REPORT OF THE 2009 ICCAT ALBACORE STOCK ASSESSMENT SESSION
(Madrid, Spain - July 13 to 18, 2009)

1. Opening, adoption of agenda and meeting arrangements

The meeting was held at the ICCAT Secretariat in Madrid July 13 to 18, 2009. Mr. Driss Meski, ICCAT Executive Secretary, opened the meeting and welcomed participants ("the Group").

Ms. Victoria Ortiz de Zárate (EC-Spain), meeting Chairperson, welcomed meeting participants and thanked the Secretariat for the efforts made to prepare the meeting. Ms. Ortiz de Zárate proceeded to review the Agenda which was adopted with minor changes (**Appendix 1**).

The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**. The following participants served as rapporteurs:

Items 1, 9 and 10	P. Pallarés
Item 2	V. Ortiz de Zárate and G. Scott
Item 3	P. Kebe
Item 4	C. Palma, H. Arrizabalaga, L. Kell and V. Restrepo
Item 5.1	J.M. Ortiz de Urbina and S. Yeh
Item 5.2	L. Kell and B. Linton
Items 6.1 and 7.1	G. Díaz. G. Scott and H. Arrizabalaga
Items 6.2 and 7.2	P. De Bruyn, V. Restrepo and L. Kell
Items 6.3 and 7.3	M. Schirripa
Item 8	V. Ortiz de Zárate and G. Scott

2. Biological data, including tagging and environmental information

No new information was presented to the Working Group at this meeting, therefore the hypothesis of two separate stocks, a northern and a southern stock separated at 5ºN latitude, has been maintained for the assessments purposes (**Figure 1**).

Regarding the biology of Atlantic albacore, no new studies were presented to the working group. To address the modeling of growth for North Atlantic albacore stock, the estimated growth parameters by Bard (1981) were applied (L_{inf} = 124.74, k = 0.23, to = -0.9892).

As concerns conversion factors for length-weight relationships not new information has been provided, thus parameters applied in the assessment were those estimated by Santiago (1993) included in the Chapter 2 of ICCAT Manual for Atlantic albacore. http://www.iccat.int/en/ICCATManual.htm

The maturity vector for North albacore was assumed as been 50 % mature at age 5 and complete mature onwards. (Anon. 2008b).

The natural mortality was assumed to be constant and equal to 0.3 for all age classes for the North Atlantic albacore stock. Nevertheless, the group reviewed the mortalities by age estimated for Pacific albacore stock (SPC, 2003) and estimated by Santiago (2004) using the Chen and Watanabe method (1989).

The Working Group decided to evaluate the sensitivity of the stock assessment to an age-varying natural mortality rate pattern. The Group used the approach of Chen and Watanabe (1989), which is based on life history characteristics, for ages 1 to 15 according to the growth parameters derived from Bard's model. However this approach resulted in some extreme values for older ages and the Group decided to fix the value of M at that predicted at age 11 for ages 11-15. Results are included in **Table 1 and Figure 2.** It was noted, however, that a preferred approach would be to use tag-recapture data to estimate a natural mortality rate pattern rather than relying upon patterns based on life history assumptions, alone.

The available tagging information (**Figure 3**), which has been revised by national scientists and updated by Secretariat, was considered for this assessment. Nevertheless, further effort needs to be done to incorporate recoveries not available yet in the Secretariat and to take steps to assure that historical releases are fully incorporated into the data base. For this assessment, the available data were organized into tagging events which were defined as release of 50 or more tagged fish in a calendar quarter. All recaptured fish which were released during a "release event" were included in the data compilation for the MFCL. **Table 2** provides a summary of the provisional tagging events, the number of fish released and the subsequent number of fish recaptured from these events.

3. Catch data, including size frequencies and fisheries trends

3. Catch data (Task-I nominal catches and CATDIS)

The Secretariat presented the nominal catches (Task I) for the period 1950-2007, published in the ICCAT webpage prior to the meeting according to the work plan adopted. The Group reviewed in detail the albacore Northern stock catch distribution by country, gear and year and noted an important decline of the catch reported by Spain, France, Ireland and Chinese Taipei in 2007. The high drop of total catches in 2007 (22,215 t) compared to year 2006 (37,017 t) could be the result of high fuel costs relative to the value of the catch, a change in stock abundance or other causes.

It was also noted that no information was reported by Cuba in 2007 and the group decided to carry over the 2006 catch (527 t) for 2007. Task I catch trends, is shown in **Table 3** and **Figure 4** and geographical distribution of the catch for the entire Atlantic (CATDIS) by main gears and decade is show in **Figure 5.**

Albacore CATDIS dataset (Task I nominal catches estimations that uses Task II catch and effort information to split catches by quarter and 5 by 5 degree squares) was also revised to be synchronized (relative differences less than 1%) with Task I.

Aiming the use of Task I and CATDIS datasets by Multifan-CL, the corresponding Northern Atlantic albacore stock information, have been classified into the 10 predefined fisheries (**Table 4).** The final the yearly nominal catches by fishery and year are presented in **Table 5** and the accumulated catches by fishery and year (either for Task I or CATDIS) in **Figure 6**.

3.2 Size frequencies and catch & effort data

3.2.1 Task-II (Size frequencies)

The catalog and the data of albacore size frequencies available in the Secretariat and published in ICCAT Webpage were presented by the Secretariat at the beginning of the meeting. In order to be used by the Multifan-CL, all the size frequencies information was also classified by the 10 predefined fisheries for the albacore Northern stock. During the first day of the meeting Chinese Taipei submitted revised size data for years 1996, 2000 and 2001, once it was identified that those datasets available at the Secretariat were incomplete (covered only the first two trimesters). Those revisions were included in the Secretariat database and the corresponding size frequencies data used in Multifan-CL updated accordingly.

Later on, new size data was submitted by Chinese Taipei, but the group decided not to use it due the time constraint and the group asked the Secretariat to work closely with Chinese Taipei in order to clarify all the revised size information time series before the 2009 meeting of SCRS.

In the preparation of Multifan-CL data set, the Secretariat conducted some analyses to clean the basic data file. The screening criteria for dropping size frequencies series was the same than the one used in last albacore assessment (Anon. 2008): discard from the analysis size frequency series (stratified by fishery, year and quarter) with less than 50 fish in total, or with less than 10 size class (1 cm) bins, or with large asymmetry in the frequency distribution (skewness > 5). **Table 6** summarizes the results of the size frequency screening. Globally, from a total of 749 size frequency series, 17% were discarded (7% by one of the 3 criteria, 7% by two of the 3 criteria and 3% by all 3 criteria). By fishery the rejection was more heterogeneous. Only fisheries 2, 3 and 8 had more than 90% positive cases (acceptable size frequency series). Fisheries 1, 4, 6 and 9 had at least 80% acceptable cases. With larger discarded cases (more than 25% of the size frequency series) were identified fisheries 5, 7 and 10.

Figures 7 and **8** shows (before and after screening cases, respectively) indicators of centrality and dispersion (means of number of fish, and size class bin percentiles: 10%, median, 90%) in size frequency series across years for each fishery. The same statistical output is shown for each fishery in **Figure 9**, where dropped size frequencies series (right panel – after screening) are plotted with negative numbers for easy identification. The final size frequency time series used in Multifan-CL are presented in **Figure 10** (histograms in 2 cm classes by fishery and trimester).

3.2.2 Task-II (Catch and effort)

The Task II catch and effort data in ICCAT data base were also presented. The Secretariat prepared a specific dataset where catch and effort data by fishery were standardized using General Linear Models to provide indices of abundance for the 2009 Atlantic MFCL stock assessment, in cases where no official standardized CPUE's arrived in time for the meeting.

The catch and effort information corresponding to the albacore North Atlantic stock was previously selected and then classified into the corresponding 10 albacore fisheries. After a cleaning process (mainly elimination of effort duplication: "double" reporting the same effort in different datasets with partial species catch composition) permitted improve somehow the quality of the information.

Afterwards, the catch and effort data information submitted to ICCAT in number of fish was converted to weight by using the mean weight calculated from size samples available by fleet and major gear. This number to weight conversion was made to the nine major tuna and tuna like species (albacore included) with the main goal of obtaining a dataset to be used in CPUE standardization (trough GLM's) using the ratio of albacore in the total catch of each strata (Fishery/Fleet/Gear/Year/Trimester/Month). This additional potential explanatory variable (never included in previous studies) was drawn to be used as an additional factor for explaining partial variability in GLM models (targeting effect). The results of this study are presented in SCRS/2009/101, which also includes a detailed exploratory analysis. Many results show incoherencies in the base data (error in effort units, etc.) and at the same time the inadequacy of much of the Task II catch and effort information reported to the ICCAT Secretariat.

3.3 Data recovery

Following the 2005 SCRS recommendation on data recovery, the group noticed the effort made by IRD scientist Alain Fonteneau to recover the French Task II albacore data from 1967 to 1993. As the data was submitted just one week before the meeting, the Group has no time to conduct a deeper analysis of the files. The SCRS/2009/104 document summarized the information received before the meeting. It was noted that supplementary work will be required before using this useful information.

During the meeting, an analysis was conducted to compare the original data spreadsheets and the database into which the spreadsheet data had been collected. There were a small number of records that differed between the two sources, and additional information on the processing of the records in the databases will be needed. For most of the records, effort was reported as a categorical variable representing the percentage of the day fished with categories for 40%, 60%, and 100% of the day. The percentage of records in each effort category is presented in **Figure 11**. After 1976, all of the records were assigned to the 100% effort category. In addition, a preliminary nominal CPUE series was constructed assuming 10 hours of fishing for the 40% effort category, 14 hours of fishing for the 60% effort category, and 24 hours for the 100% effort category (**Figure 12**). Additional work is needed to investigate and prepare the effort data so that an abundance index for the recovered French data can be constructed.

Document SCRS/2009/080 describes also the detailed information for the period 1987-2006 recovered for the Basque fleet (Spain). The aggregated data in one degree square by month was submitted to ICCAT Secretariat but further work is needed to attempt to get the effort information for this data set.

These datasets might be helpful in the future to further distribute surface Task I into time and space.

4. Catch-at-size (CAS) and Catch-at-Age (CAA)

4.1 CAS estimates for the northern and southern stocks

The Secretariat presented at the beginning of the meeting an update of albacore catch-at-size (CAS) for the Northern Atlantic stock, from 1975 to 2007. The previous catch-at-size dataset (1975 to 2005) was slightly adjusted to match Task I figures. Provisional 2004 and 2005 estimations obtained in 2007 assessment were completely rebuilt to take into account size updates and new size information received. Years 2006 and 2007 were estimated for the first time. Details of the estimations and also the substitution rules used are presented in SCRS/2009/103.

During the meeting, Chinese Taipei proposed the revision of size frequencies of 1996, 2000 and 2001 because it was found that the datasets used to produce CAS were incomplete (only first semester samples available). The Group also noted that the reported USA commercial CAS for years 2004 to 2007 had a substantially increase on the mean weight (from an average of 22 kg to more than 40 kg per year). This increase was considered unrealistic, and, the Group decided to replace them by the size frequency series converted weight frequencies estimated by the Secretariat.

The CAS was then updated to reflect Chinese Taipei and USA changes, and, all the associated substitutions previously made with the above size frequency series were also redrawn. The Cuba 2007 catches (2006 carry over) was also included in the revision. When comparing CAS with Task I the differences in weight are residual.

Table 7 and **Figure 13** shows final estimations of the global albacore CAS matrix for the northern stock, by Year and 2 cm (lower limit) size classes. **Figure 14** shows the CAS mean weights (overall and by major fishery).

Catch at size is plotted to evaluate changes in the ICCAT database between the 2007 and 2009 assessments and within fisheries over time. Gross changes in the database are shown in **Figure 15** which illustrates differences between the 2007 and 2009 data bases, all years combined, for the long line, surface (GN, BB, TR and TW) and all other gears. Higher resolution comparisons are made in **Figures 16 to 18** which compare the Japanese long line catch at size length distributions for 1992 to 2005; **Figures 19 and 20** Chinese Taipei long line from 1996 to 2005 and **Figure 21** US longline for 2004 and 2005.

Figure 22 show the change in catch at size for BB, TR and TW in 1975, 1985, 1990, 2000 and 2005. **Figure 23** compares 2007 and 1975, using the 2009 data base, for the long line, surface (GN, BB, TR and TW) and all other gears. **Figure 24** shows a comparison between long lines, using the 2009 data base, surface and all other gears for 1975 and 2007.

4.2 CAA estimates for the northern and southern stocks

The July 2006 Data Preparatory Meeting for the Albacore Assessment recommended to produce the catch-at-age (CAA) estimates for the northern stock, applying the Kimura-Chikuni algorithm (Kimura and Chikuni, 1987). In the 2007 assessment, this algorithm was used. The quarterly age-length keys were derived from normal length at age distributions for ages 1 to 8. The group noted significant differences between the catch at age estimated in 2007 and the one used in previous assessments that had important impacts on assessment results. Among other things, it was noticeable the relatively low proportion of age 7 fish in most of the years.

Paper SCRS/2009/102 addressed this issue and suggested the use of alternative age length keys derived from normal length distributions for ages 0 to 15. In the paper, length at age distributions for ages 0 and 1 combined, and 8-15 combined (8+ plus group) were provided, and the new catch at age showed larger proportions of age 7 fish than in 2007.

The Group considered a third way to compute CAA, following essentially the 2007 Kimura Chikuni methodology but considering 0 to 15 ages, and then summing the numbers at age 0 and 1, on one hand, and age 8 and older on the other hand.

The catch at age estimated with the three Kimura Chikuni alternatives (using length at age for ages 1 to 8, ages 0-1 to 8+, and ages 0 to 15, respectively) are shown in **Figures 25** (total) and **26** (by fishery). The effect of the three alternative CAA matrices on the VPA was inspected using the 2007 run with Fratio=0.5 in the first year and shrinking the vulnerabilities of the last 4 years with a standard deviation of 0.5 (see SCRS/2008/089). Computing CAA in the same way as in 2007 showed a steep declining trend in SSB (**Figure 27**), suggesting that the steep decline observed in 2007 was due to the way Kimura Chikuni was computed (i.e. considering length at age distributions for ages 1 to 8). However, considering length at age distributions for ages 0-1 to 8+ (as suggested in SCRS/2009/102) gave extremely high F values, specially for age 7 (**Figure 28**), that allowed to explain the relatively high numbers at age 7 caught. Selectivity estimates were also considered unrealistic, given that selectivity at ages 7 and 8 were highest. On the other hand, CAA based on 0 to 15 length at age distributions gave maximum selectivity values at ages 3 and 4, followed by age 6 (**Figure 29**).

Given that in the 2007 assessment a 6+ age group was considered in the VPA, the group analyzed the effect of Kimura Chikuni with 0-1 to 8+ versus 0 to 15 age classes on a VPA run with a 6+ plus group. Results showed minor differences in SSB and recruitment (**Figure 30**), fishing mortality rates (**Figure 31**) and selectivity vectors (**Figure 32**). This result is not unexpected since the different Kimura Chikuni algorithms mostly affect ages 7 and 8, and both are absorbed into the 6+ plus group category. These results suggest that it is irrelevant which CAA (either 0 to 15 or 0-1 to 8+ groups) to use in a 6+ plus group VPA. However, when considering a higher plus group, it might be safer to use length at age distributions for ages 0 to 15 (**Table 8**). In any case, the group felt that more research is needed before next assessment, to solve the issues related to catch at age estimation. This research should more thoroughly analyze the effects of the alternative lengths at age within Kimura Chikuni, and might also consider other alternative methods.

The estimates using this latest method (**Table 9**, **Figures 25** and **26**) show dominance of ages 1 to 4. For the surface fisheries (Spain BB and TR, France TR) the first three age groups are those most represented in the catches. In the longline fisheries, Japan shows a predominance of ages 3, 4 and 5, the United States a predominance of ages 4 to 7. Chinese Taipei longline shows three distinct periods: before 1987 with large dispersion between ages 3 to 8; dominance of ages 3 and 4 between 1993 and 2001; dominance of age 6 from 2002 onwards.

Catch curves are used to extract total mortality (Z) signals from the catch-at-age data. The slope of a catch curve is an estimator of total mortality for a year class if the catchability is constant over ages. Although this is generally not the case, but if the change in catchability is constant then changes in slope over time is an estimator of changes in total mortality over time. Averaging over an age range can reveal if the overall impression of mortality is similar to other estimates of mortality. Averaging over a year range and comparing with other year ranges have the potential of revealing possible changes in exploitation pattern (or potential changes in natural mortality for the younger age groups). A comparison of the catch curves based on the Adapt input data and that estimated by Multifan-CL is made in **Figures 36** and **37**.

A comparison of the catch at age data used in Adapt and that estimated by Multifan-CL are compared in **Figures 33, 34** and **35.** These show the relative catch proportions at age within a year (**Figure 33**), the relative catch proportions within an age across years (**Figure 34**) and the standardized catch proportions at age (**Figure 35**).

5. Relative abundance indices

5.1 Indices by age for VPA-2BOX model fit

Relative abundance indices by age group of albacore caught by the Spanish troll fleet in the northeastern Atlantic were estimated using catch rate data in number of fish by fishing day (CPUE) from 6,932 individual trips collected for the period 1981-2007 (Ortiz de Zárate and Ortiz de Urbina, 2009). Standardized CPUEs for age groups 1 to 4 were estimated this fleet does not target age 1 and the availability of age 4 varies on an annual basis, the Group decided, as in previous assessments, to use only the standardized CPUE for ages 2 and 3 as relative abundance indices for North stock. However, CPUE for age 1 might be considered as an indicator of recruitment to the fishery

Nominal catch per unit effort (number of fish caught per thousand hooks) of north Atlantic albacore recorded from Chinese Taipei longliners from 1967 to 2008 was used to estimate standardized CPUEs by means of a generalized linear model (GLM) approach assuming a log-normal error distribution (SCRS/2009/105). Factors year, quarter, subarea and by-catch effects of bigeye tuna, yellowfin tuna and swordfish were implemented in the model for obtaining standardized yearly abundance trend. The results show that the standardized CPUE highly fluctuated before mid-1980s and then continuously declined up to mid-1990s; thereafter, it remained relative stable till present.

Standardized Japanese longline catch rates in the North Atlantic were updated up to 2007 by means of a generalized linear model (GLM) approach assuming a negative binomial error distribution (SCRS/2007/103).

An index of relative abundance of albacore tuna was generated by standardizing catch and effort data from the United States pelagic longline fishery in the North Atlantic from 1986 to 2008 (SCRS/2009/100). This fleet has also an observer program with an average annual coverage of 5% of the trips (PLOP) since 1992. The standardization procedure evaluated the following factors: year, area, season, gear characteristics (light sticks, main line length, hook density, etc.) and fishing operation characteristics (bait type, fleet type and target species). Standard indices were estimated using Generalized Linear Mixed Models under a delta-lognormal modeling approach.

Regarding the French troll earlier fishery from 1967 to 1986 years, the catch per unit of effort (CPUE) for ages 2 and 3 was analyzed with a GLM model with log-normal error structure to standardize daily CPUE (Goujon *et al.* 1996). Since then no updated information of the French fleet has been available to the Group.

Standardized CPUE series used for final VPA models: Spanish troll indices for ages 2 and 3, Chinese Taipei longline index for ages 3-8+, American longline index for ages 3-8, Japanese longline index for ages 3- 8+ and French troll earlier fishery index for ages 2-3 are presented in **Table 10. Figure 38** shows the scaled time series of CPUE for surface and longline main fisheries used in the assessment.

5.2 CPUE indices used in Multifan-CL

Nominal catch per unit effort (CPUE) in number of fish per fishing day of North Atlantic albacore caught by the Spanish bait boat fleet in the northeastern Atlantic had been collected by individual trip for the period 1981-2007 and analyzed by generalized linear model (GLM). A year*quarter interaction factor was included to obtain a standardized year-quarterly CPUE series for use in Multifan-CL (SRCS/2009/096). The GLM had a log-normal error distribution with constant variance. Relative indices of abundance of albacore tuna from the Irish mid water pair trawl fishery were presented for the years 1998-2007 (Cosgrove, 2009). National landings log book data and onboard observer data were combined to estimate catch rates in biomass (kg) and number of fish. Standardized indices were estimated using GLM assuming a log-normal error distribution with constant variance. A combined index was generated using GLM to take the weighted (by catch) average of the Spanish bait boat index and the Irish mid water trawl index.

Nominal CPUEs in number of fish per fishing day of North Atlantic albacore caught by the Spanish troll fleet in the North Eastern Atlantic had been collected by individual trip for the period 1981-2007 and analyzed by GLM. A year*quarter interaction factor was included to obtain a standardized year-quarterly CPUE series for use in Multifan-CL (SRCS/2009/097). The GLM had a log-normal error distribution with constant variance. The 1981-2007 Spanish troll index was averaged with the 1931-1975 Spanish troll index (Bard, 1977) and the 1967-1986 French troll index (Anon. 2008b) using GLM to generate a combined index.

The standardized CPUE series for French and Spanish troll fleets for the years 1957-1976 was used without change from the 2007 albacore assessment (Anon. 2008b).

The standardized CPUE series for the Azores and Portuguese baitboat fleets for the years 1970-2005 was used without change from the 2007 albacore assessment (Anon. 2008b).

The standardized catch rates (in number of fish per thousand hooks) on year*quarter strata of North Atlantic albacore for the Japanese longline fleet were updated to 2007 using GLM and provided to the Secretariat. Those CPUEs were standardized for three separate periods (1959-1969, 1969-1975 and 1975-2007) using a negative binominal (NB) error structure as previously done in the 2007 assessment session (Uosaki and Shono, 2008).

Nominal CPUEs (number of fish caught per thousand hooks) on year*quarter strata of North Atlantic albacore recorded from Chinese Taipei longliners from 1967 to 2007 were used to estimate standardized CPUEs by means of a GLM approach assuming a log-normal error distribution (SCRS/2009/105). Factors of quarter-series, subarea, and by-catch effects of bigeye tuna, yellowfin tuna and swordfish were included in the GLM.

Nominal catch rates of North Atlantic albacore from the longline fisheries of Korea, Panama, and Cuba were collected for the years 1966-2007. A standardized CPUE series on year*quarter strata was estimated using GLM with a delta-poisson modeling approach (SCRS/2009/101).

Nominal catch rates of North Atlantic albacore from minor surface fisheries (baitboat and troll) not included in the previous indices were collected for the years 1976-2007. A standardized CPUE series on year*quarter strata was estimated using GLM with a delta-lognormal modeling approach (SCRS/2009/101).

All indices reported in units of numbers per unit effort were converted to biomass (kg) per unit effort using fleet-specific annual mean weights of captured fish to estimate the fishing effort within each fleet. Each standardized index was scaled to a mean of one. The standardized indices used in Multifan-CL are presented in **Table 11** and **Figure 39**.

While for some series detailed log book data are available for others CPUE series have to be standardized using catch and effort data from the ICCAT database. Therefore standardized CPUE time series using general linear models (GLMs) by year and quarter were prepared for all fisheries (SCRS/2009/101). Standardization was performed in advance of the meeting using a systematic approach based upon inspection of diagnostics (Ortiz and Arocha, 2004) using the open source R statistical environment (cran.r-project.org). The data, R code and analyses are all available as part of a Google project at http://code.google.com/p/glmscrs/. The project can be accessed by project members to allow committing changes and by non members who may only check out read-only working copies see http://code.google.com/p/glmscrs/source/checkout for more details. The project is managed using subversion and under windows TottoiseSVN provides an easy to use user interface; see http://code.google.com/p/mseflr/wiki/UsingTortoiseSVN for a guide on how to use tortoise.

The standardized indices are available at:
http://code.google.com/p/glmscrs/source/browse/trunk/Results/cpueStd2009.txt

All the results presented in document (SCRS/2009/101) were examined and discussed by the Group. It was decided to use the standardized CPUE´s from fleets being analyzed by the national scientists and presented to the Group. On the other hand for fisheries ALBN09 and ALBN10 the results from these analyses were used to fit the MFCL model. As it was evidence of over dispersion for these two fisheries the delta poisson error distribution GLMs were rerun using a quasi Poison family to allow the dispersion parameter to be estimated.

6. Methods and stock status results

6.1 VPA-2BOX

The Group decided to apply a VPA-2BOX model repeating the Base Case scenario from the 2007 northern albacore stock assessment using the revised catch-at-age data. The analysis was conducted using updated versions of the Spanish troll, U.S. LL, Chinese Taipei LL, and Japanese LL fisheries indices and the historical index of French troll fishery (same fisheries used in the 2007 assessments) (**Table 10**). A lognormal error structure was assumed for all indices within the VPA model. The total and partial catch-at-age matrices used in the VPA were the ones presented in document SCSS/2009/102 which were different from the matrices used in the 2007 assessment. The selectivity at age for each index was estimated from the partial catches using the method proposed by Butterworth and Geromont (equation 4, Butterworth and Germont, 1999), except for the two Spanish troll indices, which reflect only one age class. The terminal (2007) fishing mortality rates for ages 2-7 were estimated and the 2007 fishing mortality rate on age 1 was set to 20% of that on age 2. Initially, the F-ratio (F on the oldest age divided by the F on the next younger age) was fixed to 0.5 for the first year of the time series (1975) and F-ratios for all other years were estimated with a random walk. The natural mortality rate was fixed at 0.3 for all ages. The VPA model was set to run with an 8-plus age group and for the period 1975-2007.

Following the setting of the VPA model in the 2007 stock assessment, the weight-at-age matrix was estimated as constant annual weight-at-age estimated from the growth and L-W equations (mid-year weight in kg).

The initial run showed a relatively good fit to the indexes (**Figure 40**). However, the estimated SSB showed great differences with the 2007 assessment (**Figure 41**) and very high terminal apical F (F=5). The Group decided to perform alternative runs using an F-ratio of 1.0 and 2.0 for the first year and one run with a fixed F-ratio of 1.0 for all years. These runs provided similar results with respect to the original run and were quite different from the SSB estimated in the 2007 assessment. Estimated deterministic terminal relative SSB (SSB/SSB_{MSY}) were very low (range 0.22-0.28) and terminal relative fishing mortality (F/F_{MSY}) ranged from 8.7 to 10.2 (**Figure 42**).

To assess if the observed differences in the estimated SSB between the 2007 and the present assessment were due to the settings of the VPA model, a run was performed using the 2007 VPA with the 2009 catch-at-age and partial catch-at-age matrices (without including the data for years 2006 and 2007). The estimated SSB was very similar to those estimated with the 2009 VPA, therefore confirming that the observed differences between the 2007 and 2009 VPA results was due to the different catch-at-age matrix used for the 2009 assessment and not to the settings/assumptions in the 2009 VPA model.

The group decided to perform a series of new runs using a 6-plus age group instead of the original 8-plus age group. The rationale for this decision was that the high terminal F associated to the sharp increase of age 7 catches in the revised catch-at-age could be better handled by the model with an 6-plus age group. The runs with the 6-plus age group showed a better fit to the observed indexes, particularly for the longline fleets (**Figure 43**). In addition, deterministic terminal F ranged from 0.67 to 0.88 and deterministic relative SSB from 0.58 to 1.10 (**Figure 44**).

A decision was made to run 500 bootstraps for the VPA model using a 6-plus age group and the three different F-ratios for the initial year (F-ratios 0.5, 1.0, and 2.0). The output of these runs showed some dissimilar results. For instance, SSB_{1975} was as high as 171,550 t for an initial year F-ratio of 0.5 and as low as 41,345 t for the F-ratio of 2.0. However, terminal SSB_{2007} ranged from about 25,000 t to 44,000 t (**Figure 45**). In contrast, estimated apical F and number of recruits were similar among the three F-ratio scenarios (**Figure 45**). Estimated median benchmarks for these 3 runs are presented in **Table 12**. Although the estimated MSY levels were similar (in the range of 35,200-37,300 t), other estimated benchmarks were not. For instance, B_{MSY} was as high as 51,100 t for the F-ratio 0.5 case and as low as 16,900 t for the F-ratio 2.0 case. Estimated benchmarks also showed that for the cases of F-ratio of 1.0 and 2.0 B_{MSY} was lower than MSY, suggesting a higher contribution of immature fish to the total catch. In fact, recruits per spawner at MSY (the inverse of SPR at MSY) for F-ratios of 0.5, 1.0, and 2.0 were 5.38, 7.83, and 15.7, respectively; while the SPR at MSY for the same F-ratios were 0.186, 0.128, and 0.064, respectively.

Regarding the status of the stock, **Figure 46** shows the phase-plot of the terminal year (2007) using 500 bootstraps. Generally, an F-ratio of 2.0 showed the most optimistic outcome with the median indicating that the stock was not overfished and overfishing is occurring with a relative F=1.11. In contrast, the F-ratio of 0.5 showed the most pessimistic result in indicating that the stock was overfished (median relative SSB=0.93) and undergoing overfishing (median relative F=1.52). Model output showed that the model rapidly estimated lower F-ratios for years subsequent to the initial year when F-ratio was assumed to be 2.0. The Group interpreted this result as an indication that the assumed F-ratio was too high. Because the Group had not enough information to decide which run (F-ratio 0.5 and 1.0) was more appropriate, the status of the stock was also estimated joining the result of the bootstraps of the two runs mentioned. More specifically, a ‘phase-plot’ using the 500 bootstraps from each of the 2 runs was made for relative SSB vs. relative F (**Figure 46**). This approach indicated that the stock was not overfished but fully exploited with relative SSB=1, but overfishing was occurring with a relative F=1.5.

The uncertainty associated the estimated median results shown in **Figure 46** was characterized as the percentage of bootstrap results indicating a particular stock status. In **Figure 47**, the percentage shown in the ‘red zone’ correspond to the results that indicated that the stock was both overfished and undergoing overfishing, the ‘green zone’ indicates that the stock was not overfished and overfishing was not occurring, and the ‘yellow zone’ corresponds to results that indicated that the stock was either overfished or overfishing was occurring (but, not both conditions at the same time). As indicated before, the run with an F-ratio of 2.0 showed the most optimistic status of the stock, with 22% of the bootstraps in the ‘green zone’ and 75% in the ‘yellow zone’. In contrast, the run with an F-ratio=0.5 showed 62% of the results in the ‘red zone’ and 37% in the ‘yellow zone’.

Stock status trajectories (“snail-tracks”) for the period 1975-2007 are shown in **Figure 48**. Relative F for the terminal year (2007) was estimated as the geometric mean of years 2004, 2005, and 2006. In all cases, the stock was not overfished in 1975. Only the most optimistic case corresponding to the F-ratio of 2.0 showed a significant number of years when the stock was not overfished and not undergoing overfishing. The other 3 cases indicated that the stock was under overfishing conditions during the entire time series with several year also showing overfished conditions.

The Group was unsure of the proper average weight to assign to the age 6+ group and it decided to further investigate the issue and to assess the potential impact of any changes in the used weight might have on the VPA results presented in this report.

6.2 Multifan-CL

Basic data

The data sets used for the Multifan-CL analyses were compiled during the July 2009 stock assessment meeting. The data was separated into 10 fisheries using the same definitions as those used in the 2007 stock assessment. The basic input data (catch, effort and catch-at-size) was, however, revised due to updates in the ICCAT database. All input and output files are stored by the ICCAT secretariat. A summary of catch and effort data are presented in **Tables 13** and **14** and **Figures 49** and **50**

The model runs

Model specification for the initial runs 4A and 4B were identical to those used in the past base case assessment, and described in detail in document SCRS/2009/108. In total 14 model runs were carried out during the 2009 stock assessment meeting (**Table 15**). Run 4A, was conducted using the same MFCL executable file (mfcl32.exe) as the 2007 assessment, while run 4B was conducted using the latest MFCL release (mfclo32.exe). Run 4C was changed to include effort variability priors suggested by a Stock Synthesis 3 assessment fit to the same basic input data and constrained to have the same model assumptions as run 4B. Run 4D was the same as run 4B, however, all selectivities for ages 5 and older were constrained to be equal. 4E used both the variabilities included in 4C as well as the age constraints included in 4D. 4F was a variation of 4B where the growth function was fitted internally instead of fixing the growth curve according to the equation of Bard (1981). 4G was another variation on 4B where catchability was constrained to be constant over time (although still allowing for seasonal variability). Run 4H varied from 4B as it included an age-specific vector of natural mortality. The vector was calculated using the method of Chen and Watanabe (1988) and the Von Bertalanffy parameters of Bard (1981). The vector was modified slightly to ensure all natural mortalities for ages 11 and older were equal. Run 4I included tagging data to the basic 4B model run. Run 4K was the same as run 4I in that it also utilised tagging data, but also calculated an age specific vector of natural mortality internally. Run 4L used Z averaged over the first 5 time periods of the model to calculate the initial population. This was a change from the 10 years used in the previous model runs. As in previous runs, several fisheries had been grouped by selectivity, run 4N allowed selectivity to be calculated independently for each fishery (1-10). Run 4O was a major deviation from the other runs in terms of input data. Instead of the catch and effort being stratified by quarter, it was collated by year. Lastly run 4P forced a dome-shaped selectivity pattern onto the surface fisheries (1-3).

Model selection

Output parameters and diagnostics for each model run were used to screen out model runs that were unrealistic or which fitted the data badly. Run 4A was discarded as it utilised an outdated version of the MFCL software. Runs 4C, 4F, 4L, 4O and 4P were discarded as they produced unrealistically high selectivity values for age 15 fish in fishery 1 (a baitboat fishery targeting small fish). 4D and 4E were discarded as they produced unrealistically high values of MSY and SSB_{MSY} and thus exceptionally optimistic reference points. Lastly 4I, 4K and 4L were discarded as they produced unrealistically high values of mean annual F. This resulted in 4 model runs (4B, 4G, 4H and 4N) remaining. Of these, the continuity run 4B was considered the most appropriate model run for the 2009 albacore stock assessment based on the AIC model selection criteria. Although run 4G had a lower AIC value, it included different variabilities and penalties rendering a direct comparison between this and other models impossible.

Model results

Figure 51 shows the key SSB (adult biomass) reference points generated by the four models that were not discarded. Although the models differ in overall scale, they all indicate that the current SSB to SSB at MSY ratio is less than 1, indicating that the current SSB is lower than the SSB that would produce MSY. This is level of depletion is supported by the F_{MSY} reference points indicated in **Figure 52** where except for model 4H, recent and current F values are above that of F_{MSY} indicating the exploitation of the stock is high. **Figure 53** shows the absolute estimates of recruitment from the three models. All the models display a similar trend in recruitment even though absolute values differ. In all cases, a very large recruitment event was calculated for year 25 of the model (1955/6).

Selectivity estimates by fleet are provided in **Figure 54** for the continuity run 4B. As expected, the longline fisheries display asymptotic selectivity with age (although several were constrained to do so by the model). Surface fisheries generally display dome-shaped selectivity and this appears to be the case here, although there is an increase in selectivity with age for age classes 6 and over. The reason for this increase is not clear as few large fish are recorded for these fisheries. Selectivity was constrained to be equal for age classes 10 and over, resulting in an asymptotic selectivity shape.

The effort deviations by fishery are presented in **Figure 55**. If the model is coherent with the effort data, an even scatter of effort deviations about zero would be expected although some outliers would also be expected. This is not the case for several of the fisheries, indicating that the model may not be extracting most of the information present in the data regarding catchability variation. This was addressed by varying the model specification during the model runs (eg. 4C) however none of these runs significantly altered this situation.

Figure 56 shows the reference point trajectory from model 4B. As the majority of the time series is in the top left quadrant (F/F_{MSY} >1, SSB/SSB_{MSY} >1) this could indicate the northern albacore stock is being over-exploited. The most recent value is in fact still within this region (see **Figure 57**[1]). **Figure 58** splits these trajectories into decadal time steps. These clearly show that model 4B is predicting an increasing level of exploitation and depletion of the stock as the trajectories have moved steadily from the bottom right quadrant into the top left over time. **Figure 59** shows the scatter plot of SSB and recruitment estimates and the fitted relationship.

The Group noted that the MSY levels can be affected by changes in selectivity, among other things. Since the MFCL application allowed for a long-term view of the resource starting in 1930, the Group calculated changes in MSY benchmarks over time. The estimated trend in MSY is shown in **Figure 60**. A gradual increase in MSY between the mid-1950s until the mid-1960s is evident, concurrent with the increase in fishing by longline fisheries which caught larger fish than the troll fisheries did. This trend is similar to the one calculated during the 2007 assessment although the absolute values have increased.

Figures 62 to **64** are a comparison of model outputs between the 2007 stock assessment and runs 4A and 4B in the current assessment. These were investigated as the version of MFCL used to carry out the assessments has changed between assessments. As the results from this assessment are more pessimistic than the last assessment, this was thus done to ascertain whether differences in the status of the stock between these assessments were due to changes in the model or changes in the input data. It would appear that a combination of both the model and data changes have resulted in the difference in assessment results. It is clear that a large biomass increase in the late 1950s was not predicted using the 2007 dataset, and although present using the 2009 data, was predicted to be lower using the old MFCL model version. It is thus likely that no one factor is responsible for the differences in the assessment results.

Notes on MSY benchmarks

The Group recalled that the MSY levels can be affected by changes in selectivity, among other things. The F/F_{MSY} and B/B_{MSY} trends mentioned above refer to equilibrium yield calculations using the 2005-2006 overall selectivity. Since the MFCL application allowed for a long-term view of the resource starting in 1930, the Group calculated changes in MSY benchmarks over time, based on data from Run 4B and standard equilibrium yield computations using a spreadsheet. The selectivity vector used by MFCL is based on the average aggregate F for 2005 and 2006. For the year-by year calculations, the same concept was used: For any given year, the selectivity was calculated from the average F of the preceding two years.

The estimated trend in MSY over time is shown in **Figure 60**. A gradual increase in MSY between the mid-1950s until the early 1970s is evident, concurrent with the increase in fishing by longline fisheries which caught larger fish than the troll fisheries did.

The estimates of MSY (29000 t) and SSB/SSB_{MSY} (0.62) for the last year of the time series (2007) were very close to those estimated by Multifan Run 4B. However, F/F_{MSY} values were slightly lower than those estimated by Multifan CL Run 4B, showing slightly more optimistic state of the stock (**Figure 61**). For the year 2007, these spreadsheet computations showed F/F_{MSY} value of 0.81, versus F/F_{MSY} value of 1.045 in Multifan Run 4B. The Group was very unsure about exactly how MFCL finds the F that maximizes yield-per-recruit, and therefore reason for these differences is not well understood. The Group expressed grave concern about the lack of documentation on some MFCL calculations.

6.3 Stock Synthesis Model

As a means to further evaluate model uncertainty in the 2007 North Atlantic albacore assessment, SCRS/2009/099 constructed an alternative to the MFCL population assessment using the same data sets and assumptions but within a different modeling platform. Stock Synthesis 3 (SS3), an integrated assessment model, was fit to the same input streams as those used in the MFCL assessment. Three configurations were presented: In Configuration 1 SS3 was configured as closely as possible to the MFCL base case from the 2007 assessment. Growth, natural mortality, life history parameters, and selectivity values were fixed at the MFCL values. Catchability for each fleet was allowed to vary is a manner similar to that of MFCL (i.e. random walk).

[1] It was assumed that the estimates of current F/F_{MSY} and B/B_{msy} had the same coefficients of variation and the same correlation as estimated in the 2007 base case assessment. Uncertainty in the current rations was depicted by generating 1,000 random numbers from a bi-variate normal distribution with means [0.622, 1.04] and covariance matrix:

$$\begin{matrix} 0.00732 & -0.00321 \\ -0.00321 & 0.009132 \end{matrix}$$

Weightings, effective sample sizes, and informative priors were matched as closely as possible. Estimated parameters included virgin recruitment, steepness, initial fishing mortality in 1930, and base catchability for each design block. Configuration 2 was identical to previous configuration except that the selectivity parameters modeled as a functional form (double normal) and were allowed to be estimated, but with the same stipulations as the MFCL configuration. Configuration 3 used (and estimated) length-based selectivity with no stipulations, utilized all observations of size-at-age, and assumed a constant catchability within a fishery. The resulting spawning stock biomass trends from configuration 1 matched reasonably well with the MFCL estimates. However, the models differed considerably in the estimates of starting biomass in 1930. Configuration 2 resulted in considerably lower selectivities for the older (age-5+) fish in the surface fisheries. This resulted in the SS3 model estimating higher overall biomass for the time series, as a larger proportion of the population was estimated as unavailable to be caught in this case. Configuration 3 resulted in the overall best fit to the data, however was also the most different of the configurations tested, from the MFCL base case model.

Several additional SS configurations were presented during the assessment group meeting for the group's consideration. Generally speaking, except for a few relatively minor details, each of the SS results was in very reasonable agreement with the MFCL results. The models demonstrated the most disagreement from 1930 to 1960, where data was sparse. This was especially true for the initial conditions in 1930. The exact reason for the lack of agreement in 1930 was not fully resolved, however, it was noted that MFCL and SS use different methods for calculating the starting point of the model. Because of the importance of the sharp decline in SSB during the period 1930-1960, and because the only data to inform the model during this time was information from fleet 2, a sensitivity analysis was run excluding the CPUE data from fleet 2. While removing this data from the model changed the annual variation in SSB during that time, it did not have any meaningful effect on the overall trend in the biomass, suggesting that it was not the only source of influence on this observed trend.

The MFCL 4A and 4B model used a fixed growth function from the ICCAT manual (Bard, 1981) while SS attempted to use direct observations of age-at-length to estimate the function within the integration process of the model. A total of 2254 age estimates from spines were made available from various age reading investigations. Most of the age samples were sampled from the Spanish bait boat fishery (fleet 1) with a small portion coming from the Spanish/French trawl fleet (fleet 2). Because of the nature of these fisheries, 90 percent of the spine samples were estimated to be between the ages 1 and 5, and 99 percent between ages 1 and 8. While initial results indicated a lack of agreement between the two different growth functions, further investigation found this to be an unreliable conclusion, mostly due to the lack of older fish in the age sample. In essence, it is believed that the lack of older fish provided the model with a means to create unrealistic estimates of growth to improve fits to other data. The lack of data on older fish allowed to model to do this without significant penalty. The age data was still useful however for estimating the standard deviation of size-at-age for the younger fish, which was estimated to be 21 percent. It was concluded that future research should seek to increase the number of age samples from older fish, presumably from the longline fleets.

Several runs were attempted to estimate fleet specific selectivity. The basis for these runs was that the current grouping may be too restrictive and that it may be resulting in poor fits to the length compositions. This issue was addressed via the SS model by estimating a separate length-based selectivity for each of the ten fleets. The result of this exploration was a most unreasonable stock size that showed virtually no variation for the entire time series. It was obvious that allowing all selectivity parameters to be estimated was not reasonable at this time. Time did not allow for the further exploration as to which parameters might be reasonable to fix or constrain for this to provide reliable estimates. However, it was agreed that this remains a viable route to continue to explore in the future.

The last SS configuration considered was one that collapsed all seasonal data into years. The basis of this run was that, not only were the seasonal assignments of catch perhaps unreliable in the early years, but also that the seasonal partitioning of the data resulted in increased sparseness. Results of this SS model run were more optimistic than previous runs; however, time did not permit close scrutiny of any of the model fit diagnostics. Based on the convergence criteria, lack of correlations between variables, and fitting diagnostics that were examined, this SS configuration (which used annual data, fixed growth, constant catchability and length-based selectivity) was deemed the most parsimonious model with the best fit to the given data. Thus, it was considered the SS base case. As the objective of this work was to further evaluate the uncertainty in the albacore assessment, as well as provide guidance in the selection of the base case, further comparisons will focus on the comparisons between: (1) the runs that included the 2009 data sets and the old MFCL executable (MFCL run 4A); (2) the 2009 data sets and the new MFCL executable (MFCL run 4B); and (3) and the base case SS configuration.

Estimates of the time series SSB from the SS base case were similar to those from the MFCL base case (4B, **Figure 65**). Furthermore, estimates of SSB from the new MFCL executable were more similar to the SS estimates than those from the older MFCL executable in the manner in which it attempted to account for an alleged increase in SSB event in the early 1960s. This suggests those data signals that were found in the new data sets by both SS and the new MFCL models were not being interpreted in the same manner by the previous version of MFCL. This increase in SSB was due to a potentially strong recruitment event as perceived by the new MFCL model, the SS model, but not the previous version of MFCL (**Figure 66**). Because the constraints and assumptions on the new MFCL were exactly the same as those of the previous version, this pattern essentially shows the "version effect" of the new MFCL model. Estimates of fishing mortality were also quite similar between the three model configurations (**Figure 67**). All three models show very similar year-to-year variability as well as overall magnitude. Also interesting to note is the strong agreement between all three models with regard to the estimate of fishing mortality in 2009.

One of the more significant differences between the MFCL and SS model structures is the manner in which selectivity at age is derived from the models estimates of selectivity at length. MFCL does length selectivity by calculating age selectivity as a function of mean size-at-age. This makes it hard to deselect the very large or very small fish. SS does length based selectivity more directly, but still calculates average age selectivity from the length selectivity in order to do the age fishing mortalities. The length conditioned age-based selectivities estimated by SS are shown in **Figure 68**. In essence, these are derived by multiplying the estimated selectivity for a given length by the probability of a fish at that length of being a given age. In this way it is possible to have a length conditioned age-based selectivity at a given age be less than 1.0, as is seen in **Figure 68**.

While estimates of stock size between the MFCL 4B and SS models were very similar, and the estimates of steepness of the stock recruitment curve were virtually identical (h = 0.87), the resulting estimates of yield at MSY for MFCL 4B (MSY = 29,000 t) and SS (MSY = 39,220) were quite different. The difference in the yield at MSY was thus a function of the differences in the estimates of overall, fleet-wide gear selectivity (as derived from the aggregated fishing mortalities for all fleets, **Figure 69**).

Difference in estimates of MSY between MFCL and SS resulted in differences in the perceived status of the stock. While estimates in B/B_{MSY} were slightly more optimistic than those from MFCL (**Figure 70**), the SS estimated population started out at a higher level and so thus end up more depleted. Likewise, estimates of F/F_{MSY} were more optimistic from the SS model (**Figure 71**). As noted above, this is mainly due to the differences in estimated selectivities. However, without reliable estimates of growth and further sampling of older fish, the selectivity on these fish will remain highly uncertain, regardless of the modeling platform used.

Overall, the evaluation of the same data set using the two different modeling platforms (MFCL and SS), coupled with the fact that both platforms arrived at some similar results, provided some evidence that the changes made in the new version of MFCL may in fact be an improvement as opposed to merely a change. This conclusion adds support to the choice of the continuation of MFCL model 4B as the base case model for northern albacore. The differences that were observed seem to be explained mostly by the differences in gear selectivity, with the differences most pronounced for age 5 and older. These differences are most likely a result of (1) the manner in which the two platforms calculate age-based selectivity from the estimated length-based selectivity; (2) the fact that MFCL forced selectivities for ages 10-15 to all be equal; and (3) MFCL forced fleet 4 and longline fleets to have asymptotic selectivity patterns. The SS base case model applied none of these constraints. There is insufficient data to objectively determine with certainty which of the selectivities estimates may in fact be more correct. As with the growth model, sample of age from older fish may be helpful in providing improved estimates of selectivity on the older ages as well as improved estimates of growth.

