Sensitivity of Stock Assessment Analysis of Gulf of Mexico King Mackerel To Alternative Methods for Estimating the Historic Catch At Age Matrix 1981-2002

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In response to the recommendations of the MSAP and the SEDAR5-WG, the protocols, algorithms and data inputs for the catch sizing and ageing of king mackerel stocks were revised and updated (MSAP 2002, MSAP 2003, SEDAR5-WG). Since 1985, the MSAP has reviewed the status of king mackerel stocks, normally having a 'full' assessment every other year for the Atlantic and Gulf stocks. The normal procedures during a full assessment year would incorporate new data, and update 2-3 prior years with final estimates of landings, size and age samples. Therefore, the Catch at Age matrix for the full assessment evaluation would on average have 2 new years of data, as well as possible updates for the last 2 years of the prior assessment. This implies that catch sizing and ageing were normally restricted to the last 4 years of the assessment, and decisions on the particularities on sizing and ageing, such as minimum sample size, the application of Age-Length-Keys to quarters, areas, and stock, were done in conjunction with the MSAP agreement. Unfortunately due to time restrictions, it was not possible to fully test the assumptions introduced in the new ALK construction with simulated data. For this reason, especially since the revised criteria applied herein are different from what has been traditionally used by the Mackerel Stock Assessment Panel for advising the Councils on stock status and appropriate levels of harvest, caution in application of the ALKs developed by these revised procedures should be taken until such time that simulation testing of the robustness of these approaches can be conducted.

Catch Ageing Protocol

During the 2002 stock assessment of king Gulf stock, the catch, size samples and aged-fish samples were both revised for the years 1997 to 1999, while the years 2000 and 2001 were added as new data. The revision of aged king samples resulted in the addition of fish into the Age Length Key database for calendar years 1995-1997, which had not previously been used in the prior assessments (2000 and before) due to miscodification of the data. The overall change to the database based on this review added

209 fish (108 in 1995, 144 in 1996, and 37 in 1997). This resulted in changes in the CAA matrix distribution comparing the 2000 and 2002 CAA inputs (MSAP-02). Briefly, the 2002 CAA allocated more catch into Ages 1, 2 and 3, thus reducing proportionally the catches of ages 4, 5 and 6 as the total numbers of catch by year were not different, compared to the 2000 CAA (see table 7 and Fig 12-13 Ortiz et al 2002). This change in the 2002 CAA matrix was attributed to the additional aged-samples in the Age Length Keys (ALK) for those years, as no new size samples were included in 2002 for the 1995-1998 data; thus the Catch at Size (CAS) matrix distribution was identical between 2000 and 2002 evaluations. The additions of aged-fish in the ALK were mostly fish of size corresponding to the tails of the size distributions (Cummings 2003). Also, between 2000 and 2002 procedures, for the 1997 year in 2000 SA the ALK's were applied to 3 quarters of the year (Jan-Aug), while in 2002 SA the ALKs were applied to the full year (Jan-Dec).

The change of age distributions for the 2002 CAA matrix had implications for the stock status evaluation. The VPA model (FADAPT) uses Partial Catch-at-age (PCAA) associated with several indices of abundance (Restrepo 1996). The P-CAAs were estimated from the CAA for the following indices: Florida FWC commercial indices of Northwest and Southwest, the MRFSS index, the HeadBoat index, and the Texas PWD index. Also, in projections of stock status, the program used as an input the average of catch by age for each sector (commercial and recreational) which was also estimated from the CAA input. However, it is important to mention that other inputs were also different during the 2002 SA compared to 2000 SA, which could have potentially influence the results of the assessment in 2002, such as the updated indices of abundance and update(s) of total catch and estimated king bycatch from the shrimp fishery (Ortiz et al 2002).

During the SEDAR 5-WG (NMFS SEFSC Miami Lab Dec 1st to 5th 2003) the Group identified several (396 records) king mackerel aged-samples in the ALK database that were in need of further verification by the NMFS SEFSC Panama City laboratory in order to resolve questions about these data. This verification took place in January 2004 and the revised and corrected (DeVries and Palmer, *personal communication*) aged-king mackerel samples were used for re-construction of ALK of king mackerel for all years (1986-2002) (Table 1). In addition, ALK algorithms were revised and updated. Aged-king mackerel samples for each stock, year and sex group were grouped into 5 cm bin intervals usually from 25 cm to 180 cm (see Ortiz et al 2003 for complete description of size frequency and sex distribution of aged-king samples) (Table 2). Due to limited number of samples, particularly in the smaller and larger sizes, 5 cm size bin intervals were grouped together to increase the number of samples until a minimum of approximately 10 observations were available per size bin. This procedure was done from the tails towards the center of the size distribution. Then the ALK for each year and sex group was estimated as the probability of age at each given size bin, such as the sum over ages 0 to 19+ was equal to one.

$$\sum_{i=0to19+} p(A_i \mid size_{l,u}) = 1.0$$

the size bin was defined by the lower size (*l*) and the upper size (*u*), which could be varied for the smaller and larger sizes, under the condition of a minimum number of fish per bin (~10). The oldest age assigned to king mackerel from otolith reading was a 26 year-old fish; however for ALK purposes, age 19 was considered the plus group for both Atlantic and Gulf stocks.

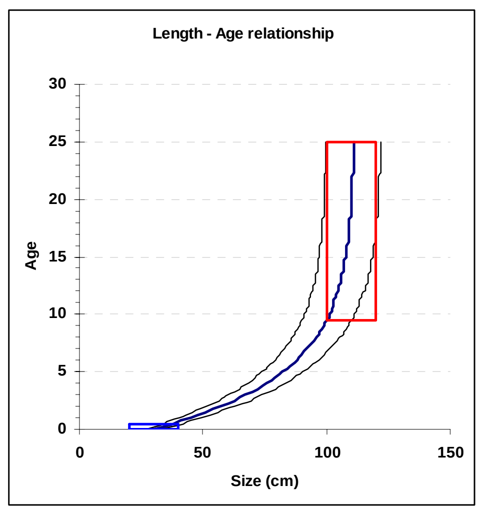
Thus revised ALKs were constructed for each stock (Atlantic, Gulf), year (1986-2002) and sex (Males, Females). From 1986 to 1994 aged samples from the Gulf were further split into regions: the eastern Gulf of Mexico (EGF), and western Gulf of Mexico (WGF). After 1994, no aged-king samples were available for WGF, thus the EGF were eventually designated Gulf (GOM) and applied Gulf- wide. Then, the procedure identified when in the year (by month or quarter) most of the aged-samples had come, and matched the ALK with the corresponding month or quarter of the catch at size (CAS) by sex data. This information was used to create an "instruction file" that would indicate for a particular year, region, and quarter (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec) if the ALK would be applied or not. In the case of Atlantic king mackerel, only one region was considered: but for Gulf kings, two regions (EGF and WGF) were used. The instruction file used for the 2002 SA ageing procedures is presented in Table 43 in Ortiz et al (2003).

For the king mackerel revisions to the ALKs for 2004, the algorithms of construction were again modified. First, it was assumed that the samples were collected either randomly or randomly within size stratification, and two factors were unknown: a) the sex of the fish, and b) the age of the fish. Therefore, all the grouping and size bin distribution were considered for both sex samples combined, not separate as in previous ALK constructions. Second, based on the historic distribution of aged-samples per year, a minimum value of aged-sexed fish was established such that an ALK could be created. This value was arbitrarily set at 400 samples. Third, within each year and region, aged fish were also grouped into size bins of initially 5 cm intervals, and set a minimum number of samples per bin of 15 aged fish (combined across sex). If the number of samples was less than 15, a combination of size bins was also done, however this was only applied to the smaller size fish toward the center of the distribution. No binning (ie. combination of consecutive size bins) was done for the larger sizes. And fourth, a minimum size was selected below which all fish were considered Age 0,

$$p(Age_0 \mid size_{\min l'}) = 1.0,$$

and the minimum size (*min l'*) was set at 15 cm fork length. No king mackerel less than 15 cm had been aged, at least within the ALK database. This value was applied to both the Atlantic and Gulf ALKs. In the king-aged database there are very few samples for Age 0 kings, and not in all years; therefore, this minimum size definition prevents fish from the smallest size class having positive probabilities of older age classes due to Age 0 class missing observations from the aged-sample.

The decision made to not combine size bins into the larger size classes (when the total number of samples is less than 15 fish) can be explained with a plot. At smaller sizes, relatively larger increases in the size bin would result in lesser change in expected age, due to the growth characteristics of king mackerel at small, thus the margin of error introduced in terms of predicting age from size would be smaller. However, for the larger size king mackerel, a single size bin of 5 cm could have positive probabilities for more than one age, and perhaps several ages, as the size approaches the asymptotic length. Therefore, if several bins were combined, the margin of error in assigning the correct age would increase only because of the binning process. Unfortunately due to time restrictions, it was not possible to fully test the assumptions introduced in the new ALK construction with simulated data.



Using the described assumptions and modifications in conjunction with the updated aged-king database, ALKs for Atlantic and Gulf stocks were constructed for 1986 to 2002 years. Table 3 shows the total number of aged samples available per stock, year and region, shaded areas represent where the stock-year combinations for which ALK were created. Ageing of the complete CAS by sex data for Atlantic and Gulf king (1981-2002) was done using the new ALKs. The instruction file was also updated. ALKs were applied for those stocks, year and quarter by matching the proportion of catch caught by quarter and the proportion of aged-samples that went into the ALK by quarter also (Tables 4, 5, 6 and 7). Overall, if a quarter provided 15% or more of the aged samples, the ALKs were applied to the corresponded quarter CAS by sex. For the WGF, after 1996, the ALK from the EGF were used for the ageing of CAS by sex data (this was also done in the ageing procedure previously applied by the MSAP, Table 8). For those stocks, for year-quarters where no ALKs were available, the stochastic length deconvolution method (SAR) of Shepherd (1985, Cummings 2003, Cummings and Devries 2002) was applied.

King mackerel CAS by sex files from 1981-2002 were used as input for the ageing programs, although in few instances, the CAS by sex files required some modification to complete the automated ageing procedure. All of the modifications in the CAS by sex data corresponded to the records of catch where the size distribution of the catch by sex was larger than the asymptotic length of the corresponding stock and sex group. In those cases, the records of catch would have been excluded in the estimated oa CAA had modifications not been made; although overall, these records represented very few fish and were mostly of the Atlantic stock males with sizes greater than 95 cm fork length. Modifications of two CAS by sex files were done for the following years and sectors: Atlantic commercial expanded CAS for 1983 and 1984 (2 records with total of 5 males),and Gulf commercial expanded CAS for 1987 (1 record with 9 fish (males) of size distribution greater than 113 cm fork length). All the modifications to the CAS by sex data applied to records aged by the SAR method.

Tables 9 and 10 and Figures 1 and 2 present a comparison of the CAA matrix generated with the ALK procedures applied herein, the 2002 SA CAA matrix for Gulf king mackerel, and the 2003 SA CAA matrix for Atlantic king mackerel, respectively. For this report, the updated historic CAA matrix of Gulf king mackerel was used as the input for the stock evaluation, using the same programs and protocols as the 2004 base case scenario (Ortiz 2004). The following sections describes the additional inputs and conditions of the VPA FADAPT model for completeness purposes, prior to presenting the results of the stock evaluation using the historic updated CAA matrix of Gulf king mackerel. It should be noted, however, that this document only addresses sensitivity of analysis to some alternative methods for developing and applying ALKs to the CAS data. An additional issue not addressed in this manuscript is the potential effect on estimating CAA based on possible revisions to the underlying growth assumptions used in the SAR component of the procedure. Brooks and Ortiz (2004) identify some additional issues that should be considered.

Directed Catch

As in the base 04 case scenario (Ortiz 2004), U.S. commercial and recreational catches, size frequency data for calendar years 1997, 1998, 1999, 2000 and 2002 (provisional) were updated. No new estimates of shrimp bycatch were available for 2004, thus for this simulation, the same value as in the base 04 scenario were used, which was a carry over of the estimated bycatch of 2002 SA. All king bycatch was assigned to age 0.

BIOLOGICAL CHARACTERISTICS

Natural Mortality

The natural mortality rate (M) used for the Gulf king mackerel analyses in this report is the same as used in previous assessments, i.e. 0.2. The stochastic analyses allowed the value of M to vary over both years and ages using a random draw from a uniform distribution of 0.15 to 0.25 such that the mean of the distribution matches the point estimate.

Fecundity

The fecundity at age vector is the same as used in prior assessments. The age specific fecundity values correspond to millions of eggs. The derivation of the egg values comes from an age-length relationship (Manooch *et al*. 1987), a linear spline fit to maturity at age data (data from Finucane *et al.* 1986), and an eggs-length relationship (Finucane *et al.* 1986). The values of age specific fecundity that reported spawning stock are in trillions (10^{12}) of eggs.

ABUNDANCE TRENDS FROM INDICES

Indices

As in previous mackerel stock assessments conducted since 1985, catch per unit of effort (CPUE) data from multiple sources were evaluated as indices of stock abundance. CPUE indices affect assessment results by calibrating estimates of population size to annual trends in CPUE, assuming they are directly proportional to abundance. The annual trends in CPUE were assumed to represent age-specific abundance trends. The procedures used to derive annual indices of abundance were similar to those of previous assessments, and took into consideration technical decisions made by the Panel during the 1996 Panel Review of Gulf king mackerel and the 1997, and 1998 Panel Reviews of Atlantic king mackerel and Gulf Spanish mackerel stocks (Cummings 1996, MSAP 1996, MSAP Supplemental 1996, MSAP 1997, MSAP 1998). During those meetings, after consideration by the Panel of the available historical CPUE data for indexing abundance of mackerels, recommendations were made regarding the continued use of specific data sets and the data to be included in the analysis. Emphasis was placed on analyses that accounted for possible biases in the index due impacts of regulations (*e.g.*, bag limits, state trip limits, regulated seasons).

For this assessment, each set of the CPUE data was analyzed separately using Generalized Linear Modeling theory and information on area of catch, amount landed, month of capture, vessel, and other available auxiliary information incorporated into the index to adjust for changes in CPUE while applying the rationale specified by the MSAP 1996, MSAP 1997, and MSAP 1998 reviews. Indices updated for this Stock Assessment analyses are described below. In addition, all tuning indices used in the VPA analyses are listed in Table 11, along with the time of the year when the index related to abundance, whether the index was compared to estimated numbers or biomass, and the age range used for tuning.

A. Florida Fish and Wildlife Commission (FL_FWC) Marine Fisheries Trip Ticket Program

The FL-FWC commercial trip ticket data have been used to develop two indices, the Panhandle index (NW) and the South Florida index (SW), for fish sold in Florida. The Panhandle index included only observations between the months July and October and landings from the counties of Taylor through Escambia and was applied to ages 1 through 6. The South area index was applied to fish ages 2 through 8, and included observations from November and December in Monroe or Collier counties and was restricted to a maximum catch limit of 3,500 pounds. At the SEDAR WG 5 the FL-FWC submitted updated indices for the NW and SW commercial fishery; however the updated indices varied in the years covered by the index. In the 2002 assessment, the FL-FWC_NW and FL-FWC_SW included 1985 to 2000, while the 2004 indices for the NW and SW included 1992-2002. Due to time restrictions, it was not possible to clarify the reasons for the change of year's coverage, therefore for the present assessment it was decided to use the 2002 indices without the updated data.

B. Marine Recreational Fishing Statistical Survey (MRFSS) - Florida

Observations of private or charter boat anglers in Florida successfully catching king mackerel and/or indicating that they were targeting king mackerel were used to index abundance using the protocol recommended by the MSAP in the 1996 and 1998 Reviews. Observations from July through December were used in the index to minimize the impact of bag limits and the analysis was constrained to data collected since 1985. The index developed was the standardized number of fish per angler hour adjusted for month, county of interview, and fishing mode and included the annual standardized probability of having a successful trip, adjusted by month, county, and mode. This index was applied to fish of ages 1 through 8 (Table 11). A detailed report of the standardization procedure is presented in Ortiz (2003).

C. Texas Parks and Wildlife Department (TX-PWD) Recreational Angler Creel Survey

Successful recreational anglers in Texas that caught king mackerel were also used to index CPUE. The data used included observations between the months of May and September from the private and charter boat fisheries. As recommended in the 1996 and 1998 Reviews, auxiliary data on bay vs. inshore was not used in the model. The index was the standardized number of fish caught per 100 angler hours of fishing, adjusted for month and fishing mode and was used to index ages two through eight (Table 11). A detailed report of the standardization procedure is presented in Ortiz and Phares (MSAP-02-03).

D. NMFS Beaufort Laboratory Headboat (Southeast Florida)

CPUE data from this source represent successful recreational anglers fishing from headboats. Historically, data from southeast Florida; headboat areas from Daytona through the Florida Keys during the months of November through March have been used as an index of abundance of the eastern group of king mackerel. The index is the standardized numbers of fish caught per trip divided by the number of anglers reported on a trip, adjusted for individual month and vessel terms. A detailed report of the standardization procedure is presented in Ortiz (MSAP-03). This index was applied against the size of fish ages two through six (Table 11).

E. Bycatch Indices from GLM and Delta Lognormal Approaches

Tuning indices from the bycatch analyses have been computed using the traditional method of dividing the total estimated bycatch in a year by the total shrimp effort in that year. When estimating the total bycatch for use in this tuning index, areas that used BRDs are instead assigned the commercial catch rate in order to have a consistent time series (i.e. removing the observations from BRD tows). Because no new bycatch information was available in 2004, the index was not updated, and for the current evaluation the index of 2002 assessment was used instead.

F. SEAMAP index

The SEAMAP survey of larval abundance resource survey provided a fishery independent index for king mackerel in the Gulf of Mexico. The index for this assessment was an estimate of the percent of occurrence of king larvae (Gledhill and Lyczkowski-Shultz 2000).

G. Other indices

In prior assessments two other indices of abundance for Gulf king mackerel have been used: a) the Florida Charter Northwest index off the Florida Panhandle area, and b) the Florida Charter Southwest Index covering the South Florida and the Florida Keys regions. These indices covered the years from 1985 to 1994/95.

METHODS

Virtual Population Analysis

As in previous mackerel stock assessments, a tuned VPA (FADAPT) method (Powers and Restrepo 1992, Restrepo 1996) was used to obtain statistical estimates of population parameters. The method is a non-linear least squares (LS) estimation process in which observed indices of abundance are fit by population estimates from cohort analyses for appropriate age groups:

$$\min_p LS = \Sigma_{it} [X_{it} - q_i \Sigma_j (b_{ijt} N_{ijt})]^2$$

where X_{it} is the index i in year t, N_{ijt} is the abundance in year t of the j ages represented in index i and the b_{ijt} are appropriate conversion factors for that index and age (for example conversion from numbers to weight, conversion of the abundance from the beginning of the year to mid-year, or conversion of selectivity by age within the age group). For the present analysis each index was given equal weight in the minimization process.

The scaling parameters q_i are computed by maximum likelihood during the minimization process in both situations, they were not estimated directly. In each analysis, the fishing mortality rates at age in the 2001-02 fishing year (terminal year) were the parameters estimated. An additional assumption made in each analysis was that the fishing mortality rate was the same in the plus group (Age 11+) and the previous age (Age 10) for all years. The upper right corner of a VPA matrix (recent years and younger ages) was difficult to estimate. For this reason, a Separable VPA (SVPA) was run over a range of fixed selectivity ages and terminal year F values in order to estimate the appropriate relative selectivity pattern of the youngest ages in the terminal year (Fig 3). For the current Assessment, the average of mean selectivity for age 0 relative to age 2 was 1.5 (F_0/F_2 =1.5), while the average of mean selectivity for age 1 relative to age 2 was 0.33 (F_1/F_2 =0.33). The F value for ages 2-10 in the terminal year were the parameters estimated within FADAPT, with the F for the plus group (F_{11+}) in the terminal year set equal to the F at age 10.

In this analysis, selectivity at age for each index by year was computed based on the partial catch at age (PCAA) associated with the index during that year. The catch at age for a particular index year was first used to find the proportion of total fishing mortality due to that amount of catch as

$$F_{y,a,i} = F_{y,a} * Catch_{y,a,i} / Catch_{y,a}$$

where y, a and I denote year, age and index, respectively. The selectivity at age was then formed by dividing each $F_{y,a,i}$ by the maximum value over age for that year and index. This use of partial catches to form the selectivity patterns for the tuning indices added stability to the solutions by allowing different indices to tune to the same ages but at differing levels of importance over the ages. Because the historic CAA matrix was updated, the Partial CAA for each index application was also reviewed, and for some indices, the age coverage was modified based on the catch proportion at age plots (Fig 4 and 5).

