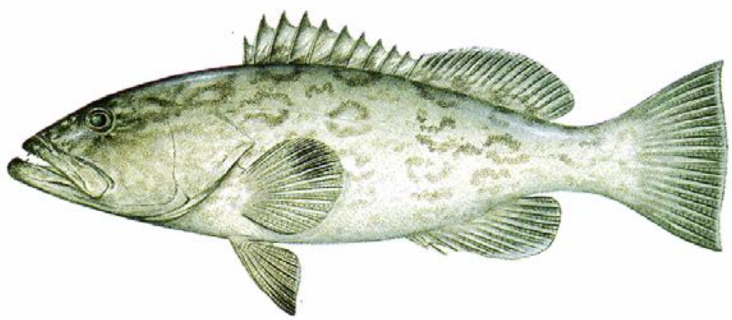
Stock Assessment of Gag in the Gulf of Mexico

-- SEDAR Update Assessment --



Report of Assessment Workshop
Miami, Florida
March 30-April 2, 2009

August 3, 2009

1 Introduction

A SEDAR Assessment Workshop (AW) was convened during March 30-April 2, 2009 at the NMFS Southeast Fisheries Science Center, Miami, Florida, by the Gulf of Mexico Fishery Management Council and the NMFS Southeast Fisheries Science Center under the SEDAR process. The objective of the AW's was to update the benchmark assessments of gag (*Mycteroperca microlepis*) and red grouper (*Epinephelus morio*) within US waters of the Gulf of Mexico (benchmark assessments conducted in 2006 as SEDAR 10 and SEDAR 12, respectively). This report presents results of the 2009 gag update assessment. Results of the 2009 red grouper update assessment are presented in a separate report.

1.1 Terms of Reference

1. Evaluate any relevant data and parameters to be included into the stock assessment model. This evaluation should be conducted in a workshop setting with all relevant scientific input.
2. Evaluate the relative reliability of fishery dependent and independent data sources and adjust model input appropriately.
3. Update the approved SEDAR 10 gag model base configuration, forward projection catch-age model using CASAL with data through 2008. This configuration includes time-varying catchability, adjusted natural mortality scaling, incorporation fishery-dependent indices of abundance from commercial handline, commercial longline, recreational headboat, and MRFSS, and fishery-independent indices of abundance from the SEAMAP video and SEAMAP Copperbelly video indices. Plus Beverton-Holt spawner-recruit relationship.
4. Document any changes or corrections made to input datasets and tabulate complete updated input datasets. Provide tables of commercial and recreational landings and discard in pounds gutted weight. Clarify units of measurement in all tables.
5. Estimate and provide complete updated tables of stock parameters.
6. Update measures of uncertainty and provide representative measures of precision for stock parameter estimates.
7. Update estimates of stock status and SFA parameters; provide declarations of stock status relative to current SFA criteria.
8. Specify OFL, and may recommend a range of ABC for review by the SSC in compliance with ACL guidelines.
9. Evaluate future stock status for 2009-2014 according to the specifications in Table 2.
10. Review the research recommendations from the previous assessment, note any which have been completed, and make any necessary additions or clarifications.
11. Develop a stock assessment workshop report to fully document the input data, methods, and results of the stock assessment update.

1.2 Update Assessment Workshop Participants

Assessment Panel

Luiz Barbieri, Chair .... GMFMC SSC
Harry Blanchet .... GMFMC SSC
Bill Lindberg........ GMFMC SSC
Russell Nelson .... GMFMC Reef Fish AP

Analytical team

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Appointed Observers

Kay Williams........ GMFMC member

Observers

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Bob Spaeth........SOFA
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1.3 List of Update Workshop Working Papers & Documents

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR-UPDATE-01	Index Updates for Gulf of Mexico Gag and Red Grouper Sampled during NMFS Bottom Longline and Reef Fish Video Surveys through 2008	Ingram, Walter
SEDAR-UPDATE-02	An update on standardized and nominal catch rates and distribution of red grouper, *Epinephelus morio*, collected during NOAA Fisheries Bottom Longline Surveys from the U.S. Gulf of Mexico (2000-2008).	Walter Ingram, Linda Lombardi-Carlson, and John Walter
SEDAR-UPDATE-03	Brief summary of the NMFS PC Lab St. Andrew Bay fishery-independent survey of juvenile red grouper in the St. Andrew Bay, Florida	Walter Ingram
SEDAR-UPDATE-04	Summary of fishery-independent surveys of juvenile gag in the Gulf of Mexico	Walter Ingram and Luke McEachron
SEDAR-UPDATE-05	Summary of the fishery-independent NMFS PC Lab trap-camera survey of gag and red grouper in the northeast Gulf of Mexico	Walter Ingram
SEDAR-UPDATE-06	Summary of gag and red grouper age data from the northeastern Gulf of Mexico for SEDAR (10/12) update: 2006-2008	Linda Lombardi, Gary Fitzhugh, Chris Palmer, Beverly Barnett, Laura Goetz, and Carrie Fioramonti
SEDAR-UPDATE-07	Annual Indices and Trends of Abundance for Gag (*Mycteroperca microlepis*) on the Shallow Continental Shelf in the Northeastern Gulf of Mexico	William J. Lindberg, Mary C. Christman, Doug M. Marcinek and Thomas F. Bohrmann
SEDAR-UPDATE-08	Bottom longline fishery bycatch of red grouper from observer data: update	Loraine Hale
SEDAR-UPDATE-09	Recreational Survey Data for Gag in the Gulf of Mexico	Vivian M. Matter
SEDAR-UPDATE-10	Recreational Survey Data for Red Grouper in the Gulf of Mexico	Vivian M. Matter

2 Background Information

2.1 Regulatory history

Effective Date	**Regulations**
	- Minimum size of 20 inches TL - 5 grouper recreational bag limit;

February 21, 1990	- 9.2 MP, WW, shallow-water quota.
November 8, 1990	Closure of commercial shallow water grouper in EEZ until December 31, 1990; catch met the commercial allocation
November 12, 1991	One time increase in shallow-water quota from 9.2 to 9.9 MP, WW. Until December 31, 1991.
June 22, 1992	Commercial shallow-water grouper quota increased from 8.2 to 9.8 MP WW
January 1, 1994	- Established a 15.1 MP ABC, - Maintained the 20 inch TL commercial size limit.
June 19, 2000	- Increased the commercial size limit for gag from 20 to 24 inches TL, - Increased recreational size limit for gag from 20 to 22 inches TL, - Prohibited commercial harvest and sale of gag, black, and red grouper each year from February 15 to March 15, and - Established two marine reserves (Steamboat Lumps and Madison-Swanson) closed year-round to fishing for all species under the Council's jurisdiction.. A longline and buoy gear boundary at approximately the 50-fathom depth contour west of Cape San Blas, Florida, and the 20-fathom contour east of Cape San Blas, Florida was established. Vessels fishing with longlines and buoy lines were prohibited from fishing inshore of the 20- and 50-fathom contours.
November 24, 2000	
August 19, 2002	Established Tortugas marine reserves and provide enhanced protections in the vicinity of the Dry Tortugas.
June 3, 2004	Steamboat Lumps and Madison-Swanson marine reserves were continued for an additional six years.
July 15, 2004	Shallow-water aggregate quota reduced to 8.8 MP, GW;
November 15, 2004	Closure of the commercial shallow-water grouper in the EEZ until January 1, 2005 due to the red grouper quota being met.
February 17, 2005	Commercial trip limits implemented (shallow water or red grouper); - 10,000-pound limit to start, - 7,500-pound limit when 50 percent of the quota is reached,

	- 5,500-pound limit when 75 percent of the quota is reached.
June 9, 2005	Shallow water and deep water grouper trip limit reduced to 7500 lbs until December 31, 2005.
August 4, 2005	Shallow water grouper trip limit reduced to 5500 lbs until December 31, 2005.
August 9, 2005	- Aggregate bag limit reduced from 5 to 3 fish per person per day, - Closed season for all recreational grouper harvest for November-December 2005.
October 10, 2005	Closure of shallow water grouper until January 1, 2006 due to the red grouper quota being met.
October 31, 2005	- Aggregate bag limit for recreational grouper increased from 3 to 5 fish per person per day, - Shallow water grouper re-opened (excluding red grouper)
January 1, 2006	Establishes a 6000 lb commercial trip limit for shallow and deep water grouper in EEZ

3 Life History

3.1 Management Unit

The management unit for Gulf of Mexico gag extends from the United States–Mexico border in the west through the northern Gulf of Mexico waters and west of the Dry Tortugas and the Florida Keys (waters within the Gulf of Mexico Fishery Management Council boundaries).

3.2 Natural mortality

Additional age information based on 3,649 gag otoliths collected during 2006-2008 support the conclusion that the maximum age of gag in the Gulf of Mexico is 31 years. Therefore, the update AW Panel recommended the use of the natural mortality estimate (M) developed for

Gulf of Mexico gag during the SEDAR 10 Data Workshop. As stated in the Terms of Reference, a base M of 0.15 was used instead of the base M estimated by Hoenig's (1983) method (M=0.14), which was used in the 2006 assessment.

Following the recommendations of the SEDAR10-AW and RW, the natural mortality rate of Gulf of Mexico gag was modeled as a declining 'Lorenzen' function of size, translated to age by the use of a growth curve. The Lorenzen curve was rescaled such that the average value of M for fish age-3 and older was 0.15.

3.3 Meristic Conversions

Updated meristic relationships were calculated for gag caught in the Gulf of Mexico for length types (total and fork) and body weights (whole and gutted), (Table 3.1). Coefficients of determination were high for linear (length) and nonlinear (weight) regressions ($r^2 > 0.95$).

3.4 Age and growth

An additional 3,649 gag otoliths collected during 2006-2008 were aged and incorporated into the existing gag dataset (Lombardi-Carlson et al. 2009). The most recent age distribution indicates a strong 2002 year class progression (defined as exceeding 30% of the total age structure during at least one year and dominating the age structure for two or more years within the time period, Lombardi-Carlson et al. 2006a). Mean ages were significantly different among years (single factor ANOVA, $F = 62.6$, $df = 17$, $p < 0.0001$, $r^2 = 0.05$). Annual age composition of gag continues to represent an extensive range (1 – 31 yrs; Lombardi-Carlson et al. 2009).

Gag data (observed total lengths and fractional ages) from the entire time series (1991-2008, n = 20,507) were fit to a size-modified von Bertalanffy growth model to obtain population growth parameters. In general, the model fit the data well and the assumption of constant deviances in size-at-age in fish age 2 and older was satisfied. The model fit resulted in the following growth parameters: $L_\infty = 1300$ mm, $k = 0.14$, $t_0 = -0.39$, which were similar to the parameters fit during the 2006 assessment.

3.5 Reproductive biology

No new information on the reproductive biology of gag in the eastern Gulf of Mexico was available to the AW update Panel and working group. Therefore, gag reproductive parameters used in the last benchmark assessment (SEDAR 10, 2006) were used for the 2009 gag assessment update. A summary of the reproductive biology of gag in the Gulf of Mexico can be found in Fitzhugh et al. 2006, SEDAR10-DW3.

No changes were recommended for the maturity vector used in the SEDAR 10 benchmark assessment. As indicated in prior reports (SEDAR 10 Report), spawning biomass results represent female biomass only for this stock. Gag is a protogynous species, maturing first as females (50% mature females at 3.7 years old) and then becoming males (50% mature males at 10.8 years old)

4 Commercial fisheries

4.1 Commercial landings

Commercial landings were available since 1963. All commercial landings were converted to gutted weight, and partitioned into the following fisheries: commercial longline (1979-2008), commercial handline (1963-2008), and "other commercial fisheries" (1963-2008). The last category included: landings from trawls, traps, spear fishing, and "unclassified" from several years. The handline fishery also groups several gears (electric reels, hand reels, handlines and commercial rod and reel). Commercial landings also reflected the conversion of black grouper landings to gag due to miss-identification problems, particularly for the North Gulf of Mexico (see SEDAR-10 Data Workshop report for further details).

4.2 Commercial discards

The SEDAR10-DW concluded that commercial discards are exclusively due to minimum size regulations, which started in 1990 in Federal waters (McCarthy 2006). Thus, it was assumed that commercial fisheries did not discard Gag prior to 1990, and after that discarded only fish below the legal size limit. The size distribution of discarded fish was estimated from the cumulative size frequency distribution observed for the respective commercial sectors (handline, longline, other) during 1984-1989 up to the corresponding minimum size. From 1990 to June-2000 the minimum size regulation of Gag for commercial fisheries was 20 inches (51 cm TL). From Jul-2000 to the present the minimum size increased to 24 inches (61 cm TL).

Commercial dead discards were estimated following the recommendation of the SEDAR 10-RW (SEDAR 2007). The same size-at-depth matrix from the SEDAR 10 assessment was used to convert discards-at-size to discards-at-size-at-depth. Discard mortality rates were calculated as a function of depth using the same mortality-depth relationship as in the SEDAR 10 assessment. The depth-specific discard mortality rates then were applied to the discards-at-size-at-depth to obtain the estimate of dead discards (Table 4.1).

5 Recreational fisheries

5.1 Overview of components

Estimates of recreational retained catch (A+B1) and discards (B2) were available for the Gulf of Mexico from MRFSS since 1981 and from the Headboat survey since 1986. Texas Parks and Wildlife Division (TPWD) provided estimates of recreational landings in Texas, but not discards. For modeling purposes, the recreational fisheries were classified into two sectors: Headboat (1986-2007) and other recreational (MRFSS; 1981-2008). There were some adjustments to the estimates of A+B1 (kept recreational catch) and B2 (discards) in response to the re-classification of black grouper as gag for most of the Gulf with exception of the Florida Keys catches [See SEDAR-10 DW report]. Ratios of discards to retained catch for the Headboat fishery are based on the ratios of discards from the MRFSS estimates. In addition, it was known that a substantial recreational fishery existed for Gag in 1980 and prior years, therefore the AW recommended extrapolating back to 1963 using indicators that take into account human coastal population, commercial catch, number of vessels and estimated total expenditure in dollars for recreational fisheries (SEDAR-10 RW report). The historical discards (back to 1963) were determined from the extrapolated historical recreational catch using the ratios of 1981-1989 discards/kept fish, period of non-minimum size restrictions. The size composition of the AB1 retained catch was determined from size samples collected by MRFSS and other sources (SEDAR-10 DW report). Very limited size data have been collected on discarded fish from recreational fisheries.

5.2 Catch estimates

5.2.1 MRFSS

Tables 5.1 and 5.2 show the MRFSS catch estimates by mode and by state for the Gulf of Mexico. The Florida Keys (Monroe county) is not included in the estimates for West Florida. Post-stratified FLW files were provided by NMFS headquarters in order to exclude Monroe county. The missing estimate for 1981, wave 1 was substituted using the average of wave1/waves 2-6 for 1982-1984 by state, mode, and area. This is consistent with SEDAR 10.

In the tables, estimated A+B1 is the catch that was killed and B2 is the catch that was released alive. In the intercepts, Type A is the catch that was seen and identified by the interviewer. Type B is the catch that was not seen by the interviewer but was reported by the angler. Type B1 is the type B catch reported dead (released dead, used as bait, eaten, etc.) and type B2 is the type B catch reported as released alive.

Tabulated estimates use the new charterboat method (FHS) for 1998-2008. The charterboat estimates for 1986-1997 and charter+headboat estimates for 1981-1985 are calibrated to the new method using the conversion factors estimated in Diaz and Phares.

Table 5.1. Estimated MRFSS A+B1 (fish killed) and B2 catch (released alive) by mode for gag in the Gulf of Mexico. Charterboat and cbt/hbt estimates use the new method or are calibrated to the new method.

Table 5.2. Estimated MRFSS A+B1 (fish killed) and B2 catch (released alive) by state for gag in the Gulf of Mexico. Charter and cbt/hbt estimates use the new method or are calibrated to the new method. Post-stratified MRFSS estimates were used to exclude Monroe county from FLW.

5.2.2 Headboat Survey

Table 5.3 shows the Headboat Survey catch estimates by year and area group. Headboat areas for Florida Keys (areas 12 and 17) are not included in this dataset. This is consistent with SEDAR 12. Headboat estimates for 2008 were not available as of the date of this document. 2008 estimates were substituted using a five year average (2003-2007).

Headboat Survey Gulf area codes for reference in reviewing the tables:

- 18=Dry Tortugas (Gulf vessels)
- 21=SW FL - full day trips (Naples to Crystal River)
- 22=Fl. Middle Grounds trips
- 23=NW FL and AL (Carrabelle to Pensacola, including Panama City and Destin)
- 24=LA
- 25=NE TX (Sabine Pass-Freeport)
- 26=Port Aransas, TX
- 27=Port Isabel, TX

5.2.3 Texas Parks and Wildlife Survey (TPWD)

Table 5.4 shows the TPWD landings for gag for the state of Texas. Very few gag are caught in Texas. TPWD estimates were only available through November 20, 2007 as of the date of this document. 2007 was assumed to be complete since only such a short period of time was missing and in prior years catch is usually very low then. 2008 estimates were substituted using a five year average from 2002-2006 (to avoid the “partial” 2007). Consistent with SEDAR 10, it is assumed that 500 fish were caught from headboats each year from 1981 to 1985 in the state of Texas, equal to an approximate average of catches from the earliest years of data available from Texas in the HBS in 1986 and 1987. Discards are assumed to be zero for gag.

5.2.4 Adjustment to estimates

Misreporting of gag as black grouper

Gag (*Mycteroperca microlepis*) and black grouper (*Mycteroperca bonaci*) look similar. This only adds to confusion caused by the fact that, in parts of the Gulf, *Mycteroperca microlepis* has traditionally been called black grouper. The MRFSS data suggest that these challenges resulted in misreporting of many gag landings as black groupers prior to 1990. The problem was apparently corrected with updated interviewer training, interview supervision, and contractor QA/QC work with many new requirements that were implemented in the 1990 MRFSS contracts. This issue was examined in SEDAR 10 by looking at the total gag and black grouper for all years. It was decided to correct for the likely misreporting of gag as black grouper prior to 1990 by examining the data from 1990 onwards and calculating gag as a proportion of all gag and black grouper. This proportion averaged 0.972 for Louisiana, 1 for Mississippi and Alabama, and 0.994 for West Florida, excluding Monroe County. Then, gag catches prior to 1990 were adjusted by applying this proportion to the sum of gag and black grouper for those years.

Estimation of the number of fish released in the Headboat Survey

Table 5.5 shows the estimated number of discards for the headboat mode using the MRFSS charter boat mode ratios of B2/ (A+B1). This is consistent with SEDAR 10. These ratios were applied to the HBS number of fish landed, since there is no estimate of fish released dead in the Headboat Survey. The MRFSS includes fish released dead in the B1 catch, and while the fish released dead cannot be separated from other kinds of B1 catch in the estimates, this quantity is small in the sample data relative to the total B1 samples.

In 2004 the Headboat Survey logbook trip reports started collecting information on fish released alive and returned dead but estimates of the total fish released were not generated. However, the sample data (trip reports) for 2004-2007 can be used to re-examine which mode of estimates from the MRFSS to use to estimate the releases in the Headboat Survey.

Examination of the 2004-2007 headboat release data by vessel indicate that some vessels may not have been reporting released fish (or at least not on some trips). Since it was not clear which trips were reporting zero released fish and which were simply not reporting, only trips with some release data for any species were selected. Of those trips reporting releases, trips with gag (kept or released) were further selected. Of these, the quality of data may have varied. For instance, the reports for certain vessels often contained identical entries for the number of fish released as the number of fish kept, a prominent difference from other vessels.

Table 5.6 shows the ratios for fish released alive to total catch (kept + released dead+ released alive) calculated using Headboat Survey 2004-2007 trip reports. The ratios are calculated as r_hbt = live/ (num+dead+live), where live = fish released alive, num = fish kept, and dead = fish released dead.

State-run headboat observer programs were implemented in Alabama in 2004 and in Florida in 2005. During randomly sampled trips, catches and releases of all species are observed. Table 5.7 shows the B2/ (A+B1+B2) ratios from the headboat observer programs conducted by Florida and Alabama. Size data collected from released gag were used to estimate the discard size composition for the headboat fishery from 2000-2008. Discard size data was available from the headboat observer program for 2005-2007. For 2000-2004 and 2008, discard size data were generated by bootstrapping the observed discard size samples from 2005-2007. The bootstrap sample size for each year was 1,160 (i.e., the average sample size for 2005-2007).
Tables 5.8 and 5.9 show the ratios of B2/ (A+B1+B2) calculated using the MRFSS private and charter boat mode estimates respectively. The ratios are calculated as r_mrf = B2 / (A+B1+B2).

Figures 5.1 and 5.2 depict the discard ratios for gag from all sources for 2004-2007.

5.2.5 Dead Discards

Dead discards for the recreational fisheries were estimated following the recommendation of the SEDAR 10-RW (SEDAR 2007). Discards were distributed among 3 zones: inshore, ocean < 10m, ocean > 10m; and 2 regions: Panhandle FL and Peninsular FL. Each zone-region combination was assigned the same zone-region-specific discard mortality rate, based on average depth, as in the SEDAR 10 assessment. These zone-region-specific mortality rates were applied to the discards to obtain the estimate of dead discards (Table 5.10).

6 Indices of abundance

Both fishery-dependent and fishery-independent indices of abundance were included in the assessment developed for the 2009 gag assessment update.

Fishery-dependent abundance indices:

- commercial handline fishery
- commercial longline fishery
- recreational headboat fishery
- MRFSS (a combined index from the recreational charter and private boat fisheries as presented by the SEDAR-10 data workshop).

Fishery-independent abundance indices:

- SEAMAP reef fish video survey
- SEAMAP copper-belly video survey
- Age-0 (juveniles sampled in inshore nursery habitat)

Some fishery-dependent indices were divided into separate time periods, based on changes in size limits, for which individual catchability parameters were estimated. The commercial handline and longline indices were divided into periods with a 20” size limit (1990-1999) and a 24” size limit (2000-2008). The recreational headboat index was divided into periods with no size limit (1986-1989), a 20” size limit (1990-1999), and a 22” size limit (2000-2008).

Tables 6.1-6.3 and Fig. 6.1 summarize the standardized indices of abundance for gag in the Eastern Gulf of Mexico developed with a delta-lognormal model. Please refer to SEDAR documents SEDAR 10-DW-12, SEDAR-UPDATE-01, SEDAR-UPDATE-03, SEDAR-UPDATE-04, and SEDAR-UPDATE-09 for a more detailed description of how gag indices were calculated and standardized.

7 Stock assessment methods

The CASAL (C++ Algorithmic Stock Assessment Laboratory, Bull et al. 2005), which is a statistical age-structured forward reconstruction model, was approved as the assessment method for the SEDAR 10 Gulf of Mexico gag assessment by the RWP (SEDAR 2006, 2007). The update AWP agreed that CASAL should be used as the assessment method for the Gulf of Mexico gag update assessment.

Fishing – Five fisheries were modeled individually: commercial handline, commercial longline, other commercial (primarily spear, trap and trawl), recreational headboat, and general recreational (sampled by MRFSS). Total fishing pressure was calculated in CASAL for all fisheries combined.

Selectivity – Individual selectivity functions were estimated in CASAL for each of the fisheries. Selectivity for the commercial longline fishery was modeled with a logistic function. Selectivity patterns for the remaining four fisheries were modeled with double logistic functions. Selectivity for the other commercial fishery was modeled as a function of age. Selectivity patterns for the remaining four fisheries were modeled as functions of size.

Separate selectivity functions were estimated in different time periods for some fisheries due to changes in size limits. For the commercial handline fishery, separate selectivity functions were estimated for the period before the 24” size limit (1963-1999) and after the 24” size limit (2000-2008). For the recreational headboat fishery, separate selectivity functions were estimated for the period with no size limit (1986-1989), 20” size limit (1990-1999), and 22” size limit (2000-2008).

Catch – Total annual catches (retained catch and dead discards) were estimated via Pope’s approximation (Quinn and Deriso 1999).

Indices of abundance – The model was fit to the seven indices of abundance described above: four fishery-dependent indices (commercial handline, commercial longline, recreational headboat, and MRFSS) and three fishery-independent indices (SEAMAP video, SEAMAP copper-belly video, and age-0).

Initialization – The update AWP decided to start the assessment period in 1986, when grouper landings were first reported by species. The assessment model, however, starts in 1963. This initialization period (1963-1985) was used to define the age structure at the start of the assessment period. Including an initialization period diverges from what was done in the SEDAR 10 assessment, which started the assessment period in 1963 with no initialization period. The period from 1963-1985 is a data poor period consisting of only catch data prior to 1981. As a result, quantities such as equilibrium spawning biomass and equilibrium recruitment are poorly estimated. Since these equilibrium quantities are not used to calculate benchmarks for gag (i.e., F_{max} is used as a proxy for F_{msy}), the update AWP felt it was appropriate to use these years of data as an initialization period. In addition, this decision leads to greater consistency with the red grouper assessment, which begins its assessment period in 1986.

Fitting criterion – The fitting criterion was a likelihood approach in which observed catches-at-age and abundance indices were fit. Index data were fit using a lognormal likelihood, the value of which is inversely related to the CV (Tables 6.1-6.3). Catch-at-age data were fit using a multinomial likelihood, which was weighted by the effective sample size. In the SEDAR 10 assessment, effective sample sizes were set equal to 50 for the other commercial fishery and to 500 for the remaining four fisheries. The update AWP felt that these relatively high effective sample sizes over emphasized model fit to the catch-at-age data at the expense of fit to the index data. Therefore, the update AWP decided to set effective sample sizes equal to 20 for the other commercial fishery and to 200 for the remaining four fisheries. The total likelihood also included penalty terms to discourage model fits that do not allow the fishery catch to be taken and to ensure that annual deviations in recruitment have a mean of one.

7.1 Measures of uncertainty

Measures of uncertainty for benchmark estimates cannot be determined using CASAL because the program does not include a bootstrap procedure. The assessment model must be bootstrapped to generate a range of model results. Benchmarks could be estimated for each bootstrap run using PRO-2BOX (Porch 2002). Then, confidence intervals could be calculated using the range of benchmark estimates.

7.2 Alternative models

Ten alternative models were developed for gag. The first model, referred to as the central model, calculated Lorenzen M with a base M of 0.15 and included no systematic trend in catchability. The second model, referred to as the 0.19 base M model, was identical to the central model except that Lorenzen M was calculated with a base M of 0.19. The third model, referred to as the 0.11 base M model, was identical to the central model except that Lorenzen M was calculated with a base M of 0.11. The fourth model, referred to as the increasing catchability model, was identical to the central model except that a 2% annual increase in catchability was assumed. The 2% annual increase in catchability was implemented by decrementing the indices of abundance externally to CASAL. The fifth model, referred to as the decreasing catchability model, was identical to the central model except that a 2% annual decrease in catchability was assumed. The 2% annual decrease in catchability was implemented by incrementing the indices of abundance externally to CASAL. The sixth model, referred to as the red tide model, was identical to the central model except that an episodic mortality rate was estimated in CASAL for 2005 to represent the severe red tide event which occurred in that year. The commercial handline, commercial longline, recreational headboat, and MRFSS indices all show a sudden decline in abundance between 2005 and 2006 (Figure 6.1). The SEAMAP video and SEAMAP copper-belly video indices show a decline beginning after 2004 and continuing through 2006 (Figure 6.1). The AWP felt that this decline most likely was due to an episodic mortality event, such as the 2005 red tide, rather than to the fishery. Therefore, the AWP recommended that a model should be developed that included an episodic red tide mortality event in 2005. The episodic red tide mortality rate was applied equally across all ages of fish. The seventh model, referred to as the red tide 0.19 base M model, was identical to the red tide model except that Lorenzen M was calculated with a base M of 0.19. The eighth model, referred to as the red tide 0.11 base M model, was identical to the red tide model except that Lorenzen M was calculated with a base M of 0.11. The ninth model, referred to as the red tide increasing catchability model, was identical to the red tide model except that a 2% annual increase in catchability was assumed. The tenth model, referred to as the red tide decreasing catchability model, was identical to the red tide model except that a 2% annual decrease in catchability was assumed.

8 Assessment results

8.1 Model fits

In general, the models fit the data well. The central model did have difficulty fitting the sudden decline in the indices between 2005 and 2006, splitting the difference between the two years (Figure 8.1). There were no systematic patterns in residuals for the model fits to the catch-at-age data (Figure 8.2). In addition, the central model was able to track the relatively strong year classes from 1989, 1993, 1996, 1999, and 2002. Model fits for the 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models were nearly identical to those of the central model.

The red tide model provided a better fit to the indices of abundance than the models without a red tide event. The red tide model predicts that the sudden decline in abundance occurs after 2004, which matches the SEAMAP video and SEAMAP copper-belly video indices (Figure 8.3). The SEAMAP video and SEAMAP copper-belly video indices show the decline occurring after 2004, because the survey upon which the indices are based covered the peak of the 2005 red tide event in August. The commercial handline, commercial longline, recreational headboat, and MRFSS indices show the sudden decline in abundance occurring after 2005, because the majority of the catch in these fisheries occurred before the peak of the 2005 red tide event. The CASAL applies the episodic red tide mortality rate over the course of the entire year. As a result, CASAL cannot account for the fine-scale timing of the red tide event relative to the prosecution of the fisheries and surveys. The red tide model provides a similar fit to the catch-at-age data as the other models, and shows no systematic trends in residuals (Figure 8.4). Model fits for the red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models were nearly identical to those of the red tide model.

8.2 Selectivity

Estimated selectivities for the central model are presented in Table 8.1 and Figure 8.5. In the recent period of size regulations, fish were nearly fully selected at age 7 for commercial handline, age 10 for commercial longline, age 5 for other commercial, age 4 for recreational headboat, and age 5 for MRFSS. Selectivity patterns for the other nine alternative models were nearly identical to selectivity patterns from the central model.

8.3 Fishing mortality rates

Estimated apical fishing mortality rates from the central model increased steadily from 1999 to 2004, declined from 2004 to 2006, and increased sharply from 2006 to 2008 (Table 8.2, Figure 8.6). The extremely high fishing mortality rate in 2008 (F=0.92) was due to the combination of relatively high catch and one of the lowest estimated population biomass values of the entire model time series occurring in that last year.

Annual trends in apical fishing mortality rates for the 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models were nearly identical to the fishing mortality trend from the central model, though the scale of that trend differed between models. Apical fishing mortality rates for the 0.19 base M model were lower than fishing mortality rates from the central model over the entire time series. Apical fishing mortality rates for the 0.11 base M model were higher than fishing mortality rates from the central model over the entire time series. Apical fishing mortality rates for the increasing catchability model were nearly identical to fishing mortality rates from the central model prior to 2000, and slightly higher than fishing mortality rates from the central model after 2000. Apical fishing mortality rates for the decreasing catchability model were nearly identical to fishing mortality rates from the central model prior to 2000, and slightly lower than fishing mortality rates from the central model after 2000.

Apical fishing mortality rates from the red tide model were relatively constant from 1999 to 2004, declined from 2004 to 2005, and increased from 2005 to 2008 (Table 8.2, Figure 8.6). Annual trends in apical fishing mortality rates for the red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models were nearly identical to the fishing mortality trend from the red tide model, though the scale of that trend differed between models. Apical fishing mortality rates for the red tide 0.19 base M model were lower than fishing mortality rates from the red tide model over the entire time series. Apical fishing mortality rates for the red tide 0.11 base M model were higher than fishing mortality rates from the red tide model over the entire time series. Apical fishing mortality rates for the red tide increasing catchability model were nearly identical to fishing mortality rates from the red tide model prior to 2000, and slightly higher than fishing mortality rates from the red tide model after 2000. Apical fishing mortality rates for the red tide decreasing catchability model were nearly identical to fishing mortality rates from the red tide model prior to 2000, and slightly lower than fishing mortality rates from the red tide model after 2000.

8.4 Fishing mortality rate at age

Estimated F at age from the central model is shown in Table 8.3. In any given year, the maximum F at age may be less than that year's apical F. This inequality exists because selectivity patterns for all of the fisheries, except the other commercial fishery, were estimated as length-based selectivities in CASAL and were converted to age-based selectivities using mean lengths at age. The 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models showed similar trends in estimated F at age to the central model due to similarities in the selectivity patterns between models. Estimated F at age from the red tide model is shown in Table 8.4. The red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models showed similar trends in estimated F at age to the red tide model due to similarities in the selectivity patterns between models.

8.5 Abundance at age

The central model provides estimates of abundance in numbers at age (Table 8.5). Numbers at age generally increased from 1986 to 1998 and then declined through 2008. Abundance of older age fish has increased slightly since 2000 as strong year classes from the 1990s have moved into older ages. The 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models show nearly identical trends, with different scales, in numbers and biomass at age as the central model. The red tide model provides estimates of abundance in numbers at age (Table 8.6). Numbers and biomass at age generally increased from 1986 to 1998, was relatively stable until 2004, and then declined through 2008. The red tide model showed similar trends in the abundance of older age fish as the central model. The red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models show nearly identical trends, with different scales, in numbers and biomass at age as the red tide model.

8.6 Total biomass and spawning biomass

Total biomass and spawning biomass from the central model showed similar trends to each other (Figures 8.7 and 8.8). Biomass generally increased from 1986 to 2001 and then declined through 2008. Total biomass in 2008 (16,362 thousand lbs) was the second lowest estimated biomass in the time series. The lowest estimate of total biomass (16,114 thousand lbs) occurred in 1990. Spawning biomass in 2008 (10,828 thousand lbs) was the second lowest estimated biomass in the time series. The lowest estimate of spawning biomass (10,722 thousand lbs) occurred in 1992. The 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models displayed similar trends in total and spawning biomass as the central model. Total biomass and spawning biomass from the red tide model generally increased from 1986 to 2001, was relatively stable until 2004, and then declined through 2008 (Figures 8.7 and 8.8). The later, steeper decline in biomass in the red tide model was due to the episodic red tide mortality event in 2005. The models with no red tide event can only account for the observed sudden decline in biomass by gradually decreasing the stock through the fisheries. The red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models displayed similar trends in total and spawning biomass as the red tide model.

8.7 Stock and recruitment

The stock recruitment function from the central model was poorly estimated (Figure 8.9), because a key parameter of the Beverton-Holt stock recruitment function, equilibrium biomass, was poorly estimated. Equilibrium spawning biomass was poorly estimated because it is strongly influenced by the early years of data in the initialization period of the model (1963-1985), which is a data poor period consisting of only catch data prior to 1981. Therefore, the stock recruitment function was not used for model projections or management advice. The other nine alternative models also produced poorly estimated stock recruitment functions.

8.8 Miscellaneous

The red tide model estimated an episodic mortality rate of 0.35, which translates to a red tide kill of 1.8 million gag (i.e., 23% of the estimated population abundance) in 2005. Estimated episodic mortality rates ranged from 0.27-0.45 for the red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models, which translates to red tide kills ranging from 18%-29% of the estimated population abundance.

The CASAL input files (i.e., population, estimation, and output files) for the central and red tide models are included in Appendices A and B, respectively.

8.9 Comparison to benchmark assessment

The results of models with a red tide event more closely match the results from the SEDAR 10 assessment up to 2004 than the models with no red tide event. The similarities between the red tide event models and SEDAR 10 model results are due to the fact that the red tide model can account for the sudden decline in the indices after 2005 through the episodic red tide mortality event. The models with no red tide event can only account for this sudden decline in the indices by gradually increasing fishing mortality and decreasing stock biomass over the later part of the model time series.

