Stock Assessment Analysis on Gulf of Mexico King Mackerel

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Since 1985 the Mackerel Stock Assessment Panel (MSAP) has met annually to review the status of mackerel and other coastal pelagic stocks within the jurisdiction of the Gulf of Mexico and South Atlantic Fishery Management Councils and to recommend Acceptable Biological Catches (ABC's) for mackerels. The most recent full assessment of the Gulf king mackerel migratory group was on May 2002 (Ortiz et al 2002). This document provides: updated baseline analyses considering catch and effort through 2001/02 fishing year, comparison of evaluation results with the prior assessment, and measures of uncertainty in the results to use in advising the Gulf Council of risk assessment for the Gulf of Mexico king mackerel migratory group under different levels of catch for the 2004 management season.

The report is organized into sections dealing with discussions of the catch, biological characteristics, indices, and assessment methods and results. Emphasis in the presentation is on changes in data and methodology from those used in year 2002. Comparison of the 2000, 2002 and 2004 results are presented for discussion. Based on prior history, further exploration by the Assessment Panel is expected at the SEDAR meeting in order to build upon the record of MSAP reports and supporting documentation provided since 1985.

CATCH

Directed Catch

U.S. commercial landings, recreational catches, and size-frequency data for calendar years 1997, 1998, 1999, 2000, 2001 and 2002* were updated in this assessment. Estimates through the 2001/02 fishing year (which corresponds from July 1st 2001 to June 30th 2002) were incorporated into these analyses. Table 1 presents the directed catch by the sectors (commercial and recreational) during each fishing year in both numbers and weight of fish landed (Fig 1).

Shrimp Trawl Bycatch

Estimates of annual bycatch of king mackerel in the Gulf of Mexico shrimp trawl fishery were NOT updated in year 2004. Bycatch estimates were available only through fishing year 2000-01, for the fishing year 2001-02 it was assumed the same bycatch level as in 2000-01 (442,066 fish age 0). The bycatch estimates are nearly identical to those from the 2000 assessment (Fig 2, Table 2). As described in 2002 report, the bycatch GLM estimation model takes into account the implementation of bycatch reduction devices (BRDs) in the Gulf of Mexico shrimp fishery.

Size and Age Distribution of the Catches

Procedures and protocols used for matching length samples to catch by migratory group, year, month, sector, and gear strata were developed at the 1989 MSAP workshop held in Panama City, Florida and have been since discussed in detail (SEDAR WG5 2003, MSAP 1997). Briefly, all size frequency samples within a stratum are combined into a composite sample and then matched to the catches of the same strata. In the event that there are insufficient size samples (<100 per analytical stratum), additional composite samples are added from neighboring strata until sufficient sample sizes (≥ 100) are obtained to size the catch. Strata used historically in assigning size samples to catch have been year, month, area, sector, and gear. Each match is assigned a code so that calculations can be made of the amount of catch that is sized with exact matches (approximately 80%) and the amount requiring substitution samples (MSAP Supplemental 1997). A review of the catch-at-size and size-sample distributions were presented and discussed at the SEDAR WG5 (Dec 2003, Miami). Detailed report of sizing of king Gulf catch is described in Ortiz et al (2003).

In addition to convert catch into Catch-at-size (CAS), the protocol used estimated sex-at-size ratios to convert the CAS into CAS by sex. Sex ratios for Gulf king were available from 1984 to 1994 (Restrepo 1996). A recommendation from the SEDAR WG5 indicated updating the estimated sex-ratio-at-size for the years 1995 on, however due to limited number of sex-samples, and time restrictions, the Sex-ratios-at size for 1995-2001 were not available prior to this evaluation. Therefore, as in prior assessments, the CAS was converted to CAS by sex by using the 1994 sex-ratios for 1995-2001.

The CAS by sex, year, and region [Western Gulf of Mexico, or Eastern Gulf of Mexico] were assigned ages with one of two approaches: a) using an Age-Length-Key (ALK) which was specific to year, quarter, and stock or, b) by applying a stochastic ageing procedure (SAR) that utilized a growth

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* Data for calendar year 2002 are provisional NMFS SEFSC Miami

model by sex (Manooch et al 1987) which accounts for monthly variation in the length at age (see Ortiz et al 2003, Cummings 1989). The variability in length at age was determined using previously published growth models for king mackerel and this method was adopted by MSAP 1989 and since reviewed (MSAP 1997).

For the 2002 Stock Assessment of Gulf king catches and size samples were both revised (1997-1999) and calendar years 2000 and 2001 were added as new data. This resulted in the addition of fish into the Age Length Key database for calendar years 1995-1997 which had been excluded in the prior assessments (2000 and before). The overall change to the database added 209 fish (108 in 1995, 144 in 1996, and 37 in 1997). The 2002 Stock Assessment reported significant changes in the CAA matrix comparing the 2000 and 2002 CAA inputs (MSAP-02). Briefly, the 2002 CAA allocated significantly more catch into Ages 1, 2 and 3, thus reducing proportional catches of ages 4, 5 and 6 compared to the 2000 CAA. Consequently, The MSAP and the SEDAR 5 WG recommended a review and evaluation of the aged database, procedures and algorithms for Catch sizing and ageing, and their effect on the assessment results. During the SEDAR 5-WG the group identified several king aged-samples of the ALK database that were revised and corrected (DeVries and Palmer, *personal communication*). In addition, ALK algorithms were revised and updated, after the SEDAR 5-WG. Thus, for the 2004 CAS by sex data, ageing was performed using revised ALKs for the years 1997 through 2002, and a modified algorithm for construction of the ALKs (Ortiz 2004). As a result CAA matrix for 2004 assessment of king Gulf included updates for the fishing years of 1997-98 through 2001-02. Table 3 presents the 2004 CAA input and Figure 3 shows the relative proportion of CAA by year. By comparison, the 2004 CAA show a catch distribution at age analogous to the 2000 CAA rather than the 2002 CAA distribution. Table 4 presents the changes in proportion at age between the 2002 CAA and the 2004 CAA matrices.

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, 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. The point estimate has been selected by the MSAP based upon the longevity and growth rates of the mackerels and by analogy with other species with similar life history characteristics.

Fecundity

The fecundity at age vector is the same as used in previous 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

Standardization Methods

In prior assessments, the General Linear Modeling (GLM) approach was used to standardize several catch-per-unit-effort (CPUE) series (Legault *et al.* 2000). Briefly, the model may be expressed as:

$$\text{Log(CPUE)} = a + \Sigma_i b_i I_i + e$$

where a and the b_i are parameters, the I_i are categorical variables and e is the error term assumed to be normally distributed with mean 0 and variance σ^2. The categorical variables include year and other factors which contribute to the variation in log(CPUE) independently of abundance. However, this model requires modifying values of zero catch (to make the logarithmic transformation). Traditionally a value of 1 or other constant positive value was added to all observations prior to the standardization procedure. In cases where the proportion of zero catch values to the total observations is relatively high, the standardized catch rates may dependent largely on the selection of such constant value (Ortiz *et al*. 2000). Following, Cooke and Lankester (1996) suggestions for alternative statistical models for catch-effort standardization, and Punt *et al.* (2000) protocols, some of the CPUE indices for king mackerel were standardized using Generalized Linear Models, specifically the delta lognormal model. Briefly, the delta model separates the estimation process into two components: the probability of encountering king mackerel and the density to fish given that at least one fish was encountered. Standardized catch rates for Gulf king mackerel using the delta model have previously presented to the MSAP working group (Ortiz and Phares 2003, Ortiz *et al.* 2000).

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, assumed directly proportional to abundance. The annual trends in CPUE are 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 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 5, 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 three through six. The South area index was applied to fish ages three through eight, included observations from November and December in Monroe or Collier counties and was restricted to a maximum catch limit of 3,500 pounds. These selections were made to account for concern expressed by the 1996 and 1998 MSAP of potential biases in indices from trip limits put into place during specific months. Both indices have been modeled as the standardized pounds per day fished adjusted for month and county (Table 5). At the SEDAR WG 5 the FL-FWC submitted updated indices for the NW and SW commercial fishery; however the updated indices vary 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 (Fig 4A). Due to time restrictions, it was not possible to clarify the reasons for the change of year's coverage, therefore for the present assessment (2004) it was decided to use the 2002 indices with out 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 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, also adjusted by month, county, and mode. This index was applied to fish of ages two through eight (Table 5). A detailed report of the standardization procedure is presented in Ortiz (2003). A comparison of the pattern in the data available for the previous assessment and the current one are shown in Figure 4B.

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 5). A detailed report of the standardization procedure is presented in Ortiz and Phares (MSAP-02-03). A comparison of the pattern in the data available for the previous assessment and the current one are shown in Figure 5.

D. NMFS Beaufort Laboratory Headboat (Southeast Florida)

CPUE data from this source represents 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 5). A comparison of the pattern in the data available for the previous assessment and the current one are shown in Figure 6.

E. Bycatch Indices from GLM and Delta Lognormal Approaches

Tuning indices from the bycatch analyses have been computed using the traditional method, 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 (Fig 7).

F. SEAMAP index

The SEAMAP survey of larval abundance resource survey provided a fishery independent index for king mackerel in the Gulf of Mexico. A review and description of the SEAMAP surveys were presented at the SEDAR 5WG (Lyczkowski and Hanisko, 2003). The working group recommended a standardization of the index for king mackerel, however due to time restrictions, the index for this assessment is as in prior assessments an estimate of the percent of occurrence of king larvae (Gledhill and Lyczkowski-Shultz 2000) (Fig 8).

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 cover from 1985 to 1994/95 years (Fig 9).

METHODS

Virtual Population Analysis

As in previous mackerel stock assessments, a tuned VPA (FADAPT) method (Powers and Restrepo 1992, Restrepo 1996) is 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 indices series, there is an option to assign a weight factor that in theory will translate the level of uncertainty of each index into the VPA's fitting procedure. Although in the past the working group suggested to evaluate alternative weighting for each index, it was concluded that at the present was not possible to assign an equivalent variance estimate among all indices (MSAP 2000, 2001). Thus, in 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 are not estimated directly. Since all indices are scaled to their own mean prior to fitting in the VPA, the absolute values of the q_i are not meaningful relative to the original data used to create the index. In each analysis, the fishing mortality rates at age in the 2001-02 fishing year (terminal year) are the parameters estimated. Note that this is analytically equivalent to estimating the population abundance in the next year at the next age. An additional assumption made in each analysis is 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) is 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. The result from the SVPA runs between the Stock Assessment in year 2000 and 2002 the varied significantly (MSAP-02). The result from the SVPA run in 2004 was more in agreement with those of 2000 (Fig 10). For the current Assessment, the average of mean selectivity for age 0 relative to age 2 was 1.7 (F_0/F_2=1.7), 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 are 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 these analyses, selectivity at age for each index by year is 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 is 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 is 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.

Characterization of Uncertainty

The uncertainty in the assessment estimation is 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 repeats 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 are accumulated and sorted to provide probability statements of relevant statistics. Projections are 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 are 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 are 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 are 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 comes 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. The stock recruitment model was 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 are used to create the relationship, excluding the last 2 years as they are highly variable. In the case of Gulf king mackerel, this means that only years 1987-1999 are used. The maximum recruitment is set at the average recruitment estimated during these years and declines linearly to the origin when the spawning stock size drops below the Abreak point@. The Abreak point@ is determined by the average of the five lowest spawning stock sizes within the years 1987-1999 (Fig 11).

The bycatch fishing mortality rate for the projection years is 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 year 1998 is not included in this average because BRDs were partially implemented then. 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 are 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 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 are again unique assuming the SPR can be achieved in that year. The yield resulting from application of the directed fishing mortality rates on the estimated population abundance generates the ABC value. This approach of treating separately the commercial and recreational sectors was used in previous assessments.

The recent reauthorization of the Magnuson-Stevens Fishery Management and Conservation Act (MFMCA) requires the use of both biomass and fishing mortality rate limits to classify the status of stocks. Following the decisions made at the MSAP, the recommended proxy for F_{MSY} is $F_{30\%SPR}$ and the proxy for B_{MSY} is the spawning stock that results 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 $(1\text{-}M)*B_{MSY}$ and the

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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.

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), can be calculated from the results of the bootstraps for two year constant catch projections.

Sensitivity to Mixing Assumptions

The sensitivity of estimates of Gulf and Atlantic Migratory Group productivity and ABC levels to different assumptions about mixing between these stocks was evaluated by estimating alternative CAA matrices under the assumption that either 50% or 98% of the winter catch of king mackerel along the east coast of Florida was of Atlantic migratory group fish, rather than the status quo assumption of 100% Gulf Migratory Group fish. For these evaluations, the estimated winter-time CAA from the east coast of Florida was proportioned and the subsequent fractions of the status quo CAA was added to the Atlantic CAA and subtracted from the Gulf CAA. The VPA specifications for the Atlantic Migratory Group were the base-line specifications used by MSAP 2003 and those for the Gulf were as described in this document.

RESULTS AND DISCUSSION

This stock assessment used the base model from the Mackerel Stock Assessment Panel 2000 report as the starting point for the analyses. This was decided because the adopted assessment by the MSAP in 2002 was a combination of two different cases (MSAP -02). For the present analyses, an 'equal' weighting option with the normal error assumption for all indices of abundance available, with the same Age(s) coverage and time of year application as presented in the indices section was adopted. 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 =1.7, F_1/F_2 =0.33, and F_{11}/F_{10} =1.0.

For this stock assessment, the following updated data was available in comparison with the year 2000 SA: Commercial and recreational catch for calendar years 1997, 1998, 1999, 2000, 2001 and 2002. Thus, the Catch at Age (CAA) was updated for the fishing years 1997-98 through 2001-02. For fishing years 1981-82 to 1996-97 the CAA was the same as in the 2000 SA. Also updated were the corresponding Partial CAA [1997-98 to 2001-02] for the following indices of abundance: the FL-FWC_NW, FL-FWC_SW, Headboat, MRFSS, and TX-PWD. The proportion of directed catch by age for the commercial and recreational sectors was also estimated (Fig 12) from the average of CAA by sector for the fishing years 1997-2001.

Following the base model of 2004 SA evaluation, the Gulf of Mexico king mackerel virtual population tuning results are given in Table 6, including abundance at age and fishing mortality at age estimates, parameter estimates with standard errors and coefficients of variation, index fits, index selectivity, residual analyses, and diagnostics (for all purposes this run was labeled BASE 04 model). Figure 13 shows a comparison of the 2000 SA estimates of stock size, fishing mortality rates and stock biomass (square symbols) with the corresponding estimates from the 2004 Base 04 model. In general, the 2004 Base 04 model estimated somewhat smaller stock sizes, particularly for ages 7 and older, from 1990 on, and somewhat greater biomass for ages 3 to 6 from 1996 on. The 2002 Base 04 model also estimated lower fishing mortality rates for ages 7 and older since 1992 on, but higher fishing mortality rates for ages 3 to 6 during the same period. This translates into a lower stock biomass estimates for Gulf king mackerel stock (Age 3-11+) with a somewhat different age composition, with higher proportion of ages 3-6 during the 1987-1995 period, followed by a lower biomass compared to the 2000 SA after 1996. Also, the estimated biomass of the older age classes (7+) has been higher since 1985. Figure 14 shows the VPA fitting and residuals of the ten index series.

The impact of each index value on the VPA results can be determined from a jackknife analysis. The jackknife systematically removes each index point and runs the VPA without that particular observation.. The most influential point for tuning according to the jackknife analysis was the 1994 Charter FL-SW point (Table 7), followed by 1992 FL-FWC SW.

Figures 15 and 16 present in more detail, the comparison of estimates between year 2000 SA (diamond symbols) and year 2004 Base 04 Gulf king assessment. In terms of stock size, the 2004 base 04 model predicted similar numbers and trends for younger ages (0-4) consistently in all common years, compared to 2000 SA (Fig 15), with the exception of cohort 1989, which in base 04 model was consistently predicted as larger than in 2000 SA. In ages 5 to 8, the base 04 model estimated similar trends in early years (1981-1990). After 1991 the trends differed compared to the 2000 SA, with larger numbers at age predicted for the 1995 and later years. Overall, the estimates of stock size were greater in the 1985-1992 years compared to 2000 SA and slightly lower in the 1995-1998 period (Fig 15 bottom panel). The fishing mortality rates for ages 0 through 4 were similar between 2000 SA and 2004 base 04 model, in the early years (1981-1992), but differed in the latest years. Somewhat more pronounced are the differences in estimates of ages 5, 6, 7 and 8, again after 1992 mainly (Fig 16). Overall the total fishing mortality rate estimated in the base 04 model was similar for the 1981-1988 period compared to the 2000 SA, since 1990 total F was estimated slightly lower for all years in the base 04 model (Fig 16 bottom panel).

The estimated of spawning potential ratios (SPR) are shown in Figure 17. The unweighted SPR trends show an increase from 1983 to a peak in 1992, follow by a slow decrease until 1998, and since then an upward trend. The static SPR trends show 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 are above 30% (36.6%), while the unweighted SPR was estimated below 30% in 2002 fishing year (28.1%). For the base 04 case, under the prior status determination criteria[3], Gulf king mackerel stock would be classified as overfished because the median unweighted transitional SPR estimate is below 30% and classified as not undergoing overfishing in 2002-03 because the median static SPR estimate is above 30%.

As stated in the latest Gulf king mackerel evaluation report (Ortiz et al 2002, Legault *et al.* 2000), in order to determine the stock status under the new definitions, the maximum sustainable yield fishing mortality rate and associated spawning stock proxies must first be calculated. These proxies are based upon $F_{30\%SPR}$ and the two-line model of stock recruitment relationship described before. 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 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 8. The Base 04 model scenario estimates of median and the deterministic run were very similar for all of benchmarks. Figure 18 shows a comparison of the benchmarks estimates for the 2000 SA, the 2002 SA (Base 10 model), and the 2004 base 04 model. In comparison, the 2000 SA and 2004 base-04 model estimated similar values, both higher than those estimated in the 2002 base case scenario. However, the 80% confidence intervals do overlap among all estimates.

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3 This definition was included in the 2000 MSAP report.

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 can be calculated. For the Base 04 case, 86 of the 500 bootstraps (17%) estimated $F_{2002} > MFMT$ (Fig 19), while 88 of the 500 bootstraps (18%) estimated a $SS_{2003} < MSST$ (Fig 20). In addition, the base 04 case estimated $F_{2002} > F_{OY}$ for 352 (70%) 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) recommended lower risk of exceeding threshold levels, suggesting 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 21.

The fishing year 2003/2004 acceptable biological catch (ABC) for the base 04 scenario using an $F_{30\%}$ criterion have a median value of 10.32 million pounds, and estimated 80% pseudo confidence interval between 7.5 and 13.5 million pounds (Table 8 and Figure 22).

Sensitivity to Mixing Assumptions

Estimates of stock-specific productivity levels to different assumed levels of mixing between the Atlantic and Gulf Migratory Groups from November-March along the Florida east coast are shown in Table 9. Table 10 provides projected ABC estimates for Atlantic and Gulf Migratory Groups under different assumed levels of mixing. Figures 23-25 provide bootstrap based estimates of stock status criteria and the distributions of ABC under three presumed levels of mixing for the Gulf Migratory Group while Figures 26-28 provide the complementary bootstrap based estimates for Atlantic Migratory Group kings under the same mixing assumptions. As previously documented, the stock status indicators for the Atlantic Migratory Group are generally insensitive to these alternative assumptions while those for the Gulf Migratory Group show sensitivity with higher proportions of Atlantic Group fish from the area leading towards higher proportions of the bootstrap results indicating the occurrence of overfishing and overfished status in the most recent years. Figures 29 (Gulf) and 30 (Atlantic) show comparison of the bootstrap distributions of productivity, biomass, fishing rate b, and ABC levels across the mixing assumptions. The patterns shown are consistent with those previously estimated under similar ranges of mixing rate assumptions.

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Table 1. King mackerel Gulf Stock catch summary in thousand pounds (July 1st – June 30th fishing year).