Characterization of Uncertainty

The uncertainty in the assessment estimation was characterized as in the past by both sensitivity analyses on selected components and by mixed Monte Carlo/bootstrap simulations of the tuned VPA. The simulation method repeated the VPA a number of times (500) randomly selecting from 1) a uniform distribution of natural mortality rate for each age and year; 2) a lognormal distribution of directed catch at age assuming the point estimate represented the mean and the variance was characterized by a CV of 25%; 3) a lognormal distribution of bycatch at age assuming the point estimate represented the mean and the variance was characterized by a CV of 25%; and 4) the observed deviations between the indices of abundance and the predicted population model from the original VPA fit. The results were accumulated and sorted to provide probability statements of relevant statistics. Projections were made using each bootstrap iteration such that benchmarks, stock trends and ABC could be evaluated on an absolute or relative scale. Probability distributions from these observations were used to construct 80% pseudo-confidence intervals (removing the 10% lowest and highest observations).

The stochastic simulations estimate the same number of parameters as the deterministic case. The final estimates from the deterministic case were used as initial guesses for the terminal year fishing mortality rates at age. Thus, the potential exists for highly different VPA estimates in each simulation, especially given that all the random selections described above were uncorrelated. The use of uncorrelated random selections could be a problem for the catch and index generated from the bycatch data as well as other indices tuning to young ages.

Projections

Population abundances at age in the terminal year of the VPA (2001-02 fishing year) are projected into the 2002/03 fishing year according to the estimated F and M at age values in the terminal year. Recruitment in the projection years came from a stock recruitment model specific within each bootstrap. The point estimate was projected deterministically following this stock recruitment model while the bootstraps used the estimated variability about the model to create a lognormal distribution from which recruitment was randomly chosen. This simulation used the stock recruitment model developed during the 1998 MSAP meeting according to the following rules. Only years in which both the stock and recruitment values have tuning information present were used to create the relationship, excluding the last 2 years as they were highly variable (1987-1999). The maximum recruitment was set at the average recruitment estimated during these years and declines linearly to the origin when the spawning stock size drops below the "break point". The "break point" was determined by the average of the five lowest spawning stock sizes within the years 1987-1999 (Fig 6).

The bycatch fishing mortality rate for the projection years was computed as the average of the F at age due to bycatch during the period 1993-1997, modified by the expected bycatch reduction due to full implementation of BRDs. The bycatch reduction due to BRDs implementation was estimated as 50% for king mackerel (S. Nichols, MSAP 2000), starting in year 1998 and beyond. The directed fishing mortality rates at age were assumed separable by sector (commercial and recreational) with the selectivity at age pattern for each sector computed as the average over the last five fishing years (1997-98 to 2001-02) and the year multipliers specific to each sector. For the 2002-03 fishing year, the two fishing mortality rate multipliers were estimated simultaneously such that the observed total catch in weight for the commercial sector[1] and the 2002-03 total catch in numbers for the recreational sector[2] were achieved. The total fishing mortality rate at age was computed as the sum of the bycatch F at age, the product of the commercial multiplier and selectivity at age, and the product of the recreational multiplier and selectivity at age. The two multipliers were unique values assuming both catches are smaller than the estimated population.

The population abundances were then projected into the 2003-04 fishing year according to the total fishing mortality rate at age and the natural mortality rate at age. The two fishing mortality rate multipliers (commercial and recreational) for the 2003-04 fishing year were estimated simultaneously

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1 The commercial catch for Gulf king mackerel fishing year 2002-03 was set to 3,125,555 lbs. From the Preliminary Quota Monitoring Report No. 22 on April 28 2003.
2 The recreational catch for Gulf king mackerel fishing year 2002-03 was set to 594,343 fish. From the recreational landings MRFSS FY02/03 with substitutions for HeadBoat and Tx-PWD estimates of 2003.

such that a desired spawning potential ratio (SPR transitional unweighted) was achieved and the ratio of catches in weight by the two sectors (commercial and recreational) equaled the allocation for the specific migratory group. These F multipliers were again unique assuming the SPR could be achieved in that year. The yield resulting from application of the directed fishing mortality rates on the estimated population abundance generated the ABC value. This approach of treating separately the commercial and recreational sectors was used in previous assessments.

Following the decisions of the MSAP, the recommended proxy for F_{MSY} is $F_{30\%SPR}$ and the proxy for B_{MSY} was the spawning stock that resulted in equilibrium under the F_{MSY} proxy according to the stock recruitment relationship. The default control rule of Restrepo et al (1998) was accepted by the MSAP, this default control rule sets the minimum stock size threshold (MSST) to (1-M)*B_{MSY} and the maximum fishing mortality threshold (MFMT) to F_{MSY} for SS>MSST and decreasing linearly to the origin for SS<MSST. Risks associated with overfishing, P(F>MFMT), and being overfished, P(SS<MSST), could be calculated from the results of the bootstraps for two year constant catch projections.

RESULTS AND DISCUSSION

This assessment used the base 04 model from the Stock Assessment 2004 report (Ortiz 2004) as the comparison point for the analysis as well the results from the 2000 assessment. For the present analysis, an 'equal' weighting option with the normal error assumption was assumed for all indices of abundance available, with the same time of year application as presented in the indices section and age coverage. The VPA model estimated nine fishing mortality rates in the last year, corresponding to the ages 2 through 10, with fixed F ratios for ages 0, 1 and 11+. F ratios where defined as: $F_0/F_2=1.5$, $F_1/F_2=0.33$, and $F_{11}/F_{10}=1.0$.

For this assessment, the following updated data were available in comparison with the year 2000 SA: Commercial and recreational catch for calendar years 1997, 1998, 1999, 2000, 2001 and 2002. The whole Catch at Age (CAA) was updated for the fishing years 1981-82 through 2001-02. Also updated was the corresponding Partial CAA [1981-02 to 2001-02] for the following indices of abundance: the FL-FWC_NW, FL-FWC_SW, Headboat, MRFSS, TX-PWD, Charter Florida Northwest and Charter Florida Southwest. Note that the age coverage for several indices changed after the revision of the historical Partial CAA age distribution plots. Figures 4 and 5 present for each index the proportional catch-age distribution of the Partial Catch at Age derived from the update CAA matrix. The age distribution of the Florida commercial catch for the northern region [Jul-Oct] indicated that significant proportion of ages 1 and 2 king were consistently caught in this fishery from 1985 to 2001 (the years of available index), in prior assessments, for this particular index only ages 3 to 6 were included. Also, for the Florida commercial southwest fishery [Nov-Dec] from 1985-2001 the updated Partial-CAA indicated that age 2 was consistently present in the catch, thus age coverage for this index was extended from ages 2 to 8. The recreational MRFSS index was also modified in terms of ages coverage (previously it included only ages 2 to 8): the age distribution of the updated Partial-CAA indicated that age 1 was also a important component on this fishery. Therefore, for the MRFSS index age coverage was extended to include ages 1 through 8. Partial CAAs for the Charter Florida indices (north and south) were also revised. For the Charter Northwest [May-Oct] age coverage was extended to include ages 1 to 7, and for the Charter Southwest [Nov-Apr] age coverage included ages 1 to 8. The proportion of directed catch by age for the commercial and recreational sectors was also estimated from the average of CAA by sector for the fishing years 1997-2001.

Table 12 presents the results of the deterministic run for the tuned VPA new-ALK model. These included the estimated abundance at age and year, the overall fishing mortality at age-year, parameter estimates for Ages 2 through 10 (with standard errors and coefficients of variation), indices fit and residual, and estimated selectivity at age for each index (for all purposes this run was labeled New-ALK model). Figure 7 shows the distribution pattern of the indices residuals, and Figure 8 shows the plots of observed vs. predicted values for all ten indices. The predicted indices follow similar patterns as in the base-04 scenario.

Figure 9 shows a comparison of the new-ALK 2004 model estimates of stock size, fishing mortality rates and stock biomass (solid lines), with the corresponding estimates from the 2004 Base 04 model. In general, the new-ALK model estimated somewhat smaller stock sizes, particularly for ages 7 and older, from 1992 on, and somewhat greater biomass for ages 3 to 6 from 1997 on. The trend of stock size estimated for the plus group (age 11+) were different compared to the estimates from the 2004 Base 04 model. This was also reflected in the estimated biomass of older ages 7-11, where the new-ALK model estimated lower biomass especially in the recent years. The new-ALK model also estimated higher fishing mortality rates for ages 7 and older from 1984 on.

Figures 10 and 11 present estimates of Stock size and fishing mortality rates from the new-ALK model and compared it to corresponding values of the 2000 SA results (solid diamonds). Stock size trends showed similar patterns particularly for the younger age classes (ages 0-5). More different trends can be observed for older ages, particularly for the plus group (age 11+). Overall, the stock size estimated with the new-ALK model was somewhat lower in recent years compared to the estimates in 2000 SA. Fishing mortality rates were also in agreement for the younger age classes. The new-ALK model estimated much higher F mortalities for the older ages (8-11+) particularly in the early and mid years (1981-82, and 1991-92). The overall F was greater from the new-ALK model, compared to the estimates from the 2000 SA.

The estimated of spawning potential ratios (SPR) are shown in Figure 12. The unweighted SPR trends showed an increase from 1983 to a peak in 1987, follow by a decrease until 1997, and since then an upward trend. The static SPR trends showed an overall increase since 1994, with a peak in 1999 and a decline in 2000, followed by increases in 2001 and 2002. The median 2002 static SPR estimates were above 30% (38.7%), while the unweighted SPR was estimated below 30% in 2002 fishing year (26.1%).

The proxies for stock status are based upon $F_{30\%SPR}$ and the two-line model of stock recruitment relationship described previously. These proxies were computed by projecting each bootstrap to the year 2070 under constant recruitment and estimated F mortality of $F_{30\%SPR}$ both specific to each bootstrap run. Similarly, proxies for the optimum yield (OY) were computed using $F_{40\%SPR}$. The median and 80% confidence intervals for these MSY and OY related benchmarks are given in Table 13. The Base 04 model and the new-ALK model scenarios estimates of median and the deterministic run were similar for most of the benchmarks. Figure 18 shows a comparison of the benchmarks estimates for the 2004 base 04 model, and New-ALK model. In comparison, the base-04 model and New-ALK model estimated similar values for MSY and OY. Estimated of F bench marks were higher for the New-ALK model with large confidence bounds.

Using the bootstrap specific estimates of MFMT and MSST, the probability of being classified as undergoing overfishing or being overfished in fishing year 2002/03 were calculated. For the New-ALK model, 34 of the 500 bootstraps (7%) estimated F_{2002} > MFMT (Fig 14), while 49 of the 500 bootstraps (10%) estimated a SS_{2003} < MSST (Fig 15). In addition, the base 04 case estimated $F_{2002} > F_{OY}$ for 291 (58%) out of 500 bootstraps. Since currently, the acceptable resource risk of being overfished or undergoing overfishing is not defined, no definite statement about stock status can be made. However, the Technical Guidelines (Restrepo et al 1998) recommend lower risk of exceeding threshold levels, suggesting that a value not be greater than 20-30% and certainly less than 50%. Phase plots for the Gulf king mackerel stock status in fishing year 2002/03 are shown in Figure 16.

The fishing year 2003/2004 acceptable biological catch (ABC) for the New-ALK using an $F_{30\%}$ criterion had a median value of 12.0 million pounds, and estimated 80% pseudo confidence interval between 8.9 and 15.8 million pounds (Table 14 and Figure 17).

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Table 1. Number of king-aged samples per calendar year, fishing year and month for the Gulf king stock updated aged database 2004.

GROUP Gulf

MONTH

YEAR	Fyear	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
1986	1985						17							17
	1986							177	81	27	1	4		290
1987	1986	4	6	37	5	81	180							313
	1987							289	172	118	1	19	12	611
1988	1987					12	142							154
	1988							403	68	33	12	3	9	528
1989	1988	9	23	1	2	51	127							213
	1989							281	170	99	47	15	20	632
1990	1989	42		9	2	63	176							292
	1990							189	105	37	25	5	39	400
1991	1990	37	18		17	101	303							476
	1991							576	190	97	7	63	191	1124
1992	1991	31	68	19	42	70	267							497
	1992							548	140	86	66	28	48	916
1993	1992	32	10	28	125	11	126							332
	1993							461	137	173	37	110	43	961
1994	1993	7	11	10	174	44	67							313
	1994							174	121	187	88	114	19	703
1995	1994	34	6	1	129	56	61							287
	1995							136	65	106	24	183	225	739
1996	1995	37	165	93	119	91	162							667
	1996							65	83	325	147	86	431	1137
1997	1996	259	122	260	54	40	72							807
	1997							30	47	203	85	20	18	403
1998	1997	92	137	64	63	13	28							397
	1998							42	37	3	28	71	128	309
1999	1998	111	56	26	10	3	78							284
	1999							68	68	10	46	50	56	298
2000	1999	133	211	186		29	27							586
	2000							52	8	47	19	144	35	305
2001	2000	411	430	261	5	2	2							1111
	2001							70	113	79	160	51	127	600
2002	2001	667	76	235	9	11	113							1111

Atlantic

YEAR	Fyear	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
1986	1986				20	27	85	116	97	20	10			375
1987	1987				31	63	118	90	46	18	21	110		497
1988	1988				37	145	116	63	33	44	6			444
1989	1989					64	67	164	97	218	196	13		819
1990	1989	1		18										19
	1990				12	74	135	140	208	179	115	38	6	907
1991	1990	40	10	9										59
	1991				24	40	55	158	145	141	131	34	17	745
1992	1991	17	13	1										31
	1992				23	65	173	252	177	293	162	40	43	1228
1993	1992	19	65	40										124
	1993				79	136	215	97	51	97	60	8	37	780
1994	1993	28	39	19										86
	1994				47	187	35	103	88	241	44	13	31	789
1995	1994			27										27
	1995				11	255	83	134		85	39		14	621
1996	1995	8	11											19
	1996				86	98	229	173	162	38	110			896
1997	1997					29	85	103	51	139	78		23	508
1998	1997	17	15	30										62
	1998					158	70	143	34	148	97	25		675
1999	1998	19	13											32
	1999				160	164	92	53	147	102	43	82		843
2000	1999			26										26
	2000				1	49	95	208	80	128	87	34		682
2001	2001				36	73	179	157	76	154	93	31	22	821
2002	2001			25										25
	2002					2								2

Table 2. Number of king-aged samples by 5 cm fork length size bin and year updated aged-data.

Gulf king

SIZEBIN	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Grand Total
35-40				2							2							4
40-45		4		9		5				1				2				21
45-50		19	1	27		43	3	4	7	4	2	6	1	15	3	1	4	140
50-55	11	18	6	64	8	46	15	12	10	9	13	13	3	34	5	1	8	276
55-60	24	37	12	43	59	76	85	35	32	19	58	59	9	26	17	10	11	612
60-65	22	38	29	61	47	53	113	30	45	55	143	76	44	45	66	79	85	1031
65-70	22	101	56	31	79	133	134	110	74	83	202	132	56	66	74	104	122	1579
70-75	27	125	52	47	66	208	155	154	111	71	180	178	108	54	78	489	269	2372
75-80	28	77	75	82	52	206	183	184	130	84	174	137	102	63	87	350	274	2288
80-85	23	69	77	85	63	164	169	150	104	101	380	212	91	69	211	261	151	2380
85-90	21	78	70	69	51	133	123	133	117	123	247	165	58	43	151	154	71	1807
90-95	37	62	56	71	50	121	111	100	85	107	169	84	40	34	83	92	45	1347
95-100	21	56	39	49	53	89	72	94	56	87	62	51	41	27	40	74	25	936
100-105	14	36	28	51	20	93	61	79	49	59	47	46	36	20	16	32	19	706
105-110	12	36	39	22	41	70	44	49	51	62	39	25	29	10	11	22	10	572
110-115	10	33	25	23	26	37	45	46	40	44	28	13	29	11	11	23	3	447
115-120	11	29	36	34	26	44	36	40	31	45	22	6	18	14	12	8	3	415
120-125	8	34	30	16	14	31	30	28	28	26	21	2	24	21	9	8	3	333
125-130	6	16	18	20	12	24	20	27	26	21	9	2	8	13	5	1	2	230
130-135		25	15	19	13	9	6	10	12	14	2	2	3	12	7	1	2	152
135-140	3	13	10	11	5	7	6	3	3	7	4		3	1	5	1	3	85
140-145	6	10	2	7	5	2		4	3	3		1	2				1	46
145-150	1	7	3	2	2	4	1	1	2	1			1	1				26
150-155		1	2			2	1							1				7
155-160			1															1

Atlantic king

SIZEBIN	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Grand Total
30-35							1											1
35-40	1			3	1													5
40-45	6	5	1		3			1				3						19
45-50	15	30			11	3	2	1		2	1	12		2				79
50-55	25	23	5	4	7	4	4	2	1	5	6	5		18				109
55-60	14	35	15	13	5	23	11	4	9	18	16	5	9	23	1	1		202
60-65	32	29	25	14	20	32	22	19	27	29	47	8	19	33	18	14		388
65-70	41	17	37	29	51	42	81	39	29	17	56	26	44	48	24	31	2	614
70-75	53	42	57	78	70	103	184	116	91	29	62	39	71	77	24	93	2	1191
75-80	66	39	53	113	97	84	171	138	144	93	90	42	86	105	62	111	8	1502
80-85	25	50	49	115	136	95	165	121	138	109	89	68	87	108	61	95	6	1517
85-90	21	45	39	119	132	84	132	120	107	94	107	50	61	96	82	92	4	1385
90-95	27	42	46	103	81	68	117	79	75	75	123	52	60	99	69	74	5	1195
95-100	20	29	35	55	65	62	82	58	45	38	102	44	60	71	84	72		922
100-105	8	22	21	40	57	49	80	67	49	39	82	47	61	53	65	55		795
105-110	7	13	12	39	48	39	54	41	49	34	39	32	45	36	62	43		593
110-115	5	23	14	39	41	30	46	28	32	19	34	26	38	29	45	40		489
115-120	4	9	14	25	37	31	38	26	29	19	27	20	31	28	38	30		406
120-125	2	19	12	17	26	26	26	12	17	17	17	8	27	23	33	34		316
125-130	2	12	8	10	21	18	30	16	17	7	8	10	17	10	24	20		230
130-135	1	8	1	3	4	5	11	8	8	3	3	7	12	7	14	9		104
135-140		3			6	6		4	5		5	4	5	6	1	6		51
140-145					4			2	1		1		2	2	1	1		14
145-150					1		2	1	1	1			1	1				8
150-155		2			2			1	1				1					7

Table 3. Total number of aged-samples per year for king mackerel by stock and region. For the new ALK only years with 400 or more aged-fish were constructed (shaded areas).

Aged-samples	Stock			
		Region		Grand Total
YEAR	ATL	GOM-EGF	GOM-WGF	
1986	375	208	99	682
1987	497	590	334	1421
1988	444	365	317	1126
1989	819	490	355	1664
1990	926	456	236	1618
1991	804	1223	377	2404
1992	1259	1052	361	2672
1993	904	1153	140	2197
1994	875	936	80	1891
1995	648	1026		1674
1996	915	1804		2719
1997	508	1210		1718
1998	737	706		1443
1999	875	582		1457
2000	708	891		1599
2001	821	1711		2532
2002	27	1111		1138

Table 4. Catch in numbers of fish per year (calendar) and corresponding percent per quarter for Gulf king or the Western Gulf region. Catch distribution in the Gulf of Mexico follows the percentages of catch by State as follows: FL 100% EGF, AL-MS 46.9% EGF, LA 34.2% EGF and TX 7.0% EGF.