9 Biological reference points

9.1 Estimation methods

Biological reference points were calculated using PRO-2BOX. The CASAL estimates of catch at age, fishing mortality at age, and numbers at age were used as data inputs for PRO-2BOX. The update AWP agreed that recruitments for 2006-2008 would be set equal to the geometric mean recruitment from 1984-2005, similar to what was done in the SEDAR 10 assessment. Due to problems estimating equilibrium spawning biomass and recruitment, the update AWP decided to use F_{MAX} as a proxy for F_{MSY} as was done in the SEDAR 10 assessment.

9.2 Results

Estimates of various biological reference points for the central, 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models are presented in Table 9.1. Estimates of various biological reference points for the red tide, red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models are presented in Table 9.2. Required SFA and MSRA evaluations for the central, red tide, and red tide increasing catchability models are presented in Table 9.3. The SSC recommended that the red tide increasing catchability model be used for management advice. The SSC did not accept the 2011-2014 OFL, ABC and OY values and asked that they be reevaluated when the 2009 landings are available. In the event that the reevaluation is not completed before the rebuilding plan is submitted, the SSC recommended that the ABCs for 2011-2014 be used pending the reevaluation.

For the central model, the ratio of F/F_{MAX} began at 1.59 in 1986, was relatively constant until 2000, and increased to a maximum of 4.31 in 2008 (Figure 9.1). The F ratio was greater than 1.0 for the entire assessment period. The ratio of SSB/SSB_{MAX} began at 0.68 in 1986, increased to a maximum of 1.01 in 2001, and declined to 0.46 in 2008 (Figure 9.1). The SSB ratio only exceeded 1.0 in one year of the assessment period, 2001. For the red tide model, the ratio of F/F_{MAX} began at 1.60 in 1986, was relatively constant until 2003, and increased to a maximum of 3.61 in 2008 (Figure 9.2). The F ratio was greater than 1.0 for the entire assessment period. The ratio of SSB/SSB_{MAX} began at 0.63 in 1986, increased to 1.01 in 2001, remained relatively constant through 2004, and declined to 0.48 in 2008 (Figure 9.2). The SSB ratio only exceeded 1.0 in two years of the assessment period, 2001 and 2004. For the red tide increasing catchability model, the ratio of F/F_{MAX} began at 1.56 in 1986, was relatively constant until 2003, and increased to a maximum of 4.75 in 2008 (Figure 9.3). The F ratio was greater than 1.0 for the entire assessment period. The ratio of SSB/SSB_{MAX} began at 0.64 in 1986, increased to 0.97 in 2001, remained relatively constant through 2004, and declined to 0.40 in 2008 (Figure 9.3). The SSB ratio was less than 1.0 for the entire assessment period.

9.3 Status indicators

9.3.1 Definitions

The maximum fishing mortality threshold (MFMT) was taken to be F_{MAX}, and the minimum stock size threshold (MSST) is defined by the Council as $(1\text{-}M)SSB_{MSY}$ (Restrepo et al. 1998). Overfishing is defined as F > MFMT and overfished as SSB < MSST. The update AWP decided that current status of the fishery would be calculated as the geometric mean fishing mortality from 2005-2007. Current status of the stock is estimated to be SSB in the latest year of the assessment, 2008.

9.3.2 Status of stock and fishery

According to the central model, the status of the stock is estimated to be $SSB_{CURRENT}/MSST$ = 0.54. The status of the fishery is estimated to be $F_{CURRENT}/MFMT$ = 2.43 (Table 9.3). According to the red tide model, the status of the stock is estimated to be $SSB_{CURRENT}/MSST$ = 0.56. The status of the fishery is estimated to be $F_{CURRENT}/MFMT$ = 2.20 (Table 9.3). According to the red tide increasing catchability model, the status of the stock is estimated to be $SSB_{CURRENT}/MSST$ = 0.47. The status of the fishery is estimated to be $F_{CURRENT}/MFMT$ = 2.47 (Table 9.3). Thus the stock is estimated to be overfished and undergoing overfishing.

9.3.3 Alternative models

The increasing catchability, decreasing catchability, and red tide increasing catchability models produce similar biological reference point values to the central and red tide models (Tables 9.1 and 9.2). The 0.19 base M and red tide decreasing catchability models suggest that the stock is more productive than the central and red tide models. The 0.11 base M and red tide 0.11 base M models suggest that the stock is less productive than the central and red tide models. The $F_{CURRENT}/F_{MAX}$ and SSB_{2008}/SSB_{MAX} ratios for all of the alternative assessment models, except the red tide 0.19 base M model, suggest the same stock status as the central and red tide models (i.e., overfished and undergoing overfishing). The red tide 0.19 base M model suggests the stock is not overfished but is undergoing overfishing, similar to the SEDAR 10 assessment.

10 Projections

10.1 Projection methods

Deterministic projections were run using PRO-2BOX. The CASAL estimates of catch at age, fishing mortality at age, and numbers at age were used as data inputs for PRO-2BOX. The stock was projected forward from 2009-2019 to cover the 10 year rebuilding period. The update AWP agreed that recruitments for 2006-2019 would be set equal to the geometric mean recruitment from 1984-2005, similar to what was done in the SEDAR 10 assessment. The update AWP decided that the selectivity pattern for 2009-2019 would be set equal to the geometric mean fishing mortality at age from 2005-2007, normalized by the maximum value. The 2009 landings target was set equal to 3.38 million pounds, gutted weight, and all changes in fishing mortality rates and yields began in 2010. Projections were run for the central, red tide, and red tide increasing catchability models.

A decision table was created, which reports the probability of overfishing across a range of fixed landing (i.e., kept catch only) management scenarios. The probability of overfishing was estimated using stochastic projections in PRO-2BOX. The stochastic projections were set up the same way as the deterministic projections described above with the following exceptions: 1) a six year projection period (2009-2014) was used, 2) 500 bootstrap iterations were run for each fixed landing scenario, and 3) recruitments during the projection period were randomly resampled from the historical recruitments (1963-2005). The probability of overfishing was calculated based on the number of bootstrap iterations where F exceeded F_{MAX}. The probability of overfishing was estimated for the central, 0.19 base M, 0.11 base M, increasing catchability, decreasing catchability, red tide, red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models.

10.2 Management scenarios considered

Projections considered six fixed F management scenarios.

- **Scenario 1**: $F = F_{CURRENT}$
- **Scenario 2**: $F = F_{MAX}$
- **Scenario 3**: F = 90% of F_{MAX}

- **Scenario 4**: F = 75% of F_{MAX}
- **Scenario 5**: F that rebuilds stock to SSB_{MSY} by 2019
- **Scenario 6**: F that rebuilds stock to SSB_{OY} by 2019

The decision table considered ten fixed landing management scenarios.

- **Scenario 1**: Landing target = 0.5 mp gw
- **Scenario 2**: Landing target = 1.0 mp gw
- **Scenario 3**: Landing target = 1.5 mp gw
- **Scenario 4**: Landing target = 2.0 mp gw
- **Scenario 5**: Landing target = 2.5 mp gw
- **Scenario 6**: Landing target = 3.0 mp gw
- **Scenario 7**: Landing target = 3.5 mp gw
- **Scenario 8**: Landing target = 4.0 mp gw
- **Scenario 9**: Landing target = 4.5 mp gw
- **Scenario 10**: Landing target = 5.0 mp gw

10.3 Projection results

Projection results for the central model are presented in Figure 10.1 and the yields produced under each scenario are given in Table 10.1. The fishing mortality rate that rebuilds the stock to SSB_{MSY} by 2019 is 0.19, which produces a projected yield of 3.40 million pounds, gutted weight, in 2019. The fishing mortality rate that rebuilds the stock to SSB_{OY} by 2019 is 0.14, which produces a projected yield of 3.06 million pounds, gutted weight, in 2019.

Projection results for the red tide model are presented in Figure 10.2 and the yields produced under each scenario are given in Table 10.1. The fishing mortality rate that rebuilds the stock to SSB_{MSY} by 2019 is 0.19, which produces a projected yield of 3.73 million pounds, gutted weight, in 2019. The fishing mortality rate that rebuilds the stock to SSB_{OY} by 2019 is 0.14, which produces a projected yield of 3.36 million pounds, gutted weight, in 2019.

Projection results for the red tide increasing catchability model are presented in Figure 10.3 and the yields produced under each scenario are given in Table 10.1. The fishing mortality rate that rebuilds the stock to SSB_{MSY} by 2019 is 0.20, which produces a projected yield of 3.72 million pounds, gutted weight, in 2019. The fishing mortality rate that rebuilds the stock to SSB_{OY} by 2019 is 0.14, which produces a projected yield of 3.30 million pounds, gutted weight, in 2019.

The decision tables are presented in Tables 10.2 and 10.3.

10.4 Comments on projections

As usual, projections should be interpreted in light of the model assumptions and key aspects of the data. In this case, recruitment is assumed to be constant during the projection period. Estimated recruitment patterns from CASAL suggest that gag recruitment is highly variable, with a few strong year classes dominating the fishery catch. A series of strong or weak recruitment events could dramatically affect the rebuilding of the stock. In addition, the projections fail to account for episodic environmental events, such as the 2005 red tide which may have caused the sudden decline in abundance shown by the indices. Episodic environmental events could affect the stock in such a way that formerly safe levels of harvest could suddenly endanger the stock.

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13 Tables

Table 3.1. Meristic regressions for gag from the Gulf of Mexico (1991-2008).

Conversion and units	Equation	Sample Size	r^2 values	Data Ranges
FL (mm) to TL (mm)	TL = 1.03 * FL – 0.68	4999	0.99	TL (mm): 245 – 1360 FL (mm): 238 – 1321
TL (mm) to W. Wt (kg)	W. Wt = 1×10^{-08} * ($TL^{3.03}$)	4922	0.97	TL (mm): 245 – 1360 W. Wt (kg): 0.23 – 32.74
FL (mm) to W. Wt (kg)	W. Wt = 1×10^{-08} * ($FL^{3.02}$)	3809	0.97	FL (mm): 217 – 1321 W. Wt (kg): 0.13 – 32.74
TL (mm) to G. Wt (kg)	G. Wt = 1×10^{-08} * ($TL^{2.99}$)	527	0.96	TL (mm): 446 – 1295 G. Wt (kg): 0.99 – 27.02
FL (mm) to G. Wt (kg)	G. Wt = 9×10^{-9} * ($FL^{3.05}$)	2407	0.98	FL (mm): 432 – 1335 G. Wt (kg): 0.99 – 32.21
SL (cm) to TL (cm) *for age-0 gag only*	TL = 1.85 * SL – 0.23	165	0.99	SL (cm): 2.5-10.0 TL (cm): 3.1-12.1

Table 4.1. Estimated commercial dead discards in numbers by mode (i.e., longline, handline, and other) for GOM gag.

Year	Longline	Handline	Other
1990	126	0	0
1991	0	0	0
1992	0	0	0
1993	217	0	0
1994	0	0	0
1995	251	0	0
1996	282	0	0
1997	394	0	0
1998	528	0	0
1999	458	0	0
2000	1,271	1,082	0
2001	3,975	2,784	0
2002	4,132	2,443	0
2003	4,721	1,740	0
2004	5,032	2,294	0
2005	4,753	1,618	0
2006	2,231	956	0
2007	1,475	930	0
2008	1,394	1,004	0

Table 5.1. Estimated MRFSS A+B1 (fish killed) and B2 catch (released alive) by mode for gag in the Gulf of Mexico. Charterboat and cbt/hbt estimates use the new method or are calibrated to the new method.

	Cbt		Cbt/Hbt		Priv		Shore		Total	
YEAR	ab1	b2	ab1	b2	ab1	b2	ab1	b2	ab1	b2
1981			77,389	35,814	166,658	85,272	7,646	127,637	251,693	248,723
1982			100,441	12,423	374,656	101,213	9,391	1,793	484,487	115,429
1983			171,426	21,201	749,944	397,265	76,261	8,734	997,631	427,201
1984			85,698	16,051	193,308	51,911	30,146	4,613	309,152	72,574
1985			514,011	54,167	348,940	91,392	8,560	11,188	871,511	156,747
1986	160,020	51,492			412,772	300,772	8,199	19,269	580,992	371,534
1987	89,489	17,827			305,138	234,244	3,956	0	398,583	252,071
1988	62,932	14,716			491,907	232,433	9,504	0	564,343	247,150
1989	34,801	18,612			297,381	411,530	11,366	60,109	343,548	490,252
1990	31,750	83,989			128,073	275,931			159,823	359,920
1991	12,705	1,838			228,289	781,548	17,088	86,914	258,082	870,299
1992	43,999	44,691			183,686	578,903	7,262	98,413	234,948	722,007
1993	100,569	91,819			220,213	982,653	10,434	211,888	331,216	1,286,360
1994	49,616	148,295			208,060	1,588,795	1,633	88,548	259,309	1,825,638
1995	107,010	190,854			283,920	1,530,169	13,792	123,788	404,723	1,844,811
1996	99,369	191,374			231,474	938,111	3,122	79,195	333,965	1,208,680
1997	94,892	181,140			278,850	1,460,364	2,315	63,964	376,056	1,705,468
1998	146,440	339,137			312,827	1,683,162	32,605	74,421	491,872	2,096,721
1999	126,936	209,573			382,529	1,207,813	7,631	50,876	517,097	1,468,262
2000	156,338	132,717			527,670	1,231,361	9,578	62,253	693,586	1,426,330
2001	105,072	142,127			356,723	1,678,446	0	98,240	461,795	1,918,813
2002	91,652	208,725			412,341	2,033,080	1,996	242,380	505,989	2,484,185
2003	96,332	287,772			392,206	2,941,049	605	157,077	489,144	3,385,898
2004	131,746	320,727			497,021	3,094,069	3,941	137,761	632,708	3,552,556
2005	120,576	331,647			359,070	1,914,369	7,702	201,576	487,349	2,447,592
2006	69,235	157,483			201,005	1,528,082	3,544	115,443	273,784	1,801,008
2007	48,391	147,964			253,375	2,431,527	5,073	352,413	306,839	2,931,904
2008	90,263	339,577			325,922	3,473,171	12,434	380,266	428,619	4,193,014

Table 5.2. Estimated MRFSS A+B1 (fish killed) and B2 catch (released alive) by state for gag in the Gulf of Mexico. Charter and cbt/hbt estimates use the new method or are calibrated to the new method. Post-stratified MRFSS estimates were used to exclude Monroe county from FLW.

	LA		MS		AL		FLW		Total	
YEAR	ab1	b2	ab1	b2	ab1	b2	ab1	b2	ab1	b2
1981					7,255	0	244,438	248,723	251,693	248,723
1982	3,546	0	4,598	1,797			476,343	113,632	484,487	115,429
1983	2,912	0			2,436	0	992,283	427,201	997,631	427,201
1984	172	0			6	0	308,974	72,574	309,152	72,574
1985	6,319	0			34,781	0	830,411	156,747	871,511	156,747
1986	2,924	2,839	1,961	0	11,662	2,677	564,444	366,018	580,992	371,534
1987	4,018	0	2,443	0	842	0	391,280	252,071	398,583	252,071
1988	5,875	0	321	0	6	0	558,141	247,150	564,343	247,150
1989	4,277	0	906	235	614	0	337,751	490,017	343,548	490,252
1990			117	0	1,211	0	158,495	359,920	159,823	359,920
1991	1,983	0	0	0	1,990	471	254,109	869,828	258,082	870,299
1992	2,063	768	611	24	1,339	211	230,936	721,004	234,948	722,007
1993	2,400	2,653	2,159	165	3,039	3,700	323,619	1,279,842	331,216	1,286,360
1994	2,577	1,401	1,447	3,707	5,842	7,187	249,443	1,813,343	259,309	1,825,638
1995	831	186	20	4,851	7,975	9,679	395,896	1,830,095	404,723	1,844,811
1996	10,603	2,572	5,914	2,535	21,134	16,861	296,314	1,186,712	333,965	1,208,680
1997	1,022	2,018	299	1,263	11,749	8,151	362,986	1,694,034	376,056	1,705,468
1998	2,832	607	3,813	311	7,488	36,336	477,739	2,059,467	491,872	2,096,721
1999	17,104	6,647	489	5,602	22,942	77,965	476,562	1,378,049	517,097	1,468,262
2000	3,166	0	2,342	1,566	23,253	21,567	664,825	1,403,198	693,586	1,426,330
2001	4,197	3,054	19	1,887	8,436	11,334	449,143	1,902,537	461,795	1,918,813
2002	1,964	5,636	6,921	8,118	11,003	23,505	486,101	2,446,926	505,989	2,484,185
2003	1,776	5,251	296	81	11,124	31,005	475,948	3,349,562	489,144	3,385,898
2004	13,848	7,253	0	936	6,290	25,690	612,570	3,518,677	632,708	3,552,556
2005	7,115	4,437			23,348	69,029	456,886	2,374,125	487,349	2,447,592
2006	7,382	1,636			5,757	14,336	260,645	1,785,036	273,784	1,801,008
2007	4,355	1,890	0	551	5,261	20,456	297,223	2,909,007	306,839	2,931,904
2008	2,601	6,694	0	676	1,470	45,337	424,548	4,140,308	428,619	4,193,014

Table 5.3. Headboat Survey **estimated catch** by area groups for Gulf of Mexico gag. (Estimated catch includes only kept fish.) A Gulf-wide estimate was made for 2008.

year	SW FL- Mid.gr. 18+21+22	NW FL- Texas 23-27	All Gulf areas
1986	28,403	14,092	42,495
1987	24,992	7,164	32,156
1988	23,894	2,442	26,336
1989	33,600	1,545	35,145
1990	18,105	992	19,097
1991	10,553	900	11,453
1992	12,792	997	13,789
1993	16,640	2,695	19,335
1994	18,225	2,336	20,561
1995	15,116	2,700	17,816
1996	10,369	5,693	16,062
1997	10,271	5,352	15,623
1998	29,394	6,922	36,316
1999	27,126	4,991	32,117
2000	27,384	3,440	30,824
2001	11,678	2,816	14,494
2002	9,480	2,135	11,615
2003	12,538	3,843	16,381
2004	19,923	4,747	24,670
2005	12,706	4,078	16,784
2006	4,558	2,206	6,764
2007	9,848	1,293	11,141
2008			15,148

Table 5.4. Texas Parks and Wildlife Department estimated landings for gag in the state of Texas.

year	Cbt	Hbt	Priv	Total
1981		500		500
1982		500		500
1983		500	60	560
1984		500	86	586
1985		500	116	616
1987	111			111
1989			41	41
1990			229	229
1991	41		223	264
1993			17	17
1994			134	134
1996	40		241	281
1998	60		351	411
1999	483		288	771
2000	77		588	665
2001	21		1,557	1,578
2002			485	485
2003	18		475	493
2004			157	157
2005	18		114	132
2006	9		508	517
2007	25		166	191
2008	9		348	357

Table 5.5. Headboat Survey estimated discards by area groups for Gulf of Mexico gag. Discards estimated using MRFSS charter boat mode estimates discard ratios (B2/ (A+B1)). Discard estimate for 2008 was applied using a Gulf-wide ratio.

year	SW FL- Mid.gr. 18+21+22	NW FL- Texas 23-27	All Gulf areas
1986	9,306	4,327	13,633
1987	4,996	1,271	6,267
1988	5,615	574	6,189
1989	18,174	706	18,880
1990	48,070	2,631	50,701
1991	1,808	127	1,935
1992	13,066	847	13,913
1993	15,435	1,954	17,389
1994	55,252	7,017	62,269
1995	27,150	4,299	31,449
1996	20,147	10,424	30,571
1997	19,725	9,850	29,575
1998	68,169	12,101	80,270
1999	44,922	7,085	52,007
2000	23,363	2,729	26,092
2001	15,707	3,677	19,384
2002	21,581	5,046	26,627
2003	37,746	10,793	48,539
2004	48,637	11,332	59,969
2005	35,779	10,943	46,722
2006	10,725	4,837	15,562
2007	30,274	3,649	33,923
2008			56,779

Table 5.6. Ratios of fish released alive to total catch (kept + released dead+ released alive) from the Headboat Survey trip report data for gag by year and area group. Only trips that reported discards for any species are included.

	NW FL and AL (23)			SW FL- Mid.gr. (18+21+22)		
year	rel_live	kept+dead+live	live/kept+dead+live	rel_live	kept+dead+live	live/kept+dead+live
2004	110	242	0.45	21,480	28,717	0.75
2005	239	509	0.47	12,676	19,406	0.65
2006	150	454	0.33	5,228	6,277	0.83
2007	60	253	0.24	6,640	8,039	0.83

Table 5.7. Ratios of fish released alive (B2) to total catch (A+B1+B2) for gag from headboat observer programs in Florida (2005+) and Alabama (2004+).

	FLW panhandle + AL			FLW peninsula		
year	b2	ab1b2	b2/ab1b2	b2	ab1b2	b2/ab1b2
2004	7	8	0.88			
2005	398	491	0.81	944	1251	0.75
2006	29	45	0.64	657	891	0.74
2007	7	21	0.33	1039	1207	0.86

Table 5.8. Ratios of fish released alive (B2) to total catch (A+B1+B2) from MRFSS private mode catch estimates by year and area group for gag in the Gulf of Mexico.

	FLW panhandle + AL			FLW peninsula		
year	b2	ab1b2	b2/ab1b2	b2	ab1b2	b2/ab1b2
2004	583,582	782,662	0.75	2,502,610	2,787,194	0.90
2005	454,912	581,363	0.78	1,456,431	1,685,241	0.86
2006	377,605	502,428	0.75	1,149,611	1,221,043	0.94
2007	452,914	591,054	0.77	1,976,792	2,088,130	0.95

Table 5.9. Ratios of fish released alive (B2) to total catch (A+B1+B2) from MRFSS charter boat mode catch estimates by year and area group for gag in the Gulf of Mexico.

	FLW panhandle + AL			FLW peninsula		
year	b2	ab1b2	b2/ab1b2	b2	ab1b2	b2/ab1b2
2004	84,981	163,165	0.52	235,433	288,503	0.82
2005	153,368	233,549	0.66	176,866	213,957	0.83
2006	44,781	82,580	0.54	111,932	140,735	0.80
2007	13,178	33,656	0.39	134,166	161,622	0.83

Table 5.10. Estimated recreational dead discards in numbers by mode (i.e., headboat and MRFSS) for GOM gag.

Year	Headboat	MRFSS
1981	0	35,462
1982	0	20,418
1983	0	53,860
1984	0	13,753
1985	0	36,528
1986	4,071	110,936
1987	1,484	59,694
1988	1,417	56,593
1989	2,406	62,471
1990	11,260	79,931
1991	364	163,776
1992	2,667	138,419
1993	3,714	274,745
1994	11,194	328,194
1995	6,933	406,716
1996	6,131	242,392
1997	5,203	300,009
1998	17,122	447,237
1999	11,239	317,307
2000	5,523	301,917
2001	4,317	427,357
2002	5,617	523,996
2003	10,508	733,005
2004	13,296	787,654
2005	10,685	559,731
2006	3,297	381,616
2007	6,508	562,433
2008	10,619	784,182

Table 6.1. Standardized commercial indices of abundance.

Index Name	**CMHL:1990-2000**		**CMHL:2000-2008**		**CMLL:1990-2000**		**CMLL:2000-2008**	
Size Range	>508 mm		>610 mm		>508 mm		>610 mm	
Relative (Scaled to 1)?	Yes		Yes		Yes		Yes	
Weight/Numbers	Weight		Weight		Weight		Weight	
Units	lbs/hook hr		lbs/hook hr		lbs/hook		lbs/hook	
YEAR	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
1990	0.714	0.107	-	-	1.264	0.332	-	-
1991	0.519	0.105	-	-	0.850	0.331	-	-
1992	0.758	0.085	-	-	0.706	0.417	-	-
1993	1.027	0.066	-	-	0.976	0.180	-	-
1994	0.856	0.068	-	-	0.541	0.232	-	-
1995	0.849	0.066	-	-	0.744	0.202	-	-
1996	0.978	0.061	-	-	0.878	0.154	-	-
1997	1.036	0.060	-	-	0.875	0.154	-	-
1998	1.726	0.057	-	-	1.529	0.120	-	-
1999	1.176	0.058	-	-	1.184	0.136	-	-
2000	1.361	0.064	0.818	0.065	1.454	0.170	0.635	0.265
2001	-	-	1.246	0.056	-	-	1.121	0.125
2002	-	-	1.236	0.057	-	-	1.081	0.128
2003	-	-	1.135	0.057	-	-	1.211	0.118
2004	-	-	1.434	0.056	-	-	1.351	0.107
2005	-	-	1.431	0.057	-	-	1.683	0.099
2006	-	-	0.655	0.063	-	-	0.754	0.144
2007	-	-	0.488	0.068	-	-	0.674	0.191
2008	-	-	0.557	0.069	-	-	0.489	0.221

Table 6.2. Standardized recreational indices of abundance.

Index Name	**MRFSS**		**Headboat:1986-1989**		**Headboat:1990-2000**		**Headboat:2000-2008**	
Size Range	Pending		Pending		>508 mm		>559 mm	
Relative (Scaled to 1)?	Yes		Yes		Yes		Yes	
Weight/Numbers	Numbers		Numbers		Numbers		Numbers	
Units	fish/1000 angler hrs		fish/angler hr		fish/angler hr		fish/angler hr	
YEAR	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
1981	0.284	0.560	-	-	-	-	-	-
1982	0.258	0.519	-	-	-	-	-	-
1983	0.609	0.565	-	-	-	-	-	-
1984	0.018	1.885	-	-	-	-	-	-
1985	0.030	1.122	-	-	-	-	-	-
1986	0.178	0.437	0.978	0.293	-	-	-	-
1987	0.162	0.414	1.205	0.219	-	-	-	-
1988	0.079	0.498	0.950	0.284	-	-	-	-
1989	0.294	0.406	0.866	0.315	-	-	-	-
1990	0.771	0.392	-	-	0.691	0.330	-	-
1991	0.632	0.366	-	-	0.606	0.360	-	-
1992	0.512	0.334	-	-	0.705	0.354	-	-
1993	1.288	0.315	-	-	0.836	0.297	-	-
1994	1.737	0.308	-	-	0.868	0.303	-	-
1995	1.625	0.303	-	-	0.866	0.307	-	-
1996	1.412	0.312	-	-	1.331	0.182	-	-
1997	1.071	0.305	-	-	1.339	0.176	-	-
1998	2.096	0.292	-	-	1.262	0.197	-	-
1999	1.756	0.290	-	-	1.258	0.185	-	-
2000	1.009	0.297	-	-	1.239	0.230	1.134	0.269
2001	0.815	0.299	-	-	-	-	0.866	0.258
2002	1.542	0.287	-	-	-	-	0.843	0.248
2003	1.709	0.288	-	-	-	-	1.188	0.174
2004	1.691	0.289	-	-	-	-	1.420	0.142
2005	2.003	0.288	-	-	-	-	1.571	0.117
2006	0.882	0.300	-	-	-	-	0.653	0.324
2007	1.210	0.294	-	-	-	-	0.590	0.351
2008	2.326	0.290	-	-	-	-	0.735	0.215

Table 6.3. Standardized fishery-independent indices of abundance.

Index Name	**SeaMAP R.F. Video**		**SeaMAP R.F. Video (Copper Belly)**		**Combined Age-0 Surveys**	
Size Range	425-975 mm		425-975 mm		50-400 mm	
Relative (Scaled to 1)?	Yes		Yes		Yes	
Weight/Numbers	Presence/Absence		Presence/Absence		Numbers	
Units	frequency of occurrence		frequency of occurrence		fish/haul	
YEAR	INDEX	CV	INDEX	CV	INDEX	CV
1991	-	-	-	-	4.173	0.540
1992	-	-	-	-	0.168	0.479
1993	0.783	0.423	1.444	0.399	8.851	0.085
1994	0.603	0.525	0.934	0.580	0.305	0.446
1995	0.528	0.357	0.779	0.495	0.121	0.365
1996	1.030	0.281	1.017	0.410	0.118	0.362
1997	1.100	0.308	0.637	0.571	0.075	0.374
1998	-	-	-	-	0.149	0.429
1999	-	-	-	-	0.186	0.363
2000	-	-	-	-	0.256	0.332
2001	-	-	-	-	0.198	0.468
2002	1.884	0.181	1.099	0.358	0.715	0.270
2003	-	-	-	-	0.295	0.286
2004	2.288	0.175	2.183	0.282	0.169	0.324
2005	1.100	0.188	1.178	0.260	0.186	0.307
2006	0.687	0.254	0.531	0.385	0.612	0.203
2007	0.812	0.193	0.932	0.266	1.021	0.176
2008	0.184	0.520	0.265	0.612	0.400	0.262

Table 8.1. Central model estimated selectivity at age.

	Handline		Headboat			Longline	MRFSS	Others
Age	1986-1999	2000-2008	1986-1989	1990-1999	2000-2008	1986-2008	1986-2008	1986-2008
1	0.0004	0.0000	0.0281	0.0076	0.0221	0.0001	0.0758	0.0008
2	0.0063	0.0008	0.3205	0.1824	0.2565	0.0013	0.3950	0.0095
3	0.0613	0.0255	0.7712	0.6803	0.7127	0.0109	0.7590	0.1062
4	0.2822	0.2506	0.9162	0.9054	0.8987	0.0642	0.9054	0.6127
5	0.5787	0.6051	0.8854	0.9203	0.8616	0.2258	0.9145	0.9334
6	0.7805	0.8234	0.7678	0.8486	0.7184	0.4577	0.8422	0.8517
7	0.8806	0.8923	0.6098	0.7152	0.5450	0.6602	0.7143	0.7356
8	0.9224	0.8652	0.4570	0.5623	0.3913	0.7993	0.5708	0.5905
9	0.9389	0.7912	0.3328	0.4245	0.2741	0.8845	0.4406	0.4357
10	0.9457	0.6968	0.2403	0.3149	0.1912	0.9332	0.3353	0.2959
11	0.9486	0.6036	0.1743	0.2329	0.1346	0.9602	0.2550	0.1875
12	0.9500	0.5195	0.1282	0.1732	0.0966	0.9752	0.1955	0.1129

Table 8.2. Estimated apical fishing mortality rates.