7. Projections

7.1 VPA-2BOX

Projections were conducted using 500 bootstraps. Projections were run by keeping the current catch level of 30,200 t for years 2008 and 2009 and projecting for years 2010-2050 for a constant catch of 36,000 t, 34,000 t, 32,000 t, 30,000 t, 28,000 t, 26,000 t, 24,000 t, 22,000 t, and 20,000 t. Future recruitment was assumed to follow a Beverton-Holt SRR estimated from the VPA bootstrap-specific outcomes using the spawning stock and recruitment estimates from the VPA. An assumption was used regarding the last three years of recruitment estimates from the VPA. Because the estimates of year-class strength for the most recent period in the CAA data are considered too unreliable for use in future projections, they were replaced with values derived from the SRR used for the projections.

The results of the VPA projections showed inconsistencies when compared to the projections made with MFCL. The Group was unable to identify the source of such differences and it decided that more work is needed on this issue.

7.2 Multifan-CL

Time did not allow for making projections with the Multifan-CL software. Instead, the group made projections based on the estimates obtained with the base case (Run 4B). Two sets of projections were made: One, predicting future recruitment (2008-2020) deterministically from the estimated Beverton-Holt relationship; the other one was assuming constant recruitment at the same level predicted for 2008 (8,689,423 recruits). Projections assumed a catch of 30,200 t in 2008 and 2009. Thereafter, catches ranging from 20,000 t to 36,000 t were projected.

Results from the two sets of projections are shown in **Figure 72**. The results are qualitatively similar, although the set using a stock-recruitment relationship covers a broader range of results (top panel in the figure): Low catch scenarios allow for somewhat faster rebuilding, and high catch scenarios result in faster depletion, than the constant-recruitment projections.

Both sets of projections suggest that catches of 24,000 t or lower would allow the stock to reach SSB_{MSY} on or before the year 2020. Because of recent changes in estimated stock size, SSB is expected to increase initially and then decline until 2012, to different degrees depending on the level of catch. Thereafter, TACs in excess of 28,000 t would be expected to make the spawning stock biomass decline even further.

8. Recommendations

8.1 Research and statistics

- Noting that direct ageing data can provide a substantially improved basis for assessing stock status, based on using the available aging data for North Atlantic albacore in this assessment, the Group recommends validation of the aging methods applied to read dorsal spines across laboratories and readers. Aging cross-validation through a network between different laboratories is proposed.

- Based on the differences between the MFCL and SS results being mostly attributable to the uncertainty on the selectivity of older fish, it is recommended to obtain random samples from the fishery with special focus on the longline fisheries (adult fish, > 90 cm FL) to be used on the determination of age composition of the albacore catches.

- The group has moved in recent years towards conducting stock assessments with Multifan-CL, an integrated statistical model. However, the software is not sufficiently documented, as it is an on-going project that is not fully updated. Thus, it is difficult for common users to extract key pieces of information. In addition, the group found that different software releases gave somewhat different results. It is recommended that the Secretariat contact the software keepers to see if this situation can be remedied. Alternatively, the group could consider moving to different platforms.

- Several issues have been encountered in the construction of catch-at-age from catch-at-size data using different methodologies, especially considering the number of ages estimated from size composition. The Group recommends investigating and solving these issues before the next assessment of North Atlantic albacore stock.

- Studies on fecundity and maturity for North albacore are needed to better estimate the spawning stock biomass.

- The tagging data obtained from the albacore tagging programs in the North Atlantic have been used tentatively in the assessment. More effort is needed to carry out quality controls on the tagging data and contrast the information stored in ICCAT data base against that held by national scientists.

- Tagging programs for Atlantic albacore stocks should be initiated and promoted to improve estimates of exploitation rate of North albacore. Both conventional and electronic tags.

- The Group reemphasized the need for better size data (Task II), for longline fisheries, in 5x5º squares. The scarcity of samples for adult albacore limits the precision of the analyses that the Group can conduct. As well, improved size data is needed from surface fisheries (in 1x1º squares).

- The Group recommended the development of standardized CPUE series for all the main fleets exploiting the North Atlantic albacore stocks. Furthermore, it is recommended that the high resolution catch effort data used for standardization be recorded in the ICCAT Task II data record.

- The Group recommended continuing the investigation of modelling of the North albacore stocks with statistical models for use in future assessments.

8.2 Management

North Atlantic

The total allowable catch (TAC) for the northern albacore stock through 2007 was 34,500 t, since then it was 30,200 t. The Working Group noted that the reported catches for 2005 and 2006 were over the TAC and that the 2007 catch (22,000 t) was well below TAC.

Projections indicated that the northern stock would not rebuild to the Convention Objective if future catch levels were at 28,000 t or more. If strong year classes enter the fishery, which is uncertain, the stock might rebuild with catches of 28,000 t, but weak year classes enter in the fishery would require lower catches to promote rebuilding. In 2007, the Commission implemented [Rec. 07-02], which reduced TAC to 30,200 t in 2008 and 2009. The current assessment indicates TAC in the future should be less than 28,000 t to promote stock rebuilding. Lower catch levels would promote more rapid rebuilding.

9. Other matters

No other matters were discussed.

10. Adoption of the report and closure

The report was adopted and the meeting adjourned.

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Appendix 1

AGENDA

1. Opening, adoption of the Agenda and meeting arrangements
2. Biological data, including tagging and environmental information
3. Catch data, including size frequencies and fisheries trends
4. Catch-at-size (CAS) and Catch-at-Age (CAA)
5. Relative abundance indices
    5.1 Indices by age for VPA-2BOX model fit
    5.2 Indices by quarter and fleet for MULTIFAN-CL model fit
6. Methods and Stock status results
    6.1 VPA-2BOX
    6.2 MULTIFAN-CL
    6.3 Stock Synthesis model
    6.4 Other methods
7. Projections
8. Recommendations
    8.1 Research and Statistics
    8.2 Management
9. Other matters
10. Adoption of the report and closure

Appendix 2

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Appendix 3

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SCRS/2009/024	Length-weight relationships for bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*) and albacore (*Thunnus alalunga*) (perciformes: scombrinae) in the Atlantic, Indian and eastern Pacific oceans. Zhu, G, Xu, L., Zhou, Y. Song, L.and Dai, X.
SCRS/2009/029	Evaluating the efficacy of minimum stock size thresholds in the presence of natural variability and parameter uncertainty: an application to northern albacore tuna (*Thunnus alalunga*). Ortiz, M., Cass-Calay, S.L. and Scott, G.P.
SCRS/2009/070	The age and growth of albacore tuna (*Thunnus alalunga*) of the north east Atlantic ocean as inferred from the Irish pelagic trawl fishery of 2002. Boyd, J.
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SCRS/2009/096	Standardized Spanish baitboat CPUEs by quarter for the period 1981-2007. Ortiz de Zárate, V. and Ortiz de Urbina, J.M.
SCRS/2009/097	Standardized Spanish troll CPUE´s by quarter for the period 1981-2007. Ortiz de Zárate, V. and Ortiz de Urbina, J.M.
SCRS/2009/099	Comparison of north Atlantic albacore stock assessment using Multifan-CL and Stock Synthesis 3. Schirripa, M.J.
SCRS/2009/100	Standardized Catch rates for albacore tuna (*Thunnus alalunga*) from the U.S. Pelagic longline fleet 1986-2008. Ortiz, M.
SCRS/2009/101	Standardization of the north Atlantic albacore (*Thunnus alalunga)* CPUE. Kell, L.T. and Palma, C.
SCRS/2009/102	Notes on the estimation of catch at age for North Atlantic albacore. Restrepo,V. Arrizabalaga, H. and Palma, C.
SCRS/2009/103	Update of the Atlantic Albacore (*Thunnus alalunga*/) catch-at-size estimations (North and South stocks, 1975 to 2007). Palma, C.
SCRS/2009/104	French albacore data recovery. Kebe, P.
SCRS/2009/105	Standardized northern Atlantic albacore (*Thunnus alalunga*) CPUE, from 1967 to 2008, based on Taiwanese longline catch and effort statistics. Hsieh, C., Chang, F. and Yeh, S.
SCRS/2009/106	Conversion on sampled-CAS into CAA of North Atlantic Taiwanese albacore catch, dating from 1981 to 2008, using knife cutting algorithm. Chang, F., Chang, Y. and Yeh, S.
SCRS/2009/107	Standardized CPUE of South Atlantic albacore (*Thunnus alalunga*) based on Taiwanese longline catch and effort statistics dating from 1967 to 2008. Chang, F. and Yeh, S.
SCRS/2009/108	A preliminary update of the albacore tuna (*Thunnus alalunga*) stock assessment for the northern Atlantic Ocean using the integrated stock assessment model, Multifan-CL. de Bruyn, P., Arrizabalaga, H. Ortiz de Zarate, V. and Palma, C.

Table 1. Natural mortality by age estimated using the approach of Chen and Watanabe (1988) for ages 1 to 15 according to the growth parameters derived from Bard's model. Values from ages 11 to 15 were fixed to the value predicted at group older than 11.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mortality	0.63	0.46	0.38	0.34	0.31	0.29	0.31	0.34	0.38	0.44	0.55	0.55	0.55	0.55	0.55

Table 2. Provisional tagging events and associated releases and recaptures of albacore considered in the analysis.

Year	*Quarter*	*Releases*	*Recaptures*
1976	3	214	2
1978	3	142	7
1980	3	223	3
1982	3	53	0
1983	3	287	18
1984	2	198	1
1985	3	146	0
1986	3	71	2
1986	4	142	2
1988	3	497	23
1989	3	2798	60
1989	4	301	5
1990	3	4636	60
1991	3	4349	94
1991	4	89	0
1993	3	120	0
1994	3	75	0
1998	3	74	0
2002	3	83	1
2003	3	542	11
2004	3	119	1
2005	3	468	11
2005	4	80	0
2006	3	1625	1
2006	4	1089	1
2007	3	135	0

Table 3. Task I albacore Northern stock catches by flag and year (1930 to 2007).

Year	Barbados	Belize	Brasil	Canada	Cape Verde	China P.R.	Chinese Taipei	Cuba	Dominican Republic	EC.España	EC.France	EC.Ireland	EC.Portugal	EC.United Kingdom	FR.St Pierre et Miq	Grenada	Iceland	Japan	Korea Rep.	Maroc	Mexico	Mixed flags (FR+ES)	NEI (Flag related)	Panama	Philippines	Sierra Leone	St. Vincent	Sta. Lucia	Trinidad & Tobago	U.S.A.	U.S.S.R.	UK.Bermuda	Vanuatu	Venezuela	Total
1930																						11250													11250
1931																						15600													15600
1932																						12850													12850
1933																						11450													11450
1934																						18880													18880
1935																						20750													20750
1936																						16800													16800
1937																						13500													13500
1938																						14622													14622
1939																						17078													17078
1940																						11488													11488
1941																						13244													13244
1942																						16780													16780
1943																						16764													16764
1944																						16963													16963
1945																						27586													27586
1946																						23266													23266
1947																						20268													20268
1948																						24101													24101
1949																						27865													27865
1950										24943	14680																								39623
1951										19446	14703																								34149
1952										18177	14220																								32397
1953										16925	13192																								30117
1954										26341	13638																								39979
1955										16804	14620																								31424
1956										24148	16750							2																	40900
1957										21923	20064							135																	42122
1958										33924	17279		300					945																	52448
1959										29822	18921		570					599																	49912
1960										31014	19597		600					1131																527	52869
1961										24335	17092		600					380																323	42730
1962							17			31499	20293		620					5716																642	58787
1963							18			28155	16239		970					14633																325	60340
1964							103			28500	19486		500					15713	52															280	64634
1965							114	118		29278	15548		830					14325	174															271	60658
1966							204	151		25795	13413		340					5860	1471															129	47363
1967							761	91		32745	15533		740					4771	3926															575	59142
1968							1907	345		24580	13239		110					3306	1588															145	45220
1969							2352	81		22607	9385		500					4717	6844															244	46730
1970							4675			23731	6163		200					5875	5011															240	45895
1971							2871			30196	9210		300					6472	7707															65	56821
1972							4410	36		25121	9158		434					1319	7922					240										141	48781
1973							9501			19799	6859		887					1467	4794					2366											45673
1974							9538			25290	8425		1229					2059	2823					217											49581
1975							8130	87		22601	5666		911					1331	2843					226										93	41888
1976							14837	85		26735	6800		610					1345	5379					1227										133	57151
1977							13723	83		25155	7733		62					825	5579					557										102	53819
1978							9324	89		25404	10400		85					531	3048					768						1	68			397	50115
1979							6973			29630	9320		149					1219	2997					425							59			593	51365
1980							7090	31		25202	3955		79					1036	797		2			193						22				300	38707
1981							6584	48		20819	2929		442					1740	938					177						472	51			331	34531
1982							10500	82		25478	2855		321					781	1326					494						699				137	42673
1983					10		14254	38		29557	2391		1778					1156	478		33			357					268	347				823	51490
1984					10		14923	69		15656	2797		775					576	967					2551					194	2206				1076	41800
1985							14899	20		20672	1860		657					844	390					601					318	98				467	40826
1986				1			19646	31		24387	1200		498					470	373					525						251				172	47554
1987				21			6636	15		28206	1921		433					494	18					44						301				26	38115
1988				47			2117	4		26738	2805		184					723	16											288				137	33059
1989				22			1294			25424	4050		169					764	53							10		0		243				41	32070
1990				6			3005	2		25792	3300	40	3185					737	34										4	357				95	36557
1991				5			4318			17233	4123	60	709					691	1				11							479				319	27949
1992				1			2209			18174	6924	451	1638	59				466					19	29				1	247	438				205	30861
1993				9			6300			18380	6293	1946	3385	499				485	8				13	60			2	1		509				246	38135
1994				32		14	6409			16998	5934	2534	974	613				505					10	103			0	0		741				282	35149
1995				12		8	3977			20197	5304	918	6470	196		2		386					8	73			0	1		545				279	38376
1996				24		20	3905			16324	4694	874	1634	49		1		466	2				11	11			0	1		472				315	28803
1997	1			31			3330		323	17295	4618	1913	395	33		6		414	1				3	5				0	2	577		1		49	28997
1998	1			23			3098		121	13285	3711	3750	91	117		7		446					8				0	0	1	829				107	25595
1999	1			38		21	5785		73	15363	6888	4858	324	343		6	0	425					12		4		1	0	1	315		2		91	34551
2000			4	122		16	5299		95	16000	5718	3464	278	15		12		688							0		704	1	2	406		2		1374	34199
2001	2			51		57	4399			9177	6006	2093	1175			21		1126			0					91	1370	3	11	322		2		349	26254
2002	5			113		196	4330	1		8952	4345	1100	1953		4	23		711		55							300	2	9	480		0		162	22741
2003	5			56		155	4557	322		12530	3456	755	553			46		680		81							1555	10	12	444		0		424	25641
2004				27		32	4278	435		15379	2455	175	513		7	25		893		120							89		12	646		1	414	457	25958
2005				52		112	2540	424		20447	7232	306	556	6	2	29		1336	59	178					9		802	2	9	488		1	507	175	35270
2006	9			27		202	2357	527		24538	6585	521	119	19		19		781	45	98				96			76	2	12	400			235	321	36989
2007	7	22		25		59	1297	527		14582	3179	596	184	30	3	20		294	12	96	0				8		263	2	18	532		0	95	375	22226

Table 4.; Northern Atlantic albacore fisheries defined to be used in Multifan-CL.

Fishery	*Name*	*Years*	*Gears/Flags*	*Notes*
1	ESP BB Recent	1981-2007	a- ESP BB	a- CPUE in SCRS/2007/040 (Ortiz de Zárate & O. de Urbina)
			b- MWTD all flags	a-Only Cantabrian sea-North east Atlantic
			c- FR BB 1981- 2007	
2	ESP FR TR all	1930-2007	a- MIX.FR+ES TR 1930-1949	a1- CPUE in 1931-1975 from Bard (SCRS/1976/059); allocate yearly catch in trimester 3
			b- ESP-TR, FRA-TR 1950-2007	a2- France TR CPUE in Goujon et al. 1967-1981 (SCRS/1996/) re-analized by Year*quarter by Arrizabalaga using the extended France TR time series to 1986 done by Santiago (2005) during ALB WG.
			c- GN (ESP, FRA, UK, IRL) 1987- 2007	b- CPUE ESP TR 1981-2005 in SCRS/2006/056 (Ortiz de Zárate & O. de Urbina)
				c- ICCAT analysis at WG , source: catdis
3	FR+SP BB early	1948-1980	a- ESP+FR BB	a- CPUE from SCRS/76/59 (Bard); split by quarters with fixed proportions based on recent data BB ESP
4	PRT BB	1958-2007	a- PRT BB (Madeira, Azores)	a- CPUE obtained at meeting
			b- ESP BB (Canary Islands, Cadiz)	
5	JPN target LL	1956-1969	a- JPN LL	a- CPUE sent by Koji
6	JPN Trans LL	1970-1975	a- JPN LL	a- CPUE sent by Koji
7	JPN Byc LL	1976-2007	a- JPN LL	a- CPUE sent by Koji
8	CHTAI LL	1962-2007	a- Chinese Taipei LL	a- CPUE presented by Yeh
			b- all other LL 1960- 2007	
			(except Fishery 9)	
9	KOR+PAN+CUB LL	1964-2007	a- LL (KOR, PAN) 1964-2007	a- CPUE obtained at meeting
			b- LL (CUBA) 1964-1993	
10	OTH SURF	1950-2007	a- BB (CPV, VEN, others not above)	a- CPUE
			b- TR (IRL, PRT, Grenada, SVG, St Lucia,USA)	Source: catdis
			c- All the remainder surf catches	

Table 5. Albacore North Atlantic stock: Task I and CATDIS catches (t) by fishery and year.

Year	ALBN01	ALBN02	ALBN03	ALBN04	ALBN05	ALBN06	ALBN07	ALBN08	ALBN09	ALBN10	TOTAL
1930		11250									11250
1931		15600									15600
1932		12850									12850
1933		11450									11450
1934		18880									18880
1935		20750									20750
1936		16800									16800
1937		13500									13500
1938		14622									14622
1939		17078									17078
1940		11488									11488
1941		13244									13244
1942		16780									16780
1943		16764									16764
1944		16963									16963
1945		27586									27586
1946		23266									23266
1947		20268									20268
1948		24101									24101
1949		27865									27865
1950		39623									39623
1951		34149									34149
1952		32397									32397
1953		26242	3875								30117
1954		32729	7250								39979
1955		28299	3125								31424
1956		35398	5500		2						40900
1957		30028	11959		135						42122
1958		33945	17258	300	945						52448
1959		30796	17947	570	599						49912
1960		33072	17539	600	1131			527			52869
1961		20907	20520	600	380			323			42730
1962		30943	20849	620	5716			659			58787
1963		24625	19769	970	14633			343			60340
1964		28058	19928	500	15713			383	52		64634
1965		25544	19029	1083	14325			385	292		60658
1966		22791	16130	627	5860			333	1622		47363
1967		30669	17293	1056	4771			1336	4017		59142
1968		23993	13478	458	3306			2052	1933		45220
1969		17923	13690	879	4717			2596	6925		46730
1970		15706	13938	450		5875		4915	5011		45895
1971		24029	14977	700		6472		2936	7707		56821
1972		26517	7037	1159		1319		4551	8198		48781
1973		18712	7468	1365		1467		9515	7172		45700
1974		20958	11707	2279		2059		9563	3040		49606
1975		9491	9694	9993		1331		8223	3156		41888
1976		13918	13461	6766			1345	15054	6691		57235
1977		17391	9878	5681			825	14037	6219		54031
1978		23931	10713	1245			531	9727	3905	69	50121
1979		23332	15014	750			1219	7566	3429	62	51372
1980		13059	15580	597			1036	7394	1021	4	38691
1981	11962	10778		1451			1740	6916	1163	521	34531
1982	14983	12831		824			781	10523	1902	828	42673
1983	18389	12788		2546			1156	14834	873	904	51490
1984	6438	11029		1747			576	15546	3587	2877	41800
1985	10409	10654		2102			844	15558	1011	247	40826
1986	14307	10837		893			470	19833	929	300	47568
1987	18407	11539		611			494	6725	77	300	38153
1988	17175	12078		451			723	2270	20	342	33059
1989	17307	11999		307			764	1421	54	219	32071
1990	15056	12975		4601			737	1910	36	1567	36882
1991	8029	12675		1407			691	4623	1	523	27949
1992	11925	12275		3114			466	2656	30	397	30863
1993	10957	13126		6468			485	6540	68	491	38135
1994	10754	13066		3344			505	6700	104	691	35163
1995	11811	13739		7649			386	4398	75	320	38377
1996	10991	9620		2918			466	4163	13	632	28803
1997	11252	11527		1446			414	3632	6	746	29023
1998	8441	11902		439			446	3589		929	25746
1999	11829	13117		2294			425	6285		601	34551
2000	14088	10265		530			688	6633		1996	34200
2001	8800	6826		2645			1126	6246		611	26254
2002	8980	3989		3034			711	5468		558	22741
2003	9854	5202		1833			680	7017		1055	25641
2004	9527	7491		970			893	6016		1061	25958
2005	16326	10179		1133			1336	5505	59	767	35305
2006	20312	10277		347			781	4301	141	831	36989
2007	11564	6093		336			294	3166	179	762	22394

Table 6. Numbers of size frequency series used in Multifan-CL after screening.

	Criteria			Fishery									
Dropped ?	N<50	cnt<10	skew>5	ALBN01	ALBN02	ALBN03	ALBN04	ALBN05	ALBN06	ALBN07	ALBN08	ALBN09	ALBN10
NO				58	113	18	90	15	16	88	132	46	44
YES (1 bad)			X		1								
		X					3			1		3	5
	X			6	2	1	7			9		2	11
YES (2 bad)		X	X										4
	X		X	1									
		X		1			11	6	1	12		3	17
YES (3 bad)	X	X	X				1	1	1	10		2	7
TOTAL				66	116	19	112	22	18	120	132	56	88
% Good cases				88%	97%	95%	80%	68%	89%	73%	100%	82%	50%
% Bad cases				12%	3%	5%	20%	32%	11%	27%	0%	18%	50%

Table 7. North albacore catch at size.

	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
-30	293	341	2626	2595	650	520	77	25					56	521	2	2	24	9	15								
32		11		5	25		13	7									188										
34					12									521			90								314		
36	11				19								491	79	17		1246			4			4	6	185		
38		5	11	56	31	10	13	12					326	159	150		1741	181	35	19	340	175	6	90	623	290	444
40	1149	2518	10220	13363	3048	461	13	1962	323	38	4689	3004	438	159	448	14	7047	1300	555	1307	1669	2325	708	1666	1905	1380	1966
42	3575		33	310	124	991	13	189	108	3465	374	216	818	79	2516	1098	16878	1229	9849	3695	2075	3645	3739	3226	6246	6788	3005
44	7956	3724	10302	14036	5122	5001	64	3540	749	19455	9243	4927	4381	988	9262	3969	25840	2425	16439	4547	4920	7072	7148	10784	14774	14350	2646
46	25724	4602	12099	21859	11410	16683	650	6144	3225	20912	36791	13009	7837	3988	30004	19642	54199	17864	18042	6646	17398	31664	100611	34143	46238	21193	5620
48	84497	27255	50640	69461	53105	51413	1614	22867	12728	68889	136373	74443	23795	6298	69021	44277	147242	194902	203723	95023	96152	158431	394878	117352	143424	57782	19845
50	223801	25205	144448	73482	210861	187938	12720	245390	79318	236856	249929	248323	118463	50445	237638	135012	357049	558733	393004	209918	175247	280197	573556	170397	237106	160341	47247
52	195491	34632	241768	145106	254303	182781	46989	421252	187002	324464	309990	342844	282997	123644	338056	249084	374971	493422	422309	223166	113650	190140	387794	125259	254504	239831	66513
54	165789	46575	215768	133452	277114	147807	102584	392845	284972	247271	265991	236455	307360	160847	349059	320583	245428	224607	297444	192905	44232	87816	145226	72549	222094	235367	58642
56	215295	59155	191110	136329	192248	137174	94527	358656	325729	141655	140365	177748	188872	176855	145330	241189	235465	172868	228238	139017	28830	53488	44242	82014	146296	183945	51170
58	248295	77801	153423	80572	70506	130135	83627	124554	197553	106831	171050	162682	176683	240142	133734	305655	267680	251101	250281	121724	27587	69995	87107	183758	211199	328737	67656
60	276923	221338	148806	209331	179149	344732	251119	250557	229943	268264	437795	321689	265686	381578	285763	546520	462721	516083	267598	249187	51657	110694	200803	400734	400955	512742	129958
62	193378	266735	209937	281901	228244	380366	452449	427189	309184	502076	534880	447206	369400	527193	472457	670543	407296	528840	282016	309536	104343	111602	218245	408342	430092	505902	184131
64	188339	286230	287827	277107	273524	280683	432279	468253	357793	555238	498116	386348	450208	521922	557073	596269	320260	331809	222000	315329	165949	81547	138368	298948	308097	398691	206119
66	231043	237152	258344	149994	224666	190922	381253	376502	285990	427100	264847	266748	302067	331113	362466	260870	199746	163471	199934	258740	175801	48398	46175	112457	188257	257297	151441
68	265111	259424	293942	94155	195538	160378	387447	277544	237725	310082	156590	184259	209689	231098	208827	106027	130082	116106	196018	244439	158539	39390	25106	57670	135070	138132	137970
70	302041	330751	335979	127623	226659	152818	370131	241102	224519	246329	113868	185049	250306	212594	170203	83879	136438	114700	239081	220689	147566	20782	38545	87796	162240	119243	190851
72	237839	273130	276447	181868	198161	205091	327283	207978	233564	209072	109431	183210	288237	168425	214555	105300	166847	125192	204408	228549	145106	20564	54594	120849	201369	173847	220752
74	193778	308811	287685	195391	228124	236176	366120	190996	254927	184451	127201	168959	287352	165709	219299	73894	164035	84894	232126	211212	165343	29141	71081	148630	221101	209595	234740
76	160068	230401	304880	204212	200035	248590	307197	206712	267356	156509	110802	160853	246030	140017	239948	85246	155290	90090	180638	185076	150208	45881	77940	122453	232194	221108	198219
78	162832	251269	258115	198242	184434	267758	295549	237118	262118	130070	98293	151946	181844	145188	159073	56246	133287	73225	154520	174367	123025	63903	84743	108656	207938	264813	153725
80	153825	255253	270839	117544	141562	189465	111504	136028	193883	119430	79130	112756	194605	133368	107131	44752	95331	81300	136845	152237	115007	83529	96571	83389	186568	249086	101311
82	114773	223949	232952	108349	98833	166140	83043	93509	132322	105432	70004	87497	116355	89232	64613	42918	64040	69902	125835	91909	87249	94865	87548	66082	148565	200769	61048
84	103606	166923	192716	96250	82354	129210	119637	62808	77304	89846	51893	50232	99233	61612	51356	37766	56062	43050	108016	58291	83229	85714	74478	49436	94527	120263	41160
86	69708	109945	144448	63307	60522	81719	42569	26151	40627	68622	56271	24706	51984	48362	38840	29728	45826	47121	108716	51070	69795	68662	49672	38448	53361	60788	24411
88	48516	67613	111286	58784	55446	59750	37611	19600	24938	47937	33010	16278	45802	34018	34956	22260	27151	20762	63893	44002	57429	60840	43998	30455	36566	33258	24189
90	39351	55323	113829	90512	66908	84762	26749	21471	26840	50052	43144	23036	45342	21047	33005	23974	26081	22618	56298	59740	37259	54524	48662	31492	38780	24640	19815
92	34733	41749	94804	72981	75615	80614	16201	18632	23769	44700	62867	13890	33248	26559	34523	26373	19329	10800	32638	11829	30679	48271	41590	47912	40524	27739	17477
94	27405	40453	78972	87460	80571	74394	21106	14369	22468	51326	43282	12178	33088	34768	58543	28396	16878	11432	25838	13521	31907	57382	38451	40305	47001	29019	20071
96	31149	35571	76713	86009	76488	67835	20684	12356	20800	43765	30271	13139	16592	24927	47540	37471	17133	9225	21126	23946	30675	73041	52461	37404	52467	28354	22186
98	25819	36589	59392	74415	65839	62879	17129	13136	11324	30827	22270	16914	21739	20499	45423	34781	15982	9930	22726	36526	39525	64933	56870	29930	39424	23045	22646
100	29613	39517	71746	73339	61059	78557	16213	10348	7745	29366	9239	45135	61972	30877	38124	29831	25487	12296	24864	70322	69932	62957	66545	36753	31626	23749	20347
102	31743	37803	50297	84311	56000	76701	20134	10335	6013	22280	7225	34675	29221	17717	39529	20677	17160	10791	18065	95969	81682	46441	54227	39012	35857	21838	21185
104	31289	36483	39119	79022	50934	69001	25052	11444	5807	19354	3667	12038	33236	21864	40355	24606	21285	14193	21079	57371	50969	39469	33884	23015	20754	17966	18401

106	19871	31088	29243	53681	29884	37881	16915	8565	3958	17157	2886	16067	18425	14135	40168	17993	15587	10395	16420	17455	15192	28596	23884	19805	16931	16232	15167
108	17285	30731	37892	41307	26803	31154	10612	7081	4713	15880	3288	20047	16002	22418	31762	16486	14007	10682	15329	6336	8049	17239	15159	16230	13419	12068	11907
110	14796	16645	17428	23895	21879	37430	12855	5846	2654	10635	2859	27627	9364	17353	21490	10950	7888	6826	10780	4346	3782	8846	6530	8302	4269	5287	3755
112	8746	14919	14581	19791	24547	56057	9429	5725	3327	7938	1718	21220	6701	6182	16069	6292	5000	4905	7923	1823	1395	5019	5954	6930	4025	5471	5191
114	13564	12305	10000	17888	26813	33343	15342	6020	2034	3261	516	10818	5467	3182	6479	1873	3161	2612	5178	800	1344	2200	3189	4613	1988	2108	1949
116	4146	10773	8963	10770	14769	10022	7594	3054	999	1119	365	767	5126	3124	2808	2292	1021	428	498	385	785	1313	917	3768	1385	1850	975
118	3896	9690	5738	7221	7980	5104	4611	1555	326	1379	591	107	1578	1560	731	1032	776	400	445	432	810	1012	657	2313	742	1011	589
120	9969	8966	4109	8354	6534	5694	1720	589	68	1968	307	40	2435	8714	1298	1362	678	518	320	601	199	899	371	488	180	478	582
122	1104	5632	1253	3980	1288	141	125	56	11	779		8	105	17503	37	757	191	136	47	66	109	300	216	419	322	310	260
124	3179	3641	1174	5287	1833	484	573	207	16	779			399	14999	4	282	69	226	35	470	43	294	122	335	245	152	118
126	441	2303	346	3864	739	185	26	13	5	100		98	565	8857	1	6	142	76	38	100	90	269	110	91	19	77	201
128	175	640	72	1316	105	104	13	13		68		50	7	4170	2	76	70	4	25	50	51	94	47	62	22	48	26
130	1812	1135	55	819	149	250	15	10				8	198	2083	140	132	110	55	28	59	49	186	51	46	22	28	59
132	182	230	24	75	26	13	13	10				2	112	1611		76	191	3	8	8	7	1	21	7	12		
134	300	48	8	106	81	10		8				18	63	1	52	116	178	333	25	9	7	137	20	122	15		59
136	24	101	1	60	19	10		4					2	50		69				1	19	90	0	11			18
138	6	5	1	23	13	31		4					2	1043	2	5	6	4	8	4	27	136	10	11	140		4
140	53	80	41	28	186	707		3						1042		212	1	2	4	5	3	91	2	5		3	10
142	10	11	1	5	6			3						521	116					1	4		1	101	9		15
144		5	8	23	0			3						521							1		16				3
146			1	5	0			3							19	2	4	3	4	3	3		0				1
148			1	14	0			3						1042								45	8	10	1		4
150	643	1100	552	3718	182	104	39	60					220	1562	423	4	7	7	8	12		45	0	11	7	3	
tot (10^3)	4225	4244	5363	3905	4353	4768	4551	4950	4367	4943	4301	4279	4813	4286	4960	4369	4508	4464	4841	4195	2717	2364	3503	3285	4642	4957	2588

Table 8. Quarterly mean lengths at age and standard deviations used to generate length at age distributions for Kimura Chikuni (ages 0 to 15).

	Age:	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Quarter 1	**mean**	44.46	59.75	72.06	81.96	89.93	96.35	101.52	105.68	109.03	111.72	113.89	115.63	117.04	118.17	119.08	119.81
	sigma	2.73	3.05	3.31	3.54	3.73	3.89	4.03	4.14	4.24	4.32	4.39	4.45	4.5	4.54	4.58	4.61
Quarter 2	**mean**	30.61	48.60	63.08	74.74	84.12	91.67	97.75	102.65	106.58	109.75	112.31	114.36	116.01	117.35	118.42	119.28
	sigma	2.73	3.05	3.31	3.54	3.73	3.89	4.03	4.14	4.24	4.32	4.39	4.45	4.5	4.54	4.58	4.61
Quarter 3	**mean**	35.48	52.52	66.24	77.28	86.16	93.32	99.08	103.71	107.44	110.45	112.86	114.81	116.37	117.64	118.65	119.47
	sigma	2.73	3.05	3.31	3.54	3.73	3.89	4.03	4.14	4.24	4.32	4.39	4.45	4.5	4.54	4.58	4.61
Quarter 4	**mean**	40.09	56.23	69.22	79.68	88.10	94.88	100.33	104.72	108.26	111.10	113.39	115.23	116.72	117.91	118.87	119.64
	sigma	2.73	3.05	3.31	3.54	3.73	3.89	4.03	4.14	4.24	4.32	4.39	4.45	4.5	4.54	4.58	4.61

Table 9. Total catch at age estimated using Kimura Chikuni with length at age distributions for ages 0 to 15.

Year	*Age*							
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1975	292345	1163522	1844283	534353	151521	55391	199247	51820
1976	1190861	1908720	790777	1067678	459212	246985	269582	30731
1977	632195	1898591	1429102	545561	371735	324306	228875	29226
1978	1666968	2833461	1142180	497738	251045	228631	137734	19379
1979	440734	2347225	1768273	742220	363692	68474	81445	46237
1980	1149872	1616488	1624984	399302	112608	88972	90105	22018
1981	788230	1485684	1213967	422650	76984	55152	113045	69246
1982	146163	1257544	1647637	791546	60593	109764	125246	105791
1983	761729	1305896	1798482	860273	265860	148174	155847	66753
1984	456035	1236185	980959	419078	242428	200220	254227	115832
1985	790008	1384891	1178399	311626	262974	158753	148659	117770
1986	686065	1562783	1235525	532119	235149	104963	287246	124330
1987	233394	1944372	1853880	300988	51863	26936	87688	52123
1988	1181255	2196951	1215292	222773	45127	22896	41633	24489
1989	683049	1796248	1484432	284379	60690	28493	18797	10691
1990	918359	2300507	1011250	379929	139094	66163	101846	25884
1991	1148459	2105783	582501	260494	142982	38531	17542	5127
1992	1046090	1932780	817455	242720	4912	69497	102053	63759
1993	704347	2202092	1268916	321403	88094	44971	155408	27294
1994	431563	2366446	893422	275815	75326	45197	94795	103515
1995	1058200	2153038	1124792	172861	115796	92097	201162	42493
1996	673211	2893125	367482	162133	36221	99931	116841	19926
1997	1319701	1950226	827128	238554	22538	45457	91524	12795
1998	1549165	2070210	503785	221300	28971	9562	67433	13660
1999	1374942	1665602	1099548	439550	111224	16081	115921	18468
2000	702451	1634592	1136614	378881	9536	179760	146975	5982
2001	491035	675345	878510	284507	62569	201212	119458	4302
2002	782901	502764	194268	384743	112264	261621	110185	15544
2003	1632370	776719	327237	369328	35407	244549	104923	12325
2004	551944	1546583	644790	202622	131951	75549	109590	22062
2005	1006381	1754172	1096817	470597	122596	100359	80627	10448
2006	775533	2316851	977102	670629	69530	55714	76731	14922
2007	209856	883456	1148147	150669	51162	54470	78741	11302

Table 10. Standardized annual CPUE's for North Atlantic Albacore used to fit the VPA- ADAPT model to assess the North stock.

	Japan NB	*Spain TR Age 2*	*Spain TR Age 3*	*USA*	*France TR*	*Taiwan LL*
Age range	3-8+	2	3	3- 8	2- 3	2- 8+
Catch units	Number	Number	Number	Number	Number	Number
Effort units	1000 hooks	fishing days	fishing days	1000 hooks	fishing days	1000 hooks
Selectivity	Partial catch	Partial catch	Partial catch	Partial catch	Partial catch	Partial catch
Model	negative binomial	log- normal	log- normal	delta log- normal	log- normal	log- normal
Used in Ass.	Yes	Yes	Yes	Yes	Yes	Yes
Year						
1975	2.55				1.36	6.65
1976	2.14				0.95	9.00
1977	1.41				1.23	9.20
1978	1.19				1.46	8.19
1979	1.41				1.27	7.96
1980	1.32				1.46	8.93
1981	1.43	23.08	9.09		1.57	8.02
1982	1.26	29.36	17.57		1.55	8.66
1983	1.15	21.38	18.20		0.86	8.78
1984	1.00	17.78	12.96		0.47	7.50
1985	1.10	13.66	9.58		1.70	6.60
1986	0.62	21.75	13.68	0.79	0.37	5.28
1987	0.46	24.04	11.73	0.82	0.62	5.21
1988	0.75	23.65	14.29	0.80		10.95
1989	0.71	12.88	10.03	0.93		8.53
1990	0.55	22.20	7.78	1.16		5.72
1991	0.64	32.82	8.48	1.05		7.55
1992	0.51	27.70	10.84	0.84		5.95
1993	0.50	24.69	11.69	0.93		7.08
1994	0.65	39.38	7.96	1.08		4.86
1995	0.43	29.63	9.00	0.97		4.81
1996	0.38	34.61	3.48	0.76		3.25
1997	0.52	21.42	6.18	1.04		3.92
1998	0.81	19.40	8.02	1.03		4.17
1999	0.48	15.59	7.77	0.93		2.74
2000	0.79	7.91	8.56	1.12		2.75
2001	1.08	12.00	9.50	1.84		2.86
2002	1.15	10.88	3.95	1.30		2.98
2003	0.81	12.30	4.77	0.92		5.39
2004	0.62	27.40	8.09	0.84		4.09
2005	0.84	37.12	8.13	1.28		4.65
2006	0.70	33.25	9.21	0.81		4.84
2007	0.42	26.41	9.99	0.98		3.69

Table 11. Standardized CPUE series by fishery for North Atlantic albacore to be used in Multifan-CL model.

Fishery Year	Quarter	F 01 ESP BB Recent	F 02 ESP+FR TR All	F 03 ESP+FR BB Early	F 04 PRT BB	F 05 JPN Target LL	F 06 JPN Trans LL	F 07 JPN Byc LL	F 08 CHTAI LL	F 09 KOR+PAN+CUB LL	F 10 OTH SURF
1931	1										
1931	2										
1931	3		1.368								
1931	4										
1932	1										
1932	2										
1932	3		1.066								
1932	4										
1933	1										
1933	2										
1933	3		0.878								
1933	4										
1934	1										
1934	2										
1934	3										
1934	4										
1935	1										
1935	2										
1935	3										
1935	4										
1936	1										
1936	2										
1936	3										
1936	4										
1937	1										
1937	2										
1937	3										
1937	4										
1938	1										
1938	2										
1938	3										
1938	4										
1939	1										
1939	2										
1939	3										
1939	4										
1940	1										
1940	2										
1940	3		1.047								
1940	4										
1941	1										
1941	2										
1941	3		1.546								
1941	4										
1942	1										
1942	2										
1942	3		1.857								
1942	4										
1943	1										
1943	2										
1943	3										

1943	4		
1944	1		
1944	2		
1944	3		
1944	4		
1945	1		
1945	2		
1945	3	1.584	
1945	4		
1946	1		
1946	2		
1946	3	1.211	
1946	4		
1947	1		
1947	2		
1947	3	0.942	
1947	4		
1948	1		
1948	2		
1948	3	1.382	
1948	4		
1949	1		
1949	2		
1949	3	0.948	
1949	4		
1950	1		
1950	2		
1950	3	1.010	
1950	4		
1951	1		
1951	2		
1951	3	1.020	
1951	4		
1952	1		
1952	2		
1952	3		
1952	4		
1953	1		
1953	2		
1953	3		
1953	4		
1954	1		
1954	2		
1954	3		
1954	4		
1955	1		
1955	2		
1955	3		
1955	4		
1956	1		
1956	2		
1956	3		
1956	4		
1957	1		
1957	2		
1957	3	1.446	0.869
1957	4		0.869
1958	1		

1958	2							
1958	3	1.201	0.846					
1958	4		0.846					
1959	1				6.216			
1959	2				8.673			
1959	3	1.195	1.188		1.860			
1959	4		1.188		6.027			
1960	1				5.389			
1960	2				2.468			
1960	3	1.462	1.151		2.523			
1960	4		1.151		9.820			
1961	1				13.147			
1961	2				0.817			
1961	3	1.289	1.067		1.688			
1961	4		1.067		6.296			
1962	1				26.078			
1962	2				3.043			
1962	3	1.408	1.218		2.542			
1962	4		1.218		2.707			
1963	1				3.267			
1963	2				2.190			
1963	3	0.976	1.206		1.859			
1963	4		1.206		3.196			
1964	1				3.829			
1964	2				1.617			
1964	3	1.172	1.256		1.596			
1964	4		1.256		3.915			
1965	1				4.741			
1965	2				1.450			
1965	3	1.367	0.894		1.238			
1965	4		0.894		2.437			
1966	1				2.933			
1966	2				1.113			5.043
1966	3	0.820	1.009		1.113			
1966	4		1.009		2.008			3.613
1967	1				2.133			
1967	2	1.483			1.606			
1967	3	1.064	0.551		1.569		0.953	
1967	4	1.108	0.551		2.435		1.599	
1968	1				2.027		1.993	
1968	2	0.885			1.400		1.805	
1968	3	0.884	0.833		1.556		1.767	
1968	4	1.013	0.833		2.206		1.832	
1969	1				1.692		1.979	
1969	2	0.688			1.199		1.125	
1969	3	0.953	0.702		1.106		1.796	1.301
1969	4		0.702		1.343		2.440	
1970	1					2.054	1.910	
1970	2	1.297		0.149		2.023	1.417	
1970	3	1.033	0.972	0.125		0.937	1.466	
1970	4	1.156	0.972	0.008		2.035	1.141	
1971	1					1.254	1.407	
1971	2	1.989		0.535		0.955	0.951	
1971	3	1.263	0.752	0.138		0.547	0.639	
1971	4	1.376	0.752	0.101		0.774	0.813	
1972	1					0.696	1.552	
1972	2	2.832		0.278		0.423	0.675	
1972	3	1.404	0.764	0.041		0.219	0.732	

1972	4		0.675	0.764	0.043	0.289		1.469		
1973	1					0.906		1.789	0.157	
1973	2		1.756		0.003	0.664		0.951	0.073	
1973	3		1.141	0.751	0.283	0.336		1.148	0.002	
1973	4		1.894	0.751	0.026	0.557		1.410		
1974	1					1.024		1.614	3.568	
1974	2		1.078	1.579	0.017	0.667		1.103	0.670	
1974	3		1.213	1.579	0.486	0.293		0.917	0.445	
1974	4		1.482	1.579	0.009	0.496		1.502	5.043	
1975	1					0.755		1.347	1.050	
1975	2		0.433		1.026	0.577		0.712	0.351	
1975	3		1.060	1.101	3.474	0.253		0.788	0.183	
1975	4		0.770	1.101	0.818	0.452		1.476	1.695	
1976	1						0.509	2.058	2.881	
1976	2		1.412		0.655		0.239	1.176	1.270	
1976	3		3.233		6.275		0.298	0.658	0.438	
1976	4		2.356		0.601		0.279	1.606	4.071	
1977	1						0.265	1.367	3.666	
1977	2		1.189		4.250		0.184	1.671	1.236	
1977	3		1.536		15.713		0.145	1.205	0.285	
1977	4		0.591		2.444		0.221	1.406	0.917	
1978	1						0.187	1.914	2.994	
1978	2		0.472				0.158	0.912	0.336	
1978	3		1.639		0.146		0.093	1.095	0.276	
1978	4		0.808		0.234		0.237	1.344		
1979	1						0.135	1.901	4.360	
1979	2		1.577		0.699		0.277	0.876	2.894	
1979	3		2.085		0.085		0.150	0.615		
1979	4		1.039		0.000		0.223	1.279	1.101	
1980	1						0.195	2.349	2.961	
1980	2		1.024		4.063		0.481	0.976	0.281	
1980	3		1.432		0.700		0.071	0.876	0.125	
1980	4				0.336		0.149	1.454		
1981	1						0.253	1.574	1.033	
1981	2		1.172		0.112		0.191	1.157	0.261	
1981	3	0.122	0.857		0.091		0.143	1.090	0.087	
1981	4	0.075					0.199	1.428	1.177	
1982	1						0.271	1.563	1.435	13.578
1982	2		0.662		0.398		0.310	1.344	0.874	13.578
1982	3	0.143	0.914		0.034		0.100	1.025	0.445	13.578
1982	4	0.173			0.001		0.132	1.597	0.590	13.578
1983	1						0.305	1.271	0.233	0.110
1983	2	0.104	0.520		0.110		0.166	1.257		0.012
1983	3	0.178	0.937		0.110		0.061	1.185		0.038
1983	4	0.151	0.384		0.001		0.164	1.935	1.847	0.750
1984	1						0.168	1.712	1.545	0.052
1984	2		1.501		0.155		0.209	1.093	0.796	0.001
1984	3	0.124	0.883		0.040		0.076	0.926	0.501	0.032
1984	4		0.958		0.012		0.192	1.050	1.161	1.485
1985	1						0.288	1.345		0.040
1985	2		0.735		0.549		0.166	1.166	2.505	0.007
1985	3	0.137	0.519		0.156		0.138	0.707	0.761	0.071
1985	4	0.150	0.899		0.013		0.145	1.239	2.214	0.426
1986	1						0.136	1.081	5.043	0.012
1986	2		1.353		0.171		0.065	0.766	2.664	0.001
1986	3	0.136	0.676		0.109		0.125	0.789		0.003
1986	4	0.146	0.705		0.057		0.091	0.797	1.563	0.015
1987	1						0.222	0.731	2.793	0.016

1987	2			0.089	0.049	0.564	2.236	
1987	3	0.218	0.582	0.002	0.082	0.778	0.443	0.004
1987	4	0.135	1.048	0.042	0.041	0.826	0.095	0.004
1988	1				0.139	1.578		0.001
1988	2		0.566		0.170	1.353		0.001
1988	3	0.143	0.693	0.075	0.053	1.450		0.001
1988	4	0.153	0.864	0.373	0.137	1.400	0.007	
1989	1				0.193	1.673		0.005
1989	2		0.539		0.086	0.955	0.213	0.001
1989	3	0.148	0.493	0.167	0.064	1.169	0.085	0.010
1989	4	0.122	0.480	0.376	0.127	1.077	0.057	0.001
1990	1				0.150	1.300		
1990	2		0.482	0.027	0.046	0.840		0.004
1990	3	0.261	0.663	0.385	0.060	0.565	0.064	0.006
1990	4	0.107	0.674	0.089	0.111	0.760	0.013	0.258
1991	1				0.133	1.055		0.001
1991	2		1.643		0.071	1.095	0.017	0.000
1991	3	0.168	0.874		0.054	0.820		0.008
1991	4	0.087	1.235	12.935	0.119	1.001		0.025
1992	1				0.084	1.513		
1992	2		1.510	0.174	0.066	1.562		0.001
1992	3	0.189	0.762	0.122	0.046	0.991		0.005
1992	4	0.037	1.433	0.158	0.100	1.279		0.015
1993	1				0.054	0.621	0.709	
1993	2		0.648	0.016	0.028	0.957		
1993	3	0.198	0.827	0.042	0.036	1.122		0.000
1993	4	0.138	0.938	0.308	0.061	0.772		
1994	1				0.049	0.629	0.083	0.028
1994	2		0.454		0.027	0.523		0.007
1994	3	0.221	0.916	0.095	0.058	0.766		0.026
1994	4	0.157	0.422	0.207	0.257	0.664		0.009
1995	1				0.115	0.645	0.345	0.006
1995	2		1.036	0.048	0.014	0.611	0.065	0.009
1995	3	0.198	0.926	0.279	0.067	0.942	0.015	0.005
1995	4	0.124	1.840	0.106	0.118	0.531		0.145
1996	1				0.069	0.602		
1996	2		0.508	0.295	0.050	0.412		
1996	3	0.171	0.935	0.312	0.023	0.412		
1996	4		1.156	0.377	0.140	0.331		
1997	1				0.344	0.722		
1997	2		0.757	1.407	0.043	0.545		
1997	3	0.213	0.941	0.289	0.022	0.402	0.159	0.000
1997	4	0.095	1.905	0.058	0.203	0.458		0.198
1998	1				0.688	0.533		0.024
1998	2		0.852	0.270	0.117	0.542		
1998	3	0.116	0.717	0.018	0.082	0.596		0.004
1998	4	0.120	0.362	0.079	0.061	0.572		0.000
1999	1				0.121	0.629		0.050
1999	2		0.992	0.211	0.075	0.290		0.111
1999	3	0.124	0.763	0.241	0.019	0.279		0.296
1999	4	0.039	0.355	0.072	0.079	0.350		0.001
2000	1				0.140	0.553		0.100
2000	2		0.342	0.167	0.064	0.386		0.029
2000	3	0.294	0.375	0.191	0.072	0.248		0.168
2000	4	0.032	0.127	0.026	0.375	0.248		0.663
2001	1				0.360	0.439		0.173
2001	2		0.550	6.383	0.106	0.340		0.000
2001	3	0.160	0.473	2.302	0.081	0.366		0.116

2001	4	0.117	0.064	0.167	0.175	0.454		3.388
2002	1				0.335	0.623		0.977
2002	2		0.341		0.323	0.325		0.020
2002	3	0.118	0.530	13.519	0.054	0.316		0.098
2002	4	0.035	0.349	1.027	0.168	0.370		3.399
2003	1				0.269	0.837		0.527
2003	2		0.242		0.186	0.698		0.100
2003	3	0.143	0.728		0.053	0.604		0.236
2003	4	0.076	0.344	3.062	0.113	0.846		7.116
2004	1				0.228	0.511		0.415
2004	2	0.173	0.611		0.052	0.436		0.123
2004	3	0.190	0.817	3.267	0.041	0.520		0.118
2004	4	0.073	0.540	0.368	0.122	0.778		0.004
2005	1				0.247	1.011		0.407
2005	2		0.929	1.044	0.041	0.554	3.338	0.051
2005	3	0.251	0.961	0.658	0.075	0.384	5.043	0.310
2005	4	0.119	0.994	0.049	0.190	0.728		2.272
2006	1				0.201	0.957	0.064	0.753
2006	2	0.234	0.591		0.093	0.453		0.033
2006	3	0.355	1.198		0.053	0.638	0.038	0.239
2006	4	0.095	1.204		0.168	0.625	0.019	4.057
2007	1				0.125	0.520	0.043	0.334
2007	2		0.661		0.067	0.541	0.011	0.120
2007	3	0.175	0.730		0.029	0.518	0.026	0.100
2007	4	0.088	0.318		0.087	0.333		6.149

Table 12. Estimated benchmarks using the VPA model for three different F-ratios.