STOCK **Gulf**
REGION **WGF**

	Quarter					Percent			
YR	**1**	**2**	**3**	**4**	**Total**	**1**	**2**	**3**	**4**
1981		118,278	102,641	3,915	224,834	0%	53%	46%	2%
1982		19,606	214,463	166,478	400,547	0%	5%	54%	42%
1983	30,245	19,024	75,820	15,921	141,010	21%	13%	54%	11%
1984	3,154	5,780	65,867	36,224	111,025	3%	5%	59%	33%
1985	6,411	16,740	60,385	32,061	115,597	6%	14%	52%	28%
1986	6,240	11,748	30,550	9,294	57,832	11%	20%	53%	16%
1987	9,501	27,624	42,624	8,286	88,035	11%	31%	48%	9%
1988	112	6,943	66,215	11,678	84,948	0%	8%	78%	14%
1989	282	3,120	42,683	21,671	67,756	0%	5%	63%	32%
1990	422	7,877	77,257	22,018	107,574	0%	7%	72%	20%
1991	380	3,462	72,689	12,262	88,793	0%	4%	82%	14%
1992	920	32,003	120,310	22,970	176,203	1%	18%	68%	13%
1993	284	18,010	141,490	14,495	174,279	0%	10%	81%	8%
1994	1,403	20,024	96,502	13,440	131,369	1%	15%	73%	10%
1995	1,110	25,399	89,397	8,273	124,179	1%	20%	72%	7%
1996	312	16,144	83,712	9,060	109,228	0%	15%	77%	8%
1997	1,629	26,546	122,346	14,033	164,554	1%	16%	74%	9%
1998	10,875	25,371	123,029	6,581	165,856	7%	15%	74%	4%
1999	684	19,911	119,223	6,391	146,209	0%	14%	82%	4%
2000	4,098	17,451	125,475	20,324	167,348	2%	10%	75%	12%
2001	1,829	11,883	78,272	31,694	123,678	1%	10%	63%	26%
2002	1,566	21,016			22,582	7%	93%	0%	0%

Table 5. Catch in numbers of fish per year (calendar) and corresponding percent per quarter for Gulf king or the Eastern Gulf region. Catch distribution in the Gulf of Mexico follows the percentages of catch by State as follows: FL 100% EGF, AL-MS 46.9% EGF, LA 34.2% EGF and TX 7.0% EGF.

STOCK Gulf
REGION EGF

	Quarter					Percent			
YR	1	2	3	4	Total	1	2	3	4
1981	991,687	116,006	32,234	211,842	1,351,769	73%	9%	2%	16%
1982	546,476	36,097	166,180	284,381	1,033,134	53%	3%	16%	28%
1983	375,647	14,962	208,354	71,856	670,819	56%	2%	31%	11%
1984	337,902	12,015	120,906	211,356	682,179	50%	2%	18%	31%
1985	245,996	20,564	46,806	76,966	390,332	63%	5%	12%	20%
1986	310,575	16,275	61,518	117,190	505,558	61%	3%	12%	23%
1987	212,142	146,769	128,592	211,215	698,718	30%	21%	18%	30%
1988	13,795	9,978	206,046	281,351	511,170	3%	2%	40%	55%
1989	48,208	30,439	117,038	206,575	402,260	12%	8%	29%	51%
1990	181,885	119,617	127,704	282,984	712,190	26%	17%	18%	40%
1991	131,660	73,296	371,500	243,019	819,475	16%	9%	45%	30%
1992	149,285	79,330	166,628	211,985	607,228	25%	13%	27%	35%
1993	412,461	89,583	143,705	271,553	917,302	45%	10%	16%	30%
1994	265,970	93,469	180,214	208,752	748,405	36%	12%	24%	28%
1995	458,893	137,900	67,012	166,097	829,902	55%	17%	8%	20%
1996	405,038	172,503	151,058	248,454	977,053	41%	18%	15%	25%
1997	433,210	78,495	134,166	346,627	992,498	44%	8%	14%	35%
1998	380,911	75,542	126,015	222,157	804,625	47%	9%	16%	28%
1999	416,483	87,651	117,346	180,902	802,382	52%	11%	15%	23%
2000	276,114	80,858	187,336	162,925	707,233	39%	11%	26%	23%
2001	326,815	87,473	160,558	152,352	727,198	45%	12%	22%	21%
2002	316,214	135,414			451,628	70%	30%	0%	0%

Table 6. Catch in numbers of fish per year (calendar) and corresponding percent per quarter for Atlantic king (North of North Carolina aged-samples were not included in the ALK development).

STOCK Atlantic
REGION NC-FL_A

	Quarter					Percent			
YR	1	2	3	4	Total	1	2	3	4
1981	2,200	182,443	294,880	208,683	688,206	14%	33%	27%	26%
1982	83,039	388,677	388,841	130,423	990,980	16%	33%	28%	23%
1983	1,799	381,154	383,848	133,198	899,999	15%	32%	29%	24%
1984	7,098	194,644	495,872	98,848	796,462	15%	32%	31%	22%
1985	4,523	305,639	410,526	312,263	1,032,951	11%	29%	30%	29%
1986	21,425	329,830	453,090	139,411	943,756	10%	32%	35%	22%
1987	44,769	364,615	310,573	184,980	904,937	9%	35%	36%	21%
1988	22,347	356,105	344,212	155,937	878,601	9%	38%	33%	19%
1989	25,503	229,383	252,637	118,970	626,493	9%	36%	33%	22%
1990	54,215	243,014	301,200	157,575	756,004	9%	34%	34%	23%
1991	43,155	269,151	363,993	198,941	875,240	9%	33%	36%	22%
1992	88,889	263,876	426,189	192,787	971,741	9%	35%	35%	22%
1993	42,577	210,131	201,437	128,554	582,699	13%	34%	33%	20%
1994	40,416	229,694	202,151	133,062	605,323	9%	35%	33%	23%
1995	40,155	215,475	221,915	177,939	655,484	10%	35%	33%	21%
1996	25,885	260,992	193,193	124,756	604,826	10%	34%	33%	23%
1997	116,281	316,144	263,371	160,203	855,999	10%	34%	32%	24%
1998	50,918	345,036	160,909	163,212	720,075	11%	32%	33%	24%
1999	50,227	253,443	177,524	133,695	614,889	10%	37%	32%	21%
2000	41,211	252,236	321,338	155,869	770,654	12%	33%	32%	23%
2001	21,909	240,504	175,980	87,803	526,196	10%	35%	32%	22%
2002	17,348				17,348	100%	0%	0%	0%

Table 7. Percent distribution of king-aged samples per calendar year and by quarter for each of the stocks, Atlantic and Gulf, and region in the Gulf of Mexico.

Region	YEAR	1	2	3	4	Region	YEAR	1	2	3	4
EGF	**1986**	0%	0%	98%	2%	**WGF**	**1986**	0%	17%	82%	1%
	1987	8%	33%	53%	5%		**1987**	0%	21%	79%	0%
	1988	0%	11%	83%	7%		**1988**	0%	36%	64%	0%
	1989	7%	10%	76%	7%		**1989**	0%	37%	50%	13%
	1990	11%	25%	52%	12%		**1990**	0%	55%	39%	6%
	1991	4%	28%	46%	21%		**1991**	0%	20%	80%	0%
	1992	11%	23%	55%	11%		**1992**	0%	39%	54%	7%
	1993	6%	21%	58%	16%		**1993**	0%	16%	77%	7%
	1994	3%	28%	46%	24%		**1994**	0%	30%	70%	0%
	1995	4%	24%	30%	42%						
	1996	16%	21%	26%	37%						
	1997	53%	14%	23%	10%						
	1998	42%	15%	12%	32%						
	1999	33%	16%	25%	26%						
	2000	59%	6%	12%	22%						
	2001	64%	1%	15%	20%						
	2002	88%	12%	0%	0%						

Region	YEAR	1	2	3	4
ATL	**1986**	0%	35%	62%	3%
	1987	0%	43%	31%	26%
	1988	0%	67%	32%	1%
	1989	0%	16%	58%	26%
	1990	2%	24%	57%	17%
	1991	7%	15%	55%	23%
	1992	2%	21%	57%	19%
	1993	14%	48%	27%	12%
	1994	10%	31%	49%	10%
	1995	4%	54%	34%	8%
	1996	2%	45%	41%	12%
	1997	0%	22%	58%	20%
	1998	8%	31%	44%	17%
	1999	4%	48%	35%	14%
	2000	4%	20%	59%	17%
	2001	0%	35%	47%	18%
	2002	93%	7%	0%	0%

Table 8. Instruction file input for the ageing of king mackerel. SAR refers to the stochastic length deconvolution method for ageing, KEY refers to Age-Length-Keys (shade area). The instruction file is given by stock and region for the Gulf king. For the Western Gulf of Mexico, there were not aged samples after 1994. However, the algorithms have applied the Eastern Gulf Keys for the years, quarters that were selected in the EGF region. There were not aged-samples of king mackerel prior to 1986.

2002 SA Instruction File for King mackerel

Year	Area	Q1	Q2	Q3	Q4	Area	Q1	Q2	Q3	Q4	Area	Q1	Q2	Q3	Q4
1985	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1986	ATL	SAR	KEY	KEY	SAR	EGF	SAR	KEY	KEY	SAR	WGF	SAR	KEY	KEY	SAR
1987	ATL	SAR	KEY	KEY	SAR	EGF	SAR	KEY	KEY	SAR	WGF	SAR	KEY	KEY	SAR
1988	ATL	SAR	KEY	KEY	KEY	EGF	KEY	SAR	SAR	KEY	WGF	KEY	SAR	SAR	KEY
1989	ATL	SAR	KEY	KEY	KEY	EGF	SAR	KEY	KEY	KEY	WGF	SAR	KEY	KEY	KEY
1990	ATL	SAR	KEY	KEY	KEY	EGF	SAR	KEY	KEY	SAR	WGF	SAR	KEY	KEY	SAR
1991	ATL	SAR	KEY	KEY	KEY	EGF	SAR	KEY	KEY	SAR	WGF	SAR	KEY	KEY	SAR
1992	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	SAR	WGF	SAR	KEY	KEY	SAR
1993	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	KEY	SAR
1994	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1995	ATL	SAR	KEY	KEY	KEY	EGF	SAR	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1996	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1997	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1998	ATL	KEY	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1999	ATL	SAR	KEY	KEY	KEY	EGF	SAR	SAR	KEY	KEY	WGF	SAR	SAR	SAR	SAR
2000	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
2001	ATL	SAR	KEY	KEY	KEY	EGF	KEY	SAR	KEY	KEY	WGF	SAR	SAR	SAR	SAR
2002	ATL	SAR	SAR	SAR	SAR	EGF	KEY	KEY	SAR	SAR	WGF	SAR	SAR	SAR	SAR

New Instruction File for King Mackerel (After revision of ALK 2004)

Year	Area	Q1	Q2	Q3	Q4	Area	Q1	Q2	Q3	Q4	Area	Q1	Q2	Q3	Q4
1981	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1982	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1983	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1984	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1985	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1986	ATL	SAR	SAR	SAR	SAR	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1987	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	SAR	WGF	SAR	SAR	SAR	SAR
1988	ATL	SAR	KEY	KEY	KEY	EGF	SAR	SAR	SAR	SAR	WGF	SAR	SAR	SAR	SAR
1989	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	SAR	WGF	SAR	SAR	SAR	SAR
1990	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	SAR	WGF	SAR	SAR	SAR	SAR
1991	ATL	SAR	KEY	KEY	KEY	EGF	SAR	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1992	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1993	ATL	KEY	KEY	KEY	KEY	EGF	SAR	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1994	ATL	KEY	KEY	KEY	KEY	EGF	SAR	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1995	ATL	SAR	KEY	KEY	KEY	EGF	SAR	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1996	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1997	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1998	ATL	KEY	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
1999	ATL	SAR	KEY	KEY	KEY	EGF	KEY	KEY	KEY	KEY	WGF	SAR	SAR	SAR	SAR
2000	ATL	SAR	KEY	KEY	KEY	EGF	KEY	SAR	KEY	KEY	WGF	SAR	SAR	SAR	SAR
2001	ATL	SAR	KEY	KEY	KEY	EGF	KEY	SAR	KEY	KEY	WGF	SAR	SAR	SAR	SAR
2002	ATL	SAR	SAR	SAR	SAR	EGF	KEY	KEY	SAR	SAR	WGF	SAR	SAR	SAR	SAR

Table 9. Comparison of the CAA matrices for Atlantic king mackerel. 2003 CAA refers to the CAA input of the Atlantic king stock assessment. The last table shows the percent difference between 2003 and 2004 CAA matrices, negative percentages (dark shade) indicated higher proportion at age for the 2004 CAA matrix compare to equivalent value in 2003 CAA.

Atlantic

2003 CAA input

FYear	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Total Age
1981	589.38	5853.54	14334.98	55953.81	154113.28	131162.42	101578.57	134701.92	52511.34	72984.77	21095.49	27268.27	772147.77
1982	2808.94	5519.44	5750.1	20652.77	72034.66	170069.45	168340.73	163125.18	154633.36	27181.01	2197.39	119087.12	911400.15
1983	3693.41	29287.4	60258.61	100524.46	70140.77	138440.2	72810.72	128808.69	137134.65	68940.21	31200.43	64688.87	905928.42
1984	1175.27	4165.08	10079.29	19650.82	102211.61	135161.38	119135	143956.65	54024.89	67192.18	57805.22	79609.66	794167.05
1985	1117.09	86458.97	126497.83	25568.31	64834.9	98825.55	133339.54	168219.4	201312.74	59322.97	18480.02	67228.94	1051206.26
1986	1440.51	118293.06	221906.89	115697.3	141440.49	63701.59	62909.51	92826.53	56918.47	17873.24	26755.6	57397.2	977160.39
1987	6150.74	197818.66	212011.55	139893.01	95071.83	73754.68	40806.9	33794.04	23014.04	13911.85	11902.09	43636.18	891765.57
1988	1756.75	19394.06	217480.03	192579.32	113239.85	60041.19	60993.25	62594.81	22416	46997.53	21217.57	77820.07	896530.43
1989	997.09	69084.17	101675.88	137946.41	98881.01	69186.64	45230.73	31705.03	16741.27	9811.98	41948.82	40375.71	663584.74
1990	608.24	134813.4	162793.98	78594.17	91287.24	81532.41	60087.08	26523.8	15597.27	27180.51	14470.46	56011.44	749500
1991	243.19	95988.12	321247.52	103736.46	70365.15	99801.87	83573.29	45918.66	30852.13	11984.65	8083.62	62224.51	934019.17
1992	545.56	77386.44	259453.13	279930.63	70899.66	43701.37	52410.52	46267.19	18953.62	18359.6	12190.88	62402.48	942501.08
1993	1081.3	48763.96	85149.13	129162.53	110448.3	32380.39	34361.06	34026.2	42321.19	18568.67	17947.4	45916.56	600126.69
1994	2.95	90442.62	140720.96	64185.47	75288.68	88967.98	42433.43	15377.55	20874.3	32298.27	13322.09	23653.03	607567.33
1995	59.06	112772.04	149017.33	88812.15	52138.33	61113.28	75641.88	20363.59	18559.79	20178.17	18805.3	26163.91	643624.83
1996	947.39	52538.5	184572	136548.84	93208.59	62160.86	34061.5	63734.58	25324.96	13652	5925.22	24440.21	697114.65
1997	2817.45	93356.51	282752.69	134056.45	83878.69	52738.33	29568.42	40469.98	40788.34	16502.39	5160.96	26457.1	808547.31
1998	7541.04	58509.2	177637.23	181957.77	100692.55	63644.76	35261.26	19778.18	27048.2	26661.22	6916.39	20730.91	726378.71
1999	1479.37	81222.73	104992.36	139062.46	127861.82	57181.47	29670.17	11607.77	11057.89	17605.92	15539.22	12377.43	609658.61
2000	887.61	17600.56	278528.27	99654.78	161876.84	88429.7	38838.05	13536.9	9905.61	9399.16	17208.7	36168.55	772034.73
2001	0	16448.44	94104.88	134326.76	65729.07	85685.72	45851.1	19220.42	8595.61	5596.1	7649.71	42919.25	526127.06

2004 CAA input new ALK

Fyear	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Tot_Age
1981	15015.13	114343.29	48216.17	55961.99	80605.97	85318.81	127257.41	49884.78	62643.94	41361.74	32608.14	58931.45	772148.82
1982	5589.66	8732.87	18597.44	12745.49	52538.57	100232.38	157780.91	160601.86	113784.44	81124.07	47488.09	152185.08	911400.86
1983	2008.38	18601.74	31391.17	64454.9	107020.45	78999.72	139702.46	75977.06	163924.26	40023.13	20511.06	163312.05	905926.38
1984	18140.67	33556.88	8340.27	10672.05	52469.3	97498.9	123779.13	142877.96	76657.14	42692.51	21193.78	166289.22	794167.81
1985	26831.76	8187.68	98475.54	112688.04	42221.47	80074.67	124630.45	90094.47	172020.69	130055.19	17338.88	148585.67	1051204.51
1986	43115.36	50389.7	122313.07	72303	114464.89	99470.13	80277.63	91604.77	79020.51	67117	27406.6	129670.52	977153.18
1987	1746.32	166526.19	177417.23	129100.52	92994.83	79876.25	48060.59	44325.83	31671.37	21496.37	18080.72	80470.61	891766.83
1988	0.59	16752.53	154894.87	217818.56	130096.34	32409.56	43396.01	57215.24	27692.61	74035.72	23367.77	118851.75	896531.55
1989	0	48525.78	71207.46	109185.58	97328.19	70707.47	55402.97	33433.09	27154.79	18482.46	62660.28	69497.19	663585.26
1990	24.65	92878.39	120979.34	75089.08	95983.17	89129.79	70035.74	36093.14	19658.04	33281.11	23322.34	93025.87	749500.66
1991	619.44	49304.98	255174.31	118212.78	59710.13	116039.86	111857.97	51705.5	50924.57	16354.45	9541.98	94573.93	934019.9
1992	1256.8	39085.41	178308.42	298495.29	85739.42	58833.55	56292.79	64609.39	28408.69	21184.87	18620.52	91666.61	942501.76
1993	0	25573.67	65031.47	99556.36	119160.99	46845.13	35101.19	43060.92	53506.5	27009.1	20944.64	64337.52	600127.49
1994	0	42569.79	113993.91	50844.7	88109.73	104626.3	50875.09	28855.24	26969.79	37405.27	23228.72	40088.98	607567.52
1995	0	67870.34	135895.93	74763.37	52833.6	64134.96	96331.33	31158.16	20981.49	28414.96	26215.29	45025.67	643625.1
1996	0	27776.57	151012.28	101362.04	95593.36	67511.13	56317.93	88624.5	27796.6	21021.06	15323.19	44777.24	697115.9
1997	60.75	60360.47	224041.64	139564.26	95612.87	60197.93	37269.3	53548.52	59094.45	23023.16	7834.14	47939.16	808546.65
1998	957.62	26552.96	129452.34	172812.91	122552.29	74671.79	41585.12	26299.57	43670.31	48569.13	6558.02	32696.49	726378.55
1999	1479.37	48292.38	77675.22	113881.83	140172.41	74660.91	42355.77	18151.14	18342.62	27057.74	27524.88	20064.59	609658.86
2000	0	5259.92	225532.63	101635.11	167149.36	104112.12	48449.7	17508.55	11104.3	12466.44	26742.71	52074.24	772035.08
2001	0	8548.79	49031.61	122057.36	71760.02	101978.09	58730.7	28364.43	11573.57	5804.67	10118.61	58159.33	526127.18

% age > in 2004 **% age < in 2004**

FYear	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
1981/82	-1.9%	-14.1%	-4.4%	0.0%	9.5%	5.9%	-3.3%	11.0%	-1.3%	4.1%	-1.5%	-4.1%
1982/83	-0.3%	-0.4%	-1.4%	0.9%	2.1%	7.7%	1.2%	0.3%	4.5%	-5.9%	-5.0%	-3.6%
1983/84	0.2%	1.2%	3.2%	4.0%	-4.1%	6.6%	-7.4%	5.8%	-3.0%	3.2%	1.2%	-10.9%
1984/85	-2.1%	-3.7%	0.2%	1.1%	6.3%	4.7%	-0.6%	0.1%	-2.8%	3.1%	4.6%	-10.9%
1985/86	-2.4%	7.4%	2.7%	-8.3%	2.2%	1.8%	0.8%	7.4%	2.8%	-6.7%	0.1%	-7.7%
1986/87	-4.3%	6.9%	10.2%	4.4%	2.8%	-3.7%	-1.8%	0.1%	-2.3%	-5.0%	-0.1%	-7.4%
1987/88	0.5%	3.5%	3.9%	1.2%	0.2%	-0.7%	-0.8%	-1.2%	-1.0%	-0.9%	-0.7%	-4.1%
1988/89	0.2%	0.3%	7.0%	-2.8%	-1.9%	3.1%	2.0%	0.6%	-0.6%	-3.0%	-0.2%	-4.6%
1989/90	0.2%	3.1%	4.6%	4.3%	0.2%	-0.2%	-1.5%	-0.3%	-1.6%	-1.3%	-3.1%	-4.4%
1990/91	0.1%	5.6%	5.6%	0.5%	-0.6%	-1.0%	-1.3%	-1.3%	-0.5%	-0.8%	-1.2%	-4.9%
1991/92	0.0%	5.0%	7.1%	-1.5%	1.1%	-1.7%	-3.0%	-0.6%	-2.1%	-0.5%	-0.2%	-3.5%
1992/93	-0.1%	4.1%	8.6%	-2.0%	-1.6%	-1.6%	-0.4%	-1.9%	-1.0%	-0.3%	-0.7%	-3.1%
1993/94	0.2%	3.9%	3.4%	4.9%	-1.5%	-2.4%	-0.1%	-1.5%	-1.9%	-1.4%	-0.5%	-3.1%
1994/95	0.0%	7.9%	4.4%	2.2%	-2.1%	-2.6%	-1.4%	-2.2%	-1.0%	-0.8%	-1.6%	-2.7%
1995/96	0.0%	7.0%	2.0%	2.2%	-0.1%	-0.5%	-3.2%	-1.7%	-0.4%	-1.3%	-1.2%	-2.9%
1996/97	0.1%	3.6%	4.8%	5.0%	-0.3%	-0.8%	-3.2%	-3.6%	-0.4%	-1.1%	-1.3%	-2.9%
1997/98	0.3%	4.1%	7.3%	-0.7%	-1.5%	-0.9%	-1.0%	-1.6%	-2.3%	-0.8%	-0.3%	-2.7%
1998/99	0.9%	4.4%	6.6%	1.3%	-3.0%	-1.5%	-0.9%	-0.9%	-2.3%	-3.0%	0.0%	-1.6%
1999/00	0.0%	5.4%	4.5%	4.1%	-2.0%	-2.9%	-2.1%	-1.1%	-1.2%	-1.6%	-2.0%	-1.3%
2000/01	0.1%	1.6%	6.9%	-0.3%	-0.7%	-2.0%	-1.2%	-0.5%	-0.2%	-0.4%	-1.2%	-2.1%
2001/02	0.0%	1.5%	8.6%	2.3%	-1.1%	-3.1%	-2.4%	-1.7%	-0.6%	0.0%	-0.5%	-2.9%

Table 10. Comparison of the CAA matrices for Gulf king mackerel. 2002 CAA refers to the CAA input of the Gulf king stock assessment 2002. The last table shows the percent difference between 2002 and 2004 CAA matrices, negative percentages (dark shade) indicated higher proportion at age for the 2004 CAA matrix compare to equivalent value in 2002 CAA.