	East Gulf			West Gulf			Gulf Mexico		
Fishing Year	Com	Rec	Total	Com	Rec	Total	Com	Rec	Total
1981/82	5,646	1,425	7,071	-	1,476	1,476	5,646	2,901	8,548
1982/83	3,802	3,735	7,538	837	3,958	4,795	4,640	7,693	12,333
1983/84	2,624	1,626	4,250	348	812	1,161	2,972	2,439	5,411
1984/85	2,601	2,358	4,959	603	751	1,354	3,205	3,109	6,313
1985/86	2,976	979	3,956	574	852	1,426	3,550	1,832	5,382
1986/87	1,165	2,618	3,784	308	650	958	1,473	3,269	4,742
1987/88	690	1,655	2,345	178	490	668	868	2,145	3,013
1988/89	1,103	4,515	5,618	303	761	1,063	1,405	5,276	6,681
1989/90	1,521	2,856	4,377	432	504	937	1,954	3,360	5,314
1990/91	1,395	3,288	4,683	421	664	1,084	1,816	3,951	5,767
1991/92	1,731	3,966	5,697	386	808	1,194	2,117	4,773	6,890
1992/93	2,839	5,458	8,297	760	800	1,560	3,599	6,258	9,857
1993/94	1,954	4,923	6,877	618	1,224	1,841	2,572	6,146	8,718
1994/95	2,288	7,297	9,585	613	651	1,265	2,901	7,948	10,849
1995/96	2,101	5,663	7,764	544	602	1,146	2,645	6,265	8,910
1996/97	2,339	6,273	8,612	525	659	1,185	2,864	6,933	9,797
1997/98	2,652	5,475	8,127	769	1,159	1,928	3,421	6,634	10,054
1998/99	3,207	4,360	7,567	686	875	1,561	3,893	5,235	9,128
1999/00	2,168	3,294	5,461	785	774	1,559	2,953	4,067	7,020
2000/01	2,376	4,176	6,552	703	885	1,588	3,079	5,061	8,140
2001/02	2,344	4,425	6,769	588	738	1,326	2,932	5,163	8,095

Table 1. (cont.) King mackerel Gulf stock catch summary in thousand fish (July 1st – June 30th fishing year).

	East Gulf			West Gulf			Gulf Mexico		
Fishing Year	Com	Rec	Total	Com	Rec	Total	Com	Rec	Total
1981/82	654	172	827	-	126	126	654	299	953
1982/83	406	435	841	42	388	430	449	823	1,271
1983/84	360	270	630	29	72	101	389	342	731
1984/85	282	317	599	44	81	125	326	398	724
1985/86	335	116	451	42	68	110	377	184	561
1986/87	153	384	538	19	58	77	172	442	615
1987/88	107	257	364	12	46	58	119	303	422
1988/89	103	463	566	19	62	81	122	526	647
1989/90	156	469	625	27	45	73	184	514	698
1990/91	180	436	616	37	66	103	217	502	719
1991/92	195	648	843	28	90	118	223	738	961
1992/93	340	540	881	70	92	162	410	632	1,042
1993/94	215	560	775	52	125	177	267	685	952
1994/95	276	710	986	55	82	136	330	792	1,122
1995/96	241	569	811	49	65	114	290	634	925
1996/97	320	591	911	49	72	121	369	663	1,032
1997/98	333	604	937	63	110	173	396	714	1,110
1998/99	377	475	852	64	86	150	441	561	1,003
1999/00	259	396	655	72	76	147	331	471	802
2000/01	276	488	765	62	97	160	339	585	924
2001/02	275	490	765	52	80	133	327	570	897

Table 2. Gulf of Mexico king mackerel bycatch (Age 0) estimates from two methods, GLM and Delta lognormal models. Note the Delta model did not estimate a value for 1983/84 due to lack of data and so the average of adjacent years was used. * No estimates of bycatch were available for 2001/02, value was carry over from 2000/01.

	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
GLM	367439	364263	339505	512626	485458	378920	857273	642341	1309887	874315	1094890
Delta	610384	325065	1054963	1784860	730905	531441	1538399	1224248	2526706	1688042	1877098

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02*
GLM	593257	1042106	951220	1118991	619079	740053	405192	258315	442066	442066
Delta	869289	2028434	2180036	2545294	1034516	1026683	168029	111859	128055	

Table 3. Gulf of Mexico king mackerel commercial catch at age (CAA) matrix directed fisheries.

Fishing Year	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	65	1446	7242	65376	572111	187534	48128	32219	15491	7458	4108	11624
1982-83	9441	22522	183273	135947	324974	287056	91735	64634	38302	73266	19877	20338
1983-84	82	368	129346	258565	166109	49403	69101	28827	15842	5819	2097	5233
1984-85	38	6669	10386	183855	286885	127509	53807	35385	11628	1915	1946	4027
1985-86	497	10645	41627	39065	190830	150344	80569	17960	8789	6325	4700	9689
1986-87	3577	77665	178847	100524	132548	38378	33590	20219	10150	6203	1307	11567
1987-88	1367	64736	167700	78833	43595	26985	15806	10627	3828	1844	1680	4539
1988-89	771	39373	123181	81653	190716	67345	61996	29372	12207	9957	7529	23230
1989-90	2292	220559	191102	97434	72016	37602	15230	21013	12830	6204	6826	14648
1990-91	7005	78530	199413	223494	78530	39696	34648	14600	12055	14711	2929	13139
1991-92	2218	215542	307759	188532	124847	33281	34331	13481	5645	13850	5807	15702
1992-93	2239	89108	247546	316783	123335	91130	46570	28818	32853	15529	11488	36820
1993-94	5768	168104	212503	190773	162643	78023	30426	28361	25445	15776	4481	29790
1994-95	3389	170473	139494	148795	202540	228711	96235	14868	47589	34305	12395	23399
1995-96	3722	126449	298994	177464	99129	66396	69827	35673	14235	7660	10313	14906
1996-97	649	139544	396921	187029	99113	53908	44443	34766	31014	16136	2421	26210
1997-98	0	64013	268137	322665	170212	97593	43478	43526	40282	27631	10220	22100
1998-99	0	75355	69256	206142	257242	202066	72493	43155	32552	19303	9693	15245
1999-00	0	101883	168150	130783	169522	97896	35710	27065	15657	28828	9467	17407
2000-01	19847	70360	184544	215802	171502	101276	46749	39045	18066	17443	11411	28007
2001-02	0	27175	170035	250317	175475	93506	55949	50200	27313	13846	5774	27485

Table 4. Percent difference of the Catch at age (CAA) 2002 and CAA 2004 matrix distribution by age and fishing year of Gulf king mackerel. Positive values (dark shade) indicate that the numbers at age-year in 2004 CAA matrix were larger than the equivalent values in 2002 CAA. Difference numbers, reflect the update total numbers of catch by fishing year for 1997-98 to 2000-01 compare to values of 2002 CAA matrix.

F Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Diff Numb
1997-98	0.01%	1.25%	8.52%	-0.46%	-2.30%	-1.69%	-1.23%	-1.56%	-1.05%	-0.42%	-0.32%	-0.75%	-2625.12
1998-99	0.00%	-5.52%	0.18%	0.03%	3.96%	5.31%	0.34%	-1.85%	-1.00%	-0.83%	-0.09%	-0.52%	519
1999-00	0.02%	9.15%	1.50%	0.05%	-5.00%	-2.00%	-0.56%	-0.69%	-0.17%	-1.66%	-0.57%	-0.09%	6346.05
2000-01	-2.04%	0.82%	6.06%	3.79%	-1.89%	-2.00%	-0.88%	-0.75%	-0.79%	-0.17%	-0.52%	-1.65%	30235.34

Table 5. Tuning indices for base case[1] runs 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 stock is measured in biomass, numbers or eggs.

INDICES OF ABUNDANCE

Fishing Year	Florida DEP Northwest	Florida DEP Southwest	MRFSS	Texas PWD4	HeadBoat	Charter Northwest Florida	Charter Southwest 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
Time	BEG	MID	BEG	BEG	MID	BEG	MID	BEG	BEG
Stock	Biomass	Biomass	Number	Number	Number	Number	Number	Number	Eggs
Ages	3 - 6	3 - 8	2 - 8	2 - 8	2 - 6	2 - 6	3 - 8	0	1 -11+

4 Texas PWD index was split into two series, from 1983-1985 (early TPWD) and from 1986-2001 (late TPWD). See text for further details.

Table 6. Gulf king mackerel tuned VPA results for model BASE 04 (*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	2656687	2010507	1487172	2864296	3114194	1992561	3466214	4238030	5728912	4533778	3503680
1	2204314	1844044	1309765	912301	1883666	2112081	1287208	2066334	2890624	3510793	2918993
2	1593917	1803433	1489435	1072013	740906	1532600	1659117	995454	1656217	2167696	2803485
3	1103526	1298447	1311297	1102800	868310	569039	1093598	1207178	704006	1183757	1594944
4	1512281	844501	940524	840975	737372	675653	375409	824248	914689	488618	768068
5	494013	725888	400497	620522	431379	432280	433925	268068	503394	683928	329337
6	413692	236554	337414	283380	393346	218448	319312	330920	158965	378226	524134
7	264305	295326	111559	214094	183595	249572	148601	247166	215146	116418	278422
8	217556	187360	183673	65440	143427	134122	186096	112077	175891	157201	82159
9	161761	164145	118944	136092	43112	109498	100654	148906	80758	132434	117832
10	45547	125708	68931	92131	109693	29600	84052	80744	112931	60523	95168
11+	128881	128623	172016	190654	226131	261962	227091	249127	242340	271495	257332

Age	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03
0	2733100	5492982	4712847	5064726	3287571	3832430	2989230	4954511	2094694	4789643	0
1	1884396	1702182	3554390	2999825	3137154	2133972	2471860	2082334	3823296	1299648	3522808
2	2195439	1462391	1242066	2756234	2341914	2442536	1689356	1955756	1612922	3066714	1039523
3	2017887	1574350	1005899	891185	1987094	1560073	1758081	1320615	1449594	1154217	2357376
4	1135917	1366847	1117047	689546	569988	1458253	987052	1253608	963314	992465	719894
5	516432	818834	972502	732275	475262	377450	1040511	577051	873643	634332	654619
6	239634	340793	600054	590637	539664	340523	221358	670092	384320	624000	435128
7	398151	154295	251580	404630	420642	401756	239620	116228	516400	272525	460435
8	215786	299982	100803	192561	299114	313037	289695	157344	70830	387573	177948
9	62173	147084	222657	40050	144814	216934	219998	207841	114706	41760	292678
10	83990	36950	106201	151403	25898	104020	152713	162711	144196	78205	21776
11+	269195	245643	200483	218832	280371	224935	240185	299178	353914	372264	338811

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	0.1651	0.2285	0.2887	0.2191	0.1883	0.2369	0.3173	0.1826	0.2897	0.2403	0.4202
1	0.0007	0.0136	0.0003	0.0081	0.0063	0.0414	0.057	0.0212	0.0878	0.025	0.0849
2	0.005	0.1187	0.1005	0.0107	0.0639	0.1375	0.118	0.1464	0.1358	0.1068	0.1288
3	0.0675	0.1225	0.2442	0.2025	0.0509	0.2159	0.0828	0.0775	0.1652	0.2326	0.1394
4	0.534	0.546	0.2159	0.4676	0.334	0.2428	0.1368	0.2931	0.0907	0.1945	0.1969
5	0.5364	0.5661	0.1459	0.2559	0.4804	0.1029	0.071	0.3226	0.0859	0.0661	0.118
6	0.137	0.5516	0.2549	0.2341	0.2549	0.1853	0.0561	0.2306	0.1115	0.1064	0.0749
7	0.1441	0.2749	0.3334	0.2006	0.114	0.0935	0.0821	0.1402	0.1138	0.1485	0.0549
8	0.0817	0.2544	0.0998	0.2173	0.0699	0.0871	0.0229	0.1277	0.0838	0.0883	0.0787
9	0.0522	0.6676	0.0554	0.0156	0.176	0.0645	0.0204	0.0765	0.0884	0.1304	0.1386
10	0.1046	0.191	0.0341	0.0236	0.0484	0.0499	0.0223	0.1084	0.0689	0.0548	0.0696
11+	0.1046	0.191	0.0341	0.0236	0.0484	0.0499	0.0223	0.1084	0.0689	0.0548	0.0696

Age	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02
0	0.2735	0.2353	0.2517	0.279	0.2322	0.2385	0.1615	0.0592	0.2773	0.1072
1	0.0535	0.1151	0.0543	0.0476	0.0503	0.0336	0.0342	0.0554	0.0205	0.0233
2	0.1325	0.1742	0.132	0.1272	0.2062	0.1288	0.0463	0.0995	0.1346	0.0631
3	0.1895	0.1432	0.1776	0.2469	0.1094	0.2578	0.1382	0.1155	0.1788	0.2721
4	0.1273	0.1404	0.2223	0.1722	0.2122	0.1375	0.3368	0.1611	0.2178	0.2161
5	0.2157	0.1109	0.2987	0.1052	0.1334	0.3337	0.2401	0.2065	0.1365	0.1769
6	0.2402	0.1035	0.194	0.1394	0.0951	0.1514	0.4442	0.0605	0.1437	0.104
7	0.0831	0.2257	0.0674	0.1022	0.0955	0.127	0.2206	0.2953	0.087	0.2262
8	0.1833	0.0981	0.723	0.085	0.1212	0.1527	0.1321	0.1161	0.3283	0.0808
9	0.3204	0.1257	0.1857	0.236	0.1309	0.151	0.1016	0.1656	0.183	0.4511
10	0.1631	0.1433	0.1375	0.078	0.1087	0.1145	0.0725	0.0663	0.0912	0.0848
11+	0.1631	0.1433	0.1375	0.078	0.1087	0.1145	0.0725	0.0663	0.0912	0.0848

Parameter Estimates

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

Input DATA file: Gk1c.inp
Input CONTROL file: Gk2a.inp
Output Stock Size file: gk1eqnor.naa
Output Fishing Mortality file: gk1eqnor.faa
Ouput Fitted Indices file: gk1eqnor.ind
Output Diagnostics (this) file: gk1eqnor.par

Run name: Glf_Kng_81-01_BaseRun
No. index values: 143 Parameters: 9
Mean Squared Error (rss/df) = 0.11462E+00
Rsquared = 0.2096
Loglikelihood = -0.43382E+02

res from indices   =   195.317202049467
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	0.0631	0.01697	26.91
F age 3	0.2721	0.05174	19.02
F age 4	0.2161	0.06399	29.61
F age 5	0.1769	0.04085	23.09
F age 6	0.1040	0.02499	24.04
F age 7	0.2262	0.05292	23.39
F age 8	0.0808	0.03078	38.08
F age 9	0.4511	0.15853	35.14
F age 10	0.0848	0.02463	29.03

Variances of terminal yr F and survivors

Age,	SE(F,101)	CV(F)	SE(N,102)	CV(N)
0	0.28849E-01	26.91192		
1	0.62789E-02	26.91192	0.10015E+07	28.42810
2	0.16970E-01	26.91192	0.28314E+06	27.23754
3	0.51736E-01	19.01532	0.65529E+06	27.79757
4	0.63991E-01	29.60621	0.15697E+06	21.80488
5	0.40849E-01	23.08727	0.21620E+06	33.02701
6	0.24993E-01	24.03619	0.10990E+06	25.25771
7	0.52922E-01	23.39207	0.11672E+06	25.34903
8	0.30779E-01	38.07939	46668.	26.22560
9	0.15853	35.13908	0.11616E+06	39.69030
10	0.24634E-01	29.03394	9563.8	43.91962
11	0.24634E-01	29.03394	86758.	25.60657

Obs. and pred. indices in objective function

0.47184E+00	0.61098E+00
0.57818E+00	0.74372E+00
0.60698E+00	0.49321E+00
0.49673E+00	0.66176E+00
0.52836E+00	0.42552E+00
0.70981E+00	0.71704E+00
0.78444E+00	0.65446E+00
0.10299E+01	0.11338E+01
0.86433E+00	0.12745E+01
0.10396E+01	0.14804E+01
0.92004E+00	0.11802E+01
0.14852E+01	0.13328E+01
0.20048E+01	0.12106E+01
0.12411E+01	0.13769E+01
0.17216E+01	0.13079E+01
0.15172E+01	0.13556E+01
0.45692E+00	0.29589E+00
0.44337E+00	0.54892E+00
0.59993E+00	0.61045E+00
0.86413E+00	0.48559E+00
0.81637E+00	0.98713E+00
0.10551E+01	0.65251E+00
0.10242E+01	0.66809E+00
0.20762E+01	0.95714E+00
0.12889E+01	0.12172E+01
0.70679E+00	0.10470E+01
0.10415E+01	0.10626E+01
0.13580E+01	0.13531E+01
0.10613E+01	0.13597E+01
0.13013E+01	0.14129E+01
0.70911E+00	0.11533E+01
0.11971E+01	0.13520E+01
0.34844E+00	0.49288E+00
0.83177E+00	0.86762E+00
0.81436E+00	0.70730E+00
0.54157E+00	0.92344E+00
0.15380E+01	0.72096E+00
0.17178E+01	0.13530E+01
0.12929E+01	0.96959E+00
0.88729E+00	0.10461E+01
0.84392E+00	0.48991E+00
0.66929E+00	0.12601E+01
0.12087E+01	0.14856E+01
0.14320E+01	0.12793E+01
0.84830E+00	0.71381E+00
0.97068E+00	0.90236E+00
0.11879E+01	0.13168E+01
0.86721E+00	0.92314E+00
0.10645E+01	0.64452E+00
0.10767E+01	0.13068E+01
0.85889E+00	0.82229E+00
0.74391E+00	0.80225E+00
0.86954E+00	0.60592E+00
0.78342E+00	0.66705E+00
0.87329E+00	0.61331E+00
0.67595E+00	0.73903E+00
0.15325E+01	0.10764E+01
0.10679E+01	0.10313E+01
0.10339E+01	0.76357E+00
0.10788E+01	0.11316E+01
0.13004E+01	0.14713E+01
0.12896E+01	0.15676E+01
0.10468E+01	0.10564E+01
0.11751E+01	0.95844E+00
0.94729E+00	0.88599E+00
0.80518E+00	0.10127E+01
0.77637E+00	0.10838E+01
0.12014E+01	0.50320E+00
0.82888E+00	0.93763E+00
0.18238E+01	0.67054E+00
0.62468E+00	0.41696E+00
0.41559E+00	0.49930E+00
0.59687E+00	0.33249E+00
0.40482E+00	0.77045E+00
0.34316E+00	0.41339E+00
0.66465E+00	0.87700E+00
0.52787E+00	0.74668E+00
0.87334E+00	0.13938E+01
0.10939E+01	0.10844E+01
0.11648E+01	0.15743E+01
0.11944E+01	0.71381E+00
0.11694E+01	0.12125E+01
0.15071E+01	0.12910E+01
0.14730E+01	0.14110E+01
0.13109E+01	0.11180E+01
0.14969E+01	0.14948E+01
0.10445E+01	0.12473E+01
0.12402E+01	0.99815E+00
0.89285E+00	0.75716E+00
0.88189E+00	0.76411E+00
0.88030E+00	0.10921E+01
0.95105E+00	0.11963E+01
0.99888E+00	0.11207E+01
0.93052E+00	0.10275E+01
0.12008E+01	0.94756E+00
0.12637E+01	0.89856E+00
0.79130E+00	0.48024E+00
0.10462E+01	0.55996E+00
0.89402E+00	0.38110E+00
0.73234E+00	0.10629E+01
0.94348E+00	0.81587E+00
0.10652E+01	0.15659E+01
0.15274E+01	0.35233E+00
0.58800E+00	0.73576E+00
0.57158E+00	0.55681E+00
0.52390E+00	0.41187E+00
0.73580E+00	0.79326E+00
0.69056E+00	0.86247E+00
0.46205E+00	0.55184E+00
0.93465E+00	0.95996E+00
0.80214E+00	0.11737E+01
0.16420E+01	0.15866E+01
0.11663E+01	0.12556E+01
0.13591E+01	0.97034E+00
0.67918E+00	0.75693E+00
0.14016E+01	0.15213E+01
0.13151E+01	0.13052E+01
0.17209E+01	0.14027E+01
0.86892E+00	0.91049E+00
0.10232E+01	0.10614E+01
0.10837E+01	0.82786E+00
0.10887E+01	0.13721E+01
0.13426E+01	0.58012E+00
0.46292E+00	0.96309E+00
0.85185E-01	0.82512E+00
0.89503E+00	0.84220E+00
0.33138E+00	0.81282E+00
0.51837E+00	0.78929E+00
0.58171E+00	0.80374E+00
0.55844E+00	0.86809E+00
0.93506E+00	0.86123E+00
0.10209E+01	0.93007E+00
0.89610E+00	0.10037E+01
0.14145E+01	0.10966E+01
0.14934E+01	0.11189E+01
0.13136E+01	0.11557E+01
0.16425E+01	0.11183E+01
0.12062E+01	0.11770E+01
0.15247E+01	0.12279E+01
0.13403E+01	0.12433E+01
0.12970E+01	0.12255E+01
0.96653E+00	0.12659E+01
0.15162E+01	0.12864E+01