	F-ratio 0.5			F-ratio 1.0			F-ratio 2.0		
MEASURE	LOWER CL	MEDIAN	UPPER CL	LOWER CL	MEDIAN	UPPER CL	LOWER CL	MEDIAN	UPPER CL
F at MSY	3.10E-01	3.54E-01	4.18E-01	3.79E-01	4.49E-01	6.02E-01	6.96E-01	8.46E-01	1.02E+00
MSY	3.41E+04	3.52E+04	3.64E+04	3.56E+04	3.65E+04	3.78E+04	3.66E+04	3.73E+04	3.81E+04
Y/R at MSY	3.57E+00	3.76E+00	3.93E+00	3.87E+00	4.00E+00	4.12E+00	4.10E+00	4.17E+00	4.24E+00
S/R at MSY	4.30E+00	5.48E+00	6.77E+00	2.51E+00	3.77E+00	4.78E+00	1.72E+00	1.88E+00	2.49E+00
SPR AT MSY	1.46E-01	1.86E-01	2.29E-01	8.49E-02	1.28E-01	1.62E-01	5.83E-02	6.37E-02	8.43E-02
SSB AT MSY	3.95E+04	5.11E+04	6.43E+04	2.28E+04	3.43E+04	4.38E+04	1.55E+04	1.69E+04	2.20E+04
F at max. Y/R	5.94E-01	6.53E-01	7.36E-01	6.00E-01	6.52E-01	7.71E-01	7.18E-01	8.75E-01	1.05E+00
Y/R maximum	3.92E+00	4.01E+00	4.09E+00	4.02E+00	4.09E+00	4.17E+00	4.10E+00	4.18E+00	4.25E+00
S/R at Fmax	1.59E+00	1.70E+00	1.83E+00	1.64E+00	1.76E+00	1.91E+00	1.72E+00	1.84E+00	1.99E+00
SPR at Fmax	5.38E-02	5.78E-02	6.19E-02	5.57E-02	5.97E-02	6.47E-02	5.82E-02	6.25E-02	6.73E-02
SSB at Fmax	5.81E+03	1.07E+04	1.38E+04	1.29E+04	1.48E+04	1.65E+04	1.53E+04	1.64E+04	1.77E+04
F 0.1	2.70E-01	3.09E-01	3.66E-01	2.67E-01	2.84E-01	3.08E-01	2.94E-01	3.21E-01	3.46E-01
Y/R at F0.1	3.59E+00	3.64E+00	3.70E+00	3.62E+00	3.66E+00	3.71E+00	3.60E+00	3.65E+00	3.69E+00
S/R at F0.1	6.15E+00	6.56E+00	6.98E+00	6.74E+00	7.20E+00	7.70E+00	7.51E+00	8.04E+00	8.64E+00
SPR at F0.1	2.09E-01	2.22E-01	2.36E-01	2.28E-01	2.44E-01	2.61E-01	2.54E-01	2.72E-01	2.93E-01
SSB at F0.1	5.87E+04	6.26E+04	6.70E+04	6.37E+04	6.76E+04	7.21E+04	6.77E+04	7.20E+04	7.70E+04
F 20% SPR	3.00E-01	3.33E-01	3.77E-01	3.01E-01	3.29E-01	3.78E-01	3.57E-01	4.18E-01	4.95E-01
Y/R at F20	3.64E+00	3.71E+00	3.79E+00	3.73E+00	3.80E+00	3.87E+00	3.82E+00	3.90E+00	3.96E+00
S/R at F20	5.93E+00	5.94E+00	5.95E+00	5.93E+00	5.94E+00	5.95E+00	5.93E+00	5.94E+00	5.95E+00
SSB at F20	5.48E+04	5.60E+04	5.73E+04	5.47E+04	5.55E+04	5.65E+04	5.25E+04	5.32E+04	5.41E+04
F 30% SPR	2.15E-01	2.39E-01	2.74E-01	2.15E-01	2.33E-01	2.64E-01	2.51E-01	2.89E-01	3.35E-01
Y/R at F30	3.29E+00	3.36E+00	3.43E+00	3.38E+00	3.45E+00	3.51E+00	3.48E+00	3.54E+00	3.60E+00
S/R at F30	8.88E+00	8.90E+00	8.92E+00	8.89E+00	8.90E+00	8.92E+00	8.88E+00	8.90E+00	8.91E+00
SSB at F30	8.59E+04	8.80E+04	9.00E+04	8.26E+04	8.43E+04	8.64E+04	7.87E+04	7.98E+04	8.11E+04
F 40% SPR	1.58E-01	1.76E-01	2.03E-01	1.57E-01	1.70E-01	1.91E-01	1.81E-01	2.07E-01	2.36E-01
Y/R at F40	2.89E+00	2.96E+00	3.02E+00	2.98E+00	3.04E+00	3.10E+00	3.07E+00	3.13E+00	3.18E+00
S/R at F40	1.18E+01	1.19E+01	1.19E+01	1.18E+01	1.19E+01	1.19E+01	1.18E+01	1.19E+01	1.19E+01
SSB at F40	1.16E+05	1.20E+05	1.24E+05	1.10E+05	1.13E+05	1.17E+05	1.05E+05	1.06E+05	1.08E+05
F 75% of Fmax	4.46E-01	4.90E-01	5.52E-01	4.50E-01	4.89E-01	5.78E-01	5.38E-01	6.56E-01	7.87E-01
Y 75% of Fmax	2.84E+04	3.30E+04	3.58E+04	3.48E+04	3.63E+04	3.77E+04	3.63E+04	3.69E+04	3.78E+04
Y/R at 75% Fmax	3.87E+00	3.95E+00	4.04E+00	3.96E+00	4.04E+00	4.12E+00	4.05E+00	4.13E+00	4.21E+00
S/R at 75% Fmax	3.01E+00	3.16E+00	3.32E+00	2.99E+00	3.16E+00	3.32E+00	2.99E+00	3.14E+00	3.31E+00
SSB at 75% Fmax	2.27E+04	2.62E+04	2.88E+04	2.64E+04	2.83E+04	3.01E+04	2.66E+04	2.81E+04	2.98E+04

Table 13. Catch (t) series by fishery, year and quarter used in Multifan-CL.

YY	QQ	ALBN01	ALBN02	ALBN03	ALBN04	ALBN05	ALBN06	ALBN07	ALBN08	ALBN09	ALBN10
1930	3		11250								
1931	3		15600								
1932	3		12850								
1933	3		11450								
1934	3		18880								
1935	3		20750								
1936	3		16800								
1937	3		13500								
1938	3		14622								
1939	3		17078								
1940	3		11488								
1941	3		13244								
1942	3		16780								
1943	3		16764								
1944	3		16963								
1945	3		27586								
1946	3		23266								
1947	3		20268								
1948	3		24101								
1949	3		27865								
1950	2		20530.558								
	3		18470.545								
	4		621.89665								
1951	2		17694.219								
	3		15918.801								
	4		535.98033								
1952	2		16786.425								
	3		15102.093								
	4		508.48208								
1953	2		13597.227								
	3		12232.896	3679.4411							
	4		411.87724	195.55894							
1954	2		16958.45								
	3		15256.858	6884.1155							
	4		513.69294	365.88446							
1955	2		14663.056								
	3		13191.781	2967.2912							
	4		444.16256	157.70882							
1956	2		18341.385			0.8461538					
	3		16501.031	5222.4325		0.9807692					
	4		555.58381	277.56752		0.1730769					
1957	2		15558.933			4.5190563					
	3		13997.767	11355.467		87.032668					
	4		471.29981	603.53272		43.448276					
1958	1					9.0013335					
	2		17588.517			153.70277					
	3		15823.705	16387.044	300	263.11898					
	4		532.77848	870.95641		519.17692					

1959	1				75.658998			
	2	15956.87			129.19886			
	3	14355.776	17041.272	570	79.418137			
	4	483.35384	905.72805		314.72401			
1960	1				57.211624		26.991848	
	2	17136.174			177.76699		177.49185	
	3	15416.749	16653.862	600	346.88447		21.266304	
	4	519.07644	885.13759		549.13692		301	
1961	1				54.460444		16.571739	
	2	10832.91			56.134169		108.97174	
	3	9745.9476	19484.421	600	130.40036		13.056522	
	4	328.14257	1035.5792		139.00503		184.8	
1962	1				15.511727		32.888804	
	2	16033.038			790.38465		216.2688	
	3	14424.301	19796.817	620	4738.8427		32.948293	
	4	485.66105	1052.1828		171.26088		376.7241	
1963	1				34.335323		16.678323	
	2	12759.382			8954.2385		109.67261	
	3	11479.12	18771.321	970	4890.9835		20.590275	
	4	386.49787	997.6786		753.44272		196.53879	
1964	1				406.54894		14.343112	
	2	14538.183			9480.2521		94.316826	26.575703
	3	13079.437	18922.297	500	3942.066		53.92992	1.9916218
	4	440.37998	1005.7028		1884.1329		220.31814	23.432675
1965	1			83.573574	2833.7392		13.882444	
	2	13235.56		123.27102	7517.8697		91.287587	88.926391
	3	11907.518	18068.667	853.55255	2271.4277		58.119611	55.501707
	4	400.92189	960.33316	22.602853	1701.9633		221.62836	147.5719
1966	1			94.804805	483.6052		6.6157826	
	2	11809.1		139.83709	2436.4413		43.503783	751.78576
	3	10624.188	15315.97	366.71772	886.25656		89.643254	118.83528
	4	357.7126	814.02984	25.64039	2053.6969		193.34518	751.37897
1967	1			104.38438	1176.7578		29.458957	
	2	15891.066		153.96697	1640.1459		193.71496	2006.4656
	3	14296.574	16420.277	769.41742	1118.8533		338.17015	188.03021
	4	481.36053	872.72275	28.231231	835.24294		774.55194	1822.5042
1968	1			114.95495	695.53721		342.56853	60.626846
	2	12431.913		169.55856	1034.103		447.64877	72.120721
	3	11184.509	12797.808	134.26832	1171.4183		859.40824	1742.4155
	4	376.57841	680.19183	39.218169	404.94141		402.79047	57.836909
1969	1			125.1952	1525.2577		524.74213	17.640263
	2	9286.7577		184.66291	1601.3279		377.92257	10.17964
	3	8354.9347	12999.109	498.33647	1249.2158		626.20832	6865.2261
	4	281.30766	690.89079	70.805422	341.19864		1067.479	31.953992
1970	1			82.582583		988.02215	873.42551	
	2	8138.0246		121.80931		1834.7078	1952.4918	
	3	7321.4643	13137.987	193.97391		1410.1548	1194.5901	5011
	4	246.51108	800.01293	51.634198		1642.1153	894.50459	
1971	1			132.13213		2156.0971	1104.5231	
	2	12450.566		194.89489		1589.5575	793.49418	
	3	11201.29	14137.229	87.926892		1525.4392	335.53815	7707
	4	377.14344	839.77085	285.04608		1200.9062	702.06858	

1972	1				239.48949		751.04148		1983.1682	1048.1417	
	2		13739.717		356.65013		149.21741		296.44186	1252.2566	
	3		12361.089	6654.9827	103.92607		279.72516		625.40664	3321.6402	
	4		416.19346	382.01729	458.93431		139.01594		1645.7513	2575.9615	
1973	1						525.89225		4373.2549	907.94241	
	2		9695.576		5.1231294		160.97676		1223.3155	1104.9332	
	3		8722.7327	7030.3316	555.16093		194.30104		2286.4789	2911.3837	
	4		293.69129	437.66844	804.71594		585.82996		1632.4107	2247.9407	
1974	1						773.28637		2696.2968	384.56103	
	2		3995.1963	14.399484	36.6		328.60824		2558.5908	465.73702	
	3		16733.719	11284.829	1150.2		479.43755		1367.0398	1235.269	
	4		229.0842	407.77108	1092.2		477.66784		2940.9965	954.43291	
1975	1				440		477.23563		2862.2005	762.82188	
	2		1360.5241		654.11585		355.85899		1225.445	952.30126	
	3		7618.5382	9296.3114	307.08933		110.88414		1049.5194	475.44447	
	4		511.93766	397.68859	8591.7948		387.02124		3085.8351	965.43238	
1976	1				152.79794			444.69903	6107.8062	1779.5144	
	2		1287.9278		238.42192			153.84023	1302.8846	2289.0298	
	3		11932.238	10293.039	428.51736			348.83119	1914.6412	1635.4814	
	4		697.83386	3167.9612	5946.2628			397.62956	5728.668	987.00011	
1977	1				429.86979			384.56413	4774.6352	2483.0101	
	2		3355.0702		387			43.231582	2055.9953	2071.9343	
	3		13446.036	6222.4383	46.958333			29.106252	1871.7972	1061.616	
	4		589.89366	3655.5617	4817.1719			368.09803	5334.5722	602.43959	
1978	1				179			170.72602	4599.5845	1327.3694	
	2		1694.4633	5.5	967.28571			14.164481	1997.977	960.43503	0.0851064
	3		21442.939	8218.0963	13.314286			65.060584	1288.5947	961.55659	1.9148936
	4		793.5975	2489.4037	85.4			281.04892	1840.8438	655.63899	67
1979	1				43.836066			326.12928	2971.9113	1486.1501	1.9672131
	2		1880.3989		572.85246			141.03011	1500.0978	1303.3102	0.7704918
	3		20982.426	12432.664	131.08197			98.210598	962.48562	342.13418	40.016393
	4		469.17463	2581.3363	2.2295082			653.63001	2131.5053	297.70953	19.245902
1980	1				8.9594595			339.51279	2452.0454	559.1383	
	2		1088.993		370.07243			55.910916	1518.9463	113.52336	2.1188757
	3		11837.014	13158.02	64.022161			138.66582	1121.7859	231.62155	0.8928548
	4		132.99334	2421.9796	153.94595			501.91047	2301.2224	116.71679	0.5882696
1981	1				952			477.21637	1533.6906	251.32421	
	2	0.0071429	881.4215		193.86121			157.28682	1677.4576	208.81841	40.015808
	3	11753.507	9767.9699		305.13879			367.23478	1943.5831	416.68075	429.37844
	4	208.48622	128.60856					738.26203	1761.2687	286.17663	51.675753
1982	1				309.8024			115.85993	2206.7579	494.72111	22.121212
	2	0.0035	327.99353		435.32695			104.68262	2866.976	651.36506	87.297541
	3	14392.95	12347.494		73.770573			93.7351	2134.3155	619.98715	623.26907
	4	590.53604	155.51201		5.1000855			466.72234	3314.9506	135.92668	95.462173
1983	1				91.20339			867.5061	3300.7797	169.165	327.0198
	2	105.54511	3.9998868		823.46405			58.375691	4202.016	249.60322	110.0925
	3	12690.317	12535.403		1576.7299			27.946314	3023.7094	273.62826	372.1997
	4	5593.228	248.59705		54.602682			202.17189	4307.4949	180.60351	94.897998
1984	1	1.1017455			849.20123			197.93644	5026.5376	503.2158	530.27365
	2	27.94463	214.90522		424.74849			87.493063	4036.5213	1858.9822	214.35942
	3	6013.5332	10623.163		206.58145			15.358932	2883.9853	901.15043	2034.2154
	4	395.47042	190.9317		266.46884			275.21157	3598.9558	323.65152	98.451485

1985	1			451.24402	506.49336	4551.3033	186.61486	45.512625
	2		222.81253	951.96698	49.965212	3642.0094	380.57171	18.840439
	3	8796.2314	9129.7513	512.25885	73.660055	2805.599	368.98001	153.00423
	4	1613.0486	1301.4362	186.53014	213.88137	4559.1283	74.833411	29.962709
1986	1	0.1009191		304.35437	145.18869	7219.5602	454.83864	26.133333
	2	8.1744482	1095.6776	124.85774	10.268452	5164.848	359.36485	22.029709
	3	9083.1239	8784.554	149.46465	71.382304	3604.8424	90.0048	228.3832
	4	5215.6007	956.76844	314.32324	243.16056	3843.4894	24.791704	23.173761
1987	1			47.46737	187.65047	4127.0645	43.934351	29.14552
	2		1531.3005	79.519423	7.7146113	1293.0521	13.492324	16.663452
	3	15124.905	8630.6745	125.82158	65.458311	1010.6184	16.463568	247.53545
	4	3282.1253	1377.025	358.19162	233.17661	294.62497	3.1097561	6.2555739
1988	1			212.12738	292.04669	489.15285	0.8181818	72.247858
	2	5.0999671	897.67531	130.55918	11.990233	915.9182	11.69697	32.452019
	3	11366.649	9094.3474	6.7855339	35.559967	580.49756	7.3939394	222.24976
	4	5803.3111	2085.9773	101.5279	383.40311	284.4314	0.0909091	15.180364
1989	1			150.62715	436.76919	396.12724	0.6390418	14.334201
	2		995.58571	4.4066884	48.754447	383.9549	38.061495	6.5899474
	3	10545.454	8492.4071	15.182347	30.169201	297.25743	13.801065	162.13484
	4	6761.6063	2511.0071	136.78381	248.30716	343.66043	1.0083979	35.881008
1990	1			114.63021	405.05481	564.9069	12.668732	452.54393
	2		1664.134	80.043566	4.0378533	430.57401	18.03111	349.56875
	3	12289.89	10149.486	1267.4787	20.969306	379.21486	4.3346411	441.2906
	4	2766.1101	1161.5217	3138.8475	306.93803	535.30423	0.9655172	323.65672
1991	1			158.13802	299.98272	1371.3109		3.3971312
	2		2487.1487	65.758786	10.172716	1449.1621	1	193.89132
	3	7028.457	9289.8822	5.2961733	16.95921	903.48179		222.82012
	4	1000.543	897.9691	1177.807	363.88536	898.60619		103.03442
1992	1			52.747305	186.05313	367.50442	0.2	140.17896
	2	0.0250871	1886.0018	316.91614	5.682411	683.96208	29.37	72.806673
	3	10588.107	9647.803	422.41286	12.29544	1073.3279		97.772094
	4	1336.9177	741.19519	2321.9237	261.96902	531.36162		85.987271
1993	1			109.19135	186.713	94.556469	67.773	230.96203
	2		1306.5325	13.786616	11.710733	2486.4159		3.0191094
	3	10209.392	11447.292	965.95247	14.374925	1770.6106		240.83548
	4	748.07816	372.17517	5379.0696	272.20135	2188.174		16.213377
1994	1	0.4981648		98.942455	211.12947	853.26003	103.601	102.47326
	2	0.039375	1323.7881		4.2344458	1036.052		162.84128
	3	8444.0014	11142.034	585.54684	26.592319	3168.7245		368.17997
	4	2309.5311	600.17761	2659.5107	263.04377	1642.0576		57.23949
1995	1			21.39349	74.746349	562.53923	0.166	32.172352
	2		1453.1908	246.45473	5.8104471	955.37676	0.013	77.911711
	3	9427.3775	11314.764	2859.4883	15.678734	1485.3745	73.253	25.036106
	4	2383.6225	971.04507	4521.6634	289.76447	1394.6435	1.438	184.48203
1996	1			342.28673	79.254369	2702.6644		31.160016
	2	10.898239	940.76878	188.0506	41.336299	495.45936		110.76518
	3	9214.0343	8348.4094	397.97717	28.298461	406.40278	12.8	315.74886
	4	1766.0675	330.82185	1989.6855	317.11087	558.01049		174.50994
1997	1	2.3763455		601.18889	131.83123	1538.4368	2.4017106	82.294947
	2	2.7150167	926.34999	512.49722	30.151766	696.45519		81.775113
	3	9210.2226	10104.563	177.98013	8.6814217	312.1017	2.4097863	458.94016
	4	2036.686	496.08713	154.33375	243.33559	1084.6983	0.7365031	123.25978

1998	1	0.9740205			174.85415			253.15257	1419.8667		121.36683
	2	94.824278	1243.6279		73.752738			35.884047	853.65063		39.303421
	3	8067.9987	10461.884		9.9493684			13.837639	894.61433		684.22297
	4	277.20296	196.48808		180.44374			143.12575	420.69668		84.473777
1999	1	3.9049593			344.11584			109.09685	2192.0333		74.479151
	2	348.78005	1397.0807		326.00615			44.412172	927.61591		89.617291
	3	10753.382	11594.368		725.37215			7.8012342	1269.4374		404.08813
	4	722.71924	125.54768		898.50586			263.68975	1896.0113		32.838695
2000	1	1.0233544			112.14612			139.47736	2424.6557		97.711745
	2	45.275355	954.64192		91.162687			33.418478	2381.2817		88.616032
	3	13082.283	9258.5263		208.91395			72.796196	1022.8636		569.51454
	4	959.90239	51.67178		117.77724			442.30797	804.02191		1240.465
2001	1	0.2426656			355.32846			391.35114	1817.8902		165.77272
	2	1.6379925	953.99591		1162.4185			99.098108	2411.4082		7.8556248
	3	8252.6322	5813.763		838.39844			29.951198	1120.2961		254.38486
	4	545.00384	57.982675		289.32461			605.59955	896.58541		183.16246
2002	1	0.0712344			89.959885			422.63883	2157.0902		125.29453
	2	3.9085049	331.07053		1339.5444			97.584712	1194.4742		32.499222
	3	6798.6146	3413.1909		1230.8973			14.263278	906.50842		355.87198
	4	2177.0127	245.03397		374.04542			176.91418	1210.1359		44.495252
2003	1	0.0074245			536.71563			364.06431	1864.0639		159.31874
	2	17.64672	259.68745		625.55093			117.64271	1833.2424		96.885647
	3	8866.8755	4570.5284		388.12768			20.323059	2149.9186		623.11764
	4	968.99345	371.75921		282.66177			178.25091	1170.0802		175.64856
2004	1	0.4716017			399.51839			428.92878	1621.9635		116.27835
	2	122.03131	450.725		171.44276			63.994026	2132.3189		302.83345
	3	8408.1831	6530.7617		237.70549			42.287552	1457.52		552.37297
	4	996.55619	509.558		161.09936			357.60264	804.41402		89.309903
2005	1				131.85433			802.79494	1285.7848		48.775372
	2	13.256079	948.06481		380.23206			47.640376	1655.0708	13.472952	26.474071
	3	13956.032	8505.6593		468.97303			55.067905	1635.9732	45.527048	598.31848
	4	2357.0756	724.8162		151.77658			430.27577	928.17931		93.527502
2006	1	1.261551			128.94211			507.70692	690.73511	1.8047144	115.30664
	2	1031.3177	684.9672		43.106357			38.062302	1128.046	8.6405304	28.610302
	3	17081.153	8972.0666		56.841935			15.513786	1560.9337	30.135047	585.47849
	4	2197.8159	620.24618		117.6496			219.38499	920.93585	100.75171	101.87465
2007	1	0.0378223			23.646056			124.48045	613.40205	99.41585	128.00131
	2	8.0727663	413.19885		256.9151			10.447658	836.7342	77.751637	103.88388
	3	9613.7125	4817.6757		9.353202			17.454363	1074.8457	2.2345133	420.03749
	4	1941.8466	861.95899		45.966937			141.75653	640.54684		110.16149

Table 14. Standardized effort series by fishery, Year and quarter used in Multifan-CL.

YY	QQ	ALBN01	ALBN02	ALBN03	ALBN04	ALBN05	ALBN06	ALBN07	ALBN08	ALBN09	ALBN10
1930	3		-1								
1931	3		11400.113								
1932	3		12057.558								
1933	3		13046.125								
1934	3		-1								
1935	3		-1								
1936	3		-1								
1937	3		-1								
1938	3		-1								
1939	3		-1								
1940	3		10973.813								
1941	3		8568.7801								
1942	3		9037.8695								
1943	3		-1								
1944	3		-1								
1945	3		17418.294								
1946	3		19210.672								
1947	3		21514.129								
1948	3		17436.29								
1949	3		29396.27								
1950	2		-1								
	3		18280.798								
	4		-1								
1951	2		-1								
	3		15613.596								
	4		-1								
1952	2		-1								
	3		-1								
	4		-1								
1953	2		-1								
	3		-1	-1							
	4		-1	-1							
1954	2		-1								
	3		-1	-1							
	4		-1	-1							
1955	2		-1								
	3		-1	-1							
	4		-1	-1							
1956	2		-1			-1					
	3		-1	-1		-1					
	4		-1	-1		-1					
1957	2		-1			-1					
	3		9678.6837	13068.801		-1					
	4		-1	694.59485		-1					
1958	1					-1					
	2		-1			-1					
	3		13175.716	19372.641	-1	-1					
	4		-1	1029.6382		-1					
1959	1					12.172365					
	2		-1			14.897369					
	3		12008.92	14340.538	-1	42.706821					
	4		-1	762.18652		52.218036					

1960	1				10.616324		-1	
	2	-1			72.03913		-1	
	3	10547.396	14464.506	-1	137.473		-1	
	4	-1	768.77528		55.917846		-1	
1961	1				4.1423778		-1	
	2	-1			68.747476		-1	
	3	7562.6427	18255.611	-1	77.246743		-1	
	4	-1	970.26905		22.078525		-1	
1962	1				0.5948129		-1	
	2	-1			259.72284		-1	
	3	10247.821	16247.311	-1	1864.1185		-1	
	4	-1	863.52973		63.261905		-1	
1963	1				10.51045		-1	
	2	-1			4088.6806		-1	
	3	11765.271	15570.258	-1	2630.2759		-1	
	4	-1	827.54502		235.76801		-1	
1964	1				106.17869		-1	
	2	-1			5863.9886		-1	-1
	3	11163.51	15062.181	-1	2469.5207		-1	-1
	4	-1	800.54117		481.22845		-1	-1
1965	1			-1	597.69933		-1	
	2	-1		-1	5185.251		-1	-1
	3	8713.4066	20218.847	-1	1835.3662		-1	-1
	4	-1	1074.6133	-1	698.45671		-1	-1
1966	1			-1	164.89671		-1	
	2	-1		-1	2188.6588		-1	149.07106
	3	12952.946	15178.507	-1	796.60337		-1	-1
	4	-1	806.72378	-1	1022.8491		-1	207.99264
1967	1			-1	551.8106		-1	
	2	10717.864		-1	1021.2953		-1	-1
	3	13434.816	29787.935	-1	712.90357		355.01171	-1
	4	434.56555	1583.2016	-1	342.9927		484.2884	-1
1968	1			-1	343.1556		171.85817	-1
	2	14047.612		-1	738.84575		247.98273	-1
	3	12645.604	15356.095	-1	753.00362		486.38196	-1
	4	371.58159	816.16242	-1	183.57841		219.90928	-1
1969	1			-1	901.61997		265.20596	-1
	2	13502.825		-1	1335.7697		336.06541	-1
	3	8764.1655	18511.413	-1	1129.8563		348.60214	5275.2889
	4	-1	983.8647	-1	254.12831		437.45528	-1
1970	1			-1		481.01118	457.40313	
	2	6273.1306		819.58884		907.07568	1377.8267	
	3	7088.6216	13520.611	1547.5689		1505.7406	815.09111	-1
	4	213.32695	823.31209	6374.918		806.84042	784.15745	
1971	1			-1		1719.0652	785.1367	
	2	6261.0923		364.56795		1664.3533	834.2993	
	3	8871.2923	18798.144	637.55092		2790.6188	524.72899	-1
	4	274.10142	1116.6356	2823.0326		1551.865	863.6481	
1972	1			-1		1078.9809	1277.5504	-1
	2	4851.1945		1284.6175		352.98156	439.34861	-1
	3	8804.8017	8710.7122	2564.875		1276.1704	854.31014	-1
	4	616.28462	500.02274	10574.209		481.68966	1120.6787	-1
1973	1					580.14051	2444.5371	5797.0583
	2	5522.7662		1829.2756		242.33813	1286.224	15081.273
	3	7644.6845	9359.2855	1965.017		577.60063	1991.5838	1174646.5
	4	155.04451	582.65587	30849.156		1050.9014	1157.9591	-1

1974	1						754.92026		1670.505	107.78848	
	2		3704.5475	9.1179897	2202.4577		492.81259		2320.716	694.95003	
	3		13797.851	7145.7394	2367.9421		1635.1279		1490.3182	2775.742	
	4		154.61158	258.20735	120551.3		962.54256		1957.6094	189.25382	
1975	1				-1		632.22442		2124.3995	726.50512	
	2		3141.7604		637.3555		616.32144		1720.5788	2710.4795	
	3		7188.1122	8447.1103	88.40879		437.91288		1332.042	2600.622	
	4		664.51057	361.36046	10497.834		856.37952		2090.1218	569.53462	
1976	1				-1			872.81862	2967.3993	617.7605	
	2		911.99246		364.24282			642.74279	1107.5351	1801.9223	
	3		3691.0562	-1	68.290457			1169.4843	2910.7716	3737.1859	
	4		296.22553	-1	9900.8725			1424.3215	3567.8794	242.47011	
1977	1				-1			1452.6378	3491.7662	677.36877	
	2		2822.0382		91.050846			235.35549	1230.6898	1676.989	
	3		8751.9843	-1	2.9884945			200.65335	1552.8544	3719.8035	
	4		998.28928	-1	1971.0221			1664.6582	3794.0343	657.30296	
1978	1				-1			915.22732	2402.822	443.36744	
	2		3588.7046	-1	-1			89.662263	2190.2374	2862.426	-1
	3		13084.197	-1	91.231578			703.05235	1176.822	3479.1843	-1
	4		982.42098	-1	365.63338			1188.2551	1369.7685	-1	-1
1979	1				-1			2411.0113	1563.663	340.83189	-1
	2		1192.2621		819.48482			508.40641	1712.5037	450.35103	-1
	3		10063.753	-1	1547.8469			654.66381	1565.5656	-1	-1
	4		451.35012	-1	6315.5122			2925.8759	1666.375	270.40802	-1
1980	1				-1			1741.7416	1043.9082	188.86277	
	2		1063.7298		91.083441			116.12751	1555.9038	404.71086	-1
	3		8263.5454	-1	91.488353			1951.3877	1281.0691	1851.585	-1
	4		-1	-1	458.06891			3361.5281	1582.6663	-1	-1
1981	1				-1			1883.4506	974.65841	243.30558	
	2	-1	751.8175		1730.2624			824.81724	1449.9083	800.65993	-1
	3	95976.204	11398.479		3369.641			2567.2541	1783.6941	4796.698	-1
	4	2796.0838	-1					3712.9783	1233.5992	243.14931	-1
1982	1				-1			426.85525	1412.1507	344.81185	1.6292489
	2	-1	495.33635		1094.1356			337.37536	2133.0049	745.44399	6.4295493
	3	100612.18	13504.009		2191.8333			941.18122	2082.7831	1393.901	45.904377
	4	3408.3759	-1		9014.185			3539.347	2075.997	230.23977	7.0308825
1983	1				-1			2844.4103	2597.9214	725.66445	2971.7699
	2	1018.8024	7.6870636		7465.9038			350.93044	3342.6017	-1	9044.2884
	3	71452.788	13381.674		14292.613			454.5345	2550.6953	-1	9691.5323
	4	36955.445	647.31278		59906.719			1230.7842	2226.1724	97.759417	126.49934
1984	1	-1			-1			1179.3264	2936.6964	325.8081	10168.303
	2	-1	143.20327		2734.2325			418.47295	3691.6705	2336.5329	231977.16
	3	48400.937	12030.204		5196.3728			202.19852	3115.1706	1797.6988	64088.839
	4	-1	199.20216		21595.839			1436.9713	3426.4239	278.66178	66.279997
1985	1				-1			1761.4419	3384.8554	-1	1150.5693
	2		303.28103		1734.2508			300.27653	3122.7286	151.91725	2574.5303
	3	64430.033	17600.5		3283.682			532.95525	3969.1977	484.56463	2154.5016
	4	10754.028	1447.4071		13962.903			1480.0014	3680.9273	33.804142	70.388113
1986	1	-1			-1			1067.1362	6679.7482	90.189631	2194.5974
	2	-1	809.91312		729.15847			156.92626	6742.2303	134.90022	30112.171
	3	66706.223	12998.72		1367.3027			572.00612	4571.6104	-1	76919.164
	4	35840.219	1356.2373		5560.4773			2657.7141	4825.1235	15.863329	1568.3276
1987	1				-1			847.03843	5643.7436	15.732538	1774.1116
	2		-1		893.19258			158.06102	2291.4164	6.0345044	-1
	3	69312.556	14836.589		58409.103			793.7579	1299.2335	37.19552	58703.472
	4	24241.537	1313.8656		8444.2283			5707.6416	356.79877	32.811387	1553.6151

1988	1			-1	2095.0135	310.0383	-1	60301.112
	2	-1	1586.9765	-1	70.597446	677.19675	-1	55100.045
	3	79406.935	13127.607	90.870511	674.60142	400.45788	-1	338897.89
	4	37843.092	2413.8791	272.48401	2808.1705	203.10693	12.992307	-1
1989	1			-1	2264.0058	236.74392	-1	2980.2893
	2		1846.1898	-1	563.84677	401.89515	178.52098	7149.904
	3	71363.059	17215.885	90.945101	475.09162	254.37864	163.22368	16697.43
	4	55626.403	5235.2268	364.16029	1954.8185	319.14824	17.730387	30433.05
1990	1			-1	2692.8529	434.42243	-1	-1
	2		3449.5762	3006.2766	87.099164	512.53773	-1	95110.902
	3	47011.747	15311.959	3288.0766	351.88129	671.46031	68.08042	70414.784
	4	25879.433	1722.1272	35318.163	2767.999	704.7148	75.777612	1255.2644
1991	1			-1	2260.0636	1300.2881		2649.7017
	2		1513.946	-1	144.01718	1322.8469	57.961805	423321.71
	3	41850.38	10624.432	-1	315.83958	1101.8505		27329.204
	4	11497.971	727.33102	91.0524	3048.3698	898.09291		4173.8253
1992	1			-1	2225.4781	242.87845	-1	-1
	2	-1	1249.1693	1820.3088	86.122469	437.91617	-1	140869.81
	3	56117.087	12662.831	3459.4723	270.02734	1083.1249		21489.903
	4	36244.165	517.38398	14658.636	2626.7982	415.53978		5658.2086
1993	1			-1	3461.7907	152.34837	95.576982	-1
	2		2015.7796	866.81863	417.37053	2598.8494		-1
	3	51630.881	13837.023	23055.467	395.18498	1577.9918		488230.68
	4	5432.4652	396.61825	17442.19	4490.9101	2832.8203		-1
1994	1	-1		-1	4345.3961	1356.9863	1243.5174	3610.5173
	2	-1	2916.1975		158.00918	1980.6433		22429.757
	3	38181.177	12161.025	6182.3906	456.83538	4138.5486		14354.768
	4	14699.688	1421.7352	12826.866	1024.5627	2472.8873		6470.1498
1995	1			-1	652.12374	872.08314	0.4814884	5554.4055
	2		1402.9884	5157.5784	427.04589	1563.1842	0.1993395	8774.4212
	3	47704.086	12214.086	10240.186	233.98083	1577.1144	4823.1004	5551.2592
	4	19184.593	527.80633	42505.819	2455.541	2625.3618	-1	1276.6385
1996	1			-1	1153.3892	4491.8079		-1
	2	-1	1851.9346	637.52748	821.66969	1202.67		-1
	3	53846.388	8927.5382	1274.8565	1215.0067	986.49553	-1	-1
	4	-1	286.20726	5283.6989	2258.2578	1687.5808		-1
1997	1	-1		-1	382.86419	2129.9258	-1	-1
	2	-1	1223.6486	364.34182	697.98758	1278.4365		-1
	3	43204.646	10737.12	616.03555	397.87708	775.44628	15.171151	1643616
	4	21392.101	260.47995	2661.087	1200.7472	2368.1233	-1	621.1525
1998	1	-1		-1	368.0445	2666.0424		5039.7264
	2	-1	1460.1116	273.15157	306.67984	1574.8246		-1
	3	69417.183	14594.634	546.32531	168.73068	1500.3591		182625.96
	4	2312.5261	543.49756	2278.7684	2356.7413	735.64563		414818.9
1999	1	-1		-1	904.80417	3486.1109		1481.4404
	2	-1	1408.3723	1547.8603	588.33476	3198.648		808.20344
	3	86386.838	15188.867	3004.6785	409.59321	4547.3262		1364.5455
	4	18722.523	354.13705	12565.029	3355.4989	5422.9205		44041.218
2000	1	-1		-1	995.23445	4385.3267		980.79555
	2	-1	2788.5717	546.50976	520.49749	6165.6368		3007.4952
	3	44542.586	24717.243	1091.7489	1004.0929	4124.57		3398.4826
	4	29876.352	407.08107	4557.6109	1180.3691	3242.118		1870.6408
2001	1	-1		-1	1086.4084	4140.3272		960.83436
	2	-1	1735.2396	182.10169	937.51954	7089.3929		25137.741
	3	51464.531	12292.49	364.2034	370.47892	3061.83		2186.5983
	4	4656.5534	909.20692	1729.9661	3469.4321	1974.9627		54.062311

2002	1	-1			-1			1262.9623	3460.3698		128.19417
	2	-1	970.0574		-1			302.51113	3672.6332		1646.6312
	3	57548.377	6437.0335		91.050843			266.02372	2870.9654		3644.7815
	4	62194.237	702.10622		364.20341			1053.4881	3271.0225		13.090562
2003	1	-1			-1			1353.1982	2225.7909		302.59942
	2	-1	1072.9165		-1			632.41621	2626.786		971.14895
	3	62207.236	6277.8219		-1			380.41079	3557.1255		2645.5457
	4	12772.563	1081.7809		92.324648			1573.862	1383.7036		24.684096
2004	1	-1			-1			1881.8176	3174.7662		280.51067
	2	706.35669	738.20117		-1			1227.0795	4886.6172		2470.5135
	3	44141.776	7988.863		72.754357			1030.0836	2800.8853		4679.26
	4	13575.829	943.8377		438.27808			2929.318	1034.141		22265.506
2005	1				-1			3252.1173	1271.8664		119.79634
	2	-1	1020.1392		364.22366			1171.2688	2986.1066	4.0362029	520.45439
	3	55577.061	8851.0995		713.21397			737.0305	4265.8127	9.027526	1928.7048
	4	19771.866	729.19335		3119.9962			2265.1325	1275.4682		41.156439
2006	1	-1			-1			2528.2602	721.96952	28.138967	153.11476
	2	4403.7213	1158.9239		-1			409.32385	2492.2543	-1	870.60977
	3	48111.664	7489.6413		-1			294.06811	2445.5445	792.75151	2445.5621
	4	23099.044	515.31553		-1			1302.3303	1474.146	5216.6773	25.11281
2007	1	-1			-1			996.85999	1178.7617	2302.1374	383.44587
	2	-1	625.16653		-1			156.748	1547.4857	6977.5616	866.22282
	3	54929.281	6596.6528		-1			609.75137	2076.3223	84.817876	4190.3033
	4	22188.85	2713.6552		-1			1628.9202	1921.4444		17.915063

Table 15. MFCL runs for the 2007 North Atlantic albacore assessment (yellow highlighted text indicates models that were discarded).

Run	*Definition*	*ObjFun*	*#Param*	*AIC*	*MeanF year*	*MSY*	*S15,1*	*S15,2*	*S15,3*	F_{MSY}	SSB_{MSY}	$SSB0/SSB_{MSY}$	SSB_{cur}/SSB_{MSY}	F_{cur}/F_{MSY}
4A	Continuity 1: new data, 2007 Executable	93933.7	1527	96988	0.245	28560	0.42	0.19	0.42	0.166	58170	2.57	0.66	1.06
4B	Continuity 2: new data, 2009 Executable	95632.8	1436	98505	0.274	29000	0.49	0.21	0.49	0.175	53660	2.64	0.62	1.04
4C	Run4B + Change input variances as suggested by SS3 runs	89031.1	1436	91903	0.284	29950	0.63	0.31	0.63	0.173	56050	2.96	0.60	1.11
4D	Run4B + Assume ages 5+ have same selectivity	94284.0	1406	97096	0.035	61490	0.21	0.07	0.21	0.192	96150	4.77	3.37	0.02
4E	Runs 4C and 4D together	87921.6	1406	90734	0.015	128800	0.23	0.11	0.23	0.019	202700	5.26	3.95	0.001
4F	Run4B + Estimate growth curve internally	96221.4	1437	99095	0.107	43920	0.86	0.36	0.86	0.15	77880	3.89	2.54	0.32
4G	Run4B+Constant q for all fisheries	95052.9	1324	97701	0.249	28630	0.41	0.20	0.41	0.18	52810	2.35	0.51	1.25
4H	Run 4B+ Include M at age vector	95595.5	1436	98468	0.252	30450	0.50	0.24	0.50	0.18	38640	3.44	0.94	0.81
4I	Run 4B + Include tagging data	95214.7	1438	98091	0.359	29520	0.45	0.28	0.45	0.17	55280	2.34	0.47	1.06
4K	Run 4I, estimating M	95238.1	1449	98136	0.381	30620	0.40	0.26	0.40	0.18	63720	2.17	0.38	1.21
4L	Run 4B, change initial condition for Z from 10 to 5 years	95488.3	1436	98360	0.566	30970	0.84	0.41	0.84	0.17	60240	1.71	0.21	1.85
4N	Run 4B, ungroup fisheries for selectivity estimation	95788.9	1476	98741	0.254	28090	0.45	0.19	0.53	0.18	53220	2.65	0.76	1.00
4O	Run using annual catch rather than quarterly catch. Same specifications as 4B	36931.9	637	38206	0.528	33580	0.79	0.22	0.79	0.17	53110	2.31	0.22	1.43
4P	Run 4B, enforcing dome shaped selectivity for surface fleets	94481.6	1425	97332	0.365	30490	0.00	0.00	1.00	0.17	49560	2.70	0.55	0.74

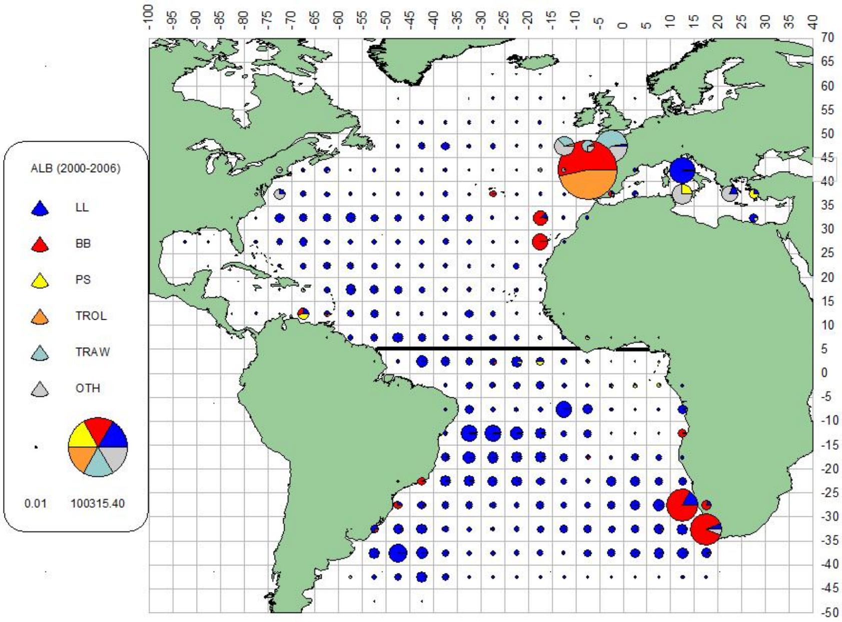


Figure 1. Definition of the Atlantic albacore stock limits.