Gulf King — **2002 CAA input**

FYear	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Sum Total
1981	65	1446	7242	65376	572111	187534	48128	32219	15491	7458	4108	11624	952802
1982	9441	22522	183273	135947	324974	287056	91735	64634	38302	73266	19877	20338	1271365
1983	82	368	129346	258565	166109	49403	69101	28827	15842	5819	2097	5233	730792
1984	38	6669	10386	183855	286885	127509	53807	35385	11628	1915	1946	4027	724050
1985	497	10645	41627	39065	190830	150344	80569	17960	8789	6325	4700	9689	561040
1986	3577	77665	178847	100524	132548	38378	33590	20219	10150	6203	1307	11567	614575
1987	1367	64736	167700	78833	43595	26985	15806	10627	3828	1844	1680	4539	421540
1988	771	39373	123181	81653	190716	67345	61996	29372	12207	9957	7529	23230	647330
1989	2292	220559	191102	97434	72016	37602	15230	21013	12830	6204	6826	14648	697756
1990	7005	78530	199413	223494	78530	39696	34648	14600	12055	14711	2929	13139	718750
1991	2218	215542	307759	188532	124847	33281	34331	13481	5645	13850	5807	15702	960995
1992	2239	89108	247546	316783	123335	91130	46570	28818	32853	15529	11488	36820	1042219
1993	5768	168104	212503	190773	162643	78023	30426	28361	25445	15776	4481	29790	952093
1994	3389	170473	139494	148795	202540	228711	96235	14868	47589	34305	12395	23399	1122193
1995	3722	126449	298994	177464	99129	66396	69827	35673	14235	7660	10313	14906	924768
1996	649	139544	396921	187029	99113	53908	44443	34766	31014	16136	2421	26210	1032154
1997	161	78033	363508	318288	145077	78987	29871	26286	28730	22974	6725	13843	1112483
1998	36	19973	70997	206344	296774	255143	75853	24594	22513	10982	8798	9977	1001984
1999	163	173947	178738	130183	128359	81238	30997	21337	14190	15394	4893	16583	796022
2000	994	75407	232711	242627	149029	80121	37341	31078	10420	15367	6378	12345	893818

2004 CAA input new ALK

Fyear	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Sum of To
1981	0	26278.05	29046.5	23952.73	393891.68	321222.82	56712.67	53204.19	22315.6	7885.52	4883.76	13408.24	952801.9
1982	72.26	38440.52	59500.89	215826.17	213058.15	313571.18	160373.67	47760.88	53948.78	25935.94	10959.72	131918.4	1271366.7
1983	16.75	25446.32	24613.86	300932.45	196572.42	52857.24	63249.99	25562.91	22693.36	8288.83	2055.07	8503.3	730792.7
1984	0	49785.53	43344.73	45056.84	287698.13	160250.69	45577.52	56705.87	18855.7	6039.22	3363.14	7367.61	724049.8
1985	0	26769.53	22447.5	61405.99	167740.76	113023.27	98219.81	36467.92	10798.99	8311.87	5551.41	10304.73	561042.1
1986	6261.78	62945.41	201589.07	115126.96	65203.76	69423.06	40447.72	23019.13	11871.95	5036.63	2455.03	11196.63	614577.2
1987	639.93	35617.04	78739.06	140728.44	54506.44	60353.64	21356.99	10574.1	4079.93	8809.47	1840.2	4295.01	421540.5
1988	40.17	62818.21	49608.54	54173.87	142210.2	157855.91	56339	63189.82	19325.48	9125.04	5955.73	26688.54	647330.7
1989	224.27	114343.2	165896.16	157351.09	78697.82	78561.7	34338.46	23648.65	15853.67	9021.25	4339.8	15480.63	697757
1990	20356.96	48936.91	116953.59	137683.49	214205.2	55278.48	49225.97	19520.76	27193.86	10733.51	2698.86	15961.4	718751.5
1991	2733.57	186230.48	333805.06	159473.17	90218.04	68926.51	40747.34	21219.4	7003.22	24044.08	9583.53	17009.28	960994
1992	549.8	110190.26	193060.44	173558.92	248359.53	104911.68	86005.25	31833.93	16973.46	21516.19	28345.72	26914.67	1042219.7
1993	2434.57	108789.4	130060.62	162210.19	196305.93	153751.89	54336.13	64623.71	23967.96	10486.95	2188.52	42936.75	952093
1994	503.88	130869.32	119260.39	146670.74	230965.2	221520.5	95735.85	34593.57	55770.95	37637.05	13005.63	35662.19	1122194.9
1995	1528.41	68845.1	254055.18	187137.27	114048.43	84823.93	87951.59	50981.82	21789.67	10573.06	17276.06	25756.87	924767.6
1996	0	67505.44	341757.67	225005.29	117821.05	69013.21	53220.18	45928.93	45998.69	18618.41	3797.18	43489.34	1032155.5
1997	0	64013.24	268137.05	322665.14	170211.78	97593.02	43478.36	43525.89	40282.17	27631.24	10220.15	22099.84	1109857.8
1998	0	82412.55	140955.05	248845.56	219146.23	121900.03	58743.59	31692.96	34890.59	37113.97	13114.49	13688.2	1002503.1
1999	0	95186.41	141352.78	137564.91	188237.85	101283.84	42891.68	26890.41	16202.09	26996.58	9537.41	16224.1	802368
2000	19846.81	70360.36	184544.28	215802.29	171501.51	101276.23	46749.13	39045.18	18065.88	17442.88	11411.32	28007.47	924053.4
2001	0	27175.2	170034.82	250317.3	175474.68	93506.2	55949.25	50200.11	27313.28	13846.39	5773.81	27485.1	897075.9

% age > in 2004 (dark shade); % age < in 2004 (light shade)

FYear	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
1981/82	0.0%	-2.6%	-2.3%	4.3%	18.7%	-14.0%	-0.9%	-2.2%	-0.7%	0.0%	-0.1%	-0.2%
1982/83	0.7%	-1.3%	9.7%	-6.3%	8.8%	-2.1%	-5.4%	1.3%	-1.2%	3.7%	0.7%	-8.8%
1983/84	0.0%	-3.4%	14.3%	-5.8%	-4.2%	-0.5%	0.8%	0.4%	-0.9%	-0.3%	0.0%	-0.4%
1984/85	0.0%	-6.0%	-4.6%	19.2%	-0.1%	-4.5%	1.1%	-2.9%	-1.0%	-0.6%	-0.2%	-0.5%
1985/86	0.1%	-2.9%	3.4%	-4.0%	4.1%	6.7%	-3.1%	-3.3%	-0.4%	-0.4%	-0.2%	-0.1%
1986/87	-0.4%	2.4%	-3.7%	-2.4%	11.0%	-5.1%	-1.1%	-0.5%	-0.3%	0.2%	-0.2%	0.1%
1987/88	0.2%	6.9%	21.1%	-14.7%	-2.6%	-7.9%	-1.3%	0.0%	-0.1%	-1.7%	0.0%	0.1%
1988/89	0.1%	-3.6%	11.4%	4.2%	7.5%	-14.0%	0.9%	-5.2%	-1.1%	0.1%	0.2%	-0.5%
1989/90	0.3%	15.2%	3.6%	-8.6%	-1.0%	-5.9%	-2.7%	-0.4%	-0.4%	-0.4%	0.4%	-0.1%
1990/91	-1.9%	4.1%	11.5%	11.9%	-18.9%	-2.2%	-2.0%	-0.7%	-2.1%	0.6%	0.0%	-0.4%
1991/92	-0.1%	3.1%	-2.7%	3.0%	3.6%	-3.7%	-0.7%	-0.8%	-0.1%	-1.1%	-0.4%	-0.1%
1992/93	0.2%	-2.0%	5.2%	13.7%	-12.0%	-1.3%	-3.8%	-0.3%	1.5%	-0.6%	-1.6%	1.0%
1993/94	0.4%	6.2%	8.7%	3.0%	-3.5%	-8.0%	-2.5%	-3.8%	0.2%	0.6%	0.2%	-1.4%
1994/95	0.3%	3.5%	1.8%	0.2%	-2.5%	0.6%	0.0%	-1.8%	-0.7%	-0.3%	-0.1%	-1.1%
1995/96	0.2%	6.2%	4.9%	-1.0%	-1.6%	-2.0%	-2.0%	-1.7%	-0.8%	-0.3%	-0.8%	-1.2%
1996/97	0.1%	7.0%	5.3%	-3.7%	-1.8%	-1.5%	-0.9%	-1.1%	-1.5%	-0.2%	-0.1%	-1.7%
1997/98	0.0%	1.2%	8.5%	-0.5%	-2.3%	-1.7%	-1.2%	-1.6%	-1.0%	-0.4%	-0.3%	-0.7%
1998/99	0.0%	-6.2%	-7.0%	-4.2%	7.8%	13.3%	1.7%	-0.7%	-1.2%	-2.6%	-0.4%	-0.4%
1999/00	0.0%	10.0%	4.8%	-0.8%	-7.3%	-2.4%	-1.5%	-0.7%	-0.2%	-1.4%	-0.6%	0.1%
2000/01	-2.0%	0.8%	6.1%	3.8%	-1.9%	-2.0%	-0.9%	-0.7%	-0.8%	-0.2%	-0.5%	-1.6%

Table 11. Tuning indices for the new-ALK case run of Gulf of Mexico king mackerel. Time of comparison between observed and predicted values is either mid-year (MID) or at the start of the year (BEG), and the index reflects the stock measurement in units of biomass, numbers or eggs, Age correspond to the coverage of ages by each index.

Fishing Year	Florida FWC NorthWest	Florida FWC SouthWes	MRFSS	Texas PWD	HeadBoat	Charter NorthWest Florida	Charter SouthWes t Florida	Bycatch Shrimp Fishery	SEAMAP occurrence
1981/82					1.1929			2.1547	
1982/83					0.8230			2.0945	0.0921
1983/84				0.8489	1.8108			1.9198	0.0169
1984/85				0.8586	0.6202			2.6963	0.1781
1985/86	17.753	36.787		0.6849	0.4126			2.5305	0.0659
1986/87	21.755	35.696	0.2028	0.4854	0.5926			1.6932	0.1031
1987/88	22.838	48.300	0.4842	0.5674	0.4020			3.4250	0.1157
1988/89	18.690	69.571	0.4741	0.5112	0.3407	0.4480	0.4160	2.9394	0.1111
1989/90	19.880	65.726	0.3153	0.5698	0.6599	0.4425	0.5500	6.0170	0.1860
1990/91	26.707	84.943	0.8954	0.4411	0.5241	0.4417	0.4700	4.2740	0.2031
1991/92	29.515	82.456	1.0000	1.0000	0.8671	0.4772	0.3850	4.9805	0.1783
1992/93	38.750	167.154	0.7526	0.6968	1.0862	0.5012	0.4960	2.4888	0.2814
1993/94	32.521	103.767	0.5165	0.6746	1.1565	0.4669	0.5600	5.1361	0.2971
1994/95	39.116	56.904	0.4913	0.7039	1.1859	0.6025	0.8030	4.8192	0.2614
1995/96	34.617	83.851	0.3896	0.8485	1.1611	0.6341		6.3063	0.3268
1996/97	55.880	109.332	0.7036	0.8415	1.4964			3.1842	0.2400
1997/98	75.432	85.442	0.8336	0.6831	1.4625			3.7494	0.3034
1998/99	46.696	104.764	0.4938	0.7668	1.3016			3.9712	0.2667
1999/00	64.776	57.090	0.5651	0.6181	1.4863			3.9894	0.2581
2000/01	57.088	96.376	0.6915	0.5254	1.0371			4.9200	0.1923
2001/02			0.5048	0.5066	1.2314				0.3017
Timing	BEG	MID	BEG	BEG	MID	BEG	MID	BEG	BEG
Units	Biomass	Biomass	Number	Number	Number	Number	Number	Number	Eggs
Ages	1 - 6	2 - 8	1 - 8	2 - 8	2 - 6	1 - 7	1 - 8	0	1 - 11

Table 12. Gulf king mackerel tuned VPA results for model new ALK (*see text for model setting definitions*).

Stock At Age at beginning of year.

Age	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92
0	2364139	2940379	1792332	2682541	2596783	2669280	3035713	4070760	5037213	3835896	3018941
1	1927584	1604707	2079065	1161924	1735018	1689210	1838474	1715205	2754410	2947238	2336342
2	1587934	1554441	1279114	1679214	906366	1396338	1326188	1473053	1347585	2151911	2368802
3	842372	1273860	1218958	1025023	1335688	721801	961646	1014744	1161249	953813	1656296
4	1379324	668050	848653	727580	798550	1038147	487296	660576	781914	808991	656900
5	785508	775690	355857	518112	338224	502931	791132	349835	412946	569226	469947
6	382346	355771	354536	243745	280424	175585	349225	593284	145408	267400	416202
7	271154	261959	148017	233341	158547	141574	107395	266651	434941	88186	174628
8	116684	174135	171490	98175	140083	97023	95185	78394	161519	334758	54648
9	41538	75453	94170	119959	63412	104949	68737	74248	46818	117946	249550
10	111021	26912	38529	69625	92764	44429	81379	48340	52566	30215	86887
11+	304785	323923	159422	152541	172209	202634	189958	216613	187507	178679	154201

Age	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03
0	2571414	6099036	4263602	6426192	3173836	3765367	4001803	5053911	2324626	5511280	0
1	1488466	1571490	4053169	2635027	4252696	2041521	2417007	2911096	3904674	1487687	4113537
2	1744865	1119255	1188484	3200308	2095218	3420852	1613665	1904479	2297472	3133339	1193476
3	1638718	1254554	799148	865527	2391044	1407712	2558904	1194043	1431748	1714563	2411921
4	1212272	1185211	880986	522290	540347	1754737	862464	1870686	853613	977863	1178304
5	456549	769122	793631	513824	325060	336450	1283188	509236	1361879	544597	642672
6	322678	279477	491386	450873	344314	204069	187861	940672	325808	1023657	361704
7	304019	186940	179929	316177	290012	233974	127976	101110	731445	224640	787611
8	123851	220212	95134	116186	212960	196084	152392	76299	58630	563621	138784
9	38432	86110	158689	28333	75517	132991	124306	93401	47897	31794	436804
10	182635	12325	61050	96095	13729	45098	84031	68467	52237	23590	13655
11+	173415	241746	167398	143269	157243	97521	87709	116473	128210	112292	81362

F at Age during year.

Age	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92
0	0.1875	0.1466	0.2334	0.2357	0.23	0.1729	0.3709	0.1906	0.336	0.2958	0.5072
1	0.0152	0.0268	0.0136	0.0484	0.0172	0.042	0.0216	0.0412	0.0468	0.0185	0.0919
2	0.0204	0.0431	0.0215	0.0289	0.0277	0.173	0.0677	0.0378	0.1456	0.0618	0.1685
3	0.0319	0.2062	0.316	0.0497	0.052	0.1929	0.1755	0.0606	0.1615	0.1729	0.1121
4	0.3756	0.4298	0.2935	0.566	0.2623	0.0717	0.1314	0.2698	0.1175	0.3432	0.1638
5	0.592	0.5829	0.1784	0.4139	0.4556	0.1647	0.0878	0.6779	0.2346	0.1131	0.176
6	0.1781	0.677	0.2183	0.2301	0.4835	0.2916	0.0698	0.1105	0.3001	0.2261	0.1141
7	0.2429	0.2237	0.2106	0.3103	0.2911	0.197	0.1148	0.3013	0.0618	0.2785	0.1436
8	0.236	0.4147	0.1574	0.2371	0.0888	0.1447	0.0484	0.3155	0.1144	0.0937	0.152
9	0.234	0.4721	0.102	0.0571	0.1558	0.0544	0.152	0.1453	0.2379	0.1056	0.1122
10	0.0497	0.5888	0.0606	0.0547	0.0682	0.0628	0.0253	0.1457	0.0954	0.1036	0.1295
11+	0.0497	0.5888	0.0606	0.0547	0.0682	0.0628	0.0253	0.1457	0.0954	0.1036	0.1295

Age	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02
0	0.2924	0.2086	0.2812	0.2128	0.2412	0.2433	0.1182	0.058	0.2463	0.0925
1	0.0851	0.0793	0.0363	0.0292	0.0177	0.0352	0.0383	0.0367	0.0201	0.0204
2	0.1299	0.1369	0.1171	0.0915	0.1977	0.0903	0.1012	0.0853	0.0927	0.0617
3	0.124	0.1535	0.2253	0.2711	0.1094	0.2899	0.1133	0.1356	0.1813	0.1751
4	0.255	0.2011	0.3392	0.2742	0.2738	0.113	0.3269	0.1174	0.2494	0.2197
5	0.2908	0.248	0.3654	0.2003	0.2655	0.3827	0.1105	0.2466	0.0855	0.2092
6	0.3459	0.2404	0.2409	0.2413	0.1863	0.2666	0.4195	0.0516	0.1718	0.0621
7	0.1225	0.4755	0.2374	0.1952	0.1914	0.2288	0.3172	0.345	0.0606	0.2816
8	0.1635	0.1276	1.0113	0.2308	0.2708	0.2558	0.2896	0.2656	0.412	0.0549
9	0.9373	0.1439	0.3016	0.5245	0.3155	0.2591	0.3964	0.3811	0.5082	0.6451
10	0.1872	0.2172	0.2666	0.2202	0.3614	0.2861	0.1883	0.1664	0.2743	0.3129
11+	0.1872	0.2172	0.2666	0.2202	0.3614	0.2861	0.1883	0.1664	0.2743	0.3129