INDEX RESULTS

Equal weighting for indices
ML estimate of variance (all indices): 0.1074

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	0.6110	-0.1391	-0.4246
86/87	0.5782	0.5782	0.7437	-0.1655	-0.5051
87/88	0.6070	0.6070	0.4932	0.1138	0.3472
88/89	0.4967	0.4967	0.6618	-0.1650	-0.5036
89/90	0.5284	0.5284	0.4255	0.1028	0.3138
90/91	0.7098	0.7098	0.7170	-0.0072	-0.0221
91/92	0.7844	0.7844	0.6545	0.1300	0.3966
92/93	1.0299	1.0299	1.1338	-0.1039	-0.3171
93/94	0.8643	0.8643	1.2745	-0.4102	-1.2515
94/95	1.0396	1.0396	1.4804	-0.4408	-1.3451
95/96	0.9200	0.9200	1.1802	-0.2601	-0.7937
96/97	1.4852	1.4852	1.3328	0.1523	0.4648
97/98	2.0048	2.0048	1.2106	0.7942	2.4234
98/99	1.2411	1.2411	1.3769	-0.1358	-0.4143
99/00	1.7216	1.7216	1.3079	0.4137	1.2622
00/01	1.5172	1.5172	1.3556	0.1617	0.4934

ML estimate of catchability: 0.52936E-07
Pearsons (parametric) correlation: 0.757 P= 0.0000
Kendalls (nonparametric) Tau: 0.550 P= 0.0000

Selectivity at age from Partial Catches

year	3	4	5	6
85/86	0.035	1.000	0.649	0.244
86/87	0.532	1.000	0.965	0.329
87/88	0.341	1.000	0.555	0.133
88/89	0.278	1.000	0.151	0.487
89/90	1.000	0.270	0.144	0.102
90/91	1.000	0.215	0.079	0.761
91/92	0.307	1.000	0.362	0.094
92/93	1.000	0.130	0.789	0.544
93/94	1.000	0.642	0.396	0.367
94/95	0.789	1.000	0.736	0.491
95/96	0.695	1.000	0.641	0.772
96/97	0.920	1.000	0.527	0.637
97/98	0.856	0.567	1.000	0.418
98/99	1.000	0.706	0.417	0.911
99/00	0.487	0.875	1.000	0.392
00/01	0.538	1.000	0.858	0.534

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	0.2959	0.1610	0.4914
86/87	0.4434	0.4434	0.5489	-0.1055	-0.3221
87/88	0.5999	0.5999	0.6104	-0.0105	-0.0321
88/89	0.8641	0.8641	0.4856	0.3785	1.1550
89/90	0.8164	0.8164	0.9871	-0.1708	-0.5210
90/91	1.0551	1.0551	0.6525	0.4026	1.2283
91/92	1.0242	1.0242	0.6681	0.3561	1.0865
92/93	2.0762	2.0762	0.9571	1.1191	3.4146
93/94	1.2889	1.2889	1.2172	0.0717	0.2187
94/95	0.7068	0.7068	1.0470	-0.3402	-1.0381
95/96	1.0415	1.0415	1.0626	-0.0212	-0.0645
96/97	1.3580	1.3580	1.3531	0.0049	0.0148
97/98	1.0613	1.0613	1.3597	-0.2985	-0.9107
98/99	1.3013	1.3013	1.4129	-0.1117	-0.3408
99/00	0.7091	0.7091	1.1533	-0.4442	-1.3553
00/01	1.1971	1.1971	1.3520	-0.1549	-0.4726

ML estimate of catchability: 0.60762E-07
Pearsons (parametric) correlation: 0.518 P= 0.0012
Kendalls (nonparametric) Tau: 0.483 P= 0.0002

Selectivity at age from Partial Catches

year	3	4	5	6	7	8
85/86	0.002	0.000	1.000	0.262	0.005	0.024
86/87	0.334	1.000	0.619	0.091	0.018	0.016
87/88	0.373	0.941	0.221	1.000	0.000	0.000
88/89	0.012	1.000	0.747	0.008	0.002	0.064
89/90	1.000	0.771	0.521	0.314	0.915	0.249
90/91	0.843	1.000	0.010	0.249	0.262	0.000
91/92	0.293	1.000	0.120	0.190	0.195	0.115
92/93	0.861	0.014	1.000	0.102	0.002	0.243
93/94	0.783	0.570	0.355	0.288	1.000	0.184
94/95	0.832	0.818	0.359	0.173	0.043	1.000
95/96	1.000	0.851	0.434	0.403	0.268	0.214
96/97	1.000	0.915	0.368	0.465	0.240	0.153
97/98	1.000	0.545	0.809	0.351	0.400	0.297
98/99	1.000	0.661	0.390	0.746	0.428	0.391
99/00	0.335	0.667	0.844	0.300	1.000	0.565
00/01	0.676	1.000	0.578	0.354	0.304	0.765

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	0.4929	-0.1444	-0.4407
87/88	0.8318	0.8318	0.8676	-0.0359	-0.1094
88/89	0.8144	0.8144	0.7073	0.1071	0.3267
89/90	0.5416	0.5416	0.9234	-0.3819	-1.1652
90/91	1.5380	1.5380	0.7210	0.8171	2.4931
91/92	1.7178	1.7178	1.3530	0.3647	1.1129
92/93	1.2929	1.2929	0.9696	0.3233	0.9864
93/94	0.8873	0.8873	1.0461	-0.1588	-0.4845
94/95	0.8439	0.8439	0.4899	0.3540	1.0802
95/96	0.6693	0.6693	1.2601	-0.5908	-1.8026
96/97	1.2087	1.2087	1.4856	-0.2769	-0.8448
97/98	1.4320	1.4320	1.2793	0.1527	0.4660
98/99	0.8483	0.8483	0.7138	0.1345	0.4104
99/00	0.9707	0.9707	0.9024	0.0683	0.2085
00/01	1.1879	1.1879	1.3168	-0.1290	-0.3935
01/02	0.8672	0.8672	0.9231	-0.0559	-0.1707

ML estimate of catchability: 0.29766E-06
Pearsons (parametric) correlation: 0.512 P= 0.0014
Kendalls (nonparametric) Tau: 0.400 P= 0.0016

Selectivity at age from Partial Catches

year	2	3	4	5	6	7	8
86/87	0.386	1.000	0.499	0.157	0.260	0.104	0.058
87/88	1.000	0.592	0.729	0.465	0.256	0.227	0.092
88/89	0.631	0.300	1.000	0.610	0.772	0.409	0.370
89/90	0.940	1.000	0.485	0.303	0.356	0.715	0.199
90/91	0.396	1.000	0.289	0.109	0.196	0.524	0.178
91/92	0.893	0.630	1.000	0.369	0.182	0.142	0.151
92/93	0.457	0.632	0.212	0.547	0.630	0.222	1.000
93/94	0.793	0.650	0.478	0.338	0.368	1.000	0.403
94/95	0.333	0.288	0.297	0.371	0.227	0.052	1.000
95/96	0.505	0.919	1.000	0.683	0.824	0.637	0.461
96/97	0.950	0.537	1.000	0.801	0.635	0.536	0.605
97/98	0.564	0.855	0.492	1.000	0.462	0.462	0.474
98/99	0.173	0.406	0.673	0.281	1.000	0.532	0.298
99/00	0.401	0.467	0.657	0.777	0.246	1.000	0.489
00/01	1.000	0.780	0.864	0.546	0.386	0.333	0.709
01/02	0.218	1.000	0.500	0.457	0.318	0.662	0.296

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	0.6445	0.4199	1.2814
84/85	1.0767	1.0767	1.3068	-0.2301	-0.7022
85/86	0.8589	0.8589	0.8223	0.0366	0.1117

ML estimate of catchability: 0.10725E-05
Pearsons (parametric) correlation: 0.306 P= 0.3727
Kendalls (nonparametric) Tau: 0.333 P= 0.3254

Selectivity at age from Partial Catches

year	2	3	4	5	6	7	8
83/84	0.004	0.017	0.161	0.284	0.563	1.000	0.027
84/85	0.001	0.096	0.401	0.864	0.249	0.477	1.000
85/86	0.020	0.022	0.230	0.680	0.206	1.000	0.036

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	0.8023	-0.0583	-0.1780
87/88	0.8695	0.8695	0.6059	0.2636	0.8044
88/89	0.7834	0.7834	0.6670	0.1164	0.3551
89/90	0.8733	0.8733	0.6133	0.2600	0.7933
90/91	0.6760	0.6760	0.7390	-0.0631	-0.1925
91/92	1.5325	1.5325	1.0764	0.4561	1.3918
92/93	1.0679	1.0679	1.0313	0.0366	0.1116
93/94	1.0339	1.0339	0.7636	0.2703	0.8248
94/95	1.0788	1.0788	1.1316	-0.0528	-0.1611
95/96	1.3004	1.3004	1.4713	-0.1709	-0.5214
96/97	1.2896	1.2896	1.5676	-0.2780	-0.8482
97/98	1.0468	1.0468	1.0564	-0.0096	-0.0294
98/99	1.1751	1.1751	0.9584	0.2167	0.6612
99/00	0.9473	0.9473	0.8860	0.0613	0.1870
00/01	0.8052	0.8052	1.0127	-0.2075	-0.6333
01/02	0.7764	0.7764	1.0838	-0.3074	-0.9380

ML estimate of catchability: 0.40807E-06
Pearsons (parametric) correlation: 0.647 P= 0.0000
Kendalls (nonparametric) Tau: 0.450 P= 0.0004

Selectivity at age from Partial Catches

year	2	3	4	5	6	7	8
86/87	0.124	0.640	0.777	0.817	1.000	0.843	0.787
87/88	0.171	0.398	1.000	0.354	0.365	0.351	0.364
88/89	0.221	0.298	0.521	1.000	0.585	0.481	0.404
89/90	0.113	0.485	0.354	0.577	1.000	0.578	0.435
90/91	0.132	0.263	0.818	0.538	0.619	1.000	0.609
91/92	0.196	0.581	0.578	0.865	0.410	0.490	1.000
92/93	0.174	0.423	0.379	0.635	1.000	0.401	0.624
93/94	0.319	0.247	0.361	0.310	0.186	1.000	0.173
94/95	0.587	1.000	0.223	0.458	0.360	0.371	0.331
95/96	0.437	1.000	0.876	0.500	0.567	0.373	0.276
96/97	0.568	0.519	1.000	0.649	0.569	0.464	0.330
97/98	0.139	0.506	0.377	1.000	0.506	0.462	0.556
98/99	0.116	0.430	0.521	0.371	1.000	0.549	0.497
99/00	0.088	0.287	0.589	0.815	0.294	1.000	0.629
00/01	0.205	0.367	0.673	0.603	0.474	0.369	1.000
01/02	0.096	0.648	0.586	0.604	0.401	1.000	0.324

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	0.5032	0.6982	2.1304
82/83	0.8289	0.8289	0.9376	-0.1088	-0.3318
83/84	1.8238	1.8238	0.6705	1.1532	3.5188
84/85	0.6247	0.6247	0.4170	0.2077	0.6338
85/86	0.4156	0.4156	0.4993	-0.0837	-0.2554
86/87	0.5969	0.5969	0.3325	0.2644	0.8067
87/88	0.4048	0.4048	0.7704	-0.3656	-1.1156
88/89	0.3432	0.3432	0.4134	-0.0702	-0.2143
89/90	0.6647	0.6647	0.8770	-0.2123	-0.6479
90/91	0.5279	0.5279	0.7467	-0.2188	-0.6676
91/92	0.8733	0.8733	1.3938	-0.5204	-1.5880
92/93	1.0939	1.0939	1.0844	0.0096	0.0292
93/94	1.1648	1.1648	1.5743	-0.4095	-1.2495
94/95	1.1944	1.1944	0.7138	0.4806	1.4664
95/96	1.1694	1.1694	1.2125	-0.0431	-0.1316
96/97	1.5071	1.5071	1.2910	0.2161	0.6593
97/98	1.4730	1.4730	1.4110	0.0620	0.1892
98/99	1.3109	1.3109	1.1180	0.1929	0.5885
99/00	1.4969	1.4969	1.4948	0.0022	0.0066
00/01	1.0445	1.0445	1.2473	-0.2028	-0.6188
01/02	1.2402	1.2402	0.9982	0.2420	0.7385

ML estimate of catchability: 0.39948E-06
Pearsons (parametric) correlation: 0.547 P= 0.0001
Kendalls (nonparametric) Tau: 0.390 P= 0.0003

Selectivity at age from Partial Catches

year	2	3	4	5	6
81/82	0.031	0.118	1.000	0.001	0.084
82/83	0.391	1.000	0.762	0.287	0.206
83/84	0.025	1.000	0.443	0.635	0.117
84/85	0.036	0.143	1.000	0.336	0.428
85/86	1.000	0.105	0.542	0.624	0.041
86/87	0.072	1.000	0.367	0.076	0.247
87/88	0.577	0.614	1.000	0.302	0.320
88/89	0.092	0.232	0.670	1.000	0.249
89/90	1.000	0.702	0.270	0.236	0.418
90/91	0.382	1.000	0.204	0.082	0.194
91/92	0.585	1.000	0.686	0.404	0.413
92/93	0.309	0.696	0.431	1.000	0.692
93/94	1.000	0.684	0.823	0.823	0.942
94/95	0.233	0.265	0.271	1.000	0.617
95/96	0.484	1.000	0.797	0.552	0.740
96/97	0.772	0.438	1.000	0.758	0.476
97/98	1.000	0.800	0.248	0.350	0.136
98/99	0.583	0.503	1.000	0.415	0.378
99/00	1.000	0.767	0.714	0.693	0.175
00/01	1.000	0.796	0.581	0.327	0.281
01/02	0.246	1.000	0.656	0.489	0.230

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	0.7572	0.1357	0.4140
89/90	0.8819	0.8819	0.7641	0.1178	0.3594
90/91	0.8803	0.8803	1.0921	-0.2118	-0.6461
91/92	0.9510	0.9510	1.1963	-0.2452	-0.7482
92/93	0.9989	0.9989	1.1207	-0.1219	-0.3718
93/94	0.9305	0.9305	1.0275	-0.0970	-0.2960
94/95	1.2008	1.2008	0.9476	0.2532	0.7726
95/96	1.2637	1.2637	0.8986	0.3652	1.1143

ML estimate of catchability: 0.28430E-06
Pearsons (parametric) correlation: -0.036 P= 0.6320
Kendalls (nonparametric) Tau: 0.000 P= 0.7071

Selectivity at age from Partial Catches

year	2	3	4	5	6
88/89	0.906	0.436	0.974	0.377	1.000
89/90	0.831	1.000	0.471	0.270	0.258
90/91	0.942	1.000	0.664	0.256	0.304
91/92	0.927	0.436	1.000	0.315	0.080
92/93	1.000	0.639	0.221	0.222	0.384
93/94	1.000	0.769	0.474	0.253	0.254
94/95	1.000	0.711	0.717	0.424	0.270
95/96	0.652	1.000	0.356	0.169	0.175

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	0.4802	0.3111	0.9492
89/90	1.0462	1.0462	0.5600	0.4862	1.4837
90/91	0.8940	0.8940	0.3811	0.5129	1.5651
91/92	0.7323	0.7323	1.0629	-0.3305	-1.0085
92/93	0.9435	0.9435	0.8159	0.1276	0.3894
93/94	1.0652	1.0652	1.5659	-0.5007	-1.5277
94/95	1.5274	1.5274	0.3523	1.1751	3.5856

ML estimate of catchability: 0.46297E-06
Pearsons (parametric) correlation: -0.226 P= 0.3010
Kendalls (nonparametric) Tau: -0.143 P= 0.3705

Selectivity at age from Partial Catches

year	3	4	5	6	7	8
88/89	0.097	1.000	0.663	0.432	0.113	0.063
89/90	1.000	0.393	0.329	0.573	0.267	0.234
90/91	0.317	0.411	0.212	0.365	1.000	0.062
91/92	0.915	0.629	0.538	0.603	0.652	1.000
92/93	0.467	0.329	0.546	0.608	0.392	1.000
93/94	0.768	1.000	0.868	0.867	0.911	0.847
94/95	0.085	0.112	0.478	0.285	0.065	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	0.7358	-0.1478	-0.4509
82/83	0.5716	0.5716	0.5568	0.0148	0.0451
83/84	0.5239	0.5239	0.4119	0.1120	0.3418
84/85	0.7358	0.7358	0.7933	-0.0575	-0.1753
85/86	0.6906	0.6906	0.8625	-0.1719	-0.5246
86/87	0.4620	0.4620	0.5518	-0.0898	-0.2740
87/88	0.9346	0.9346	0.9600	-0.0253	-0.0772
88/89	0.8021	0.8021	1.1737	-0.3716	-1.1338
89/90	1.6420	1.6420	1.5866	0.0554	0.1689
90/91	1.1663	1.1663	1.2556	-0.0893	-0.2725
91/92	1.3591	1.3591	0.9703	0.3888	1.1863
92/93	0.6792	0.6792	0.7569	-0.0777	-0.2372
93/94	1.4016	1.4016	1.5213	-0.1197	-0.3652
94/95	1.3151	1.3151	1.3052	0.0099	0.0302
95/96	1.7209	1.7209	1.4027	0.3183	0.9711
96/97	0.8689	0.8689	0.9105	-0.0416	-0.1268
97/98	1.0232	1.0232	1.0614	-0.0382	-0.1166
98/99	1.0837	1.0837	0.8279	0.2558	0.7806
99/00	1.0887	1.0887	1.3721	-0.2835	-0.8650
00/01	1.3426	1.3426	0.5801	0.7625	2.3266

ML estimate of catchability: 0.27695E-06
Pearsons (parametric) correlation: 0.755 P= 0.0000
Kendalls (nonparametric) Tau: 0.674 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	0.9631	-0.5002	-1.5262
83/84	0.0852	0.0852	0.8251	-0.7399	-2.2578
84/85	0.8950	0.8950	0.8422	0.0528	0.1612
85/86	0.3314	0.3314	0.8128	-0.4814	-1.4690
86/87	0.5184	0.5184	0.7893	-0.2709	-0.8267
87/88	0.5817	0.5817	0.8037	-0.2220	-0.6775
88/89	0.5584	0.5584	0.8681	-0.3097	-0.9448
89/90	0.9351	0.9351	0.8612	0.0738	0.2253
90/91	1.0209	1.0209	0.9301	0.0908	0.2771
91/92	0.8961	0.8961	1.0037	-0.1076	-0.3284
92/93	1.4145	1.4145	1.0966	0.3179	0.9701
93/94	1.4934	1.4934	1.1189	0.3745	1.1428
94/95	1.3136	1.3136	1.1557	0.1579	0.4819
95/96	1.6425	1.6425	1.1183	0.5241	1.5992
96/97	1.2062	1.2062	1.1770	0.0293	0.0893
97/98	1.5247	1.5247	1.2279	0.2968	0.9056
98/99	1.3403	1.3403	1.2433	0.0970	0.2959
99/00	1.2970	1.2970	1.2255	0.0715	0.2183
00/01	0.9665	0.9665	1.2659	-0.2993	-0.9133
01/02	1.5162	1.5162	1.2864	0.2298	0.7011

ML estimate of catchability: 0.21241E-06
Pearsons (parametric) correlation: 0.805 P= 0.0000
Kendalls (nonparametric) Tau: 0.537 P= 0.0000

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 7. Jacknife estimates for tuned VPA model fit Base 04.

