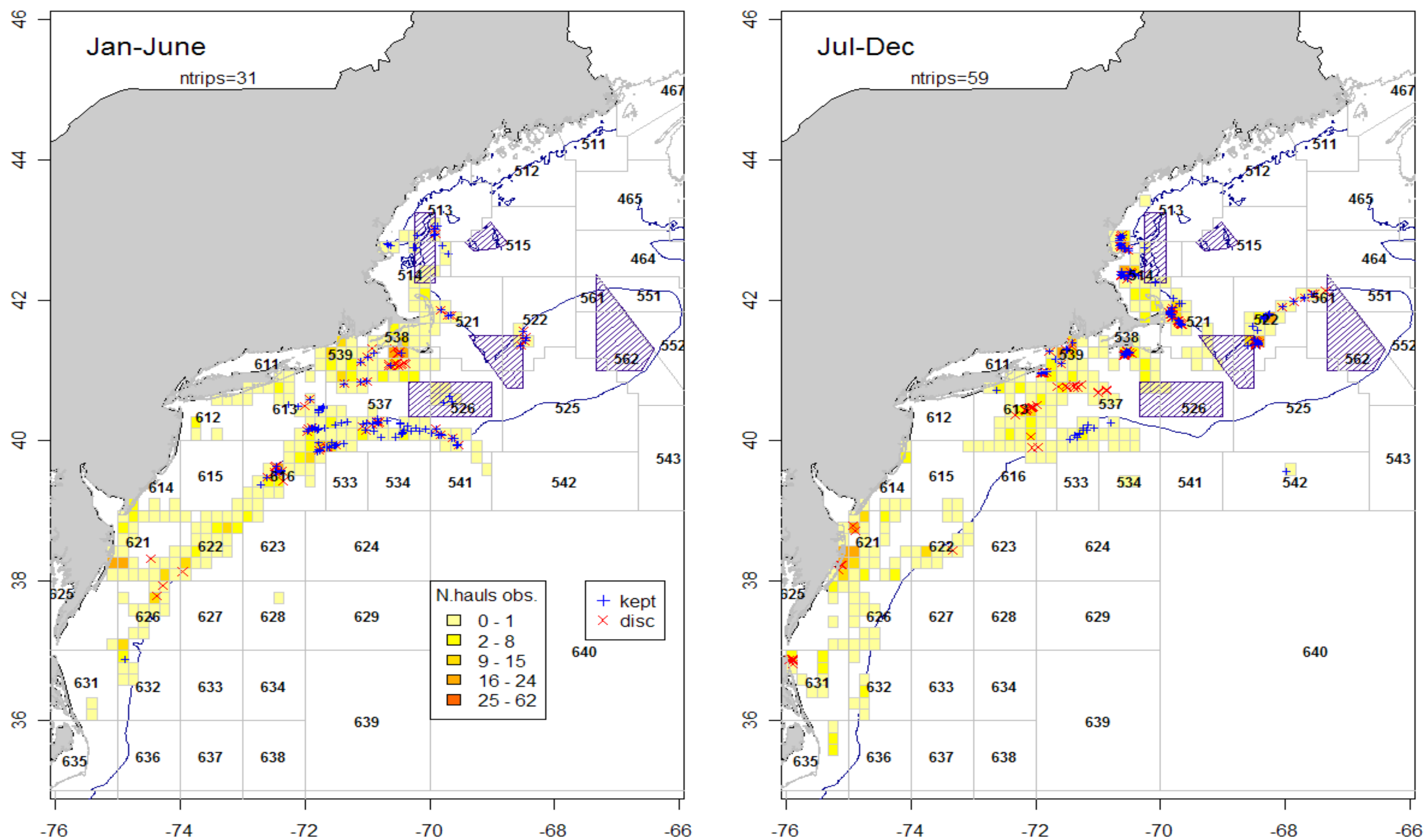


Figure B40. Observed kept and discarded white hake from 1989-1993 in the small-mesh otter trawl fishery.

Observed White Hake Trawl Catches for Mesh Size < 5.5 1995-1999

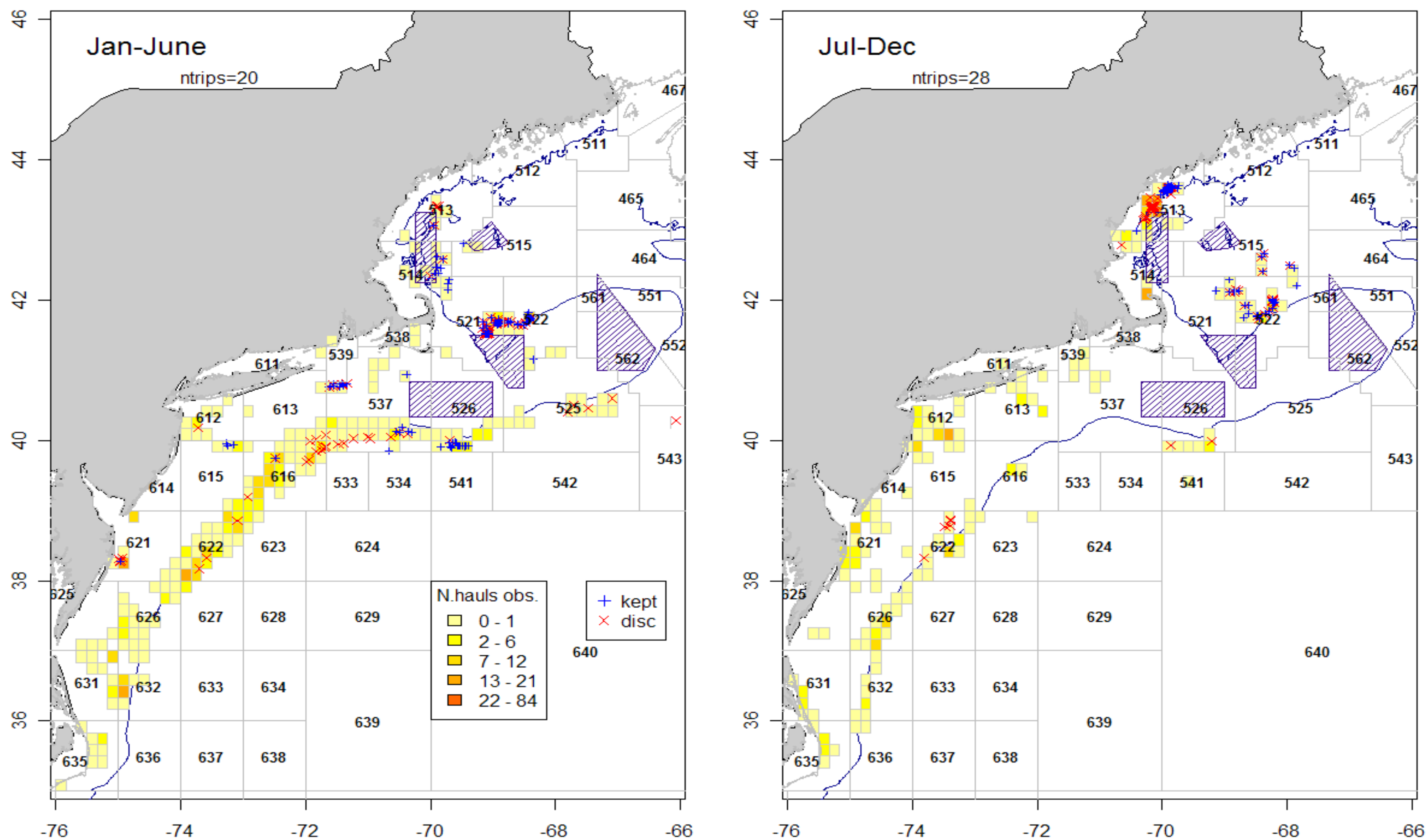


Figure B41. Observed kept and discarded white hake from 1995-1999 in the small-mesh otter trawl fishery.

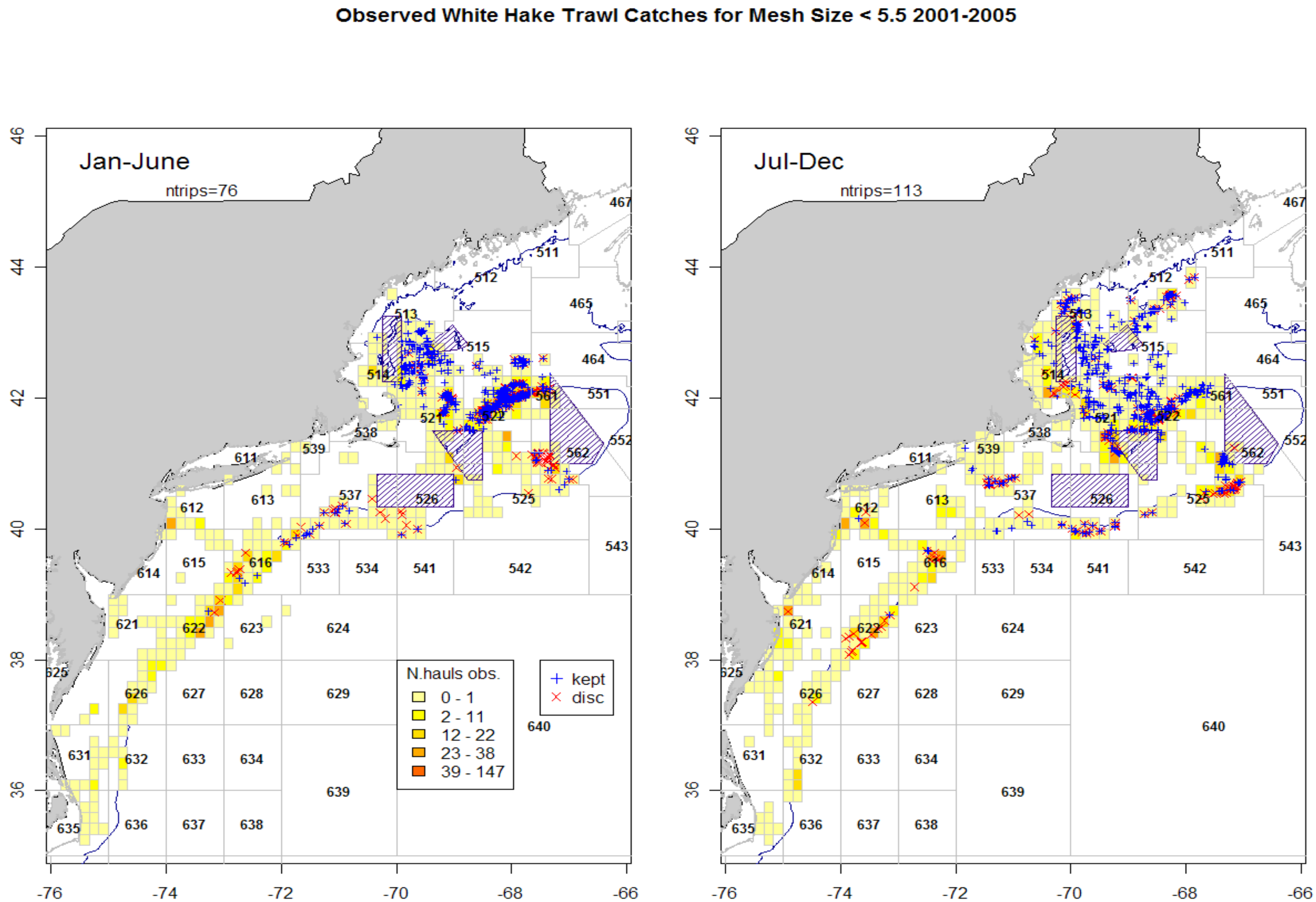


Figure B42. Observed kept and discarded white hake from 2001-2005 in the small-mesh otter trawl fishery.

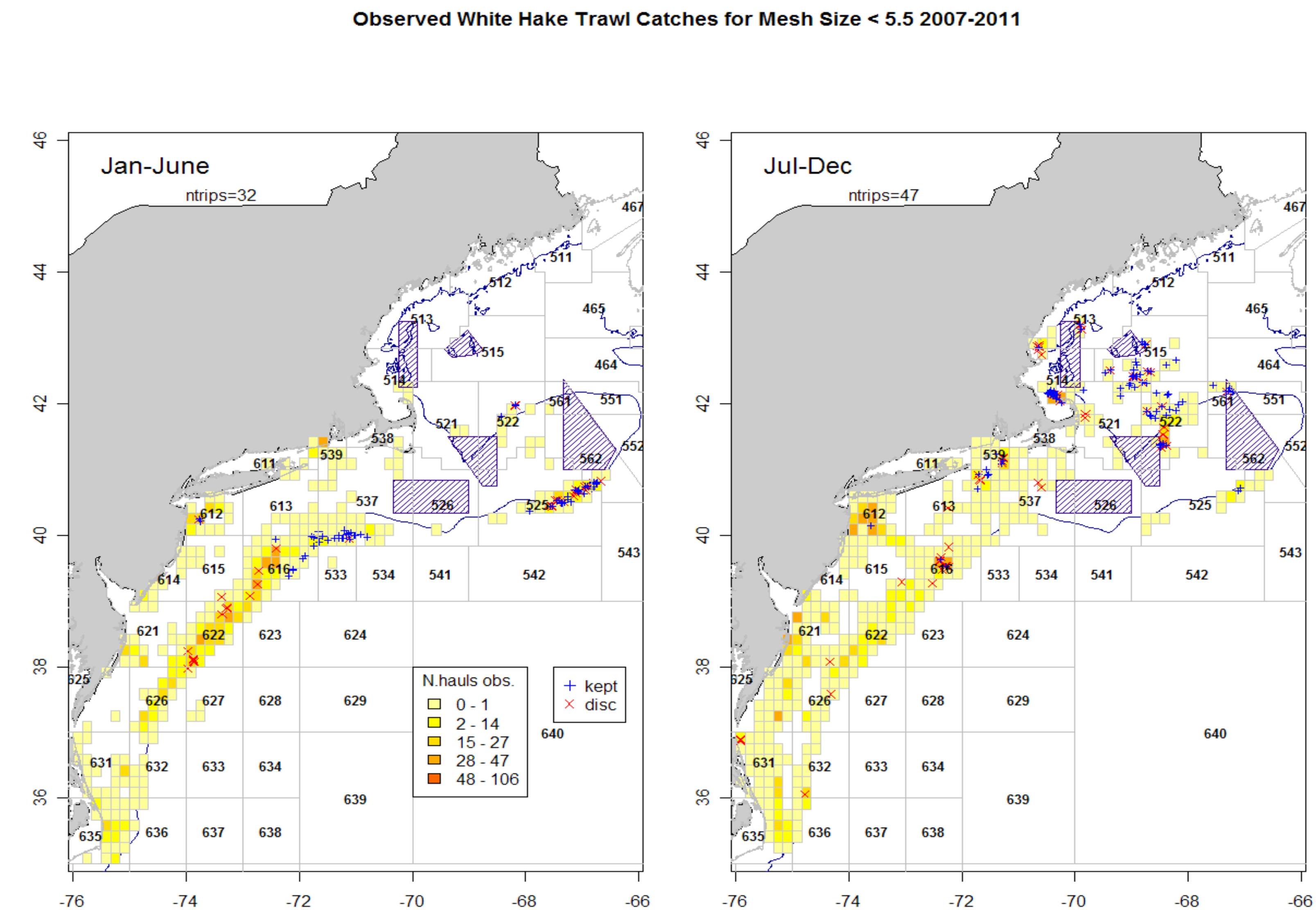


Figure B43. Observed kept and discarded white hake from 2007-2011 in the small-mesh otter trawl fishery.

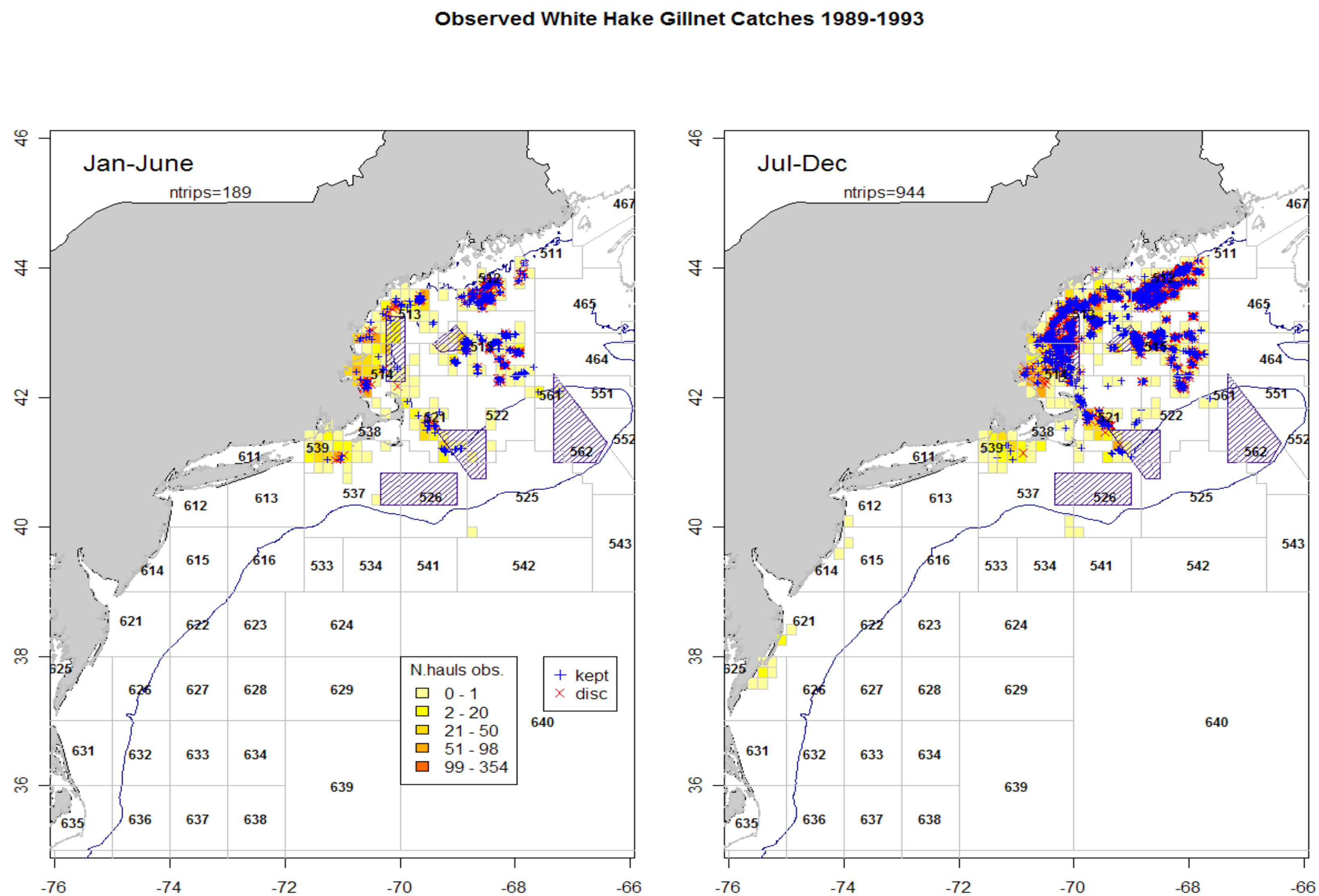


Figure B44. Observed kept and discarded white hake from 1989-1993 in the sink gill net fishery.

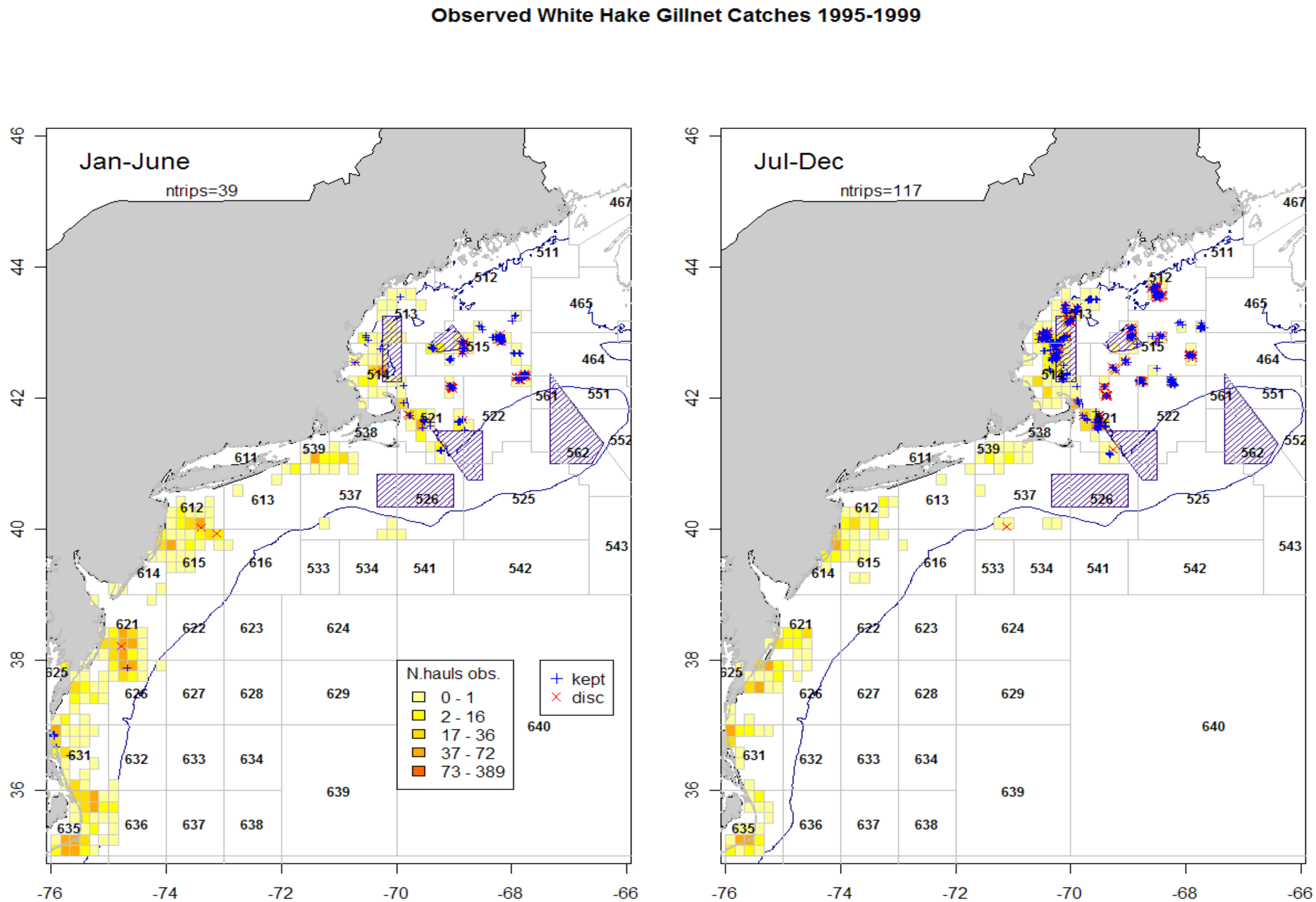


Figure B45. Observed kept and discarded white hake from 1995-1999 in the sink gill net fishery.

Observed White Hake Gillnet Catches 2001-2005

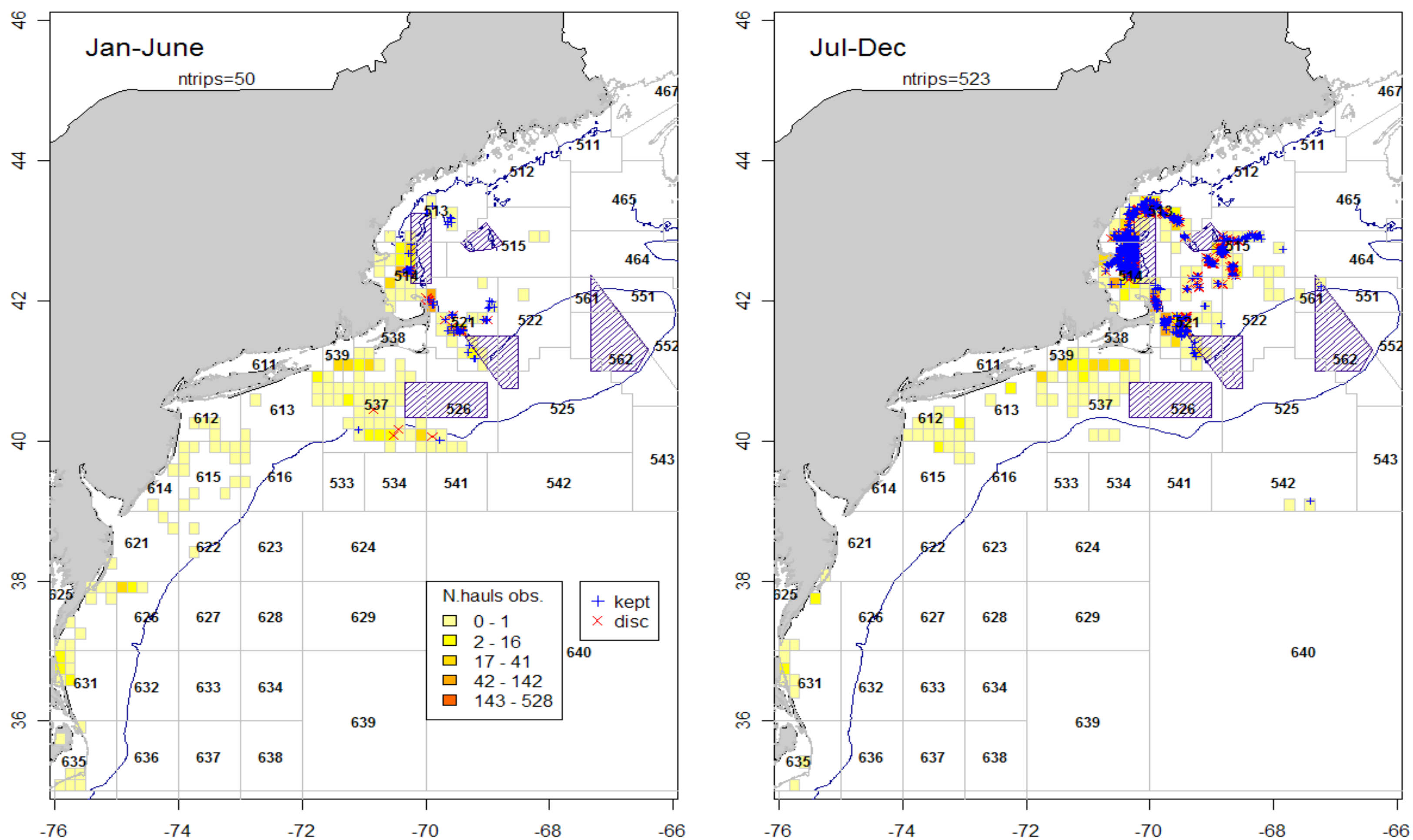


Figure B46. Observed kept and discarded white hake from 2001-2005 in the sink gill net fishery.

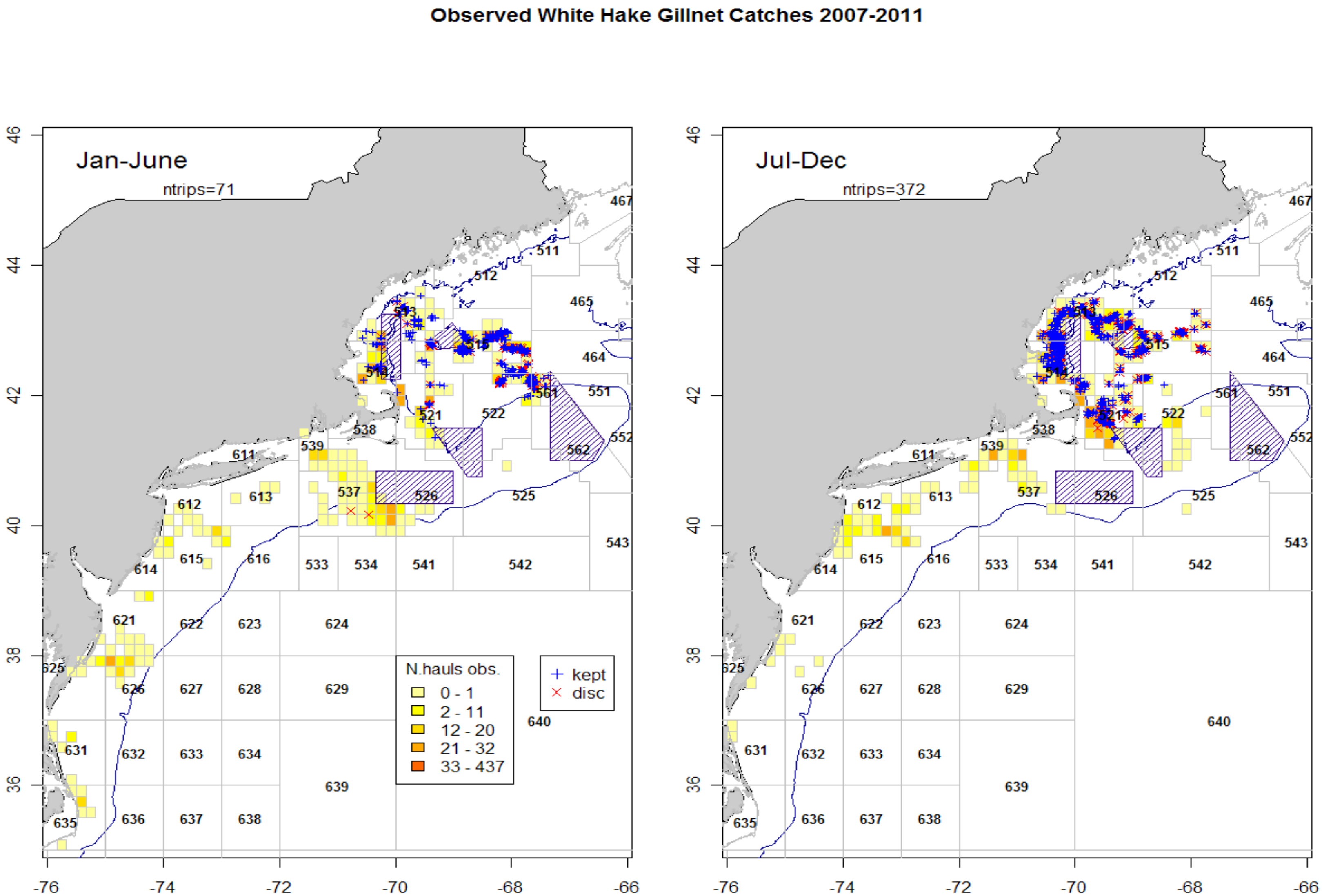


Figure B47. Observed kept and discarded white hake from 2007-2011 in the sink gill net fishery.

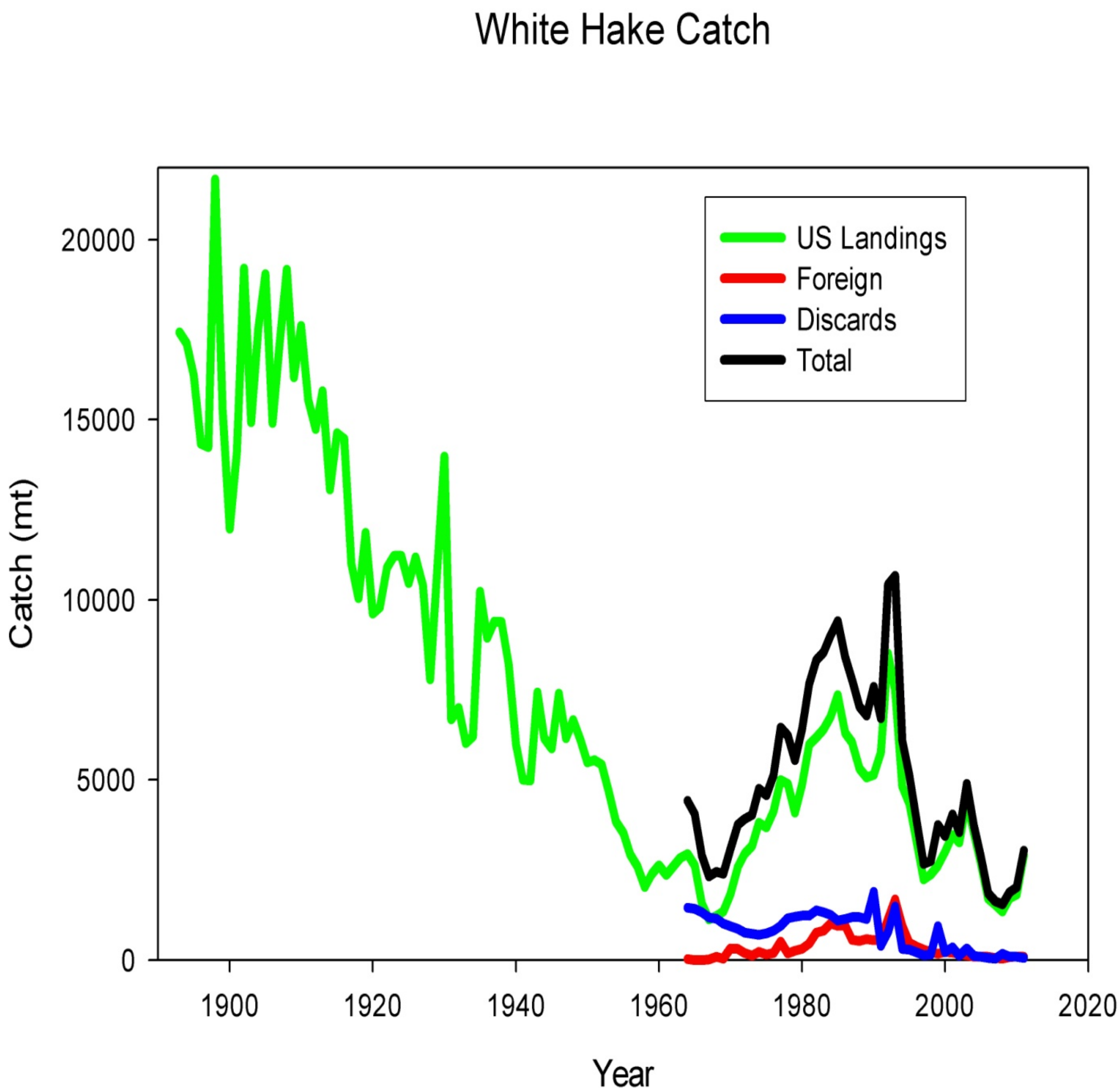


Figure B48. Total catch of white hake. The green line is US landings, the red line is foreign landings and the blue line is US discards. The black line is the total catch from 1964-2011.

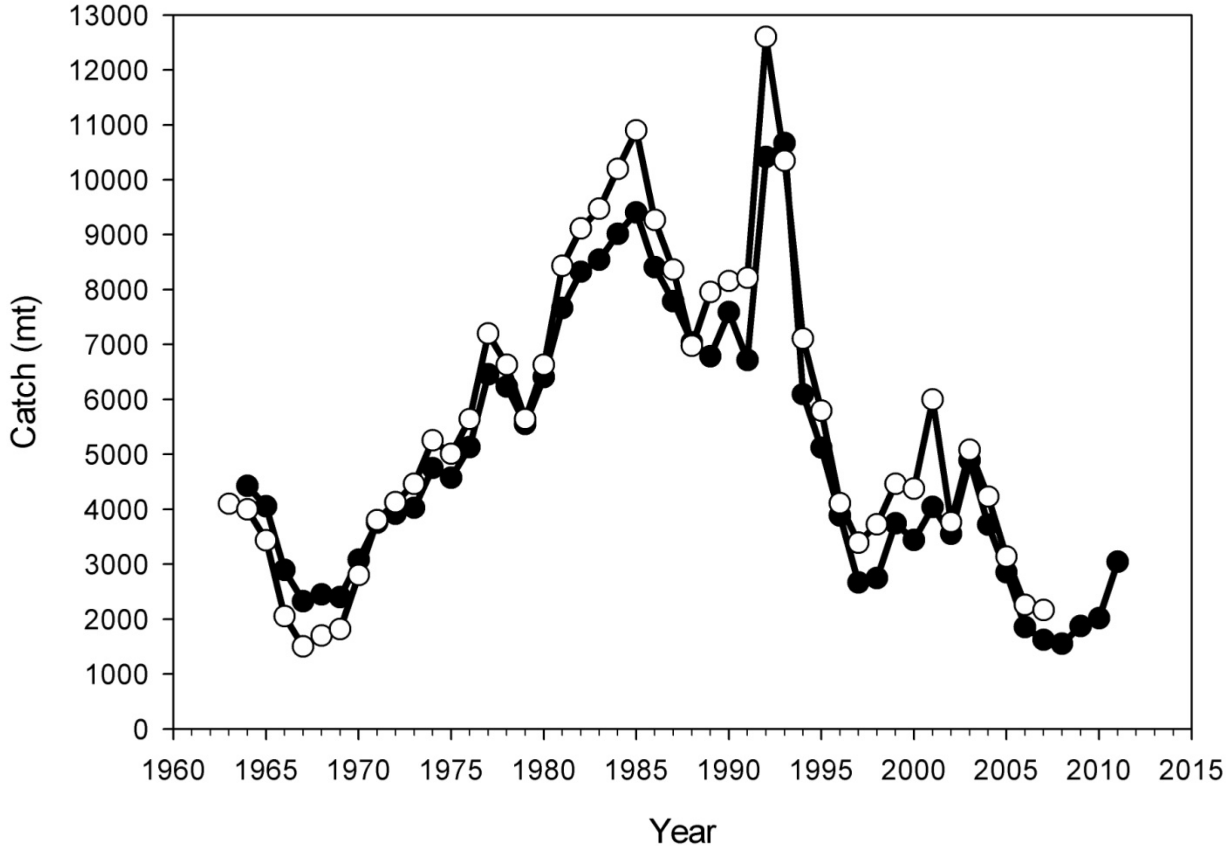


Figure B49. Total catch of white hake estimated in this assessment (filled circles) compared to the estimates of catch from GARM III (open circles).

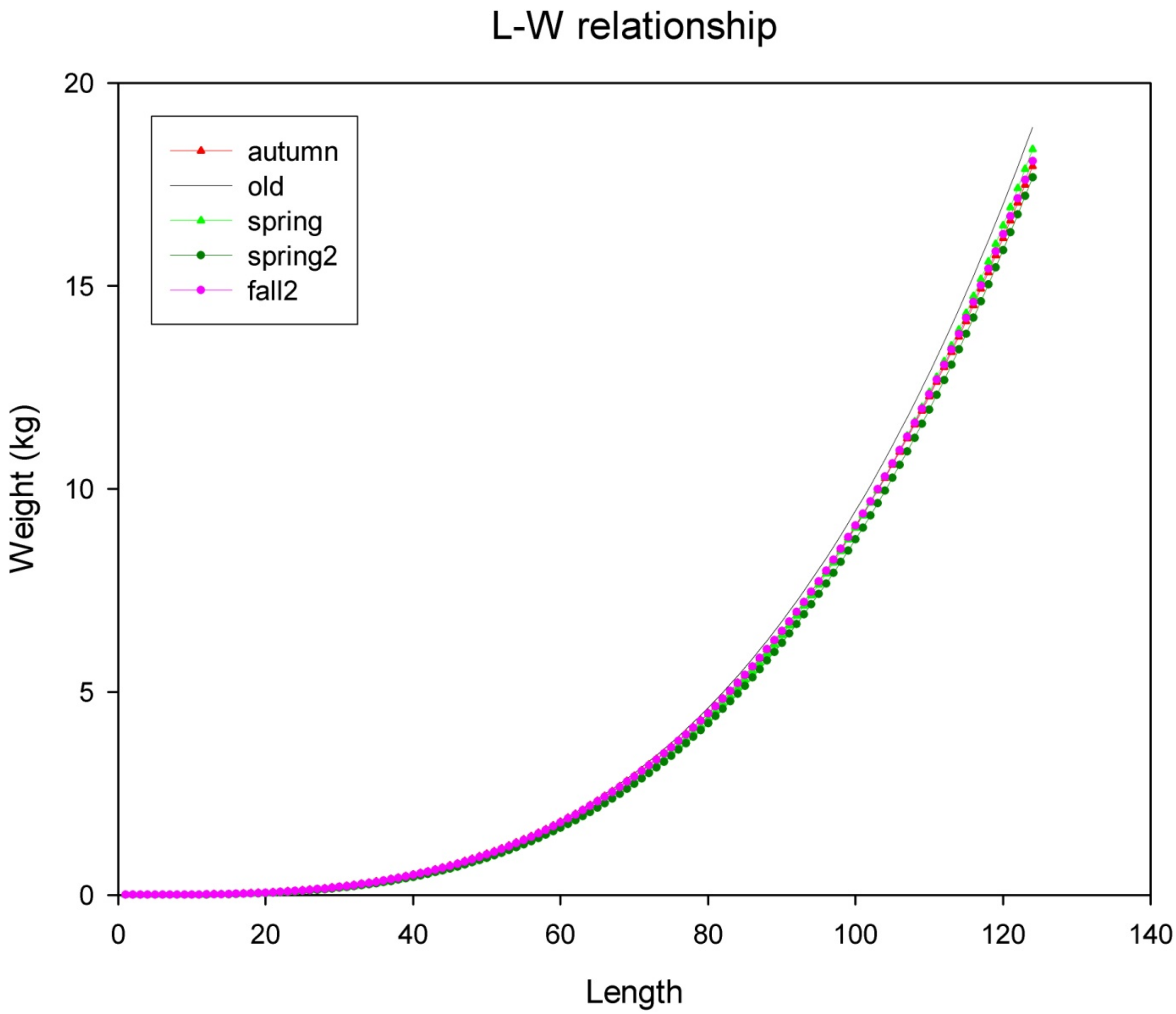


Figure B50. Length-weight relationships of white hake for estimating catch-at-length and catch-at-age. Old is the annual relationship used in the last assessment. Autumn and spring are from Wigley et al (2002). Autumn2 and spring2 have been re-estimated using survey data from 1992-2012.

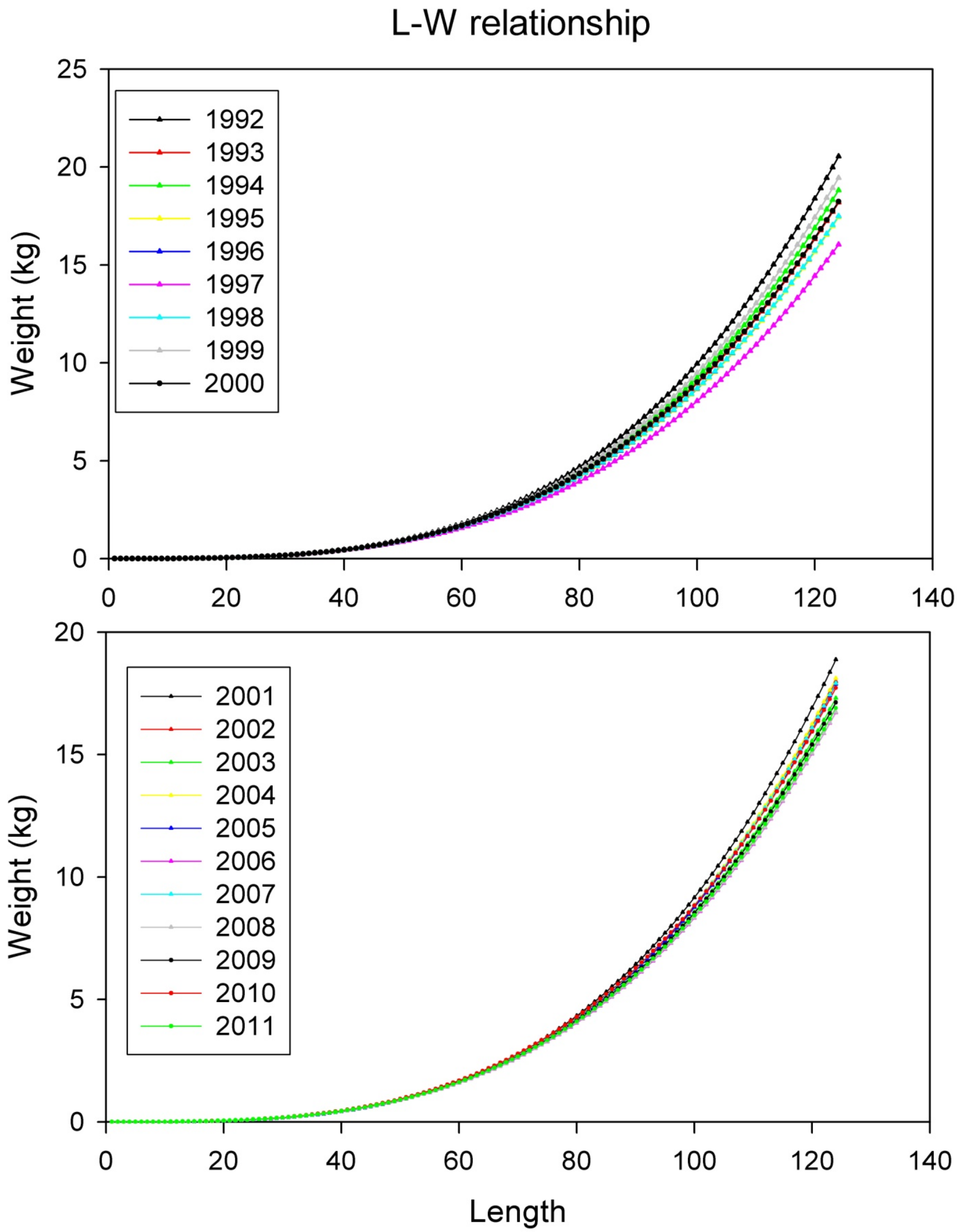


Figure B51. Annual length-weight relationships from the NEFSC spring survey.

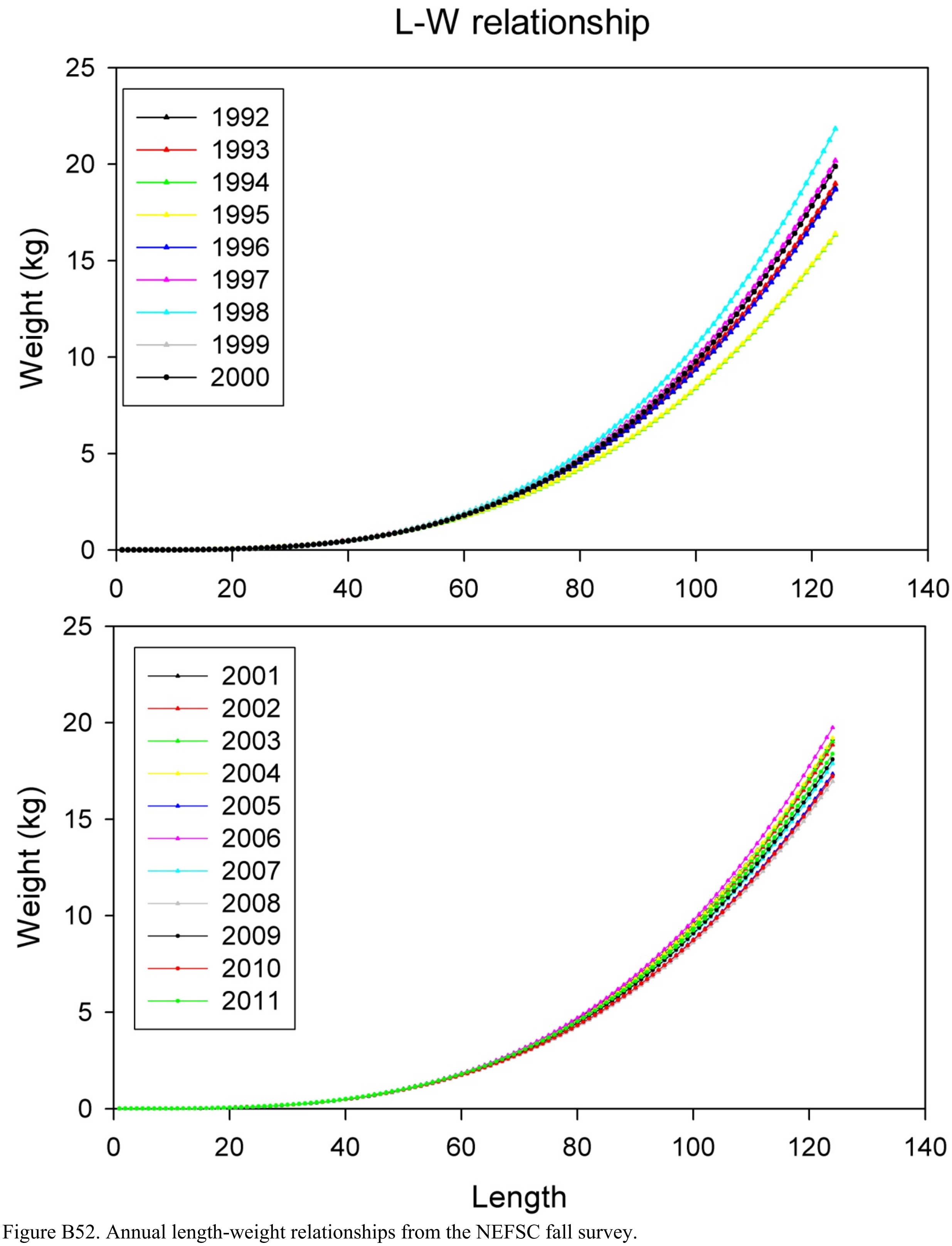


Figure B52. Annual length-weight relationships from the NEFSC fall survey.

Figure B53. Age composition of the landings of white hake. The red bubbles indicate that a pooled ALK was used.

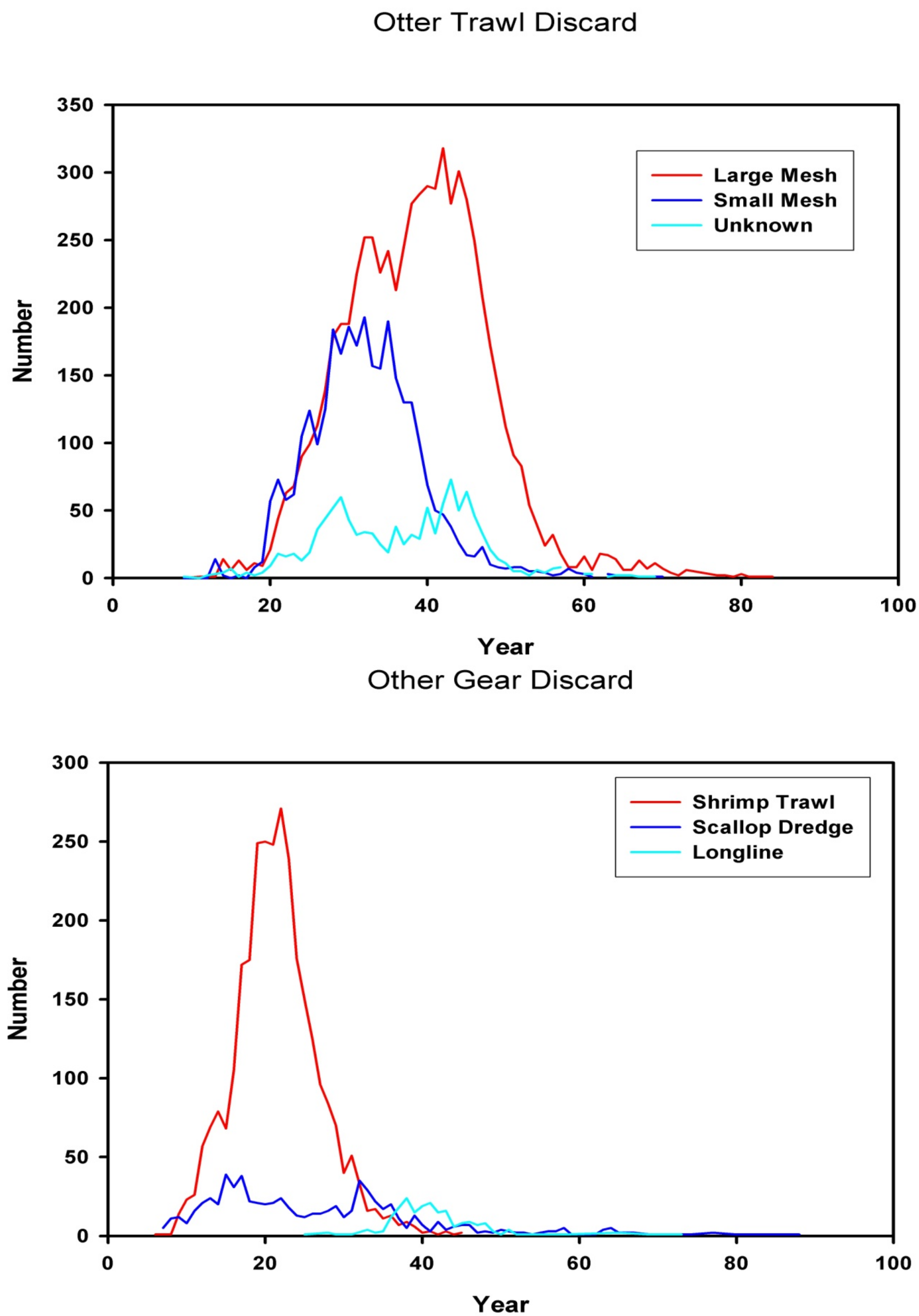


Figure B54. Length composition of discarded white hake from the otter trawl fishery (top panel) and other gear types (bottom panel).

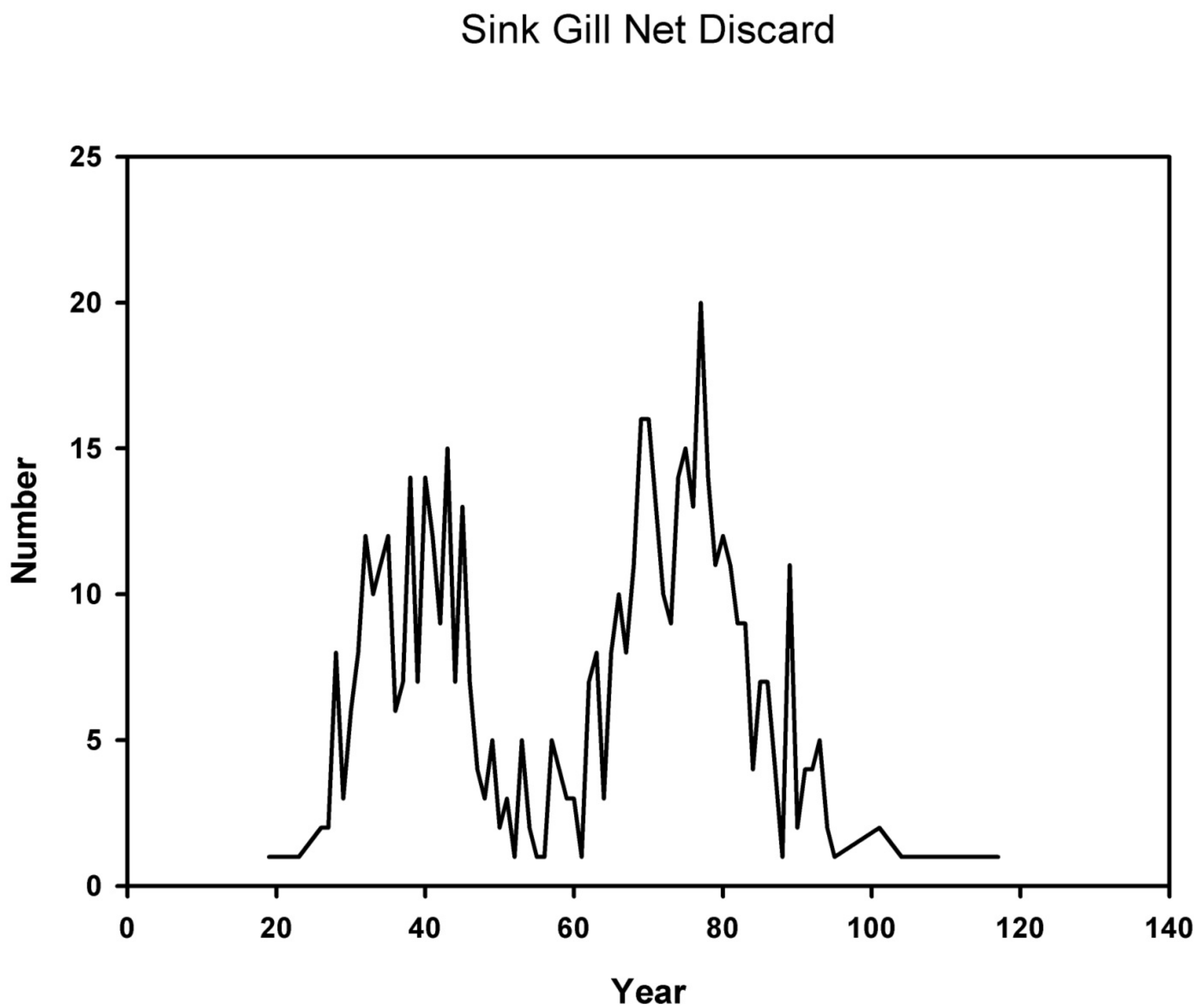


Figure B55. Length composition of white hake discarded in the sink gill net fishery.

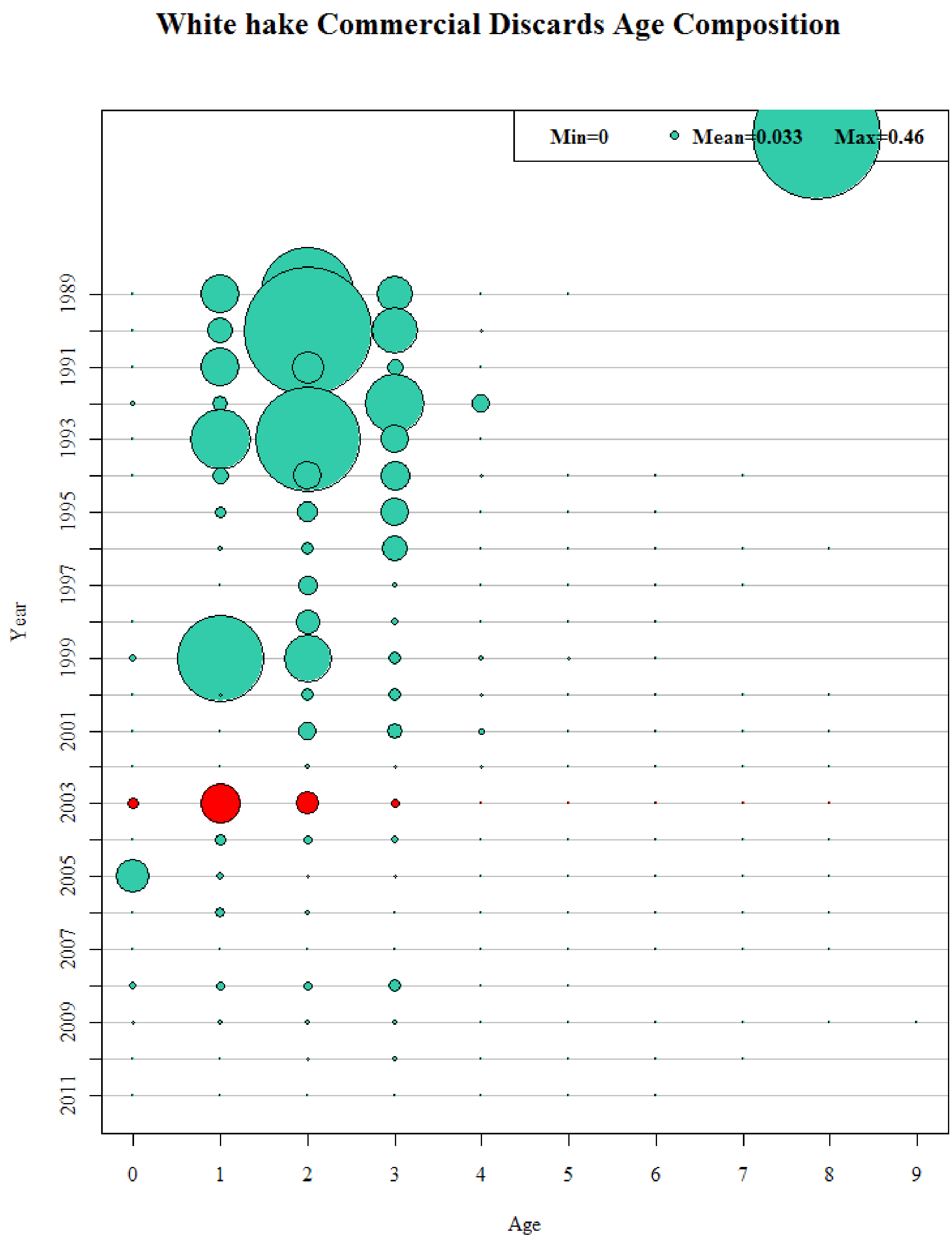


Figure B56. Age composition of the discards of white hake. The red bubbles indicate that a pooled ALK was used.

Figure B57. Age composition of the catch of white hake. The red bubbles indicate that a pooled ALK was used.

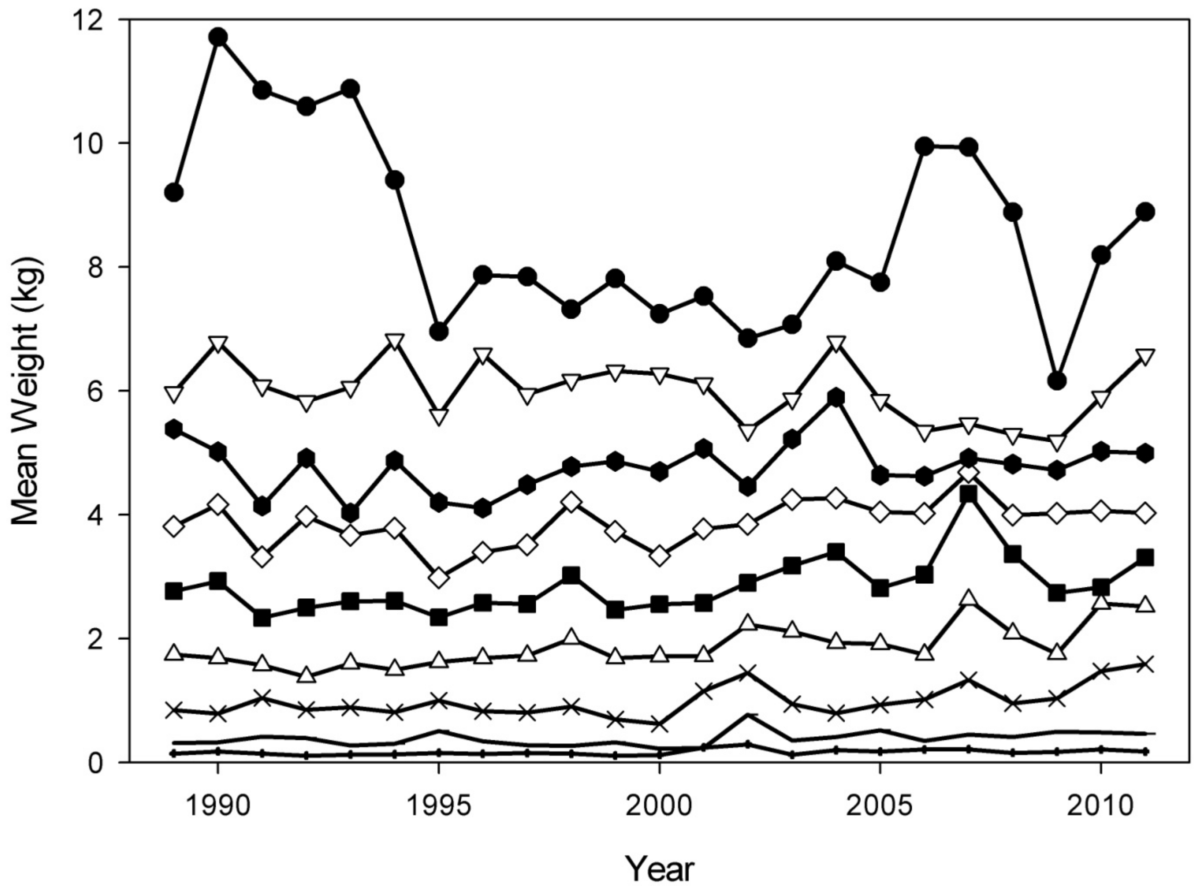


Figure B58. Mean weight-at-age of the white hake catch.

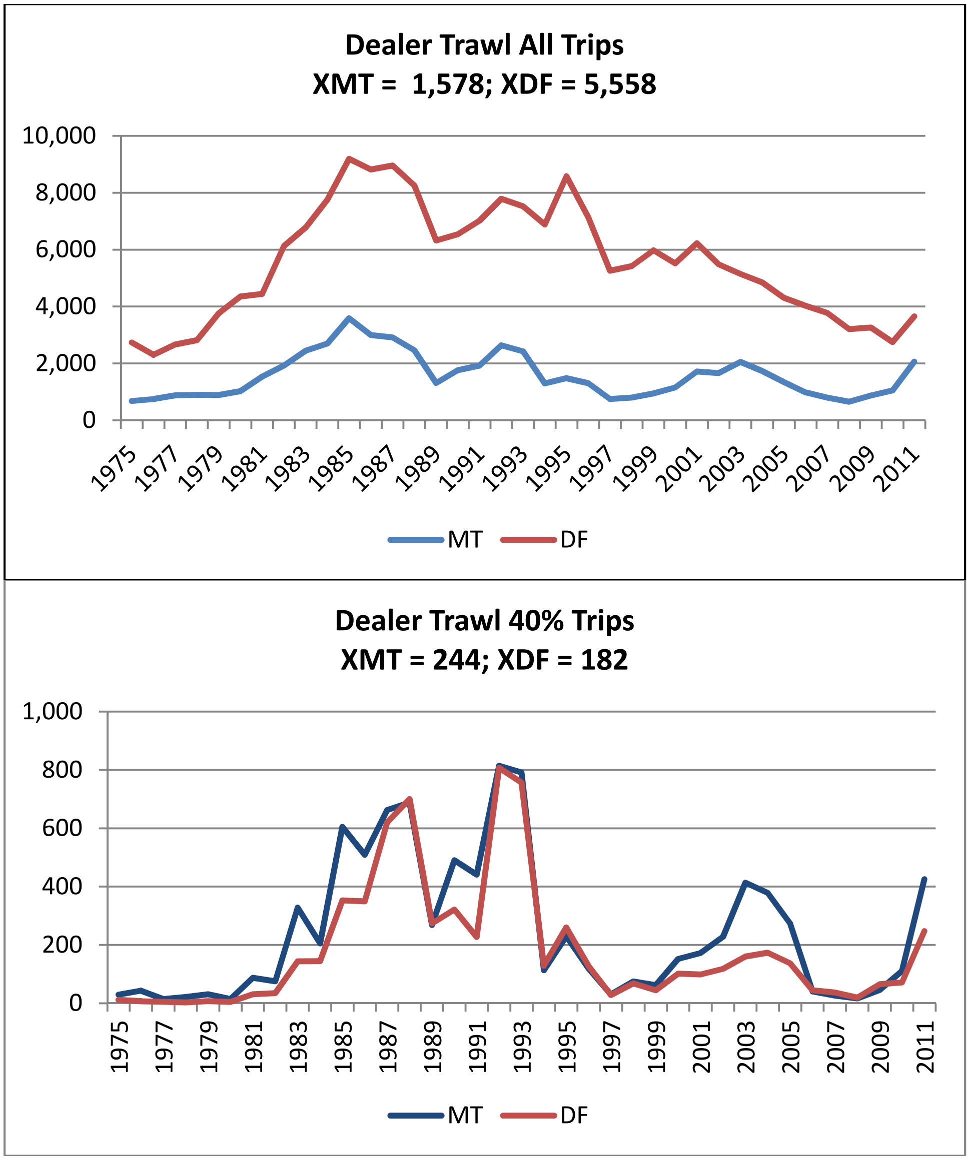


Figure B59. Summary of commercial dealer trawl landings, days fished, and nominal LPUE. The top Panel is All Trips (100% of Landings, 100% of DF). The bottom Panel is trips that land more than 40% white hake (Over time series, 15% of Mean Annual Landings, 3% of Mean Annual DF).

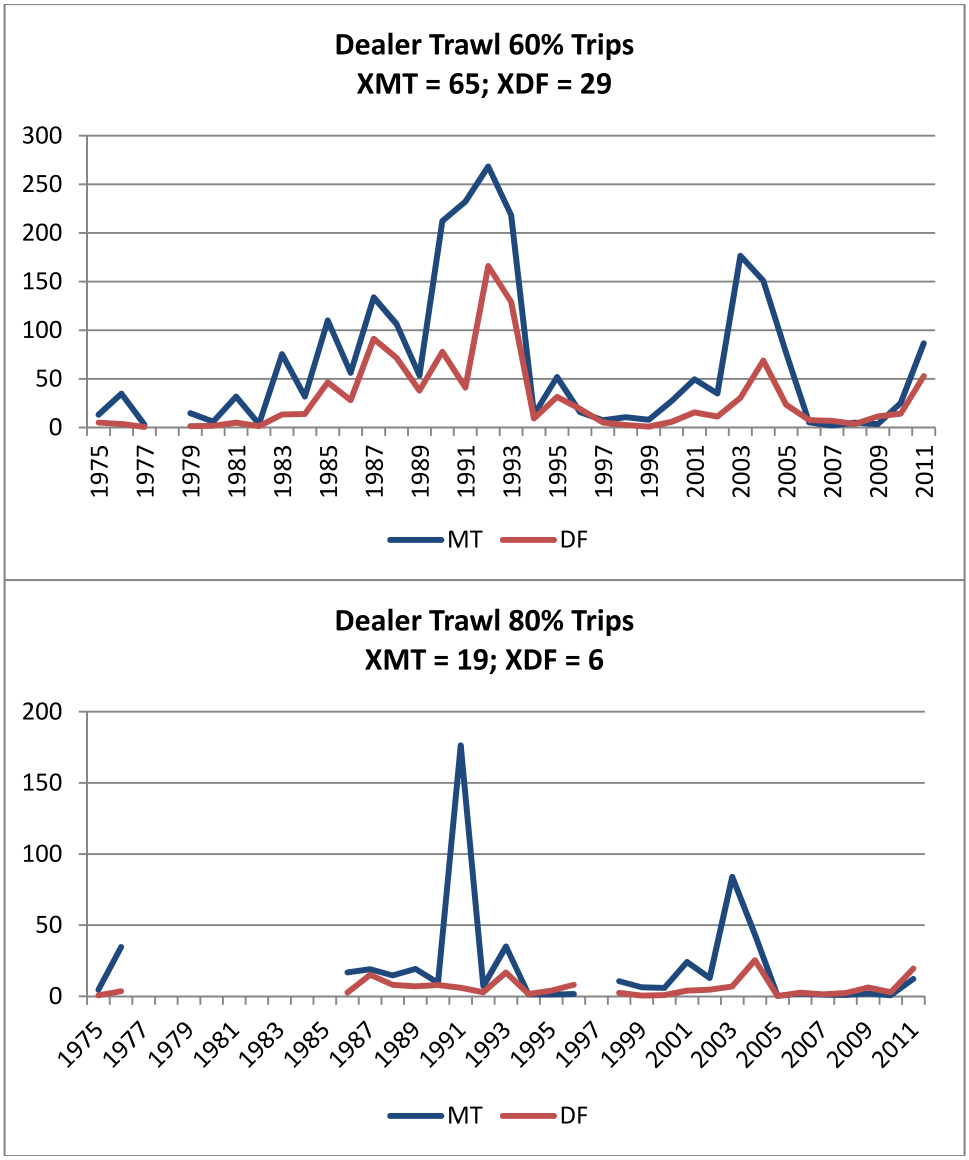


Figure B60. Summary of commercial dealer trawl landings, days fished, and nominal LPUE. The top Panel is trips that landed over 60% white hake (Over time series, 4% of Mean Annual Landings, 1% of Mean Annual DF). The bottom panel is trips that landed over 80% white hake (Over time series, 1% of Mean Annual Landings, 0.1% of Mean Annual DF).

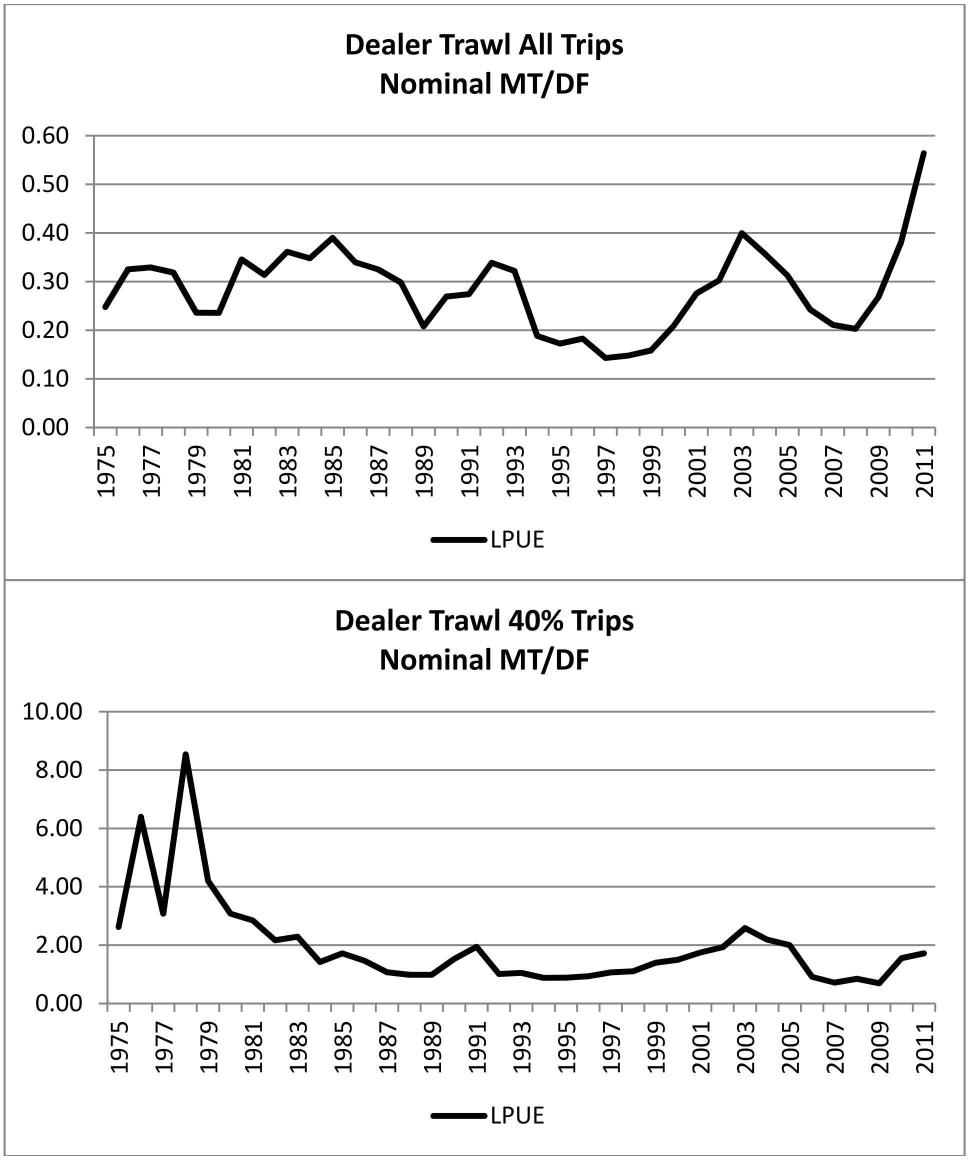


Figure B61. Nominal LPUE (mt/df) from all otter trawl trips (top panel) and otter trawl trips in which white hake accounted for 40% of the catch (bottom panel).

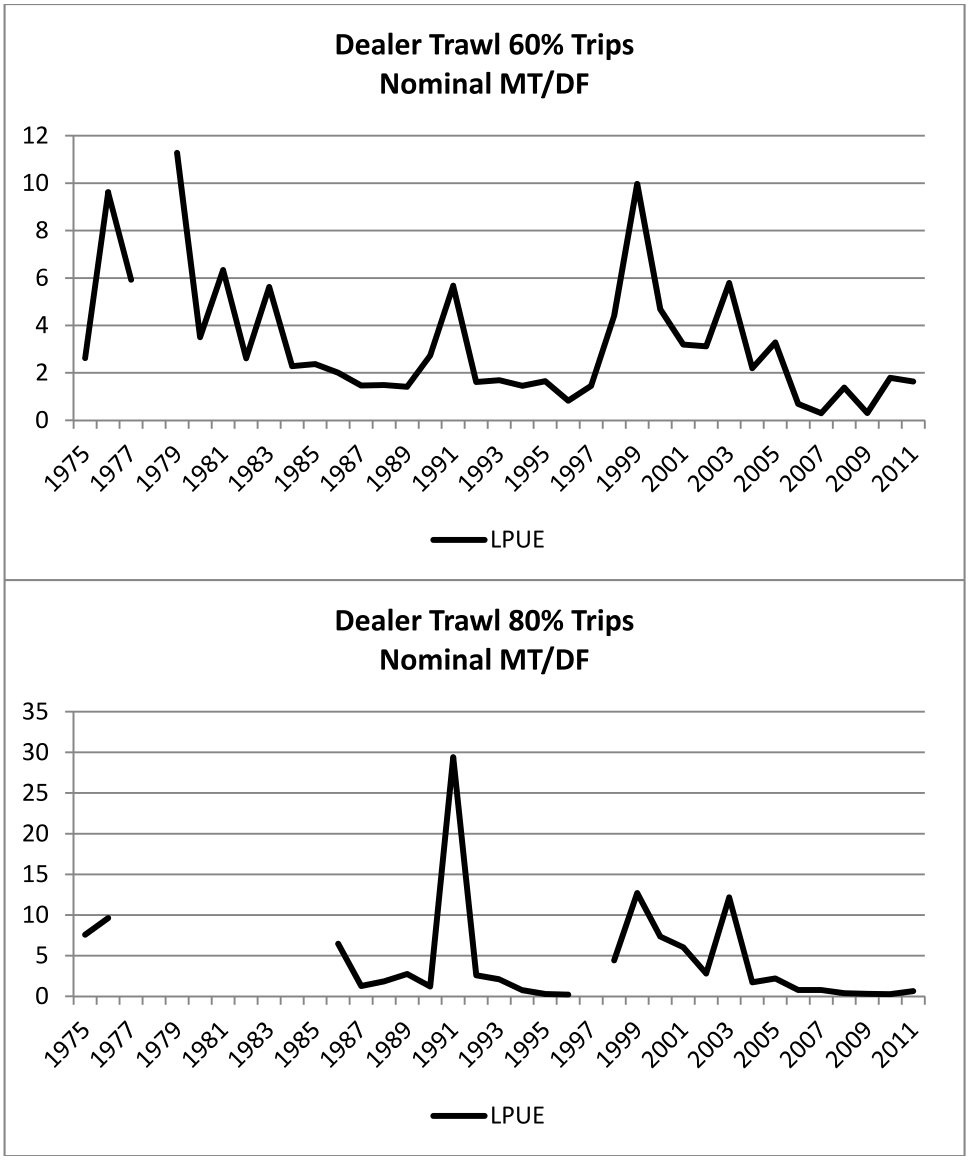


Figure B62. Nominal LPUE (mt/df) from otter trawl trips in which white hake accounted for 60% of the catch (top panel) and otter trawl trips in which white hake accounted for 80% of the catch (bottom panel).

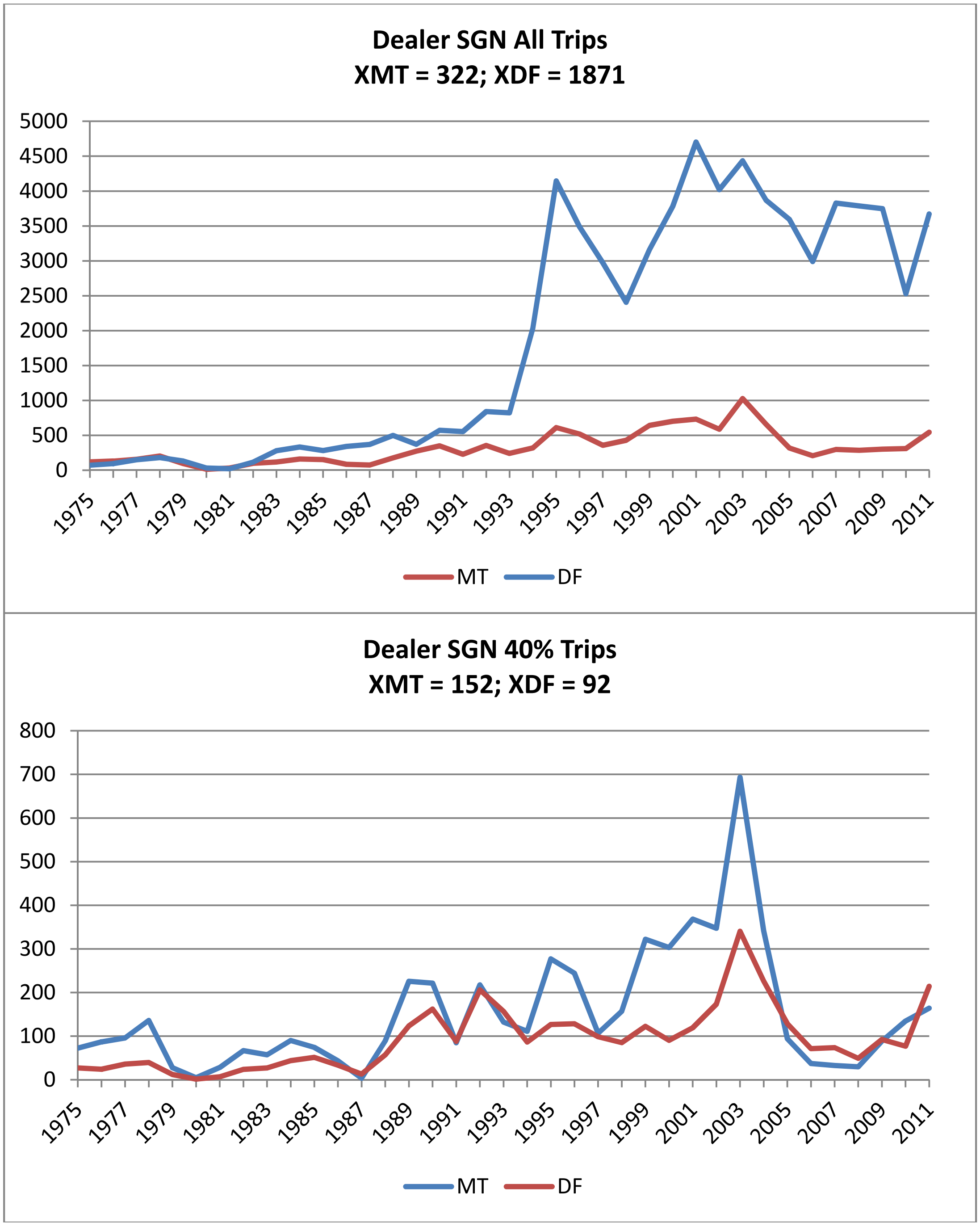


Figure B63. Summary of commercial dealer sink gill net landings, days fished, and nominal LPUE. The top Panel is All Trips (100% of Landings, 100% of DF). The bottom Panel is trips that land more than 40% white hake (Over time series, 47% of Mean Annual Landings, 5% of Mean Annual DF, Over1994-2011, 3% of Mean Annual DF).