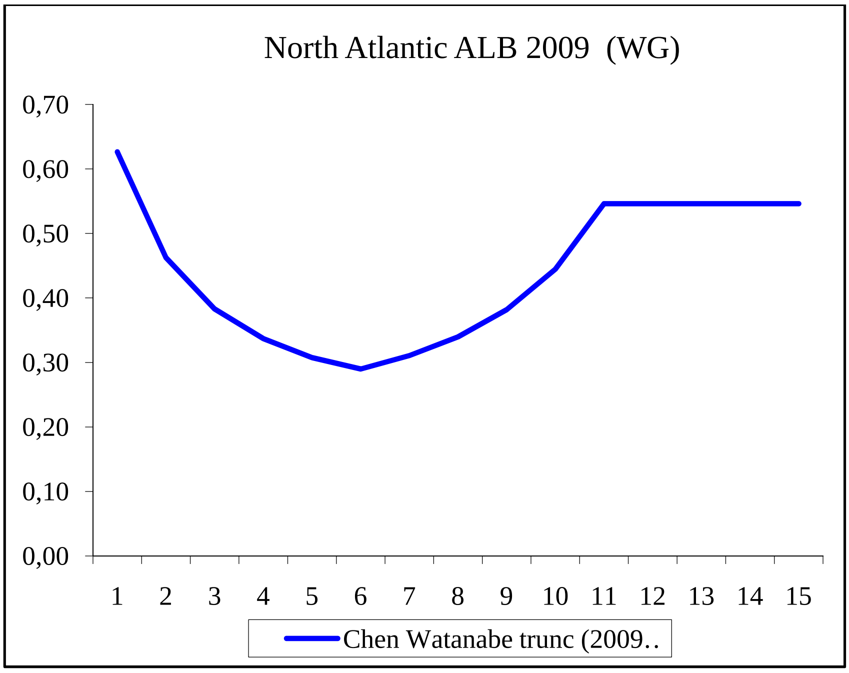


Figure 2. Natural mortality by age estimated using the approach of Chen and Watanabe (1989) for ages 1 to 15 according to the growth parameters derived from Bard's model. Values from ages 11 to 15 were fixed to the value predicted at group older than 11.

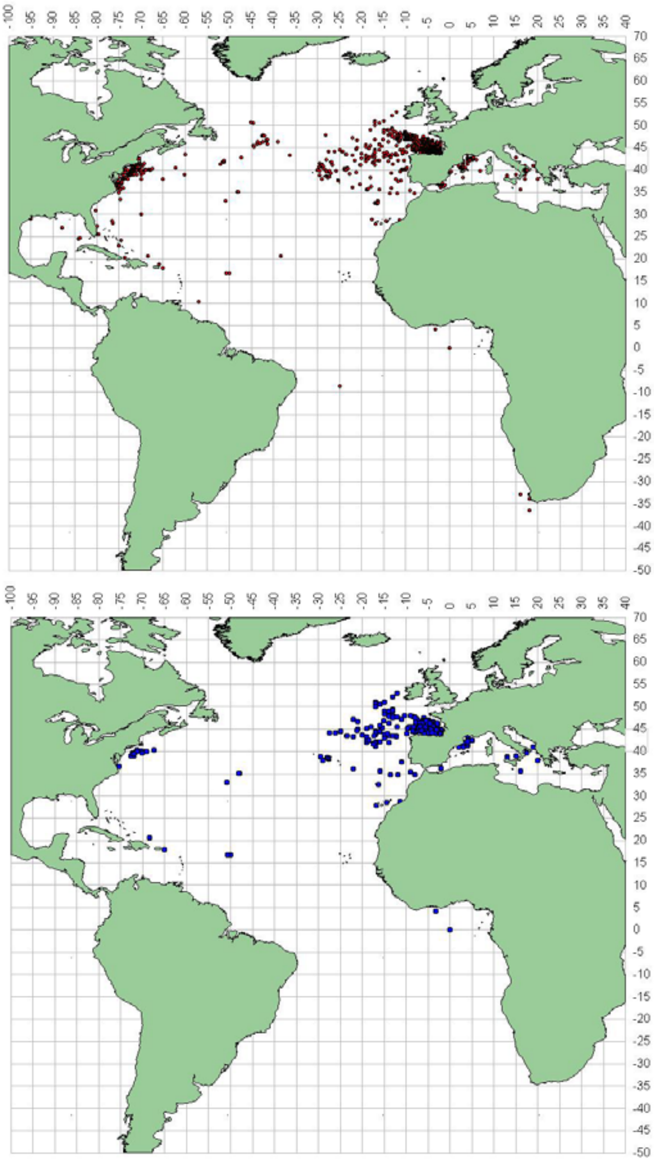


Figure 3. Maps showing the albacore releases (upper) and recoveries (lower).

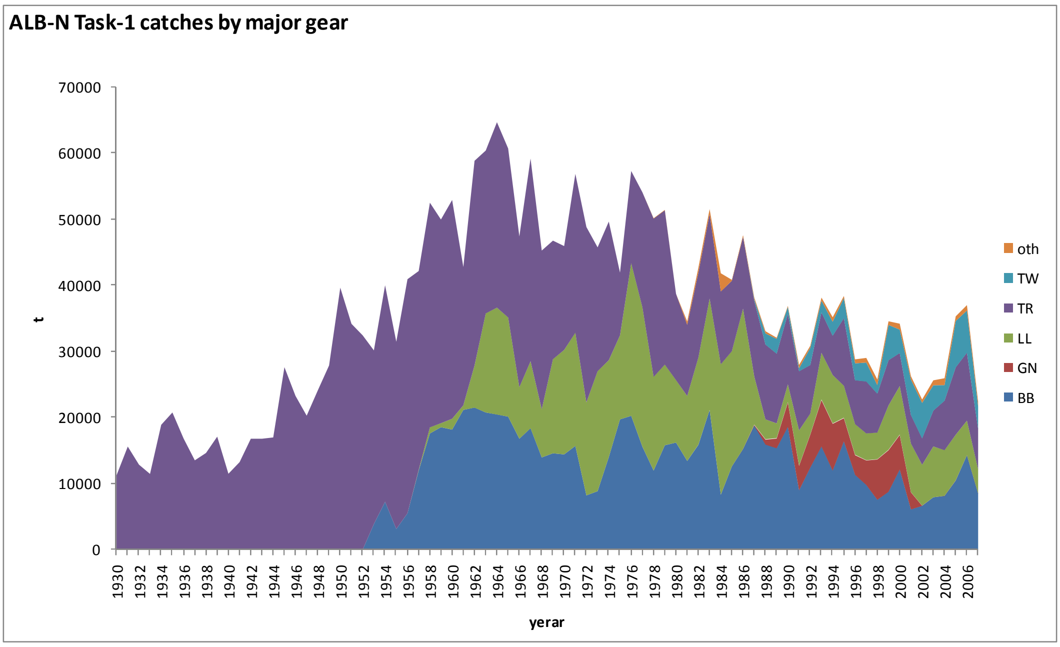
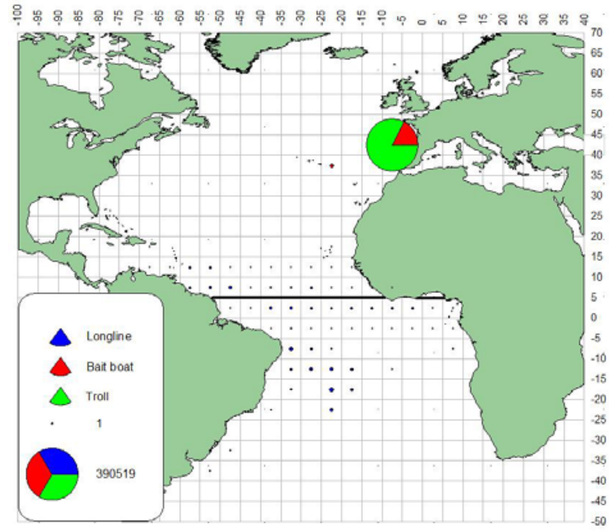
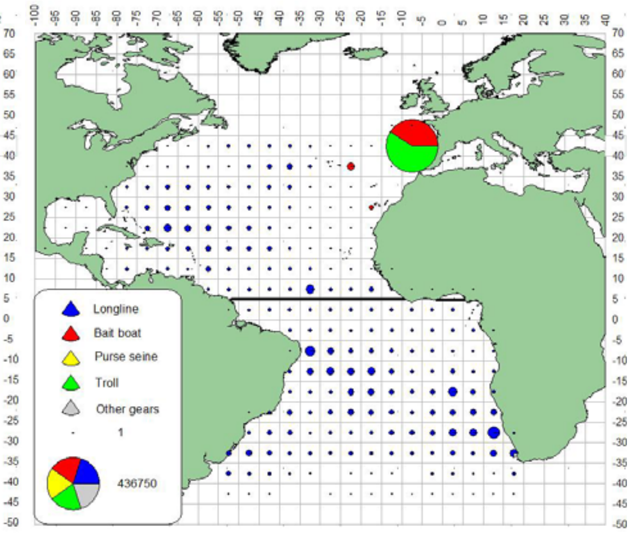


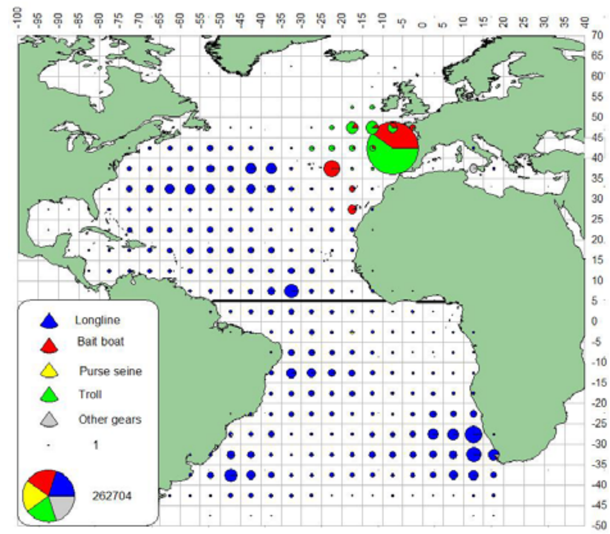
Figure 4. Northern albacore Task I catches by major gear and year.



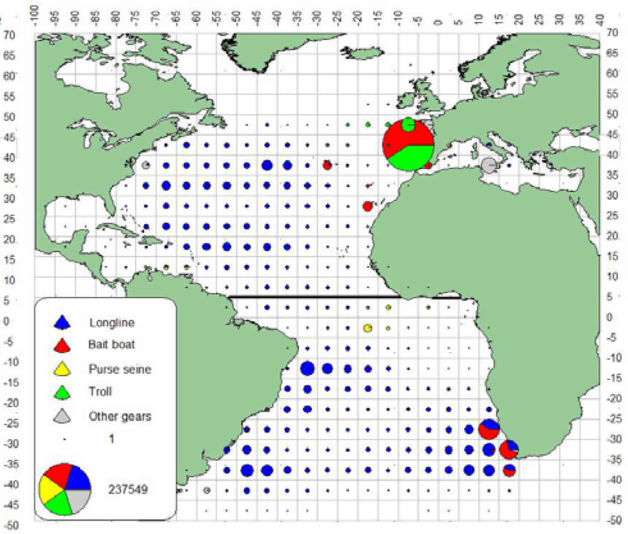
a. ALB(1950-59)



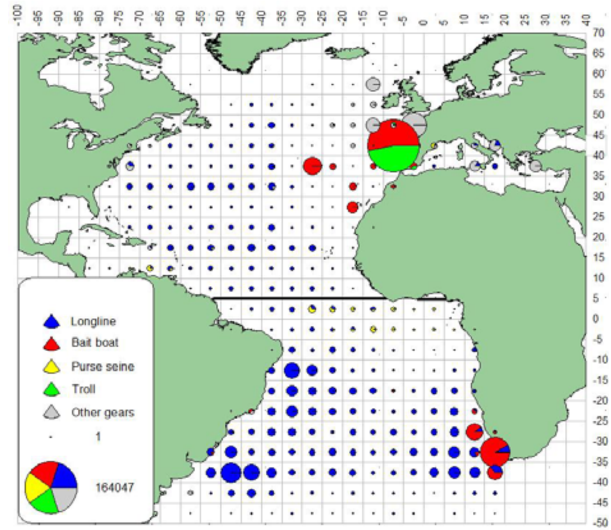
b. ALB(1960-69)



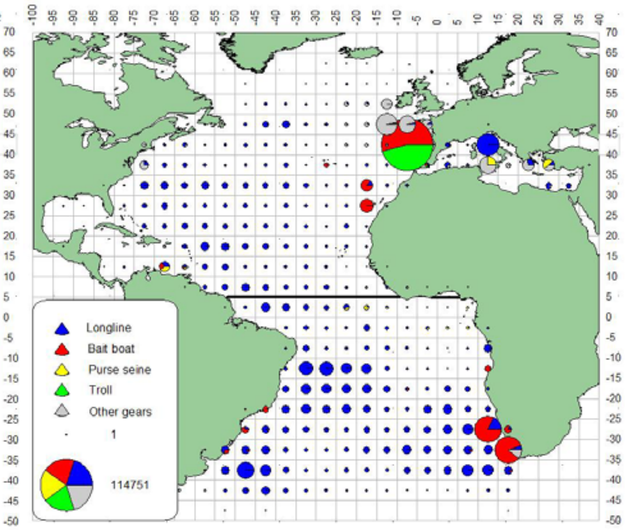
c. ALB(1970-79)



d. ALB(1980-89)



e. ALB (1990-99)



f. ALB (2000-2007)

Figure 5. Geographic distribution of ALB catch by major gears and decade.

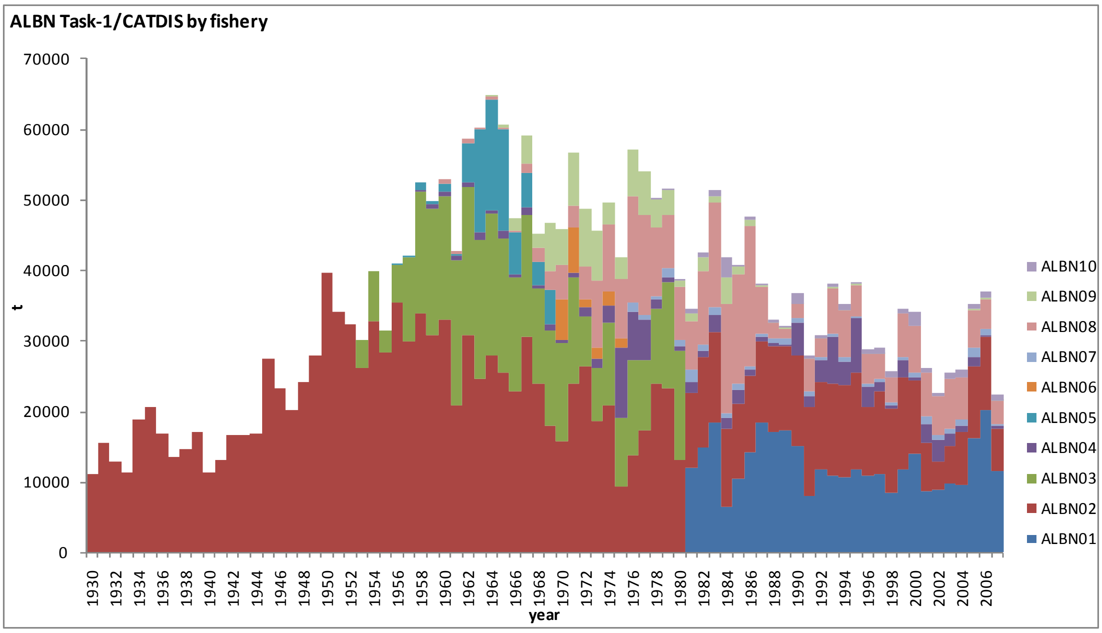


Figure 6. Albacore Northern stock: Task I/CATDIS cumulative catches by fishery and year.

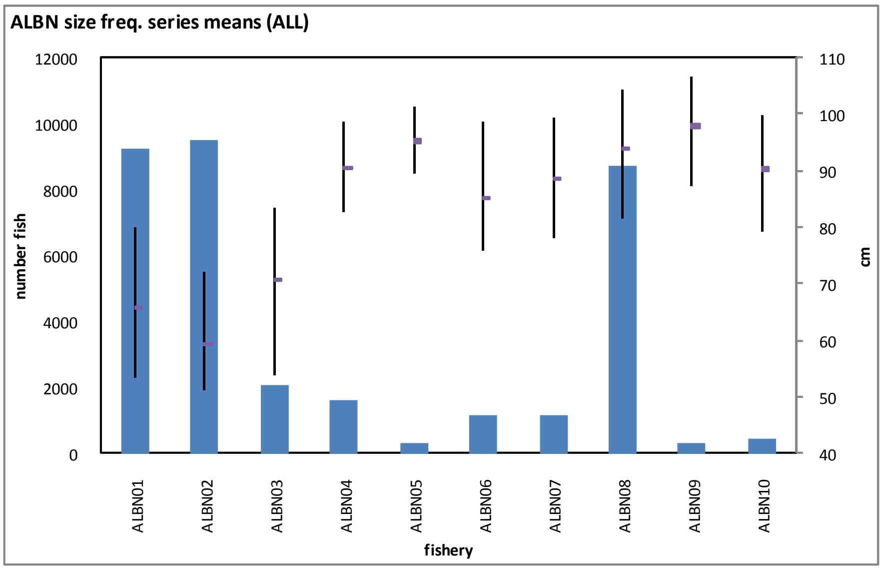


Figure 7. Albacore size frequency series means (left axis: number of fish in left; right axis: size class bin percentiles 10%, 50%, 90%) in each fishery before screening.

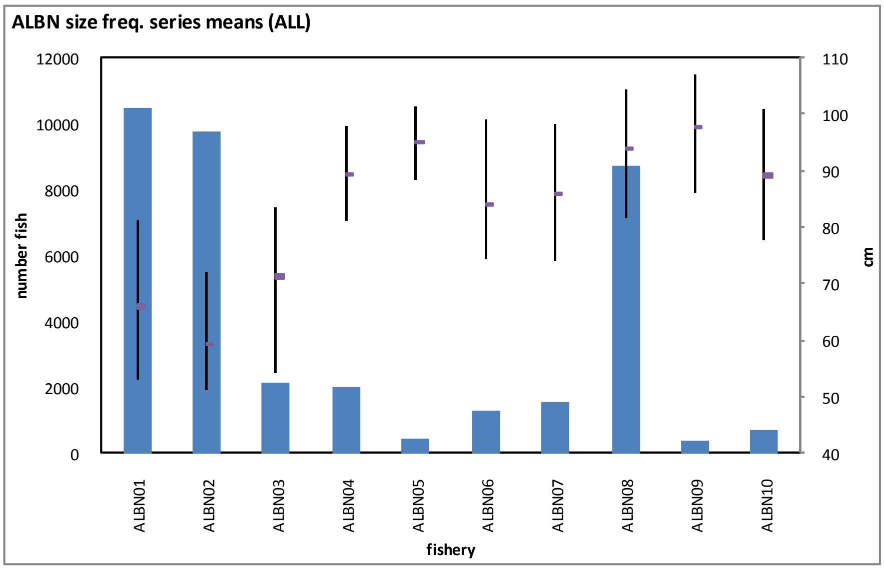
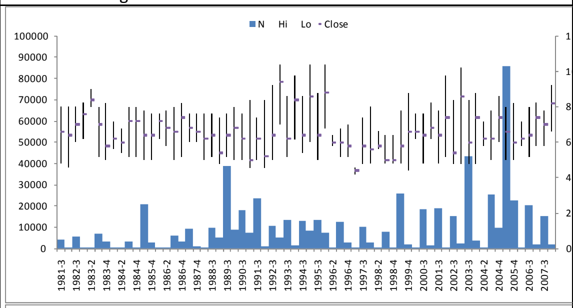
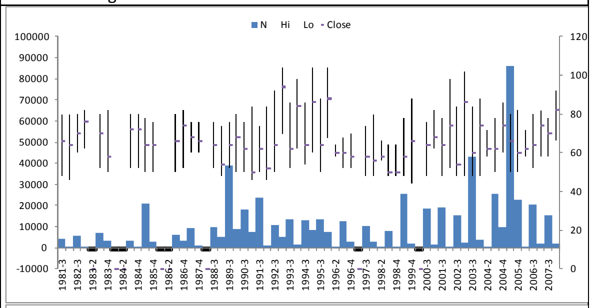
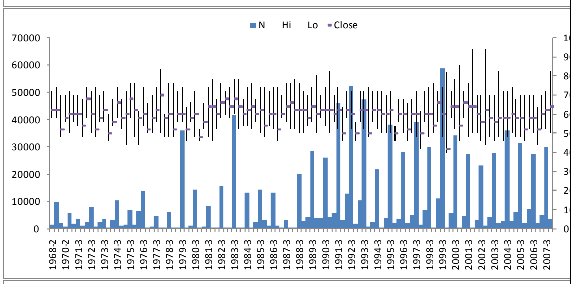
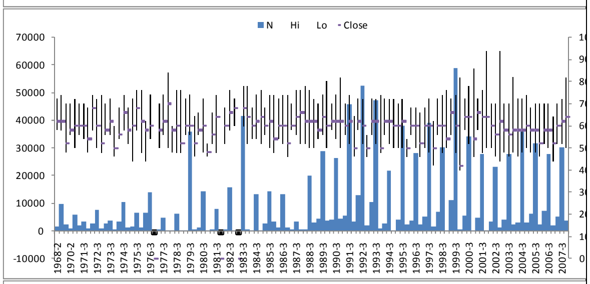
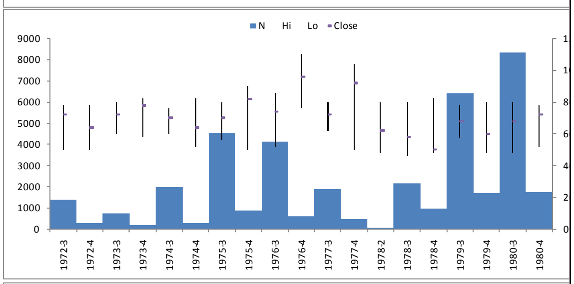
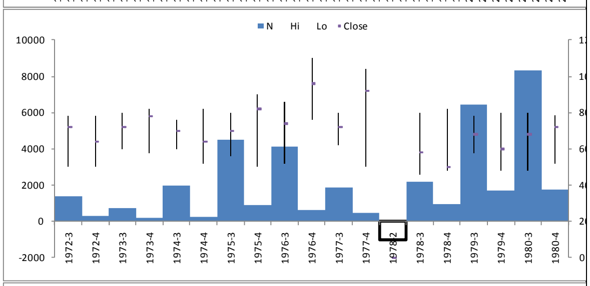
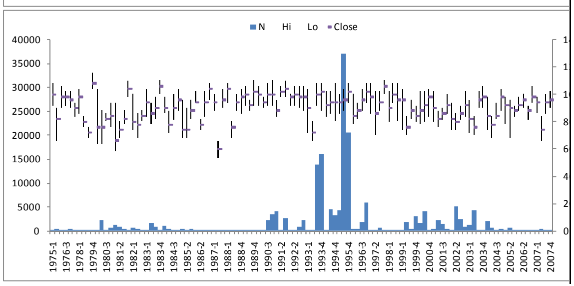
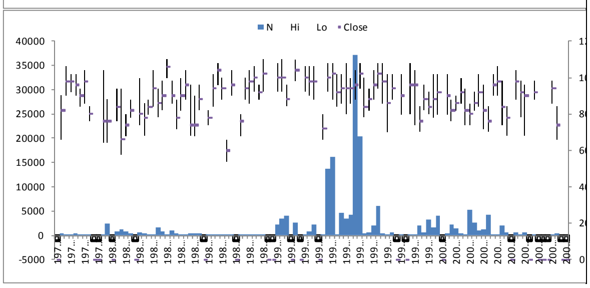


Figure 8. Albacore size frequency series means (left axis: number of fish in left; right axis: size class bin percentiles 10%, 50%, 90%) in each fishery after screening.

Fishery	Before screening	After screening
ALBN01		
ALBN02		
ALBN03		
ALBN04		

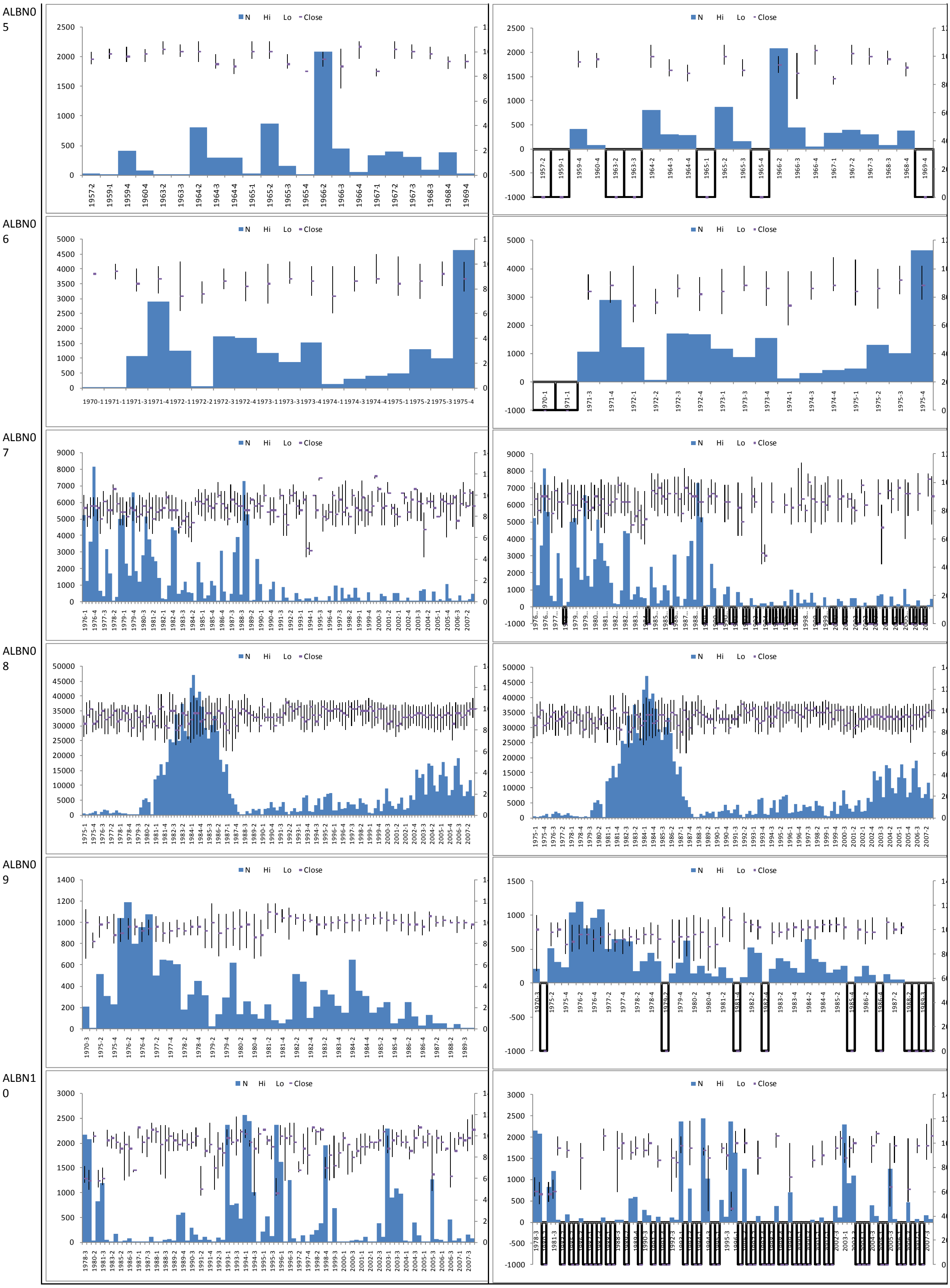
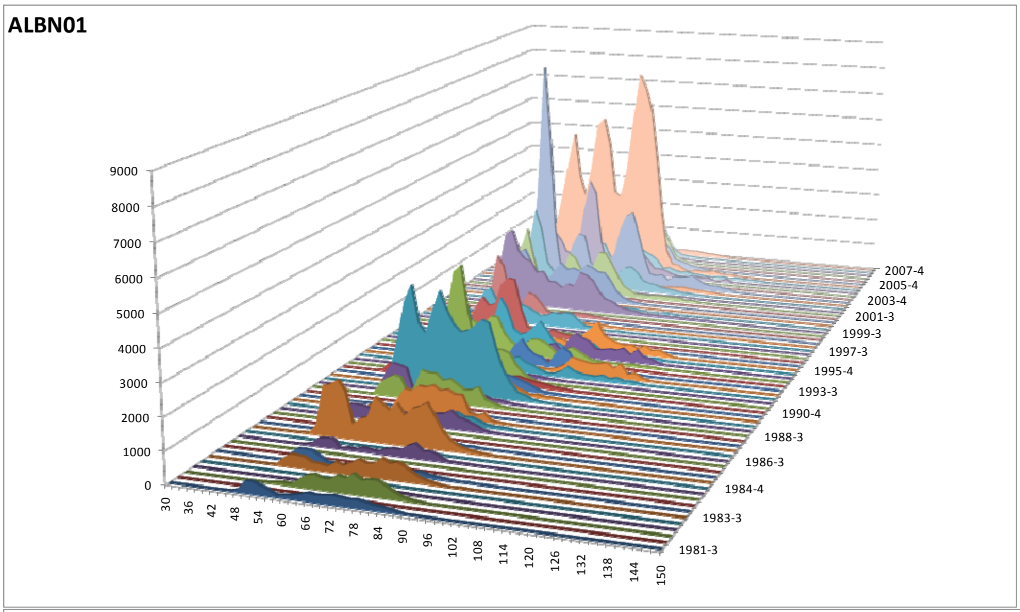
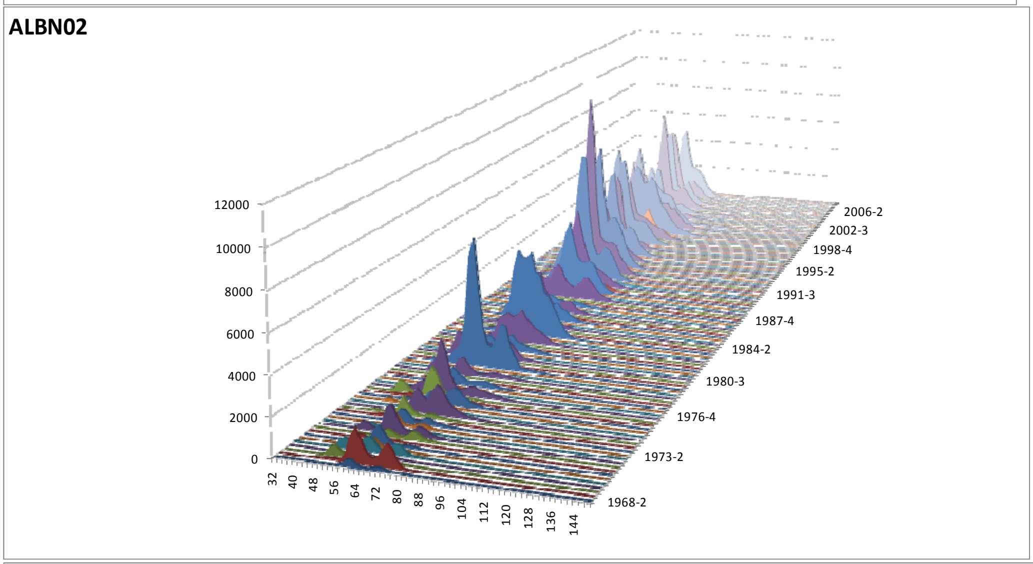
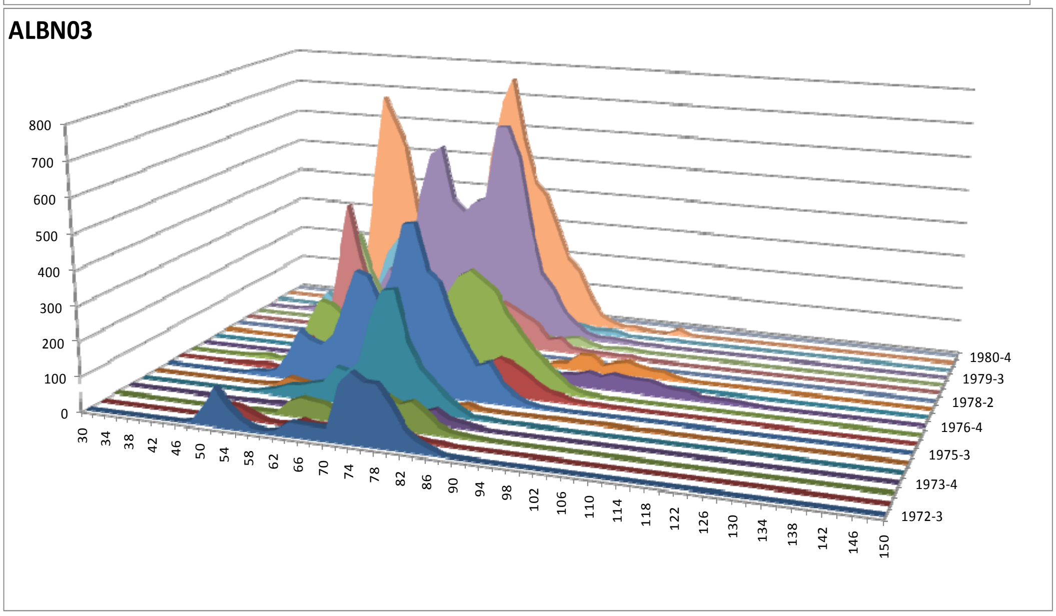
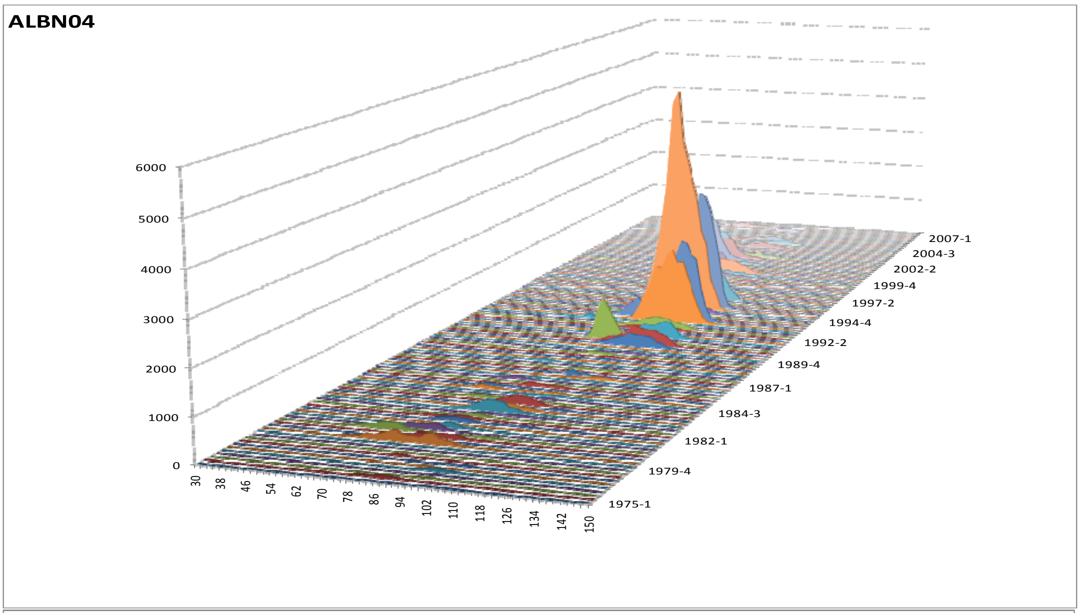


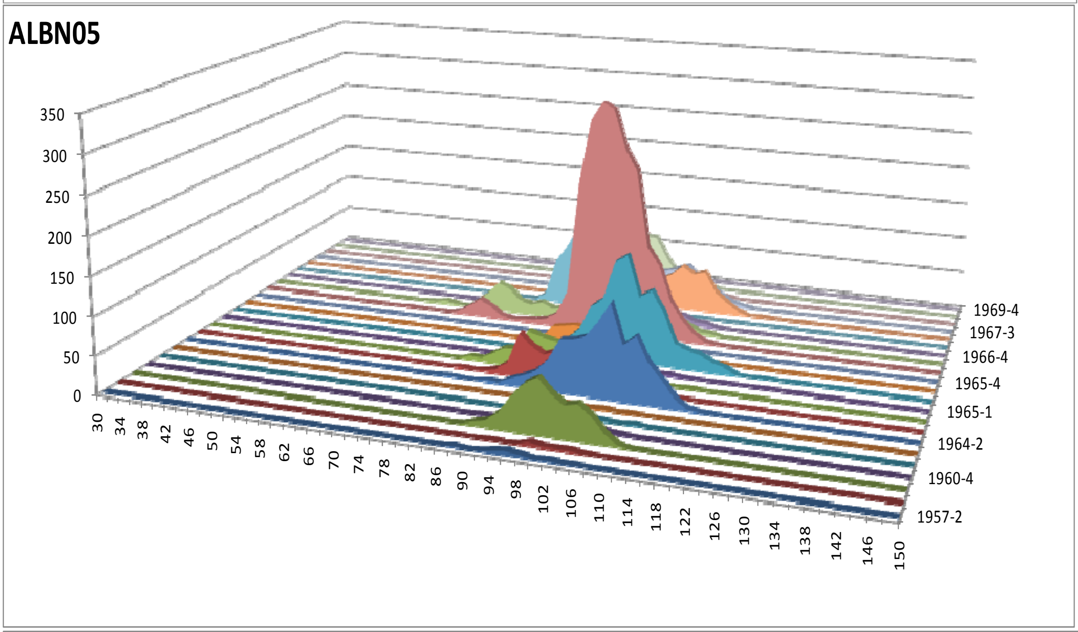
Figure 9. Albacore Northern stock size frequency series means (left axis: number of fish; right axis: size class bin percentiles 10%, 50% and 90%) by fishery, before (left panel) and after screening (right panel) in each fishery. Discarded series in each fishery are shown as negative number (-1000) on right panel.