INDEX	Year	Flag	Ln(liklhd)	MSE	Parameters								
Initial estimates			43.382	0.115	0.0631	0.2721	0.2161	0.1769	0.104	0.2262	0.0808	0.4511	0.0848
Charter_FL_SW	1994	*0*	36.711	0.105	0.0631	0.2721	0.2162	0.177	0.104	0.2263	0.0808	0.4514	0.0849
FL_FWC_SW	1992	*0*	36.794	0.105	0.0641	0.2824	0.2253	0.1738	0.1042	0.2284	0.075	0.4679	0.1036
HeadBoat	1983	*0*	36.909	0.105	0.0619	0.258	0.2001	0.1714	0.0983	0.216	0.0788	0.4128	0.0772
FL_FWC_NW	1997	*0*	40.107	0.11	0.0621	0.2676	0.2112	0.1683	0.0983	0.2184	0.0789	0.4951	0.0773
Bycatch_GLM	1999	*0*	40.268	0.11	0.0227	0.2737	0.2194	0.1792	0.1057	0.2285	0.083	0.4584	0.0859
MRFSS	1990	*0*	40.293	0.11	0.0631	0.2657	0.2161	0.177	0.104	0.2258	0.0809	0.4368	0.0861
Bycatch_GLM	2000	*0*	40.486	0.111	0.0802	0.2711	0.2148	0.176	0.1033	0.2252	0.08	0.4471	0.084
SEAMAP	1983	*0*	40.856	0.111	0.0642	0.2793	0.2235	0.1828	0.1086	0.2348	0.0859	0.4847	0.0931
HeadBoat	1981	*0*	41.24	0.112	0.0625	0.2655	0.2086	0.1744	0.1013	0.2215	0.0799	0.4328	0.0811
Charter_FL_SW	1993	*0*	41.289	0.112	0.0628	0.2704	0.2147	0.1758	0.1031	0.2246	0.0805	0.4441	0.0829
MRFSS	1995	*0*	41.647	0.112	0.0621	0.2755	0.2106	0.1726	0.1008	0.2207	0.0802	0.4479	0.0761
FL_FWC_NW	1999	*0*	41.703	0.112	0.0627	0.269	0.2136	0.1727	0.1005	0.3116	0.0808	0.3839	0.0793
HeadBoat	1991	*0*	42.128	0.113	0.0627	0.276	0.2241	0.1752	0.1045	0.2261	0.0803	0.4458	0.0799
SEAMAP	1995	*0*	42.194	0.113	0.0634	0.2756	0.2182	0.1784	0.105	0.2288	0.0804	0.4669	0.0901
FL_FWC_SW	1999	*0*	42.216	0.113	0.0623	0.2602	0.2081	0.1764	0.102	0.2266	0.0829	0.3214	0.0772
SEAMAP	1982	*0*	42.306	0.113	0.0641	0.279	0.2231	0.1824	0.1083	0.2343	0.0852	0.4832	0.093
Charter_FL_SW	1990	*0*	42.313	0.113	0.063	0.2713	0.2155	0.1764	0.1036	0.2255	0.0807	0.4479	0.0839
Charter_FL_SW	1989	*0*	42.387	0.114	0.0626	0.2685	0.213	0.1745	0.1022	0.2227	0.08	0.4361	0.0807
SEAMAP	1985	*0*	42.447	0.114	0.0637	0.2759	0.2201	0.1801	0.1065	0.2309	0.0839	0.4686	0.089
HeadBoat	1994	*0*	42.449	0.114	0.0635	0.2726	0.2147	0.1791	0.1049	0.2285	0.0815	0.4629	0.0899
FL_FWC_NW	1994	*0*	42.491	0.114	0.0625	0.2676	0.2122	0.1787	0.1045	0.2258	0.08	0.4399	0.0787
TX_PWD_86-01	1991	*0*	42.493	0.114	0.0633	0.2728	0.2174	0.1772	0.1043	0.2216	0.0808	0.4288	0.0877
TX_PWD_83-85	1983	*0*	42.612	0.114	0.063	0.2713	0.2155	0.1764	0.1036	0.2255	0.0807	0.448	0.084
HeadBoat	1993	*0*	42.659	0.114	0.063	0.2774	0.225	0.1765	0.1054	0.2278	0.0808	0.4537	0.0822
FL_FWC_NW	1993	*0*	42.697	0.114	0.0628	0.2704	0.2146	0.1794	0.1052	0.2275	0.0806	0.4496	0.082
TX_PWD_86-01	2001	*0*	42.714	0.114	0.0623	0.2686	0.2127	0.1718	0.0997	0.1797	0.0789	0.4455	0.0811
FL_FWC_SW	1990	*0*	42.794	0.114	0.0628	0.2703	0.2146	0.1733	0.1019	0.2225	0.0785	0.4369	0.0835
Bycatch_GLM	1991	*0*	42.835	0.114	0.0615	0.2718	0.2144	0.1762	0.1035	0.2255	0.079	0.4508	0.0855
MRFSS	1989	*0*	42.844	0.114	0.0635	0.2799	0.2192	0.1792	0.1057	0.23	0.0815	0.4769	0.0884
MRFSS	1991	*0*	42.853	0.114	0.0634	0.2681	0.2179	0.1784	0.105	0.2279	0.0813	0.4461	0.0887
Charter_FL_NW	1995	*0*	42.869	0.114	0.0627	0.2698	0.2139	0.1754	0.1028	0.2244	0.0799	0.4536	0.0814
Bycatch_GLM	1988	*0*	42.877	0.114	0.0648	0.2712	0.2173	0.177	0.104	0.2259	0.0828	0.4465	0.0827
SEAMAP	1993	*0*	42.88	0.114	0.063	0.2726	0.2158	0.1765	0.1036	0.2258	0.0787	0.4523	0.0861
FL_FWC_SW	1988	*0*	42.897	0.114	0.063	0.2721	0.2162	0.1753	0.1031	0.2249	0.0795	0.4465	0.0854
Charter_FL_SW	1991	*0*	42.923	0.114	0.0632	0.2731	0.217	0.1776	0.1045	0.2272	0.0811	0.4554	0.0861
HeadBoat	1987	*0*	42.932	0.114	0.0633	0.2762	0.2214	0.1782	0.1056	0.2289	0.0813	0.4612	0.0864
TX_PWD_83-85	1984	*0*	42.946	0.114	0.0631	0.2723	0.2164	0.1771	0.1041	0.2265	0.0809	0.4523	0.0852
FL_FWC_SW	1991	*0*	42.961	0.114	0.0632	0.2734	0.2173	0.1756	0.1035	0.2257	0.0793	0.4504	0.0872
FL_FWC_SW	1994	*0*	42.97	0.114	0.0628	0.2698	0.2141	0.1792	0.1047	0.2271	0.0834	0.4521	0.0811
Bycatch_GLM	1995	*0*	42.982	0.115	0.0611	0.2721	0.2144	0.1774	0.1134	0.2268	0.079	0.4547	0.0847
MRFSS	1994	*0*	42.984	0.115	0.0631	0.2707	0.2166	0.1773	0.1042	0.2266	0.081	0.4488	0.0858
FL_FWC_SW	1997	*0*	43.035	0.115	0.0634	0.2742	0.2176	0.1827	0.1072	0.2132	0.0852	0.4683	0.0876
MRFSS	1992	*0*	43.047	0.115	0.0634	0.2706	0.218	0.1785	0.1051	0.2282	0.0813	0.4521	0.0883
SEAMAP	1992	*0*	43.078	0.115	0.0629	0.2716	0.2151	0.176	0.1032	0.225	0.0789	0.4482	0.0848
SEAMAP	2000	*0*	43.1	0.115	0.0623	0.2678	0.2101	0.1721	0.1002	0.2201	0.0758	0.4326	0.0816
Charter_FL_SW	1988	*0*	43.106	0.115	0.063	0.2713	0.2155	0.1764	0.1036	0.2255	0.0807	0.4479	0.0839
SEAMAP	1988	*0*	43.112	0.115	0.0634	0.2739	0.2182	0.1786	0.1053	0.2287	0.0827	0.4598	0.0867
SEAMAP	1997	*0*	43.13	0.115	0.0633	0.2742	0.2173	0.1782	0.1052	0.229	0.0831	0.4627	0.0877
MRFSS	1996	*0*	43.14	0.115	0.0635	0.2804	0.219	0.1785	0.1053	0.2289	0.0814	0.4494	0.0889
TX_PWD_86-01	1996	*0*	43.14	0.115	0.0634	0.2749	0.2185	0.1789	0.1055	0.234	0.0817	0.4625	0.0883
HeadBoat	2001	*0*	43.207	0.115	0.0632	0.2965	0.2154	0.1775	0.104	0.2271	0.081	0.4575	0.0856
TX_PWD_86-01	1993	*0*	43.22	0.115	0.063	0.2713	0.2157	0.1763	0.1036	0.2233	0.0806	0.4376	0.0847
SEAMAP	1986	*0*	43.223	0.115	0.0634	0.2738	0.218	0.1785	0.1052	0.2284	0.0824	0.4592	0.0867
FL_FWC_NW	1995	*0*	43.227	0.115	0.0628	0.2703	0.2146	0.1778	0.1043	0.2262	0.0805	0.4473	0.0823
Charter_FL_NW	1994	*0*	43.23	0.115	0.0627	0.2698	0.214	0.1754	0.1028	0.2243	0.0804	0.449	0.0817
Charter_FL_NW	1991	*0*	43.232	0.115	0.0628	0.2704	0.2146	0.1758	0.1031	0.2246	0.0804	0.446	0.0827
Bycatch_GLM	1998	*0*	43.238	0.115	0.0622	0.2833	0.2165	0.1768	0.104	0.2266	0.0799	0.4547	0.0852
TX_PWD_86-01	1987	*0*	43.244	0.115	0.063	0.2711	0.2154	0.1762	0.1034	0.2236	0.0806	0.439	0.0842
HeadBoat	1986	*0*	43.251	0.115	0.063	0.2707	0.2145	0.1765	0.1035	0.2253	0.0807	0.4477	0.0843
TX_PWD_86-01	1989	*0*	43.253	0.115	0.0631	0.2718	0.2161	0.1767	0.1038	0.2243	0.0807	0.442	0.0851
Bycatch_GLM	1993	*0*	43.265	0.115	0.0657	0.2829	0.23	0.1854	0.1109	0.2398	0.0393	0.502	0.0952
TX_PWD_86-01	2000	*0*	43.284	0.115	0.0624	0.2658	0.2121	0.173	0.1009	0.2207	0.0788	0.3876	0.0802
FL_FWC_NW	2000	*0*	43.285	0.115	0.0631	0.2586	0.2132	0.2224	0.1033	0.2257	0.0823	0.4528	0.0834
SEAMAP	2001	*0*	43.29	0.115	0.0644	0.2763	0.2233	0.1816	0.1075	0.2316	0.0853	0.4673	0.0875
HeadBoat	2000	*0*	43.306	0.115	0.063	0.2542	0.2185	0.1771	0.1046	0.2267	0.0809	0.4498	0.0852
HeadBoat	1996	*0*	43.328	0.115	0.0628	0.268	0.2107	0.176	0.1025	0.2245	0.0806	0.4587	0.0826
Charter_FL_NW	1990	*0*	43.332	0.115	0.063	0.2718	0.2159	0.1768	0.1039	0.2261	0.0808	0.4516	0.0844
FL_FWC_SW	2000	*0*	43.34	0.115	0.0629	0.2716	0.2155	0.1552	0.1042	0.2265	0.0827	0.4537	0.0842
TX_PWD_86-01	1998	*0*	43.34	0.115	0.0631	0.2727	0.2165	0.1773	0.1041	0.2251	0.0809	0.4652	0.0849
SEAMAP	1987	*0*	43.34	0.115	0.0633	0.2734	0.2176	0.1781	0.1049	0.2279	0.0821	0.4571	0.0861
HeadBoat	1990	*0*	43.348	0.115	0.063	0.2733	0.2181	0.1769	0.1043	0.2266	0.0808	0.4519	0.0843
HeadBoat	1989	*0*	43.358	0.115	0.0631	0.274	0.2189	0.1772	0.1046	0.2272	0.0809	0.4542	0.0848
HeadBoat	1998	*0*	43.362	0.115	0.063	0.2695	0.2127	0.1771	0.1034	0.2386	0.0809	0.4512	0.0838
HeadBoat	1984	*0*	43.375	0.115	0.063	0.2706	0.2144	0.1764	0.1034	0.2252	0.0806	0.4472	0.0841
TX_PWD_86-01	1995	*0*	43.414	0.115	0.0634	0.2743	0.218	0.1785	0.1052	0.2311	0.0816	0.4637	0.0874
FL_FWC_SW	1989	*0*	43.428	0.115	0.0633	0.2735	0.2174	0.1796	0.1056	0.2291	0.0826	0.4623	0.0861
Bycatch_GLM	1985	*0*	43.434	0.115	0.0636	0.2718	0.2165	0.177	0.104	0.2261	0.0815	0.4497	0.0841
FL_FWC_NW	1998	*0*	43.44	0.115	0.063	0.2722	0.2159	0.1778	0.0972	0.2275	0.0809	0.4534	0.0859
FL_FWC_NW	1986	*0*	43.445	0.115	0.0632	0.2729	0.2169	0.1783	0.1049	0.2277	0.081	0.4561	0.0857
FL_FWC_NW	1988	*0*	43.447	0.115	0.0631	0.2724	0.2164	0.1779	0.1046	0.2272	0.0809	0.4538	0.0851
FL_FWC_NW	1996	*0*	43.448	0.115	0.0628	0.2705	0.2146	0.1745	0.1024	0.224	0.0802	0.4543	0.0825
MRFSS	1993	*0*	43.45	0.115	0.0631	0.2747	0.2167	0.1773	0.1043	0.227	0.0809	0.4585	0.0852

MRFSS	1997 *0*	43.451	0.115	0.0629	0.2691	0.2153	0.1766	0.1036	0.2258	0.0807	0.4583	0.0836
SEAMAP	1994 *0*	43.453	0.115	0.0631	0.2726	0.2163	0.177	0.104	0.2264	0.0801	0.4533	0.0858
FL_FWC_SW	1985 *0*	43.456	0.115	0.063	0.2718	0.216	0.1763	0.1036	0.2257	0.0804	0.449	0.0847
MRFSS	2000 *0*	43.464	0.115	0.063	0.2607	0.2156	0.1774	0.104	0.2263	0.0809	0.4558	0.0853
Bycatch_GLM	1981 *0*	43.473	0.115	0.0635	0.2726	0.217	0.1774	0.1044	0.2269	0.0814	0.4531	0.0852
FL_FWC_SW	1998 *0*	43.478	0.115	0.0629	0.2712	0.215	0.1779	0.0974	0.2265	0.0822	0.4527	0.0843
MRFSS	1986 *0*	43.478	0.115	0.0631	0.2734	0.2166	0.1773	0.1043	0.2269	0.0809	0.4554	0.0854
FL_FWC_NW	1985 *0*	43.485	0.115	0.0631	0.2727	0.2167	0.1779	0.1046	0.2273	0.081	0.4547	0.0855
Charter_FL_NW	1988 *0*	43.485	0.115	0.063	0.2719	0.216	0.1768	0.1039	0.2261	0.0808	0.4499	0.0847
MRFSS	1998 *0*	43.488	0.115	0.0631	0.2713	0.2162	0.1772	0.1041	0.2266	0.0809	0.4599	0.0847
Charter_FL_SW	1992 *0*	43.49	0.115	0.0631	0.2725	0.2165	0.1772	0.1042	0.2266	0.0809	0.4528	0.0853
Charter_FL_NW	1992 *0*	43.495	0.115	0.063	0.2717	0.2158	0.1767	0.1038	0.2259	0.0807	0.4503	0.0843
FL_FWC_NW	1991 *0*	43.496	0.115	0.0631	0.2723	0.2163	0.1765	0.1038	0.226	0.0808	0.4511	0.0852
Charter_FL_NW	1989 *0*	43.507	0.115	0.063	0.2713	0.2154	0.1764	0.1036	0.2254	0.0807	0.4472	0.0839
TX_PWD_86-01	1988 *0*	43.512	0.115	0.063	0.2717	0.2159	0.1766	0.1038	0.2251	0.0807	0.4456	0.0847
FL_FWC_NW	1987 *0*	43.516	0.115	0.063	0.2717	0.2158	0.1763	0.1036	0.2255	0.0807	0.4488	0.0844
Bycatch_GLM	1983 *0*	43.518	0.115	0.0628	0.2718	0.2157	0.1767	0.1038	0.226	0.0806	0.4502	0.0847
HeadBoat	1982 *0*	43.519	0.115	0.0632	0.2738	0.2182	0.1775	0.1047	0.2274	0.081	0.4558	0.0857
SEAMAP	1991 *0*	43.52	0.115	0.0631	0.2724	0.2166	0.1773	0.1043	0.2268	0.0815	0.4527	0.0851
MRFSS	1988 *0*	43.522	0.115	0.0631	0.2711	0.216	0.1769	0.1039	0.2261	0.0808	0.4487	0.0849
FL_FWC_NW	1992 *0*	43.523	0.115	0.0631	0.2721	0.2162	0.1777	0.1045	0.2269	0.0809	0.4526	0.0847
FL_FWC_SW	1986 *0*	43.524	0.115	0.0631	0.2723	0.2163	0.1776	0.1044	0.2269	0.0813	0.4537	0.085
FL_FWC_NW	1989 *0*	43.527	0.115	0.063	0.2716	0.2158	0.1764	0.1036	0.2256	0.0807	0.4488	0.0844
Charter_FL_NW	1993 *0*	43.527	0.115	0.063	0.272	0.216	0.1769	0.1039	0.2262	0.0808	0.4513	0.0847
SEAMAP	1998 *0*	43.529	0.115	0.0632	0.2729	0.2167	0.1777	0.1046	0.2275	0.0821	0.4557	0.0858
Bycatch_GLM	1990 *0*	43.536	0.115	0.0635	0.2718	0.2164	0.1769	0.104	0.2261	0.0813	0.4499	0.0843
SEAMAP	1990 *0*	43.537	0.115	0.063	0.2717	0.2157	0.1766	0.1037	0.2257	0.0803	0.4495	0.0846
Bycatch_GLM	1986 *0*	43.539	0.115	0.0633	0.2724	0.2166	0.1772	0.1042	0.2266	0.0811	0.4524	0.0851
HeadBoat	1985 *0*	43.544	0.115	0.0631	0.2728	0.217	0.1772	0.1043	0.2267	0.0809	0.453	0.0852
Bycatch_GLM	1992 *0*	43.548	0.115	0.0633	0.2724	0.2167	0.1772	0.1042	0.2266	0.0812	0.4511	0.0852
FL_FWC_SW	1993 *0*	43.55	0.115	0.063	0.2719	0.216	0.1759	0.1034	0.2253	0.0801	0.4479	0.0849
HeadBoat	1997 *0*	43.55	0.115	0.0631	0.2711	0.2147	0.1774	0.1071	0.2263	0.081	0.451	0.0846
SEAMAP	1999 *0*	43.55	0.115	0.0632	0.2729	0.2171	0.1778	0.1047	0.2275	0.082	0.4553	0.0857
MRFSS	1999 *0*	43.551	0.115	0.0631	0.2721	0.2166	0.1775	0.1044	0.2274	0.0811	0.4637	0.0853
SEAMAP	1989 *0*	43.551	0.115	0.063	0.2718	0.2158	0.1766	0.1037	0.2258	0.0804	0.4496	0.0846
HeadBoat	1988 *0*	43.554	0.115	0.0631	0.2724	0.2166	0.177	0.1041	0.2264	0.0809	0.4519	0.0849
TX_PWD_86-01	1999 *0*	43.557	0.115	0.0631	0.2728	0.2166	0.1774	0.1043	0.2266	0.0811	0.4601	0.0853
TX_PWD_86-01	1990 *0*	43.558	0.115	0.063	0.2721	0.2161	0.177	0.104	0.2267	0.0808	0.4536	0.0847
MRFSS	2001 *0*	43.559	0.115	0.063	0.2681	0.2158	0.1769	0.1039	0.2261	0.0808	0.4514	0.0848
TX_PWD_86-01	1986 *0*	43.56	0.115	0.0631	0.2722	0.2162	0.177	0.1041	0.2269	0.0809	0.4542	0.0848
Bycatch_GLM	1989 *0*	43.56	0.115	0.0627	0.2721	0.2157	0.1768	0.1039	0.2261	0.0804	0.4514	0.0851
Bycatch_GLM	1984 *0*	43.561	0.115	0.0632	0.2722	0.2164	0.1771	0.1041	0.2264	0.0811	0.4515	0.0848
TX_PWD_86-01	1994 *0*	43.562	0.115	0.063	0.2719	0.2159	0.1768	0.1039	0.2268	0.0808	0.4538	0.0844
SEAMAP	1984 *0*	43.563	0.115	0.063	0.2716	0.2156	0.1765	0.1037	0.2257	0.0805	0.449	0.0843
HeadBoat	1995 *0*	43.567	0.115	0.0631	0.2729	0.2173	0.1772	0.1043	0.2267	0.0809	0.4508	0.0854
Bycatch_GLM	1996 *0*	43.568	0.115	0.0632	0.2721	0.2163	0.1754	0.104	0.2262	0.0809	0.4508	0.0849
Bycatch_GLM	1997 *0*	43.568	0.115	0.0632	0.2718	0.2118	0.177	0.104	0.2262	0.0811	0.4508	0.0848
TX_PWD_83-85	1985 *0*	43.569	0.115	0.0631	0.2721	0.2162	0.177	0.104	0.2263	0.0808	0.4514	0.0849
TX_PWD_86-01	1992 *0*	43.57	0.115	0.063	0.2718	0.216	0.1767	0.1038	0.2256	0.0808	0.448	0.0847
MRFSS	1987 *0*	43.571	0.115	0.0631	0.2724	0.2161	0.1769	0.104	0.2263	0.0808	0.4519	0.0848
SEAMAP	1996 *0*	43.573	0.115	0.0631	0.2723	0.2163	0.177	0.104	0.2264	0.0809	0.4522	0.0851
Bycatch_GLM	1987 *0*	43.574	0.115	0.0632	0.2721	0.2163	0.177	0.104	0.2263	0.081	0.4512	0.0848
FL_FWC_SW	1995 *0*	43.575	0.115	0.0631	0.2722	0.2163	0.1772	0.1042	0.2265	0.081	0.4514	0.085
FL_FWC_SW	1987 *0*	43.576	0.115	0.0631	0.2721	0.2161	0.177	0.104	0.2263	0.0809	0.4513	0.0848
TX_PWD_86-01	1997 *0*	43.576	0.115	0.0631	0.2721	0.2162	0.177	0.104	0.2264	0.0808	0.4511	0.0849
HeadBoat	1992 *0*	43.576	0.115	0.0631	0.2721	0.2161	0.177	0.104	0.2263	0.0809	0.4515	0.085
Bycatch_GLM	1982 *0*	43.576	0.115	0.063	0.272	0.2161	0.1769	0.104	0.2262	0.0808	0.451	0.0848
Bycatch_GLM	1994 *0*	43.576	0.115	0.063	0.272	0.216	0.1769	0.1039	0.2264	0.0808	0.451	0.0848
FL_FWC_NW	1990 *0*	43.577	0.115	0.0631	0.2721	0.2161	0.177	0.104	0.2263	0.0808	0.4512	0.0848
FL_FWC_SW	1996 *0*	43.577	0.115	0.0631	0.2719	0.216	0.1768	0.1039	0.226	0.0818	0.4504	0.0847
HeadBoat	1999 *0*	43.577	0.115	0.0631	0.272	0.2177	0.1769	0.104	0.2262	0.0808	0.451	0.0848
AVERAGE				0.0629	0.272	0.2162	0.1771	0.104	0.2267	0.0806	0.4509	0.0849