Parameter Estimates

of FADAPT Version 3 (Feb 96) by V. Restrepo

Input DATA file: GK1nALK4.inp
Input CONTROL file: GK2nALK4.inp
Output Stock Size file: gknALK4.naa'
Output Fishing Mortality file: gknALK4.faa'
Ouput Fitted Indices file: gknALK4.ind'
Output Diagnostics (this) file: gknALK4.par'

Run name: Glf_Kng_81-01_NewALK
No. index values: 143 Parameters: 9
Mean Squared Error (rss/df) = 0.14626E+00
Rsquared = -0.0085
Loglikelihood = -0.60809E+02

res from indices = 212.743803629401
res from curvature = 0.000000000000000E+000

Program termination OK

More details of the run can be found in fileFADAPT5.RUN

Parameter	Estimate	S.E.	% C.V.
F age 2	0.0617	0.01842	29.87
F age 3	0.1751	0.08367	47.79
F age 4	0.2197	0.14965	68.10
F age 5	0.2092	0.04175	19.96
F age 6	0.0621	0.02513	40.44
F age 7	0.2816	0.06187	21.97
F age 8	0.0549	0.02490	45.36
F age 9	0.6451	0.25733	39.89
F age 10	0.3129	0.19302	61.69

Variances of terminal yr F and survivors

Age,	SE(F,101)	CV(F)	SE(N,102)	CV(N)
0	0.27634E-01	29.87048		
1	0.60795E-02	29.87048	0.12883E+07	31.31946
2	0.18423E-01	29.87048	0.36026E+06	30.18561
3	0.83673E-01	47.79083	0.74364E+06	30.83175
4	0.14965	68.10345	0.61549E+06	52.23542
5	0.41752E-01	19.95624	0.48912E+06	76.10769
6	0.25125E-01	40.43839	80247.	22.18583
7	0.61868E-01	21.97176	0.32882E+06	41.74947
8	0.24901E-01	45.35836	35130.	25.31250
9	0.25733	39.88726	0.20380E+06	46.65624
10	0.19302	61.69170	7448.2	54.54489
11	0.19302	61.69170	49580.	60.93743

Obs. and pred. indices in objective function

0.47184E+00	0.29012E+00
0.57818E+00	0.36646E+00
0.60698E+00	0.65630E+00
0.49673E+00	0.65824E+00
0.52836E+00	0.54655E+00
0.70981E+00	0.93798E+00
0.78444E+00	0.14088E+01
0.10299E+01	0.82829E+00
0.86433E+00	0.13285E+01
0.10396E+01	0.13762E+01
0.92004E+00	0.89301E+00
0.14852E+01	0.14476E+01
0.20048E+01	0.11400E+01
0.12411E+01	0.13466E+01
0.17216E+01	0.10825E+01
0.15172E+01	0.11645E+01
0.45692E+00	0.28932E+00
0.44337E+00	0.41780E+00
0.59993E+00	0.98602E+00
0.86413E+00	0.24629E+00
0.81637E+00	0.34626E+00
0.10551E+01	0.58072E+00
0.10242E+01	0.13324E+01
0.20762E+01	0.11868E+01
0.12889E+01	0.10285E+01
0.70679E+00	0.56509E+00
0.10415E+01	0.99959E+00
0.13580E+01	0.13474E+01
0.10613E+01	0.14390E+01
0.13013E+01	0.16103E+01
0.70911E+00	0.87508E+00
0.11971E+01	0.12983E+01
0.34844E+00	0.39221E+00
0.83177E+00	0.50835E+00
0.81436E+00	0.42012E+00
0.54157E+00	0.11281E+01
0.15380E+01	0.13769E+01
0.17178E+01	0.14345E+01
0.12929E+01	0.10867E+01
0.88729E+00	0.11319E+01
0.84392E+00	0.89868E+00
0.66929E+00	0.12380E+01
0.12087E+01	0.11262E+01
0.14320E+01	0.11115E+01
0.84830E+00	0.10627E+01
0.97068E+00	0.10542E+01
0.11879E+01	0.85222E+00
0.86721E+00	0.71778E+00
0.10645E+01	0.92630E+00
0.10767E+01	0.13046E+01
0.85889E+00	0.55226E+00
0.74391E+00	0.28092E+00
0.86954E+00	0.39853E+00
0.78342E+00	0.49492E+00
0.87329E+00	0.49892E+00
0.67595E+00	0.21399E+00
0.15325E+01	0.56584E+00
0.10679E+01	0.62220E+00
0.10339E+01	0.82996E+00
0.10788E+01	0.82691E+00
0.13004E+01	0.14964E+01
0.12896E+01	0.16282E+01
0.10468E+01	0.13004E+01
0.11751E+01	0.11390E+01
0.94729E+00	0.88997E+00
0.80518E+00	0.11218E+01
0.77637E+00	0.12014E+01
0.12014E+01	0.65618E+00
0.82888E+00	0.11783E+01
0.18238E+01	0.80343E+00
0.62468E+00	0.46019E+00
0.41559E+00	0.51583E+00
0.59687E+00	0.65627E+00
0.40482E+00	0.36687E+00
0.34316E+00	0.78807E+00
0.66465E+00	0.12570E+01
0.52787E+00	0.62892E+00
0.87334E+00	0.15124E+01
0.10939E+01	0.58776E+00
0.11648E+01	0.12724E+01
0.11944E+01	0.89191E+00
0.11694E+01	0.79484E+00
0.15071E+01	0.82106E+00
0.14730E+01	0.13985E+01
0.13109E+01	0.10926E+01
0.14969E+01	0.14629E+01
0.10445E+01	0.13937E+01
0.12402E+01	0.10903E+01
0.89285E+00	0.30756E+00
0.88189E+00	0.91606E+00
0.88030E+00	0.88236E+00
0.95105E+00	0.12849E+01
0.99888E+00	0.93288E+00
0.93052E+00	0.11255E+01
0.12008E+01	0.11524E+01
0.12637E+01	0.75473E+00
0.79130E+00	0.43257E+00
0.10462E+01	0.14830E+01
0.89402E+00	0.75209E+00
0.73234E+00	0.81672E+00
0.94348E+00	0.11222E+01
0.10652E+01	0.45346E+00
0.15274E+01	0.31065E+00
0.58800E+00	0.64434E+00
0.57158E+00	0.80139E+00
0.52390E+00	0.48849E+00
0.73580E+00	0.73111E+00
0.69056E+00	0.70774E+00
0.46205E+00	0.72750E+00
0.93465E+00	0.82737E+00
0.80214E+00	0.11095E+01
0.16420E+01	0.13729E+01
0.11663E+01	0.10455E+01
0.13591E+01	0.82280E+00
0.67918E+00	0.70083E+00
0.14016E+01	0.16623E+01
0.13151E+01	0.11620E+01
0.17209E+01	0.17514E+01
0.86892E+00	0.86501E+00
0.10232E+01	0.10262E+01
0.10837E+01	0.10907E+01
0.10887E+01	0.13774E+01
0.13426E+01	0.63357E+00
0.46292E+00	0.11211E+01
0.85185E-01	0.85262E+00
0.89503E+00	0.86223E+00
0.33138E+00	0.83223E+00
0.51837E+00	0.82961E+00
0.58171E+00	0.87195E+00
0.55844E+00	0.94255E+00
0.93506E+00	0.91155E+00
0.10209E+01	0.96627E+00
0.89610E+00	0.10159E+01
0.14145E+01	0.10864E+01
0.14934E+01	0.10678E+01
0.13136E+01	0.10227E+01
0.16425E+01	0.93705E+00
0.12062E+01	0.96540E+00
0.15247E+01	0.10268E+01
0.13403E+01	0.11029E+01
0.12970E+01	0.11669E+01
0.96653E+00	0.12875E+01
0.15162E+01	0.13800E+01

INDEX RESULTS

Equal weighting for indices
ML estimate of variance (all indices): 0.1371

Fit results for index = FL_FWC_NW
Index Fitted to Beginning Stock Size in BIOMASS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
85/86	0.4718	0.4718	0.2901	0.1817	0.4909
86/87	0.5782	0.5782	0.3665	0.2117	0.5719
87/88	0.6070	0.6070	0.6563	-0.0493	-0.1332
88/89	0.4967	0.4967	0.6582	-0.1615	-0.4363
89/90	0.5284	0.5284	0.5466	-0.0182	-0.0491
90/91	0.7098	0.7098	0.9380	-0.2282	-0.6164
91/92	0.7844	0.7844	1.4088	-0.6244	-1.6866
92/93	1.0299	1.0299	0.8283	0.2016	0.5445
93/94	0.8643	0.8643	1.3285	-0.4641	-1.2537
94/95	1.0396	1.0396	1.3762	-0.3366	-0.9093
95/96	0.9200	0.9200	0.8930	0.0270	0.0730
96/97	1.4852	1.4852	1.4476	0.0375	0.1014
97/98	2.0048	2.0048	1.1400	0.8648	2.3361
98/99	1.2411	1.2411	1.3466	-0.1055	-0.2850
99/00	1.7216	1.7216	1.0825	0.6391	1.7263
00/01	1.5172	1.5172	1.1645	0.3527	0.9528

ML estimate of catchability: 0.45350E-07
Pearsons (parametric) correlation: 0.615 P= 0.0001
Kendalls (nonparametric) Tau: 0.467 P= 0.0003

Selectivity at age from Partial Catches

year	1	2	3	4	5	6
85/86	0.000	0.003	0.018	0.238	1.000	0.144
86/87	0.008	0.153	1.000	0.040	0.228	0.226
87/88	0.372	1.000	0.396	0.350	0.232	0.138
88/89	0.028	0.129	0.537	0.836	1.000	0.096
89/90	0.143	1.000	0.187	0.127	0.569	0.015
90/91	0.110	0.570	1.000	0.730	0.143	0.463
91/92	0.689	1.000	0.495	0.674	0.767	0.496
92/93	0.407	1.000	0.460	0.155	0.119	0.368
93/94	0.220	0.835	1.000	0.799	0.552	0.592
94/95	0.251	0.578	0.800	1.000	0.844	0.679
95/96	0.037	0.127	0.416	1.000	0.746	0.953
96/97	0.146	1.000	0.561	0.911	0.849	0.920
97/98	0.041	0.316	0.840	0.406	1.000	0.641
98/99	0.311	0.533	0.640	0.758	0.300	1.000
99/00	0.096	0.216	0.471	0.497	1.000	0.241
00/01	0.037	0.294	0.476	1.000	0.469	0.557

Fit results for index = FL_FWC_SW
Index Fitted to Mid-Year Stock Size in BIOMASS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
85/86	0.4569	0.4569	0.2893	0.1676	0.4527
86/87	0.4434	0.4434	0.4178	0.0256	0.0691
87/88	0.5999	0.5999	0.9860	-0.3861	-1.0429
88/89	0.8641	0.8641	0.2463	0.6178	1.6689
89/90	0.8164	0.8164	0.3463	0.4701	1.2699
90/91	1.0551	1.0551	0.5807	0.4743	1.2813
91/92	1.0242	1.0242	1.3324	-0.3082	-0.8326
92/93	2.0762	2.0762	1.1868	0.8894	2.4025
93/94	1.2889	1.2889	1.0285	0.2603	0.7032
94/95	0.7068	0.7068	0.5651	0.1417	0.3828
95/96	1.0415	1.0415	0.9996	0.0419	0.1132
96/97	1.3580	1.3580	1.3474	0.0106	0.0287
97/98	1.0613	1.0613	1.4390	-0.3777	-1.0202
98/99	1.3013	1.3013	1.6103	-0.3091	-0.8348
99/00	0.7091	0.7091	0.8751	-0.1660	-0.4483
00/01	1.1971	1.1971	1.2983	-0.1012	-0.2733

ML estimate of catchability: 0.54225E-07
Pearsons (parametric) correlation: 0.617 P= 0.0001
Kendalls (nonparametric) Tau: 0.500 P= 0.0001

Selectivity at age from Partial Catches

year	2	3	4	5	6	7	8
85/86	0.003	0.005	0.031	0.245	1.000	0.487	0.245
86/87	0.014	0.178	0.210	0.576	1.000	0.189	0.036
87/88	0.041	0.740	0.657	0.801	1.000	0.462	0.081
88/89	0.000	0.003	0.133	1.000	0.120	0.036	0.179
89/90	0.013	0.157	0.293	0.246	1.000	0.078	0.177
90/91	0.021	0.165	1.000	0.330	0.397	0.390	0.079
91/92	0.657	0.560	0.796	1.000	0.673	0.519	0.362
92/93	0.653	0.750	0.365	0.289	1.000	0.250	0.822
93/94	0.426	0.592	0.595	0.436	0.387	1.000	0.319
94/95	0.235	0.493	0.509	0.283	0.161	0.060	1.000
95/96	0.340	0.733	1.000	0.544	0.483	0.317	0.332
96/97	1.000	0.587	0.807	0.560	0.584	0.377	0.142
97/98	0.506	1.000	0.398	0.825	0.550	0.640	0.443
98/99	0.478	0.781	0.867	0.342	1.000	0.965	0.921
99/00	0.130	0.299	0.350	0.780	0.170	0.941	1.000
00/01	0.513	0.598	1.000	0.316	0.369	0.185	0.838

Fit results for index = MRFSS
Index Fitted to Beginning Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
86/87	0.3484	0.3484	0.3922	-0.0438	-0.1183
87/88	0.8318	0.8318	0.5083	0.3234	0.8736
88/89	0.8144	0.8144	0.4201	0.3942	1.0649
89/90	0.5416	0.5416	1.1281	-0.5865	-1.5843
90/91	1.5380	1.5380	1.3769	0.1612	0.4353
91/92	1.7178	1.7178	1.4345	0.2833	0.7652
92/93	1.2929	1.2929	1.0867	0.2062	0.5569
93/94	0.8873	0.8873	1.1319	-0.2446	-0.6606
94/95	0.8439	0.8439	0.8987	-0.0548	-0.1479
95/96	0.6693	0.6693	1.2380	-0.5687	-1.5362
96/97	1.2087	1.2087	1.1262	0.0825	0.2228
97/98	1.4320	1.4320	1.1115	0.3205	0.8656
98/99	0.8483	0.8483	1.0627	-0.2144	-0.5791
99/00	0.9707	0.9707	1.0542	-0.0835	-0.2255
00/01	1.1879	1.1879	0.8522	0.3356	0.9066
01/02	0.8672	0.8672	0.7178	0.1494	0.4036

ML estimate of catchability: 0.26384E-06
Pearsons (parametric) correlation: 0.606 P= 0.0001
Kendalls (nonparametric) Tau: 0.433 P= 0.0007

Selectivity at age from Partial Catches

year	1	2	3	4	5	6	7	8
86/87	0.108	0.071	1.000	0.253	0.213	0.489	0.144	0.084
87/88	0.090	0.379	0.427	0.693	0.289	0.398	1.000	0.374
88/89	0.270	0.079	0.325	0.331	1.000	0.062	0.256	0.113
89/90	0.531	0.540	0.974	0.747	0.350	1.000	0.087	0.273
90/91	0.598	0.787	0.789	1.000	0.196	0.211	0.182	0.046
91/92	0.448	1.000	0.631	0.703	0.302	0.478	0.750	0.807
92/93	1.000	0.435	0.460	0.468	0.546	0.336	0.432	0.487
93/94	1.000	0.681	0.471	0.578	0.480	0.449	0.552	0.379
94/95	0.145	0.692	0.653	0.664	0.476	0.566	0.765	1.000
95/96	0.325	0.467	1.000	0.899	0.662	0.840	0.612	0.800
96/97	0.098	0.869	0.346	1.000	0.751	0.401	0.493	0.646
97/98	0.299	0.294	1.000	0.304	0.998	0.643	0.416	0.467
98/99	0.407	0.451	0.297	1.000	0.282	0.867	0.776	0.448
99/00	0.332	0.387	0.590	0.516	0.481	0.275	1.000	0.238
00/01	0.115	0.429	0.690	0.410	0.139	0.395	0.114	1.000
01/02	0.085	0.164	0.286	0.547	0.886	0.123	1.000	0.393

Fit results for index = TX_PWD_83-85
Index Fitted to Beginning Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
83/84	1.0645	1.0645	0.9263	0.1382	0.3732
84/85	1.0767	1.0767	1.3046	-0.2279	-0.6156
85/86	0.8589	0.8589	0.5523	0.3066	0.8283

ML estimate of catchability: 0.10896E-05
Pearsons (parametric) correlation: 0.888 P= 0.0033
Kendalls (nonparametric) Tau: 1.000 P= 0.0189

Selectivity at age from Partial Catches

year	2	3	4	5	6	7	8
83/84	0.005	0.028	0.140	0.661	0.495	1.000	0.769
84/85	0.001	0.031	0.369	0.897	1.000	0.532	0.636
85/86	0.008	0.007	0.053	0.574	0.302	1.000	0.072

Fit results for index = TX_PWD_86-01
Index Fitted to Beginning Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
86/87	0.7439	0.7439	0.2809	0.4630	1.2506
87/88	0.8695	0.8695	0.3985	0.4710	1.2723
88/89	0.7834	0.7834	0.4949	0.2885	0.7793
89/90	0.8733	0.8733	0.4989	0.3744	1.0112
90/91	0.6760	0.6760	0.2140	0.4620	1.2478
91/92	1.5325	1.5325	0.5658	0.9667	2.6112
92/93	1.0679	1.0679	0.6222	0.4457	1.2039
93/94	1.0339	1.0339	0.8300	0.2039	0.5508
94/95	1.0788	1.0788	0.8269	0.2519	0.6804
95/96	1.3004	1.3004	1.4964	-0.1960	-0.5293
96/97	1.2896	1.2896	1.6282	-0.3386	-0.9146
97/98	1.0468	1.0468	1.3004	-0.2536	-0.6851
98/99	1.1751	1.1751	1.1390	0.0362	0.0977
99/00	0.9473	0.9473	0.8900	0.0573	0.1548
00/01	0.8052	0.8052	1.1218	-0.3166	-0.8552
01/02	0.7764	0.7764	1.2014	-0.4251	-1.1482

ML estimate of catchability: 0.56855E-06
Pearsons (parametric) correlation: 0.467 P= 0.0040
Kendalls (nonparametric) Tau: 0.417 P= 0.0010

Selectivity at age from Partial Catches

year	2	3	4	5	6	7	8
86/87	0.001	0.022	0.056	0.269	1.000	0.466	0.432
87/88	0.008	0.003	0.358	0.322	0.426	1.000	0.031
88/89	0.001	0.033	0.287	1.000	0.239	0.361	0.736
89/90	0.031	0.028	0.140	0.822	1.000	0.382	0.270
90/91	0.000	0.025	0.110	0.163	0.295	1.000	0.007
91/92	0.006	0.018	0.423	1.000	0.087	0.929	0.080
92/93	0.045	0.076	0.146	1.000	0.340	0.483	0.004
93/94	0.005	0.015	0.313	0.667	1.000	0.975	0.409
94/95	0.027	0.130	0.503	0.485	0.451	1.000	0.934
95/96	0.182	0.675	1.000	0.688	0.790	0.529	0.561
96/97	0.342	0.305	0.887	1.000	0.805	0.751	0.551
97/98	0.085	0.497	0.270	1.000	0.777	0.725	0.812
98/99	0.107	0.251	0.509	0.243	1.000	0.923	0.873
99/00	0.064	0.231	0.278	0.676	0.150	0.846	1.000
00/01	0.113	0.296	0.615	0.301	0.451	0.205	1.000
01/02	0.075	0.335	0.479	0.574	0.192	1.000	0.177

