SEDAR 10 –AW- 02

Preliminary Status of Gag Grouper In The Gulf of Mexico, SEDAR-10 (Not to Be Distributed Without Panel Report)

Mauricio Ortiz

Southeast Fisheries Science Center
Sustainable Fisheries Division
75 Virginia Beach Drive
Miami, FL 33149

April 26, 2006

Sustainable Fisheries Division Contribution SFD 2006-019

Introduction

The status of gag, *Mycteroperca microlepis*, in the US Gulf of Mexico (GOM) was reviewed and updated using information on landings and discards from 1963 through 2004, size and age composition, catch rate information from fisheries independent and dependent sources, and updated biological information. A preliminary review of input data was done at the SEDAR 10 Data Workshop on Jan-2006 in Charleston NC. Please review the Report from the SEDAR 10 Data Workshop for complete details of input data and group recommendations for the assessment evaluation.

In the previous stock assessment of gag GOM a VPA model (VPA-2Box) was used for stock status evaluation with data from 1986 through 2000 (Turner et al. 2001). During the Data workshop the group recommended investigating alternative assessment methods that allow input of historical catch and effort data. The present evaluation used a forward projected catch at age model (CASAL) with gag GOM data from 1963 through 2004.

Model inputs and settings

CASAL (C++ algorithmic stock assessment laboratory) is a generalized age or size structured fish stock assessment model that allows for flexibility in specifying the population dynamics, parameter estimation, and model outputs (Bull et al. 2005). It can calculate likelihood or posterior profiles and can generate Bayesian posterior distributions using Monte Carlo Markov Chain (MCMC) methods. CASAL allows a wide range of observation types, observation error structures, and prior distributions. The program is written in C++ and uses automatic differentiation (based on freeware ADOL-C) for estimation. It can be download it from the web at ftp://ftp.niwa.co.nz/software/casal. A recent comparison of available integrate stock assessments models including CASAL was done at a workshop on stock assessment methods by the ITTC in La Jolla, CA Nov-2005, a report of the workshop review and conclusions is available at http://www.iattc.org/PDFFiles2/Assessment-methods-WS-Nov05-ReportENG.pdf.

The inputs for stock evaluation of gag GOM into CASAL model included:

a) landings of gag grouper from 1963 through 2004 both commercial and recreational fisheries,
b) death discards from commercial and recreational fisheries,
c) indices of abundance of fishery independent and fishery dependent sources,
d) catch at age proportion for commercial and recreational fisheries,
e) estimates of maturity at age,
f) estimates of natural mortality constant or by age
g) estimates of size at age parameters, and
h) estimates of size and weight relationship.

Briefly a review of the catch and discard inputs is presented, followed by a description of the population dynamics model assumed under CASAL for gag GOM.

Landings and Discards

As presented in the Data workshop report, commercial landings were available since 1963 for gag GOM. All commercial landings were converted to gutted weight (MT) and summarize by year for the following fisheries; commercial longline fishery (1979-2004), commercial handline fishery (1963-2004), and other commercial fisheries (1963-2004). The other category included trawl catches (1963-1992), trap catches (1964-2004), spear fish (1977-2004), and unclassified commercial catches (1963-2004). These fisheries account for less than 3% of total gag GOM catch overall years. It is important to point out that the handline fishery includes a variety of gears such electric reels, hand reels, handlines and commercial rod and reel catches. The commercial landings reflect corrections due to misidentification of gag with black grouper (*M. bonaci*).

Data on dead discards from commercial fisheries has been only collected for the handline fishery since 2001 (SEDAR10-DW-11). Because of changes in minimum size restrictions affecting commercial fisheries and the different size that the longline fishery targets, it was concluded that this estimates were not appropriate for the whole commercial fishery. Therefore, estimates of commercial fisheries death discards were calculated following the approach used in the 2001 assessment. It was assumed that prior to 1990 when the 1st federal minimum size restriction went into effect (20 in, 51 cm), there were not discards in any of the commercial fisheries. Thus the size distribution of each commercial fishery represented during this "base" period should reflect the selectivity of each fishery. For both handline and longline there were size samples from 1984 to 1989. After 1990 minimum size restriction was again increased for commercial fisheries in 2000 (Ref) to 24 in (61 cm). As such, the size frequency distribution of the period 1984-1989 was defined a "base", the size frequency of 1990-1999 was defined as "phase 1", and the size frequency of 2000-2004 was defined as "phase 2". It was then assumed that the difference between size frequencies of "phase 1" and "base" for fish 51 TL cm or less approximates the discards of the fishery in response to the minimum size restriction, similarly the difference between size frequency of "phase 2" and "base" for fish 61 cm or less was due to minimum size restriction. These differences were translated into proportion of catch below 51 (or 61 cm) to total catch for the "base" period, and for each correspondening phase period. The ratio of the proportion below 51 cm base to below 51 cm phase 1 represents the discarded catch in phase 1 due to minimum size, if the ratio was greater than 1. Similar procedure was used for phase 2. These analyses were done by year and season (trimester) periods for each commercial sector (handline and longline). No size frequency data was available for the other commercial fisheries, thus no discards were estimated for those fisheries. Later on it will be explain how these estimated discards were split into dead discards and live discards.

Recreational landings were available from MRFSS since 1981, as detailed in the Data Workshop report, historical recreational catch for gag in the Gulf of Mexico was estimated (SEDAR10 2006). The historical recreational catch included estimates of landed (AB1) and discarded fish (B2). Recreational landings were partitioned into Headboat fishery and MRFSS fishery, which represents basically non-HeadBoat data. Estimates of landings from Headboat are only available since 1986. Therefore it was assumed for modeling purposes that prior to 1984 all recreational catch was from the MRFSS fishery category (Table 1).

Dead discards estimation

Dead discards were estimated in the 2001 assessment as a fixed proportion of the total discards, 20% mortality for recreational discards and 30% mortality for commercial discards across all years (Turner et al. 2001). During the Data workshop, the life history group reviewed discard mortality data from different sources, mostly studies of mortality of gag as function of depth of capture. It was concluded that higher mortality rates were associated with fish caught in deeper waters. Indeed the LH group recommended including depth-related mortality in the assessment methods. First, a logistic function was estimated that relates release mortality and depth (Figure 1), this function predicts a 50% mortality of fish caught at about 45.5 m depth, with a range of 6% mortality for fish caught at surface to 95% mortality for fish caught at 96 m or deeper.

For the present evaluation two approaches were used to estimate death discards from commercial and recreational fisheries. a) A fixed mortality proportion similar to the values used in 2001 assessment, 20% for recreational discards and 30% for commercial discards, and b) Mortality as function of Catch-At-Depth distribution. The later method was possible from data collected for individual fish of depth of capture and size from the TIP database. In the TIP sampling program of 83,081 (80,956 com and 2,125 rec) gag fish sampled, 62,377 had depth at capture recorded (62,006 com and 371 rec). Analysis shows that for both commercial and recreational samples, there is a positive correlation between size distribution and depth of capture. Figures 2 and 3 show the proportion of fish by size bin (5 cm TL) as function of depth intervals (10 m from surface), the proportion of smaller size fish decreases as depth increases, conversely the proportion of larger size fish is higher in deeper waters. Therefore, it was possible to generate Size-at-depth matrices for commercial fisheries (handline, longline, and others) and one for recreational fisheries combined. The Size-at-depth matrices were assumed constant through the years.

Having Catch-at-Size information and Size-at-depth, a matrix of Catch-at-depth was constructed for the recreational combined, longline, handline and other commercial fisheries by year, semester or season (trimester commercial fisheries) or wave (bimonthly recreational fisheries) if sufficient size samples were available in the strata, if not then a higher strata was used, at least to the year Catch-at-depth. Next, the mortality at depth function was applied to each Catch-at-depth matrix to estimate dead discards. In general, the Catch-at-depth matrix method estimated a higher percentage of mortality compared to the fixed proportions used in 2001 assessment. For recreational fisheries on average mortality of discards were about 32%, while for the commercial fisheries the average mortality was around 67%. Estimates of death discards by Catch-at-depth were in numbers of fish, converted to weight units by multiplying the numbers by the average weight at size (size bin 5 cm) in both commercial and recreational fisheries. As mentioned previously, it was assumed that there were no discard in the commercial fisheries prior to 1989. However, for the recreational fishery, historical estimates of catch included discards (B2) from 1965 on. Death discards for the 1965-1980 were also estimated, a) as fixed proportion (20%), or b) the average percent of the death discards in the 1984-1989 period of the Catch-at-depth estimates (32%) (Figure 4). Table 2 shows the estimates of death discards by either method for commercial and recreational fisheries. There is a noticeable increase in the latest years of discards from the recreational fishery, and a correspondingly larger proportion of death discards in this sector (Figure 5).

Indices of abundance

The Data workshop provided a list of available fisheries dependent (1-4) and independent (5-6) indices of abundance (SEDAR10 2006, Table 3). Following their recommendations, the following relative indices and estimates of variability (coefficients of variation) were considered for the CASAL model runs:

1. Handline commercial index from 1990 to 2004 as continuous index, or the alternative version of the index split into two series 1990-2000 and 2000-2004. This index was associated with the commercial Handline fishery in CASAL.
2. Longline commercial index from 1990 to 2004 as continuous index, or the split version 1990-2000 and 2000-2004. The index was associated with the commercial Longline fishery.
3. MRFSS index from 1981 to 2004. In all cases the index was used as a continuous series as it is not influence by minimum size restrictions. The index was associated with the recreational fisheries except Headboat.
4. Headboat index from 1986 to 2004 as continuous series, or the split version 1986-1989, 1990-2000, 2000-2004 series. The index was associated with the Headboat recreational fishery.
5. SEAMAP RF Video survey index 1993 to 2004 with some missing years, and the corresponding “Copper Belly” Video index same years. These indices were associated with the longline fishery in the simulation runs of CASAL.
6. FMRI Otter trawl survey index 1996 to 2004. This index is for juveniles or age 0 class.

Catch at Size

Size and age samples of gag GOM were compiled and reviewed during the Data workshop. Size samples from recreational fisheries were available from the Headboat bioprofile sampling program, MRFSS interviews sampling, Mote Marine Laboratory sampling, and the TIP program. There were a total of 29,568 observations; all converted to TL cm units using the appropriate meristic functions when needed. Figure 6 shows the distributions of size-samples by various categories. Size sampling started in 1981, but increase in numbers since 1998. By sector or mode, the Headboat (mode=2) fishery has 9,029 samples; Charter has 14,784 samples, and Private/shore 5,755. Samples were available for most waves (bimonthly aggregations) and year combinations. Size range covers primarily from 20.0 cm to 110 cm. Figure 8 shows the frequency distribution of size by year for all sectors.

Size frequency matrices were created for Headboat, Charter and Private/shore samples modes by year, semester and wave, with a minimum of 150 length samples per strata. In case of insufficient samples, the size frequencies of other strata were used. For example, for the Private/shore mode, sufficient samples were only available after 1991; it was then assumed that size frequencies of prior years (1981-1990) were similar to 1991 size frequency distribution. For the Charter mode, size frequency distributions for 1982 and 1990 were substituted by distributions of 1983 and 1990-Headboat, respectively. Few size samples (201) were collected from tournaments; these samples were added to the private/shore mode. Size range was from 0 to 200 TL cm with increments of 1 cm, obvious outliers were removed from the input data. These Size-frequency matrices were used to convert the catch (in numbers) of retained fish (AB1) and discarded fish (B2) of recreational fisheries and generate Catch-at-Size (CAS) files. Figure10 shows the distribution of size proportions by year and mode from the recreational size samples available. To estimate total landings in biomass units from recreational fisheries, CAS (1 cm size bin) files were multiply by the expected weight of gag using the weight-size power relationship (see below).

Size samples from commercial fisheries were all from the TIP program 95,122 observations all converted to TL cm units (Figure 7). Commercial size samples were available since1984, but increased in number of samples in 1998, 98% of the samples come from the Florida state, and are primarily from the longline (40,440) and handline (51,942) modes. Size range covers from 40 cm to 130 cm. Figure 9 shows the frequency distribution of size by years for all sectors.

Size frequency matrices were created for the longline, spear, trap, and other gears. The handline mode include the gears handline, electric reels and rod & reel commercial as it was done in the 2001 assessment. Table 4 shows the available number of samples per year for each mode. A minimum of 150 size samples criteria was applied for generating a size frequency matrix, clearly for the modes spear, trap and others were insufficient samples in most years, and therefore they were all grouped into a single category and estimated a size frequency distribution for all years. When possible for the other modes, longline, handline frequency matrices were generated by year, semester and season (trimester groups). In few occasions no sufficient samples were present for the handline mode, 1998 and 1989, in this cases matrices were replaced with those of the handline 1987 and 1990 size frequency matrices of handline mode. For longline only in 1989 there were insufficient size samples, thus it was used the 1988 size frequency matrix. Figure11 and 11b show the distribution of size proportions by year and mode from the commercial size samples available. Size frequency matrix ranged from 0 to 200 TL cm with increments of 1 cm. Because catch from commercial fisheries is only in biomass units (pounds landed), the size frequency matrices were converted to size-at-weight (pounds) frequency by multiplying each size by the expected weight of gag using the weight-size power relationship (wgt_kg = 1.33824e-5 * TL (cm) ^ 2.9768501846).

These weight-frequency matrices were then used to convert Catch (landings) by strata (mode, year, semester, season) to Catch (pounds)-at-size and dividing by the mean weight at each size bin, to generate Catch (numbers) at size (CAS) files. Similar procedure was applied for the estimated discards, to obtained CAS of discarded commercial fish. To recall, that mortality of discarded fish both from commercial and recreational fisheries was estimated using a Catch-at-depth matrix approach, in that case the CAS files were used to generate the Catch-at-depth in conjunction with the Size-at-depth matrices, only that in this case CAS 1 cm files were aggregated into CAS 5 cm bin size, to match the Size-at-depth matrices.

Catch at Age

In previous assessments catch was converted to catch at age using several methodologies (Turner et al. 2001). In 2001 assessment the working group selected to use primarily Age Length Keys (ALK) if available for ageing the catch, if not use a stochastic length deconvolution method based on Shepherd's (1985) theory and implemented in an algorithm by Parrack and Cummings (Ref .). ALK were developed from aged samples of gag grouper, age was inferred from otolith annual mark readings. The life history group in the Data Workshop reviewed and commented on ageing procedures, ageing precision between laboratories and sample distribution between areas and stocks (SEDAR10-DW report). Compared to the 2001 assessment, at the present evaluation there were available a greater number of aged samples, the NMFS Panama City laboratory provided the database of aged gag GOM samples. The current data included 16,436 samples from 1991 to 2005. Most of the aged samples came from commercial sources (11,823, 61%) follow by recreational samples (3,883, 33%) and much lower number from scientific programs (713, 6%) (Figure 12). An updated growth equation was estimated for gag GOM stock, assuming a von Bertalanffy growth model. SEDAR10-DW2 describe in detailed the methods and results of the updated growth model, important to point out that this model differs from the von Bertalanffy model used in the 2001 assessment (Figure 13), in particular for the estimated size at age of the younger ages, 0 through 6. This shift on expected size at age has important implications for the assessment results as several parameters and relationships of gag are based on size, and later on converted to age using the expected size-at-age from the von Bertalanffy function. Among others, for example a) conversion of CAS to Catch-at-Age (CAA) using the stochastic length method, b) conversion of size base maturity and fecundity relationships of gag to age base functions, c) estimates of age proportions of catch from size samples, d) expected mean weight at age, etc. The Life history group concluded that the updated von Bertalanffy model was a more realistic and in agreement with the observed data (SEDAR10-DW report).

Age Length Keys (ALK)

For the ALK construction a total of 16,147 aged samples were used from 1991 to 2004. Figure 14 shows the distribution of samples per year and month. Overall, aged samples ranged from age 0 to age 31, but main proportion of samples were from ages 4 through 8. By sector, commercial samples had overall higher average mode age (5) compared recreational samples mode age (3) (Figure 15). Table 5 shows the distribution of aged samples by sector, year and semester. The distributions by semester or year were the basis to create and ALK. Determining the minimum number of aged samples per strata needed to construct an ALK has been a rather subjective decision. Age sampling has increased particularly in the last 5 years, with over 1,500 samples collected per year, although most are from commercial fishery sampling, a much less from recreational fisheries. Distribution of aged samples is even more uneven when broken down by semester and sector.

Table 5 presents a schematic of the decision criteria for creating the gag GOM ALK's. It was decided using size bin of 5 cm from 0 to 200 TL cm, and to age size samples from ages 0 to 12, where the 12 represents a plus group (2001 assessment ageing was only up to age 10+). At age 12 gag GOM has reached about 84% of their mean asymptotic size, and more important a proportion of individuals have completed the sex transition from females to males, allowing to better discriminate female and male spawning stock biomass. Then, it was assumed that for all years combined this age-size sample would represent the "best" possible sampling of size at age for gag GOM, or basically our universe of possible samples from an statistical point of view. Defining this as our ideal age-size sample matrix it allowed us comparing for each year/sector/strata how well the age-size sample were covered. The "best" matrix (13 ages, 0-12+; 40 sizes, 0-200 in 5 cm intervals) has data for 143 cells, Table 5 shows then the number of cells in each ALK strata combination and the percent of cells sampled in relation with the "best" sampling matrix (143), the highlighted cells represent those strata when the sampling coverage was 20% or below. The other criteria used for ALK construction is the number of observations per size interval, in the past a minimum number of 5 to 10 samples has been used (with no really statistical reason for such decision) and if the number of samples was inferior, then consecutive size bins were joined until reaching the criteria threshold. This practice have a tendency of joining bins particularly in the tails of the size distribution; at the lower end then smaller fish tend to have increasing probability of being assign a larger age class even if no (or very few) samples were collected. Table 5 shows the number of cells when less than 5 samples per size were available, and the last column shows the overall proportion of cells where more than 5 samples per size bin were available in each strata age-size matrix. In summary, the highlighted cells in Table 5 show the strata where less than 20% of the age-size matrix was sampled, and strata where less than 20% of cells have 5 or more samples per size bin. As expected in years when the age-size sampling was limited, the overall coverage of the sample (in reference to the “ideal” matrix) was below 20% and most likely also the number of cells with low size samples per cell was quite high.   It also shows that even with high sampling (2,400 aged samples in 2004) the coverage is about 70% and still about 35% of the cells have less than 5 samples.