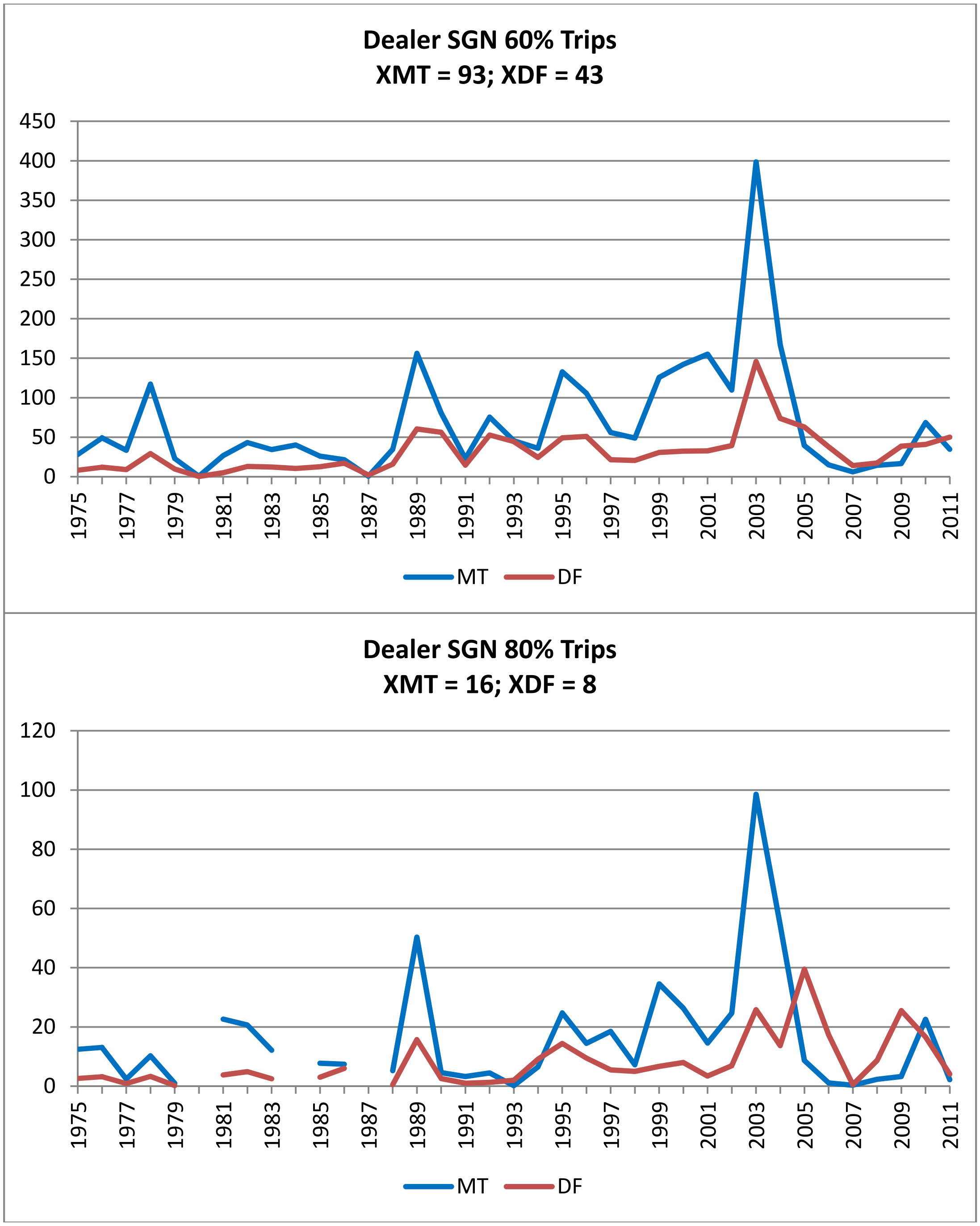


Figure B64. Summary of commercial dealer sink gill net landings, days fished, and nominal LPUE. The top Panel is trips that land more than 60% white hake (Over time series 29% of Mean Annual Landings, 2% of Mean Annual DF; Over 1994-2011, 1% of Mean Annual DF). The bottom Panel is trips that land more than 80% white hake (Over time series, 5% of Mean Annual Landings, 0.4 % of Mean Annual DF; Over 1994-2011, 0.3% of Mean Annual DF).

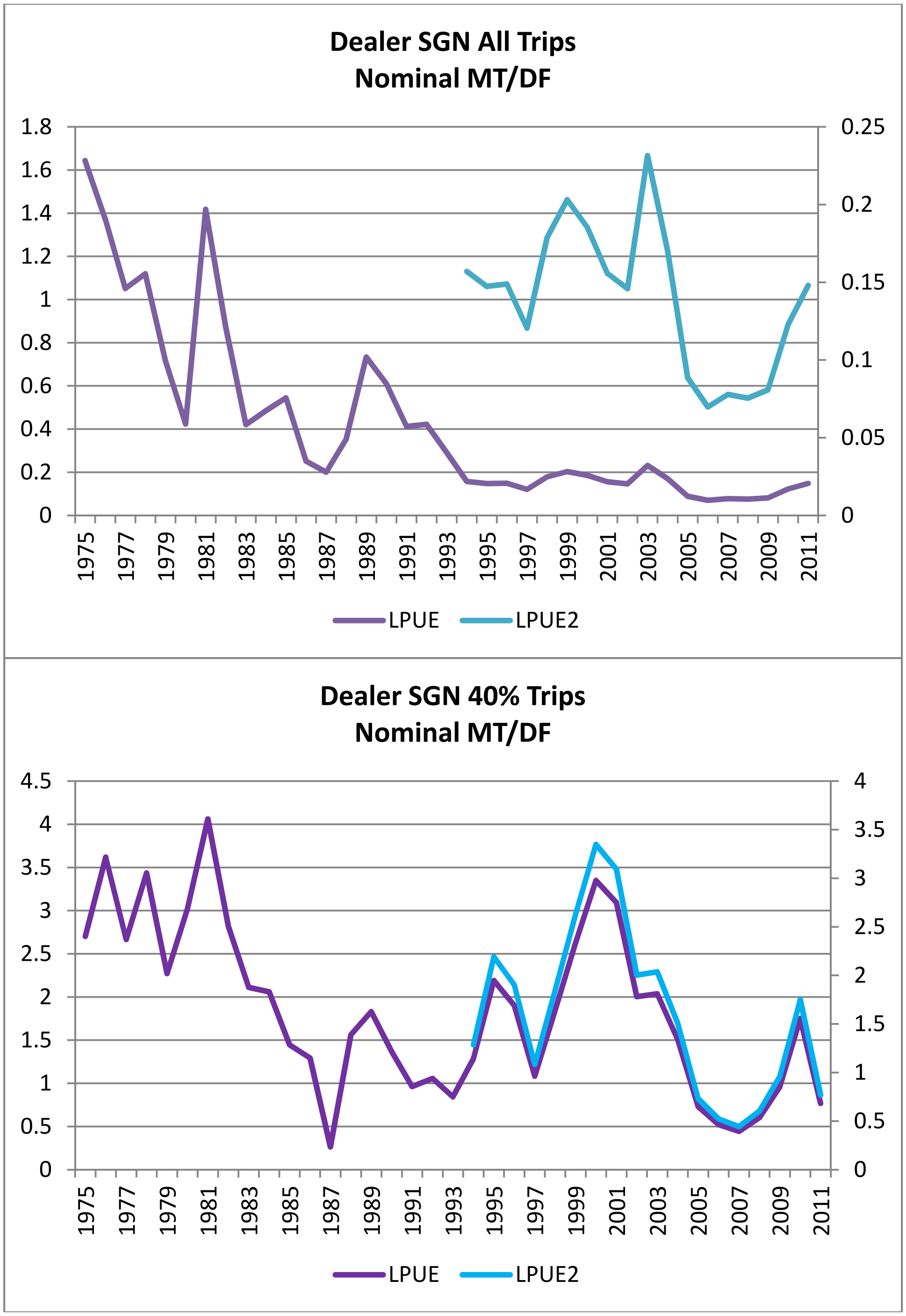


Figure B65. Nominal LPUE (mt/df) from all sink gill net trips (top panel) and sink gill net trips in which white hake accounted for 40% of the catch (bottom panel). The blue line is the LPUE scaled for only 1994-2011, since there may be a change in the way effort was calculated starting in 1994.

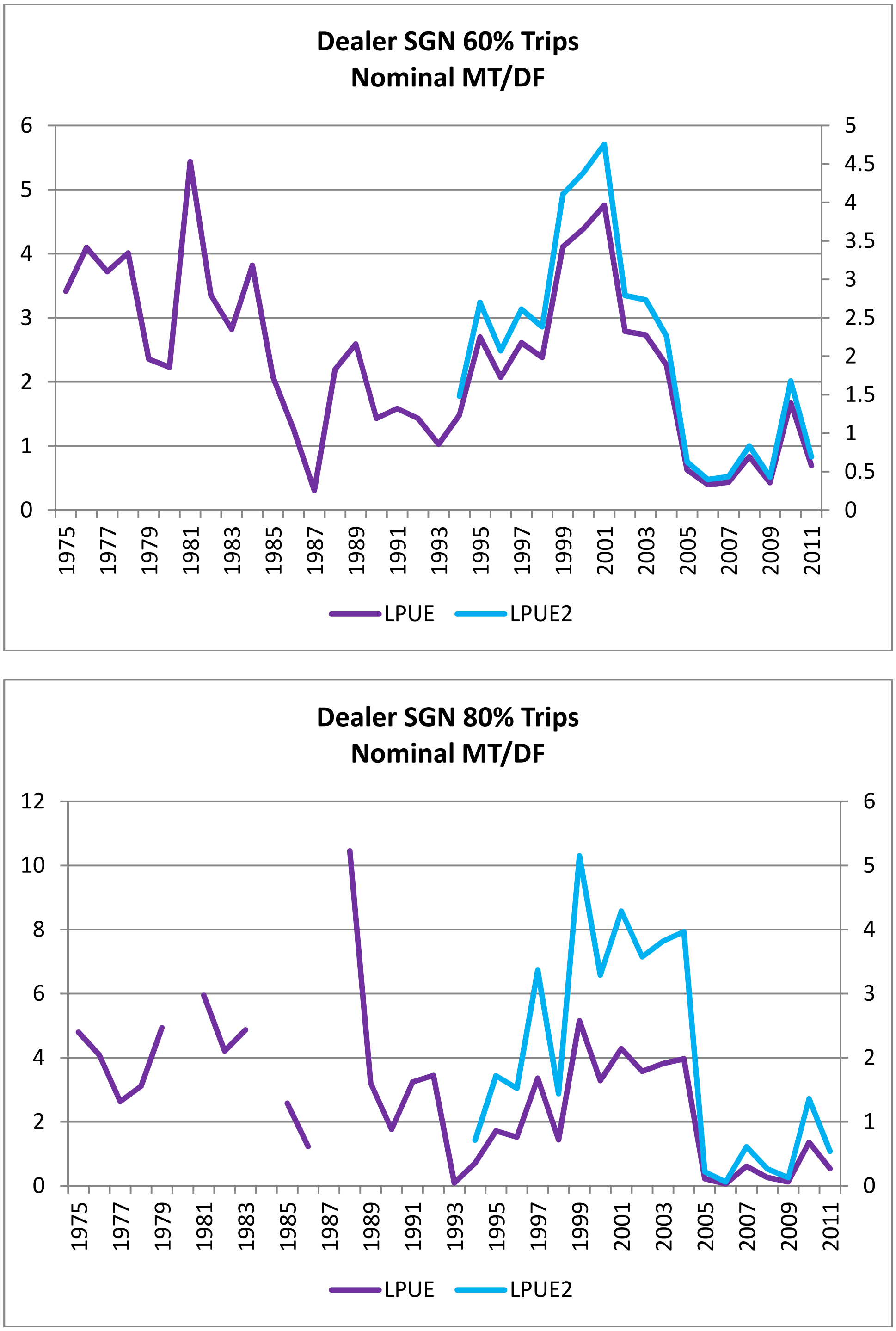


Figure B66. Nominal LPUE (mt/df) from sink gill net trips in which white hake accounted for 60% of the catch (top panel) and sink gill net trips in which white hake accounted for 80% of the catch (bottom panel). The blue line is the LPUE scaled for only 1994-2011, since there may be a change in the way effort was calculated starting in 1994.

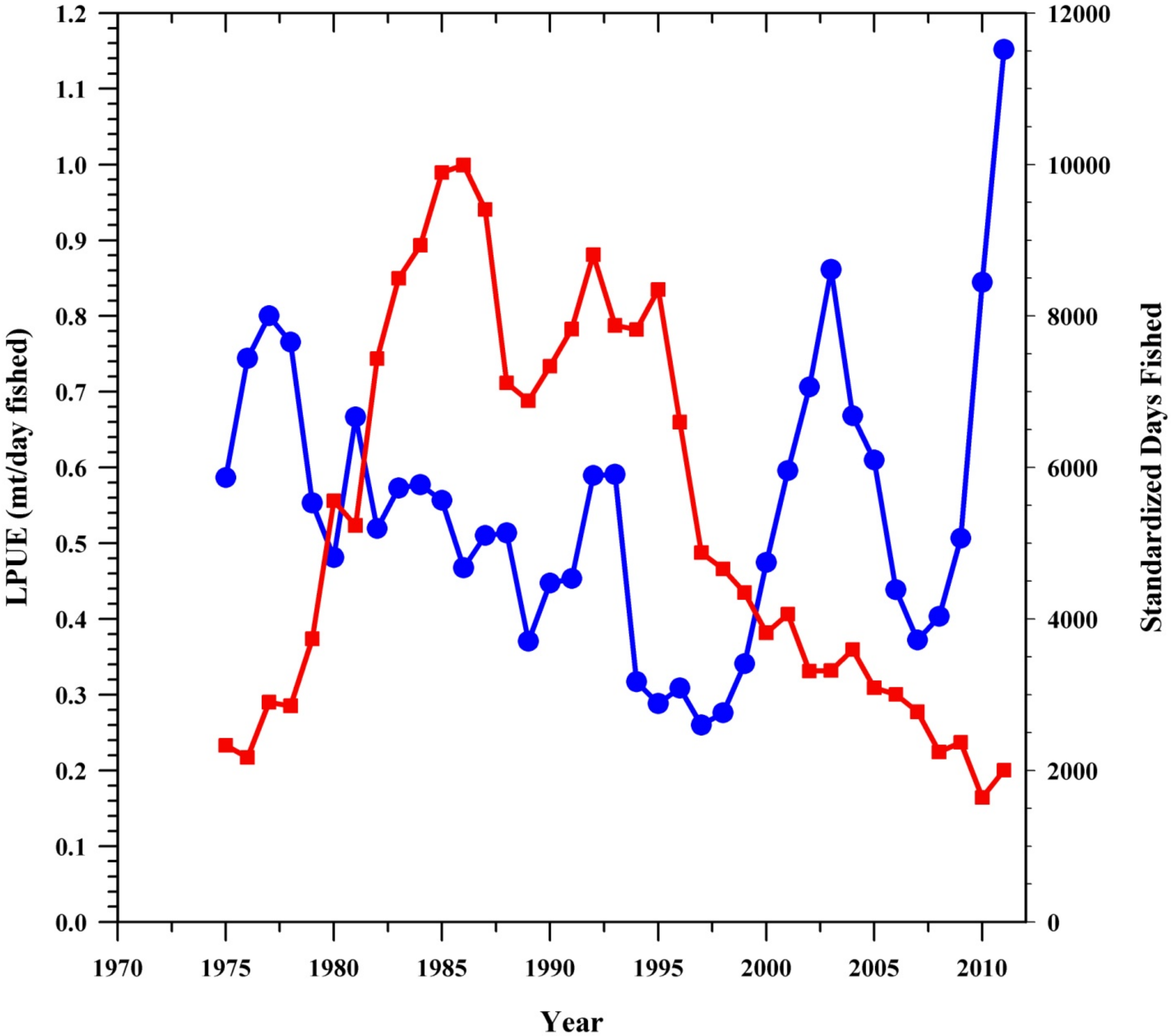


Figure B67. Standardized landings per day fished (LPUE, circles) and effort (days fished raised to total otter trawl landings, solid line) of all white hake trips using a general linear model: year, quarter, area, and tonnage class.

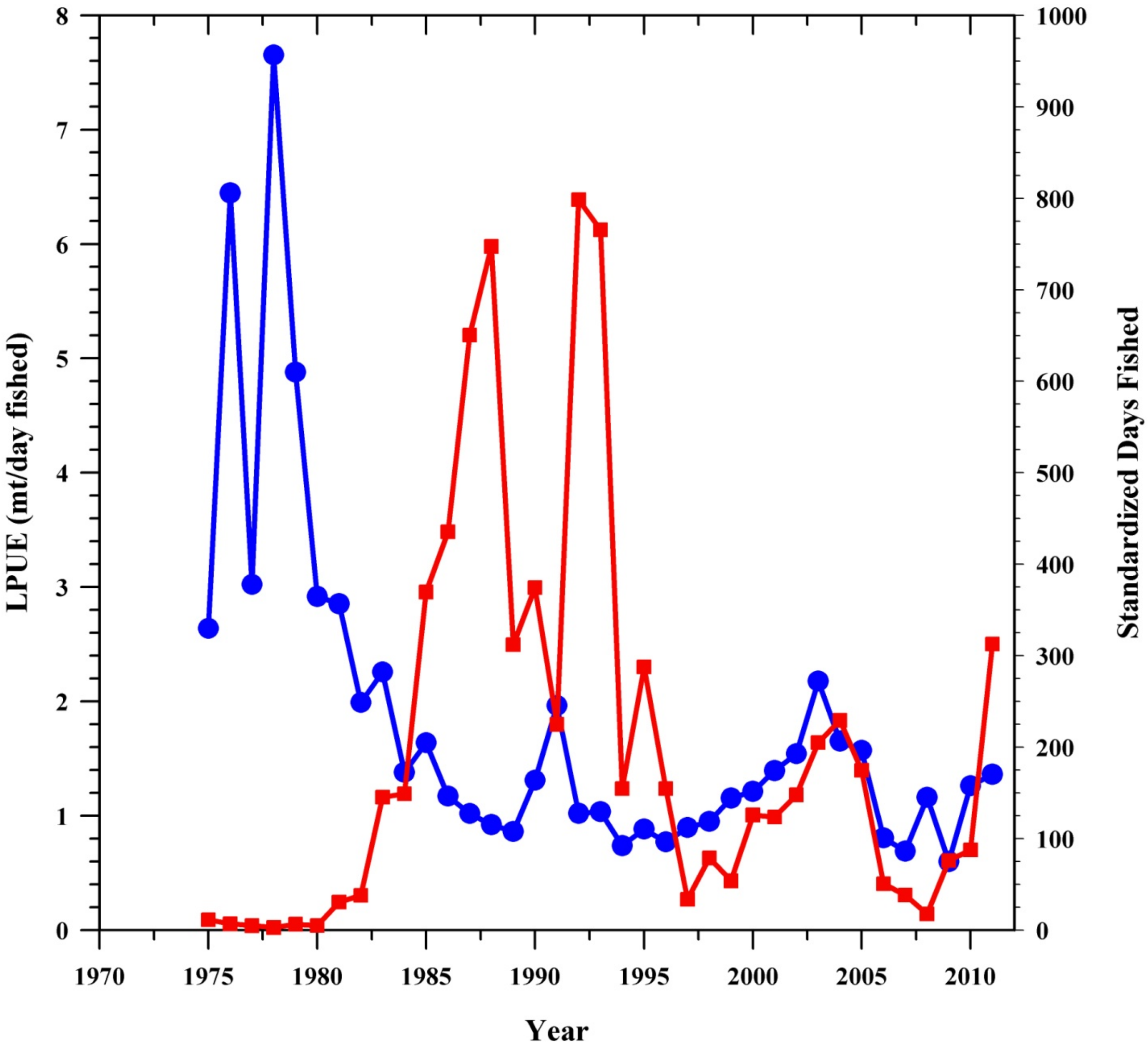


Figure B68. Standardized landings per day fished (LPUE, circles) and effort (solid line) of directed (>40%) white hake trips using a general linear model: year, quarter, area, and tonnage class.

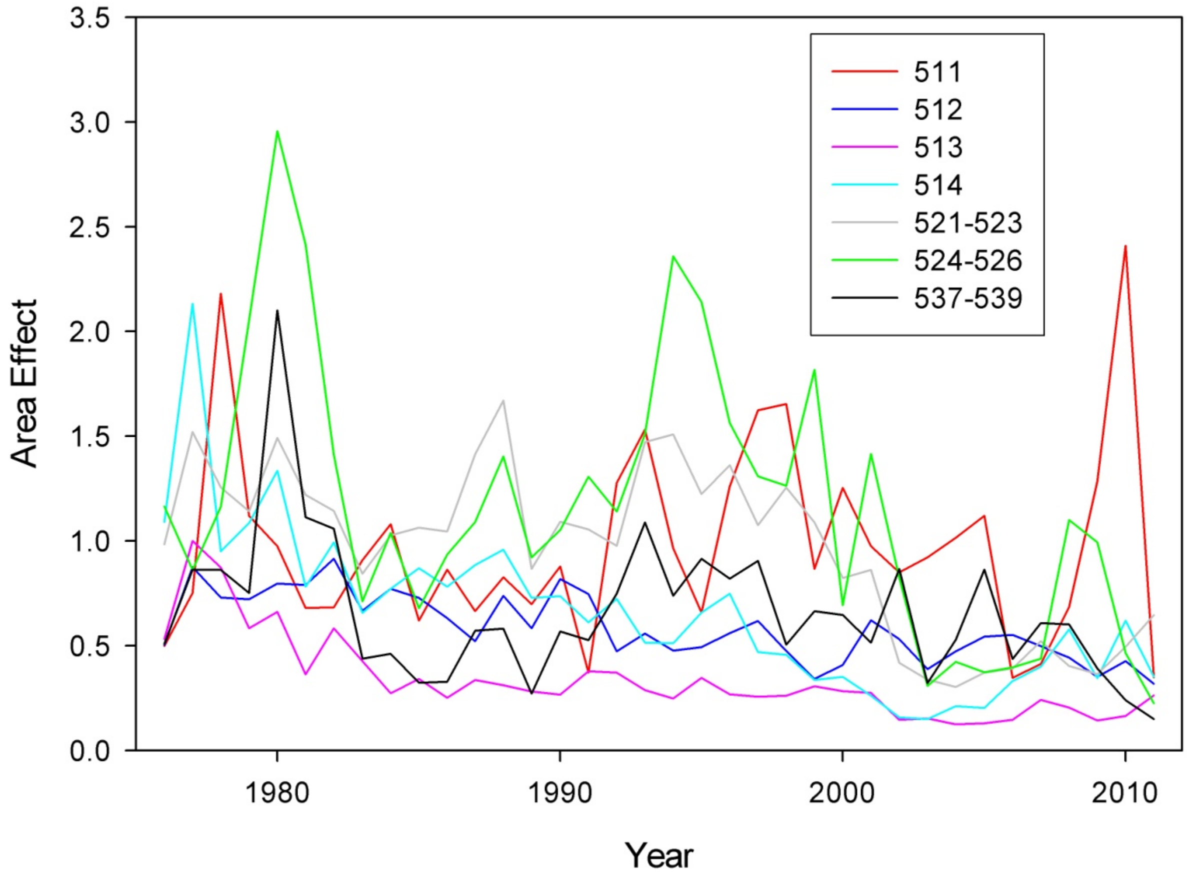


Figure B69. GLM results incorporating a year*area interaction term.

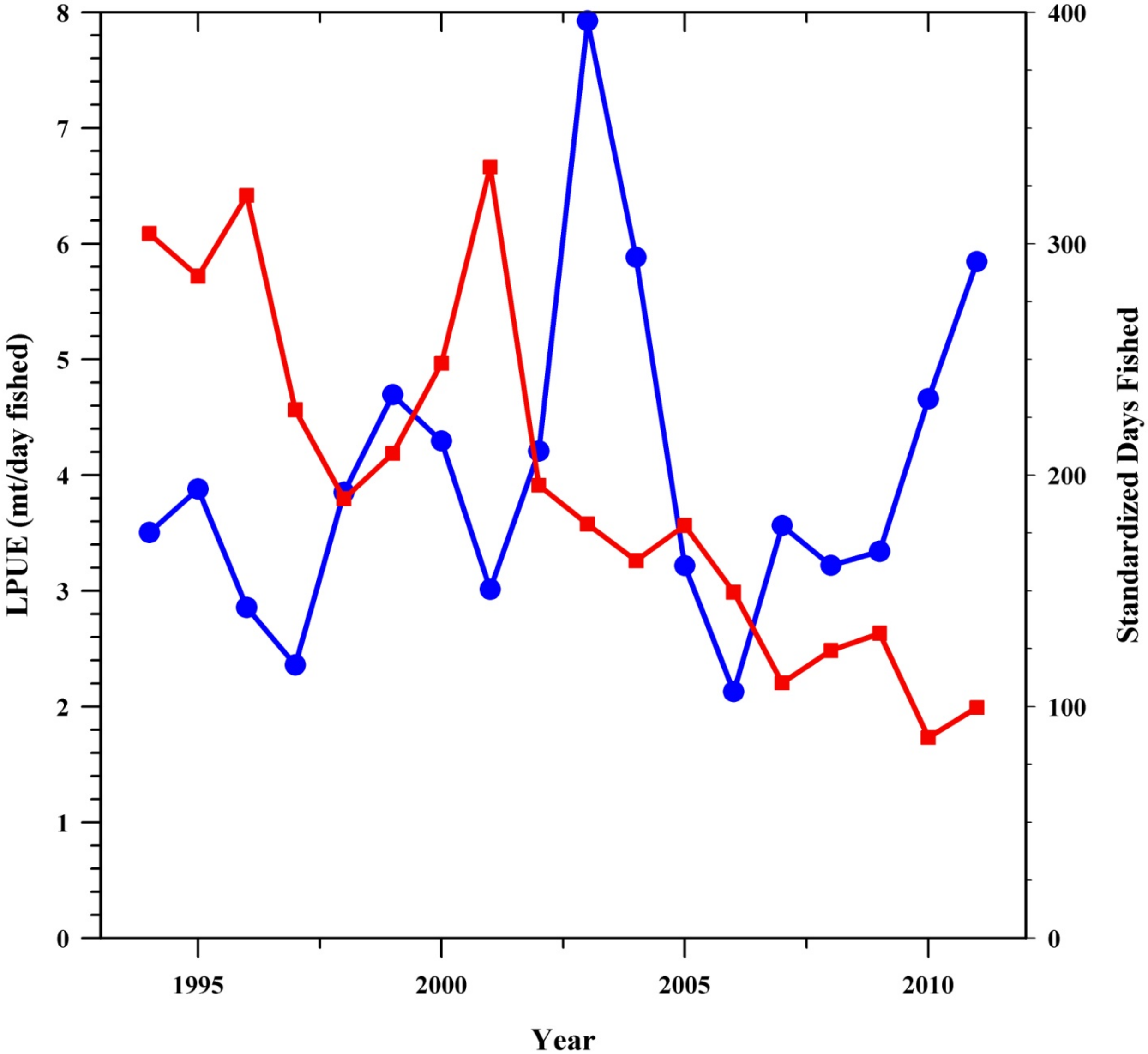


Figure B70. Standardized landings per day fished (LPUE, circles) and effort (days fished raised to total sink gill net landings, solid line) of all white hake trips using a general linear model: year, quarter, area, and tonnage class.

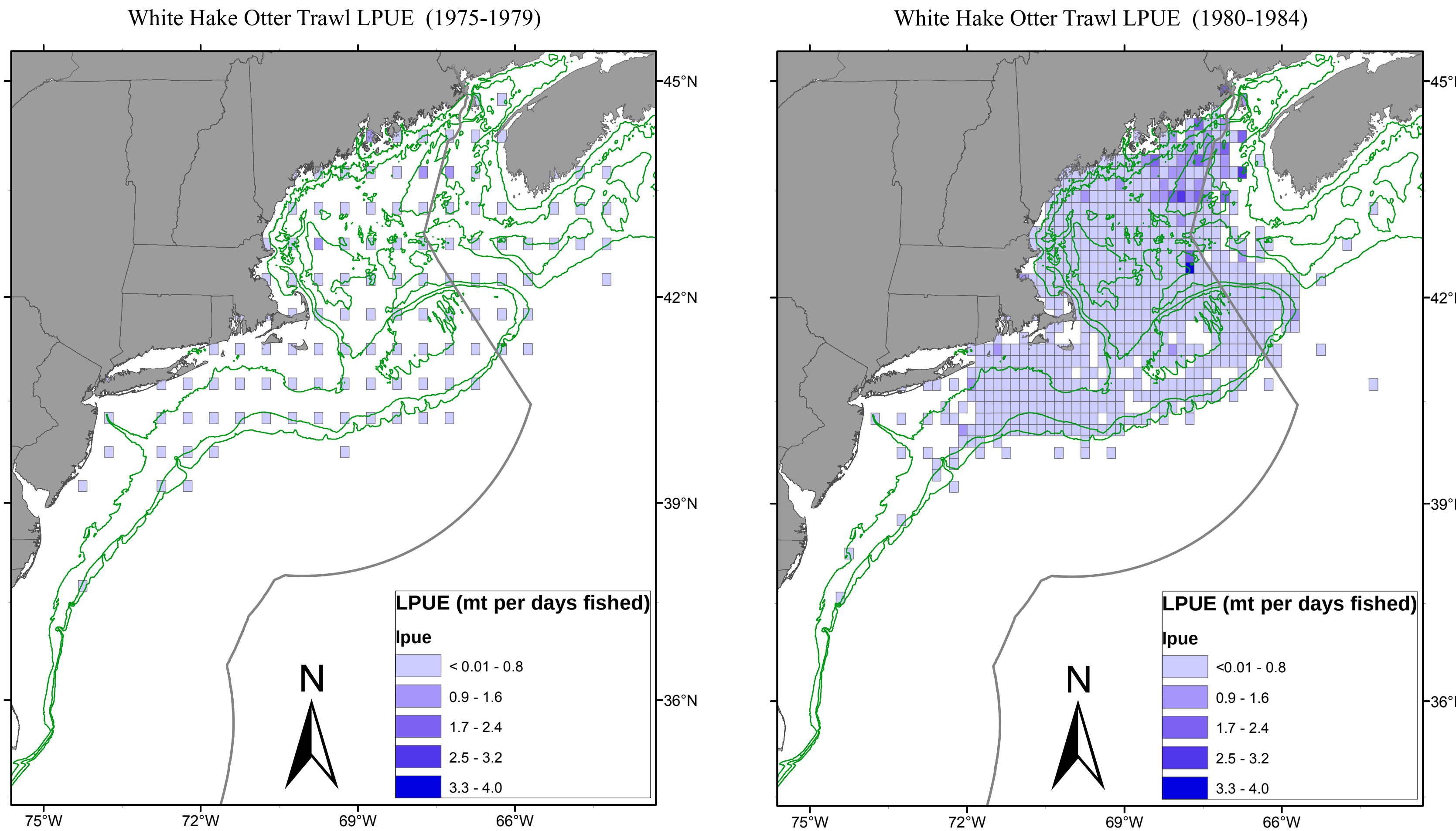
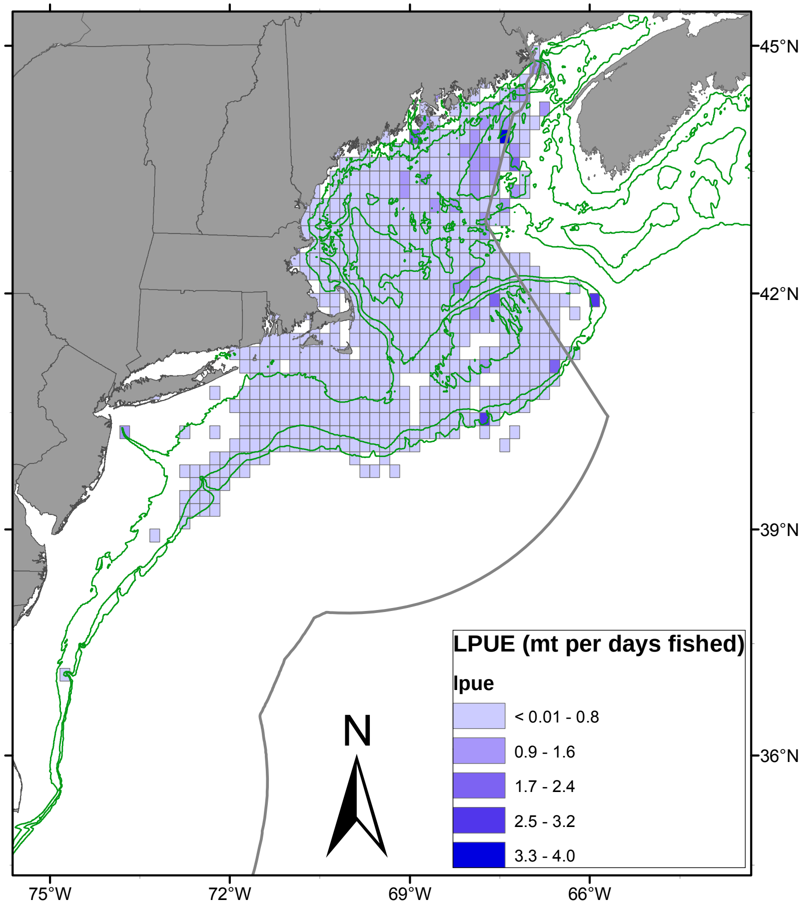


Figure B71. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the otter trawl fishery from 1975-1979 and 1980-1984.

White Hake Otter Trawl LPUE (1985-1989)



White Hake Otter Trawl LPUE (1990-1994)

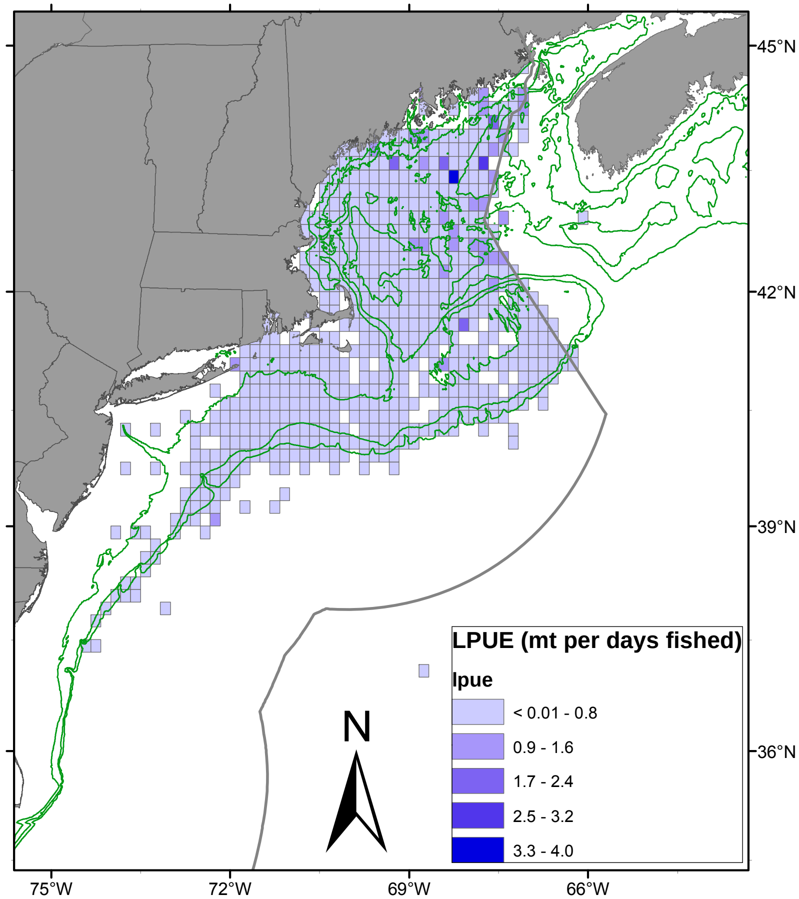
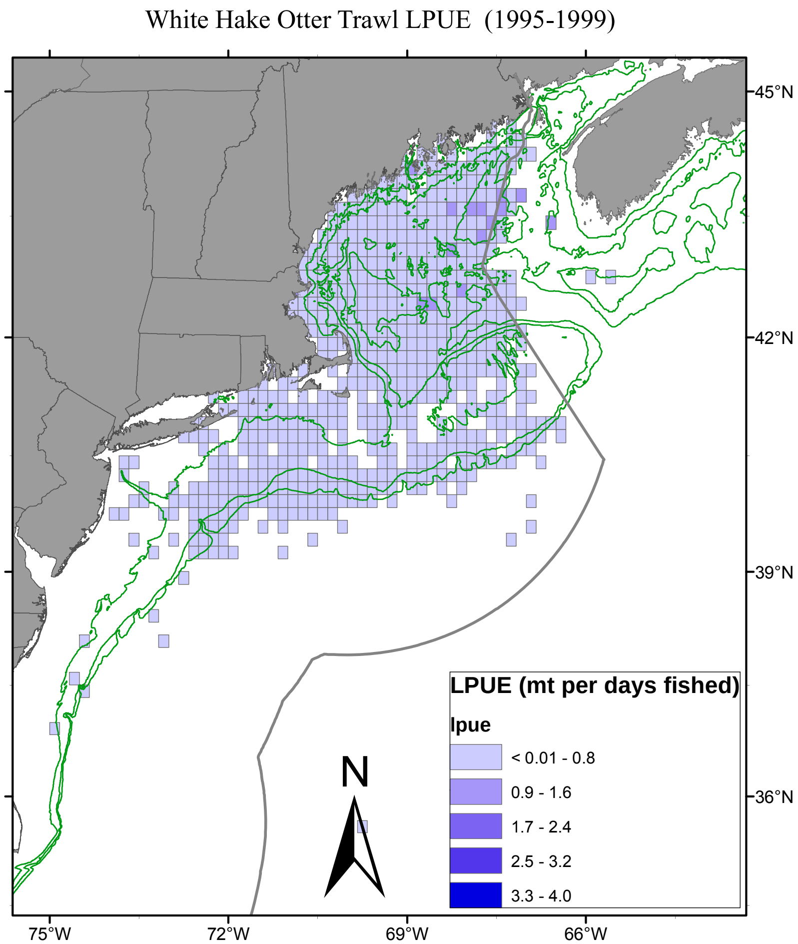


Figure B72. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the otter trawl fishery from 1985-1989 and 1990-1994.



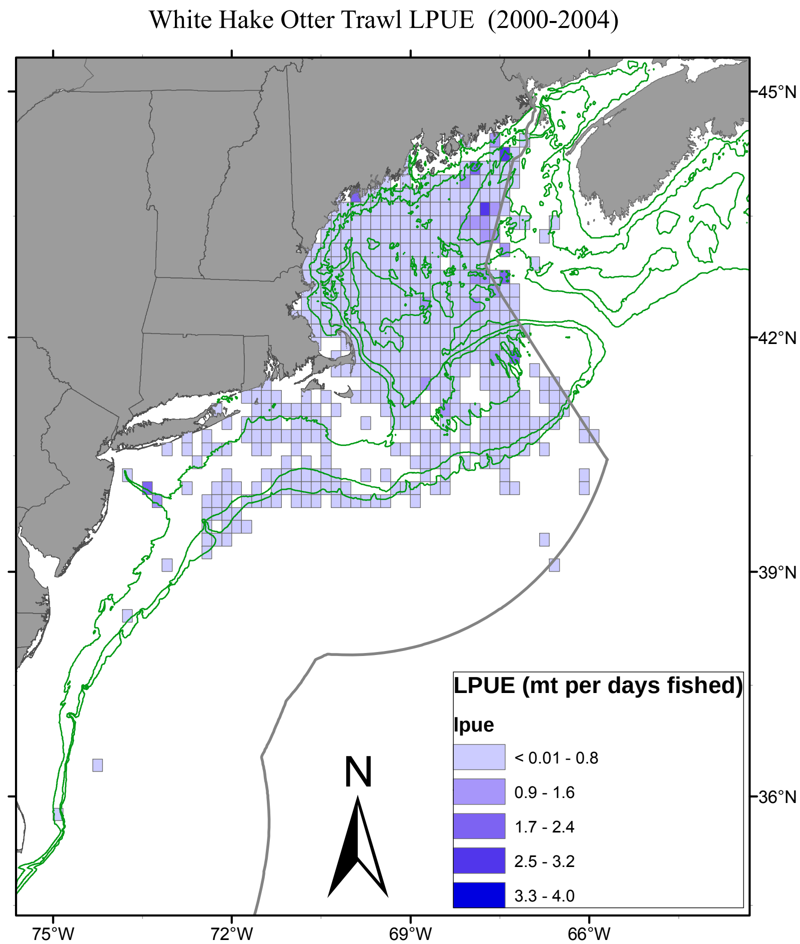


Figure B73. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the otter trawl fishery from 1995-1999 and 2000-2004.

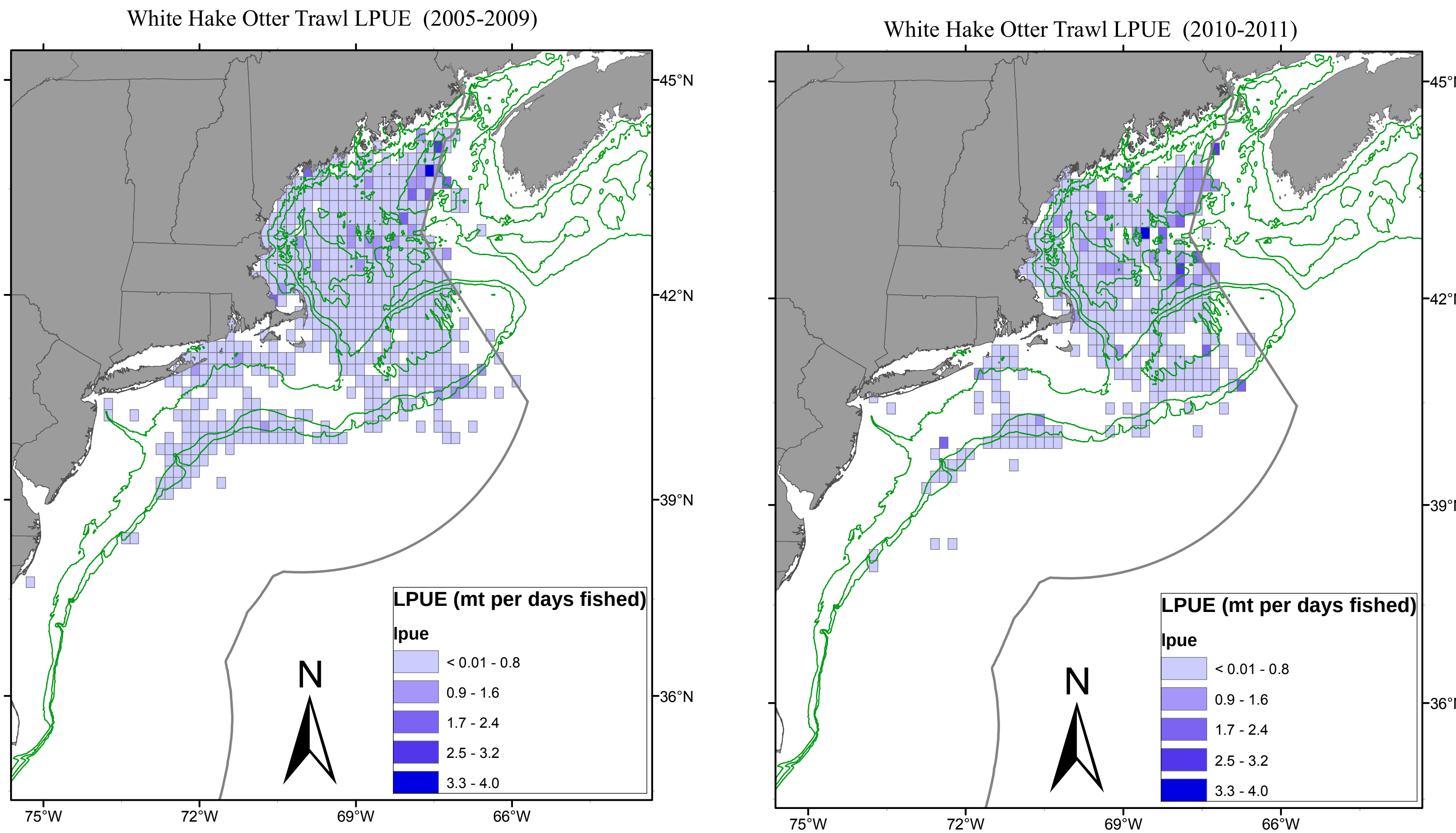
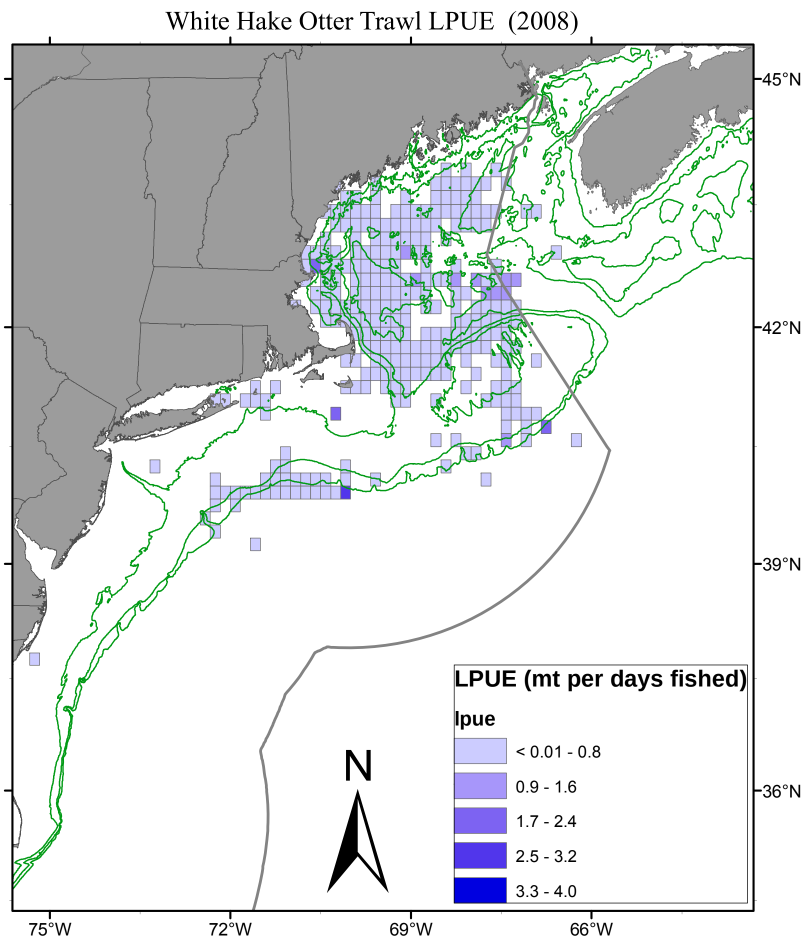


Figure B74. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the otter trawl fishery from 2005-2009 and 2010-2011.



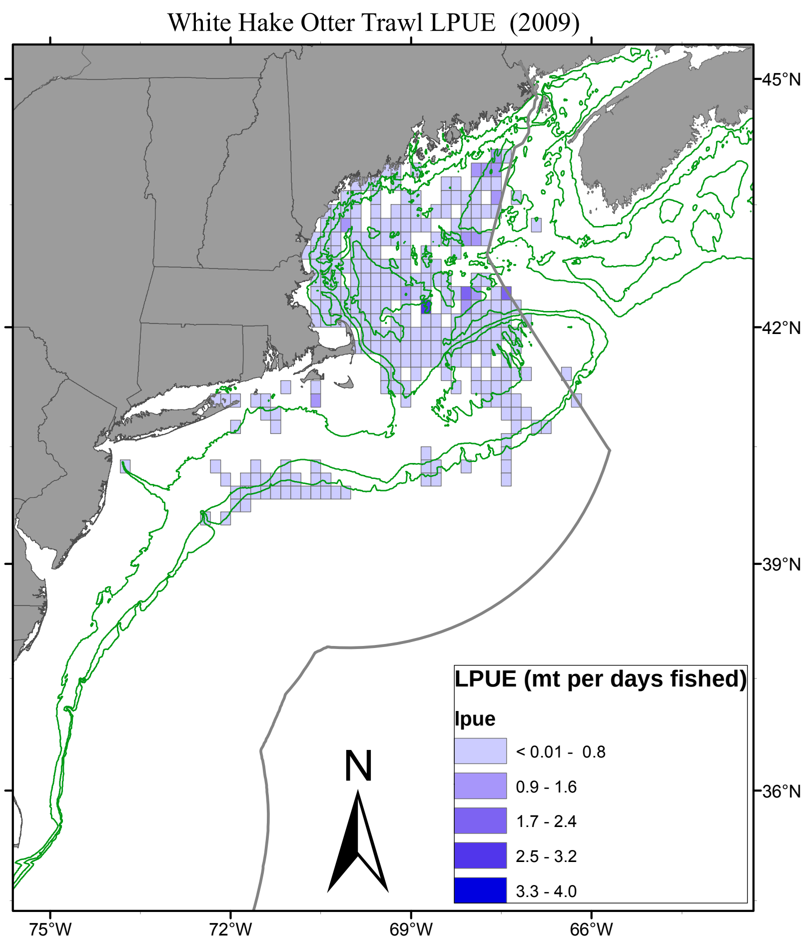
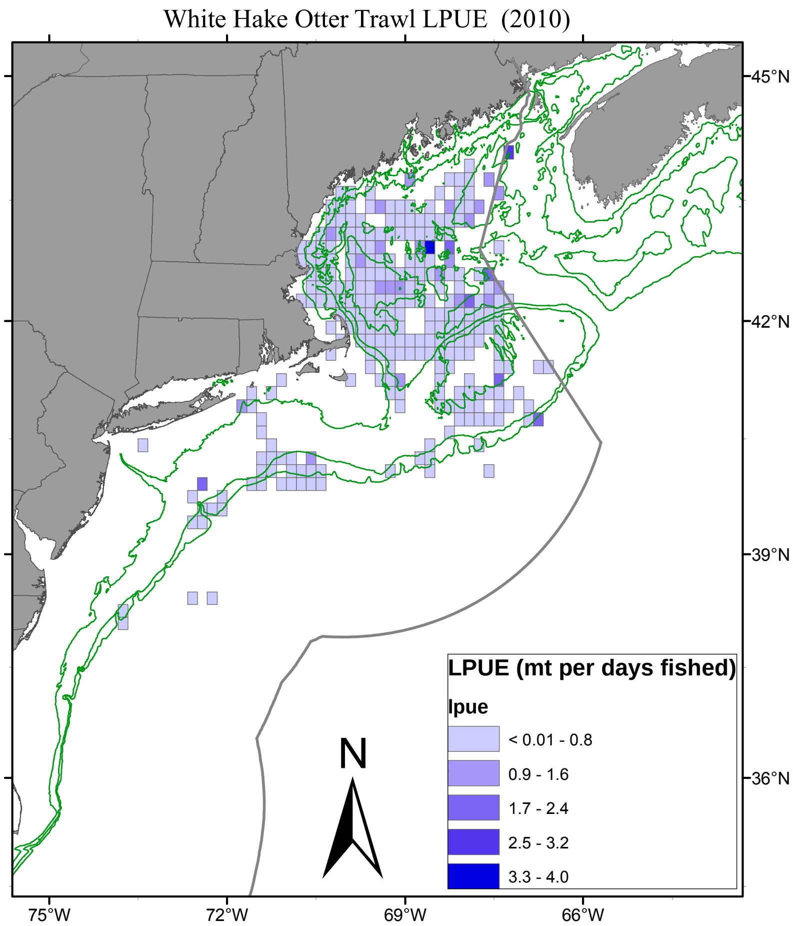


Figure B75a. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the otter trawl fishery from 2008-2011.



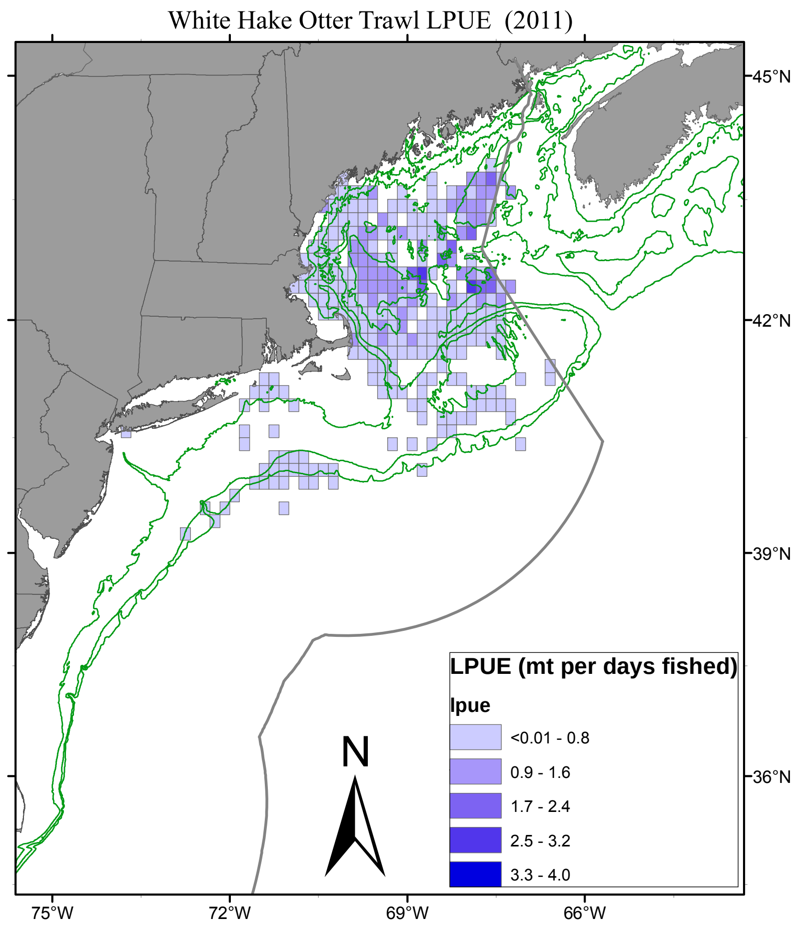
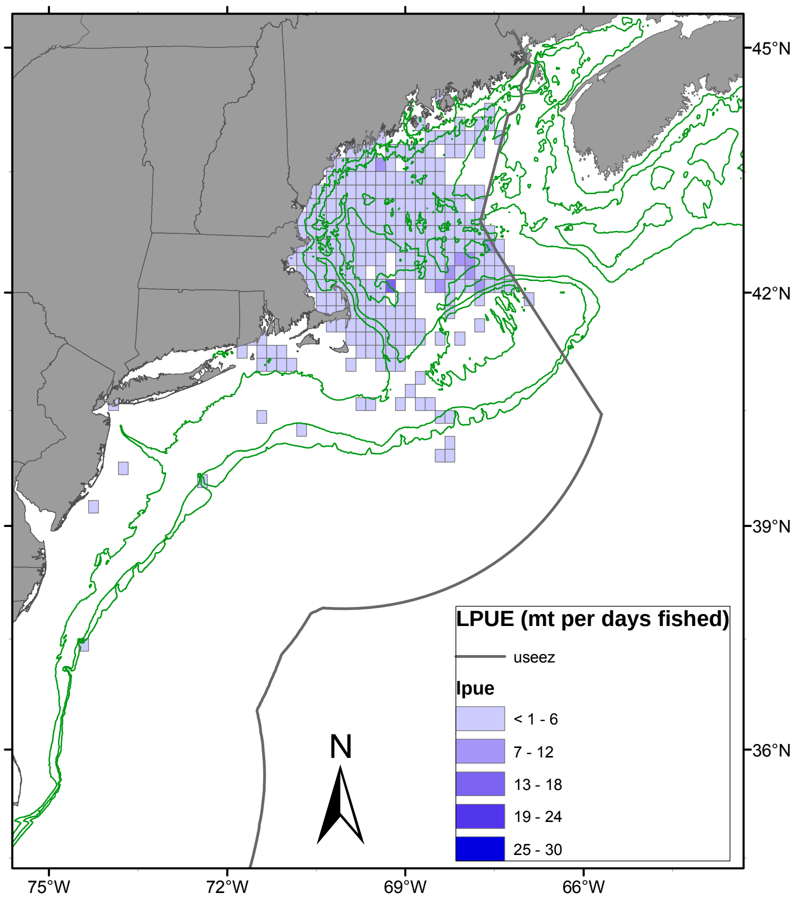


Figure B75b. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the otter trawl fishery from 2008-2011.

White Hake Gillnet LPUE (1995-1999)



White Hake Gillnet LPUE (2000-2004)

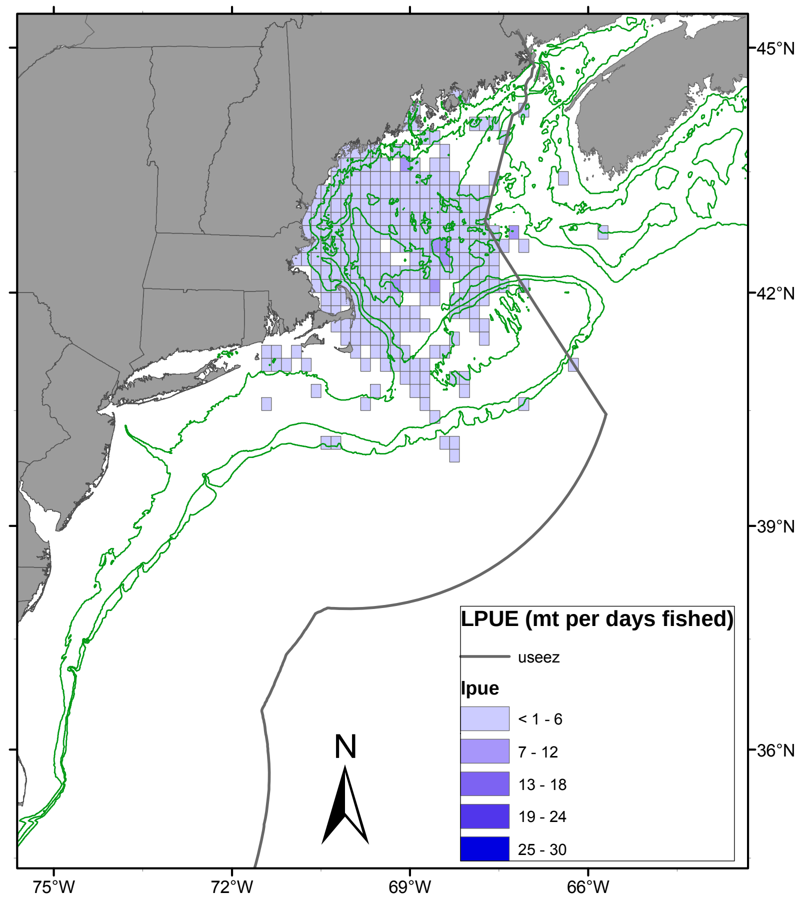


Figure B76. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the sink gill net fishery from 1995-1999 and 2000-2004.

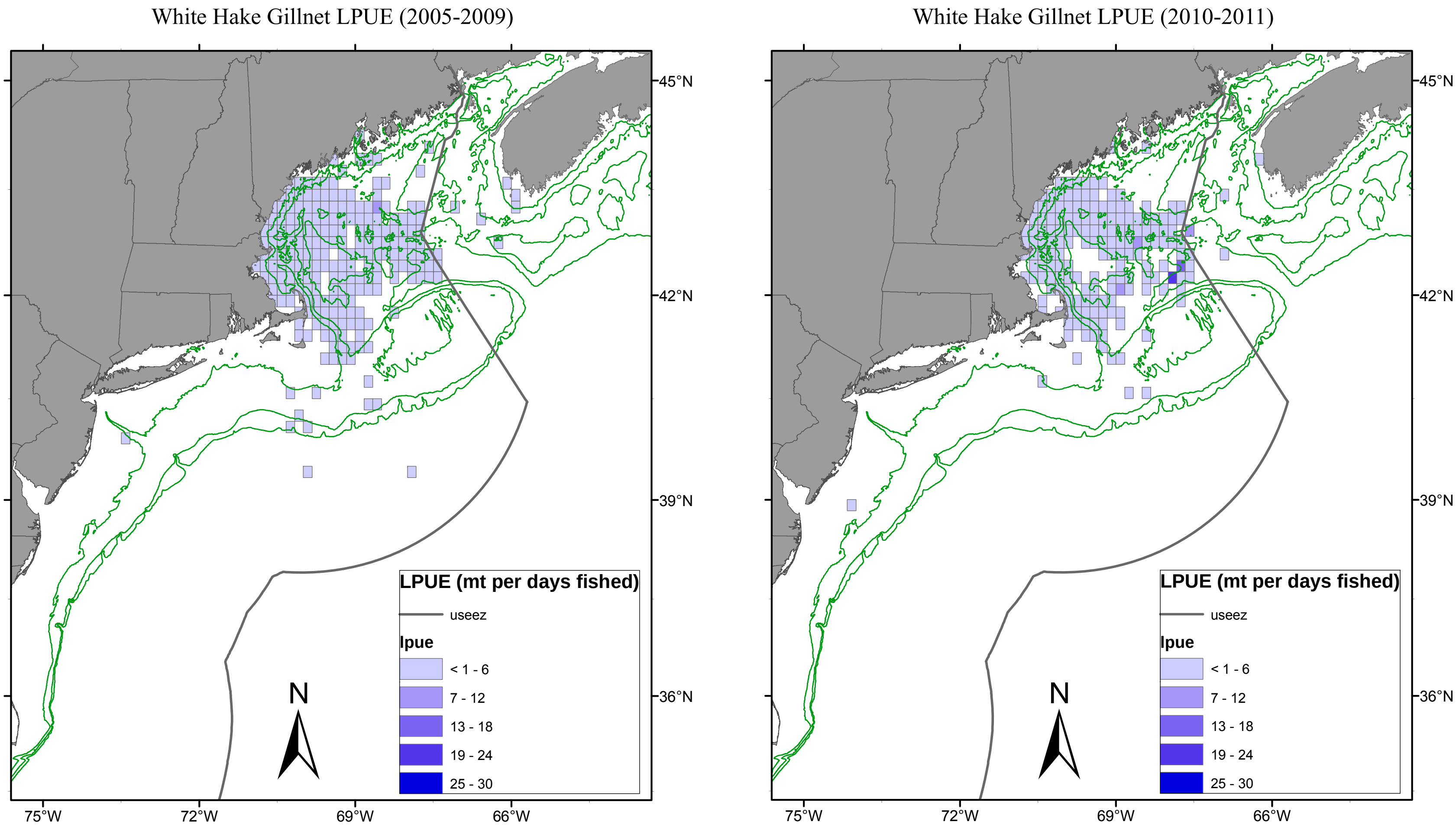


Figure B77. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the sink gill net fishery from 2005-2009 and 2010-2011.

White Hake Gillnet LPUE (2008)

White Hake Gillnet LPUE (2009)

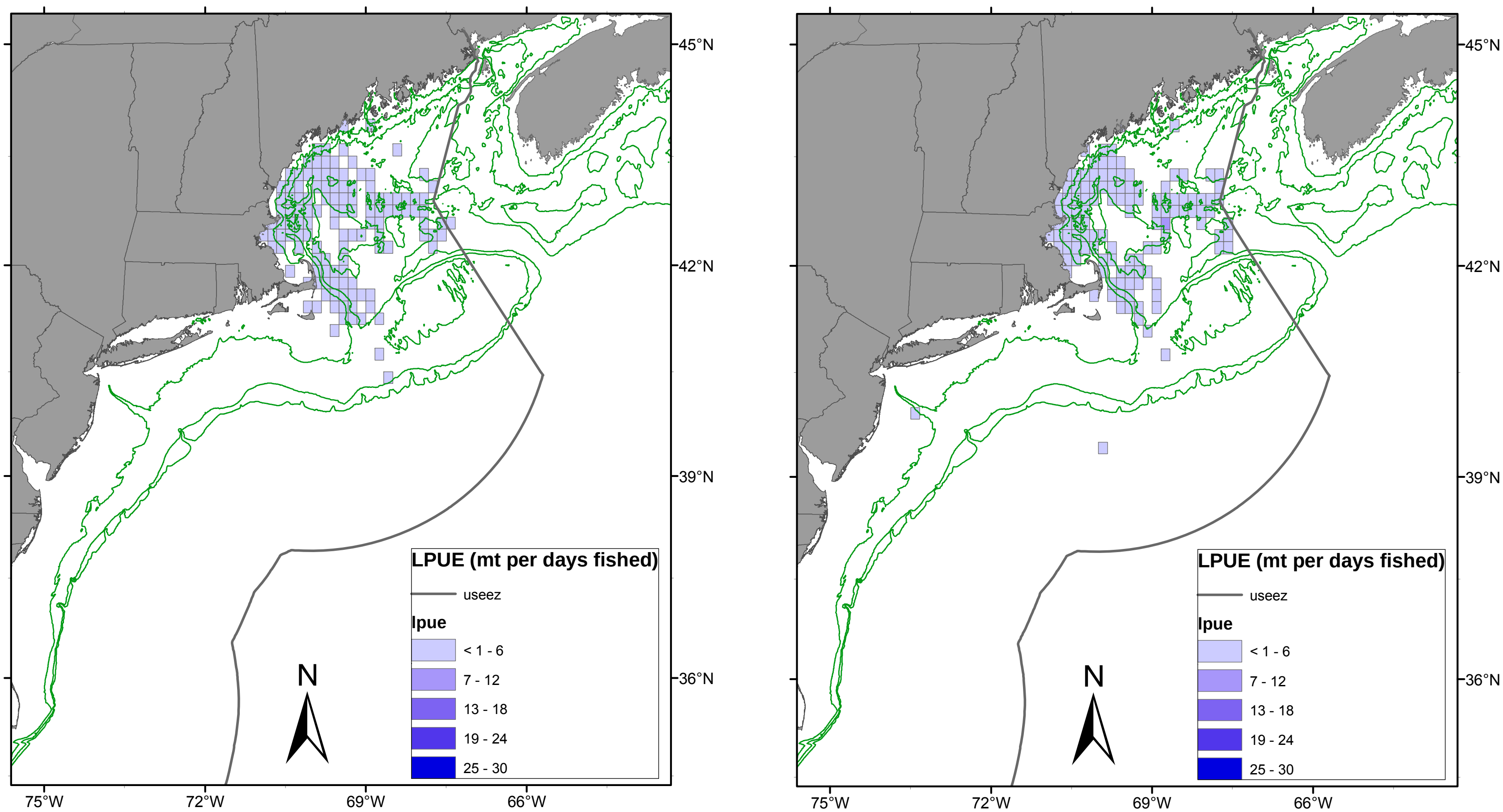


Figure B78a. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the sink gill net fishery from 2008-2011.

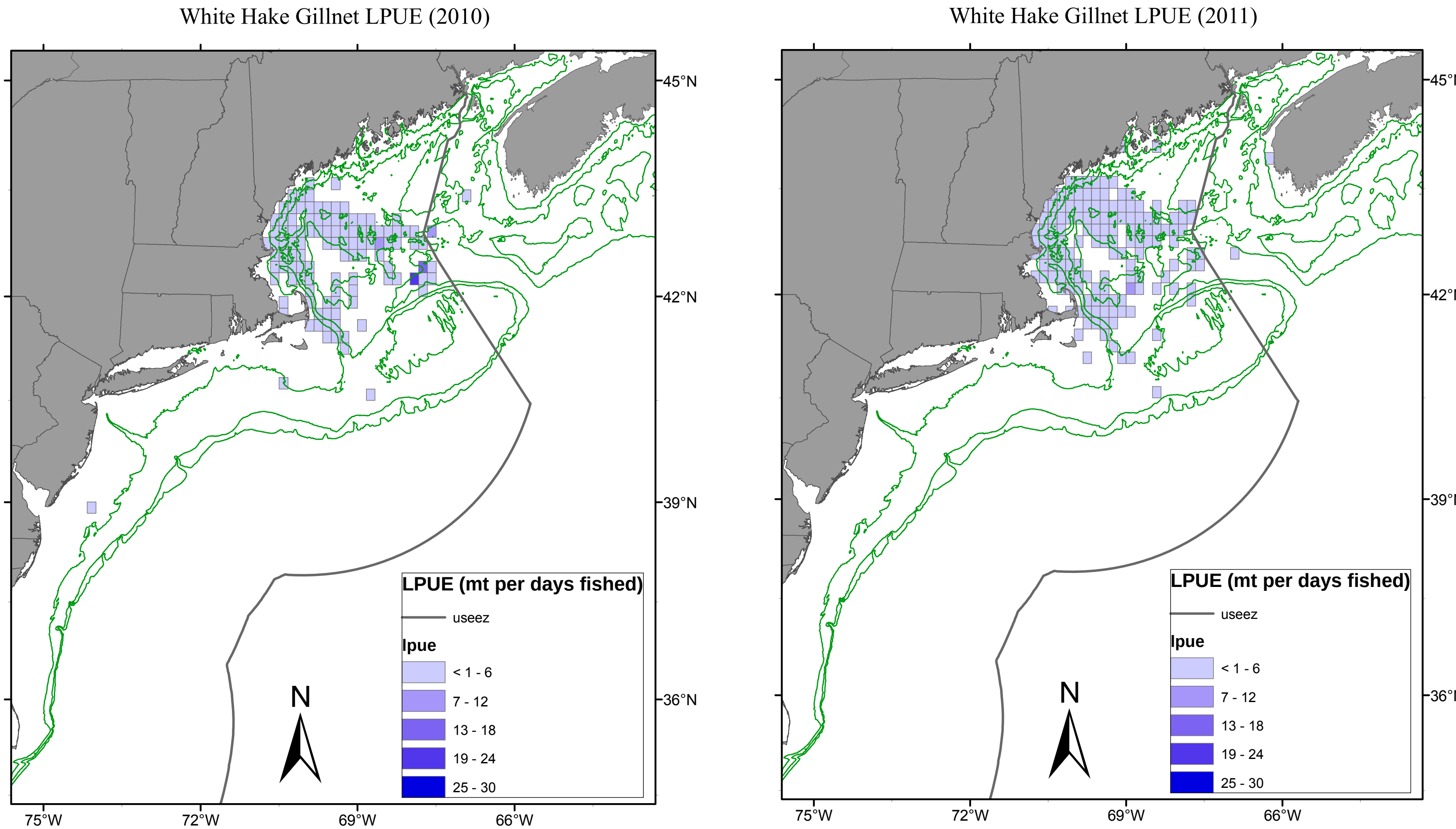


Figure B78b. Weighted LPUE (sum pounds landed in a ten-minute square/ sum of days fished in that ten-minute square) from the sink gill net fishery from 2008-2011.

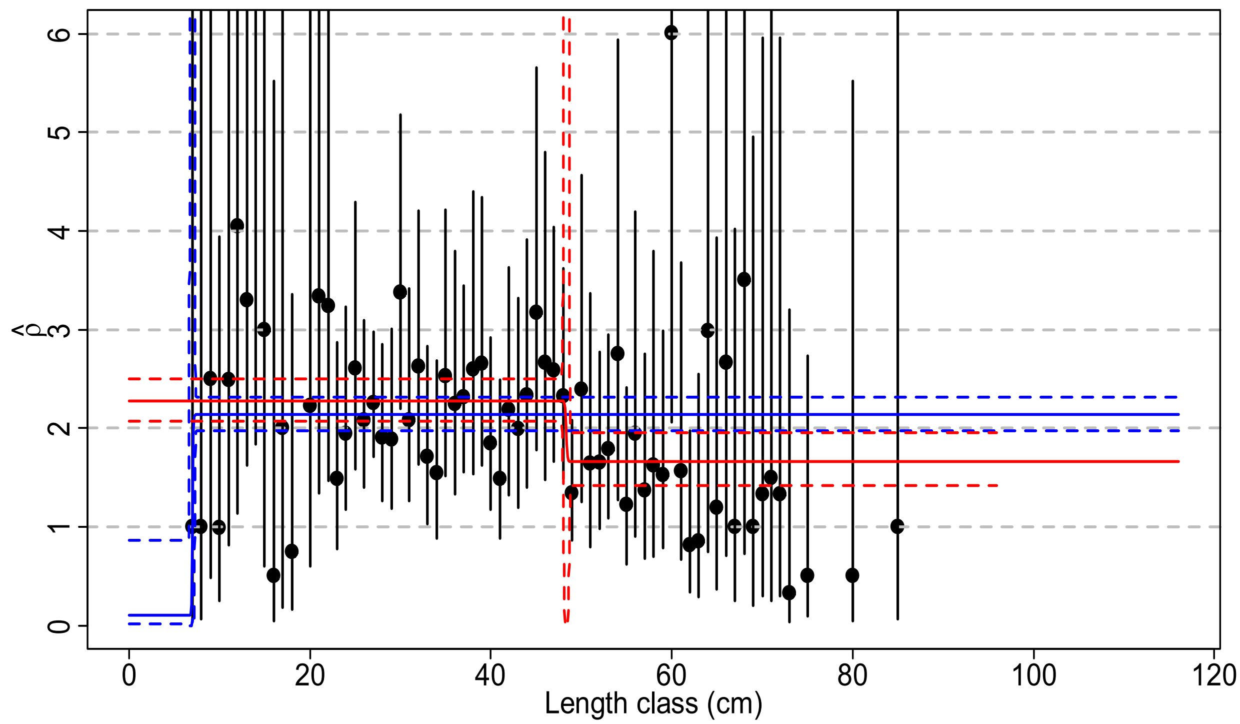


Figure B79. Beta-binomial based estimates of calibration factors and corresponding 95% confidence intervals by length class (1 cm bins) for **white hake**. The black points and vertical bars represent results where different calibration factors are estimated for each length class. The blue lines represent results from logistic model where the slope is estimated to be positive whereas the red lines represent results from a logistic model where the slope is forced to be negative.

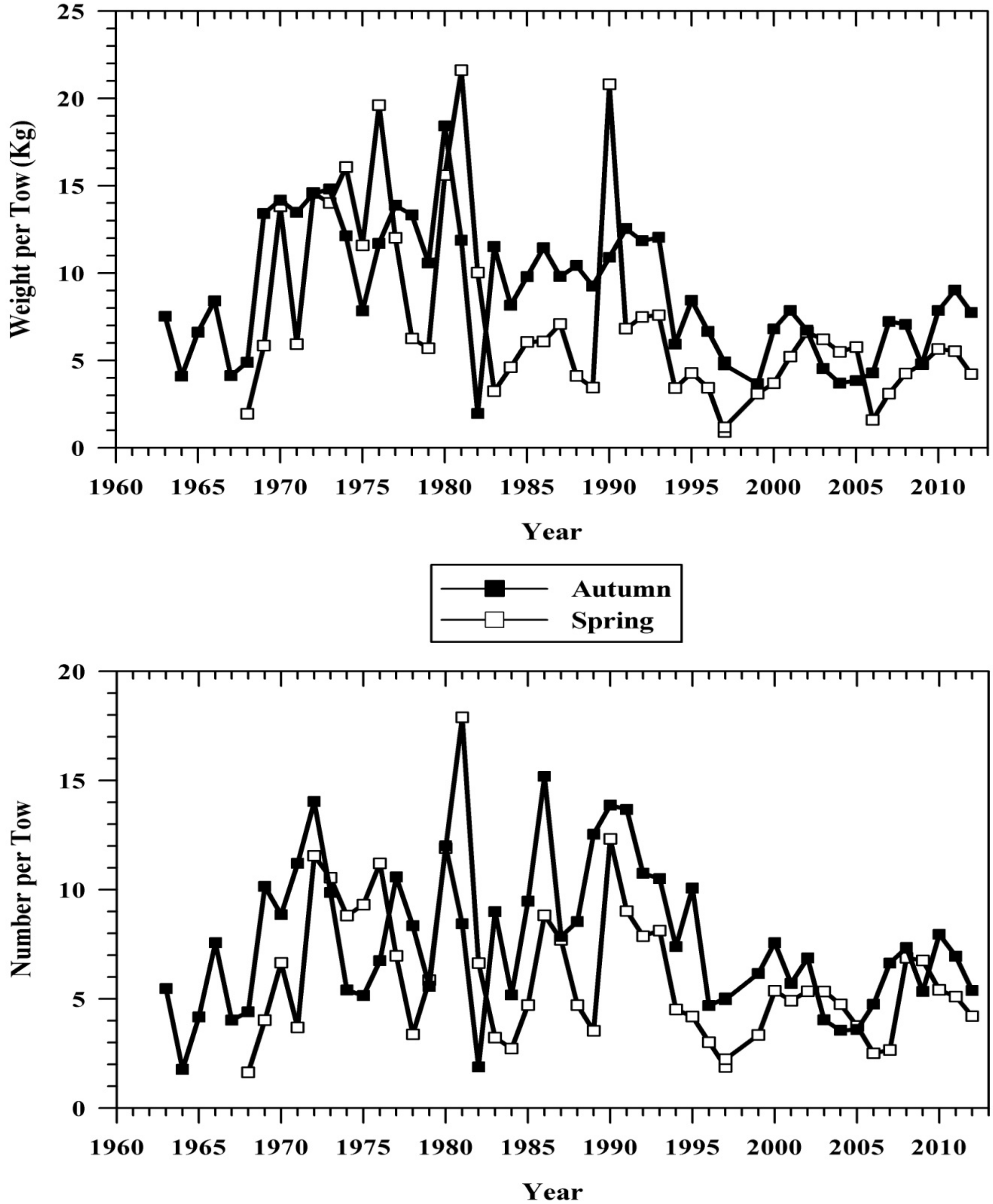


Figure B80. White hake indices of biomass (top panel) and abundance (bottom panel) from the NEFSC bottom trawl spring (solid line) and autumn (dashed line) surveys in the Gulf of Maine to Northern Georges Bank region (offshore strata 21-30, 36-40), 1963-2012.

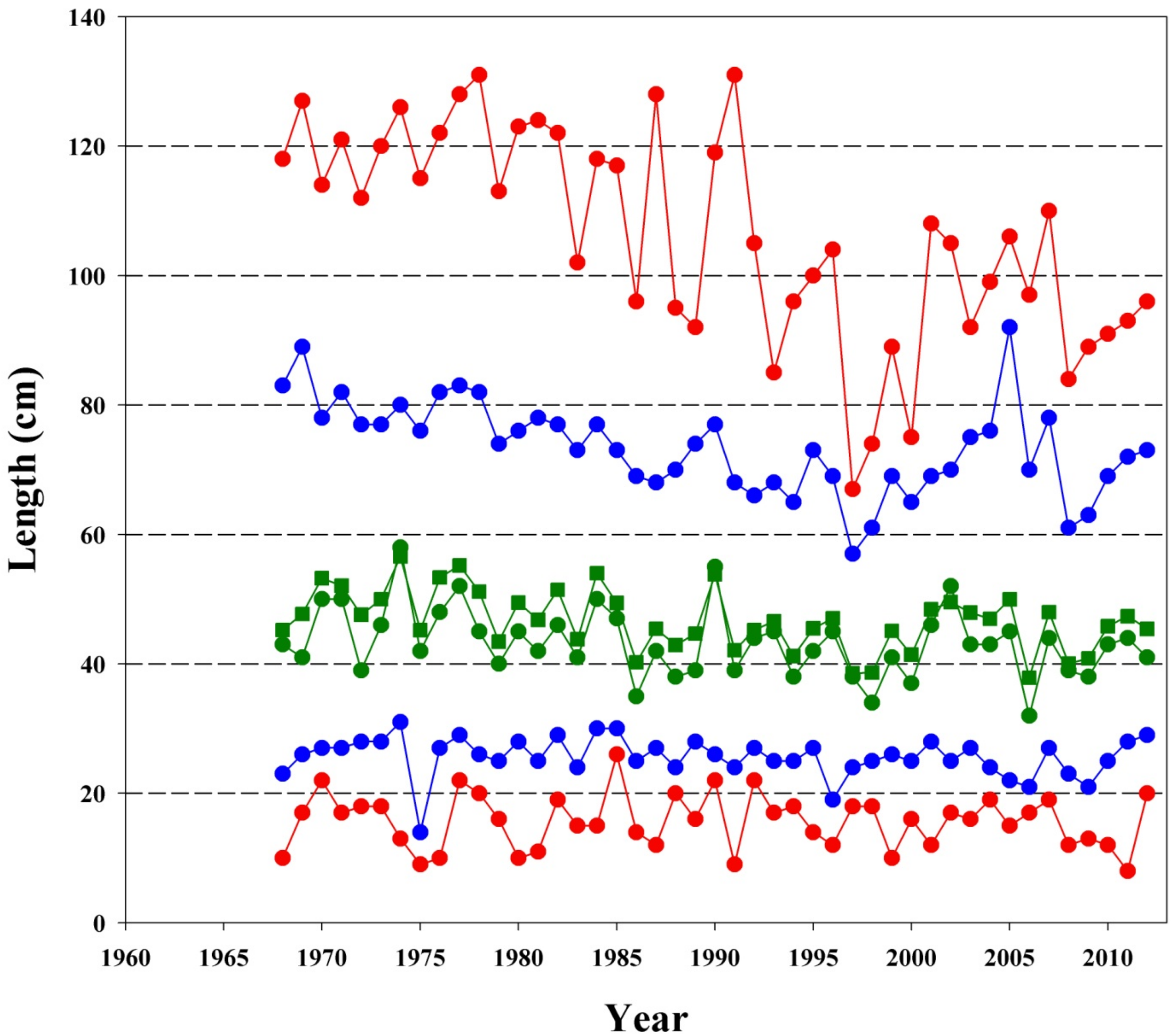


Figure B81. Minimum and maximum (red circles), 5th and 95th percentiles (blue circles), mean (green squares) and 50th percentile (green circles) of white hake length from the NEFSC spring bottom trawl surveys.

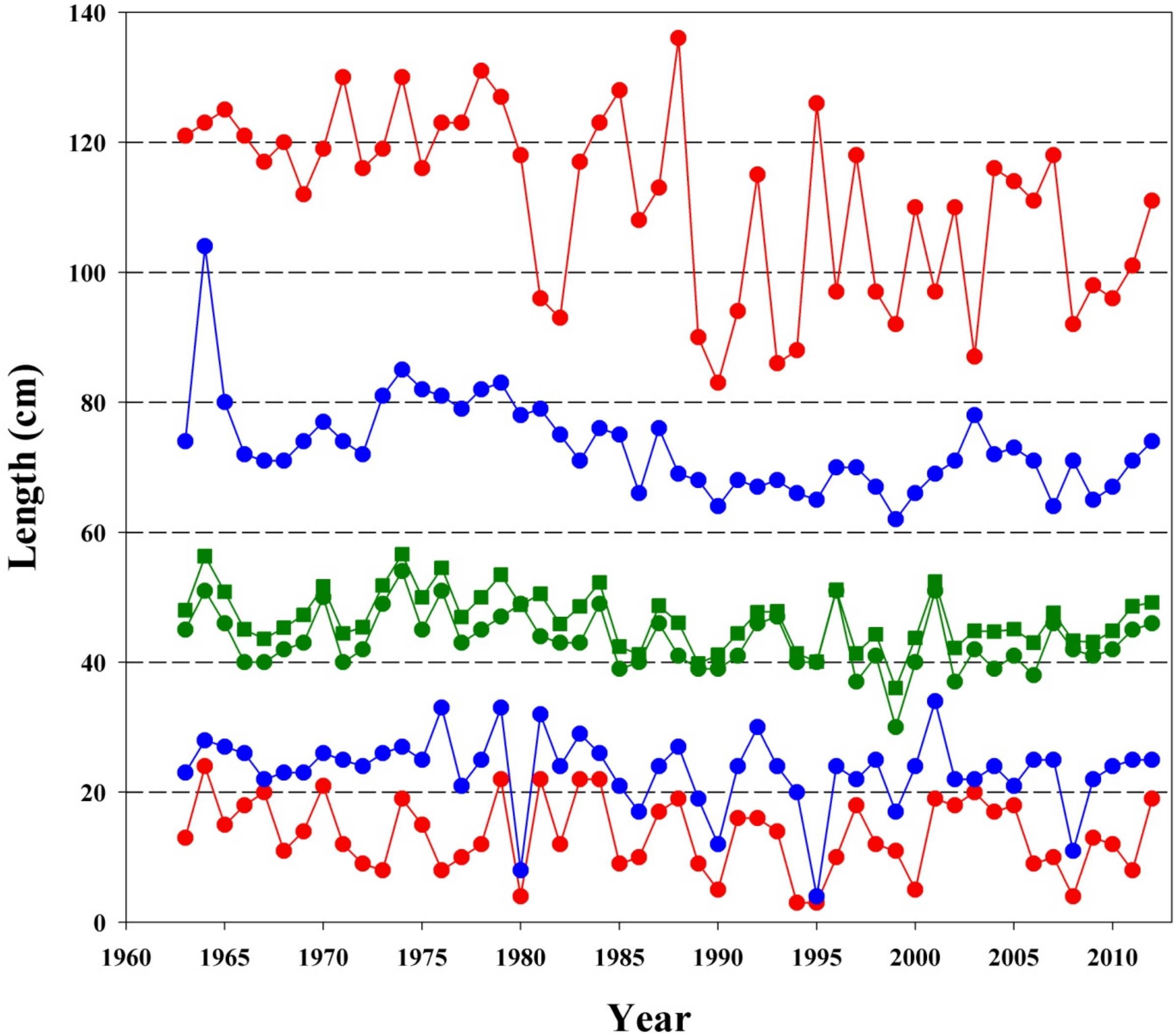


Figure B82. Minimum and maximum (red circles), 5th and 95th percentiles (blue circles), mean (green squares) and 50th percentile (green circles) of white hake length from the NEFSC autumn bottom trawl surveys.