Fit results for index = HeadBoat
Index Fitted to Mid-Year Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
81/82	1.2014	1.2014	0.6562	0.5452	1.4727
82/83	0.8289	0.8289	1.1783	-0.3494	-0.9438
83/84	1.8238	1.8238	0.8034	1.0203	2.7561
84/85	0.6247	0.6247	0.4602	0.1645	0.4443
85/86	0.4156	0.4156	0.5158	-0.1002	-0.2708
86/87	0.5969	0.5969	0.6563	-0.0594	-0.1604
87/88	0.4048	0.4048	0.3669	0.0380	0.1025
88/89	0.3432	0.3432	0.7881	-0.4449	-1.2018
89/90	0.6647	0.6647	1.2570	-0.5924	-1.6002
90/91	0.5279	0.5279	0.6289	-0.1010	-0.2729
91/92	0.8733	0.8733	1.5124	-0.6390	-1.7261
92/93	1.0939	1.0939	0.5878	0.5062	1.3673
93/94	1.1648	1.1648	1.2724	-0.1076	-0.2906
94/95	1.1944	1.1944	0.8919	0.3025	0.8170
95/96	1.1694	1.1694	0.7948	0.3745	1.0117
96/97	1.5071	1.5071	0.8211	0.6860	1.8530
97/98	1.4730	1.4730	1.3985	0.0745	0.2012
98/99	1.3109	1.3109	1.0926	0.2183	0.5897
99/00	1.4969	1.4969	1.4629	0.0340	0.0918
00/01	1.0445	1.0445	1.3937	-0.3492	-0.9432
01/02	1.2402	1.2402	1.0903	0.1499	0.4049

ML estimate of catchability: 0.53220E-06
Pearsons (parametric) correlation: 0.419 P= 0.0034
Kendalls (nonparametric) Tau: 0.324 P= 0.0026

Selectivity at age from Partial Catches

year	2	3	4	5	6
81/82	0.031	0.148	1.000	0.001	0.090
82/83	0.413	1.000	0.863	0.255	0.136
83/84	0.026	1.000	0.457	0.652	0.098
84/85	0.019	0.119	1.000	0.358	0.411
85/86	0.169	0.200	0.240	0.969	1.000
86/87	0.248	1.000	0.201	0.231	0.484
87/88	0.008	0.084	1.000	0.142	0.328
88/89	0.370	0.319	0.527	1.000	0.393
89/90	0.630	0.840	1.000	0.188	0.804
90/91	0.002	0.259	0.714	1.000	0.171
91/92	0.303	0.968	1.000	0.523	0.307
92/93	0.134	0.158	0.325	1.000	0.031
93/94	1.000	0.338	0.573	0.684	0.442
94/95	0.107	0.250	0.984	1.000	0.321
95/96	0.075	0.947	1.000	0.363	0.171
96/97	0.069	0.343	1.000	0.755	0.317
97/98	0.256	1.000	0.356	0.644	0.336
98/99	0.477	0.193	0.765	0.282	1.000
99/00	0.453	0.913	0.299	1.000	0.220
00/01	0.225	0.824	1.000	0.276	0.638
01/02	0.020	0.390	0.967	1.000	0.241

Fit results for index = Charter_FL_NW
Index Fitted to Beginning Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
88/89	0.8929	0.8929	0.3076	0.5853	1.5810
89/90	0.8819	0.8819	0.9161	-0.0342	-0.0923
90/91	0.8803	0.8803	0.8824	-0.0021	-0.0056
91/92	0.9510	0.9510	1.2849	-0.3338	-0.9018
92/93	0.9989	0.9989	0.9329	0.0660	0.1783
93/94	0.9305	0.9305	1.1255	-0.1950	-0.5267
94/95	1.2008	1.2008	1.1524	0.0484	0.1308
95/96	1.2637	1.2637	0.7547	0.5090	1.3750

ML estimate of catchability: 0.24029E-06
Pearsons (parametric) correlation: 0.132 P= 0.4386
Kendalls (nonparametric) Tau: 0.214 P= 0.2078

Selectivity at age from Partial Catches

year	1	2	3	4	5	6	7
88/89	0.052	0.069	0.116	0.633	1.000	0.065	0.620
89/90	0.453	0.629	0.831	0.329	1.000	0.175	0.125
90/91	0.154	0.665	1.000	0.595	0.283	0.549	0.493
91/92	0.735	1.000	0.400	0.454	0.389	0.204	0.194
92/93	0.282	1.000	0.637	0.318	0.250	0.367	0.183
93/94	0.767	1.000	0.845	0.615	0.399	0.429	0.762
94/95	0.404	1.000	0.749	0.762	0.546	0.418	0.345
95/96	0.174	0.392	1.000	0.546	0.202	0.248	0.190

Fit results for index = Charter_FL_SW
Index Fitted to Mid-Year Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
88/89	0.7913	0.7913	0.4326	0.3587	0.9690
89/90	1.0462	1.0462	1.4830	-0.4368	-1.1799
90/91	0.8940	0.8940	0.7521	0.1419	0.3834
91/92	0.7323	0.7323	0.8167	-0.0844	-0.2279
92/93	0.9435	0.9435	1.1222	-0.1788	-0.4829
93/94	1.0652	1.0652	0.4535	0.6118	1.6525
94/95	1.5274	1.5274	0.3106	1.2168	3.2868

ML estimate of catchability: 0.47731E-06
Pearsons (parametric) correlation: -0.287 P= 0.2168
Kendalls (nonparametric) Tau: -0.143 P= 0.3705

Selectivity at age from Partial Catches

year	1	2	3	4	5	6	7	8
88/89	0.177	0.058	0.101	0.235	1.000	0.041	0.420	0.085
89/90	0.236	1.000	0.849	0.361	0.572	0.672	0.039	0.275
90/91	0.099	0.086	0.307	0.447	0.333	0.720	1.000	0.817
91/92	0.084	0.288	0.301	0.363	0.204	0.421	0.443	1.000
92/93	0.450	0.153	0.250	0.479	0.875	1.000	0.449	0.420
93/94	0.039	0.141	0.112	0.189	0.378	0.325	1.000	0.086
94/95	0.005	0.031	0.101	0.129	0.436	0.224	0.274	1.000

Fit results for index = Bycatch_GLM
Index Fitted to Beginning Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
81/82	0.5880	0.5880	0.6443	-0.0563	-0.1522
82/83	0.5716	0.5716	0.8014	-0.2298	-0.6208
83/84	0.5239	0.5239	0.4885	0.0354	0.0956
84/85	0.7358	0.7358	0.7311	0.0047	0.0127
85/86	0.6906	0.6906	0.7077	-0.0172	-0.0464
86/87	0.4620	0.4620	0.7275	-0.2655	-0.7170
87/88	0.9346	0.9346	0.8274	0.1073	0.2898
88/89	0.8021	0.8021	1.1095	-0.3073	-0.8301
89/90	1.6420	1.6420	1.3729	0.2691	0.7269
90/91	1.1663	1.1663	1.0455	0.1209	0.3265
91/92	1.3591	1.3591	0.8228	0.5363	1.4487
92/93	0.6792	0.6792	0.7008	-0.0216	-0.0585
93/94	1.4016	1.4016	1.6623	-0.2607	-0.7041
94/95	1.3151	1.3151	1.1620	0.1531	0.4135
95/96	1.7209	1.7209	1.7514	-0.0305	-0.0824
96/97	0.8689	0.8689	0.8650	0.0039	0.0106
97/98	1.0232	1.0232	1.0262	-0.0031	-0.0083
98/99	1.0837	1.0837	1.0907	-0.0070	-0.0189
99/00	1.0887	1.0887	1.3774	-0.2887	-0.7800
00/01	1.3426	1.3426	0.6336	0.7091	1.9153

ML estimate of catchability: 0.27255E-06
Pearsons (parametric) correlation: 0.745 P= 0.0000
Kendalls (nonparametric) Tau: 0.568 P= 0.0000

Selectivities set to 1.0

year	0
81/82	1.000
82/83	1.000
83/84	1.000
84/85	1.000
85/86	1.000
86/87	1.000
87/88	1.000
88/89	1.000
89/90	1.000
90/91	1.000
91/92	1.000
92/93	1.000
93/94	1.000
94/95	1.000
95/96	1.000
96/97	1.000
97/98	1.000

98/99	1.000
99/00	1.000
00/01	1.000

Fit results for index = SEAMAP

Index Fitted to Beginning Stock Size in NUMBERS

	Scaled	Obj.Function	Predicted	Residual	Scaled resid
82/83	0.4629	0.4629	1.1211	-0.6582	-1.7780
83/84	0.0852	0.0852	0.8526	-0.7674	-2.0730
84/85	0.8950	0.8950	0.8622	0.0328	0.0886
85/86	0.3314	0.3314	0.8322	-0.5008	-1.3529
86/87	0.5184	0.5184	0.8296	-0.3112	-0.8407
87/88	0.5817	0.5817	0.8719	-0.2902	-0.7840
88/89	0.5584	0.5584	0.9425	-0.3841	-1.0376
89/90	0.9351	0.9351	0.9116	0.0235	0.0635
90/91	1.0209	1.0209	0.9663	0.0546	0.1476
91/92	0.8961	0.8961	1.0159	-0.1198	-0.3236
92/93	1.4145	1.4145	1.0864	0.3281	0.8863
93/94	1.4934	1.4934	1.0678	0.4256	1.1498
94/95	1.3136	1.3136	1.0227	0.2909	0.7859
95/96	1.6425	1.6425	0.9370	0.7054	1.9055
96/97	1.2062	1.2062	0.9654	0.2408	0.6505
97/98	1.5247	1.5247	1.0268	0.4979	1.3450
98/99	1.3403	1.3403	1.1029	0.2373	0.6411
99/00	1.2970	1.2970	1.1669	0.1301	0.3515
00/01	0.9665	0.9665	1.2875	-0.3209	-0.8669
01/02	1.5162	1.5162	1.3800	0.1362	0.3679

ML estimate of catchability: 0.23716E-06

Pearsons (parametric) correlation: 0.525 P= 0.0002

Kendalls (nonparametric) Tau: 0.400 P= 0.0003

Selectivities input

year	1	2	3	4	5	6	7	8	9	10	11
82/83	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
83/84	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
84/85	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
85/86	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
86/87	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
87/88	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
88/89	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
89/90	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
90/91	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
91/92	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
92/93	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
93/94	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
94/95	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
95/96	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
96/97	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
97/98	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
98/99	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
99/00	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
00/01	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853
01/02	0.015	0.121	0.308	0.612	1.037	1.425	1.829	2.247	2.667	3.079	3.853

Table 13. Maximum sustainable yield (MSY) and optimum yield (OY) related bench mark values for the base-04 case and the new-ALK scenarios. SS is spawning stock biomass in trillions of eggs, F values are associated with the fully selected age, and yields are given in millions of pounds.

Model **Base 04**

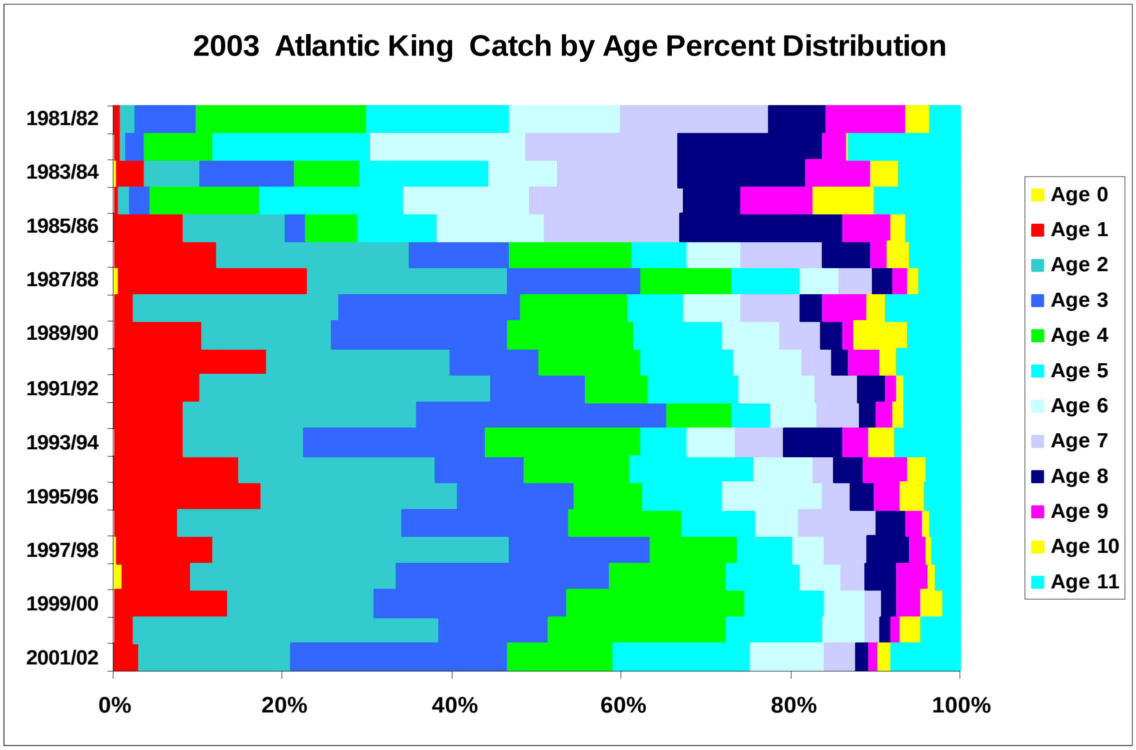
	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	6.385	0.269	11.417	8.524	0.190	10.113
low 80%	5.556	0.235	9.609	7.436	0.166	8.522
upp 80%	7.387	0.366	13.606	9.779	0.255	12.098
deterministic	6.380	0.226	11.286	8.506	0.160	9.974

Model **NewALK4**

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	6.379	0.388	11.984	8.471	0.265	10.821
low 80%	5.525	0.283	10.221	7.455	0.198	9.232
upp 80%	7.499	0.579	14.277	9.954	0.382	12.782
deterministic	6.358	0.408	12.114	8.477	0.279	10.954

Table 14. Fishing year 2003/2004 acceptable biological catch (ABC) in millions of pounds for the base-04 case and the New-ALK scenarios for two levels of F mortality. Probability denotes likelihood of exceeding the desired F mortality rate.

		Base 04		New ALK	
Probability		*$F_{30\%}SPR$*	*$F_{40\%}SPR$*	*$F_{30\%}SPR$*	*$F_{40\%}SPR$*
50%	Median	10.322	7.442	12.005	8.414
10 %	Lower CI	7.544	5.421	8.876	6.208
90%	Upper CI	13.504	9.836	15.829	11.188



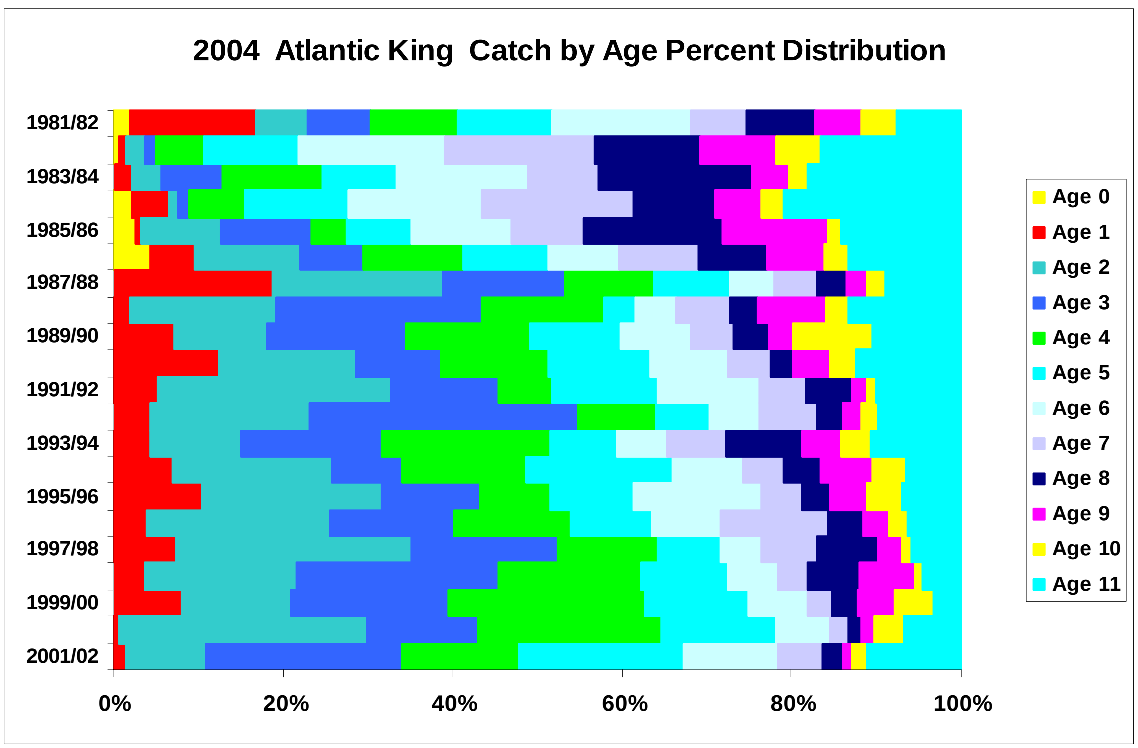
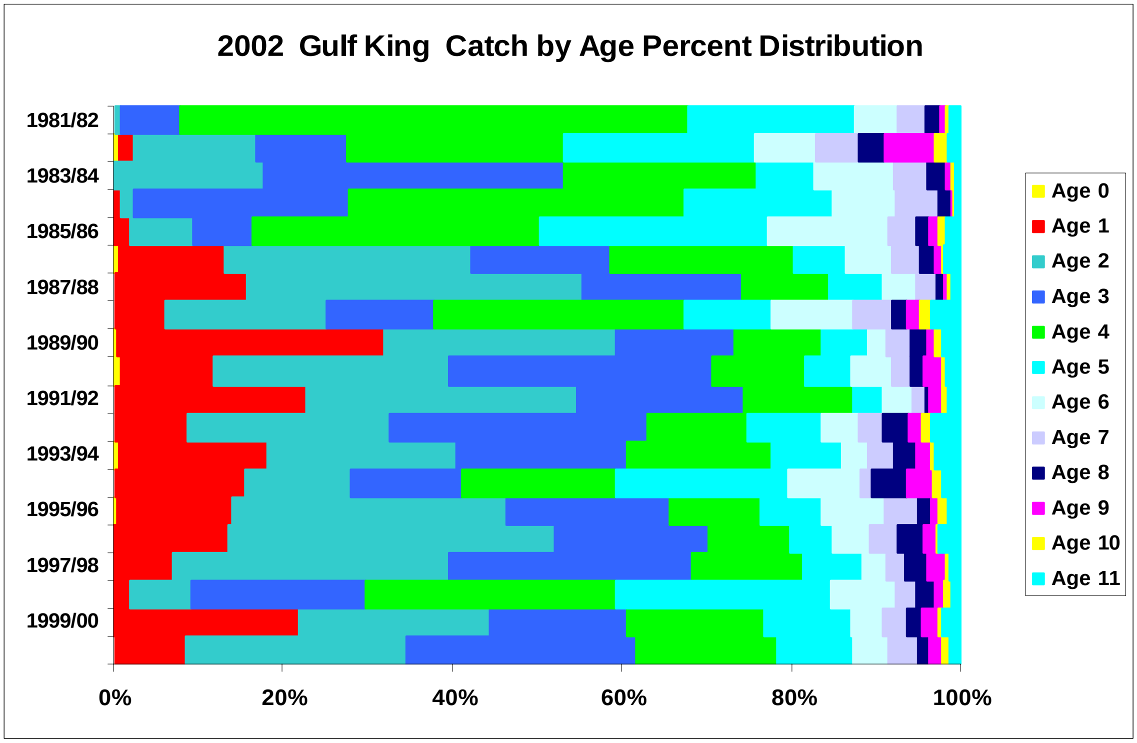


Figure 1. Comparison of the age distribution for Atlantic king mackerel directed catch from 2003 CAA input matrix (top) and the new-ALK 2004 CAA matrix.