The decision then to create an ALK for a given strata was a combination of the percent of coverage (at least 20%) and the percent of samples per size bin (20% or more). It was also applied a minimum number of samples per year (135). Table 6 shows the so-called instruction file passed to the ageing program that indicates what method to use for ageing the CAS files, and if ALK, what ALK strata level to use. Because of reduced sampling ALKs for 1991, 1997, 1999, and 2000 were aggregated to the year level in certain semesters. Prior to 1991, all ageing was done using the stochastic length decomposition method (SAR).

Comparison of CAA 2001 vs. 2006

The SAR ageing method uses the update growth parameters of the von Bertalanffy growth model (asymptotic length = 131.0 cm, k = 0.14, t0 = -0.37). It also assumed that any fish at or below 20 cm TL was age 0.   This was based on analysis of size distribution of aged samples.

CAA files were then estimated for landing commercial and recreational fisheries (1984-2004) and for death discards from both sectors. As two methods were used to estimate discard mortality (a) fixed proportion, and (b) mortality based on Catch-at-depth, thus two CAA were also estimated for each discard mortality method.   Tables 7 and 9 show the two CAA input files.   Figure 16 shows the cumulative removals by sector and disposition of catch from 1984 to 2004 assuming the fixed proportion of mortality for discards of 20% in recreational and 30% in commercial fisheries.   Figure 17 show similar plots for the CAA assuming a mortality of discards in function of catch-at-depth. Using the Catch-at-depth mortality procedure it was estimated higher number of total gag removals, increasing in particular in the latest years 25% higher since 2000 (Figure 18).

CAA files were also estimated for the each sector and fishery mode; partial CAA for the Headboat and MRFSS recreational fisheries, and partial CAA for the Longline, Handline and Other commercial fisheries (Tables 8 and 11).   Comparing to the CAA estimated in 2001 assessment, in 2006 there were important changes particularly in age distributions. Figure 19 shows the total estimated CAA for gag GOM in 2001 and 2006, higher numbers of fish were estimated in 2001 for 1986-1999. It also shows the difference of age frequency distribution of both CAAs (positive deviations indicate higher proportion in 2006 CAA) the main difference is that in 2001 age 0 and age 1 were about 40% of the total estimated CAA by year, while in 2006 there were not removals of age 0 and age 1 are less than 0.5% (Table 10, Figure 20).   In summary in 2006 most of the catch was allocated to ages 2, 3, 4, 5, 6 and 7, while non-catch of age 0 and only few age 1 fish.   This difference is primarily the result of the update growth von Bertalanffy function. The higher number of total fish removed by year in 2001 CAA is explained because for the same landings of commercial catch (commercial catch inputs were in biomass) smaller fish had to be estimated (Figure 21).

Maturity

In the last 5 years a great deal of information and data has been collected for maturity and fecundity of gag grouper. At the Data Workshop, the life history group provided updated size based functions of gag GOM maturity from immature to mature females, and for the transition of females to males (gag is a protogynous species). Figure 22 shows the estimated functions of maturity-at-size provided for females and males. Because gag transition from female to male, the percent of mature females at size was estimated as the difference between percent females minus percent males at a given size (green line). For modeling purposes, in CASAL and VPA-2box maturity vector must be entered as vector at age, using the updated von Bertalanffy growth model, proportions of mature females and males were estimated for each age class at the beginning of the 3rd month (assumed spawning peak is in March). In addition, using the weight-at-size function, estimates of spawning biomass-females per age were estimated. For the plus group estimates were weighted by the expected number of fish surviving at each class up to age 20. Figure 23 shows the estimated maturity at age functions, females start maturing at age 3, and by age 4 about 70% are mature, by age 6 they are all mature. Males instead start transition at age 7-8, and reach 50% transition at age 13. However, at age 12+ still there is a relative high percent of females. In the current assessment models, it was dealt with spawning biomass of females exclusively, in VPA-2box the spawning biomass of mature females was the input vector, in CASAL the percent of mature females (internally CASAL estimates spawning biomass).

Natural Mortality

By recommendation of the Data Workshop natural mortality parameter was input as a fixed parameter in the assessment model(s). For gag GOM natural mortality M was 0.15, sensitivity analysis were recommended with values of M at 0.10 and 0.20. The group also recommended investigating models with varying M by age. The proposal was to use the Lorenzen's protocol to estimate M at age (Ref?). Table 12 shows the Lorenzen's model and estimates for gag GOM using age 30 as maximum age and estimating mean size at age in the mid-year. Figure 24 shows the estimated survival per recruit under the two options for treating natural mortality in the assessment models.

Assessment Models

The current evaluation of gag GOM stock used primarily a forward projection statistical integrated model as per recommendation of the SEDAR Data Workshop. For comparison purposes, a 'continuity' case was also carried out with the model and settings similar to those used in the evaluation of 2001 (Turner et al. 2001). Initially the aim was to develop a statistical model tailored to the features of gag as species, particularly related to their protogynous condition, however due to time constrains the model was not available. Instead, we selected an integrated stock assessment model already programmed and tested, that allows introducing as much flexibility and data as originally intended. CASAL was the selected software, it is a C++ based program that uses a version of the Automatic Differentiation algorithms (ADOL-C v.1.8.4, Griewank et al 1996) similar to the AD model Builder (AUTODIF, Fournier 1994) for estimation of parameters. CASAL uses a quasi-Newton optimizer and scalar, vector, and matrix types from the AD package. CASAL was created by scientist at the National Institute of Water and Atmospheric Research (NIWA) in New Zealand (Bull et al. 2005). It serves as the base assessment tool for most of the New Zealand fisheries, and has been successfully applied to other stocks including non-fish species (Refs). The version used for the present evaluation is v2.07-2005/08/21. For the continuity case scenario, the VPA-2Box package (Porch 2002) was used; runs were carried out with the latest available version from the toolbox package (v3.01). The inputs and analyses of the continuity case are been described in an accompanying document (Ref of the document for continuity).

CASAL settings

Full description of the CASAL package including algorithms and options are provided in the manual, including examples of assessment evaluations (Bull et al. 2005). What if follows is a brief description of the settings assumed for the CASAL model in regards to the gag GOM evaluation. CASAL can be used as generalized age or size structured model, for gag it was assumed as age-generalized structured model, with age specifications of minimum age 0 to maximum age 12, where the age group 12 represents a plus group. Perhaps the simplest way to explain the settings of the model is following an input file example of gag GOM run. Appendix 1 provides the three input files required by CASAL for a single run analysis. The first file is the population file (G06-population.csl) that describes the model of the fish population dynamics. Include processes such as recruitment, migration, natural and fishing mortality.

Population Dynamics Gag GOM

CASAL uses an annual cycle, corresponding to the calendar year. The annual cycle can be broken into one or more *steps* in which different process can occur. For gag three steps were selected, simulating the annual transition of the fishery and population dynamics. In step 2 (February) spawning occurs, in step 3 (March-December) fishing mortality takes place, and recruits are inputted into the population, in step 1 ageing occurs. There is not sex partition definition for gag within CASAL, spawning related function are defined in terms of female gag. With CASAL the user can have sex partitions; however it is not a protogynous type of population modeling. Only one area was defined for gag GOM, the time sequence defined initial year 1963 and current year 2004, with final year 2010 (for projections between current and final). These settings are covered in the sections #Partition, #Time sequence, and @annual_cycle of the population.cls input file.

It was assumed that growth is continuous through the year and the growth proportions are equivalent to the monthly *steps*. CASAL uses a Pope's approximation for estimating removals due to natural and fishing mortality when more than one fishery is describe (option: Baranov false). In this scenario, five fisheries were describe, three commercial fisheries (Longline, Handline and Others) (Others and Trap is the same fishery), and two recreational (Headboat and MRFSS). All fishing mortality takes place in the 3rd step, and in the single area, there is migration movements.

The section #Recruitment defines the parameter for the type of stock recruitment relationship. Recruits in numbers of fish are added to the minimum age class following the relationship

$$R_y = R_0 \times YCS_{y-y\_enter} \times SR(SSB_{y-y\_enter})$$

where R_0 is the stock's average recruitment (ignoring the stock-recruitment function); YCS are year class strength multipliers (recruitment multipliers); y_{enter} is the number of years between spawning and recruit to the stock population; and SR is the stock-recruitment function (if =1 no Stock-recruitment). In CASAL there are two available SR functions, Beverton-Holt and Ricker, both parameterized in function of *steepness* ($h = SR^*(0.2B_0)$). In the case of gag GOM, the stock recruitment function assumed is a Beverton-Holt with an initial guess of 0.8. In this section, YCS are provided for all years, and standardization of YCS start in 1963 through 2001. Later on it will be explained how to restrict the YCS particularly for those initial years when there was not much information in terms of recruitment trends.

Maturity was assumed to be female proportions at age of gag GOM, this proportion will be multiply by the mean weight at age at the spawning step by CASAL, to estimate SSB_females. Natural mortality in this run is assumed constant by age (0.15).

The following section describes the fishery dynamics of the model. In CASAL for each fishery, a total catch is entered by year, and a selectivity ogive must be defined. Ogives are parametric functions with a different value for each age or size class, CASAL offers several ogives functions (see manual pp 45 on), that can defined selectivity based on age or size (even when the model is age-based, as with gag GOM). In the present evaluations, it was assumed that four fisheries have size-based selectivity Handline, Longline, Headboat and MRFSS fisheries, while the Other fishery was age-based. Initially, size base selectivities (Handline, Headboat, MRFSS) assumed a double-logistic ogive with 5 parameters to be estimated by CASAL, and logistic ogive with 3 parameters for the Longline and Other fisheries.

Size at age was assumed to follow a von Bertalanffy growth model, and used the parameters suggested by the Data Working group with an estimated coefficient of variation (0.1). Similarly, size-weight parameters for a power function model were inputted. These basically define the gag GOM population dynamics in the CASAL model.

Estimation Section Gag GOM

The next file required by CASAL is the estimation.csl file (G06-estimation.csl). This file defines what the parameters to estimate are and how to estimate them. In CASAL parameter point estimation can be done using least-squares (SSE) fit, maximum likelihood (MLE), or maximum posterior density estimate (MPD) Bayesian estimation. The *objective function* is defined based on the estimation method, for least-squares is a weighted sum of squares, for MLE is a negative log-likelihood function, and for Bayesian estimation is the negative log-posterior function (see manual for complete details of the objective function definitions). For gag GOM estimation was initially accomplish with MLE, however estimates of variance for parameters were obtained from Bayesian derived posteriors using non-informative priors.

The estimation file also inputs the *observations* to CASAL. Observations are data which is "fit" to the population dynamics model by estimating the unknown parameters. Observations include CPUE indices, survey biomass estimates, catch-at-age, size frequencies, etc. In CASAL catches are treated as population parameters not as observations. The example file (G06-estimation.csl) defines the method to use for estimation (likelihood) ML in the case of gag GOM, and set the maximum number of iterations, evaluations for searching (300, 1000), and the gradient tolerance for the convergence (0.002). The observations in the runs were:

a) Indices of abundance. Headboat CPUE, associated with the ogive of the headboat fishery. Handline CPUE associated with the ogive of the Handline fishery. Longline CPUE associated with the ogive of the longline fishery. MRFSS CPUE associated with the ogive of the MRFSS fishery. Video CPUE associated with the Longline fishery ogive. And, the Copper Belly CPUE associated also with the Longline fishery ogive. The FMRI Otter trawl index of age 0, was not include because of convergence problems in all runs.

b) Proportions of catch-at-age. For the Handline fishery ages 0-12+ 1984-2004; Headboat fishery ages 0-12+ 1986-2004; Longline fishery ages 0-12+ 1984-2004; MRFSS fishery ages 0-12+ 1984-2004; and Other fishery (Trap) ages 0-12+ 1984-2004. It was assumed a multinomial error distribution for all partial catch-at age, and equal sample size for all fisheries years with exception of the

Other fishery, where sample size was 0.10*Longline, as total catch by this fishery is low and more uncertain.

The catchability parameters, *q* for each fishery in CASAL can be treated as a fully estimable parameter or a "nuisance" parameter. In the initial runs of CASAL *q's* were treated as nuisance parameters. In that case, for each set of values of the free parameters, CASAL finds algebraically a value of *q* that minimizes the objective function. This approach reduces the size of the parameter vector and improves the performance of the estimation method (see CASAL manual pp 81 and on).

Then, the so-called free parameters estimated by CASAL are specified in the section #Free Parameters. These included, Biomass B_0 which is defined in CASAL as the Spawning Stock Biomass that would exist if recruitment were equal to R_0 every year and there were no fishing (equivalent virgin spawning biomass). Initial Biomass in year 1963 $B_{initial}$, YCS or annual recruitment deviates, *steepness* parameter, and the parameters for the ogives of the parametric selectivities Headboat, Handline, Longline, MRFSS, and Other fisheries. For each free parameter CASAL request a lower and upper bound, and estimation is restricted to that range of values, and a prior used if estimation method is Bayesian. The initial guess for each of these parameters is given in the population file, with exception of the *q's* (when estimated as nuisance parameters). Finally, the estimation file also defines the penalties applied to the model run. In the gag GOM runs penalties were applied to the catch by fishery, to penalize model fits that do not allow a given fishery catch to be taken. The other penalty was a vector average penalty to force the YCS to average to 1. In the gag GOM runs, the YCS for the years 1963-1983 were restricted by closing the upper and lower boundaries near or to 1. This forces the model to assume an average recruitment for those years when no information on recruitment trends is available in the input data.

Output Section Gag GOM

The third file required by CASAL is the output.csl file. This file as its name suggest specify the type and quantities outputted by the model run. CASAL is quite flexible in the amount of information output provided, most request work with false-true switches. Parameters, objective function, fits, residuals, etc can be requested. The output is usually handled through another accessory programs, such as R or S-Plus, or Excel (see manual for further details).

For gag GOM runs, requested outputs include fits to indices of abundance and proportions of catch-at-age, stock and recruitment trends, average fishing mortality F, and selectivity functions at size and age.

Gag GOM Preliminary CASAL model runs and results

The following section is a brief summary of preliminary runs using the CASAL program and following most of the assumptions and settings used in 2001 evaluations. This preliminary runs are intended to provide a start point for the assessment working group, as well an overview of the model results, plots and diagnostics to facilitate the evaluation of gag GOM stock. In summary, Gag GOM evaluations using the CASAL program assumed:

- An age-structured model,
- With catch data from1963 to 2004 that includes estimated death discards,
- Five major fisheries; three commercial Handline, Longline and others (Trap, spear, trawl, others), and two recreational Headboat and MRFSS (private and charter).
- Six indices of abundance; Handline, Longline, Headboat, MRFSS, Video, and Copper Belly Video.
- Five catch-at-age proportions for Handline, Longline, MRFSS, Headboat, and Other fisheries 1984-2004 (same as partial CAA in VPA-2box).
- Maturity vector at age for females only, CASAL estimates Spawning biomass as the product of maturity vector times the average weight at size.
- Size at age following a von Bertalanffy growth model (updated), and
- Three time steps in a year, with spawning in the second step, fishing in the third step. Recruits move into the population at the beginning of 3^{rd} step.
- Beverton-Holt stock recruitment relationship
- User input natural mortality vector
- Parametric user selected selectivity for a fishery, where the parameters of the function are estimated by CASAL.
- Catchability coefficients are estimated as nuisance parameters, or equivalent q's constant.
- Penalties for total catch in each fishery to be realized, and for the average recruitment deviations to be one.

One important difference between 2001 and 2006 inputs to the model evaluation is the catch composition. As mention before, in 2006 there is no commercial or recreational catch of age 0 gag GOM, and very few age 1. For modeling purposes it was decided removing age 0 from the catch inputs. For gag GOM minimum size restrictions were implemented in 1989 (20 inches), and in 2000 (24 inches). Models were explored that split the fisheries into three time series, a) 1963-1989, b) 1990-1999) and c) 2000-2004. and use the associated indices of abundance calculated within each time period. The MRFSS index and fishery were not split as the index is based on total catch (retained and discarded fish), also the other fishery was not split. Per suggestion of the data working group, an alternative natural mortality values were evaluated. In the later case, natural mortality was age dependent, based on the Lorenzen's estimation of M.

Table 13 presents a summary of the preliminary runs carry out with CASAL. Figure 25 shows an example of the results/plots in this case for the run 1963-2004 continuous fisheries, with 6 indices, 5 selectivity ogives estimated, and constant M (0.15) and q's.   Figure 26shows results of the case run 1963-2004 with 3 split fisheries, 10 indices, 8 selectivity ogives and constant M.

CASAL offers the capability of full Bayesian estimation (Bull et al. 2005). CASAL uses a straightforward implementation of the Metropolis algorithm. It uses a Monte Carlo Markov Chain (MCMC) to generate a sample from the posterior distribution of the free parameters and output the sampled values. Description of the Bayesian procedures and methods in CASAL is explained in the manual section 6.5.   Figure 27 shows an example of posterior density plots for one of the Gag runs.

Literature Cited

Bull, B., Francis R.I.C.C., A. Dunn, A. McKenzie, D.J. Gilbert and M.H. Smith. 2005. CASAL (C++ algorithmic stock assessment laboratory): CASAL User Manual v2.07-2005/08/21. NIWA Technical Report 127. 272 p.

Fournier, D.A. 1994. AUTODIF. A C++ array language extension with automatic differentiation for use in nonlinear modeling and statistics. Otter Research Ltd., Sidney, Canada. 123 p.

Francis, R.I.C.C., V. Haist and B. Bull. 2003. Assessment of hoki (*Macruronus novaezelandiae*) in 2002 using a new model. New Zealand Fisheries Assessment Report 2003/6. 69 p.