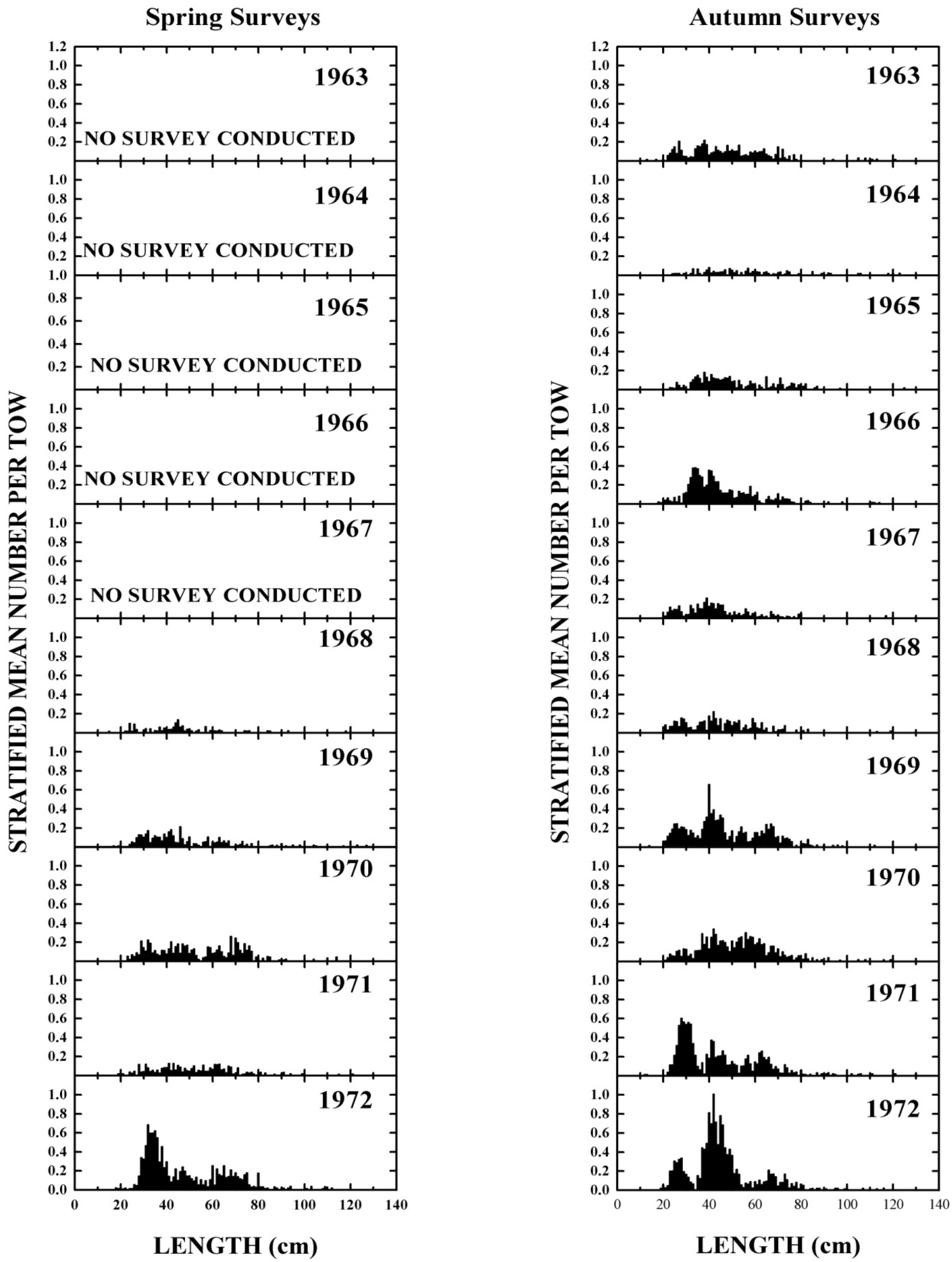


Figure B83a. Length composition of white hake from the NEFSC spring and autumn surveys from 1963-1972.

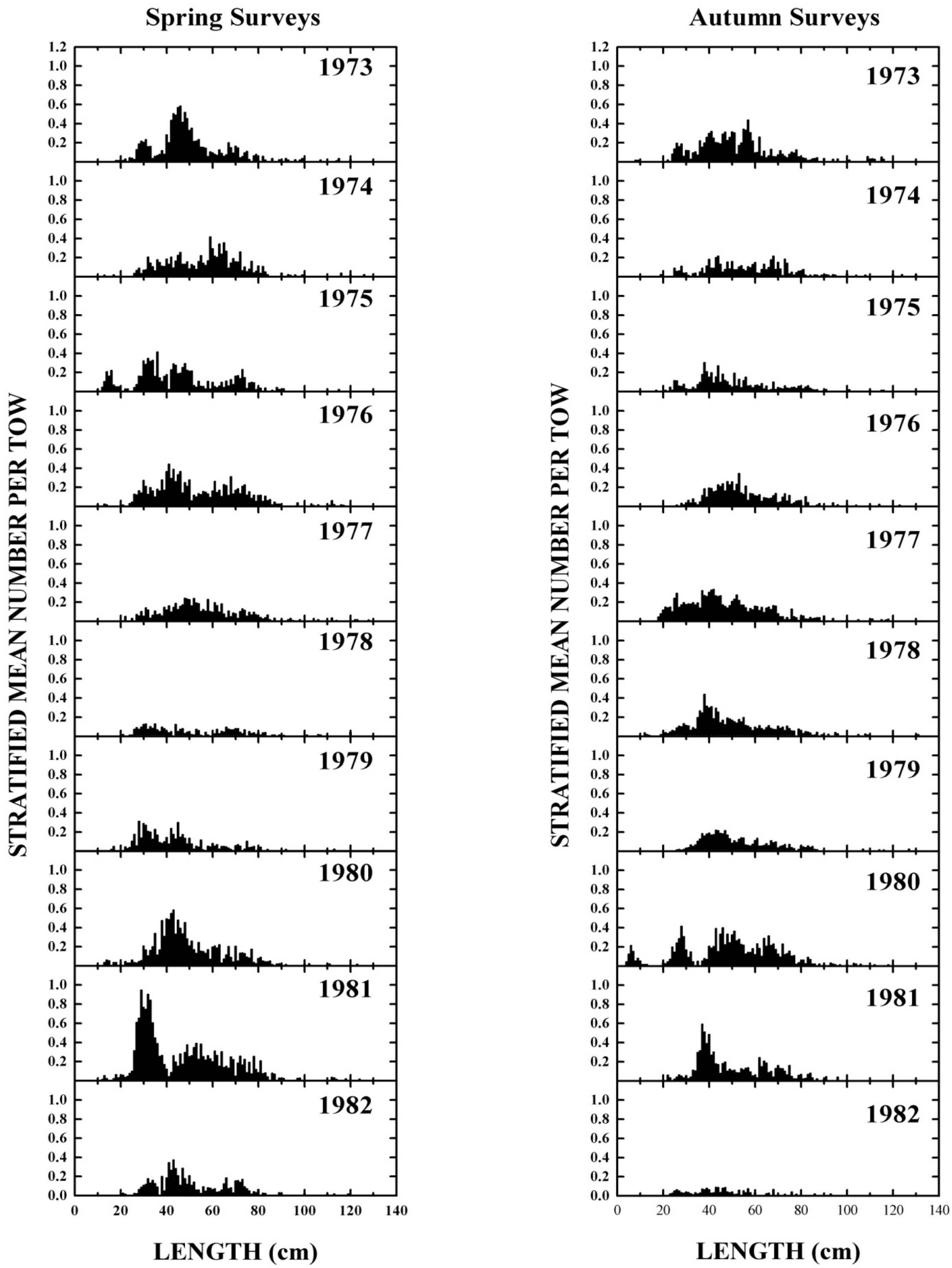


Figure B83b. Length composition of white hake from the NEFSC spring and autumn surveys from 1973-1982.

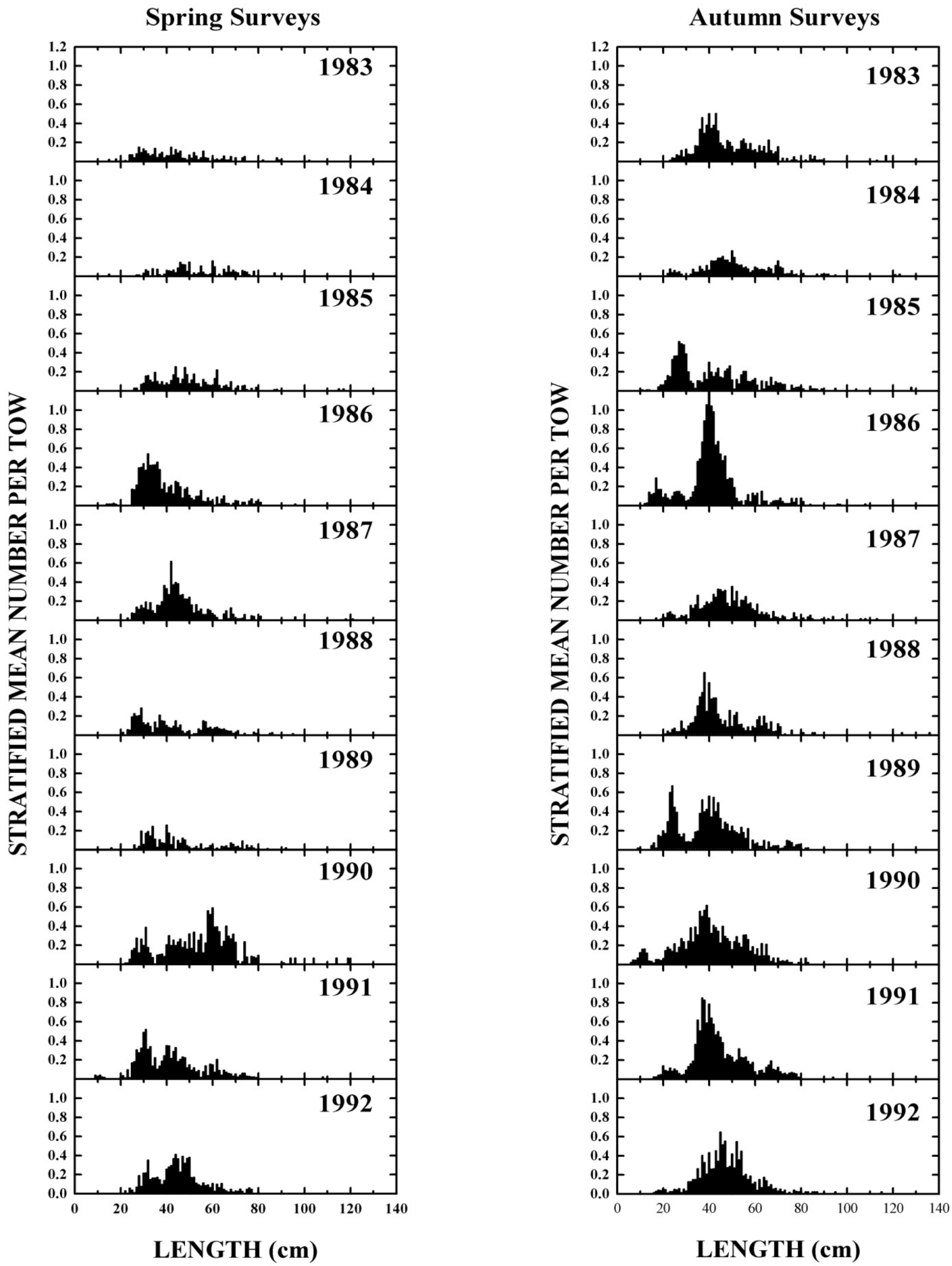


Figure B83c. Length composition of white hake from the NEFSC spring and autumn surveys from 1983-1992.

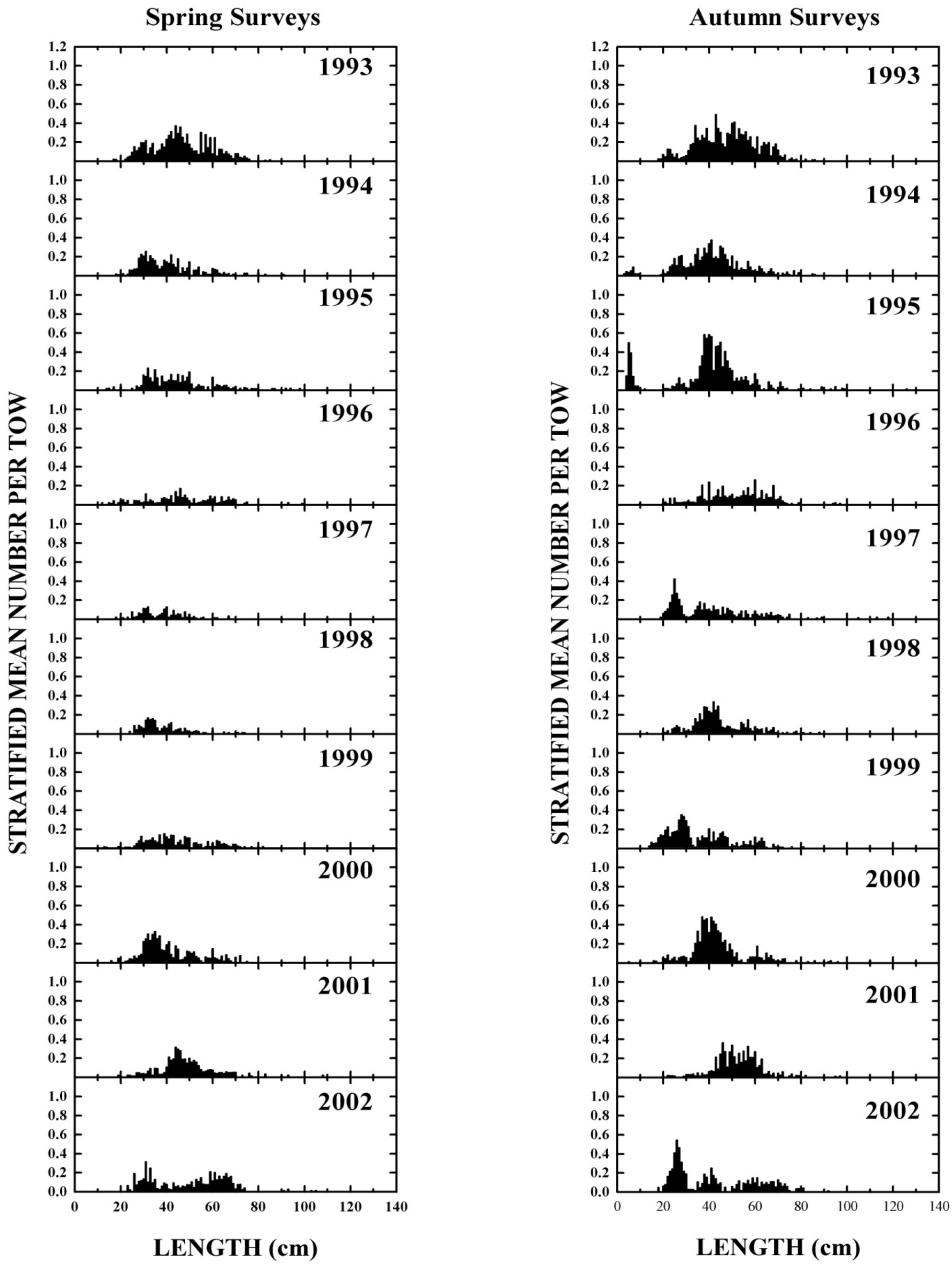


Figure B83d. Length composition of white hake from the NEFSC spring and autumn surveys from 1993-2002.

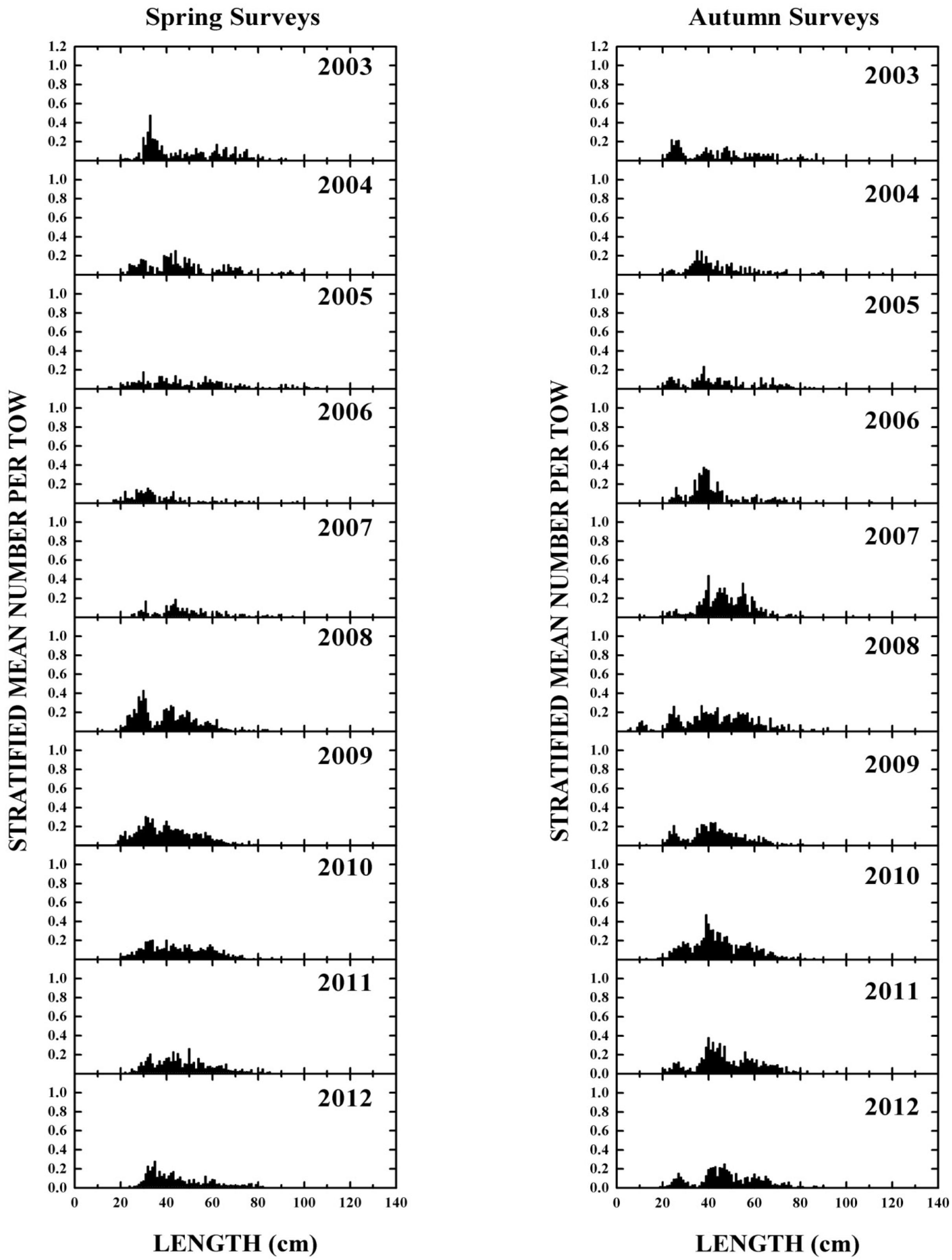


Figure B83e. Length composition of white hake from the NEFSC spring and autumn surveys from 2003-2012.

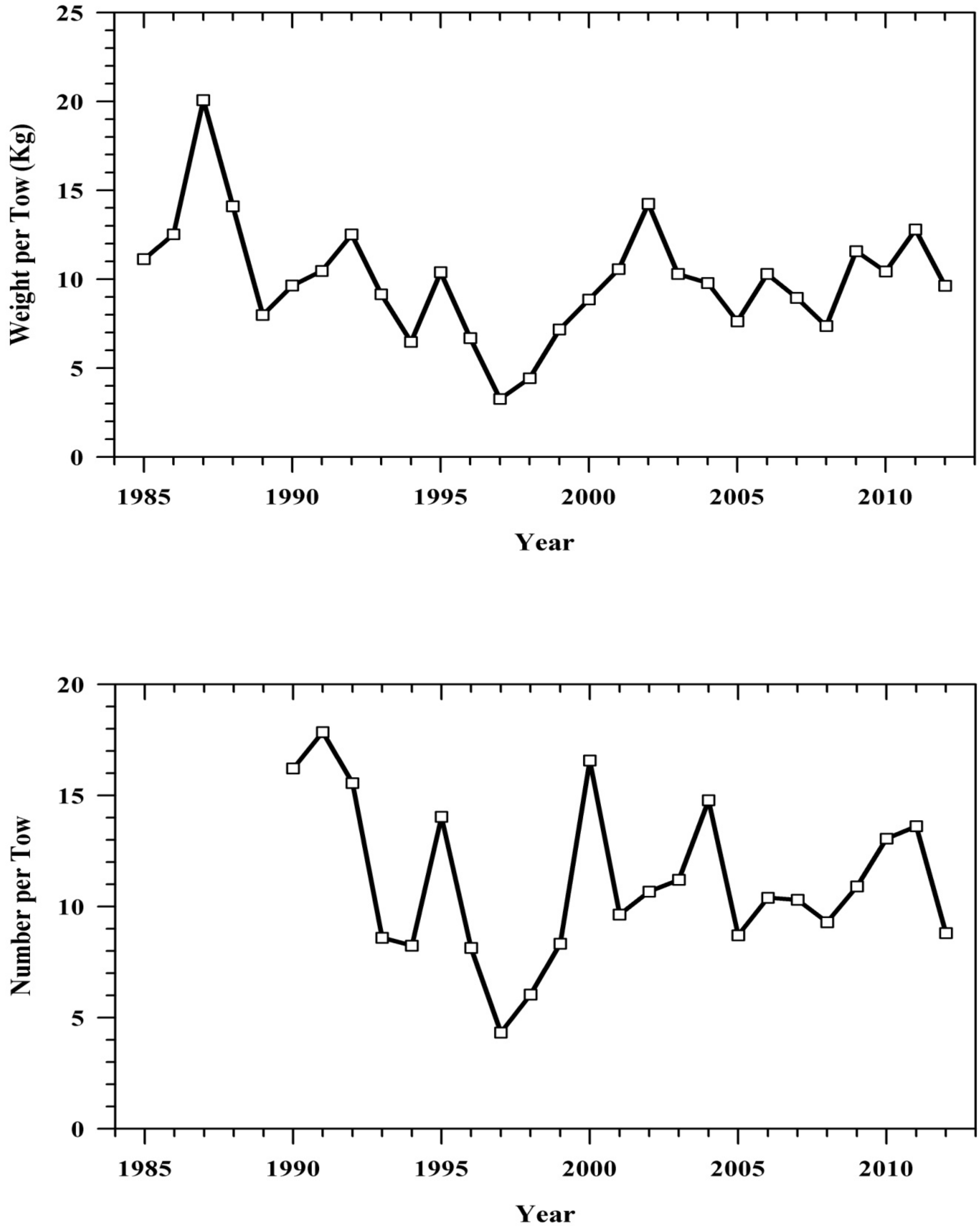


Figure B84. White hake indices of biomass (top panel) and abundance (bottom panel) from the ASMFC shrimp trawl surveys in the Gulf of Maine (shrimp strata 1,3, 5-8), 1985-2012.

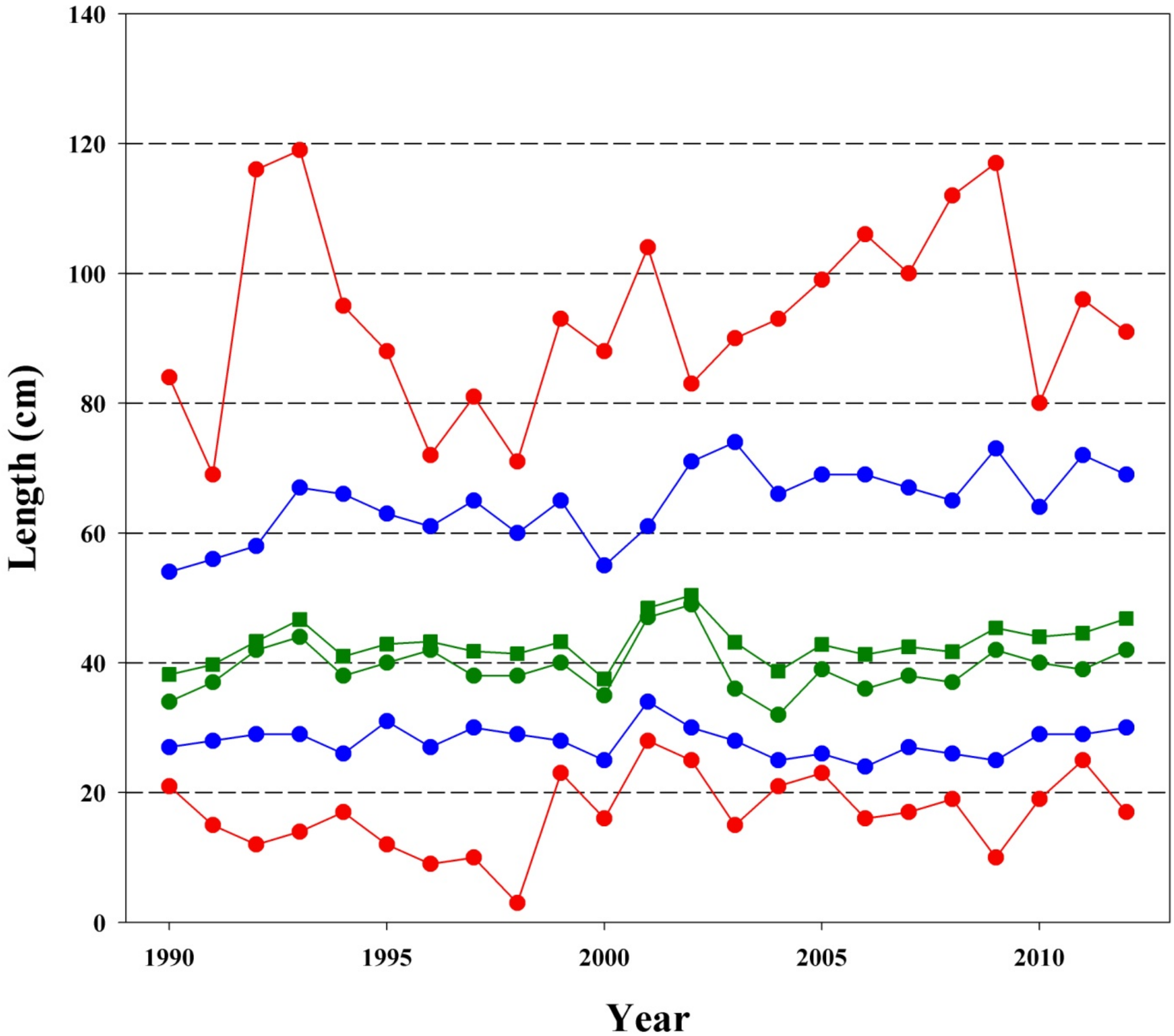


Figure B85. Minimum and maximum (red circles), 5th and 95th percentiles (blue circles), mean (green squares) and 50th percentile (green circles) of white hake length from the ASMFC shrimp surveys.

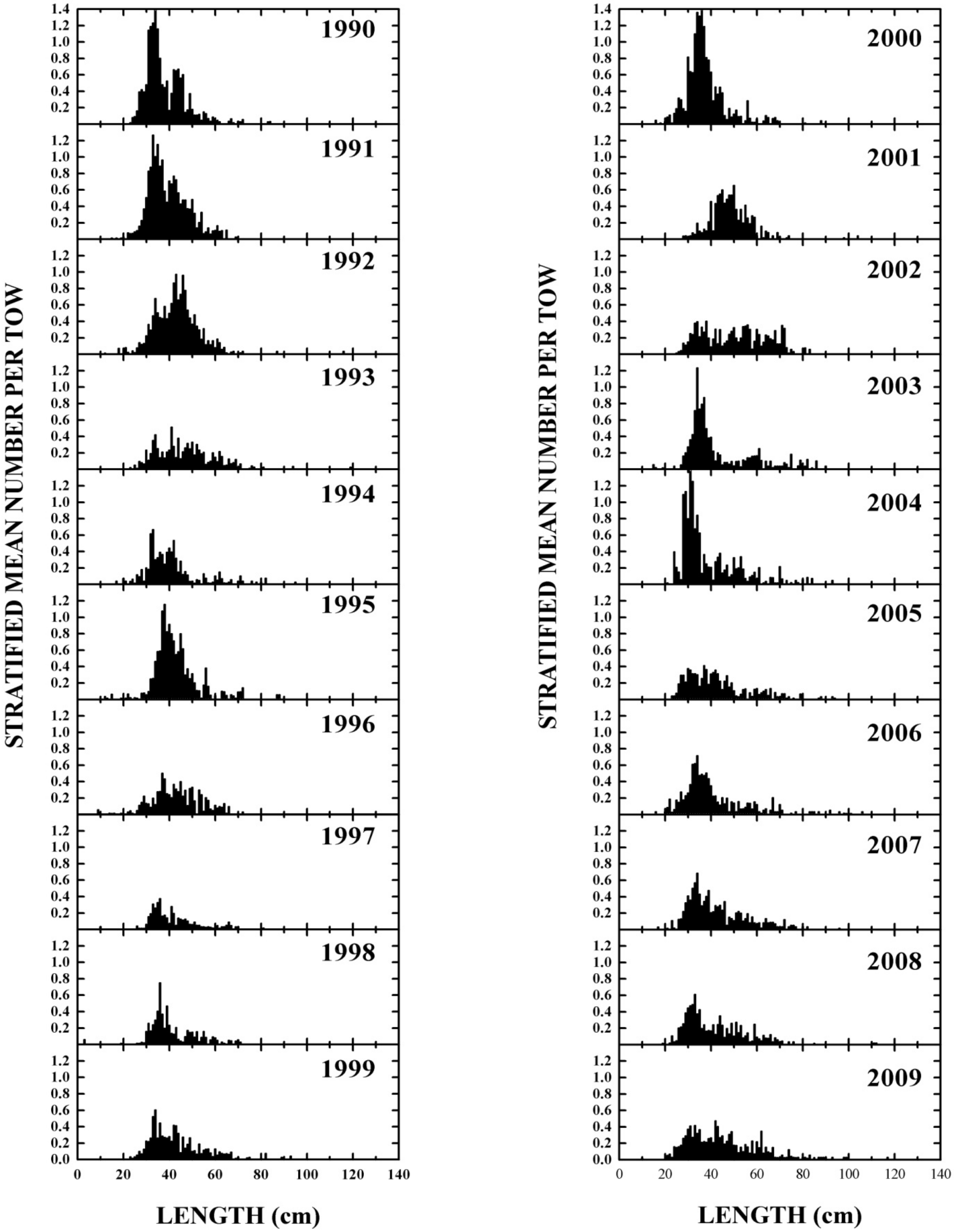


Figure B86a. Length composition of white hake from the ASMFC shrimp survey from 1990-2009.

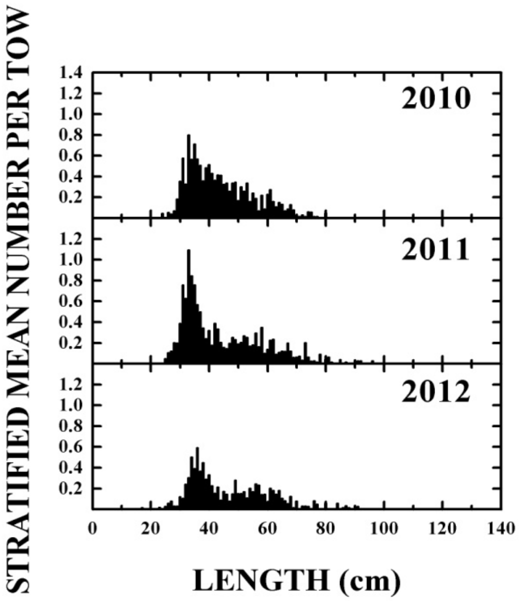

STRATIFIED MEAN NUMBER PER TOW
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2010
2011
2012
0
20
40
60
80
100
120
140
LENGTH (cm)

Figure B86b. Length composition of white hake from the ASMFC shrimp survey from 2010-2012.

Region	Stratum	Area(nm²)
1. Buzzards Bay	11	102
Vineyard Sd &	12	160
coastal water	13	88
south of Marthas	14	16
Vineyard		
2. Nantucket Sound	15	190
	16	212
3. East of Cape Cod	17	85
Race Point to	18	88
Muskeget Island	19	39
	20	24
	21	40
4. Cape Cod Bay	25	47
	26	87
	27	94
	28	93
	29	103
	30	32
5. Massachusetts	31	41
Bay north to	32	49
N.H. border	33	78
	34	38
	35	174
	36	33

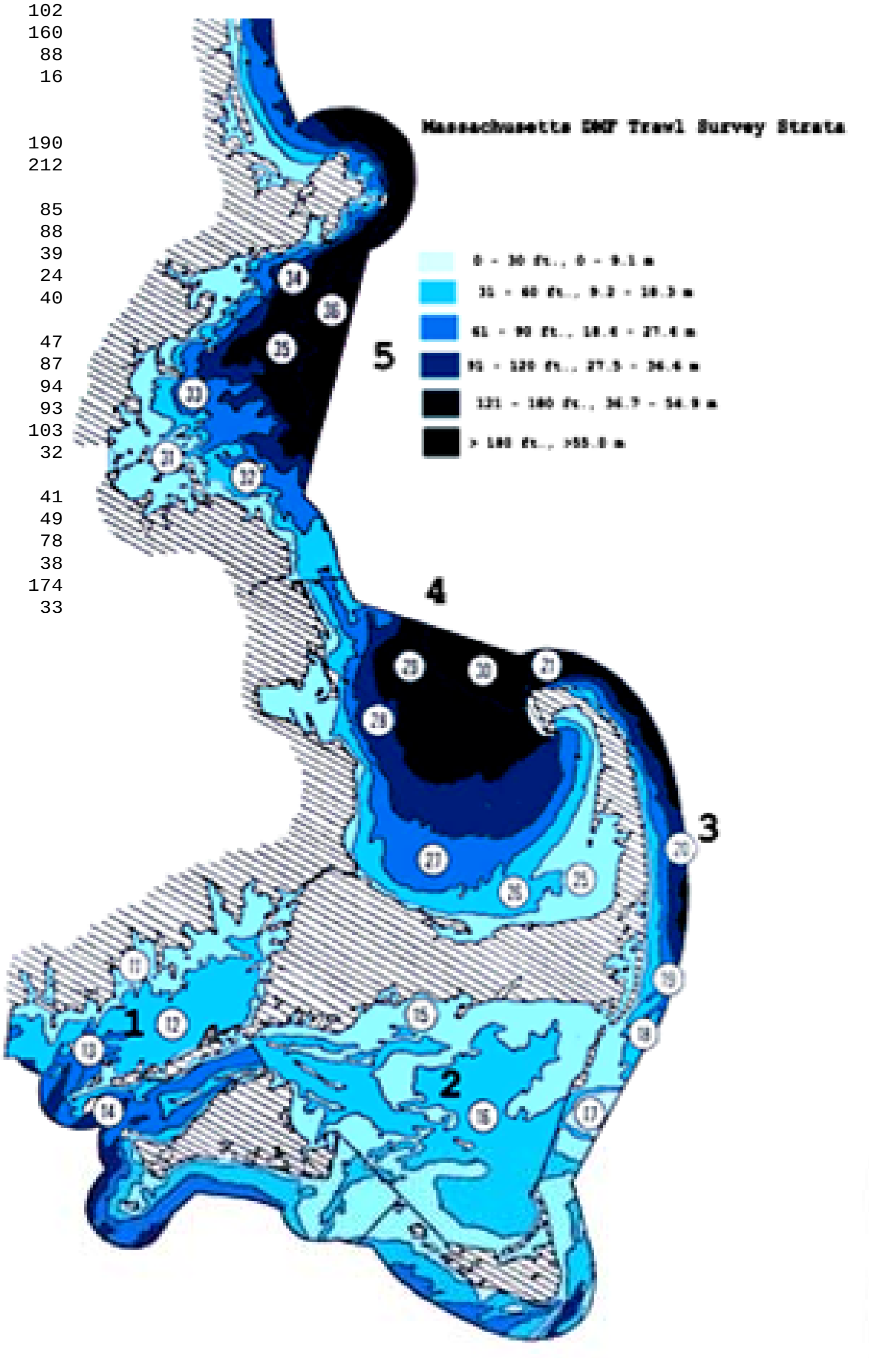
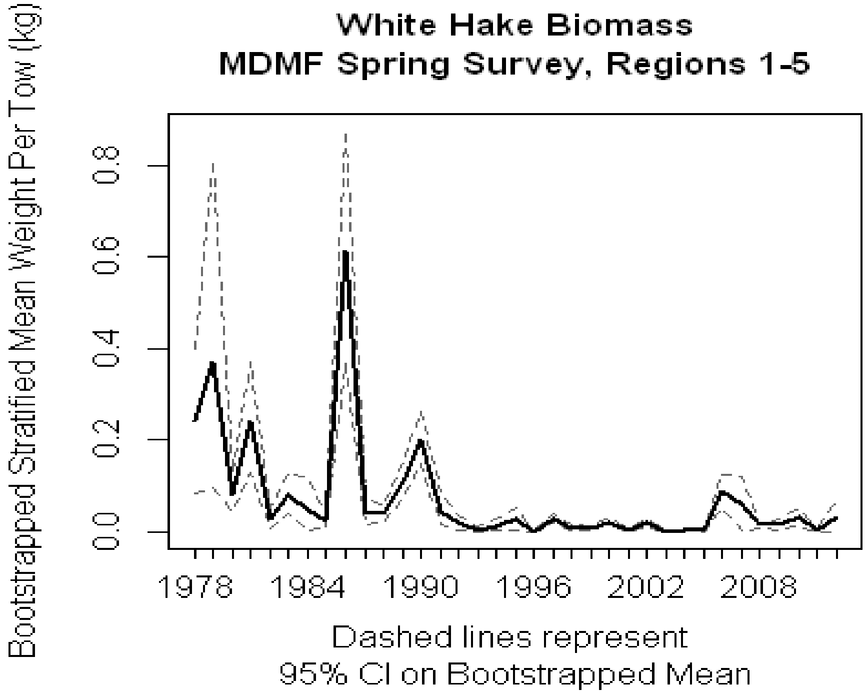


Figure B87. Strata used in the Massachusetts survey.



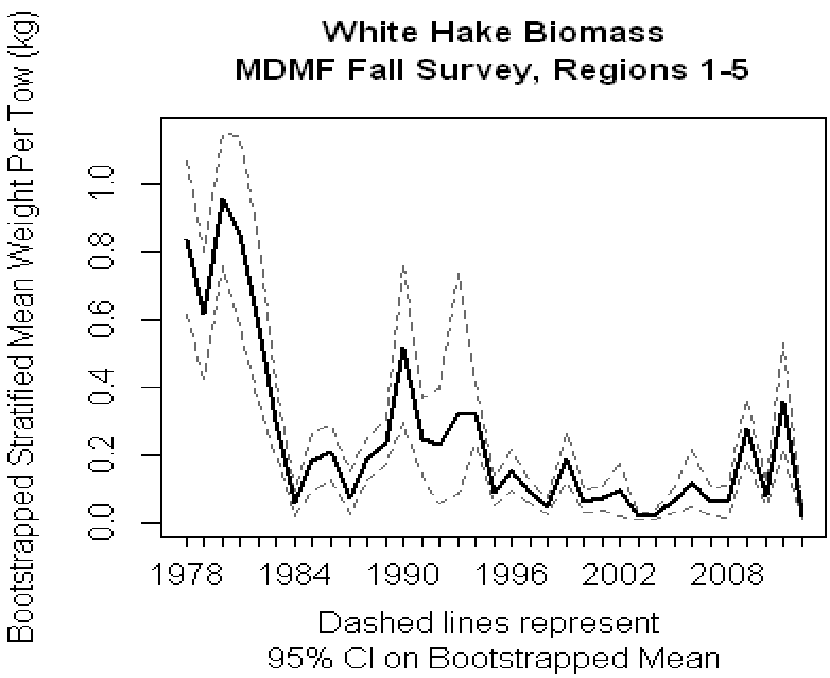
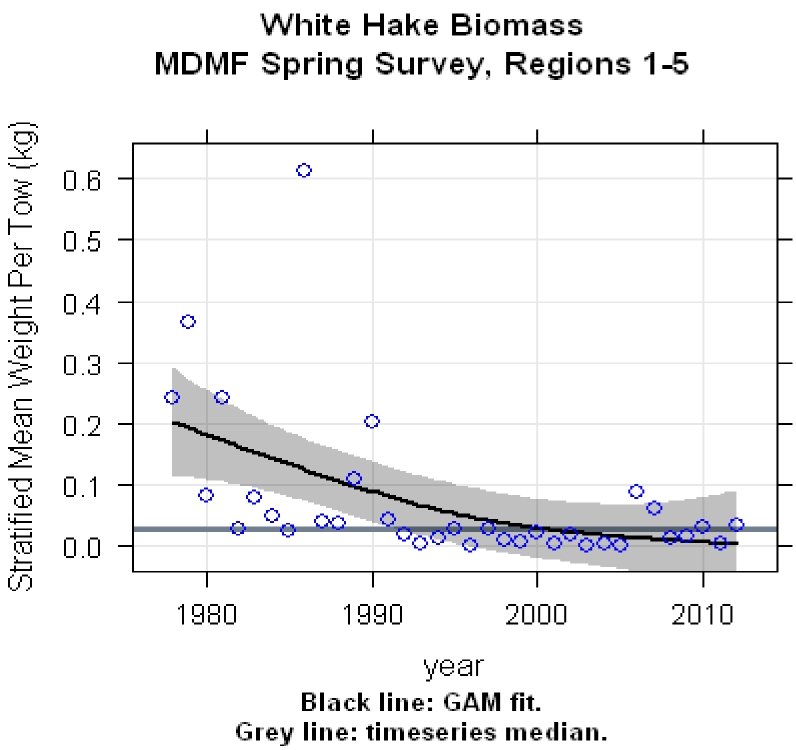


Figure B88. White hake biomass from the Massachusetts spring and fall surveys.



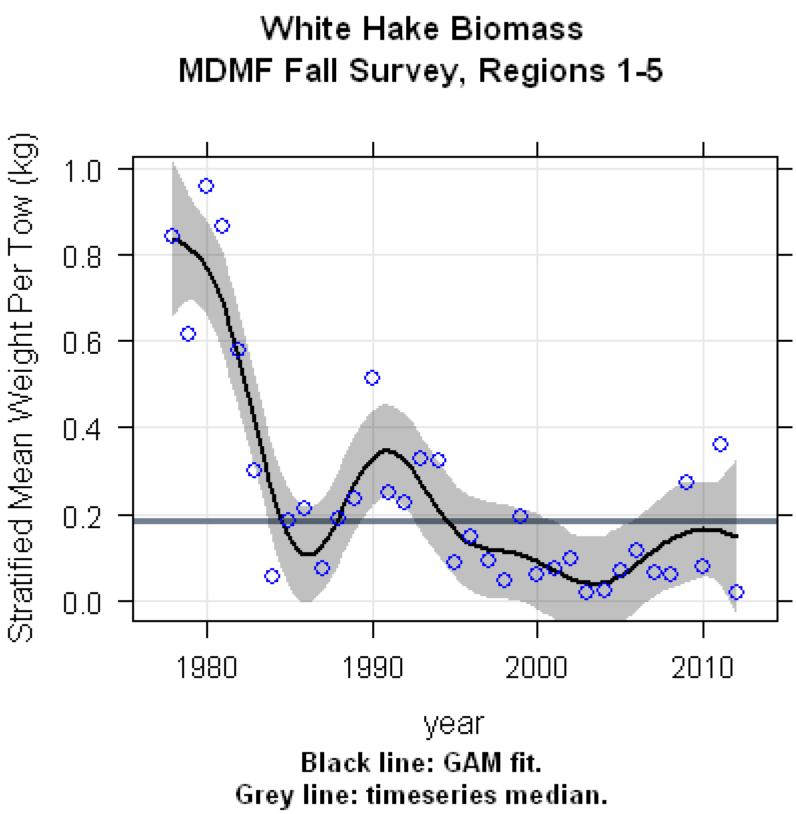
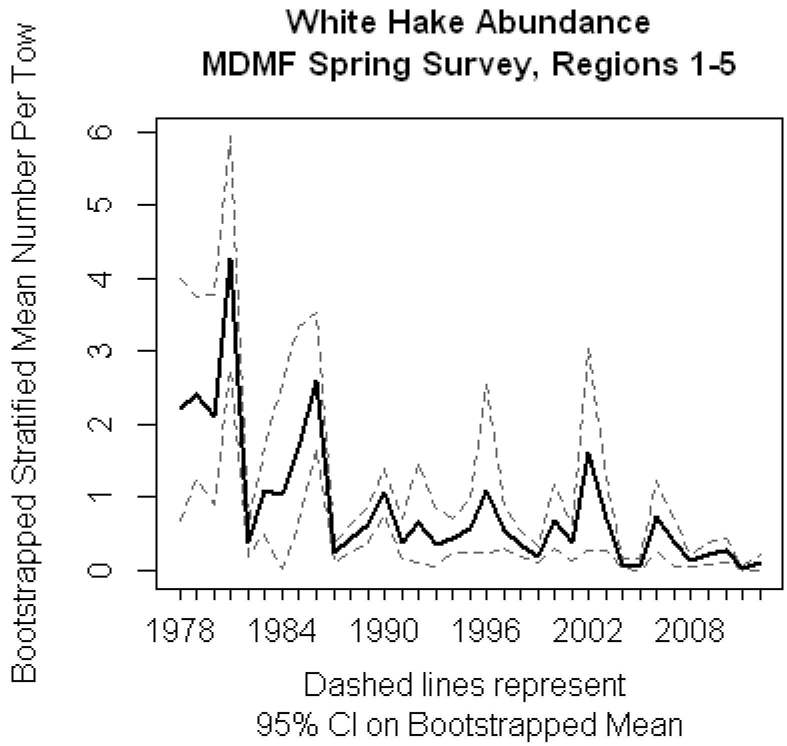


Figure B89. White hake biomass from the Massachusetts spring and fall surveys smoothed with a GAM.



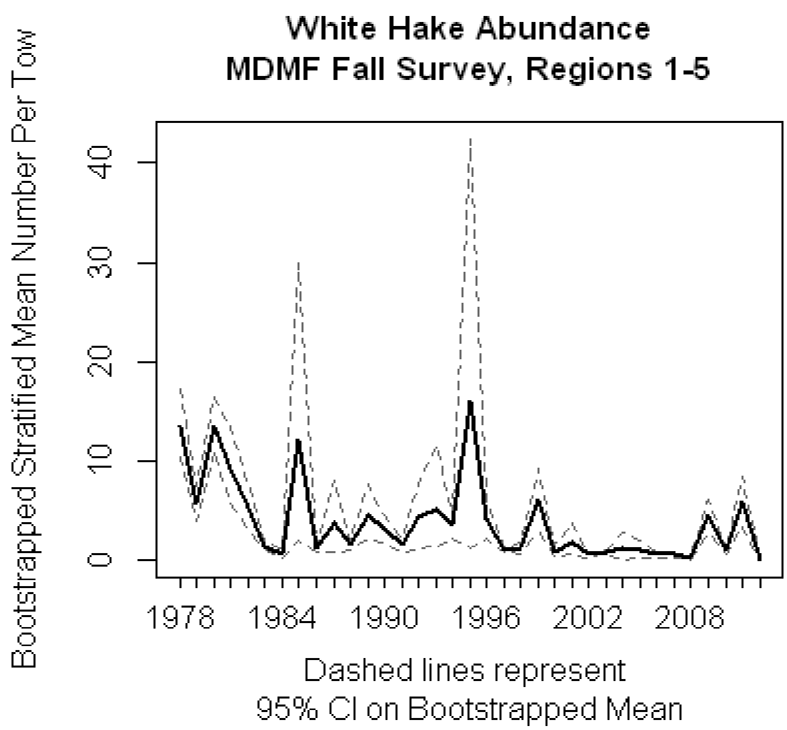
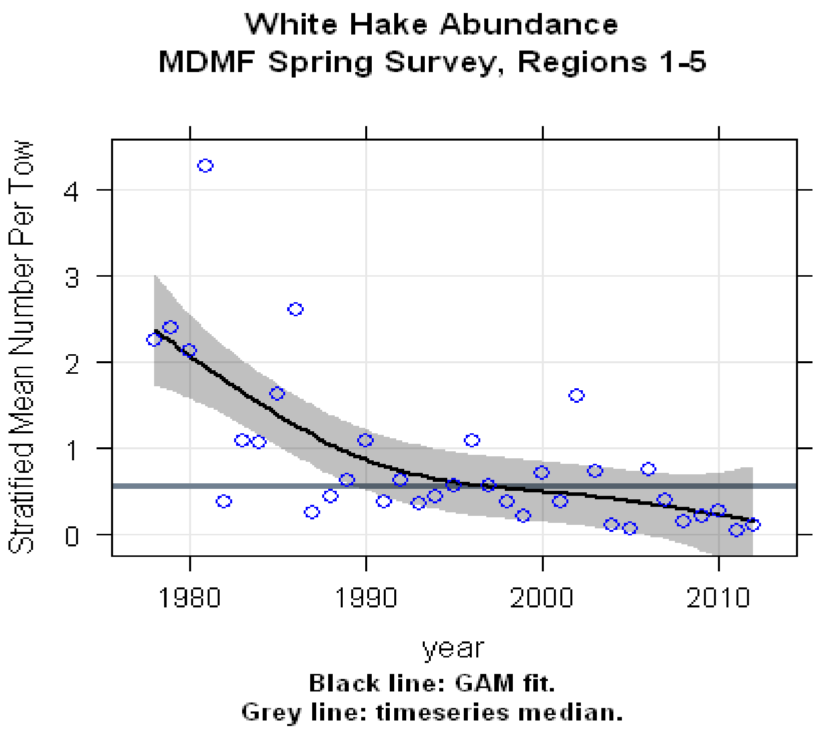


Figure B90. White hake abundance from the Massachusetts spring and fall surveys.



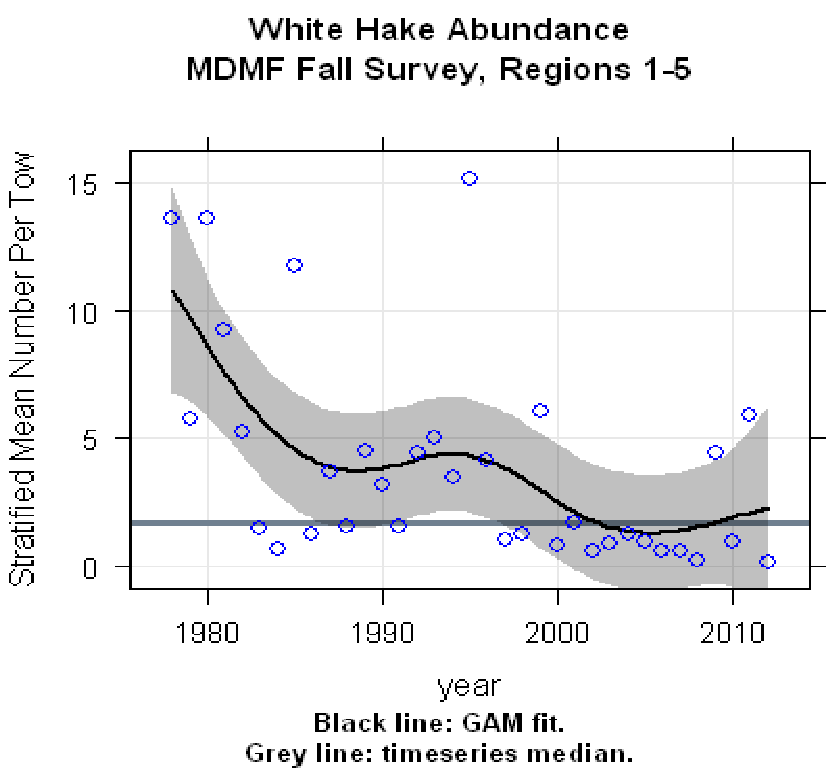


Figure B91. White hake abundance from the Massachusetts spring and fall surveys smoothed with a GAM.

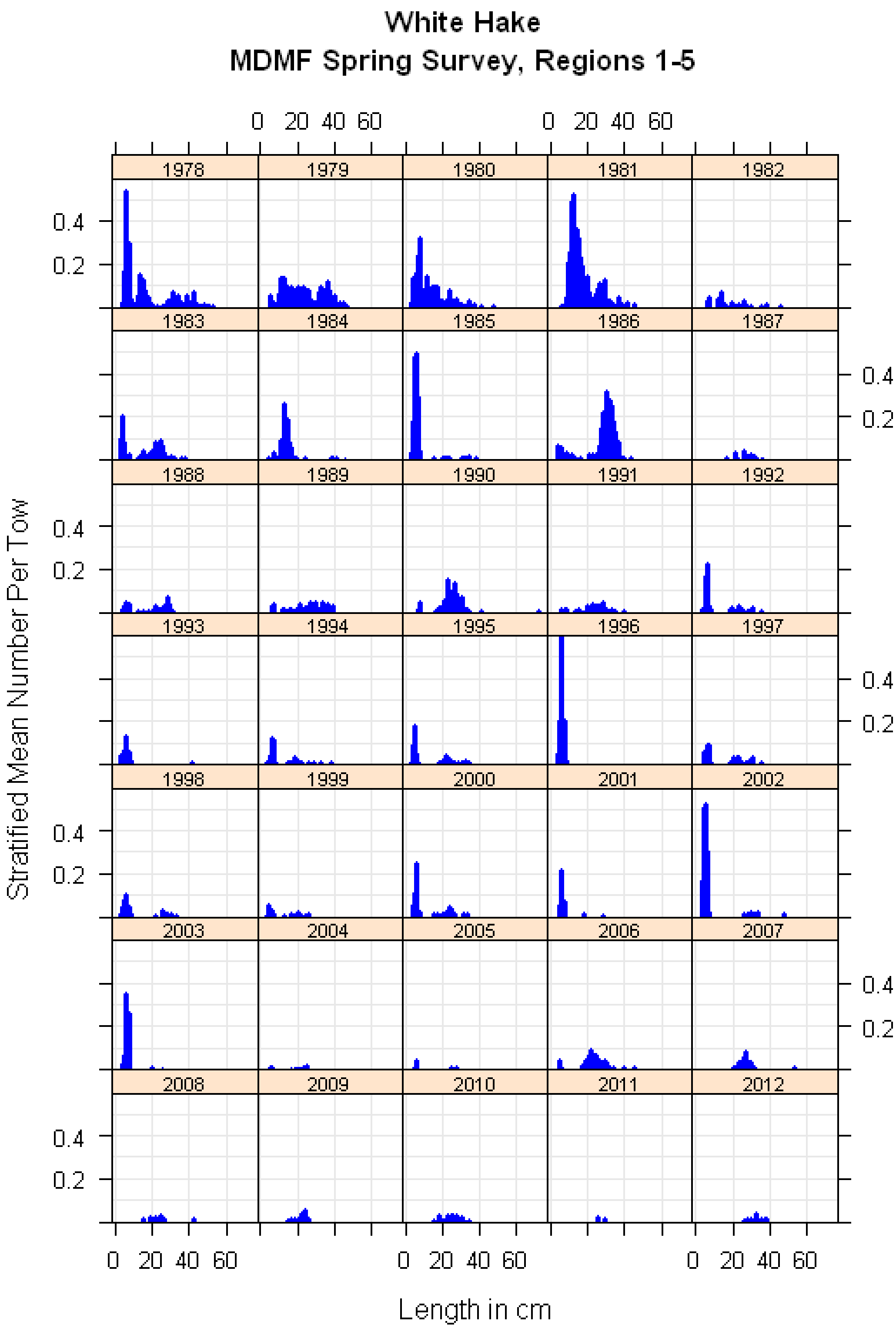


Figure B92. White hake length composition from the Massachusetts spring survey.

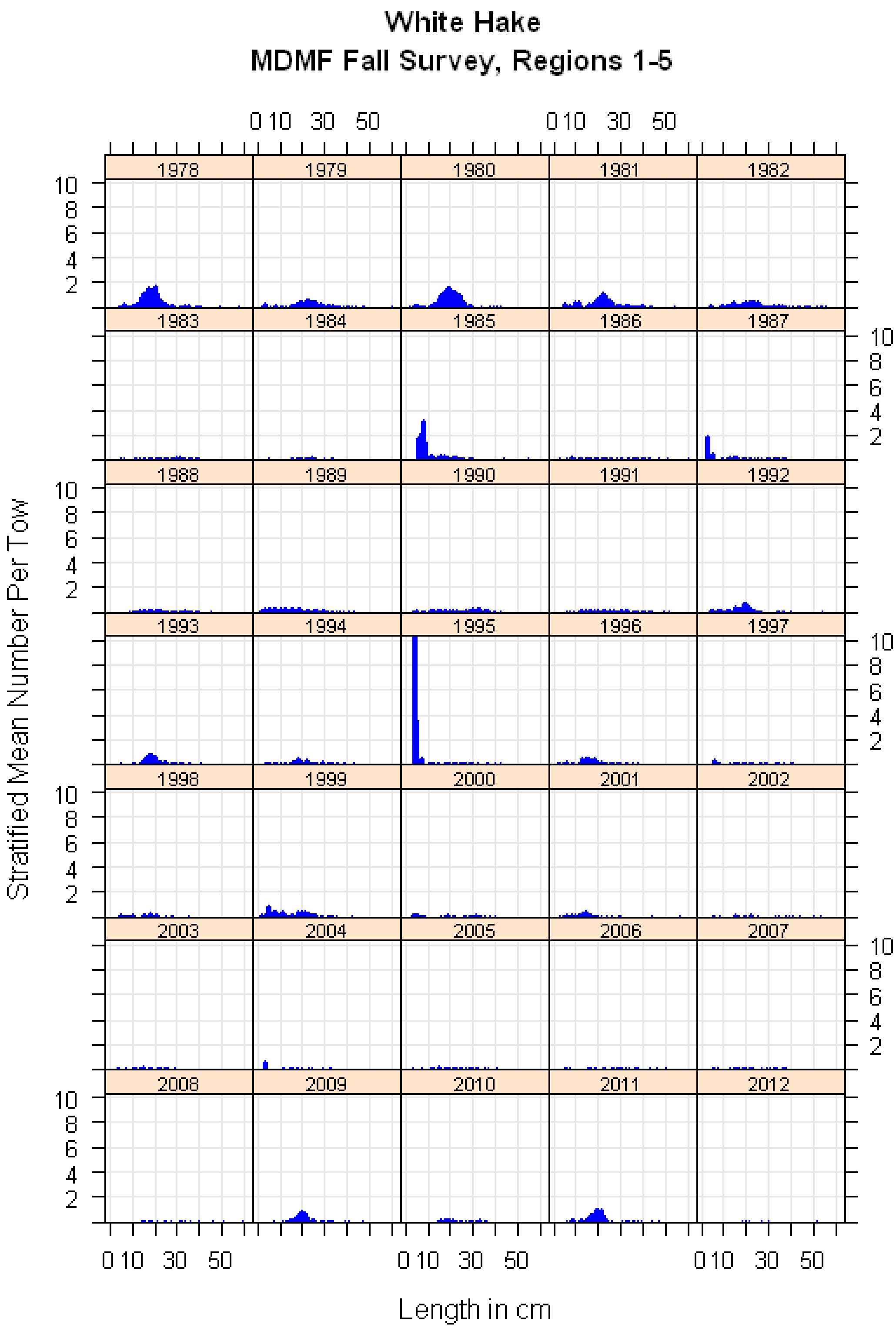


Figure B93. White hake length composition from the Massachusetts autumn survey.

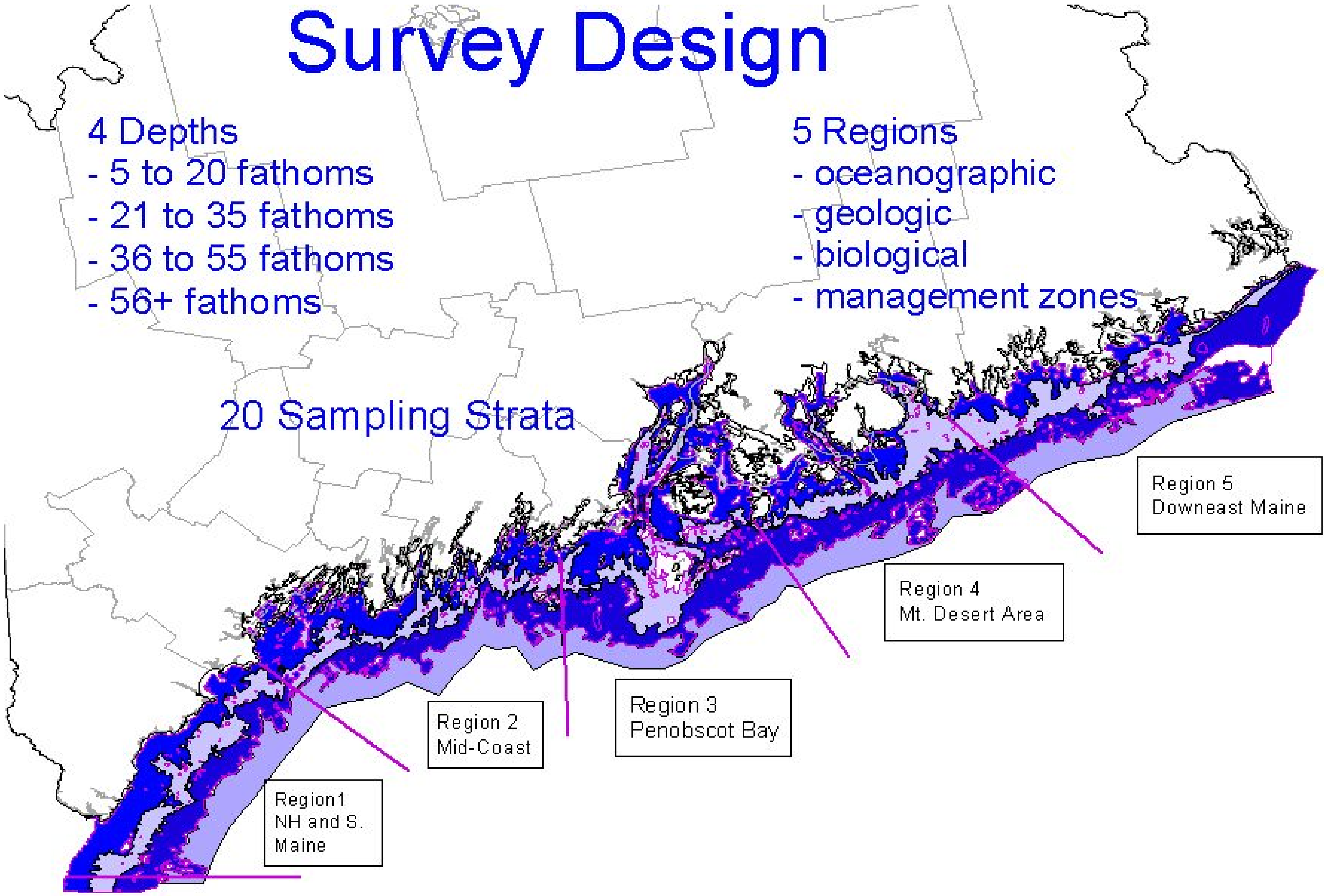


Figure B94. Survey design of the ME/NH survey.

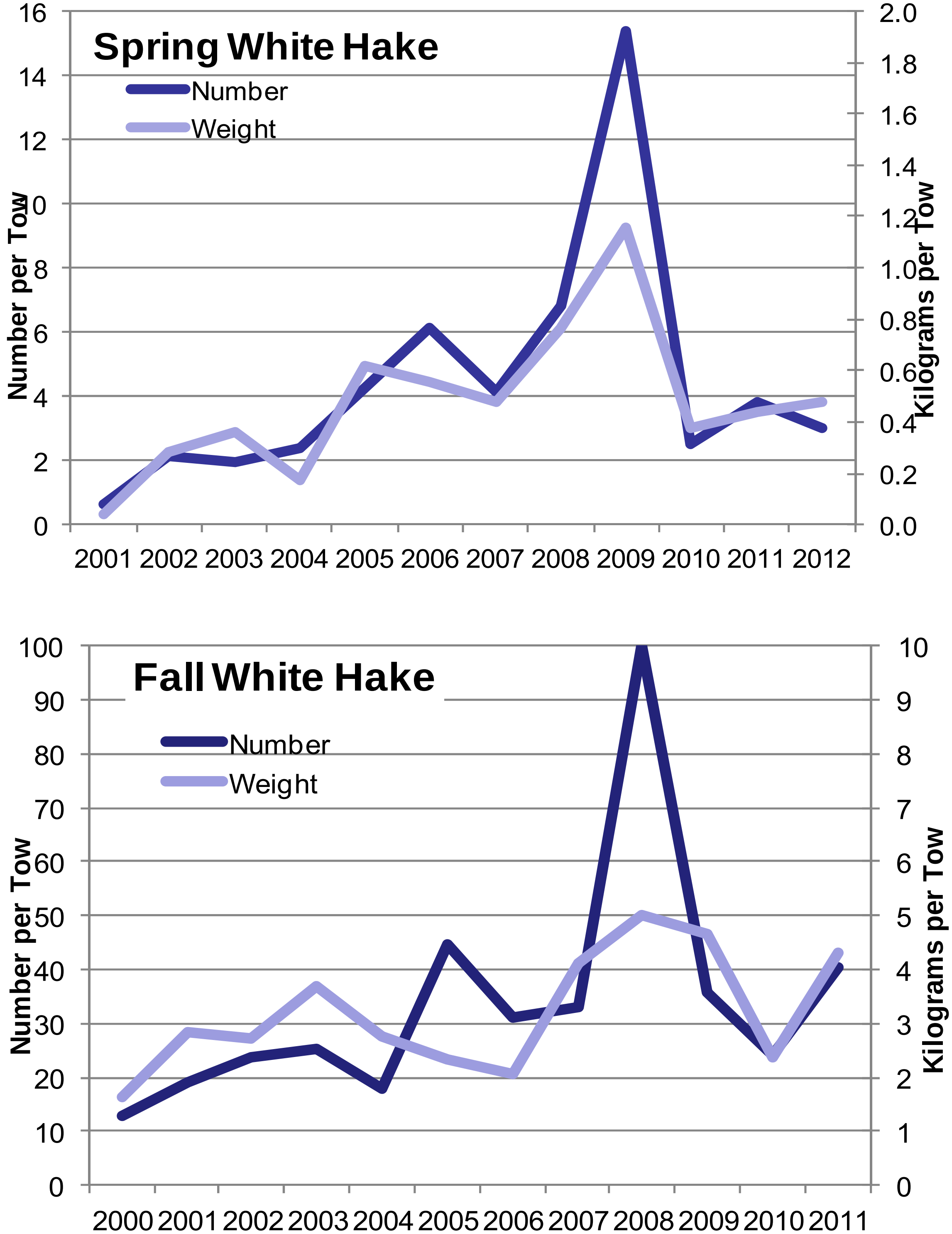


Figure B95. Abundance and biomass indices from the ME/NH spring (top panel) and autumn (bottom panel) surveys.

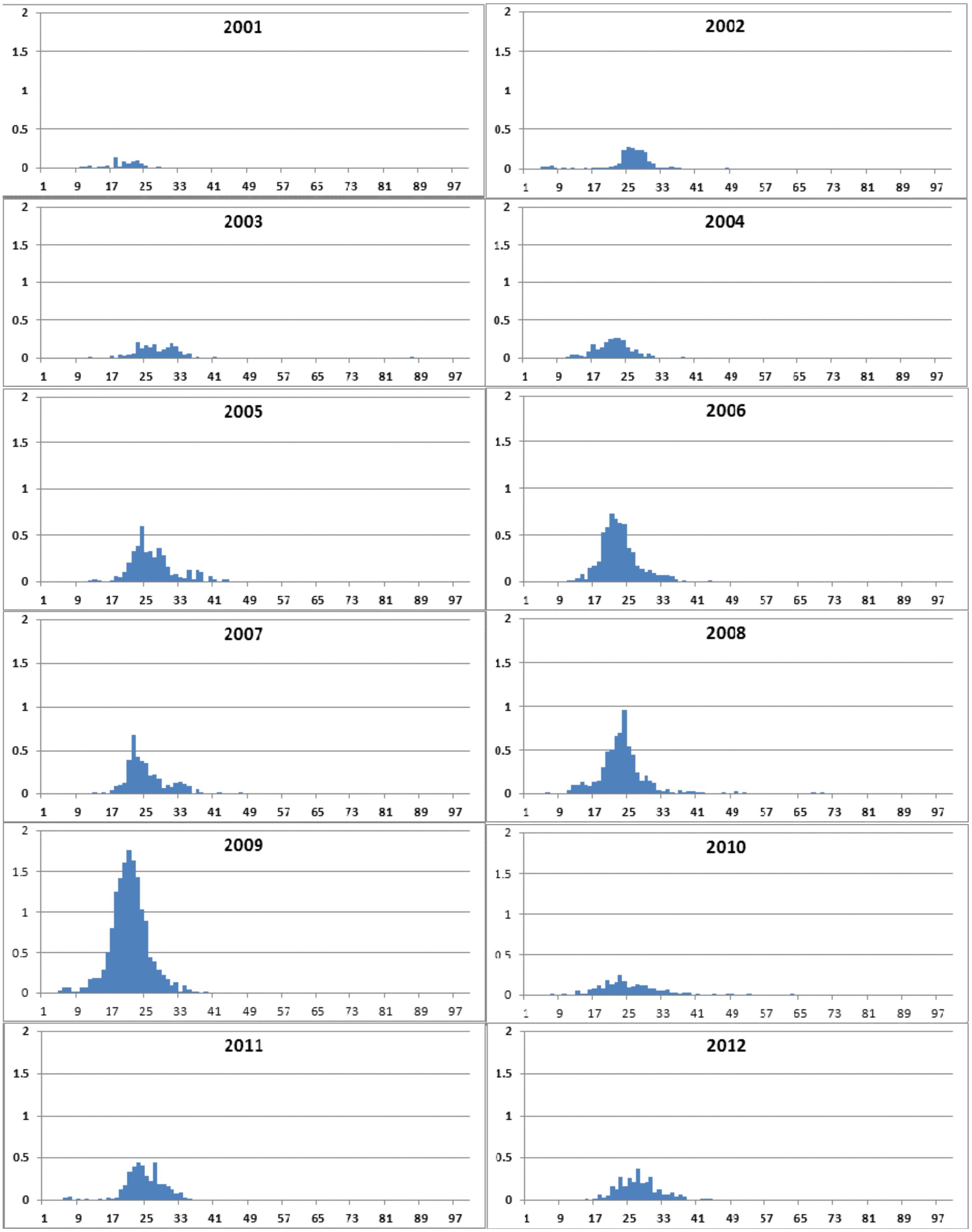


Figure B96. Length composition of the ME/NH spring survey from 2001-2012.

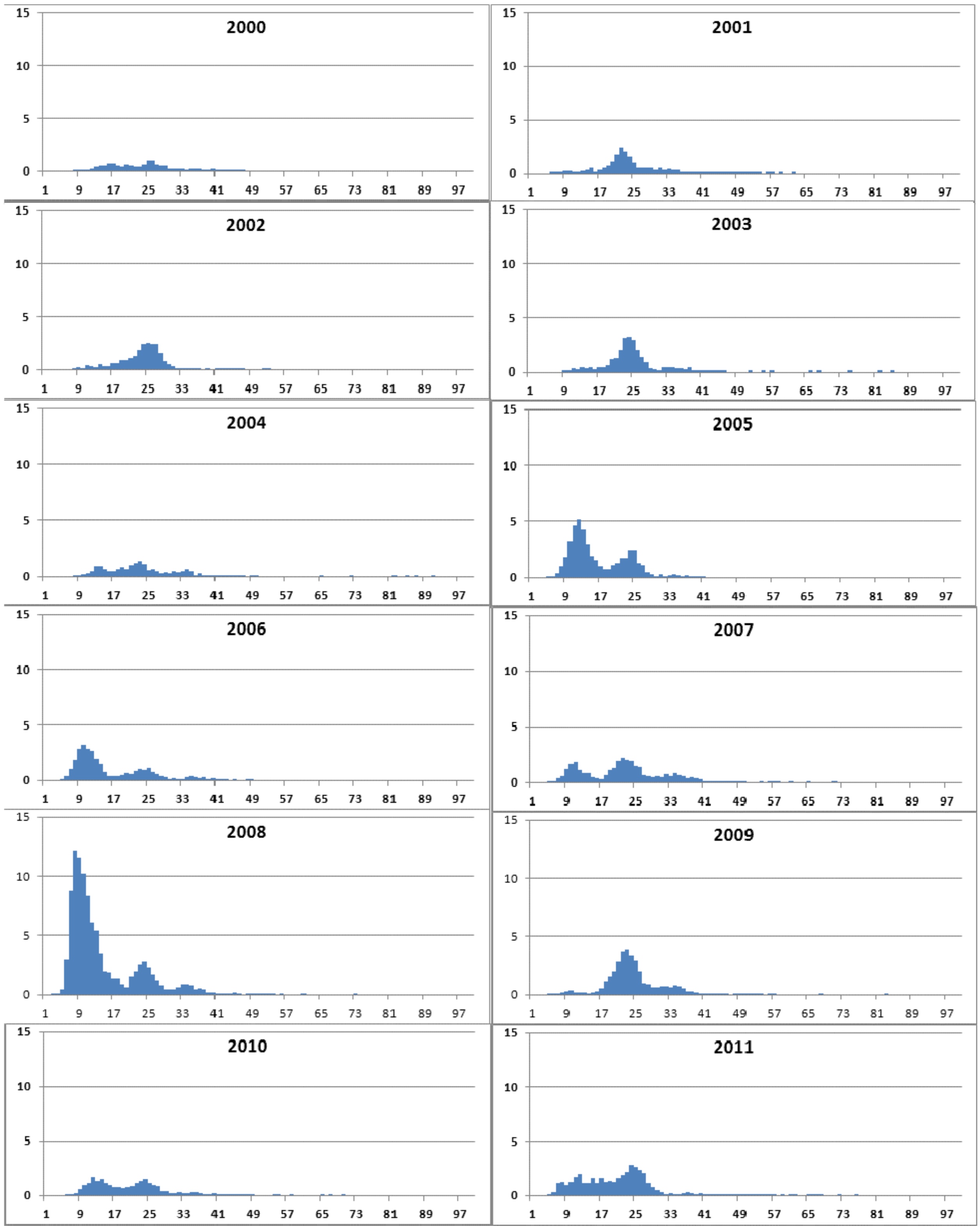


Figure B97. Length composition of the ME/NH autumn survey from 2000-2011.

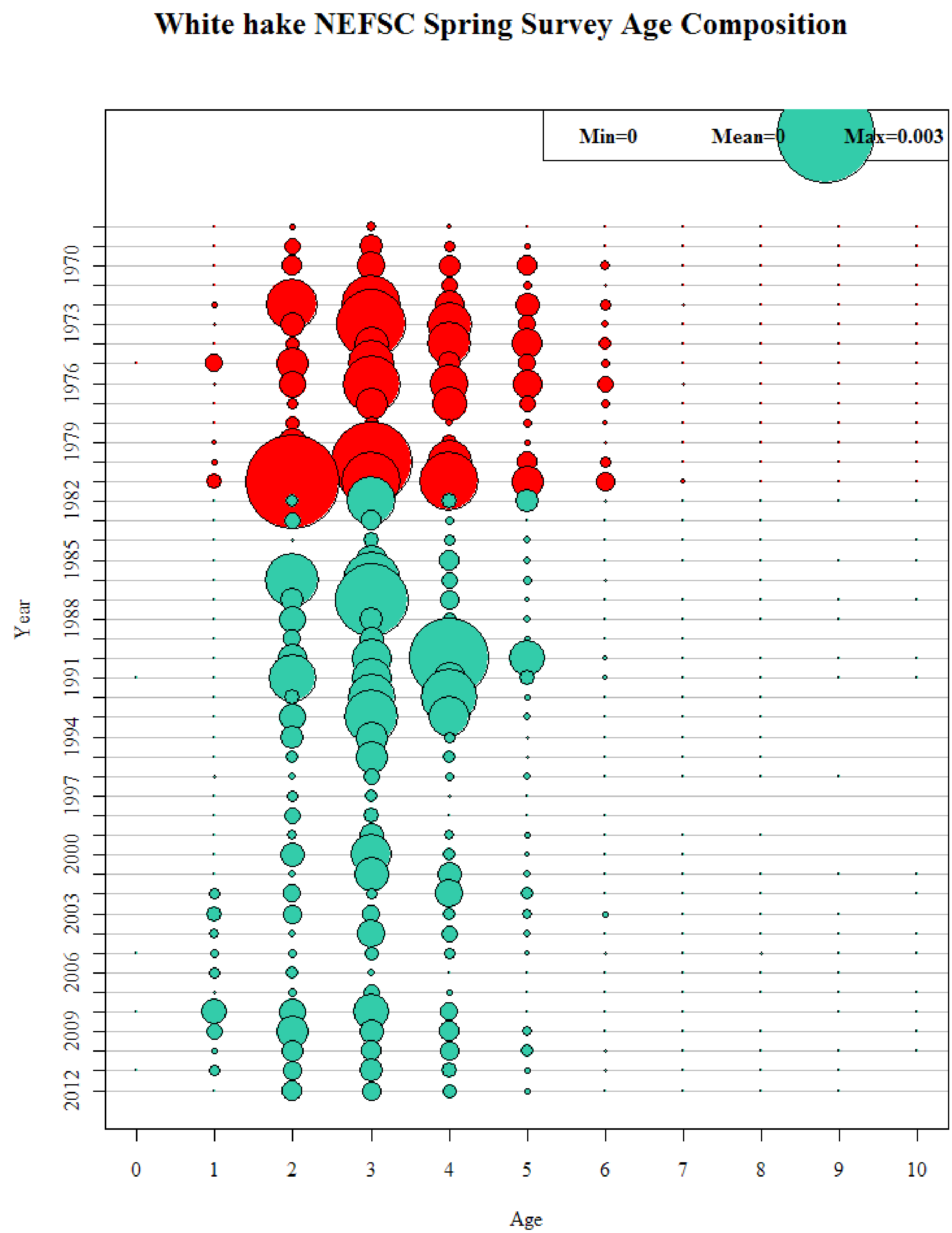


Figure B98. Age composition of the NEFSC spring survey from 1968-2012. The red bubbles indicate that a pooled ALK was used.

Figure B99. Age composition of the NEFSC autumn survey from 1963-2011. The red bubbles indicate that a pooled ALK was used.

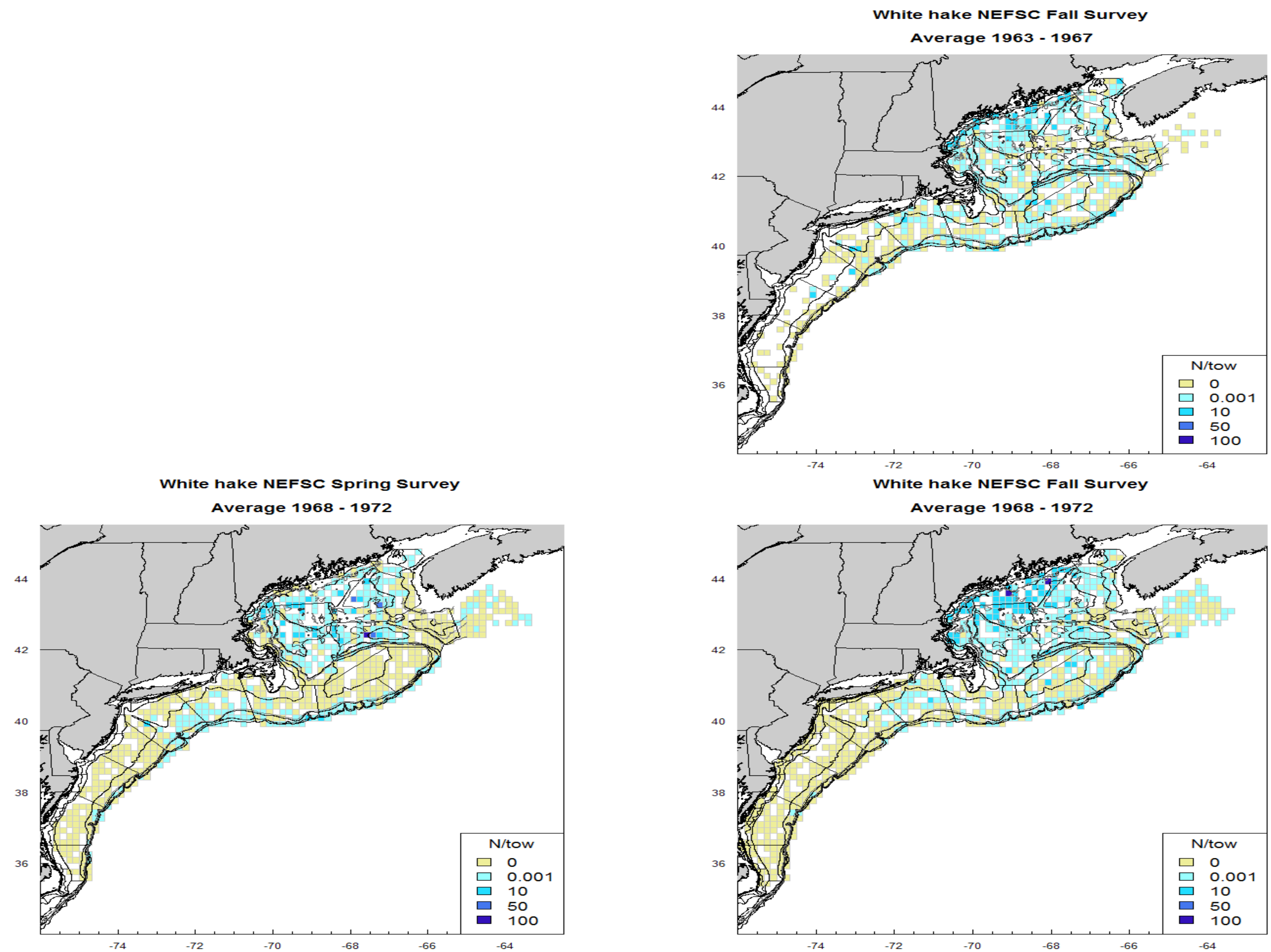


Figure B100a. Distribution of white hake number/tow from the NEFSC spring and autumn surveys from 1963-1972.

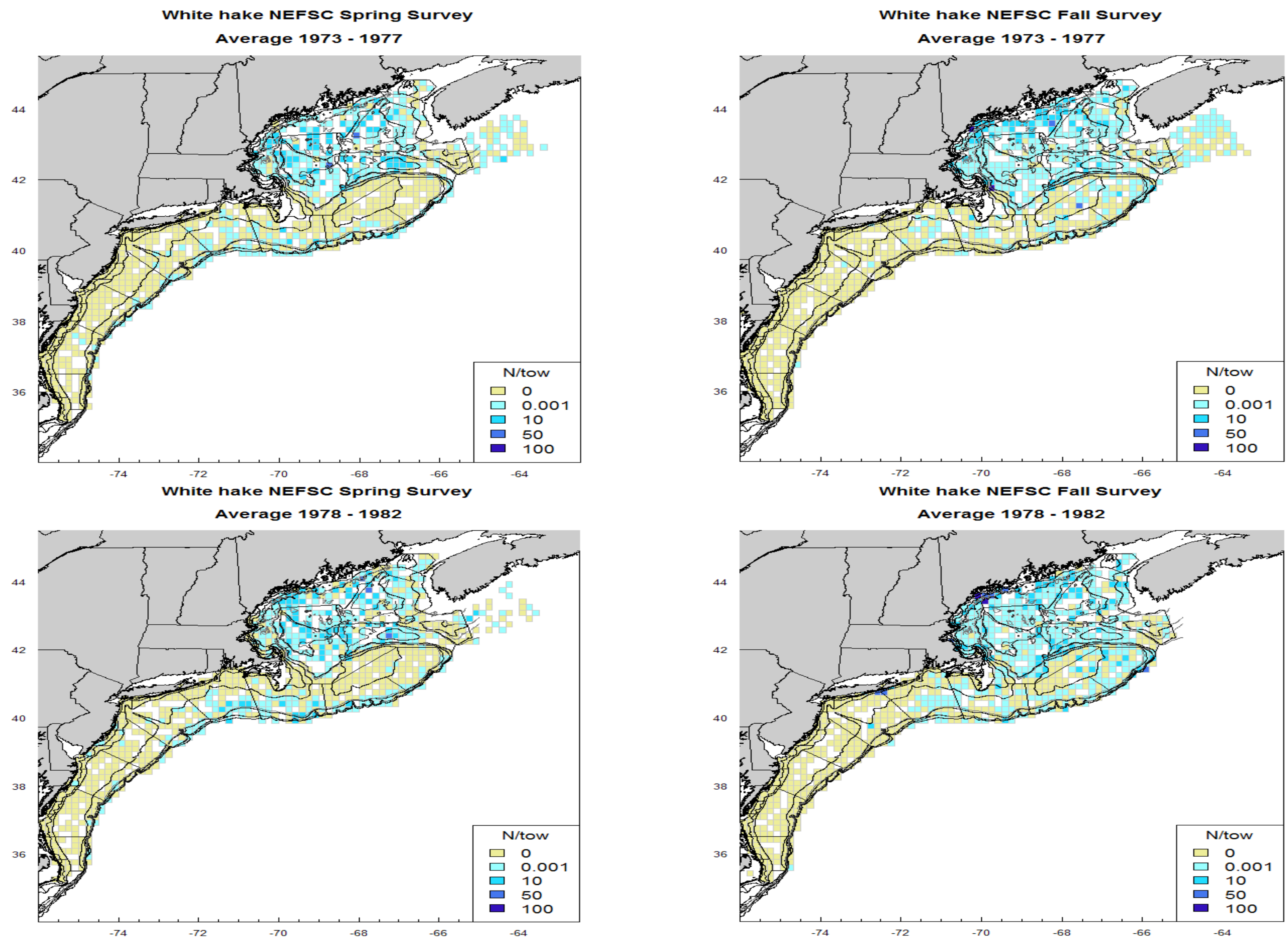


Figure B100b. Distribution of white hake in number/tow from the NEFSC spring and autumn surveys from 1973-1982.