Year	Central	Red Tide
1986	0.34	0.34
1987	0.28	0.28
1988	0.35	0.35
1989	0.31	0.31
1990	0.27	0.27
1991	0.39	0.39
1992	0.36	0.35
1993	0.44	0.43
1994	0.35	0.34
1995	0.40	0.39
1996	0.32	0.31
1997	0.29	0.27
1998	0.39	0.37
1999	0.31	0.29
2000	0.37	0.35
2001	0.41	0.37
2002	0.43	0.38
2003	0.44	0.37
2004	0.64	0.47
2005	0.58	0.49
2006	0.45	0.42
2007	0.54	0.49
2008	0.92	0.76

Table 8.3. Central model estimates of fishing mortality at age.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1986	0.02	0.09	0.20	0.27	0.32	0.34	0.33	0.30	0.26	0.24	0.22	0.20
1987	0.01	0.08	0.16	0.22	0.26	0.28	0.28	0.26	0.24	0.22	0.20	0.19
1988	0.02	0.11	0.23	0.31	0.35	0.35	0.33	0.29	0.25	0.21	0.19	0.17
1989	0.01	0.08	0.16	0.23	0.29	0.31	0.31	0.28	0.26	0.24	0.22	0.21
1990	0.01	0.05	0.11	0.16	0.22	0.26	0.27	0.27	0.25	0.24	0.23	0.22
1991	0.02	0.10	0.22	0.31	0.37	0.39	0.38	0.34	0.31	0.27	0.25	0.23
1992	0.01	0.08	0.18	0.25	0.32	0.36	0.36	0.34	0.31	0.29	0.27	0.25
1993	0.02	0.10	0.21	0.31	0.39	0.44	0.43	0.40	0.37	0.33	0.31	0.29
1994	0.01	0.07	0.16	0.25	0.32	0.35	0.35	0.33	0.30	0.28	0.26	0.24
1995	0.02	0.09	0.20	0.30	0.37	0.40	0.39	0.36	0.33	0.30	0.27	0.26
1996	0.01	0.07	0.15	0.22	0.29	0.32	0.32	0.31	0.28	0.26	0.25	0.23
1997	0.01	0.06	0.14	0.20	0.25	0.28	0.29	0.27	0.25	0.23	0.22	0.21
1998	0.01	0.08	0.18	0.26	0.34	0.39	0.39	0.37	0.34	0.32	0.30	0.28
1999	0.01	0.07	0.15	0.22	0.28	0.31	0.31	0.29	0.27	0.25	0.23	0.22
2000	0.02	0.09	0.19	0.27	0.34	0.37	0.36	0.32	0.28	0.24	0.20	0.17
2001	0.02	0.09	0.18	0.27	0.36	0.41	0.41	0.37	0.33	0.29	0.25	0.22
2002	0.02	0.10	0.21	0.30	0.39	0.43	0.43	0.39	0.34	0.30	0.26	0.23
2003	0.02	0.11	0.23	0.32	0.40	0.44	0.43	0.39	0.34	0.30	0.26	0.23
2004	0.03	0.16	0.34	0.48	0.59	0.64	0.61	0.53	0.45	0.38	0.32	0.28
2005	0.02	0.13	0.29	0.41	0.52	0.58	0.56	0.49	0.42	0.36	0.31	0.27
2006	0.02	0.13	0.26	0.36	0.43	0.45	0.42	0.36	0.31	0.26	0.22	0.19
2007	0.03	0.16	0.34	0.46	0.53	0.54	0.49	0.42	0.35	0.29	0.24	0.20
2008	0.04	0.25	0.56	0.79	0.92	0.91	0.79	0.63	0.49	0.39	0.31	0.25

Table 8.4. Red tide model estimates of fishing mortality at age.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1986	0.02	0.09	0.20	0.27	0.32	0.34	0.32	0.29	0.26	0.24	0.22	0.20
1987	0.01	0.07	0.16	0.21	0.26	0.28	0.27	0.26	0.23	0.21	0.20	0.19
1988	0.02	0.11	0.23	0.30	0.34	0.35	0.32	0.28	0.24	0.21	0.19	0.17
1989	0.01	0.07	0.16	0.23	0.28	0.31	0.30	0.28	0.26	0.23	0.22	0.21
1990	0.01	0.05	0.11	0.16	0.22	0.25	0.27	0.26	0.25	0.24	0.23	0.22
1991	0.02	0.10	0.22	0.31	0.37	0.39	0.37	0.34	0.30	0.27	0.24	0.23
1992	0.01	0.08	0.17	0.25	0.32	0.35	0.35	0.33	0.31	0.28	0.26	0.25
1993	0.02	0.09	0.21	0.30	0.39	0.43	0.42	0.39	0.36	0.33	0.30	0.28
1994	0.01	0.07	0.16	0.24	0.31	0.34	0.34	0.32	0.29	0.27	0.25	0.24
1995	0.02	0.09	0.20	0.29	0.36	0.39	0.38	0.35	0.32	0.29	0.27	0.25
1996	0.01	0.07	0.15	0.22	0.28	0.31	0.31	0.29	0.27	0.25	0.24	0.23
1997	0.01	0.06	0.13	0.19	0.24	0.27	0.27	0.26	0.24	0.22	0.21	0.20
1998	0.01	0.08	0.17	0.25	0.33	0.37	0.37	0.35	0.33	0.30	0.28	0.27
1999	0.01	0.07	0.15	0.21	0.27	0.29	0.29	0.28	0.26	0.24	0.22	0.21
2000	0.02	0.09	0.18	0.26	0.32	0.35	0.33	0.30	0.26	0.22	0.19	0.16
2001	0.01	0.08	0.17	0.25	0.33	0.37	0.37	0.34	0.30	0.26	0.23	0.20
2002	0.02	0.09	0.18	0.26	0.34	0.38	0.37	0.34	0.30	0.26	0.23	0.20
2003	0.02	0.09	0.19	0.27	0.33	0.37	0.36	0.32	0.29	0.25	0.22	0.20
2004	0.02	0.12	0.26	0.36	0.44	0.47	0.45	0.40	0.34	0.29	0.25	0.22
2005	0.02	0.12	0.25	0.36	0.45	0.49	0.48	0.43	0.37	0.32	0.27	0.24
2006	0.02	0.12	0.25	0.33	0.40	0.42	0.39	0.34	0.29	0.24	0.21	0.18
2007	0.03	0.14	0.31	0.41	0.48	0.49	0.45	0.38	0.32	0.26	0.22	0.19
2008	0.04	0.22	0.48	0.66	0.76	0.76	0.66	0.54	0.42	0.34	0.27	0.22

Table 8.5. Central model estimates of numbers at age.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1986	1,643,810	1,025,090	711,915	423,772	431,667	256,994	140,957	73,089	41,547	28,504	14,104	64,809
1987	1,080,540	1,125,080	661,085	442,437	254,976	253,543	150,926	85,073	45,916	27,152	19,255	56,079
1988	1,345,530	741,802	738,775	427,667	281,363	159,466	158,099	95,768	55,561	30,901	18,755	54,204
1989	791,231	917,829	470,137	443,645	248,093	160,915	92,430	95,421	60,810	36,990	21,383	53,297
1990	3,263,030	543,396	602,413	302,478	277,548	150,916	97,263	56,966	60,734	39,992	25,014	52,643
1991	1,343,250	2,251,980	367,140	410,395	202,652	180,453	96,236	62,093	36,920	40,135	26,919	53,916
1992	1,727,310	917,234	1,436,530	222,579	237,468	113,225	100,395	55,135	37,237	23,176	26,183	55,566
1993	1,911,450	1,184,360	598,693	913,444	136,262	139,633	65,399	58,706	33,234	23,221	14,897	54,929
1994	4,256,500	1,307,420	761,997	367,847	528,838	74,425	74,546	35,545	33,218	19,642	14,253	45,328
1995	2,255,050	2,922,730	859,451	490,210	226,965	312,198	43,244	43,973	21,652	20,951	12,770	40,570
1996	2,073,010	1,542,580	1,882,820	531,021	287,612	126,973	172,229	24,394	25,846	13,284	13,333	35,812
1997	5,462,580	1,424,270	1,018,660	1,227,960	335,704	175,177	76,090	104,363	15,184	16,577	8,749	33,728
1998	2,935,270	3,757,110	946,463	674,278	794,956	211,199	108,934	47,848	67,255	10,053	11,242	29,974
1999	1,859,080	2,012,990	2,453,730	601,080	409,143	457,945	118,532	61,714	27,936	40,642	6,264	26,899
2000	4,228,580	1,276,820	1,326,350	1,593,250	379,410	250,119	276,477	72,544	38,854	18,135	27,102	23,102
2001	3,097,040	2,893,780	824,949	829,973	956,839	217,731	141,859	161,237	44,449	25,095	12,283	36,041
2002	2,255,480	2,120,760	1,877,250	520,664	499,990	541,215	119,363	78,897	93,657	27,187	16,118	33,416
2003	2,863,020	1,541,100	1,359,250	1,155,720	304,696	275,030	289,317	65,037	45,120	56,624	17,308	33,936
2004	1,578,200	1,953,050	978,324	819,605	661,964	165,254	145,887	157,065	37,138	27,258	36,010	35,005
2005	1,987,010	1,067,800	1,181,380	528,573	401,575	296,964	72,070	66,628	78,086	20,162	15,971	45,486
2006	2,793,440	1,349,650	660,990	672,525	276,772	192,884	137,836	34,588	34,345	43,497	12,036	40,396
2007	1,267,980	1,900,090	843,058	385,271	370,887	146,332	101,808	75,896	20,298	21,487	28,758	37,492
2008	2,703,160	857,769	1,148,770	456,170	192,605	176,577	70,156	51,923	42,120	12,212	13,828	46,234

Table 8.6. Red tide model estimates of numbers at age.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1986	1,648,830	1,028,000	714,451	425,470	433,605	258,463	141,946	73,692	41,933	28,796	14,257	65,576
1987	1,084,400	1,129,180	663,930	444,691	256,448	255,211	152,116	85,844	46,381	27,451	19,484	56,823
1988	1,351,260	744,821	742,407	430,106	283,254	160,691	159,464	96,720	56,176	31,275	18,998	55,007
1989	795,032	922,448	473,024	446,923	250,225	162,514	93,426	96,501	61,552	37,471	21,678	54,144
1990	3,280,240	546,282	606,306	304,905	280,286	152,688	98,568	57,775	61,616	40,599	25,410	53,587
1991	1,352,720	2,264,620	369,443	413,584	204,658	182,710	97,682	63,153	37,584	40,870	27,429	55,045
1992	1,744,710	924,428	1,447,850	224,654	240,261	114,910	102,194	56,253	38,053	23,696	26,770	56,902
1993	1,938,720	1,197,050	604,512	923,060	138,037	141,973	66,759	60,123	34,111	23,867	15,315	56,516
1994	4,340,940	1,327,090	771,983	372,754	537,230	75,948	76,448	36,605	34,308	20,320	14,758	46,948
1995	2,318,430	2,982,580	874,162	498,264	231,134	319,353	44,489	45,476	22,480	21,804	13,307	42,298
1996	2,144,670	1,587,310	1,927,040	542,750	294,438	130,555	178,117	25,373	27,006	13,923	13,999	37,630
1997	5,670,580	1,474,550	1,050,870	1,262,340	345,389	180,966	79,074	109,130	15,964	17,497	9,258	35,748
1998	3,076,010	3,902,940	982,483	698,871	822,895	219,328	113,760	50,285	71,094	10,679	11,982	32,046
1999	1,993,530	2,111,560	2,558,870	628,553	428,834	481,391	125,345	65,664	29,889	43,689	6,759	29,149
2000	4,731,460	1,370,530	1,397,110	1,674,870	401,459	266,274	295,867	78,117	42,061	19,717	29,572	25,356
2001	3,692,280	3,242,640	891,200	885,068	1,023,760	235,720	154,987	177,025	48,993	27,718	13,580	39,948
2002	2,887,920	2,532,630	2,119,970	571,169	545,517	597,532	134,142	89,567	106,572	30,926	18,288	37,784
2003	3,926,180	1,978,050	1,642,700	1,337,220	346,301	314,498	337,191	77,148	53,807	67,243	20,414	39,503
2004	2,282,700	2,687,660	1,278,420	1,028,350	808,011	201,096	180,074	197,266	47,112	34,441	44,918	42,531
2005	2,390,200	1,554,520	1,684,690	747,741	565,926	420,661	103,218	95,798	111,708	28,469	22,029	59,892
2006	3,092,830	1,451,190	692,146	703,485	292,307	206,455	149,623	37,840	37,349	46,539	12,582	39,356
2007	1,454,790	2,107,900	914,543	410,491	397,358	159,079	112,360	84,772	22,761	23,851	31,287	37,566
2008	3,148,830	987,145	1,293,540	510,600	214,393	199,295	80,452	60,106	48,942	14,136	15,741	48,893

Table 9.1. Non-red tide model benchmark estimates from deterministic projection runs. Biomass units are pounds, gutted weight (MSY, SSB, Y, Y/R). Objective function represents the estimated log-likelihood of the model fit. F Current is geometric mean F for 2005-2007. F Rebuild rebuilds stock to SSBmax or to SSBoy by 2019. F at max Y/R used as proxy for F at MSY.

		Base M		Catchability	
Quantities	Central	0.19	0.11	2% Increase	2% Decrease
Objective function	4836.08	4851.21	4824.41	4797.35	4886.51
F 2008	0.92	0.75	1.27	1.18	0.81
F Current	0.52	0.45	0.59	0.57	0.46
SSB 2008	10,214,018	12,046,060	8,853,766	8,827,310	12,184,951
MSST	18,887,148	15,965,842	24,698,203	18,628,658	19,223,518
MSY	3,938,118	3,621,997	4,677,240	3,908,179	3,974,737
F at max. Y/R	0.21	0.25	0.17	0.22	0.21
Y/R maximum	1.88	1.19	3.19	1.89	1.87
S/R at Fmax	4.82	2.79	8.98	4.82	4.83
SPR at Fmax	0.39	0.38	0.39	0.39	0.39
SSB at Fmax	22,220,174	18,783,343	29,056,710	21,916,068	22,615,904
F 0.1	0.14	0.17	0.11	0.14	0.14
Y/R at F0.1	1.79	1.12	3.03	1.80	1.78
S/R at F0.1	6.39	3.72	11.83	6.38	6.39
SPR at F0.1	0.51	0.51	0.52	0.51	0.51
SSB at F0.1	29,418,929	25,050,469	38,272,033	29,017,467	29,958,400
F 20% SPR	0.41	0.45	0.34	0.42	0.41
Y/R at F20	1.63	1.07	2.72	1.65	1.61
S/R at F20	2.55	1.62	4.63	2.57	2.52
SSB at F20	11,756,967	10,910,039	14,976,643	11,704,630	11,829,477
F 30% SPR	0.28	0.33	0.23	0.29	0.28
Y/R at F30	1.83	1.16	3.09	1.84	1.82
S/R at F30	3.76	2.21	6.93	3.76	3.76
SSB at F30	17,343,350	14,884,027	22,422,117	17,111,181	17,635,308
F 40% SPR	0.20	0.24	0.17	0.21	0.20
Y/R at F40	1.88	1.18	3.19	1.89	1.87
S/R at F40	5.02	2.94	9.23	5.01	5.01
SSB at F40	23,145,895	19,814,908	29,853,901	22,815,643	23,484,966
F 90% max Y/R	0.12	0.14	0.10	0.12	0.12
Y 90% max Y/R	3,540,272	3,254,927	4,206,950	3,507,467	3,567,587
Y/R 90% max Y/R	1.69	1.07	2.87	1.70	1.68
S/R 90% max Y/R	7.07	4.12	13.05	7.08	7.09
SSB 90% max Y/R	32,554,564	27,708,803	42,201,112	32,205,572	33,201,180
F 75% of Fmax	0.16	0.19	0.13	0.16	0.16
Y 75% of Fmax	3,838,425	3,531,696	4,557,793	3,809,632	3,873,545
Y/R at 75% Fmax	1.84	1.16	3.11	1.85	1.82
S/R at 75% Fmax	5.92	3.43	10.98	5.91	5.93
SSB at 75% Fmax	27,274,272	23,098,275	35,534,994	26,898,384	27,770,973
Fcurrrent/Fmax	2.43	1.77	3.41	2.64	2.18
SSB2008/MSST	0.54	0.75	0.36	0.47	0.63
F Rebuild					
to SSBmax	0.19	0.24	0.14	0.20	0.19
to SSBoy	0.14	0.18	0.09	0.14	0.14

Table 9.2. Red tide model benchmark estimates from deterministic projection runs. Biomass units are pounds, gutted weight (MSY, SSB, Y, Y/R). Objective function represents the estimated log-likelihood of the model fit. F Current is geometric mean F for 2005-2007. F Rebuild rebuilds stock to SSBmax or to SSBoy by 2019. F at max Y/R used as proxy for F at MSY.

		Red Tide + Base M		Red Tide + Catchability	
Quantities	Red Tide	0.19	0.11	2% Increase	2% Decrease
Objective function	4825.05	4838.85	4814.09	4790.78	4868.10
F 2008	0.76	1.10	0.93	1.02	0.73
F Current	0.47	0.40	0.53	0.53	0.39
SSB 2008	11,536,792	13,670,867	10,083,945	9,576,882	14,643,105
MSST	20,453,753	11,847,226	38,045,641	20,413,838	20,496,291
MSY	4,254,988	2,646,473	7,260,970	4,282,546	4,217,664
F at max. Y/R	0.21	0.25	0.17	0.22	0.21
Y/R maximum	1.89	1.17	3.22	1.90	1.87
S/R at Fmax	4.84	2.80	8.99	4.83	4.85
SPR at Fmax	0.39	0.38	0.39	0.39	0.39
SSB at Fmax	24,063,239	13,937,913	44,759,577	24,016,280	24,113,284
F 0.1	0.14	0.16	0.11	0.14	0.14
Y/R at F0.1	1.79	1.11	3.05	1.80	1.77
S/R at F0.1	6.41	3.73	11.87	6.39	6.41
SPR at F0.1	0.51	0.51	0.52	0.51	0.51
SSB at F0.1	31,912,799	18,543,612	59,070,446	31,819,102	31,913,901
F 20% SPR	0.41	0.45	0.35	0.41	0.41
Y/R at F20	1.63	1.05	2.75	1.65	1.61
S/R at F20	2.55	1.60	4.63	2.58	2.52
SSB at F20	12,688,068	7,958,204	23,038,971	12,815,142	12,520,605
F 30% SPR	0.28	0.33	0.24	0.29	0.28
Y/R at F30	1.83	1.14	3.12	1.85	1.82
S/R at F30	3.77	2.21	6.94	3.77	3.77
SSB at F30	18,756,072	10,998,158	34,511,828	18,743,175	18,749,899
F 40% SPR	0.20	0.23	0.17	0.20	0.20
Y/R at F40	1.88	1.17	3.22	1.90	1.87
S/R at F40	5.02	2.94	9.24	5.02	5.01
SSB at F40	24,977,496	14,630,693	45,973,002	25,004,172	24,954,788
F 90% max Y/R	0.12	0.14	0.10	0.12	0.11
Y 90% max Y/R	3,828,019	2,375,856	6,524,030	3,850,330	3,792,789
Y/R 90% max Y/R	1.70	1.05	2.89	1.71	1.68
S/R 90% max Y/R	7.07	4.13	13.08	7.07	7.08
SSB 90% max Y/R	35,184,679	20,561,548	65,085,098	35,175,200	35,252,141
F 75% of Fmax	0.16	0.19	0.13	0.16	0.16
Y 75% of Fmax	4,147,425	2,579,872	7,077,236	4,174,828	4,110,299
Y/R at 75% Fmax	1.84	1.14	3.14	1.85	1.82
S/R at 75% Fmax	5.93	3.44	10.99	5.92	5.95
SSB at 75% Fmax	29,520,121	17,142,553	54,685,010	29,459,494	29,588,465
Fcurrrent/Fmax	2.20	1.60	3.08	2.47	1.87
SSB2008/MSST	0.56	1.15	0.27	0.47	0.71
F Rebuild					
to SSBmax	0.19	TBD	TBD	0.20	TBD
to SSBoy	0.14	TBD	TBD	0.14	TBD

Table 9.3. Required SFA and MSRA evaluations for Gulf of Mexico gag for central and red tide models. Biomass units are million pounds, gutted weight (SSB, MSST, MSY, OY, OFL, ABC). *The red tide increasing catchability model was recommended by the SSC. The SSC did not accept the 2011-2014 OFL, ABC and OY values and asked that they be reevaluated when the 2009 landings are available. In the event that the reevaluation is not completed before the rebuilding plan is submitted, the SSC recommended that the ABCs for 2011-2014 be used pending the reevaluation.

Criteria	Definition	Central	Red Tide	*Red Tide w/ +2% q
	Mortality Rate Criteria			
$F_{MSY\ or\ proxy}$	F_{MAX}	0.21	0.21	0.22
MFMT	F_{MAX}	0.21	0.21	0.22
F_{OY}	75% OF F_{MAX}	0.16	0.16	0.16
$F_{CURRENT}$	Geometric mean 2005-2007	0.52	0.47	0.53
$F_{CURRENT}$/MFMT	Geometric mean 2005-2007	2.43	2.20	2.47
Base M		0.15	0.15	0.15
	Biomass Criteria			
SSB_{MAX}	Equilibrium SSB @ F_{MAX}	22.22	24.06	24.02
MSST	(1-M)*SSB_{MAX} M=0.15	18.89	20.45	20.41
$SSB_{CURRENT}$	SSB_{2008}	10.21	11.54	9.58
$SS_{CURRENT}$/MSST	SSB_{2008}	0.54	0.56	0.47
Equilibrium MSY	Equilibrium Yield @ F_{MSY}	3.94	4.25	4.28
Equilibrium OY	Equilibrium Yield @ F_{OY}	3.84	4.15	4.17
OFL	Annual Yield @ MFMT			
	SEDAR 10 OFL 2009	4.25	4.25	4.25
	Update OFL 2010	0.94	1.29	0.88
	Update OFL 2011	1.28	1.65	1.27
	Update OFL 2012	1.74	2.13	1.80
	Update OFL 2013	2.20	2.58	2.31
	Update OFL 2014	2.60	2.96	2.77
Annual OY (ACT)	Annual Yield @ F_{OY}			
	SEDAR 10 OY 2009	3.38	3.38	3.38
	Update OY 2010	0.72	0.98	0.67
	Update OY 2011	1.02	1.31	1.01
	Update OY 2012	1.44	1.76	1.48
	Update OY 2013	1.87	2.19	1.97
	Update OY 2014	2.26	2.58	2.41
	2010 Yield @ 65% MFMT	0.63	0.87	0.59
Alternative ACT:	2010 Yield @ 75% MFMT	0.72	0.98	0.67
	2010 Yield @ 85% MFMT	0.80	1.11	0.78
Generation Time		n/a	n/a	n/a
Rebuild Time	(if B_{2008}<MSST)			
Tmin	@ F=0	5 yrs	5 yrs	5 yrs
Midpoint	mid of Tmin, Tmax	7.5 yrs	7.5 yrs	7.5 yrs
Tmax	if Tmin>10y, Tmin + 1 Gen	10 yrs	10 yrs	10 yrs
ABC	Recommended by SSC			
	2010 Yield @ $F_{Rebuild}$	n/a	n/a	0.82
	2011 Yield @ $F_{Rebuild}$	n/a	n/a	1.20
	2012 Yield @ $F_{Rebuild}$	n/a	n/a	1.71
	2013 Yield @ $F_{Rebuild}$	n/a	n/a	2.23
	2014 Yield @ $F_{Rebuild}$	n/a	n/a	2.68

Table 10.1. Projected yields for Gulf of Mexico gag from central, red tide, and red tide increasing catchability models under six fixed F management scenarios. Units for yield are million pounds gutted weight.

Projection Scenario	Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Central												
Fcurrent	5.34	3.38	2.06	2.25	2.52	2.72	2.86	2.94	2.98	3.00	3.01	3.02
Fmax	5.34	3.38	0.94	1.28	1.74	2.20	2.60	2.91	3.13	3.28	3.40	3.49
90%Fmax	5.34	3.38	0.54	0.78	1.14	1.52	1.88	2.17	2.40	2.58	2.71	2.82
75%Fmax	5.34	3.38	0.72	1.02	1.44	1.87	2.26	2.58	2.82	2.99	3.13	3.23
Frebuild-SSBoy	5.34	3.38	0.63	0.91	1.30	1.71	2.09	2.41	2.64	2.82	2.96	3.06
Frebuild-SSBmax	5.34	3.38	0.85	1.17	1.62	2.07	2.47	2.78	3.01	3.18	3.30	3.40
Red Tide												
Fcurrent	5.34	3.38	2.58	2.75	3.00	3.18	3.30	3.37	3.41	3.43	3.44	3.45
Fmax	5.34	3.38	1.29	1.65	2.13	2.58	2.96	3.25	3.46	3.61	3.72	3.81
90%Fmax	5.34	3.38	0.74	1.01	1.39	1.78	2.14	2.44	2.67	2.84	2.98	3.09
75%Fmax	5.34	3.38	0.98	1.31	1.76	2.19	2.58	2.89	3.12	3.30	3.43	3.53
Frebuild-SSBoy	5.34	3.38	0.87	1.18	1.60	2.02	2.40	2.71	2.94	3.12	3.25	3.36
Frebuild-SSBmax	5.34	3.38	1.16	1.52	1.98	2.43	2.82	3.12	3.35	3.51	3.63	3.73
Red Tide w/ Increasing Catchability												
Fcurrent	5.30	3.38	1.94	2.25	2.60	2.86	3.04	3.14	3.20	3.23	3.24	3.25
Fmax	5.30	3.38	0.88	1.27	1.80	2.31	2.77	3.11	3.36	3.55	3.68	3.78
90%Fmax	5.30	3.38	0.50	0.78	1.17	1.59	1.99	2.33	2.58	2.78	2.93	3.05
75%Fmax	5.30	3.38	0.67	1.01	1.48	1.97	2.41	2.76	3.03	3.23	3.38	3.49
Frebuild-SSBoy	5.30	3.38	0.59	0.90	1.33	1.79	2.22	2.56	2.83	3.03	3.18	3.30
Frebuild-SSBmax	5.30	3.38	0.82	1.20	1.71	2.23	2.68	3.03	3.29	3.48	3.61	3.72

Table 10.2. Estimated probability of overfishing given ten fixed landings management scenarios for the central, 0.19 base M, 0.11 base M, increasing catchability, and decreasing catchability models. Landings include the kept catch only, and are reported in million pounds, gutted weight.

Fixed	Non-Red Tide Models				
Landings	Central	0.11 Base M	0.19 Base M	Decreasing q	Increasing q
			2009		
3.38 mp	1.00	1.00	1.00	1.00	1.00
			2010		
0.5 mp	0.00	0.38	0.00	0.00	0.25
1.0 mp	0.52	0.88	0.01	0.03	0.79
1.5 mp	0.86	0.98	0.45	0.59	0.93
2.0 mp	0.97	1.00	0.79	0.88	0.99
2.5 mp	0.99	1.00	0.93	0.98	1.00
3.0 mp	1.00	1.00	0.98	1.00	1.00
3.5 mp	1.00	1.00	0.99	1.00	1.00
4.0 mp	1.00	1.00	1.00	1.00	1.00
4.5 mp	1.00	1.00	1.00	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00
			2011		
0.5 mp	0.00	0.07	0.00	0.00	0.04
1.0 mp	0.21	0.64	0.00	0.01	0.51
1.5 mp	0.64	0.89	0.20	0.32	0.81
2.0 mp	0.86	0.98	0.57	0.68	0.93
2.5 mp	0.96	1.00	0.80	0.88	0.98
3.0 mp	0.99	1.00	0.92	0.97	1.00
3.5 mp	1.00	1.00	0.97	0.99	1.00
4.0 mp	1.00	1.00	0.99	1.00	1.00
4.5 mp	1.00	1.00	1.00	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00
			2012		
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.04	0.34	0.00	0.00	0.26
1.5 mp	0.39	0.73	0.07	0.11	0.62
2.0 mp	0.71	0.91	0.38	0.47	0.85
2.5 mp	0.89	0.98	0.64	0.74	0.95
3.0 mp	0.97	1.00	0.84	0.91	0.99
3.5 mp	0.99	1.00	0.94	0.98	1.00
4.0 mp	1.00	1.00	0.98	1.00	1.00
4.5 mp	1.00	1.00	1.00	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00

Table 10.2. Continued.

			2013		
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.01	0.13	0.00	0.00	0.09
1.5 mp	0.22	0.55	0.03	0.04	0.46
2.0 mp	0.57	0.83	0.25	0.32	0.76
2.5 mp	0.82	0.95	0.55	0.63	0.90
3.0 mp	0.93	0.99	0.78	0.85	0.97
3.5 mp	0.99	1.00	0.91	0.95	1.00
4.0 mp	1.00	1.00	0.97	0.99	1.00
4.5 mp	1.00	1.00	1.00	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00
			2014		
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.00	0.03	0.00	0.00	0.03
1.5 mp	0.09	0.38	0.00	0.01	0.33
2.0 mp	0.45	0.74	0.12	0.18	0.67
2.5 mp	0.75	0.90	0.46	0.53	0.87
3.0 mp	0.91	0.97	0.73	0.79	0.95
3.5 mp	0.97	1.00	0.89	0.93	0.99
4.0 mp	1.00	1.00	0.96	0.98	1.00
4.5 mp	1.00	1.00	1.00	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00

Table 10.3. Estimated probability of overfishing given ten fixed landings management scenarios for the red tide, red tide 0.19 base M, red tide 0.11 base M, red tide increasing catchability, and red tide decreasing catchability models. Landings include the kept catch only, and are reported in million pounds, gutted weight.

Fixed	Red Tide Models				
Landings	Red Tide	0.11 Base M	0.19 Base M	Decreasing q	Increasing q
			2009		
3.38 mp	1.00	1.00	1.00	1.00	1.00
0.5 mp	0.00	0.01	0.00	0.00	0.03
1.0 mp	0.12	0.66	0.00	0.00	0.59
1.5 mp	0.61	0.93	0.05	0.04	0.89
2.0 mp	0.88	0.99	0.43	0.45	0.97
2.5 mp	0.98	1.00	0.73	0.76	1.00
3.0 mp	1.00	1.00	0.90	0.94	1.00
3.5 mp	1.00	1.00	0.98	0.99	1.00
4.0 mp	1.00	1.00	0.99	1.00	1.00
4.5 mp	1.00	1.00	1.00	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00
			2011		
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.03	0.33	0.00	0.00	0.29
1.5 mp	0.33	0.71	0.03	0.02	0.66
2.0 mp	0.67	0.91	0.24	0.25	0.87
2.5 mp	0.87	0.99	0.52	0.55	0.97
3.0 mp	0.97	1.00	0.74	0.78	0.99
3.5 mp	0.99	1.00	0.89	0.92	1.00
4.0 mp	1.00	1.00	0.97	0.98	1.00
4.5 mp	1.00	1.00	0.99	1.00	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00
			2012		
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.01	0.10	0.00	0.00	0.08
1.5 mp	0.14	0.46	0.01	0.01	0.41
2.0 mp	0.43	0.77	0.10	0.13	0.71
2.5 mp	0.72	0.92	0.35	0.34	0.89
3.0 mp	0.89	0.99	0.60	0.61	0.97
3.5 mp	0.97	1.00	0.80	0.81	0.99
4.0 mp	0.99	1.00	0.92	0.95	1.00
4.5 mp	1.00	1.00	0.98	0.99	1.00
5.0 mp	1.00	1.00	1.00	1.00	1.00

Table 10.3. Continued.

2013					
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.00	0.02	0.00	0.00	0.02
1.5 mp	0.04	0.28	0.00	0.00	0.27
2.0 mp	0.30	0.60	0.05	0.06	0.58
2.5 mp	0.57	0.83	0.27	0.25	0.81
3.0 mp	0.80	0.95	0.50	0.50	0.93
3.5 mp	0.93	0.99	0.73	0.73	0.99
4.0 mp	0.99	1.00	0.88	0.88	1.00
4.5 mp	1.00	1.00	0.96	0.97	1.00
5.0 mp	1.00	1.00	0.99	0.99	1.00
2014					
0.5 mp	0.00	0.00	0.00	0.00	0.00
1.0 mp	0.00	0.00	0.00	0.00	0.00
1.5 mp	0.01	0.13	0.00	0.00	0.13
2.0 mp	0.16	0.45	0.02	0.03	0.46
2.5 mp	0.46	0.75	0.17	0.15	0.74
3.0 mp	0.73	0.91	0.44	0.40	0.90
3.5 mp	0.90	0.99	0.68	0.65	0.97
4.0 mp	0.97	1.00	0.85	0.83	1.00
4.5 mp	1.00	1.00	0.95	0.95	1.00
5.0 mp	1.00	1.00	0.99	0.99	1.00

14 Figures

Figure 5.1. Ratios of fish released alive (B2) to total catch (A+B1+B2) for gag from all sources for FL panhandle + AL.

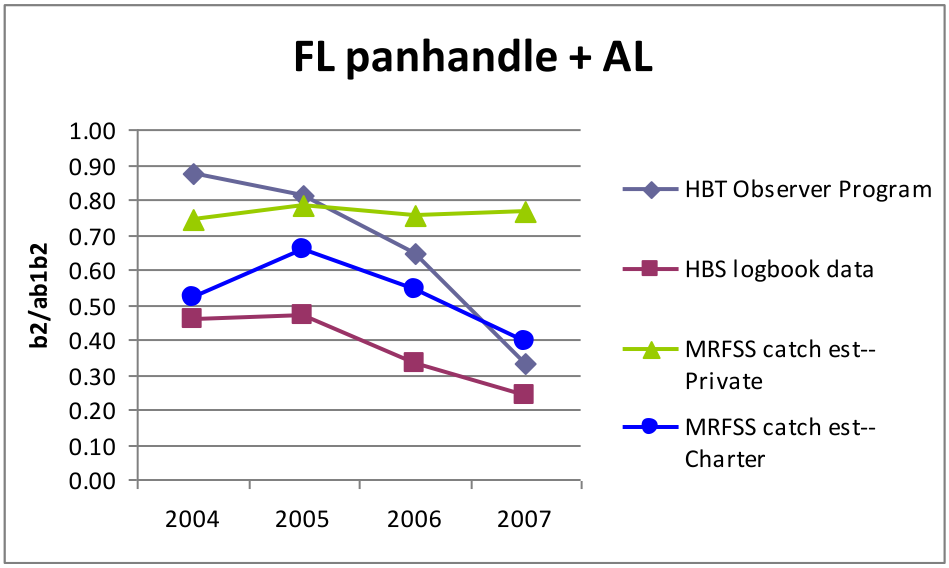


Figure 5.2. Ratios of fish released alive (B2) to total catch (A+B1+B2) for gag from all sources for FL peninsula.

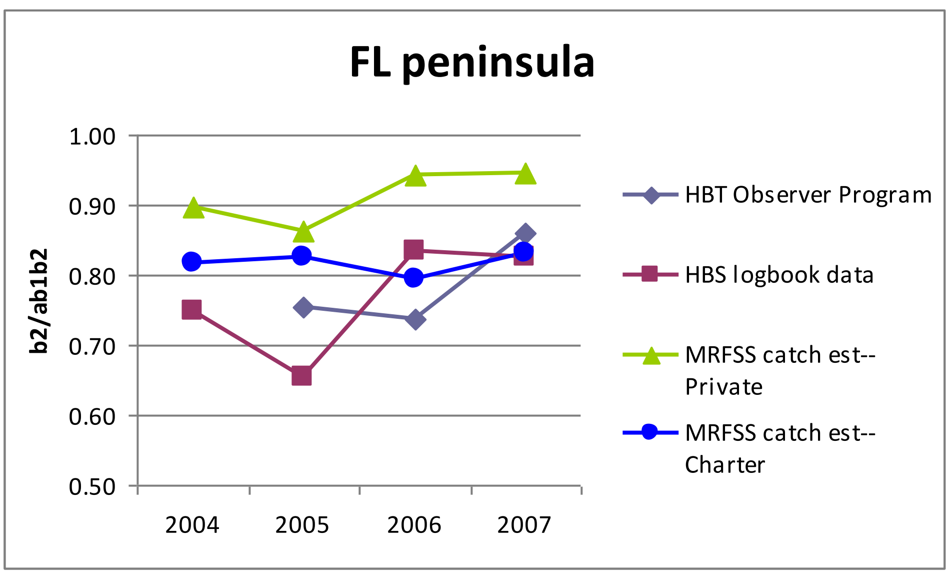


Figure 6.1. Standardized indices of abundance for headboat (HB), MRFSS, handline (HL), longline (LL), SEAMAP video, and SEAMAP copper-belly video (CB).

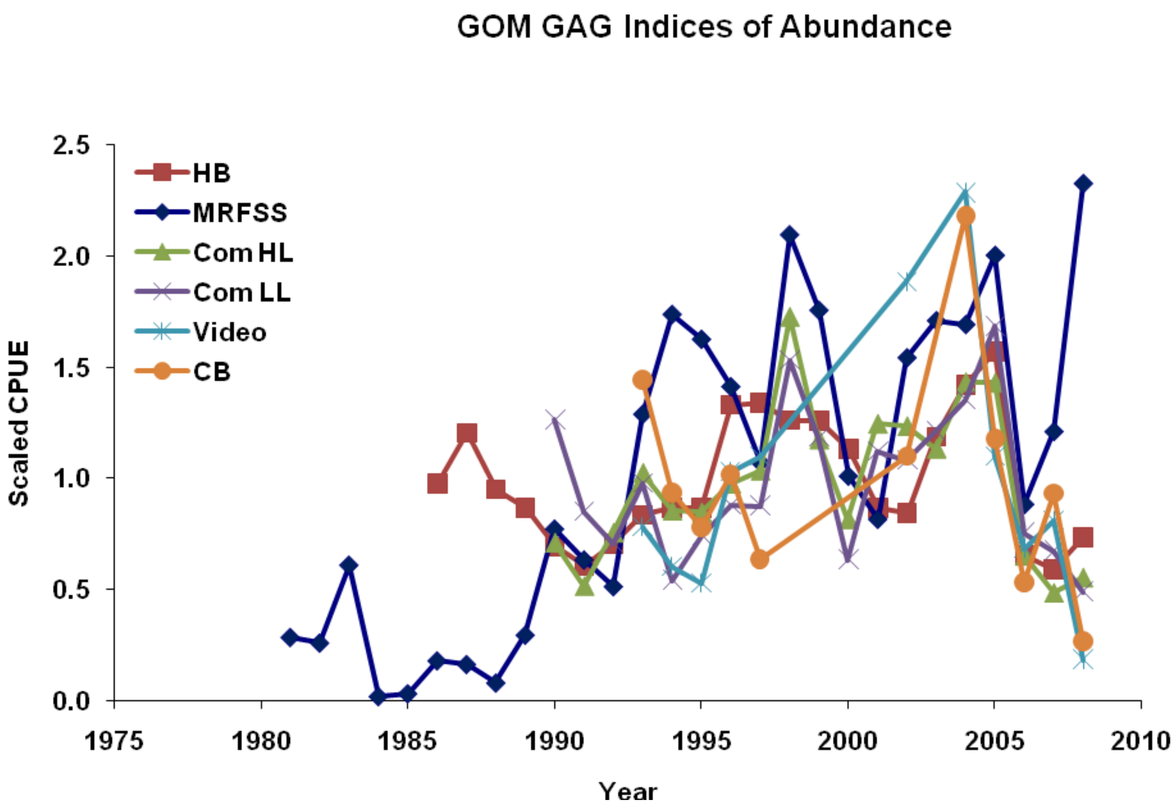


Figure 8.1. Central model fits to indices of abundance: age-0 (Age0CPUE), SEAMAP copper-belly video (CopperBCPUE), 1990-1999 handline (HandlineCPUE2), 2000-2008 handline (HandlineCPUE3), 1986-1989 headboat (HeadboatCPUE1), 1990-1999 headboat (HeadboatCPUE2), 2000-2008 headboat (HeadboatCPUE3), 1990-1999 longline (LonglineCPUE2), 2000-2008 longline (LonglineCPUE3), MRFSS (MRFSSCPUE), and SEAMAP video (VideoCPUE). Lefthand panels depict observed (blue points) and predicted (red line) CPUE. Righthand panels depict normalized residuals (blue bars).