Griewank, A., D. Juedes, H. Mitev, J. Utke, O. Vogel, and A. Walther. 1996. ADOL-C: A package for the automatic differentiation of algorithms written in C/C++. ACM transactions on Mathematical Software 22(2):131-167. Algorithm 755.

Porch, C. E. 2002. VPA -2BOX Version 3.0 User's Guide. NOAA Fisheries, Southeast Fisheries Science Center, Sustainable Fisheries Division Contribution SFD-01/02-151.

SEDAR10. 2006.   South Atlantic and Gulf of Mexico Gag grouper Data Workshop Report. Charleston, NC Jan 23-27 2006.

SEDAR10-DW-11. McCarthy, K.J. 2006.   Estimates of gag grouper discard by vessels with Federal Permits in the Gulf of Mexico.

Turner, S.C., C.E. Porch, D. Heinemann, G.P. Scott, and M. Ortiz. 2001. Status of gag in the Gulf of Mexico, Assessment 3.0. NMFS, Southeast Fisheries Science Center, Miami, FL. Sustainable Fisheries Division Contribution: SFD 01/02–134. 32 p. plus Tables and Figures.

Table 1. Estimated total biomass removals (landings + death discards) of gag GOM by sector and fishery mode in thousand pounds 1963-2004. Left table correspond to estimates assuming a fixed percent mortality for discards, right table correspond to estimates assuming a depth dependent release mortality.

Year	Longline	Handline	Others	MRFSS	Headboat	Total
1963	-	1,289	1	5,828	-	7,118
1964	-	1,632	9	9,103	-	10,745
1965	-	1,816	1	10,619	-	12,435
1966	-	1,457	1	7,214	-	8,671
1967	-	1,156	10	4,492	-	5,657
1968	-	1,192	4	4,709	-	5,906
1969	-	1,377	3	6,241	-	7,621
1970	-	1,284	3	5,350	-	6,636
1971	-	1,377	3	6,067	-	7,446
1972	-	1,460	4	6,694	-	8,158
1973	-	1,081	5	3,474	-	4,560
1974	-	1,184	1	4,232	-	5,417
1975	-	1,447	4	6,298	-	7,749
1976	-	1,198	9	4,289	-	5,496
1977	-	977	8	2,484	-	3,469
1978	-	875	11	1,691	-	2,577
1979	1	1,342	10	5,175	-	6,528
1980	89	1,318	12	5,579	-	6,998
1981	467	1,499	16	2,164	-	4,146
1982	1,010	1,335	14	3,361	-	5,720
1983	681	1,039	18	6,918	-	8,656
1984	433	1,098	18	2,038	-	3,588
1985	381	1,398	28	6,788	-	8,595
1986	517	1,155	29	3,748	292	5,741
1987	656	853	30	2,532	208	4,277
1988	402	791	23	3,904	156	5,276
1989	426	1,235	31	2,620	321	4,634
1990	623	1,130	41	1,559	275	3,628
1991	510	993	63	4,408	110	6,083
1992	593	1,003	69	3,395	146	5,205
1993	479	1,280	106	4,527	197	6,590
1994	352	1,148	119	4,363	256	6,238
1995	390	1,157	105	4,946	156	6,755
1996	393	1,106	68	3,793	137	5,497
1997	415	1,101	83	4,675	128	6,401
1998	602	1,848	82	6,039	324	8,894
1999	549	1,481	68	5,543	243	7,884
2000	617	1,592	81	6,696	239	9,225
2001	997	2,053	101	7,092	149	10,391
2002	1,035	1,901	62	8,606	114	11,718
2003	1,124	1,454	67	8,677	185	11,506
2004	1,122	1,728	73	10,016	265	13,204

Year	Longline	Handline	Others	MRFSS	Headboat	Total
1963	-	1,289	1	5,828	-	7,118
1964	-	1,632	9	9,103	-	10,745
1965	-	1,816	1	10,635	-	12,451
1966	-	1,457	1	7,238	-	8,696
1967	-	1,156	10	4,516	-	5,682
1968	-	1,192	4	4,744	-	5,941
1969	-	1,377	3	6,300	-	7,680
1970	-	1,284	3	5,413	-	6,699
1971	-	1,377	3	6,151	-	7,530
1972	-	1,460	4	6,802	-	8,266
1973	-	1,081	5	3,538	-	4,624
1974	-	1,184	1	4,320	-	5,506
1975	-	1,447	4	6,445	-	7,896
1976	-	1,198	9	4,400	-	5,607
1977	-	977	8	2,556	-	3,540
1978	-	875	11	1,744	-	2,630
1979	1	1,342	10	5,351	-	6,704
1980	89	1,318	12	5,786	-	7,205
1981	467	1,499	16	2,459	-	4,440
1982	1,010	1,335	14	3,509	-	5,868
1983	681	1,039	18	7,460	-	9,198
1984	433	1,098	18	2,134	-	3,684
1985	381	1,398	28	6,967	-	8,774
1986	517	1,155	29	4,263	308	6,273
1987	656	853	30	2,827	231	4,596
1988	402	791	23	4,224	165	5,605
1989	426	1,235	31	3,264	338	5,295
1990	625	1,130	41	1,991	308	4,094
1991	510	993	63	4,843	111	6,520
1992	593	1,003	69	3,951	156	5,771
1993	482	1,281	106	5,874	211	7,954
1994	352	1,148	119	6,458	317	8,394
1995	394	1,158	105	7,251	195	9,102
1996	397	1,107	68	5,311	177	7,059
1997	420	1,101	83	6,794	168	8,565
1998	609	1,849	82	8,598	428	11,565
1999	550	1,481	68	7,252	315	9,666
2000	637	1,605	81	8,375	271	10,969
2001	1,053	2,088	101	8,767	167	12,175
2002	1,059	1,934	62	10,641	145	13,840
2003	1,190	1,477	67	12,219	240	15,193
2004	1,191	1,757	73	13,718	327	17,066

Table 2. Estimated total removals (kept and death discards) of gag GOM by sector and fishery mode in numbers of fish 1984 - 2004. Left table correspond to estimates assuming a fixed percent mortality for discards, right table correspond to estimates assuming a depth dependent release mortality

	Com		Rec		
Year	Death disc	Landed	Death disc	Landed	Total
1984	-	100,347	14,512	309,671	424,530
1985	-	120,425	31,348	872,031	1,023,804
1986	-	116,498	77,032	623,476	817,006
1987	-	94,703	48,212	408,920	551,835
1988	-	71,345	50,663	590,682	712,690
1989	-	94,210	101,823	378,695	574,728
1990	58	95,934	82,123	179,066	357,181
1991	7	96,712	174,438	269,599	540,756
1992	11	102,070	147,191	248,732	498,004
1993	93	130,609	260,753	350,572	742,027
1994	11	127,877	377,576	280,018	785,482
1995	119	127,346	375,253	422,542	925,260
1996	123	147,738	247,847	350,225	745,933
1997	155	158,720	347,010	391,680	897,565
1998	232	230,584	435,400	528,845	1,195,061
1999	51	170,586	304,058	549,705	1,024,400
2000	1,411	181,020	290,488	724,716	1,197,635
2001	3,895	234,337	387,634	476,638	1,102,504
2002	2,725	207,893	502,165	518,015	1,230,798
2003	3,365	178,246	686,902	503,663	1,372,176
2004	3,829	207,179	722,125	653,529	1,586,662

	Com		Rec		
Year	Ddisc	Kept	Ddisc	Kept	Total
1984		100,347	23,538	309,671	433,556
1985		120,425	50,832	872,031	1,043,288
1986		116,498	124,914	623,476	864,888
1987		94,703	78,184	408,920	581,807
1988		71,345	82,164	590,682	744,191
1989		94,210	165,119	378,695	638,024
1990	144	95,934	133,173	179,066	408,317
1991	13	96,712	282,886	269,599	649,210
1992	19	102,070	238,679	248,732	589,500
1993	224	130,609	422,835	350,572	904,240
1994	21	127,877	612,307	280,018	1,020,223
1995	283	127,346	608,531	422,542	1,158,702
1996	295	147,738	401,924	350,225	900,182
1997	380	158,720	562,729	391,680	1,113,509
1998	563	230,584	706,064	528,845	1,466,056
1999	116	170,586	493,065	549,705	1,213,472
2000	3,046	181,020	471,058	724,716	1,379,840
2001	8,489	234,337	628,619	476,638	1,348,083
2002	5,690	207,893	814,329	518,015	1,545,927
2003	7,604	178,246	1,113,911	503,663	1,803,424
2004	8,551	207,179	1,171,030	653,529	2,040,289

Table 3. Indices of abundance from commercial, recreational and independent fisheries for gag GOM.

RECOMMENDED FD INDICES

COMMERCAL

Index Name	**CMHL:1990-2004**		**CMHL:1990-2000**		**CMHL:2000-2004**		**CMLL:1990-2004**		**CMLL:1990-2000**		**CMLL:2000-2004**	
Size Range	>508 mm		>508 mm		>610 mm		>508 mm		>508 mm		>610 mm	
Relative (Scaled to 1)?	No		No		No		No		No		No	
Weight/Numbers	Weight		Weight		Weight		Weight		Weight		Weight	
Units	Lbs/Hook_Hour		Lbs/Hook_Hour		Lbs/Hook_Hour		lbs/hook		lbs/hook		lbs/hook	
YEAR	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
1981	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	0.537535449	0.117	0.653040367	0.138	-	-	0.849883366	0.450	1.263523789	0.332	-	-
1991	0.379607251	0.110	0.465700281	0.134	-	-	0.562190283	0.463	0.850069446	0.331	-	-
1992	0.476513861	0.099	0.576358326	0.122	-	-	0.452355835	0.606	0.706373501	0.417	-	-
1993	0.761432621	0.062	0.925583908	0.078	-	-	0.624425122	0.251	0.976023949	0.180	-	-
1994	0.594985256	0.064	0.730907076	0.084	-	-	0.355157008	0.326	0.54109724	0.232	-	-
1995	0.741422183	0.061	0.890967986	0.078	-	-	0.498558244	0.278	0.74390762	0.202	-	-
1996	0.867145119	0.053	1.041221859	0.069	-	-	0.585552052	0.208	0.877762052	0.154	-	-
1997	0.927312489	0.052	1.129424344	0.067	-	-	0.585366928	0.210	0.874673239	0.154	-	-
1998	1.524325644	0.047	1.831293273	0.061	-	-	1.028643485	0.157	1.529127814	0.120	-	-
1999	1.063982128	0.048	1.289458048	0.063	-	-	0.779554532	0.181	1.183686171	0.136	-	-
2000	1.129660624	0.049	1.466044532	0.070	0.740800882	0.083	1.014401186	0.160	1.45375518	0.170	0.591896952	0.329
2001	1.543227123	0.047	-	-	1.087781028	0.075	1.832232763	0.110	-	-	1.045528638	0.154
2002	1.510135631	0.048	-	-	1.071871086	0.075	1.752185995	0.112	-	-	0.994197328	0.161
2003	1.256533041	0.048	-	-	0.893393319	0.076	1.951392003	0.104	-	-	1.113879909	0.148
2004	1.686181579	0.048	-	-	1.206153685	0.075	2.128101198	0.097	-	-	1.254497174	0.134

Index Name	**MRFSS**		**Headboat:1986-2004**		**Headboat:1986-1989**		**Headboat:1990-2000**		**Headboat:2000-2004**	
Size Range	Pending		Pending		Pending		Pending		Pending	
Relative (Scaled to 1)?	No		No		No		No		No	
Weight/Numbers	Numbers		Numbers		Numbers		Numbers		Numbers	
Units	Fish/1000 angler hours									
YEAR	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV	INDEX	CV
1981	12.152	0.414	-	-	-	-	-	-	-	-
1982	5.358	0.456	-	-	-	-	-	-	-	-
1983	10.275	0.471	-	-	-	-	-	-	-	-
1984	3.728	0.599	-	-	-	-	-	-	-	-
1985	14.555	0.392	-	-	-	-	-	-	-	-
1986	13.070	0.342	1.14	0.156	0.978	0.293	-	-	-	-
1987	3.500	0.376	1.317	0.119	1.205	0.219	-	-	-	-
1988	3.966	0.388	1.057	0.147	0.95	0.284	-	-	-	-
1989	5.401	0.385	0.993	0.157	0.866	0.315	-	-	-	-
1990	8.524	0.397	0.72	0.177	-	-	0.691	0.33	-	-
1991	6.460	0.372	0.597	0.218	-	-	0.606	0.36	-	-
1992	5.737	0.340	0.718	0.214	-	-	0.705	0.354	-	-
1993	14.556	0.324	0.826	0.179	-	-	0.836	0.297	-	-
1994	19.389	0.319	0.836	0.187	-	-	0.868	0.303	-	-
1995	18.521	0.313	0.853	0.2	-	-	0.866	0.307	-	-
1996	16.038	0.322	1.35	0.113	-	-	1.331	0.182	-	-
1997	11.972	0.315	1.327	0.11	-	-	1.339	0.176	-	-
1998	24.210	0.303	1.26	0.121	-	-	1.262	0.197	-	-
1999	20.283	0.301	1.237	0.115	-	-	1.258	0.185	-	-
2000	11.554	0.307	1.048	0.151	-	-	1.239	0.23	0.915	0.386
2001	9.109	0.310	0.778	0.208	-	-	-	-	0.88	0.327
2002	17.938	0.299	0.825	0.209	-	-	-	-	0.94	0.326
2003	19.630	0.299	1.039	0.155	-	-	-	-	1.102	0.273
2004	19.559	0.301	1.078	0.144	-	-	-	-	1.163	0.27

Index Name	**SeaMAP R.F. Video**		**SeaMAP R.F. Video (Copper Belly)**		**FMRI Otter Trawl**	
Comment	Table 12 SEDAR10-DW-12		Table 15 SEDAR10-DW-12		Table 3 SEDAR-10-30	
Size Range	425-975 mm		425-975 mm		50-400 mm	
Relative (Scaled to 1)?	No		No		No	
Weight/Numbers	***Presence/Absence***		***Presence/Absence***		Numbers	
Units	Proportion Positive Trips		Proportion Positive Trips		Number/Haul	
YEAR	-	-	-	-	-	-
1981	-	-	-	-	-	-
1982	-	-	-	-	-	-
1983	-	-	-	-	-	-
1984	-	-	-	-	-	-
1985	-	-	-	-	-	-
1986	-	-	-	-	-	-
1987	-	-	-	-	-	-
1988	-	-	-	-	-	-
1989	-	-	-	-	-	-
1990	-	-	-	-	-	-
1991	-	-	-	-	-	-
1992	-	-	-	-	-	-
1993	0.663	0.424467	1.244	0.403	-	-
1994	0.513	0.528376	0.844	0.586	-	-
1995	0.446	0.360877	0.670	0.497	-	-
1996	0.879	0.28771	0.758	0.457	1.13399	0.6656
1997	0.932	0.30967	0.544	0.574	0.31773	1.07858
1998	-	-	-	-	0.2317	1.28399
1999	-	-	-	-	0.61968	0.7432
2000	-	-	-	-	0.44081	0.84245
2001	-	-	-	-	0.70821	0.78985
2002	1.587	0.189639	0.964	0.371	3.29081	0.40103
2003	-	-	-	-	1.79145	0.49632
2004	1.980	0.186472	1.977	0.297	0.46561	0.94286

Table 4. Size sample distribution of gag GOM by year semester and season for commercial and recreational fisheries.