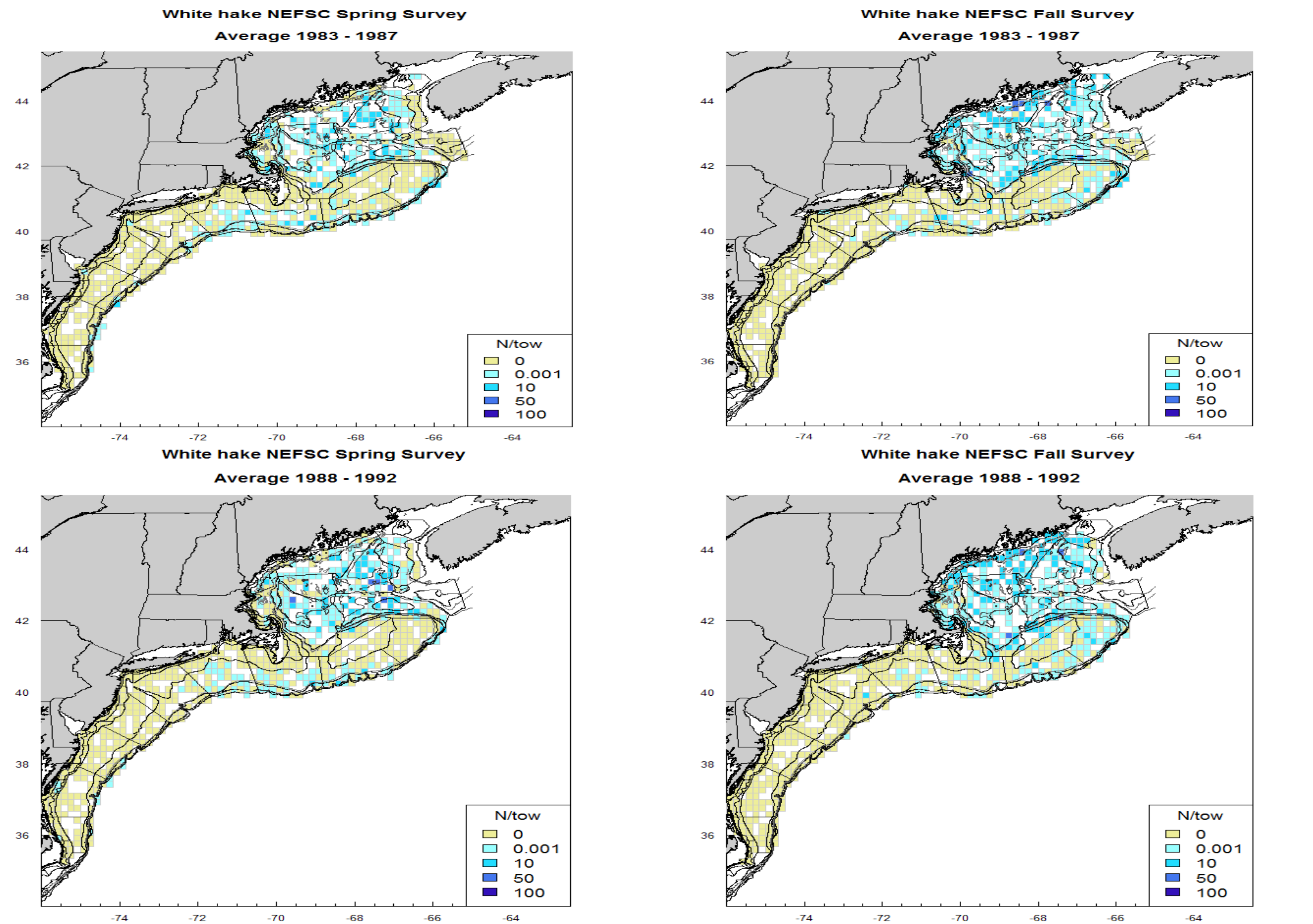


Figure B100c. Distribution of white hake in number/tow from the NEFSC spring and autumn surveys from 1983-1992.

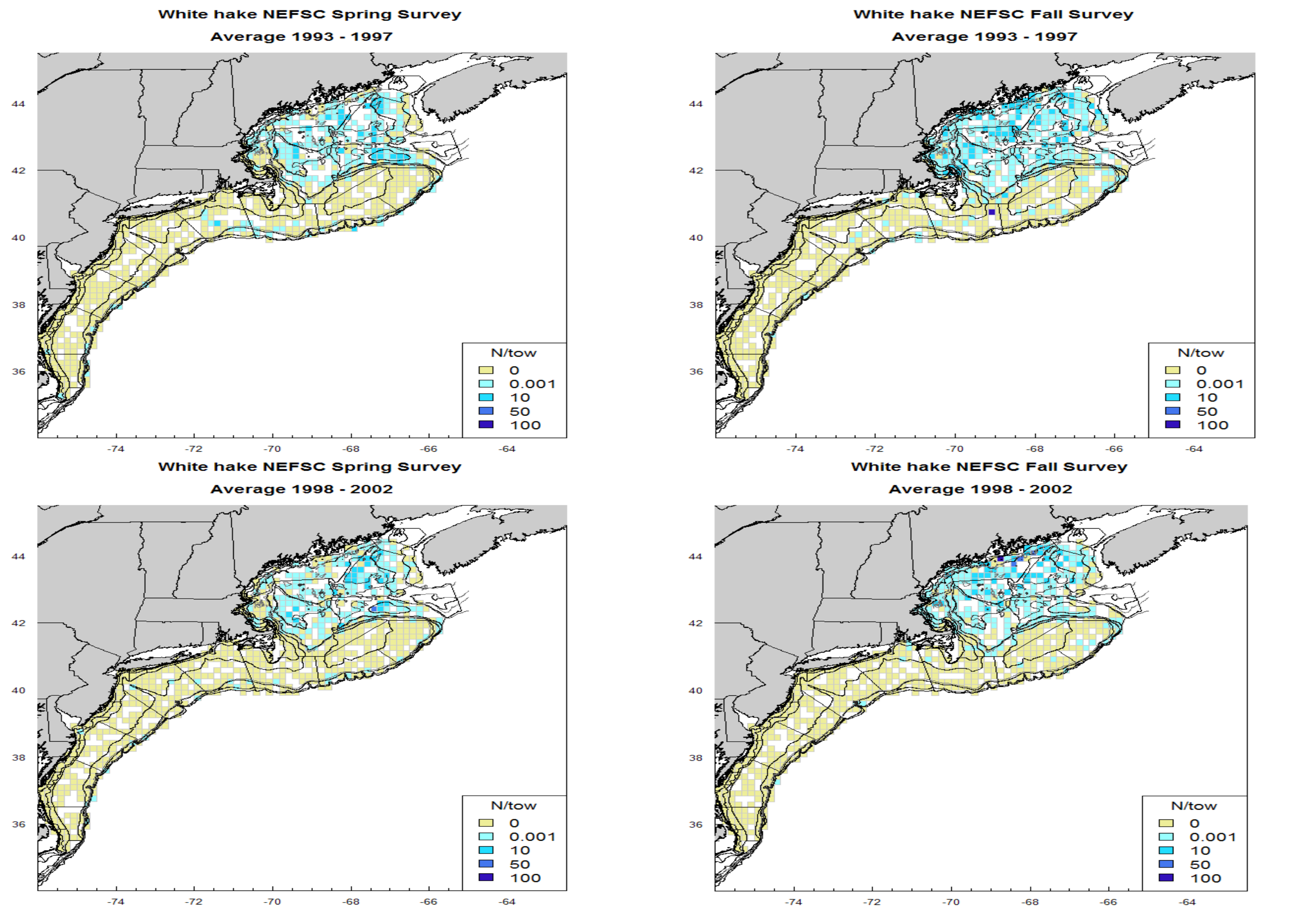


Figure B100d. Distribution of white hake in number/tow from the NEFSC spring and autumn surveys from 1993-2002.

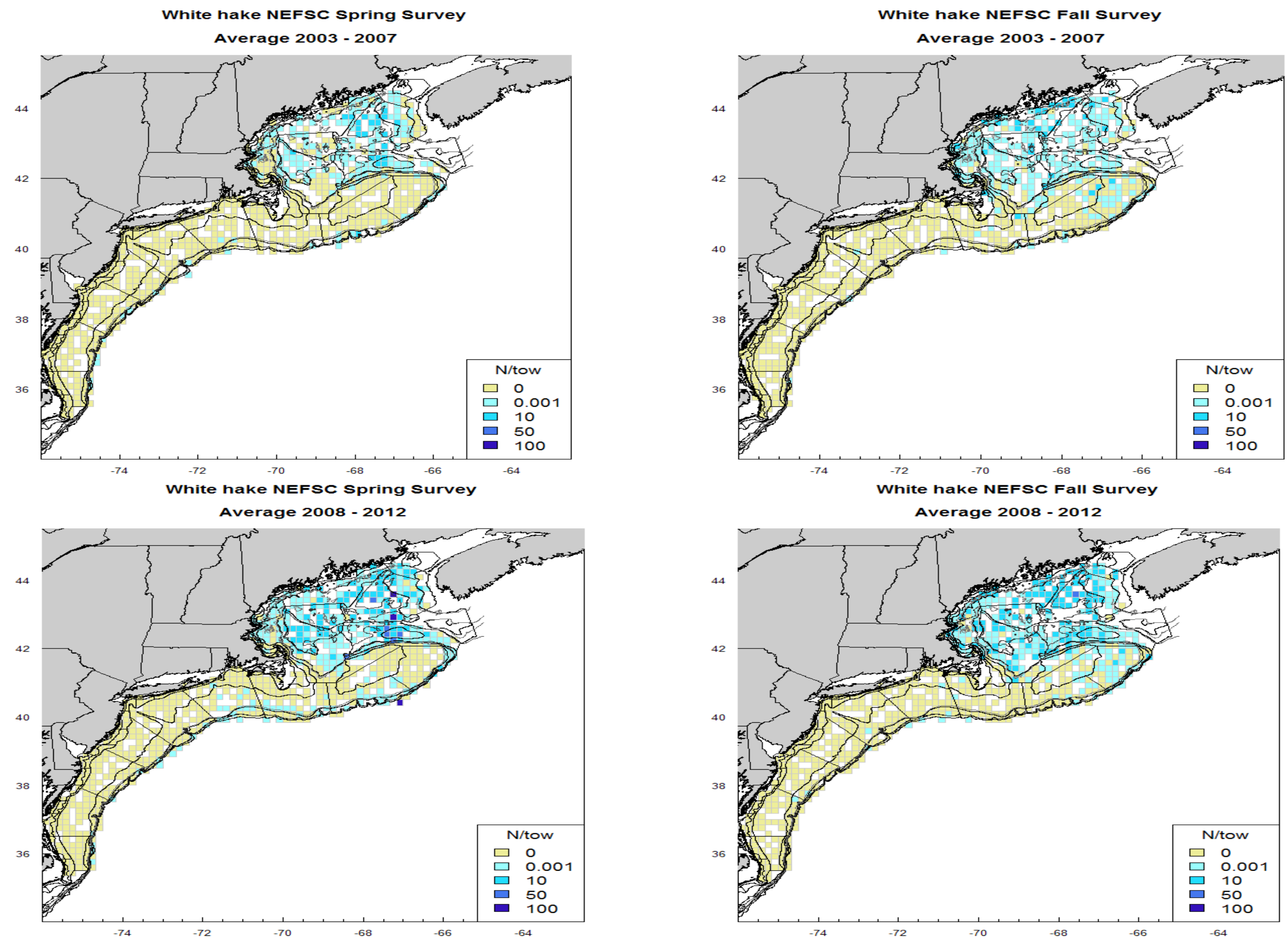


Figure B100e. Distribution of white hake from the NEFSC spring and autumn surveys from 2003-2012.

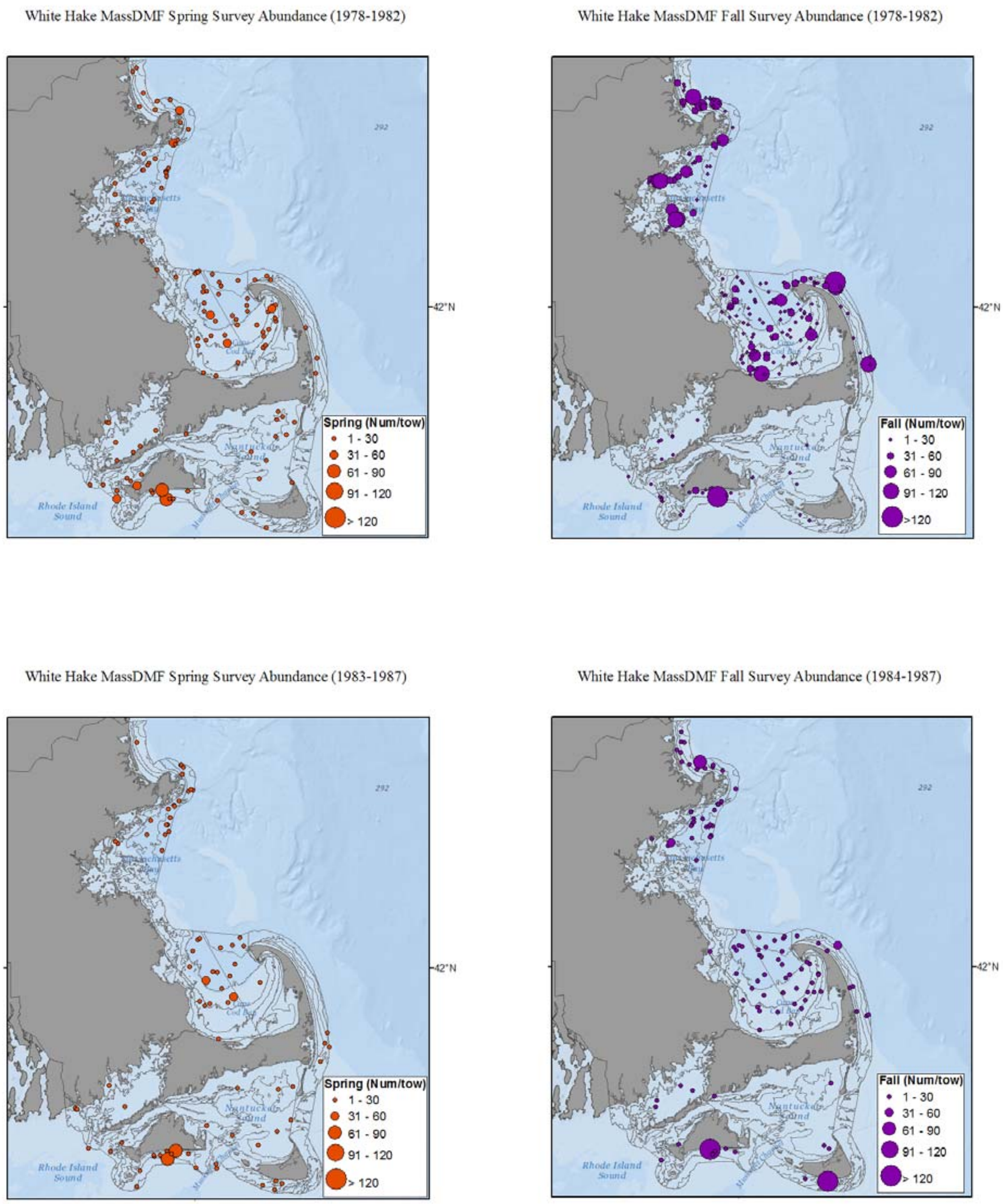


Figure B101a. Distribution of white hake in number/tow from the MADMF spring and autumn surveys from 1978-1987.

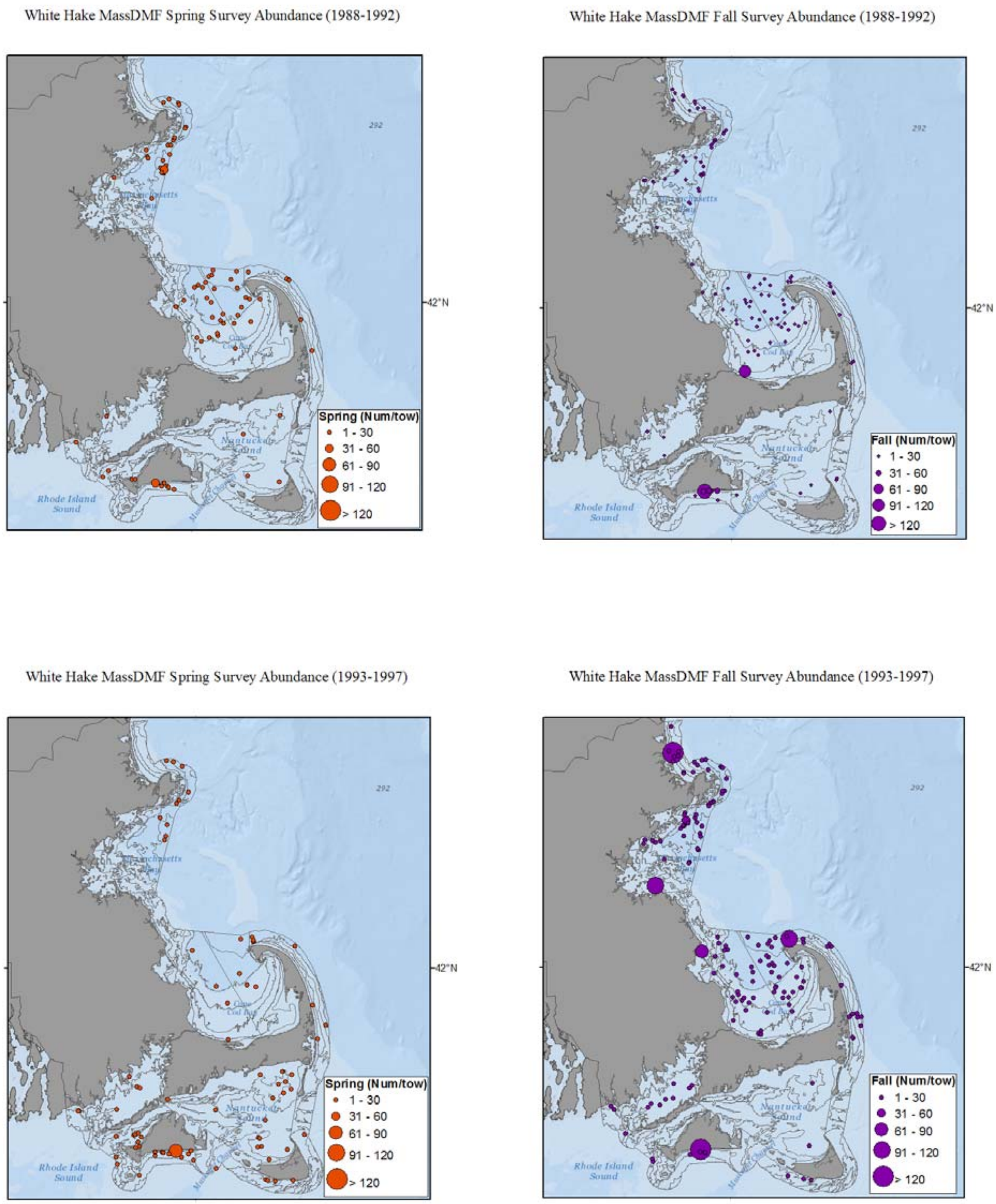


Figure B101b. Distribution of white hake in number/tow from the MADMF spring and autumn surveys from 1988-1997.

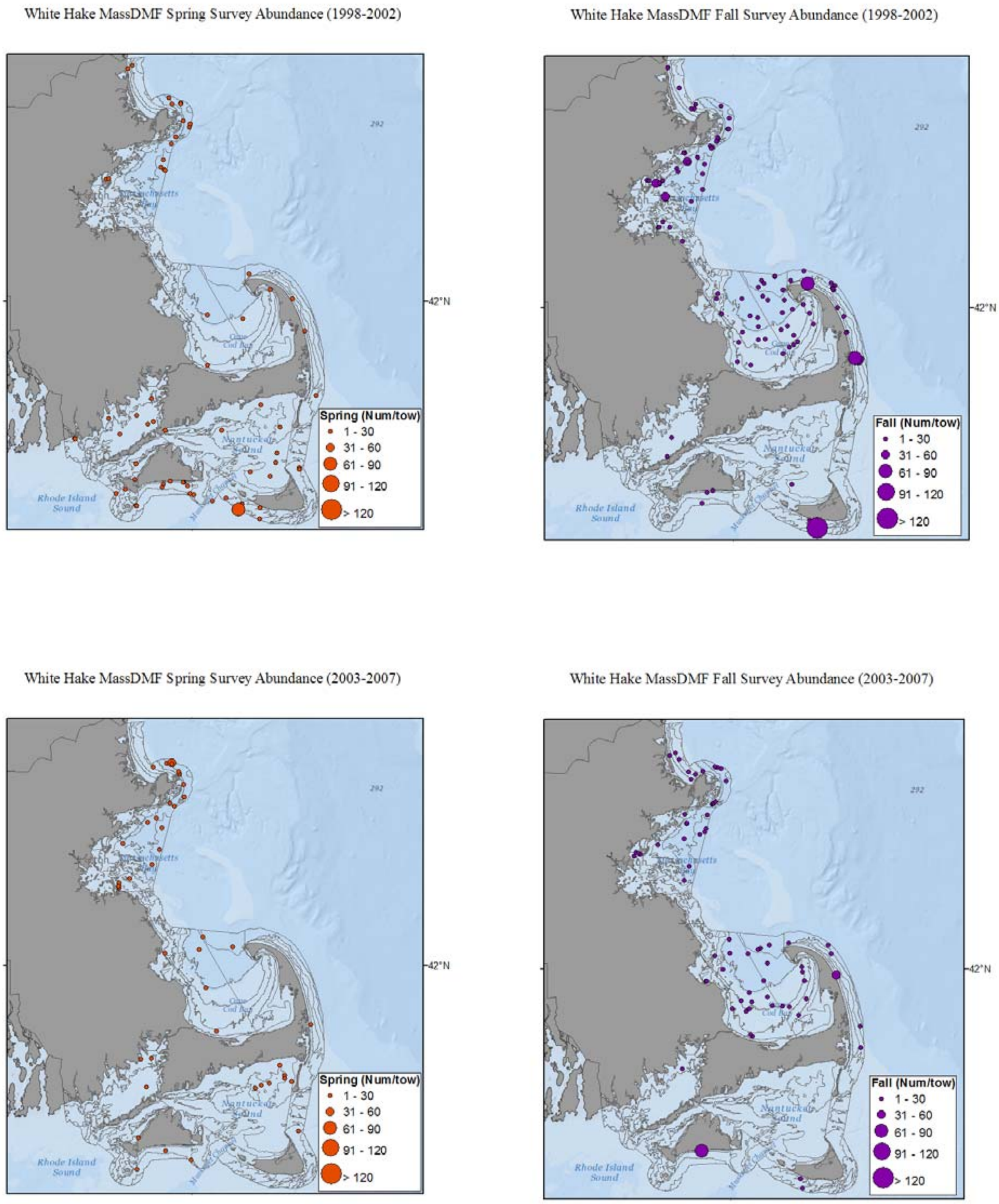


Figure B101c. Distribution of white hake in number/tow from the MADMF spring and autumn surveys from 1998-2007.

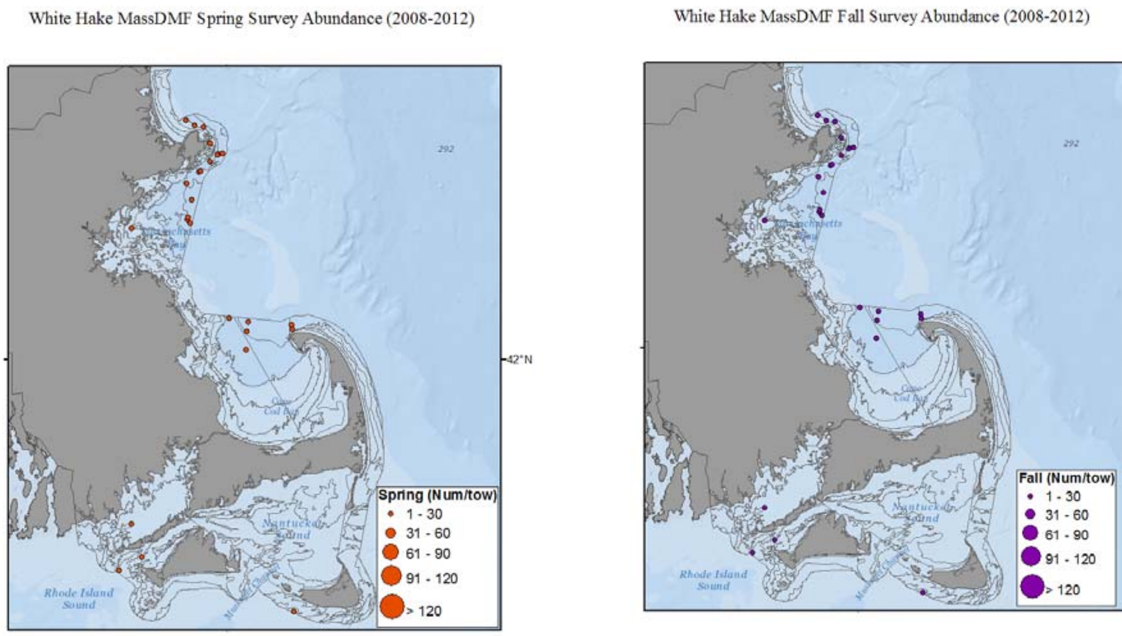


Figure B101d. Distribution of white hake in number/tow from the MADMF spring and autumn surveys from 2008-2012.

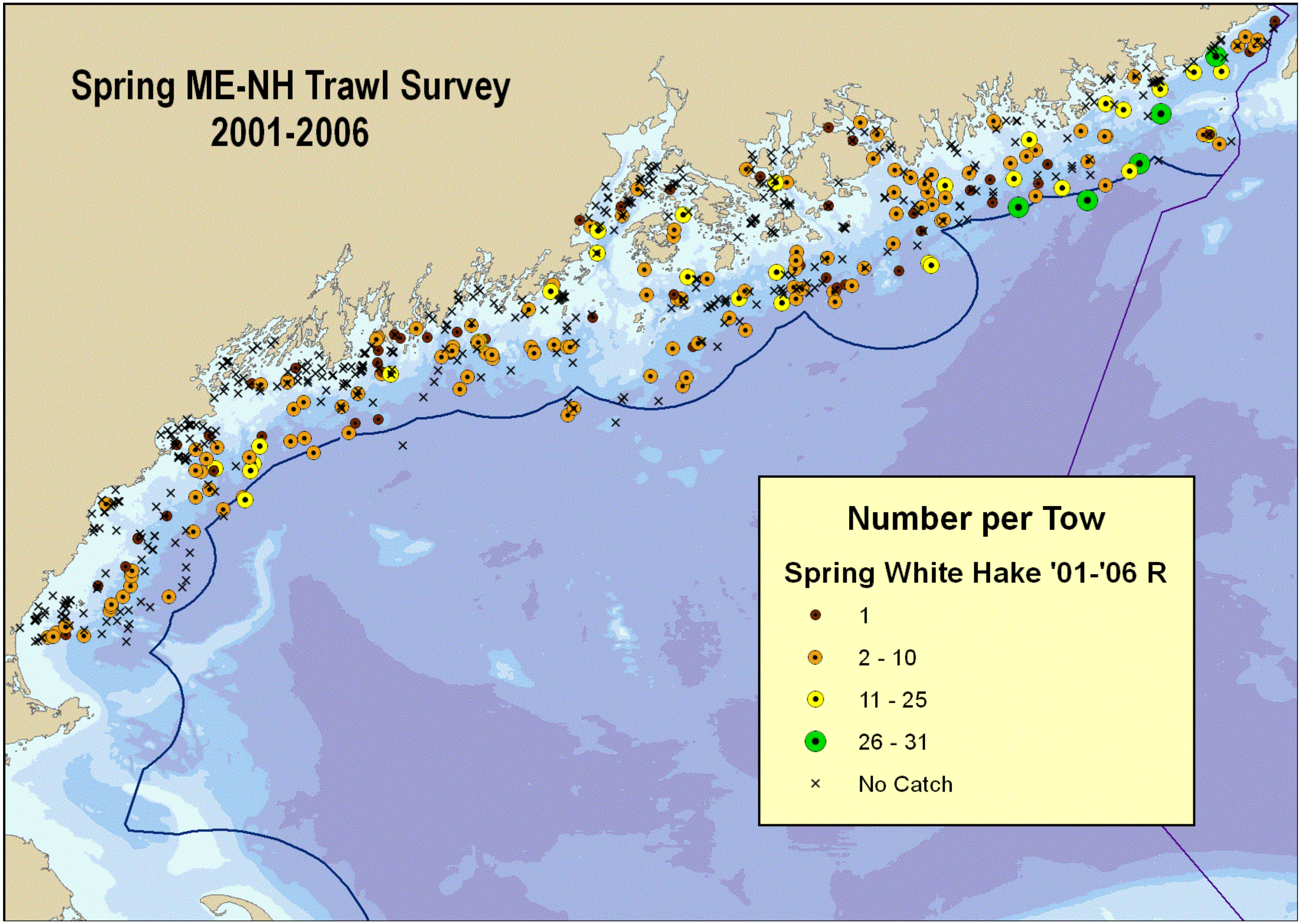


Figure B102a. Distribution of white hake in number/tow from the ME/NH spring surveys from 2001-2006.

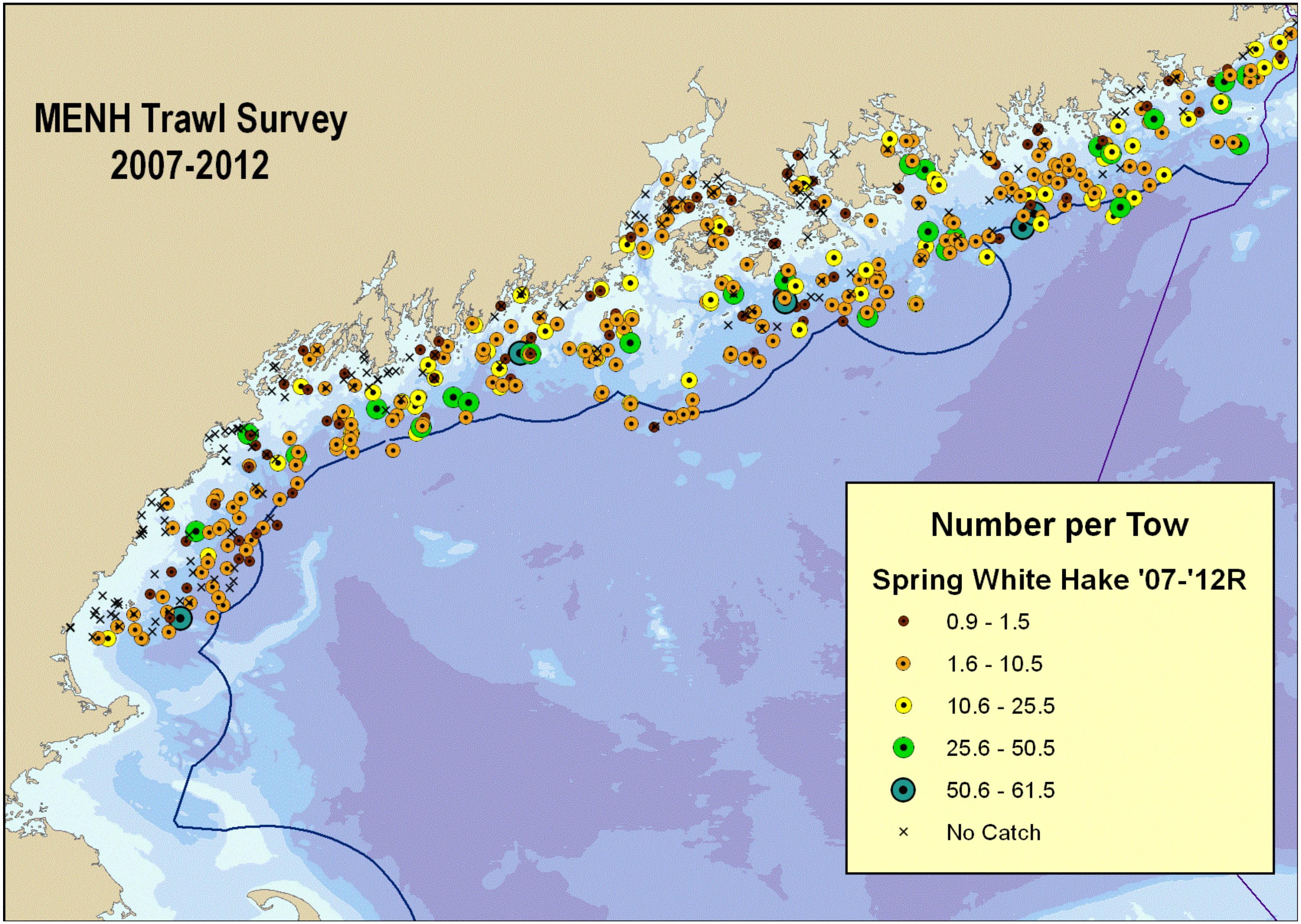


Figure B102b. Distribution of white hake in number/tow from the ME/NH spring surveys from 2007-2012.

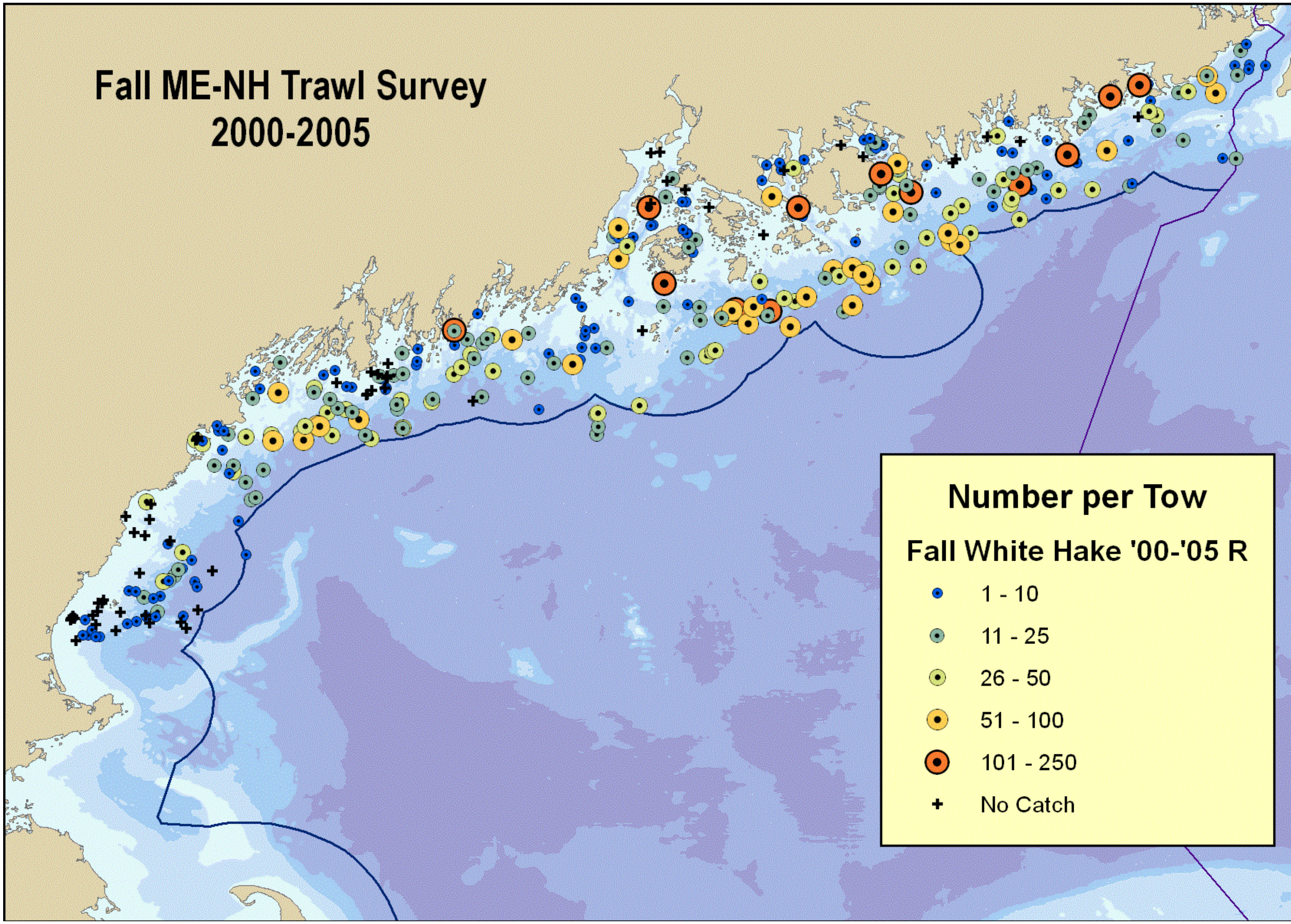


Figure B103. Distribution of white hake in number/tow from the ME/NH autumn surveys from 2000-2005.

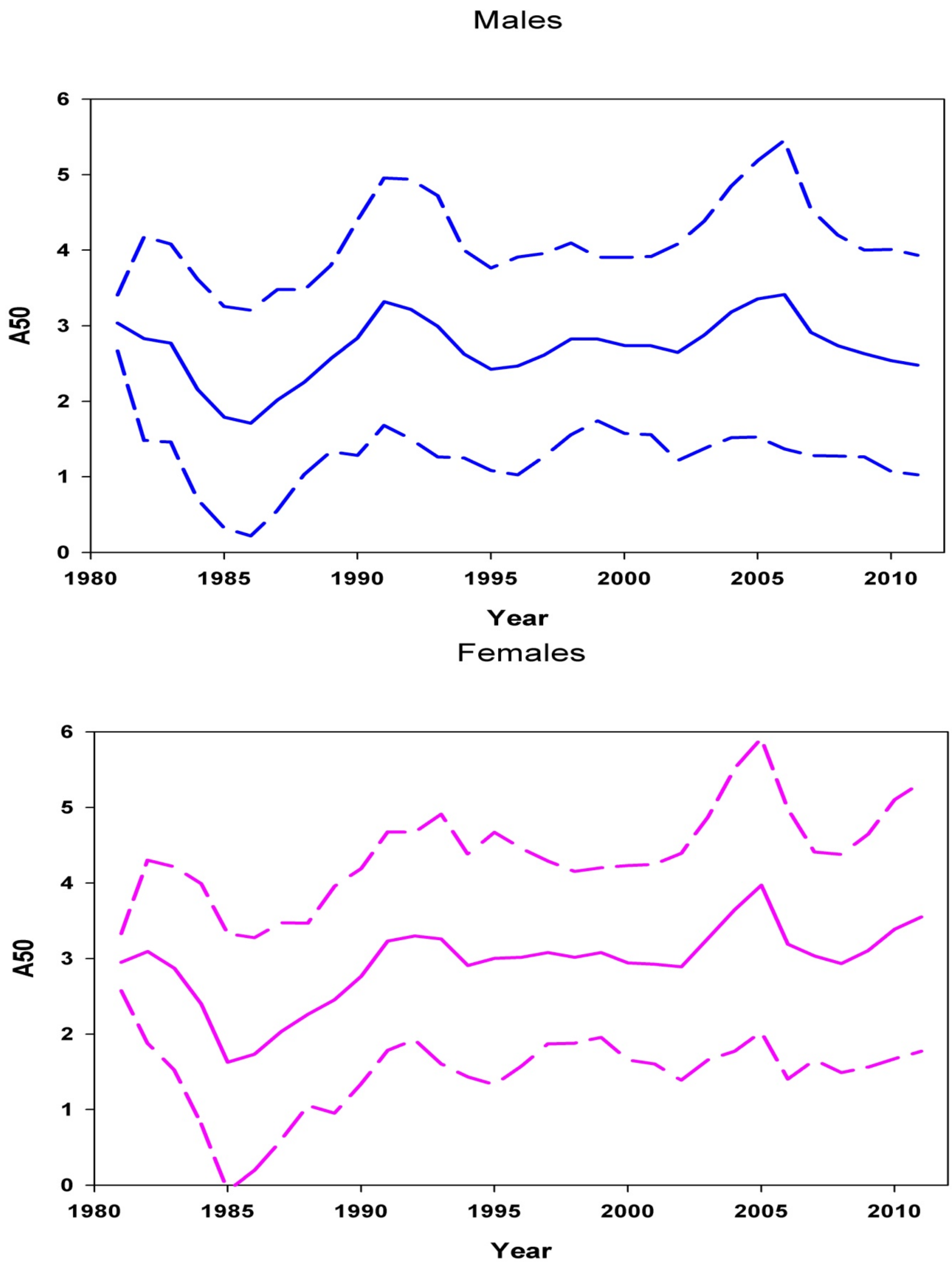
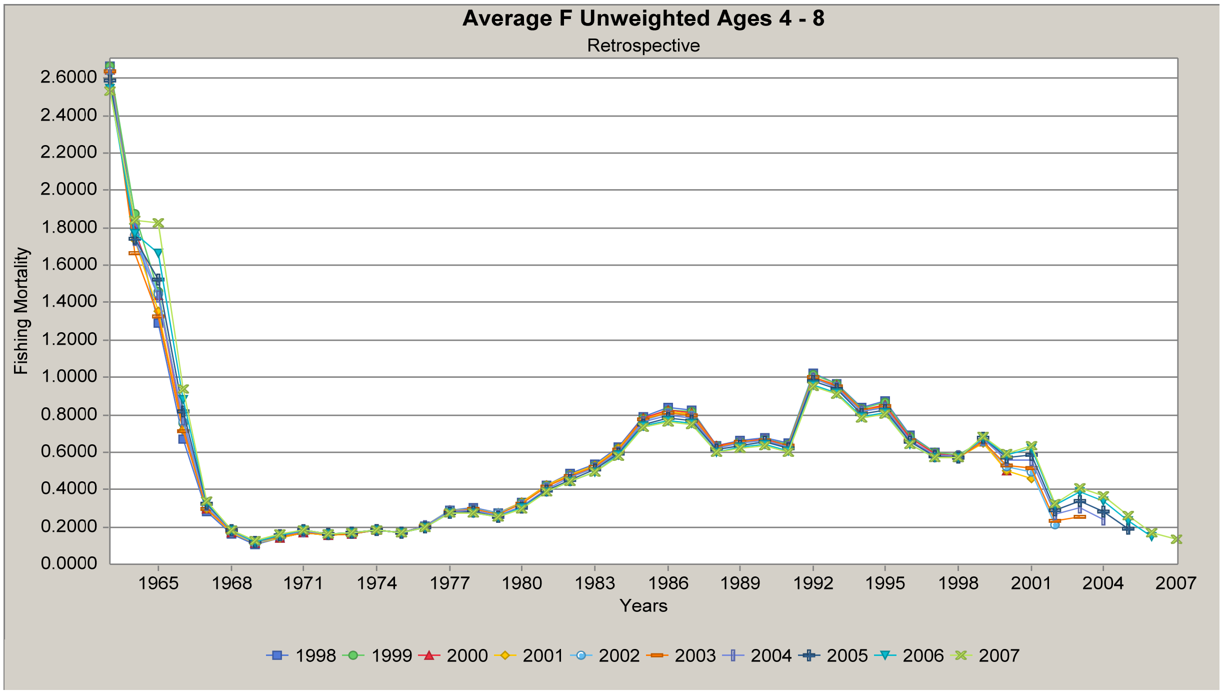


Figure B104. Three-year moving averages of the average age-at-50% maturity (A50) and corresponding 95% confidence intervals for male (top panel) and female (bottom panel) white hake from 1982 to 2011.



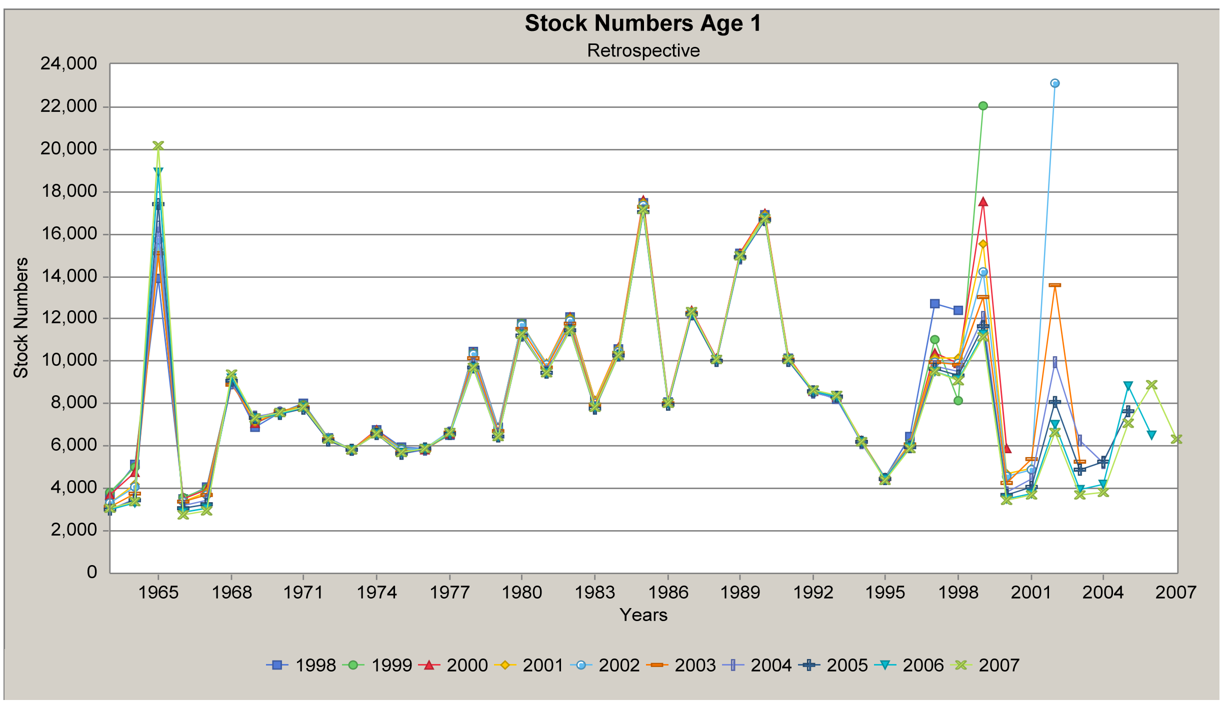


Figure B105. Estimates of fishing mortality (top panel) and recruitment (bottom panel) from the GARM III BRP meeting ASAP run.

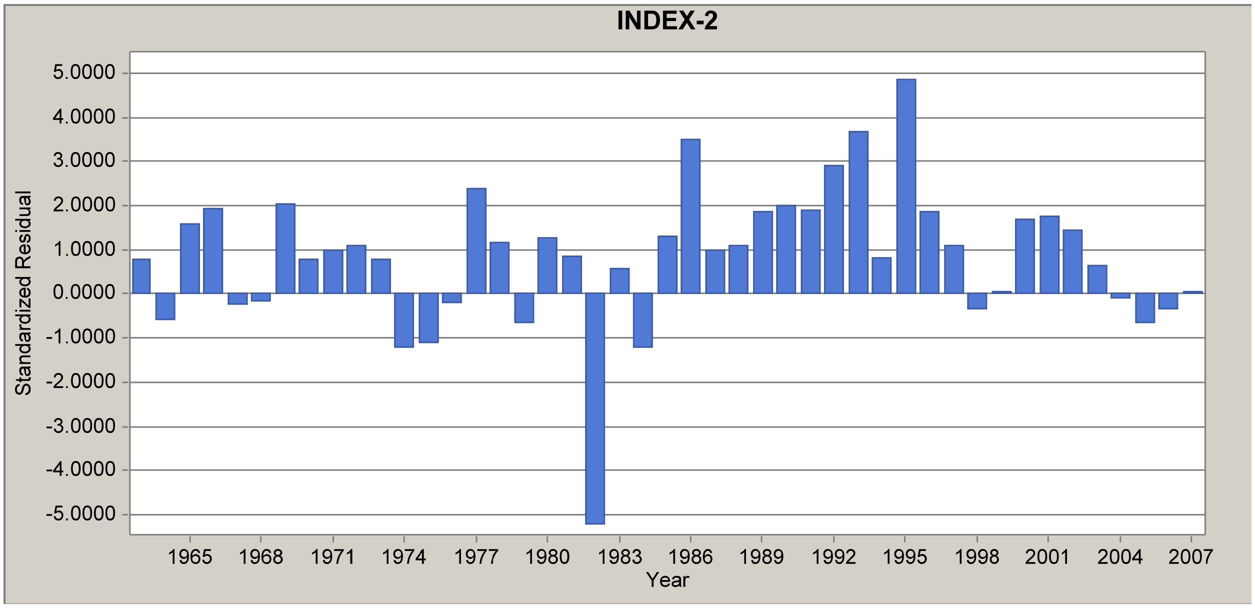


Figure B106. Residual pattern from the autumn survey GARM III BRP meeting ASAP run.

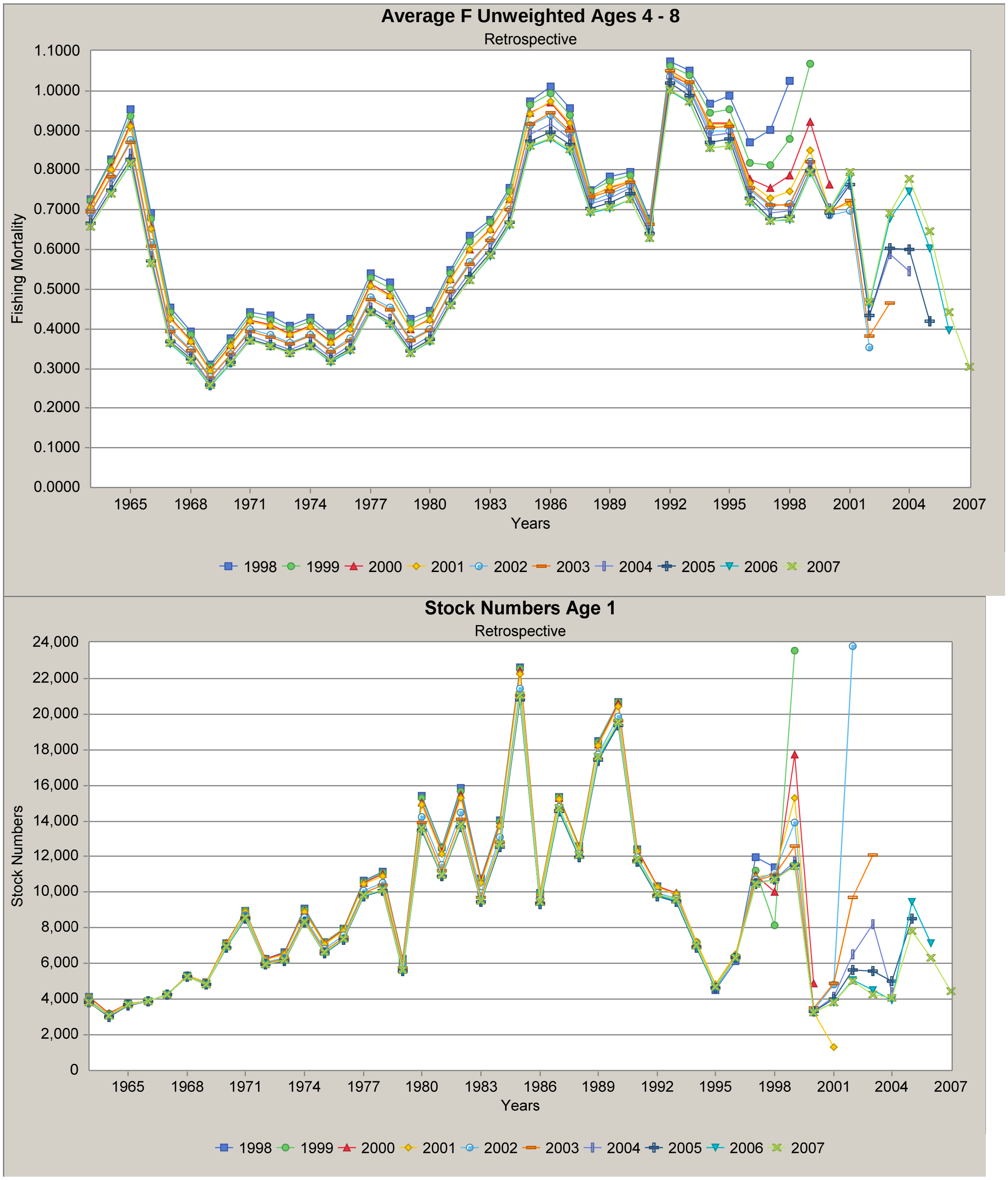


Figure B107. Estimates of fishing mortality (top panel) and recruitment (bottom panel) from the GARM III final meeting ASAP run.

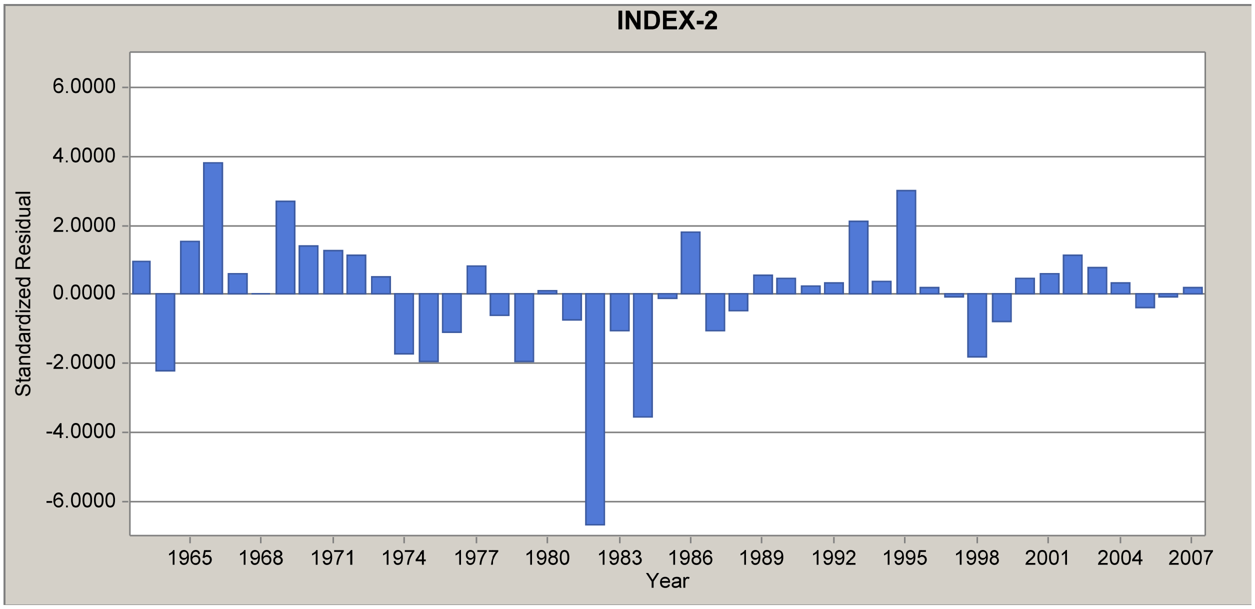


Figure B108. Residual pattern from the autumn survey GARM III final meeting ASAP run.

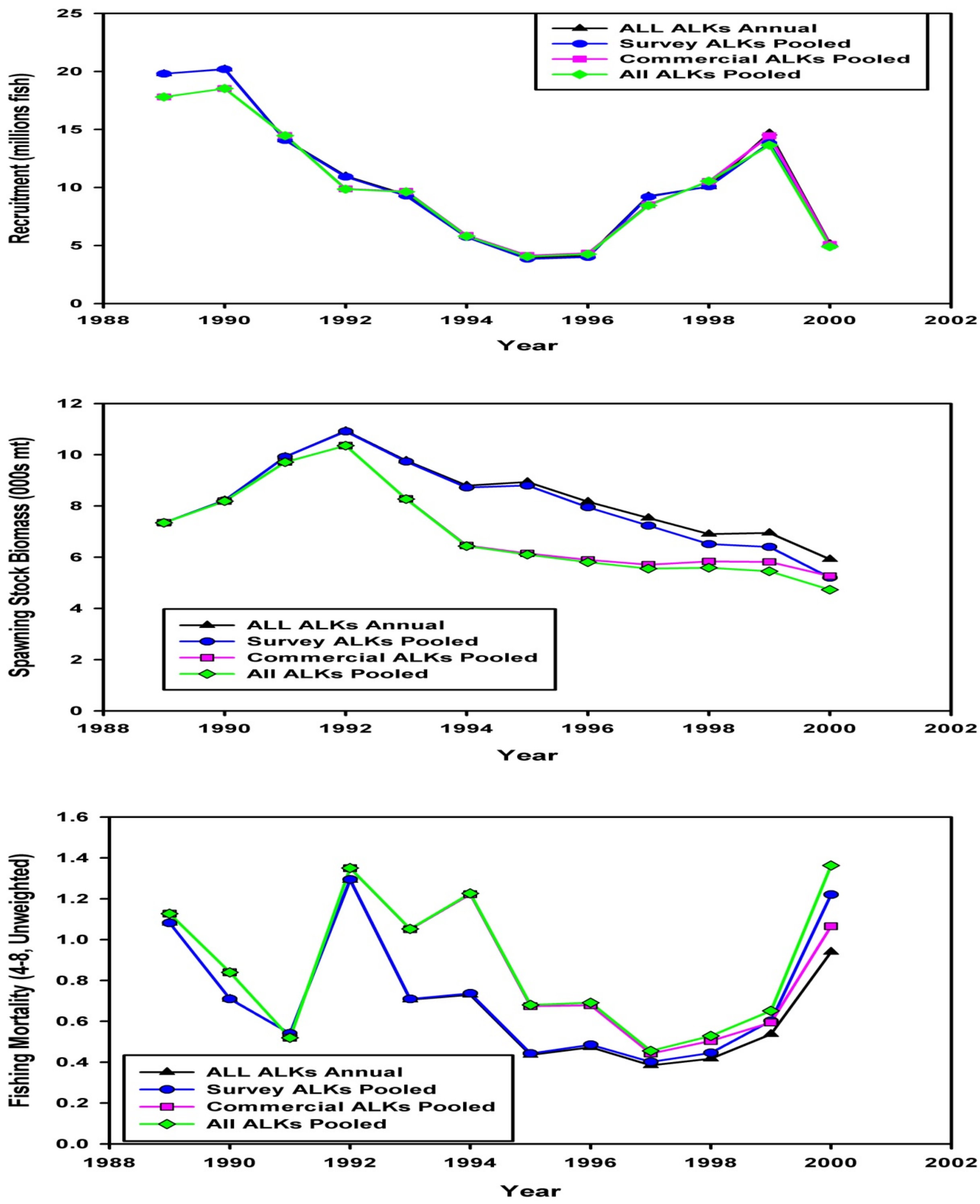


Figure B109. Results from the VPA model formulations for examining the use of pooled ALKs. The top panel is recruitment in millions of fish, the middle panel is spawning stock biomass in 000s mt , and the bottom panel is fully recruited fishing mortality (Ages 5-8).

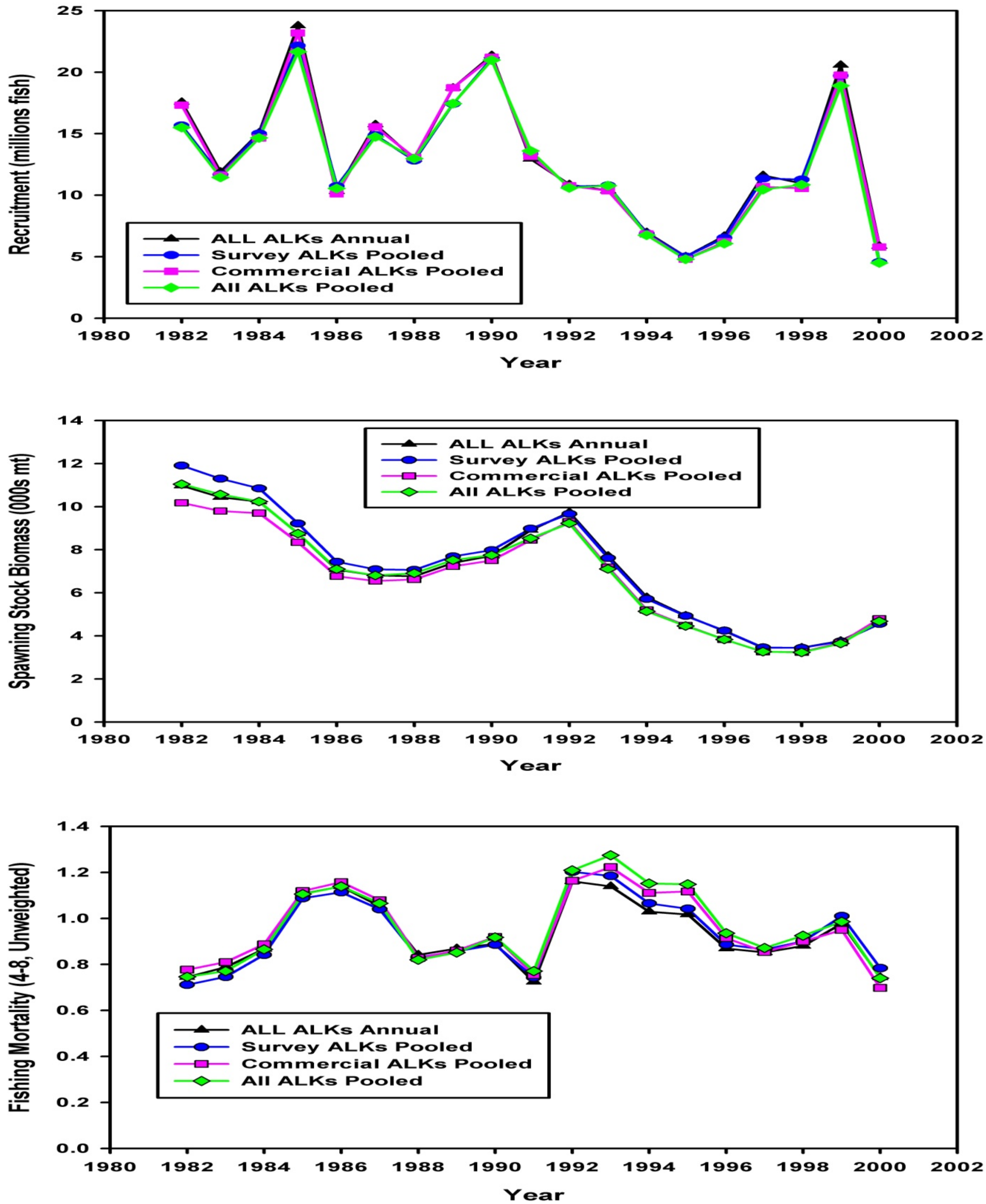
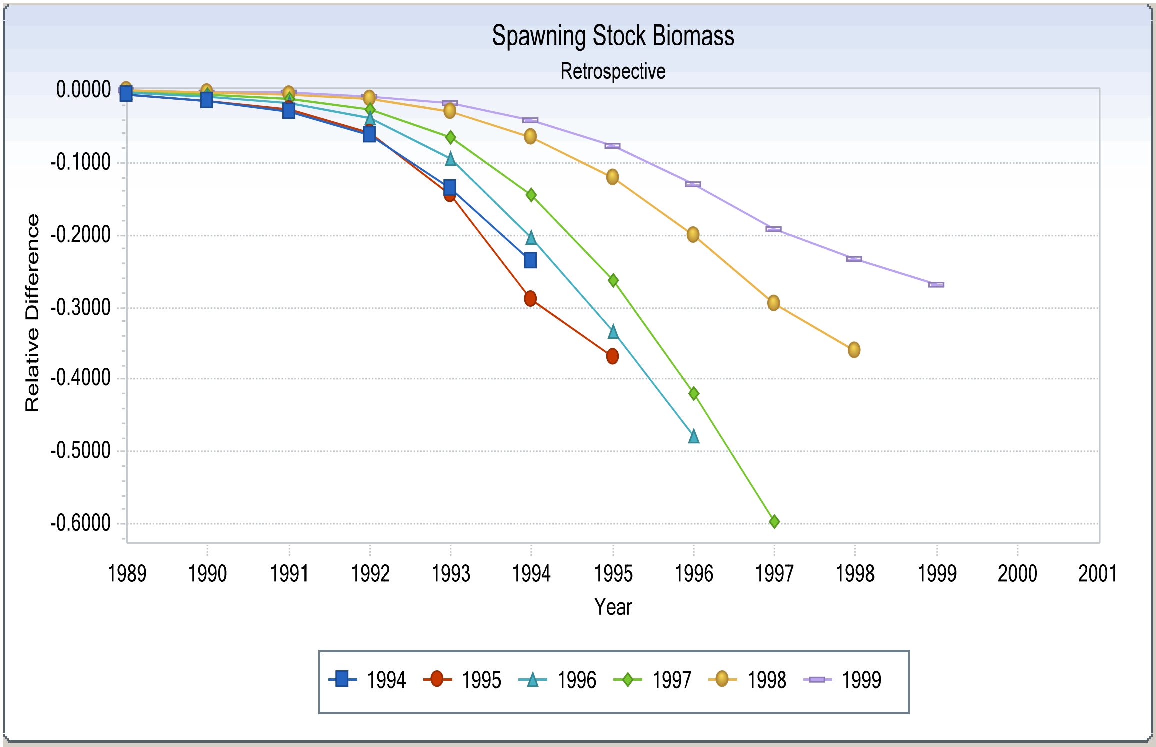


Figure B110. Results from the ASAP model formulations used to examine the use of pooled ALKs. The top panel is recruitment in millions of fish, the middle panel is spawning stock biomass in 000s mt , and the bottom panel is fully recruited fishing mortality (Age 5).



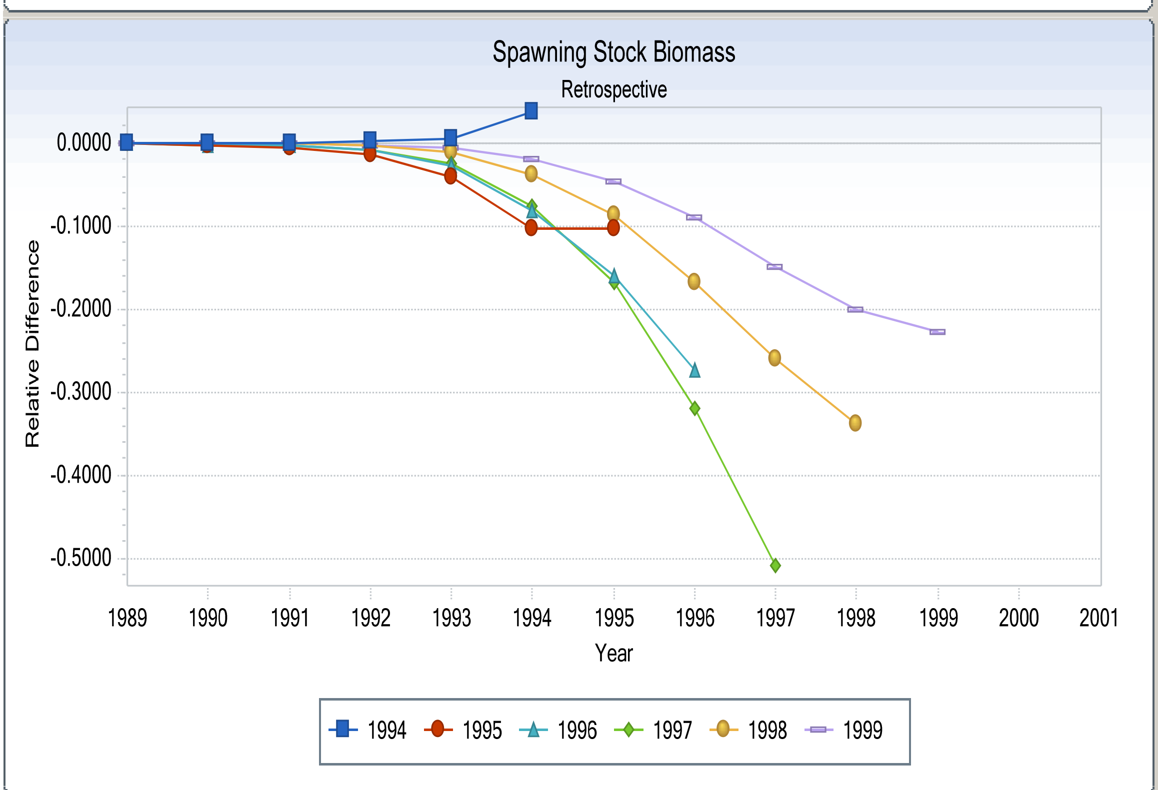


Figure B111. Retrospective results of SSB from the VPA formulations, all ALKs un-pooled (top panel) and commercial only pooled (bottom panel).

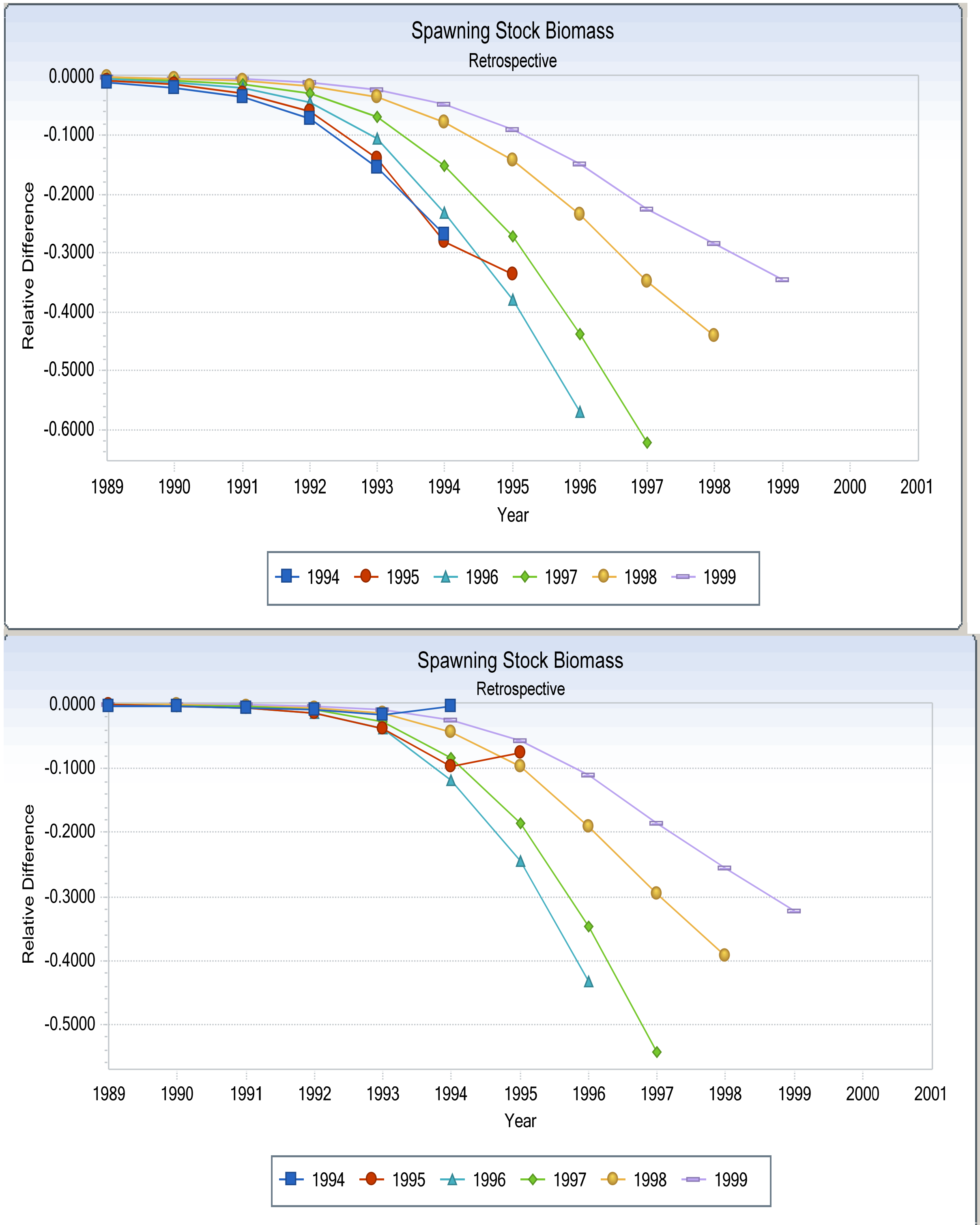


Figure B112. Retrospective results of SSB from the VPA formulations, survey ALKs pooled (top panel) and all ALKs pooled (bottom panel).

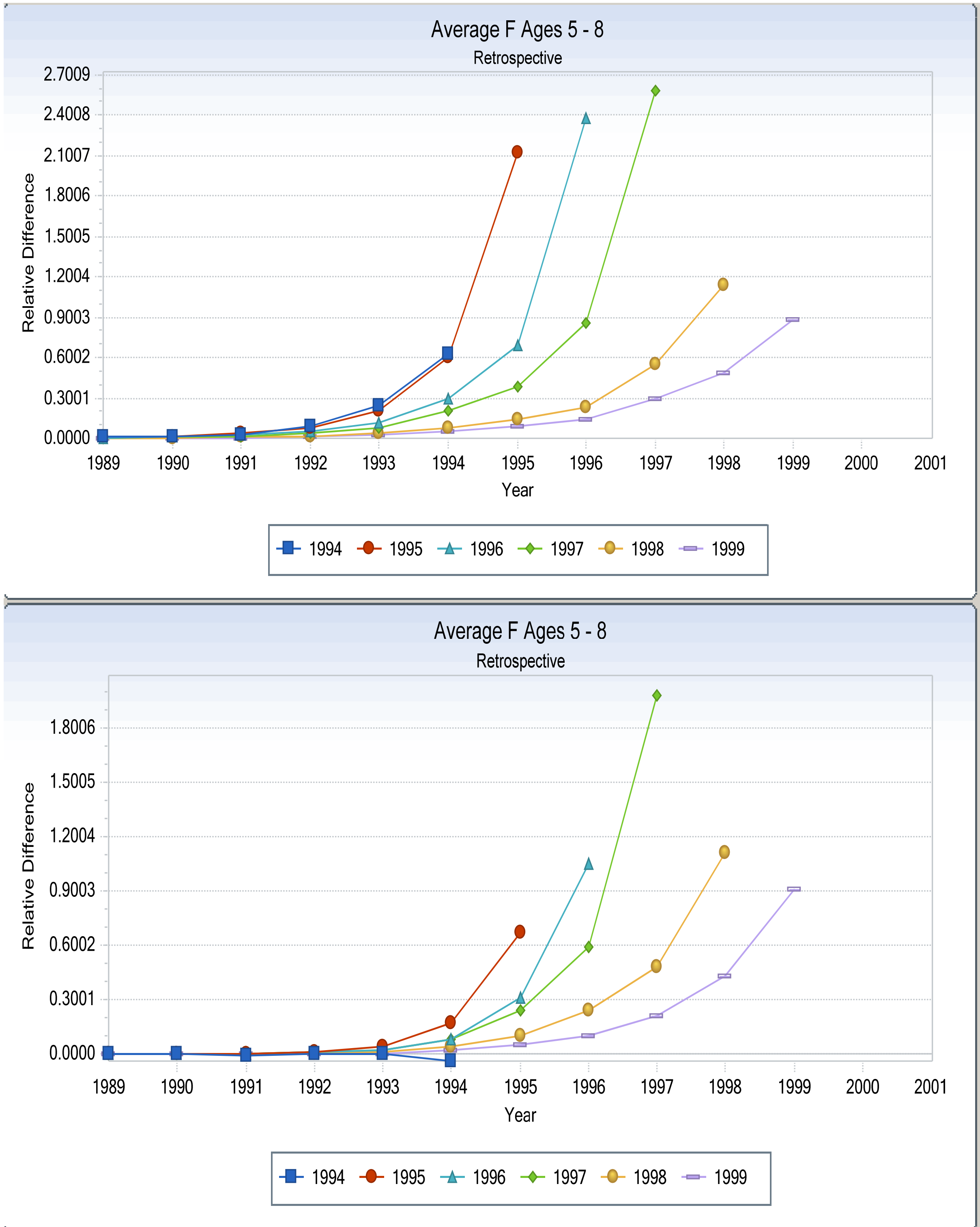


Figure B113. Retrospective results of fishing mortality (Ages 5-8) from the VPA formulations, all ALKs un-pooled (top panel) and commercial only pooled (bottom panel).

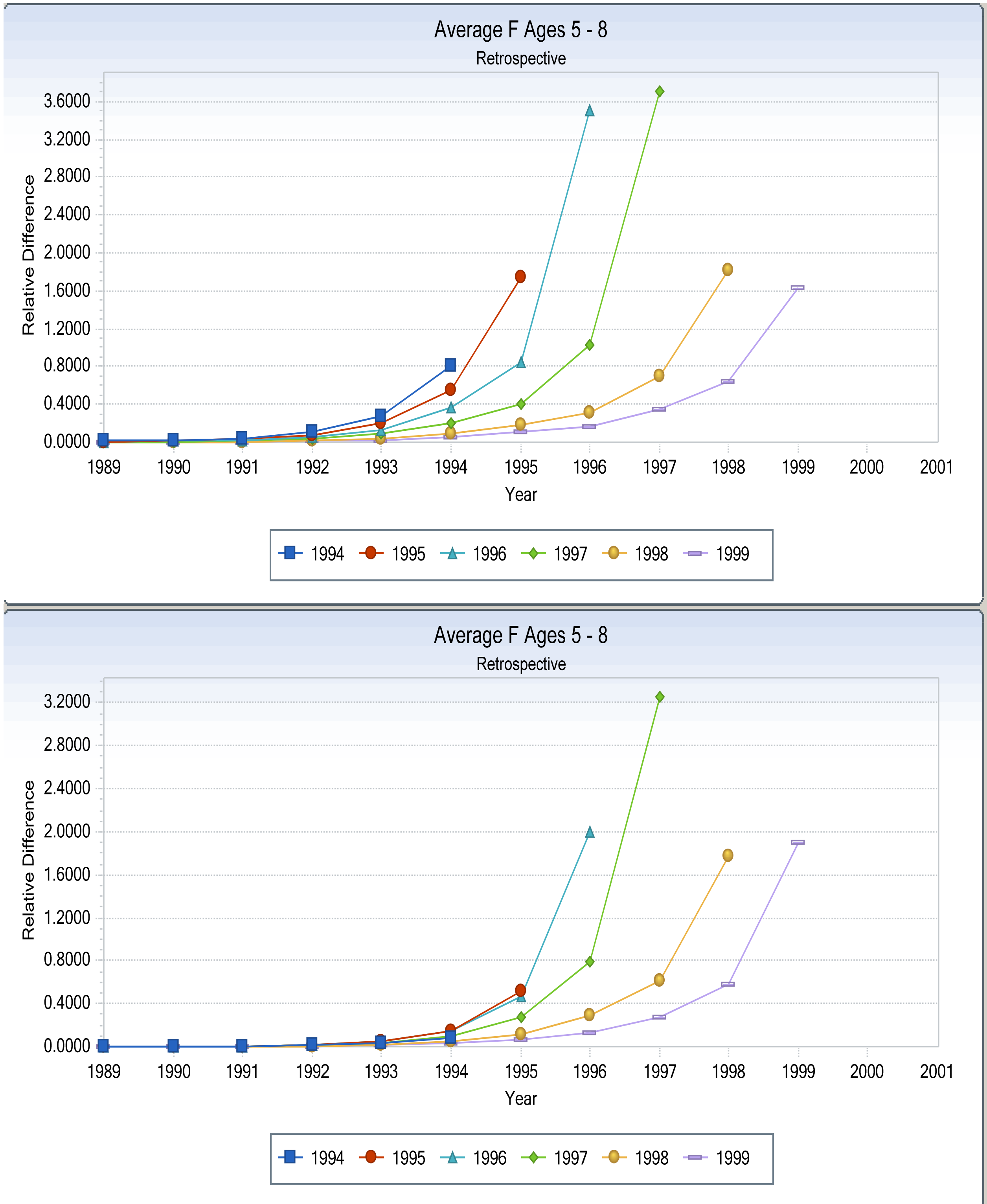


Figure B114. Retrospective results of fishing mortality (Ages 5-8) from the VPA formulations, survey ALKs pooled (top panel) and all ALKs pooled (bottom panel).

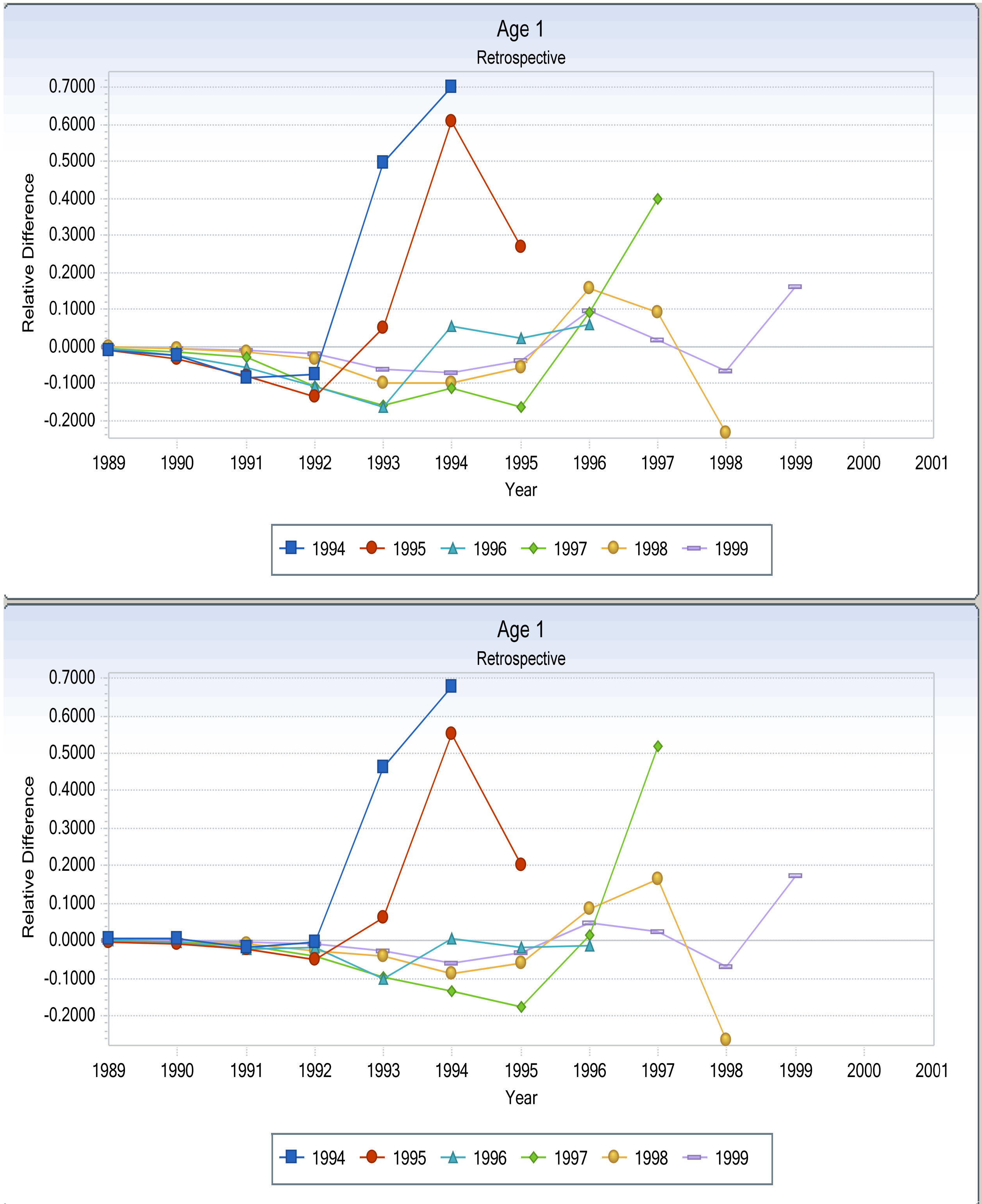
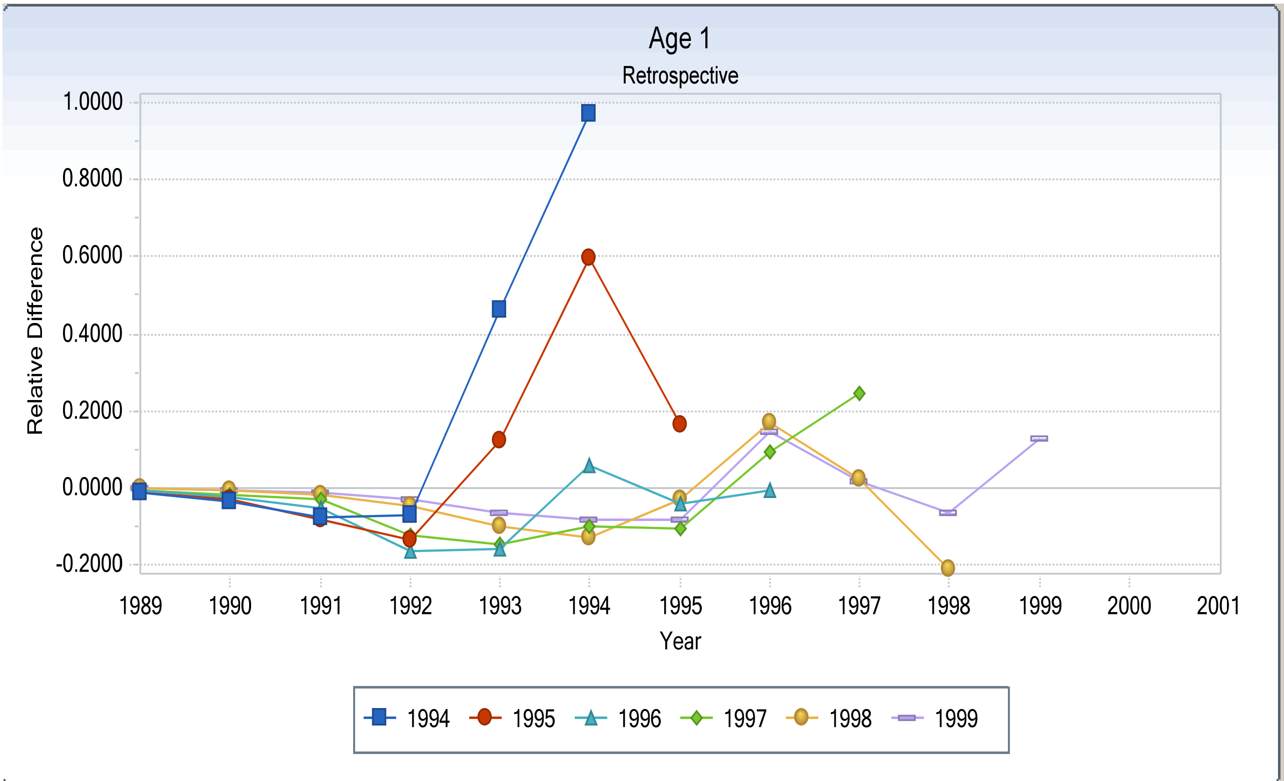


Figure B115. Retrospective results of recruitment from the VPA formulations, all ALKs un-pooled (top panel) and commercial only pooled (bottom panel).