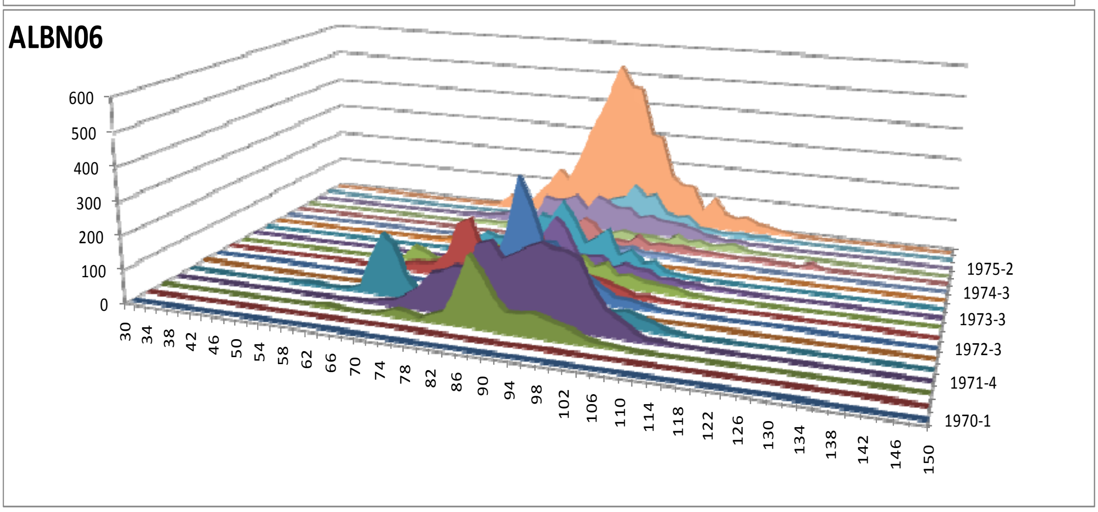

ALBN01
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
30 36 42 48 54 60 66 72 78 84 90 96 102 108 114 120 126 132 138 144 150
2007-4
2005-4
2003-4
2001-3
1999-3
1997-3
1995-4
1993-3
1990-4
1988-3
1986-3
1984-4
1983-3
1981-3

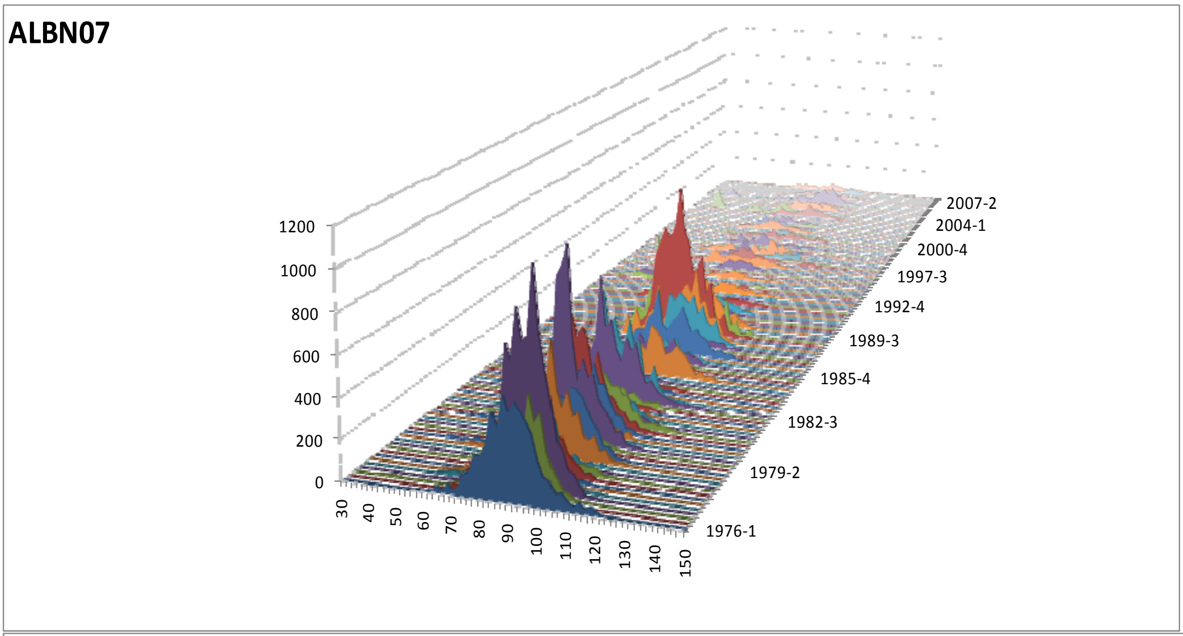

ALBN02
12000
10000
8000
6000
4000
2000
0
32 40 48 56 64 72 80 88 96 104 112 120 128 136 144
2006-2
2002-3
1998-4
1995-2
1991-3
1987-4
1984-2
1980-3
1976-4
1973-2
1968-2

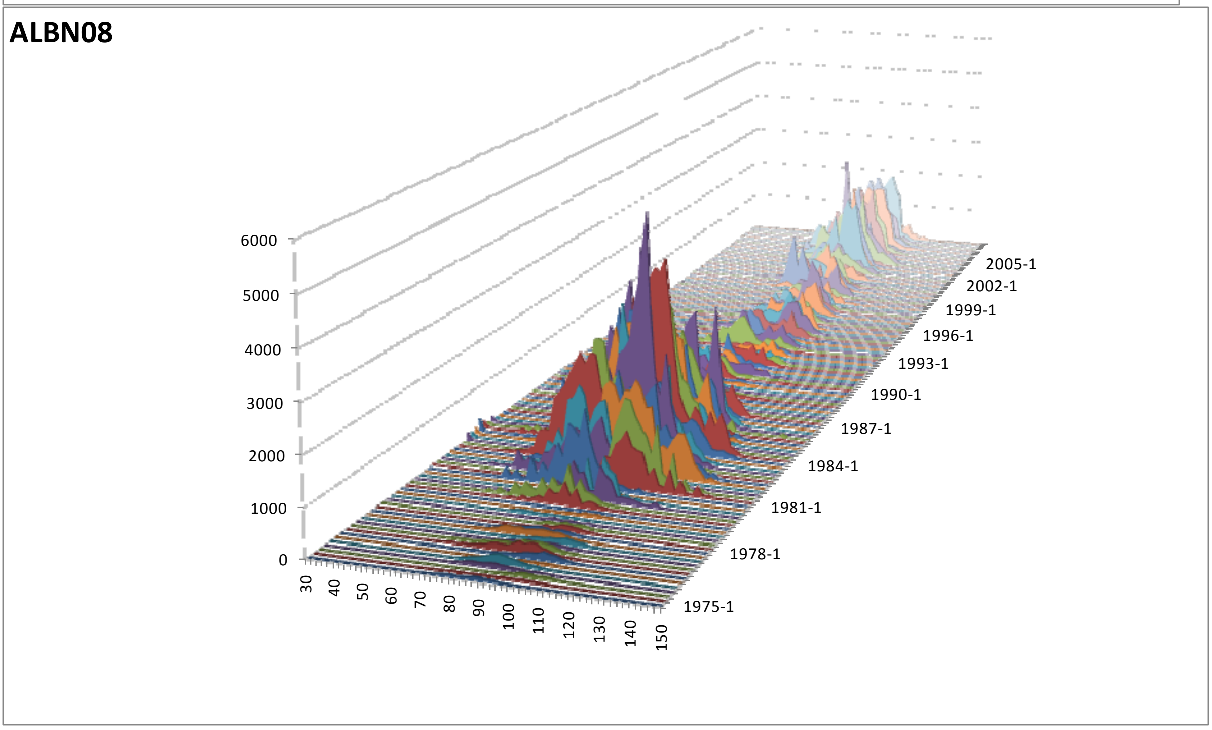

ALBN03
800
700
600
500
400
300
200
100
0
30 34 38 42 46 50 54 58 62 66 70 74 78 82 86 90 94 98 102 106 110 114 118 122 126 130 134 138 142 146 150
1980-4
1979-3
1978-2
1976-4
1975-3
1973-4
1972-3


ALBN04
6000
5000
4000
3000
2000
1000
0
30
38
46
54
62
70
78
86
94
102
110
118
126
134
142
150
2007-1
2004-3
2002-2
1999-4
1997-2
1994-4
1992-2
1989-4
1987-1
1984-3
1982-1
1979-4
1975-1


ALBN05
350
300
250
200
150
100
50
0
30
34
38
42
46
50
54
58
62
66
70
74
78
82
86
90
94
98
102
106
110
114
118
122
126
130
134
138
142
146
150
1969-4
1967-3
1966-4
1965-4
1965-1
1964-2
1960-4
1957-2


ALBN06
600
500
400
300
200
100
0
30
34
38
42
46
50
54
58
62
66
70
74
78
82
86
90
94
98
102
106
110
114
118
122
126
130
134
138
142
146
150
1975-2
1974-3
1973-3
1972-3
1971-4
1970-1


ALBN07
1200
1000
800
600
400
200
0
30
40
50
60
70
80
90
100
110
120
130
140
150
1976-1
1979-2
1982-3
1985-4
1989-3
1992-4
1997-3
2000-4
2004-1
2007-2


ALBN08
6000
5000
4000
3000
2000
1000
0
30
40
50
60
70
80
90
100
110
120
130
140
150
1975-1
1978-1
1981-1
1984-1
1987-1
1990-1
1993-1
1996-1
1999-1
2002-1
2005-1

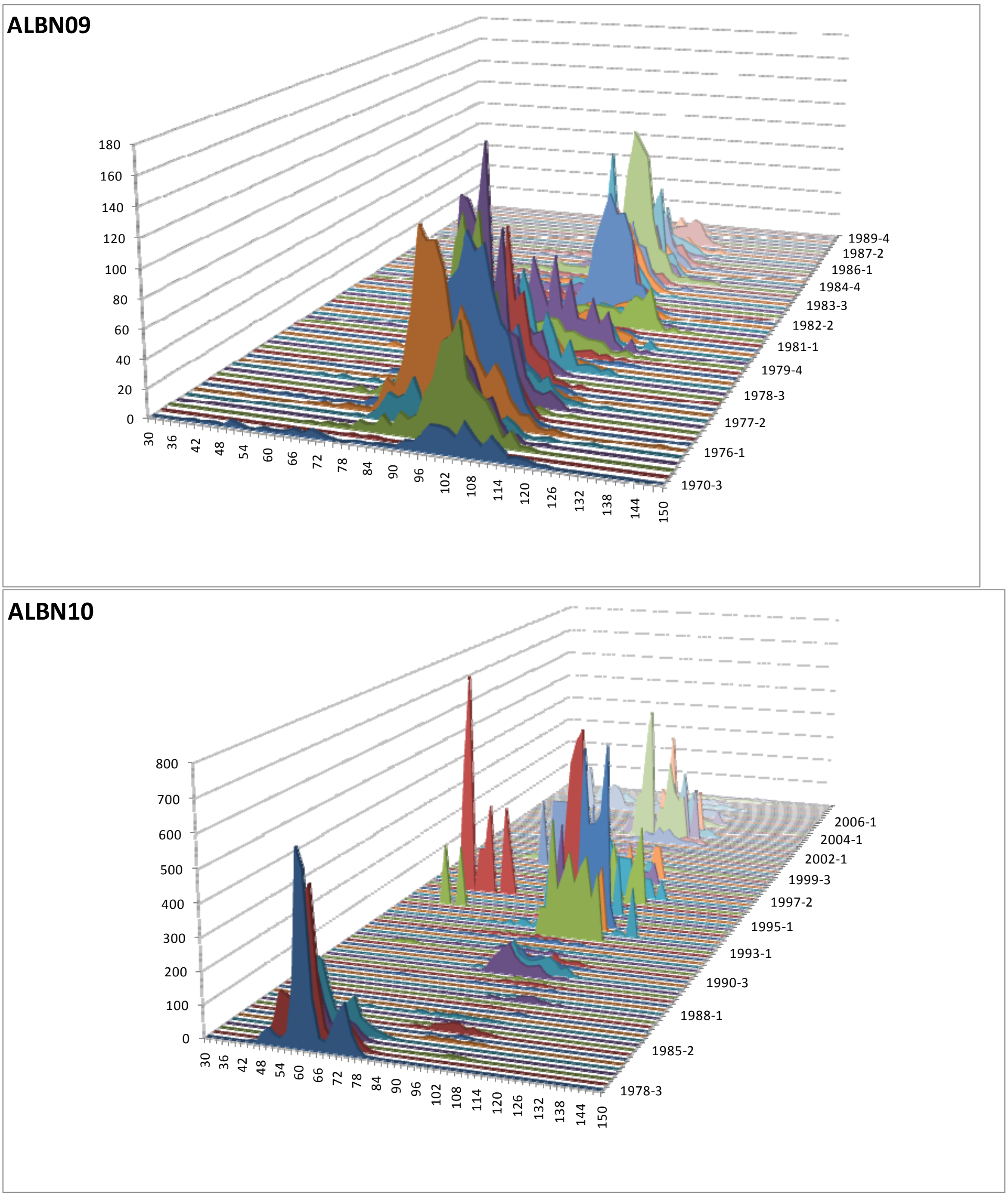


Figure 10. Histograms of size frequencies distributions by fishery and year used by Multifan-CL (after screening).

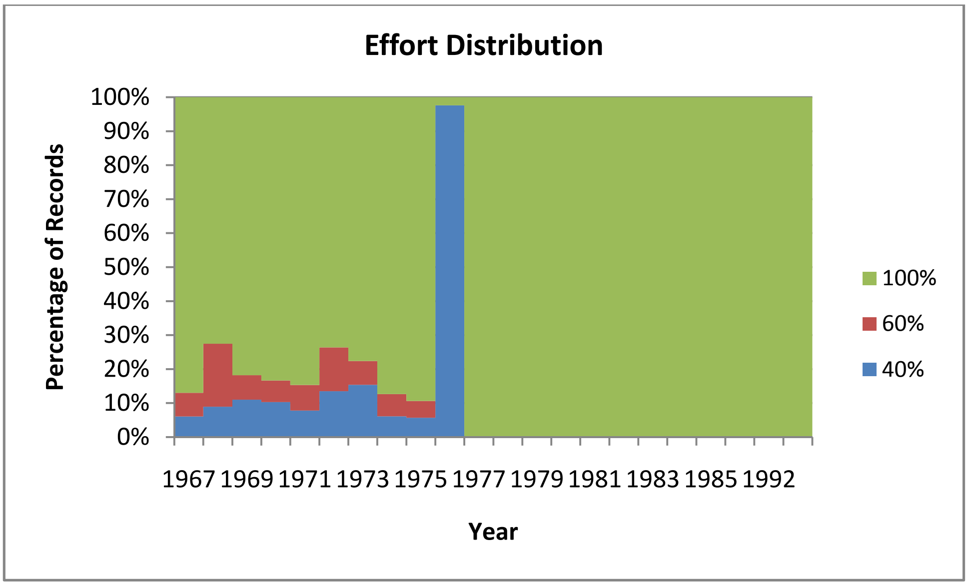


Figure 11. Percentage of catch records assigned to each effort category (fished 40%,60%, or 100% of day) by year for the French Task II albacore data from 1967-1993.

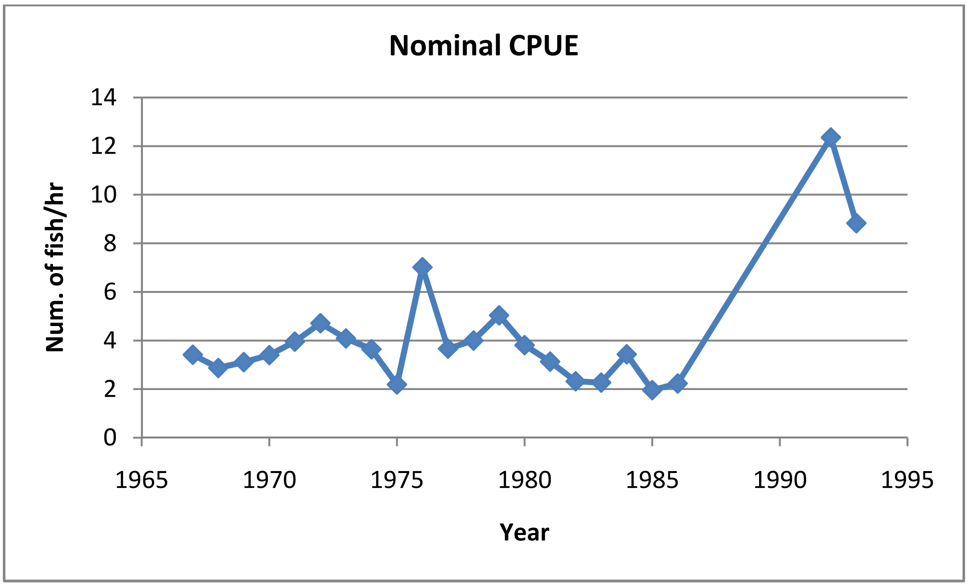


Figure 12. Preliminary nominal CPUE series for the French Task II albacore data from 1967-1993**.**

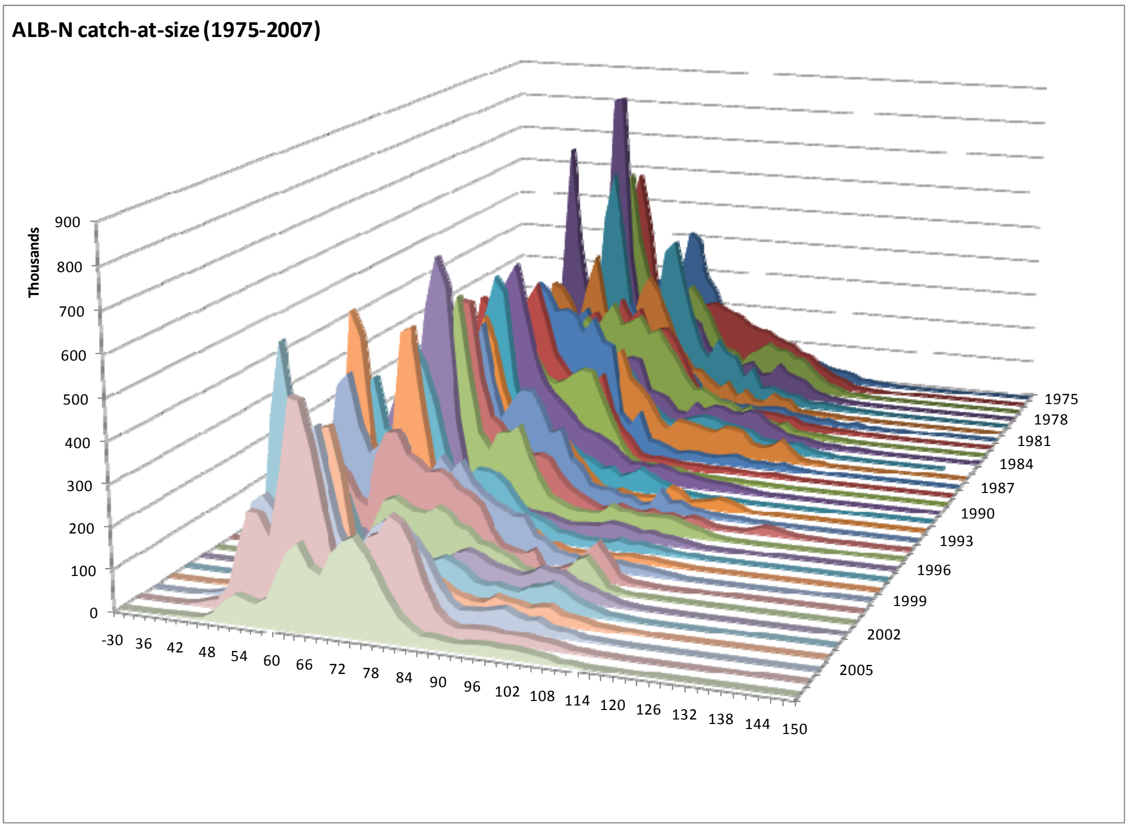


Figure 13. North Atlantic albacore overall catch-at-size, by year and in 2 cm (lower limit) length classes. First and last classes are minus/plus groups.

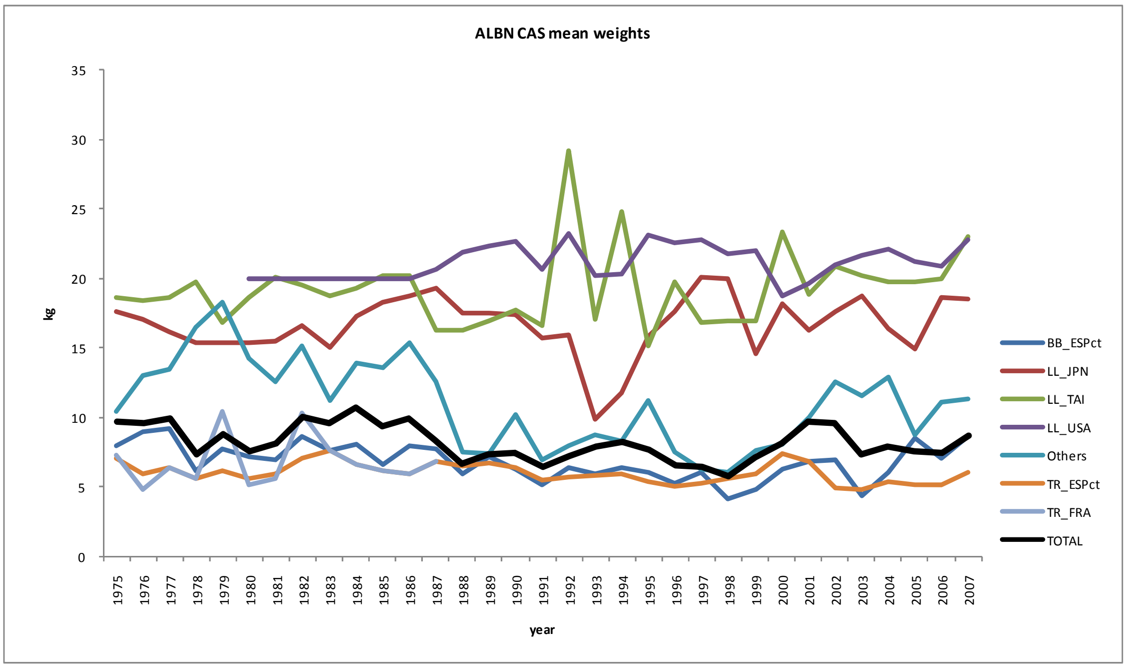


Figure 14. Estimated mean weights of ALB-N CAS (overall and by major fishery).

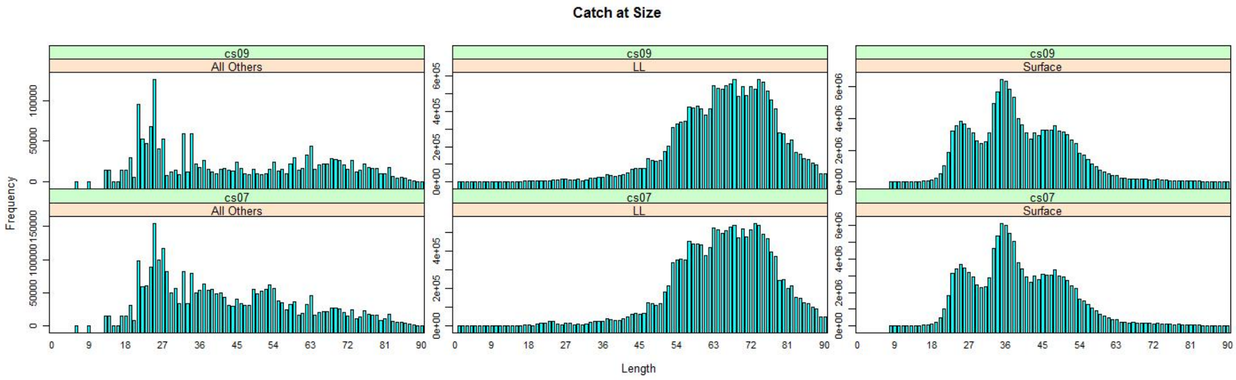


Figure 15. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for long line, surface (GN, BB, TR and TW) and other fisheries all years in database combined.

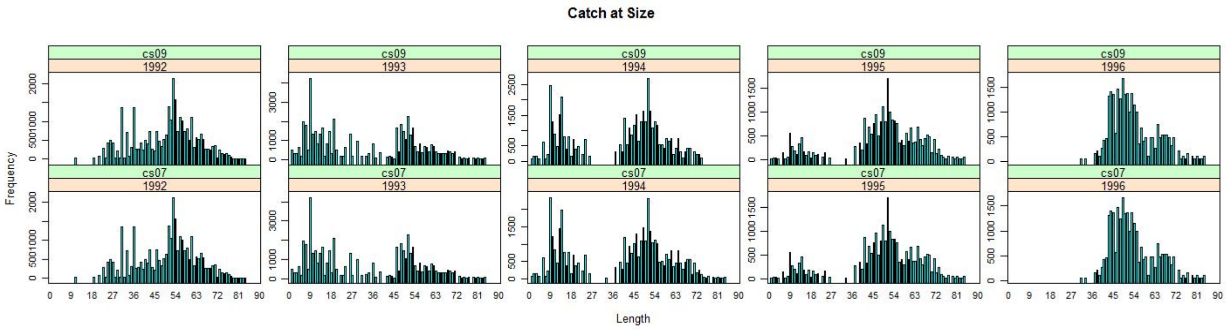


Figure 16. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for Japanese long line catch at size length distributions for 1992 to 1996.

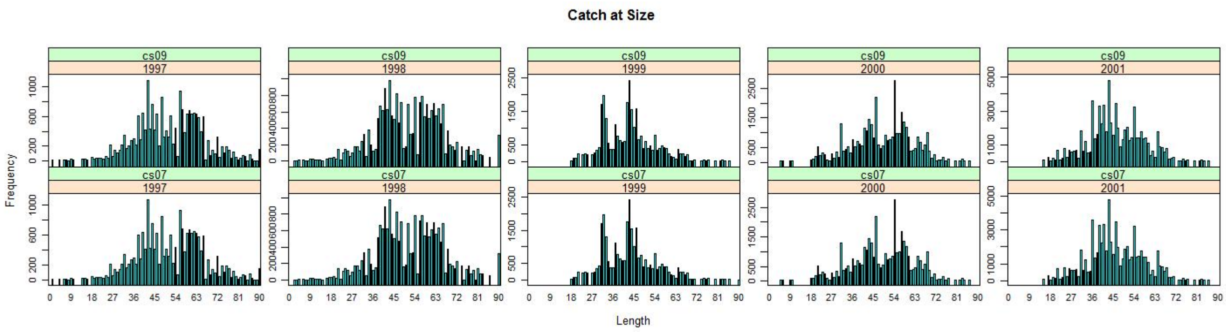


Figure 17. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for Japanese long line catch at size length distributions for 1997 to 2001.

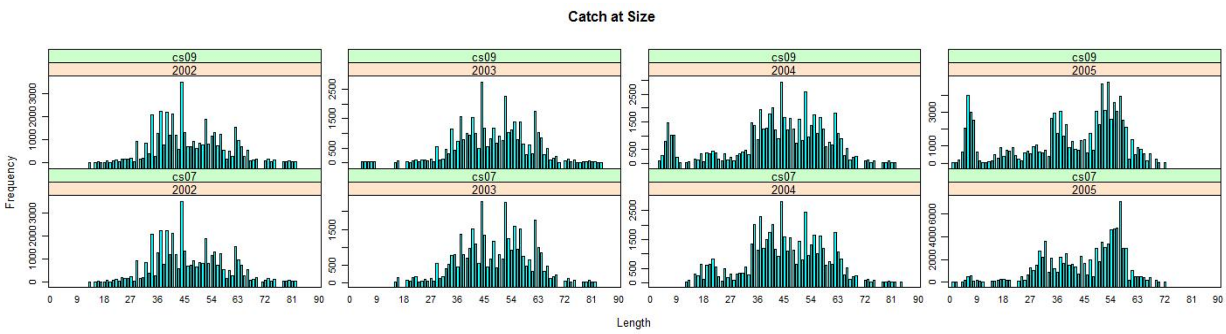


Figure 18. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for Japanese long line catch at size length distributions for 2002 to 2005.

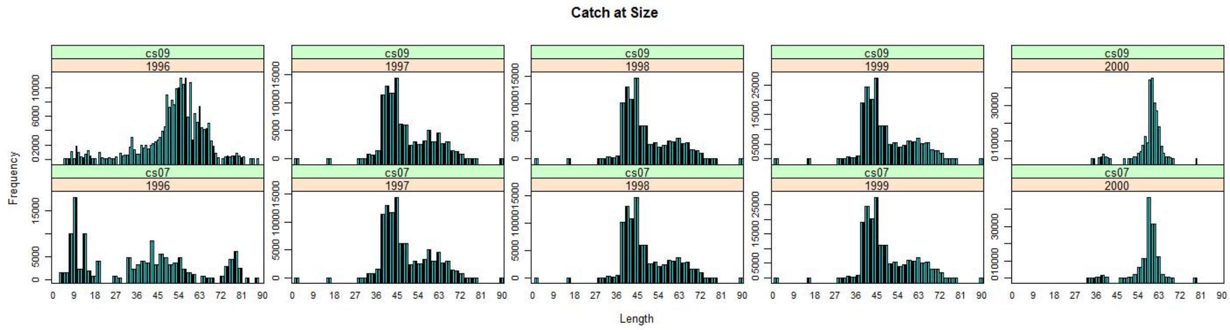


Figure 19. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for Chinese Taipei long line from 1996 to 2000.

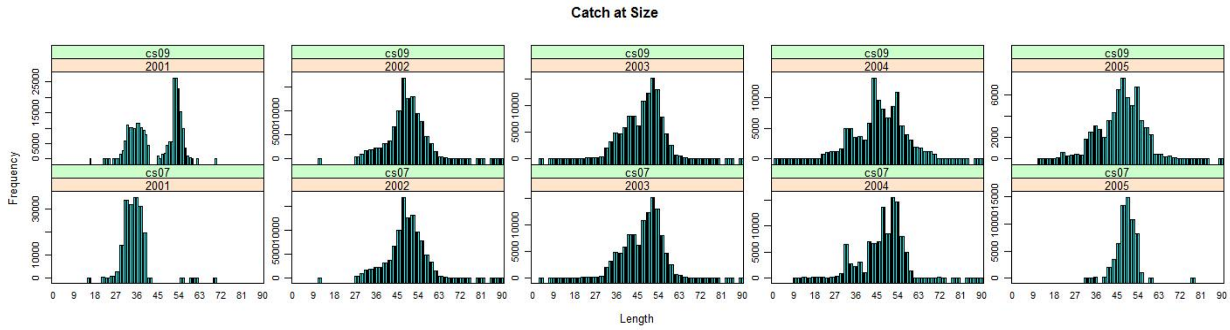


Figure 20. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for Chinese Taipei long line from 2001 to 2005

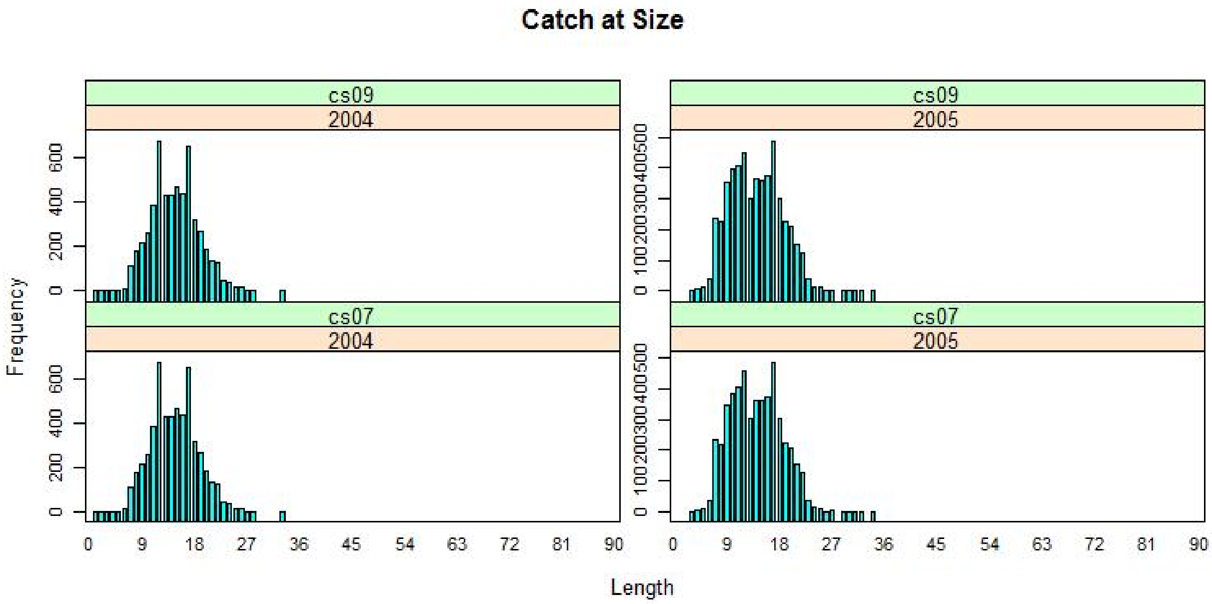


Figure 21. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for US longline for 2004 and 2005.

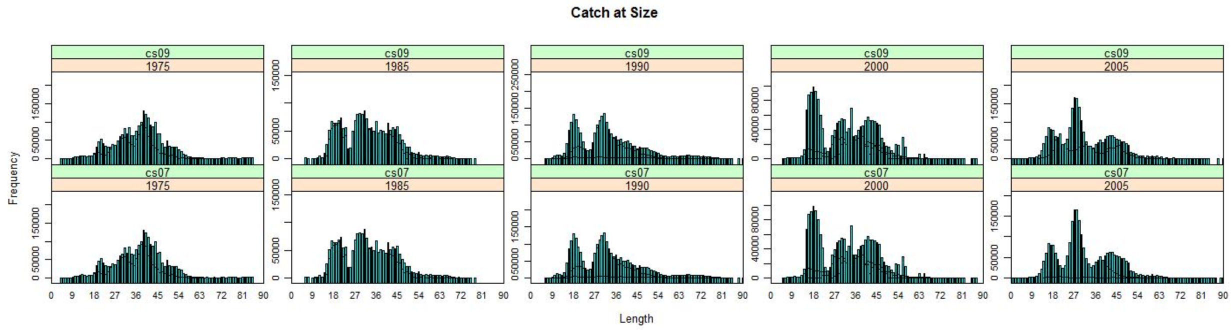


Figure 22. Comparison between albacore catch at size from the ICCAT data base in 2007 and 2009 for change in catch at size for BB, TR and TW in 1975, 1985, 1990, 2000 and 2005.

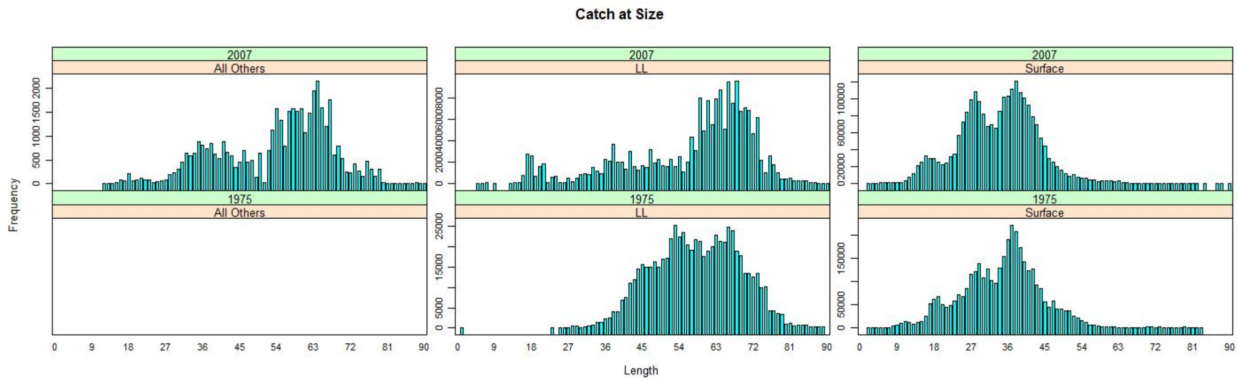


Figure 23. A comparison between the 2007 and 1975 albacore catch at size, using the 2009 data base, for the long line, surface (GN,BB,TR & TW) and all other gears.

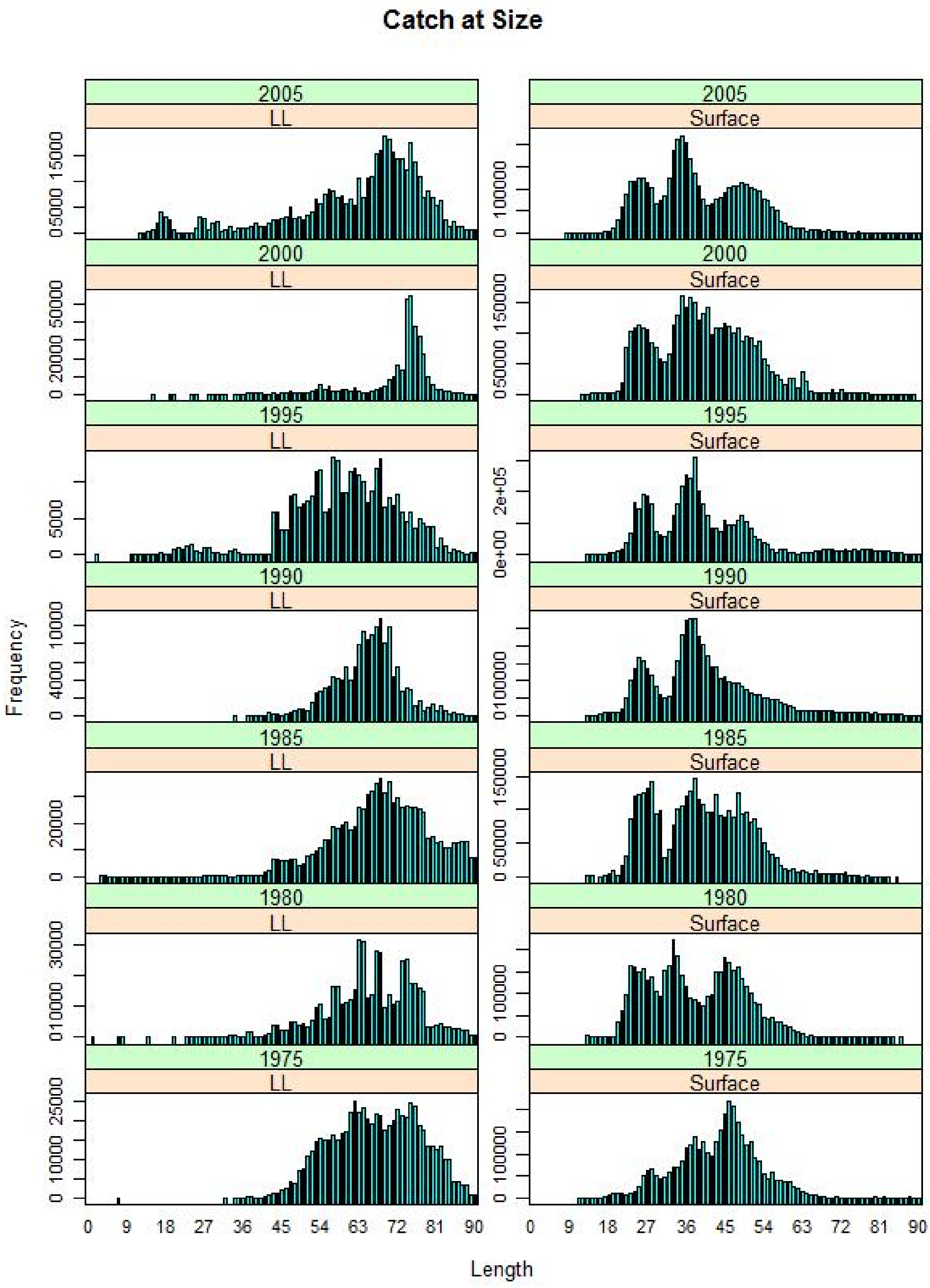


Figure 24A. comparison between long lines, using the 2009 data base, surface and all other gears for 1975 and 2007.

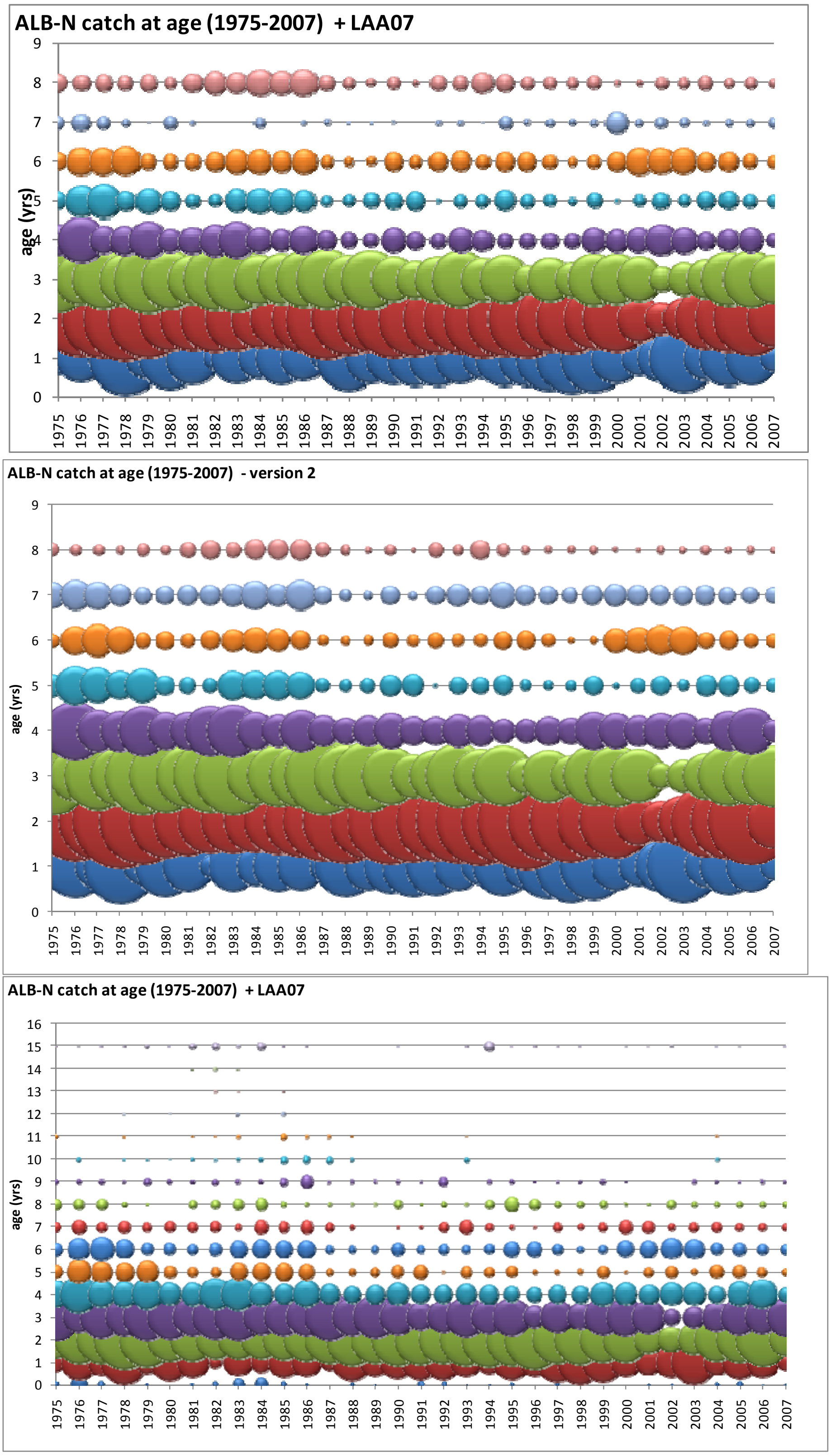
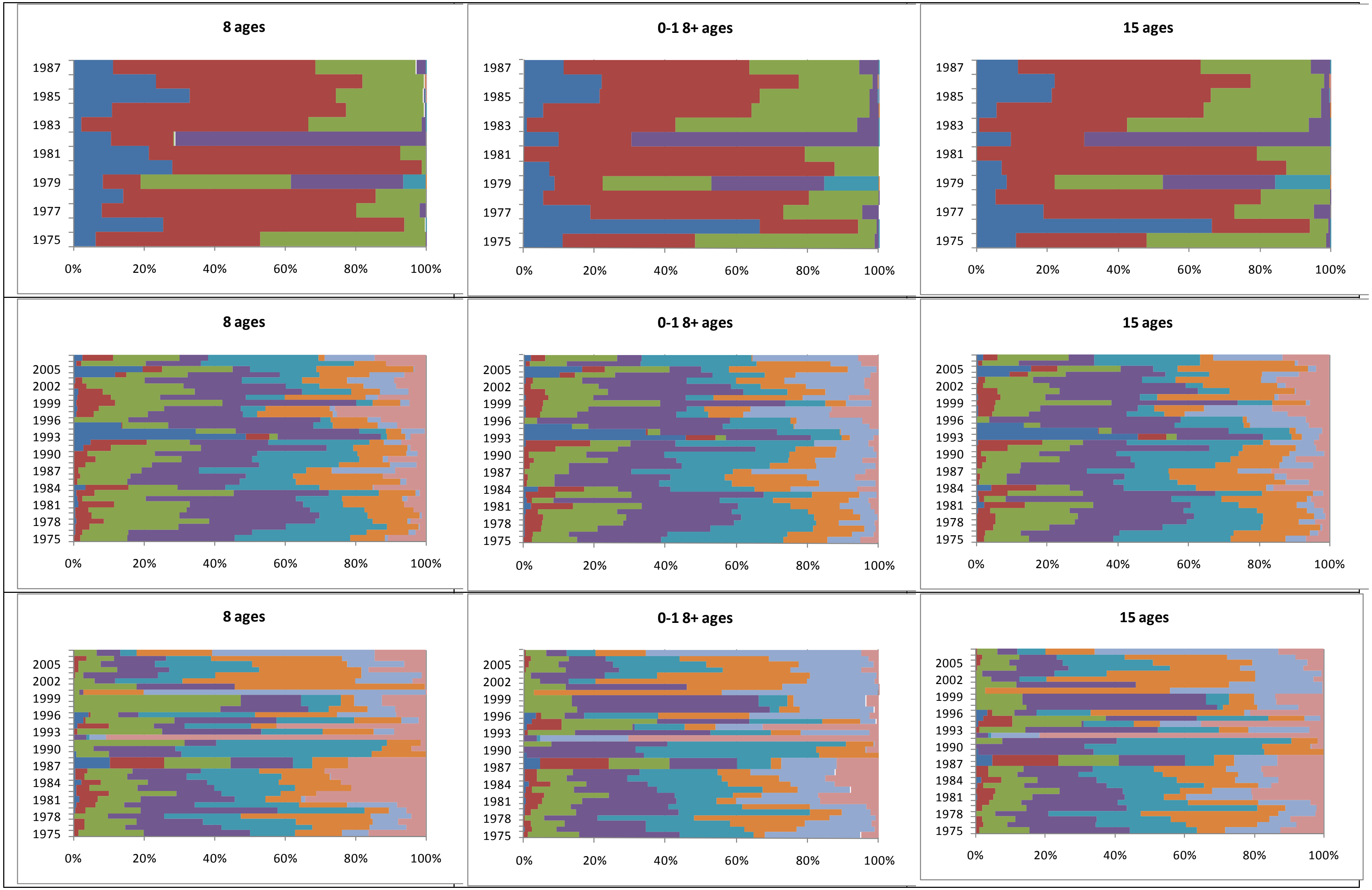


Figure 25. Catch at age using the latest catch at size and Kimura Chikuni (lengths at age for ages 1 to 8 (up), ages 0-1 to 8+ (middle), and 0 to 15 (down)).


8 ages
1987
1985
1983
1981
1979
1977
1975
0% 20% 40% 60% 80% 100%
0-1 8+ ages
1987
1985
1983
1981
1979
1977
1975
0% 20% 40% 60% 80% 100%
15 ages
1987
1985
1983
1981
1979
1977
1975
0% 20% 40% 60% 80% 100%
8 ages
2005
2002
1999
1996
1993
1990
1987
1984
1981
1978
1975
0% 20% 40% 60% 80% 100%
0-1 8+ ages
2005
2002
1999
1996
1993
1990
1987
1984
1981
1978
1975
0% 20% 40% 60% 80% 100%
15 ages
2005
2002
1999
1996
1993
1990
1987
1984
1981
1978
1975
0% 20% 40% 60% 80% 100%
8 ages
2005
2002
1999
1996
1993
1990
1987
1984
1981
1978
1975
0% 20% 40% 60% 80% 100%
0-1 8+ ages
2005
2002
1999
1996
1993
1990
1987
1984
1981
1978
1975
0% 20% 40% 60% 80% 100%
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2005
2002
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1993
1990
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1981
1978
1975
0% 20% 40% 60% 80% 100%

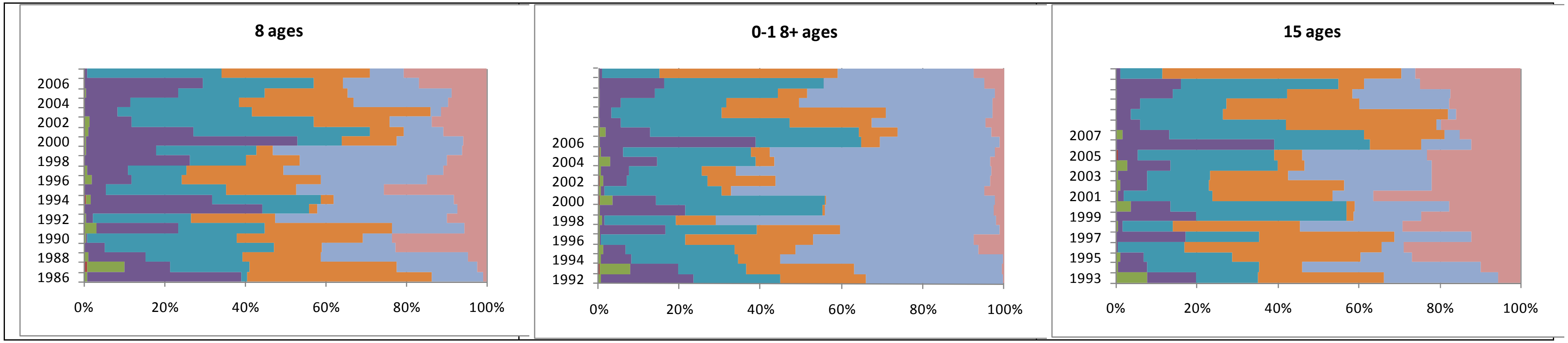


Figure 26. Comparison of catch at age proportions by fleet, using the latest catch at size and Kimura Chikuni (lengths at age for ages 1 to 8, for ages 0-1 to 8+, and for ages 0 to 15). First row = French troll; second row = Japan LL; third row = Taiwan LL; forth row = US LL.