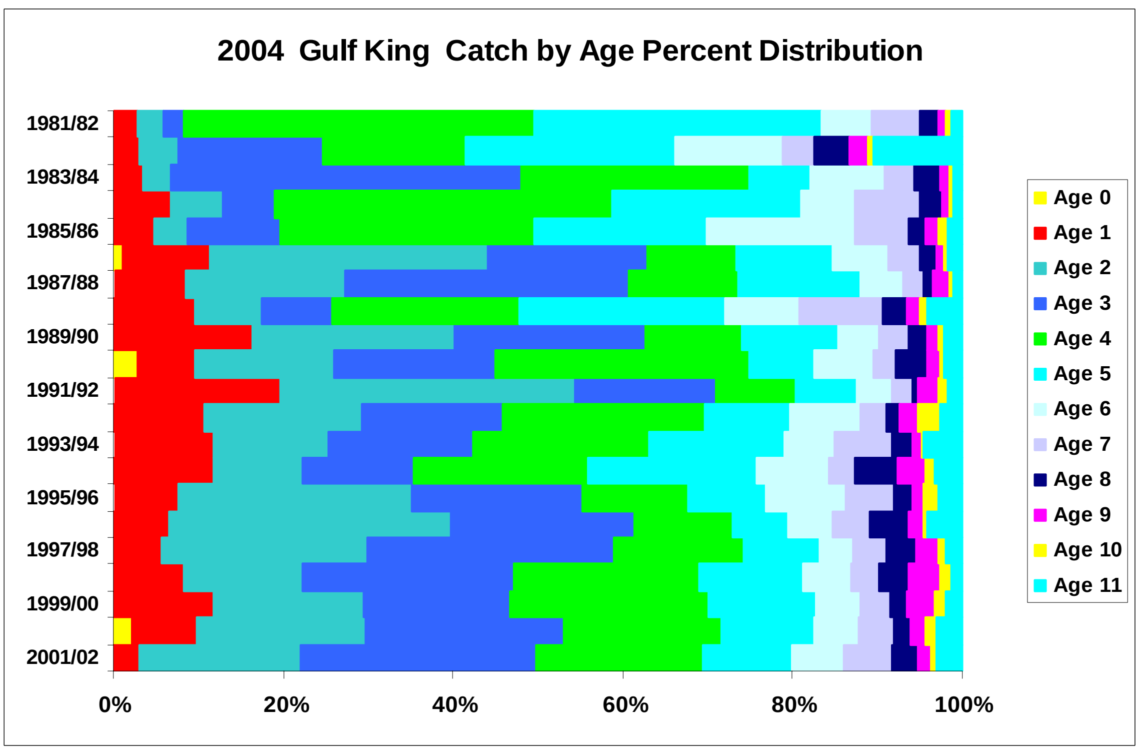


Figure 2. Comparison of the age distribution for Gulf king mackerel directed catch from 2002 CAA input matrix (top) and the new-ALK 2004 CAA matrix.

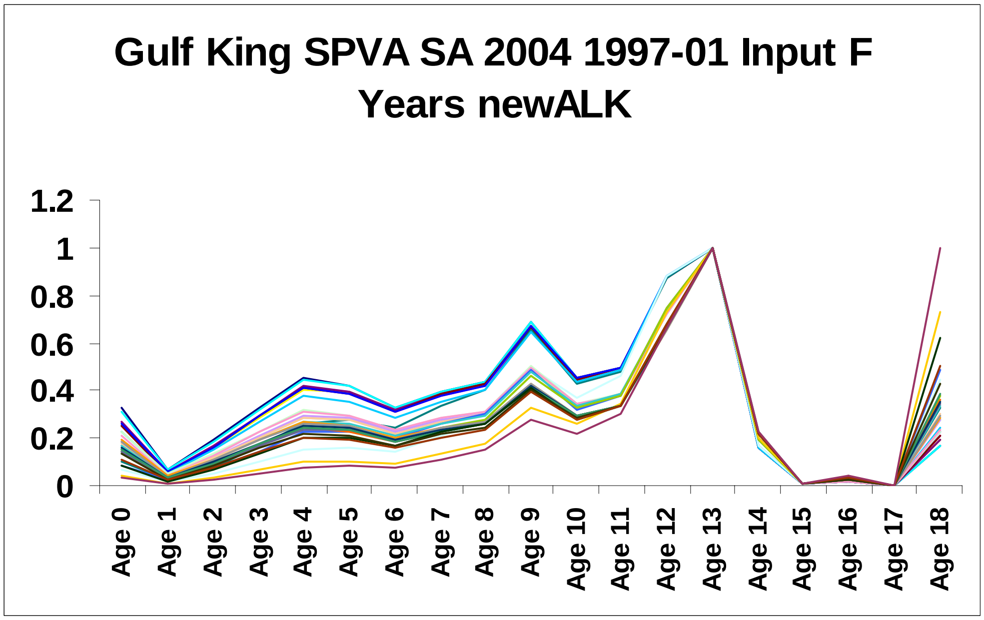


Figure 3. Selectivity patterns results from SVPA models with a range of fixed F ratios for new-ALK CAA of Gulf king mackerel.

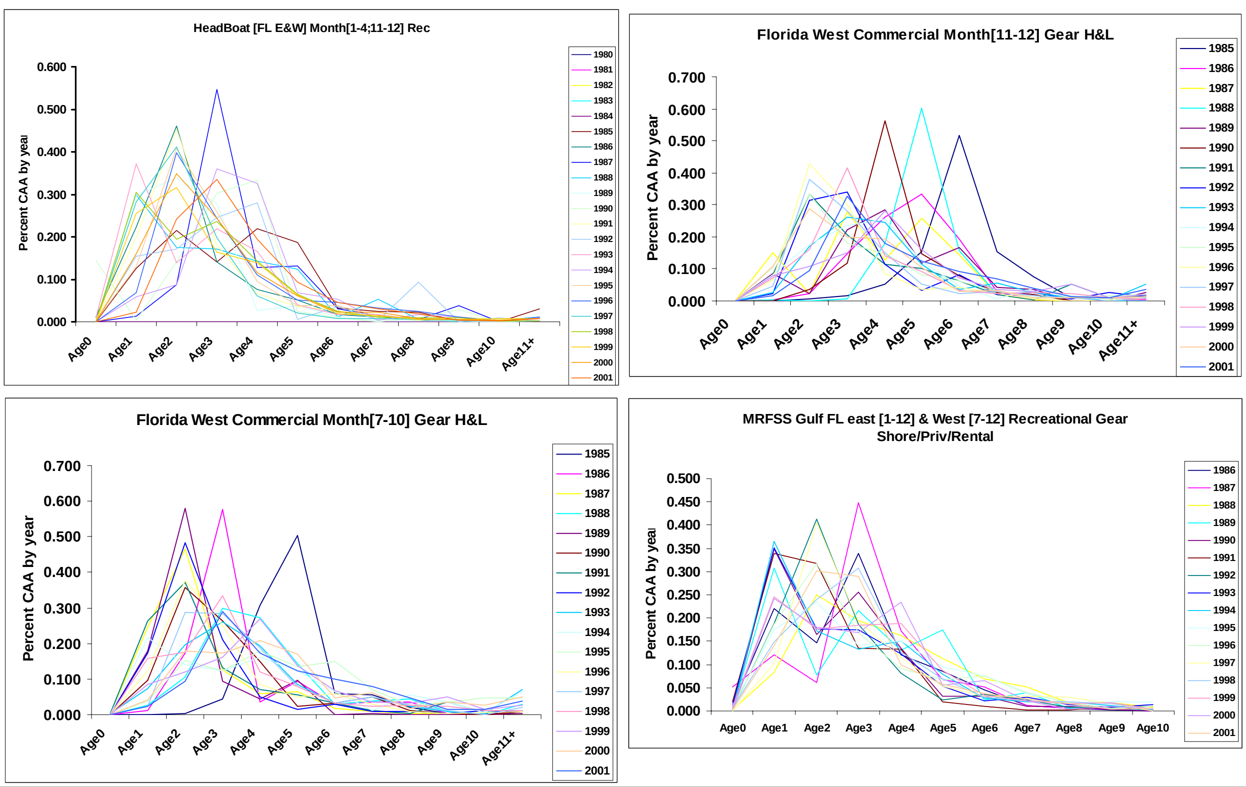


Figure 4. Proportional age distribution of the Partial Catch at Age (PCAA) for the Headboat fishery 1981-2002 (top left), the Florida West commercial fisheries in the south 1985-2001 (top right), the Florida West commercial fisheries in the north 1985-2001 (bottom left) and the MRFSS recreational fishery 1988-2001 (bottom right).

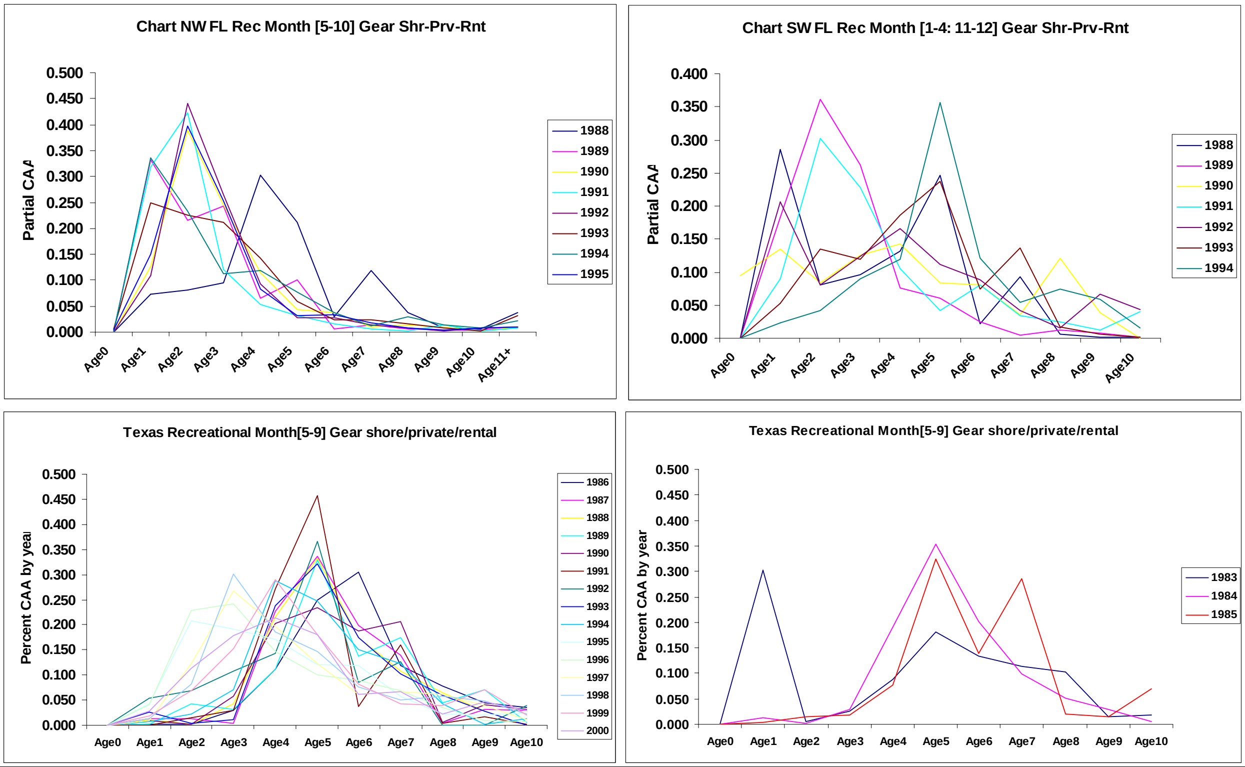


Figure 5. Proportional age distribution of the Partial Catch at Age (PCAA) for the Charter Florida NW fishery 1988-1995 (top left), the Charter Florida SW recreational fishery 1988-1994 (top right), the Texas recreational fisheries 1986-2000 (bottom left), and the Texas recreational fishery 1983-1985 (bottom right).

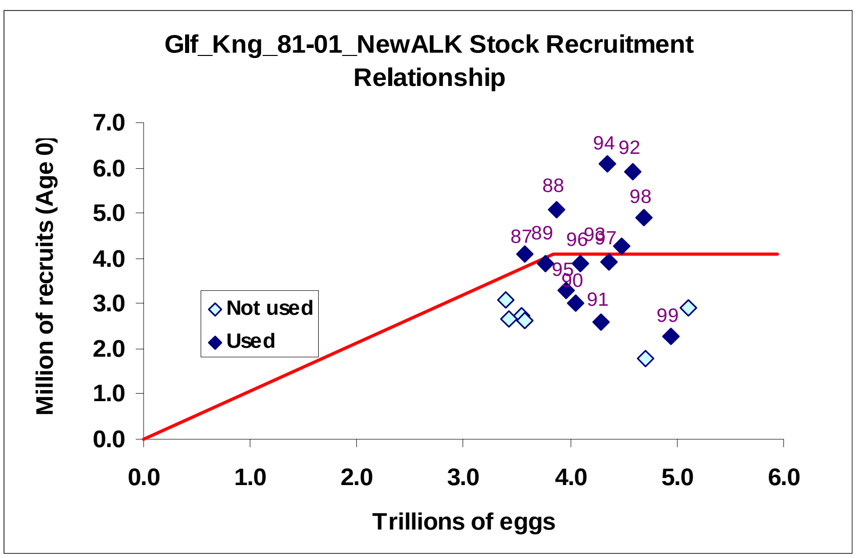
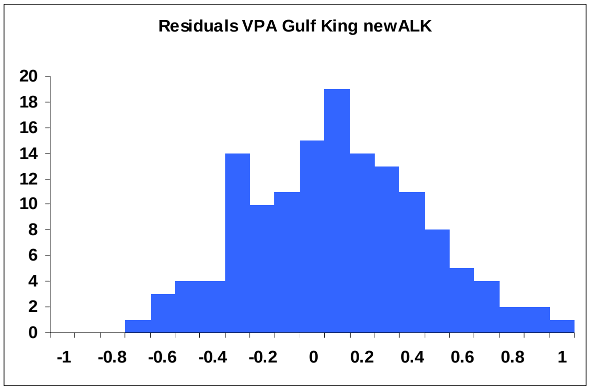


Figure 6. Stock recruitment relationship under the two line model definition for the new-ALK scenario.



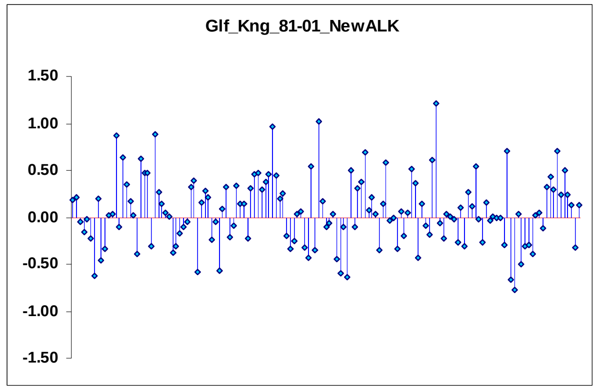


Figure 7. VPA residuals distribution from the new-ALK deterministic run.

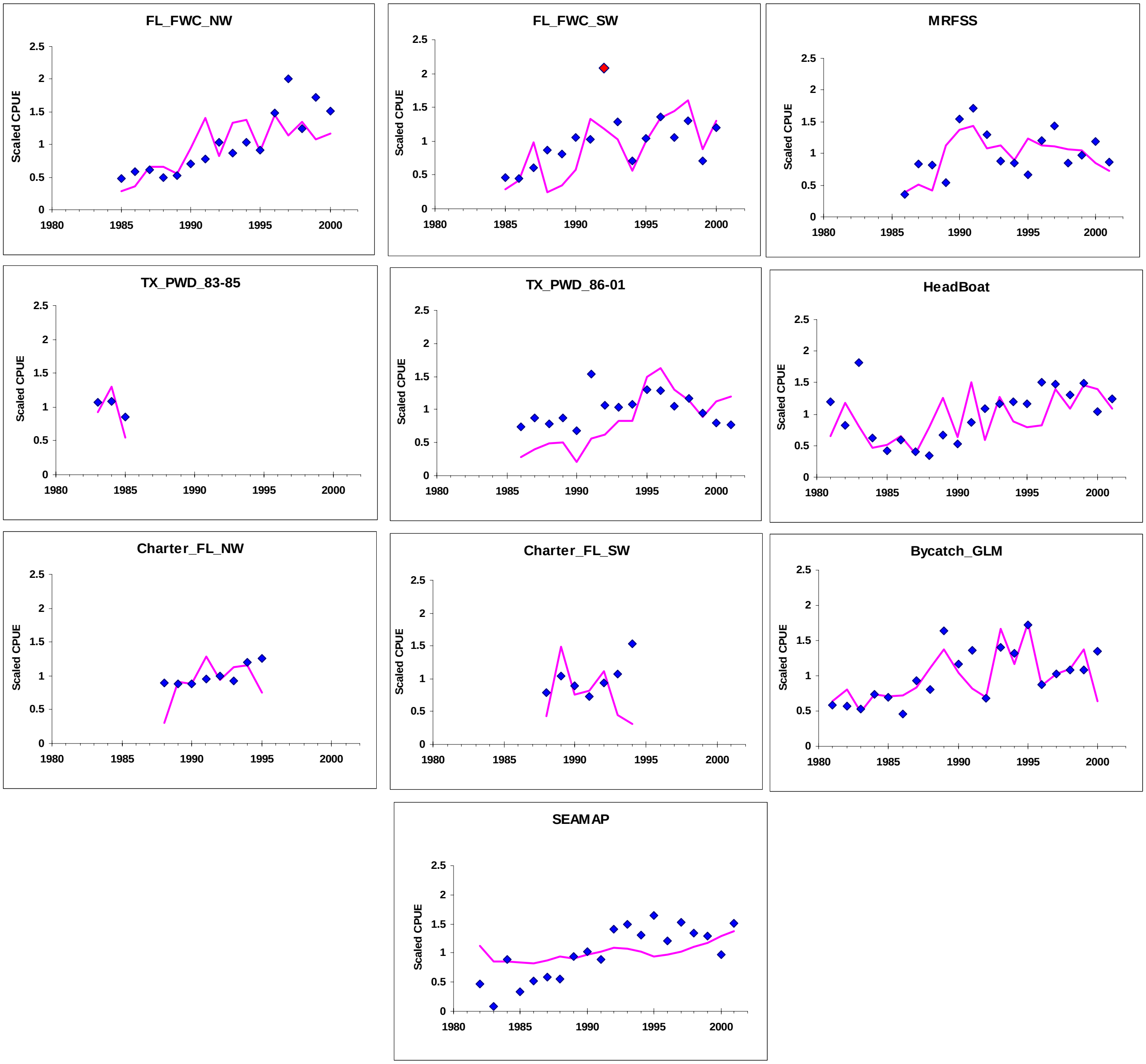


Figure 8. Gulf king mackerel predicted (solid line) and standardized indices of abundance (diamonds) from the tuned VPA new-ALK model.

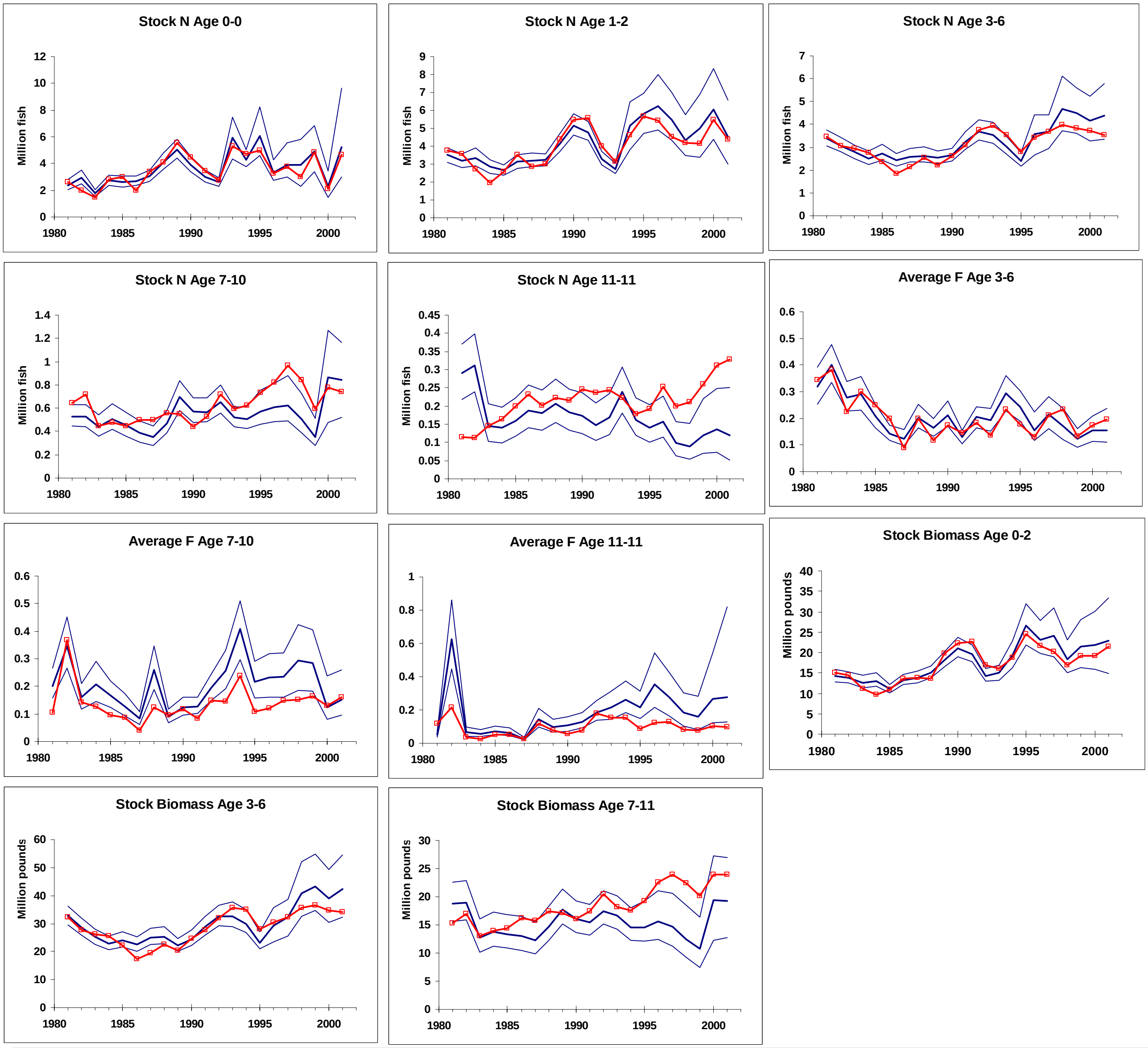


Figure 9. Gulf king mackerel population trends with 80% confidence intervals from the new-ALK model (solid lines). For comparison results from the 2004 Base-04 scenario are shown (open square marker line).