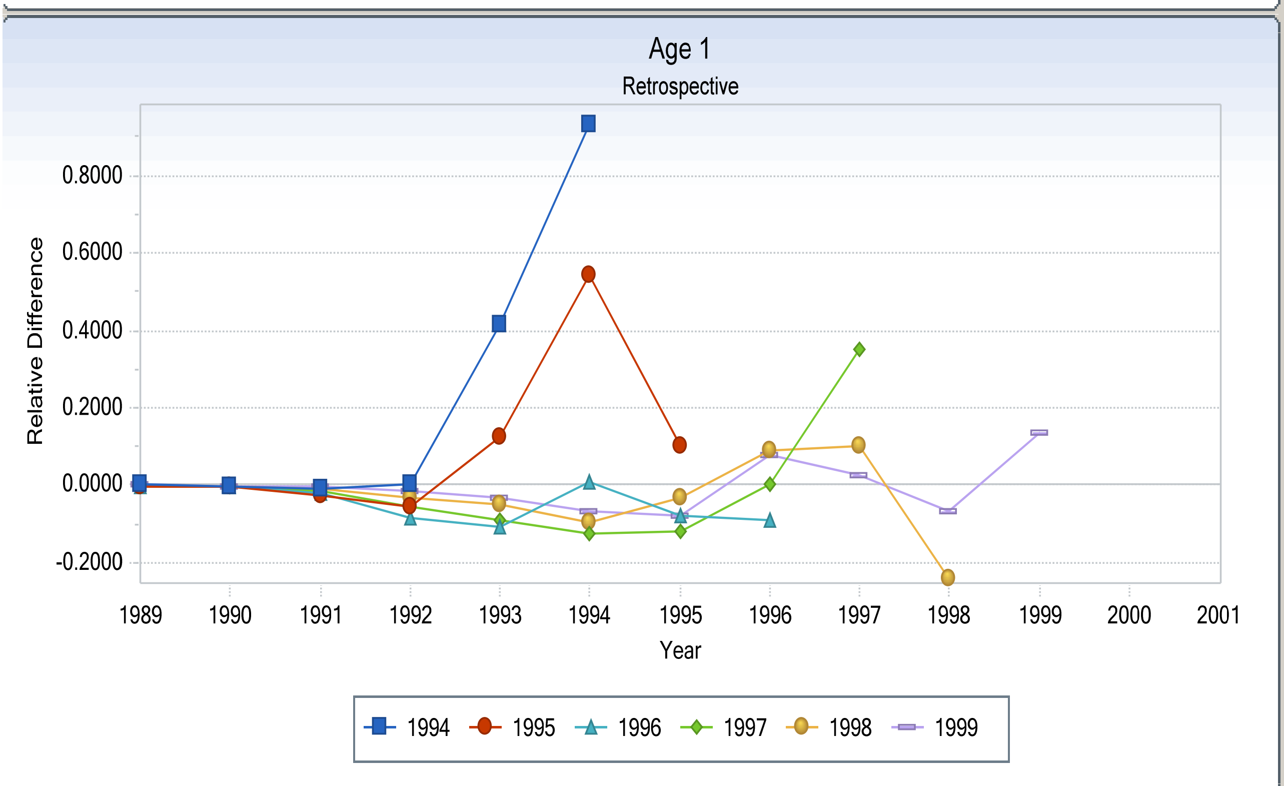


Figure B116. Retrospective results of recruitment from the VPA formulations, survey ALKs pooled (top panel) and all ALKs pooled (bottom panel).

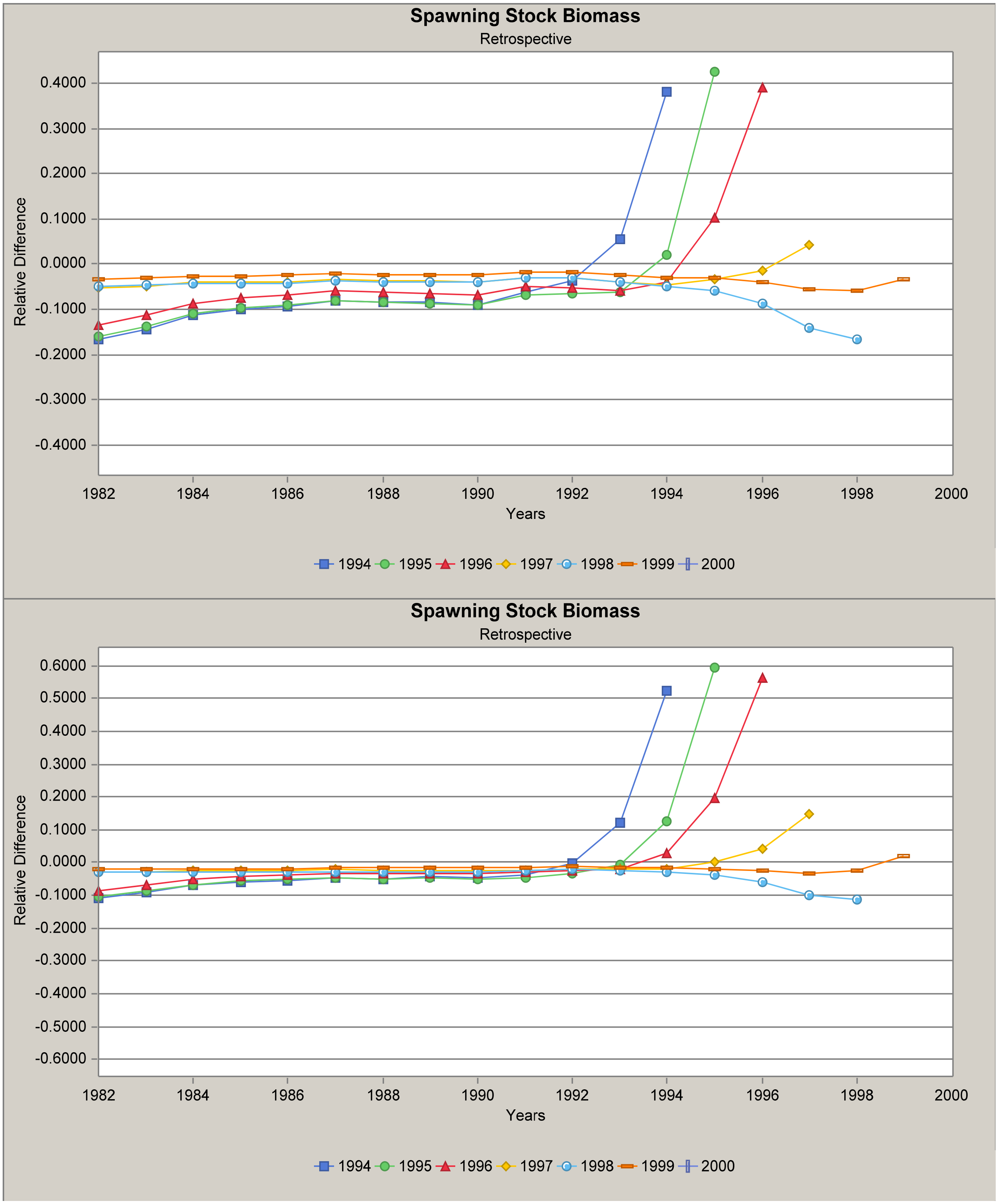


Figure B117. Retrospective results of SSB from the ASAP formulations, all ALKs un-pooled (top panel) and commercial only pooled (bottom panel).

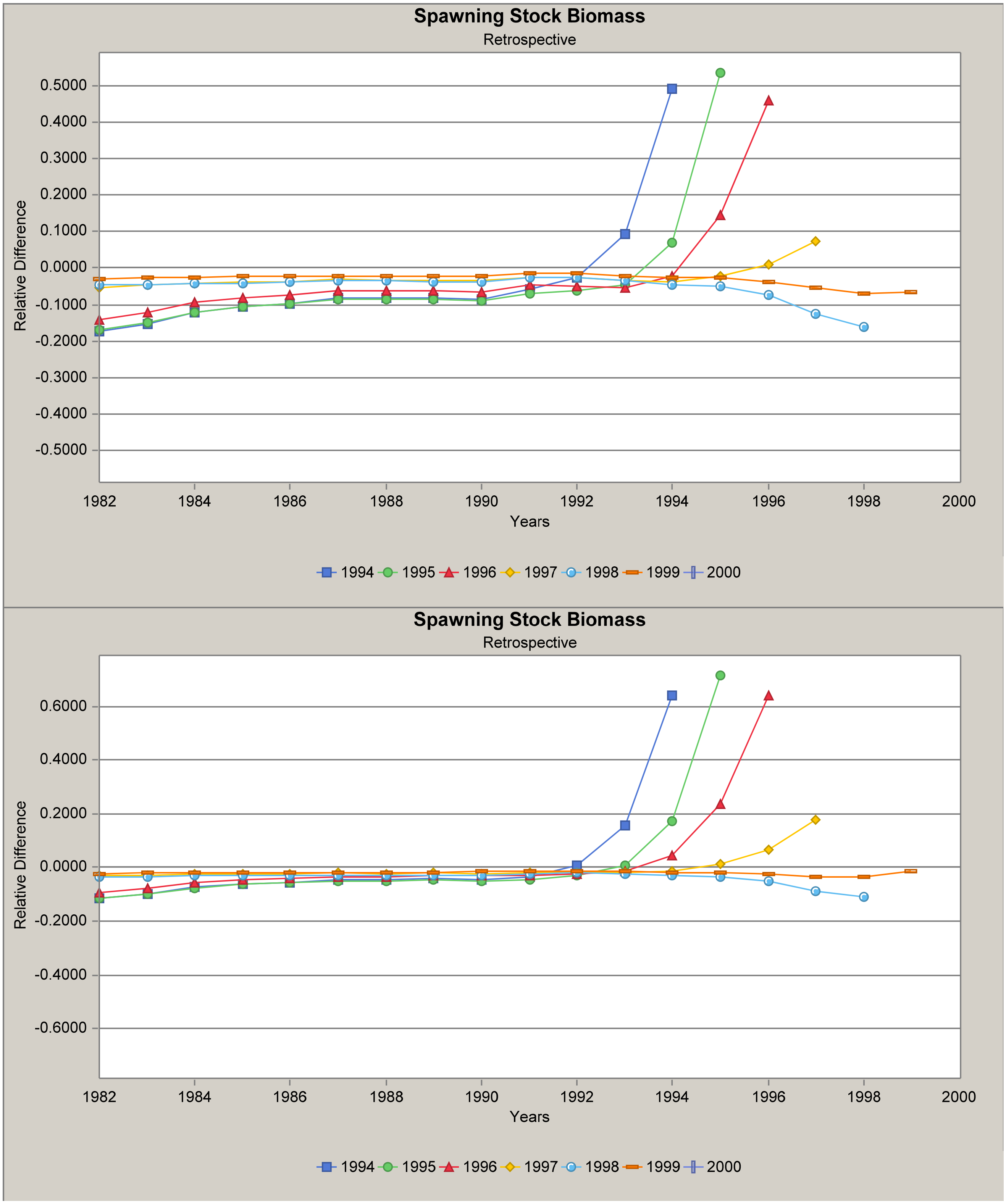


Figure B118. Retrospective results of SSB from the ASAP formulations, survey ALKs pooled (top panel) and all ALKs pooled (bottom panel).

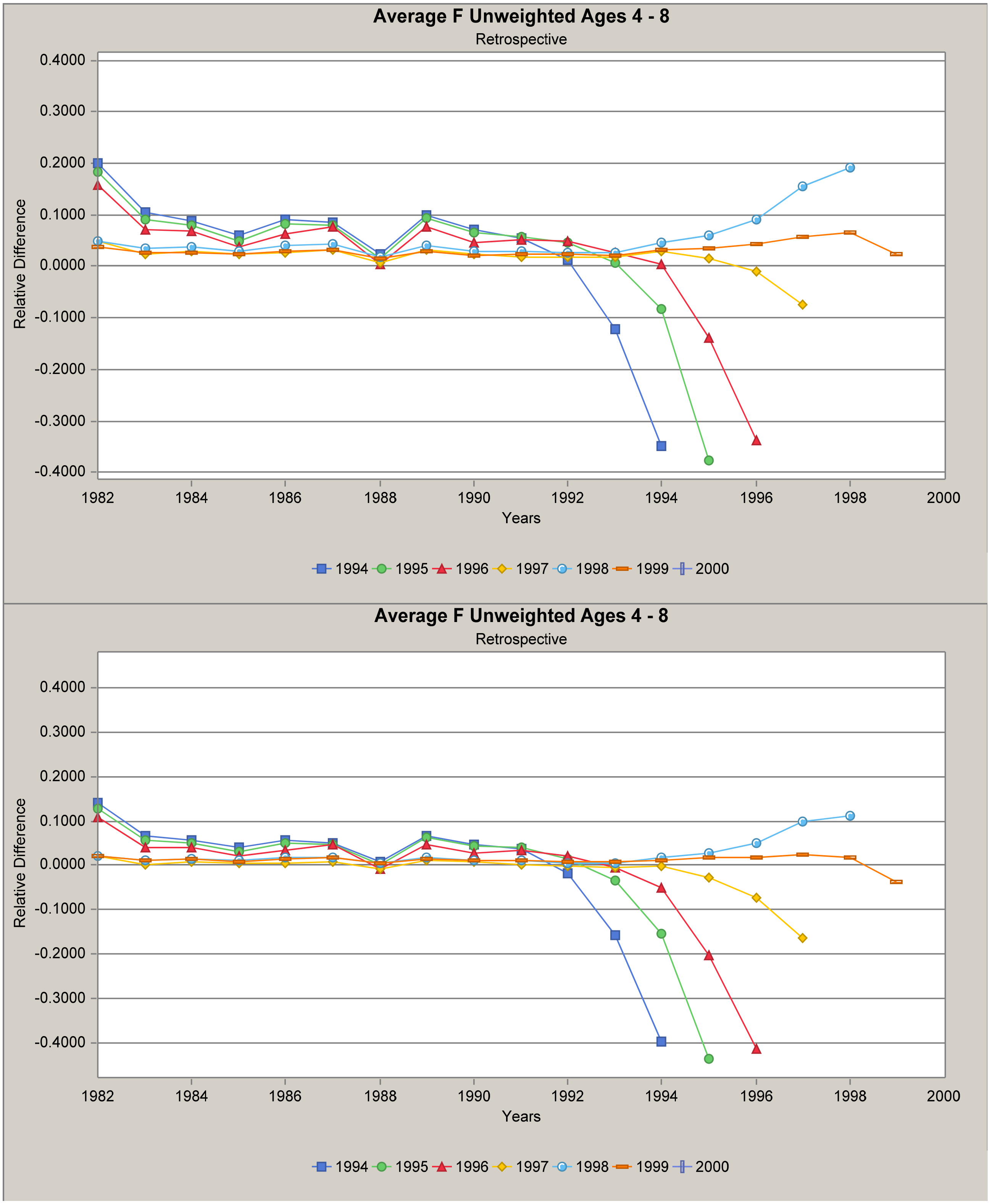


Figure B119. Retrospective results of fishing mortality (5-8) from the ASAP formulations, all ALKs un-pooled (top panel) and commercial only pooled (bottom panel).

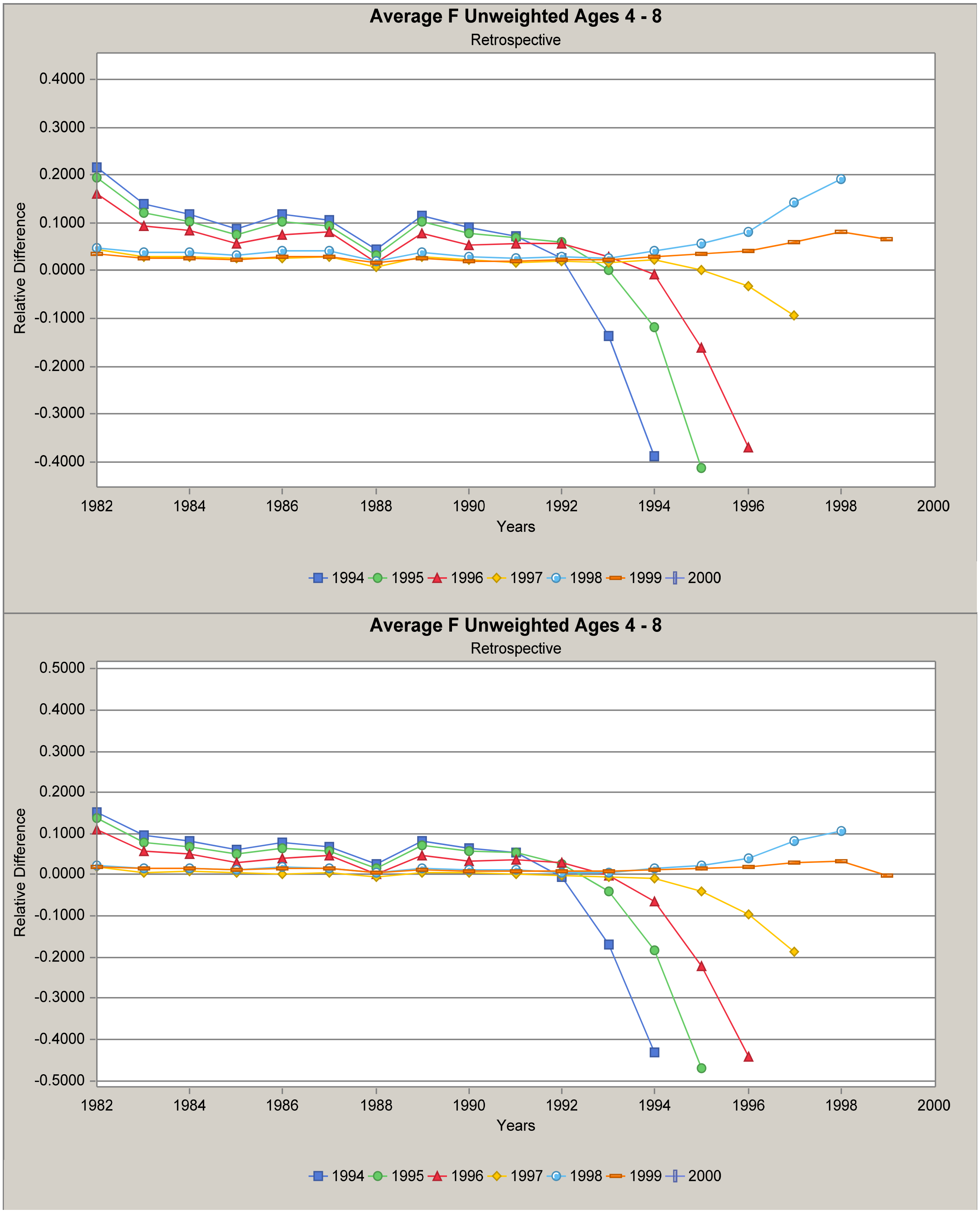
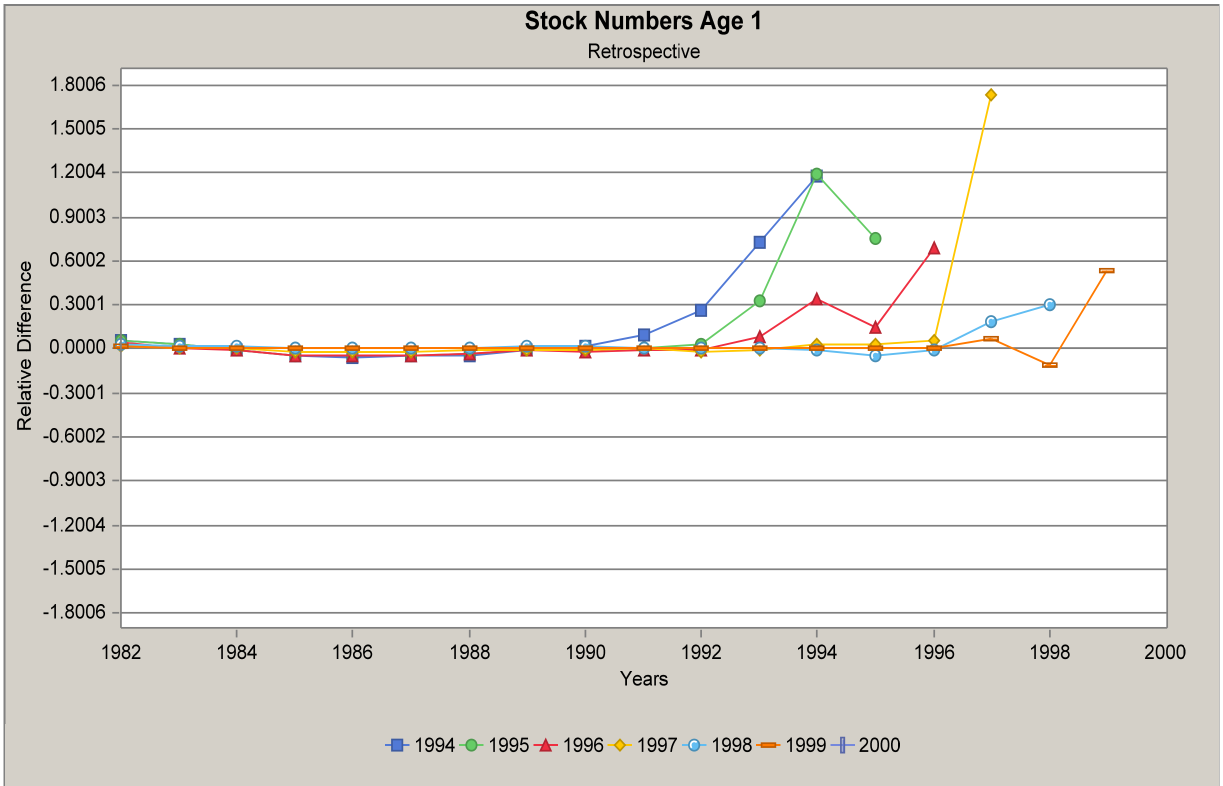


Figure B120. Retrospective results of fishing mortality (5-8) from the ASAP formulations, survey ALKs pooled (top panel) and all ALKs pooled (bottom panel).



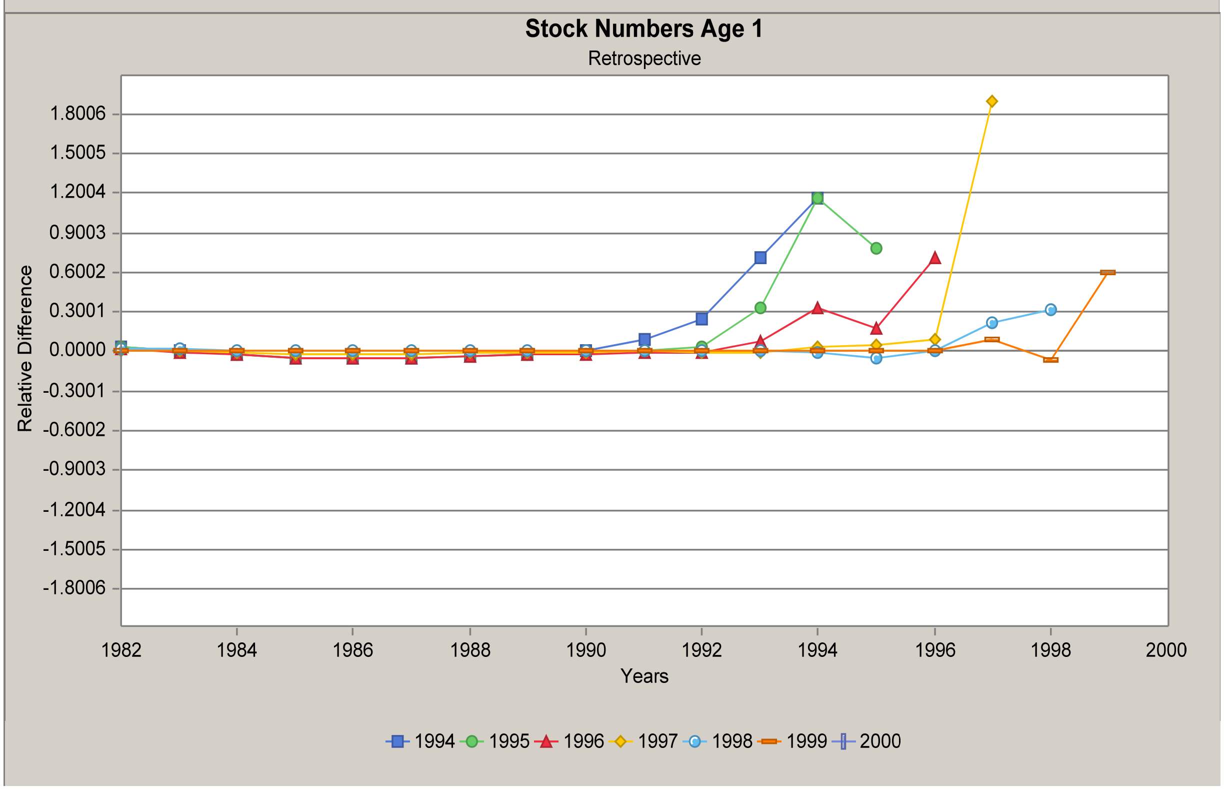


Figure B121. Retrospective results of recruitment from the ASAP formulations, all ALKs un-pooled (top panel) and commercial only pooled (bottom panel).

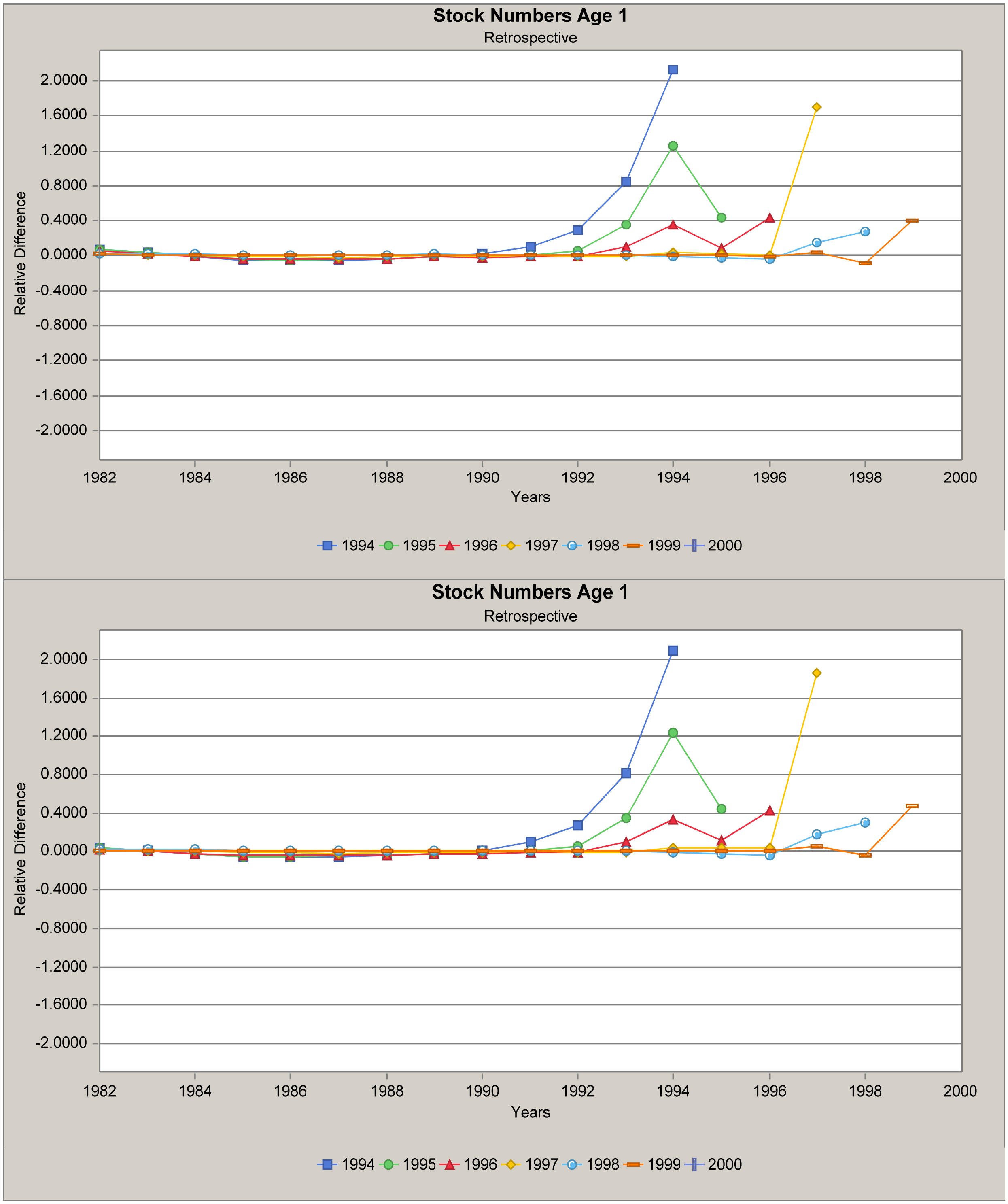


Figure B122. Retrospective results of recruitment from the ASAP formulations, survey ALKs pooled (top panel) and all ALKs pooled (bottom panel).

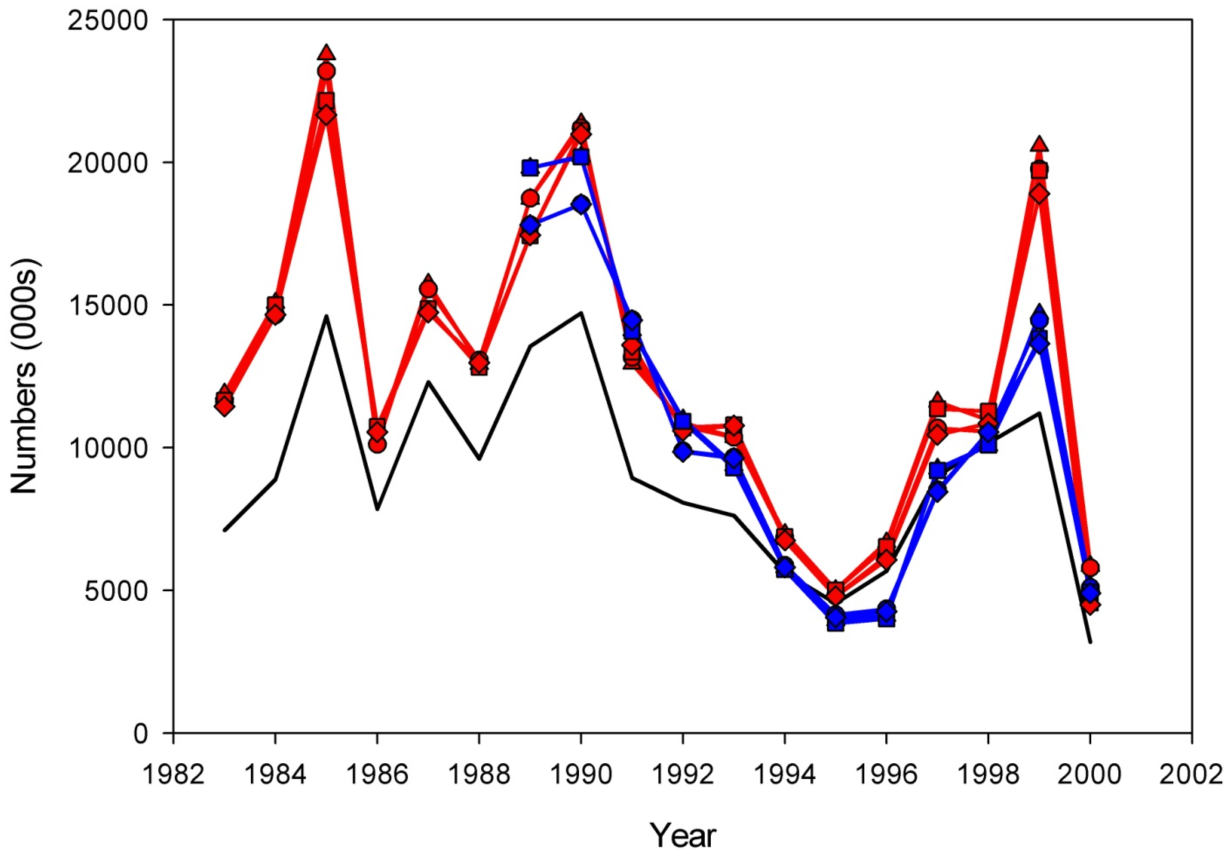


Figure B123. Comparison of recruitment estimates from the VPA (blue lines) and the ASAP (red lines) models for the pooled ALK analysis as well as the recruitment from the GARMIII model (black line).

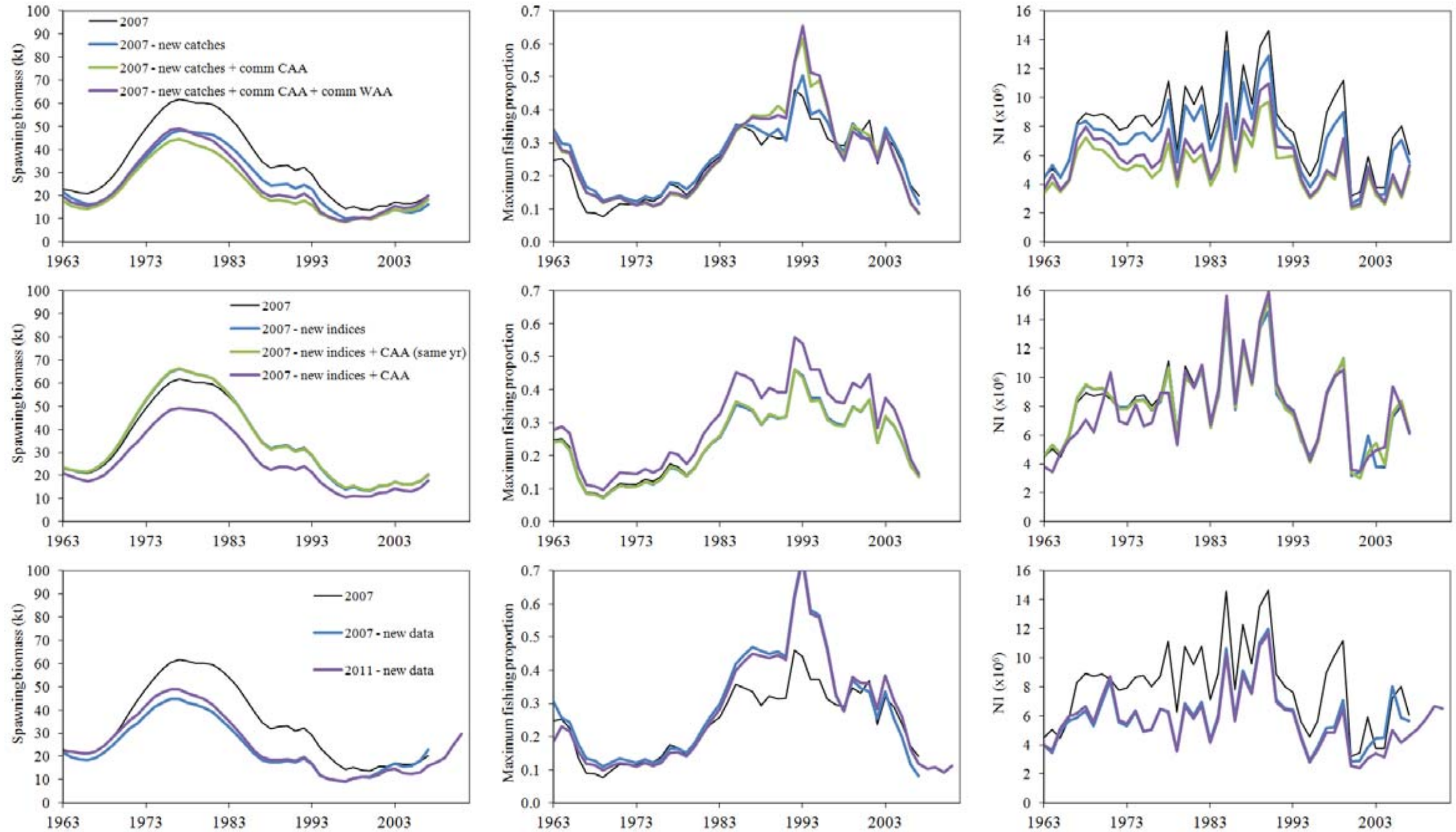


Figure. B124. Spawning biomass, maximum fishing proportion and recruitment trajectories from the bridge-building exercise using SCAA.

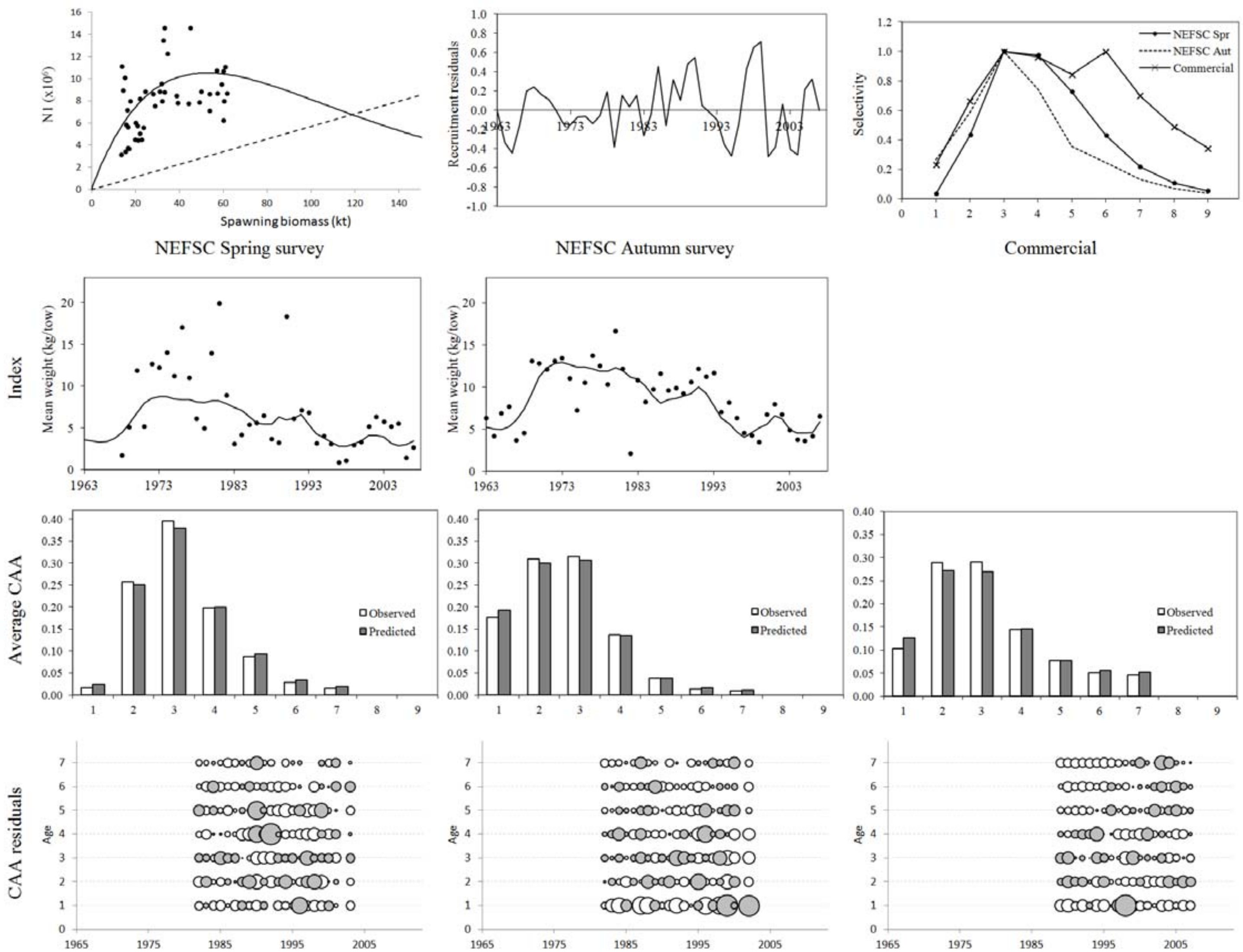


Figure B125. Results for the "2007" white hake assessment.

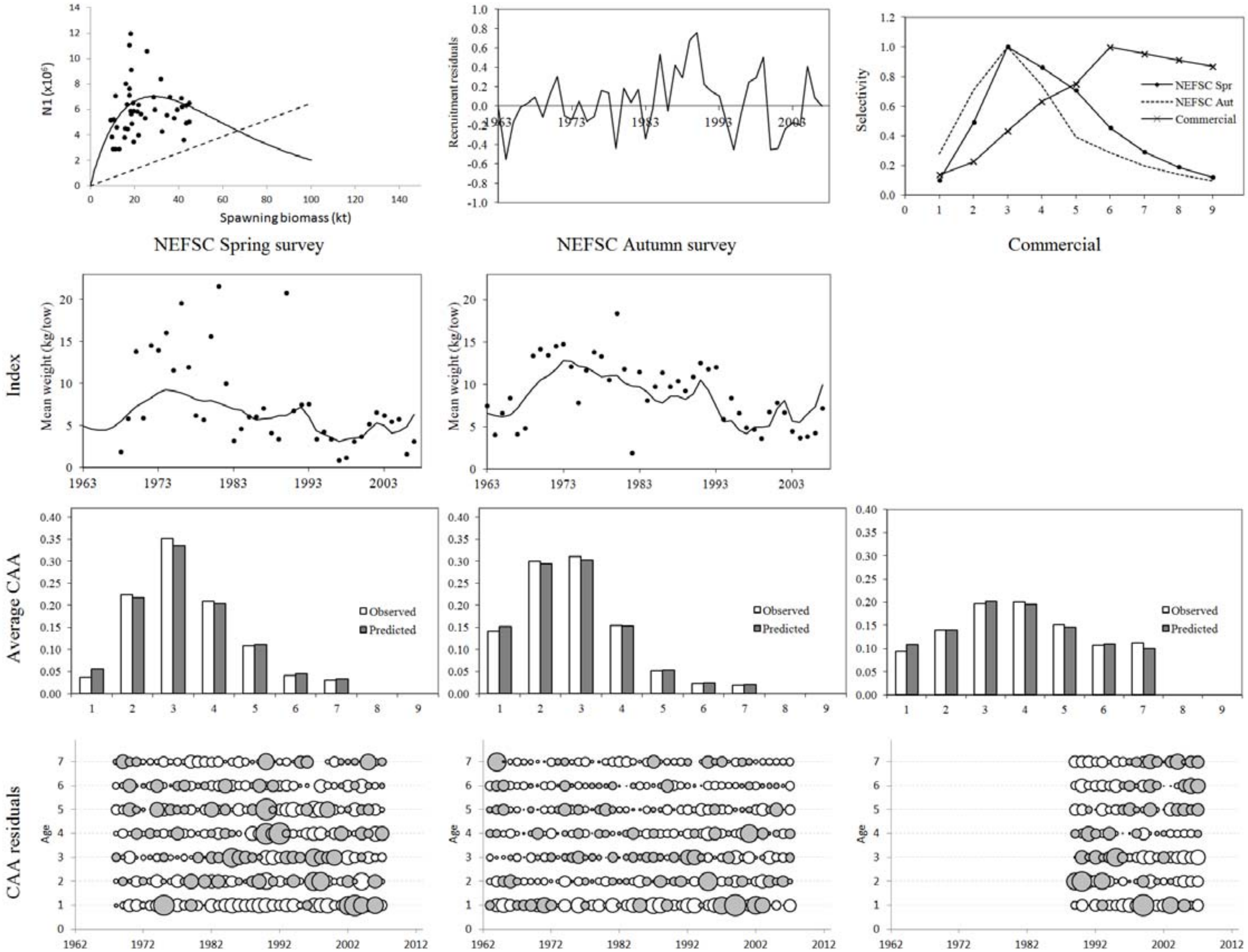


Figure B126: Results for the "2007 - new data" white hake assessment.

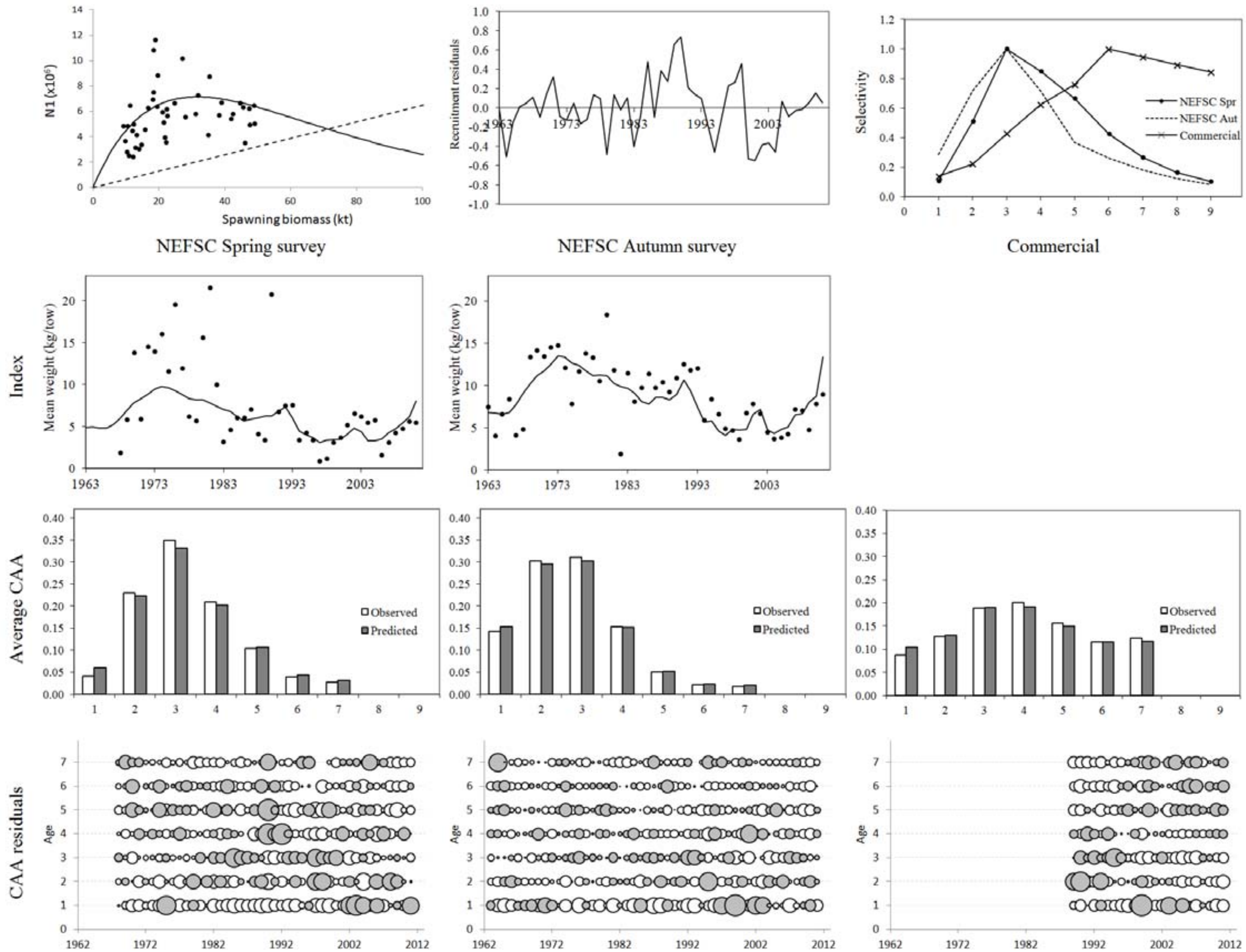
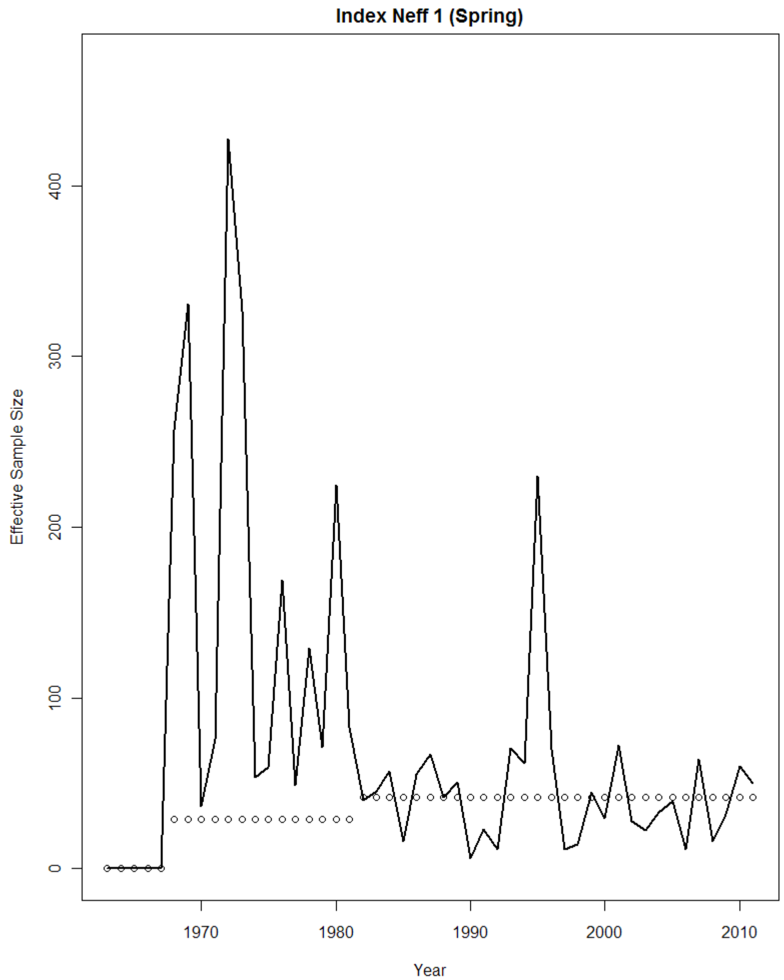


Figure B127. Results for the "2011 - new data" white hake assessment.



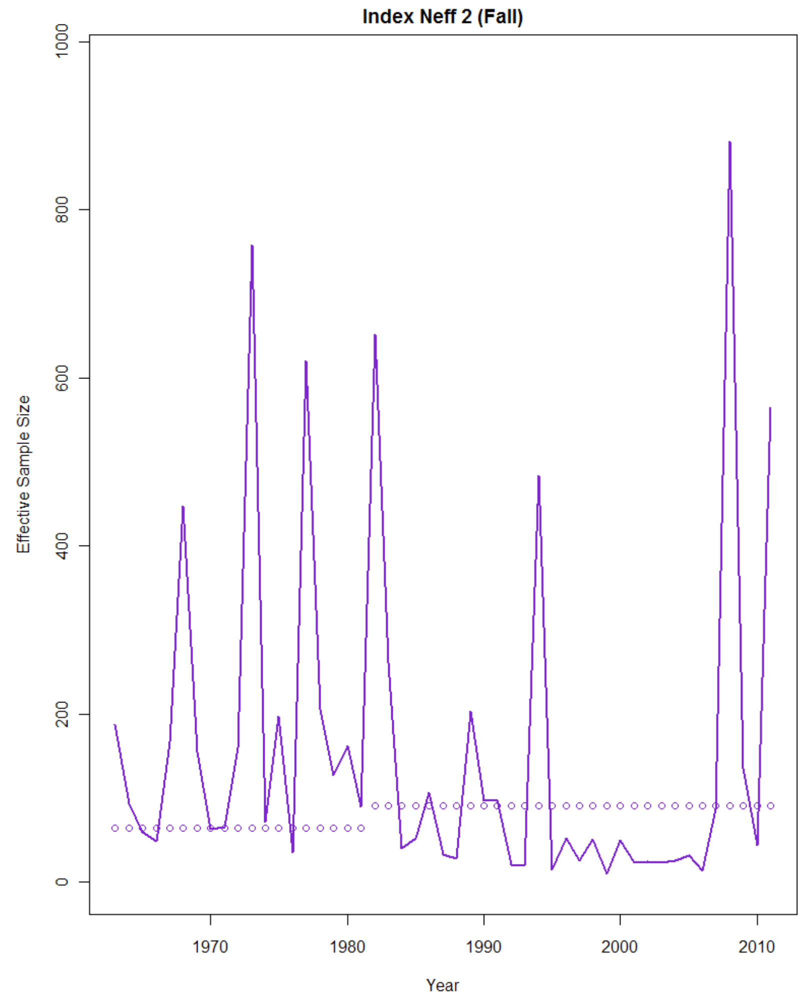


Figure B128. Effective sample sizes from the spring (left panel) and the autumn (right panel) surveys from the Base Model.

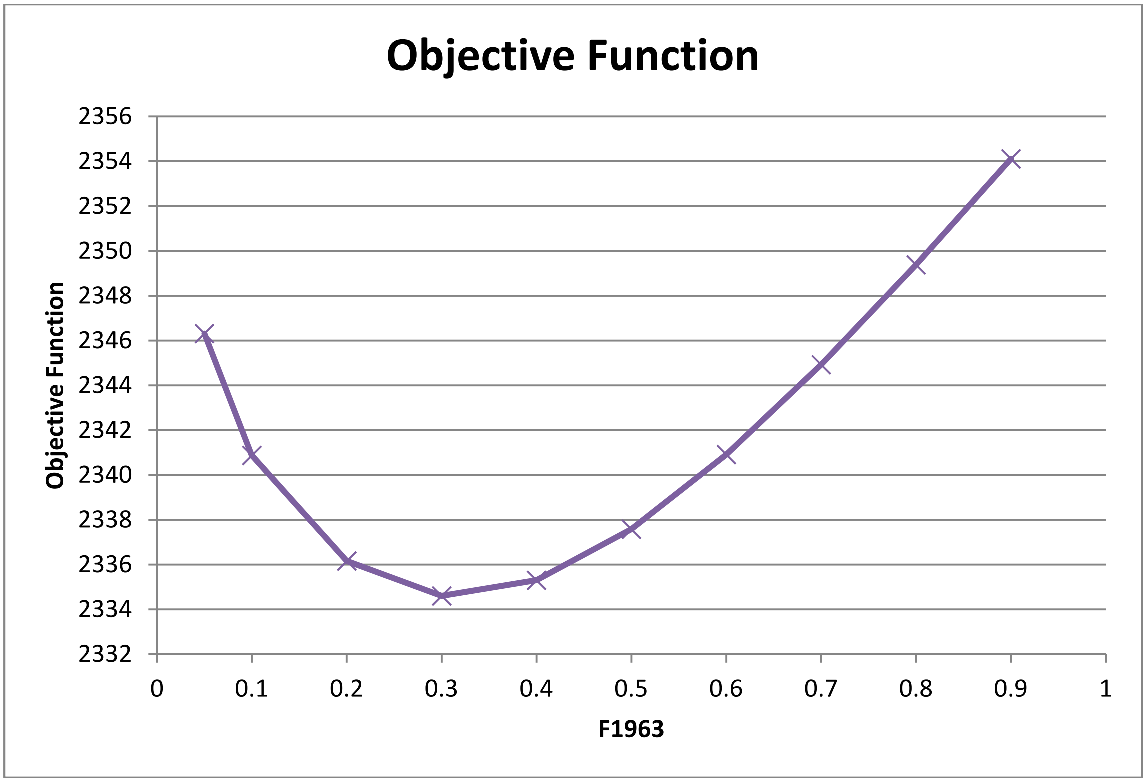
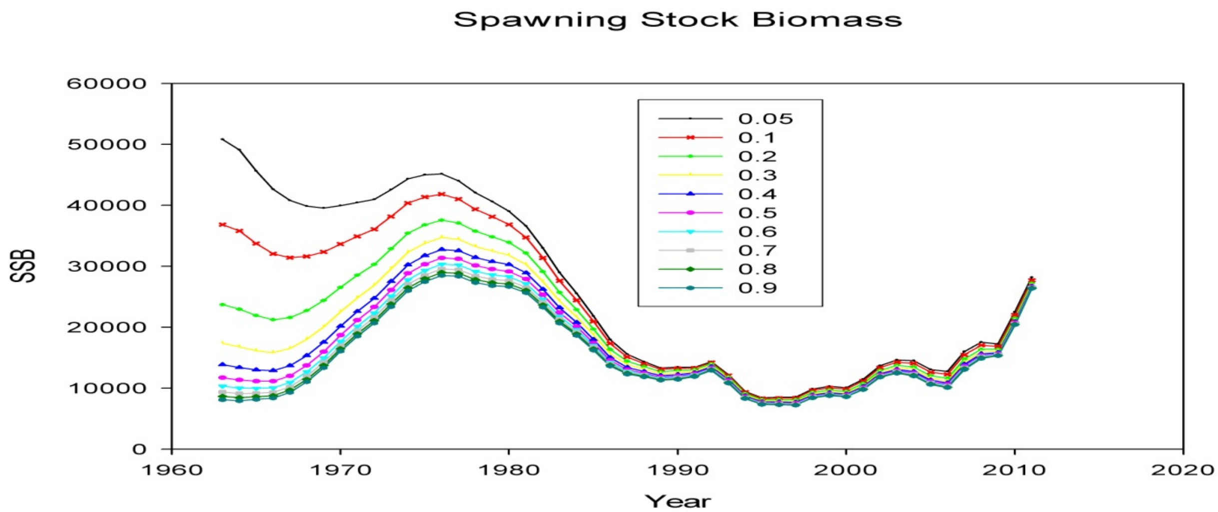
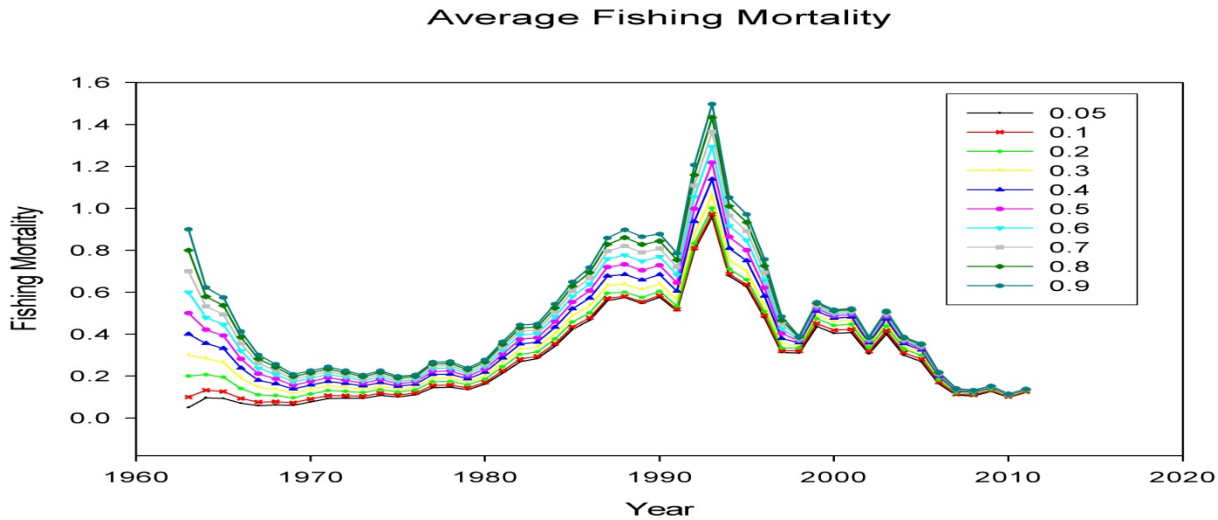


Figure B129. Profile of the objective function from ASAP runs in which the F1963 was fixed at different values.





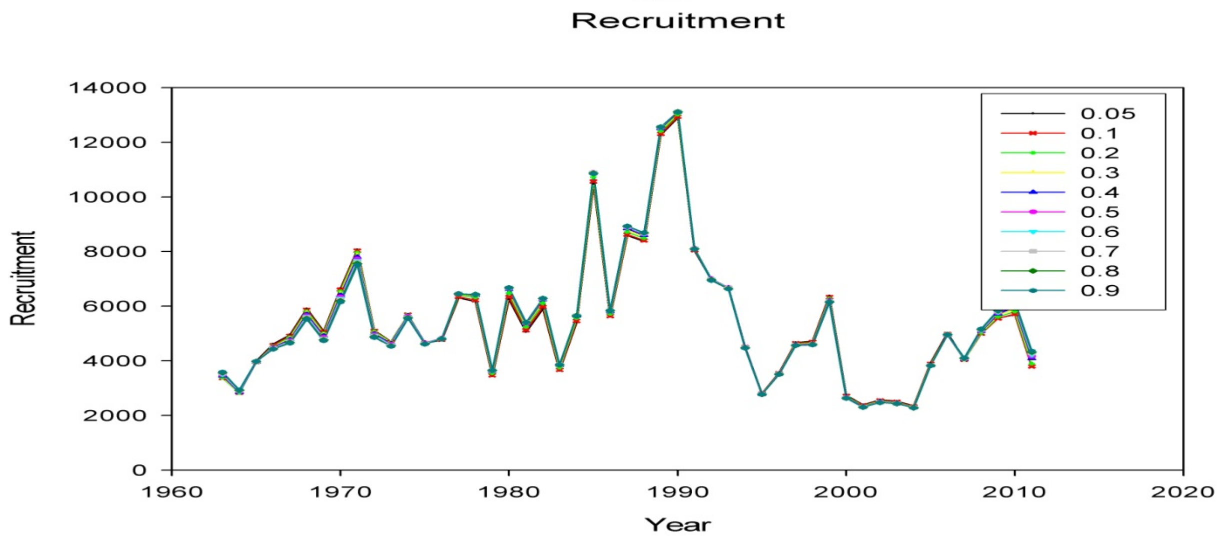


Figure B130. Comparison of the SSB (top panel), average fishing mortality (middle panel) and recruitment (bottom panel) under various values of F1963.

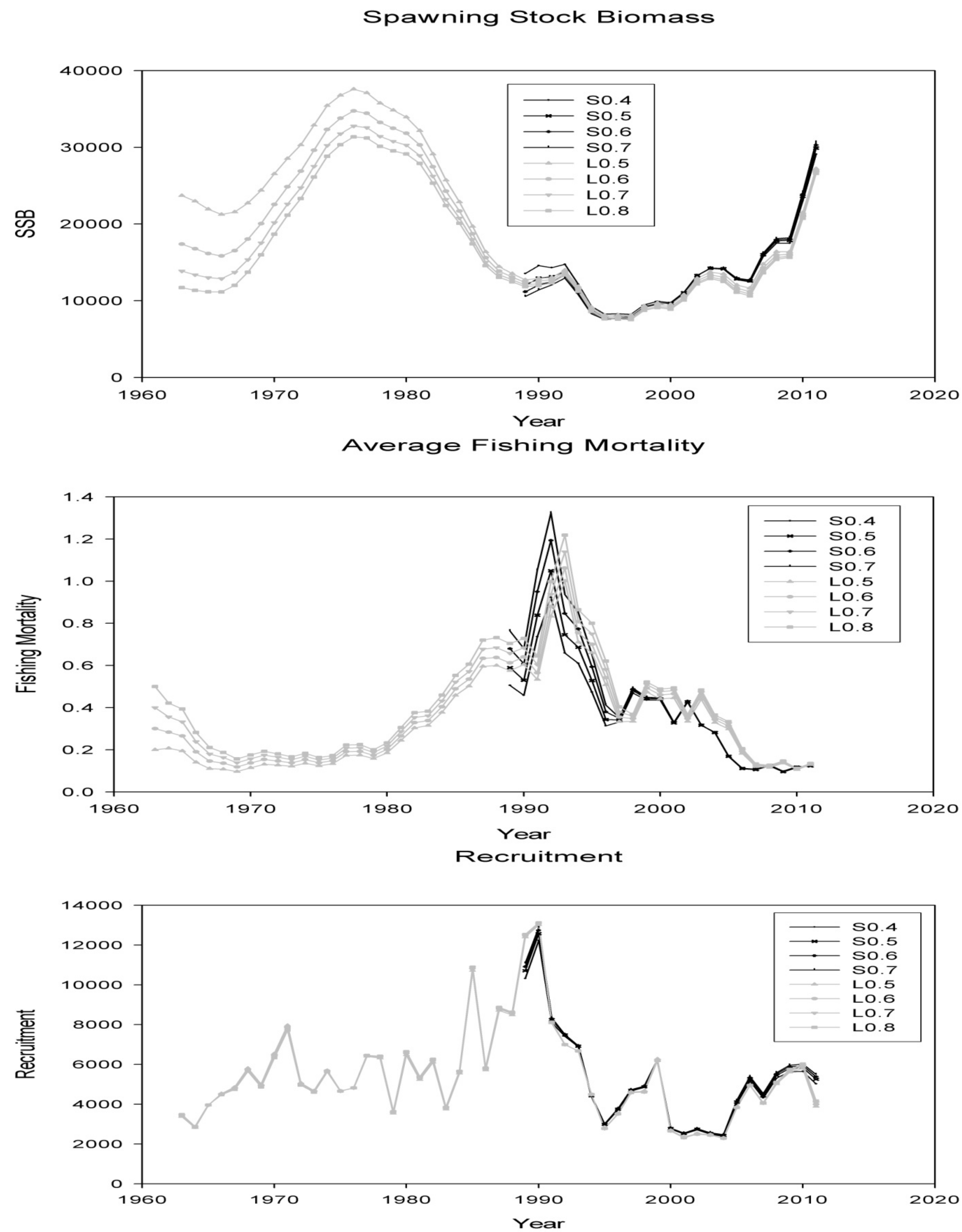


Figure B131. Comparison of the SSB (top panel), Average Fishing mortality (middle panel) and recruitment (bottom panel) under the most likely values of starting Fmult from the Base ASAP model and the 1989 ASAP model.

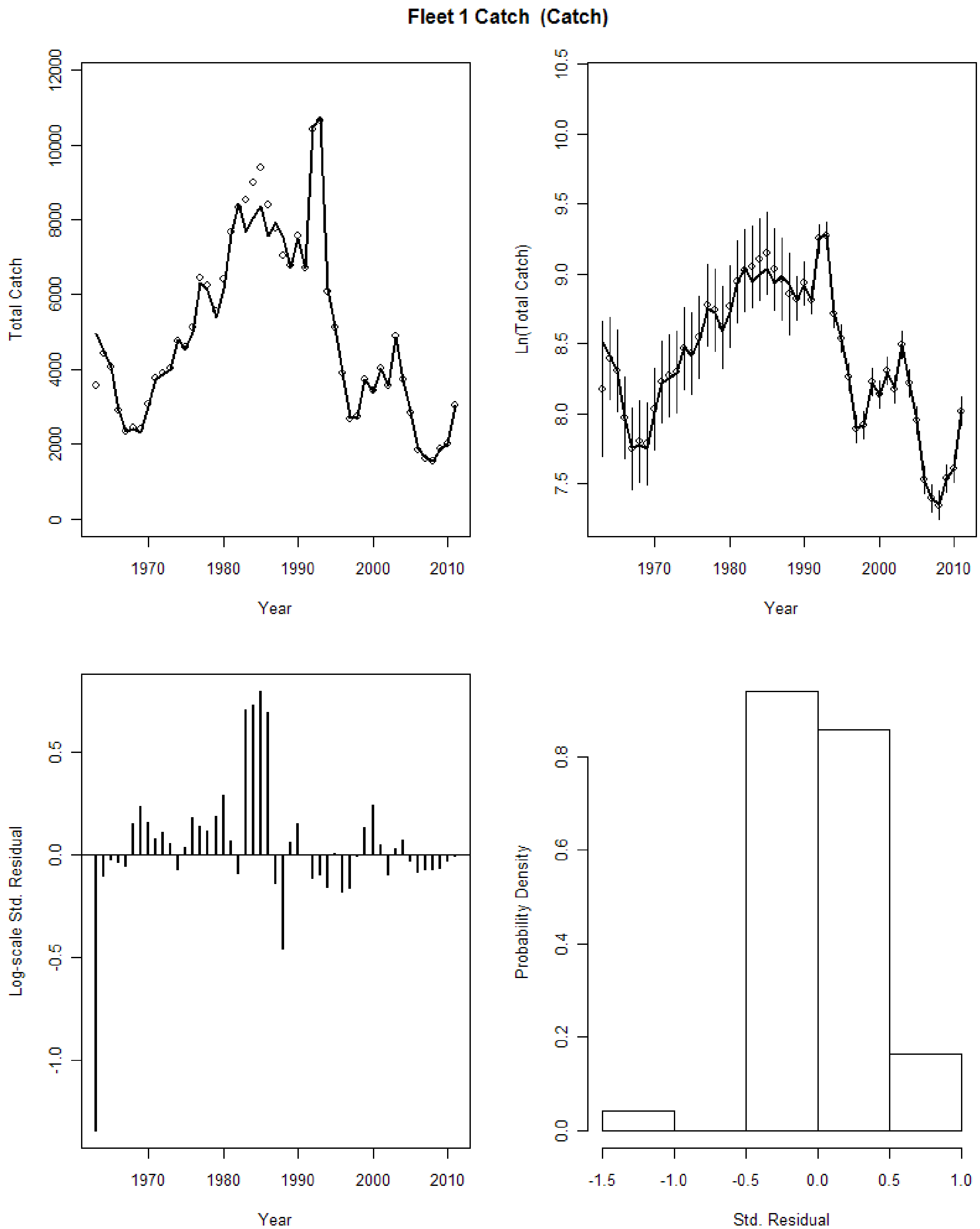


Figure B132. Fits to the catch data from the Base ASAP model.

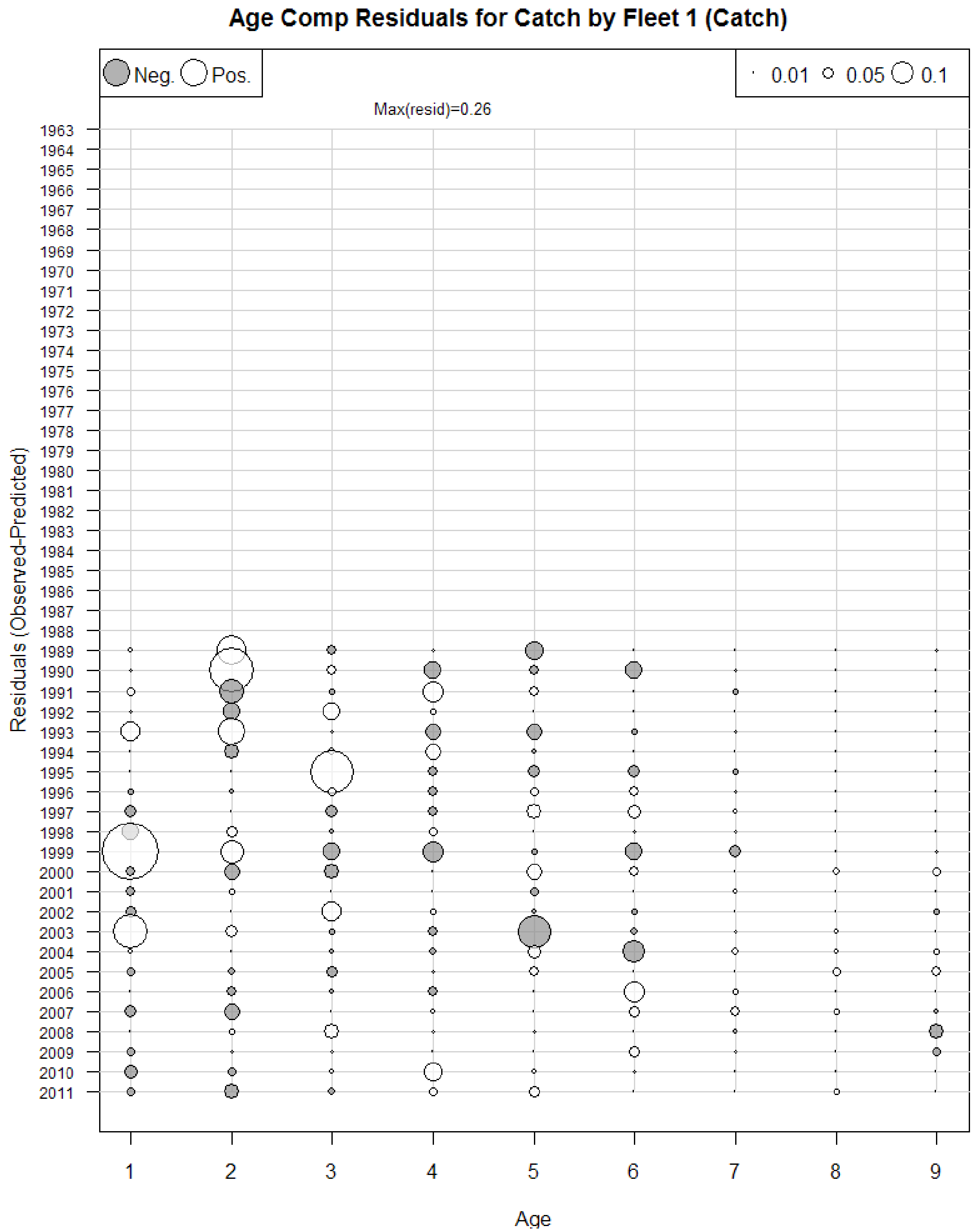


Figure B133. Age composition residuals from the commercial catch from the Base Model.

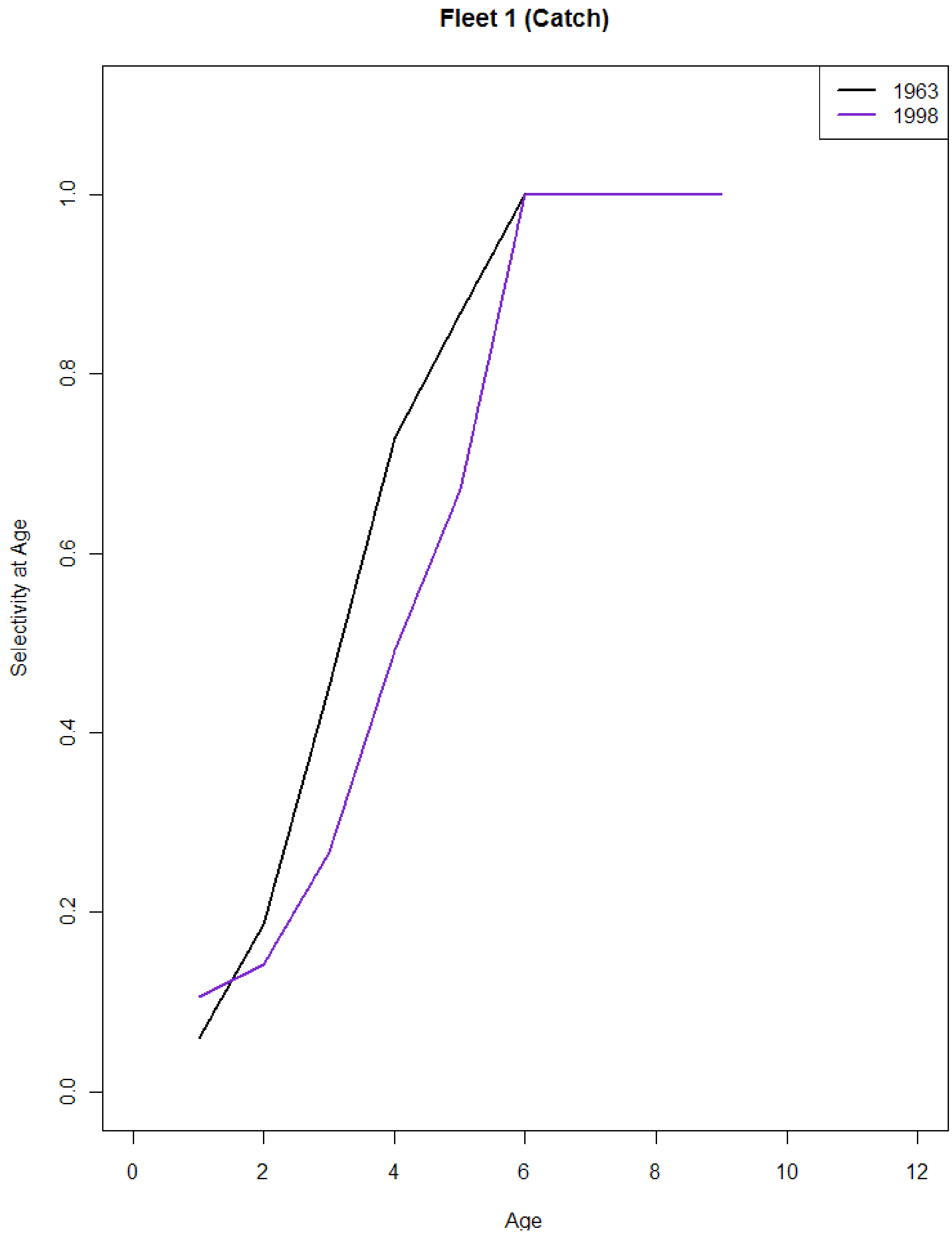


Figure B134. Selectivity patterns from the commercial fishery in tow time periods.

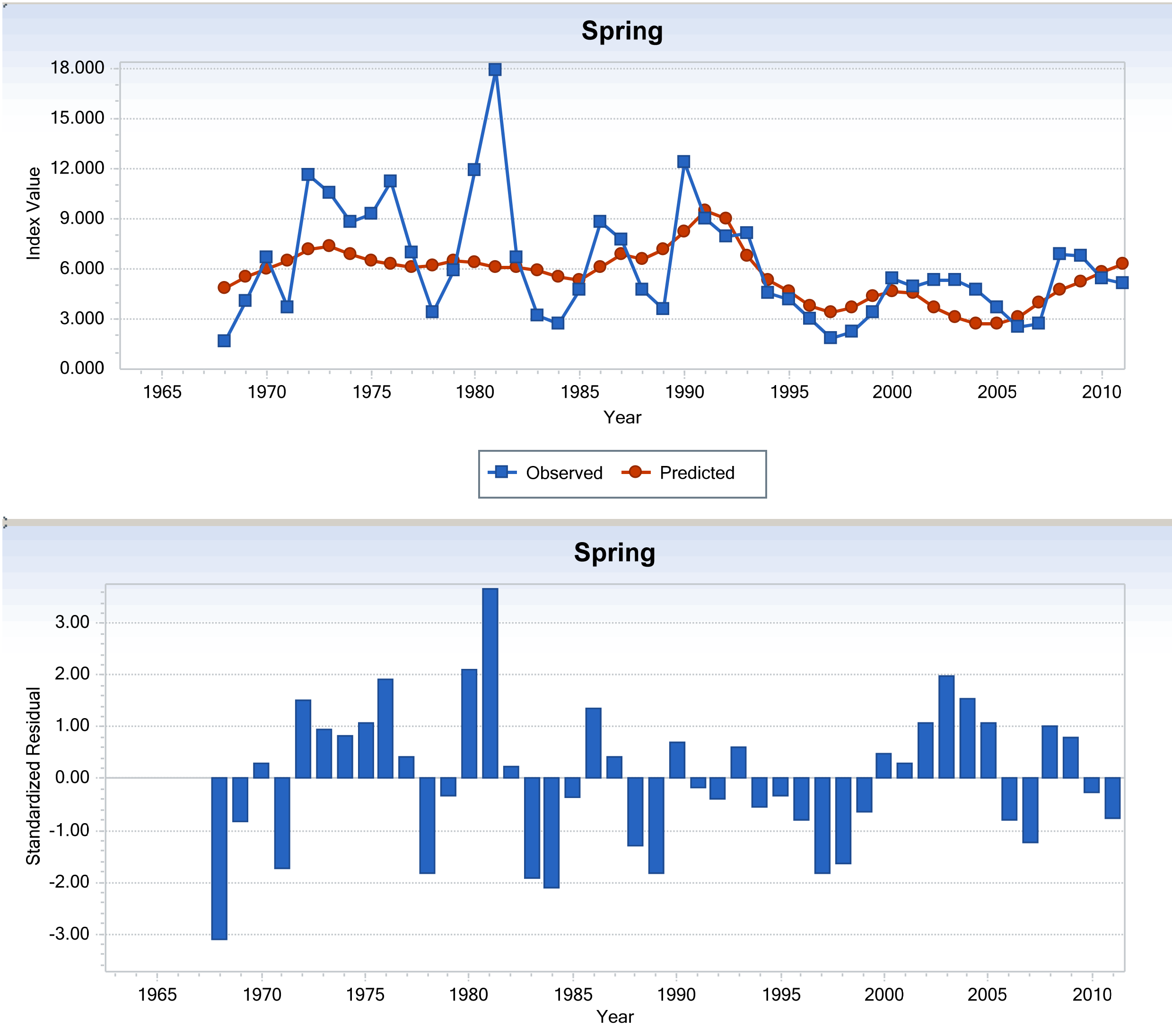


Figure B135. Residuals from the NEFSC spring survey from the Base Model.

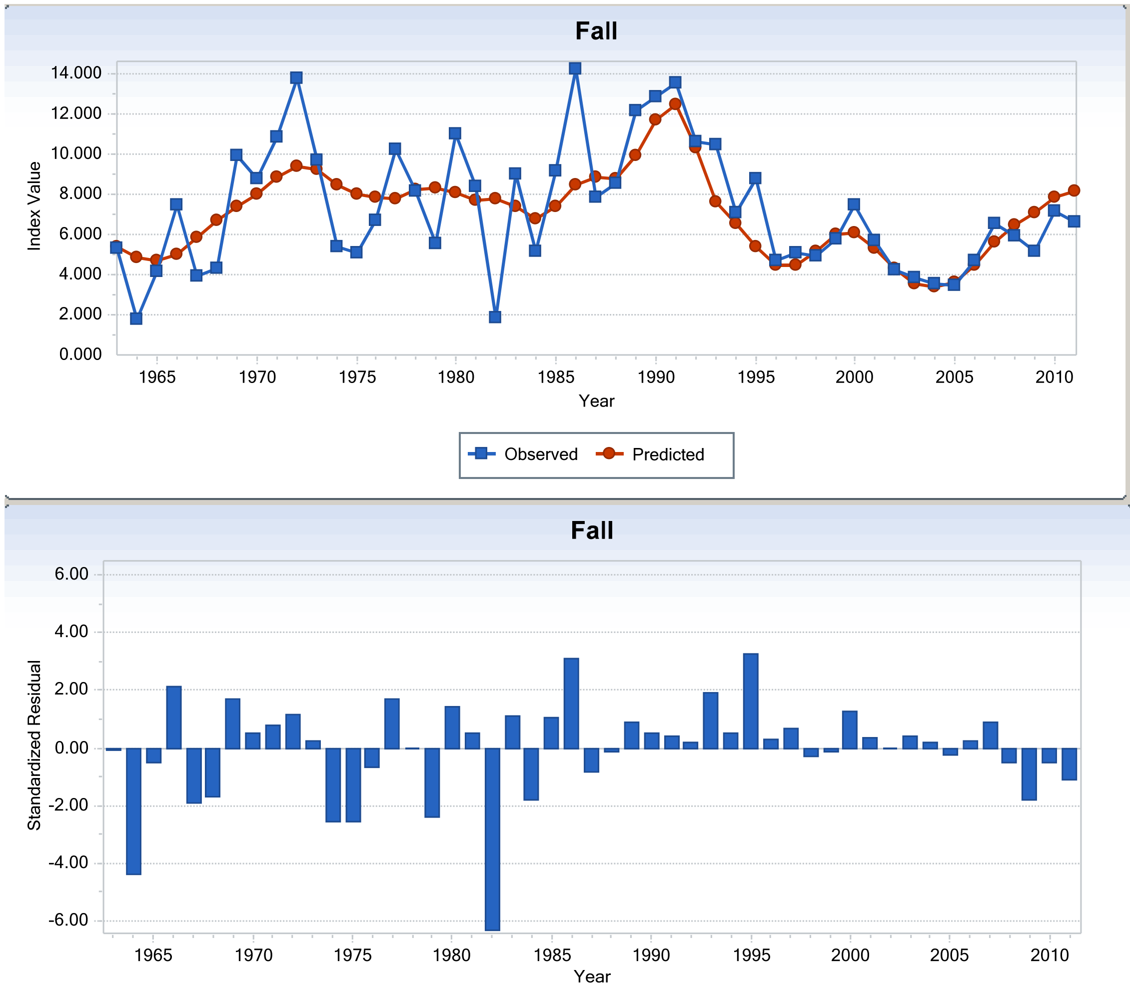


Figure B136. Residuals from the NEFSC autumn survey from the Base Model.