Table 8. Maximum sustainable yield (MSY) and optimum yield (OY) related values for the base case (Base 04) scenario. 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

Table 9. Fishing year 2003/2004 acceptable biological catch (ABC) in millions of pounds for the base case scenario under two levels of F mortality. Probability denotes likelihood of exceeding the desired F mortality rate.

		Base 04	
Probability		$F_{30\%SPR}$	$F_{40\%SPR}$
50%	Median	10.322	7.442
10 %	Lower CI	7.544	5.421
90%	Upper CI	13.504	9.836

Table 10. Maximum sustainable yield (MSY) and optimum yield (OY) related bench mark values for the simulation VPA runs with different allocation of the directed catch from the mixed area (Florida Volusia-Monroe Nov-Mar) between the Gulf and Atlantic king stocks.

Model **Glf 100%**

	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
determinist	6.380	0.226	11.286	8.506	0.160	9.974

Model **Glf 50%**

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	5.355	0.285	9.529	7.147	0.199	8.472
low 80%	4.742	0.235	8.219	6.356	0.166	7.276
upp 80%	6.212	0.415	11.404	8.235	0.283	9.942
determinist	5.385	0.256	9.508	7.180	0.180	8.405

Model **Glf 2%**

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	4.584	0.315	8.114	6.107	0.217	7.212
low 80%	4.030	0.247	7.046	5.371	0.171	6.219
upp 80%	5.251	0.499	9.565	7.015	0.331	8.518
determinist	4.551	0.295	8.082	6.067	0.204	7.143

Model **Atl 0%**

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	2.921	0.288	5.643	4.354	0.205	5.836
low 80%	1.499	0.252	2.726	3.396	0.180	4.436
upp 80%	4.385	0.335	8.483	6.053	0.237	8.168
determinist	3.054	0.262	5.888	4.072	0.187	5.424

Model **Atl 50%**

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	3.769	0.309	7.359	5.113	0.218	6.929
low 80%	2.707	0.267	4.950	4.135	0.189	5.343
upp 80%	5.184	0.363	10.466	6.956	0.255	9.747
determinist	3.561	0.297	6.971	4.748	0.210	6.410

Model **Atl 98%**

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	4.161	0.312	8.338	5.609	0.218	7.738
low 80%	3.340	0.269	6.455	4.601	0.191	6.175
upp 80%	5.656	0.369	11.518	7.602	0.256	10.520
determinist	3.908	0.284	7.872	5.210	0.197	7.306

Table 11. Estimated acceptable biological catch (ABC) in millions of pounds for the simulation VPA runs with different allocation of the directed catch from the mixed area (Florida Volusia-Monroe Nov-Mar) between the Gulf and Atlantic king stocks. Probability denotes the likelihood of exceeding the desired F mortality rates.

	Gulf 100%		Gulf 50%		Gulf 2%	
Probability	$F_{30\%SPR}$	$F_{40\%SPR}$	$F_{30\%SPR}$	$F_{40\%SPR}$	$F_{30\%SPR}$	$F_{40\%SPR}$
50% Median	10.322	7.442	7.987	5.708	6.435	4.569
10% lower CI	7.544	5.421	5.640	3.967	4.586	3.205
90% upper CI	13.504	9.836	11.072	8.013	8.802	6.237
	Atlantic 0%		Atlantic 50%		Atlantic 98%	
Probability	$F_{30\%SPR}$	$F_{40\%SPR}$	$F_{30\%SPR}$	$F_{40\%SPR}$	$F_{30\%SPR}$	$F_{40\%SPR}$
50% Median	7.740	5.650	9.720	7.140	10.158	7.307
10% lower CI	5.234	3.837	6.159	4.477	6.860	5.035
90% upper CI	12.269	9.021	15.362	11.260	16.278	11.706

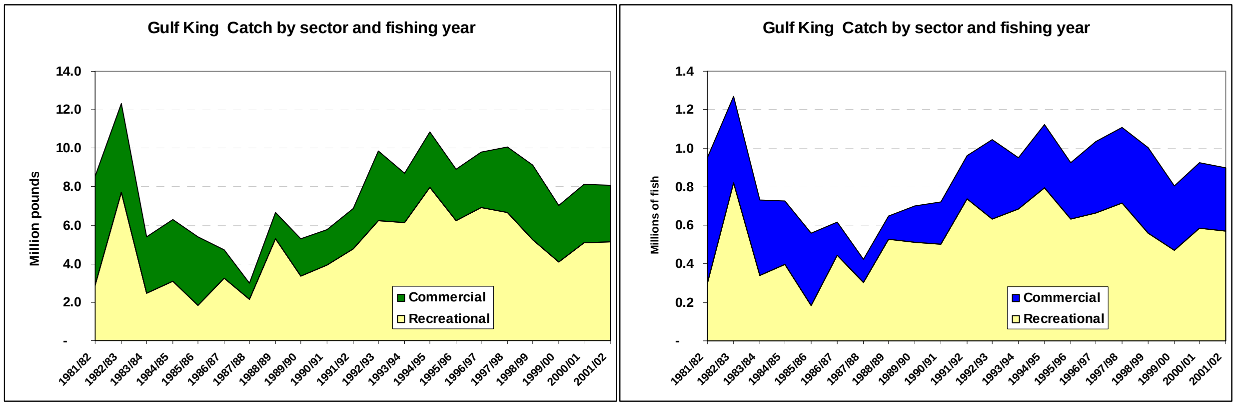

Figure 1. Gulf king mackerel catch and yield by fishing year and sector from 1981/82 through 2001/20. Fishing year starts in July 1st and ends on June 30th of following year.

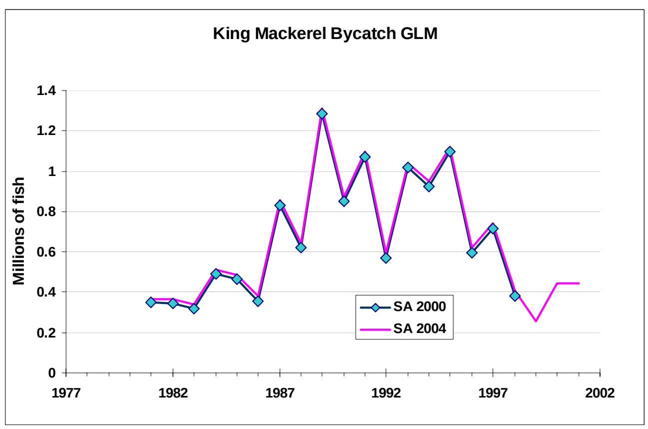

Figure 2. Estimates of king mackerel bycatch from the US Gulf of Mexico shrimp fishery. Estimates from the GLM model for 2000 and 2002 assessments, the value for 2001 was carry over from 2000.

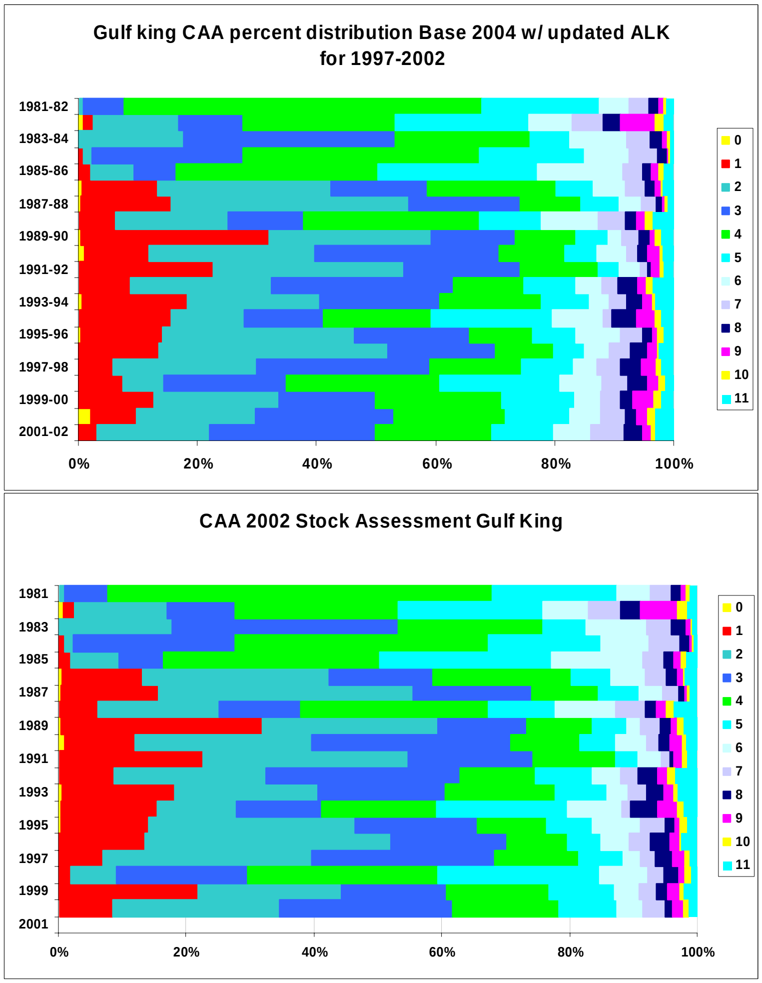

Figure 3. Gulf king Catch-at-age (CAA) percent distribution by age and fishing year. Top panel corresponds to the 2004 base 04 model, bottom panel corresponds to the 2002 CAA.

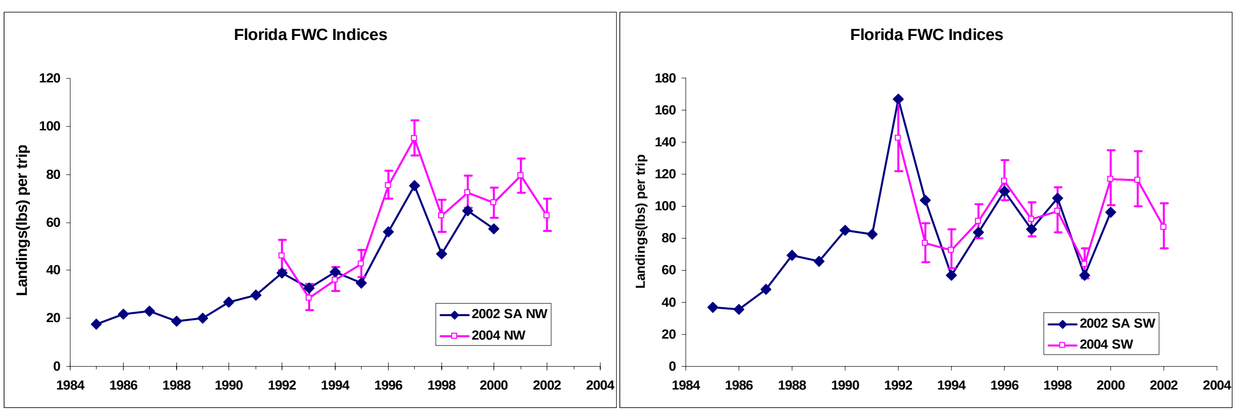

Figure 4A. Comparison of the standardized CPUE rates estimated from the Florida trip ticket data for the Gulf king mackerel stock used in the 2002 assessment (solid diamonds) and available series for the 2004 assessment (open squares). Error bars indicate estimated 95% confidence range for the most recent time series.

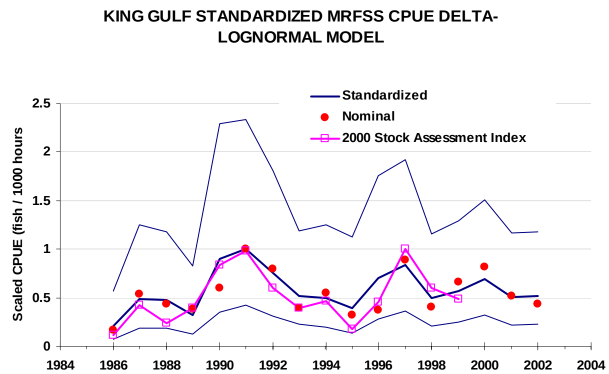

Figure 4B Comparison of 2000 and 2004 standardized CPUE index from the MRFSS data set. Outer lines represent 95% confidence range.

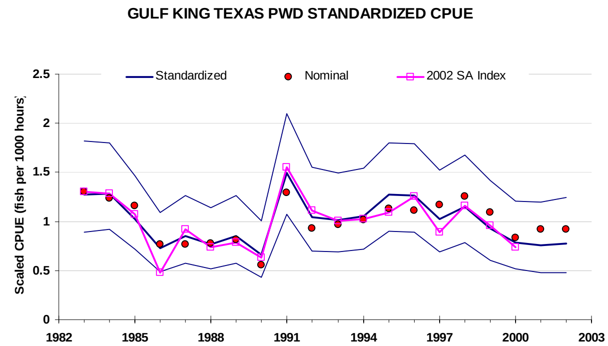

Figure 5. Comparison of 2000 and 2004 standardized CPUE index for the TPWD data set. Outer lines represent 95% confidence range.

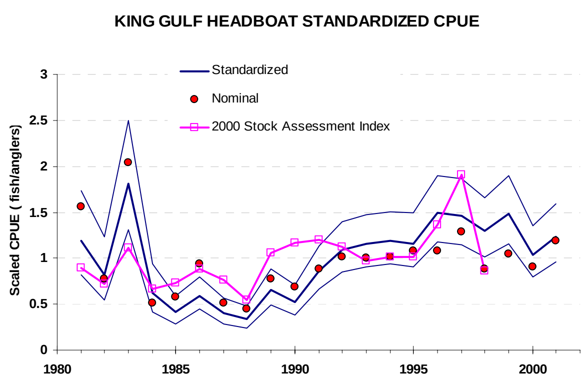

Figure 6. Comparison of 2000 and 2004 standardized CPUE index for the Headboat data set. Outer lines represent 95% confidence range.

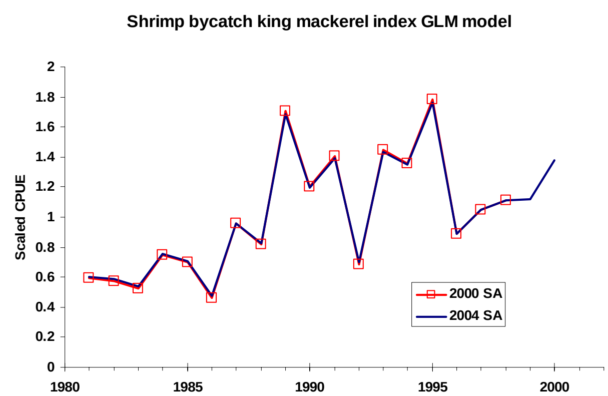

Figure 7. Gulf king Shrimp bycatch standardized CPUE index from the GLM model for 2000 (open squares) and 2004 (solid line) assessments.

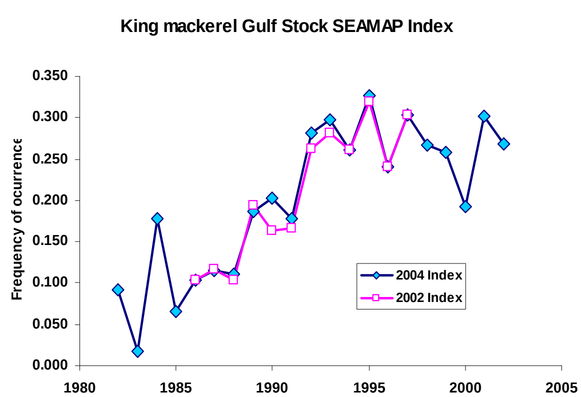

Figure 8. Percentage of occurrence index of king mackerel from the Gulf of Mexico SEAMAP survey.