Commercial Length Frequency Samples used in converting Catch to CAS

Year	Semester	Season	Mode1 Longline	Mode2 Handline	Mode3 Spear	Mode4 Traps	Mode5 Others
1984	1	1	0	0	81	284	334
1984	1	2	59	444	166	416	237
1984	2	3	242	195	121	309	193
1984	2	4	157	190	138	307	154
1985	1	1	128	299	0	0	0
1985	1	2	146	118	0	0	0
1985	2	3	151	152	0	0	0
1985	2	4	172	206	0	0	0
1986	1	1	145	170	0	0	0
1986	1	2	167	101	0	0	0
1986	2	3	447	75	0	0	0
1986	2	4	374	12	0	0	0
1987	1	1	180	166	0	0	0
1987	1	2	141	102	0	0	0
1987	2	3	130	152	0	0	0
1987	2	4	234	139	0	0	0
1988	1	1	244	175	0	0	0
1988	1	2	32	0	0	0	0
1989	1	2	0	7	0	0	0
1989	2	3	10	0	0	0	0
1989	2	4	160	35	0	0	0
1990	1	1	461	273	0	0	0
1990	1	2	406	306	0	0	0
1990	2	3	650	257	0	0	0
1990	2	4	148	148	0	0	0
1991	1	1	216	400	0	0	0
1991	1	2	292	393	0	0	0
1991	2	3	176	84	0	0	0
1991	2	4	256	128	0	0	0
1992	1	1	236	308	0	0	0
1992	1	2	340	338	0	0	0
1992	2	3	185	331	0	0	0
1992	2	4	168	173	0	0	0
1993	1	1	209	386	0	0	0
1993	1	2	260	662	0	0	0
1993	2	3	149	650	0	0	0
1993	2	4	171	190	0	0	0
1994	1	1	293	1467	0	0	0
1994	1	2	187	782	0	0	0
1994	2	3	171	301	0	0	0
1994	2	4	126	270	0	0	0
1995	1	1	187	361	0	0	0
1995	1	2	182	487	0	0	0
1995	2	3	377	293	0	0	0
1995	2	4	251	1296	0	0	0
1996	1	1	231	885	0	0	0
1996	1	2	220	753	0	0	0
1996	2	3	176	614	0	0	0
1996	2	4	411	895	0	0	0
1997	1	1	227	928	0	0	0
1997	1	2	209	1015	0	0	0
1997	2	3	316	801	0	0	0
1997	2	4	472	620	0	0	0
1998	1	1	830	2610	0	0	0
1998	1	2	1387	1606	0	0	0
1998	2	3	1009	1240	0	0	0
1998	2	4	1841	2543	0	0	0
1999	1	1	1268	2365	0	0	0
1999	1	2	1383	2018	0	0	0
1999	2	3	988	655	0	0	0
1999	2	4	1015	839	0	0	0
2000	1	1	802	843	0	0	0
2000	1	2	1390	1503	0	0	0
2000	2	3	436	588	0	0	0
2000	2	4	1540	983	0	0	0
2001	1	1	1250	1845	0	0	0
2001	1	2	1531	2214	0	0	0
2001	2	3	695	951	0	0	0
2001	2	4	675	423	0	0	0
2002	1	1	894	1969	0	0	0
2002	1	2	1830	1062	0	0	0
2002	2	3	737	340	0	0	0
2002	2	4	676	745	0	0	0
2003	1	1	935	754	0	0	0
2003	1	2	1189	723	0	0	0
2003	2	3	931	356	0	0	0
2003	2	4	866	368	0	0	0
2004	1	1	740	981	0	0	0
2004	1	2	936	655	0	0	0
2004	2	3	605	223	0	0	0
2004	2	4	383	1007	0	0	0

Recreational Length Frequency Samples used in converting Catch to CAS

Year	Semester	Wave	Mode2 Headboat	Mode3 Charter	Mode4 Private
1981	1	1	0	15	0
1981	1	2	0	16	0
1981	1	3	0	13	0
1981	2	4	0	13	5
1981	2	5	0	12	8
1981	2	6	0	9	10
1982	1	1	0	7	1
1982	1	2	0	33	8
1982	1	3	0	5	24
1982	2	4	0	8	16
1982	2	5	0	4	4
1982	2	6	0	11	16
1983	1	1	0	10	0
1983	1	2	0	33	16
1983	1	3	0	31	14
1983	2	4	0	21	9
1983	2	5	0	13	1
1983	2	6	0	19	0
1984	1	1	0	18	3
1984	1	2	0	14	0
1984	1	3	0	96	11
1984	2	4	0	110	15
1984	2	5	0	85	2
1984	2	6	0	11	10
1985	1	1	0	18	0
1985	1	2	0	15	1
1985	1	3	0	15	1
1985	2	4	0	9	14
1985	2	5	0	65	6
1985	2	6	0	18	4
1986	1	1	168	49	0
1986	1	2	132	36	0
1986	1	3	100	3	2
1986	2	4	92	36	2
1986	2	5	107	23	10
1986	2	6	96	8	2
1987	1	1	114	0	4
1987	1	2	104	43	24
1987	1	3	134	60	26
1987	2	4	88	5	12
1987	2	5	117	13	5
1987	2	6	118	8	5
1988	1	1	95	20	0
1988	1	2	69	0	1
1988	1	3	111	10	17
1988	2	4	63	8	6
1988	2	5	64	34	11
1988	2	6	5	14	23
1989	1	1	56	27	8
1989	1	2	72	13	4
1989	1	3	76	7	3
1989	2	4	80	1	0
1989	2	5	90	13	3
1989	2	6	98	15	0
1990	1	1	118	0	3
1990	1	2	132	1	2
1990	1	3	85	7	13
1990	2	4	50	0	1
1990	2	5	12	18	6
1990	2	6	29	70	8
1991	1	1	38	106	22
1991	1	2	29	148	17
1991	1	3	41	60	23
1991	2	4	21	38	12
1991	2	5	25	47	23
1991	2	6	33	72	35
1992	1	1	18	60	14
1992	1	2	53	184	30
1992	1	3	34	102	32
1992	2	4	24	20	32
1992	2	5	31	102	53
1992	2	6	19	50	40
1993	1	1	25	10	58
1993	1	2	20	129	30
1993	1	3	59	146	45
1993	2	4	44	67	32
1993	2	5	17	47	24
1993	2	6	13	21	68
1994	1	1	68	2	7
1994	1	2	21	80	62
1994	1	3	19	113	27
1994	2	4	21	46	109
1994	2	5	78	49	17
1994	2	6	41	61	50
1995	1	1	31	33	14
1995	1	2	46	39	23
1995	1	3	32	11	24
1995	2	4	34	9	35
1995	2	5	38	27	61
1995	2	6	24	38	33
1996	1	1	10	14	3
1996	1	2	42	102	34
1996	1	3	61	208	28
1996	2	4	41	15	23
1996	2	5	84	5	26
1996	2	6	52	17	22
1997	1	1	35	35	14
1997	1	2	55	26	21
1997	1	3	69	128	44
1997	2	4	87	57	24
1997	2	5	218	154	74
1997	2	6	82	222	96
1998	1	1	488	191	31
1998	1	2	320	161	36
1998	1	3	257	221	66
1998	2	4	222	98	56
1998	2	5	107	202	82
1998	2	6	80	252	100
1999	1	1	120	273	91
1999	1	2	123	389	179
1999	1	3	206	356	82
1999	2	4	177	189	56
1999	2	5	106	261	59
1999	2	6	55	318	172
2000	1	1	61	213	80
2000	1	2	133	353	156
2000	1	3	57	513	153
2000	2	4	59	134	38
2000	2	5	131	274	77
2000	2	6	57	169	112
2001	1	1	75	118	42
2001	1	2	103	226	53
2001	1	3	109	307	122
2001	2	4	67	98	55
2001	2	5	55	242	66
2001	2	6	84	201	144
2002	1	1	31	122	62
2002	1	2	31	181	80
2002	1	3	15	232	51
2002	2	4	61	70	126
2002	2	5	78	212	214
2002	2	6	148	306	224
2003	1	1	51	75	43
2003	1	2	77	260	132
2003	1	3	125	401	127
2003	2	4	81	213	73
2003	2	5	84	223	89
2003	2	6	108	218	88
2004	1	1	24	91	54
2004	1	2	81	373	109
2004	1	3	133	455	61
2004	2	4	29	213	52
2004	2	5	35	819	110
2004	2	6	77	372	91

Table 5. Number of aged-samples for gag GOM by year sector and semester available for construction of Age length Keys. Left table is by year/semester, right table by year only. See section ALK in document for further explanations and definitions of columns and values.

Year	Semester	Sector	Ncells	Nobs	PercNcell	Ncell < 5 obs	Ncell >= 5 ob	Ncell > 10	PercNobs5+
1991	Jan-Jun	Comm	39	198	27%	30	9	5	23%
1991	Jul-Dec	Comm	14	19	10%	14	0	0	0%
1991	Jan-Jun	Rec	24	52	17%	20	4	0	17%
1991	Jul-Dec	Rec	31	82	22%	28	3	2	10%
1992	Jan-Jun	Comm	25	40	17%	24	1	0	4%
1992	Jul-Dec	Comm	25	51	17%	22	3	0	12%
1992	Jan-Jun	Rec	45	236	31%	30	15	7	33%
1992	Jul-Dec	Rec	38	169	27%	29	9	4	24%
1993	Jan-Jun	Comm	46	318	32%	34	12	7	26%
1993	Jul-Dec	Comm	43	112	30%	37	6	1	14%
1993	Jan-Jun	Rec	46	283	32%	32	14	5	30%
1993	Jul-Dec	Rec	35	114	24%	26	9	1	26%
1994	Jan-Jun	Comm	51	344	36%	33	18	6	35%
1994	Jul-Dec	Comm	32	99	22%	26	6	2	19%
1994	Jan-Jun	Rec	37	169	26%	22	15	4	41%
1994	Jul-Dec	Rec	27	138	19%	17	10	5	37%
1995	Jan-Jun	Comm	49	285	34%	29	20	7	41%
1995	Jul-Dec	Comm	25	57	17%	22	3	1	12%
1995	Jan-Jun	Rec	41	184	29%	29	12	5	29%
1995	Jul-Dec	Rec	31	158	22%	19	12	3	39%
1996	Jan-Jun	Comm	44	218	31%	30	14	2	32%
1996	Jul-Dec	Comm	42	138	29%	38	4	2	10%
1996	Jan-Jun	Rec	40	405	28%	23	17	10	43%
1996	Jul-Dec	Rec	26	284	18%	16	10	5	38%
1997	Jan-Jun	Comm	19	21	13%	19	0	0	0%
1997	Jul-Dec	Comm	14	21	10%	14	0	0	0%
1997	Jan-Jun	Rec	25	154	17%	19	6	4	24%
1997	Jul-Dec	Rec	22	81	15%	18	4	3	18%
1998	Jan-Jun	Comm	36	86	25%	31	5	0	14%
1998	Jul-Dec	Comm	45	128	31%	38	7	2	16%
1998	Jan-Jun	Rec	26	95	18%	20	6	3	23%
1998	Jul-Dec	Rec	23	33	16%	23	0	0	0%
1999	Jan-Jun	Comm	69	351	48%	47	22	9	32%
1999	Jul-Dec	Comm	35	56	24%	34	1	0	3%
1999	Jan-Jun	Rec	29	90	20%	25	4	1	14%
1999	Jul-Dec	Rec	20	40	14%	18	2	1	10%
2000	Jan-Jun	Comm	32	78	22%	25	7	0	22%
2000	Jul-Dec	Comm	68	505	48%	41	27	11	40%
2000	Jan-Jun	Rec	15	29	10%	15	0	0	0%
2000	Jul-Dec	Rec	20	46	14%	19	1	0	5%
2001	Jan-Jun	Comm	76	943	53%	35	41	25	54%
2001	Jul-Dec	Comm	70	706	49%	37	33	22	47%
2001	Jan-Jun	Rec	29	123	20%	22	7	4	24%
2001	Jul-Dec	Rec	30	86	21%	22	8	1	27%
2002	Jan-Jun	Comm	74	1232	52%	34	40	29	54%
2002	Jul-Dec	Comm	76	694	53%	41	35	18	46%
2002	Jan-Jun	Rec	27	148	19%	16	11	5	41%
2002	Jul-Dec	Rec	42	267	29%	31	11	6	26%
2003	Jan-Jun	Comm	65	834	45%	28	37	25	57%
2003	Jul-Dec	Comm	90	867	63%	49	41	24	46%
2003	Jan-Jun	Rec	33	176	23%	20	13	4	39%
2003	Jul-Dec	Rec	37	235	26%	25	12	6	32%
2004	Jan-Jun	Comm	88	1374	62%	37	51	33	58%
2004	Jul-Dec	Comm	82	1070	57%	39	43	25	52%
2004	Jan-Jun	Rec	33	114	23%	22	11	0	33%
2004	Jul-Dec	Rec	38	91	27%	34	4	1	11%
2005	Jan-Jun	Comm	77	1374	54%	25	52	35	68%
2005	Jul-Dec	Comm	17	28	12%	16	1	0	6%
2005	Jan-Jun	Rec	29	116	20%	19	10	4	34%
2005	Jul-Dec	Rec	36	109	25%	29	7	2	19%

Year	Sector	Ncells	Nobs	PercNcell	Ncell < 5 obs	Ncell >= 5 ob	Ncell > 10	PercNobs5+
1991	Comm	40	217	28%	30	10	6	25%
1991	Rec	43	134	30%	34	9	2	21%
1992	Comm	38	91	27%	35	3	1	8%
1992	Rec	57	405	40%	34	23	13	40%
1993	Comm	58	430	41%	35	23	7	40%
1993	Rec	53	397	37%	32	21	9	40%
1994	Comm	60	443	42%	38	22	8	37%
1994	Rec	44	307	31%	25	19	10	43%
1995	Comm	60	342	42%	34	26	8	43%
1995	Rec	50	342	35%	29	21	10	42%
1996	Comm	57	356	40%	35	22	4	39%
1996	Rec	45	689	31%	25	20	13	44%
1997	Comm	29	42	20%	29	0	0	0%
1997	Rec	34	235	24%	26	8	5	24%
1998	Comm	57	214	40%	43	14	5	25%
1998	Rec	37	128	26%	27	10	3	27%
1999	Comm	78	407	55%	49	29	9	37%
1999	Rec	37	130	26%	31	6	2	16%
2000	Comm	73	583	51%	45	28	16	38%
2000	Rec	25	75	17%	21	4	1	16%
2001	Comm	84	1649	59%	30	54	32	64%
2001	Rec	47	209	33%	34	13	6	28%
2002	Comm	91	1926	64%	36	55	38	60%
2002	Rec	47	415	33%	28	19	14	40%
2003	Comm	95	1701	66%	38	57	35	60%
2003	Rec	53	411	37%	32	21	10	40%
2004	Comm	101	2444	71%	37	64	42	63%
2004	Rec	51	205	36%	34	17	4	33%
2005	Comm	83	1402	58%	28	55	35	66%
2005	Rec	42	225	29%	24	18	6	43%

Average		551.8
percentiles	0.15	131.4
	0.25	210.25
stdev		614.7
CV		111%

Table 6. Instruction file used for convert Catch-at-size (CAS) to Catch-at-age (CAA) of gag GOM by sector, year and season. Keys refers to Age Length Keys (annual or by semester), and SAR refers to the stochastic length deconvolution method of Sheperd (1985).

	Recreational						Commercial			
Year	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Season 1	Season 2	Season 3	Season 4
1984	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1985	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1986	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1987	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1988	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1989	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1990	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR	SAR
1991	KEY S_I	KEY S_I	KEY S_I	KEY YR	KEY YR	KEY YR	KEY S_I	KEY S_I	KEY YR	KEY YR
1992	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
1993	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
1994	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
1995	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
1996	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
1997	KEY S_I	KEY S_I	KEY S_I	KEY YR	KEY YR	KEY YR	KEY S_I	KEY S_I	KEY YR	KEY YR
1998	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
1999	KEY S_I	KEY S_I	KEY S_I	KEY YR	KEY YR	KEY YR	KEY S_I	KEY S_I	KEY YR	KEY YR
2000	KEY YR	KEY YR	KEY YR	KEY SII	KEY SII	KEY SII	KEY YR	KEY YR	KEY SII	KEY SII
2001	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
2002	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
2003	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII
2004	KEY S_I	KEY S_I	KEY S_I	KEY SII	KEY SII	KEY SII	KEY S_I	KEY S_I	KEY SII	KEY SII

Table 7. Estimated Catch at age (CAA) gag GOM of kept and death discards assuming a fixed released mortality.

Year	Age0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12+
1984	0	2644	75347	44067	128354	71353	34478	21965	17229	7242	236	3300	18315
1985	0	4440	114708	151924	221437	358564	48894	51678	18795	10254	2990	1391	38729
1986	0	4849	138147	174684	207537	159534	59240	19658	22878	10077	1032	673	18697
1987	0	4634	101585	88116	142954	92142	47380	27965	18667	10350	1978	3090	12974
1988	0	9542	182064	64457	224702	108499	42540	26940	20005	7391	3590	245	22715
1989	0	3716	106134	93416	129661	103101	50953	21497	28522	11466	10104	2460	13698
1990	0	3540	62250	21767	92518	46628	43347	25554	20636	20644	5827	1081	13389
1991	0	4819	115147	18999	111361	39957	125924	36376	17778	23636	6739	4433	35587
1992	0	4146	36525	188220	39468	95393	38825	45492	10286	2795	2398	6108	28348
1993	0	757	32641	105897	402512	61846	52167	28549	32172	10521	2666	798	11501
1994	0	3418	20311	132604	139343	368815	65613	18276	12632	9015	3620	7783	4052
1995	0	0	73794	247974	202327	122839	226974	24713	6228	6202	5466	431	8312
1996	0	0	2769	291310	258558	81887	36199	51817	3121	6044	4812	593	8823
1997	0	0	8378	64884	646620	73764	47713	22224	24250	0	1806	1480	6446
1998	0	10823	21703	212883	369771	454321	56285	17148	20143	3640	10172	1216	16956
1999	0	0	26225	320750	206973	243640	168788	21527	13083	8029	2908	3225	9252
2000	0	11333	156811	149730	598850	53448	136038	56926	12069	2885	9668	3345	6532
2001	0	3078	15546	87012	224397	523772	84130	91576	38439	6516	9146	2750	16142
2002	0	3563	36948	440319	132724	276367	233673	37798	19060	26807	3216	1889	18434
2003	0	40	22928	344287	596123	83781	149108	115261	17323	14659	5841	6503	16322
2004	0	107	28900	366904	432982	526478	86142	64569	50306	8051	6302	4973	10948

Table 8. Estimated partial CAA gag GOM for sector fisheries mode assuming a fixed mortality of discards.