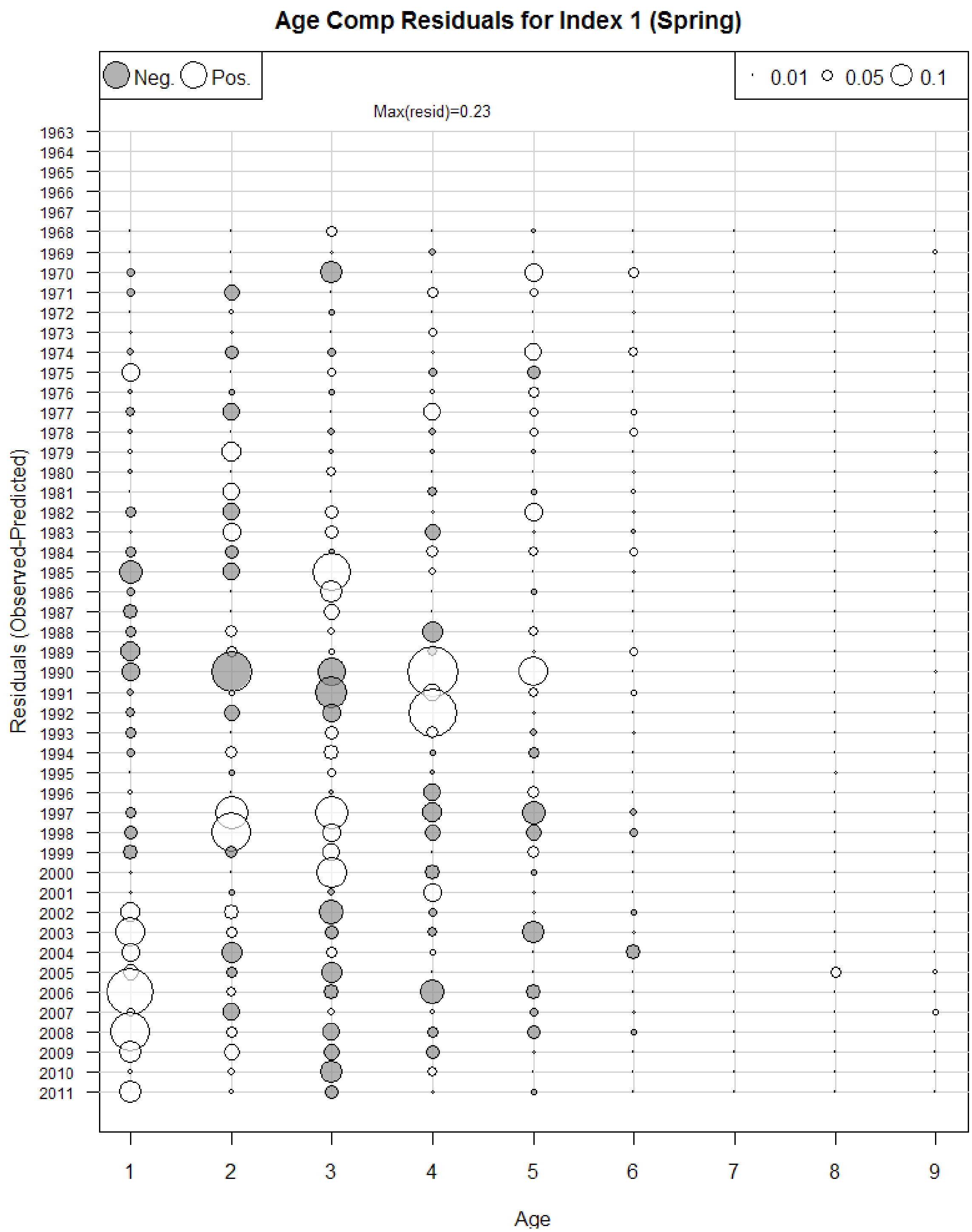


Figure B137. Age composition residuals from the NEFSC spring survey from the Base Model.

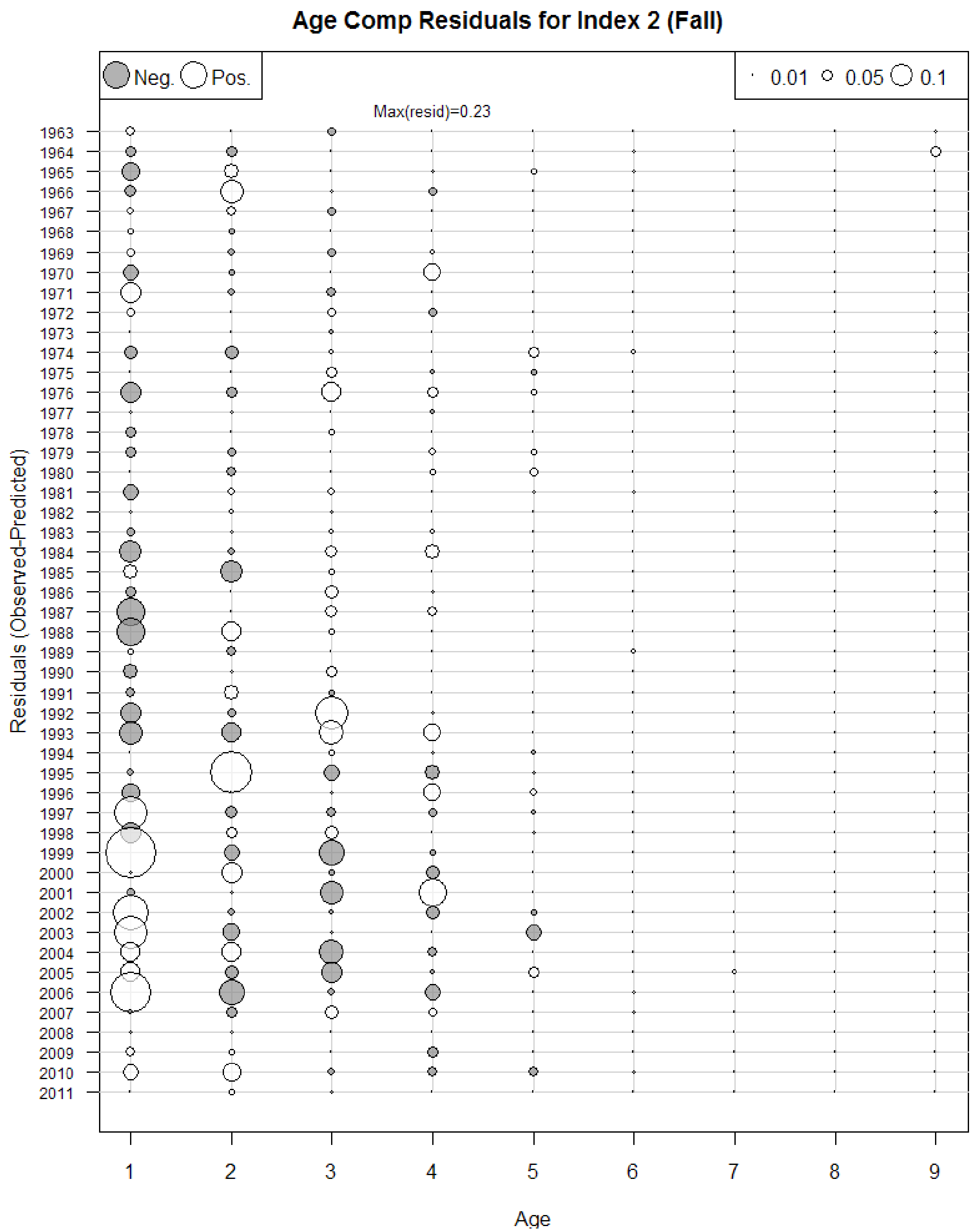


Figure B138. Age composition residuals from the NEFSC autumn survey from the Base Model.

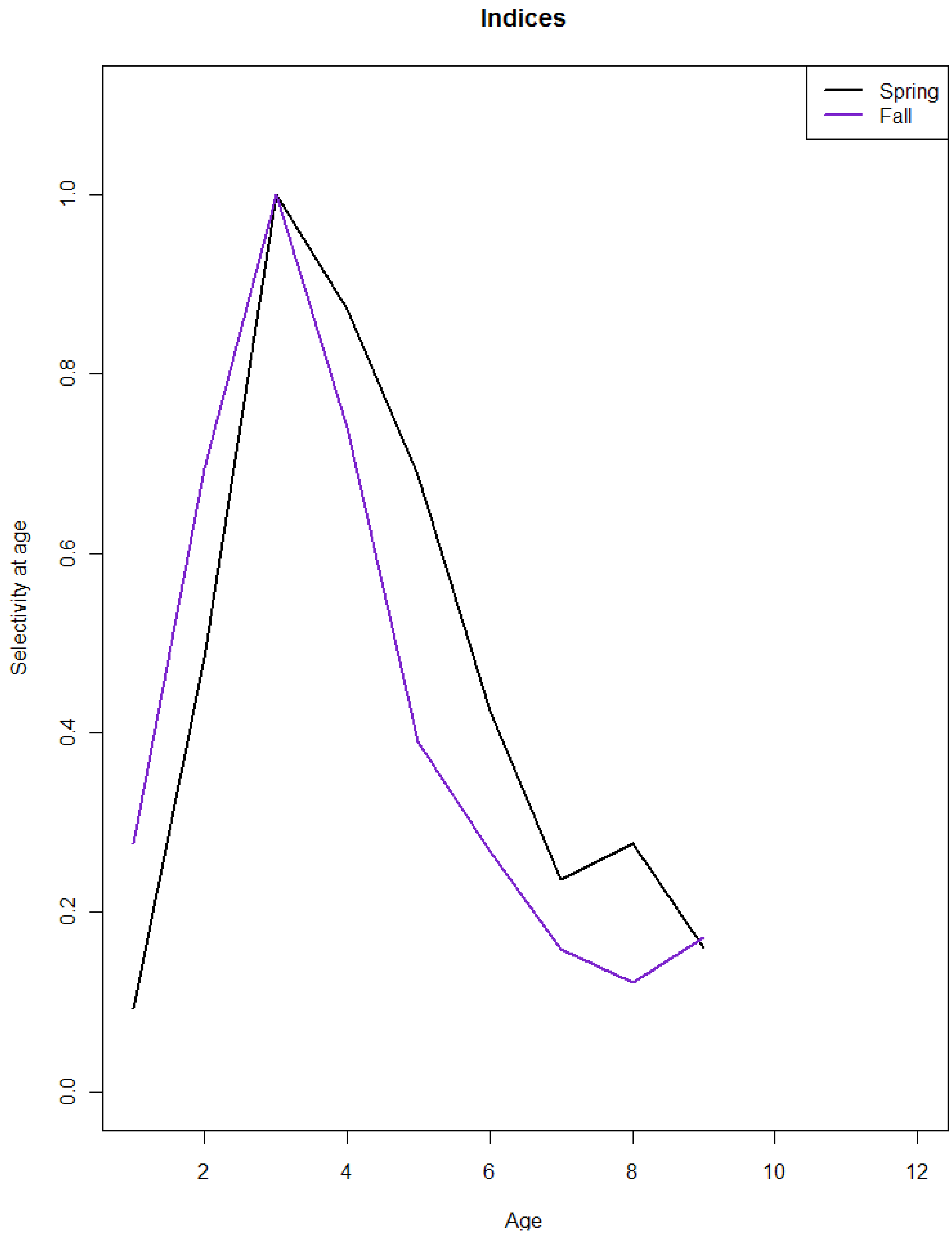


Figure B139. Selectivity for the NEFSC spring and autumn surveys estimated from the Base ASAP model.

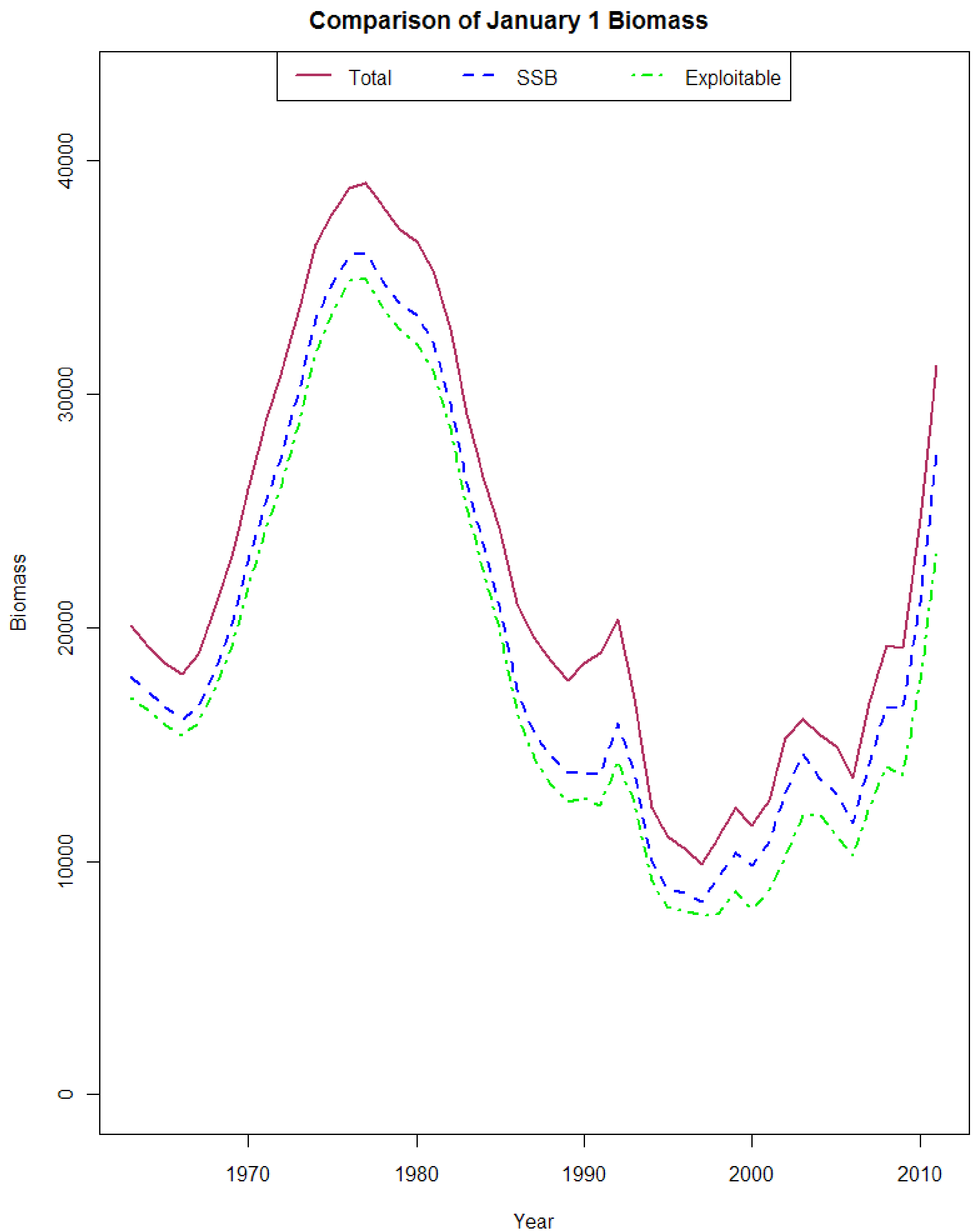


Figure B140. Estimates of January1-Biomass and Spawning Stock Biomass from the Base ASAP model.

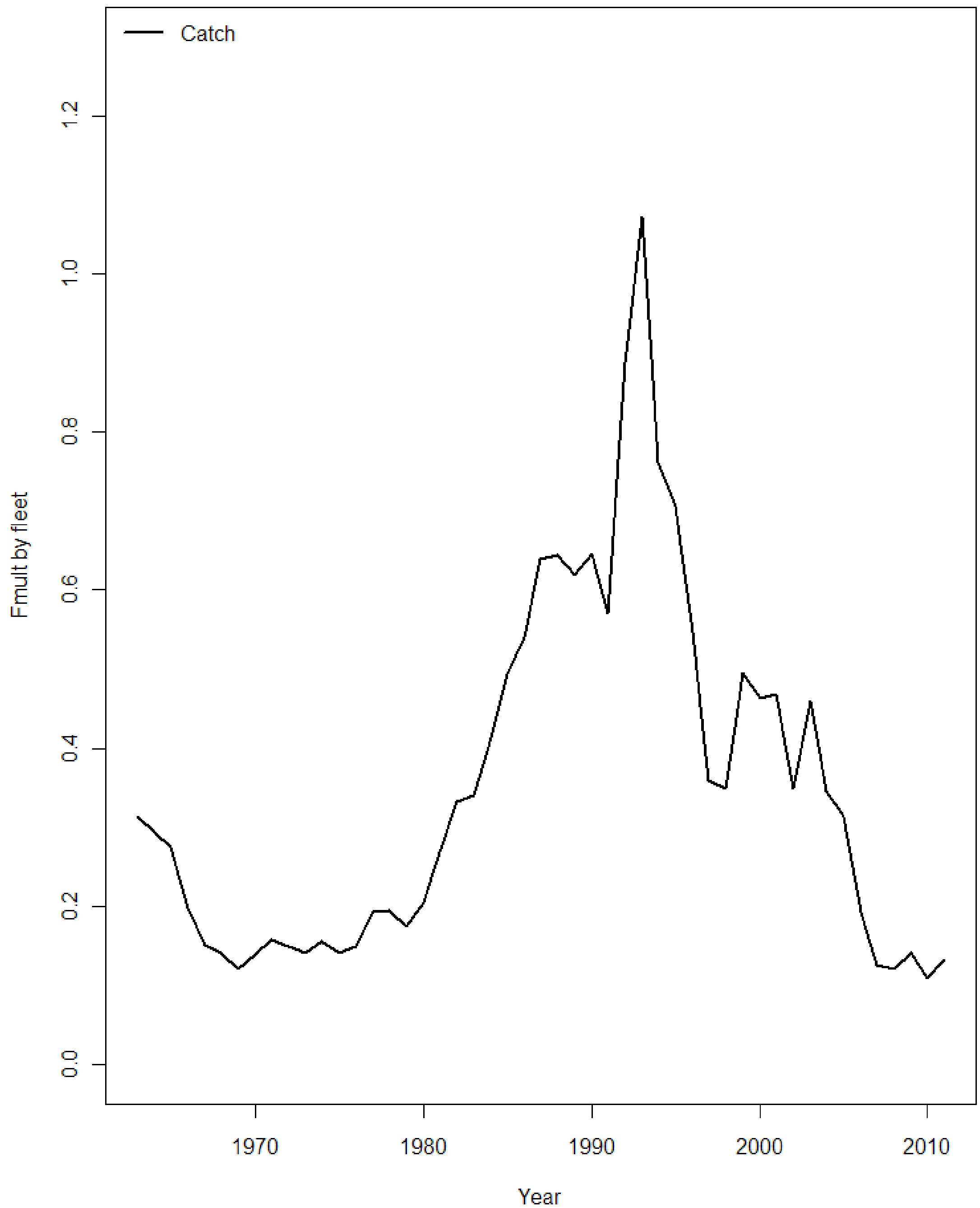


Figure B141. Estimates of fishing mortality from the Base ASAP model.

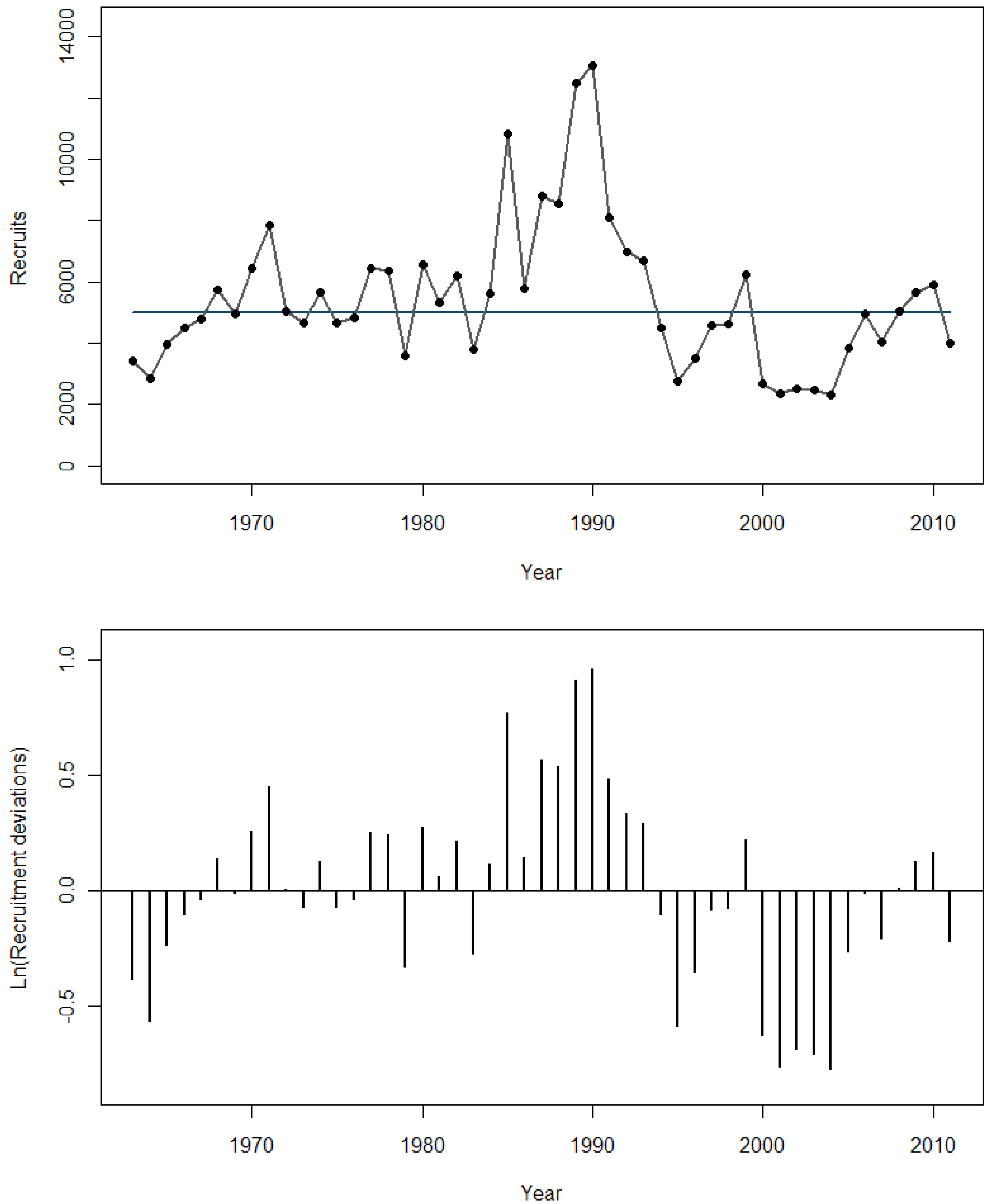


Figure B142. Estimates of recruitment (top panel) and deviations from the geometric mean (bottom panel) from the base ASAP model.

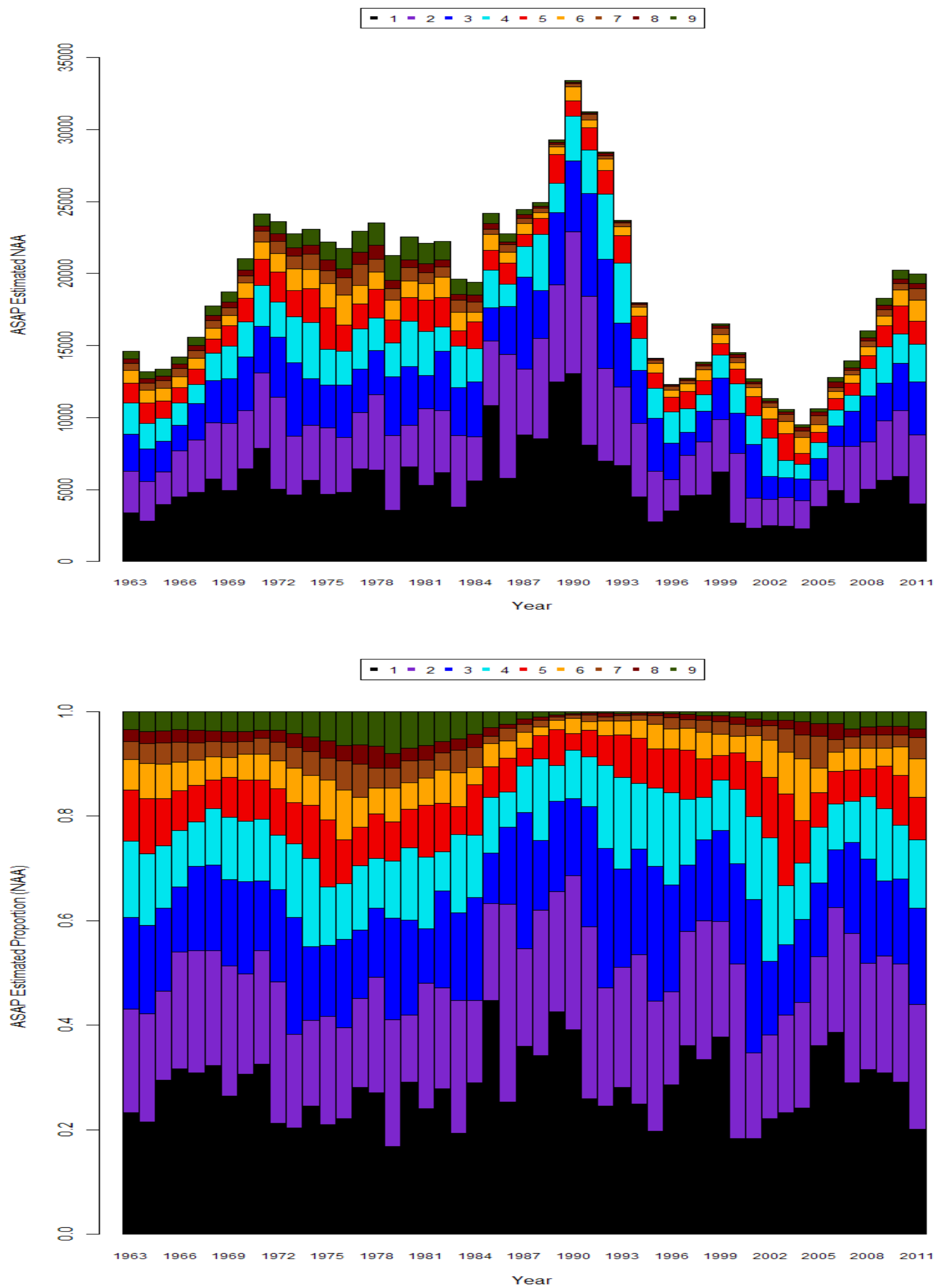


Figure B143. Numbers at age (000s, top panel) and proportion (bottom panel) from the Base ASAP model.

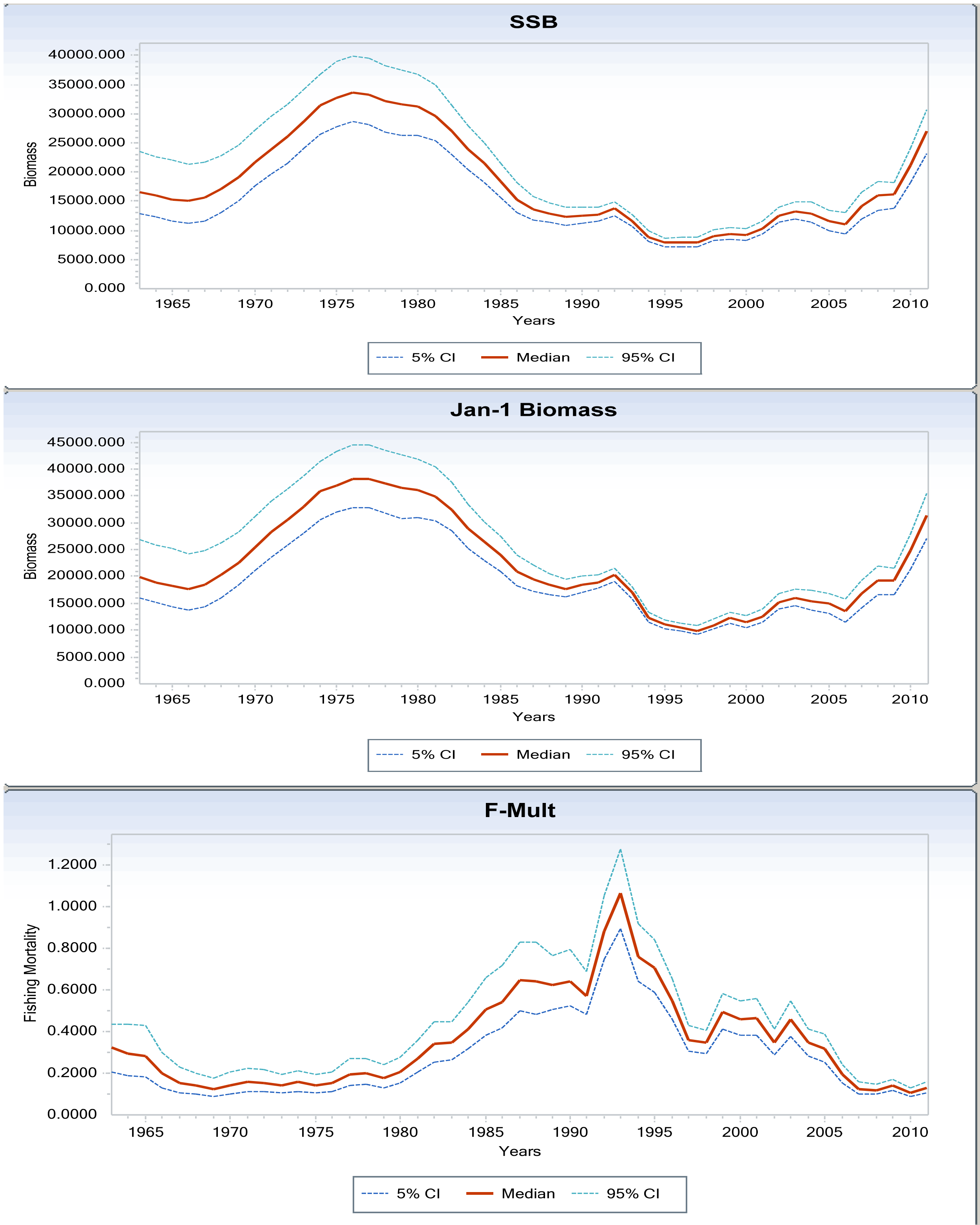
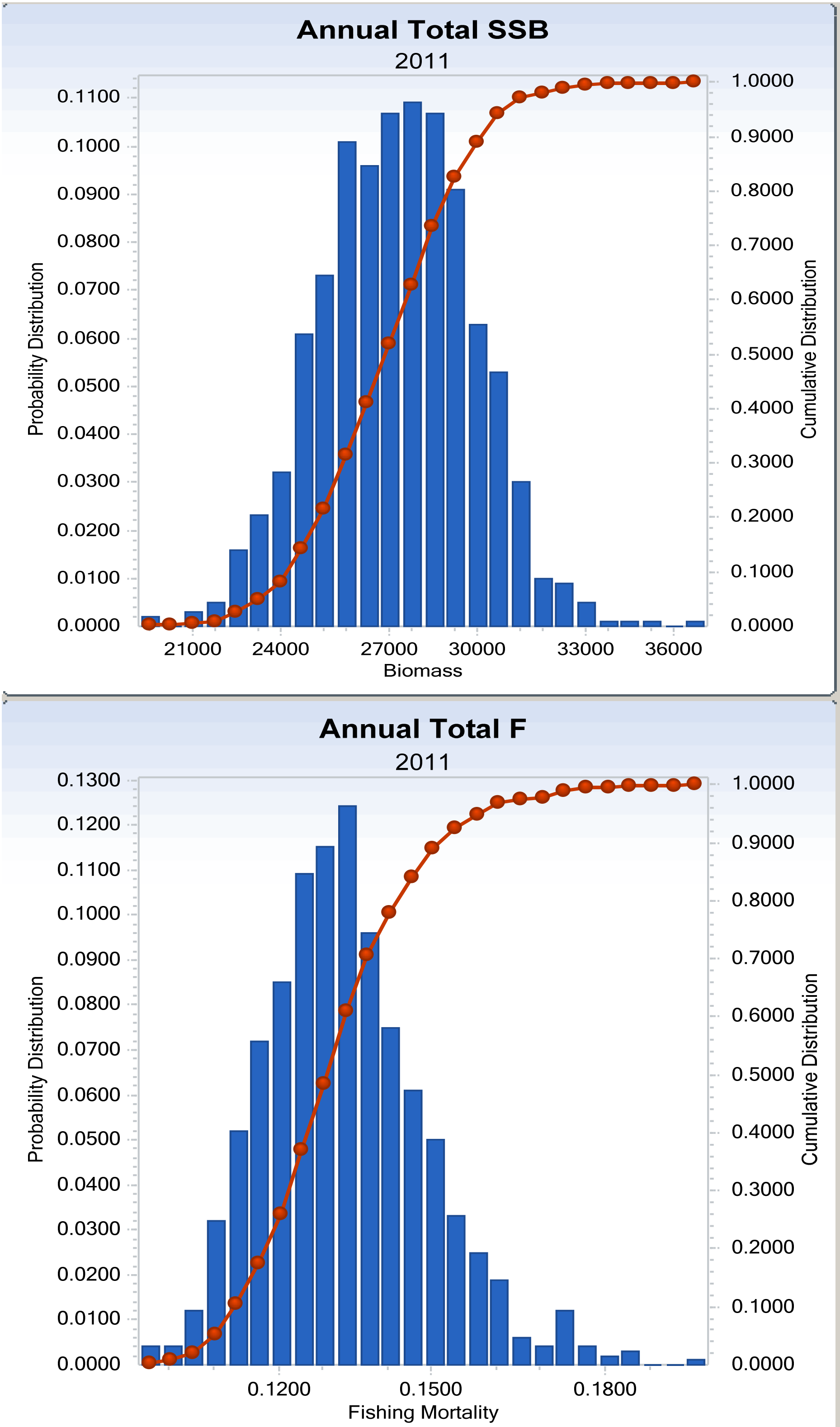


Figure B144. A 90% probability interval for white hake SSB (top panel), January 1 Biomaa (middle panel) and fishing mortality (bottom panel) fromthe Base ASAP model. The median value is in red, while the 5th and 95th percentiles are in light blue.



Annual Total SSB
2011
Probability Distribution
Cumulative Distribution
0.1100
0.1000
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
1.0000
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
21000
24000
27000
30000
33000
36000
Biomass
Annual Total F
2011
Probability Distribution
Cumulative Distribution
0.1300
0.1200
0.1100
0.1000
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
1.0000
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
0.1200
0.1500
0.1800
Fishing Mortality

Figure B145.

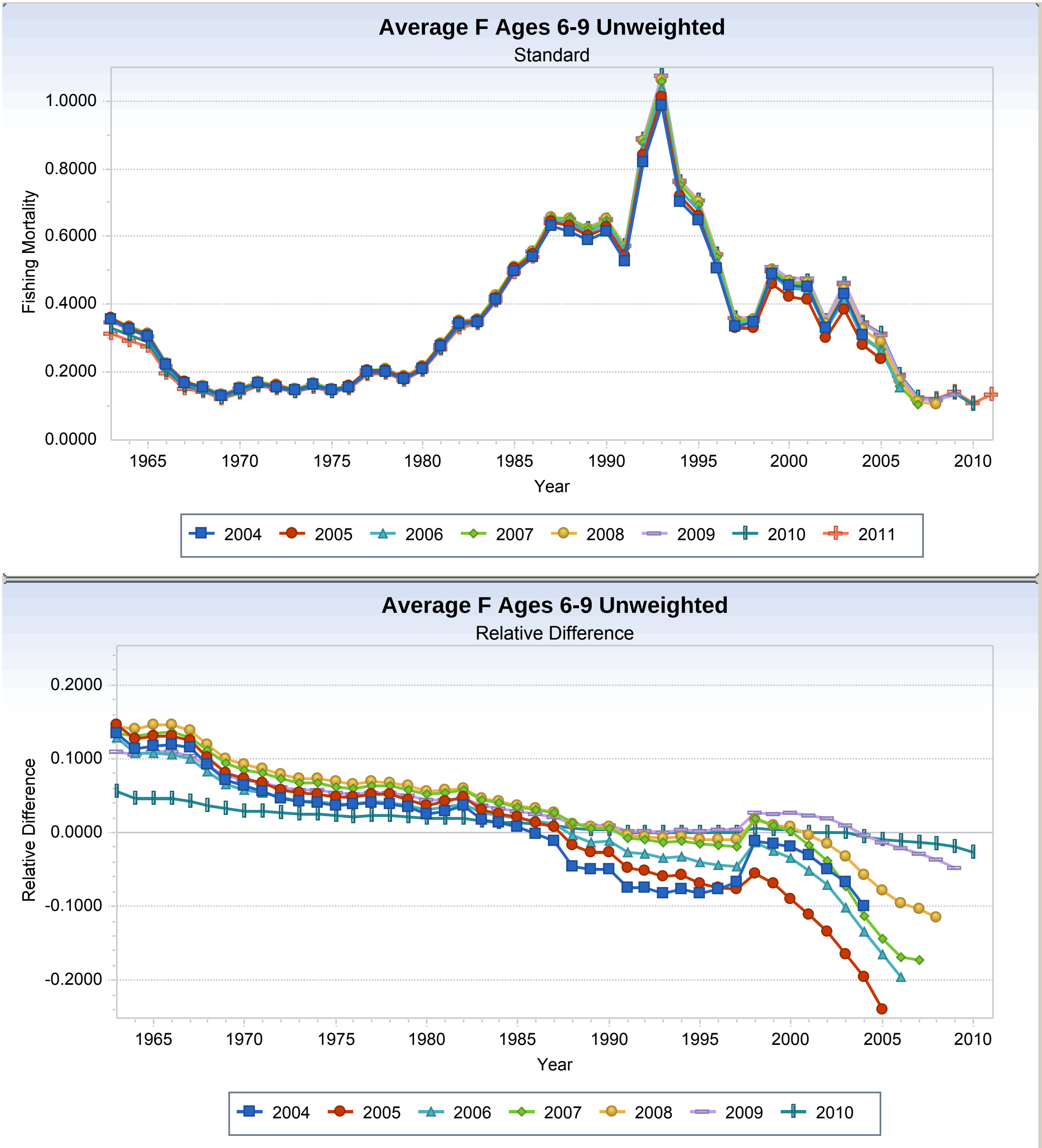


Figure B146. Retrospective plots for fishing mortality from the Base ASAP model.

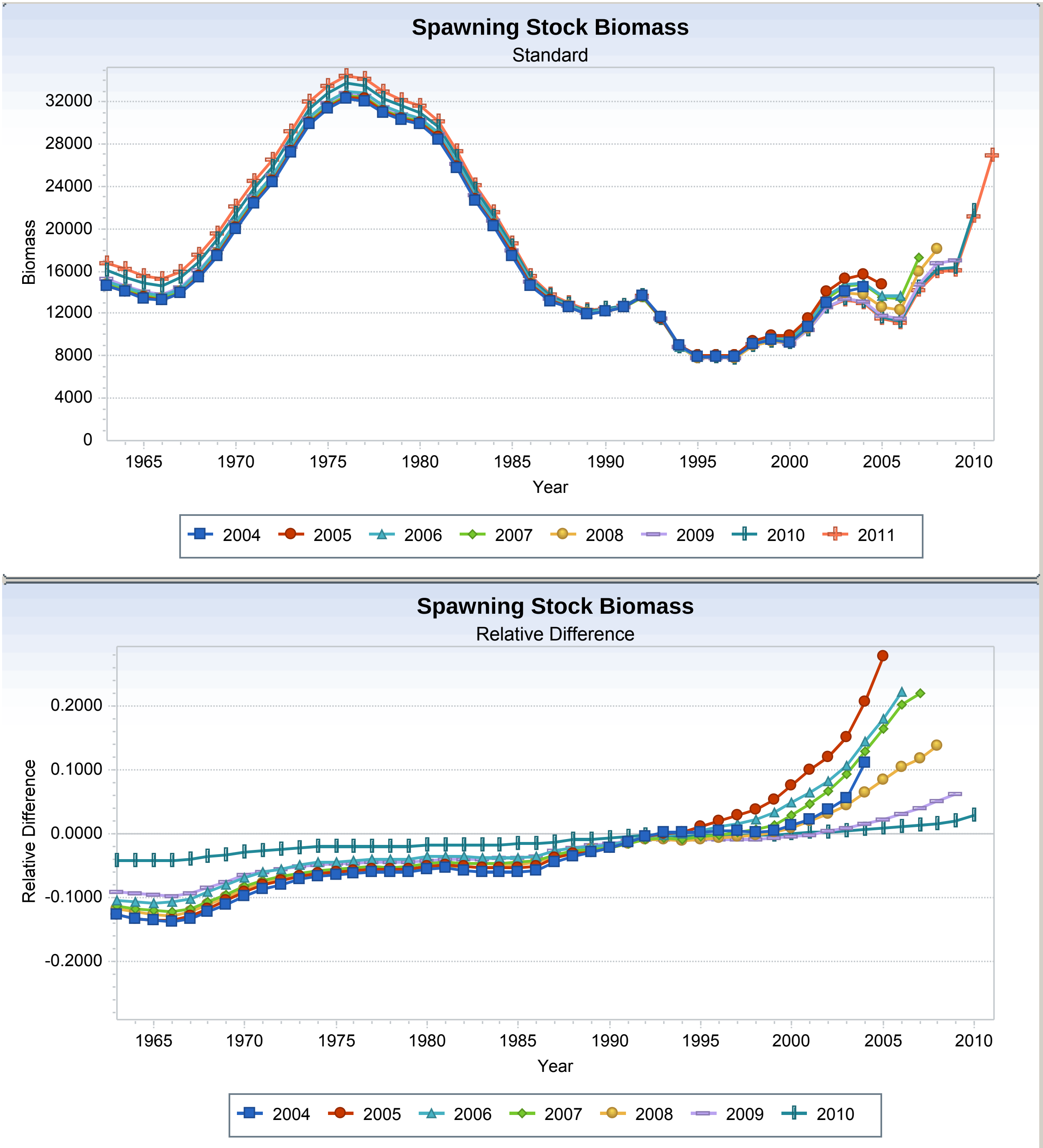


Figure B147. Retrospective plots for spawning stock biomass from the Base ASAP model.

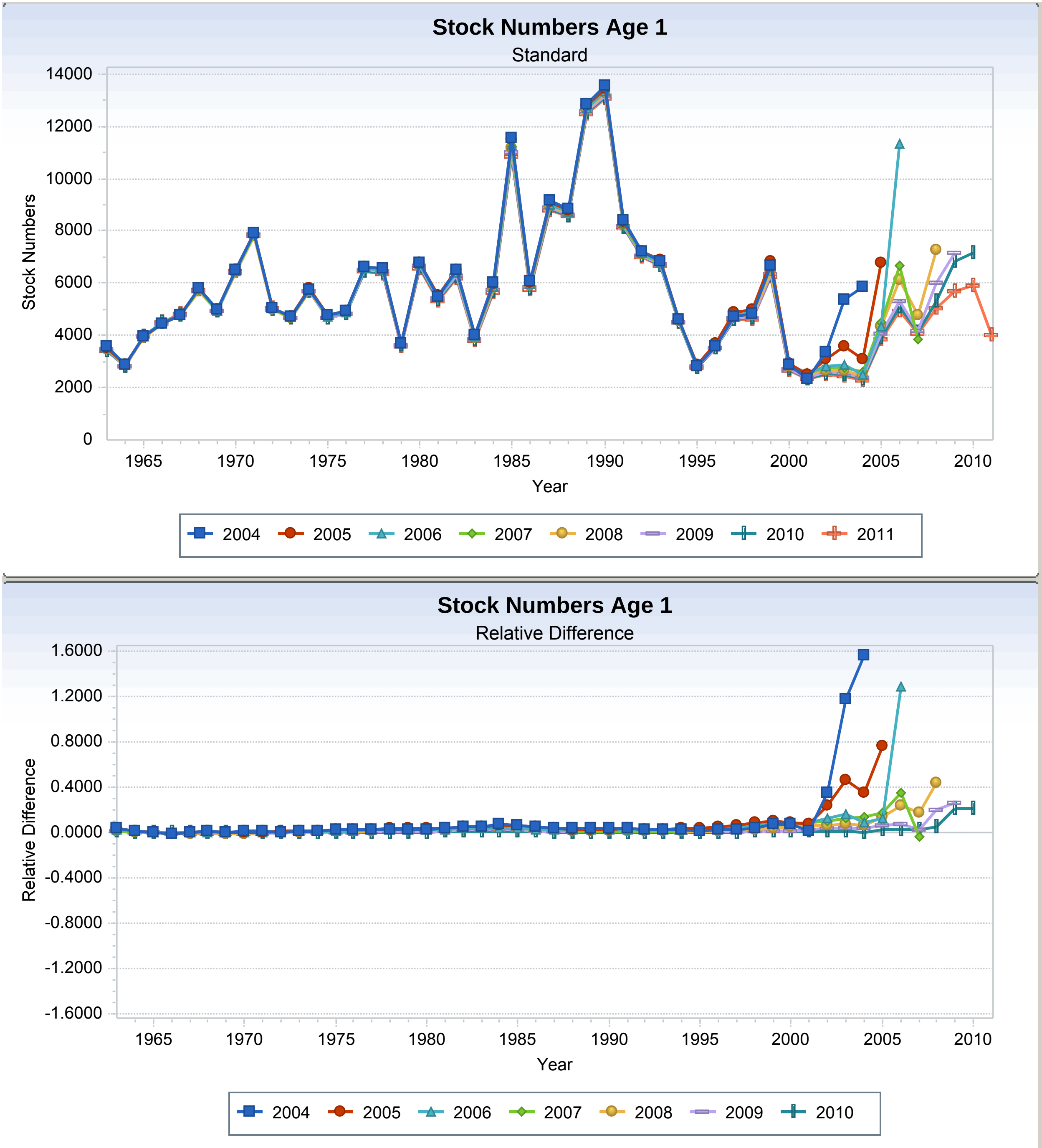


Figure B148. Retrospective plots for recruitment from the Base ASAP model.

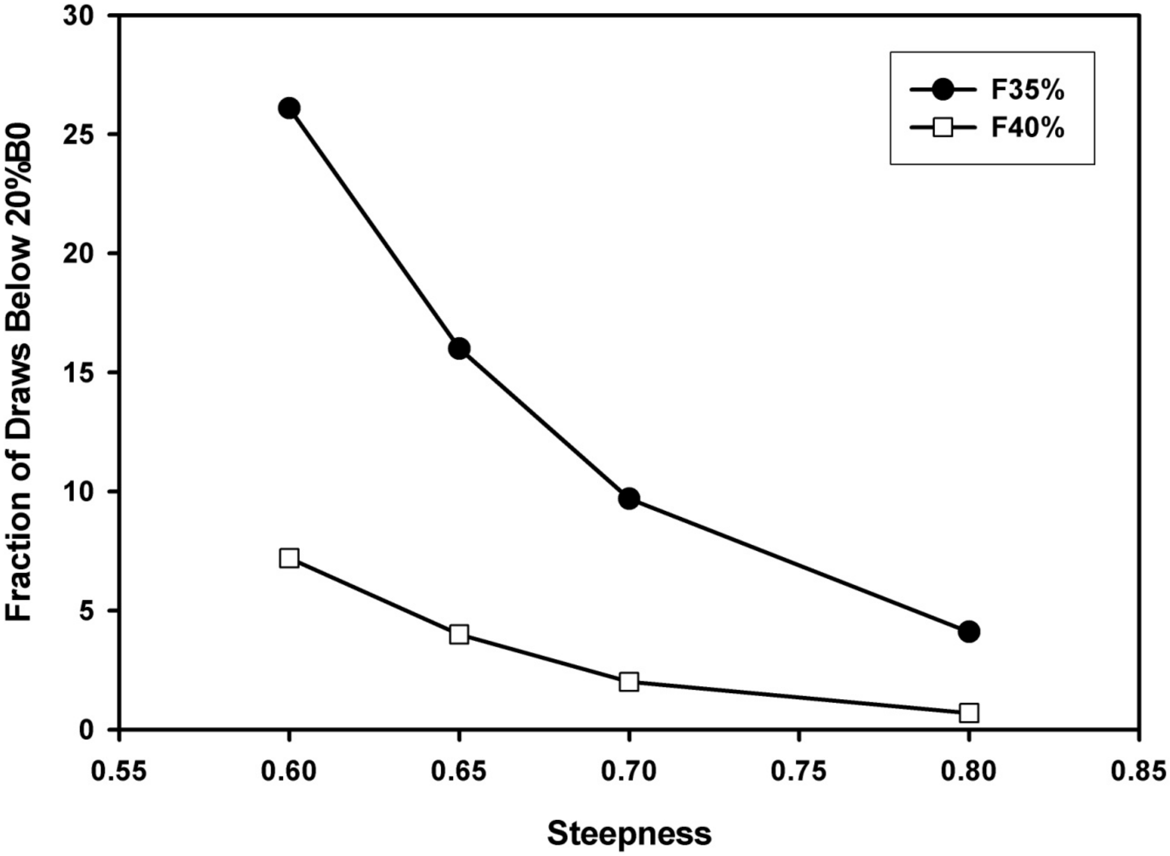


Figure B149. Analysis of the probability of falling below twenty percent Bzero using long-term projections under different recruitment assumptions.

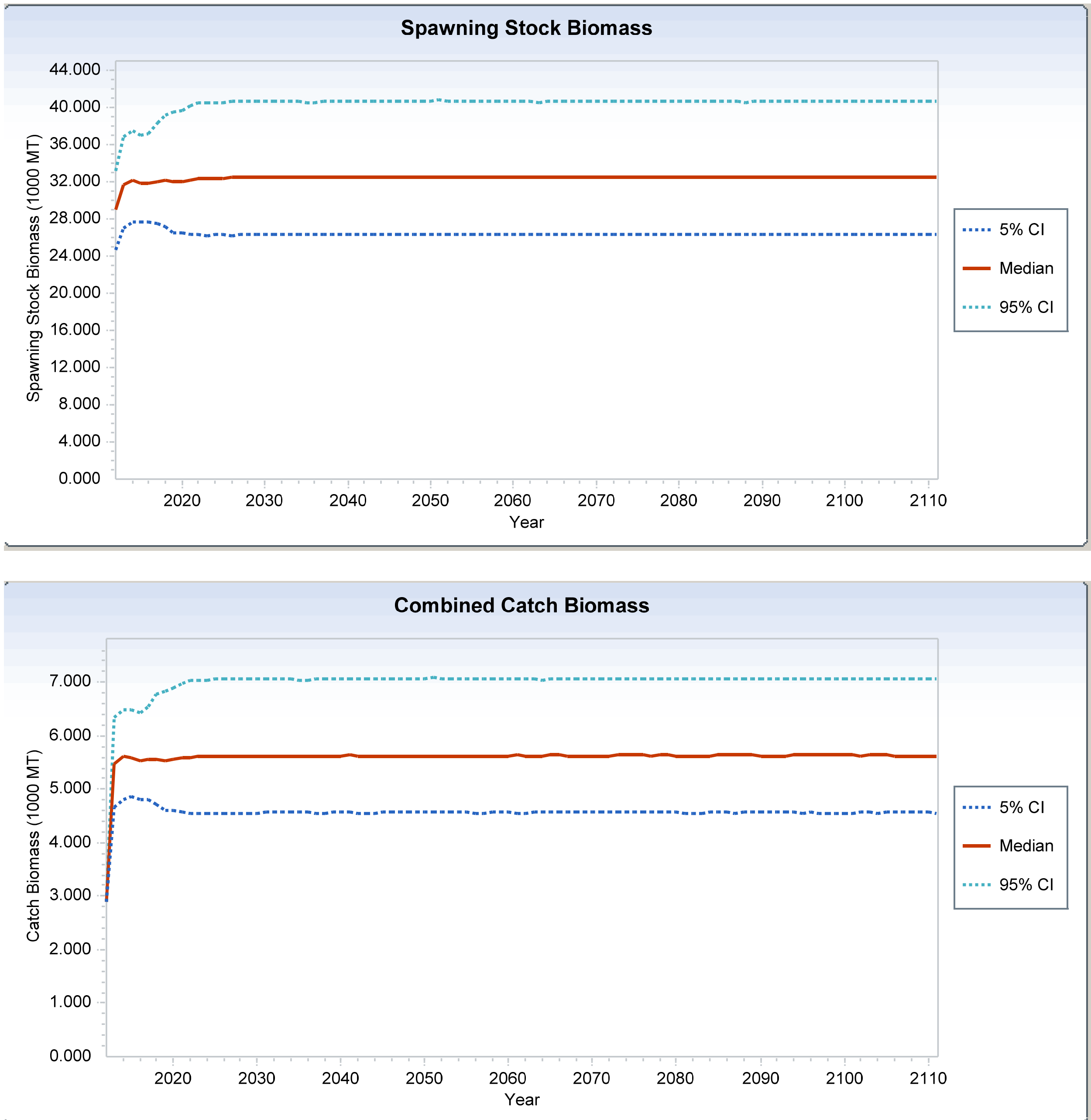


Figure B150. SSBmsy and MSY estimates from long-term projections under Fmsyproxy of 0.2.

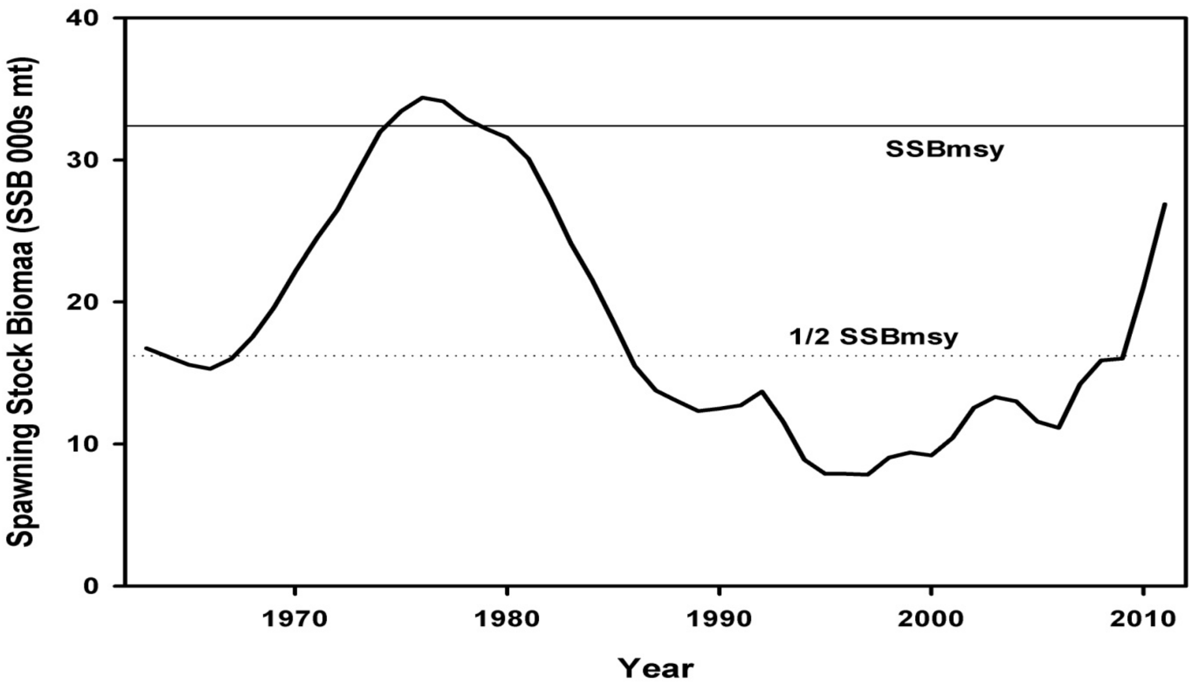


Figure B151. Estimated trends in the spawning stock biomass of Gulf of Maine-Georges Bank white hake between 1963 and 2011 and the corresponding SSB_{target} (SSB_{MSY}) and $SSB_{threshold}$ (1/2 SSB_{MSY}) based on the 2013 assessment.

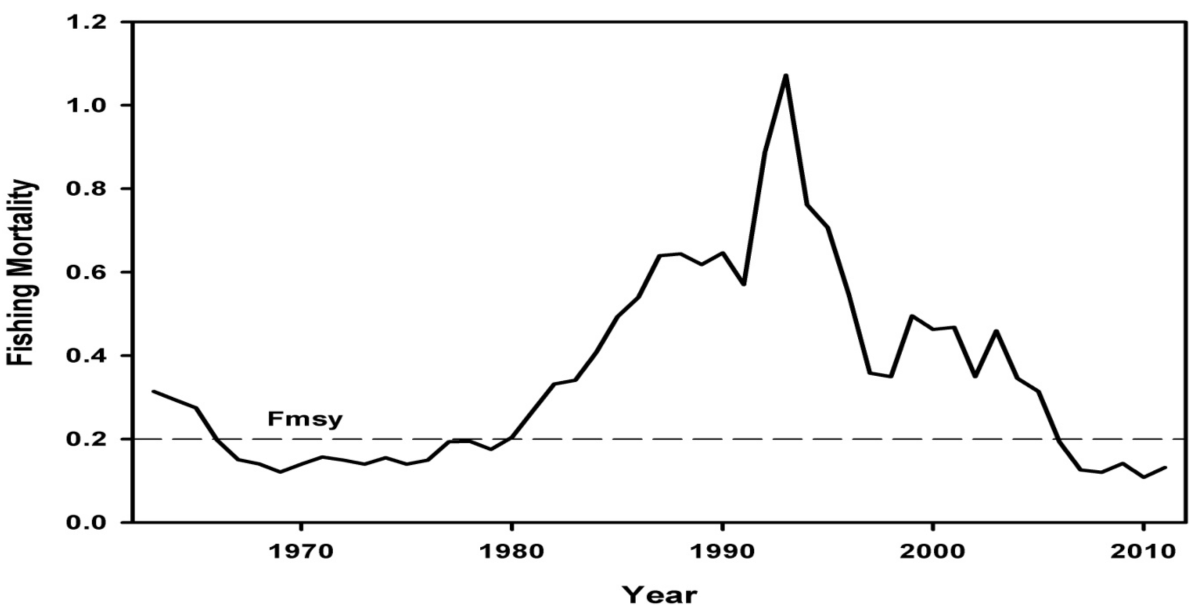


Figure B152. Estimated trends in the fully selected fishing mortality (F_{full}) of Gulf of Maine-George Bank white hake between 1963 and 2011, and the corresponding F_{MSY} based on the 2013 assessment. **Note that the time series includes two selectivity blocks (1963-1997, 1998-2011) and the F_{full} values are not comparable between blocks.*

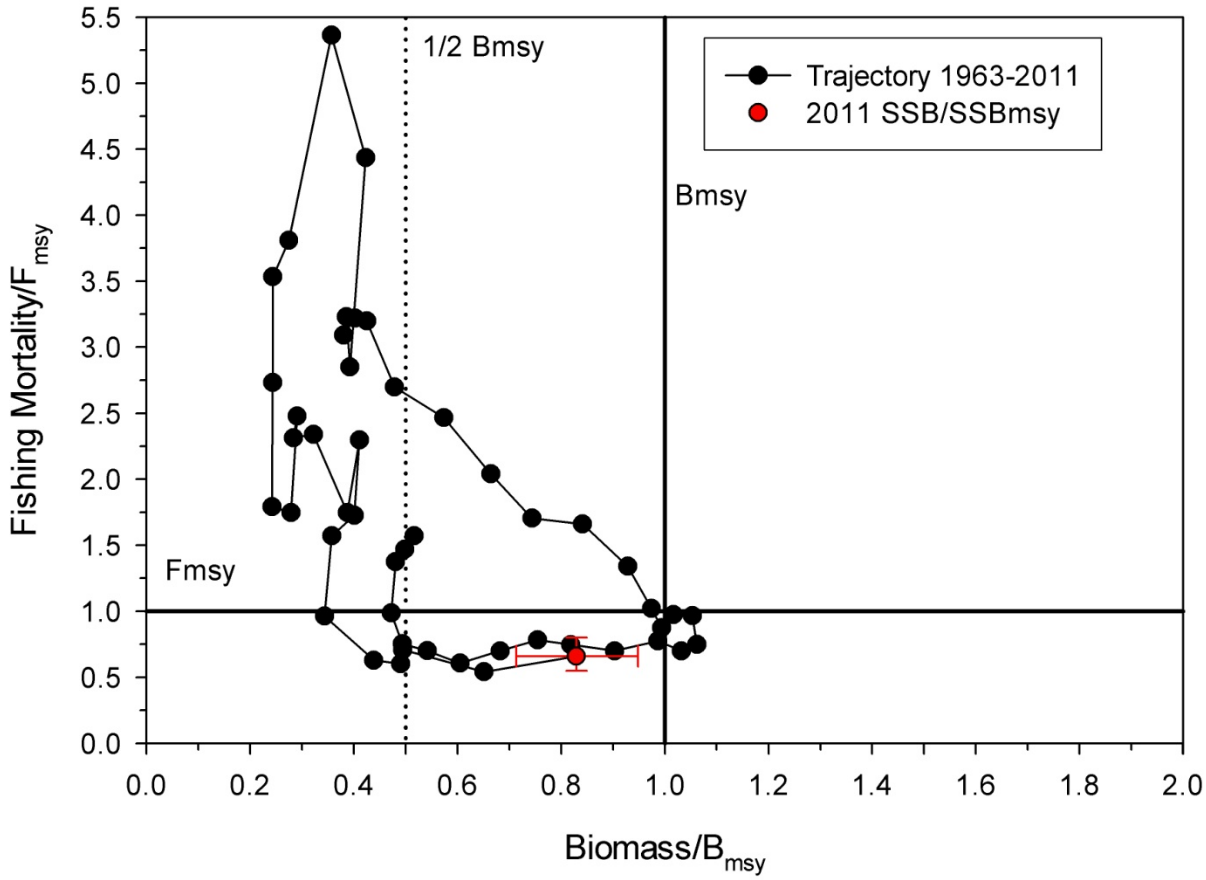


Figure B153. Stock status of Gulf of Maine-Georges Bank white hake for 2011 relative to MSY reference points for spawning stock biomass (SSB) and fishing mortality (FFull); 2011 estimate is the colored dot, error bars represent 90% posterior probability intervals. Gray dotted line is the
1963-2010 time series ratio of SSB to SSBmsy based on 2012 MSY reference points.

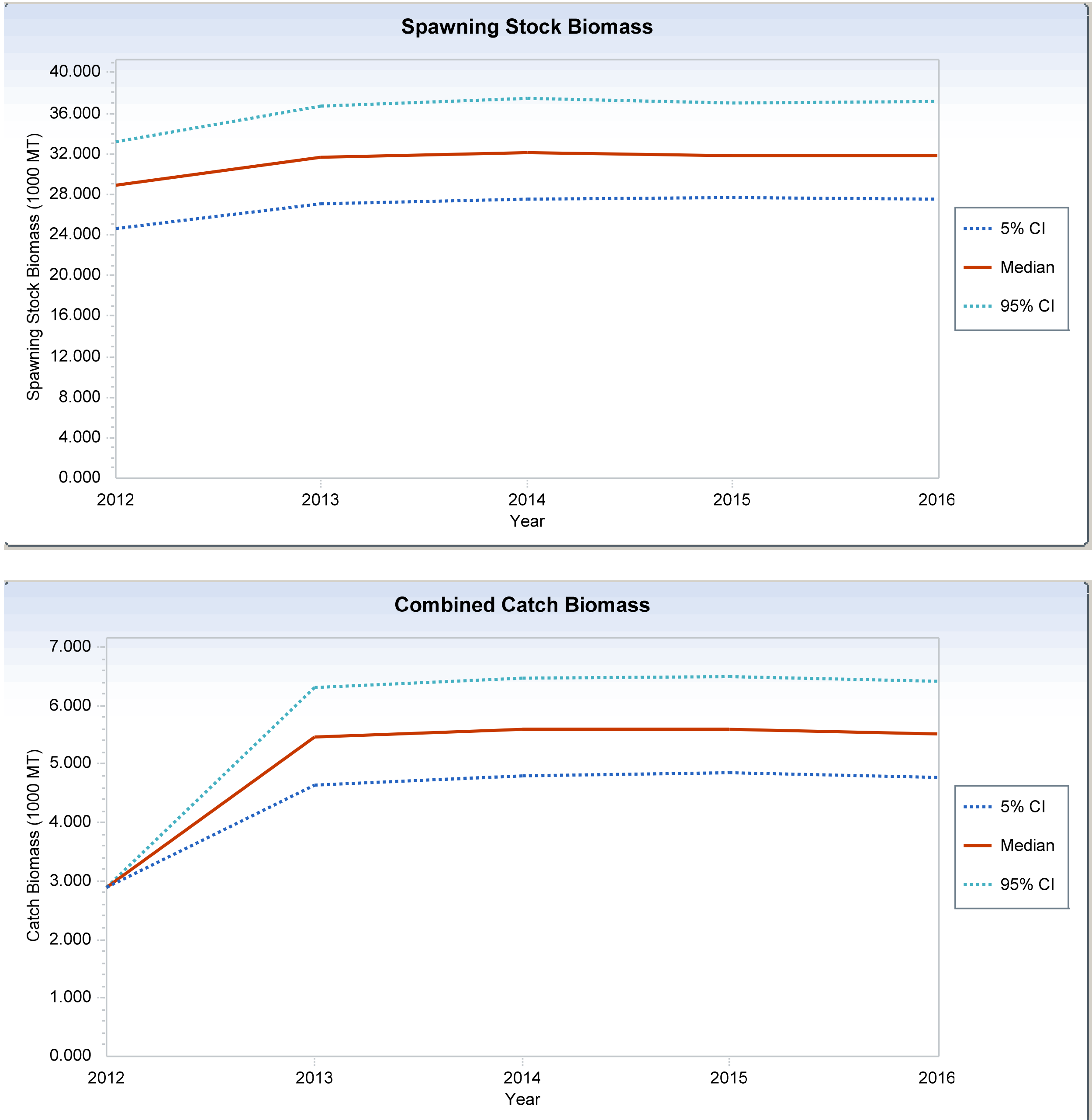
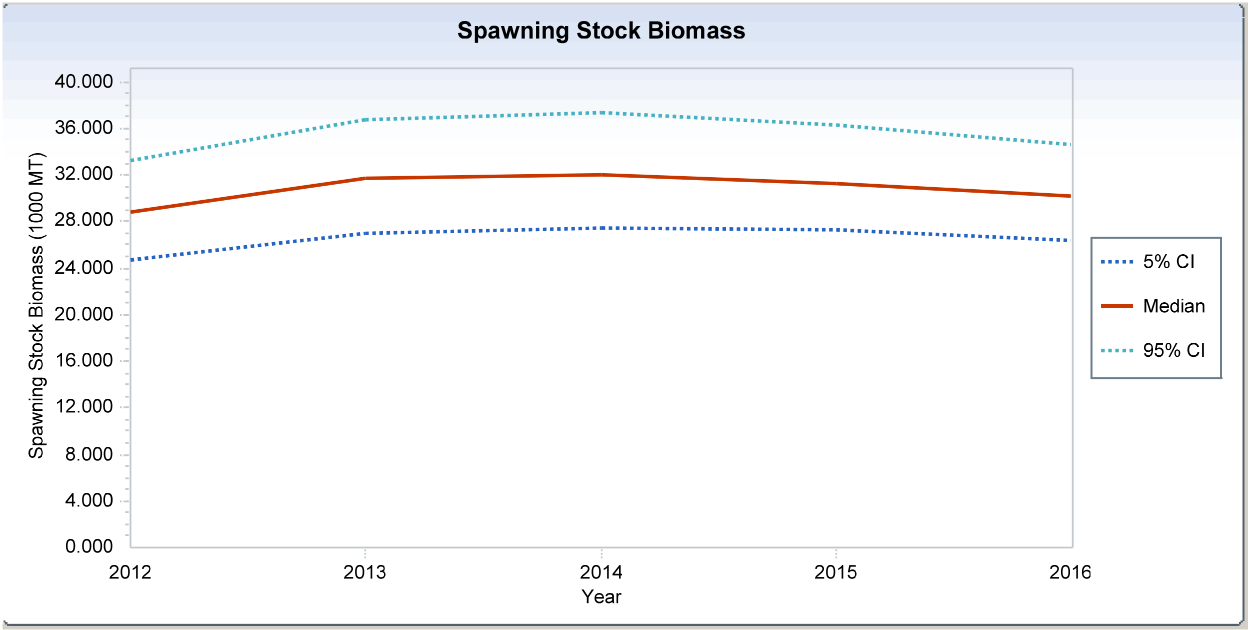


Figure B154. Short-term projections under F40 using the long time series of recruitment values (1963-2009).



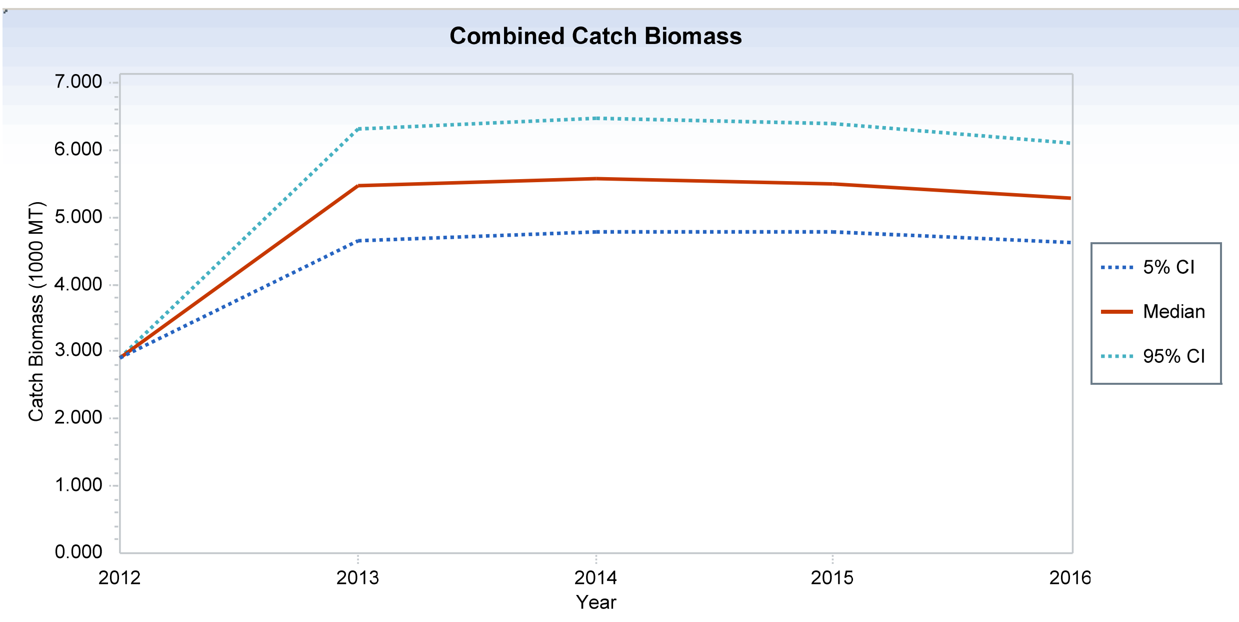


Figure B155. Short-term projections under F40 using the long time series of recruitment values (1963-2009).

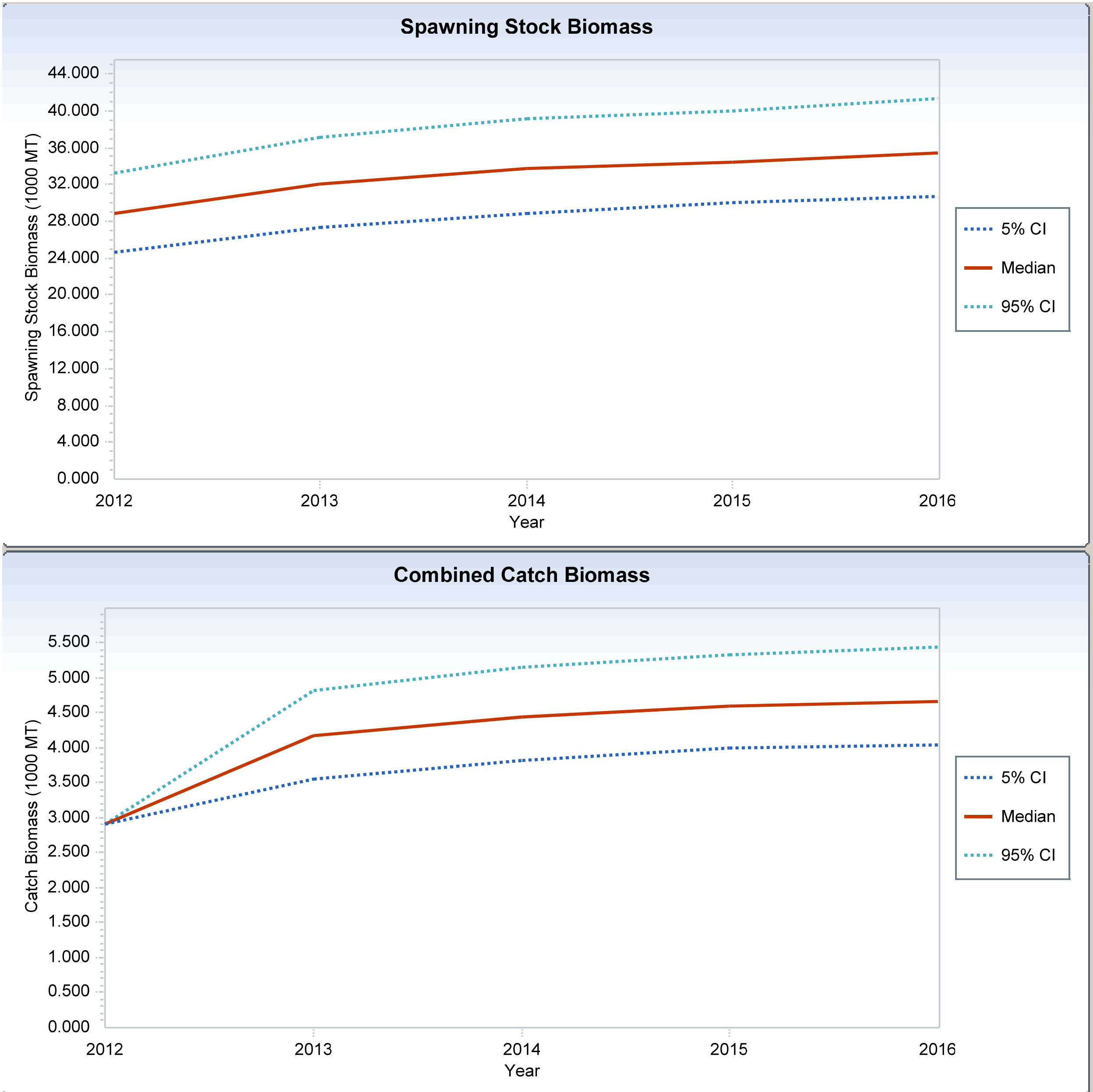
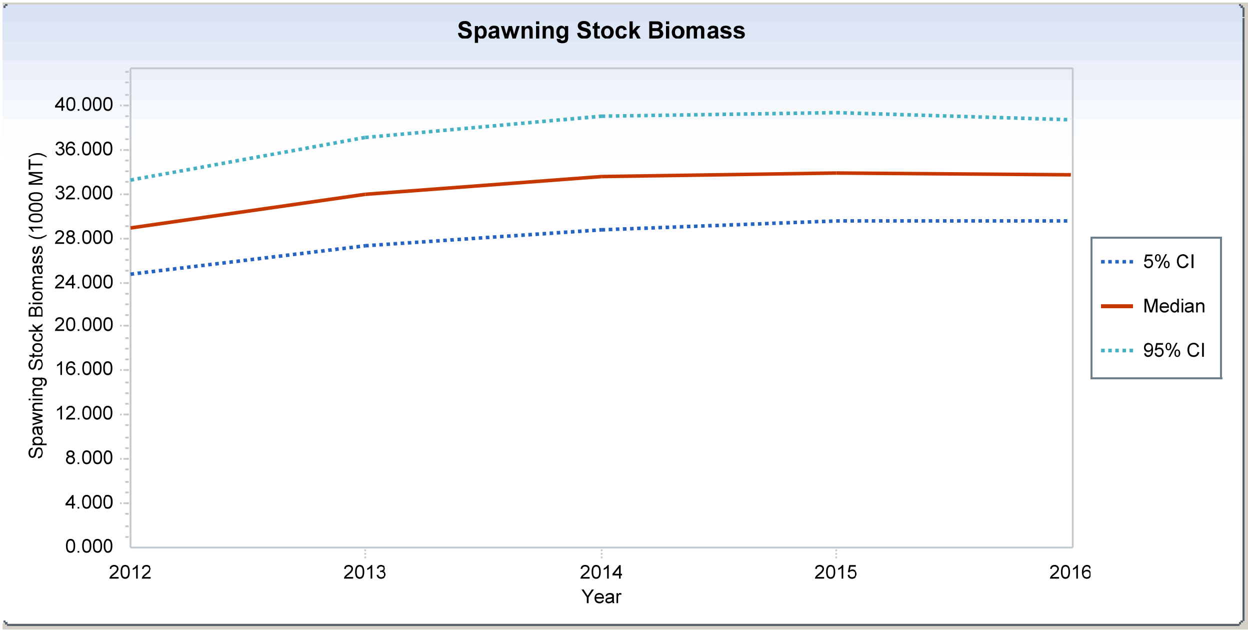


Figure B156. Short-term projections under 75%F40 using the long time series of recruitment values (1963-2009).



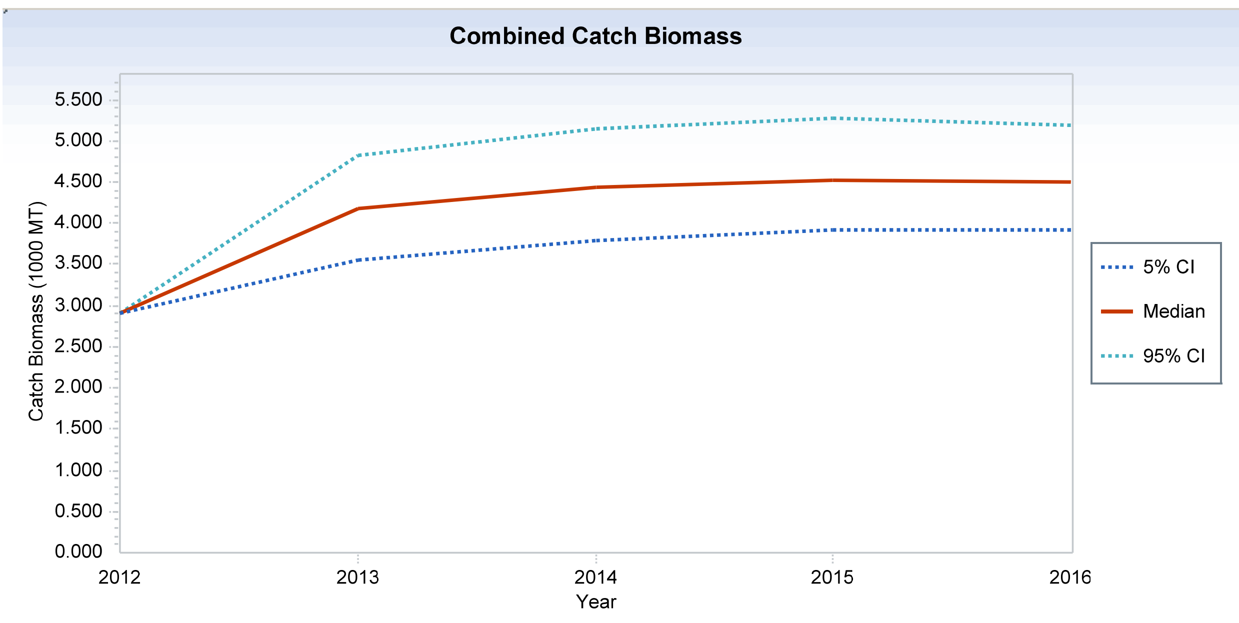


Figure B157. Short-term projections under 75%F40 using the short time series of recruitment values (1995-2009).

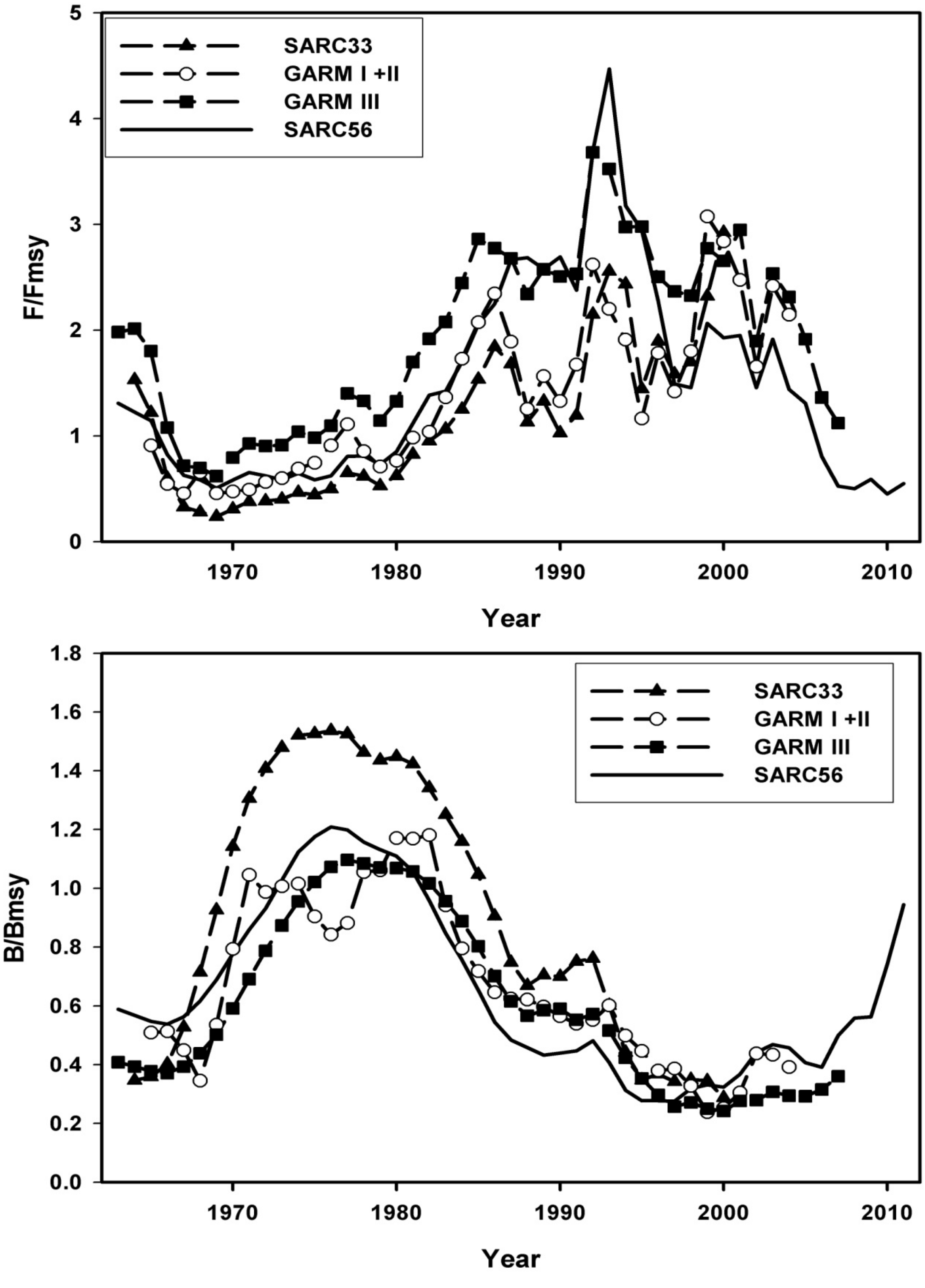


Figure B158. Historical retrospective of F/Fmsy and B/Bmsy from SARC33 (ASPIC model), GARM I and II (AIM), GARM III (ASPM) and SARC 56 (ASAP).