Figure 10. Estimated stock size by age from the tuned VPA results of the new-ALK model (solid line) and corresponding estimates from the 2000 stock assessment.

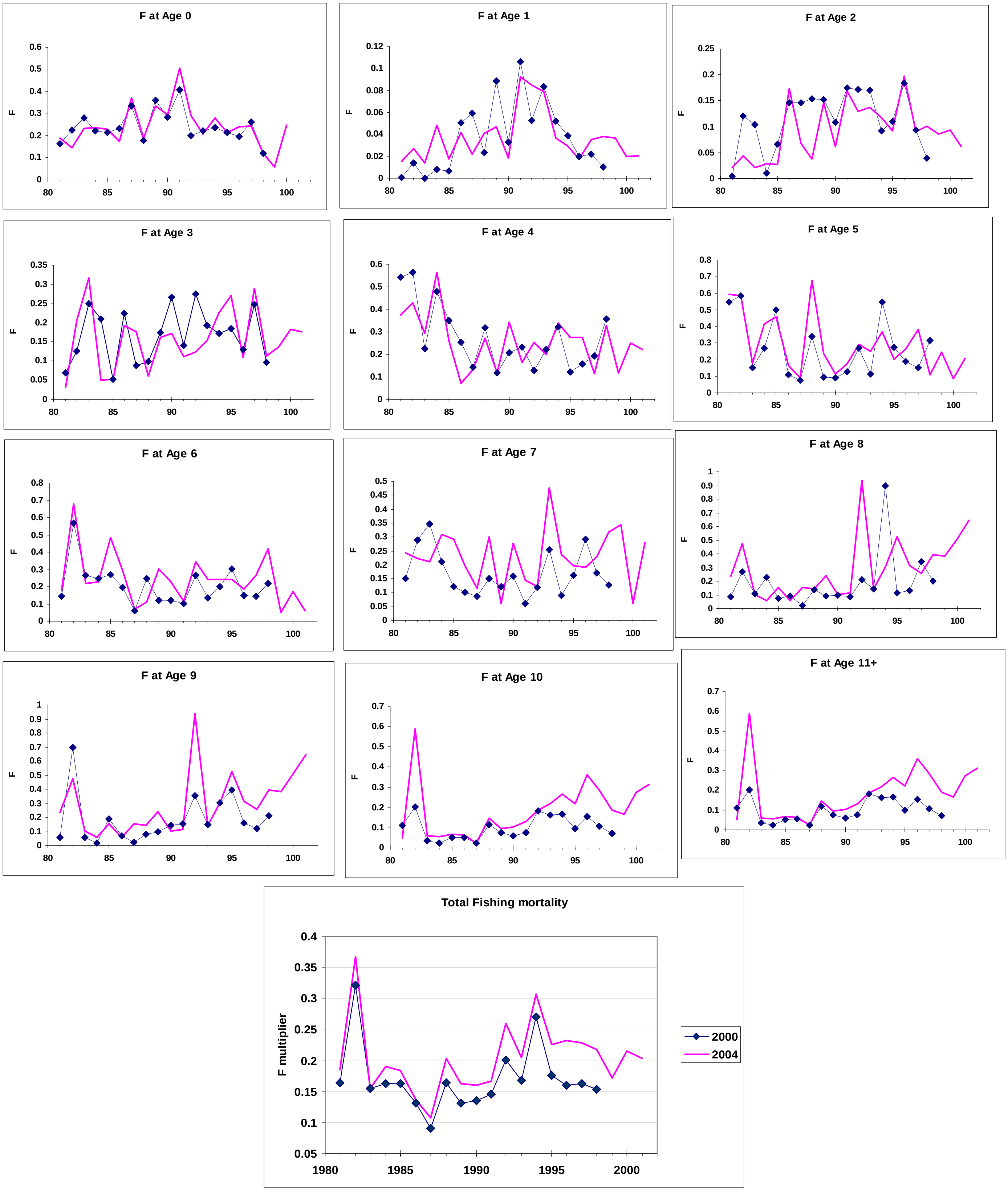


Figure 11. Estimated fishing mortality rates (F) by age from the tuned VPA results of the new-ALK model (solid line) and corresponding estimates from the 2000 stock assessment (solid diamonds line).

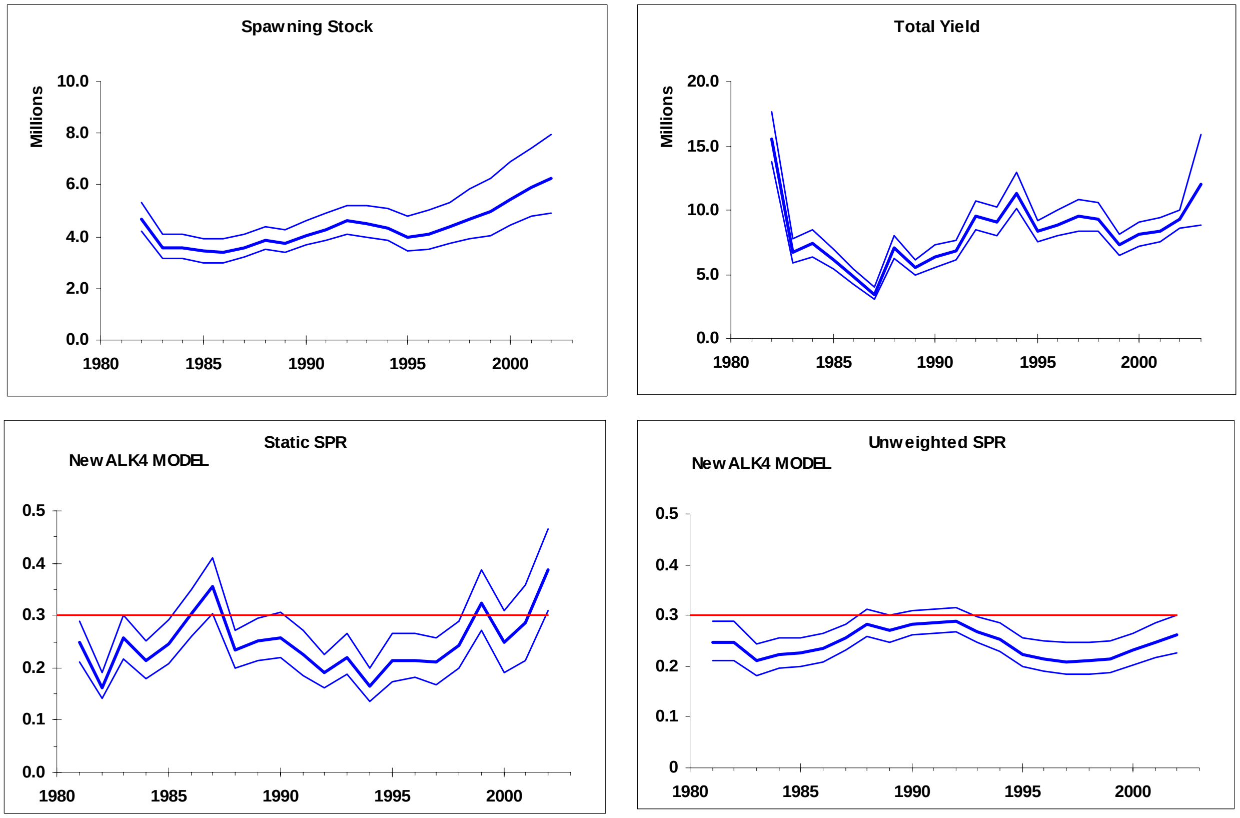


Figure 12. Trends of spawning stock, total yield, static and unweighted SPR from the new-ALK model. Thin lines represent approximate 80% confidence intervals base on 500 bootstraps.

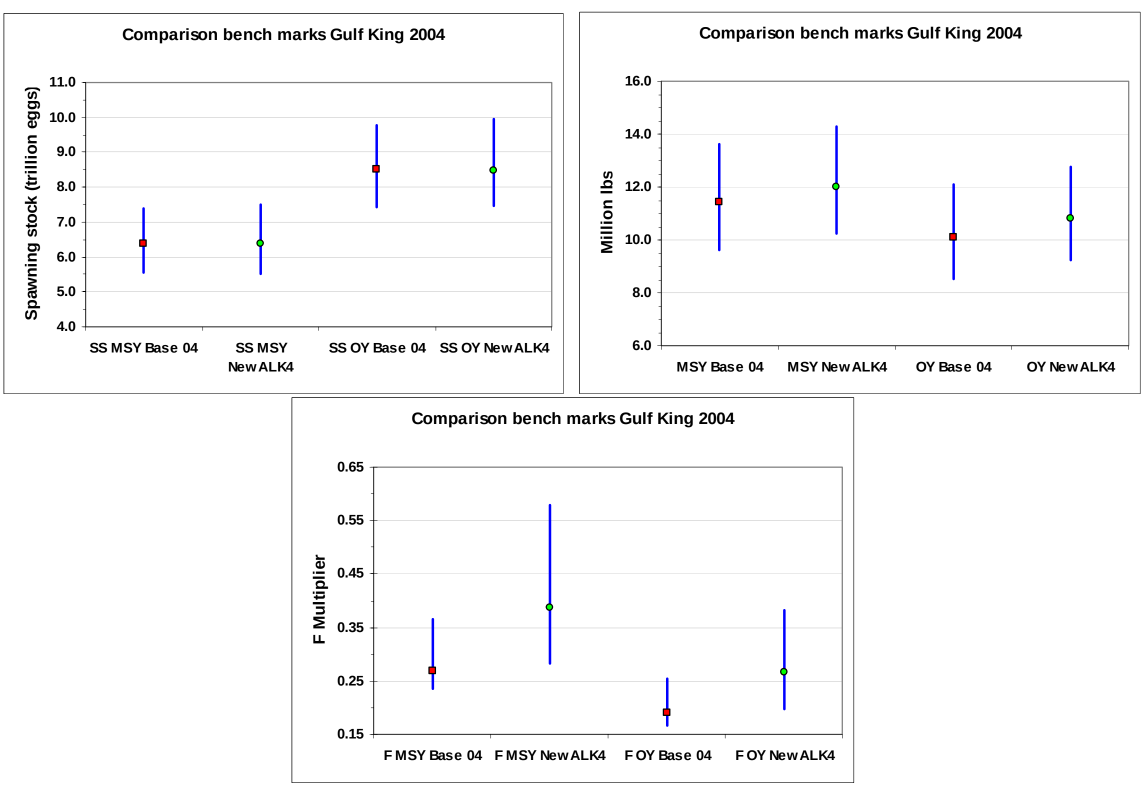
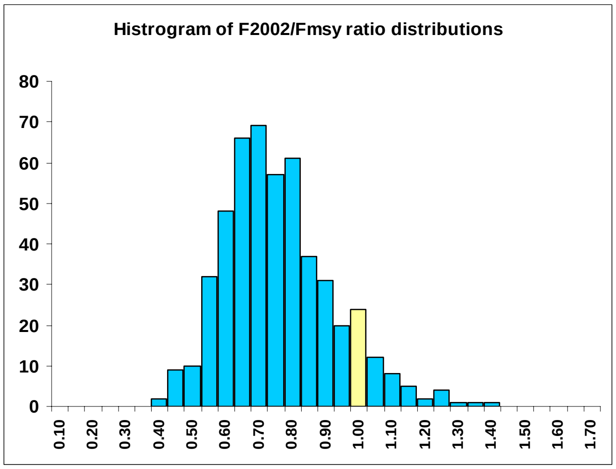


Figure 13. Gulf king benchmarks 2004 assessment. Spawning stock (SS) biomass, MSY, OY (millions of pounds), and corresponding F mortality rates from the base-04 model (solid squares) and the new-ALK model (circles)



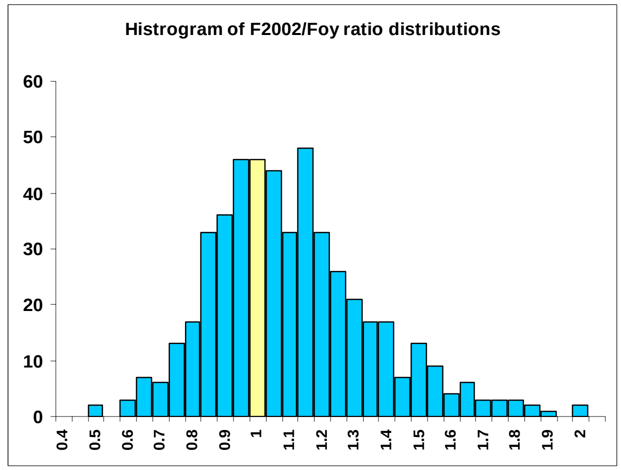
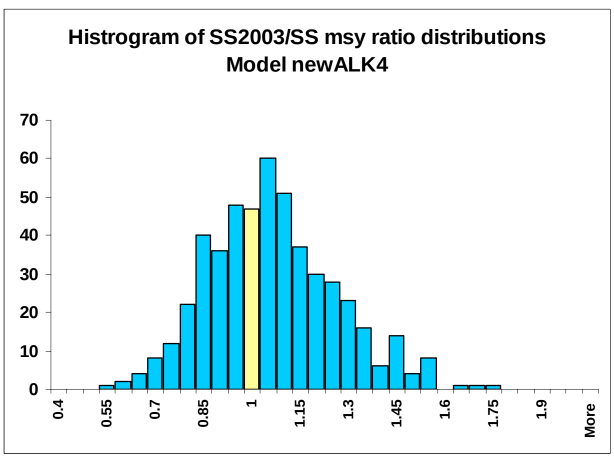


Figure 14 Distribution of Gulf king F_{2002}/F_{MSY} (left) and F_{2002}/F_{OY} (right) ratios from 500 bootstraps for the New-ALK model.



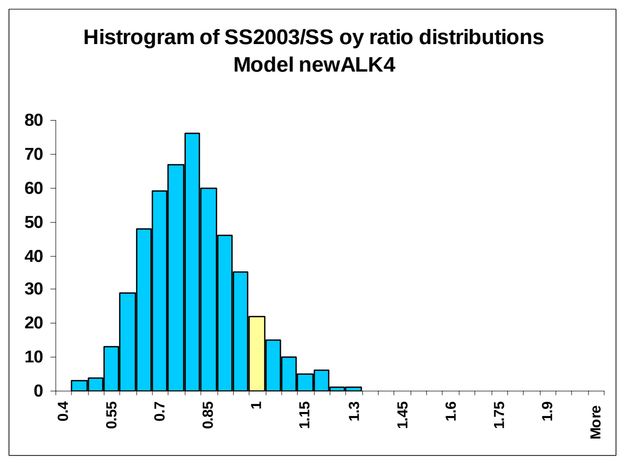


Figure 15 Distribution of Gulf king SS_{2003}/SS_{MSY} (left) and SS_{2003}/SS_{MSY} (right) ratios from 500 bootstraps for the New-ALK model.

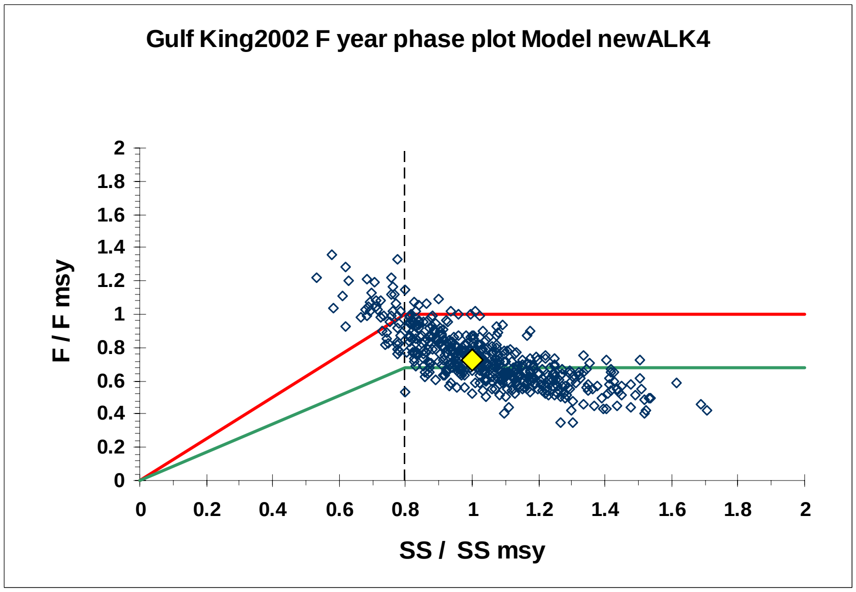


Figure 16. Phase plot of 500 bootstraps for the new-ALK model. The solid top line represents the MFMT, the vertical dash line denotes MSST, and the lower solid horizontal line denotes the OY control rule. The deterministic run corresponds to the larger diamond marker.

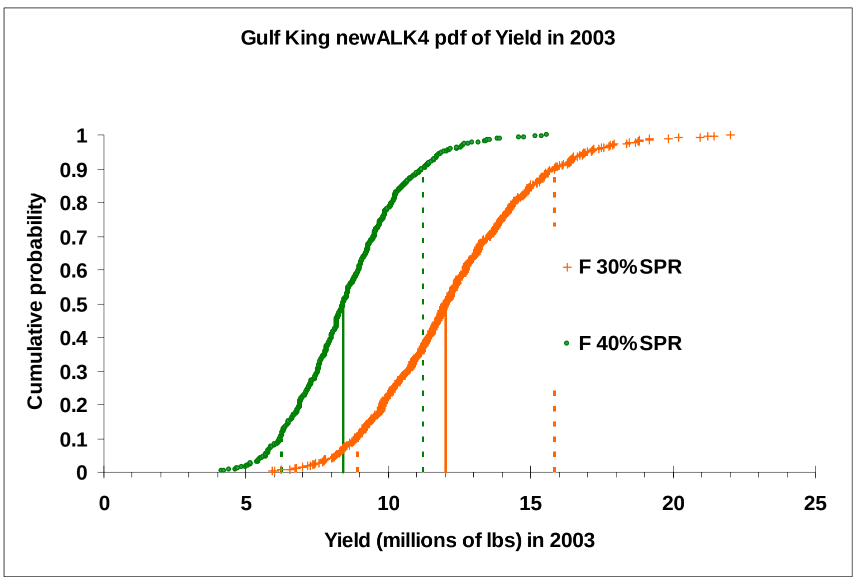


Figure 17. Frequency distribution of 500 boostraps range of allowable biological catch (ABC) based on probability of F exceeding $F_{30\%SPR}$ and $F_{40\%SPR}$ in the 2003-04 fishing year for Gulf king mackerel from the New-ALK model. A vertical solid line represents 0.5 percentile; broken lines represent 0.1 and 0.9 percentiles of the distributions.