Partial Catch At Age for sector fisheries mode Fixed mortality proportion

Sector	Rec
ModeC	Headboat

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1986	0	306	3773	19379	1850	15191	378	2332	567	240	1004	0	197
1987	0	481	3915	11816	11677	3129	2312	1197	0	624	8	0	366
1988	0	0	3028	7549	14022	0	644	2113	0	0	0	0	216
1989	0	1181	4572	11721	2141	7140	5987	1961	2609	245	409	2	957
1990	0	0	993	2479	8291	4318	8216	2361	1913	563	0	0	103
1991	0	145	2908	841	2279	834	3185	606	273	356	0	34	376
1992	0	117	1317	7400	1283	2958	1236	1505	91	31	16	0	615
1993	0	67	1358	2994	12610	2095	1424	639	1001	158	27	0	442
1994	0	42	645	6269	6004	15044	3165	630	484	54	0	410	262
1995	0	0	2739	7614	5095	2713	5118	381	83	282	62	23	0
1996	0	0	97	10130	8483	1918	795	703	4	0	13	0	32
1997	0	0	370	1196	17465	1716	249	464	77	0	0	0	0
1998	0	432	1285	12310	17570	17832	2055	232	460	0	0	0	194
1999	0	0	1932	21175	8235	7214	3260	429	88	103	0	0	83
2000	0	482	6121	4972	18976	624	3271	1097	0	0	332	0	167
2001	0	51	418	1600	4195	9116	1384	1185	357	0	62	0	0
2002	0	0	562	9121	2426	3070	1573	120	12	36	0	0	24
2003	0	0	586	8125	12591	1472	1479	1435	67	374	0	0	135
2004	0	51	1251	10952	9404	10973	1370	1457	962	0	0	0	0

Sector	Com
ModeC	Handline

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	0	2648	594	5442	10460	13389	11782	6885	6667	1	1313	8977
1985	0	0	1355	1438	10836	10217	26812	8229	10337	9276	1912	1111	7724
1986	0	0	566	2153	15970	16063	11857	14484	2617	9026	0	0	6941
1987	0	0	619	1792	1173	7706	10996	16301	4707	6848	270	2074	1601
1988	0	0	1713	1990	365	5040	8613	8982	10176	1822	3584	135	3503
1989	0	0	2535	493	679	4793	11995	15601	11194	7387	6231	1097	5072
1990	0	0	1473	322	448	4590	10457	14717	9978	7218	5680	1050	4788
1991	0	0	0	0	5475	5238	29102	4837	7056	2629	3716	402	5191
1992	0	0	793	10189	5429	12275	9625	12387	4641	858	883	3072	5299
1993	0	0	208	5357	37170	6362	12872	8820	11933	4763	842	462	5488
1994	0	0	0	3154	10640	49251	7546	6481	3705	5304	2276	2424	2391
1995	0	0	0	15726	17937	10565	23680	8180	4040	3832	3260	157	5395
1996	0	0	22	15083	42715	22476	11460	15218	2006	3745	74	138	2252
1997	0	0	0	24600	44138	2754	29269	7196	11498	0	860	673	2204
1998	0	0	2624	10187	43103	88802	16416	8388	5518	2102	1510	936	6301
1999	0	0	2744	1864	16485	39422	49359	8555	5113	3057	1600	802	3472
2000	0	0	2103	9284	57168	19265	20360	18355	7555	1497	1092	1752	2576
2001	0	0	56	3006	13199	86240	18267	22139	16621	3641	3758	1276	3804
2002	0	0	439	4667	8798	33381	64507	12890	10416	6277	1304	842	3756
2003	0	0	52	1500	19084	13545	33682	28318	5700	2847	2469	827	3231
2004	0	0	133	3471	16590	50242	17227	22504	18454	4374	1774	1356	2736

Sector	Com
ModeC	Longline

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	0	305	513	3791	6277	6968	4246	3567	559	223	1846	1947
1985	0	0	534	295	7705	5857	5591	1326	1716	792	161	167	3909
1986	0	0	410	1204	1482	6059	10068	2698	7229	799	21	490	3158
1987	0	0	0	1020	746	3711	6783	10322	5902	2863	456	878	4546
1988	0	0	530	27	2051	425	5582	3556	3993	3867	4	0	2723
1989	0	0	417	282	1468	1171	5049	3792	4114	3828	2	1193	2174
1990	0	0	157	152	304	349	4098	6766	2799	12478	144	0	3227
1991	0	0	0	0	406	1305	8462	2516	4136	1760	2657	289	4167
1992	0	0	46	489	632	4294	4675	6424	2886	475	716	2991	4732
1993	0	0	18	554	3351	1319	3123	3694	5163	2939	625	325	2876
1994	0	0	0	284	1333	7878	1628	2410	1890	2583	1249	1161	775
1995	0	0	0	770	2775	2263	5780	2426	1905	1912	2045	60	2701
1996	0	0	0	776	3295	4667	3526	7023	880	2199	53	139	1329
1997	0	0	0	1511	4300	778	4520	3498	6145	0	941	790	2372
1998	0	0	97	820	4480	10555	3817	3949	3132	1486	1263	234	5303
1999	0	0	32	165	1451	4395	10481	3179	2598	2169	1284	620	3259
2000	0	0	110	334	3793	3781	4578	6878	4351	1354	1175	1559	3357
2001	0	0	13	404	1697	12665	5905	9671	10349	2781	3245	1441	5906
2002	0	0	23	344	1170	6775	18832	7234	6907	5071	1641	1042	6313
2003	0	0	33	320	3460	4246	16206	18032	5801	3303	3349	1350	5465
2004	0	0	21	739	3587	12933	7649	11820	12014	3539	1973	1912	6379

Sector	Rec	
ModeC	(Multiple Items)	Private Charte (excluding Headboat)

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	2644	72390	42695	118670	53871	13854	5840	6726	5	4	138	7346
1985	0	4440	112812	149745	202069	341326	16086	41999	6669	169	912	110	27042
1986	0	4543	133392	151564	187330	121020	36518	3	12389	3	0	173	8356
1987	0	4153	97045	73107	128258	76398	26854	2	7995	3	1240	130	6422
1988	0	9542	176788	54551	207425	102098	27359	12187	5780	1695	0	105	16243
1989	0	2535	98602	80443	124260	88666	27468	2	10527	4	3459	166	5461
1990	0	3540	59616	18168	81933	35713	19978	1521	5844	383	0	29	5227
1991	0	4674	112239	18158	100232	31557	82404	28160	6149	18851	313	3705	25758
1992	0	4029	33873	167587	29937	74522	22766	24202	2623	1408	771	0	17636
1993	0	690	30976	95744	341687	51340	33482	14931	13403	2593	1155	0	2509
1994	0	3376	19661	121682	118528	289681	52259	8156	6349	788	0	3649	456
1995	0	0	71055	221686	172881	105479	189380	13017	0	0	0	187	0
1996	0	0	2650	264305	200579	50448	19503	28119	143	0	4671	315	5164
1997	0	0	8008	35467	576328	68283	10832	10555	5885	0	0	0	1795
1998	0	10391	17445	188805	302010	332472	33223	4285	10874	0	7367	0	5003
1999	0	0	21325	297330	179210	189085	103234	9112	5167	2642	0	1788	2351
2000	0	10851	148064	133511	513485	28897	106978	29996	0	0	7032	0	348
2001	0	3027	15042	81206	203518	408603	57712	57861	10669	0	1994	0	6272
2002	0	3563	35724	425009	118895	230939	146256	17354	1601	15361	260	0	8274
2003	0	40	22180	333811	556823	63328	96144	66476	5669	8086	0	4319	7425
2004	0	56	27353	350887	401002	448125	59132	28114	18493	84	2534	1691	1763

Sector	Com	
ModeC	(Multiple Items)	Others

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	0	4	265	451	745	267	97	51	11	8	3	45
1985	0	0	7	446	827	1164	405	124	73	17	5	3	54
1986	0	0	6	384	905	1201	419	141	76	9	7	10	45
1987	0	0	6	381	1100	1198	435	143	63	12	4	8	39
1988	0	0	5	340	839	936	342	102	56	7	2	5	30
1989	0	0	8	477	1113	1331	454	141	78	2	3	2	34
1990	0	0	11	646	1542	1658	598	189	102	2	3	2	44
1991	0	0	0	0	2969	1023	2771	257	164	40	53	3	95
1992	0	0	496	2555	2187	1344	523	974	45	23	12	45	66
1993	0	0	81	1248	7694	730	1266	465	672	68	17	11	186
1994	0	0	5	1215	2838	6961	1015	599	204	286	95	139	168
1995	0	0	0	2178	3639	1819	3016	709	200	176	99	4	216
1996	0	0	0	1016	3486	2378	915	754	88	100	1	1	46
1997	0	0	0	2110	4389	233	2843	511	645	0	5	17	75
1998	0	0	252	761	2608	4660	774	294	159	52	32	46	155
1999	0	0	192	216	1592	3524	2454	252	117	58	24	15	87
2000	0	0	413	1629	5428	881	851	600	163	34	37	34	84
2001	0	0	17	796	1788	7148	862	720	443	94	87	33	160
2002	0	0	200	1178	1435	2202	2505	200	124	62	11	5	67
2003	0	0	77	531	4165	1190	1597	1000	86	49	23	7	66
2004	0	0	142	855	2399	4205	764	674	383	54	21	14	70

Table 9. Estimated Catch at age (CAA) gag GOM total removals assuming a depth depedent released mortality.

Year	Age0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12+
1984	0	2567	73275	44943	136126	68747	36288	24732	16934	8044	237	3296	18367
1985	0	4112	110304	155393	239545	349594	53909	56937	18551	12157	2946	1387	38453
1986	0	4410	127258	174989	253349	144228	68798	35119	21207	14524	977	649	19380
1987	0	3986	93027	91709	169376	84014	52814	37881	17973	12940	1864	3081	13142
1988	0	8798	170992	71093	251173	99967	49687	36396	19438	10314	3593	236	22504
1989	0	1990	83163	107272	183393	85132	65624	41384	27097	17558	9738	2447	13226
1990	0	2901	51927	30887	137409	33821	46516	41430	17401	25165	5833	1070	13957
1991	0	19346	173287	30556	118250	41744	138340	38504	20951	26208	7528	3321	31175
1992	0	10587	62649	224382	40886	98575	45011	55793	11313	3314	2674	6109	28207
1993	0	6007	90808	135055	418494	72014	63167	38108	42555	12036	3095	799	22102
1994	0	10998	59437	196697	171086	388315	85792	26529	26449	10541	3620	17260	23499
1995	0	0	132018	305485	222588	123941	265127	29353	12180	29390	12146	3969	22505
1996	0	0	4379	360475	265998	94765	52198	85879	3369	6068	8690	1110	17251
1997	0	0	80541	78452	673401	96378	56618	57142	46975	0	1816	1487	20699
1998	0	46944	72240	252496	415394	479549	62480	34492	31298	3664	20425	1221	45853
1999	0	0	36670	419463	211407	252135	190413	37333	27527	11548	2910	5567	18499
2000	0	17638	223738	162548	629998	51908	133981	78454	12303	2940	46725	3422	16185
2001	0	2896	79422	133068	272598	534694	112136	97537	58605	6773	12034	2873	35447
2002	0	30876	125129	590218	129280	265644	252275	47817	22610	37478	4840	1944	37816
2003	0	37842	76214	529523	611885	79939	189815	143038	50335	21423	6087	19434	37889
2004	0	14903	130140	442905	514879	556284	95974	112958	98121	15202	20298	7684	30941

Table 10. Comparison of the CAA age distributions between 2001 SA and 2006 SA. Positive (light blue shade) deviations indicate higher proportion in 2006 at age.

Difference	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1986	-16%	-24%	-3%	7%	16%	14%	4%	0%	1%	0%	1%
1987	-16%	-23%	-2%	1%	16%	11%	5%	3%	2%	1%	2%
1988	-18%	-21%	5%	-6%	22%	10%	2%	1%	1%	0%	2%
1989	-20%	-20%	6%	4%	12%	10%	3%	0%	3%	1%	3%
1990	-17%	-21%	2%	-5%	16%	5%	6%	3%	3%	4%	3%
1991	-25%	-24%	7%	-6%	12%	1%	19%	4%	2%	3%	7%
1992	-21%	-37%	-4%	29%	2%	14%	4%	7%	1%	0%	6%
1993	-25%	-21%	-30%	9%	50%	5%	5%	2%	3%	1%	1%
1994	-28%	-35%	-6%	-3%	16%	45%	7%	2%	1%	1%	1%
1995	-25%	-25%	-25%	24%	10%	12%	24%	2%	0%	0.00	1%
1996	-21%	-26%	-6%	0%	34%	6%	4%	7%	0%	1%	1%
1997	-23%	-27%	-14%	6%	44%	8%	2%	2%	3%	0%	1%
1998	-21%	-26%	-16%	8%	30%	18%	4%	-1%	2%	0%	2%
1999	-21%	-27%	-16%	20%	15%	24%	3%	2%	-1%	1%	1%

Table 11. Estimated partial CAA gag GOM for sector fisheries mode assuming a depth dependent mortality of discards

Partial Catch At Age for sector fisheries mode Depth related mortality of discards

Sector	Com
ModeC	Handline

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	0	2648	594	5442	10460	13389	11782	6885	6667	1	1313	8977
1985	0	0	1355	1438	10836	10217	26812	8229	10337	9276	1912	1111	7724
1986	0	0	566	2153	15970	16063	11857	14484	2617	9026	0	0	6941
1987	0	0	619	1792	1173	7706	10996	16301	4707	6848	270	2074	1601
1988	0	0	1713	1990	365	5040	8613	8982	10176	1822	3584	135	3503
1989	0	0	2535	493	679	4793	11995	15601	11194	7387	6231	1097	5072
1990	0	0	1469	322	450	4593	10459	14718	9979	7218	5680	1050	4788
1991	0	0	0	0	5472	5240	29107	4838	7057	2629	3716	402	5191
1992	0	0	790	10188	5431	12281	9627	12388	4641	858	883	3073	5299
1993	0	0	208	5352	37178	6363	12874	8822	11935	4763	842	462	5489
1994	0	0	0	3147	10643	49262	7546	6481	3706	5305	2276	2425	2391
1995	0	0	0	15711	17953	10571	23687	8184	4041	3835	3260	157	5397
1996	0	0	22	15073	42721	22489	11466	15224	2007	3747	74	138	2253
1997	0	0	0	24592	44145	2754	29275	7203	11499	0	860	673	2205
1998	0	0	2601	10188	43119	88827	16419	8393	5522	2104	1511	937	6303
1999	0	0	2739	1865	16489	39421	49373	8557	5114	3058	1600	802	3473
2000	0	0	2102	9264	57237	19467	20569	18534	7642	1515	1110	1778	2603
2001	0	0	49	2975	13291	86723	18720	22588	16984	3727	3853	1315	3922
2002	0	0	454	4631	8690	33727	65492	13106	10598	6399	1344	866	3874
2003	0	0	58	1500	18961	13647	34300	28791	5797	2902	2519	848	3309
2004	0	0	153	3423	16553	50720	17564	22920	18791	4453	1814	1394	2826

Sector	Rec
ModeC	Headboat

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1986	0	288	3724	18837	4115	14274	821	2753	533	379	944	0	242
1987	0	436	3765	11484	13489	2831	2685	1761	0	762	8	0	401
1988	0	0	2973	7499	14465	0	832	2267	0	73	0	0	233
1989	0	1066	4376	11476	5193	6446	6078	2519	2356	448	369	2	940
1990	0	0	1319	3958	14237	2819	7115	3609	1251	948	0	0	281
1991	0	163	3021	871	2318	836	3188	623	276	369	0	34	377
1992	0	216	1796	8111	1340	3091	1298	1620	115	41	27	0	646
1993	0	107	2004	3444	13113	2200	1550	739	1074	181	39	0	522
1994	0	324	1869	8199	7362	15861	3831	917	783	114	0	729	764
1995	0	0	3601	8458	5488	2847	5946	457	167	577	165	80	236
1996	0	0	143	11995	8435	2205	1198	1554	9	0	161	17	257
1997	0	0	1556	1378	17908	2163	428	1032	500	0	0	0	252
1998	0	1890	3129	13293	19212	19082	2193	886	886	0	466	0	1315
1999	0	0	2130	23160	8670	8184	4506	977	616	237	0	95	408
2000	0	552	7360	5097	19479	676	3326	1604	0	0	874	0	315
2001	0	51	876	1955	4831	9283	1677	1266	528	0	89	0	228
2002	0	252	1373	10209	2301	3250	2020	299	42	209	14	0	281
2003	0	495	1252	10566	12924	1407	2308	1836	558	409	0	203	451
2004	0	329	2868	12115	10936	11571	1566	2145	1409	136	229	53	303

Sector	Com
ModeC	Longline

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	0	305	513	3791	6277	6968	4246	3567	559	223	1846	1947
1985	0	0	534	295	7705	5857	5591	1326	1716	792	161	167	3909
1986	0	0	410	1204	1482	6059	10068	2698	7229	799	21	490	3158
1987	0	0	0	1020	746	3711	6783	10322	5902	2863	456	878	4546
1988	0	0	530	27	2051	425	5582	3556	3993	3867	4	0	2723
1989	0	0	417	282	1468	1171	5049	3792	4114	3828	2	1193	2174
1990	0	0	120	135	304	349	4143	6828	2807	12478	144	0	3247
1991	0	0	0	0	406	1305	8462	2516	4136	1760	2657	289	4167
1992	0	0	46	489	632	4294	4675	6424	2886	475	716	2991	4732
1993	0	0	18	550	3335	1335	3156	3721	5197	2949	627	326	2893
1994	0	0	0	284	1333	7878	1628	2410	1890	2583	1249	1161	775
1995	0	0	0	731	2770	2273	5854	2454	1923	1929	2061	60	2722
1996	0	0	0	727	3285	4727	3568	7081	887	2221	54	142	1342
1997	0	0	0	1378	4359	794	4595	3566	6232	0	951	797	2394
1998	0	0	51	789	4472	10674	3878	4011	3180	1508	1277	238	5352
1999	0	0	24	152	1447	4409	10512	3187	2604	2174	1286	621	3264
2000	0	0	50	239	3768	3969	4797	7132	4498	1391	1213	1610	3424
2001	0	0	2	311	1636	12890	6287	10287	10982	2952	3437	1525	6222
2002	0	0	18	294	1052	6759	19304	7425	7095	5235	1681	1073	6477
2003	0	0	12	189	2707	4433	17412	19203	6133	3503	3545	1452	5838
2004	0	0	19	539	3251	13320	8258	12679	12827	3757	2104	2048	6736

Sector	Rec
ModeC	(MRFSS Private/charter)