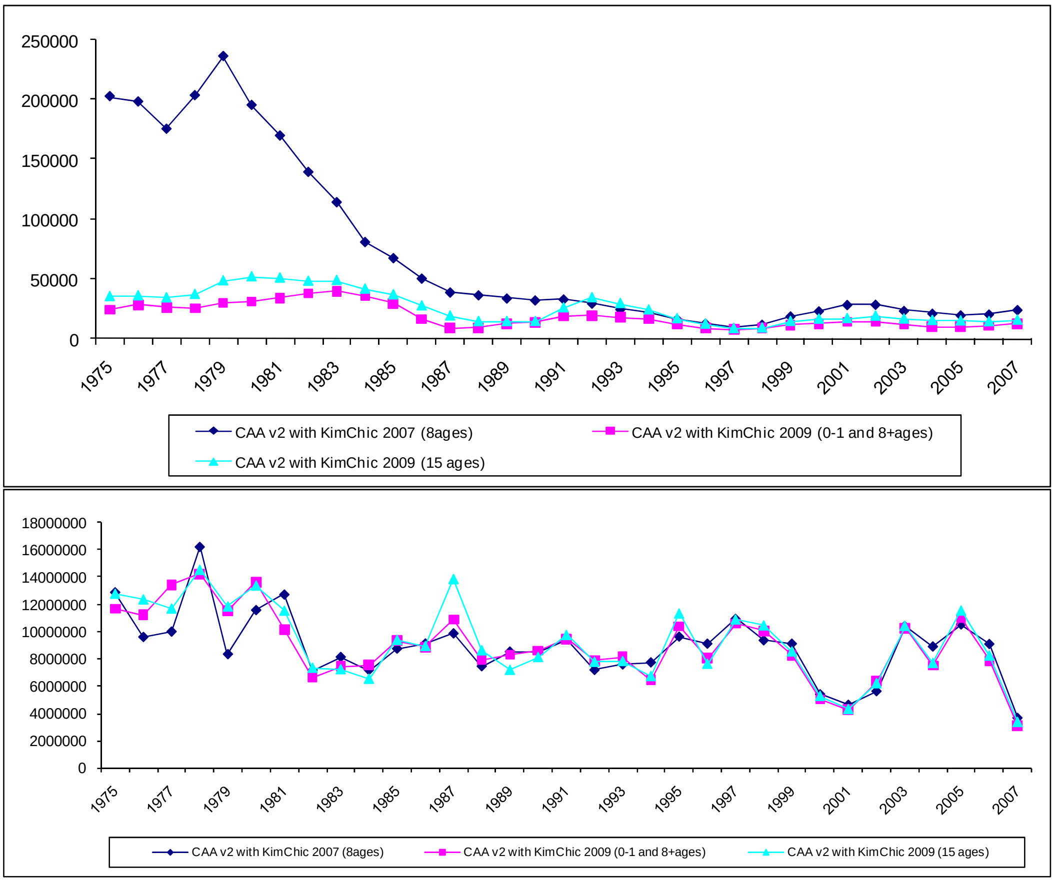
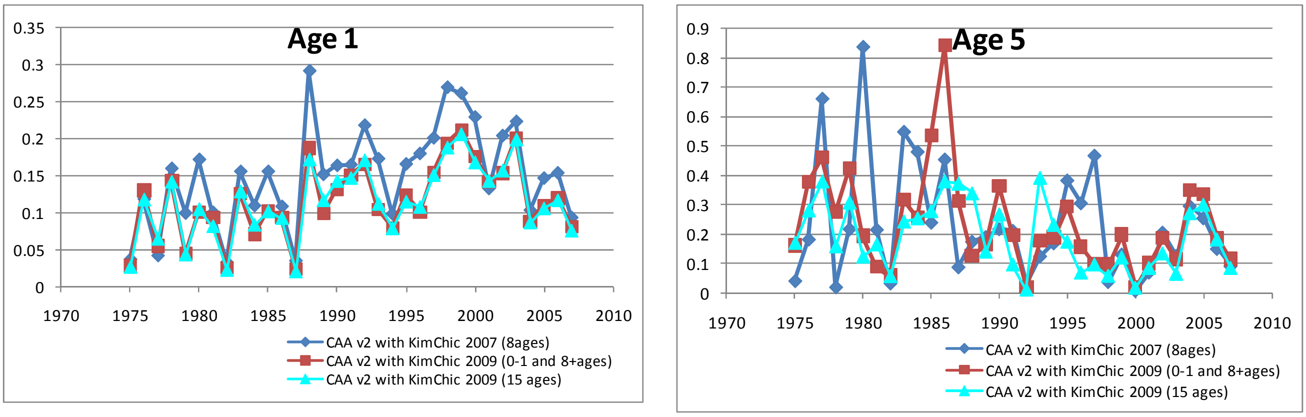


Figure 27. Effect of alternative CAA matrices on SSB (up) and recruitment (bottom), within a VPA run considering a 8+ age group.



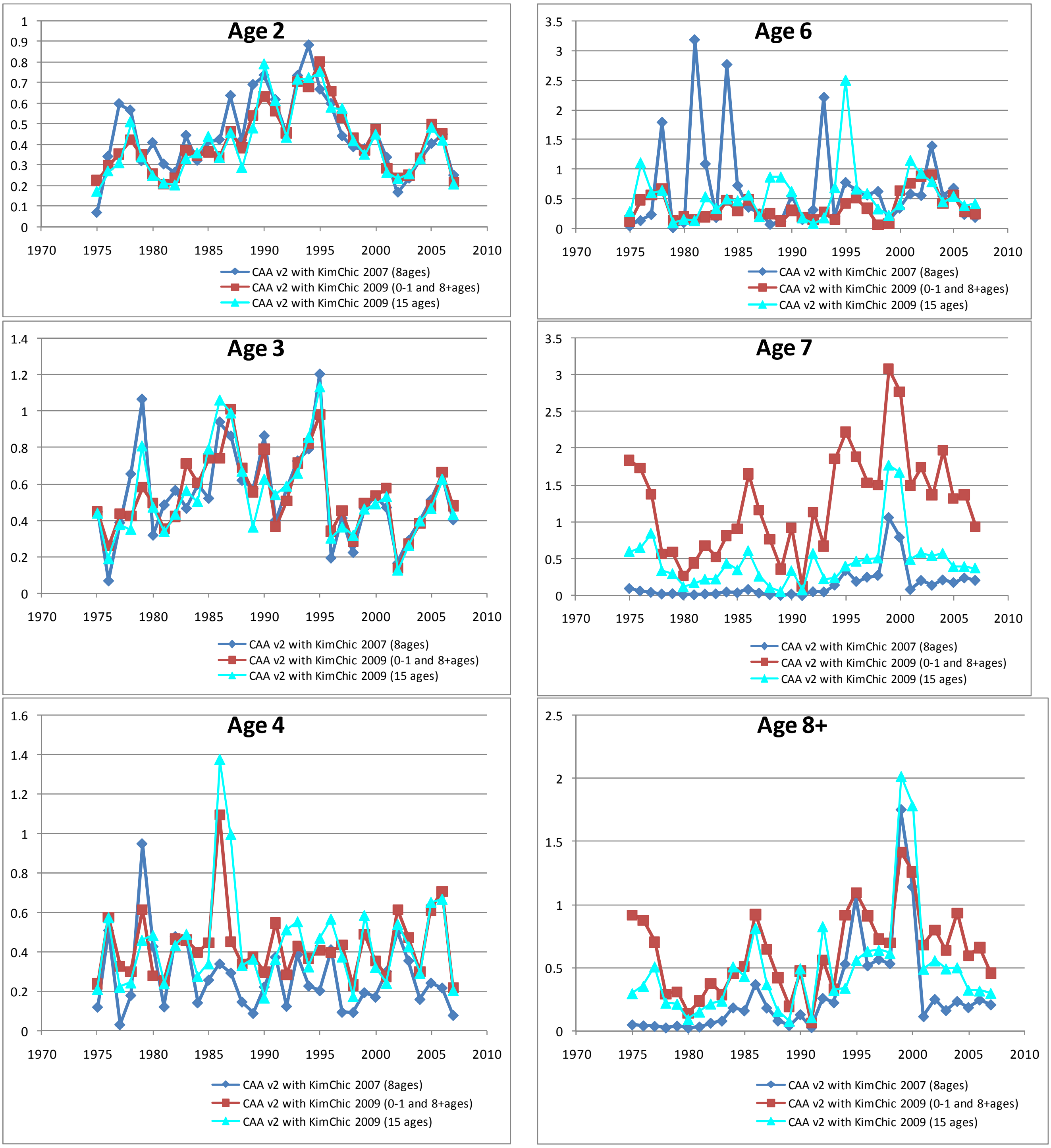


Figure 28. Effect of alternative CAA matrices on fishing mortality rates.

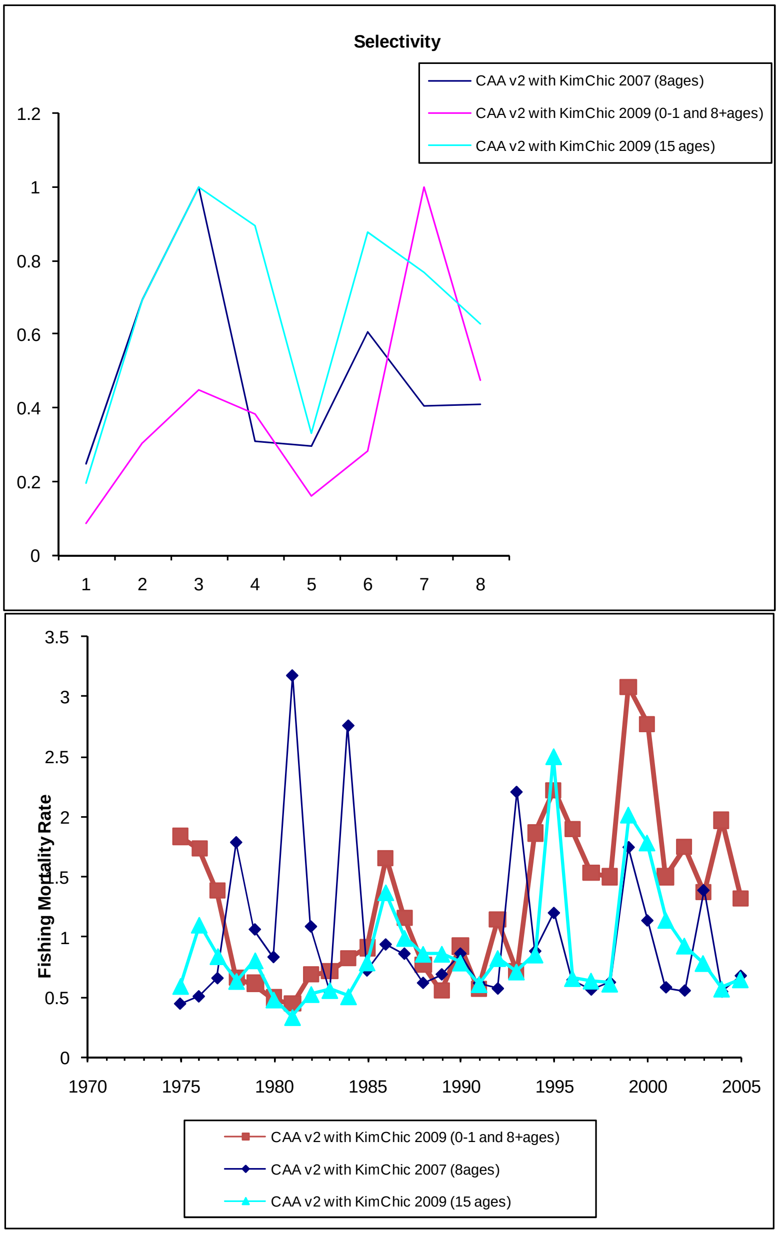
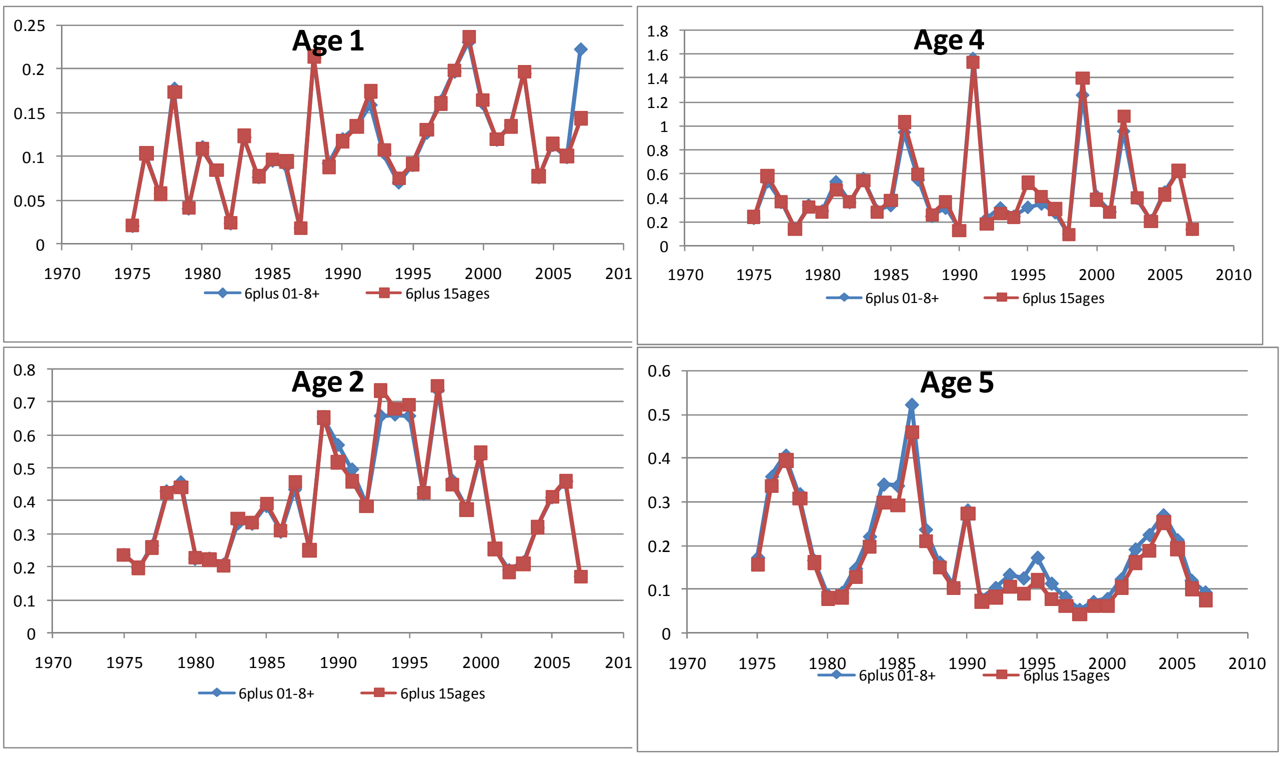


Figure 29. Effect of alternative CAA matrices on last 3 year averaged selectivity vector (up) and apical fishing mortality rate (bottom).

Figure 30. Effect of alternative CAA matrices on SSB (up) and recruitment (bottom), within a VPA run considering a 6+ age group.



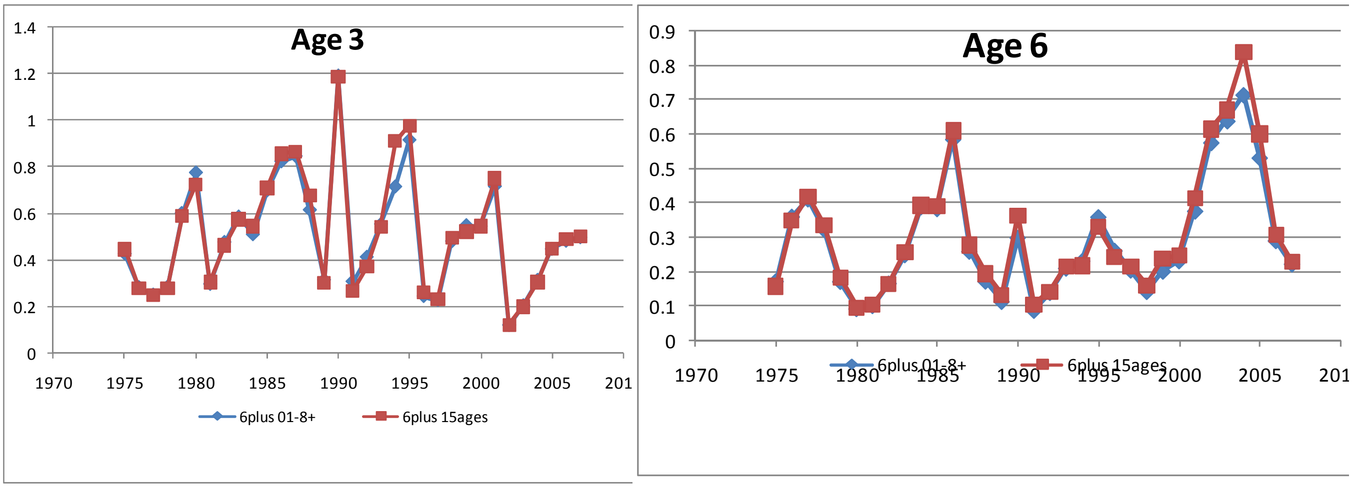


Figure 31. Effect of alternative CAA matrices on fishing mortality rates, in a VPA with a 6+ plus group.

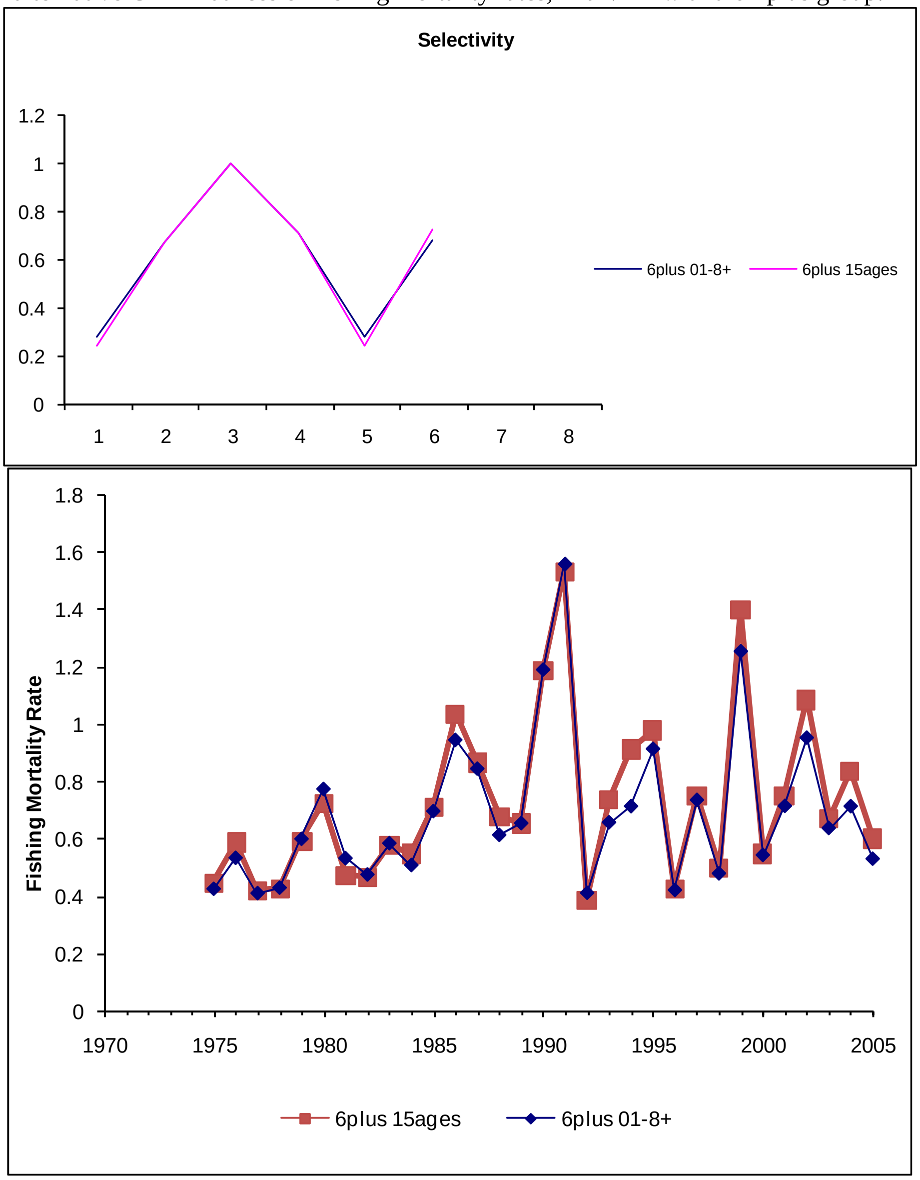


Figure 32. Effect of alternative CAA matrices on last 3 year averaged selectivity vector (up) and apical fishing mortality rate (bottom), in a VPA with a 6+ age group.

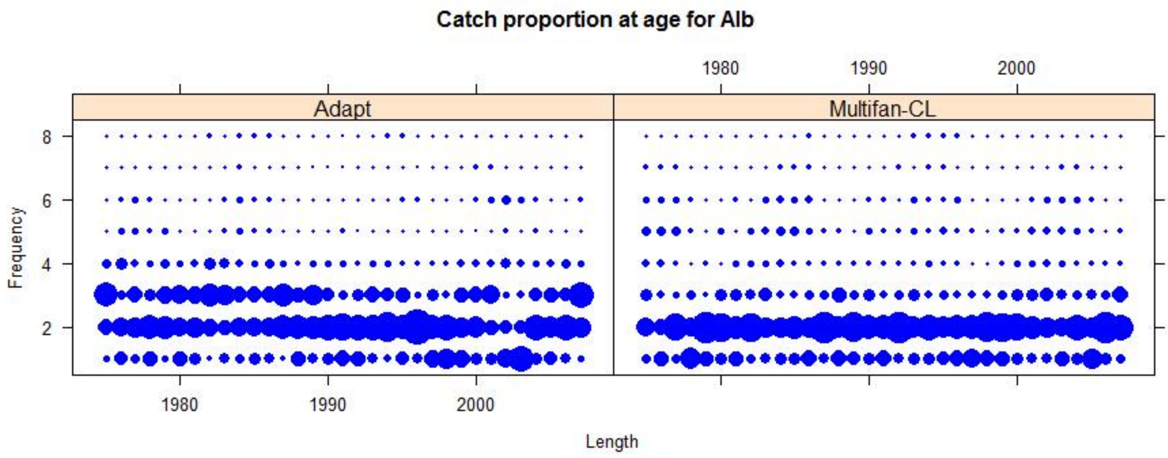


Figure 33. Relative catch proportions within a year for catch-at-age used in the Adapt-VPA runs and that estimated by Multifan-CL in run 4B.

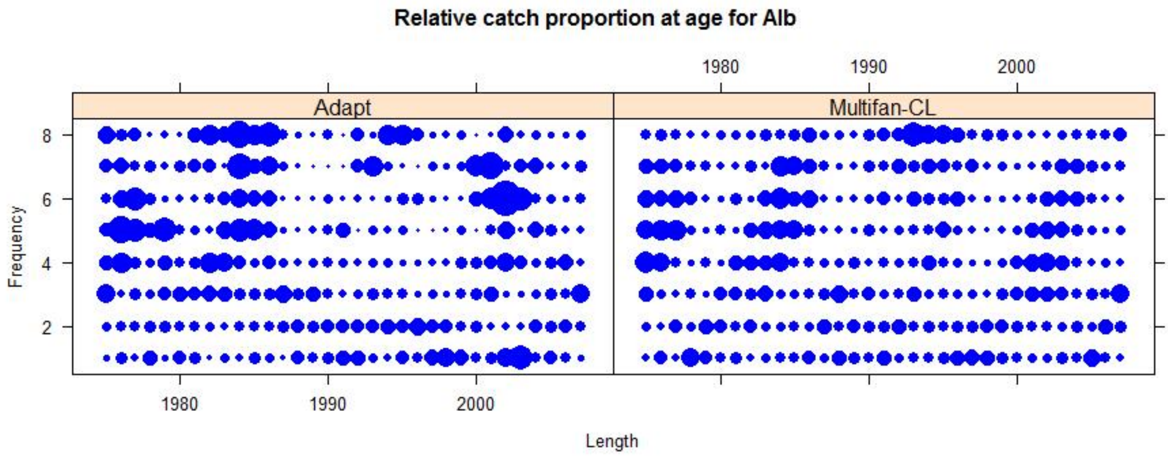


Figure 34. Relative catch proportions within an age for Catch-at-age used in the Adapt-VPA runs and that estimated by Multifan-CL in run 4B.

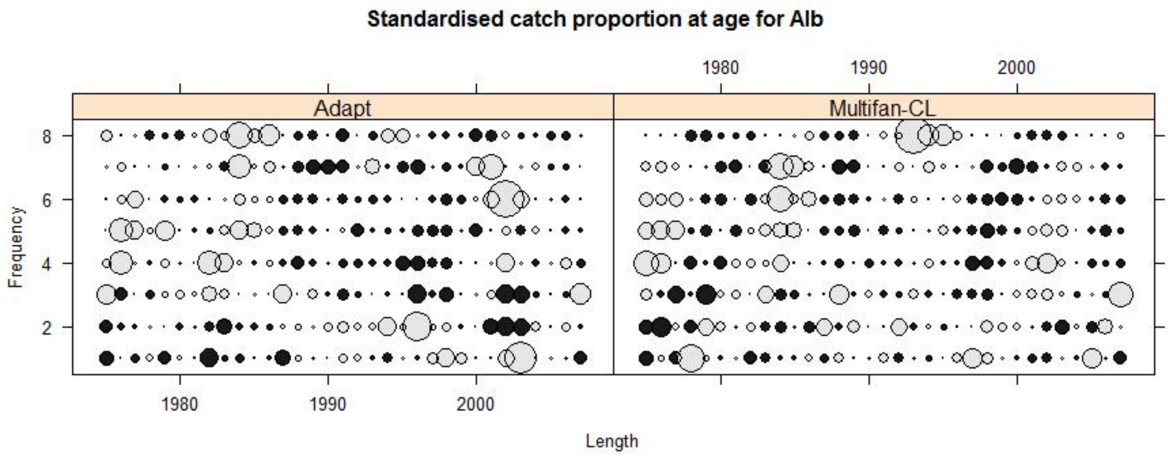


Figure 35. Standardized catch proportions within an age for Catch-at-age used in the Adapt-VPA runs and that estimated by Multifan-CL in run 4B.

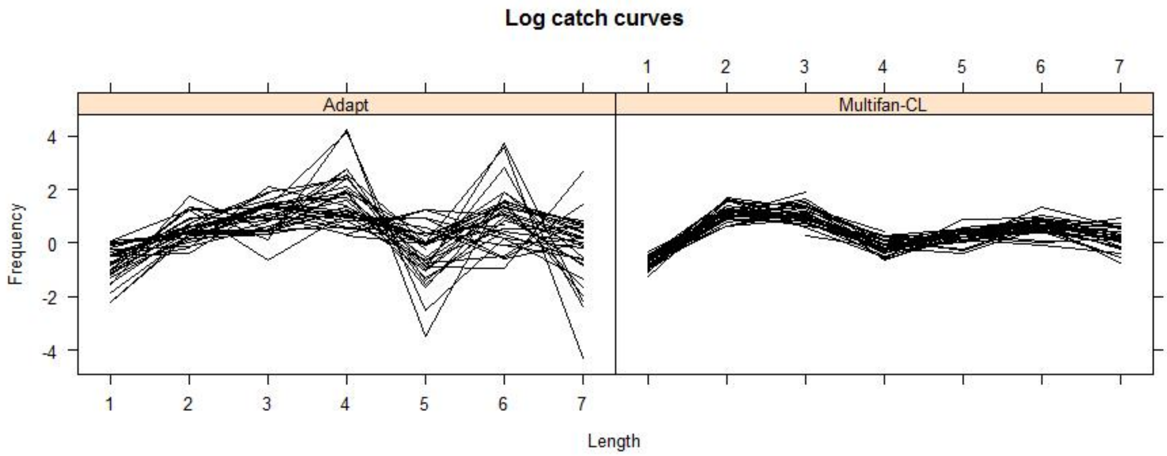


Figure 36. Log catch curves by age for catch-at-age used in the Adapt-VPA runs and that estimated by Multifan-CL in run 4B.

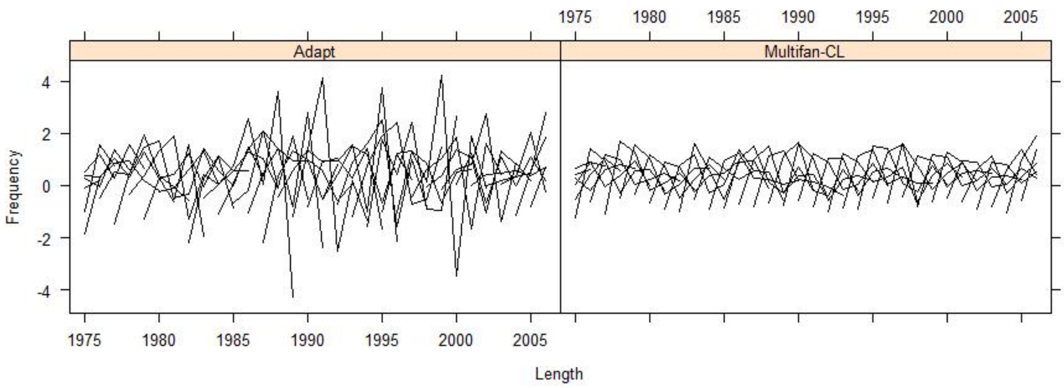


Figure 37. Log catch curves by year for catch-at-age used in the Adapt-VPA runs and that estimated by Multifan-CL in run 4B.

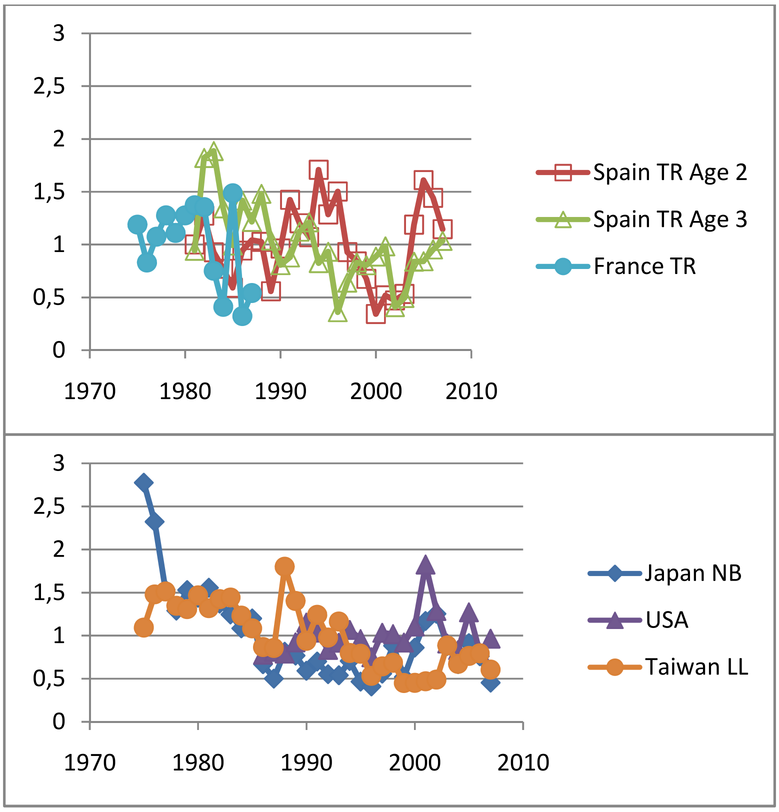


Figure 38. Standardized annual CPUE's for North Atlantic Albacore used to fit the VPA- ADAPT model to assess the North stock

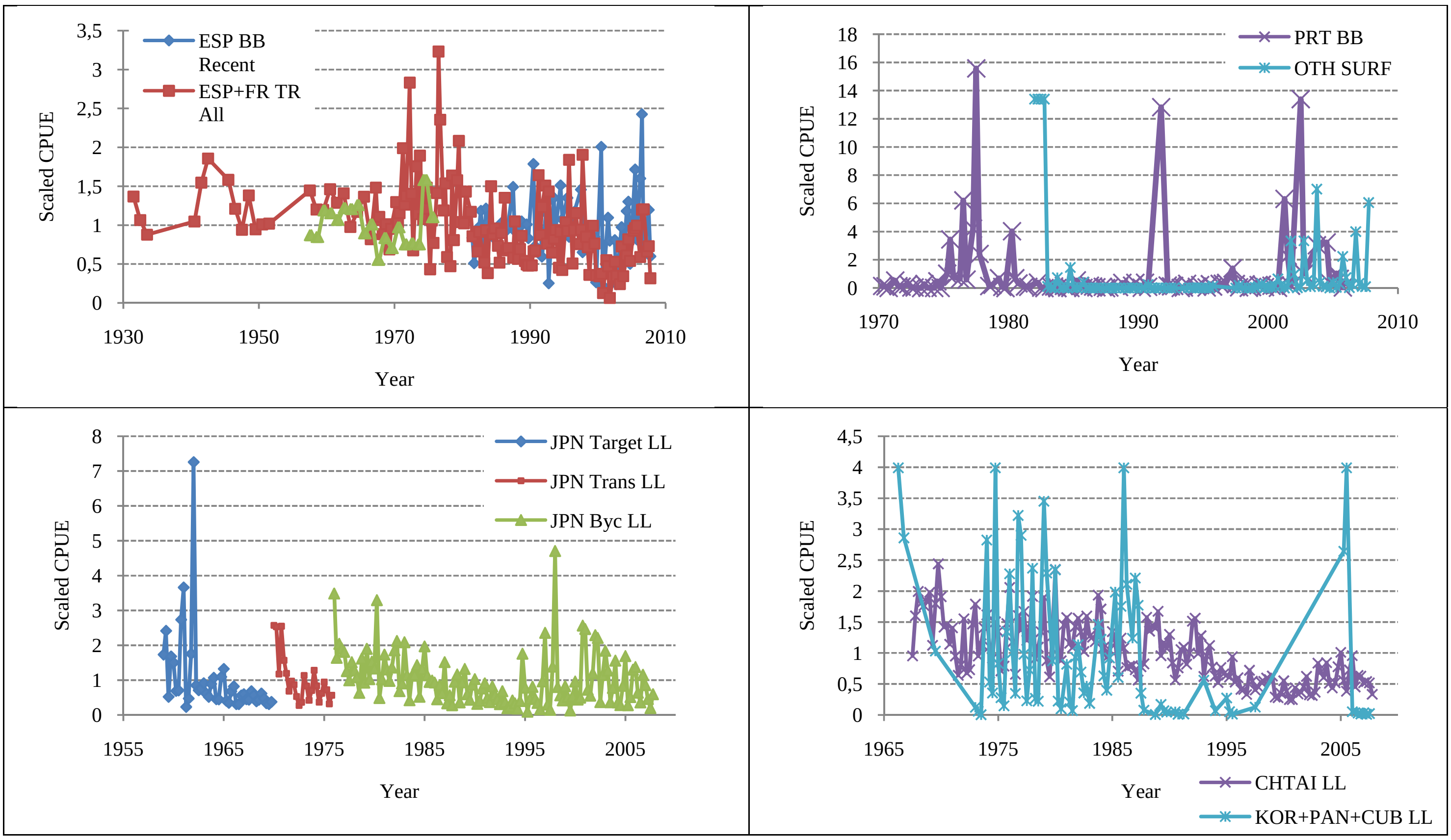


Figure 39. Standardized CPUE's by fishery for North Atlantic Albacore used to fit the Multifan CL model.

Figure 40. VPA model fits (lines) to the observed (blue squares) indices of abundance. The three lines on each graph correspond to the 4 different F-ratios used (refer to text for details). The VPA runs were set up with an 8+ age group.

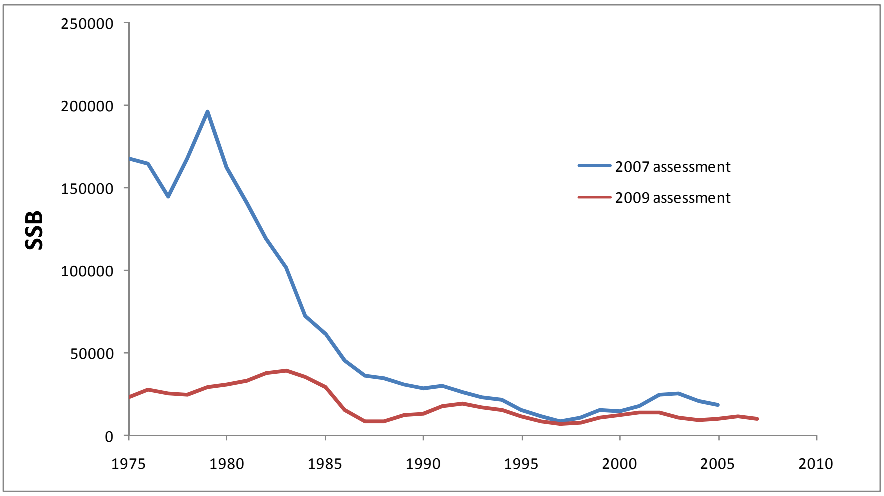


Figure 41. Estimated SSB by VPA model during the 2007 stock assessment (blue line) and the initial VPA run of the 2009 assessment (red line).

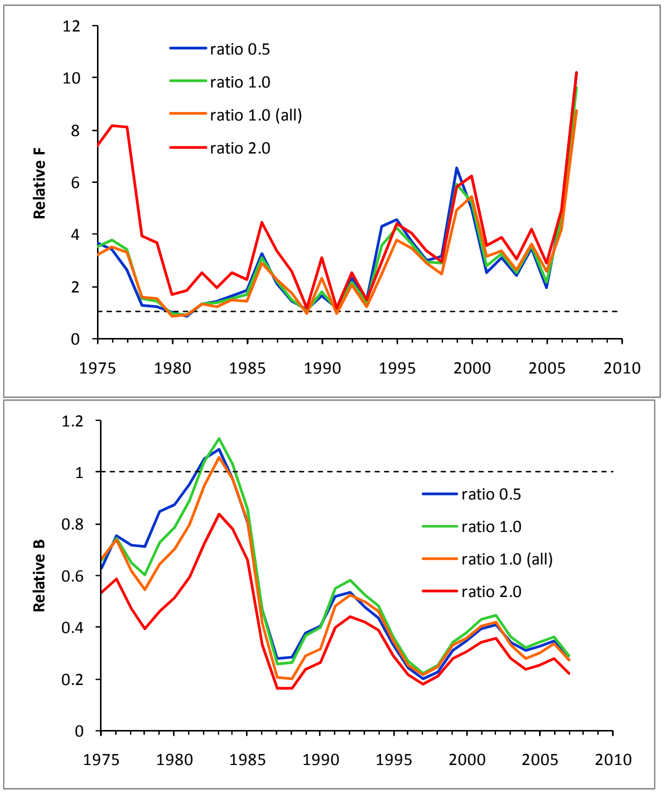


Figure 42. Estimated relative F (F/F_{MSY}) and relative SSB (SSB/SSB_{MSY}) by the VPA model using an 8-plus age group and for 4 different F-ratios (refer to text for details).

Figure 43. VPA model fits (lines) to the observed (blue squares) indices of abundance. The three lines in each graph correspond to the 3 different F-ratios used (refer to text for details). The VPA runs were set up with an 6+ age group.

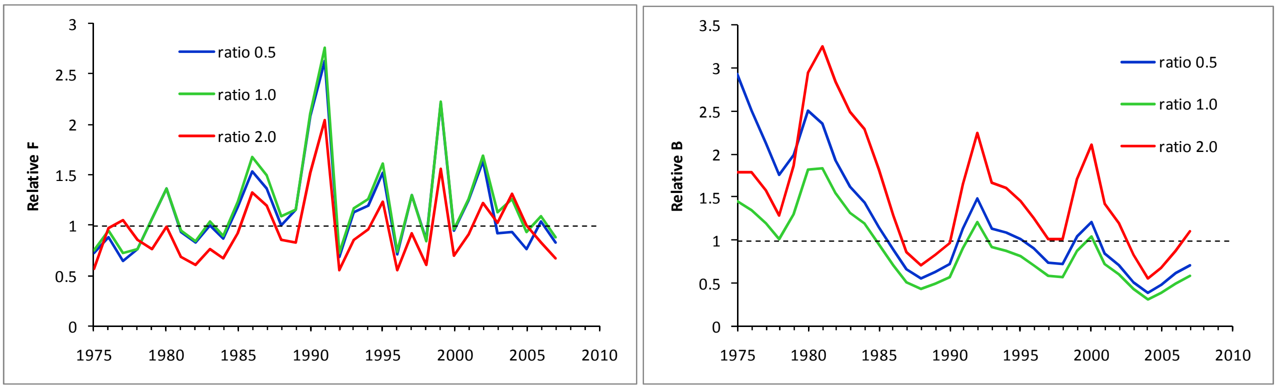


Figure 44. Estimated relative F (F/F_{MSY}) and relative SSB (SSB/SSB_{MSY}) by the VPA model using a 6-plus age group and for 3 different F-ratios (refer to text for details).

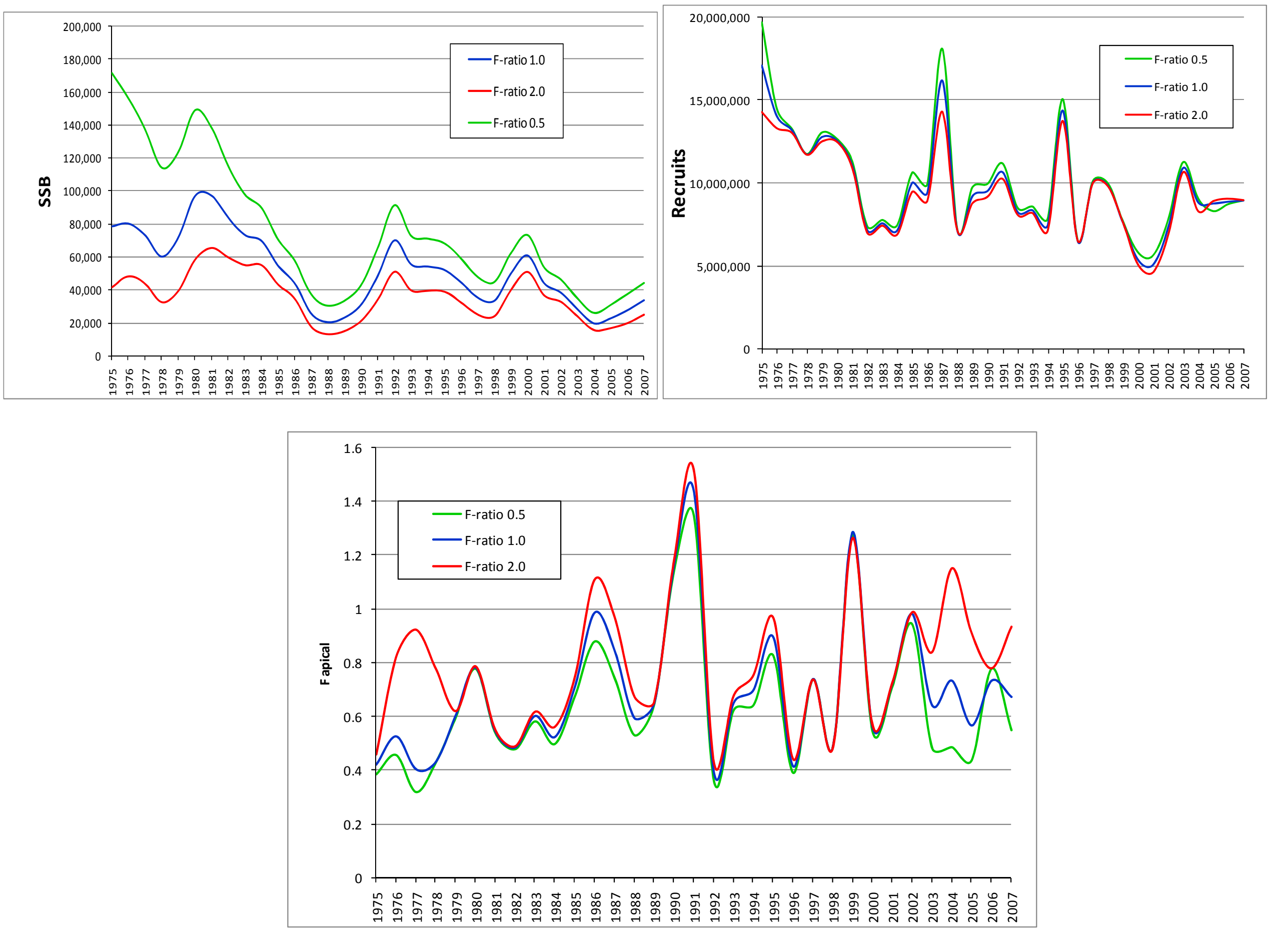


Figure 45. Estimated SSB, recruits, and F apical from 500 VPA bootstraps for three different F-ratios (refer to text for details on the F-ratios). Terminal F apical (year 2007) was estimated as the geometric mean of F for years 2004, 2005, and 2006.

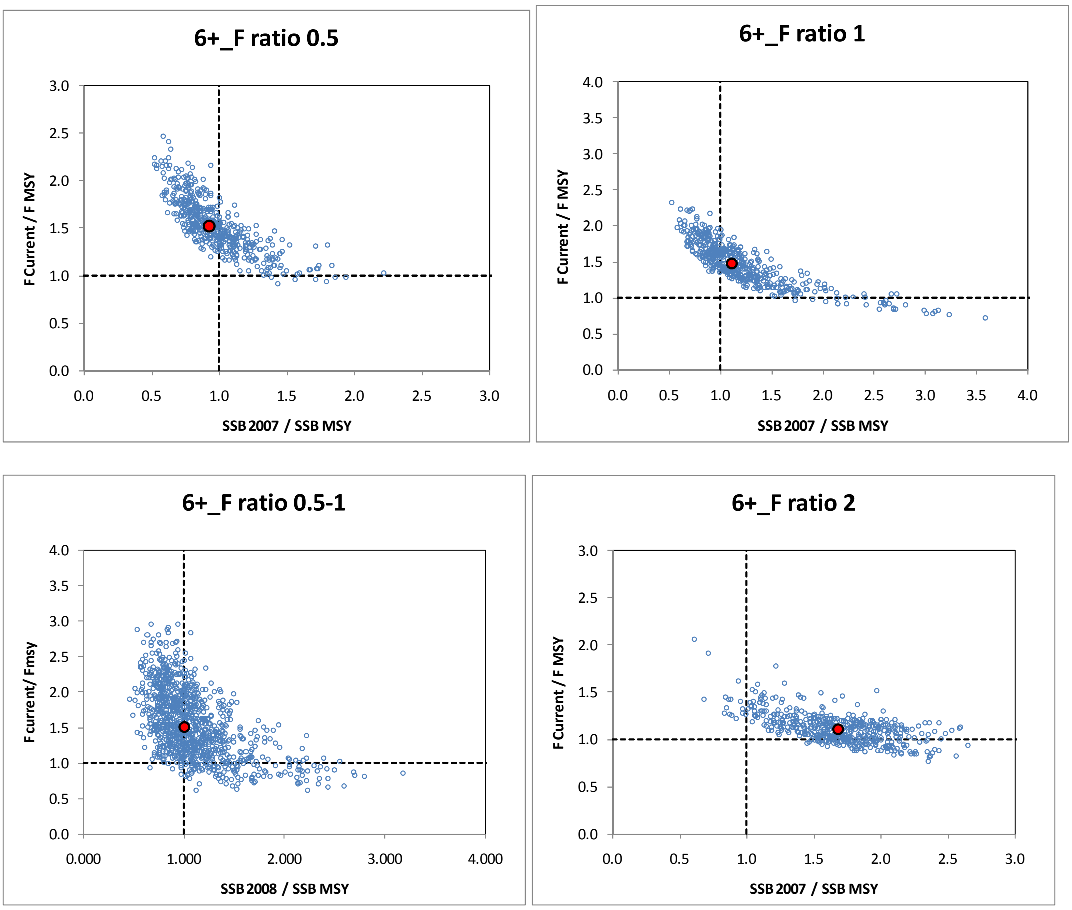


Figure 46. Phase-plots estimated using 500 bootstraps for F-ratios of 0.5, 1.0, and 2.0 and a combined plot with results from the F-ratio 0.5 and 1.0 runs. The red dot corresponds to the estimated median value. $F_{current}$ was estimated as the geometric mean of the apical F of years 2004, 2005, and 2006. The '6+' in each graphs indicates the age-plus group used in the VPA model.