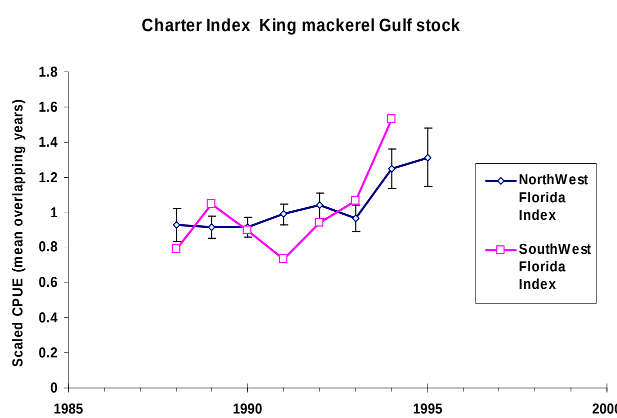

Figure 9. Standardized CPUE index series from the Florida Charter data set.

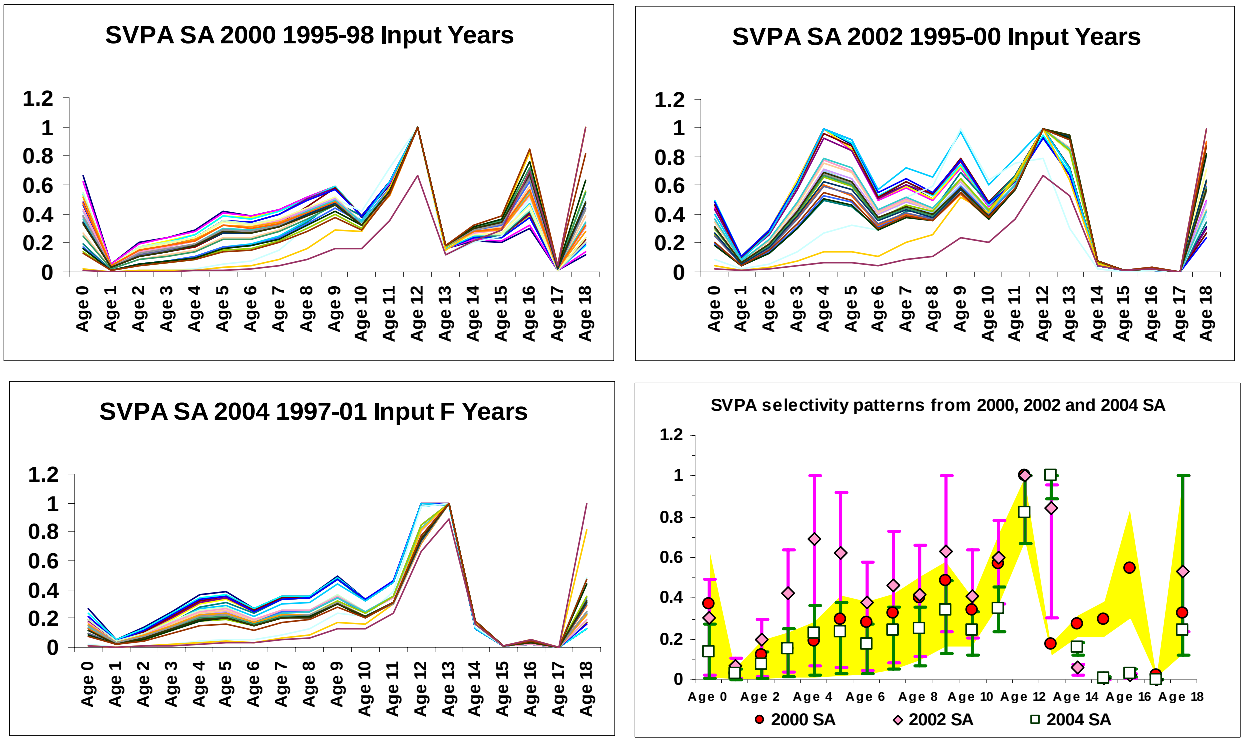

Figure 10. Selectivity pattern results from SVPA models with a range of fixed F ratios for catch at age of Gulf king mackerel. Top-left results of 2000 assessment, top-right results of 2002 assessment, bottom-left results of 2004 assessment. Bottom-right panel compares the results of all three assessments, with markers representing the mean value and the bars the minimum and maximum values per age class; solid circles and shaded area are for 2000 results, solid diamonds and bars, 2002 results and open squares and bars for 2004 results..

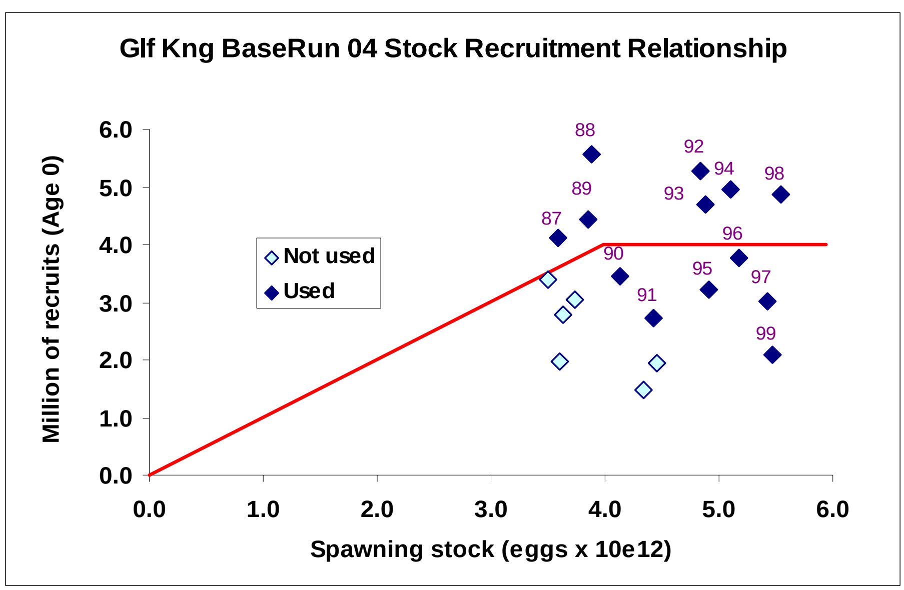

Figure 11. Stock recruitment relationship under the two line model for the base 2004 scenario. Results from the deterministic run.

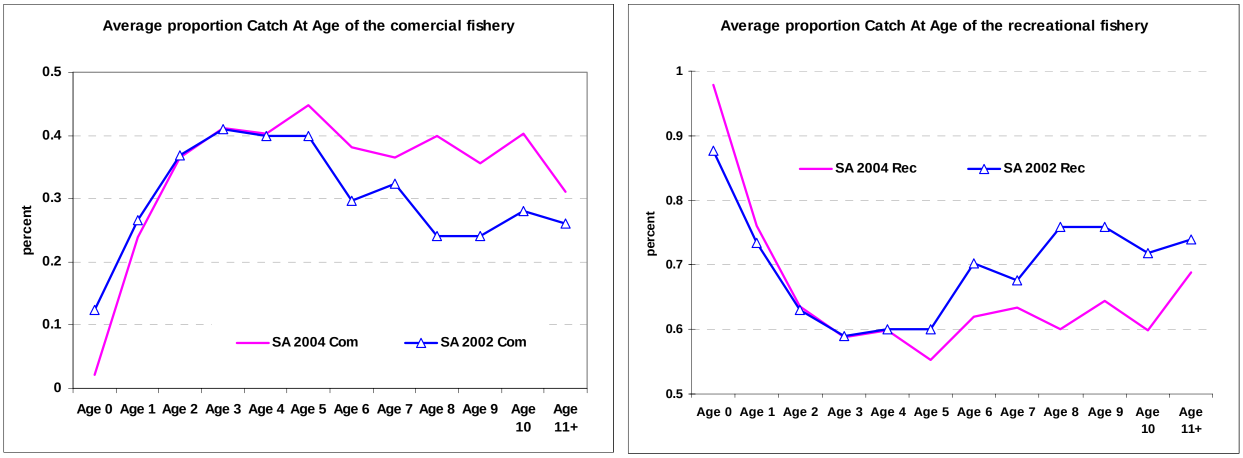

Figure 12. Estimated proportion of catch at age for Gulf king mackerel used in projection analyses. The 2002 assessment proportion is the average of fishing years 1995 to 2000. For the 2004 assessment the average proportion includes the 1997 to 2001 fishing years.

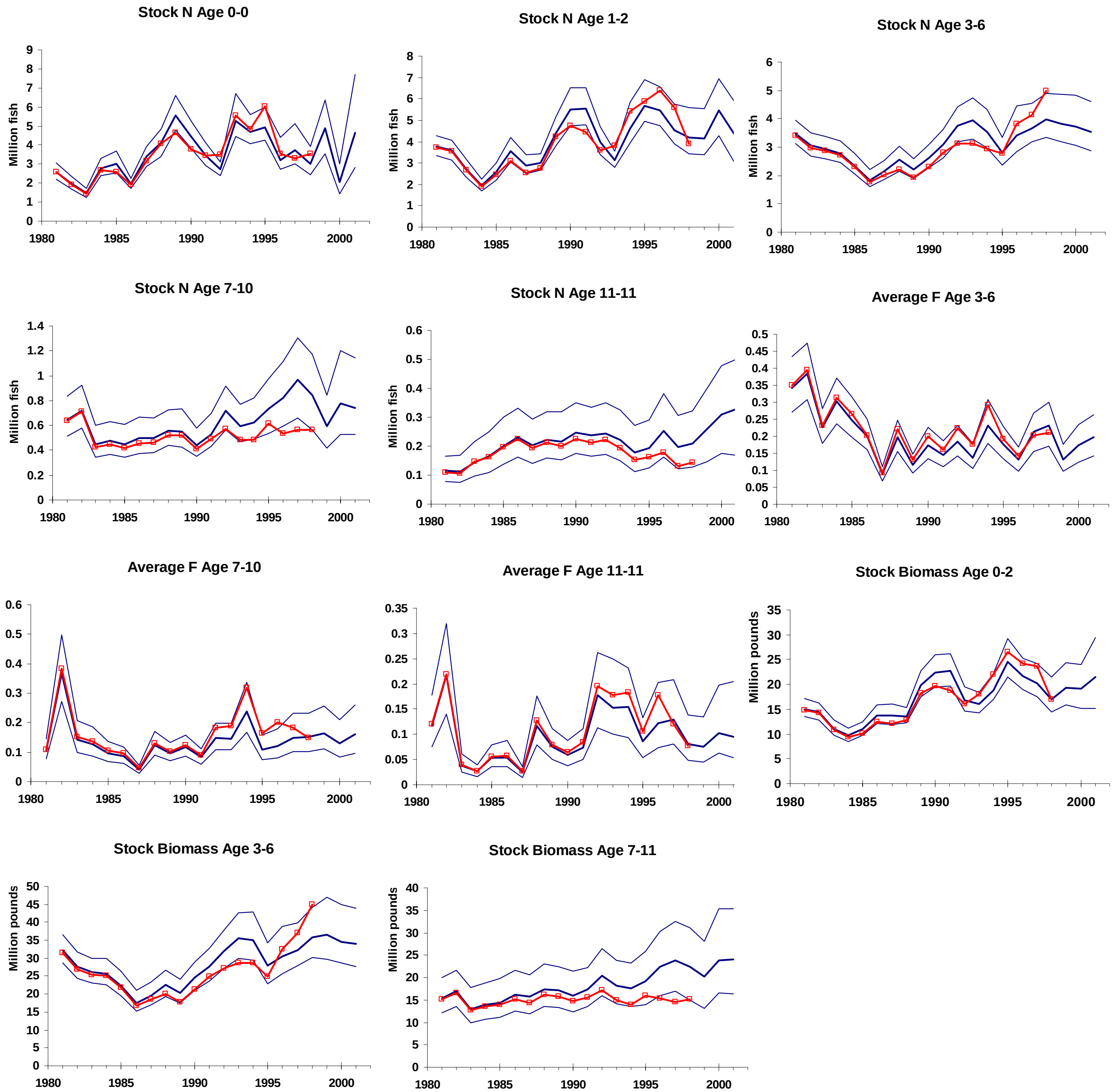

Figure 13. Gulf king mackerel population trends with 80% confidence intervals from the base-04 model (solid lines). For comparison, results from the 2000 assessment are shown (open square marker line).

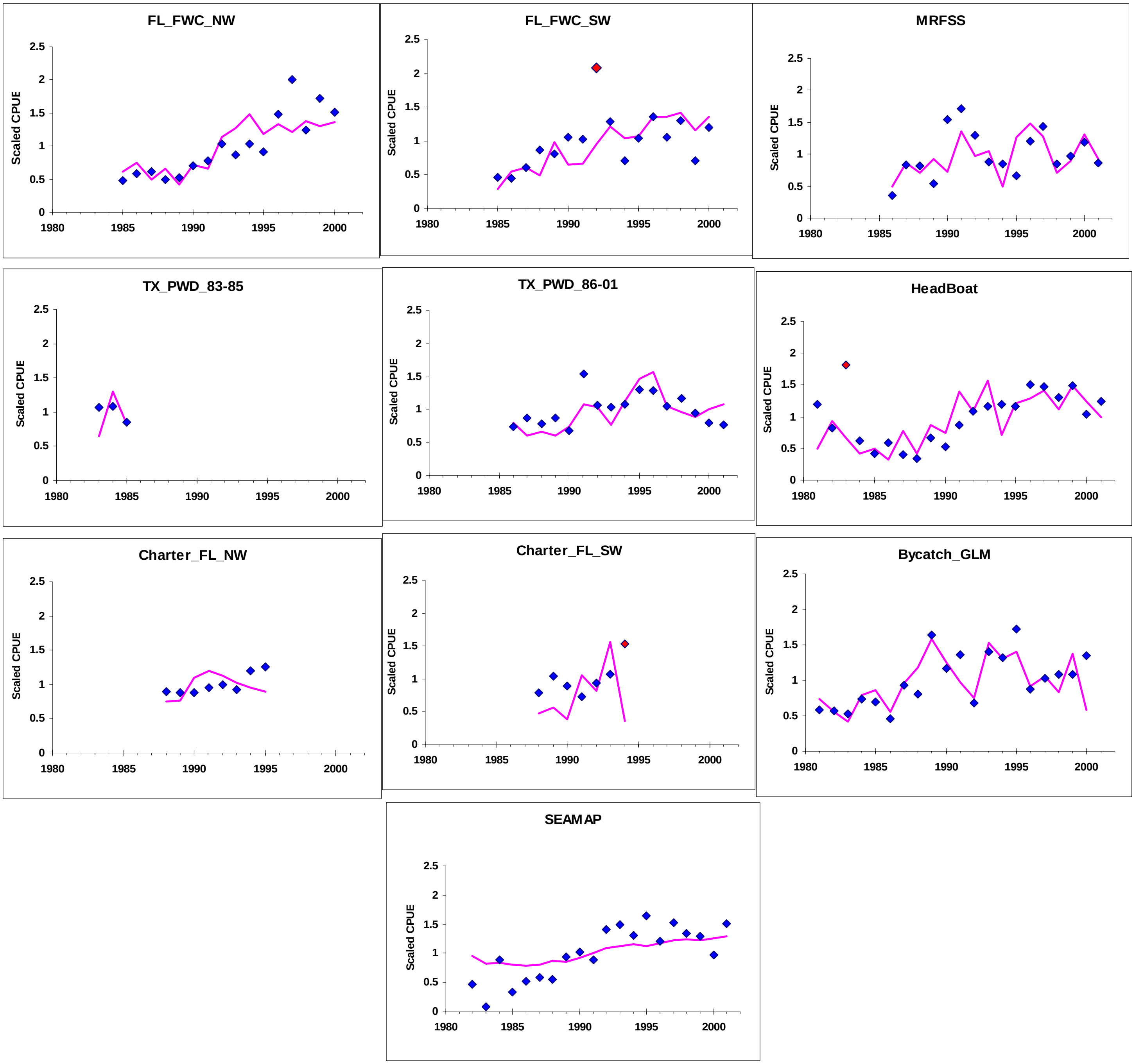

Figure 14. Gulf king mackerel predicted (solid line) and standardized indices of abundance (diamonds) from the tuned VPA model base-04.

Figure 15. Estimated stock size by age from the tuned VPA results from the base-04 model (solid line) and corresponding estimates from the 2000 assessment (solid diamonds line).

Figure 16. Estimated fishing mortality rates (F) by age from the tuned VPA results from base-04 model (solid line) and corresponding estimates from the 2000 assessment (solid diamonds line).

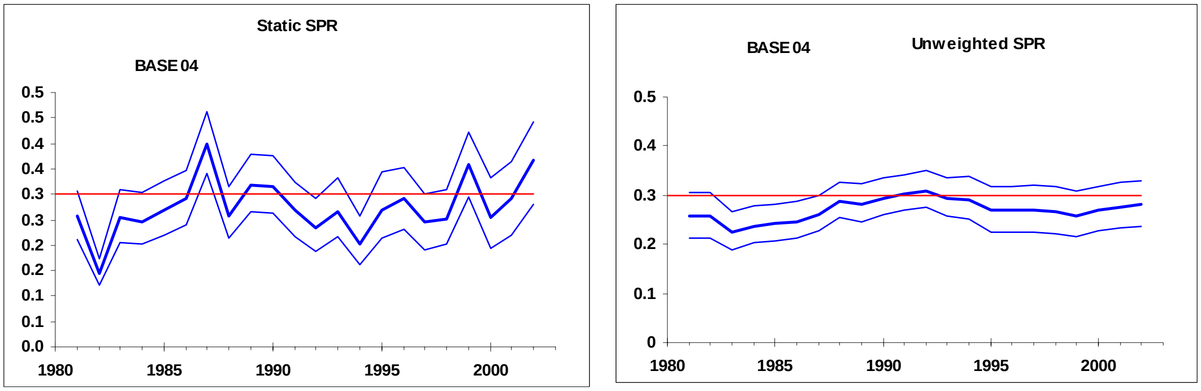

Figure 17. Trends of static and unweighted SPR from the base-04 model scenario.

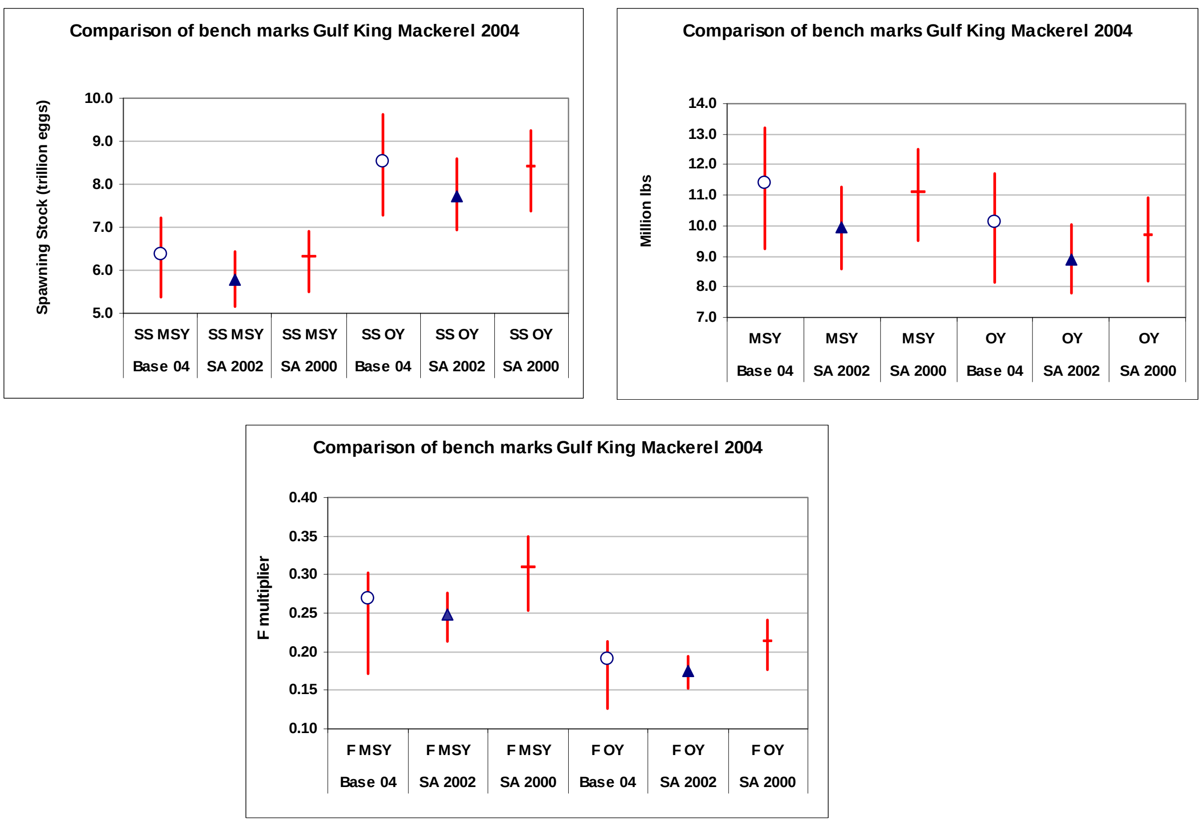

Figure 18. Gulf king mackerel benchmarks 2004 assessment. Spawning stock (SS) biomass (trillion eggs), maximum sustainable yield (MSY), optimum yield (OY), in millions of pounds, and corresponding fishing mortality rates (F_{ref}) from the base-04 model (open circles). For comparison, equivalent values are plotted from the 2000 (plus marker) and 2002 (solid triangle) assessments. Bars represent 90% range of 500 bootstrap runs.