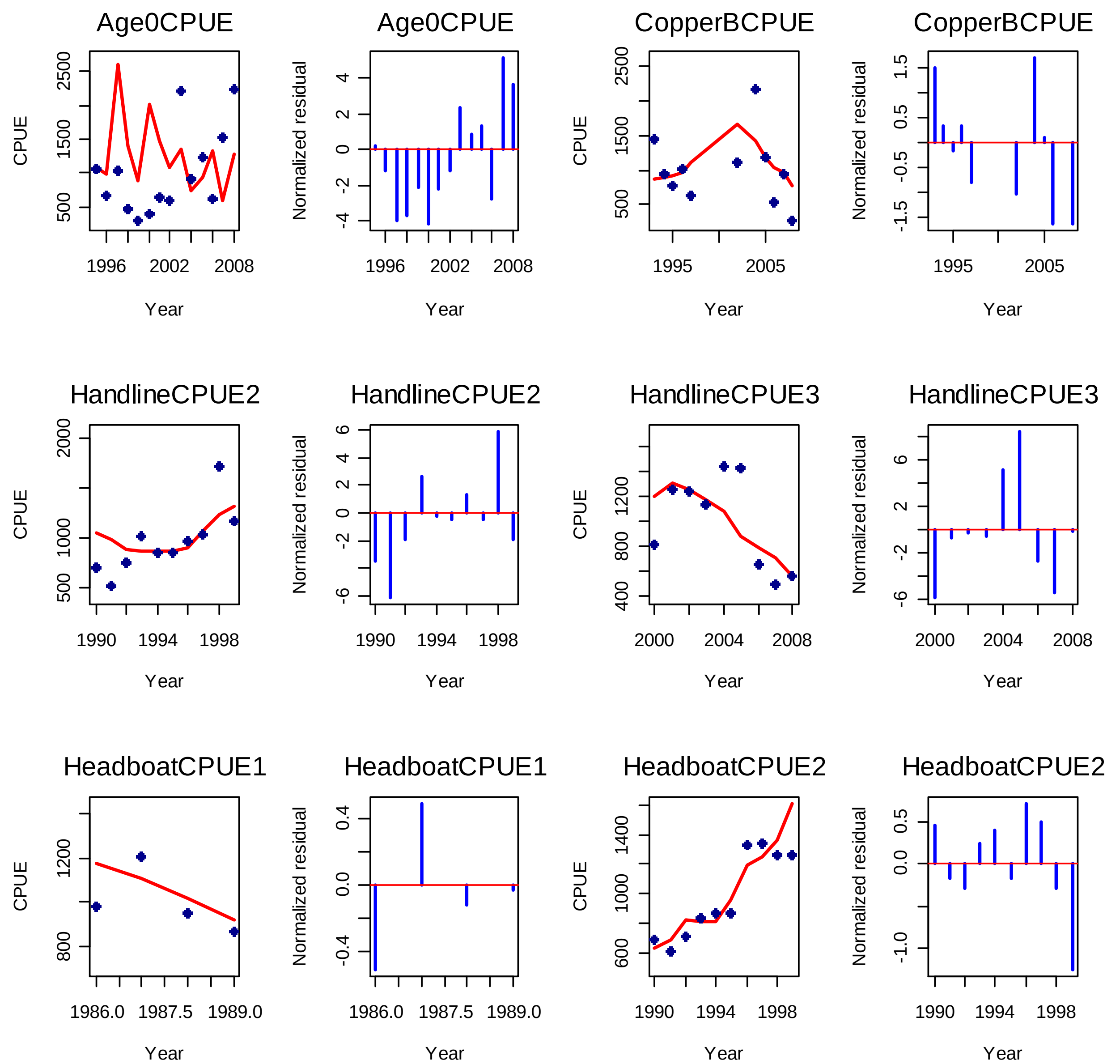


Figure 8.1. Continued.

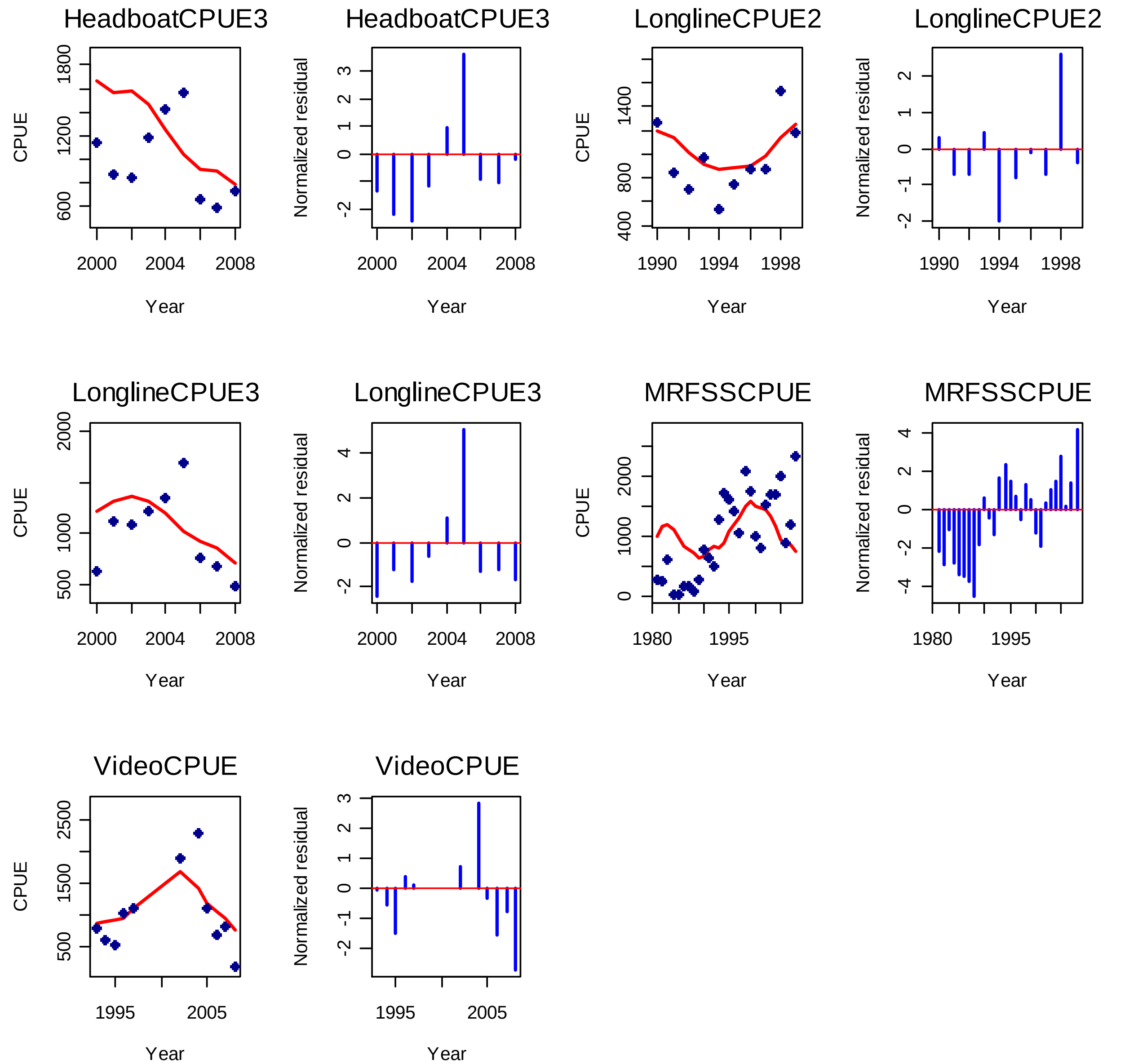


Figure 8.2. Central model fits to catch at age: 1984-1989 handline (Handline1CAA), 1990-1999 handline (Handline2CAA), 2000-2008 handline (Handline3CAA), 1986-1989 headboat (Headboat1CAA), 1990-1999 headboat (Headboat2CAA), 2000-2008 headboat (Headboat3CAA), 1984-1989 longline (Longline1CAA), 1990-1999 longline (Longline2CAA), 2000-2008 longline (Longline3CAA), MRFSS (MRFSSCAA), and other commercial (OthersCAA). Lefthand panels depict predicted catch at age. Righthand panels depict positive (red circle) and negative (light blue circle) residuals.

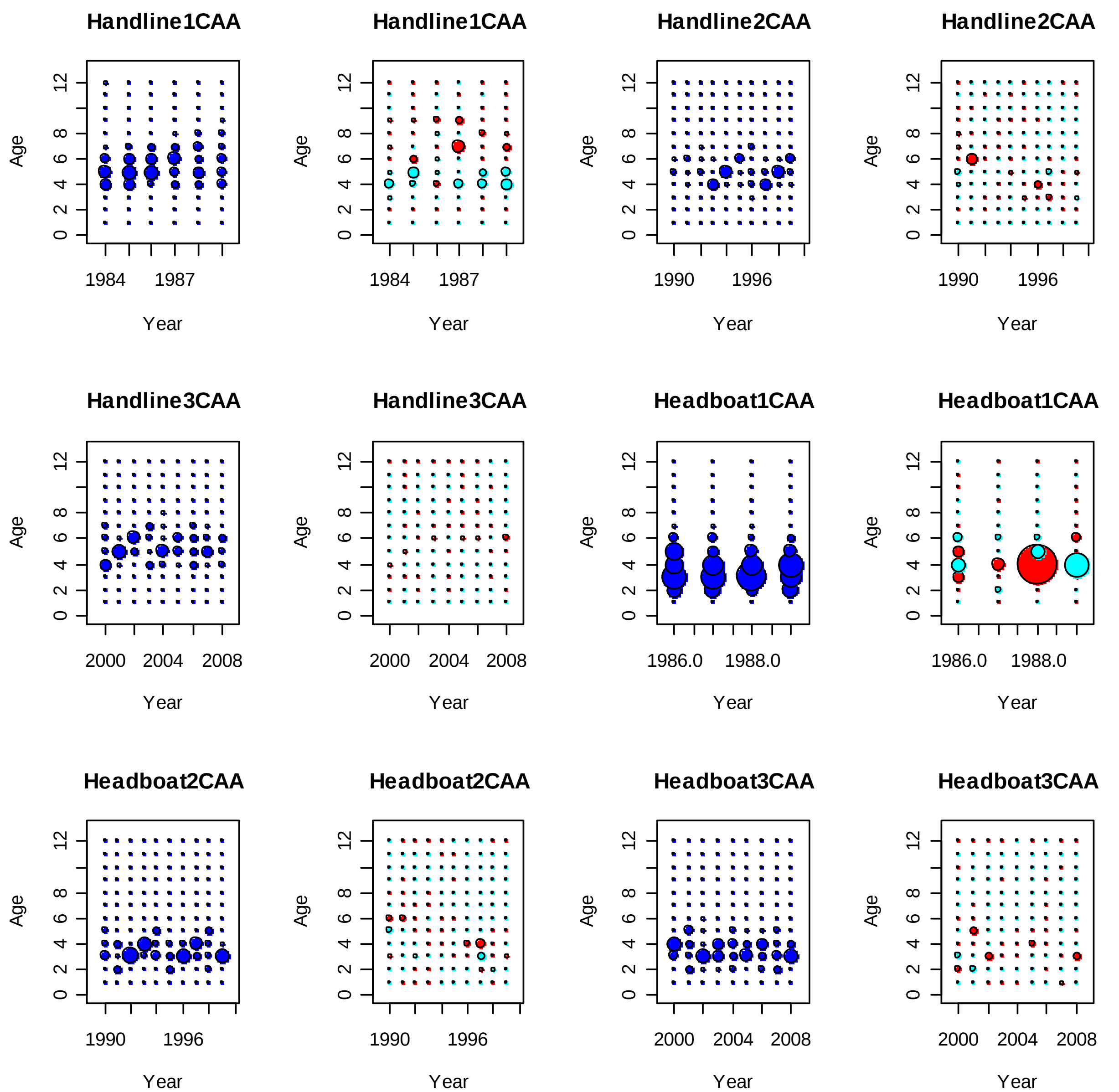


Figure 8.2. Continued

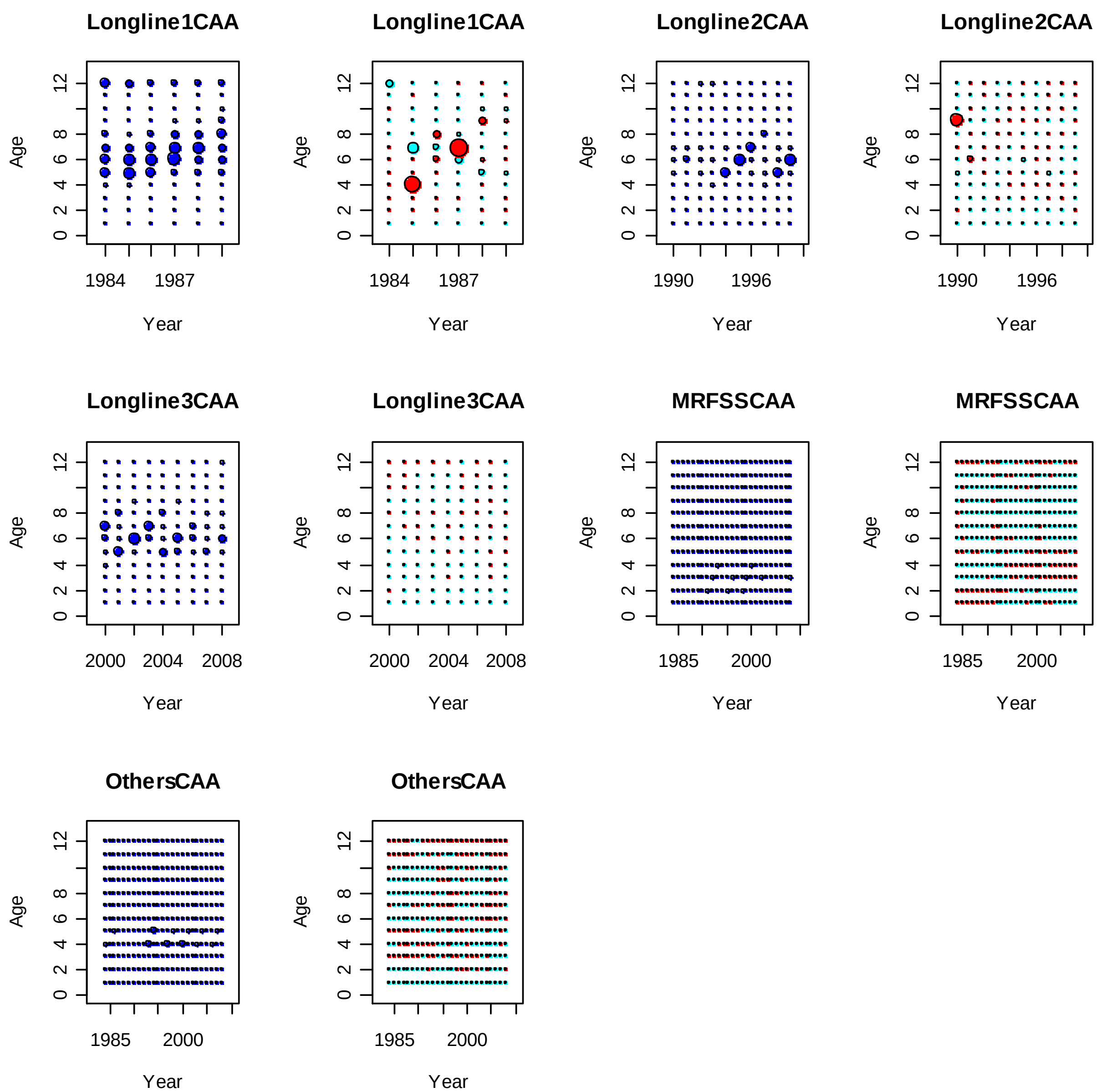


Figure 8.3. Red tide model fits to indices of abundance: age-0 (Age0CPUE), SEAMAP copper-belly video (CopperBCPUE), 1990-1999 handline (HandlineCPUE2), 2000-2008 handline (HandlineCPUE3), 1986-1989 headboat (HeadboatCPUE1), 1990-1999 headboat (HeadboatCPUE2), 2000-2008 headboat (HeadboatCPUE3), 1990-1999 longline (LonglineCPUE2), 2000-2008 longline (LonglineCPUE3), MRFSS (MRFSSCPUE), and SEAMAP video (VideoCPUE). Lefthand panels depict observed (blue points) and predicted (red line) CPUE. Righthand panels depict normalized residuals (blue bars).

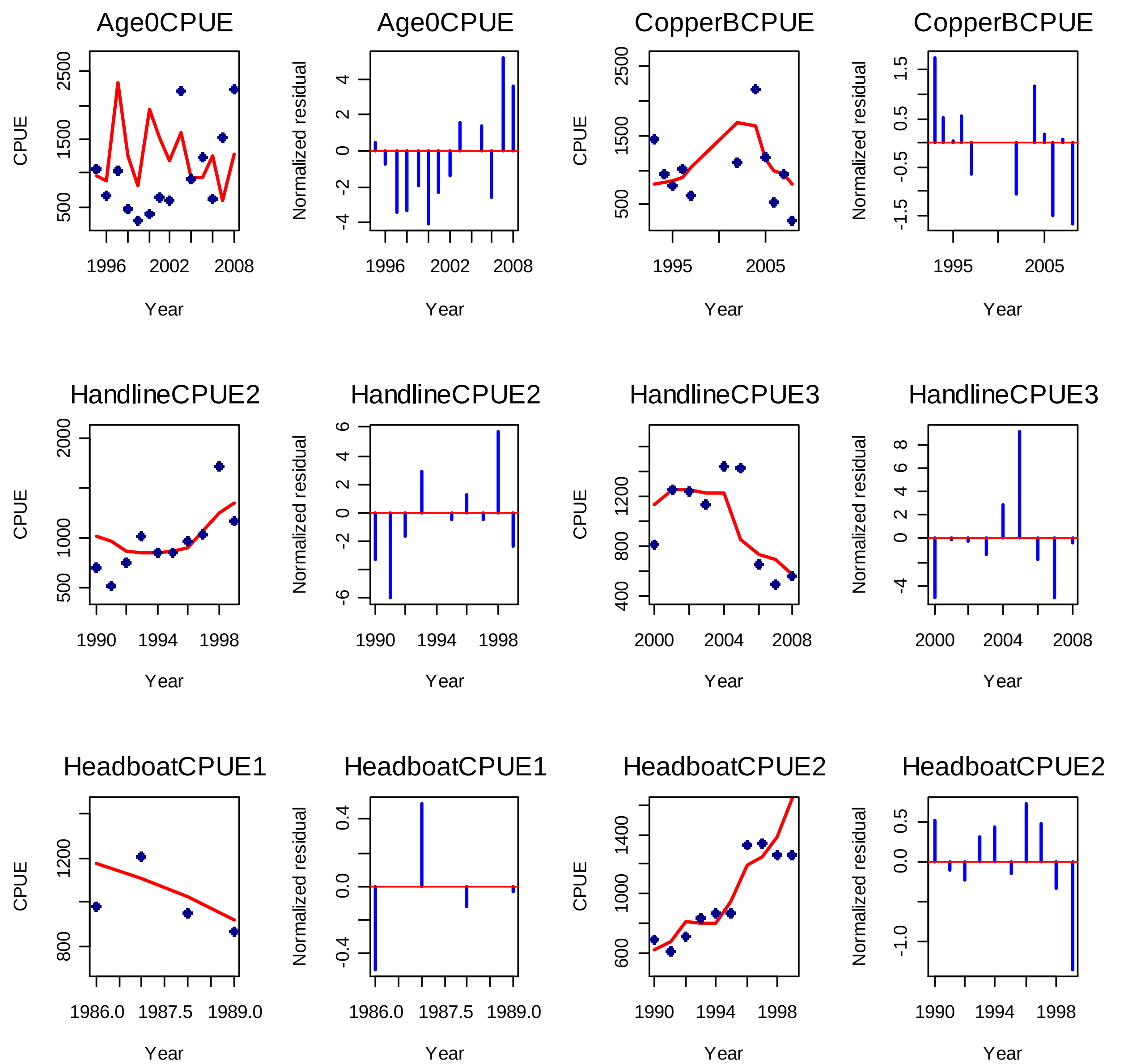


Figure 8.3. Continued.

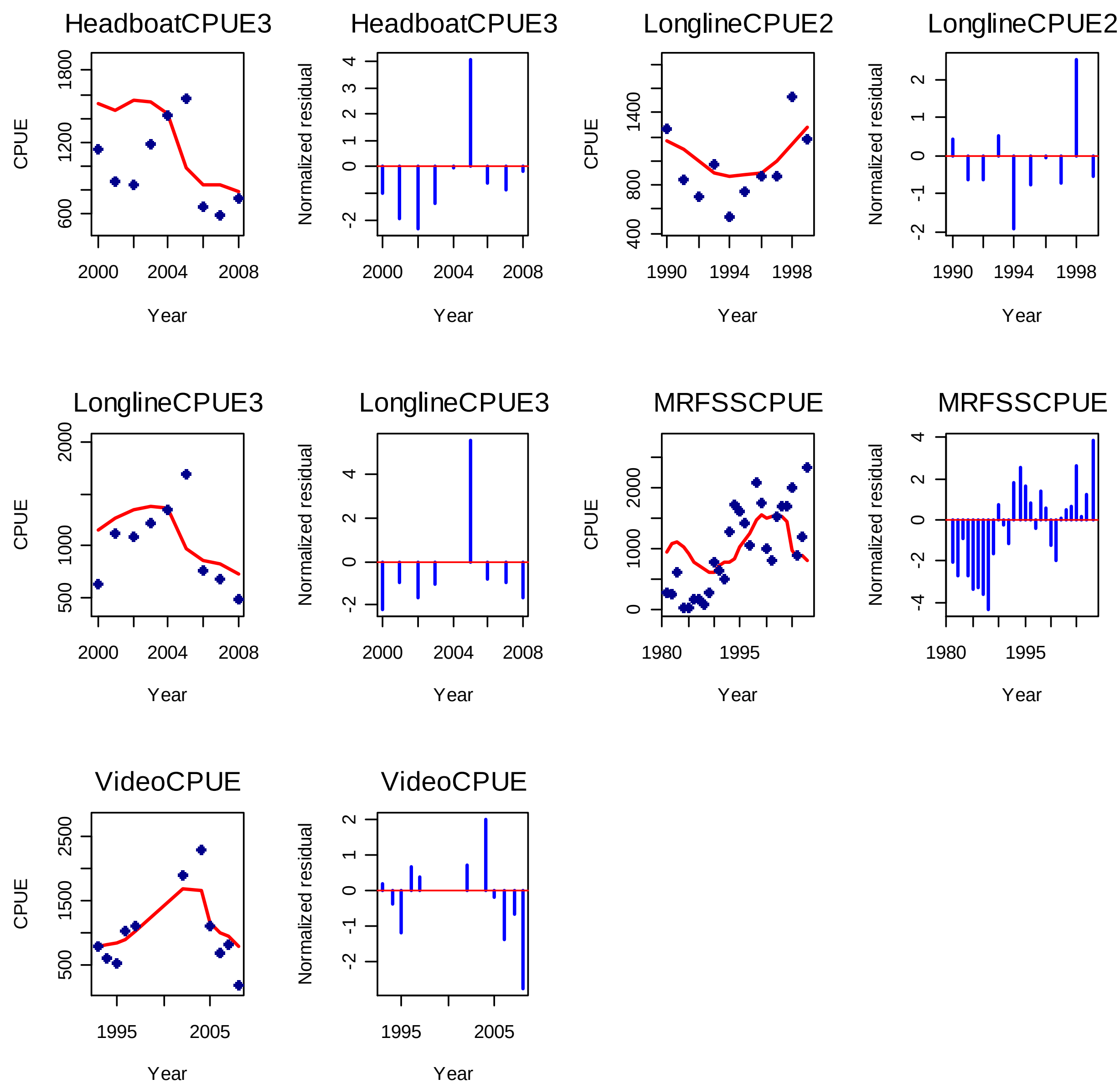


Figure 8.4. Red tide model fits to catch at age: 1984-1989 handline (Handline1CAA), 1990-1999 handline (Handline2CAA), 2000-2008 handline (Handline3CAA), 1986-1989 headboat (Headboat1CAA), 1990-1999 headboat (Headboat2CAA), 2000-2008 headboat (Headboat3CAA), 1984-1989 longline (Longline1CAA), 1990-1999 longline (Longline2CAA), 2000-2008 longline (Longline3CAA), MRFSS (MRFSSCAA), and other commercial (OthersCAA). Lefthand panels depict predicted catch at age. Righthand panels depict positive (red circle) and negative (light blue circle) residuals.

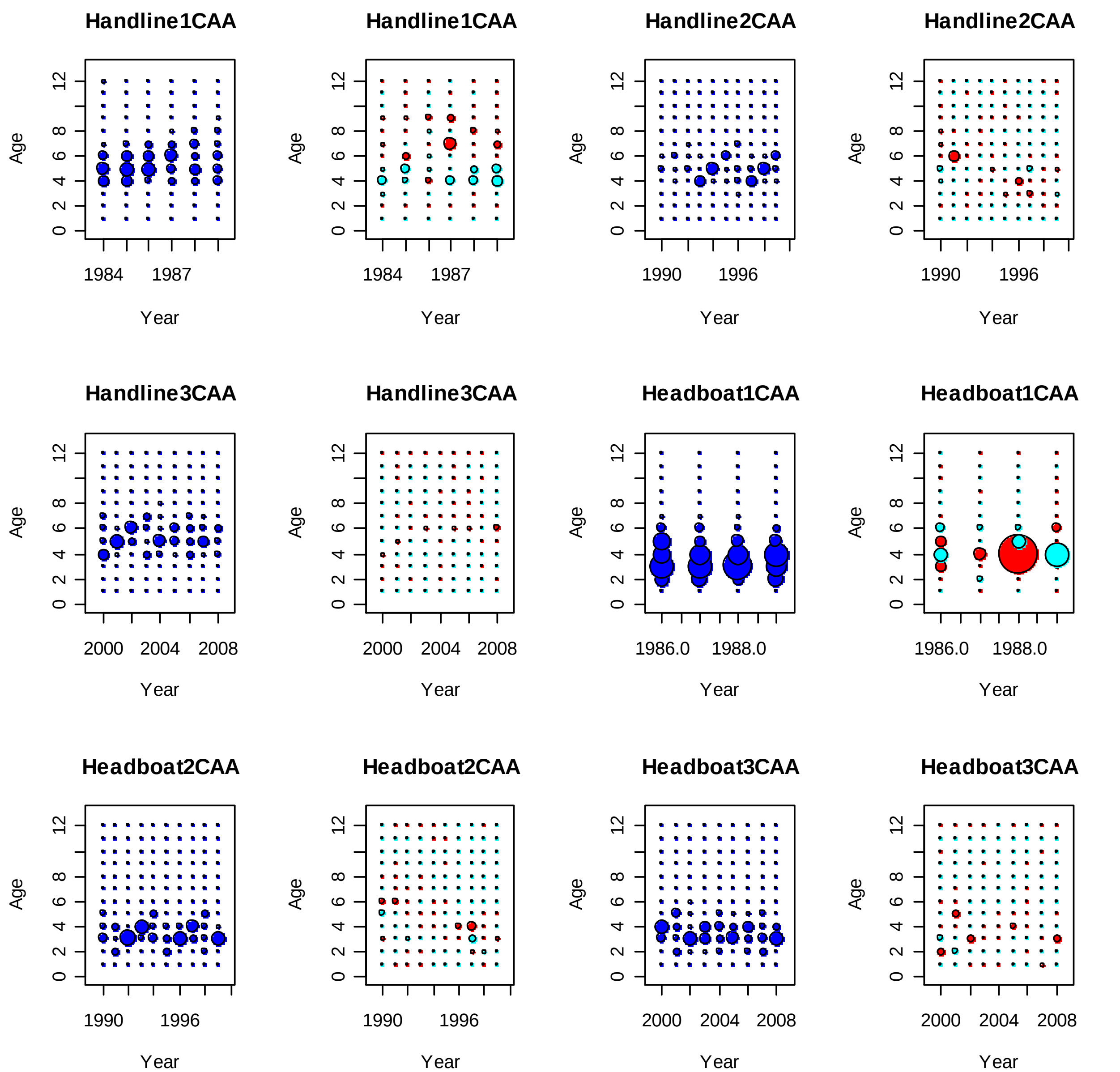


Figure 8.4. Continued.

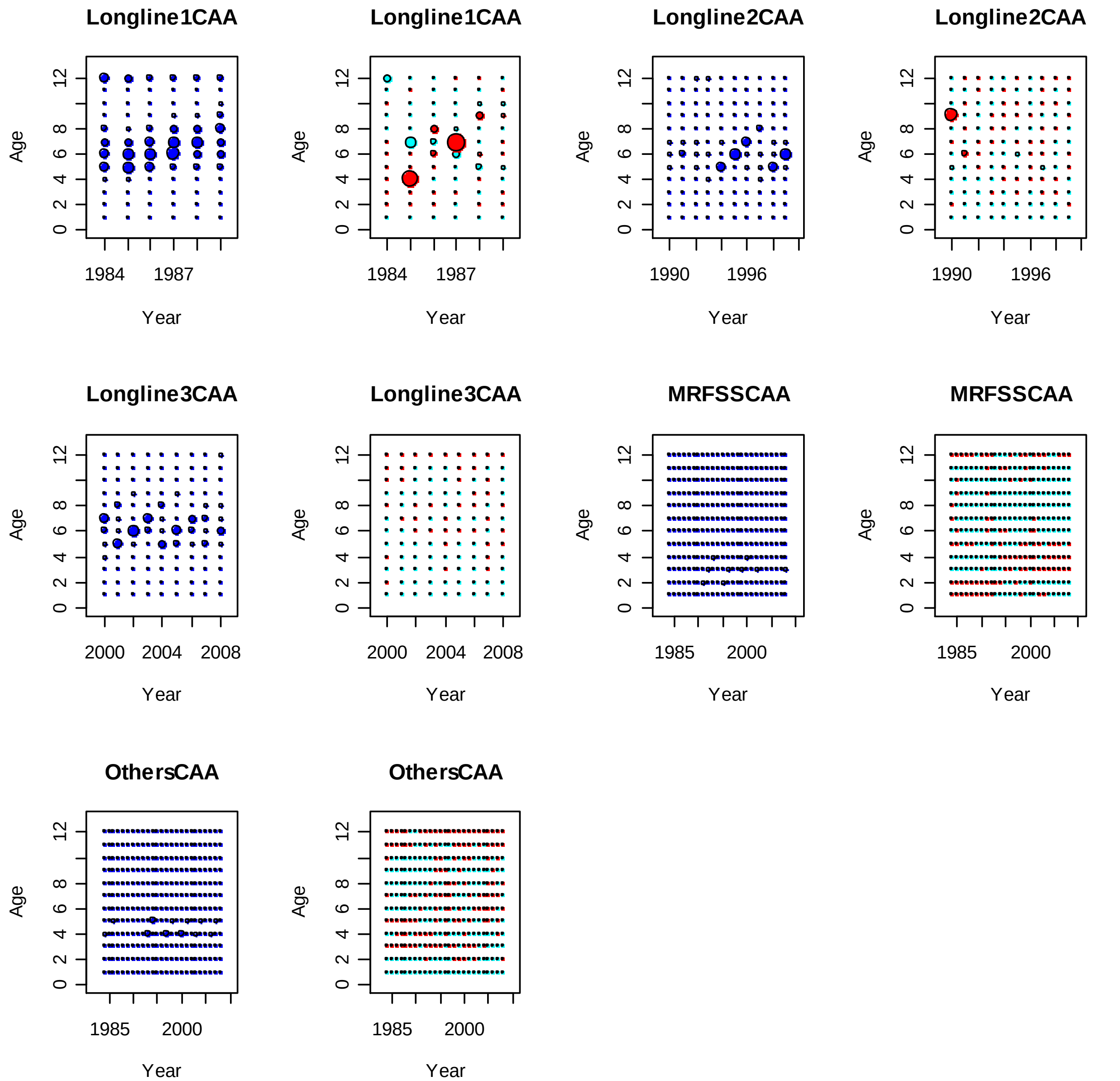


Figure 8.5. Central model estimated selectivity at age.

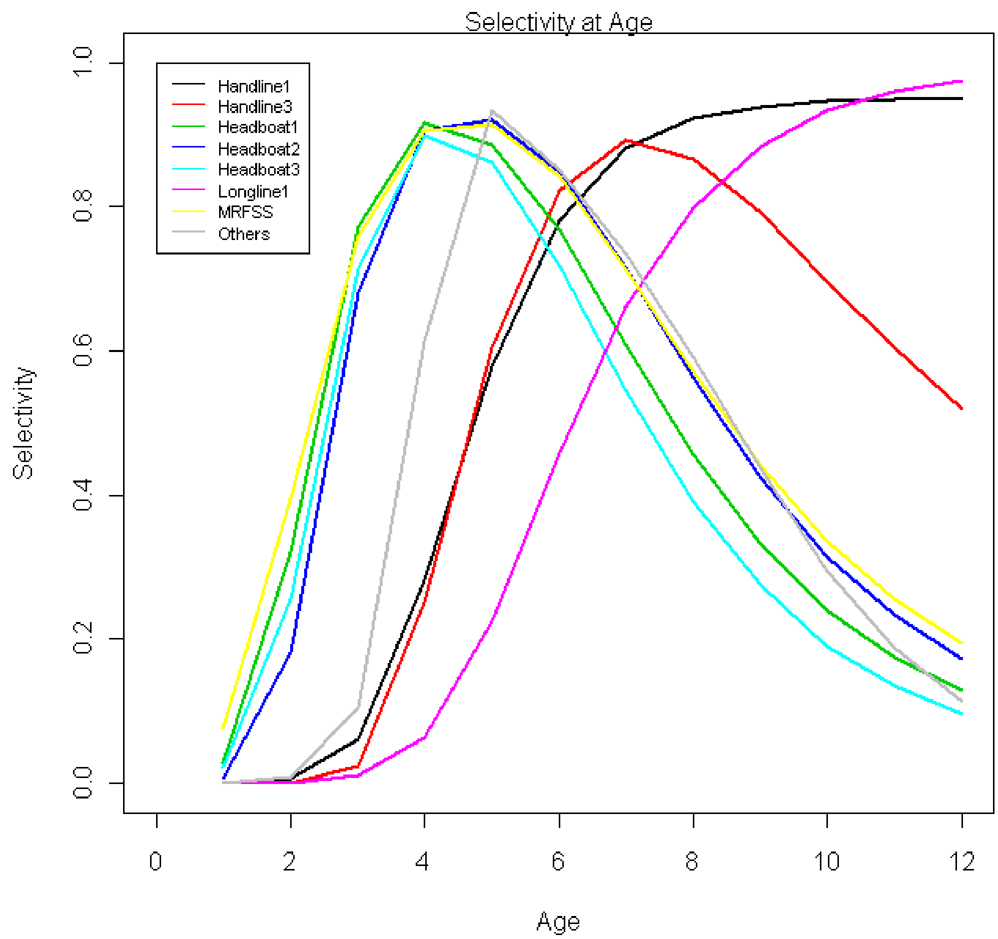


Figure 8.6. Estimated apical fishing mortality rates.