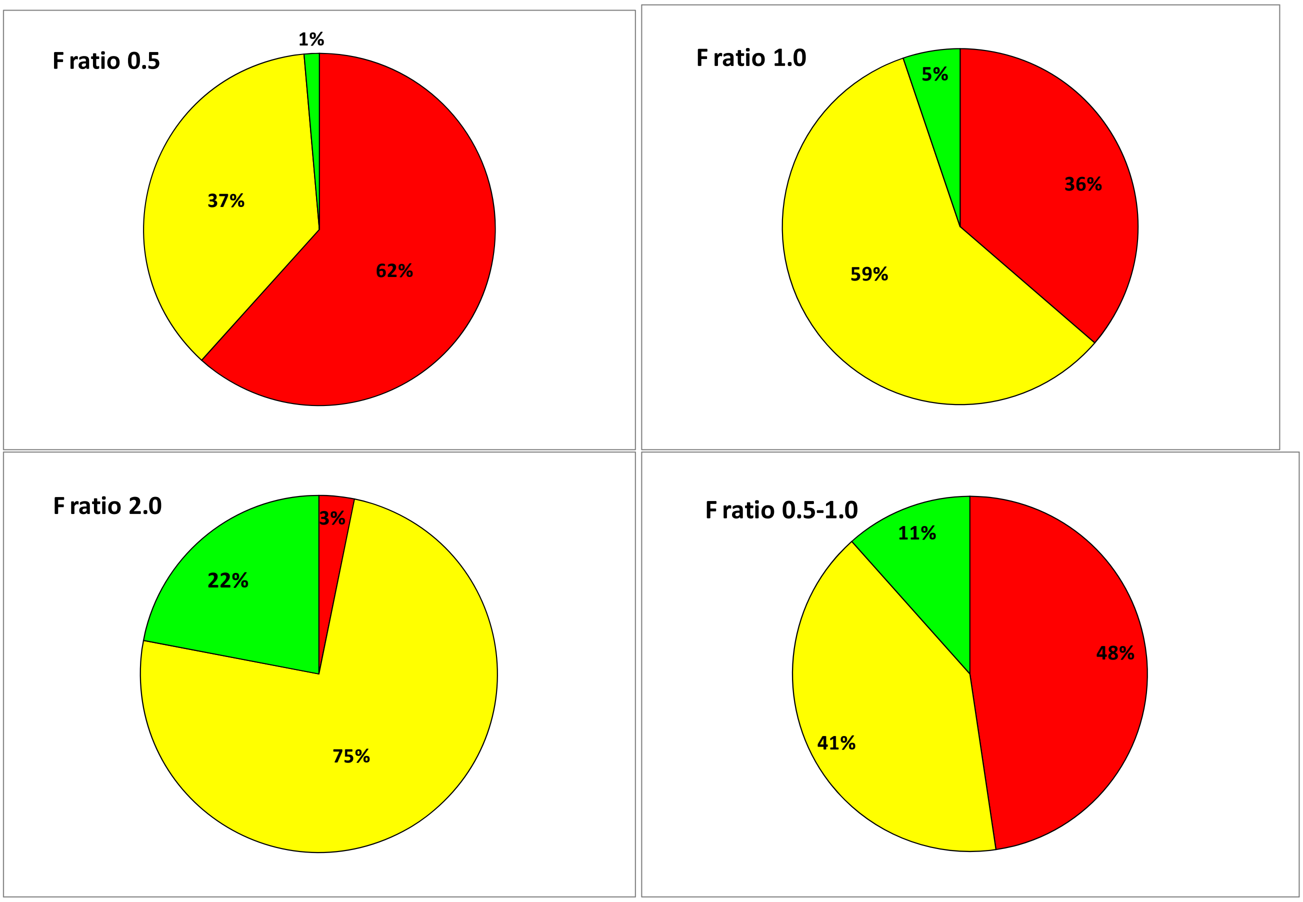


Figure 47. Percentage of 500 bootstraps outcomes indicating that the current status of the stock was overfished and undergoing overfishing (red area), not overfished and not under overfishing conditions (green area), and either overfished or undergoing overfishing (yellow area)

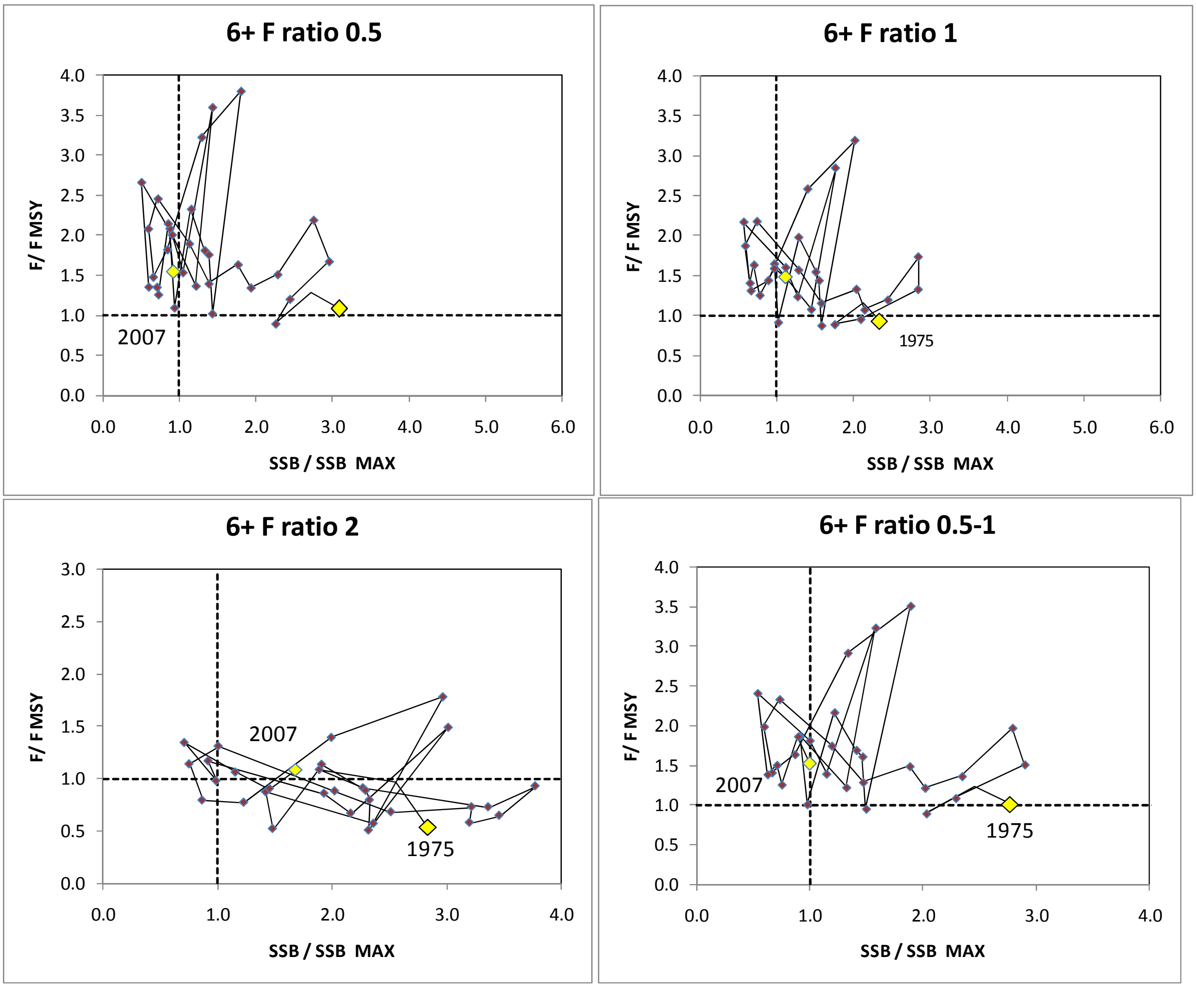
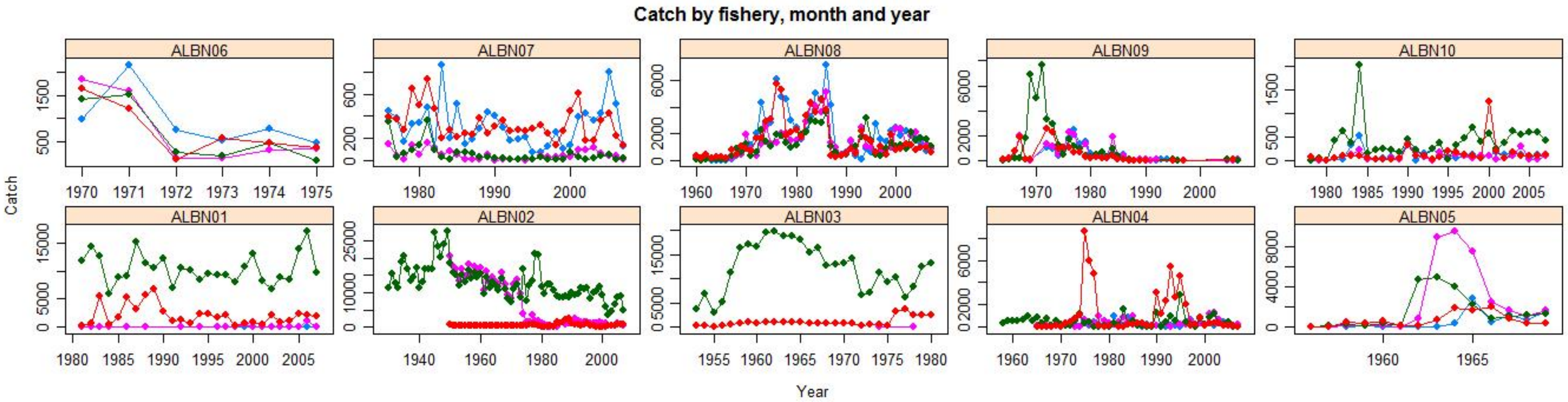
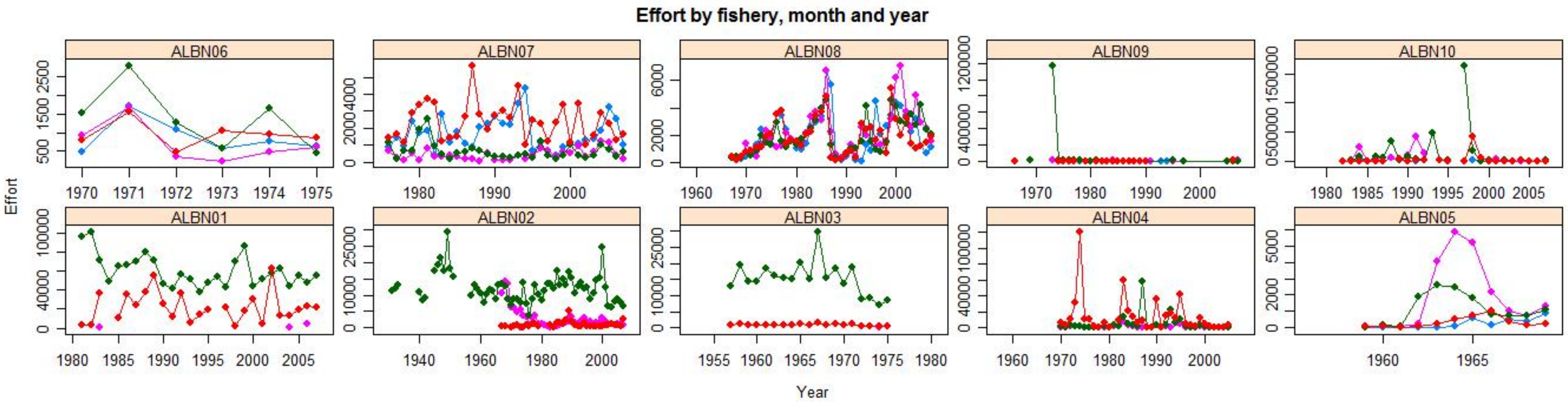


Figure 48. Stock status trajectories for the period 1975-2007 estimated using 500 bootstraps for F-ratios of 0.5, 1.0, and 2.0 and a combined plot with results from the F-ratio 0.5 and 1.0 runs. The yellow dots indicate the start and end of the time series. Relative F for the terminal year was estimated as the geometric mean of years 2004, 2005, and 2006.

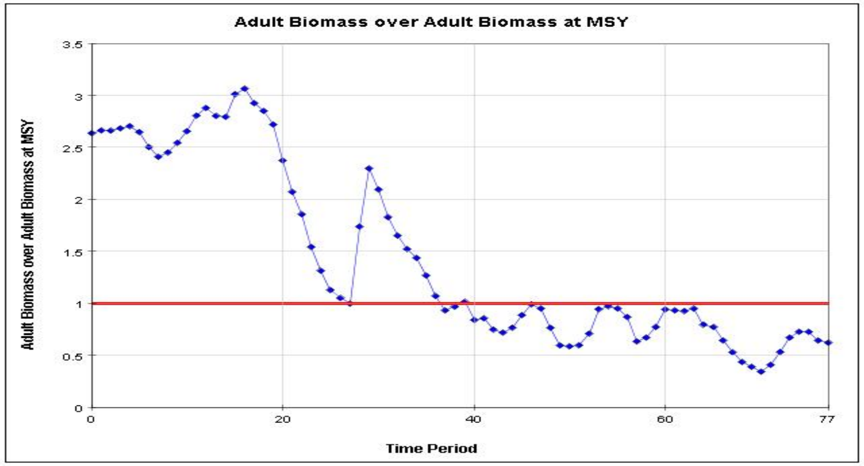


Figures 49. The catch data by fishery used in Multifan-CL (ceCatch.jpeg).

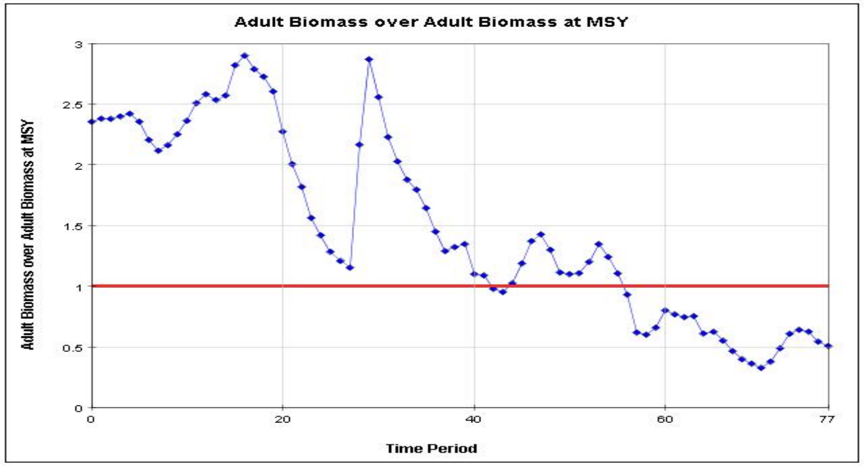


Figures 50. The effort data by fishery used in Multifan-CL (ceEffort.jpeg).

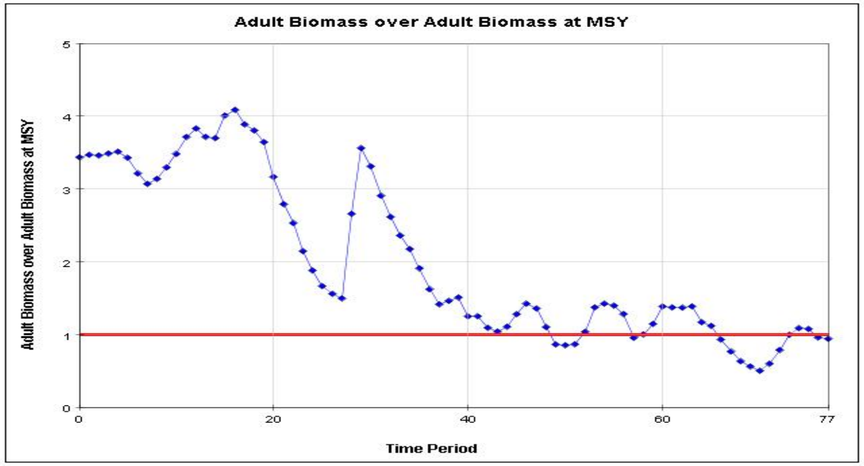
4B



4G



4H



4N

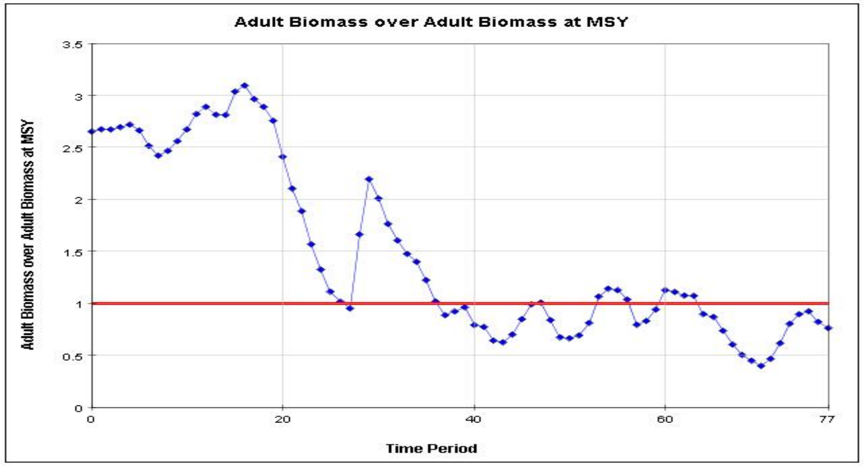
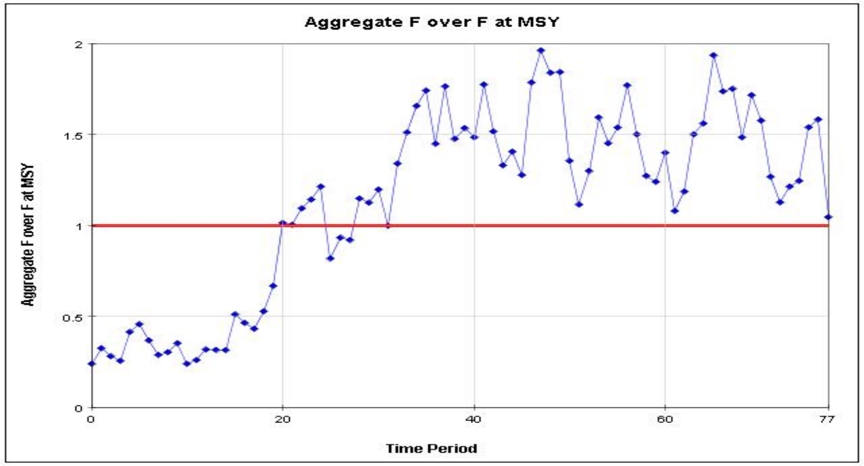
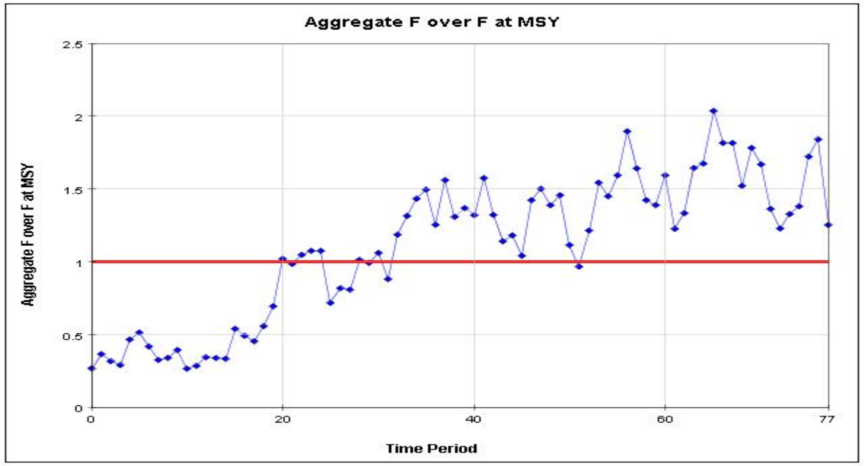


Figure 51. Estimates of relative spawning biomass obtained in 4 different runs of Multifan-CL model for the North Atlantic albacore stock.

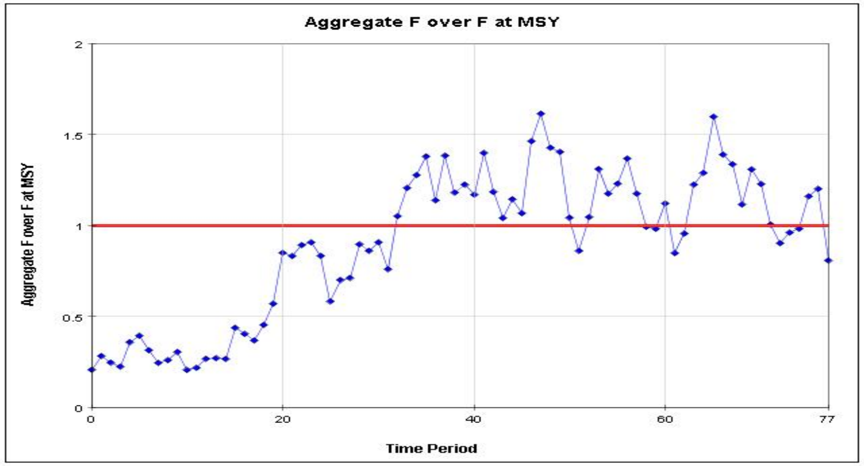
4B



4G



4H



4N

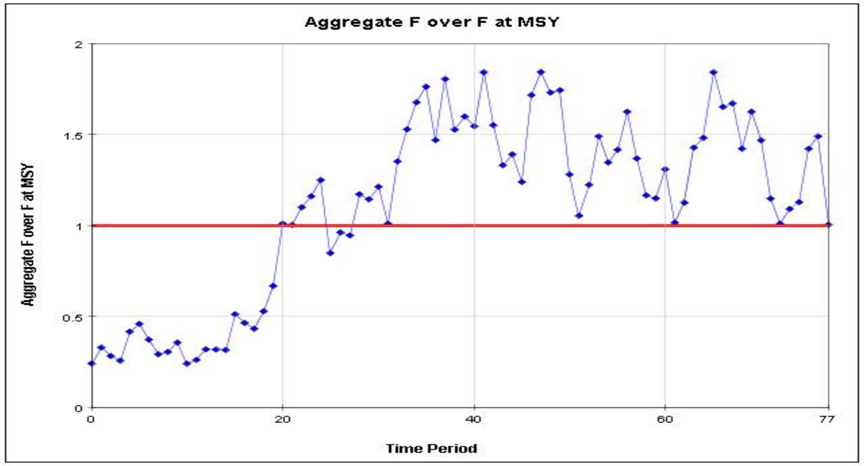
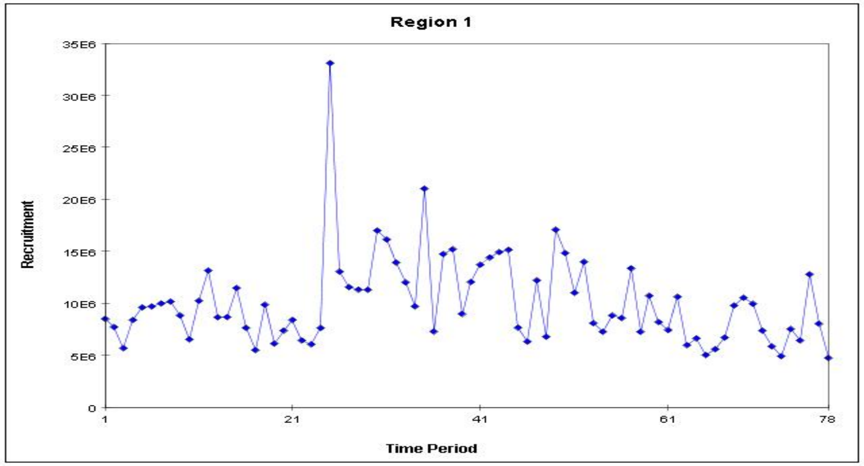
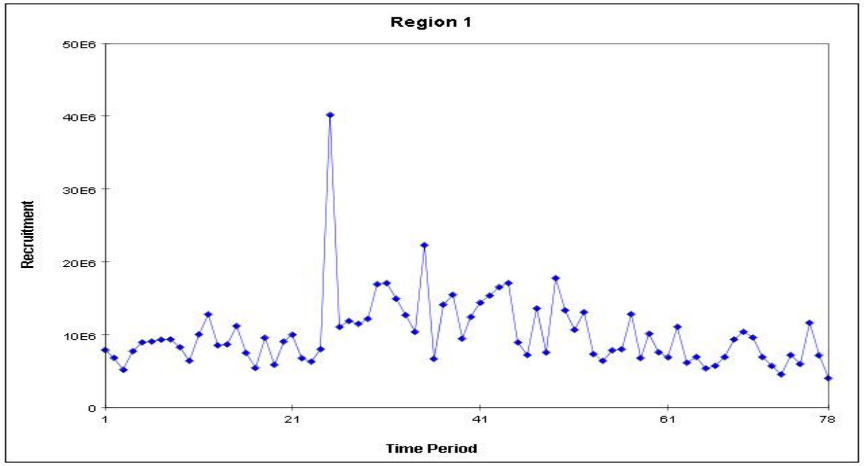


Figure 52. Estimates of relative fishing mortality obtained with 4 different Multifan-CL modeling options of the North Atlantic albacore stock.

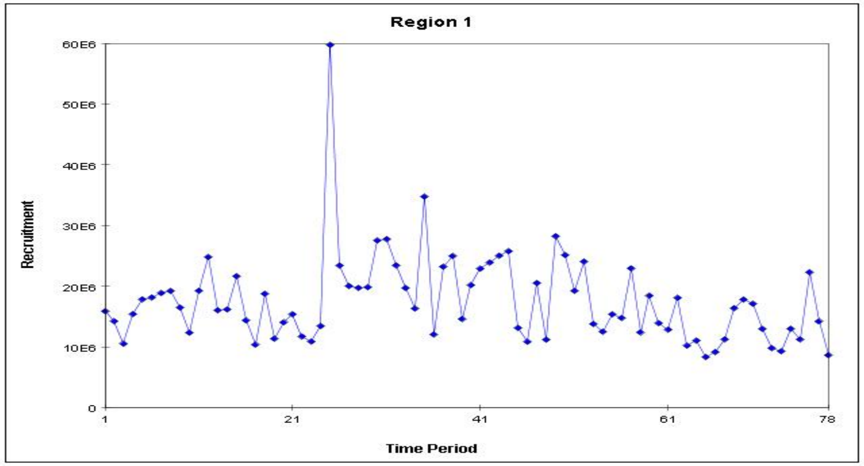
4B 4G





4H

4N



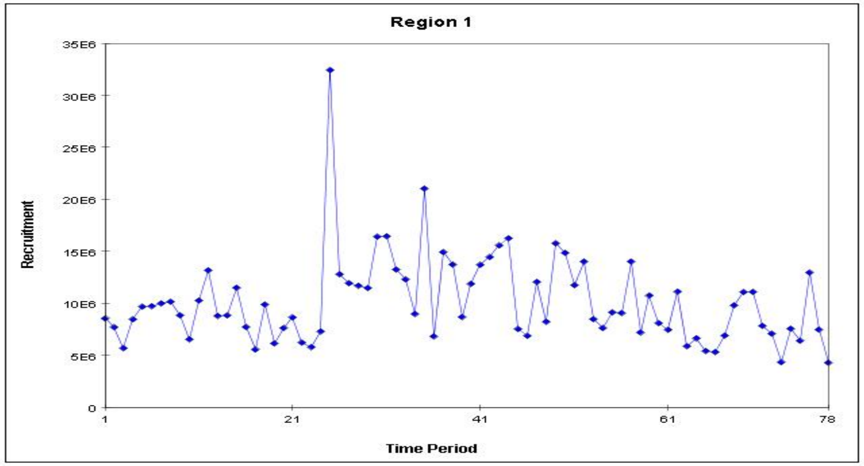
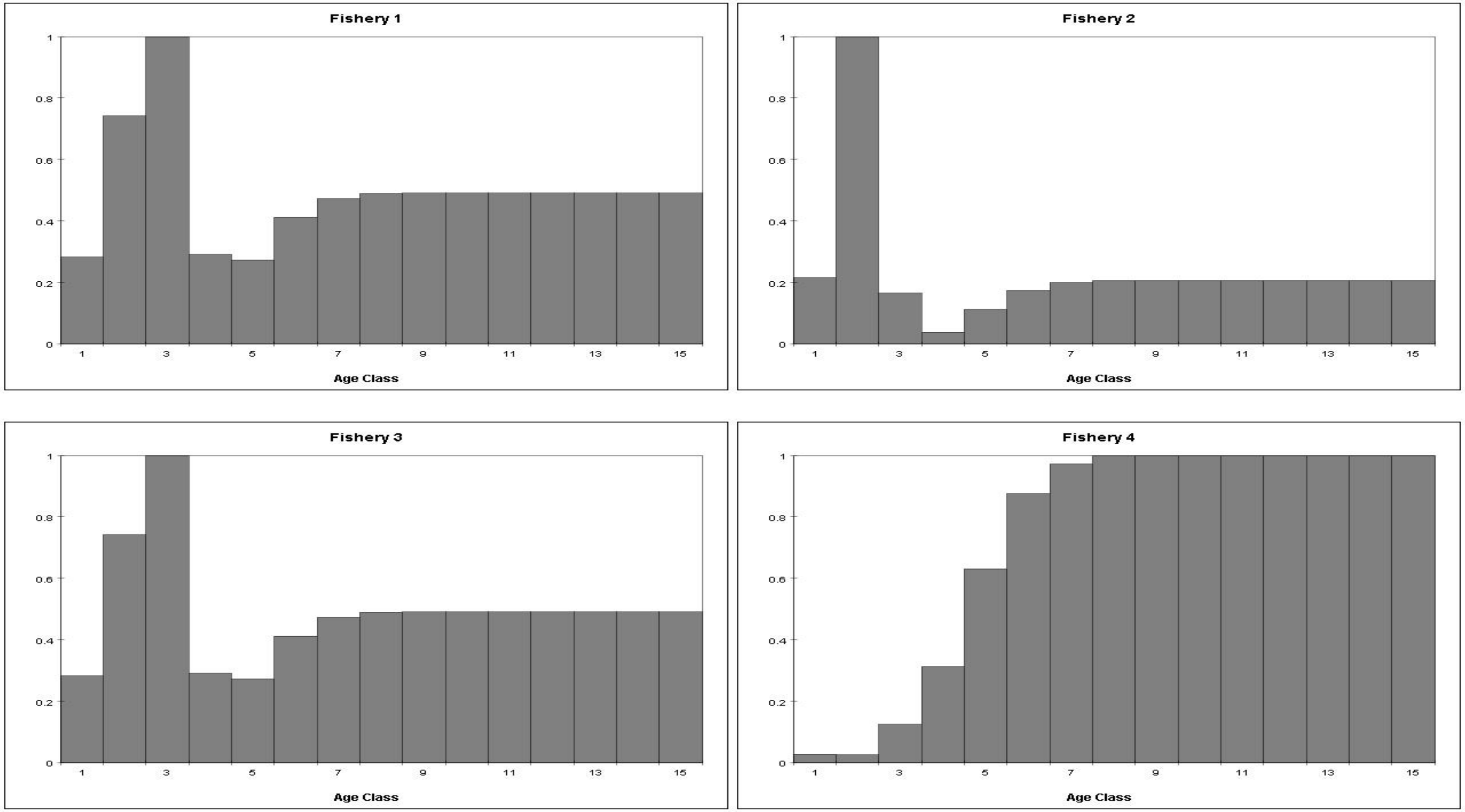
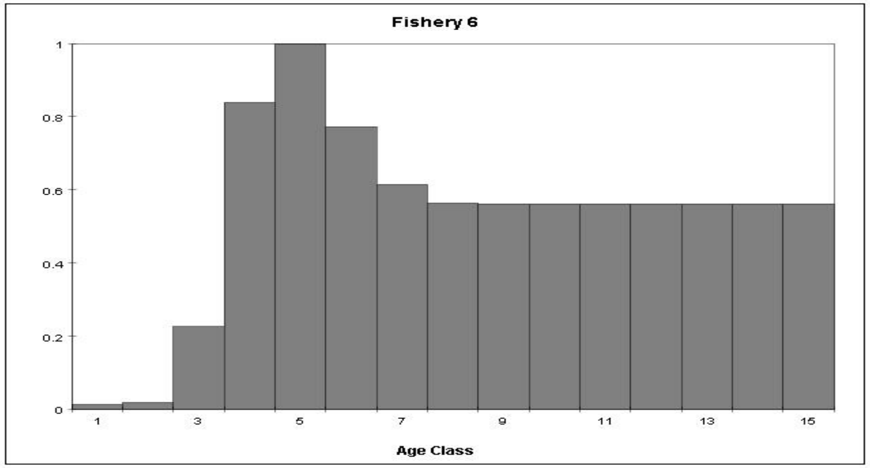


Figure 53. Estimates of recruitment obtained with 4 different model runs of Multifan-CL model of the North Atlantic albacore stock.


Fishery 1
Age Class
Fishery 2
Age Class
Fishery 3
Age Class
Fishery 4
Age Class

Fishery 5
1
0.8
0.6
0.4
0.2
0
1
3
5
7
9
11
13
15
Age Class



Fishery 6
1
0.8
0.6
0.4
0.2
0
1
3
5
7
9
11
13
15
Age Class

Fishery 7
1
0.8
0.6
0.4
0.2
0
1
3
5
7
9
11
13
15
Age Class

Fishery 8
1
0.8
0.6
0.4
0.2
0
1
3
5
7
9
11
13
15
Age Class

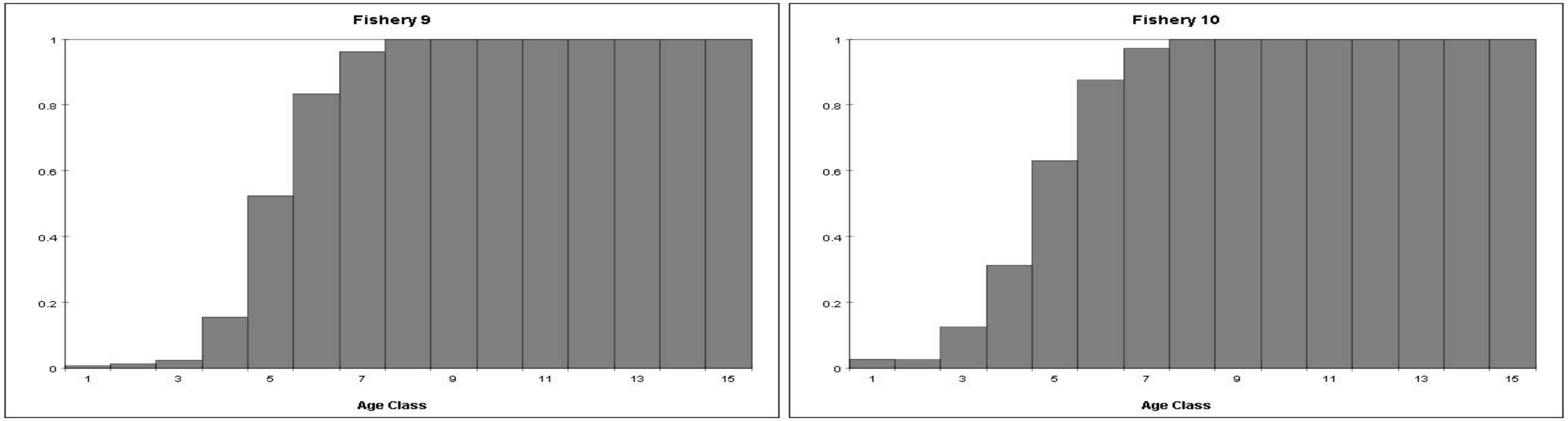
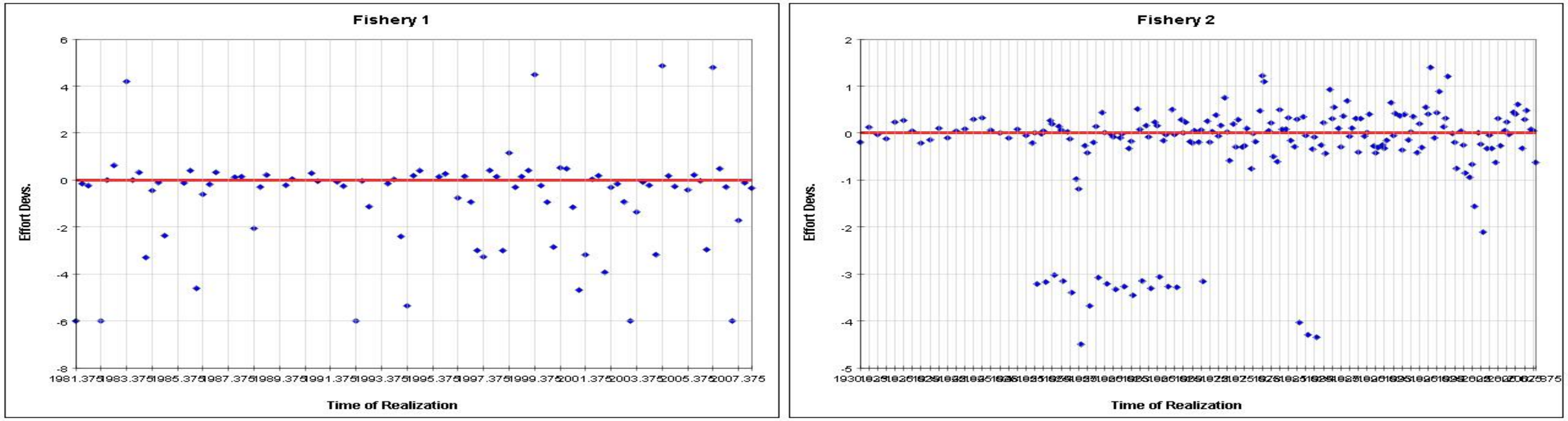
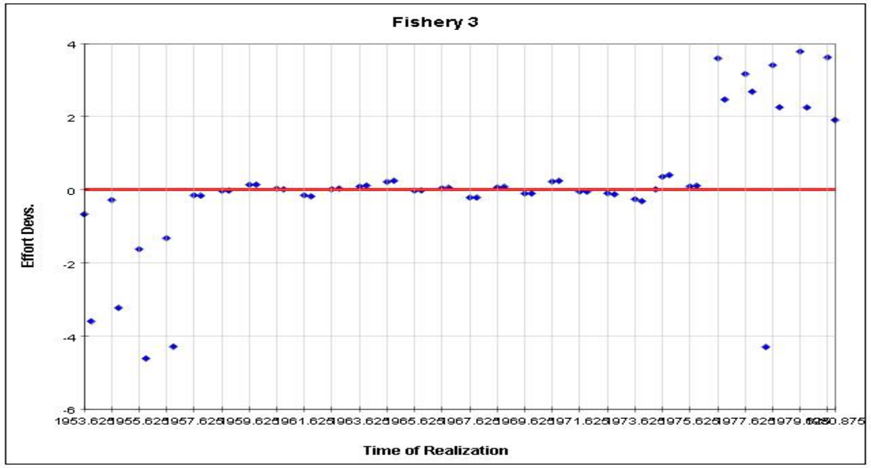
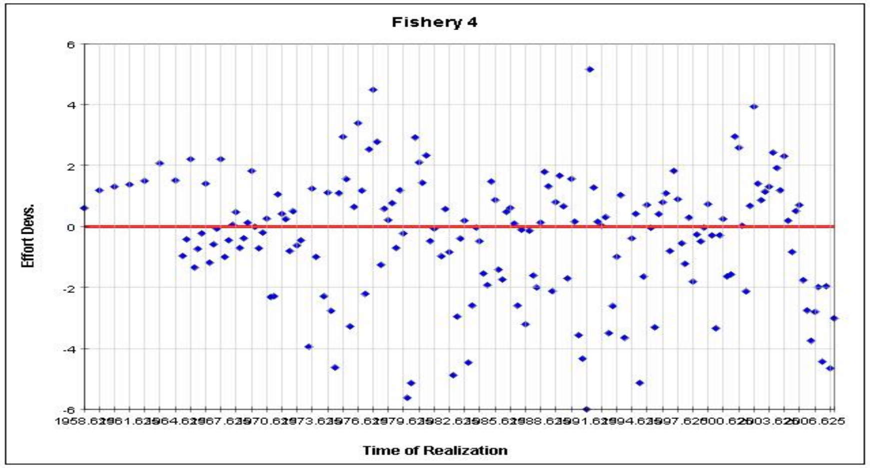
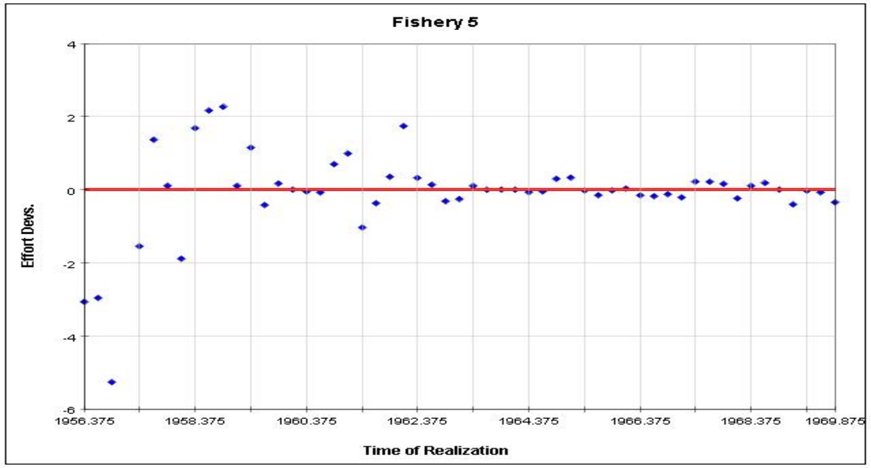


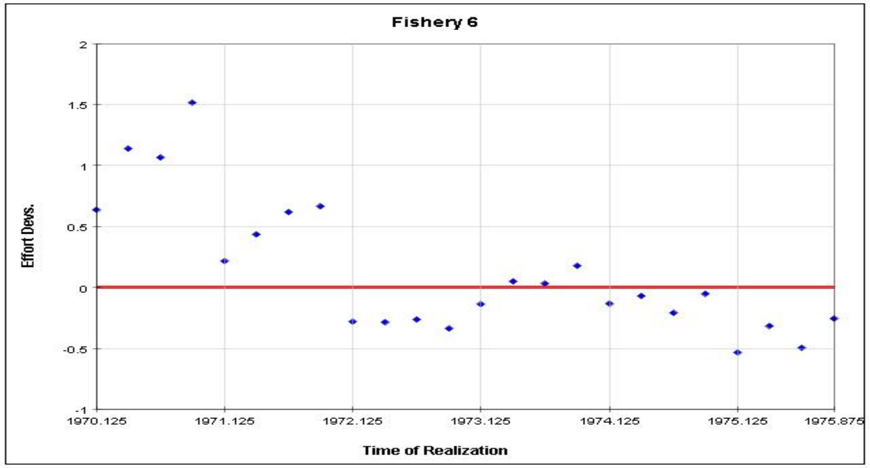
Figure 54. Estimated selectivity patterns for the 10 fisheries used in Multifan-CL model 4B for the North Atlantic albacore stock.




Fishery 3
Effort Devs.
Time of Realization
4
2
0
-2
-4
-6


Fishery 4
Effort Devs.
Time of Realization
6
4
2
0
-2
-4
-6


Fishery 5
Effort Devs.
Time of Realization
4
2
0
-2
-4
-6
1956.375
1958.375
1960.375
1962.375
1964.375
1966.375
1968.375
1969.875


Fishery 6
Effort Devs.
Time of Realization
2
1.5
1
0.5
0
-0.5
-1
1970.125
1971.125
1972.125
1973.125
1974.125
1975.125
1975.875

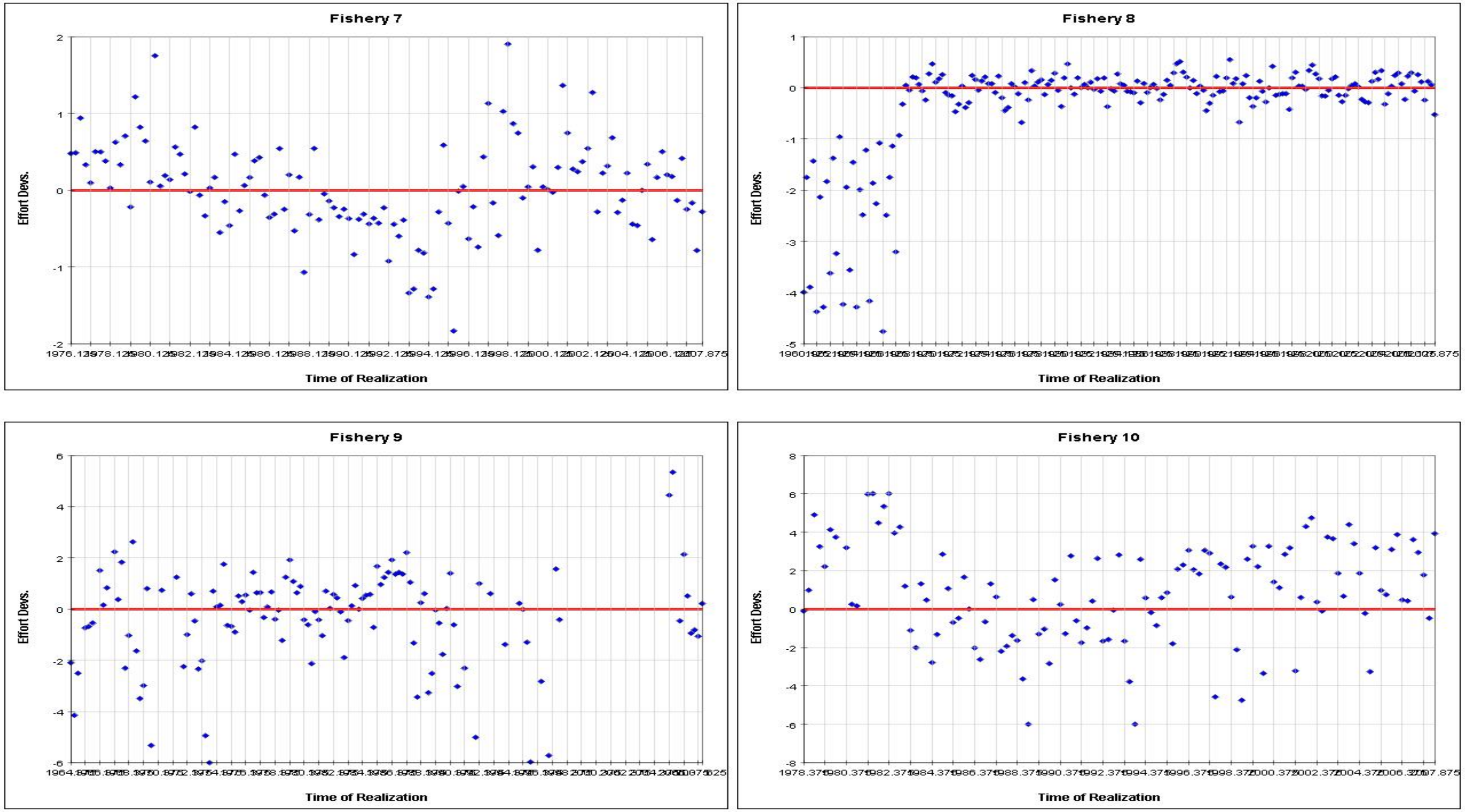


Figure 55. Effort deviations for the various fisheries modeled by Multifan-CL in model 4B in the North Atlantic albacore stock.