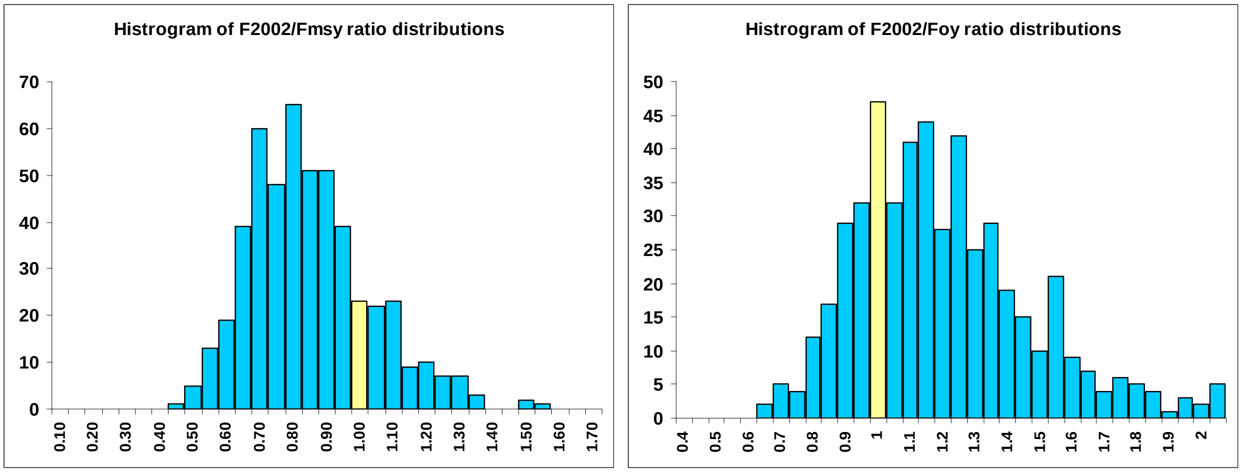

Figure 19. Distribution of Gulf king mackerel F_{2002}/F_{MSY} (left) and F_{2002}/F_{OY} (right) ratios from 500 bootstraps for the Base-04 model.

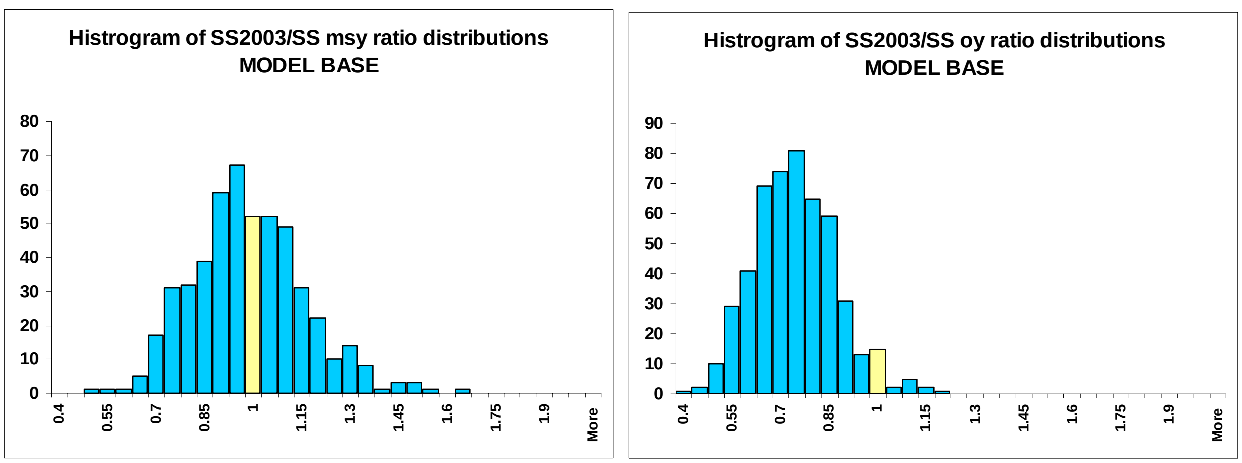

Figure 20. Distribution of Gulf king mackerel SS_{2003}/SS_{MSY} (left) and SS_{2003}/SS_{OY} (right) ratios from 500 bootstraps for the Base-04 model.

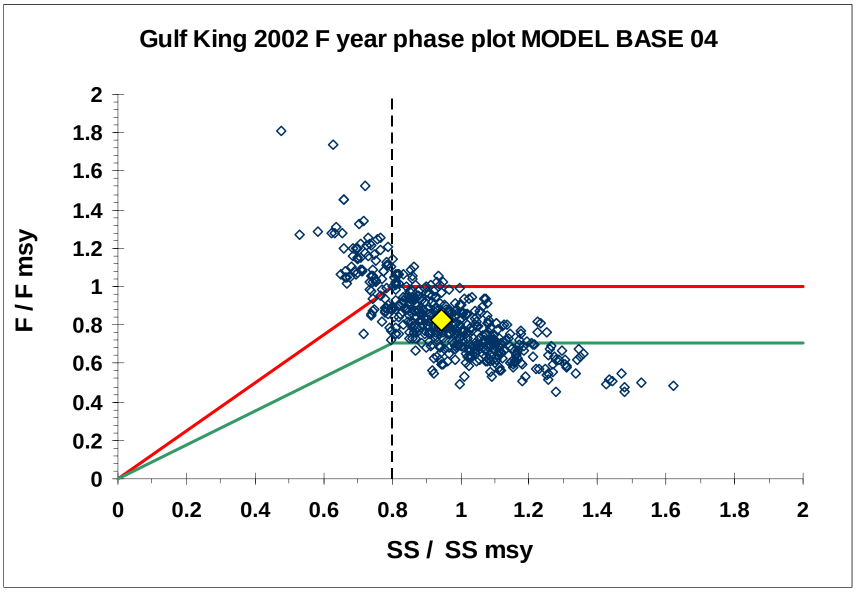

Figure 21. Phase plots of 500 bootstraps for the index scenarios. The red solid line denotes the MFMT, the vertical dashed line denotes MSST, and the lower solid line denotes the OY control rule. The deterministic run corresponds to the larger diamond marker.

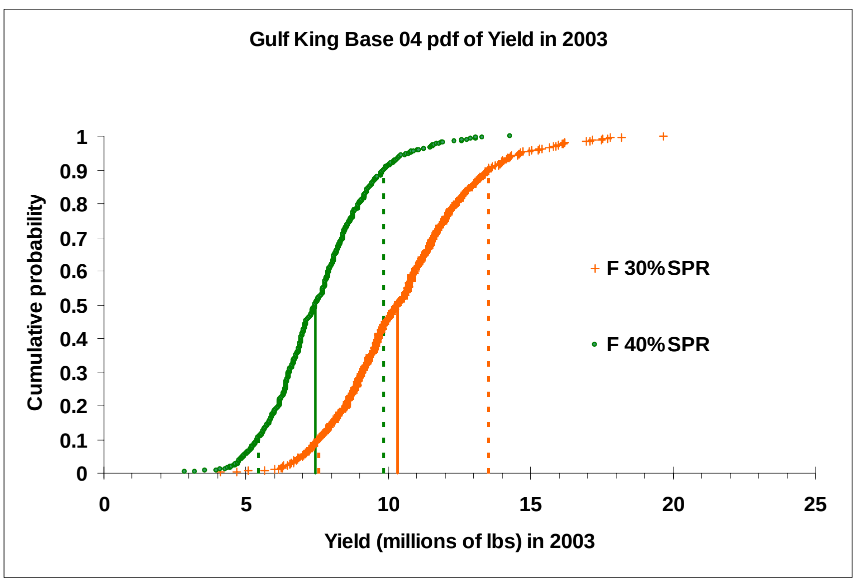

Figure 22. Frequency distribution of 500 bootstraps range of allowable biological catch (ABC) based on probability of F exceeding $F_{30\% \, SPR}$ and $F_{40\%SPR}$ in the 2003/2004 fishing year for Gulf king mackerel from the base-04 model. Vertical solid lines represent 0.5 percentile; broken lines represent 0.1 and 0.9 percentiles of the distributions.

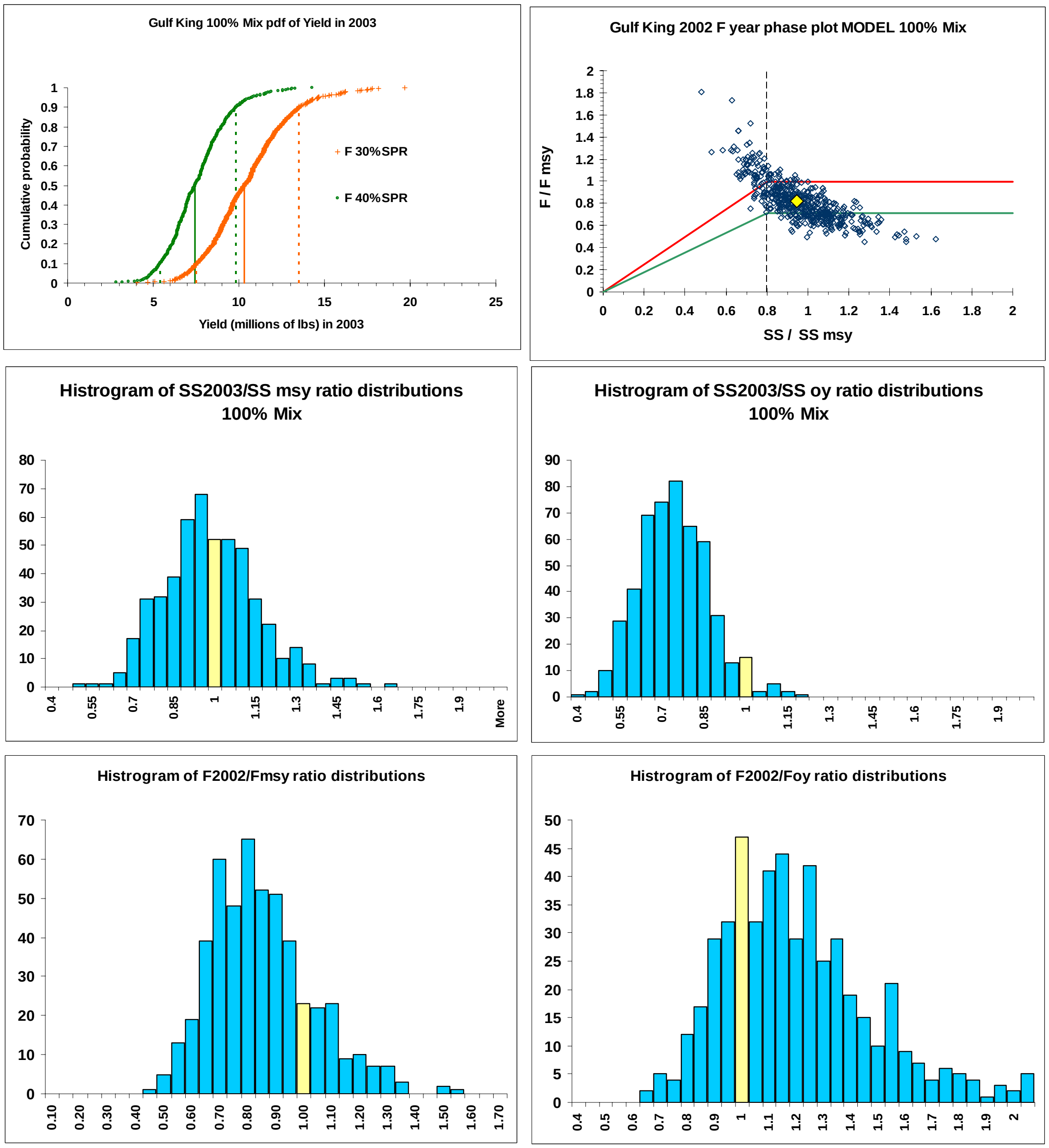

Figure 23. Mixed area VPA runs for 100% allocation to Gulf king mackerel. Histogram distributions for F_{2002}/F_{MSY}, F_{2002}/F_{OY}, SS_{2003}/SS_{MSY}, SS_{2003}/SS_{OY}, ABC cumulative distribution, and phase plot.

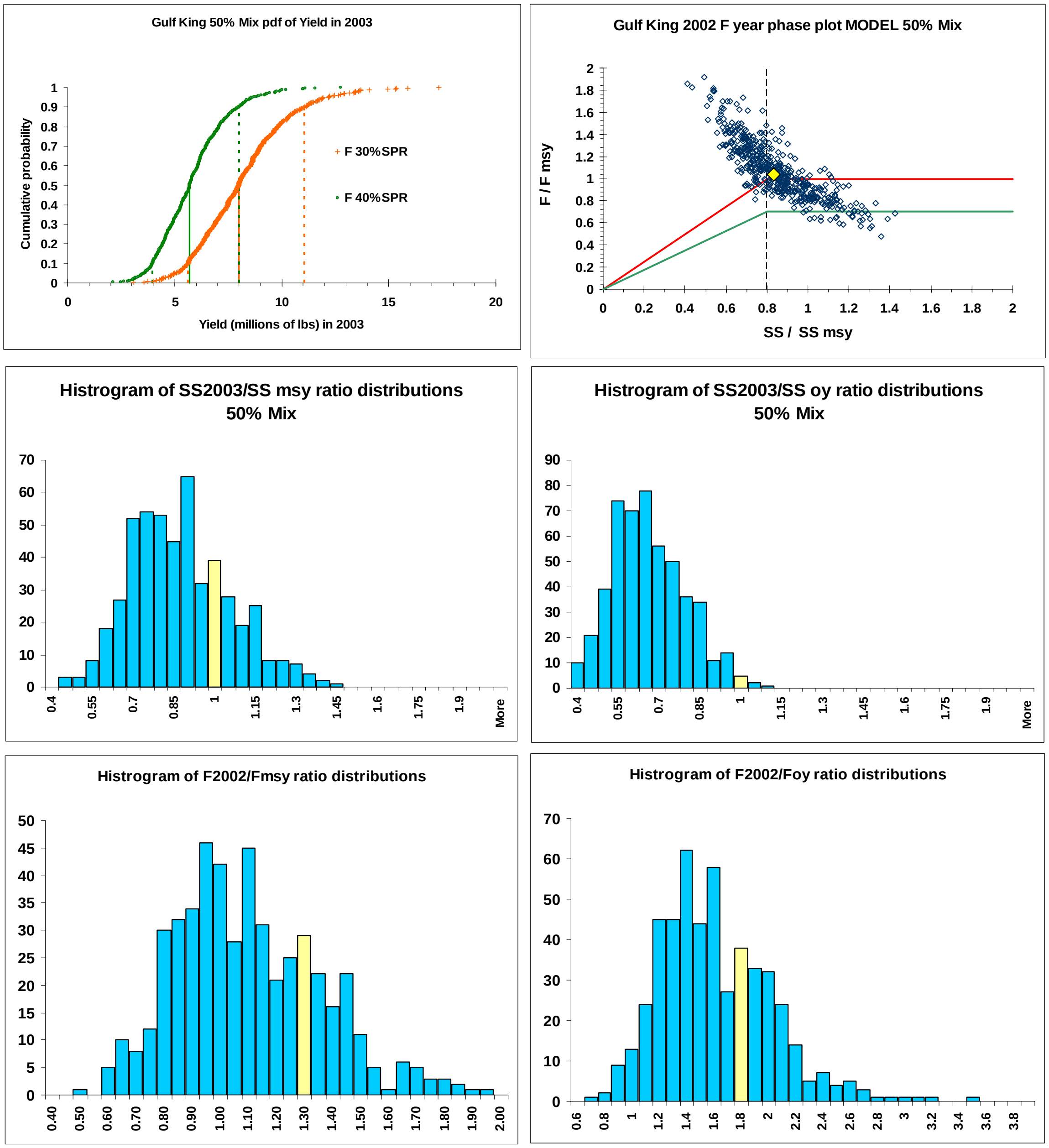

Figure 24. Mixed area VPA runs for 50% allocation to Gulf king mackerel. Histogram distributions for F_{2002}/F_{MSY}, F_{2002}/F_{OY}, SS_{2003}/SS_{MSY}, SS_{2003}/SS_{OY}, ABC cumulative distribution, and phase plot.

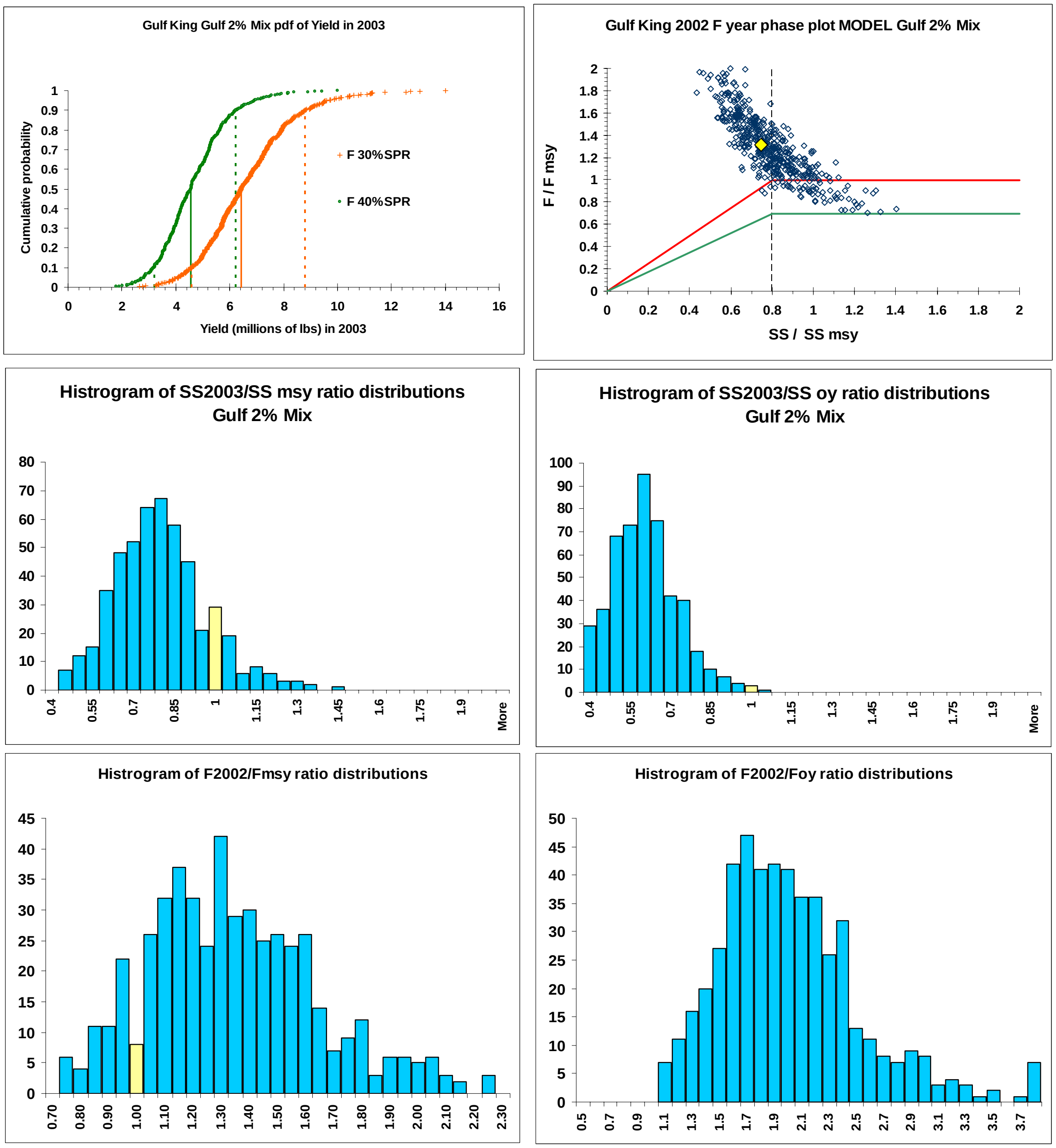

Figure 25. Mixed area VPA runs for 2% allocation to Gulf king mackerel. Histogram distributions for F_{2002}/F_{MSY}, F_{2002}/F_{OY}, SS_{2003}/SS_{MSY}, SS_{2003}/SS_{OY}, ABC cumulative distribution, and phase plot.