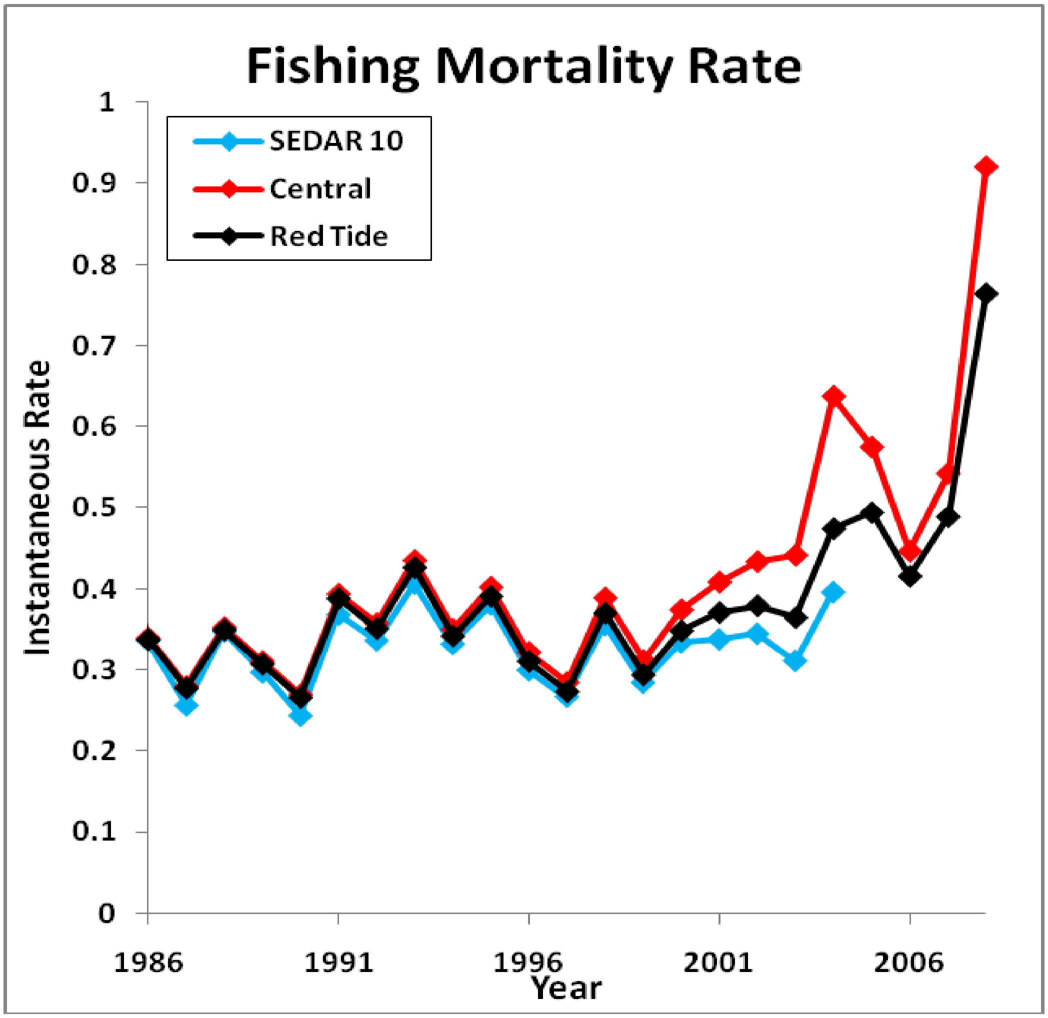


Figure 8.7. Total stock biomass estimates at start of year, before recruitment or mortality occur. Biomass units are thousand pounds, gutted weight.

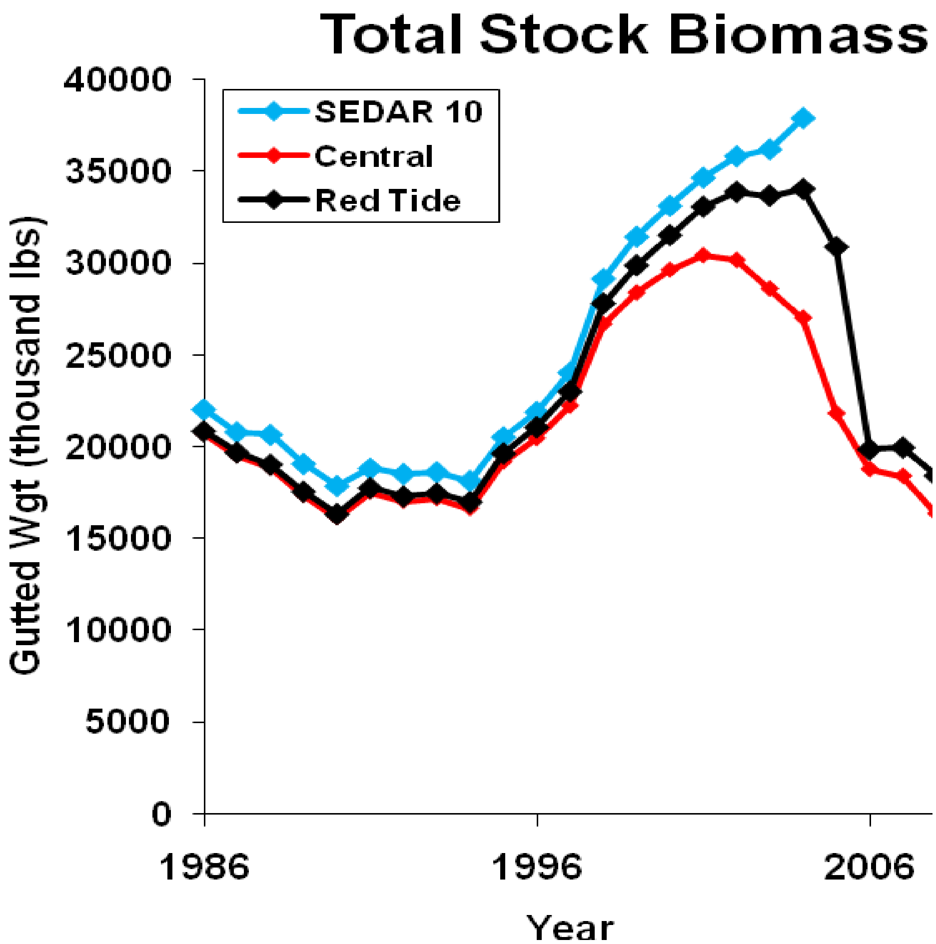


Figure 8.8. Spawning stock biomass estimates. Biomass units are thousand pounds, gutted weight.

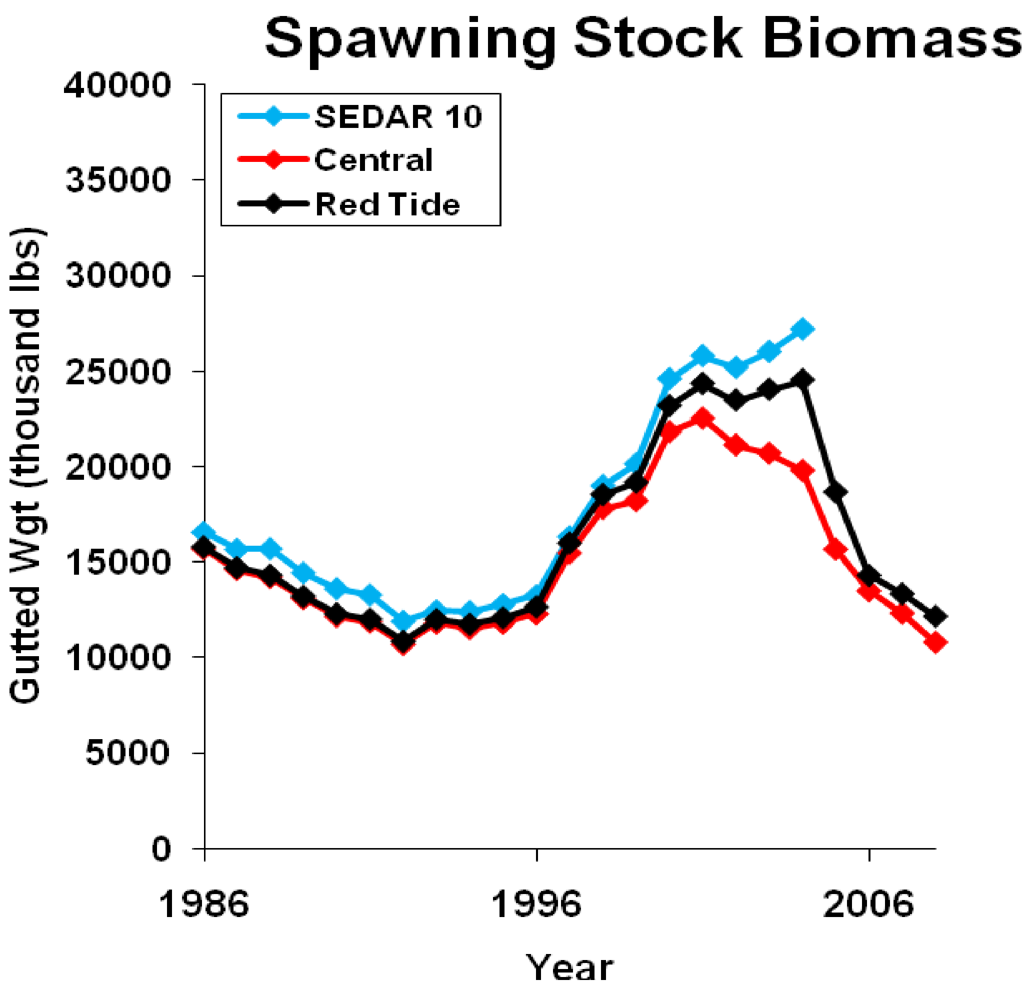


Figure 8.9. Central model estimates of spawners and recruits (blue points) from 1986-2008 and the Beverton-Holt stock-recruitment function (red line). Units for recruits is numbers of fish. Units for spawning biomass is metric tons.

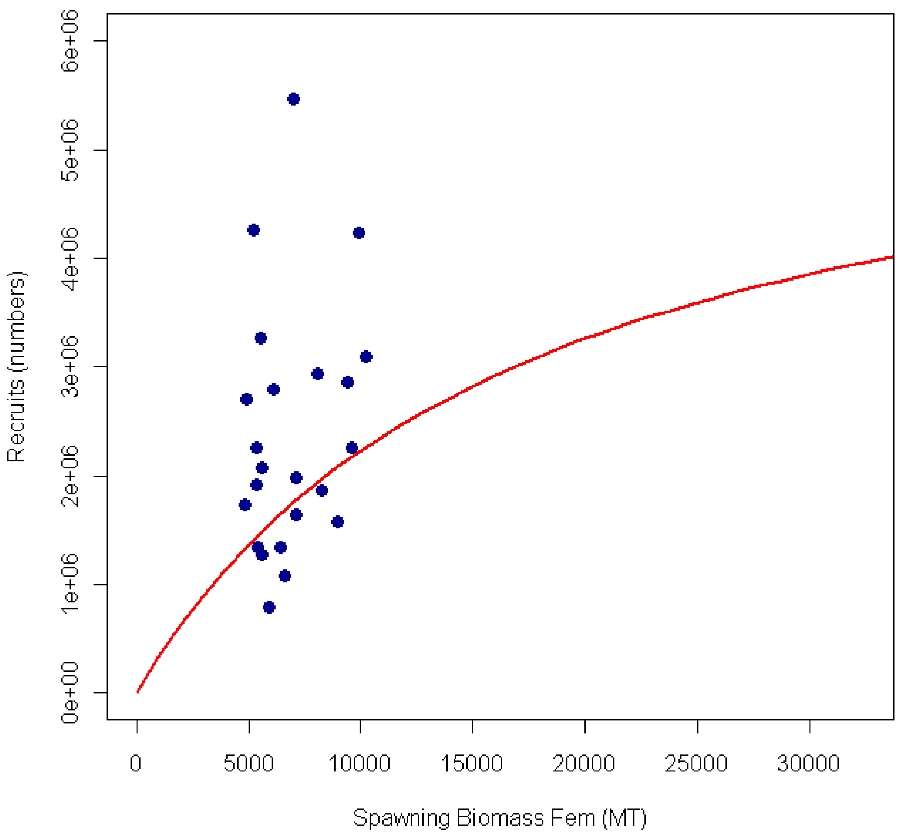


Figure 9.1. Central model trends in F and SSB relative to corresponding benchmarks.

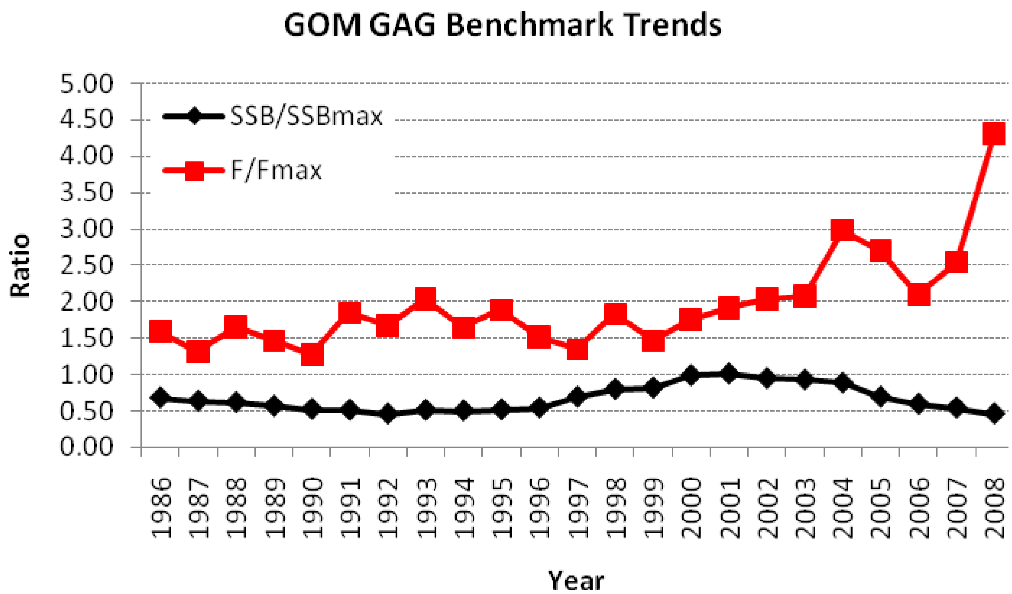


Figure 9.2. Red tide model trends in F and SSB relative to corresponding benchmarks.

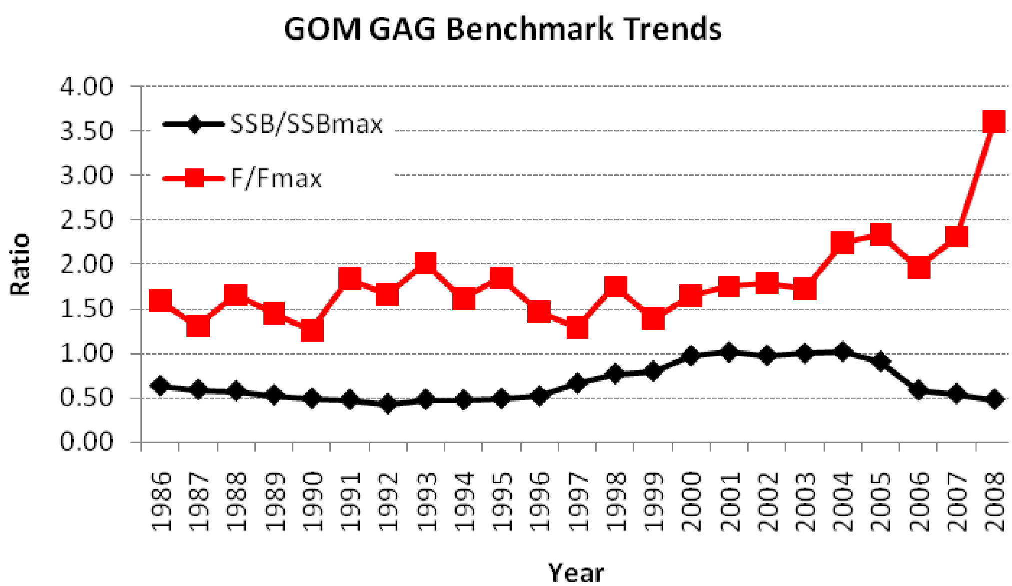


Figure 9.3. Red tide increasing catchability model trends in F and SSB relative to corresponding benchmarks.

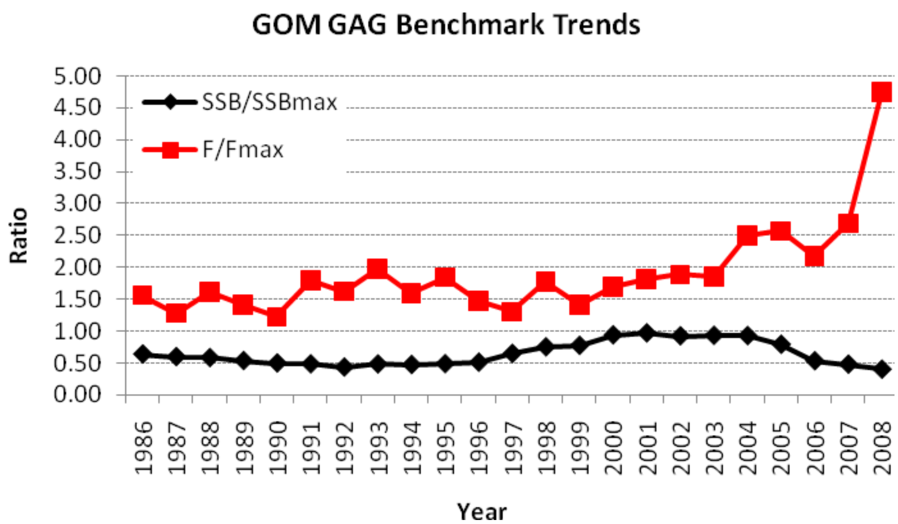


Figure 10.1. Projection results from six fixed F management scenarios for the central model. $F_{REBUILD}$ to SSB_{MAX} is 0.19, and $F_{REBUILD}$ to SSB_{OY} is 0.14.

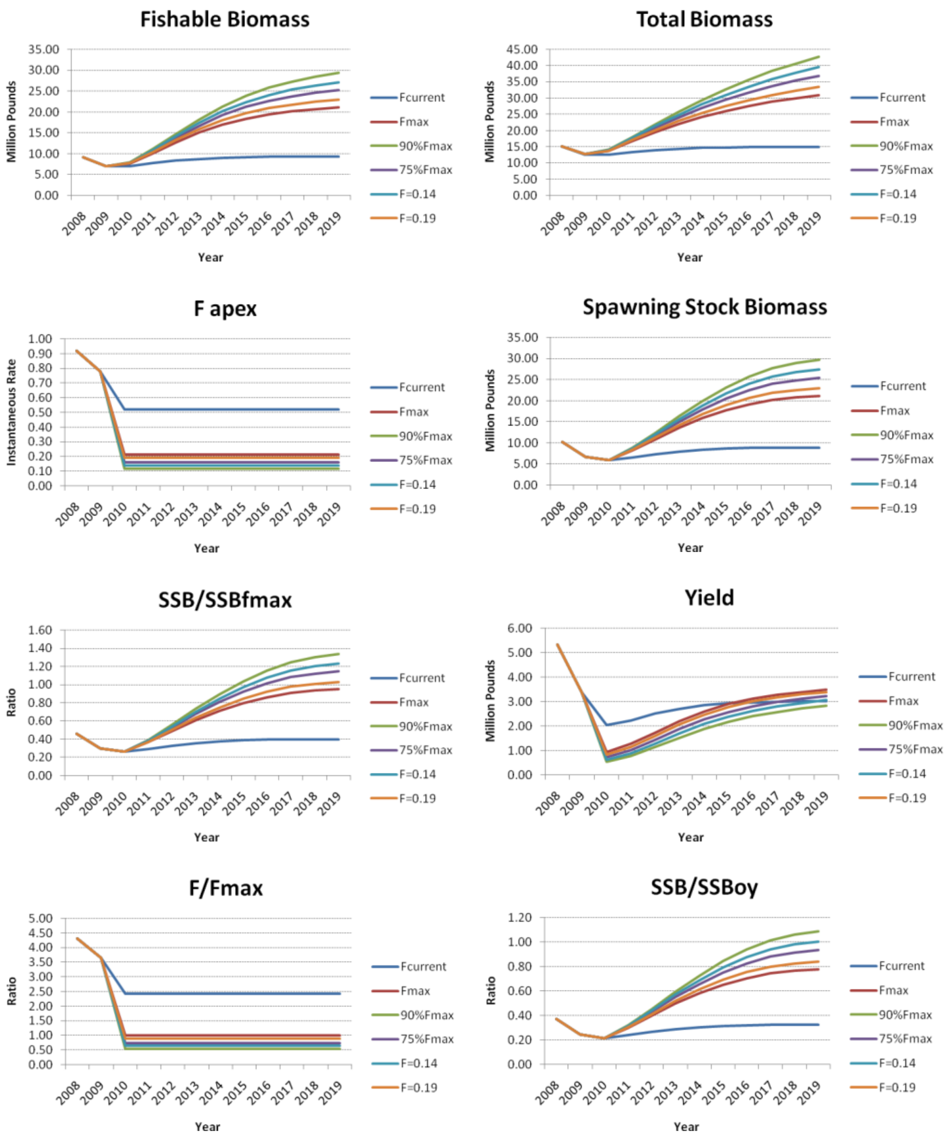


Figure 10.2. Projection results from six fixed F management scenarios for the red tide model. $F_{REBUILD}$ to SSB_{MAX} is 0.19, and $F_{REBUILD}$ to SSB_{OY} is 0.14.

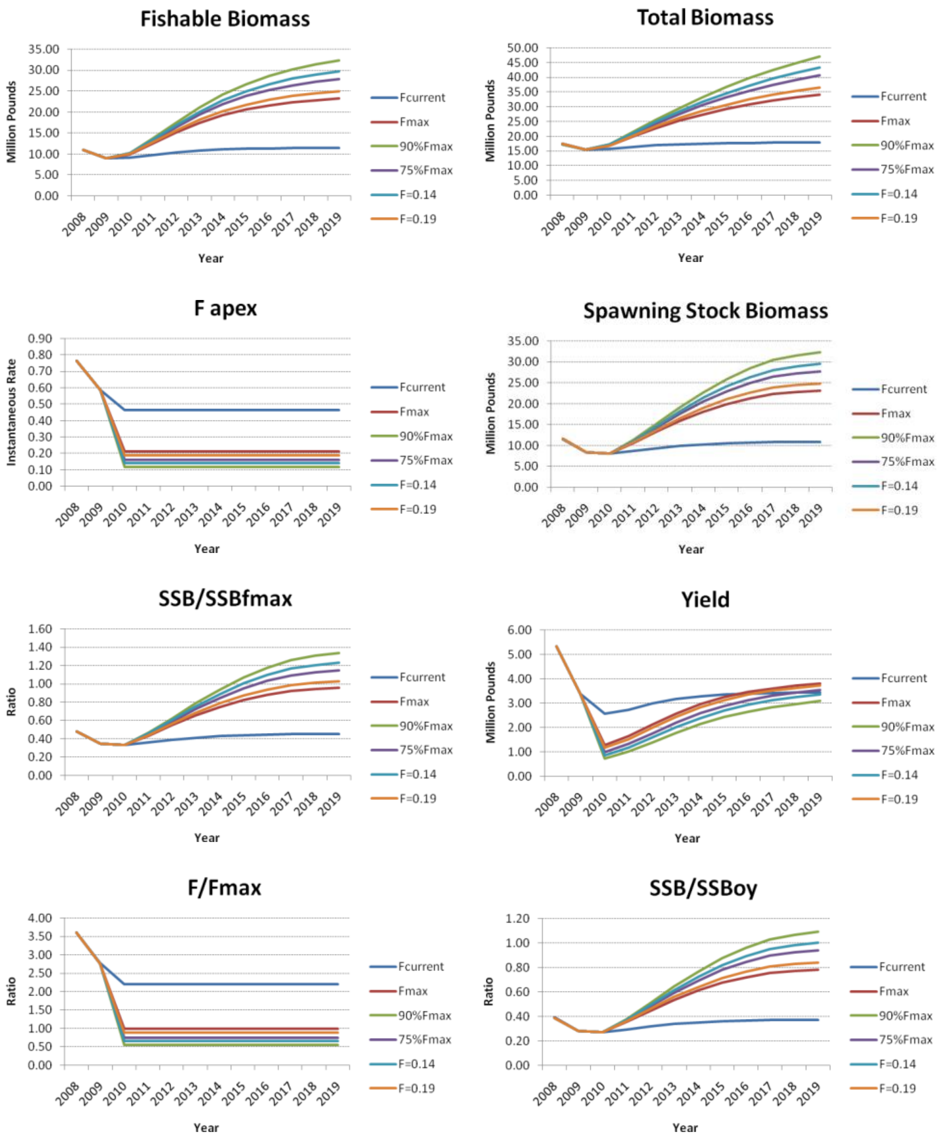
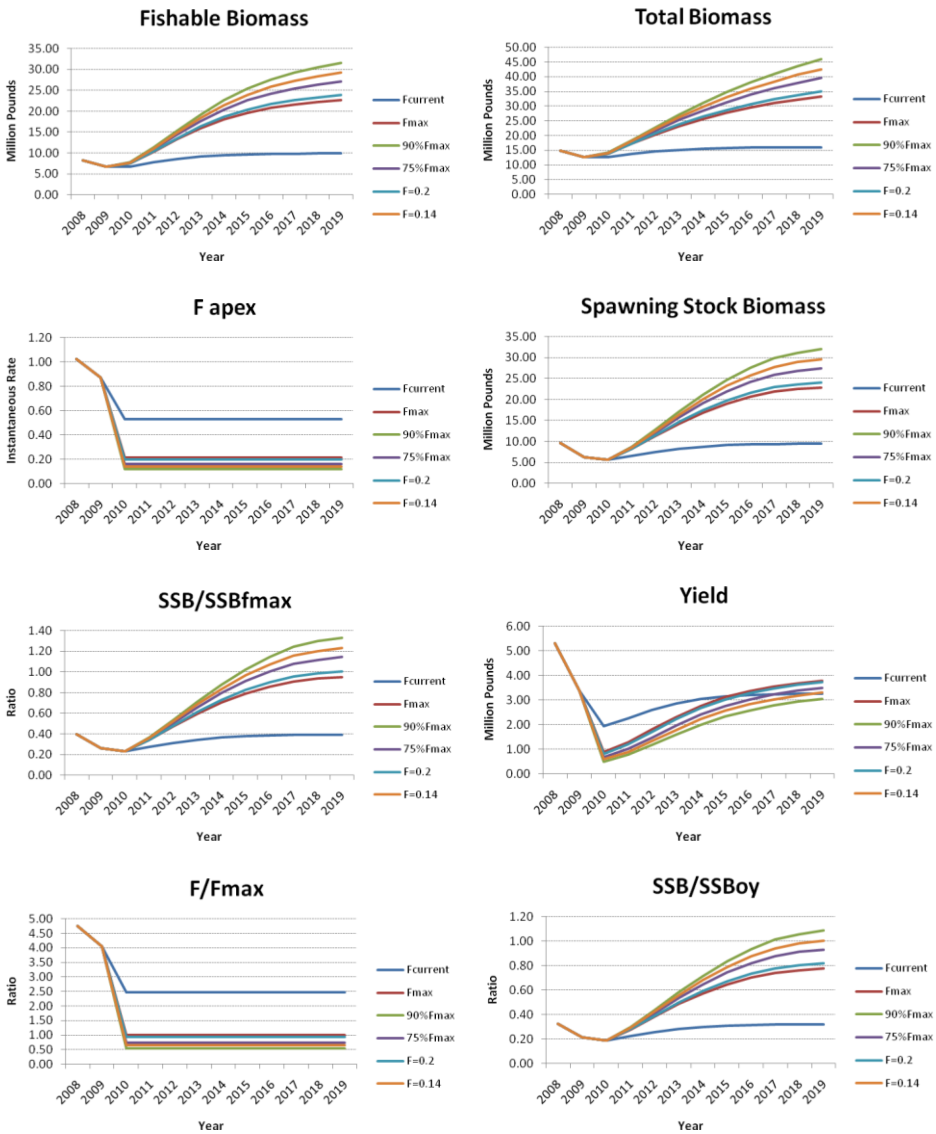


Figure 10.3. Projection results from six fixed F management scenarios for the red tide increasing catchability model. $F_{REBUILD}$ to SSB_{MAX} is 0.20, and $F_{REBUILD}$ to SSB_{OY} is 0.14.



Appendix A: CASAL input files for central model

Central model population file

```
# SETTING THE INITIAL STAGE
#INITIALIZATION (the starting value for B0 is set as 10000 t)
@initialization
B0  100000      # Initial guess for B0
Binitial 75000        # Biomass at start (1963) with reference to B0, ie 50%

# PARTITION
@size_based FALSE       # Define the model as age-based
@min_age 1       # Min age
@max_age 12       # The partition keeps account of fish aged 1-12
@plus_group TRUE       # and excludes all fish over the age of 12
@sex_partition FALSE       # The model is NOT sex-based
@mature_partition FALSE       # Maturity is excluded from the partition
@n_areas 1       # Only a single fishing area is defined
@area_names GOM       # with the (optional in a single area model) label GOM
@n_stocks 1       # This is a single stock model
@stock_names GAGGOM       # and the stock has the (optional in a single stock model) name GAGGOM

# TIME SEQUENCE
@initial 1963       # The model is defined to run from 1963
@current 2008       # to the current year, 2008
@final 2014       # Projections are run up to the year 2014

@annual_cycle
time_steps 3       # There are three time steps: Jan, Feb , Mar-Dec
recruitment_time 3       # Recruitment occurs in time step 3
recruitment_areas GOM       # in the area GOM (the only area defined)
spawning_time 2       # Spawning occurs in time step 2
spawning_part_mort 0.5       # and SSBs are calculated after spawning fish have undergone 0.5 of the
mortality assigned to this time step
spawning_areas GOM       # Spawning occurs in the area GOM
spawning_ps 1       # and all mature fish spawn
aging_time 1       # Age incrementation occurs in time step 1
growth_props 0 0.167 0.5     # proportion  of growth that occurs at each time step, so in step 3 mean
wgt of 2 yr fish is estimated as Xwgt of 2.5
```

```
M_props 0.083 0.167 0.75     # Natural mortality:1 month, 2 month, rest of year. Zum=1
baranov FALSE       # Use Pope.s approximation
midmortality_partition weighted_sum
fishery_names Headboat1 Headboat2 Headboat3 Handline1 Handline2 Handline3 Longline1 Longline2
Longline3 MRFSS Others  # Fishery(ies) and names
fishery_times 3 3 3 3 3 3 3 3 3 3 3  # and occurs in the ith time step (see above time_steps)
fishery_areas GOM       # in the area labelled GOM
n_migrations       0       # No migrations are defined

# RECRUITMENT
@y_enter 1       # Recruits enter at age 1
@standardise_YCS TRUE       # Use the Haist parameterisation of YCS
@recruitment                # the two following lines define the starting values for recruitment for
the years 1962-2007
YCS_years 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
2000 2001 2002 2003 2004 2005 2006 2007
YCS 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
first_free 1962       # with standardisation occurring over the years
last_free 2007       # 1962-2007
p_male 0.5       # Not use because is not a sex-based model
sigma_r 0.6       # Standard deviation of YCS for projections
SR BH       # Use the Beverton-Holt stock-recruit relationship
steepness 0.6       # with a steepness parameter of 0.6

# RECRUITMENT VARIABILITY
@randomisation_method lognormal       # Use the lognormal distribution when assigning YCS to unknown
years during projections
@first_random_year 2008       # Defines the first unknown YCS as 2008

#MATURATION
@maturity_props          # maturity female proportion  at Age block command when maturity is NOT a
partition character
all allvalues 0 0 0.168088509 0.72844989 0.949653936 1 0.997067985 0.965750374 0.907278972 0.819894879
0.706144695 0.575246202

# NATURAL MORTALITY
@natural_mortality
```

```
ogive_all allvalues 0.48345646 0.344857366 0.276973935 0.236894252 0.210618618 0.192203152 0.178688754
0.168434369 0.160455642 0.154125772 0.14902639 0.134358941


# FISHERIES DEFINITIONS
@fishery Headboat1       # Define the catch from the Headboat for years 1986-1989  Enter values in MT
using the depth matrix discards!
years  1986 1987 1988 1989
catches 123.691 81.898 64.525 131.037
selectivity HeadboatSel1       # Defines that the catch is removed from the population using the
selectivity defined by the label HeadboatSel1
U_max 0.9       # with a maximum possible exploitation rate of 1.0

@fishery Headboat2       # Define the catch from the Headboat for years 1990-1999  Enter values in MT
using the depth matrix discards!
years  1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
catches 91.557 47.622 54.868 77.465 83.166 57.754 51.933 44.398 111.404 90.409
selectivity HeadboatSel2       # Defines that the catch is removed from the population using the
selectivity defined by the label HeadboatSel2
U_max 0.9       # with a maximum possible exploitation rate of 1.0

@fishery Headboat3       # Define the catch from the Headboat for years 2000-2008  Enter values in MT
using the depth matrix discards!
years  2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 92.729 55.172 38.679 59.684 84.094 59.985 24.366 41.051 58.067
selectivity HeadboatSel3       # Defines that the catch is removed from the population using the
selectivity defined by the label HeadboatSel3
U_max 0.9       # with a maximum possible exploitation rate of 1.0
future_years 2009 2010 2011 2012 2013 2014  # Defines the future years and
future_catches 0 0 0 0 0 0


@fishery Handline1       # Define the catch from the Handline for years 1963-1989
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981
1982 1983 1984 1985 1986 1987 1988 1989
catches 581.952 736.217 816.063 651.401 510.785 529.298 608.599 568.517 612.213 650.686 481.352
526.244 644.052 520.314 433.662 387.146 599.716 589.578 671.627 598.173 462.857 490.228 627.964
523.249 381.117 355.215 554.944
```

```
selectivity HandlineSel1       # Defines that the catch is removed from the population using the
selectivity defined by the label HandlineSel1
U_max 0.9       # with a maximum possible exploitation rate of 1.0

@fishery Handline2       # Define the catch from the Handline for years 1990-1999
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
catches 508.716 449.033 450.039 579.416 519.811 524.096 499.357 497.363 834.334 664.408
selectivity HandlineSel1       # Defines that the catch is removed from the population using the
selectivity defined by the label HandlineSel2
U_max 0.9       # with a maximum possible exploitation rate of 1.0

@fishery Handline3       # Define the catch from the Handline for years 2000-2008
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 724.128 938.966 859.998 656.085 789.747 701.293 365.001 339.297 395.366
selectivity HandlineSel3       # Defines that the catch is removed from the population using the
selectivity defined by the label HandlineSel3
U_max 0.9       # with a maximum possible exploitation rate of 1.0
future_years 2009 2010 2011 2012 2013 2014  # Defines the future years and
future_catches  0 0 0 0 0 0  # catches for use in projections


@fishery Longline1       # Define the catch from the Longline for years 1980-1989
years 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989
catches 40.013 209.812 454.083 305.539 191.433 167.917 231.290 295.402 182.261 190.634
selectivity LonglineSel1       # Defines that the catch is removed from the population using the
selectivity defined by the label LonglineSel1
U_max 0.9       # with a maximum possible exploitation rate of 0.9

@fishery Longline2       # Define the catch from the Longline for years 1990-1999
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
catches 280.067 228.814 267.708 216.605 158.685 176.439 177.507 186.771 267.095 242.897
selectivity LonglineSel1       # Defines that the catch is removed from the population using the
selectivity defined by the label LonglineSel2
U_max 0.9       # with a maximum possible exploitation rate of 0.9

@fishery Longline3       # Define the catch from the Longline for years 2000-2008
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 262.379 440.029 474.859 508.261 511.502 407.883 240.346 219.051 158.442
```

```
selectivity LonglineSel1       # Defines that the catch is removed from the population using the
selectivity defined by the label LonglineSel3
U_max 0.9       # with a maximum possible exploitation rate of 0.9
future_years 2009 2010 2011 2012 2013 2014  # Defines the future years and
future_catches  0 0 0 0 0 0  # catches for use in projections

@fishery MRFSS       # Define the catch from the recreational for years 1963-2008
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981
1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
2002 2003 2004 2005 2006 2007 2008
catches 188.512 203.608 219.914 237.525 256.547 277.092 294.777 313.444 352.572 396.564 445.846
501.302 563.471 634.560 714.671 805.934 908.297 1020.282 784.815 1366.964 2803.758 828.175 2930.620
1407.599 1060.154 1514.286 852.498 522.163 1267.570 1025.351 1260.617 971.398 1400.619 1182.003
1232.381 1752.163 1728.842 2344.504 2215.532 2473.314 2554.380 3321.618 2301.630 1853.696 2176.511
3003.920
selectivity MRFSSSel       # Defines that the catch is removed from the population using the
selectivity defined by the label MRFSSSel
U_max 0.9       # with a maximum possible exploitation rate of 0.9
future_years 2009 2010 2011 2012 2013 2014  # Defines the future years and
future_catches 0 0 0 0 0 0  # catches for use in projections

@fishery Others       # Define the catch from the Others for years 1963-2008
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981
1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
2002 2003 2004 2005 2006 2007 2008
catches 0.548 4.120 0.237 0.478 3.780 1.762 1.433 1.030 1.162 1.801 2.232 0.617 1.916 0.326 2.823
3.888 3.048 4.460 5.637 5.736 7.840 7.190 10.815 11.758 11.419 9.228 11.846 16.406 25.799 27.864
46.562 53.104 46.748 29.756 36.945 36.794 29.483 39.239 45.339 28.013 29.571 32.969 31.307 25.050
20.399 19.283
selectivity OthersSel       # Defines that the catch is removed from the population using the
selectivity defined by the label OthersSel
U_max 0.9       # with a maximum possible exploitation rate of 0.9
future_years 2009 2010 2011 2012 2013 2014  # Defines the future years and
future_catches 0 0 0 0 0 0  # catches for use in projections


# SELECTIVITIES DEFINITIONS
@selectivity_names HeadboatSel1 HeadboatSel2 HeadboatSel3 HandlineSel1 HandlineSel3 LonglineSel1
MRFSSSel OthersSel Age0Sel
```

```
@selectivity HeadboatSel1       # Headboat1 size base
all size_based double_logistic 47.1744 11.7171 42.6078 19.9973 0.950034
@selectivity HeadboatSel2       # Headboat2 size base
all size_based double_logistic 50 10.4419 49.6964 19.7737 0.950226
@selectivity HeadboatSel3       # Headboat3 size base
all size_based double_logistic 49.3863 13.1339 41.0593 19.3723 0.950098
@selectivity HandlineSel1       # Handline1 size base
all size_based double_logistic 69.9999 15.9305 127.757 9.25621 0.951902
@selectivity HandlineSel3       # Handline3 size base
all size_based double_logistic 69.4984 11.8235 40.0029 19.9991 0.951448
@selectivity LonglineSel1       # Longline1 size base only one selectivity for longline
all size_based logistic 80.5853 16.4624
@selectivity MRFSSSel       # Recreational fisheries size base
all size_based double_logistic 49.3419 14.8224 50.7371 20 0.950139
@selectivity OthersSel       # Others Age based
all double_logistic 4.1129 1.41494 1.63368 4.99809 0.95
@selectivity Age0Sel
all allvalues 1 0 0 0 0 0 0 0 0 0 0 0

# SIZE AT AGE
@size_at_age_type von_Bert       # Defines that the age-length relationship as von Bertalanffy type
@size_at_age_dist normal       # von-Bertalanffy combined sex
@size_at_age       #
k 0.14       # units in cm and year
t0  -0.39
Linf 130
cv 0.1


# SIZE-WEIGHT
@size_weight            # Defines the length-weight relationship: units TL size(cm) and gutted weight
(Kg) * 0.001 to match Metric tonns
a  7.9860000E-09
b 3.089
verify_size_weight 50 1.4 1.7     # Check that these values are correct, by confirming that a 50 cm
fish has a weight between 1.4 and 1.7 kgs
```