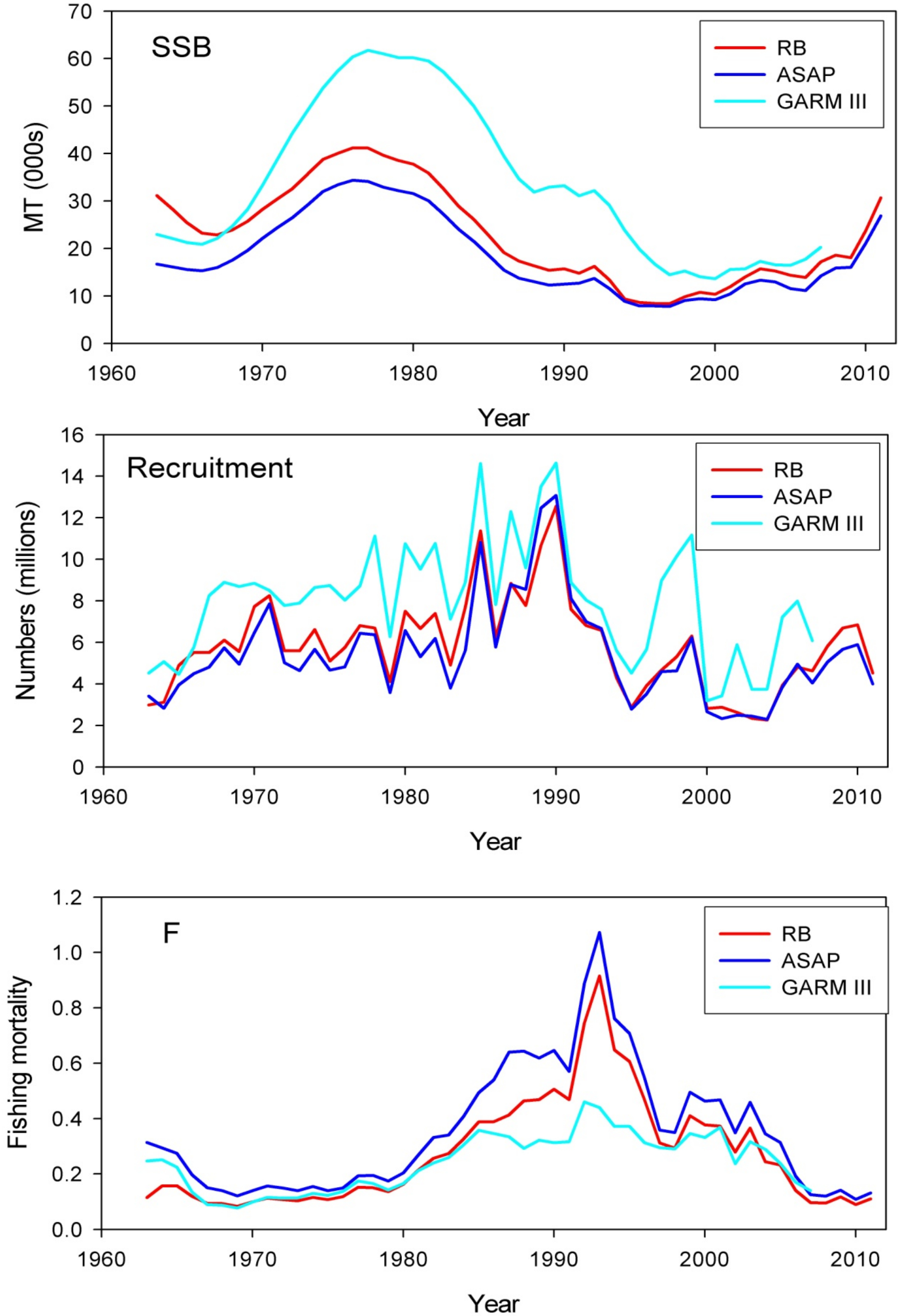


Figure B159. Comparisons of the ASPM (RB), the current ASAP, and the 2008 GARM III model.

Appendix B1. Exploration of the Statistical Catch-at-Age

Data and Methodology

The algebraic details of the methods used for the SCAA assessments and BRP estimation are set out in Appendix B2.

The following changes have been made from "2011 - new data" assessment with which the bridge-building exercise culminates to provide the provisional new Reference Case assessment “RCp”:

9. Baranov catch equation instead of Pope's approximation.
10. Survey season: spring and autumn instead of begin and mid-year (equation B2.9).
11. Survey variance: use input CV's and estimate additional variance (equation B2.16), instead of estimate year-independent variance.
12. ϕ estimated instead of fixed at 0.2.
13. μ_{spawn}=0.25 instead of 0.1667 (equation B2.6).
14. Use age-dependent σ_a for CAA (equations B2.18 and B2.21).
15. Flat commercial selectivity from age 6.
16. Commercial selectivity blocks (1963-1997, 1998-2011).

The first six of these changes are either necessitated by changes to or more accurate representation of input information, together with advances made since GARM III in the assessment methodology applied to other stocks in the region such as Gulf of Maine cod (see e.g. Butterworth and Rademeyer 2012). The necessity for change 6 in the case of white hake was confirmed through the use of AIC. Changes 7 and 8 eventuated from specific analyses for the preliminary white hake data. Regarding 7, freeing the parameter concerned resulted in only a very weak dome in the commercial selectivity vector, and little improvement of the likelihood or changes in key results compared to keeping selectivity flat at larger ages, so it was set to be flat for RCp. Inspection of proportions-at-age residuals suggested a systematic pattern change for the commercial catch proportions-at-age in the mid-1990s. Katherine Sosebee suggested two specific possibilities for the time of this change based on other information; a change from 1997 to 1998 was selected for distinguishing two commercial selectivity blocks based on a better AIC (where this criterion also clearly justified the split from the previous single block).

The list of sensitivities to RCp that are presented in this paper is given in Appendix Table B1.1.

Results

Appendix Table B1.2 lists estimates of primary parameters and management-related quantities for Georges' Bank/Gulf of Maine white hake for RCp and a series of sensitivities. Estimates of BRPs and current stock status estimates are summarized in Appendix Table B1.3. Additional runs, including the final run that was compared to the ASAP model are summarized in Appendix Table B1.4.

Appendix Figure B1.1 gives results for the RCp, while Appendix Figure B1.2 plots its fit to survey and commercial data. Appendix Figure B1.3 compares spawning biomass and recruitment trajectories for RCp and the different sensitivities. Appendix Figure B1.4 compares the stock-recruitment curves for RCp (Ricker), sensitivity 2a (Beverton-Holt) and sensitivity 2b (modified Ricker, with γ estimated). The commercial and survey selectivities for RCp and the sensitivities related to selectivities (4a/b/c/d) are plotted in Appendix Figure B1.5. Bubble plots of CAA residuals are compared for RCp, 4a (flat survey selectivity), 6a (sqrt(p)) and 6b (sqrt(p), flat survey selectivity). The fits to the survey and commercial CAA and CAL data for sensitivity 8c, for which CAA from pooled ALKs are excluded and replaced by CAL, are shown in Appendix Figure B1.6. The fits to the survey biomass indices for sensitivity 9a, in which the *RV Albatross/FRV Henry B. Bigelow* calibration factor is estimated, are plotted in Appendix Figure B1.7.

Discussion

1) The fits to the data do not suggest M values greater than 0.2. (Sensitivity 1)

2) The Ricker stock-recruitment form is favoured over Beverton-Holt, with the data suggesting a sharper peak than the standard Ricker form, though the evidence for preference in terms of improvements to the likelihood is not strong. (Sensitivity 2)
3) Fitting to aggregate abundance indices in terms of numbers, rather than biomass, results in higher current and pristine spawning biomass estimates, but current stock status relative to the MSY spawning biomass level is not greatly affected. If only the spring NEFSC survey data are used, this status is improved, with the reverse result if only the autumn survey data are used. (Sensitivity 3)
4) Investigation of alternative assumptions for selectivity functions show strong AIC support for a difference in the slopes of commercial and survey selectivities-at-age above age 6, with a preference for a near-flat commercial selectivity and strongly domed survey selectivities. The alternative sqrt(p) formulation for the distribution of the proportions-at-age residuals finds this same result, and suggests slightly improved current resource status relative to the MSY spawning biomass level than does the adjusted log-normal of RCp. Shifting the pre-1982 commercial selectivity towards a relatively larger catch of smaller hake has little impact on results. (Sensitivities 4 and 6)
5) When starting the assessment in 1963, the parameter which determines the initial age structure is poorly estimated, but this doesn't impact seriously on the estimates of biological reference points in terms of precision, with starting in 1950 instead also making little difference (note results falling well within CIs for the 1963 start in early years in Fig. 3a). In contrast, for a start in 1982, although *phi* becomes estimable with reasonable precision, the stock-recruitment relationship cannot be reasonably estimated. (Sensitivity 5)
6) Removable of an internally estimated stock-recruitment relationship results, through differences in the related shrinkage of recent estimates of recruitment, in lower estimates of current abundance. (Sensitivity 7)
7) Without inclusion of catch proportions-at-age data for years without direct ageing through use of an average ALK, the precision of the estimates of many quantities deteriorates substantially. However fitting to catch-at-length data for those years provides near unchanged results in terms of both these values and their precision. (Sensitivity 8).
8) Refining the *RV Albatross/FRV Henry B. Bigelow* calibration factor within the assessment leads to a slightly improved estimate of current stock status. The estimate of this factor decreases from 2.235 to 2.096, with an improvement in the associated standard error from 0.173 to 0.155. (Sensitivity 9)
9) The RCp assessment and a number of key sensitivities all suggest that at present the stock is not overfished and that overfishing is not occurring. Estimates of current status and of catches under 0.75 F_{MSY} are rather more optimistic when based on fitted stock-recruitment curves than on F40% MSY proxies. For the latter, starting the assessment in 1963 yields slightly more positive results than starting it in 1982. (Appendix Table B1.3)

Appendix Table B1.1: List of the sensitivities run. After each sub-heading, the RCp specifications are given in parenthesis.

1. Natural mortality (RCp: *M*=0.2)
   1a. *M*=0.4
   1b. *M* incr: *M* increasing linearly from 0.2 at age 5 to 0.4 at age 9
2. Stock-recruitment curve (RCp: Ricker)
   2a BH:Beverton-Holt stock-recruitment curve
   2b γ estimated: from the modified Ricker, eqn B2.4
3. Survey data (RCp: Fit to biomass, both surveys)
   3a Fit to numbers: for the survey indices
   3b Fit to Spring survey only: for both the index and CAA data
   3c Fit to Autumn survey only: for both the index and CAA data
4. Selectivities (RCp: flat comm. From age 6, domed survey)
   4a Flat survey selectivity: from age 6
   4b Pre-1982 comm sel shifted: shifted one year to the left
   4c Flat survey sel, domed comm. Sel: flat from age 6 for survey, free for commercial
   4d Domed survey and comm. Sel
5. Start year (RCp: start in 1963)
   5a Start in 1982
   5b Start in 1950
6. CAA error formulation (RCp: adjusted log-normal)
   6a sqrt(p)
   6b sqrt(p), flat survey selectivity
7. No internal stock-recruitment (RCp: internal stock-recruit)
   7a no SR
   7b no SR, start 1982
8. Excluding CAA from pooled ALK (RCp: include CAA from pooled ALK)
   8a Survey CAL for yrs with pooled ALK
   8b Surv and comm CAL for yrs with pooled ALK
   8c Exclude CAA from pooled ALK: not fitting to any CAL
9. Calibration refinement (RCp: calibration refinement not included)
   9a Bigelow calibration: Δlnq estimated (equation B2.33)

Appendix Table B1.2a: Results for RCp and some sensitivities. Mass units are '000 tons.

	RCp		1a		1b		2a		2b		3a		3b		3c	
			M =0.4		*M* incr		BH		γ estimated		Fit to Numbers		Fit to Spring survey only		Fit to Autumn survey only	
'-lnL:overall	-368.3		-365.3		-367.7		-367.1		-369.0		-362.0		-151.5		-280.9	
'-lnL:Survey	-34.3		-26.2		-28.5		-34.6		-34.2		-30.7		-6.9		-30.5	
'-lnL:CAAcom	-42.6		-46.4		-45.2		-42.6		-42.6		-43.4		-47.3		-48.5	
'-lnL:CAAsurv	-301.6		-301.6		-303.3		-301.3		-301.4		-300.4		-105.8		-214.1	
'-lnL:CALcom	-		-		-		-		-		-		-		-	
'-lnL:Catch	1.1		1.5		1.3		1.2		1.1		1.6		0.9		1.3	
'-lnL:CALsurv	-		-		-		-		-		-		-		-	
'-lnL:RecRes	9.0		7.4		7.9		10.2		8.1		10.9		7.7		10.8	
-lnL:calibration	-		-		-		-		-		-		-		-	
MaxGradient	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
h	1.21	(0.14)	0.62	(0.15)	0.74	(0.15)	0.78	(0.09)	1.26	(0.13)	0.81	(0.14)	1.30	(0.15)	1.24	(0.15)
γ	1.00	-	1.00	-	1.00	-	1.00	-	2.11	(0.50)	1.00	-	1.00	-	1.00	-
θ	0.57	(0.29)	0.57	(0.21)	0.56	(0.19)	0.28	(0.34)	0.77	(0.17)	0.25	(0.29)	0.77	(0.19)	0.52	(0.28)
ϕ	0.01	(4.07)	0.00	(1000)	0.00	(1000)	0.02	(1.65)	0.00	(1000)	0.03	(4.07)	0.00	(1000)	0.02	(1.81)
K^{sp}	69.13	(0.14)	68.91	(0.19)	66.39	(0.17)	128.17	(0.20)	55.08	(0.17)	120.65	(0.14)	71.01	(0.14)	64.82	(0.15)
B^{sp}_{2011}	25.34	(0.17)	37.17	(0.18)	32.38	(0.18)	24.77	(0.17)	25.25	(0.18)	29.78	(0.17)	33.99	(0.23)	22.45	(0.19)
B^{sp}_{2011}/K^{sp}	0.37	(0.21)	0.54	(0.24)	0.49	(0.22)	0.19	(0.26)	0.46	(0.21)	0.25	(0.21)	0.48	(0.26)	0.35	(0.23)
B^{sp}_{MSY}	30.43	(0.10)	32.35	(0.13)	31.57	(0.12)	42.98	(0.16)	29.38	(0.13)	39.44	(0.10)	31.05	(0.11)	28.53	(0.10)
$MSYL^{sp}$	0.44	(0.11)	0.47	(0.16)	0.48	(0.13)	0.34	(0.07)	0.53	(0.24)	0.33	(0.11)	0.44	(0.12)	0.44	(0.11)
$B^{sp}_{2011}/B^{sp}_{MSY}$	0.83	(0.18)	1.15	(0.18)	1.03	(0.18)	0.58	(0.23)	0.86	(0.20)	0.76	(0.18)	1.09	(0.22)	0.79	(0.19)
MSY	7.75	(0.10)	8.37	(0.13)	8.39	(0.12)	7.82	(0.15)	8.57	(0.13)	7.60	(0.10)	8.44	(0.10)	7.41	(0.10)
F_{MSY}	0.30	-	0.41	-	0.35	-	0.21	-	0.35	-	0.22	-	0.33	-	0.31	-
spring_q	1.16	(0.06)	0.54	(0.07)	0.86	(0.07)	1.16	(0.06)	1.16	(0.06)	1.06	(0.06)	1.10	(0.06)	-	
autumn_q	1.96	(0.05)	0.97	(0.07)	1.42	(0.07)	1.97	(0.05)	1.97	(0.05)	1.71	(0.05)	-		2.04	(0.05)
spring_σ_{Add}	0.16	(0.32)	0.17	(0.32)	0.16	(0.32)	0.16	(0.32)	0.16	(0.32)	0.13	(0.31)	0.20	(0.29)	-	
autumn_σ_{Add}	0.06	(0.48)	0.10	(0.40)	0.09	(0.41)	0.05	(0.49)	0.05	(0.49)	0.14	(0.30)	-		0.07	(0.33)

Appendix Table B.2b: Results for RCp and some sensitivities. Mass units are '000 tons.

	RCp		4a		4b		4c		4d		5a		5b	
			Flat survey selectivity		Pre-1982 comm sel shifted		Flat survey sel, domed comm sel		Domed survey and comm sel		start in 1982		start in 1950	
'-lnL:overall	-368.3		-341.1		-366.6		-355.4		-369.6		-191.8		-369.6	
'-lnL:Survey	-34.3		-37.2		-33.9		-37.7		-29.8		-22.7		-33.9	
'-lnL:CAAcom	-42.6		-33.8		-42.7		-40.4		-47.2		-45.5		-42.2	
'-lnL:CAAsurv	-301.6		-287.3		-299.8		-295.7		-301.2		-131.0		-304.4	
'-lnL:CALcom	-		-		-		-		-		-		-	
'-lnL:Catch	1.1		5.9		1.0		6.2		1.4		1.3		1.1	
'-lnL:CALsurv	-		-		-		-		-		-		-	
'-lnL:RecRes	9.0		11.4		8.7		12.1		7.3		6.0		9.9	
-lnL:calibration	-		-		-		-		-		-		-	
MaxGradient	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
h	1.21	(0.14)	1.47	(0.17)	1.19	(0.14)	1.44	(0.16)	0.98	(0.19)	0.86	(0.26)	1.25	(0.14)
γ	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
θ	0.57	(0.29)	0.19	(0.36)	0.57	(0.27)	0.22	(0.34)	0.61	(0.16)	0.04	(8.32)	0.45	(1.17)
ϕ	0.01	(4.07)	0.26	(0.19)	0.01	(2.94)	0.50	(0.32)	0.00	(1000)	0.25	(0.18)	0.53	(0.99)
K^{sp}	69.13	(0.14)	63.19	(0.31)	73.12	(0.14)	58.73	(0.28)	97.24	(0.24)	730.11	(8.27)	66.82	(0.12)
B^{sp}_{2011}	25.34	(0.17)	16.06	(0.18)	26.01	(0.17)	15.47	(0.17)	33.67	(0.23)	22.18	(0.20)	25.74	(0.17)
B^{sp}_{2011}/K^{sp}	0.37	(0.21)	0.25	(0.37)	0.36	(0.21)	0.26	(0.34)	0.35	(0.21)	0.03	(8.30)	0.39	(0.18)
B^{sp}_{MSY}	30.43	(0.10)	27.46	(0.23)	32.26	(0.10)	27.28	(0.25)	42.79	(0.18)	333.38	(8.07)	29.33	(0.10)
$MSYL^{sp}$	0.44	(0.11)	0.43	(0.11)	0.44	(0.10)	0.46	(0.17)	0.44	(0.15)	0.46	(0.22)	0.44	(0.11)
$B^{sp}_{2011}/B^{sp}_{MSY}$	0.83	(0.18)	0.58	(0.29)	0.81	(0.17)	0.57	(0.32)	0.79	(0.19)	0.07	(8.10)	0.88	(0.17)
MSY	7.75	(0.10)	8.40	(0.23)	8.08	(0.10)	8.13	(0.21)	8.87	(0.13)	63.64	(8.07)	7.63	(0.09)
F_{MSY}	0.30	-	0.41	-	0.29	-	0.66	-	0.29	-	0.22	-	0.30	-
spring_q	1.16	(0.06)	1.24	(0.05)	1.15	(0.06)	1.30	(0.05)	0.98	(0.12)	1.14	(0.07)	1.16	(0.06)
autumn_q	1.96	(0.05)	2.17	(0.05)	1.96	(0.05)	2.28	(0.04)	1.65	(0.12)	2.09	(0.06)	1.97	(0.05)
spring_σ_{Add}	0.16	(0.32)	0.16	(0.32)	0.16	(0.32)	0.17	(0.32)	0.16	(0.32)	0.14	(0.39)	0.16	(0.32)
autumn_σ_{Add}	0.06	(0.48)	0.04	(0.54)	0.06	(0.47)	0.04	(0.55)	0.09	(0.46)	0.05	(0.82)	0.06	(0.48)

Appendix Table B1.2c: Results for RCp and some sensitivities. Note that for 7a, the BRP are estimated externally to the assessment (see Appendix B2, section B2.5). For sensitivity 9a (Bigelow calibration), the first two survey q's (and associated CVs) are for the *Albatross*, followed by those for the *Bigelow*. Mass units are ‘000 tons.

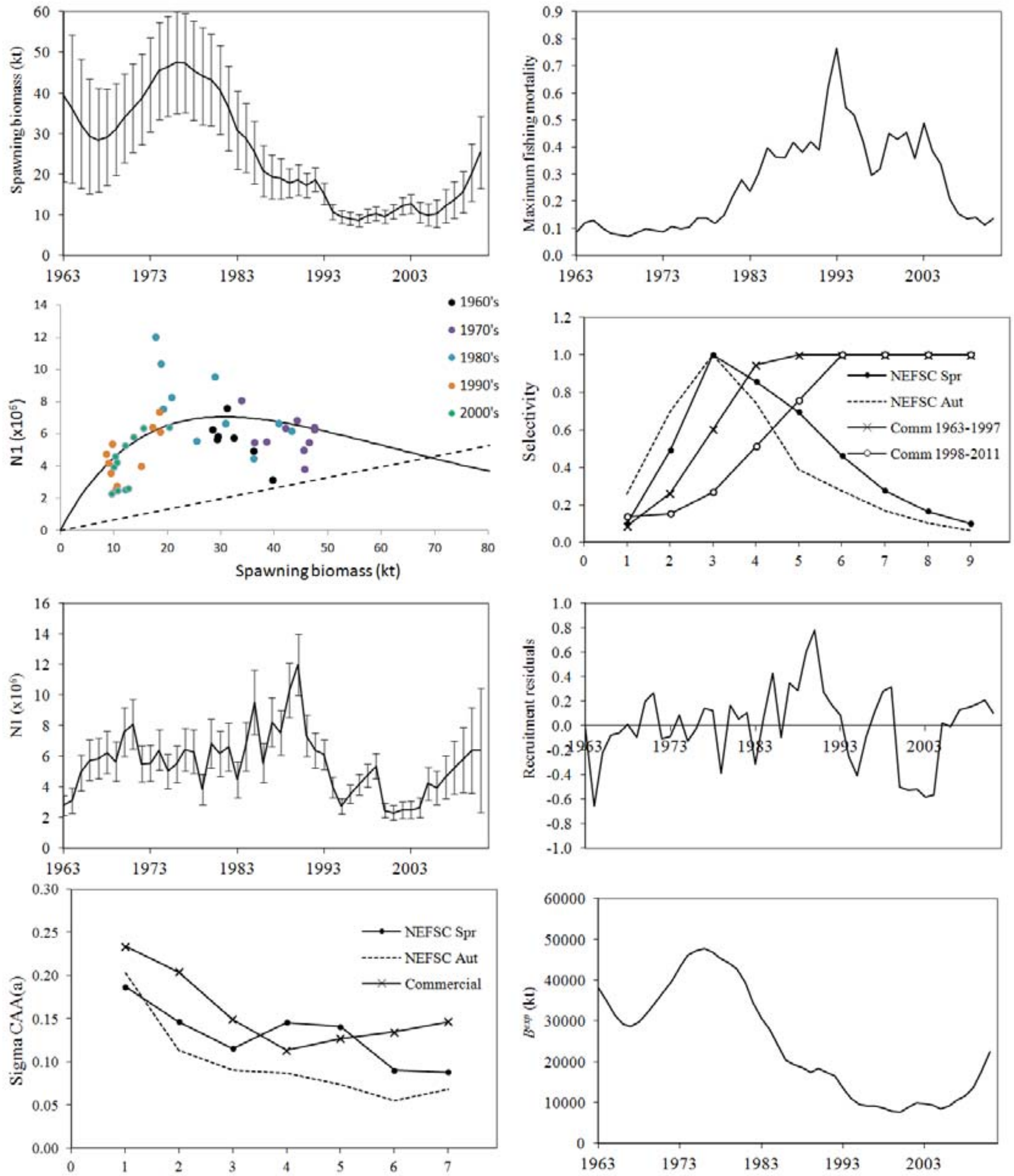
	RCp		6a		6b		7a		7b		8a		8b		8c		9a			
			sqrt(p)		sqrt(p), flat survey selectivity		no SR		no SR, start 1982		Surv CAL for yrs with pooled ALK		Surv and comm CAL for yrs with pooled ALK		Exclude CAA from pooled ALK		Bigelow calibration			
'-lnL:overall	-368.3		-1905		-1880		-376.3		-197.4		-79.6		-64.5		-158.9		-368.6			
'-lnL:Survey	-34.3		-33.1		-36.6		-36.5		-23.6		-35.0		-35.0		-38.3		-34.8			
'-lnL:CAAcom	-42.6		-327.9		-317.1		-44.1		-46.5		-24.2		-24.8		-22.7		-42.7			
'-lnL:CAAsurv	-301.6		-1556		-1545		-298.5		-129.5		-98.6		-96.5		-108.1		-301.7			
'-lnL:CALcom	-		-		-		-		-		-		13.7		-		-			
'-lnL:Catch	1.1		1.4		4.7		1.5		1.5		1.1		1.2		1.8		1.2			
'-lnL:CALsurv	-		-		-		-		-		66.9		66.6		-		-			
'-lnL:RecRes	9.0		11.0		13.6		1.3		0.7		10.2		10.2		8.4		9.0			
-lnL:calibration	-		-		-		-		-		-		-		-		0.3			
MaxGradient	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000			
h	1.21	(0.14)	1.39	(0.13)	1.59	(0.16)	-		-		1.27	(0.16)	1.29	(0.15)	1.05	(0.21)	1.22	(0.14)		
γ	1.00	-	1.00	-	1.00	-	-		-		1.00	-	1.00	-	1.00	-	1.00	-		
θ	0.57	(0.29)	0.59	(0.30)	0.23	(0.28)	0.50	(0.13)	-		0.60	(0.20)	0.57	(0.58)	0.11	(0.80)	0.57	(0.29)		
ϕ	0.01	(4.07)	0.02	(2.48)	0.28	(0.22)	0.02	(1.71)	0.25	(0.10)	0.00	(1000)	0.01	(11.75)	0.38	(0.93)	0.01	(3.81)		
K^{sp}	69.13	(0.14)	63.76	(0.13)	53.93	(0.22)	68.32	(0.13)	-		65.64	(0.15)	64.19	(0.15)	95.32	(0.47)	68.82	(0.14)		
B^{sp}_{2011}	25.34	(0.17)	25.47	(0.18)	16.80	(0.18)	21.31	(0.17)	19.17	(0.09)	23.03	(0.19)	22.74	(0.19)	19.63	(0.19)	25.97	(0.17)		
B^{sp}_{2011}/K^{sp}	0.37	(0.21)	0.40	(0.19)	0.31	(0.29)	0.31	(0.13)	-		0.35	(0.21)	0.35	(0.23)	0.21	(0.54)	0.38	(0.21)		
B^{sp}_{MSY}	30.43	(0.10)	27.66	(0.10)	23.24	(0.16)	29.49	(0.09)	-		28.80	(0.11)	28.14	(0.11)	42.70	(0.35)	30.28	(0.10)		
$MSYL^{sp}$	0.44	(0.11)	0.43	(0.10)	0.43	(0.10)	0.43	(0.09)	-		0.44	(0.14)	0.44	(0.12)	0.45	(0.17)	0.44	(0.11)		
$B^{sp}_{2011}/B^{sp}_{MSY}$	0.83	(0.18)	0.92	(0.17)	0.72	(0.23)	0.72	(0.09)	-		0.80	(0.20)	0.81	(0.20)	0.46	(0.44)	0.86	(0.18)		
MSY	7.75	(0.10)	8.01	(0.10)	7.66	(0.15)	7.50	(0.09)	-		7.46	(0.10)	7.53	(0.10)	9.45	(0.35)	7.76	(0.10)		
F_{MSY}	0.30	-	0.36	-	0.46	-	0.30		-		0.30	-	0.32	-	0.25	-	0.24	-		
spring_q	1.16	(0.06)	1.25	(0.06)	1.35	(0.05)	1.20	(0.06)	1.18	(0.07)	1.13	(0.07)	1.13	(0.07)	1.30	(0.08)	1.17	(0.06)	2.45	(0.10)
autumn_q	1.96	(0.05)	2.06	(0.06)	2.27	(0.05)	2.05	(0.05)	2.17	(0.06)	1.93	(0.07)	1.93	(0.07)	2.13	(0.07)	2.01	(0.05)	4.21	(0.09)
spring_σ_{Add}	0.16	(0.32)	0.16	(0.32)	0.16	(0.32)	0.16	(0.32)	0.14	(0.39)	0.18	(0.08)	0.16	(0.33)	0.18	(0.32)	0.16	(0.32)		
autumn_σ_{Add}	0.06	(0.48)	0.06	(0.47)	0.04	(0.52)	0.04	(0.53)	0.03	(0.95)	0.16	(0.33)	0.05	(0.52)	0.03	(0.70)	0.05	(0.50)		

Appendix Table B1.3: BRPs for RCp and some sensitivities. Mass units are tons.

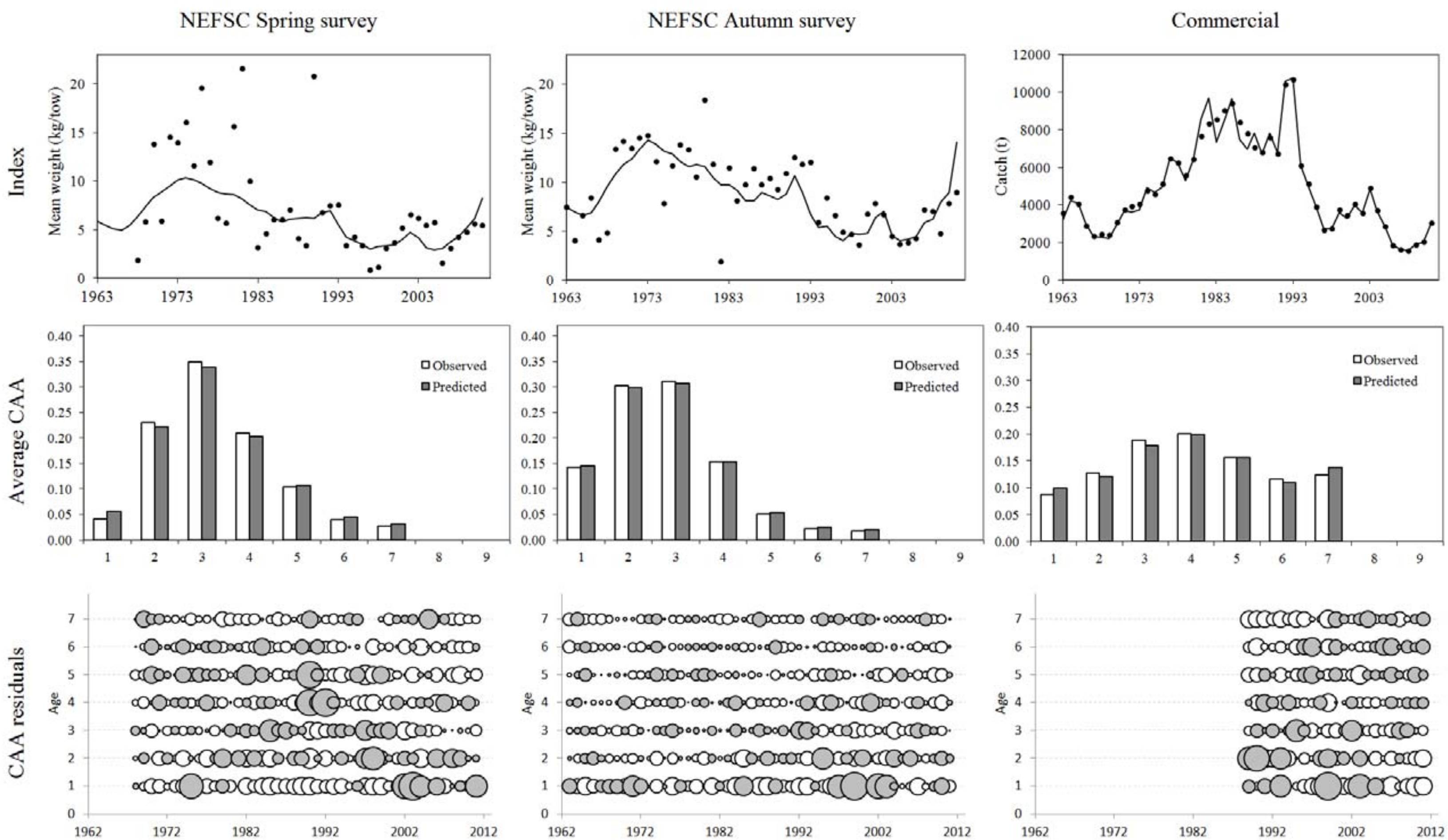
		RCp	2a	7a	7b
			BH	no SR	no SR, start 1982
	Start year	1963	1963	1963	1982
	SR relationship	Ricker	Beverton-Holt	None (Ricker external)	
SR BRPs	$B^{sp}_{2011}/B^{sp}_{MSY}$	0.83	0.58	0.72	
	F_{2011}/F_{MSY}	0.45	0.67	0.54	
	MSY	7.75	7.82	7.50	
	$C_{2012}\,(0.75F_{MSY})$	6986	4883	5786	
	overfished	No	No	No	
	overfishing	No	No	No	
*F*40% BRPs	$B^{sp}_{2011}/B^{sp}_{MSY}$	0.71	0.69	0.61	0.57
	F_{2011}/F_{MSY}	0.75	0.77	0.90	1.01
	MSY	5.73	5.74	5.57	5.40
	$C_{2012}\,(0.75F_{MSY})$	4394	4299	3650	3274
	overfished	No	No	No	No
	overfishing	No	No	No	Yes

Appendix Table B1.4 Exploration of the SCAA with the final data (RCeven_newer).

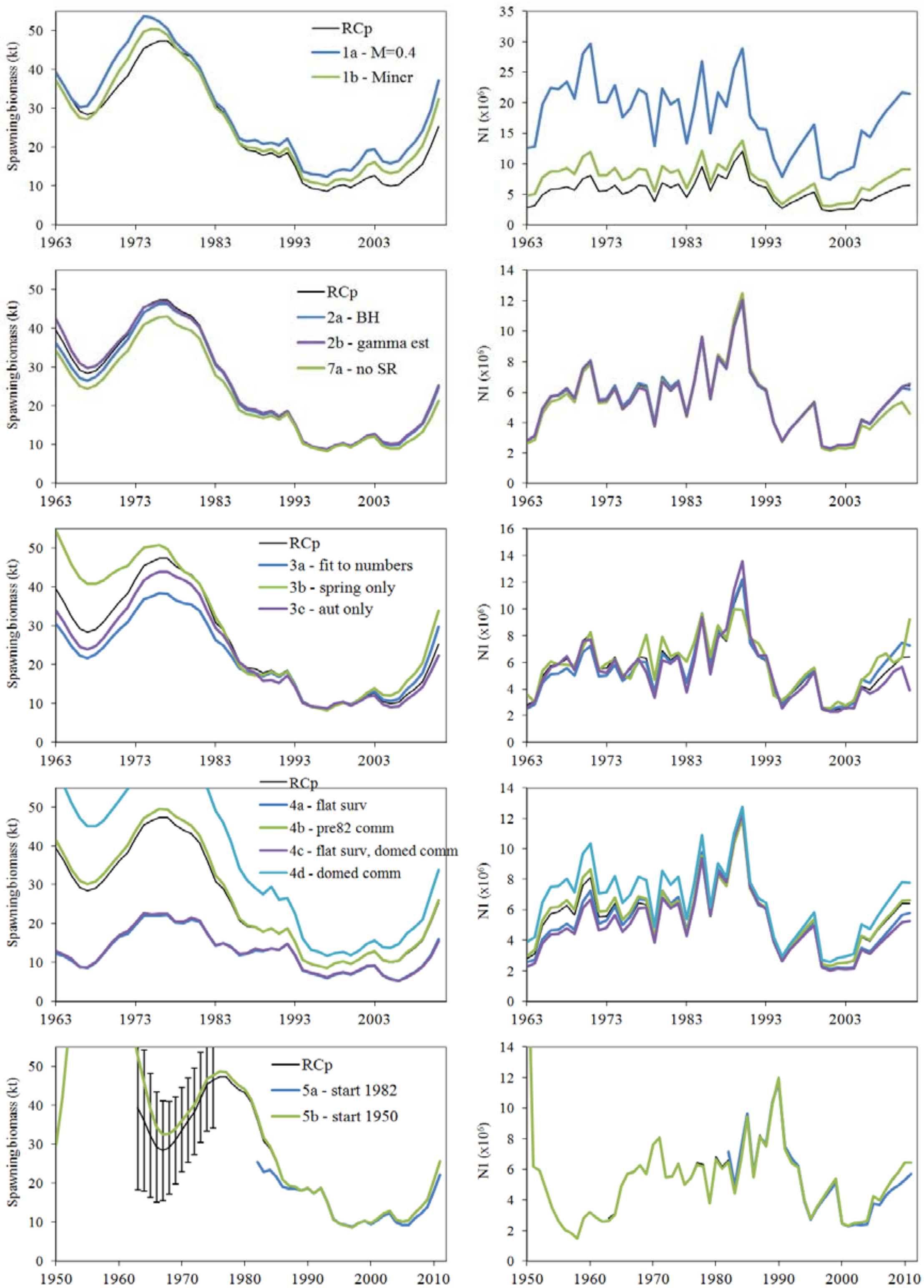
				2a	2b	5a	8a	9a	Ka	Kb	Kc
	RCnew	RCeven_newer	RCeven_newer	BH	no SR	start in 1950	CAL for yr with pooled ALK	Estimate calibration ratio	BH, ϕ=0.4	BH, $N_{y0,m}$/4	BH, ASAP Bsp
	Fit to B	Fit to B	Fit to N	Fit to N	Fit to N	Fit to N	Fit to N	Fit to N	Fit to N	Fit to N	Fit to N
'-lnL:overall	-344.3	-339.6	-348.2	-347.7	-356.7	-346.5	-117.9	-348.7	-312.7	-330.4	-293.3
'-lnL:Survey	-33.6	-34.6	-39.5	-39.7	-41.4	-39.5	-40.2	-40.1	-37.5	-40.9	-41.5
'-lnL:CAAcom	-41.6	-41.0	-43.6	-43.5	-44.6	-43.6	-44.6	-43.6	-37.8	-37.5	-47.4
'-lnL:CAAsurv	-280.6	-275.2	-275.4	-275.3	-272.7	-275.8	-107.9	-275.8	-248.1	-263.1	-242.5
'-lnL:CALcom	-	-	-	-	-	-	7.1	-	-	-	0.0
'-lnL:Catch	0.4	0.3	0.3	0.3	0.3	0.2	0.3	0.3	1.2	0.6	26.5
'-lnL:CALsurv	-	-	-	-	-	-	56.0	-	-	-	0.0
'-lnL:RecRes	11.1	10.9	10.0	10.6	1.7	12.0	11.5	10.0	9.6	10.5	11.5
-lnL:calibration	-	-	-	-	-	-	-	0.4	-	-	-
MaxGradient	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.0385
h	1.26 (0.15)	1.21 (0.15)	1.36 (0.16)	0.82 (0.10)	-	0.80 (0.11)	1.43 (0.15)	1.37 (0.16)	0.76 (0.08)	0.86 (0.11)	0.73 (0.09)
γ	1.00 -	1.00 -	1.00 -	1.00 -	-	1.00 -	1.00 -	1.00 -	1.00 -	1.00 -	1.00 -
θ	0.44 (0.28)	0.44 (0.29)	0.48 (0.31)	0.23 (0.36)	-	0.04 (14.28)	1.00 (0.28)	0.48 (0.31)	0.05 (0.36)	0.18 (0.24)	0.04 (0.55)
ϕ	0.04 (0.95)	0.04 (0.99)	0.03 (1.24)	0.04 (0.93)	0.05 (0.78)	0.96 (13.73)	-0.06 -(1)	0.03 (1.20)	0.40 -	-0.49 (0.00)	0.26 (0.08)
K^{sp}	69.63 (0.16)	76.30 (0.16)	70.12 (0.15)	138.39 (0.21)	-	138.85 (0.24)	68.19 (0.13)	69.85 (0.15)	206.46 (0.33)	118.50 (0.17)	253.59 (0.55)
B^{sp}_{2011}	25.83 (0.16)	25.36 (0.16)	35.57 (0.14)	35.35 (0.14)	30.69 (0.14)	34.89 (0.14)	34.04 (0.14)	36.57 (0.14)	35.62 (0.14)	34.78 (0.13)	25.74 (0.00)
B^{sp}_{2011}/K^{sp}	0.37 (0.23)	0.33 (0.23)	0.51 (0.20)	0.26 (0.26)	-	0.25 (0.28)	0.50 (0.18)	0.52 (0.20)	0.17 (0.37)	0.29 (0.22)	0.10 (0.55)
B^{sp}_{MSY}	28.70 (0.11)	31.57 (0.12)	28.66 (0.11)	39.03 (0.16)	-	39.74 (0.18)	27.67 (0.10)	28.53 (0.11)	61.09 (0.28)	32.19 (0.13)	76.94 (0.48)
$MSYL^{sp}$	0.41 (0.14)	0.41 (0.14)	0.41 (0.13)	0.28 (0.09)	-	0.29 (0.10)	0.41 (0.13)	0.41 (0.13)	0.30 (0.08)	0.27 (0.10)	0.30 (0.08)
$B^{sp}_{2011}/B^{sp}_{MSY}$	0.90 (0.19)	0.80 (0.19)	1.24 (0.16)	0.91 (0.21)	-	0.88 (0.23)	1.23 (0.16)	1.28 (0.16)	0.58 (0.32)	1.08 (0.19)	0.33 (0.48)
MSY	7.62 (0.10)	8.07 (0.10)	8.12 (0.09)	8.10 (0.15)	-	8.01 (0.17)	8.30 (0.09)	8.16 (0.09)	11.55 (0.27)	7.16 (0.12)	13.74 (0.48)
F_{MSY}	0.30 -	0.29 -	0.32 -	0.23 -	-	0.22 -	0.35 -	0.33 -	0.21 -	0.24 -	0.20 -
spring_q	1.06 (0.05)	1.08 (0.05)	1.13 (0.04)	1.13 (0.04)	1.16 (0.04)	1.14 (0.04)	1.14 (0.05)	1.13 (0.04)	1.13 (0.04)	1.15 (0.05)	1.24 (0.03)
autumn_q	1.81 (0.05)	1.87 (0.04)	1.63 (0.04)	1.63 (0.04)	1.67 (0.04)	1.63 (0.04)	1.65 (0.05)	1.63 (0.04)	1.64 (0.04)	1.64 (0.04)	1.84 (0.03)
spring_σ_{Add}	0.16 (0.32)	0.18 (0.28)	0.16 (0.26)	0.16 (0.26)	0.16 (0.27)	0.16 (0.26)	0.15 (0.27)	0.16 (0.26)	0.15 (0.27)	0.16 (0.26)	0.15 (0.26)
autumn_σ_{Add}	0.06 (0.46)	0.10 (0.30)	0.11 (0.27)	0.11 (0.27)	0.10 (0.27)	0.11 (0.27)	0.10 (0.27)	0.10 (0.27)	0.12 (0.26)	0.10 (0.27)	0.10 (0.26)
Calibration Ratio	**2.09 (0.10)**	**2.09 (0.10)**	**2.24 (0.08)**	**2.24 (0.08)**	**2.24 (0.08)**	**2.24 (0.08)**	**2.24 (0.08)**	2.08 (0.07)	**2.24 (0.08)**	**2.24 (0.08)**	**2.24 (0.08)**



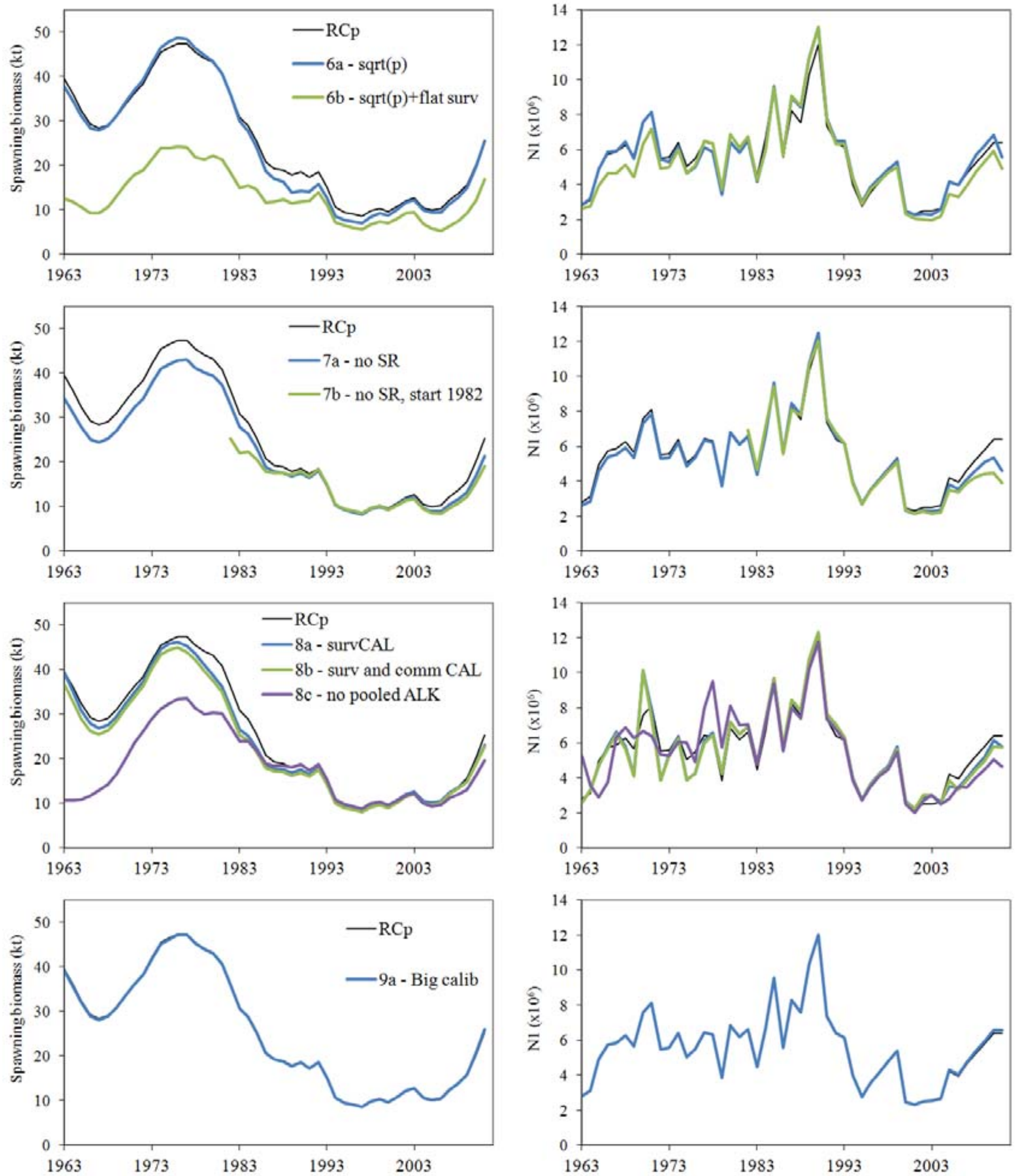
Appendix Figure B1.1: Results for the RCp Georges Bank/Gulf of Maine white hake assessment.



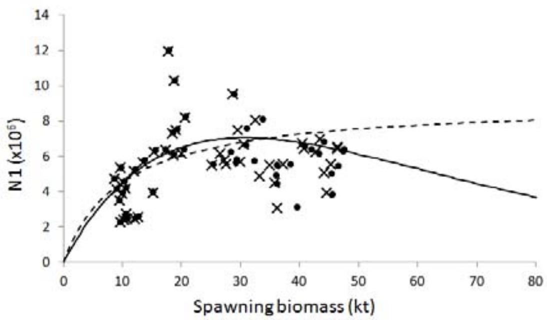
Appendix Figure B1.2: Fit of RCp to the survey and commercial data



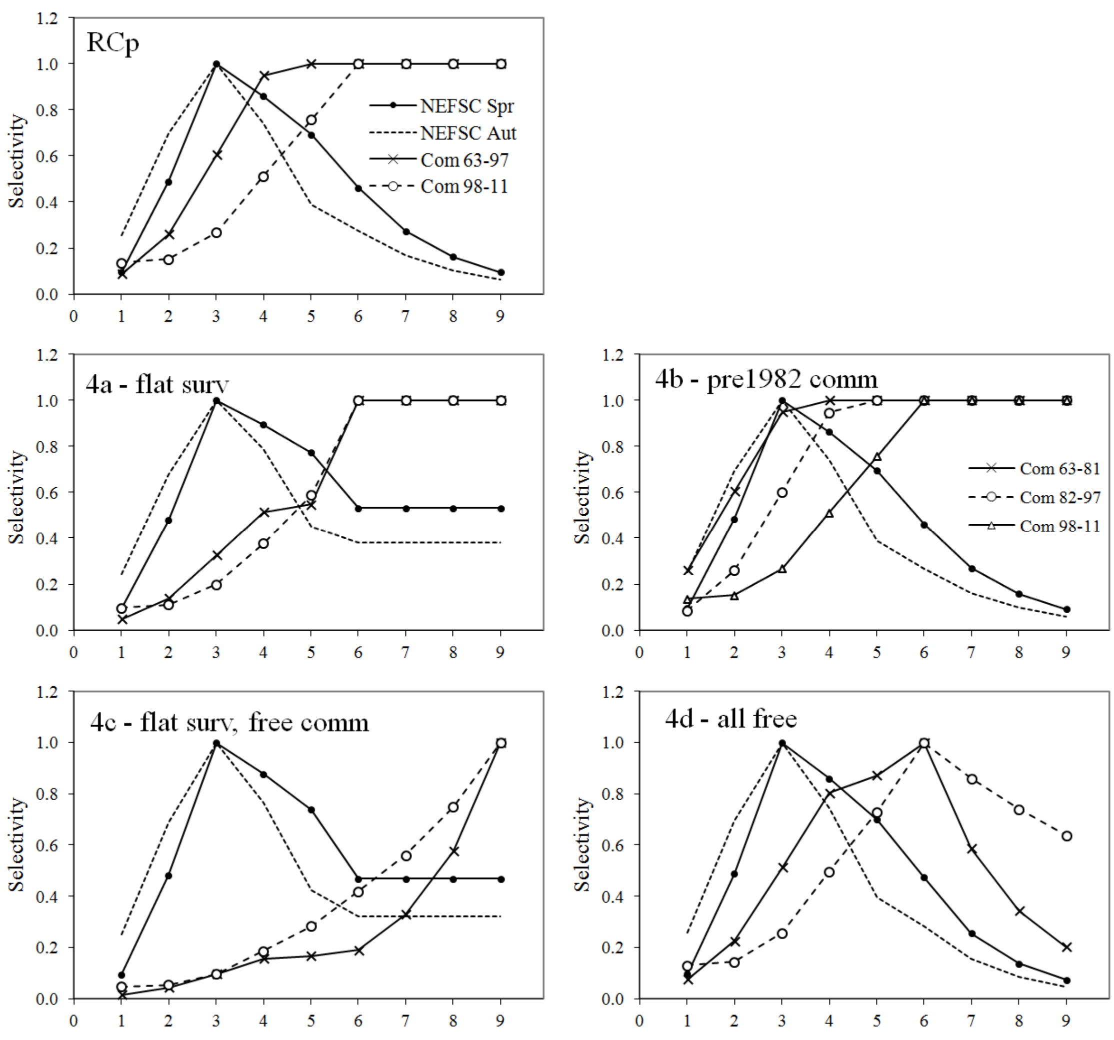
Appendix Figure B1.3a: Spawning biomass and recruitment trajectories for RCp and some sensitivities. The 95% CIs shown in the bottom left plot are for RCp.



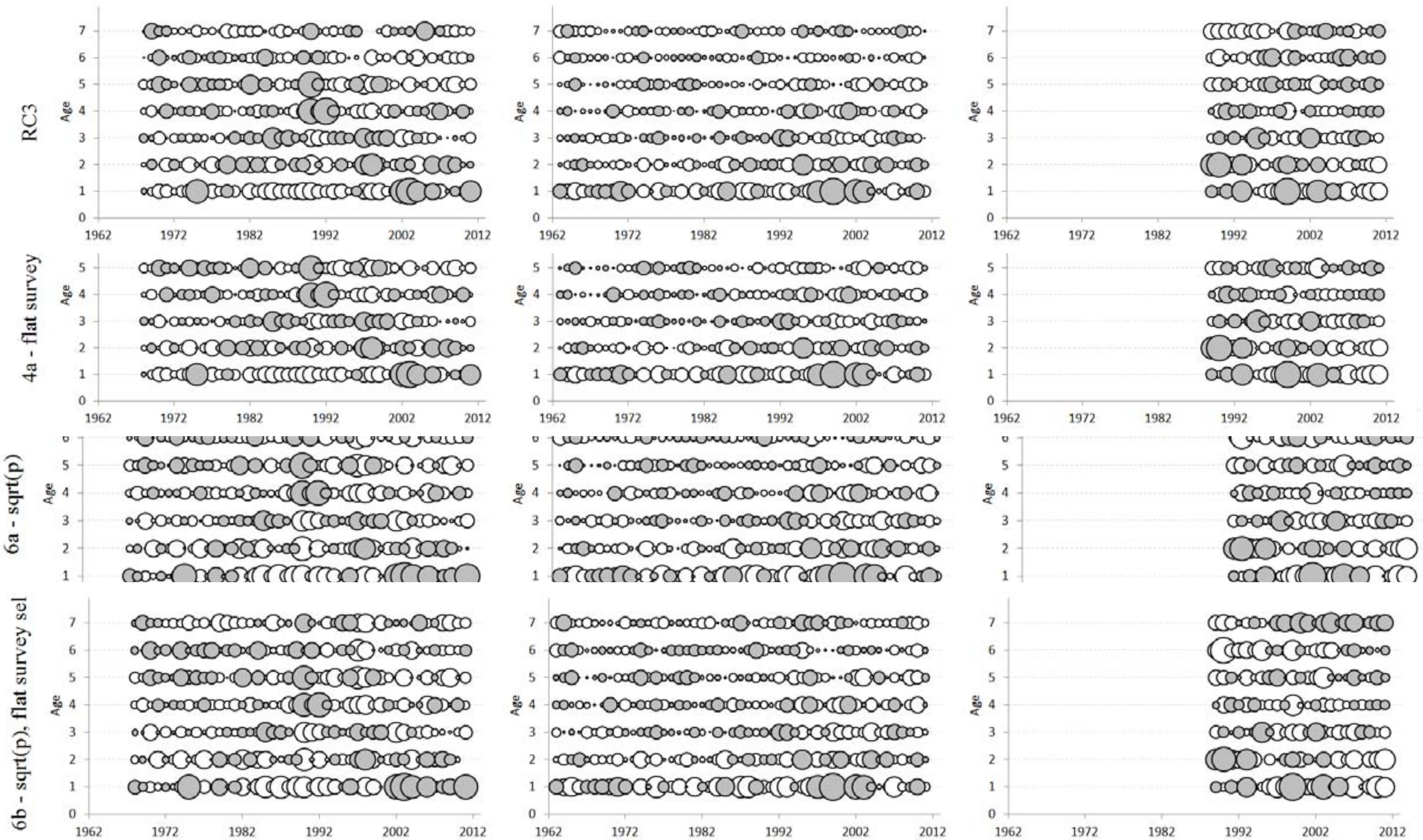
Appendix Figure B1.3b: Spawning biomass and recruitment trajectories for RCp and some sensitivities.



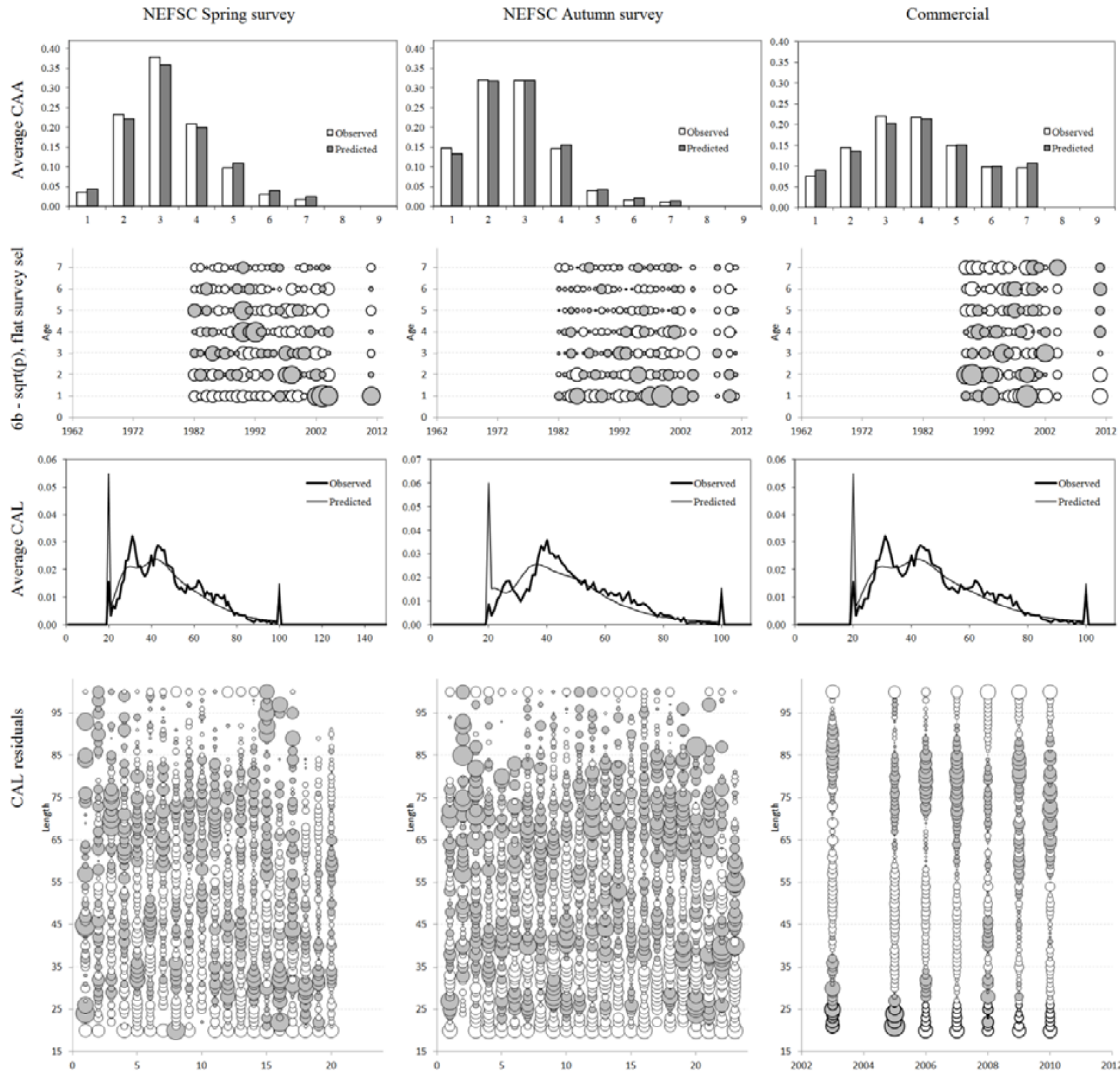
Appendix Figure B1.4: Stock-recruitment curve and estimated recruitment for RCp (full line and solid dots) and 2a (Beverton-Holt) (dashed line and crosses) for the left-hand plot and 2b (γ estimated) (dashed line and crosses) for the right-hand plot. Note that that N1 values for year y are associated with spawning biomass values for the previous year.



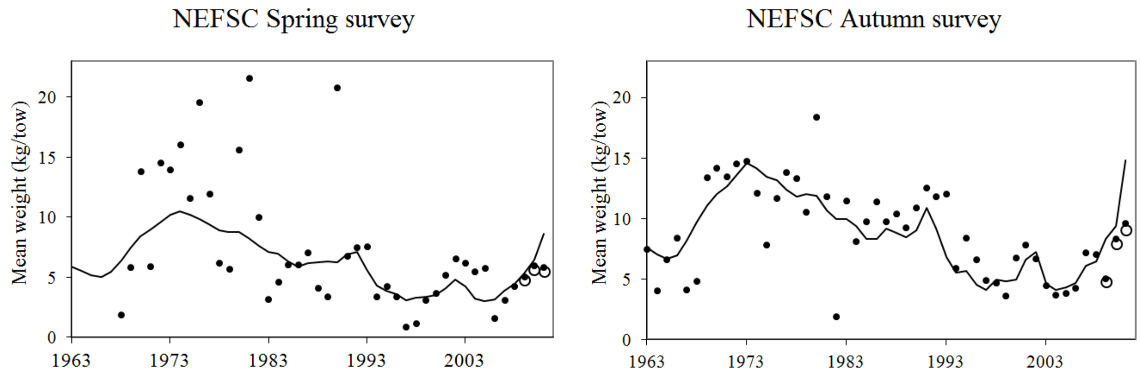
Appendix Figure B1.5: Commercial and survey selectivities for RCp and some sensitivities.



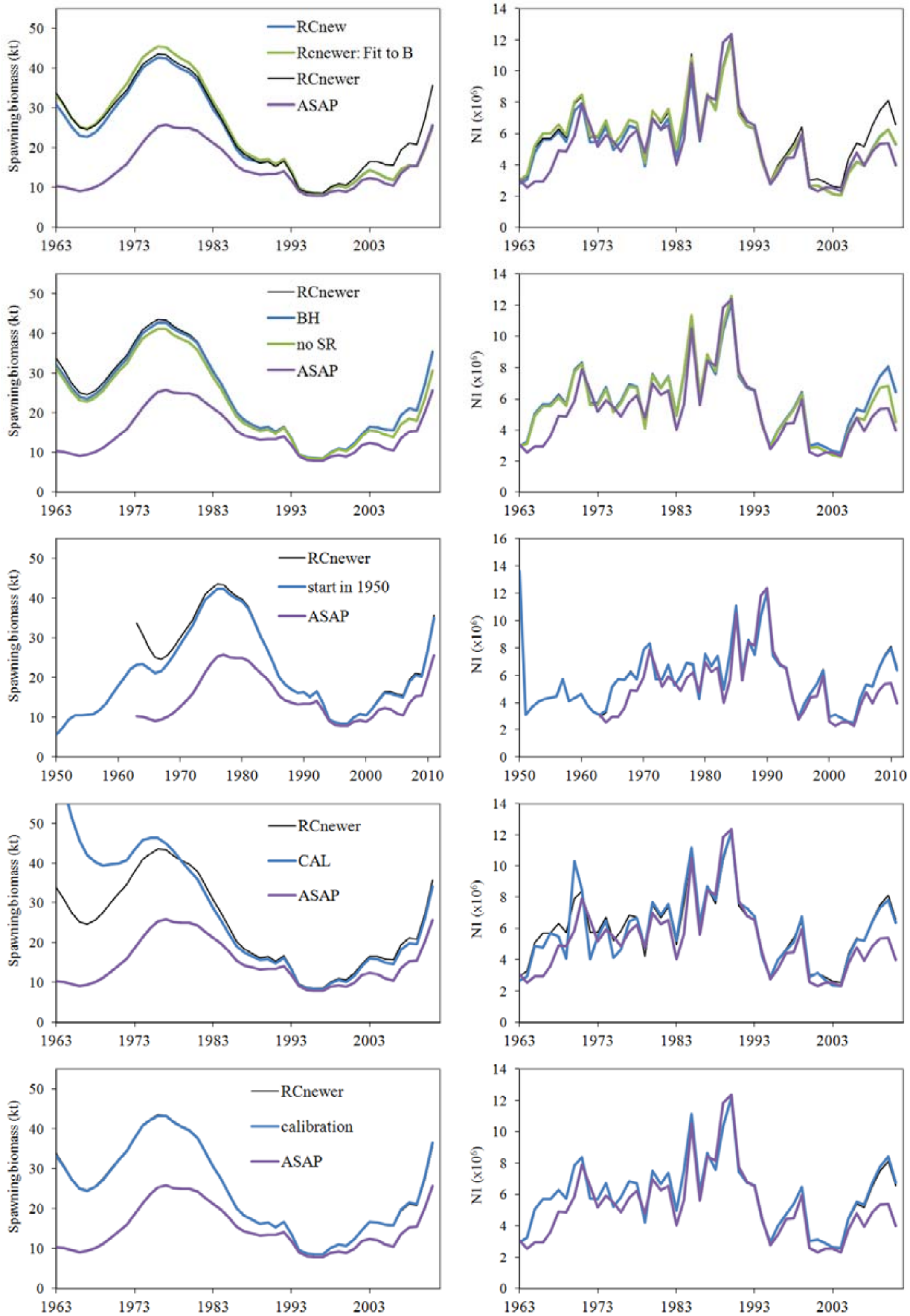
Appendix Figure B1.6: CAA standardised residuals for RCp and some sensitivities.



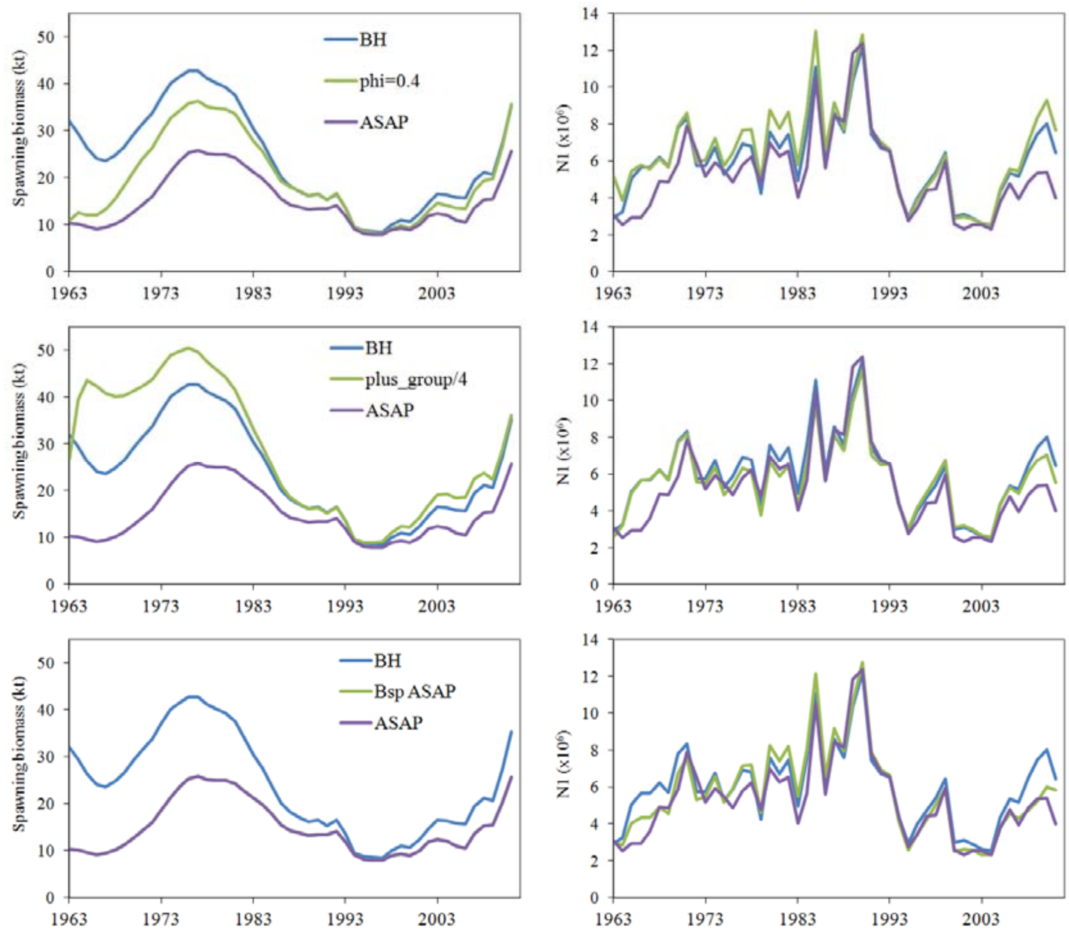
Appendix Figure B1.7: Fit to CAA and CAL for sensitivity 8c.



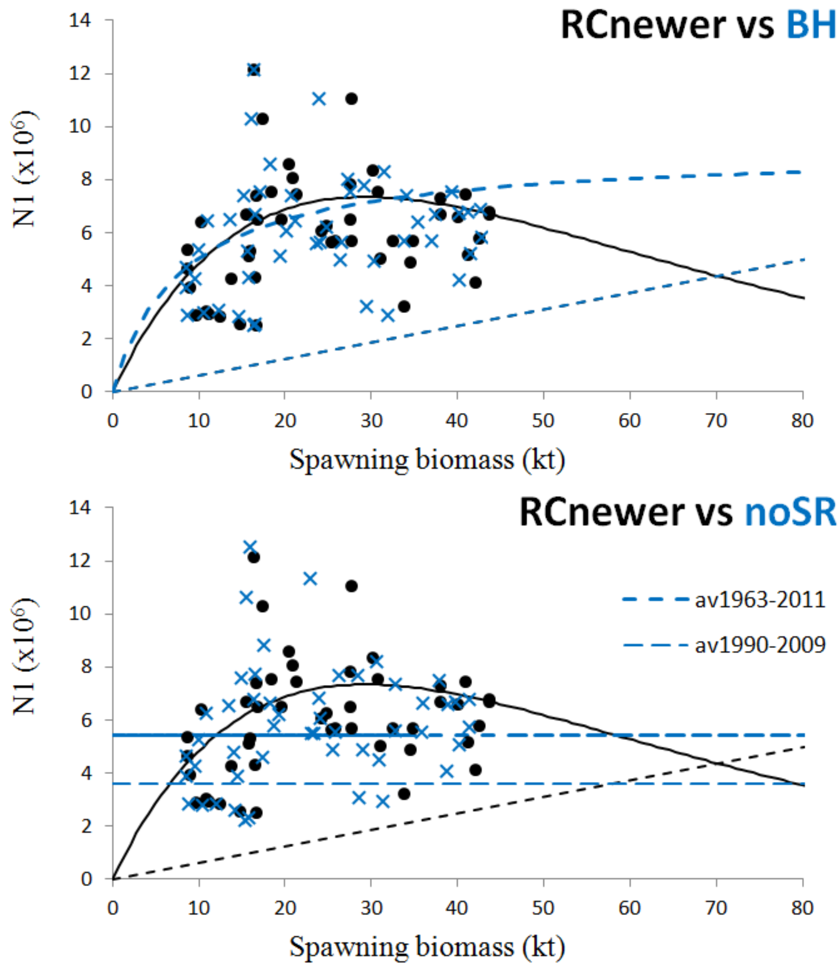
Appendix Figure B1.8: Fit to NEFSC surveys adjusted for the calibration refinement. Open circles are the surveys with the existing calibration factor.



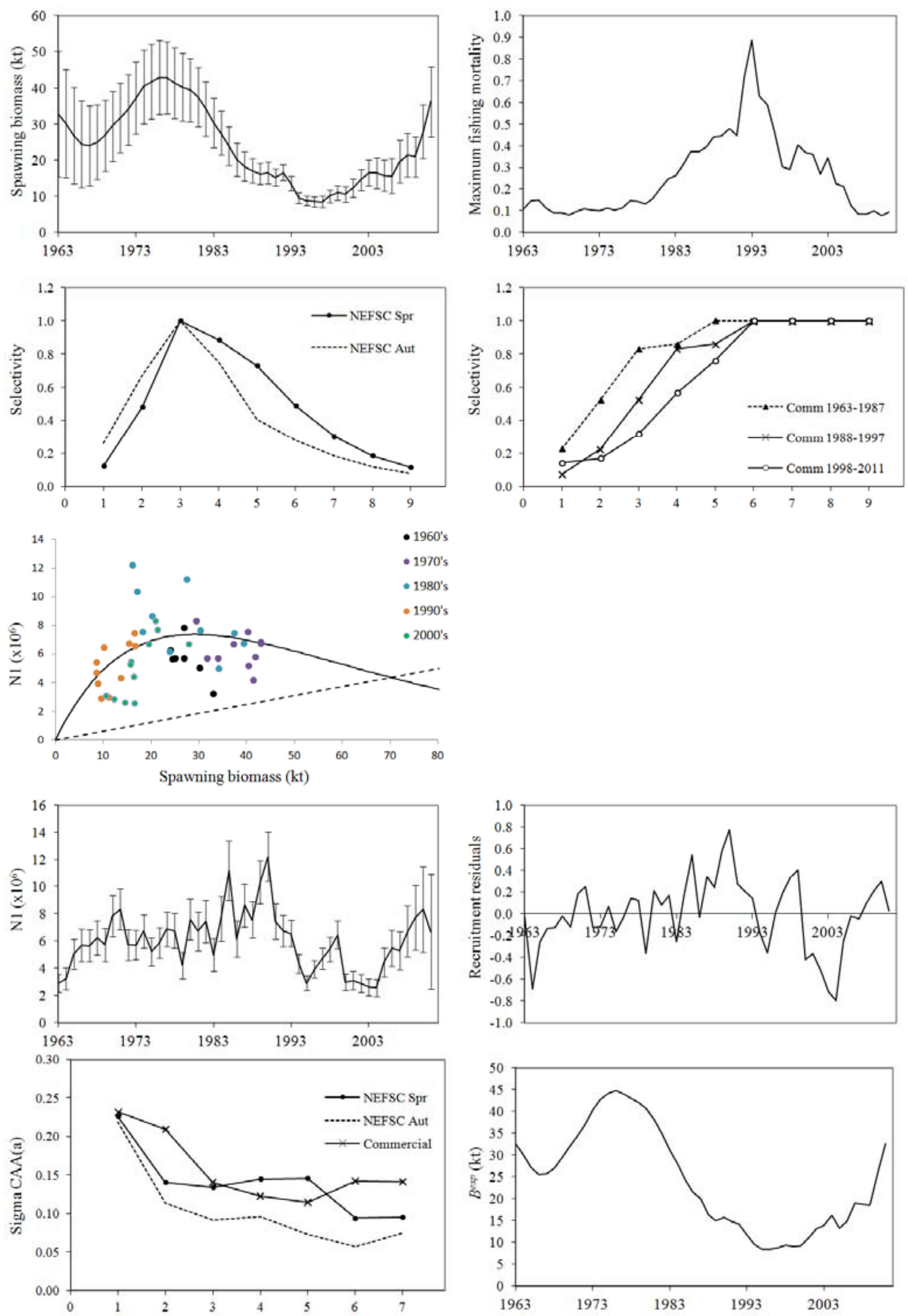
Appendix Figure B1.9a: Spawning biomass and recruitment trajectories for EvenNewerRCp and some sensitivities.



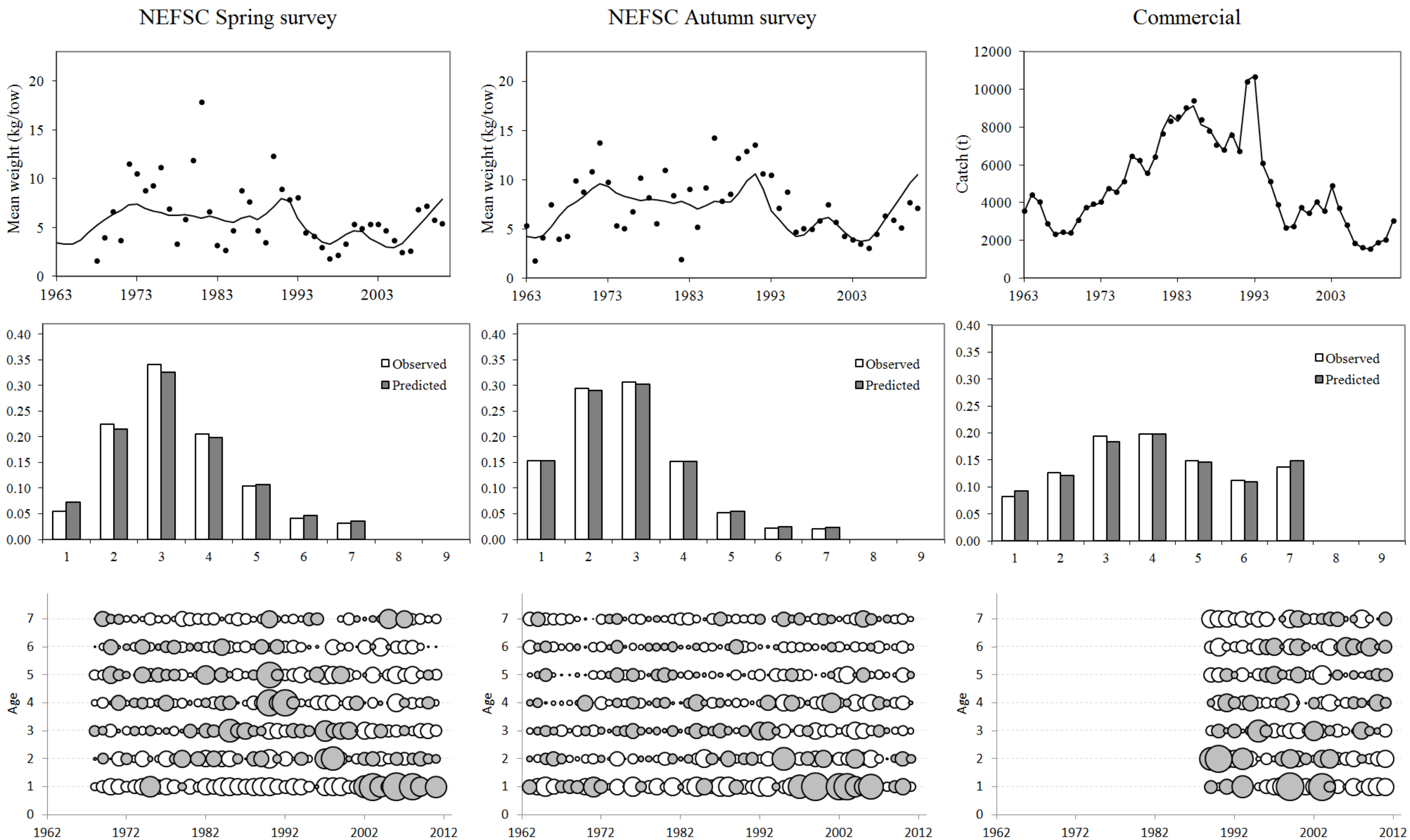
Appendix Figure B1.9b: Spawning biomass and recruitment trajectories for EvenNewerRCp and some sensitivities and a version of the ASAP.



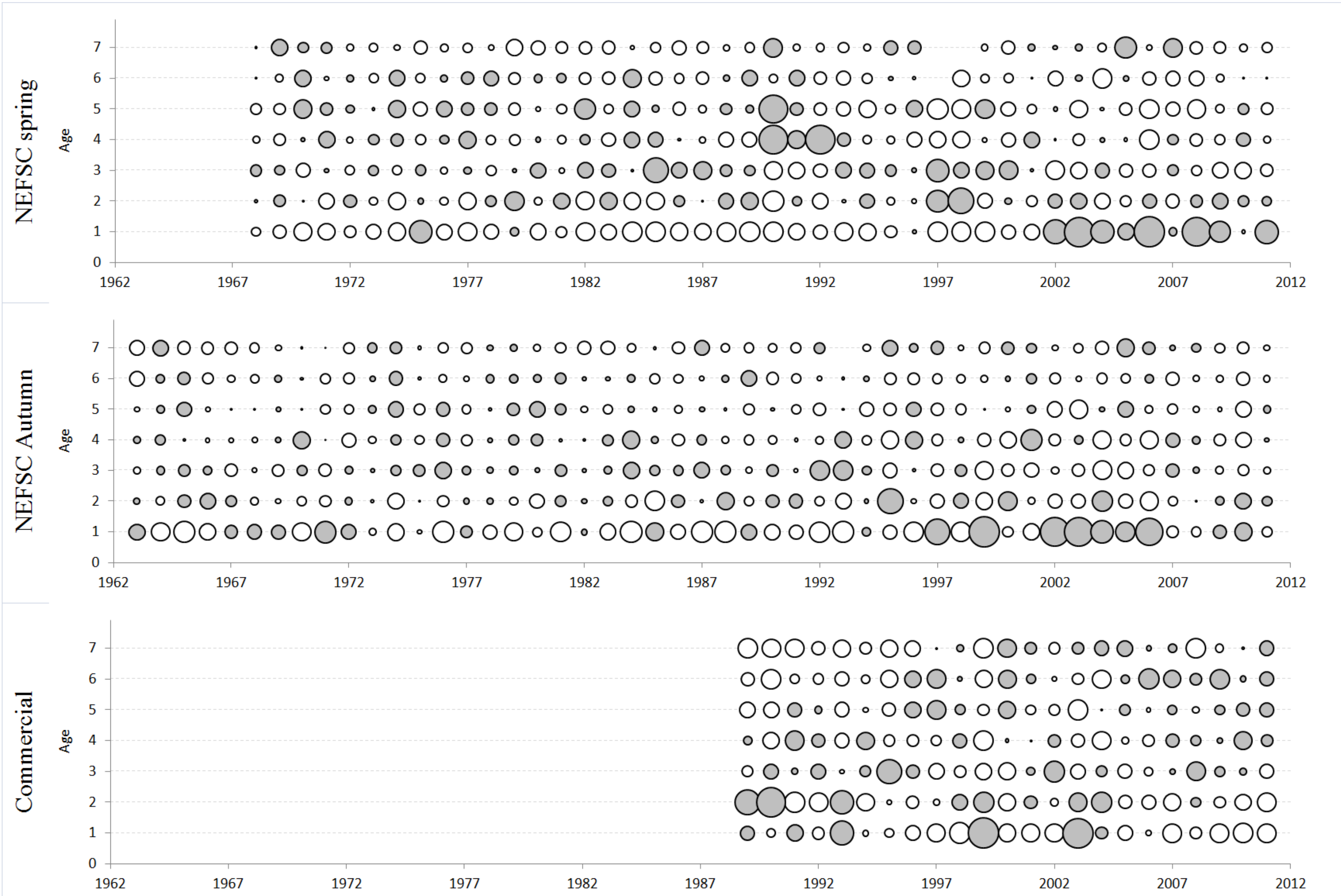
Appendix Figure B1.10. Spawner-recruit plots from RCNewer to BH and noSR



Appendix Figure B1.11: Results for the RCpEvenNewer Georges Bank/Gulf of Maine white hake assessment.



Appendix Figure B1.12a: Fit of RCpEvenNewer to the survey and commercial data



Appendix Figure B1.12b: Fit of RCpEvenNewer to the survey and commercial data

Appendix B2

Algebraic details of the Statistical Catch-at-Age Model

The text following sets out the equations and other general specifications of the Statistical Catch-at-Age (SCAA) assessment model applied to white hake, followed by details of the contributions to the (penalised) log-likelihood function from the different sources of data available and assumptions concerning the stock-recruitment relationship. Quasi-Newton minimization is applied to minimize the total negative log-likelihood function to estimate parameter values (the package AD Model Builder™, Otter Research, Ltd is used for this purpose).

Where options are provided under a particular section, the section concludes with a statement in **bold** as to which option was selected for the provisional Reference Case (RCp) run selected.

B2.1. Population dynamics

B2.1.1 Numbers-at-age

The resource dynamics are modelled by the following set of population dynamics equations:

$$N_{y+1,1} = R_{y+1} \quad \text{(B2.1)}$$

$$N_{y+1,a+1} = N_{y,a}e^{-Z_{y,a}} \qquad \text{for } 1 \le a \le m-2 \quad \text{(B2.2)}$$

$$N_{y+1,m} = N_{y,m-1}e^{-Z_{y,m-1}} + N_{y,m}e^{-Z_{y,m}} \qquad \text{(B2.3)}$$

where

$N_{y,a}$ is the number of fish of age *a* at the start of year *y*,

R_y is the recruitment (number of 1-year-old fish) at the start of year *y*,

m is the maximum age considered (taken to be a plus-group).

$Z_{y,a} = F_y S_{y,a} + M_a$ is the total mortality in year *y* on fish of age *a*, where

M_a denotes the natural mortality rate for fish of age *a*,

F_y is the fishing mortality of a fully selected age class in year *y*, and

$S_{y,a}$ is the commercial selectivity at age *a* for year *y*.