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	2567	70318	43571	126442	51265	15664	8607	6431	807	5	134	7398
1985	0	4112	108408	153214	220177	332356	21101	47258	6425	2072	868	106	26766
1986	0	4122	122552	152411	230877	106631	45633	15043	10752	4311	5	149	8994
1987	0	3550	88637	77032	152868	68568	31915	9354	7301	2455	1126	121	6555
1988	0	8798	165771	61237	233453	93566	34318	21489	5213	4545	3	96	16015
1989	0	924	75827	94544	174940	71391	42048	19331	9355	5893	3133	153	5006
1990	0	2901	49008	25826	120876	24402	24201	16086	3262	4519	6	18	5597
1991	0	19183	170266	29685	107085	33340	94812	30270	9318	21410	1102	2593	21345
1992	0	10371	59521	203039	31296	77565	28888	34387	3626	1917	1036	0	17464
1993	0	5900	88497	124461	357174	61386	44321	24361	23677	4075	1570	0	13012
1994	0	10674	57563	183852	148910	308353	71772	16122	19866	2253	0	12806	19401
1995	0	0	128417	278407	192738	106431	226624	17549	5849	22873	6561	3668	13934
1996	0	0	4214	331664	208071	62966	35051	61266	378	0	8400	812	13353
1997	0	0	78985	48994	602600	90434	19477	44830	28099	0	0	0	15773
1998	0	45054	66207	227465	345983	356306	39216	20908	21551	0	17139	0	32728
1999	0	0	31585	394070	183209	196597	123568	24360	19076	6021	0	4034	11267
2000	0	17086	213813	146319	544086	26915	104438	50584	0	0	43491	0	9759
2001	0	2845	78478	127031	251052	418650	84590	62676	29668	0	4568	0	24915
2002	0	30624	123084	573906	115802	219706	162954	26787	4751	25573	1790	0	27117
2003	0	37347	74815	516737	573128	59262	134198	92208	37761	14560	0	16924	28225
2004	0	14574	126958	425973	481740	476468	67822	74540	64711	6802	16130	4175	21006

Sector	Com
ModeC	(Traps Trawl Others Spear)

	Data												
Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1984	0	0	4	265	451	745	267	97	51	11	8	3	45
1985	0	0	7	446	827	1164	405	124	73	17	5	3	54
1986	0	0	6	384	905	1201	419	141	76	9	7	10	45
1987	0	0	6	381	1100	1198	435	143	63	12	4	8	39
1988	0	0	5	340	839	936	342	102	56	7	2	5	30
1989	0	0	8	477	1113	1331	454	141	78	2	3	2	34
1990	0	0	11	646	1542	1658	598	189	102	2	3	2	44
1991	0	0	0	0	2969	1023	2771	257	164	40	53	3	95
1992	0	0	496	2555	2187	1344	523	974	45	23	12	45	66
1993	0	0	81	1248	7694	730	1266	465	672	68	17	11	186
1994	0	0	5	1215	2838	6961	1015	599	204	286	95	139	168
1995	0	0	0	2178	3639	1819	3016	709	200	176	99	4	216
1996	0	0	0	1016	3486	2378	915	754	88	100	1	1	46
1997	0	0	0	2110	4389	233	2843	511	645	0	5	17	75
1998	0	0	252	761	2608	4660	774	294	159	52	32	46	155
1999	0	0	192	216	1592	3524	2454	252	117	58	24	15	87
2000	0	0	413	1629	5428	881	851	600	163	34	37	34	84
2001	0	0	17	796	1788	7148	862	720	443	94	87	33	160
2002	0	0	200	1178	1435	2202	2505	200	124	62	11	5	67
2003	0	0	77	531	4165	1190	1597	1000	86	49	23	7	66
2004	0	0	142	855	2399	4205	764	674	383	54	21	14	70

Table 12. Estimates and model of natural mortality by age for Gag GOM based on Lorenzen's method.

Lorenzen Estimation of differential M by age

Maximum age

30 From otolith age-reading data use in growth function estimation

0.1387 Hoenig (tmax)

*[M=exp(1.46 - 1.01*ln(tmax))]*

Lorenzen Age-Specific

[Use mid-year for calculating TL (mm)]

Comparison estimates of survivals per recruit with different Natural Mortality estimates

Age	TL (cm)	W (kg)	M	Hoenig	Age	Scaled M	or Modeling 12	Lorenzen M	Constant M 0.15	
0.5	15.0	0.043	9.66	0.1387	0	0.643	0.643	1	1	
1.5	30.2	0.340	5.13	0.1387	1	0.342	0.342	0.5255	0.8607	
2.5	43.3	0.999	3.69	0.1387	2	0.246	0.246	0.3734	0.7408	
3.5	54.8	2.007	2.98	0.1387	3	0.199	0.199	0.2920	0.6376	
4.5	64.8	3.299	2.56	0.1387	4	0.171	0.171	0.2394	0.5488	
5.5	73.4	4.792	2.29	0.1387	5	0.152	0.152	0.2018	0.4724	
6.5	80.9	6.408	2.09	0.1387	6	0.139	0.139	0.1733	0.4066	
7.5	87.5	8.076	1.95	0.1387	7	0.130	0.130	0.1507	0.3499	
8.5	93.2	9.741	1.84	0.1387	8	0.123	0.123	0.1324	0.3012	
9.5	98.1	11.362	1.76	0.1387	9	0.117	0.117	0.1171	0.2592	
10.5	102.4	12.909	1.69	0.1387	10	0.113	0.113	0.1041	0.2231	
11.5	106.1	14.363	1.64	0.1387	11	0.109	0.109	0.0931	0.1920	
12.5	109.4	15.711	1.59	0.1387	12	0.106	0.098	0.0834	0.1653	0.00885178
13.5	112.2	16.949	1.56	0.1387	13	0.104		0.0750	0.1423	0.00777872
14.5	114.7	18.077	1.53	0.1387	14	0.102		0.0677	0.1225	0.00687631
15.5	116.8	19.098	1.50	0.1387	15	0.100		0.0611	0.1054	0.00610859
16.5	118.7	20.015	1.48	0.1387	16	0.099		0.0553	0.0907	0.005449
17.5	120.3	20.836	1.46	0.1387	17	0.097		0.0501	0.0781	0.00487753
18.5	121.7	21.567	1.45	0.1387	18	0.096		0.0455	0.0672	0.00437882
19.5	122.9	22.217	1.43	0.1387	19	0.095		0.0413	0.0578	0.00394092
20.5	123.9	22.792	1.42	0.1387	20	0.095		0.0375	0.0498	0.00355434
21.5	124.9	23.300	1.41	0.1387	21	0.094		0.0341	0.0429	0.00321151
22.5	125.7	23.748	1.40	0.1387	22	0.094		0.0311	0.0369	0.00290625
23.5	126.4	24.142	1.40	0.1387	23	0.093		0.0283	0.0317	0.00263352
24.5	127.0	24.488	1.39	0.1387	24	0.093		0.0258	0.0273	0.00238912
25.5	127.5	24.791	1.39	0.1387	25	0.092		0.0235	0.0235	0.00216954
26.5	128.0	25.057	1.38	0.1387	26	0.092		0.0214	0.0202	0.00197181
27.5	128.4	25.290	1.38	0.1387	27	0.092		0.0195	0.0174	0.00179342
28.5	128.7	25.493	1.37	0.1387	28	0.092		0.0178	0.0150	0.00163221
29.5	129.0	25.671	1.37	0.1387	29	0.091		0.0163	0.0129	0.0014863
30.5	129.3	25.826	1.37	0.1387	30	0.091		0.0149	0.0111	0.00135408
			64.58	4.30		4.30				
				0.0136		0.0136				

Table 13. Summary of preliminary runs of CASAL for gag GOM 2006 stock evaluation. Please refer to the text for details and results description.

Model Run Scenario	Age initial	Age final	fisheries	Indices	selectivity ogives	M	q's estimation	Num Par estimated	Objective function	AIC	SSB0 (MT)	SSBinitial (MT)	SSB2004 (MT)	steepness	R0
Run 1963-2004 continuous fisheries	0	12+	5 fisheries	6 indices	5	0.15	nuisance	61	8601.26	17324.52	51,744.40	21,644.00	20,565.90	0.99	1,769,900
Run 1963-2004 continuous fisheries	1	12+	5 fisheries	6 indices	5	0.15	nuisance	61	8572.51	17267.02	51,428.80	19,766.60	20,291.50	0.99	1,514,080
Run 1963-2004 continuous fisheries	1	12+	5 fisheries	6 indices	5	M(age)	nuisance	61	8500.32	17122.64	65,312.60	17,331.40	19,387.00	0.989999	1,985,910
Run 1963-2004 3 split fisheries	1	12+	11 fisheries	10 indices	8	0.15	nuisance	82	7585.85	15335.70	50,738.40	44,057.80	19,866.80	0.964196	1,493,750
Run 1963-2004 3 split fisheries	1	12+	11 fisheries	10 indices	8	M(age)	nuisance	82	7585.86	15335.72	61,416.30	34,703.00	18,447.90	0.99	1,867,440

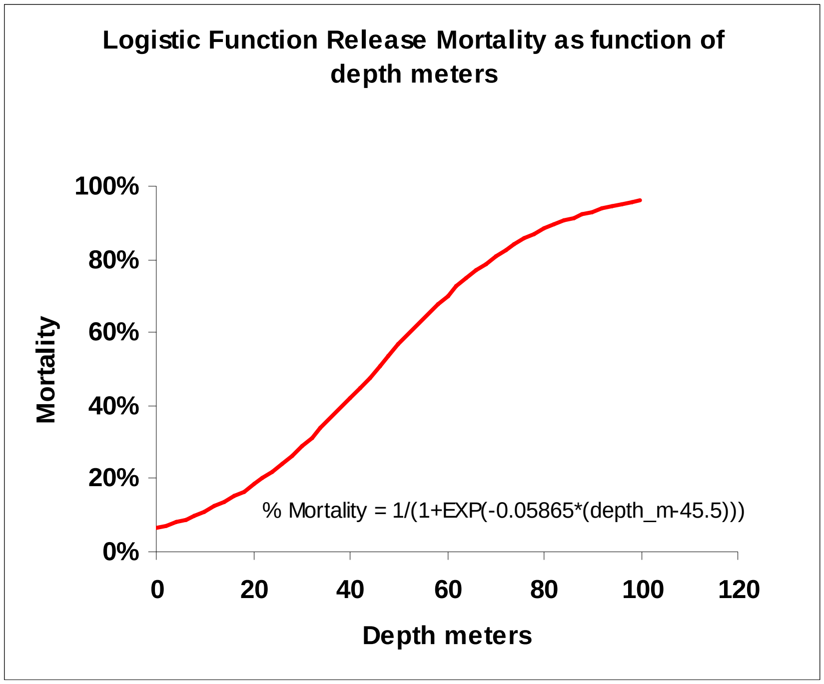


Figure 1. Estimated logistic function of release mortality as function of depth (m) for gag grouper.

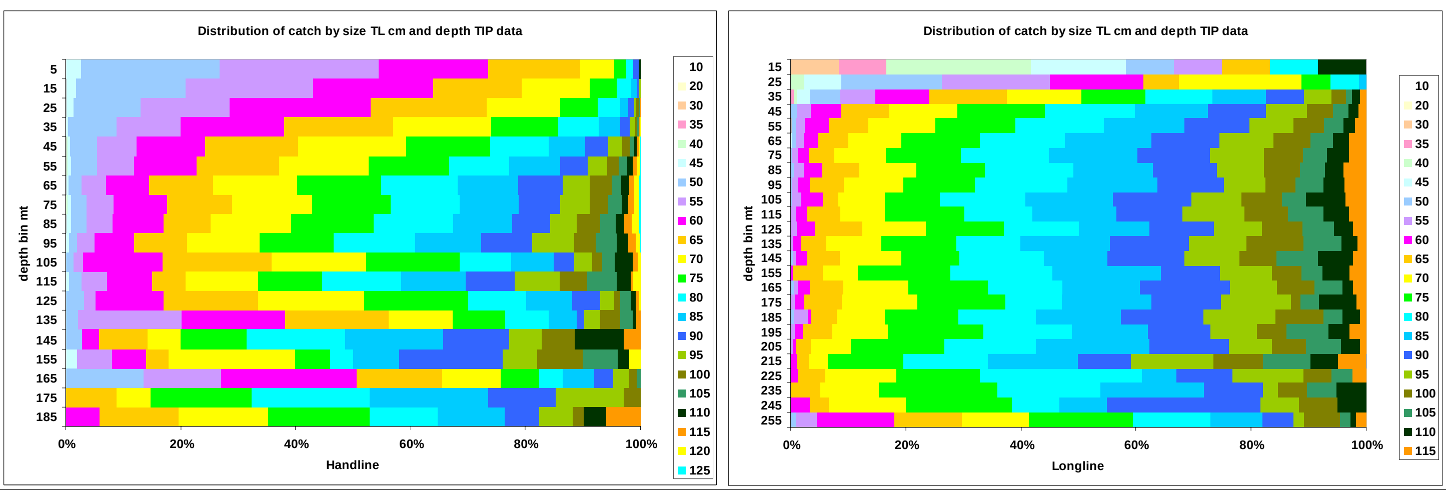


Figure 2. Proportions of size (5 cm TL) at depth (10 m) for gag GOM for commercial fisheries. Data compiled from the TIP program.

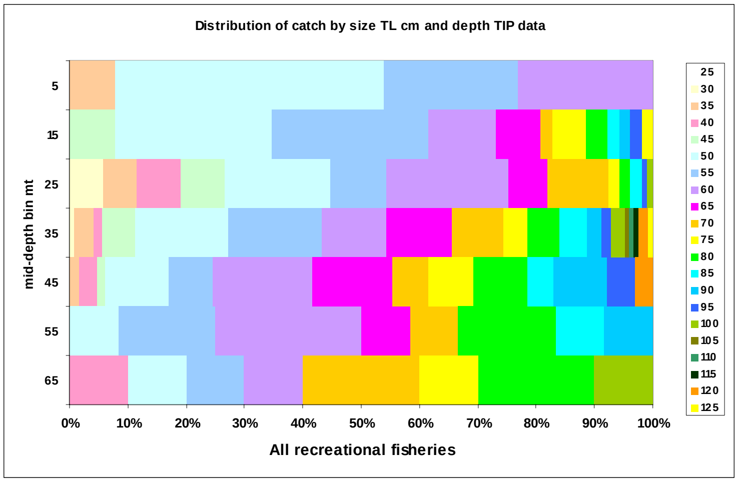
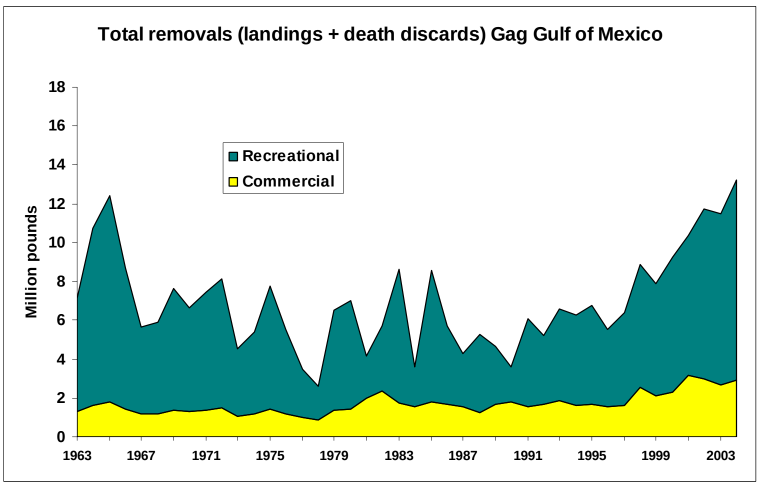


Figure 3. Proportions of size (5 cm TL) at depth (10 m) for gag GOM for recreational fisheries. Data compiled from the TIP program.



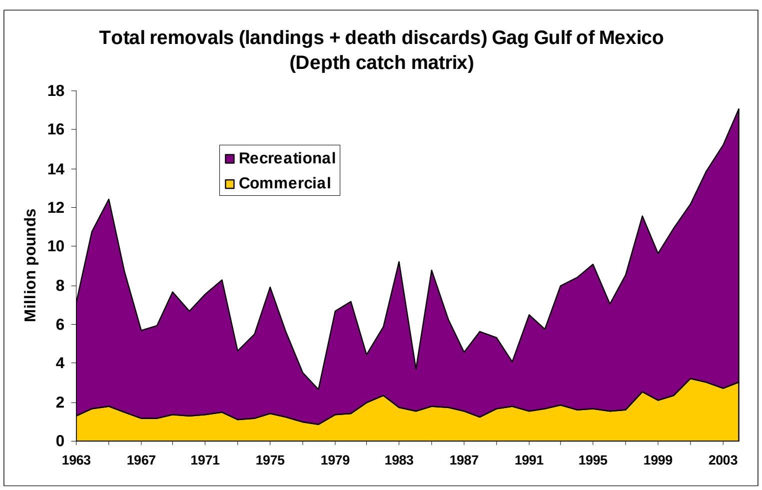


Figure 4. Estimated total biomass removals of gag GOM by commercial and recreational fisheries for 1963 – 2004. Top plot shows estimates assuming a fixed proportion of mortality for discards; bottom plot shows estimates assuming a depth dependent mortality for discards.