Central model estimation file

```
# ESTIMATION
@estimator likelihood        # Use the ML estimation method
@max_iters 1000        # With maximum of 300 iterations for the point estimates [these are default values of CASAL]
@max_evals 3000        # and 1000 function evaluations
@grad_tol 0.0002        # Set the tolerance for the convergence test at 0.0002


@profile
parameter initialization.Binitial
l 40000
u 75000
n 25


{
@MCMC
start 0        #Start the MCMC at 0
length 310000        #and evaluate for 110000 steps
keep 100        #keeping every 100th sample
stepsize 0.02        #with the stepsize for the MCMC set at 0.02
adaptive_stepsize TRUE        #but adapt the stepsize during the evaluation
adapt_at 5000        #after the 5000th step
burn_in 500        #The MCMC has a burn-in period of 500*500=250000 steps
}

# OBSERVATIONS: CPUE standardized series
@relative_abundance HeadboatCPUE1        #Define a relative abundance series HeadboatCPUE
biomass FALSE        # This time series is a number of fish index
q  HeadboatCPUE1q        # and has a relativity constant called HeadboatCPUEq
step 3        # Occurs in time step 3
proportion_mortality 0.5        # after 0.5 of mortality has been recorded in that time step
area GOM        # Occurs in the area called GOM
```

ogive HeadboatSel1 # and is applied with the selectivity HeadboatSel
years 1986 1987 1988 1989
1986 978
1987 1205
1988 950
1989 866
cv_1986 0.293
cv_1987 0.219
cv_1988 0.284
cv_1989 0.315
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HeadboatCPUE2 # Define a relative abundance series HeadboatCPUE
biomass FALSE # This time series is a number of fish index
q HeadboatCPUE2q # and has a relativity constant called HeadboatCPUEq
step 3 # Occurs in time step 3
proportion_mortality 0.5 # after 0.5 of mortality has been recorded in that time step
area GOM # Occurs in the area called GOM
ogive HeadboatSel2 # and is applied with the selectivity HeadboatSel
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
1990 691
1991 606
1992 705
1993 836
1994 868
1995 866
1996 1331
1997 1339
1998 1262
1999 1258
cv_1990 0.33
cv_1991 0.36

cv_1992 0.354
cv_1993 0.297
cv_1994 0.303
cv_1995 0.307
cv_1996 0.182
cv_1997 0.176
cv_1998 0.197
cv_1999 0.185
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HeadboatCPUE3 # Define a relative abundance series HeadboatCPUE
biomass FALSE # This time series is a number of fish index
q HeadboatCPUE3q # and has a relativity constant called HeadboatCPUEq
step 3 # Occurs in time step 3
proportion_mortality 0.5 # after 0.5 of mortality has been recorded in that time step
area GOM # Occurs in the area called GOM
ogive HeadboatSel3 # and is applied with the selectivity HeadboatSel
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
2000 1134
2001 866
2002 843
2003 1188
2004 1420
2005 1571
2006 653
2007 590
2008 735
cv_2000 0.269
cv_2001 0.258
cv_2002 0.248
cv_2003 0.174
cv_2004 0.142

cv_2005 0.117
cv_2006 0.324
cv_2007 0.351
cv_2008 0.215
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HandlineCPUE2 # Define a relative abundance series HandlineCPUE
biomass TRUE # This time series is an abundance index
q HandlineCPUE2q # and has a relativity constant called HandlineCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive HandlineSel1 # and is applied with the selectivity HandlineSel
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
1990 713.773496
1991 518.51741
1992 758.3730385
1993 1026.548488
1994 856.316818
1995 849.0176594
1996 977.795241
1997 1035.911552
1998 1726.351235
1999 1176.379906
cv_1990 0.106663516
cv_1991 0.104629504
cv_1992 0.085100502
cv_1993 0.065513292
cv_1994 0.067821527
cv_1995 0.066145075
cv_1996 0.061352814
cv_1997 0.059640636

cv_1998 0.056870633
cv_1999 0.058099475
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HandlineCPUE3 # Define a relative abundance series HandlineCPUE
biomass TRUE # This time series is an abundance index
q HandlineCPUE3q # and has a relativity constant called HandlineCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive HandlineSel3 # and is applied with the selectivity HandlineSel
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
2000 817.8408336
2001 1246.441802
2002 1236.288078
2003 1134.842842
2004 1433.900705
2005 1430.92828
2006 654.6203051
2007 488.3282328
2008 556.8089213
cv_2000 0.065216631
cv_2001 0.055674393
cv_2002 0.057148135
cv_2003 0.057043113
cv_2004 0.056077944
cv_2005 0.056854843
cv_2006 0.062964784
cv_2007 0.06835717
cv_2008 0.068570411
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

```
@relative_abundance LonglineCPUE2        # Define a relative abundance series LonglineCPUE
biomass TRUE        # This time series is an abundance index
q LonglineCPUE2q            # and has a relativity constant called LonglineCPUEq
step 3        # Occurs in time step 1
proportion_mortality 0.5        # after all mortality has been recorded in that time step
area GOM        # Occurs in the area GOM
ogive LonglineSel1        # and is applied with the selectivity LonglineSel
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
1990 1263.523789
1991 850.0694464
1992 706.3735006
1993 976.0239485
1994 541.0972395
1995 743.9076204
1996 877.7620519
1997 874.6732391
1998 1529.127814
1999 1183.686171
cv_1990 0.332
cv_1991 0.331
cv_1992 0.417
cv_1993 0.18
cv_1994 0.232
cv_1995 0.202
cv_1996 0.154
cv_1997 0.154
cv_1998 0.12
cv_1999 0.136
dist lognormal        # where the CVs have lognormal distribution
cv_process_error 0        # and there is no process error applied

@relative_abundance LonglineCPUE3        # Define a relative abundance series LonglineCPUE
```

biomass TRUE # This time series is an abundance index
q LonglineCPUE3q # and has a relativity constant called LonglineCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive LonglineSel1 # and is applied with the selectivity LonglineSel
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
2000 635.249355
2001 1120.855944
2002 1081.469939
2003 1210.968536
2004 1350.618366
2005 1683.48523
2006 754.2080191
2007 674.1860195
2008 488.9585919
cv_2000 0.265381329
cv_2001 0.124665178
cv_2002 0.128056097
cv_2003 0.118490567
cv_2004 0.10691425
cv_2005 0.09902832
cv_2006 0.143956995
cv_2007 0.190505273
cv_2008 0.221178989
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance MRFSSCPUE # Define a relative abundance series MRFSSCPUE
biomass FALSE # This time series is numbers of fish
q MRFSSCPUEq # and has a relativity constant called MRFSSCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step

area GOM # Occurs in the area GOM
ogive MRFSSSel # and is applied with the selectivity MRFSSSel
years 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
1981 283.9410907
1982 258.0839508
1983 608.804323
1984 17.58948478
1985 30.22901882
1986 178.2244847
1987 161.8548086
1988 78.69299205
1989 293.7003074
1990 771.3870609
1991 632.2243031
1992 512.2904547
1993 1287.953429
1994 1737.212709
1995 1625.200987
1996 1411.981758
1997 1070.898956
1998 2095.554399
1999 1755.675591
2000 1009.388563
2001 815.1098728
2002 1542.284927
2003 1708.986249
2004 1691.494003
2005 2003.083604
2006 882.2529603
2007 1209.917123
2008 2325.98259
cv_1981 0.559665475

cv_1982 0.518658868
cv_1983 0.565407282
cv_1984 1.884536982
cv_1985 1.122431605
cv_1986 0.437071577
cv_1987 0.414111326
cv_1988 0.497908142
cv_1989 0.40636228
cv_1990 0.391567456
cv_1991 0.365799715
cv_1992 0.334396407
cv_1993 0.315304707
cv_1994 0.308092473
cv_1995 0.302538215
cv_1996 0.311931032
cv_1997 0.305180267
cv_1998 0.291862007
cv_1999 0.28987201
cv_2000 0.296545893
cv_2001 0.299114242
cv_2002 0.287326467
cv_2003 0.287657633
cv_2004 0.289147096
cv_2005 0.287544325
cv_2006 0.300119351
cv_2007 0.293877399
cv_2008 0.290299708
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance VideoCPUE # Define a relative abundance series VideoCPUE
biomass FALSE # This time series is number of fish index
q VideoCPUEq # and has a relativity constant called VideoCPUEq

```
step 3        # Occurs in time step 1
proportion_mortality 0.5        # after all mortality has been recorded in that time step
area GOM        # Occurs in the area GOM
ogive LonglineSel1        # and is applied with the selectivity LonglineSel
years 1993 1994 1995 1996 1997 2002 2004 2005 2006 2007 2008
1993 783.1599063
1994 602.8152274
1995 528.0881856
1996 1030.412846
1997 1100.397348
2002 1884.454491
2004 2288.083059
2005 1099.500111
2006 687.155525
2007 811.7433202
2008 184.1899812
cv_1993 0.42345
cv_1994 0.52547
cv_1995 0.3571
cv_1996 0.28115
cv_1997 0.30794
cv_2002 0.18133
cv_2004 0.17472
cv_2005 0.1877
cv_2006 0.25368
cv_2007 0.19289
cv_2008 0.51977
dist lognormal        # where the CVs have lognormal distribution
cv_process_error 0        # and there is no process error applied

@relative_abundance CopperBCPUE        # Define a relative abundance series CopperBCPUE
biomass FALSE        # This time series is number of fish index
q VideoCPUEq            # and has the same q as the VideoCPUEq index
```

step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive LonglineSel1 # and is applied with the selectivity LonglineSel
years 1993 1994 1995 1996 1997 2002 2004 2005 2006 2007 2008
1993 1444.204409
1994 934.270981
1995 778.6159178
1996 1017.351642
1997 636.6635306
2002 1099.358096
2004 2182.969906
2005 1177.748931
2006 531.4961474
2007 932.1487692
2008 265.1716705
cv_1993 0.39865
cv_1994 0.57995
cv_1995 0.49462
cv_1996 0.40952
cv_1997 0.57115
cv_2002 0.35756
cv_2004 0.28173
cv_2005 0.25998
cv_2006 0.38507
cv_2007 0.26569
cv_2008 0.61238
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance Age0CPUE # Define a relative abundance series Age0CPUE
biomass FALSE # This time series is number of fish index
q Age0CPUEq # and has the q Age0CPUEq

step 3 # Occurs in time step 3
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive Age0Sel # and is applied with the selectivity Age0Sel
years 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
1995 1064.62
1996 662.77
1997 1025.49
1998 480.58
1999 304.42
2000 393.36
2001 641.65
2002 590.69
2003 2198.29
2004 904.29
2005 1235.79
2006 619.94
2007 1532.15
2008 2239.8
cv_1995 0.35931
cv_1996 0.30862
cv_1997 0.2319
cv_1998 0.28161
cv_1999 0.46871
cv_2000 0.38535
cv_2001 0.3525
cv_2002 0.44922
cv_2003 0.21818
cv_2004 0.25976
cv_2005 0.22114
cv_2006 0.26892
cv_2007 0.18965
cv_2008 0.16063

dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

#OBSERVATIONS: Proportions at age for each fishery [partial catches in VPA2Box program]
@catch_at Handline1CAA # Partial catch-at-age for the handline1 fishery
years 1984 1985 1986 1987 1988 1989 # index years
fishery Handline1 # Apply to the fishery Handline
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
#Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0 0.031189417 0.007269928 0.077004219 0.171627324 0.205781731 0.15544817 0.102563006 0.096789828 7.12738E-05 0.013613297 0.138641806
1985 0 0.007341921 0.018343941 0.125171058 0.11812238 0.29845559 0.10031062 0.104959055 0.099300563 0.029704368 0.015129135 0.08316137
1986 0 0.008645638 0.029884362 0.209021009 0.194018284 0.150124115 0.184985167 0.015317552 0.123993461 0 0 0.084010414
1987 0 0.010230783 0.023986916 0.018626204 0.150027258 0.194312193 0.319189533 0.062638561 0.149845539 0.00238052 0.03327276 0.035489733
1988 0 0.042396994 0.085271823 0.008796507 0.088746986 0.179492192 0.19102539 0.184466019 0.066918616 0.079277166 0 0.073608306
1989 0 0.043363584 0.007510394 0.010654626 0.06509008 0.174616657 0.215953626 0.182574098 0.105994904 0.089588269 0.028596123 0.076057639
N_1984 200 # effective sample size
N_1985 200
N_1986 200
N_1987 200
N_1988 200
N_1989 200
dist multinomial

r 0.00001

@catch_at Handline2CAA # Partial catch-at-age for the handline2 fishery
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 # index years
fishery Handline2 # Apply to the fishery Handline
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
#Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1990 0 0.028908099 0.00527544 0.008151459 0.068432816 0.167647252 0.226186563 0.18031817 0.11632264 0.087365238 0.033608336 0.077783986
1991 0 0 0 0.087320976 0.087229365 0.466088497 0.074663328 0.108467951 0.039392921 0.055501267 0.006046355 0.075289339
1992 0 0.012021128 0.156699654 0.083055066 0.185371259 0.148093619 0.192019307 0.070806266 0.012810394 0.012628256 0.046475624 0.080019428
1993 0 0.002227824 0.056856572 0.394220209 0.066803334 0.13587633 0.094572687 0.127268353 0.050842494 0.008660273 0.004738048 0.057933877
1994 0 0 0.034005515 0.114646263 0.529458817 0.080882817 0.069189804 0.039194224 0.055854927 0.02440693 0.026206664 0.02615404
1995 0 0 0.180211866 0.186953063 0.112412595 0.257756563 0.086421304 0.042687267 0.039934263 0.035045849 0.001580622 0.056996608
1996 0 0.00021005 0.140464968 0.3681345 0.19226342 0.098328838 0.130164091 0.017215739 0.032440199 0.000579739 0.001134273 0.019064183
1997 0 0 0.203631942 0.358432695 0.022168183 0.236280201 0.057020709 0.092155632 0 0.006981487 0.005530279 0.01779887
1998 0 0.021049611 0.057558491 0.237095072 0.472330112 0.085325736 0.042693612 0.028412876 0.010668279 0.00806526 0.004355445 0.032445506
1999 0 0.026214984 0.019466855 0.127586723 0.31176928 0.359733784 0.059456298 0.034354113 0.020422721 0.01150606 0.00569953 0.023789652
N_1990 200
N_1991 200
N_1992 200

N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
dist multinomial
r 0.00001

@catch_at Handline3CAA # Partial catch-at-age for the handline3 fishery
years 2000 2001 2002 2003 2004 2005 2006 2007 2008 # index years
fishery Handline3 # Apply to the fishery Handline
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
#Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
2000 0 0.027496879 0.072543412 0.420379263 0.128785527 0.136196408 0.120747165 0.048593452 0.009683023 0.007556193 0.011017246 0.017001433
2001 0 0.00052336 0.021295882 0.083635029 0.521924453 0.10076022 0.11839798 0.087136683 0.01922942 0.019661057 0.006765907 0.020670008
2002 0 0.00380722 0.037566706 0.066680744 0.238210415 0.437100882 0.079094202 0.063199857 0.03784185 0.007851192 0.005086958 0.023559975
2003 0 0.000663683 0.015936899 0.195616289 0.125002127 0.294658203 0.244933036 0.046738594 0.023050219 0.019663734 0.006730426 0.02700679
2004 0 0.00147749 0.030733129 0.134999799 0.373129738 0.118098918 0.153491824 0.121969808 0.028092367 0.011251655 0.008684432 0.018070839
2005 0 0 0.009475735 0.081497762 0.206203909 0.393544907 0.083027405 0.095723441 0.060082762 0.024643352 0.013895598 0.03190513

2006 0 0 0.014264069 0.138600223 0.192289444 0.314146222 0.181667917 0.049511012 0.039318018 0.029477035 0.009259401 0.031466659
2007 0 0.001592408 0.031425693 0.134168535 0.355204576 0.1547886 0.154918592 0.077118066 0.02312242 0.023024926 0.016817783 0.0278184
2008 0 0.001449683 0.029514426 0.136129486 0.225812808 0.387572132 0.076523575 0.069176636 0.029964814 0.008655876 0.006938776 0.028261787
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at Headboat1CAA # Partial catch-at-age for the headboat1 fishery
years 1986 1987 1988 1989
fishery Headboat1 # Occurs in the fishery headboat
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1986 0.011918311 0.151802779 0.351923036 0.076040973 0.278931432 0.023450083 0.069641592 0.003478858 0.007043615 0.018575386 0.004337836 0.0028561
1987 0.03905832 0.130224125 0.291897033 0.318887105 0.103679924 0.05201831 0.03668034 0 0.016913382 0 0 0.01064146
1988 0 0.131985731 0.233884625 0.529996757 0.021583252 0.02205167 0.04914784 0.000252225 3.60321E-05 0 0 0.011061867

1989 0.033742576 0.165197475 0.264321287 0.065194812 0.144184932 0.165011052 0.054195851 0.050201071 0.023622467 0.012037604 0 0.022290873
N_1986 200
N_1987 200
N_1988 200
N_1989 200
dist multinomial
r 0.00001

@catch_at Headboat2CAA # Partial catch-at-age for the headboat2 fishery
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
fishery Headboat2
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1990 0 0.026946009 0.398721876 0.202424482 0.024475409 0.263300063 0 0.08040979 0.000856475 0 0 0.002865896
1991 0.015486164 0.244986037 0.069645426 0.19708894 0.067191335 0.254717779 0.054497757 0.031395447 0.030718456 0 0.002877211 0.031395447
1992 0.029665653 0.140303951 0.430334347 0.060911854 0.154893617 0.064072948 0.083768997 0.005349544 0.000790274 0.001762918 0 0.028145897
1993 0.008027075 0.118019699 0.134420966 0.510478587 0.084175815 0.058879681 0.02889747 0.033757105 0.005467089 0.000997961 0 0.016878553
1994 0.007305476 0.058443808 0.264099254 0.205970337 0.361684038 0.069181598 0.011965866 0.006581226 0.001102119 0 0.006990585 0.006675694
1995 0 0.161939394 0.360525253 0.201373737 0.087676768 0.164040404 0.009777778 0.001979798 0.007191919 0.001979798 0.003515152 0
1996 0 0.007796305 0.541189725 0.326949076 0.068544389 0.022487607 0.030824696 0.000630915 0 0.000450653 0 0.001126634
1997 0 0.198664681 0.047888948 0.649550891 0.069071521 0.010375138 0.018876987 0.005571833 0 0 0 0
1998 0.093343563 0.10550742 0.239309841 0.264011827 0.257855044 0.028276288 0.00340588 0.005688942 0 0 0 0.002601194

1999 0 0.055540179 0.571570256 0.156149091 0.143486484 0.060891226 0.007565274 0.001545346 0.001799059 0 0 0.001453086
N_1990 200
N_1991 200
N_1992 200
N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
dist multinomial
r 0.00001

@catch_at Headboat3CAA # Partial catch-at-age for the headboat3 fishery
years 2000 2001 2002 2003 2004 2005 2006 2007 2008 # index years
fishery Headboat3
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
2000 0.014446095 0.243492378 0.124594134 0.482747235 0.016427274 0.078861923 0.027708987 0 0 0.00781465 0 0.003907325
2001 0.001915097 0.059740398 0.106447494 0.244866475 0.415576125 0.097137993 0.050058517 0.019736142 0 0.000904352 0
0.003617406
2002 0.039602811 0.10481389 0.556297544 0.10394286 0.120202079 0.063991638 0.005632658 0.000812961 0.002438883 0 0
0.002264677
2003 0.051100863 0.076130616 0.384967272 0.36480958 0.033546564 0.040724487 0.035852425 0.003198453 0.006396906 0 0
0.003272835
2004 0.026338663 0.142334132 0.286775358 0.267706166 0.23257039 0.022888298 0.015092054 0.00611057 0 0.000184371 0 0

2005 0.009208371 0.092920837 0.321528662 0.333575978 0.172156506 0.048480437 0.01266606 0.000545951 0.005787079 0 0 0.003130118
2006 0.001988665 0.224719101 0.156607338 0.351894203 0.128070001 0.076066421 0.045838719 0 0.008750124 0.004176196 0 0.001889231
2007 0.100611829 0.148538409 0.356560163 0.171651937 0.159811919 0.029231815 0.013709495 0.003172445 0 0.005041922 0 0.011670066
2008 0 0.040943843 0.616369775 0.150386153 0.113827764 0.053634494 0 0 0 0 0 0.024837971
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at Longline1CAA # Partial catch-at-age for the Longline1 fishery
years 1984 1985 1986 1987 1988 1989
fishery Longline1
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0 0.006079907 0.033294731 0.116451136 0.226725857 0.226983208 0.136138455 0.096184778 0.022518175 0.037862703 0.029917004 0.067844046
1985 0 0.011379752 0.018712601 0.299436201 0.199024593 0.213932413 0.006191415 0.074469925 0.023900937 0.000103767 0.019438968 0.133409429

1986 0 0.003419353 0.040038577 0.042698074 0.178127831 0.30636818 0.077476108 0.212642838 0.030598825 2.92252E-05 0.01706754 0.091533448
1987 0 0 0.033460476 0.018913587 0.086544785 0.124214126 0.426594765 0.066052874 0.078916217 0.01231093 0.020886492 0.132105748
1988 0 0.034790172 0.000739291 0.081930855 0.031311155 0.218090889 0.174646662 0.134681452 0.202304849 0.001869972 0 0.119634703
1989 0 0.024583155 0.011586148 0.058016246 0.052116289 0.20076956 0.166908935 0.151988029 0.187302266 0.002052159 0.046472852 0.098204361
N_1984 200 # effective sample size
N_1985 200
N_1986 200
N_1987 200
N_1988 200
N_1989 200
dist multinomial
r 0.00001

@catch_at Longline2CAA # Partial catch-at-age for the Longline2 fishery
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
fishery Longline2
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1990 0 0.005389418 0.009168584 0.007492606 0.01610253 0.108774236 0.230529083 0.063621426 0.430266185 0.017844233 3.28623E-05 0.110778837
1991 0 0 0 0.016531176 0.050954919 0.333735268 0.096230892 0.160605236 0.067991754 0.102104321 0.011046715 0.16079972
1992 0 0.001585065 0.017259598 0.022296583 0.151497006 0.16555125 0.225995069 0.101232828 0.017013033 0.025255372 0.105494893 0.166819303

1993 0 0.000744756 0.024245935 0.143448219 0.054698167 0.129711614 0.15341967 0.213207001 0.123091564 0.025942323 0.013488353 0.1180024
1994 0 0 0.013364596 0.062743259 0.372520516 0.077373974 0.113903869 0.088722157 0.121594373 0.058475967 0.054724502 0.036576788
1995 0 0 0.03770127 0.123663656 0.100667627 0.253436314 0.106296636 0.083518785 0.083911507 0.089671423 0.002661779 0.118471004
1996 0 0 0.034247143 0.142040749 0.193887693 0.146844459 0.292115289 0.036483353 0.09131191 0.002194799 0.00575617 0.055118436
1997 0 0 0.069999602 0.171578571 0.031022551 0.180368293 0.139720797 0.246311101 0 0.037465696 0.030425963 0.093107426
1998 0 0.00608485 0.026311341 0.134796327 0.303397374 0.10682292 0.108879373 0.086596428 0.040368471 0.034142769 0.006338385 0.146261761
1999 0 0.004113872 0.005923976 0.051143656 0.170939608 0.352476551 0.102682245 0.08194833 0.068191542 0.041303275 0.02024025 0.101036696
N_1990 200
N_1991 200
N_1992 200
N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
dist multinomial
r 0.00001

@catch_at Longline3CAA # Partial catch-at-age for the Longline3 fishery
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
fishery Longline3
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE

min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
2000 0 0.006409841 0.0168663 0.14972483 0.12149563 0.146714147 0.21113629 0.12988022 0.040012949 0.034541923 0.046293299 0.096924571
2001 0 0.000337388 0.010512297 0.040699636 0.275805736 0.106365977 0.168676196 0.174234218 0.04592027 0.054763385 0.024114357 0.098570541
2002 0 0.001421041 0.018242205 0.034699846 0.146301162 0.347378509 0.117401147 0.110742081 0.079677457 0.026537121 0.016722021 0.10087741
2003 0 0.000699173 0.00860287 0.087259849 0.078322592 0.26615698 0.281994771 0.084584752 0.04790856 0.047862962 0.018953672 0.077653818
2004 0 0.000430427 0.019042672 0.07612616 0.235769944 0.117714286 0.177202226 0.175332096 0.05058256 0.02806679 0.027265306 0.092467532
2005 0 0 0.007804284 0.055386432 0.1420638 0.288352613 0.088891349 0.136897843 0.105127212 0.053836645 0.035257652 0.08638217
2006 0 0 0.010481166 0.091718266 0.122291022 0.221104231 0.180663055 0.080721104 0.084333075 0.083268834 0.028605521 0.096813725
2007 0 0.000593494 0.022626952 0.064023146 0.197447977 0.150599058 0.182202604 0.119218072 0.046403798 0.0564561 0.049927668 0.110501131
2008 0 0.000311931 0.012269301 0.066753314 0.126852093 0.286820899 0.121185339 0.121393293 0.08172602 0.029217572 0.027345984 0.126124253
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at MRFSSCAA # Partial catch-at-age for the Mrfss fishery
years 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
fishery MRFSS
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0.146471297 0.167223098 0.173115089 0.238464868 0.171359238 0.033627005 0.033129308 0.017954187 0.000967572 9.27386E-06 2.47303E-05 0.017654332
1985 0.082446305 0.189257273 0.092802305 0.227729648 0.224864965 0.119809344 0.012252215 0.013523329 0.016991103 0.004447247 1.54074E-05 0.015860858
1986 0.180288444 0.218892674 0.226663815 0.151248918 0.148138727 0.041892187 0.012369945 0.013481347 1.44526E-06 0 1.01168E-05 0.007012382
1987 0.181512953 0.202925552 0.193151895 0.166346332 0.13562258 0.082770657 0.01171748 0.010740115 0.003409872 0.003442596 1.7453E-05 0.008342514
1988 0.150696536 0.22702398 0.196627639 0.14129612 0.172985683 0.037896381 0.049010355 0.006285733 0.002551012 0 1.12734E-05 0.015615287
1989 0.261748437 0.233104464 0.153344136 0.147514863 0.132169613 0.04121373 0.004666867 0.017069158 2.46273E-06 0.003452743 1.47764E-05 0.005698749
1990 0.143595321 0.156242577 0.349435145 0.120559396 0.118129956 0.059894238 0.022715055 0.018560421 0.000283365 0 0 0.010584524
1991 0.10618469 0.404761172 0.070839542 0.13719224 0.041855099 0.114175252 0.04806419 0.012122059 0.023043047 0.000573293 0.005199906 0.03598951
1992 0.056871657 0.218433873 0.440654905 0.048574191 0.115982398 0.038096565 0.045662846 0.004001425 0.001679313 0.001502543 0 0.028540283
1993 0.041285872 0.320255128 0.137320329 0.372331964 0.054441639 0.034605674 0.016778058 0.015211974 0.002958892 0.001305345 0 0.003505124
1994 0.054128426 0.210799138 0.238013958 0.171809721 0.265984367 0.044897987 0.006180855 0.004981102 0.00073687 0 0.001854937 0.00061264

1995 0 0.266927931 0.353656463 0.174916198 0.070028591 0.123168688 0.00761116 0 0 0 0.003690969 0
1996 0 0.009909112 0.647877969 0.227281792 0.04972071 0.019818223 0.032004315 0.000988483 0 0.005490418 0.000220241 0.006688737
1997 0 0.320431733 0.046170048 0.55705656 0.054107143 0.006875068 0.008232924 0.005151864 0 0 0 0.001974659
1998 0.100012027 0.119232542 0.251763406 0.282600528 0.212034482 0.020625492 0.003892426 0.004251121 0 0.00368913 0 0.001898848
1999 0.007243947 0.074166048 0.543387054 0.146243923 0.141391077 0.071306784 0.007533705 0.003606408 0.001679877 0 0.001870256 0.001570919
2000 0.016623702 0.281786807 0.126951478 0.456368805 0.020821789 0.071668634 0.020835843 0 0 0.00463476 0 0.000308181
2001 0.006297139 0.092376746 0.156063283 0.256087758 0.367830816 0.071849578 0.035187185 0.008679476 0 0.001454999 0 0.004173019
2002 0.095554641 0.124871418 0.455776405 0.096131078 0.124431812 0.081832721 0.008836762 0.000780228 0.007089012 0.000164974 0 0.004530951
2003 0.066313498 0.085735294 0.398085465 0.356039805 0.028026896 0.032024779 0.024009383 0.002690883 0.00338855 0 0.001293096 0.00239235
2004 0.00573948 0.08514254 0.332033802 0.297687031 0.244703318 0.016004793 0.011540205 0.004910905 4.36462E-05 0.000922907 0.000589928 0.000681444
2005 0.009305652 0.082124649 0.335538233 0.330912622 0.168661963 0.046352557 0.012358517 0.001355025 0.011020681 0 0 0.0023701
2006 0 0.076569606 0.249860881 0.433562073 0.13528471 0.051458044 0.029487142 0.002593332 0.005160745 0.006238632 0 0.009784834
2007 0.004260076 0.164792724 0.438992579 0.20948442 0.133341308 0.029715872 0.006178491 0.00518823 0 0.000273731 0 0.007772569
2008 0 0.015331036 0.59771341 0.196651719 0.141221273 0.04351281 0 0 0 0 0 0.005569752
N_1984 200
N_1985 200
N_1986 200
N_1987 200
N_1988 200
N_1989 200
N_1990 200
N_1991 200
N_1992 200

N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at OthersCAA # Partial catch-at-age for the Trap (other commercial) fishery
years 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
fishery Others
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0 0.001103753 0.123068433 0.249448124 0.415011038 0.091611479 0.0700883 0.015452539 0.007726269 0.007174393 0.004966887 0.014348786