B2.1.2. Recruitment

The number of recruits (i.e. new 1-year olds) at the start of year *y* is assumed to be related to the spawning stock size (i.e. the biomass of mature fish) by either a modified Ricker or a Beverton-Holt stock-recruitment relationship, allowing for annual fluctuation about the deterministic relationship.

For the modified Ricker:

$$R_y = \alpha B^{\text{sp}}_{y-1} \exp\left[-\beta\left(B^{\text{sp}}_{y-1}\right)^{\gamma}\right] e^{(\varsigma_y-(\sigma_R)^2/2)} \qquad \text{(B2.4)}$$

and for the (standard) Beverton-Holt:

$$R_y = \frac{\alpha B_{y-1}^{sp}}{\beta + B_{y-1}^{sp}} e^{(\varsigma_y - (\sigma_R)^2/2)} \quad \text{(B2.5)}$$

where

α, β, and γ are spawning biomass-recruitment relationship parameters,

ς_y reflects fluctuation about the expected recruitment for year y, which is assumed to be normally distributed with standard deviation σ_R (which is input in the applications considered here); these residuals are treated as estimable parameters in the model fitting process.

B_y^{sp} is the spawning biomass at the start of year y, computed as:

$$B_y^{sp} = \sum_{a=1}^{m} f_a w_{y,a}^{strt} N_{y,a} e^{-Z_{y,a}\mu_{spawn}} \quad \text{(B2.6)}$$

because spawning for the cod stock under consideration is taken to occur three months (μ_{spawn} = 0.25) after the start of the year and some mortality has therefore occurred,

where

$w_{y,a}^{strt}$ is the mass of fish of age a during spawning, and

f_a is the proportion of fish of age a that are mature.

For RCp, the modified Ricker, with γ fixed to 1, has been used, i.e. the classical Ricker function.

B2.1.3. Total catch and catches-at-age

The total catch by mass in year y is given by:

$$C_y = \sum_{a=1}^{m} w_{y,a}^{mid} C_{y,a} = \sum_{a=1}^{m} w_{y,a}^{mid} N_{y,a} \; S_{y,a} F_y \left(1 - e^{-Z_{y,a}}\right) \Big/ Z_{y,a} \quad \text{(B2.7)}$$

where

$w_{y,a}^{mid}$ denotes the mass of fish of age a landed in year y,

$C_{y,a}$ is the catch-at-age, i.e. the number of fish of age a, caught in year y.

The model estimate of survey index is computed as:

$$B_y^{surv} = \sum_{a=1}^{m} w_{y,a}^{surv} S_a^{surv} N_{y,a} e^{-Z_{y,a}T^{surv}/12} \quad \text{(B2.8)}$$

for biomass indices and

$$N_y^{\text{surv}} = \sum_{a=1}^{m} S_a^{\text{surv}} N_{y,a} e^{-Z_{y,a}T^{surv}/12} \quad \text{(B2.9)}$$

for numbers indices

where

S_a^{surv} is the survey selectivity for age *a*, which is taken to be year-independent.

T^{surv} is the season in which the survey is taking place (T^{surv}=3 for spring surveys and T^{surv}=9 for fall surveys), and

$w_{y,a}^{surv}$ denotes the mass of fish of age *a* from survey *surv* year, taken as $w_{y,a}^{strt}$ for the spring survey and $w_{y,a}^{mid}$ for the autumn survey.

RCp is fitted to biomass indices.

B2.1.4. Initial conditions

As the first year for which data (even annual catch data) are available for the white hake stock considered clearly does not correspond to the first year of (appreciable) exploitation, one cannot necessarily make the conventional assumption in the application of SCAA's that this initial year reflects a population (and its age-structure) at pre-exploitation equilibrium. For the first year (y_0) considered in the model therefore, the stock is assumed to be at a fraction (θ) of its pre-exploitation biomass, i.e.:

$$B_{y_0}^{\text{sp}} = \theta \cdot K^{\text{sp}} \quad \text{(B2.10)}$$

with the starting age structure:

$$N_{y_0,a} = R_{\text{start}} N_{\text{start},a} \qquad \text{for } 1 \le a \le m \quad \text{(B2.11)}$$

where

$$N_{\text{start},1} = 1 \qquad \text{(B2.12)}$$

$$N_{\text{start},a} = N_{\text{start},a-1} e^{-M_{a-1}} (1-\phi S_{a-1}) \qquad \text{for } 2 \le a \le m-1 \quad \text{(B2.13)}$$

$$N_{\text{start},m} = N_{\text{start},m-1} e^{-M_{m-1}} (1-\phi S_{m-1}) \big/ (1-e^{-M_m}(1-\phi S_m)) \quad \text{(B2.14)}$$

where ϕ characterises the average fishing proportion over the years immediately preceding y_0.

For RCp, θ and ϕ are estimated directly in the model fitting procedure.

B2.2. The (penalised) likelihood function

The model can be fit to (a subset of) survey abundance indices, and commercial and survey catch-at-age and catch-at-length data to estimate model parameters (which may include residuals about the stock-recruitment function, facilitated through the incorporation of a penalty function described below). Contributions by each of these to the negative of the (penalised) log-likelihood (- $\ell\text{n}L$) are as follows.

B2.2.1. Survey abundance data

The likelihood is calculated assuming that a survey biomass index is log normally distributed about its expected value:

$$I_y^{surv} = \hat{I}_y^{surv} \exp\left(\varepsilon_y^{surv}\right) \quad \text{or} \quad \varepsilon_y^{surv} = \ell\text{n}\left(I_y^{surv}\right) - \ell\text{n}\left(\hat{I}_y^{surv}\right) \qquad \text{(B2.15)}$$

where

I_y^{surv} is the survey index for survey *surv* in year *y*,

$\hat{I}_y^{surv} = \hat{q}^{surv} \hat{B}_y^{surv}$ is the corresponding model estimate, where

$\hat{q}^{surv}$ is the constant of proportionality (catchability) for the survey biomass series *surv*, and

ε_y^{surv} from $N\left(0, \left(\sigma_y^{surv}\right)^2\right)$.

The contribution of the survey biomass data to the negative of the log-likelihood function (after removal of constants) is then given by:

$$-\ell\text{n}\, L^{\text{survey}} = \sum_{surv} \sum_{y} \left\{ \ell\text{n}\left(\sqrt{\left(\sigma_y^{surv}\right)^2 + \left(\sigma_{Add}^{surv}\right)^2} \right) + \left(\varepsilon_y^{surv}\right)^2 / \left[2\left(\left(\sigma_y^{surv}\right)^2 + \left(\sigma_{Add}^{surv}\right)^2 \right) \right] \right\} \qquad \text{(B2.16)}$$

where

σ_y^{surv} is the standard deviation of the residuals for the logarithm of index *i* in year *y* (which are input), and

σ_{Add}^{surv} is the square root of the additional variance for survey biomass series *surv*, which is estimated in the model fitting procedure, with an upper bound of 0.5.

The catchability coefficient q^{surv} for survey biomass index *surv* is estimated by its maximum likelihood value:

$$\ell n\, \hat{q}^{surv} = 1/n_{surv} \sum_{y} \left(\ln I_y^{surv} - \ln \hat{B}_y^{surv} \right) \text{(B2.17)}$$

B2.2.3. Commercial catches-at-age

The contribution of the catch-at-age data to the negative of the log-likelihood function under the assumption of an "adjusted" lognormal error distribution is given by:

$$-\ell\text{n}\, L^{\text{CAA}} = \sum_{y} \sum_{a} \left[\ell n\left(\sigma_a^{com} / \sqrt{p_{y,a}} \right) + p_{y,a} \left(\ell n\, p_{y,a} - \ell n\, \hat{p}_{y,a} \right)^2 / 2\left(\sigma_a^{com}\right)^2 \right] \qquad \text{(B2.18)}$$

where

$p_{y,a} = C_{y,a} / \sum_{a'} C_{y,a'}$ is the observed proportion of fish caught in year *y* that are of age *a*,

$\hat{p}_{y,a} = \hat{C}_{y,a} / \sum_{a'} \hat{C}_{y,a'}$ is the model-predicted proportion of fish caught in year *y* that are of age *a*,

where

$$\hat{C}_{y,a} = N_{y,a}\ S_{y,a} F_y \left(1 - e^{-Z_{y,a}}\right) / Z_{y,a} \quad \text{(B2.19)}$$

and

σ_a^{com} is the standard deviation associated with the catch-at-age data, which is estimated in the fitting procedure by:

$$\hat{\sigma}_a^{com} = \sqrt{\sum_y p_{y,a} \left(\ell n\, p_{y,a} - \ell n\, \hat{p}_{y,a}\right)^2 / \sum_y 1} \quad \text{(B2.20)}$$

Commercial catches-at-age are incorporated in the likelihood function using equation (A1.18), for which the summation over age a is taken from age a_{minus} (considered as a minus group) to a_{plus} (a plus group).

In addition to this “adjusted” lognormal error distribution, some computations use an alternative “sqrt(p)” formulation, for which equation A1.18 is modified to:

$$-\ell\text{n}\, L^{\text{CAA}} = \sum_y \sum_a \left[\ell n\left(\sigma_a^{com}\right) + \left(\sqrt{p_{y,a}} - \sqrt{\hat{p}_{y,a}}\right)^2 / 2\left(\sigma_a^{\text{com}}\right)^2 \right] \quad \text{(B2.21)}$$

and equation A1.20 is adjusted similarly:

$$\hat{\sigma}_a^{com} = \sqrt{\sum_y \left(\sqrt{p_{y,a}} - \sqrt{\hat{p}_{y,a}}\right)^2 / \sum_y 1} \quad \text{(B2.22)}$$

This formulation mimics a multinomial form for the error distribution by forcing a near-equivalent variance-mean relationship for the error distributions.

B2.2.4. Survey catches-at-age

The survey catches-at-age are incorporated into the negative of the log-likelihood in an analogous manner to the commercial catches-at-age, assuming an “adjusted” lognormal error distribution (equation (A1.18)) where:

$p_{y,a}^{surv} = C_{y,a}^{surv} / \sum_{a'} C_{y,a'}^{surv}$ is the observed proportion of fish of age a in year y for survey *surv*,

$\hat{p}_{y,a}^{surv}$ is the expected proportion of fish of age a in year y in the survey *surv*, given by:

$$\hat{p}_{y,a}^{surv} = S_a^{\text{surv}} N_{y,a} e^{-Z_{y,a} T^{surv}/12} \Big/ \sum_{a'=1}^{m} S_{a'}^{\text{surv}} N_{y,a'}\, e^{-Z_{y,a'} T^{surv}/12} \quad . \quad \text{(B2.23)}$$

RCp uses the “adjusted log-normal” formulation for the error distribution of the commercial catch proportions-at-age and survey catch proportions-at-age.

B2.2.5. Survey catches-at-length

In some runs, catches-at-length are also incorporated in the likelihood function. These data are incorporated in the similar manner as the catches-at-age. When the model is fit to catches-at-length, the predicted catches-at-age are converted to catches-at-length:

$$\hat{p}_{y,l}^{surv} = \sum_a \hat{p}_{y,a}^{surv} A_{a,l}^{strt} \quad \text{(B2.24)}$$

for the spring survey, and

$$\hat{p}^{surv}_{y,l} = \sum_a \hat{p}^{surv}_{y,a} A^{mid}_{a,l} \qquad \text{(B2.25)}$$

for the fall survey,

where $A^{strt}_{a,l}$ and $A^{mid}_{a,l}$ are the proportions of fish of age *a* that fall in the length group *l* (i.e., $\sum_l A^{strt}_{a,l} = 1$ and $\sum_l A^{mid}_{a,l} = 1$ for all ages) at the beginning of the year and at the middle of the year respectively.

The matrices $A^{strt}_{a,l}$ and $A^{mid}_{a,l}$ are calculated under the assumption that length-at-age is normally distributed about a mean given by the von Bertalanffy equation, i.e.:

$$L^{strt}_a \sim N\left[L_\infty\left(1-e^{-\kappa(a-t_o)}\right);\left(\theta^{strt}_a\right)^2\right] \text{(B2.26)}$$

for the spring survey and

$$L^{mid}_a \sim N\left[L_\infty\left(1-e^{-\kappa(a+0.5-t_o)}\right);\left(\theta^{mid}_a\right)^2\right] \qquad \text{(B2.27)}$$

for the fall survey,

where

θ^{strt}_a and θ^{mid}_a are the standard deviation of begin and mid-year length-at-age *a* respectively, which are modelled to be proportional to the expected length-at-age *a*, i.e.:

$$\theta^{strt}_a = \beta\left[L_\infty\left(1-e^{-\kappa(a-t_o)}\right)\right] \qquad \text{(B2.28)}$$

and

$$\theta^{mid}_a = \beta\left[L_\infty\left(1-e^{-\kappa(a+0.5-t_o)}\right)\right] \qquad \text{(B2.29)}$$

with β an estimable parameter.

$L_\infty = 189\, cm$,

$\kappa = 0.0815\, yr^{-1}$,

$t_o = 0.0627 yr$,

The following term is then added to the negative log-likelihood:

$$-\ell \text{n}\, L^{\text{CAL}} = w_{len} \sum_{surv}\sum_y\sum_l \left[\ell n\left(\sigma^{surv}_{\text{len}} / \sqrt{p^{surv}_{y,l}}\right) + p^{surv}_{y,l}\left(\ell n\, p^{surv}_{y,l} - \ell n\, \hat{p}^{surv}_{y,l}\right)^2 / 2\left(\sigma^{surv}_{\text{len}}\right)^2\right] \qquad \text{(B2.30)}$$

The w_{len} weighting factor may be set to a value less than 1 to downweight the contribution of the catch-at-length data (which tend to be positively correlated between adjacent length groups because the length distributions for adjacent ages overlap) to the overall negative log-likelihood compared to that of the CPUE data.

RCp does not incorporate any catch-at-length data.

B2.2.6. Stock-recruitment function residuals

The stock-recruitment residuals are assumed to be log normally distributed. Thus, the contribution of the recruitment residuals to the negative of the (now penalised) log-likelihood function is given by:

$$-\ell nL^{\text{pen}} = \sum_{y=y_1+1}^{y_2} \left[\varepsilon_y^2 / 2\sigma_{\text{R}}^2\right] \quad \text{(B2.31)}$$

where

ε_y from $N\left(0,(\sigma_R)^2\right)$,

σ_{R} is the standard deviation of the log-residuals, which is input.

Equation B2.31 is used when the stock-recruitment curve is estimated internally. In some analyses reported in this paper where BRP estimates are based on stock-recruitment curves estimated "externally" using the assessment outputs, this "stock-recruitment" term is included for the last two years only, simply to stabilize these estimates which are not well determined by the other data. In these cases, the ε_y are calculated as the deviations from the mean log recruitment for the ten preceding years, i.e. recruitment estimates for 2010 and 2011 are shrunk towards the geometric mean recruitment over the preceding decade.

B2.2.7. Catches

$$-\ell nL^{\text{Catch}} = \sum_y \left[\frac{\ell n\, C_y - \ell n\, \hat{C}_y}{2\sigma_{\text{C}}^2}\right] \quad \text{(B2.32)}$$

where

C_y is the observed catch in year y,

$\hat{C}_y$ is the predicted catch in year y (equation B2.7), and

σ_{C} is the CV input: 0.5 for pre-1964 catches, 0.3 for catches between 1964 and 1981 and 0.1 for catches from 1982 onwards.

B2.2.8 Incorporation of Bigelow vs Albatross survey calibration

The survey data provided are adjusted for the years 2009 to 2011 which were obtained from *Bigelow* surveys; these have been adjusted to "*Albatross* equivalents" through use of calibration factors estimated independently from paired tow experiments (Miller *et al*., 2010). However the survey data before and after the switch of vessels also provide information on the calibration factors because they sample the same cohorts. Incorporation of this information in assessments in this paper has been effected by treating the estimate with its variance as a form of "prior" which is effectively updated in the penalised likelihood estimation when fitting the model. The following contribution is therefore added as a penalty (or a prior in a Bayesian contact) to the negative log-likelihood in the assessment:

$$-\ln L^{calib} = (\Delta \ln \hat{q} - \Delta \ln q)^2 / 2\sigma_{\Delta \ln q}^2 \quad \text{(B2.33)}$$

where

$\Delta \ln q = \ln(2.235)$ is the logged ratio of the catchability of the *Bigelow* to the *Albatross*, with standard error $\sigma_{\Delta \ln q} = 0.173/2.235$,

$\Delta \ln \hat{q}$ is the logged ratio of the catchabilities, estimated directly in the fitting procedure, where $q_{Big}^{Spr/Aut} = e^{\Delta \ln \hat{q}} q_{Alb}^{Spr/Aut}$.

In RCp, the calibration parameters are fixed to those estimated by Miller *et al*. (2010).

B2.3. Estimation of precision

Where quoted, CV's or 95% probability interval estimates are based on the Hessian.

B2.4. Model parameters

B2.4.1. Fishing selectivity-at-age:

For the NEFSC offshore surveys, the fishing selectivities are estimated separately for ages 1 to age 7. The estimated proportional decrease from ages 6 to 7 is assumed to continue multiplicatively to age 9+; this decrease parameter is bounded by 0, i.e. no increase is permitted.

The commercial fishing selectivity, S_a, is estimated separately for ages a_{minus} (1) to 6, and is taken to be flat thereafter. It is taken to differ over two periods: a) pre-1997, and b) 1998-present. The selectivities are estimated directly for each period.

B2.4.2. Other parameters

Stock-recruit standard dev.

σ_R 0.5

Model plus group

m 9

Commercial CAA

a_{minus}*1

a_{plus} 7

Survey CAA		NEFSC spr	NEFSC fall
	a_{minus}*	1	1
	a_{plus}	7	7

Natural mortality

M 0.2 and age independent

Proportion mature-at-age

f_a input, see Table B65

Weight-at-age

$w_{y,a}^{strt}$ input, see Table B39b

$w_{y,a}^{mid}$ input, see Table B39a

Initial conditions for a 1963 starting year

θ estimated

ϕ estimated

* Strictly not a minus group anymore since the catches at age zero are ignored.

B2.5.Biological Reference Points (BRPs)

It is possible to estimate BRPs internally within the assessment by fitting the stock-recruitment relationship directly within the assessment itself. The F_{MSY} estimate is obtained by using a bisection routine to find where the derivative of the equilibrium catch vs F relationship has a zero derivative. This has to be based on point estimates, so that the estimate of other BRPs are conditional on this point estimate of F_{MSY}, with no Hessian based CV available for this quantity.

For some results reported here, however, the stock-recruitment relationships are fitted to the estimates of recruitment and spawning biomass provided by the various assessments to provide a basis to estimate BRPs. The rationale for estimation external to the assessment itself is to avoid assumptions about the form of the relationship influencing the assessment results. These fits are achieved by minimizing the following negative log-likelihood, where the $e^{-\frac{\sigma_R^2}{2}}$ term is added for consistency with equation A1.4, i.e. the stock-recruitment curves estimated are mean-unbiased rather than median unbiased:

$$-\ln L = \sum_{y=y1}^{2009} \left[\frac{\left(\ln(N_{y,1}) - \ln\left(\hat{N}_{y,1} e^{-\frac{\sigma_R^2}{2}} \right) \right)^2}{2\left((\sigma_R)^2 + (CV_y)^2 \right)} \right] \qquad \text{(B2.34)}$$

where

$N_{y,1}$ is the "observed" (assessment estimated) recruitment in year y,

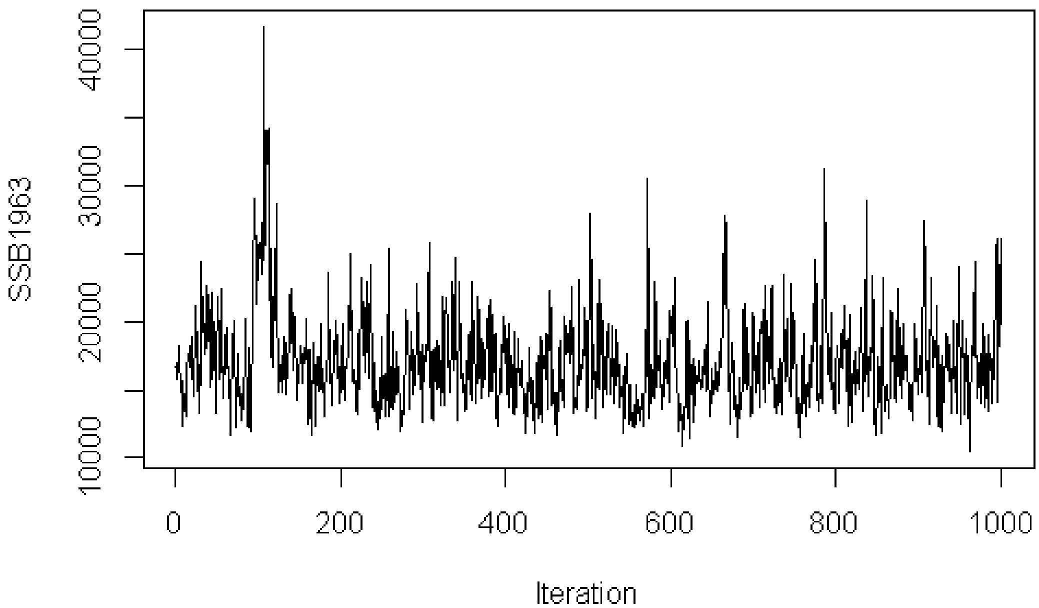
$\hat{N}_{y,1}$ is the stock-recruitment model predicted recruitment in year y,

σ_R is the standard deviation of the log-residuals which is input (and set here to 0.5), and

CV_y is the Hessian-based CV for the "observed" recruitment in year y.

Note that the differential precision of the assessment estimates of recruitment is taken into account, and that the summation ends at 2009 because little by way of direct observation is as yet available to inform estimates of recruitment for 2010 and 2011.

Appendix B3
MCMC Analysis



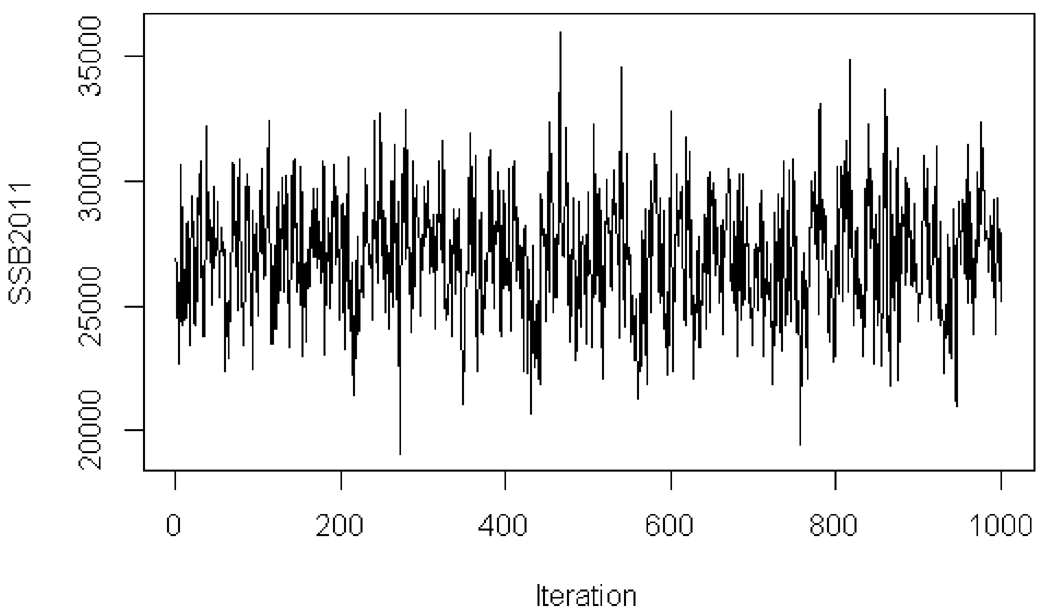


Figure Appendix B3.1a. Trace for SSB in 1963 (top) and 2011 (bottom) for the initial chain. The trace shows some indication of incomplete mixing at the beginning of the chain for the earlier SSB estimate.

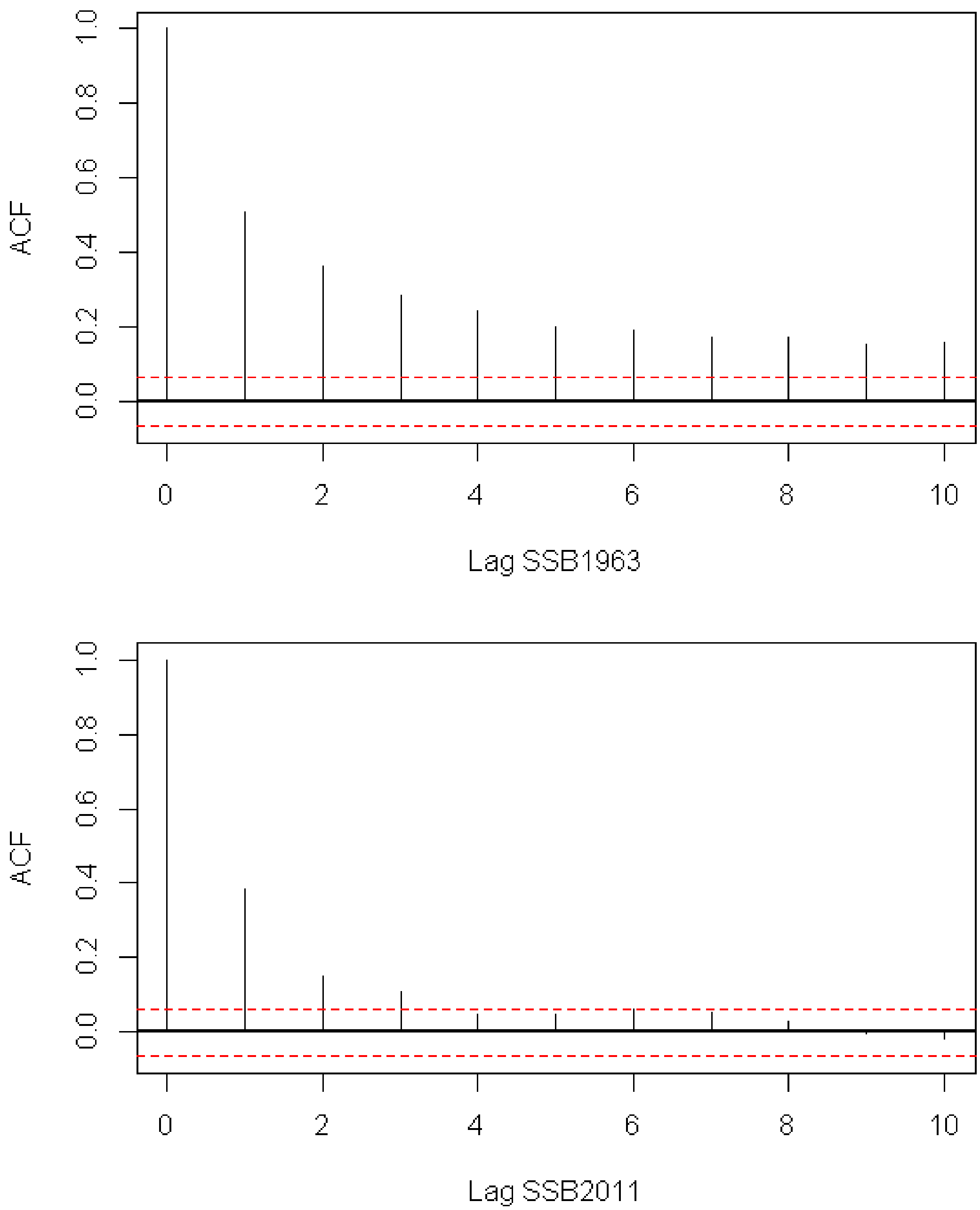


Figure Appendix B3.1b. Plot of autocorrelation within the initial chain of SSB in 1963 (top) and 2011 (bottom). This diagnostic suggests a much higher thinning rate is needed for the early estimates of SSB, while an addition thinning rate of 5 would probably suffice for more recent years.

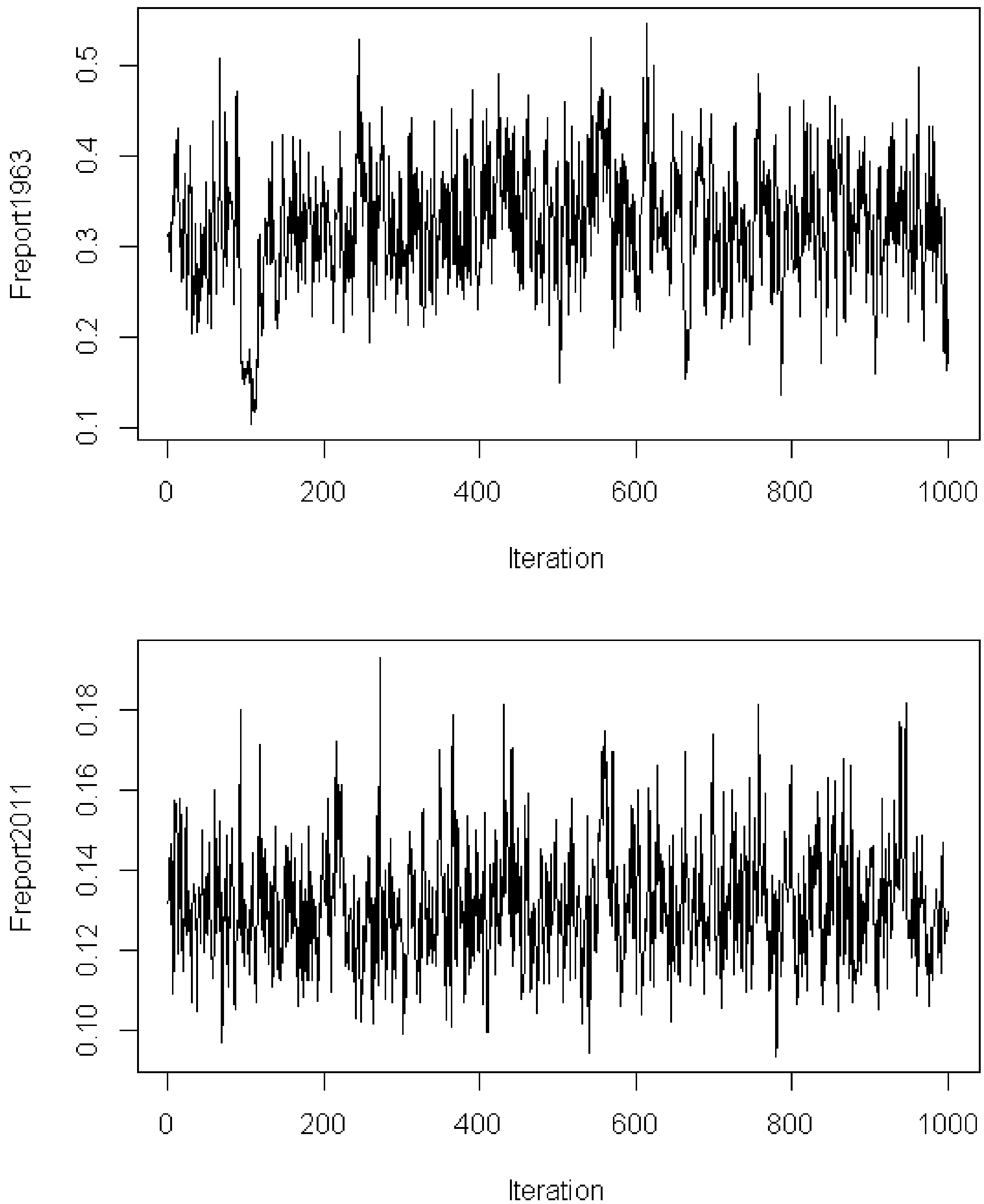


Figure Appendix B3.2a. Trace for Freport in 1963 (top) and 2011 (bottom) for the initial chain. The trace shows some indication of incomplete mixing at the beginning of the chain for the earlier Freport estimate. Freport is the full fishing mortality on age 6.

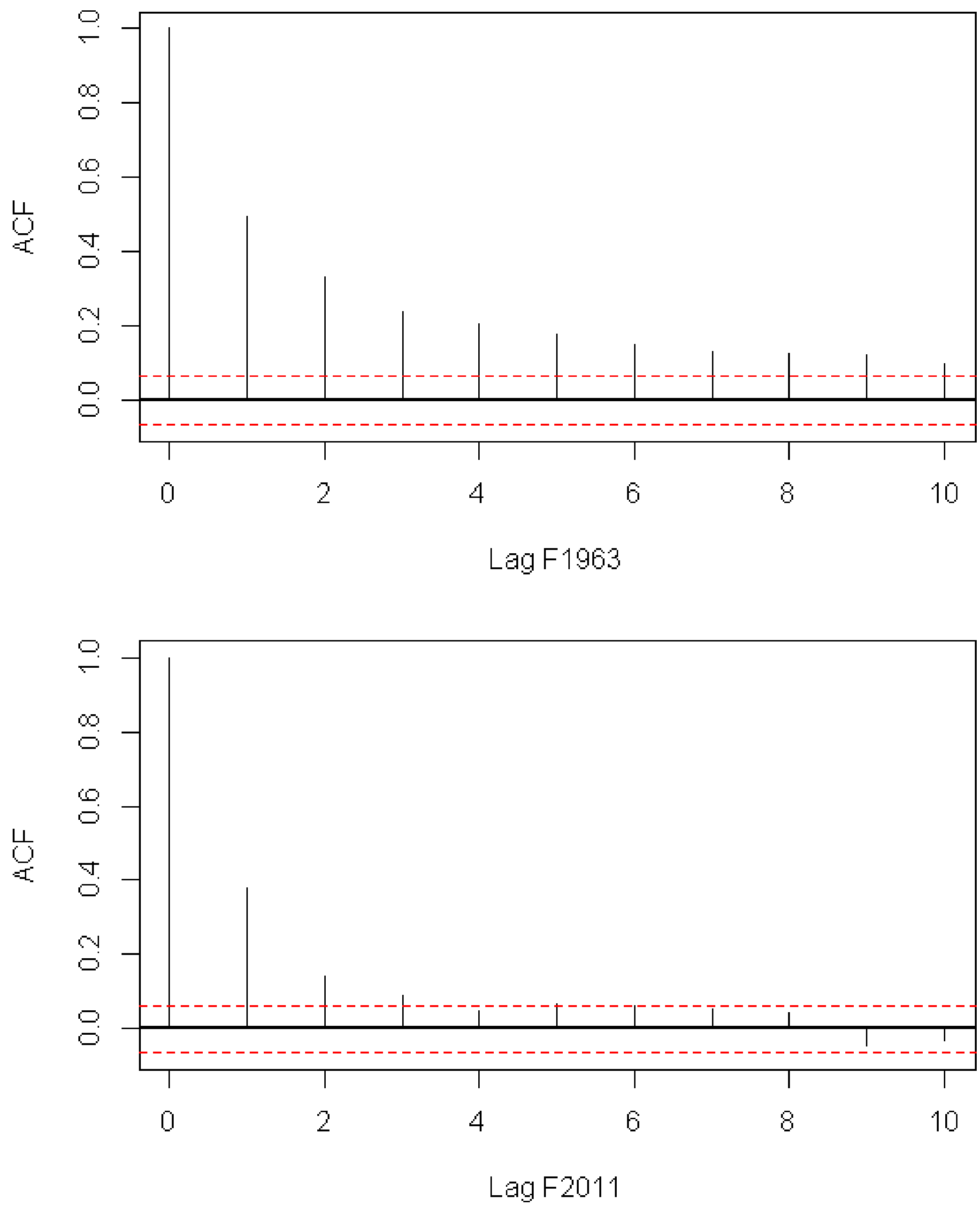
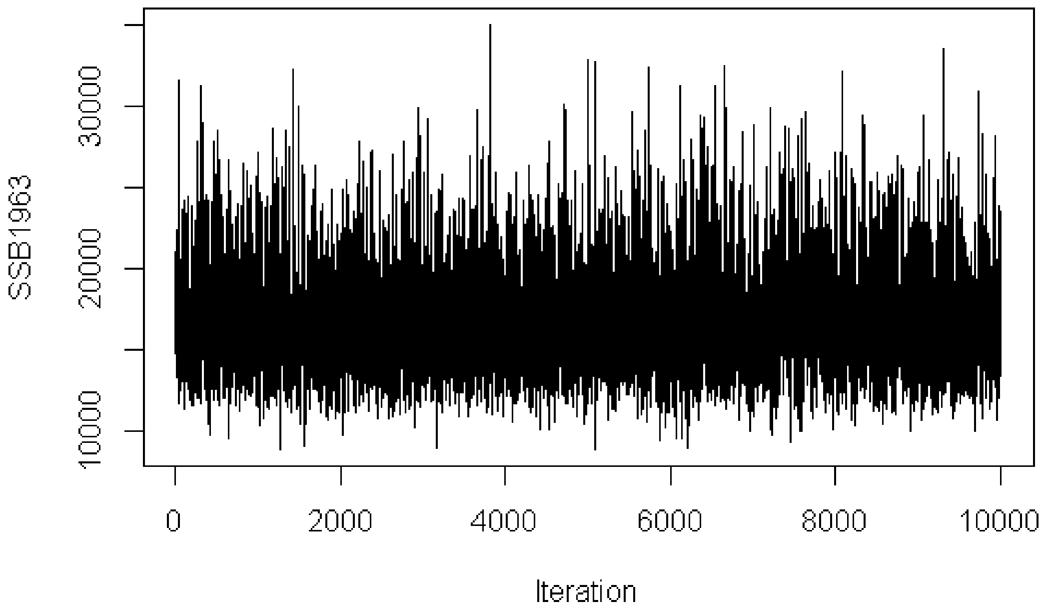


Figure Appendix B3.2b. Plot of autocorrelation within the initial chain of Freport in 1963 (top) and 2011 (bottom). This diagnostic suggests a much higher thinning rate is needed for the early estimates of Freport, while an addition thinning rate of 5 would probably suffice for more recent years.



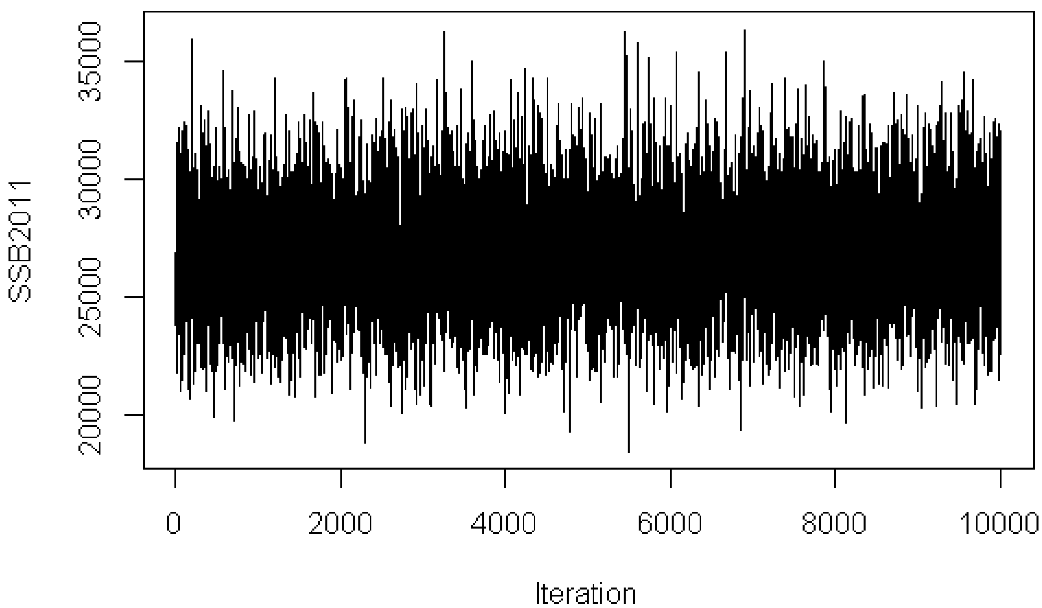


Figure Appendix B3.3a. Trace for SSB in 1963 (top) and 2011 (bottom) for the longer chain (10,000 iterations). The trace suggests adequate mixing.

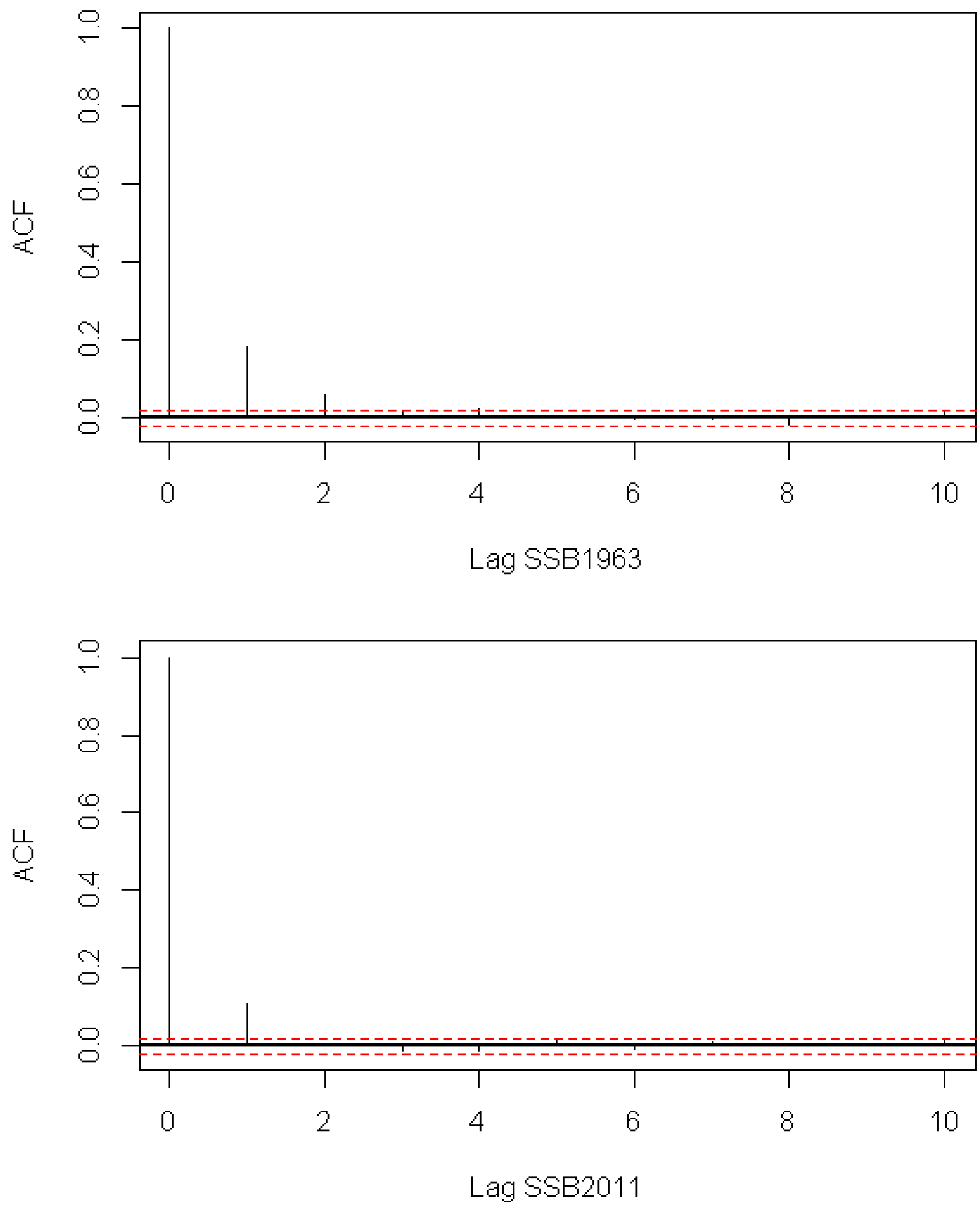
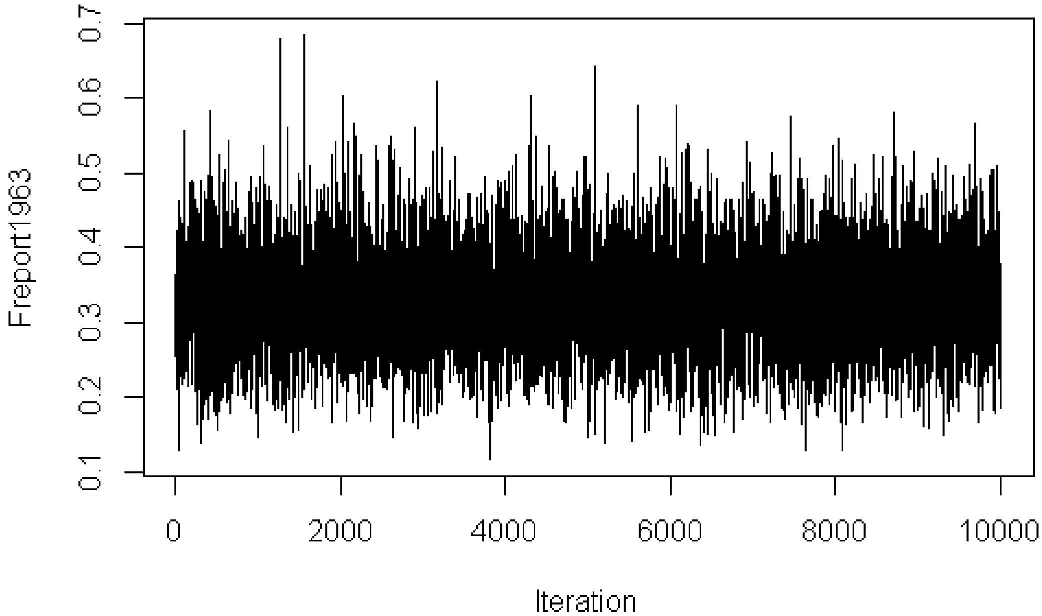


Figure Appendix B3.3b. Plot of autocorrelation within the longer chain (10,000 iterations) of SSB in 1963 (top) and 2011 (bottom). This diagnostic suggests a slightly higher thinning rate is needed for the estimates of SSB.



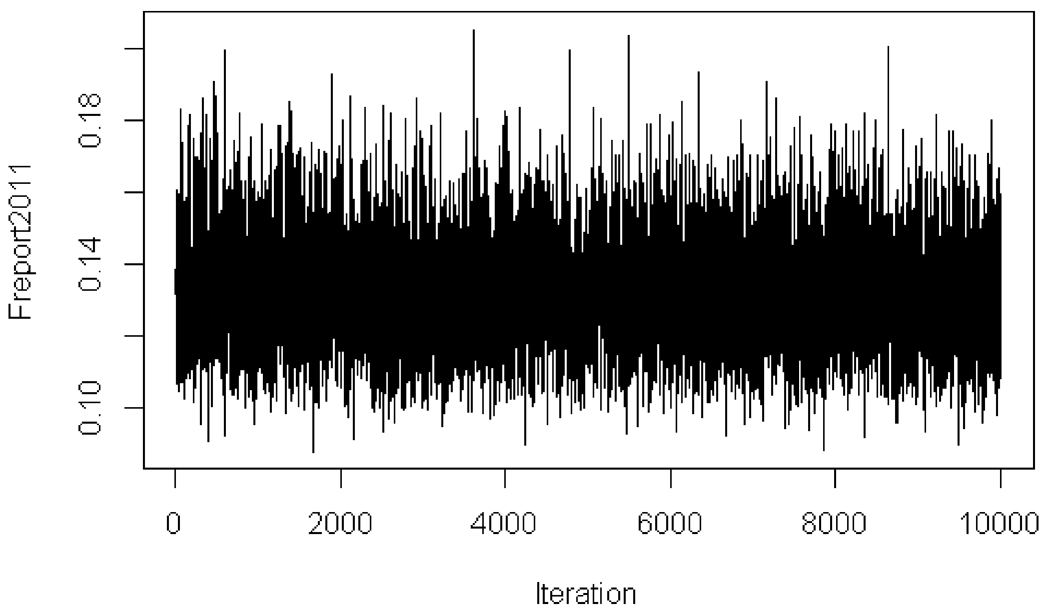
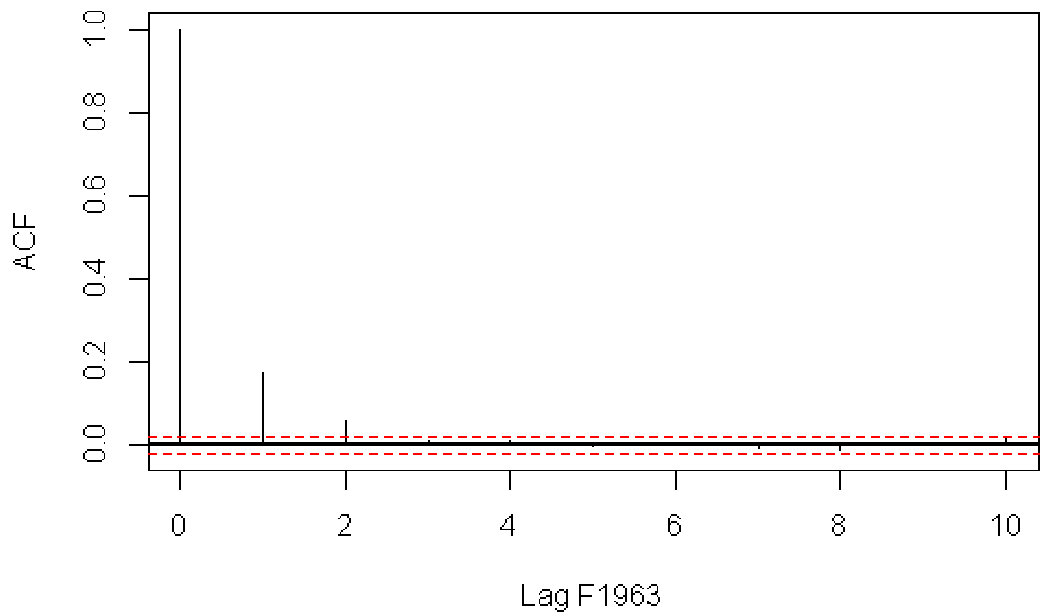


Figure Appendix B3.4a. Trace for Freport in 1963 (top) and 2011 (bottom) for the longer chain (10,000 iterations). The trace suggests adequate mixing.



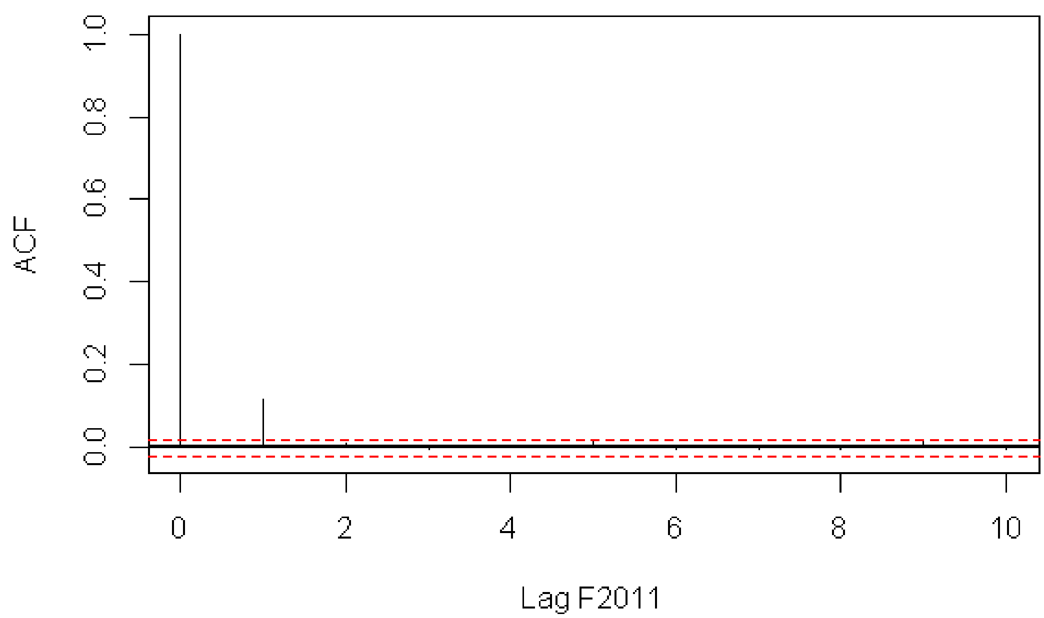


Figure Appendix B3.4b. Plot of autocorrelation within the longer chain (10,000 iterations) of Freport in 1963 (top) and 2011 (bottom). This diagnostic suggests a slightly higher thinning rate is needed for the estimates of Freport.

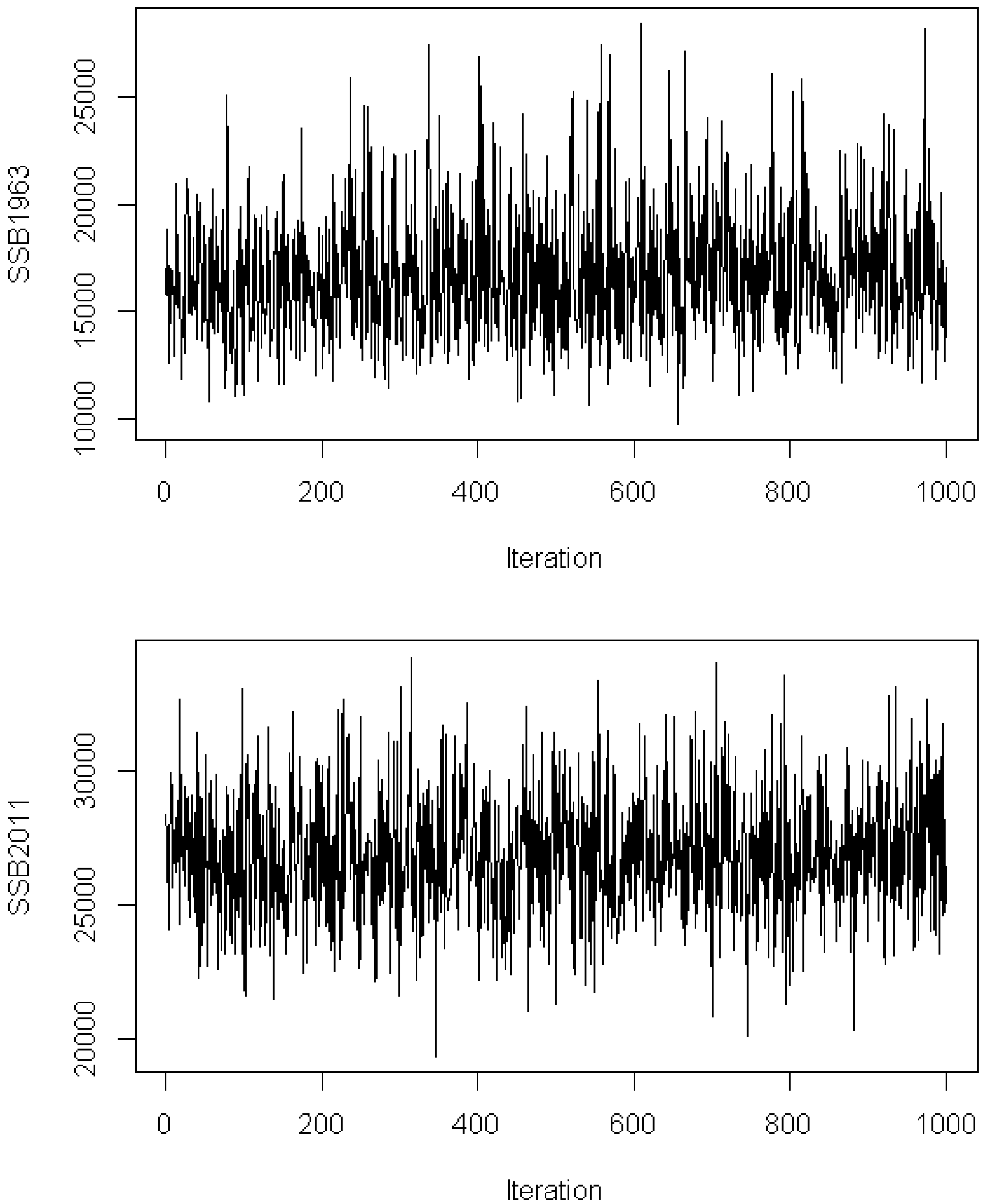
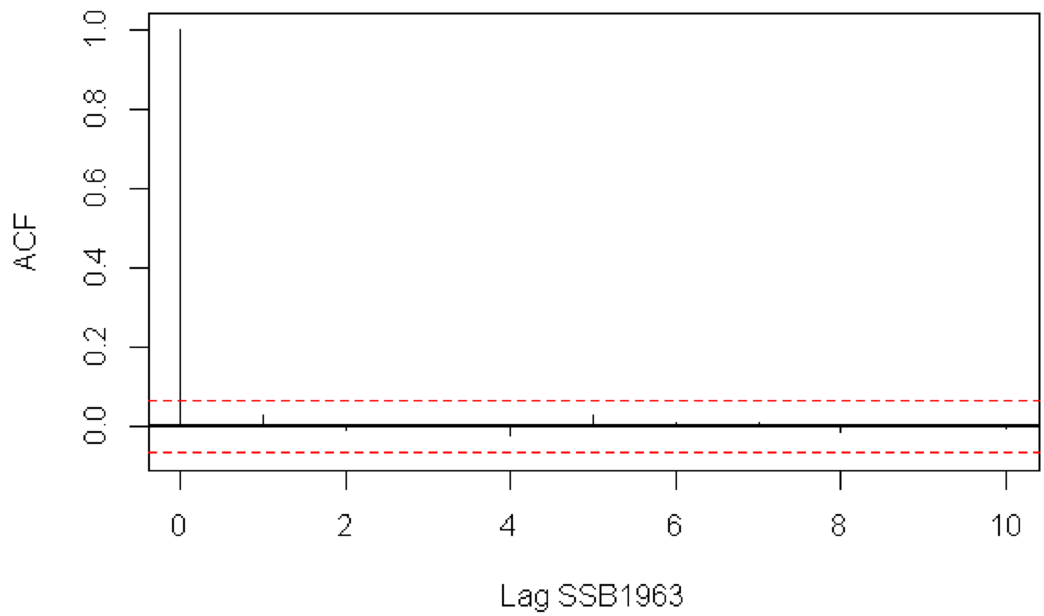


Figure Appendix B3.5a. Trace for SSB in 1963 (top) and 2011 (bottom) for the longer chain after burn-in and additional thinning (1,000 remaining iterations). The trace suggests adequate mixing.



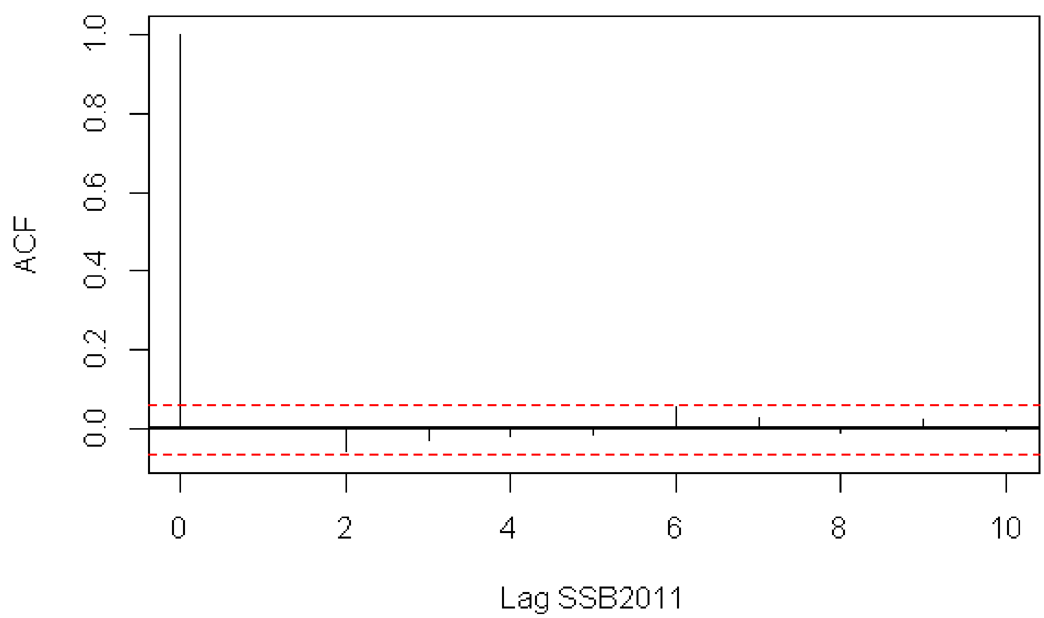


Figure Appendix B3.5b. Plot of autocorrelation within the longer chain after burn-in and thinning (1000 remaining iterations) of SSB in 1963 (top) and 2011 (bottom). This diagnostic suggests no additional thinning is needed.

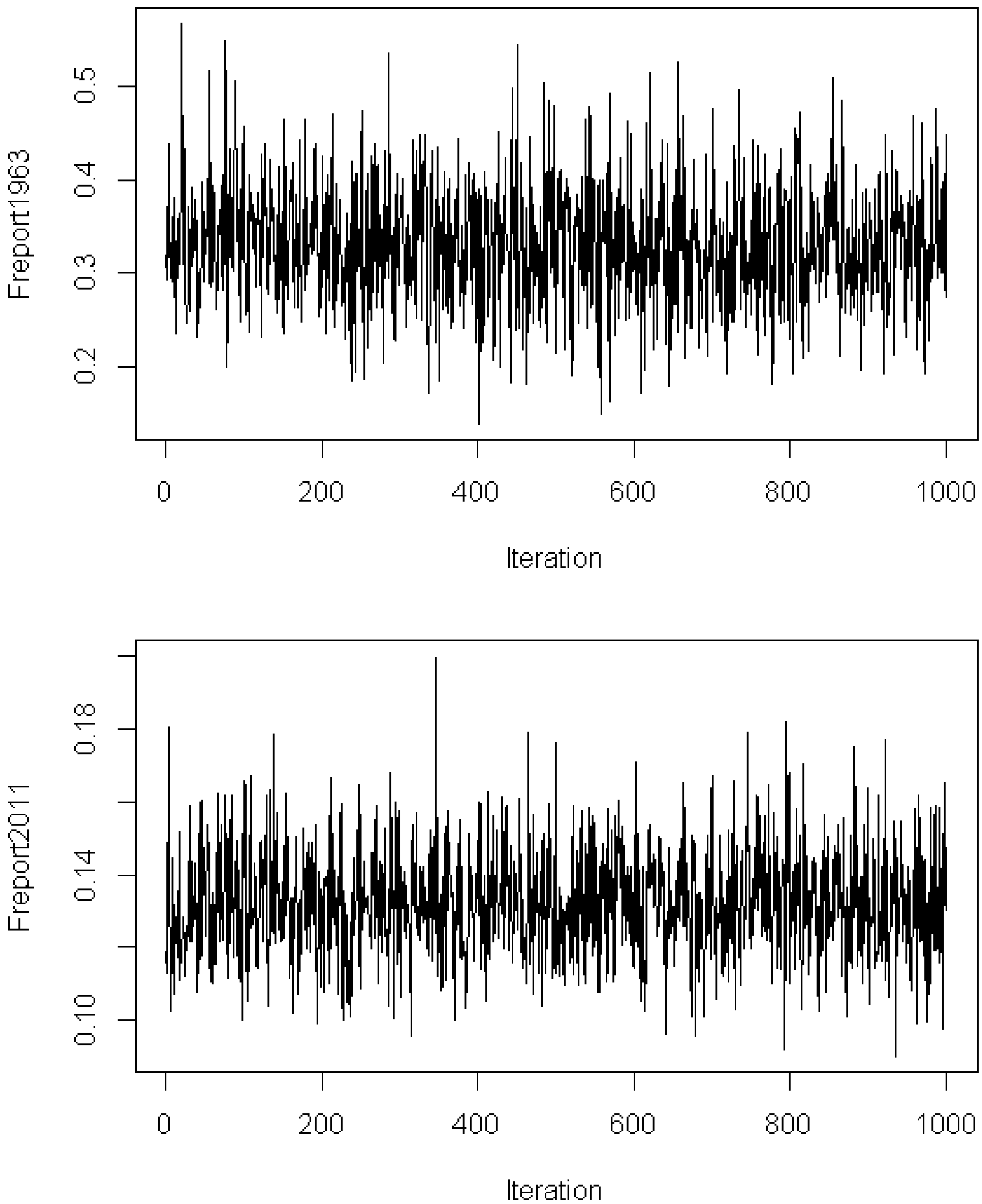


Figure Appendix B3.6a. Trace for Freport in 1963 (top) and 2011 (bottom) for the longer chain after burn-in and additional thinning (1,000 remaining iterations). The trace suggests adequate mixing.

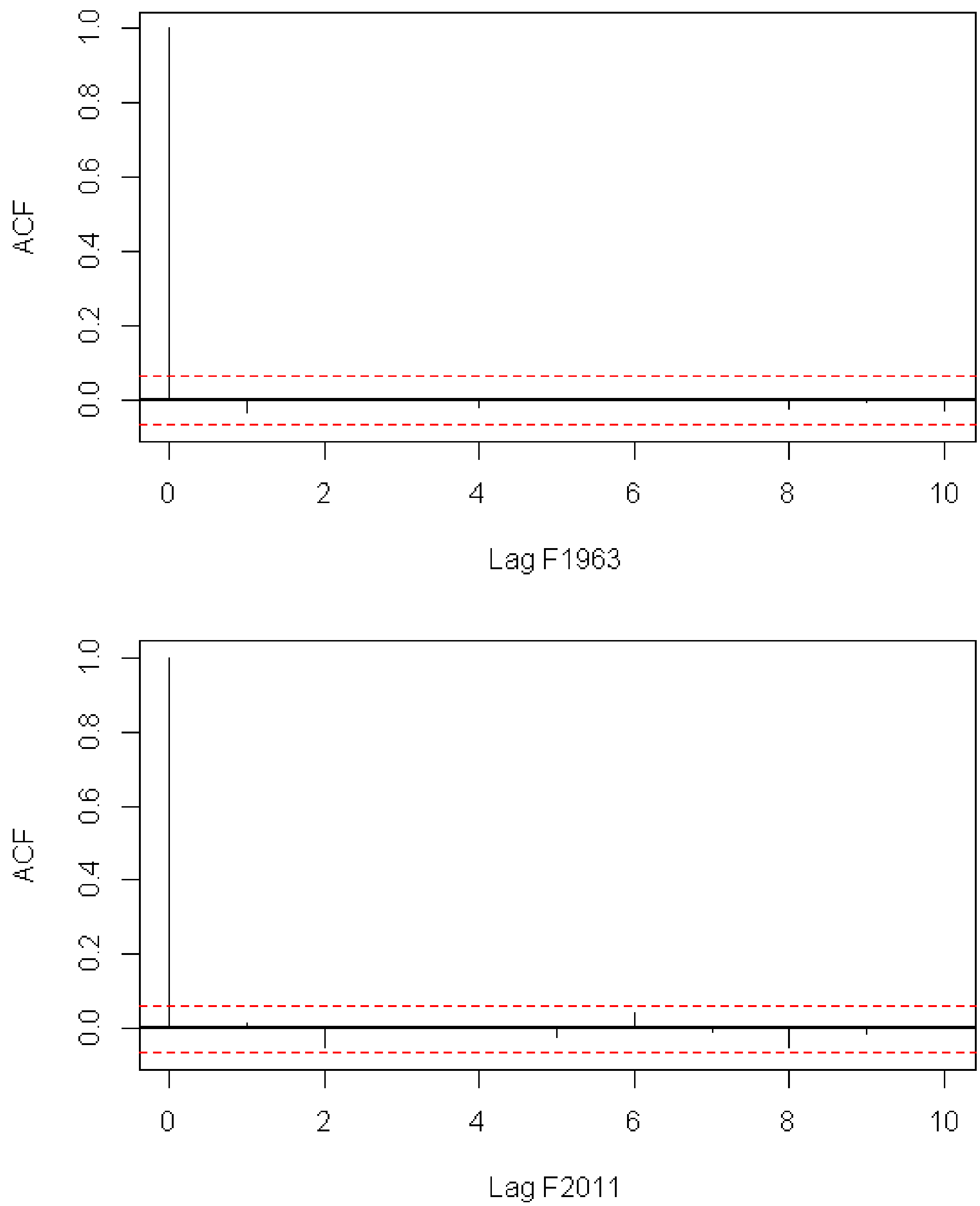


Figure Appendix B3.6b. Plot of autocorrelation within the longer chain after burn-in and thinning (1000 remaining iterations) of Freport in 1963 (top) and 2011 (bottom). This diagnostic suggests no additional thinning is needed.

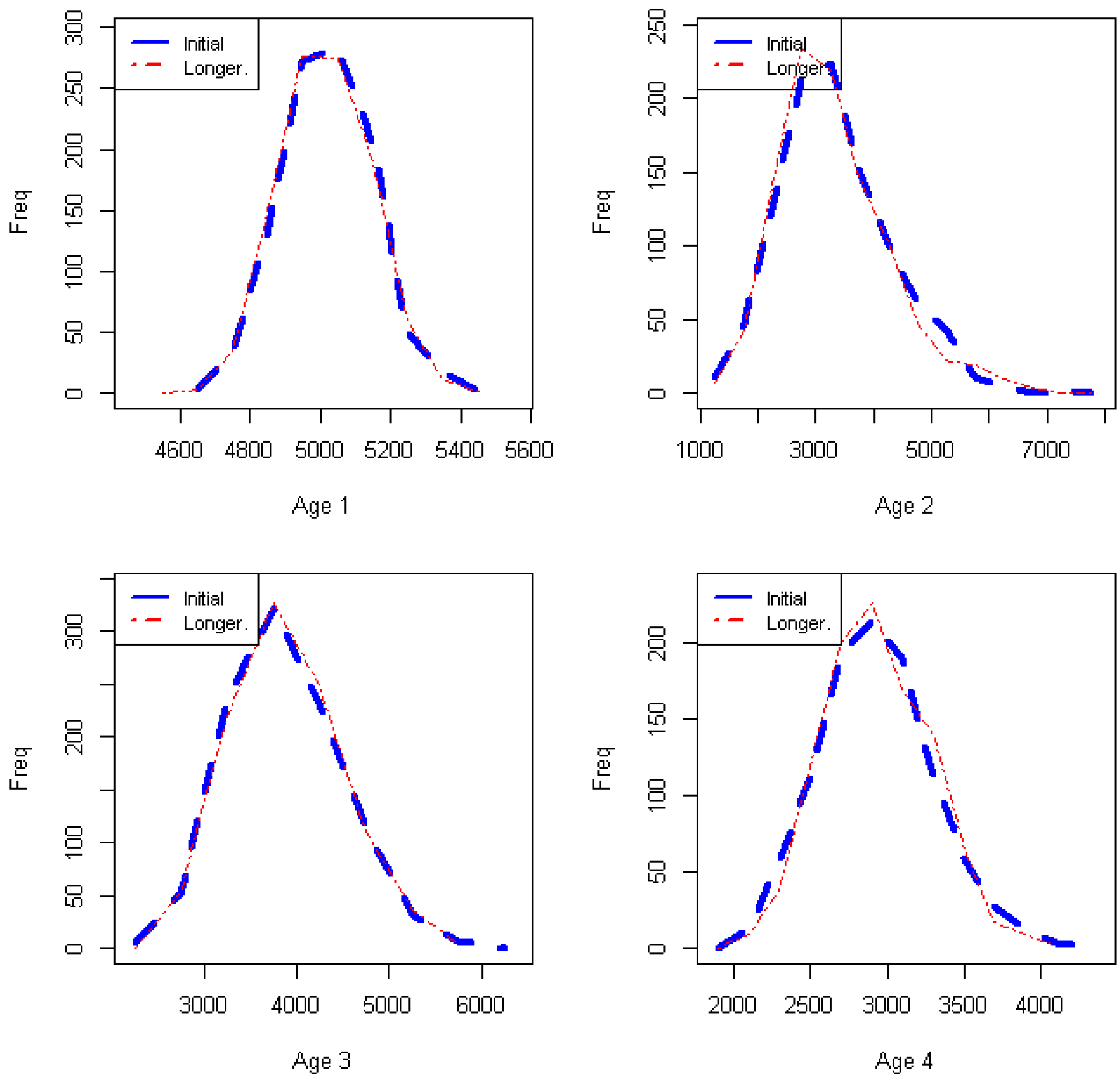


Figure Appendix B3.7. Comparison of distributions of numbers at age for the initial chain (200,000 thinned to 1000 iterations) and a longer chain (5 million, with burn-in and thinning to 1000 final iterations)

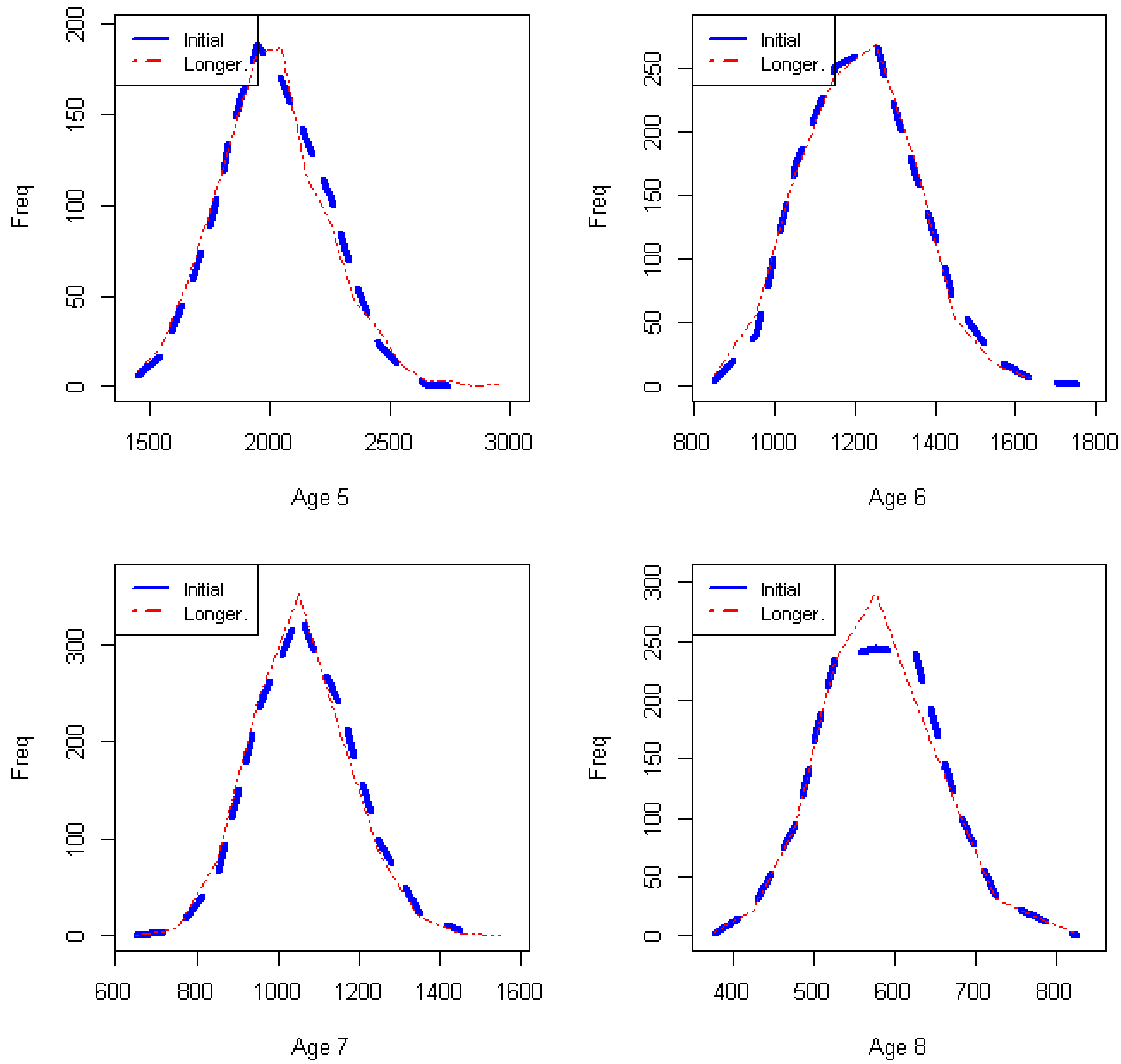


Figure Appendix B3.7 (cont.)

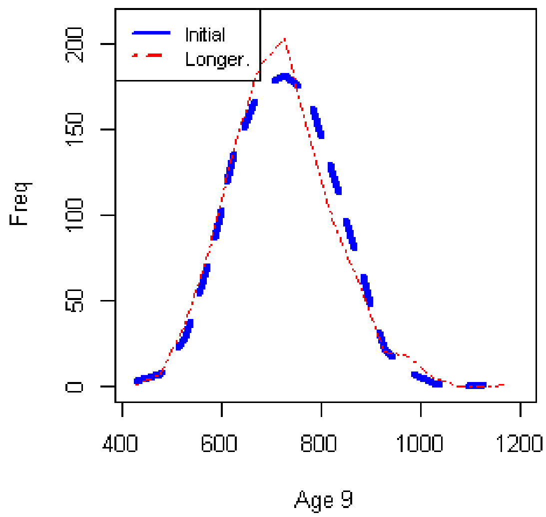
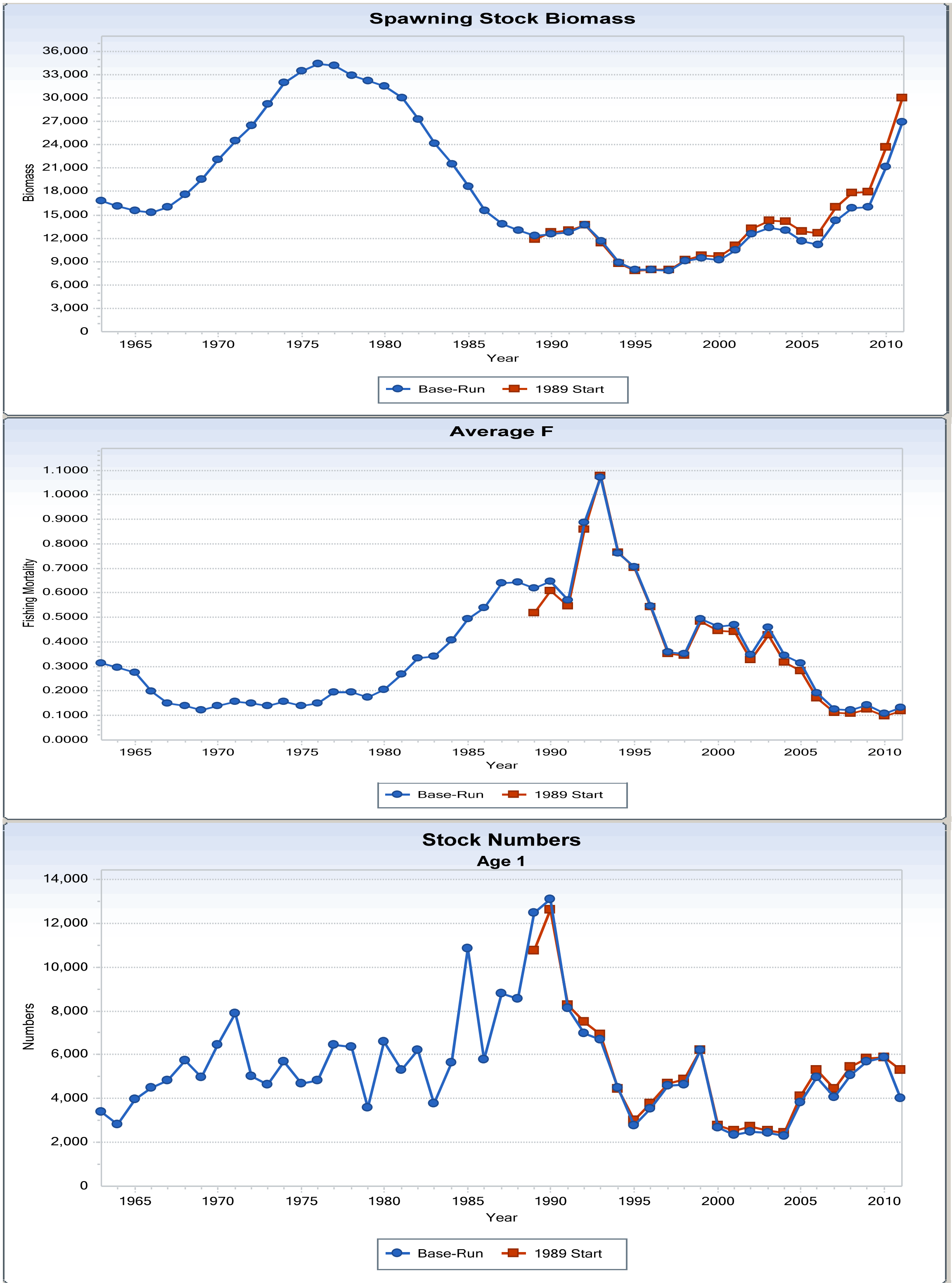
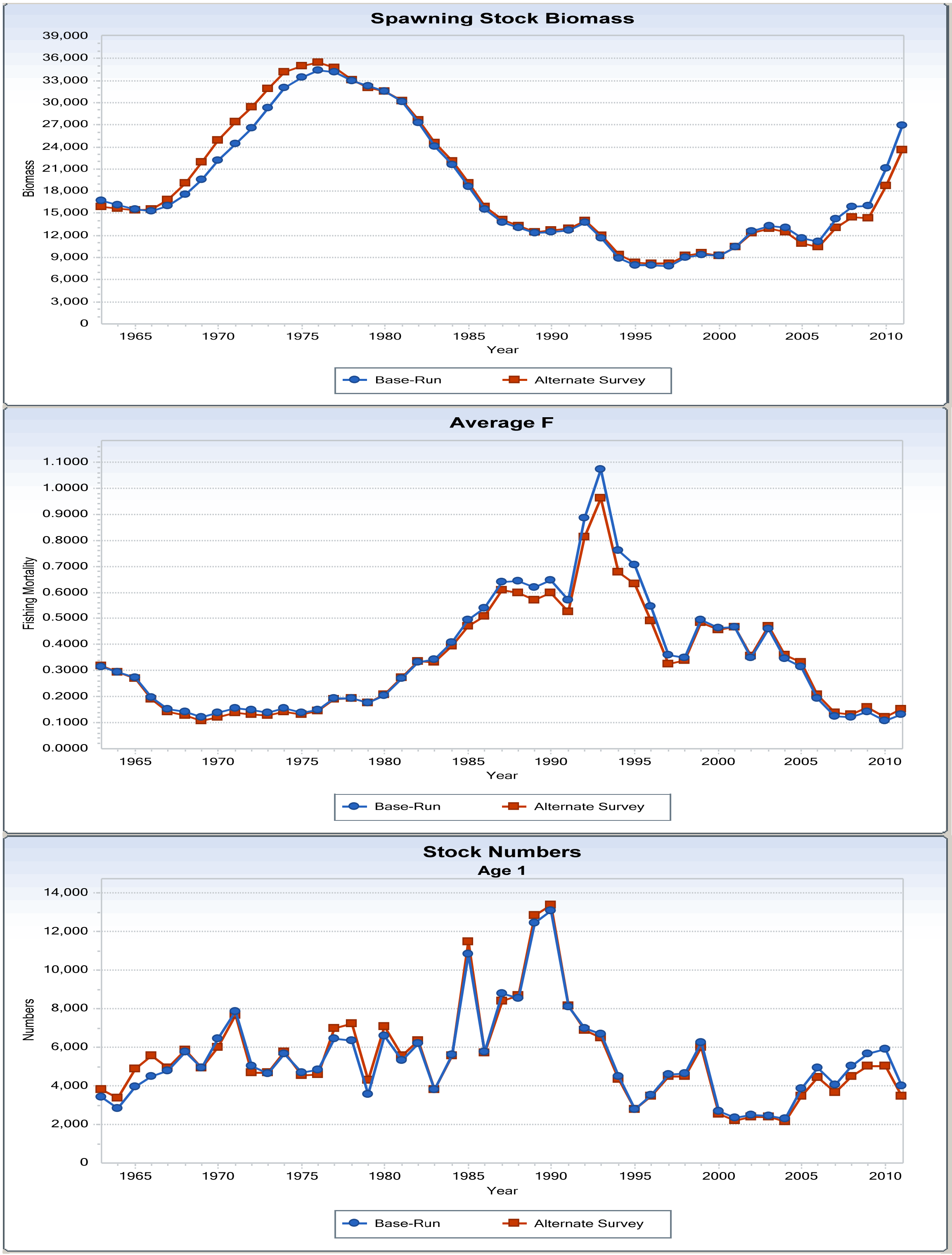


Figure Appendix B3.7 (cont.)

Appendix B4
ASAP sensitivity runs



Appendix Figure B4.1. Estimates of spawning stock biomass, fishing mortality and recruitment from a sensitivity run in which the starting year was changed from 1963-1982.



Appendix Figure B4.2. Estimates of spawning stock biomass, fishing mortality and recruitment from a sensitivity run in which the strata set used to calculate indices of abundance was changed from 01200-01300,01360-01400 (Base-Run) to 01010-01300,01360-01400 (Alternate Survey).