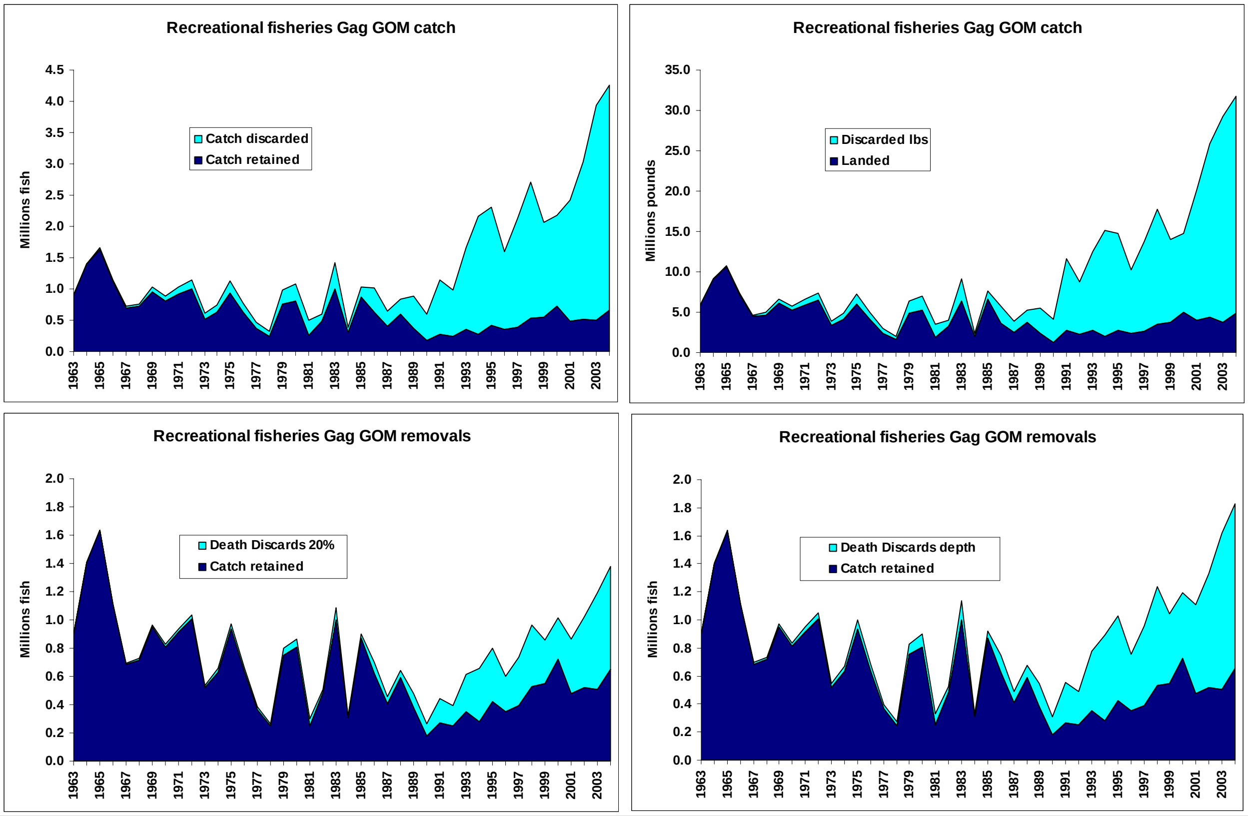
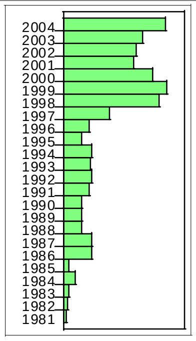


Figure 5. Estimates of catch retained and discarded for the recreational fisheries (top row) in numbers (left) and biomass (right) 1963-2004. Bottom row shows the estimated death discards (numbers of fish) assuming a fixed proportion mortality (left) or a depth dependent mortality (right).

Size samples for Gag GOM from recreational fisheries

Year

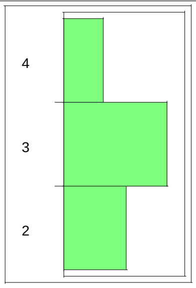


Frequencies

Level	Count	Prob
1981	101	0.00342
1982	137	0.00463
1983	167	0.00565
1984	375	0.01268
1985	166	0.00561
1986	866	0.02929
1987	880	0.02976
1988	551	0.01864
1989	566	0.01914
1990	555	0.01877
1991	790	0.02672
1992	898	0.03037
1993	855	0.02892
1994	871	0.02946
1995	552	0.01867
1996	787	0.02662
1997	1441	0.04874
1998	2970	0.10045
1999	3212	0.10863
2000	2770	0.09368
2001	2167	0.07329
2002	2244	0.07589
2003	2468	0.08347
2004	3179	0.10751
Total	29568	1.00000

24 Levels

mode

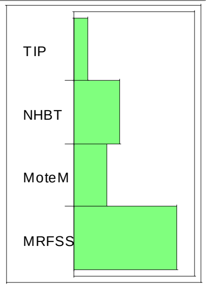


Frequencies

Level	Count	Prob
2	9029	0.30536
3	14784	0.50000
4	5755	0.19464
Total	29568	1.00000

3 Levels

dataset

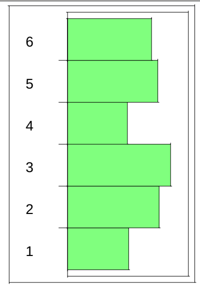


Frequencies

Level	Count	Prob
MRFSS	15539	0.52553
MoteM	4954	0.16755
NHBT	6934	0.23451
TIP	2141	0.07241
Total	29568	1.00000

4 Levels

wave

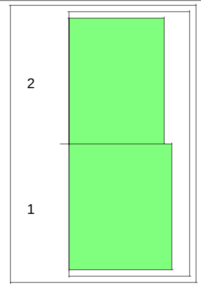


Frequencies

Level	Count	Prob
1	3687	0.12470
2	5516	0.18655
3	6219	0.21033
4	3622	0.12250
5	5452	0.18439
6	5072	0.17154
Total	29568	1.00000

6 Levels

semester



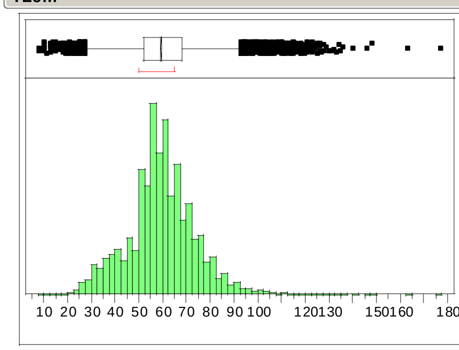
Frequencies

Level	Count	Prob
1	15422	0.52158
2	14146	0.47842
Total	29568	1.00000

2 Levels

Frequency distribution of TL length for gag GOM sampled from recreational fisheries 1981-2004

TLcm



Quantiles

100.0%	maximum	177.00
99.5%		108.15
97.5%		90.00
90.0%		77.00
75.0%	quartile	68.00
50.0%	median	59.00
25.0%	quartile	52.00
10.0%		40.00
2.5%		31.00
0.5%		24.00
0.0%	minimum	8.00

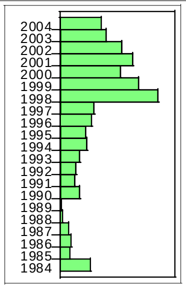
Moments

Mean	59.365158
Std Dev	14.5874
Std Err Mean	0.0848334
upper 95% Mean	59.531436
lower 95% Mean	59.198881
N	29568

Figure 6 Recreational size sample summary and distribution for gag GOM 1984-2004. Bottom plot shows the size frequency distribution of all years combined**.**

Distributions of gag GOM commercial size samples from 1984-2004

YEAR

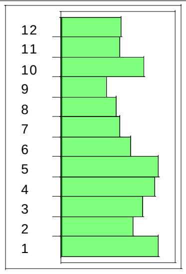


Frequencies

Level	Count	Prob
1984	4027	0.04234
1985	1372	0.01442
1986	1491	0.01567
1987	1244	0.01308
1988	451	0.00474
1989	212	0.00223
1990	2649	0.02785
1991	1945	0.02045
1992	2079	0.02186
1993	2677	0.02814
1994	3597	0.03781
1995	3434	0.03610
1996	4185	0.04400
1997	4588	0.04823
1998	13066	0.13736
1999	10531	0.11071
2000	8085	0.08500
2001	9584	0.10075
2002	8253	0.08676
2003	6122	0.06436
2004	5530	0.05814
Total	95122	1.00000

21 Levels

MONTH

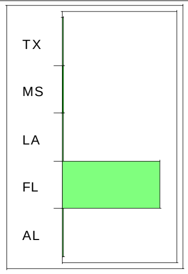


Frequencies

Level	Count	Prob
1	10642	0.11188
2	7873	0.08277
3	8845	0.09299
4	10208	0.10731
5	10569	0.11111
6	7618	0.08009
7	6432	0.06762
8	6060	0.06371
9	4970	0.05225
10	8995	0.09456
11	6389	0.06717
12	6521	0.06855
Total	95122	1.00000

12 Levels

state

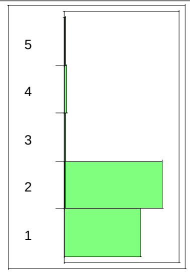


Frequencies

Level	Count	Prob
AL	80	0.00084
FL	93508	0.98303
LA	1170	0.01230
MS	137	0.00144
TX	227	0.00239
Total	95122	1.00000

5 Levels

mode

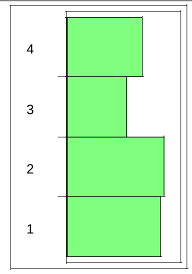


Frequencies

Level	Count	Prob
1	40440	0.42514
2	51942	0.54606
3	506	0.00532
4	1316	0.01383
5	918	0.00965
Total	95122	1.00000

5 Levels

season



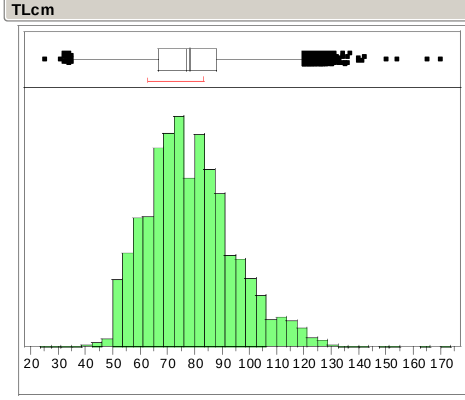
Frequencies

Level	Count	Prob
1	27360	0.28763
2	28395	0.29851
3	17462	0.18357
4	21905	0.23028
Total	95122	1.00000

4 Levels

Frequency distribution of gag GOM size samples from commercial fisheries

TLcm



Quantiles

100.0%	maximum	170.00
99.5%		123.38
97.5%		114.00
90.0%		99.00
75.0%	quartile	88.00
50.0%	median	77.00
25.0%	quartile	67.00
10.0%		59.00
2.5%		52.00
0.5%		49.00
0.0%	minimum	25.00

Moments

Mean	78.323784
Std Dev	15.699435
Std Err Mean	0.050903
upper 95% Mean	78.423554
lower 95% Mean	78.224015
N	95122

Figure 3. Commercial size sample summary and distribution for gag GOM 1984-2004. Bottom plot shows the size frequency distribution of all years combined**.**

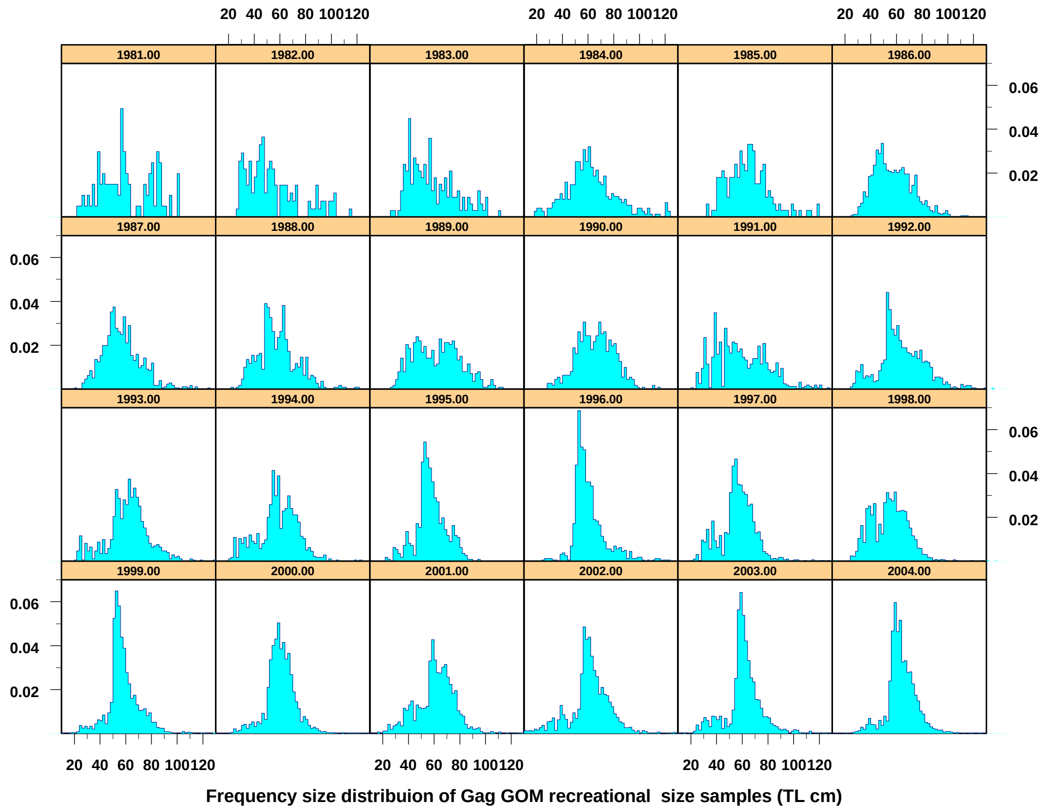


Figure 8. Frequency distribution of size samples from recreational fisheries for gag GOM by year.

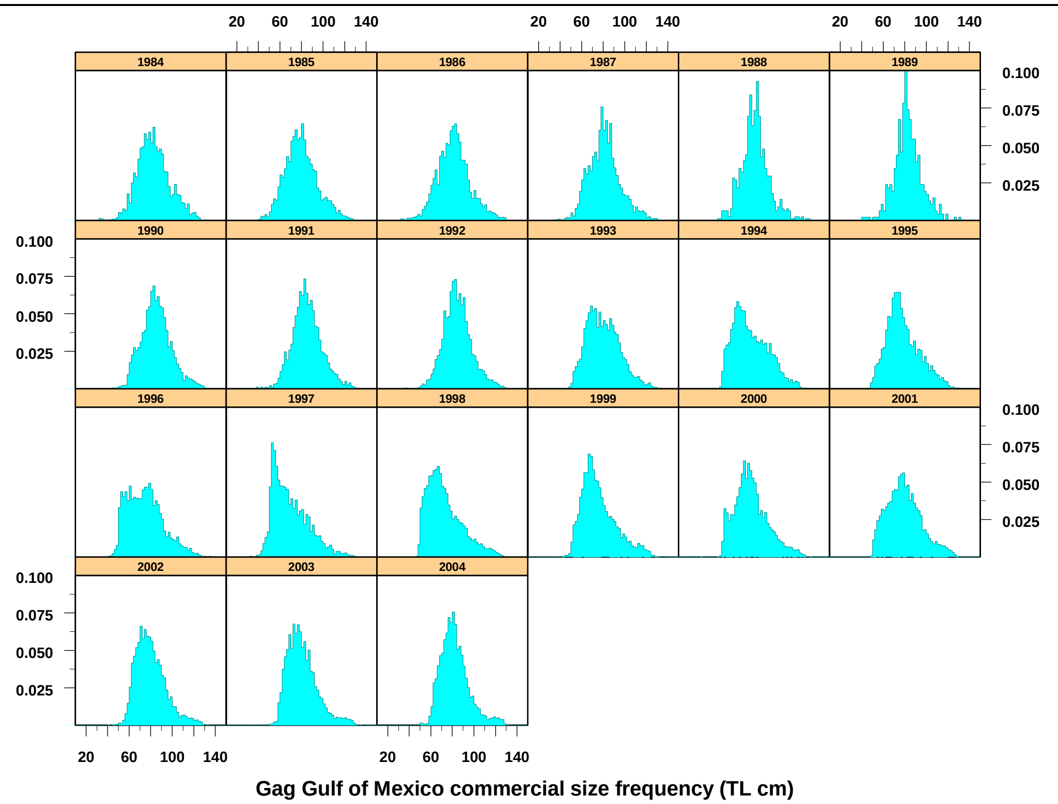


Figure 9. Frequency distribution of size samples from commercial fisheries for gag GOM by year.

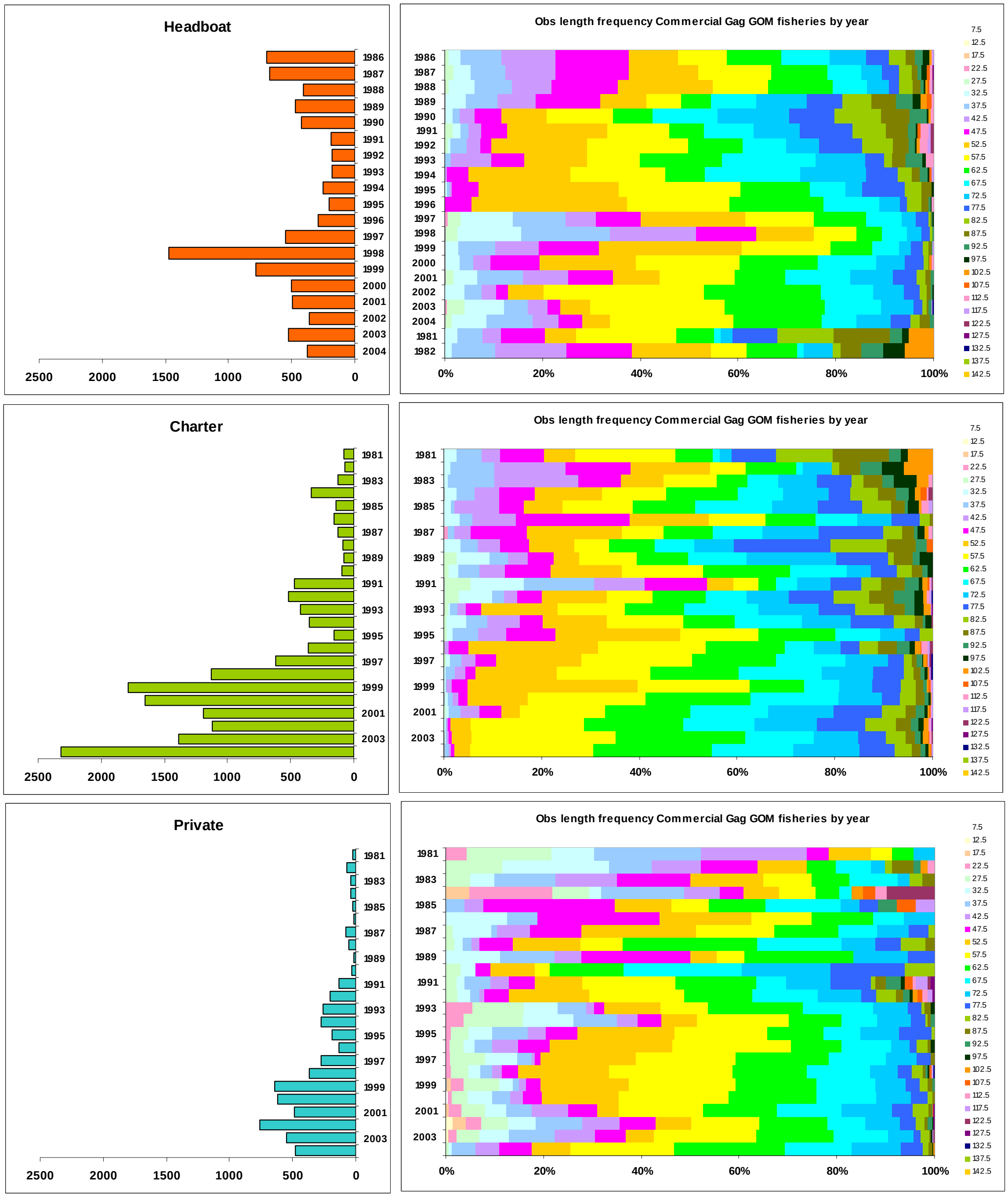


Figure 10. Size proportions (right column) and sample size (left column) by year and mode of gag GOM from recreational fisheries.