1985 0 0.00070497 0.129009517 0.27035601 0.402537892 0.09058865 0.063799789 0.015509341 0.009164611 0.00211491 0.005992245 0.010222066
1986 0 0.001007388 0.10241773 0.26292814 0.435191404 0.074546676 0.084956347 0.013096038 0.004701142 0.005372733 0.003357958 0.012424446
1987 0 0.000676819 0.089001692 0.305245347 0.403384095 0.083248731 0.08392555 0.010829103 0.006091371 0.003045685 0.004399323 0.010152284
1988 0 0.00083091 0.098047362 0.306605733 0.395928542 0.086830079 0.079767345 0.012048193 0.004154549 0.002077275 0.004570004 0.009140008
1989 0 0.000960615 0.111111111 0.282100544 0.42010887 0.073326929 0.084854307 0.014409222 0.00128082 0.000960615 0.005123279 0.005763689
1990 0 0.000691882 0.121079336 0.277905904 0.411900369 0.06849631 0.093865314 0.014760148 0.000461255 0.000461255 0.005073801 0.005304428
1991 0 0 0 0.402315485 0.137916064 0.372069465 0.035600579 0.02301013 0.006367583 0.008248915 0.000434153 0.014037627
1992 0 0.058449466 0.288864836 0.2609931 0.163036125 0.073197132 0.124475714 0.006900284 0.003923691 0.001488297 0.007982682 0.010688675
1993 0 0.007753877 0.095964649 0.596464899 0.061697515 0.107136902 0.044272136 0.059696515 0.006836752 0.001917625 0.001417375 0.016841754
1994 0 0.000388863 0.0791725 0.18867631 0.51018821 0.078705864 0.059962669 0.019443148 0.027842588 0.007543942 0.013299113 0.014776793
1995 0 0 0.161595324 0.291473268 0.152398143 0.258208699 0.065669589 0.021746605 0.018222451 0.008681451 0.00034382 0.02166065
1996 0 0 0.103221649 0.343170103 0.268685567 0.119072165 0.122938144 0.015592784 0.014690722 0.000515464 0.000515464 0.011597938
1997 0 0 0.154101765 0.376116303 0.030114226 0.269470405 0.05576324 0.097923157 0 0.001246106 0.001038422 0.014226376
1998 0 0.021553125 0.071374418 0.248456623 0.461063576 0.09455215 0.04115672 0.025343875 0.007798115 0.004657208 0.004548901 0.019495289
1999 0 0.018960488 0.024264121 0.167594802 0.374966852 0.321665341 0.040837974 0.01935826 0.009811721 0.004640679 0.002916998 0.014982763
2000 0 0.039109447 0.133188848 0.502709093 0.096936262 0.0980199 0.080484681 0.023840016 0.004531573 0.004827111 0.00522116 0.011131908
2001 0 0.001132996 0.056214049 0.133432107 0.562140492 0.083754576 0.074341991 0.049503225 0.010109813 0.009586892 0.003224682 0.016559177

2002 0 0.020185488 0.127523186 0.156983088 0.262956901 0.335651937 0.037643208 0.025777414 0.014320786 0.003409711 0.001500273 0.014048009
2003 0 0.006447453 0.048355899 0.411863314 0.133978079 0.212765957 0.140812379 0.015087041 0.008897485 0.005802708 0.002192134 0.01379755
2004 0 0.011090573 0.074514787 0.220425139 0.418784658 0.091612754 0.093230129 0.058803142 0.010397412 0.004043438 0.003003697 0.01409427
2005 0 0 0.06684458 0.132926674 0.305883848 0.339179057 0.051976109 0.049307409 0.025797433 0.007116533 0.00406659 0.016901766
2006 0 0 0.04382716 0.354320988 0.191203704 0.233796296 0.111265432 0.022685185 0.015895062 0.008641975 0.002469136 0.015895062
2007 0 0.00381025 0.064964755 0.270908745 0.388835969 0.107068013 0.085159078 0.037911983 0.009525624 0.008192037 0.006477424 0.017146123
2008 0 0.013833992 0.119235837 0.311374616 0.18818621 0.236056214 0.048089592 0.04435661 0.013833992 0.002854633 0.003732982 0.018445323
N_1984 20
N_1985 20
N_1986 20
N_1987 20
N_1988 20
N_1989 20
N_1990 20
N_1991 20
N_1992 20
N_1993 20
N_1994 20
N_1995 20
N_1996 20
N_1997 20
N_1998 20
N_1999 20
N_2000 20
N_2001 20
N_2002 20

```
N_2003 20
N_2004 20
N_2005 20
N_2006 20
N_2007 20
N_2008 20
dist multinomial
r 0.00001


# RELATIVITY CONSTANTS
@q_method nuisance      # Use the nuisance method of estimating q

@estimate
parameter q[HeadboatCPUE1q].q      # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1.00E-10        # with a lower bound
upper_bound 1.00E-02        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[HeadboatCPUE2q].q      # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1.00E-10        # with a lower bound
upper_bound 1.00E-02        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[HeadboatCPUE3q].q      # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1.00E-10        # with a lower bound
upper_bound 1.00E-02        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[HandlineCPUE2q].q      # Estimate the parameter q[HandlineCPUEq].q when fitting the model
```

```
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[HandlineCPUE3q].q      # Estimate the parameter q[HandlineCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[LonglineCPUE2q].q      # Estimate the parameter q[LonglineCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[LonglineCPUE3q].q      # Estimate the parameter q[LonglineCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[MRFSSCPUEq].q      # Estimate the parameter q[MRFSSCPUEq].q when fitting the model
lower_bound 1.00E-12        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[VideoCPUEq].q      # Estimate the parameter q[VideoCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior
```

```
@estimate
parameter q[Age0CPUEq].q
lower_bound 1.00E-08
upper_bound 10
prior uniform-log


#FREE PARAMETERS
@estimate
parameter initialization.B0	# Estimate B0
phase 1	# Estimate in first phase
lower_bound 1000	# Define the lower bound
upper_bound 200000	# Define the upper bound
prior uniform-log	# and use a uniform-log prior


@estimate
parameter initialization.Binitial	# Estimate Binitial
phase 1	# Estimate in first phase
lower_bound 1000	# Define the lower bound
upper_bound 100000	# Define the upper bound
prior uniform-log	# and use a uniform-log prior


@estimate
parameter recruitment.YCS	# Estimate YCS when fitting the model
lower_bound 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.1 0.1
upper_bound 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 100 100 100 100 100 100 100 100 100 100 100 100
100 100 100 100 100 100 100 100 100 100 100 10 10
prior lognormal
mu 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

cv 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0.5 0.5

```
@estimate
parameter recruitment.steepness
lower_bound 0.01
upper_bound 0.99
prior uniform-log

@estimate
parameter selectivity[HeadboatSel1].all      # Estimate the HeadboatSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 50 20 150 20 1     # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[HeadboatSel2].all      # Estimate the HeadboatSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 50 20 150 20 1     # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[HeadboatSel3].all      # Estimate the HeadboatSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 50 20 150 20 1     # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[HandlineSel1].all      # Estimate the HandlineSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 70 20 150 20 1     # upper bounds
prior uniform       # and they have uniform priors
```

```
@estimate
parameter selectivity[HandlineSel3].all     # Estimate the HandlineSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01    # the five double_logistic parameters have lower and
upper_bound 70 20 150 20 1    # upper bounds
prior uniform     # and they have uniform priors

@estimate
parameter selectivity[LonglineSel1].all     # Estimate the LonglineSel ogive. Size base (cm)
lower_bound  20 5        # the two logistic parameters have lower and
upper_bound 140 50     # upper bounds
prior uniform     # and they have uniform priors

@estimate
parameter selectivity[MRFSSSel].all     # Estimate the MRFSSSel ogive. Size base (cm)
lower_bound  5 0.1 50 0.1 0.01    # the five double_logistic parameters have lower and
upper_bound 60 20 180 20 1    # upper bounds
prior uniform     # and they have uniform priors

@estimate
parameter selectivity[OthersSel].all     # Estimate the TrapSel ogive. Age base
lower_bound  0.01 0.01 1 0.01 0.01    # the five double_logistic parameters have lower and
upper_bound 6 5 16 5 1    # upper bounds
prior uniform     # and they have uniform priors

@estimate
parameter selectivity[Age0Sel].all
lower_bound  1 0 0 0 0 0 0 0 0 0 0 0
upper_bound 1 0 0 0 0 0 0 0 0 0 0 0
prior uniform


# PENALTIES
```

```
@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Headboat1CatchMustBeTaken
fishery Headboat1
log_scale TRUE
multiplier 500

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Headboat2CatchMustBeTaken
fishery Headboat2
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Headboat3CatchMustBeTaken
fishery Headboat3
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Handline1CatchMustBeTaken
fishery Handline1
log_scale TRUE
multiplier 500

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Handline2CatchMustBeTaken
fishery Handline2
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Handline3CatchMustBeTaken
fishery Handline3
```

```
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Longine1CatchMustBeTaken
fishery Longline1
log_scale TRUE
multiplier 500

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Longine2CatchMustBeTaken
fishery Longline2
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Longine3CatchMustBeTaken
fishery Longline3
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Recreational Fishing catch to be taken
label MRFSSCatchMustBeTaken
fishery MRFSS
log_scale TRUE
multiplier 1000

@catch_limit_penalty	# Penalise model fits that do not allow the Commercial Fishing catch to be taken
label OthersCatchMustBeTaken
fishery Others
log_scale TRUE
multiplier 1000
```

```
@vector_average_penalty
label meanYCS_1
vector recruitment.YCS
k 1
multiplier 10
```

Central model output file

```
@print          # Specifies the outputs that CASAL should generate
# estimation section
parameters TRUE
unused_parameters TRUE
fits_every_eval FALSE
objective_every_eval FALSE
parameters_every_eval FALSE
parameter_vector_every_eval FALSE
fits TRUE
resids TRUE
pearson_resids FALSE
normalised_resids TRUE
estimation_section FALSE
population_section TRUE
every_mean_size TRUE
covariance TRUE

# population section
requests TRUE
initial_state FALSE
state_annually FALSE
state_every_step FALSE
final_state TRUE
results TRUE

#output section
yields TRUE

@print_sizebased_ogives_at 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120
```

121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180

@quantities
all_free_parameters TRUE
fishing_pressures TRUE
nuisance_qs TRUE
true_YCS TRUE
B0 TRUE
Binitial TRUE
R0 TRUE
SSBs TRUE
YCS TRUE
actual_catches TRUE
recruitments TRUE
ogive_parameters selectivity[HeadboatSel1].all selectivity[HeadboatSel2].all selectivity[HeadboatSel3].all selectivity[HandlineSel1].all selectivity[HandlineSel3].all selectivity[LonglineSel1].all selectivity[MRFSSSel].all selectivity[OthersSel].all #selectivity[HandlineSel2].all selectivity[LonglineSel2].all selectivity[LonglineSel3}.all

@abundance total_biomass205
biomass TRUE
all_areas TRUE
step 2
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass200
biomass TRUE
all_areas TRUE
step 2
proportion_mortality 0

years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass300
biomass TRUE
all_areas TRUE
step 3
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass305
biomass TRUE
all_areas TRUE
step 3
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass310
biomass TRUE
all_areas TRUE
step 3
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass100
biomass TRUE

all_areas TRUE
step 1
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass105
biomass TRUE
all_areas TRUE
step 1
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass110
biomass TRUE
all_areas TRUE
step 1
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N100
biomass FALSE
all_areas TRUE
step 1
proportion_mortality 0

years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N200
biomass FALSE
all_areas TRUE
step 2
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N205
biomass FALSE
all_areas TRUE
step 2
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N210
biomass FALSE
all_areas TRUE
step 2
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N300
biomass FALSE

all_areas TRUE
step 3
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N305
biomass FALSE
all_areas TRUE
step 3
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N310
biomass FALSE
all_areas TRUE
step 3
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_100
step 1
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_105

step 1
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_110
step 1
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_200
step 2
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_205
step 2
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_210
step 2
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_300
step 3
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_305
step 3
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_310
step 3
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@selectivity_at SelAtAgeLongline1
step 3
ogive LonglineSel1
years 2008

@selectivity_at SelAtAgeHeadboat1
step 3
ogive HeadboatSel1
years 1989

@selectivity_at SelAtAgeHandline1
step 3
ogive HandlineSel1
years 1989

@selectivity_at SelAtAgeHeadboat2
step 3
ogive HeadboatSel2
years 1999

@selectivity_at SelAtAgeHandline3
step 3
ogive HandlineSel3
years 2008

@selectivity_at SelAtAgeHeadboat3
step 3
ogive HeadboatSel3
years 2008

@selectivity_at SelAtAgeMRFSS
step 3
ogive MRFSSSel
years 2008

@selectivity_at SelAtAgeOthers
step 3
ogive OthersSel
years 2008

@n_projections 500

```
#fishery_names Headboat1     Headboat2     Headboat3     Handline1     Handline2     Handline3     Longline1     Longline2
Longline3     MRFSS     Others
@catch_split 0 0 0.0148 0 0 0.1278 0 0 0.0778 0.7742 0.0053

@per_recruit
do_YPR_SPR TRUE
F 0 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5  #0.55 0.6 0.7
do_Fmax TRUE
do_F0_1 TRUE
do_Fx TRUE
x 30  #35 40 45 50 55 60
guess 0.25

@deterministic_MSY
do_MSY TRUE
do_yield_vs_SSB TRUE
F 0.01 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5
guess 0.25


@MCY_CAY
do_MCY TRUE
MCY_guess 30000
n_discard 100
n_keep 100
n_simulations 100
do_CAY TRUE
F_CAY_guess 0.2
interactive FALSE
```

Appendix B: CASAL input files for red tide model

Red tide population file

```
# SETTING THE INITIAL STAGE
#INITIALIZATION (the starting value for B0 is set as 10000 t)
@initialization
B0  100000      # Initial guess for B0
Binitial 75000       # Biomass at start (1963) with reference to B0, ie 50%

# PARTITION
@size_based FALSE      # Define the model as age-based
@min_age 1      # Min age
@max_age 12      # The partition keeps account of fish aged 1-12
@plus_group TRUE      # and excludes all fish over the age of 12
@sex_partition FALSE      # The model is NOT sex-based
@mature_partition FALSE      # Maturity is excluded from the partition
@n_areas 1      # Only a single fishing area is defined
@area_names GOM      # with the (optional in a single area model) label GOM
@n_stocks 1      # This is a single stock model
@stock_names GAGGOM      # and the stock has the (optional in a single stock model) name GAGGOM

# TIME SEQUENCE
@initial 1963      # The model is defined to run from 1963
@current 2008      # to the current year, 2008
@final 2014      # Projections are run up to the year 2014

@annual_cycle
time_steps 3      # There are three time steps: Jan, Feb, Mar-Dec
recruitment_time 3      # Recruitment occurs in time step 3
recruitment_areas GOM      # in the area GOM (the only area defined)
spawning_time 2      # Spawning occurs in time step 2
spawning_part_mort 0.5      # and SSBs are calculated after spawning fish have undergone 0.5 of the mortality assigned to this time
step
```

spawning_areas GOM # Spawning occurs in the area GOM
spawning_ps 1 # and all mature fish spawn
aging_time 1 # Age incrementation occurs in time step 1
growth_props 0 0.167 0.5 # proportion of growth that occurs at each time step, so in step 3 mean wgt of 2 yr fish is estimated as Xwgt of 2.5
M_props 0.083 0.167 0.75 # Natural mortality:1 month, 2 month, rest of year. Zum=1
baranov FALSE # Use Pope.s approximation
midmortality_partition weighted_sum
fishery_names Headboat1 Headboat2 Headboat3 Handline1 Handline2 Handline3 Longline1 Longline2 Longline3 MRFSS Others # Fishery(ies) and names
fishery_times 3 3 3 3 3 3 3 3 3 3 3 # and occurs in the ith time step (see above time_steps)
fishery_areas GOM # in the area labelled GOM
n_migrations 0 # No migrations are defined
disease_mortality_time 3

RECRUITMENT
@y_enter 1 # Recruits enter at age 1
@standardise_YCS TRUE # Use the Haist parameterisation of YCS
@recruitment # the two following lines define the starting values for recruitment for the years 1962-2007
YCS_years 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
YCS 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
first_free 1962 # with standardisation occurring over the years
last_free 2007 # 1962-2007
p_male 0.5 # Not use because is not a sex-based model
sigma_r 0.6 # Standard deviation of YCS for projections
SR BH # Use the Beverton-Holt stock-recruit relationship
steepness 0.6 # with a steepness parameter of 0.6

RECRUITMENT VARIABILITY
@randomisation_method lognormal # Use the lognormal distribution when assigning YCS to unknown years during projections
@first_random_year 2008 # Defines the first unknown YCS as 2008

#MATURATION
@maturity_props # maturity female proportion at Age block command when maturity is NOT a partition character
all allvalues 0 0 0.168088509 0.72844989 0.949653936 1 0.997067985 0.965750374 0.907278972 0.819894879 0.706144695 0.575246202

NATURAL MORTALITY
@natural_mortality
ogive_all allvalues 0.48345646 0.344857366 0.276973935 0.236894252 0.210618618 0.192203152 0.178688754 0.168434369 0.160455642 0.154125772 0.14902639 0.134358941

DISEASE MORTALITY
@disease_mortality # 2005 red tide event treated as disease
DM 0.12 # initial guess for disease mortality rate
selectivity RedTideSel # specifiy selectivity pattern for red tide
years 2005 # DM only occurs in 2005
index 1 # relative value of DM for each year

FISHERIES DEFINITIONS
@fishery Headboat1 # Define the catch from the Headboat for years 1986-1989 Enter values in MT using the depth matrix discards!
years 1986 1987 1988 1989
catches 123.691 81.898 64.525 131.037
selectivity HeadboatSel1 # Defines that the catch is removed from the population using the selectivity defined by the label HeadboatSell
U_max 0.9 # with a maximum possible exploitation rate of 1.0

@fishery Headboat2 # Define the catch from the Headboat for years 1990-1999 Enter values in MT using the depth matrix discards!
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
catches 91.557 47.622 54.868 77.465 83.166 57.754 51.933 44.398 111.404 90.409
selectivity HeadboatSel2 # Defines that the catch is removed from the population using the selectivity defined by the label HeadboatSel2

U_max 0.9 # with a maximum possible exploitation rate of 1.0

@fishery Headboat3 # Define the catch from the Headboat for years 2000-2008 Enter values in MT using the depth matrix discards!
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 92.729 55.172 38.679 59.684 84.094 59.985 24.366 41.051 58.067
selectivity HeadboatSel3 # Defines that the catch is removed from the population using the selectivity defined by the label HeadboatSel3
U_max 0.9 # with a maximum possible exploitation rate of 1.0
future_years 2009 2010 2011 2012 2013 2014 # Defines the future years and
future_catches 0 0 0 0 0 0

@fishery Handline1 # Define the catch from the Handline for years 1963-1989
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989
catches 581.952 736.217 816.063 651.401 510.785 529.298 608.599 568.517 612.213 650.686 481.352 526.244 644.052 520.314 433.662 387.146 599.716 589.578 671.627 598.173 462.857 490.228 627.964 523.249 381.117 355.215 554.944
selectivity HandlineSel1 # Defines that the catch is removed from the population using the selectivity defined by the label HandlineSel1
U_max 0.9 # with a maximum possible exploitation rate of 1.0

@fishery Handline2 # Define the catch from the Handline for years 1990-1999
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
catches 508.716 449.033 450.039 579.416 519.811 524.096 499.357 497.363 834.334 664.408
selectivity HandlineSel1 # Defines that the catch is removed from the population using the selectivity defined by the label HandlineSel2
U_max 0.9 # with a maximum possible exploitation rate of 1.0

@fishery Handline3 # Define the catch from the Handline for years 2000-2008
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 724.128 938.966 859.998 656.085 789.747 701.293 365.001 339.297 395.366

selectivity HandlineSel3 # Defines that the catch is removed from the population using the selectivity defined by the label HandlineSel3
U_max 0.9 # with a maximum possible exploitation rate of 1.0
future_years 2009 2010 2011 2012 2013 2014 # Defines the future years and
future_catches 0 0 0 0 0 0 # catches for use in projections

@fishery Longline1 # Define the catch from the Longline for years 1980-1989
years 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989
catches 40.013 209.812 454.083 305.539 191.433 167.917 231.290 295.402 182.261 190.634
selectivity LonglineSel1 # Defines that the catch is removed from the population using the selectivity defined by the label LonglineSel1
U_max 0.9 # with a maximum possible exploitation rate of 0.9

@fishery Longline2 # Define the catch from the Longline for years 1990-1999
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
catches 280.067 228.814 267.708 216.605 158.685 176.439 177.507 186.771 267.095 242.897
selectivity LonglineSel1 # Defines that the catch is removed from the population using the selectivity defined by the label LonglineSel2
U_max 0.9 # with a maximum possible exploitation rate of 0.9

@fishery Longline3 # Define the catch from the Longline for years 2000-2008
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 262.379 440.029 474.859 508.261 511.502 407.883 240.346 219.051 158.442
selectivity LonglineSel1 # Defines that the catch is removed from the population using the selectivity defined by the label LonglineSel3
U_max 0.9 # with a maximum possible exploitation rate of 0.9
future_years 2009 2010 2011 2012 2013 2014 # Defines the future years and
future_catches 0 0 0 0 0 0 # catches for use in projections

@fishery MRFSS # Define the catch from the recreational for years 1963-2008
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

catches 188.512 203.608 219.914 237.525 256.547 277.092 294.777 313.444 352.572 396.564 445.846 501.302 563.471 634.560 714.671 805.934 908.297 1020.282 784.815 1366.964 2803.758 828.175 2930.620 1407.599 1060.154 1514.286 852.498 522.163 1267.570 1025.351 1260.617 971.398 1400.619 1182.003 1232.381 1752.163 1728.842 2344.504 2215.532 2473.314 2554.380 3321.618 2301.630 1853.696 2176.511 3003.920
selectivity MRFSSSel # Defines that the catch is removed from the population using the selectivity defined by the label MRFSSSel
U_max 0.9 # with a maximum possible exploitation rate of 0.9
future_years 2009 2010 2011 2012 2013 2014 # Defines the future years and
future_catches 0 0 0 0 0 0 # catches for use in projections

@fishery Others # Define the catch from the Others for years 1963-2008
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
catches 0.548 4.120 0.237 0.478 3.780 1.762 1.433 1.030 1.162 1.801 2.232 0.617 1.916 0.326 2.823 3.888 3.048 4.460 5.637 5.736 7.840 7.190 10.815 11.758 11.419 9.228 11.846 16.406 25.799 27.864 46.562 53.104 46.748 29.756 36.945 36.794 29.483 39.239 45.339 28.013 29.571 32.969 31.307 25.050 20.399 19.283
selectivity OthersSel # Defines that the catch is removed from the population using the selectivity defined by the label OthersSel
U_max 0.9 # with a maximum possible exploitation rate of 0.9
future_years 2009 2010 2011 2012 2013 2014 # Defines the future years and
future_catches 0 0 0 0 0 0 # catches for use in projections

SELECTIVITIES DEFINITIONS
@selectivity_names HeadboatSel1 HeadboatSel2 HeadboatSel3 HandlineSel1 HandlineSel3 LonglineSel1 MRFSSSel OthersSel Age0Sel RedTideSel
@selectivity HeadboatSel1 # Headboat1 size base
all size_based double_logistic 47.1744 11.7171 42.6078 19.9973 0.950034
@selectivity HeadboatSel2 # Headboat2 size base
all size_based double_logistic 50 10.4419 49.6964 19.7737 0.950226
@selectivity HeadboatSel3 # Headboat3 size base
all size_based double_logistic 49.3863 13.1339 41.0593 19.3723 0.950098
@selectivity HandlineSel1 # Handline1 size base
all size_based double_logistic 69.9999 15.9305 127.757 9.25621 0.951902

@selectivity HandlineSel3 # Handline3 size base
all size_based double_logistic 69.4984 11.8235 40.0029 19.9991 0.951448
@selectivity LonglineSel1 # Longline1 size base only one selectivity for longline
all size_based logistic 80.5853 16.4624
@selectivity MRFSSSel # Recreational fisheries size base
all size_based double_logistic 49.3419 14.8224 50.7371 20 0.950139
@selectivity OthersSel # Others Age based
all double_logistic 4.1129 1.41494 1.63368 4.99809 0.95
@selectivity Age0Sel # Age-0 index age based
all allvalues 1 0 0 0 0 0 0 0 0 0 0 0
@selectivity RedTideSel # 2005 red tide event age based
all constant 1

SIZE AT AGE
@size_at_age_type von_Bert # Defines that the age-length relationship as von Bertalanffy type
@size_at_age_dist normal # von-Bertalanffy combined sex
@size_at_age #
k 0.14 # units in cm and year
t0 -0.39
Linf 130
cv 0.1

SIZE-WEIGHT
@size_weight # Defines the length-weight relationship: units TL size(cm) and gutted weight (Kg) * 0.001 to match Metric tonns
a 7.9860000E-09
b 3.089
verify_size_weight 50 1.4 1.7 # Check that these values are correct, by confirming that a 50 cm fish has a weight between 1.4 and 1.7 kgs

Red tide estimation file

```
# ESTIMATION
@estimator likelihood      # Use the ML estimation method
@max_iters 1000      # With maximum of 300 iterations for the point estimates [these are default values of CASAL]
@max_evals 3000      # and 1000 function evaluations
@grad_tol 0.0002      # Set the tolerance for the convergence test at 0.0002


@profile
parameter initialization.Binitial
l 40000
u 75000
n 25


{
@MCMC
start 0      #Start the MCMC at 0
length 310000      #and evaluate for 110000 steps
keep 100      #keeping every 100th sample
stepsize 0.02      #with the stepsize for the MCMC set at 0.02
adaptive_stepsize TRUE      #but adapt the stepsize during the evaluation
adapt_at 5000      #after the 5000th step
burn_in 500      #The MCMC has a burn-in period of 500*500=250000 steps
}

# OBSERVATIONS: CPUE standardized series
@relative_abundance HeadboatCPUE1      #Define a relative abundance series HeadboatCPUE
biomass FALSE      # This time series is a number of fish index
q  HeadboatCPUE1q      # and has a relativity constant called HeadboatCPUEq
step 3      # Occurs in time step 3
proportion_mortality 0.5      # after 0.5 of mortality has been recorded in that time step
area GOM      # Occurs in the area called GOM
```

ogive HeadboatSel1 # and is applied with the selectivity HeadboatSel
years 1986 1987 1988 1989
1986 978
1987 1205
1988 950
1989 866
cv_1986 0.293
cv_1987 0.219
cv_1988 0.284
cv_1989 0.315
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HeadboatCPUE2 # Define a relative abundance series HeadboatCPUE
biomass FALSE # This time series is a number of fish index
q HeadboatCPUE2q # and has a relativity constant called HeadboatCPUEq
step 3 # Occurs in time step 3
proportion_mortality 0.5 # after 0.5 of mortality has been recorded in that time step
area GOM # Occurs in the area called GOM
ogive HeadboatSel2 # and is applied with the selectivity HeadboatSel
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
1990 691
1991 606
1992 705
1993 836
1994 868
1995 866
1996 1331
1997 1339
1998 1262
1999 1258
cv_1990 0.33
cv_1991 0.36

cv_1992 0.354
cv_1993 0.297
cv_1994 0.303
cv_1995 0.307
cv_1996 0.182
cv_1997 0.176
cv_1998 0.197
cv_1999 0.185
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HeadboatCPUE3 # Define a relative abundance series HeadboatCPUE
biomass FALSE # This time series is a number of fish index
q HeadboatCPUE3q # and has a relativity constant called HeadboatCPUEq
step 3 # Occurs in time step 3
proportion_mortality 0.5 # after 0.5 of mortality has been recorded in that time step
area GOM # Occurs in the area called GOM
ogive HeadboatSel3 # and is applied with the selectivity HeadboatSel
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
2000 1134
2001 866
2002 843
2003 1188
2004 1420
2005 1571
2006 653
2007 590
2008 735
cv_2000 0.269
cv_2001 0.258
cv_2002 0.248
cv_2003 0.174
cv_2004 0.142

cv_2005 0.117
cv_2006 0.324
cv_2007 0.351
cv_2008 0.215
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance HandlineCPUE2 # Define a relative abundance series HandlineCPUE
biomass TRUE # This time series is an abundance index
q HandlineCPUE2q # and has a relativity constant called HandlineCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive HandlineSel1 # and is applied with the selectivity HandlineSel
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
1990 713.773496
1991 518.51741
1992 758.3730385
1993 1026.548488
1994 856.316818
1995 849.0176594
1996 977.795241
1997 1035.911552
1998 1726.351235
1999 1176.379906
cv_1990 0.106663516
cv_1991 0.104629504
cv_1992 0.085100502
cv_1993 0.065513292
cv_1994 0.067821527
cv_1995 0.066145075
cv_1996 0.061352814
cv_1997 0.059640636

```
cv_1998 0.056870633
cv_1999 0.058099475
dist lognormal        # where the CVs have lognormal distribution
cv_process_error 0        # and there is no process error applied

@relative_abundance HandlineCPUE3        # Define a relative abundance series HandlineCPUE
biomass TRUE        # This time series is an abundance index
q HandlineCPUE3q              # and has a relativity constant called HandlineCPUEq
step 3        # Occurs in time step 1
proportion_mortality 0.5        # after all mortality has been recorded in that time step
area GOM        # Occurs in the area GOM
ogive HandlineSel3        # and is applied with the selectivity HandlineSel
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
2000 817.8408336
2001 1246.441802
2002 1236.288078
2003 1134.842842
2004 1433.900705
2005 1430.92828
2006 654.6203051
2007 488.3282328
2008 556.8089213
cv_2000 0.065216631
cv_2001 0.055674393
cv_2002 0.057148135
cv_2003 0.057043113
cv_2004 0.056077944
cv_2005 0.056854843
cv_2006 0.062964784
cv_2007 0.06835717
cv_2008 0.068570411
dist lognormal        # where the CVs have lognormal distribution
cv_process_error 0        # and there is no process error applied
```

```
@relative_abundance LonglineCPUE2     # Define a relative abundance series LonglineCPUE
biomass TRUE     # This time series is an abundance index
q LonglineCPUE2q        # and has a relativity constant called LonglineCPUEq
step 3     # Occurs in time step 1
proportion_mortality 0.5     # after all mortality has been recorded in that time step
area GOM     # Occurs in the area GOM
ogive LonglineSel1     # and is applied with the selectivity LonglineSel
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
1990 1263.523789
1991 850.0694464
1992 706.3735006
1993 976.0239485
1994 541.0972395
1995 743.9076204
1996 877.7620519
1997 874.6732391
1998 1529.127814
1999 1183.686171
cv_1990 0.332
cv_1991 0.331
cv_1992 0.417
cv_1993 0.18
cv_1994 0.232
cv_1995 0.202
cv_1996 0.154
cv_1997 0.154
cv_1998 0.12
cv_1999 0.136
dist lognormal     # where the CVs have lognormal distribution
cv_process_error 0     # and there is no process error applied

@relative_abundance LonglineCPUE3     # Define a relative abundance series LonglineCPUE
```

biomass TRUE # This time series is an abundance index
q LonglineCPUE3q # and has a relativity constant called LonglineCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive LonglineSel1 # and is applied with the selectivity LonglineSel
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
2000 635.249355
2001 1120.855944
2002 1081.469939
2003 1210.968536
2004 1350.618366
2005 1683.48523
2006 754.2080191
2007 674.1860195
2008 488.9585919
cv_2000 0.265381329
cv_2001 0.124665178
cv_2002 0.128056097
cv_2003 0.118490567
cv_2004 0.10691425
cv_2005 0.09902832
cv_2006 0.143956995
cv_2007 0.190505273
cv_2008 0.221178989
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance MRFSSCPUE # Define a relative abundance series MRFSSCPUE
biomass FALSE # This time series is numbers of fish
q MRFSSCPUEq # and has a relativity constant called MRFSSCPUEq
step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step

area GOM # Occurs in the area GOM
ogive MRFSSSel # and is applied with the selectivity MRFSSSel
years 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
1981 283.9410907
1982 258.0839508
1983 608.804323
1984 17.58948478
1985 30.22901882
1986 178.2244847
1987 161.8548086
1988 78.69299205
1989 293.7003074
1990 771.3870609
1991 632.2243031
1992 512.2904547
1993 1287.953429
1994 1737.212709
1995 1625.200987
1996 1411.981758
1997 1070.898956
1998 2095.554399
1999 1755.675591
2000 1009.388563
2001 815.1098728
2002 1542.284927
2003 1708.986249
2004 1691.494003
2005 2003.083604
2006 882.2529603
2007 1209.917123
2008 2325.98259
cv_1981 0.559665475

```
cv_1982 0.518658868
cv_1983 0.565407282
cv_1984 1.884536982
cv_1985 1.122431605
cv_1986 0.437071577
cv_1987 0.414111326
cv_1988 0.497908142
cv_1989 0.40636228
cv_1990 0.391567456
cv_1991 0.365799715
cv_1992 0.334396407
cv_1993 0.315304707
cv_1994 0.308092473
cv_1995 0.302538215
cv_1996 0.311931032
cv_1997 0.305180267
cv_1998 0.291862007
cv_1999 0.28987201
cv_2000 0.296545893
cv_2001 0.299114242
cv_2002 0.287326467
cv_2003 0.287657633
cv_2004 0.289147096
cv_2005 0.287544325
cv_2006 0.300119351
cv_2007 0.293877399
cv_2008 0.290299708
dist lognormal        # where the CVs have lognormal distribution
cv_process_error 0        # and there is no process error applied

@relative_abundance VideoCPUE        # Define a relative abundance series VideoCPUE
biomass FALSE        # This time series is number of fish index
q VideoCPUEq              # and has a relativity constant called VideoCPUEq
```

step 3 # Occurs in time step 1
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive LonglineSel1 # and is applied with the selectivity LonglineSel
years 1993 1994 1995 1996 1997 2002 2004 2005 2006 2007 2008
1993 783.1599063
1994 602.8152274
1995 528.0881856
1996 1030.412846
1997 1100.397348
2002 1884.454491
2004 2288.083059
2005 1099.500111
2006 687.155525
2007 811.7433202
2008 184.1899812
cv_1993 0.42345
cv_1994 0.52547
cv_1995 0.3571
cv_1996 0.28115
cv_1997 0.30794
cv_2002 0.18133
cv_2004 0.17472
cv_2005 0.1877
cv_2006 0.25368
cv_2007 0.19289
cv_2008 0.51977
dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

@relative_abundance CopperBCPUE # Define a relative abundance series CopperBCPUE
biomass FALSE # This time series is number of fish index
q VideoCPUEq # and has the same q as the VideoCPUEq index

```
step 3        # Occurs in time step 1
proportion_mortality 0.5        # after all mortality has been recorded in that time step
area GOM        # Occurs in the area GOM
ogive LonglineSel1        # and is applied with the selectivity LonglineSel
years 1993 1994 1995 1996 1997 2002 2004 2005 2006 2007 2008
1993 1444.204409
1994 934.270981
1995 778.6159178
1996 1017.351642
1997 636.6635306
2002 1099.358096
2004 2182.969906
2005 1177.748931
2006 531.4961474
2007 932.1487692
2008 265.1716705
cv_1993 0.39865
cv_1994 0.57995
cv_1995 0.49462
cv_1996 0.40952
cv_1997 0.57115
cv_2002 0.35756
cv_2004 0.28173
cv_2005 0.25998
cv_2006 0.38507
cv_2007 0.26569
cv_2008 0.61238
dist lognormal        # where the CVs have lognormal distribution
cv_process_error 0        # and there is no process error applied