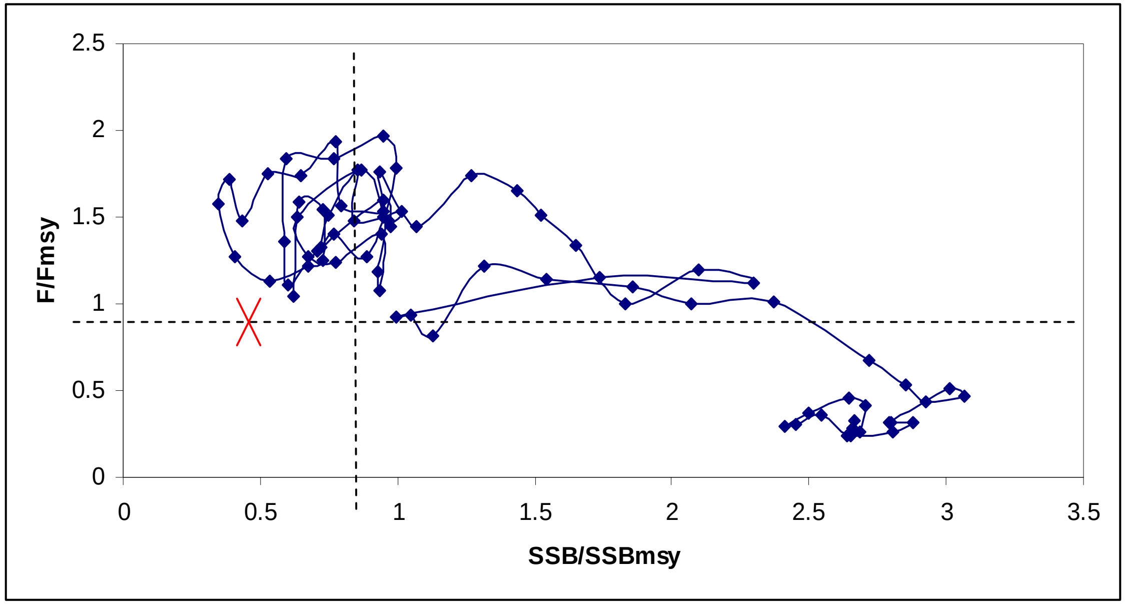


Figure 56. Trajectory of relative Fishing mortality and relative SSB for northen albacore, 1930-2007 using model 4B. The red X marks the 2007 point.

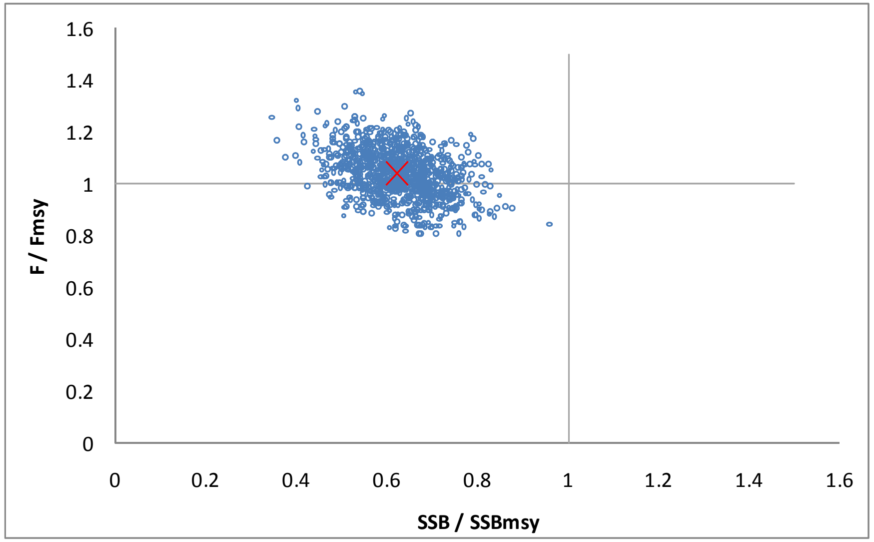
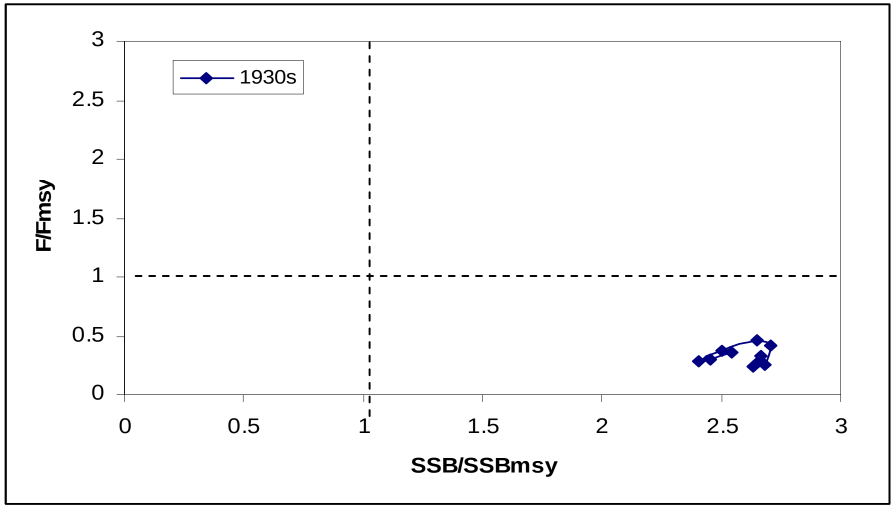
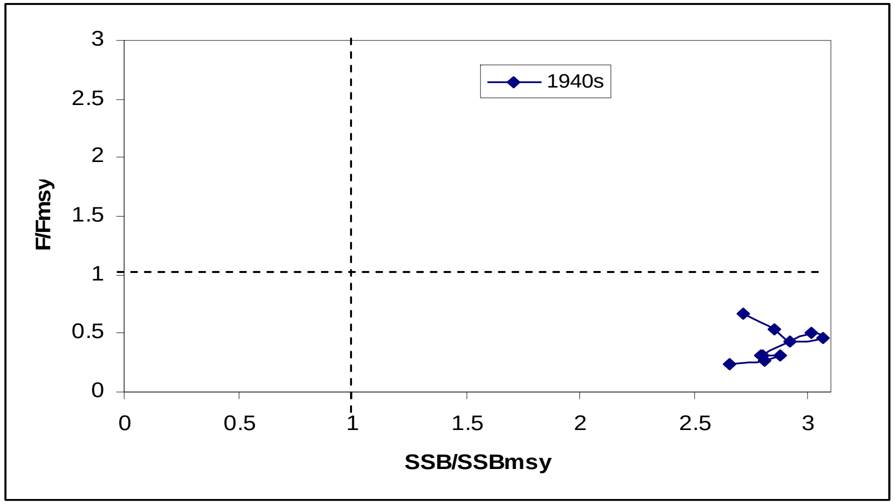
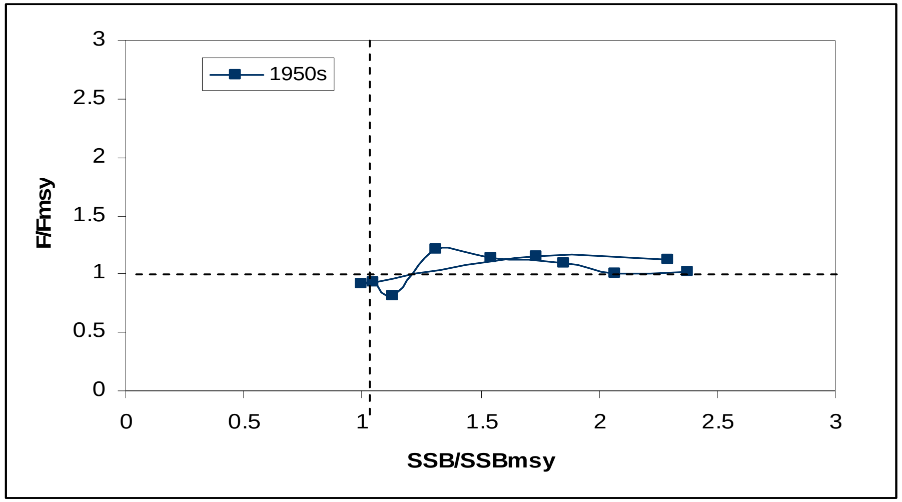
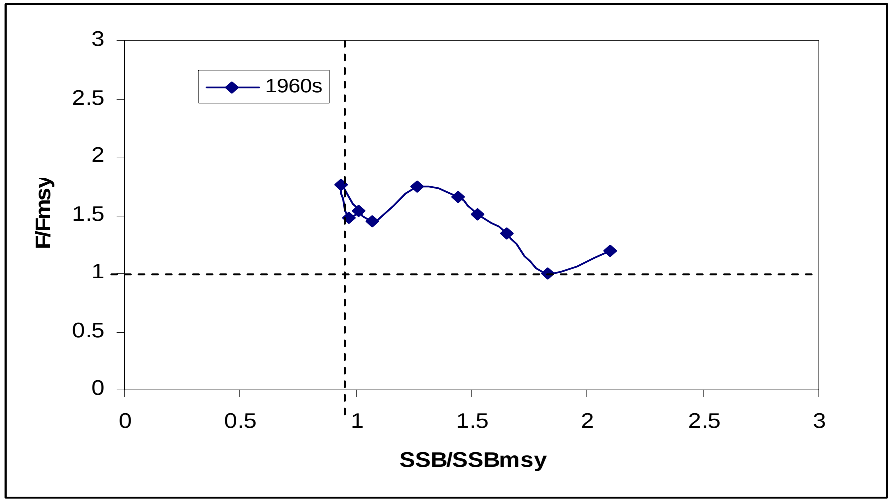


Figure 57. Uncertainty in current stock status for northern albacore, as estimated from the Multifan base case model. The X represents the current (2007) estimates of fishing mortality and spawning biomass ratios, and the scatter of points depicts uncertainty in that estimate.


1930s
F/Fmsy
SSB/SSBmsy
0
0.5
1
1.5
2
2.5
3


1940s
F/Fmsy
SSB/SSBmsy
0
0.5
1
1.5
2
2.5
3


1950s
F/Fmsy
SSB/SSBmsy
0
0.5
1
1.5
2
2.5
3


1960s
F/Fmsy
SSB/SSBmsy
0
0.5
1
1.5
2
2.5
3

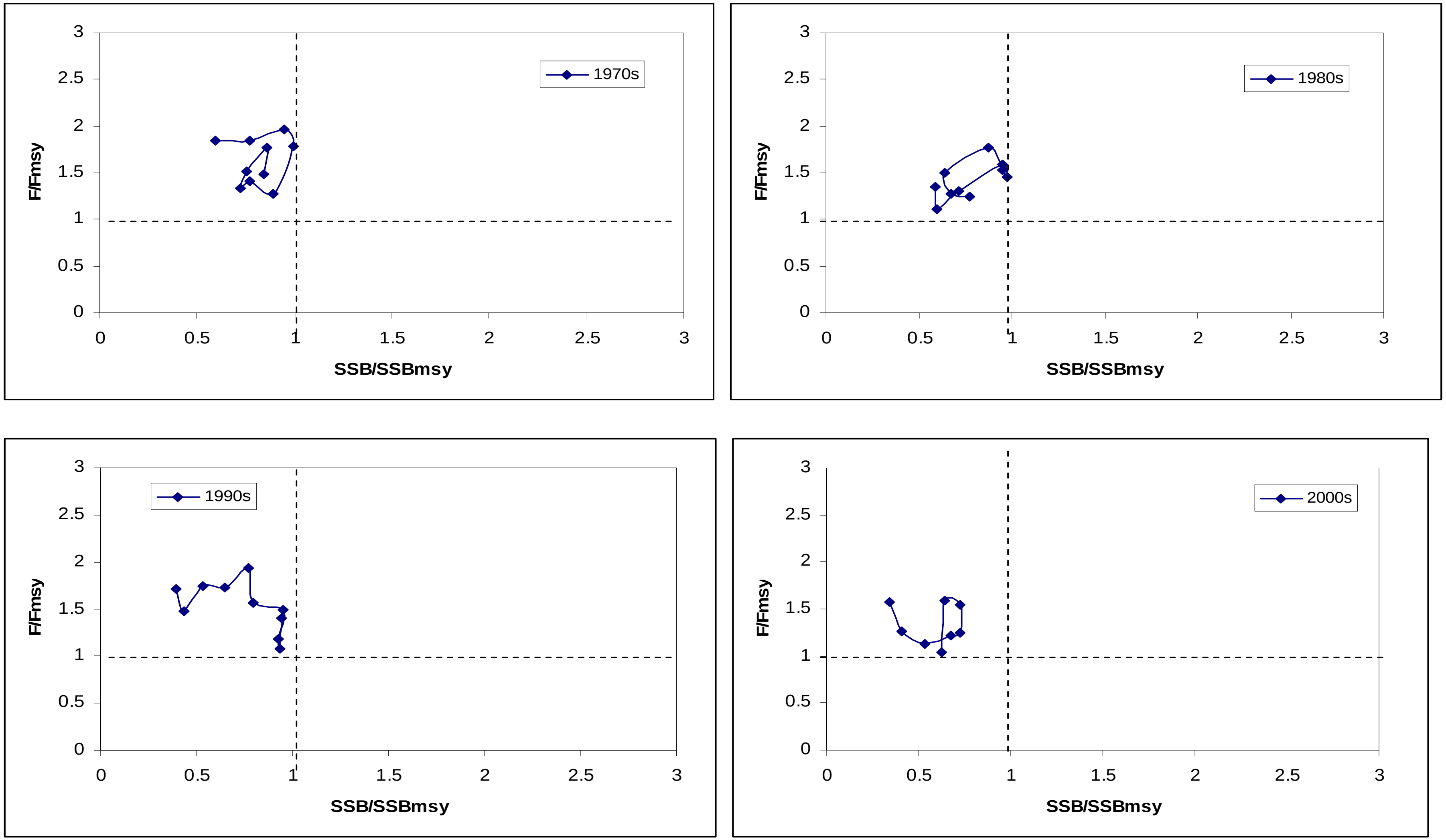


Figure 58. Trajectory of relative fishing mortality and relative SSB, by decade using model 4B for the North Atlantic stock.

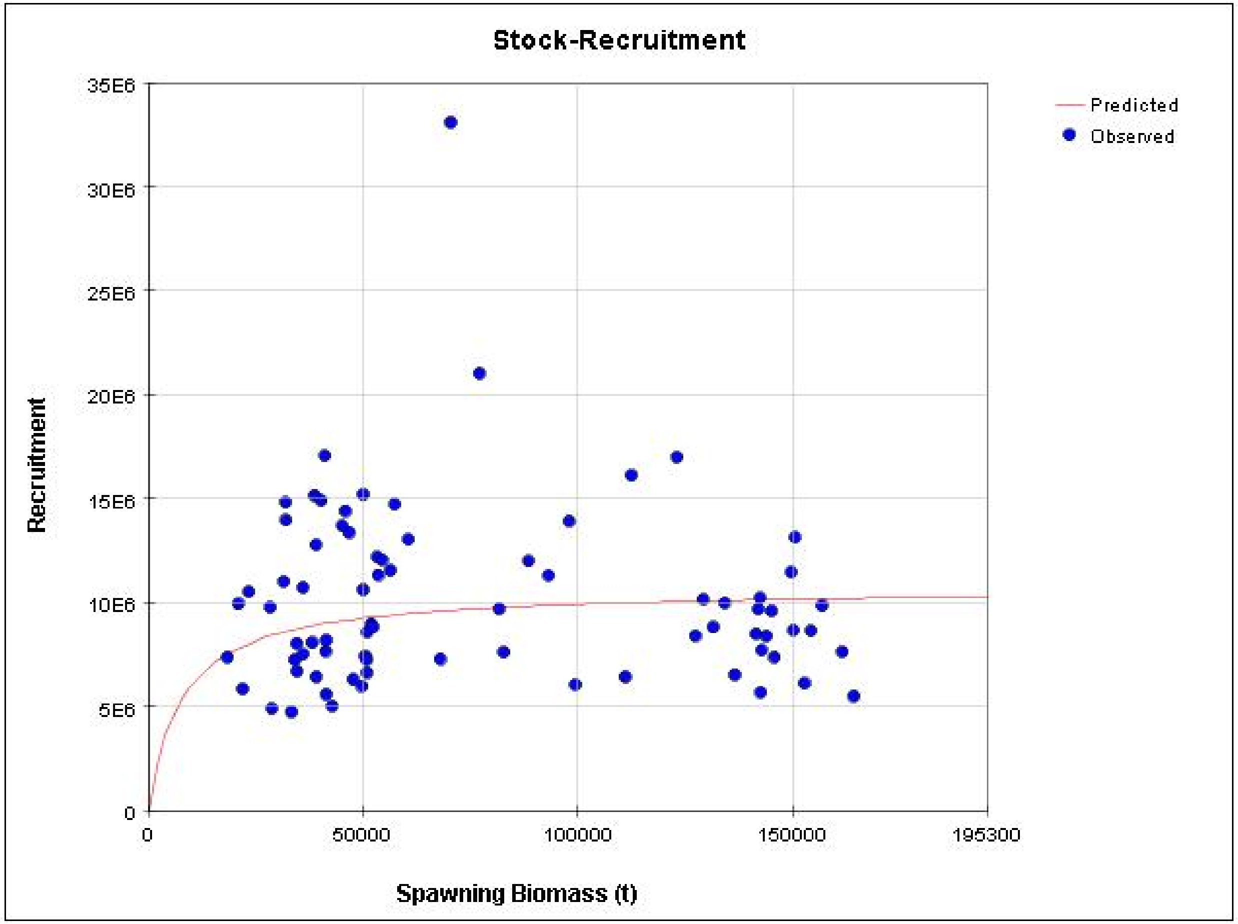


Figure 59. Estimated stock-recruitment relationship for northern albacore using model 4B.

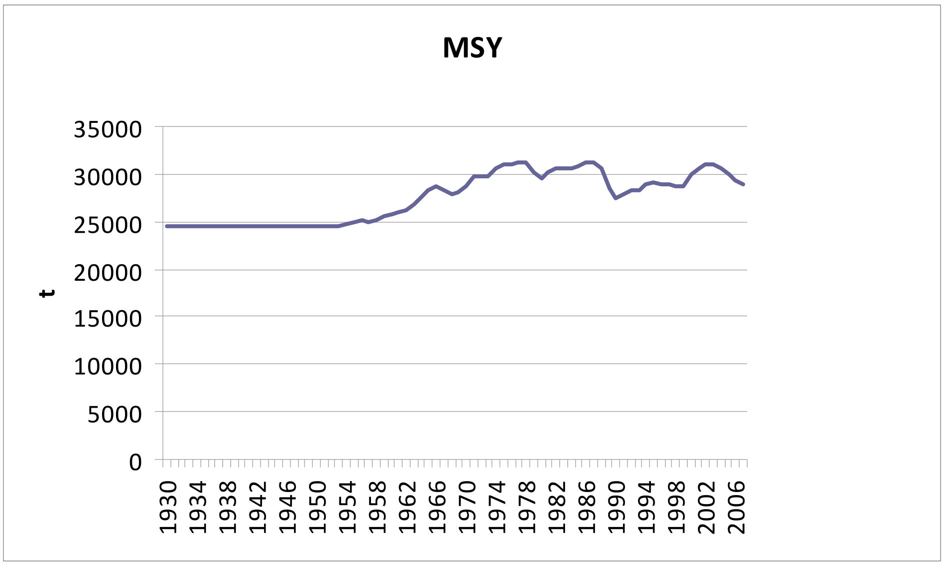


Figure 60. Estimated changes in MSY (thousand tons) for northern albacore, based on changes in total selectivity.using an spreadsheet.

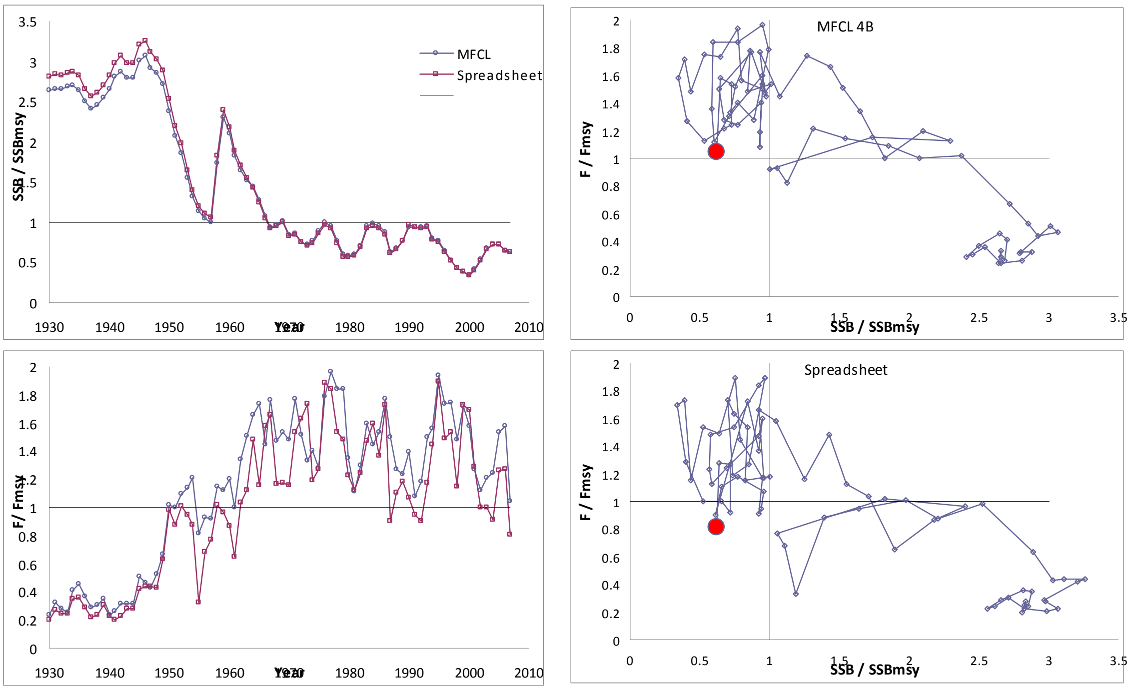


Figure 61. Comparison between SSB/SSB_{MSY}, F/F_{MSY}, and Kobe plots between MFCL Run4B and equilibrium computations conducted in the working group (see text for details).

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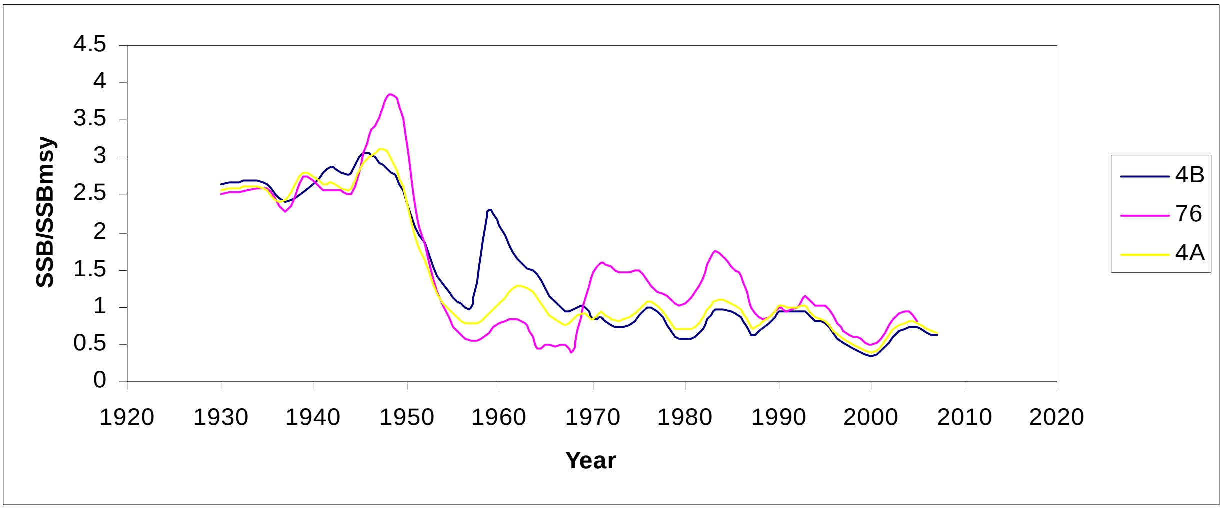

Figure 62. Estimated SSB/SSB_{MSY} per year for the 2005 base case (76), 2007 continuity run (4B) and the 2007 continuity run using the old MFCL executable (4A).

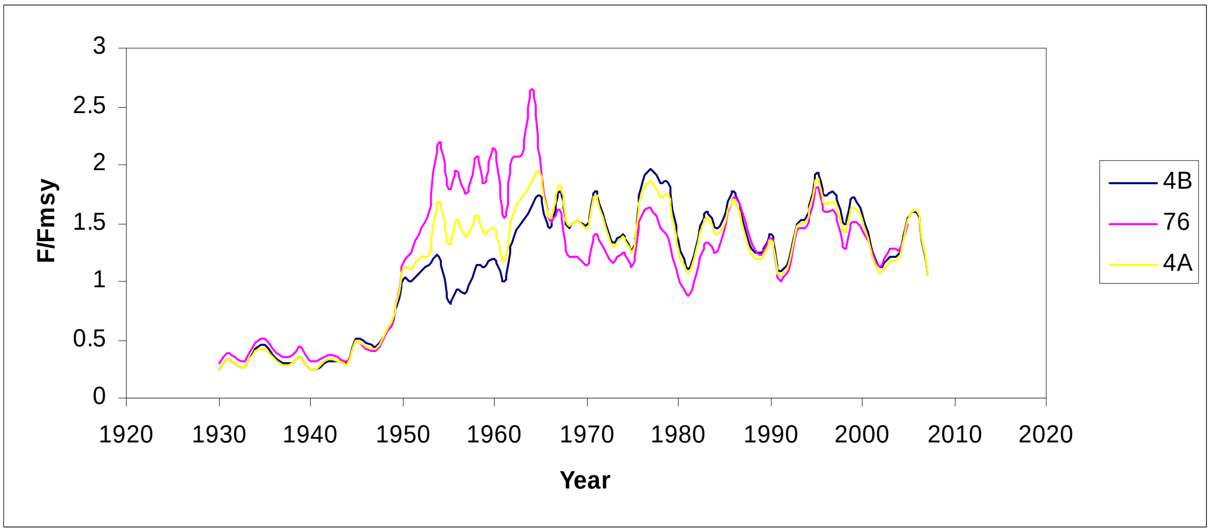

Figure 63. Estimated F/F_{MSY} per year for the 2005 base case (76), 2007 continuity run (4B) and the 2007 continuity run using the old MFCL executable (4A).

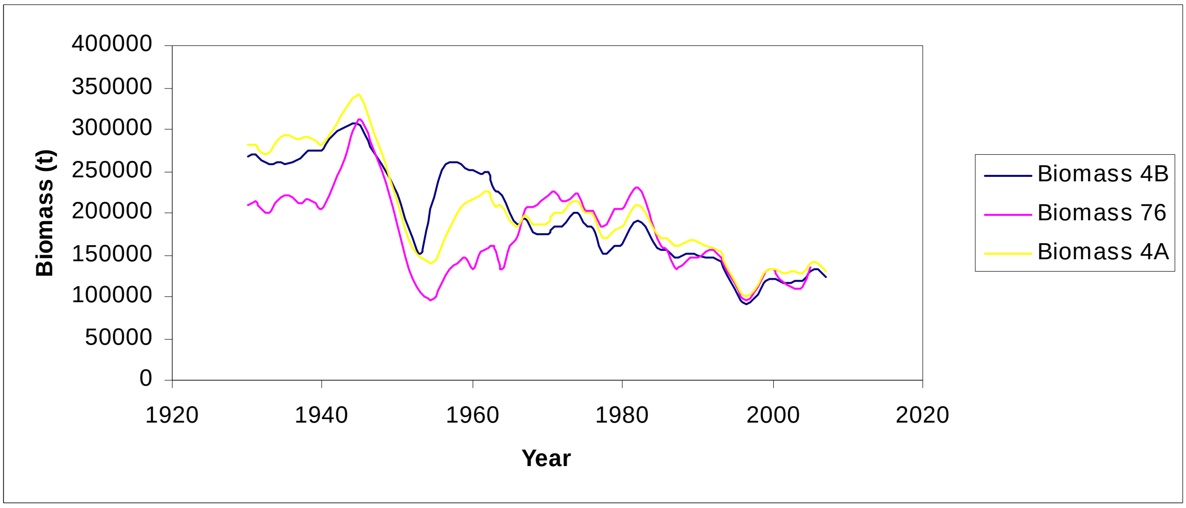

Figure 64. Estimated Biomass per year for the 2005 base case (76), 2007 continuity run (4B) and the 2007 continuity run using the old MFCL executable (4A).

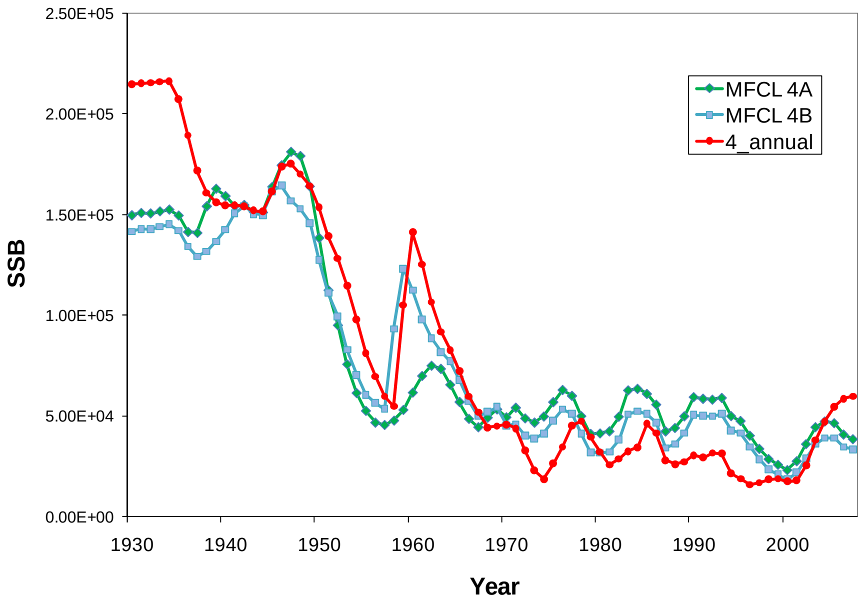

Figure 65. Time series of SSB estimates from the older version of MFCL and the new version both using the new data, and from SS, 1930-2009.

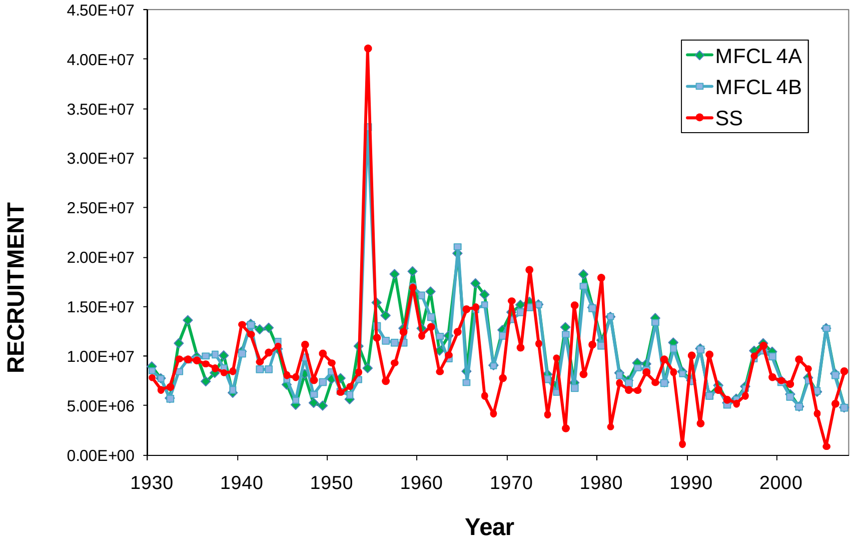

Figure 66. Time series of recruitment estimates from the older version of MFCL and the new version both using the new data, and from SS, 1930-2009.

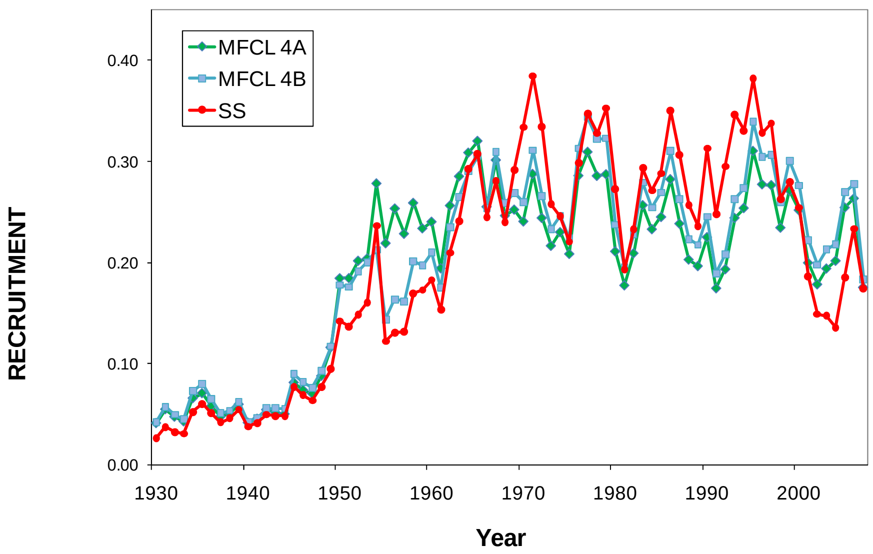

Figure 67. Time series of fishing mortality estimates from the older version of MFCL and the new version both using the new data, and from SS, 1930-2009.

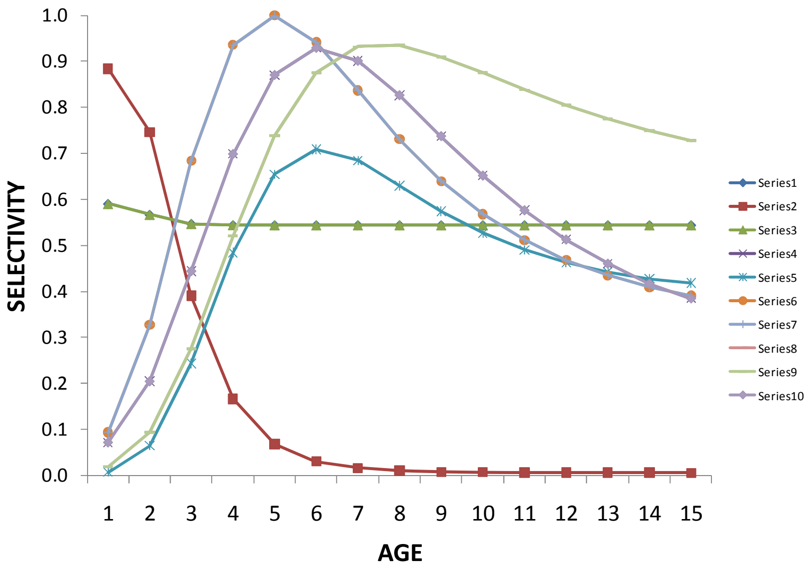

Figure 68. Length conditioned age-based selectivity for all fleets estimated by the SS base case model. Values are expressed relative to the global maximum.

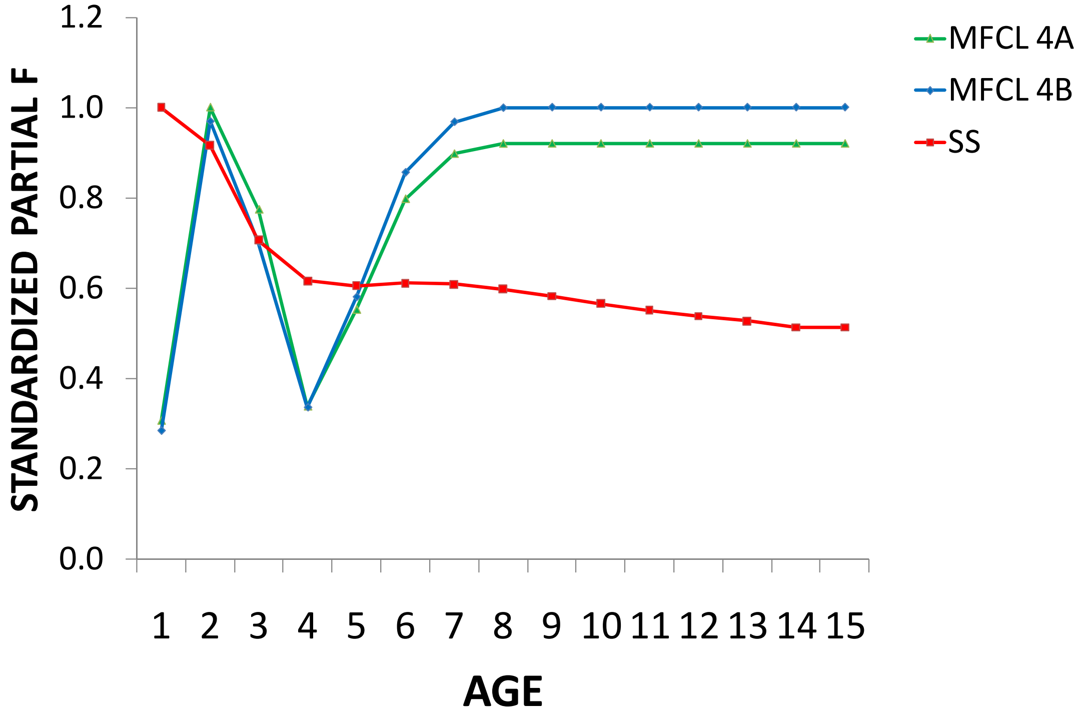

Figure 69. Standardized estimates of partial fishing mortalities averaged from 2005-2009 estimated by the runs MFCL 4A, 4B, and SS.

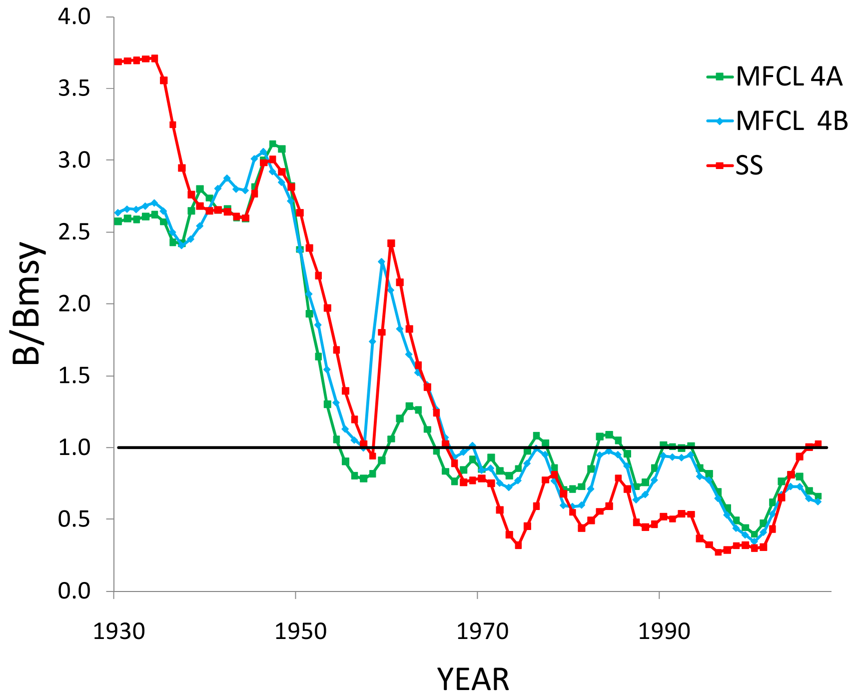

Figure 70. Estimates of B/B_{MSY} from MFCL 4A, 4B, and SS.

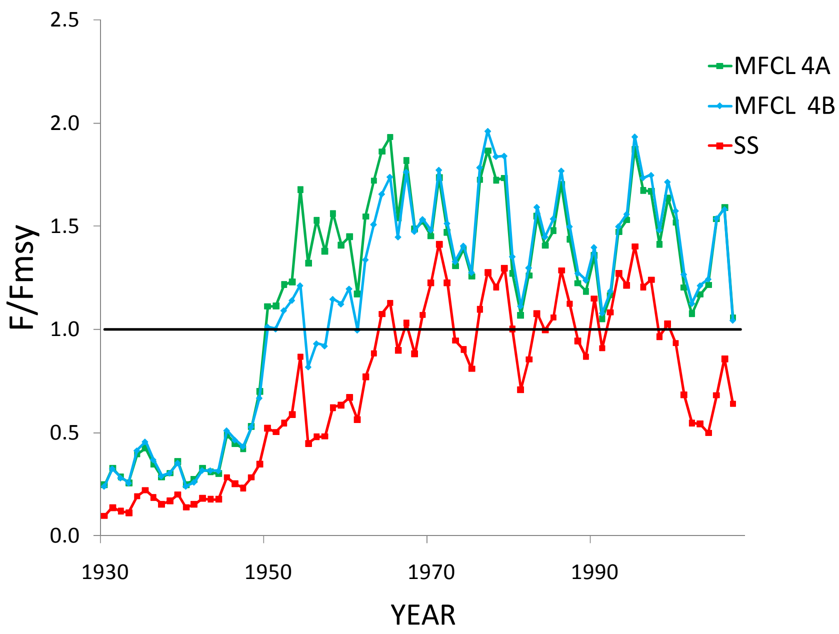

Figure 11. Estimates of F/F_{MSY} from MFCL 4A, 4B, and SS.

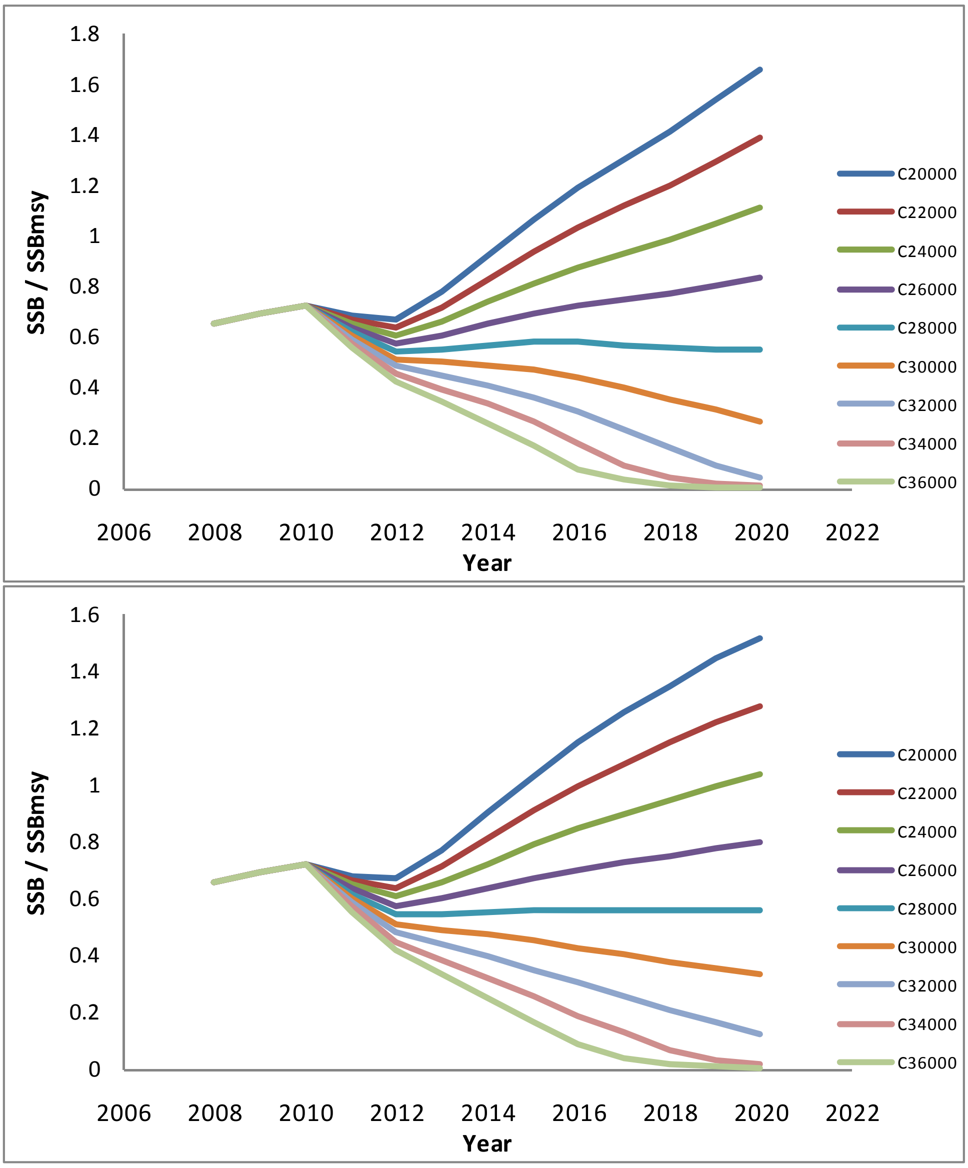

Figure 72. Deterministic projections for northern Atlantic albacore based on the base case MFCL run. The projected level of SSB/SSB_{MSY} is shown for different constant catch scenarios ranging from 20,000 t to 36,000 t. Top: Assuming a stock-recruitment relationship. Bottom: assuming constant recruitment into the future.