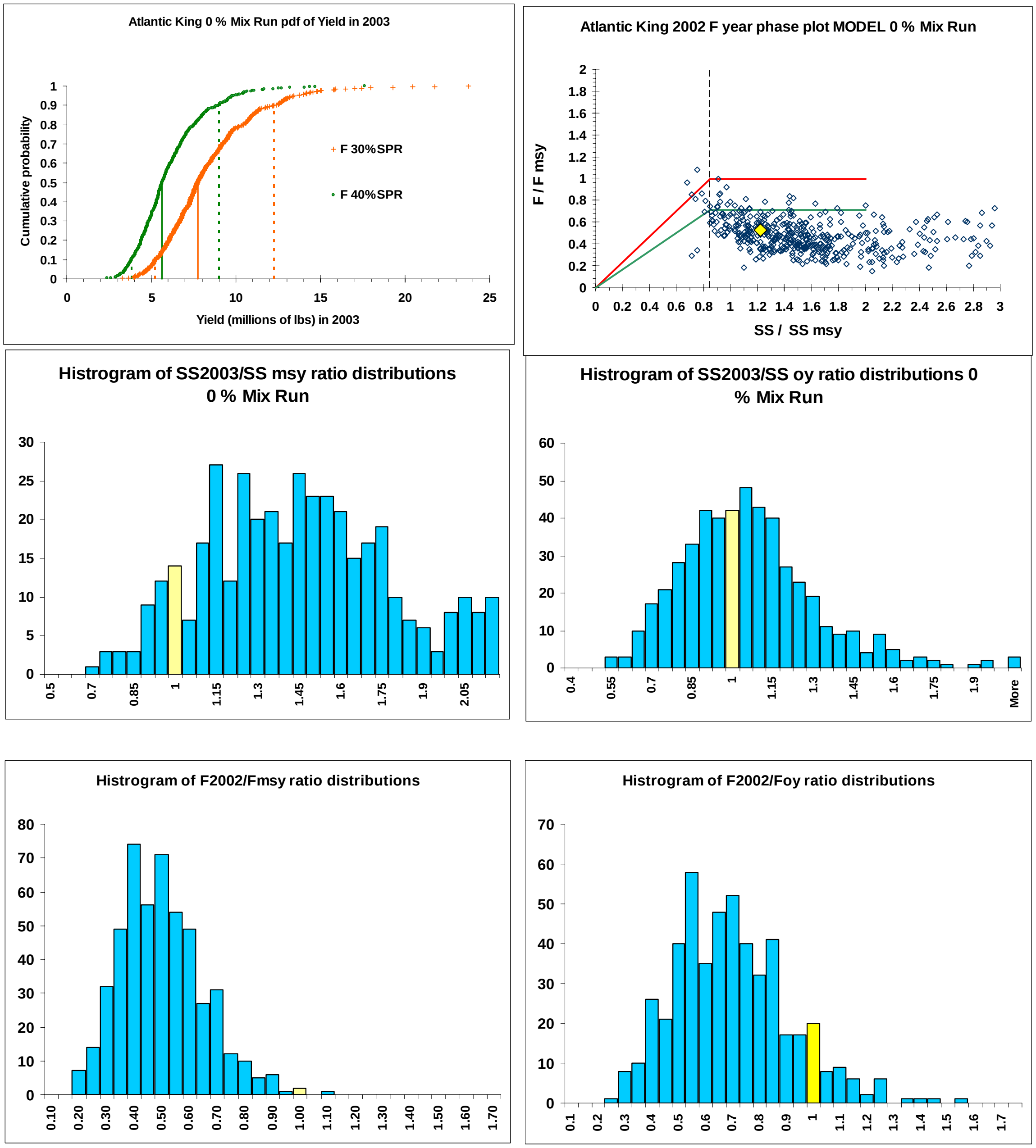

Figure 26. Mixed area VPA runs for 0% allocation to Atlantic king mackerel. Histogram distributions for F_{2002}/F_{MSY}, F_{2002}/F_{OY}, SS_{2003}/SS_{MSY}, SS_{2003}/SS_{OY}, ABC cumulative distribution, and phase plot.

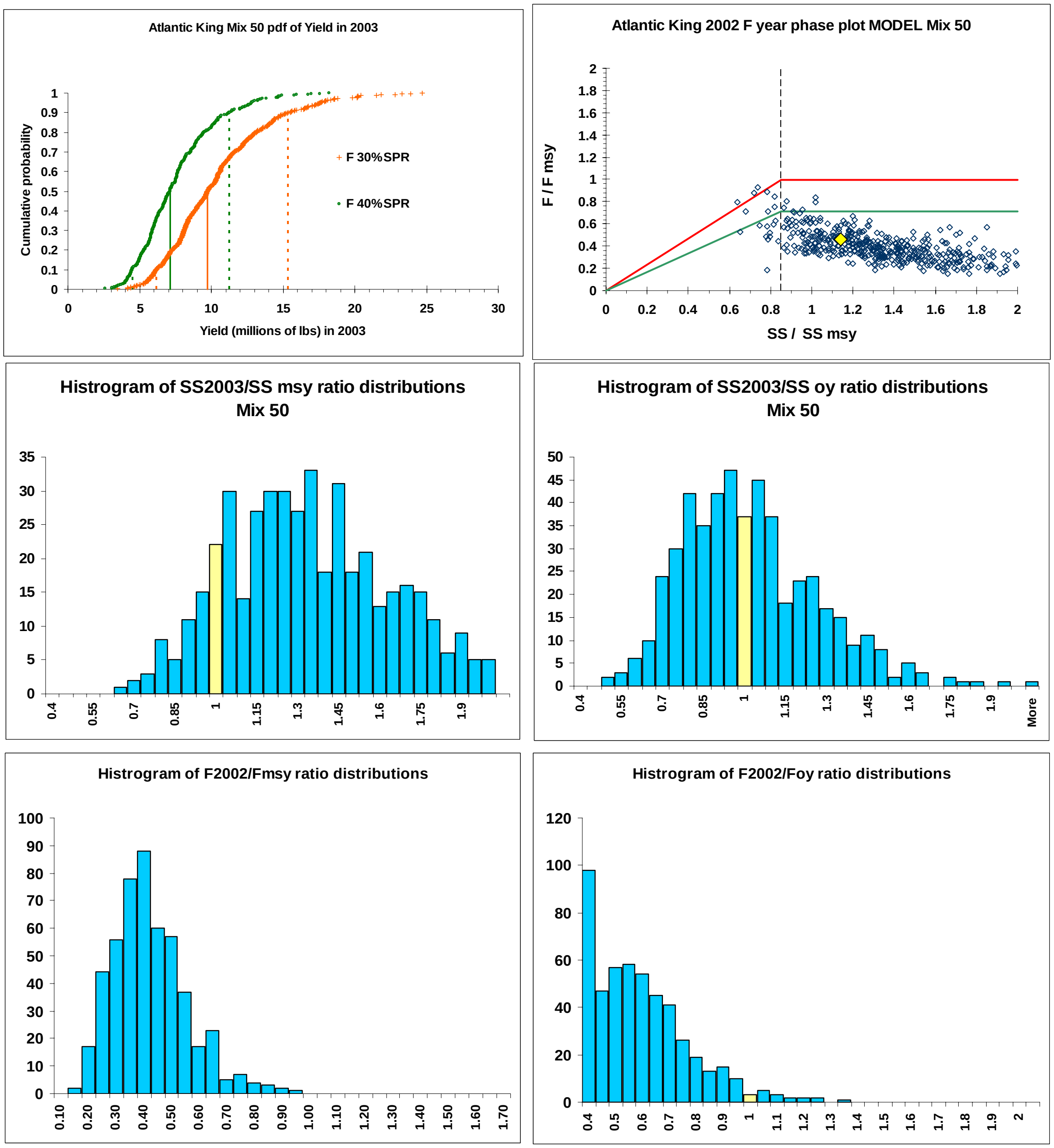

Figure 27. Mixed area VPA runs for 50% allocation to Atlantic king mackerel. Histogram distributions for F_{2002}/F_{MSY}, F_{2002}/F_{OY}, SS_{2003}/SS_{MSY}, SS_{2003}/SS_{OY}, ABC cumulative distribution, and phase plot.

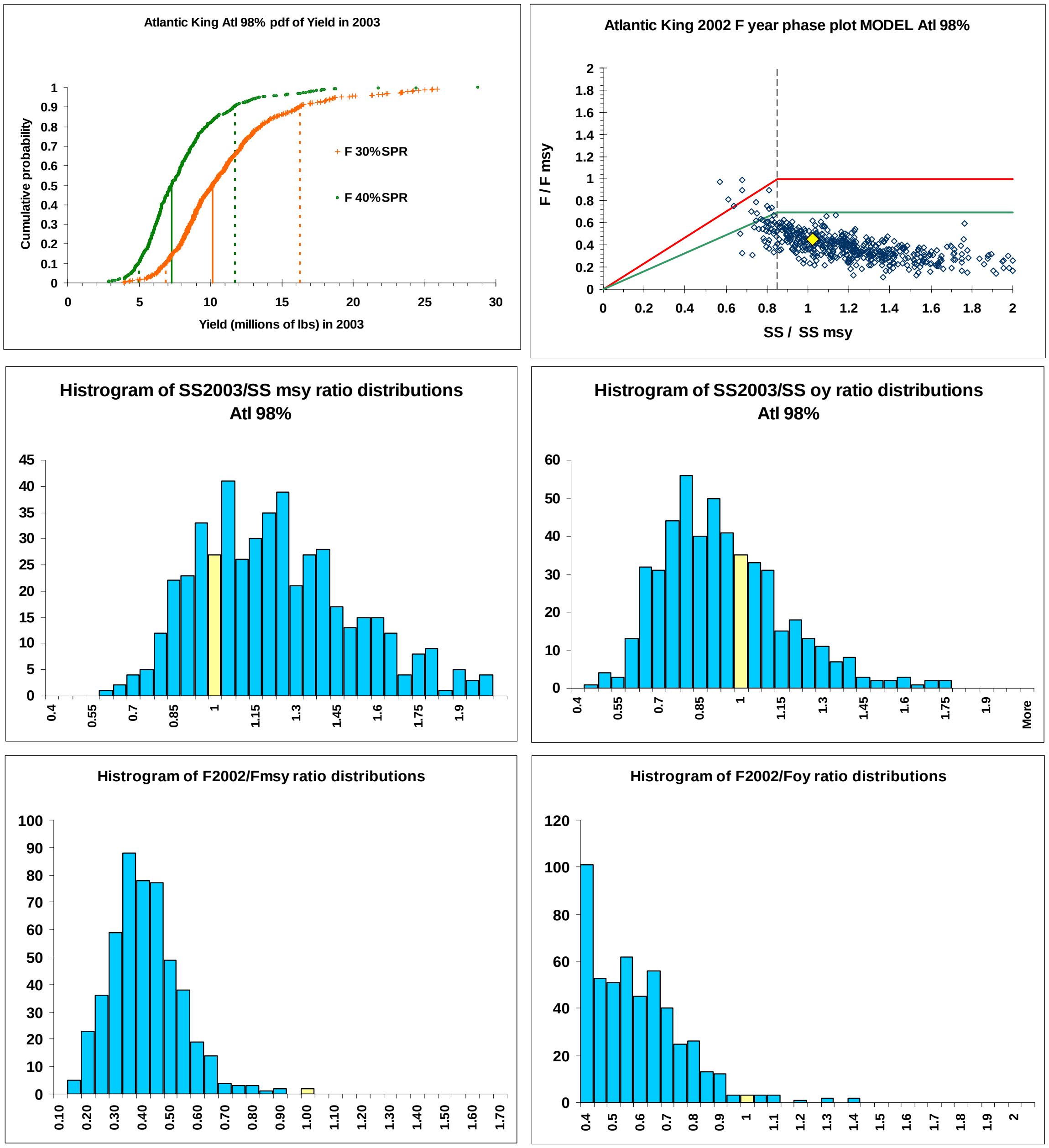

Figure 28. Mixed area VPA runs for 98% allocation to Atlantic king mackerel. Histogram distributions for F_{2002}/F_{MSY}, F_{2002}/F_{OY}, SS_{2003}/SS_{MSY}, SS_{2003}/SS_{OY}, ABC cumulative distribution, and phase plot.

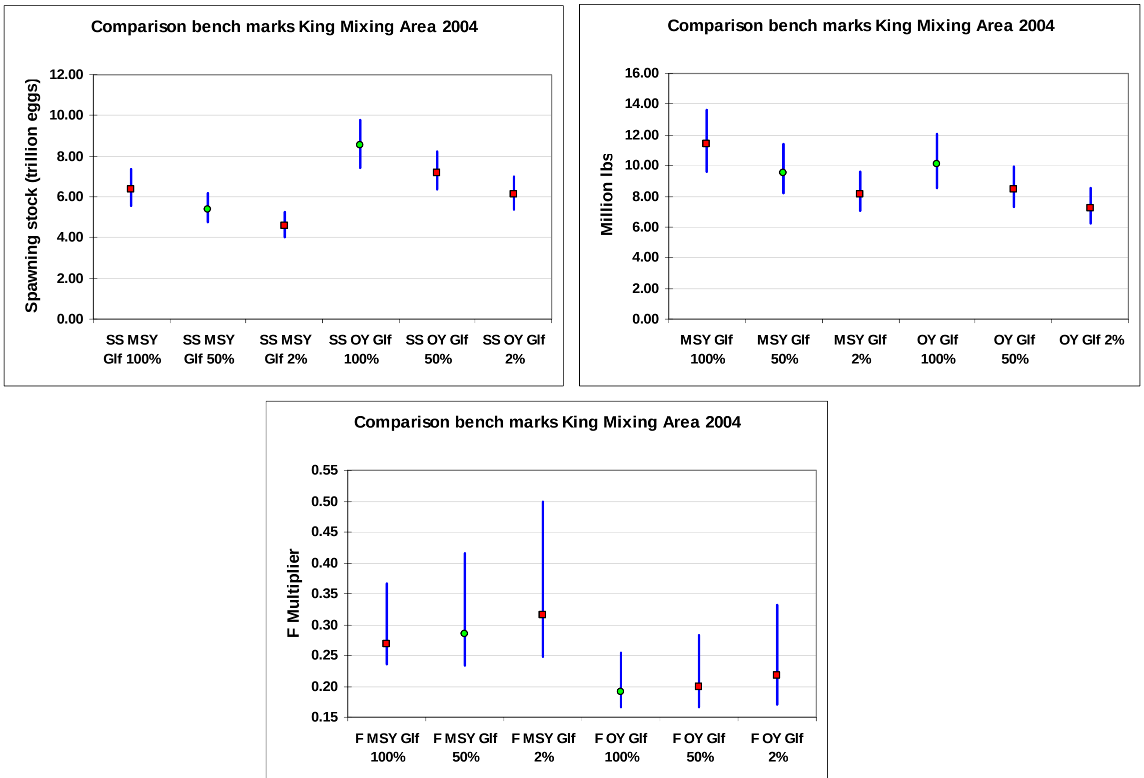

Figure 29. Comparison of estimates of Gulf king mackerel benchmarks under different assumed mixtures of Atlantic and Gulf kings from winter-time catches made along the Florida east coast.

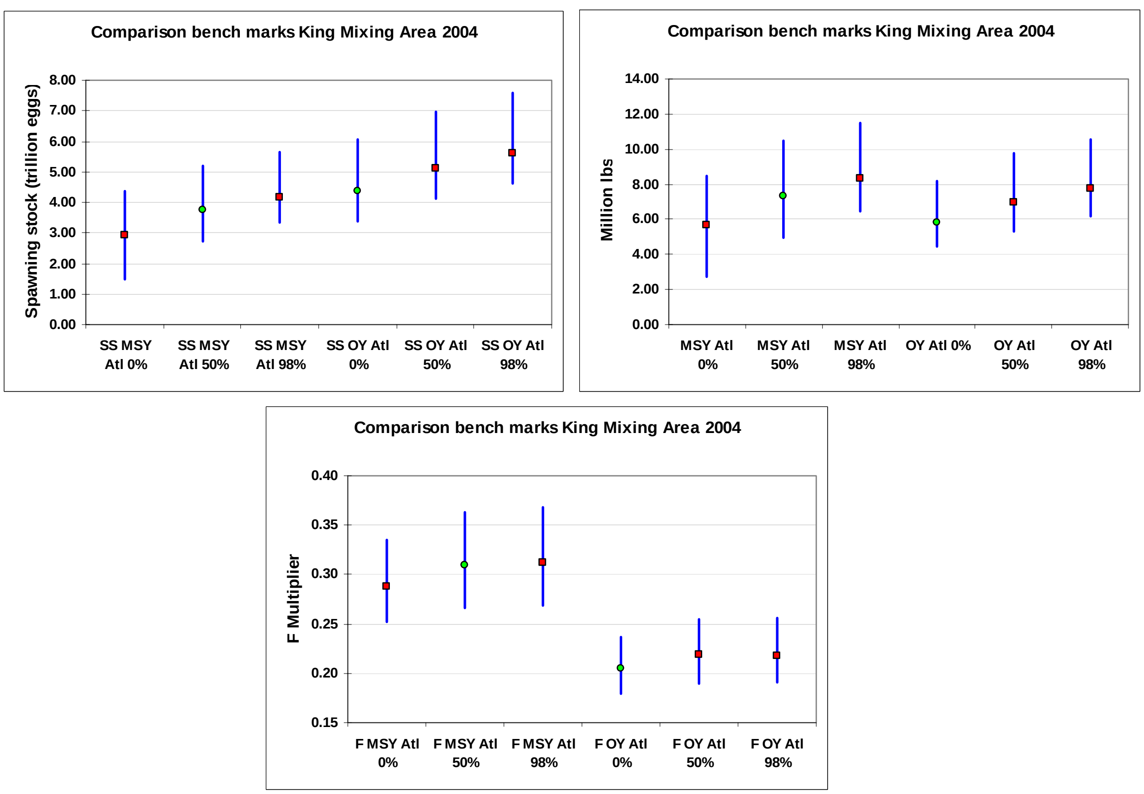

Figure 30. Comparison of estimates of Atlantic king mackerel benchmarks under different assumed mixtures of Atlantic and Gulf kings from winter-time catches made along the Florida east coast.