@relative_abundance Age0CPUE        # Define a relative abundance series Age0CPUE
biomass FALSE        # This time series is number of fish index
q Age0CPUEq            # and has the q Age0CPUEq
```

step 3 # Occurs in time step 3
proportion_mortality 0.5 # after all mortality has been recorded in that time step
area GOM # Occurs in the area GOM
ogive Age0Sel # and is applied with the selectivity Age0Sel
years 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
1995 1064.62
1996 662.77
1997 1025.49
1998 480.58
1999 304.42
2000 393.36
2001 641.65
2002 590.69
2003 2198.29
2004 904.29
2005 1235.79
2006 619.94
2007 1532.15
2008 2239.8
cv_1995 0.35931
cv_1996 0.30862
cv_1997 0.2319
cv_1998 0.28161
cv_1999 0.46871
cv_2000 0.38535
cv_2001 0.3525
cv_2002 0.44922
cv_2003 0.21818
cv_2004 0.25976
cv_2005 0.22114
cv_2006 0.26892
cv_2007 0.18965
cv_2008 0.16063

dist lognormal # where the CVs have lognormal distribution
cv_process_error 0 # and there is no process error applied

#OBSERVATIONS: Proportions at age for each fishery [partial catches in VPA2Box program]
@catch_at Handline1CAA # Partial catch-at-age for the handline1 fishery
years 1984 1985 1986 1987 1988 1989 # index years
fishery Handline1 # Apply to the fishery Handline
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
#Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0 0.031189417 0.007269928 0.077004219 0.171627324 0.205781731 0.15544817 0.102563006 0.096789828 7.12738E-05 0.013613297 0.138641806
1985 0 0.007341921 0.018343941 0.125171058 0.11812238 0.29845559 0.10031062 0.104959055 0.099300563 0.029704368 0.015129135 0.08316137
1986 0 0.008645638 0.029884362 0.209021009 0.194018284 0.150124115 0.184985167 0.015317552 0.123993461 0 0 0.084010414
1987 0 0.010230783 0.023986916 0.018626204 0.150027258 0.194312193 0.319189533 0.062638561 0.149845539 0.00238052 0.03327276 0.035489733
1988 0 0.042396994 0.085271823 0.008796507 0.088746986 0.179492192 0.19102539 0.184466019 0.066918616 0.079277166 0 0.073608306
1989 0 0.043363584 0.007510394 0.010654626 0.06509008 0.174616657 0.215953626 0.182574098 0.105994904 0.089588269 0.028596123 0.076057639
N_1984 200 # effective sample size
N_1985 200
N_1986 200
N_1987 200
N_1988 200
N_1989 200
dist multinomial

r 0.00001

@catch_at Handline2CAA # Partial catch-at-age for the handline2 fishery
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 # index years
fishery Handline2 # Apply to the fishery Handline
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
#Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1990 0 0.028908099 0.00527544 0.008151459 0.068432816 0.167647252 0.226186563 0.18031817 0.11632264 0.087365238 0.033608336 0.077783986
1991 0 0 0 0.087320976 0.087229365 0.466088497 0.074663328 0.108467951 0.039392921 0.055501267 0.006046355 0.075289339
1992 0 0.012021128 0.156699654 0.083055066 0.185371259 0.148093619 0.192019307 0.070806266 0.012810394 0.012628256 0.046475624 0.080019428
1993 0 0.002227824 0.056856572 0.394220209 0.066803334 0.13587633 0.094572687 0.127268353 0.050842494 0.008660273 0.004738048 0.057933877
1994 0 0 0.034005515 0.114646263 0.529458817 0.080882817 0.069189804 0.039194224 0.055854927 0.02440693 0.026206664 0.02615404
1995 0 0 0.180211866 0.186953063 0.112412595 0.257756563 0.086421304 0.042687267 0.039934263 0.035045849 0.001580622 0.056996608
1996 0 0.00021005 0.140464968 0.3681345 0.19226342 0.098328838 0.130164091 0.017215739 0.032440199 0.000579739 0.001134273 0.019064183
1997 0 0 0.203631942 0.358432695 0.022168183 0.236280201 0.057020709 0.092155632 0 0.006981487 0.005530279 0.01779887
1998 0 0.021049611 0.057558491 0.237095072 0.472330112 0.085325736 0.042693612 0.028412876 0.010668279 0.00806526 0.004355445 0.032445506
1999 0 0.026214984 0.019466855 0.127586723 0.31176928 0.359733784 0.059456298 0.034354113 0.020422721 0.01150606 0.00569953 0.023789652
N_1990 200
N_1991 200
N_1992 200

N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
dist multinomial
r 0.00001

@catch_at Handline3CAA # Partial catch-at-age for the handline3 fishery
years 2000 2001 2002 2003 2004 2005 2006 2007 2008 # index years
fishery Handline3 # Apply to the fishery Handline
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
#Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
2000 0 0.027496879 0.072543412 0.420379263 0.128785527 0.136196408 0.120747165 0.048593452 0.009683023 0.007556193 0.011017246 0.017001433
2001 0 0.00052336 0.021295882 0.083635029 0.521924453 0.10076022 0.11839798 0.087136683 0.01922942 0.019661057 0.006765907 0.020670008
2002 0 0.00380722 0.037566706 0.066680744 0.238210415 0.437100882 0.079094202 0.063199857 0.03784185 0.007851192 0.005086958 0.023559975
2003 0 0.000663683 0.015936899 0.195616289 0.125002127 0.294658203 0.244933036 0.046738594 0.023050219 0.019663734 0.006730426 0.02700679
2004 0 0.00147749 0.030733129 0.134999799 0.373129738 0.118098918 0.153491824 0.121969808 0.028092367 0.011251655 0.008684432 0.018070839
2005 0 0 0.009475735 0.081497762 0.206203909 0.393544907 0.083027405 0.095723441 0.060082762 0.024643352 0.013895598 0.03190513

2006 0 0 0.014264069 0.138600223 0.192289444 0.314146222 0.181667917 0.049511012 0.039318018 0.029477035 0.009259401 0.031466659
2007 0 0.001592408 0.031425693 0.134168535 0.355204576 0.1547886 0.154918592 0.077118066 0.02312242 0.023024926 0.016817783 0.0278184
2008 0 0.001449683 0.029514426 0.136129486 0.225812808 0.387572132 0.076523575 0.069176636 0.029964814 0.008655876 0.006938776 0.028261787
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at Headboat1CAA # Partial catch-at-age for the headboat1 fishery
years 1986 1987 1988 1989
fishery Headboat1 # Occurs in the fishery headboat
at_size FALSE
sexed FALSE # Observations for combined sexes
plus_group TRUE # Oldest group is a plus group
sum_to_one TRUE # Enter as age proportion of the total annual catches
min_class 1 # Mininum age class
max_class 12 # Maximum age class
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1986 0.011918311 0.151802779 0.351923036 0.076040973 0.278931432 0.023450083 0.069641592 0.003478858 0.007043615 0.018575386 0.004337836 0.0028561
1987 0.03905832 0.130224125 0.291897033 0.318887105 0.103679924 0.05201831 0.03668034 0 0.016913382 0 0 0.01064146
1988 0 0.131985731 0.233884625 0.529996757 0.021583252 0.02205167 0.04914784 0.000252225 3.60321E-05 0 0 0.011061867

1989 0.033742576 0.165197475 0.264321287 0.065194812 0.144184932 0.165011052 0.054195851 0.050201071 0.023622467 0.012037604 0 0.022290873
N_1986 200
N_1987 200
N_1988 200
N_1989 200
dist multinomial
r 0.00001

@catch_at Headboat2CAA # Partial catch-at-age for the headboat2 fishery
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
fishery Headboat2
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1990 0 0.026946009 0.398721876 0.202424482 0.024475409 0.263300063 0 0.08040979 0.000856475 0 0 0.002865896
1991 0.015486164 0.244986037 0.069645426 0.19708894 0.067191335 0.254717779 0.054497757 0.031395447 0.030718456 0 0.002877211 0.031395447
1992 0.029665653 0.140303951 0.430334347 0.060911854 0.154893617 0.064072948 0.083768997 0.005349544 0.000790274 0.001762918 0 0.028145897
1993 0.008027075 0.118019699 0.134420966 0.510478587 0.084175815 0.058879681 0.02889747 0.033757105 0.005467089 0.000997961 0 0.016878553
1994 0.007305476 0.058443808 0.264099254 0.205970337 0.361684038 0.069181598 0.011965866 0.006581226 0.001102119 0 0.006990585 0.006675694
1995 0 0.161939394 0.360525253 0.201373737 0.087676768 0.164040404 0.009777778 0.001979798 0.007191919 0.001979798 0.003515152 0
1996 0 0.007796305 0.541189725 0.326949076 0.068544389 0.022487607 0.030824696 0.000630915 0 0.000450653 0 0.001126634
1997 0 0.198664681 0.047888948 0.649550891 0.069071521 0.010375138 0.018876987 0.005571833 0 0 0 0
1998 0.093343563 0.10550742 0.239309841 0.264011827 0.257855044 0.028276288 0.00340588 0.005688942 0 0 0 0.002601194

1999 0 0.055540179 0.571570256 0.156149091 0.143486484 0.060891226 0.007565274 0.001545346 0.001799059 0 0 0.001453086
N_1990 200
N_1991 200
N_1992 200
N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
dist multinomial
r 0.00001

@catch_at Headboat3CAA # Partial catch-at-age for the headboat3 fishery
years 2000 2001 2002 2003 2004 2005 2006 2007 2008 # index years
fishery Headboat3
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
2000 0.014446095 0.243492378 0.124594134 0.482747235 0.016427274 0.078861923 0.027708987 0 0 0.00781465 0 0.003907325
2001 0.001915097 0.059740398 0.106447494 0.244866475 0.415576125 0.097137993 0.050058517 0.019736142 0 0.000904352 0
0.003617406
2002 0.039602811 0.10481389 0.556297544 0.10394286 0.120202079 0.063991638 0.005632658 0.000812961 0.002438883 0 0
0.002264677
2003 0.051100863 0.076130616 0.384967272 0.36480958 0.033546564 0.040724487 0.035852425 0.003198453 0.006396906 0 0
0.003272835
2004 0.026338663 0.142334132 0.286775358 0.267706166 0.23257039 0.022888298 0.015092054 0.00611057 0 0.000184371 0 0

2005 0.009208371 0.092920837 0.321528662 0.333575978 0.172156506 0.048480437 0.01266606 0.000545951 0.005787079 0 0 0.003130118
2006 0.001988665 0.224719101 0.156607338 0.351894203 0.128070001 0.076066421 0.045838719 0 0.008750124 0.004176196 0 0.001889231
2007 0.100611829 0.148538409 0.356560163 0.171651937 0.159811919 0.029231815 0.013709495 0.003172445 0 0.005041922 0 0.011670066
2008 0 0.040943843 0.616369775 0.150386153 0.113827764 0.053634494 0 0 0 0 0 0.024837971
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at Longline1CAA # Partial catch-at-age for the Longline1 fishery
years 1984 1985 1986 1987 1988 1989
fishery Longline1
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0 0.006079907 0.033294731 0.116451136 0.226725857 0.226983208 0.136138455 0.096184778 0.022518175 0.037862703 0.029917004 0.067844046
1985 0 0.011379752 0.018712601 0.299436201 0.199024593 0.213932413 0.006191415 0.074469925 0.023900937 0.000103767 0.019438968 0.133409429

1986 0 0.003419353 0.040038577 0.042698074 0.178127831 0.30636818 0.077476108 0.212642838 0.030598825 2.92252E-05 0.01706754 0.091533448
1987 0 0 0.033460476 0.018913587 0.086544785 0.124214126 0.426594765 0.066052874 0.078916217 0.01231093 0.020886492 0.132105748
1988 0 0.034790172 0.000739291 0.081930855 0.031311155 0.218090889 0.174646662 0.134681452 0.202304849 0.001869972 0 0.119634703
1989 0 0.024583155 0.011586148 0.058016246 0.052116289 0.20076956 0.166908935 0.151988029 0.187302266 0.002052159 0.046472852 0.098204361
N_1984 200 # effective sample size
N_1985 200
N_1986 200
N_1987 200
N_1988 200
N_1989 200
dist multinomial
r 0.00001

@catch_at Longline2CAA # Partial catch-at-age for the Longline2 fishery
years 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
fishery Longline2
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1990 0 0.005389418 0.009168584 0.007492606 0.01610253 0.108774236 0.230529083 0.063621426 0.430266185 0.017844233 3.28623E-05 0.110778837
1991 0 0 0 0.016531176 0.050954919 0.333735268 0.096230892 0.160605236 0.067991754 0.102104321 0.011046715 0.16079972
1992 0 0.001585065 0.017259598 0.022296583 0.151497006 0.16555125 0.225995069 0.101232828 0.017013033 0.025255372 0.105494893 0.166819303

1993 0 0.000744756 0.024245935 0.143448219 0.054698167 0.129711614 0.15341967 0.213207001 0.123091564 0.025942323 0.013488353 0.1180024
1994 0 0 0.013364596 0.062743259 0.372520516 0.077373974 0.113903869 0.088722157 0.121594373 0.058475967 0.054724502 0.036576788
1995 0 0 0.03770127 0.123663656 0.100667627 0.253436314 0.106296636 0.083518785 0.083911507 0.089671423 0.002661779 0.118471004
1996 0 0 0.034247143 0.142040749 0.193887693 0.146844459 0.292115289 0.036483353 0.09131191 0.002194799 0.00575617 0.055118436
1997 0 0 0.069999602 0.171578571 0.031022551 0.180368293 0.139720797 0.246311101 0 0.037465696 0.030425963 0.093107426
1998 0 0.00608485 0.026311341 0.134796327 0.303397374 0.10682292 0.108879373 0.086596428 0.040368471 0.034142769 0.006338385 0.146261761
1999 0 0.004113872 0.005923976 0.051143656 0.170939608 0.352476551 0.102682245 0.08194833 0.068191542 0.041303275 0.02024025 0.101036696
N_1990 200
N_1991 200
N_1992 200
N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
dist multinomial
r 0.00001

@catch_at Longline3CAA # Partial catch-at-age for the Longline3 fishery
years 2000 2001 2002 2003 2004 2005 2006 2007 2008
fishery Longline3
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE

min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
2000 0 0.006409841 0.0168663 0.14972483 0.12149563 0.146714147 0.21113629 0.12988022 0.040012949 0.034541923 0.046293299 0.096924571
2001 0 0.000337388 0.010512297 0.040699636 0.275805736 0.106365977 0.168676196 0.174234218 0.04592027 0.054763385 0.024114357 0.098570541
2002 0 0.001421041 0.018242205 0.034699846 0.146301162 0.347378509 0.117401147 0.110742081 0.079677457 0.026537121 0.016722021 0.10087741
2003 0 0.000699173 0.00860287 0.087259849 0.078322592 0.26615698 0.281994771 0.084584752 0.04790856 0.047862962 0.018953672 0.077653818
2004 0 0.000430427 0.019042672 0.07612616 0.235769944 0.117714286 0.177202226 0.175332096 0.05058256 0.02806679 0.027265306 0.092467532
2005 0 0 0.007804284 0.055386432 0.1420638 0.288352613 0.088891349 0.136897843 0.105127212 0.053836645 0.035257652 0.08638217
2006 0 0 0.010481166 0.091718266 0.122291022 0.221104231 0.180663055 0.080721104 0.084333075 0.083268834 0.028605521 0.096813725
2007 0 0.000593494 0.022626952 0.064023146 0.197447977 0.150599058 0.182202604 0.119218072 0.046403798 0.0564561 0.049927668 0.110501131
2008 0 0.000311931 0.012269301 0.066753314 0.126852093 0.286820899 0.121185339 0.121393293 0.08172602 0.029217572 0.027345984 0.126124253
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at MRFSSCAA # Partial catch-at-age for the Mrfss fishery
years 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
fishery MRFSS
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0.146471297 0.167223098 0.173115089 0.238464868 0.171359238 0.033627005 0.033129308 0.017954187 0.000967572 9.27386E-06 2.47303E-05 0.017654332
1985 0.082446305 0.189257273 0.092802305 0.227729648 0.224864965 0.119809344 0.012252215 0.013523329 0.016991103 0.004447247 1.54074E-05 0.015860858
1986 0.180288444 0.218892674 0.226663815 0.151248918 0.148138727 0.041892187 0.012369945 0.013481347 1.44526E-06 0 1.01168E-05 0.007012382
1987 0.181512953 0.202925552 0.193151895 0.166346332 0.13562258 0.082770657 0.01171748 0.010740115 0.003409872 0.003442596 1.7453E-05 0.008342514
1988 0.150696536 0.22702398 0.196627639 0.14129612 0.172985683 0.037896381 0.049010355 0.006285733 0.002551012 0 1.12734E-05 0.015615287
1989 0.261748437 0.233104464 0.153344136 0.147514863 0.132169613 0.04121373 0.004666867 0.017069158 2.46273E-06 0.003452743 1.47764E-05 0.005698749
1990 0.143595321 0.156242577 0.349435145 0.120559396 0.118129956 0.059894238 0.022715055 0.018560421 0.000283365 0 0 0.010584524
1991 0.10618469 0.404761172 0.070839542 0.13719224 0.041855099 0.114175252 0.04806419 0.012122059 0.023043047 0.000573293 0.005199906 0.03598951
1992 0.056871657 0.218433873 0.440654905 0.048574191 0.115982398 0.038096565 0.045662846 0.004001425 0.001679313 0.001502543 0 0.028540283
1993 0.041285872 0.320255128 0.137320329 0.372331964 0.054441639 0.034605674 0.016778058 0.015211974 0.002958892 0.001305345 0 0.003505124
1994 0.054128426 0.210799138 0.238013958 0.171809721 0.265984367 0.044897987 0.006180855 0.004981102 0.00073687 0 0.001854937 0.00061264

1995 0 0.266927931 0.353656463 0.174916198 0.070028591 0.123168688 0.00761116 0 0 0 0.003690969 0
1996 0 0.009909112 0.647877969 0.227281792 0.04972071 0.019818223 0.032004315 0.000988483 0 0.005490418 0.000220241 0.006688737
1997 0 0.320431733 0.046170048 0.55705656 0.054107143 0.006875068 0.008232924 0.005151864 0 0 0 0.001974659
1998 0.100012027 0.119232542 0.251763406 0.282600528 0.212034482 0.020625492 0.003892426 0.004251121 0 0.00368913 0 0.001898848
1999 0.007243947 0.074166048 0.543387054 0.146243923 0.141391077 0.071306784 0.007533705 0.003606408 0.001679877 0 0.001870256 0.001570919
2000 0.016623702 0.281786807 0.126951478 0.456368805 0.020821789 0.071668634 0.020835843 0 0 0.00463476 0 0.000308181
2001 0.006297139 0.092376746 0.156063283 0.256087758 0.367830816 0.071849578 0.035187185 0.008679476 0 0.001454999 0 0.004173019
2002 0.095554641 0.124871418 0.455776405 0.096131078 0.124431812 0.081832721 0.008836762 0.000780228 0.007089012 0.000164974 0 0.004530951
2003 0.066313498 0.085735294 0.398085465 0.356039805 0.028026896 0.032024779 0.024009383 0.002690883 0.00338855 0 0.001293096 0.00239235
2004 0.00573948 0.08514254 0.332033802 0.297687031 0.244703318 0.016004793 0.011540205 0.004910905 4.36462E-05 0.000922907 0.000589928 0.000681444
2005 0.009305652 0.082124649 0.335538233 0.330912622 0.168661963 0.046352557 0.012358517 0.001355025 0.011020681 0 0 0.0023701
2006 0 0.076569606 0.249860881 0.433562073 0.13528471 0.051458044 0.029487142 0.002593332 0.005160745 0.006238632 0 0.009784834
2007 0.004260076 0.164792724 0.438992579 0.20948442 0.133341308 0.029715872 0.006178491 0.00518823 0 0.000273731 0 0.007772569
2008 0 0.015331036 0.59771341 0.196651719 0.141221273 0.04351281 0 0 0 0 0 0.005569752
N_1984 200
N_1985 200
N_1986 200
N_1987 200
N_1988 200
N_1989 200
N_1990 200
N_1991 200
N_1992 200

N_1993 200
N_1994 200
N_1995 200
N_1996 200
N_1997 200
N_1998 200
N_1999 200
N_2000 200
N_2001 200
N_2002 200
N_2003 200
N_2004 200
N_2005 200
N_2006 200
N_2007 200
N_2008 200
dist multinomial
r 0.00001

@catch_at OthersCAA # Partial catch-at-age for the Trap (other commercial) fishery
years 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
fishery Others
at_size FALSE
sexed FALSE
plus_group TRUE
sum_to_one TRUE
min_class 1
max_class 12
Year Age1 Age2 Age3 Age4 Age5 Age6 Age7 Age8 Age9 Age10 Age11 Age12
1984 0 0.001103753 0.123068433 0.249448124 0.415011038 0.091611479 0.0700883 0.015452539 0.007726269 0.007174393 0.004966887 0.014348786

1985 0 0.00070497 0.129009517 0.27035601 0.402537892 0.09058865 0.063799789 0.015509341 0.009164611 0.00211491 0.005992245 0.010222066
1986 0 0.001007388 0.10241773 0.26292814 0.435191404 0.074546676 0.084956347 0.013096038 0.004701142 0.005372733 0.003357958 0.012424446
1987 0 0.000676819 0.089001692 0.305245347 0.403384095 0.083248731 0.08392555 0.010829103 0.006091371 0.003045685 0.004399323 0.010152284
1988 0 0.00083091 0.098047362 0.306605733 0.395928542 0.086830079 0.079767345 0.012048193 0.004154549 0.002077275 0.004570004 0.009140008
1989 0 0.000960615 0.111111111 0.282100544 0.42010887 0.073326929 0.084854307 0.014409222 0.00128082 0.000960615 0.005123279 0.005763689
1990 0 0.000691882 0.121079336 0.277905904 0.411900369 0.06849631 0.093865314 0.014760148 0.000461255 0.000461255 0.005073801 0.005304428
1991 0 0 0 0.402315485 0.137916064 0.372069465 0.035600579 0.02301013 0.006367583 0.008248915 0.000434153 0.014037627
1992 0 0.058449466 0.288864836 0.2609931 0.163036125 0.073197132 0.124475714 0.006900284 0.003923691 0.001488297 0.007982682 0.010688675
1993 0 0.007753877 0.095964649 0.596464899 0.061697515 0.107136902 0.044272136 0.059696515 0.006836752 0.001917625 0.001417375 0.016841754
1994 0 0.000388863 0.0791725 0.18867631 0.51018821 0.078705864 0.059962669 0.019443148 0.027842588 0.007543942 0.013299113 0.014776793
1995 0 0 0.161595324 0.291473268 0.152398143 0.258208699 0.065669589 0.021746605 0.018222451 0.008681451 0.00034382 0.02166065
1996 0 0 0.103221649 0.343170103 0.268685567 0.119072165 0.122938144 0.015592784 0.014690722 0.000515464 0.000515464 0.011597938
1997 0 0 0.154101765 0.376116303 0.030114226 0.269470405 0.05576324 0.097923157 0 0.001246106 0.001038422 0.014226376
1998 0 0.021553125 0.071374418 0.248456623 0.461063576 0.09455215 0.04115672 0.025343875 0.007798115 0.004657208 0.004548901 0.019495289
1999 0 0.018960488 0.024264121 0.167594802 0.374966852 0.321665341 0.040837974 0.01935826 0.009811721 0.004640679 0.002916998 0.014982763
2000 0 0.039109447 0.133188848 0.502709093 0.096936262 0.0980199 0.080484681 0.023840016 0.004531573 0.004827111 0.00522116 0.011131908
2001 0 0.001132996 0.056214049 0.133432107 0.562140492 0.083754576 0.074341991 0.049503225 0.010109813 0.009586892 0.003224682 0.016559177

2002 0 0.020185488 0.127523186 0.156983088 0.262956901 0.335651937 0.037643208 0.025777414 0.014320786 0.003409711 0.001500273 0.014048009
2003 0 0.006447453 0.048355899 0.411863314 0.133978079 0.212765957 0.140812379 0.015087041 0.008897485 0.005802708 0.002192134 0.01379755
2004 0 0.011090573 0.074514787 0.220425139 0.418784658 0.091612754 0.093230129 0.058803142 0.010397412 0.004043438 0.003003697 0.01409427
2005 0 0 0.06684458 0.132926674 0.305883848 0.339179057 0.051976109 0.049307409 0.025797433 0.007116533 0.00406659 0.016901766
2006 0 0 0.04382716 0.354320988 0.191203704 0.233796296 0.111265432 0.022685185 0.015895062 0.008641975 0.002469136 0.015895062
2007 0 0.00381025 0.064964755 0.270908745 0.388835969 0.107068013 0.085159078 0.037911983 0.009525624 0.008192037 0.006477424 0.017146123
2008 0 0.013833992 0.119235837 0.311374616 0.18818621 0.236056214 0.048089592 0.04435661 0.013833992 0.002854633 0.003732982 0.018445323
N_1984 20
N_1985 20
N_1986 20
N_1987 20
N_1988 20
N_1989 20
N_1990 20
N_1991 20
N_1992 20
N_1993 20
N_1994 20
N_1995 20
N_1996 20
N_1997 20
N_1998 20
N_1999 20
N_2000 20
N_2001 20
N_2002 20

N_2003 20
N_2004 20
N_2005 20
N_2006 20
N_2007 20
N_2008 20
dist multinomial
r 0.00001

RELATIVITY CONSTANTS
@q_method nuisance # Use the nuisance method of estimating q

@estimate
parameter q[HeadboatCPUE1q].q # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1.00E-10 # with a lower bound
upper_bound 1.00E-02 # and upper bound
prior uniform-log # and use a uniform-log prior

@estimate
parameter q[HeadboatCPUE2q].q # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1.00E-10 # with a lower bound
upper_bound 1.00E-02 # and upper bound
prior uniform-log # and use a uniform-log prior

@estimate
parameter q[HeadboatCPUE3q].q # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1.00E-10 # with a lower bound
upper_bound 1.00E-02 # and upper bound
prior uniform-log # and use a uniform-log prior

@estimate
parameter q[HandlineCPUE2q].q # Estimate the parameter q[HandlineCPUEq].q when fitting the model

```
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[HandlineCPUE3q].q     # Estimate the parameter q[HandlineCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[LonglineCPUE2q].q     # Estimate the parameter q[LonglineCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[LonglineCPUE3q].q     # Estimate the parameter q[LonglineCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[MRFSSCPUEq].q     # Estimate the parameter q[MRFSSCPUEq].q when fitting the model
lower_bound 1.00E-12        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior

@estimate
parameter q[VideoCPUEq].q     # Estimate the parameter q[VideoCPUEq].q when fitting the model
lower_bound 1.00E-08        # with a lower bound
upper_bound 10        # and upper bound
prior uniform-log        # and use a uniform-log prior
```

```
@estimate
parameter q[Age0CPUEq].q
lower_bound 1.00E-08
upper_bound 10
prior uniform-log


#FREE PARAMETERS
@estimate
parameter initialization.B0        # Estimate B0
phase 1        # Estimate in first phase
lower_bound 1000        # Define the lower bound
upper_bound 200000        # Define the upper bound
prior uniform-log        # and use a uniform-log prior


@estimate
parameter initialization.Binitial        # Estimate Binitial
phase 1        # Estimate in first phase
lower_bound 1000        # Define the lower bound
upper_bound 100000        # Define the upper bound
prior uniform-log        # and use a uniform-log prior


@estimate
parameter recruitment.YCS        # Estimate YCS when fitting the model
lower_bound 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.1 0.1
upper_bound 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 100 100 100 100 100 100 100 100 100 100 100 100
100 100 100 100 100 100 100 100 100 100 100 10 10
prior lognormal
mu 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
cv 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0.5 0.5

@estimate
parameter disease_mortality.DM
lower_bound 0.01
upper_bound 0.3
prior uniform-log

@estimate
parameter recruitment.steepness
lower_bound 0.01
upper_bound 0.99
prior uniform-log

@estimate
parameter selectivity[HeadboatSel1].all        # Estimate the HeadboatSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 50 20 150 20 1     # upper bounds
prior uniform        # and they have uniform priors

@estimate
parameter selectivity[HeadboatSel2].all        # Estimate the HeadboatSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 50 20 150 20 1     # upper bounds
prior uniform        # and they have uniform priors

@estimate
parameter selectivity[HeadboatSel3].all        # Estimate the HeadboatSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 50 20 150 20 1     # upper bounds
prior uniform        # and they have uniform priors

@estimate
```

```
parameter selectivity[HandlineSel1].all         # Estimate the HandlineSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 70 20 150 20 1     # upper bounds
prior uniform         # and they have uniform priors


@estimate
parameter selectivity[HandlineSel3].all         # Estimate the HandlineSel ogive. Size base (cm)
lower_bound  1 0.8 40 0.8 0.01     # the five double_logistic parameters have lower and
upper_bound 70 20 150 20 1     # upper bounds
prior uniform         # and they have uniform priors

@estimate
parameter selectivity[LonglineSel1].all         # Estimate the LonglineSel ogive. Size base (cm)
lower_bound  20 5            # the two logistic parameters have lower and
upper_bound 140 50        # upper bounds
prior uniform         # and they have uniform priors

@estimate
parameter selectivity[MRFSSSel].all         # Estimate the MRFSSSel ogive. Size base (cm)
lower_bound  5 0.1 50 0.1 0.01     # the five double_logistic parameters have lower and
upper_bound 60 20 180 20 1     # upper bounds
prior uniform         # and they have uniform priors

@estimate
parameter selectivity[OthersSel].all         # Estimate the TrapSel ogive. Age base
lower_bound  0.01 0.01 1 0.01 0.01     # the five double_logistic parameters have lower and
upper_bound 6 5 16 5 1     # upper bounds
prior uniform         # and they have uniform priors


# PENALTIES
@catch_limit_penalty        # Penalise model fits that do not allow the Commercial Fishing catch to be taken
```

label Headboat1CatchMustBeTaken
fishery Headboat1
log_scale TRUE
multiplier 500

@catch_limit_penalty # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Headboat2CatchMustBeTaken
fishery Headboat2
log_scale TRUE
multiplier 1000

@catch_limit_penalty # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Headboat3CatchMustBeTaken
fishery Headboat3
log_scale TRUE
multiplier 1000

@catch_limit_penalty # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Handline1CatchMustBeTaken
fishery Handline1
log_scale TRUE
multiplier 500

@catch_limit_penalty # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Handline2CatchMustBeTaken
fishery Handline2
log_scale TRUE
multiplier 1000

@catch_limit_penalty # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Handline3CatchMustBeTaken
fishery Handline3
log_scale TRUE

```
multiplier 1000

@catch_limit_penalty    # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Longine1CatchMustBeTaken
fishery Longline1
log_scale TRUE
multiplier 500

@catch_limit_penalty    # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Longine2CatchMustBeTaken
fishery Longline2
log_scale TRUE
multiplier 1000

@catch_limit_penalty    # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label Longine3CatchMustBeTaken
fishery Longline3
log_scale TRUE
multiplier 1000

@catch_limit_penalty    # Penalise model fits that do not allow the Recreational Fishing catch to be taken
label MRFSSCatchMustBeTaken
fishery MRFSS
log_scale TRUE
multiplier 1000

@catch_limit_penalty    # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label OthersCatchMustBeTaken
fishery Others
log_scale TRUE
multiplier 1000

@vector_average_penalty
```

label meanYCS_1
vector recruitment.YCS
k 1
multiplier 10

Red tide output file

```
@print          # Specifies the outputs that CASAL should generate
# estimation section
parameters TRUE
unused_parameters TRUE
fits_every_eval FALSE
objective_every_eval FALSE
parameters_every_eval FALSE
parameter_vector_every_eval FALSE
fits TRUE
resids TRUE
pearson_resids FALSE
normalised_resids TRUE
estimation_section FALSE
population_section TRUE
every_mean_size TRUE
covariance TRUE

# population section
requests TRUE
initial_state FALSE
state_annually FALSE
state_every_step FALSE
final_state TRUE
results TRUE

#output section
yields TRUE

@print_sizebased_ogives_at 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120
```

121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180

@quantities
all_free_parameters TRUE
fishing_pressures TRUE
nuisance_qs TRUE
true_YCS TRUE
B0 TRUE
Binitial TRUE
R0 TRUE
SSBs TRUE
YCS TRUE
actual_catches TRUE
recruitments TRUE
ogive_parameters selectivity[HeadboatSel1].all selectivity[HeadboatSel2].all selectivity[HeadboatSel3].all selectivity[HandlineSel1].all selectivity[HandlineSel3].all selectivity[LonglineSel1].all selectivity[MRFSSSel].all selectivity[OthersSel].all #selectivity[HandlineSel2].all selectivity[LonglineSel2].all selectivity[LonglineSel3}.all

@abundance total_biomass205
biomass TRUE
all_areas TRUE
step 2
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass200
biomass TRUE
all_areas TRUE
step 2
proportion_mortality 0

years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass300
biomass TRUE
all_areas TRUE
step 3
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass305
biomass TRUE
all_areas TRUE
step 3
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass310
biomass TRUE
all_areas TRUE
step 3
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass100
biomass TRUE

all_areas TRUE
step 1
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass105
biomass TRUE
all_areas TRUE
step 1
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_biomass110
biomass TRUE
all_areas TRUE
step 1
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N100
biomass FALSE
all_areas TRUE
step 1
proportion_mortality 0

years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N200
biomass FALSE
all_areas TRUE
step 2
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N205
biomass FALSE
all_areas TRUE
step 2
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N210
biomass FALSE
all_areas TRUE
step 2
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N300
biomass FALSE

all_areas TRUE
step 3
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N305
biomass FALSE
all_areas TRUE
step 3
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@abundance total_N310
biomass FALSE
all_areas TRUE
step 3
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_100
step 1
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_105

step 1
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_110
step 1
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_200
step 2
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_205
step 2
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_210
step 2
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_300
step 3
proportion_mortality 0
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_305
step 3
proportion_mortality 0.5
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@numbers_at NAA_310
step 3
proportion_mortality 1
years 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

@selectivity_at SelAtAgeLongline1
step 3
ogive LonglineSel1
years 2008

@selectivity_at SelAtAgeHeadboat1
step 3
ogive HeadboatSel1
years 1989

@selectivity_at SelAtAgeHandline1
step 3
ogive HandlineSel1
years 1989

@selectivity_at SelAtAgeHeadboat2
step 3
ogive HeadboatSel2
years 1999

@selectivity_at SelAtAgeHandline3
step 3
ogive HandlineSel3
years 2008

@selectivity_at SelAtAgeHeadboat3
step 3
ogive HeadboatSel3
years 2008

@selectivity_at SelAtAgeMRFSS
step 3
ogive MRFSSSel
years 2008

@selectivity_at SelAtAgeOthers
step 3
ogive OthersSel
years 2008

@n_projections 500

```
#fishery_names Headboat1	Headboat2	Headboat3	Handline1	Handline2	Handline3	Longline1	Longline2	Longline3	MRFSS	Others
@catch_split 0 0 0.0148 0 0 0.1278 0 0 0.0778 0.7742 0.0053

@per_recruit
do_YPR_SPR TRUE
F 0 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5  #0.55 0.6 0.7
do_Fmax TRUE
do_F0_1 TRUE
do_Fx TRUE
x 30  #35 40 45 50 55 60
guess 0.25

@deterministic_MSY
do_MSY TRUE
do_yield_vs_SSB TRUE
F 0.01 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5
guess 0.25


@MCY_CAY
do_MCY TRUE
MCY_guess 30000
n_discard 100
n_keep 100
n_simulations 100
do_CAY TRUE
F_CAY_guess 0.2
interactive FALSE
```