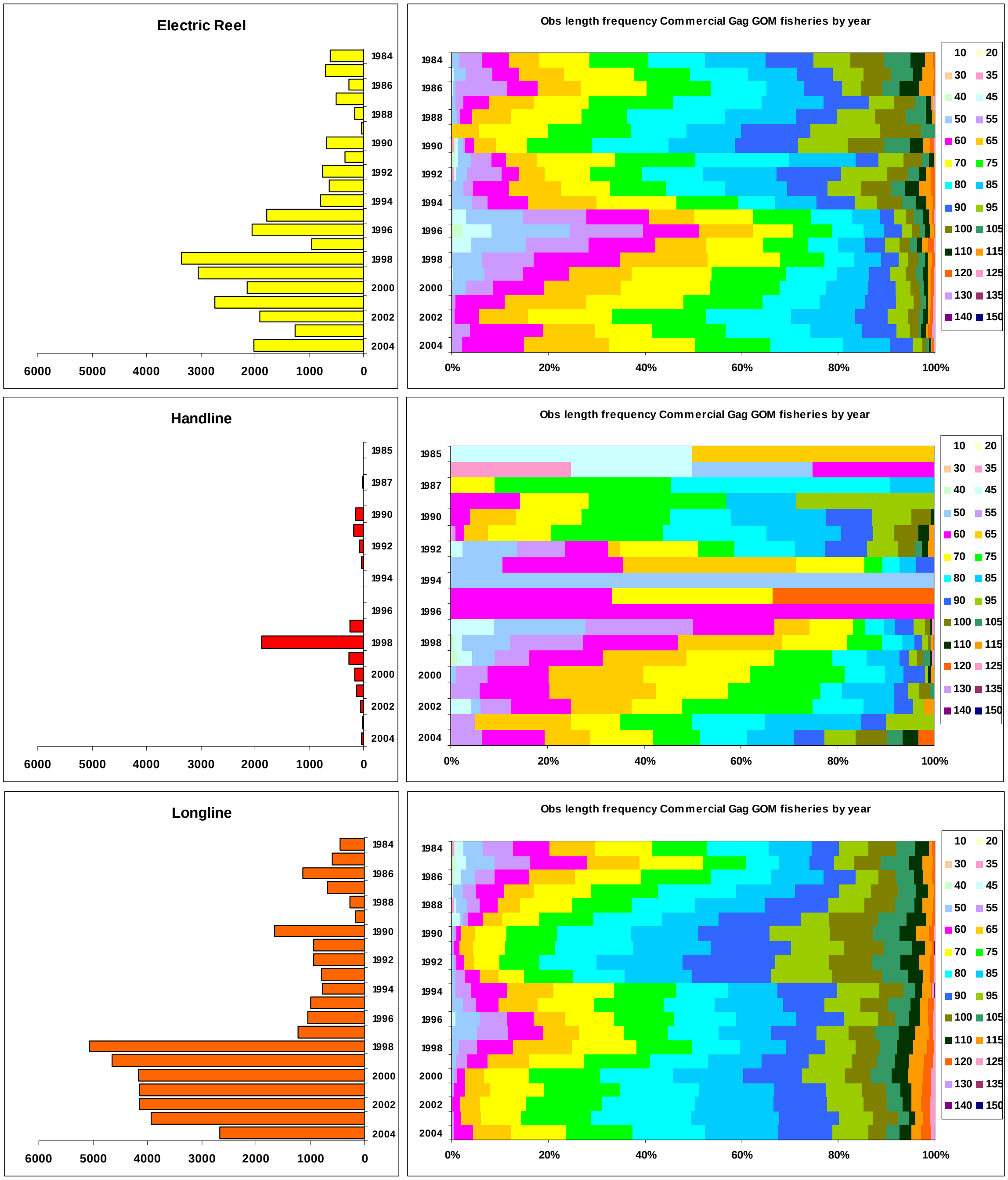


Figure 11. Size proportions (right column) and sample size (left column) by year and mode of gag GOM from commercial fisheries.

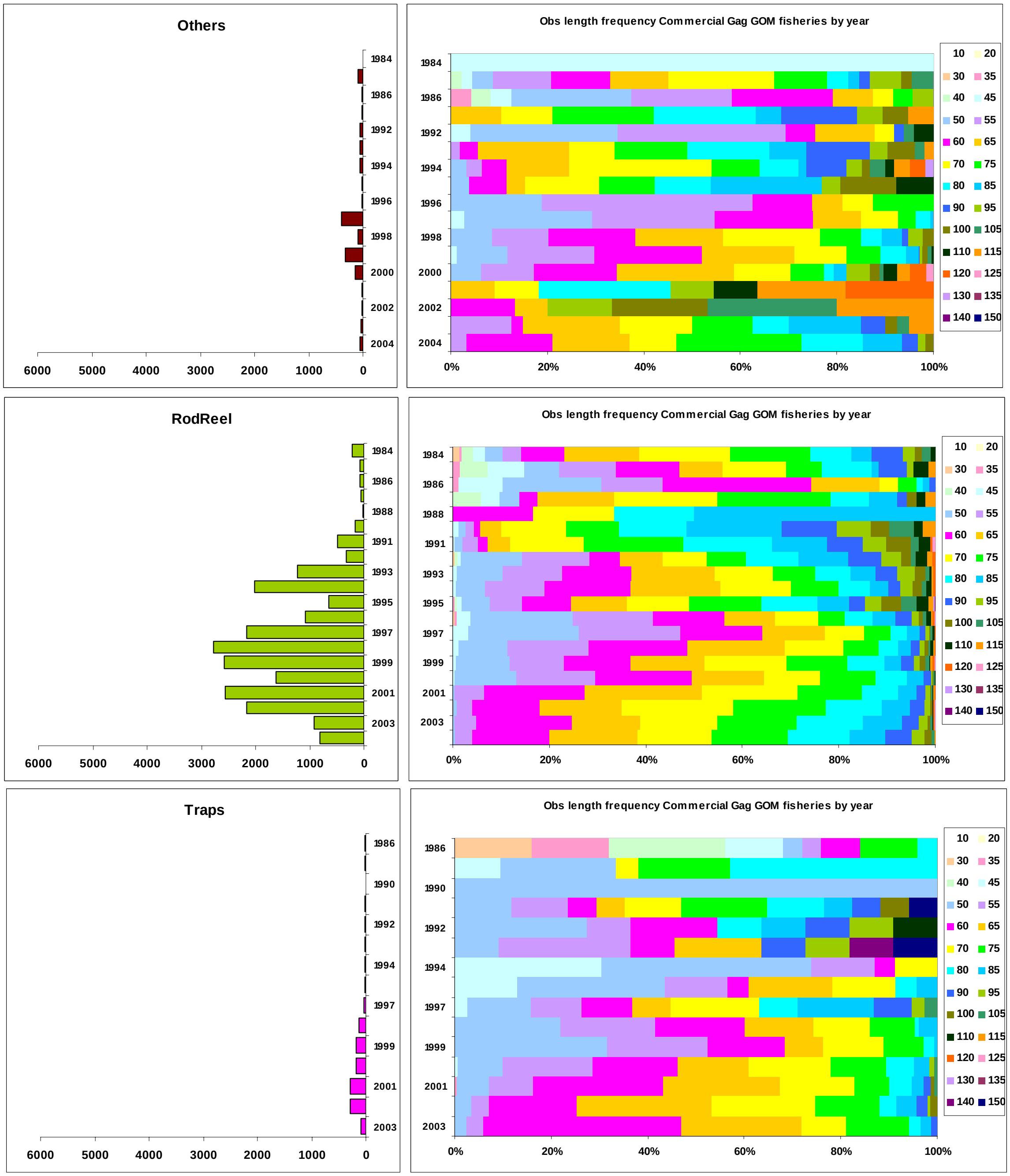


Figure 11b. Size proportions (right column) and sample size (left column) by year and mode of gag GOM from commercial fisheries.

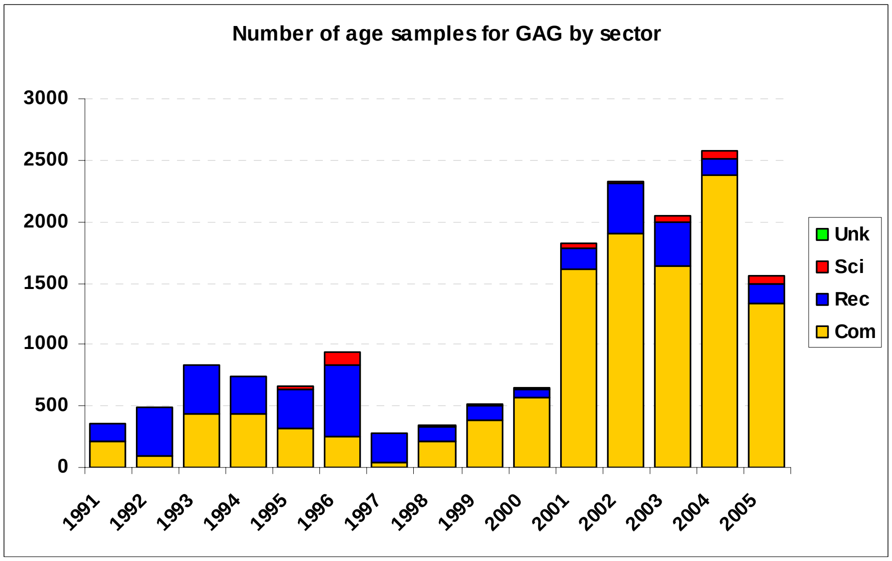
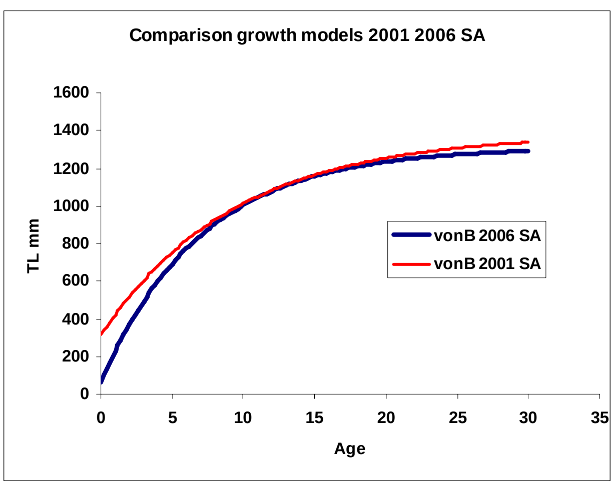


Figure 12. Distribution of aged-samples of gag GOM by sector and year.



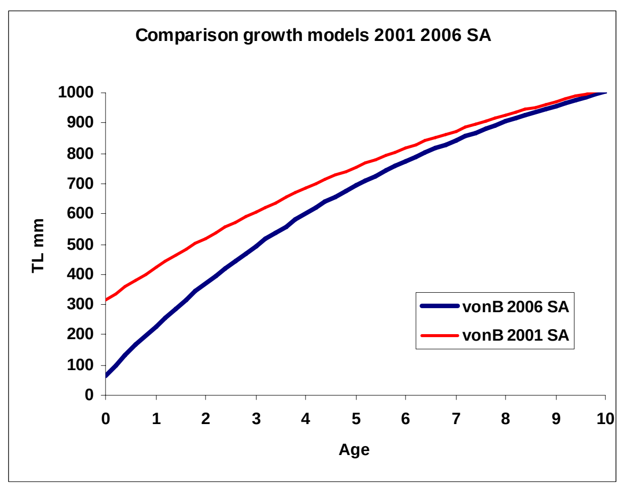


Figure 13. Von Bertalanffy growth models for gag GOM in 2001 and 2006 stock evaluation.

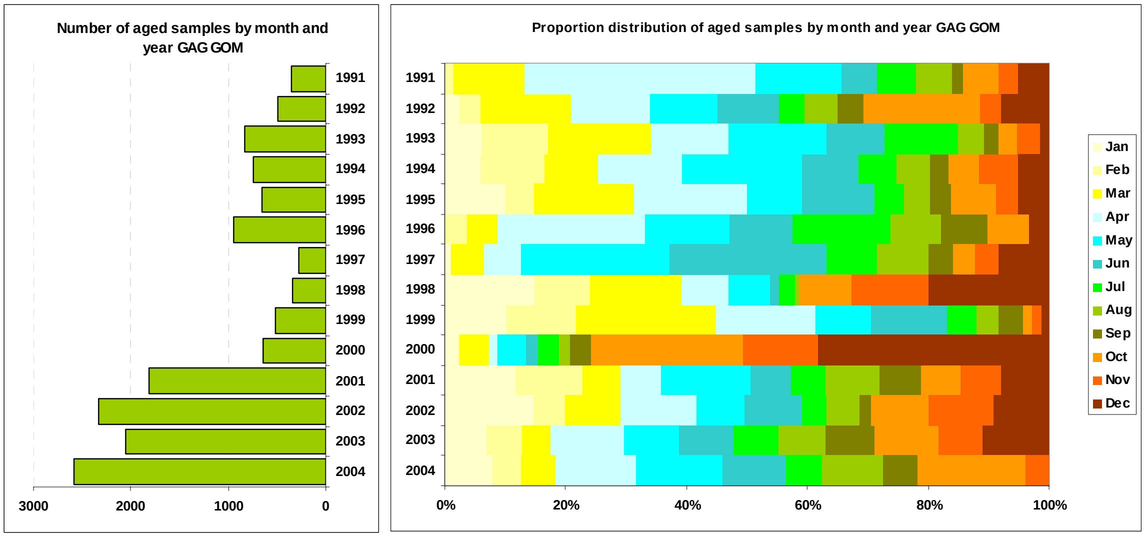


Figure 14. Distributions of aged-samples (otoliths) gag GOM by year and month available for construction of Age Length Keys (ALK).

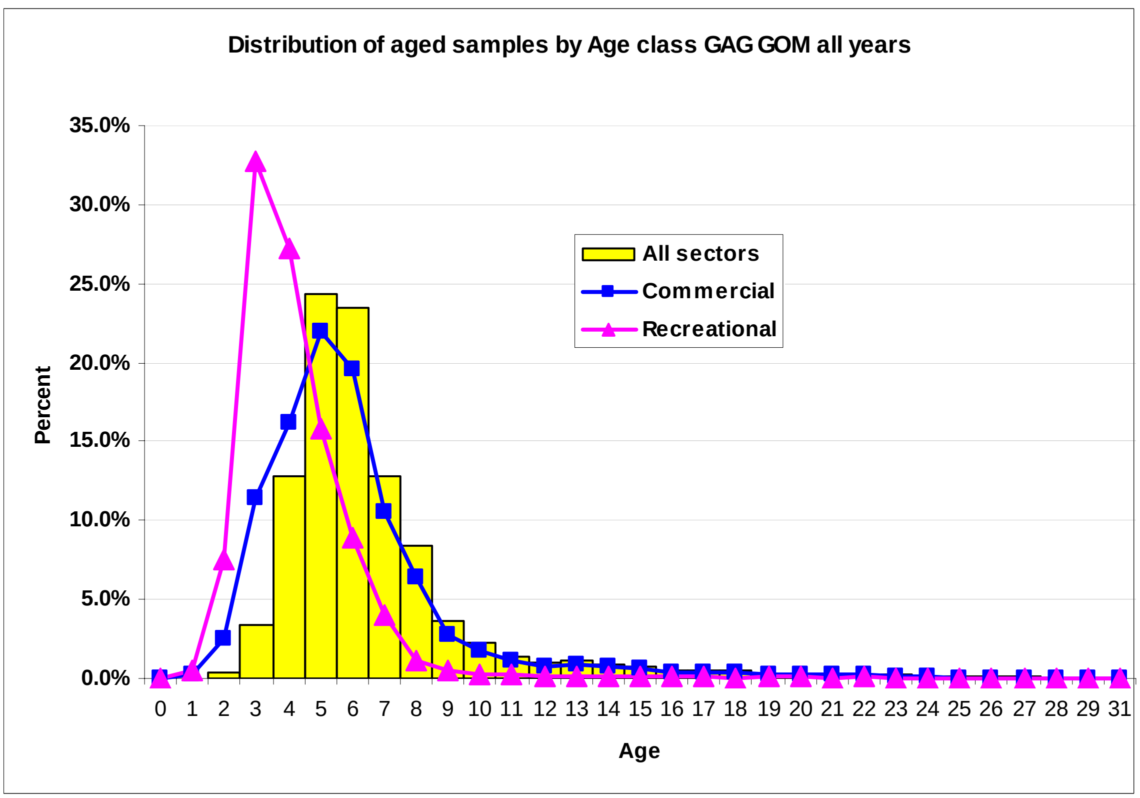


Figure 15. Distribution of integer age readings for otoliths of gag GOM by sector all years combined.

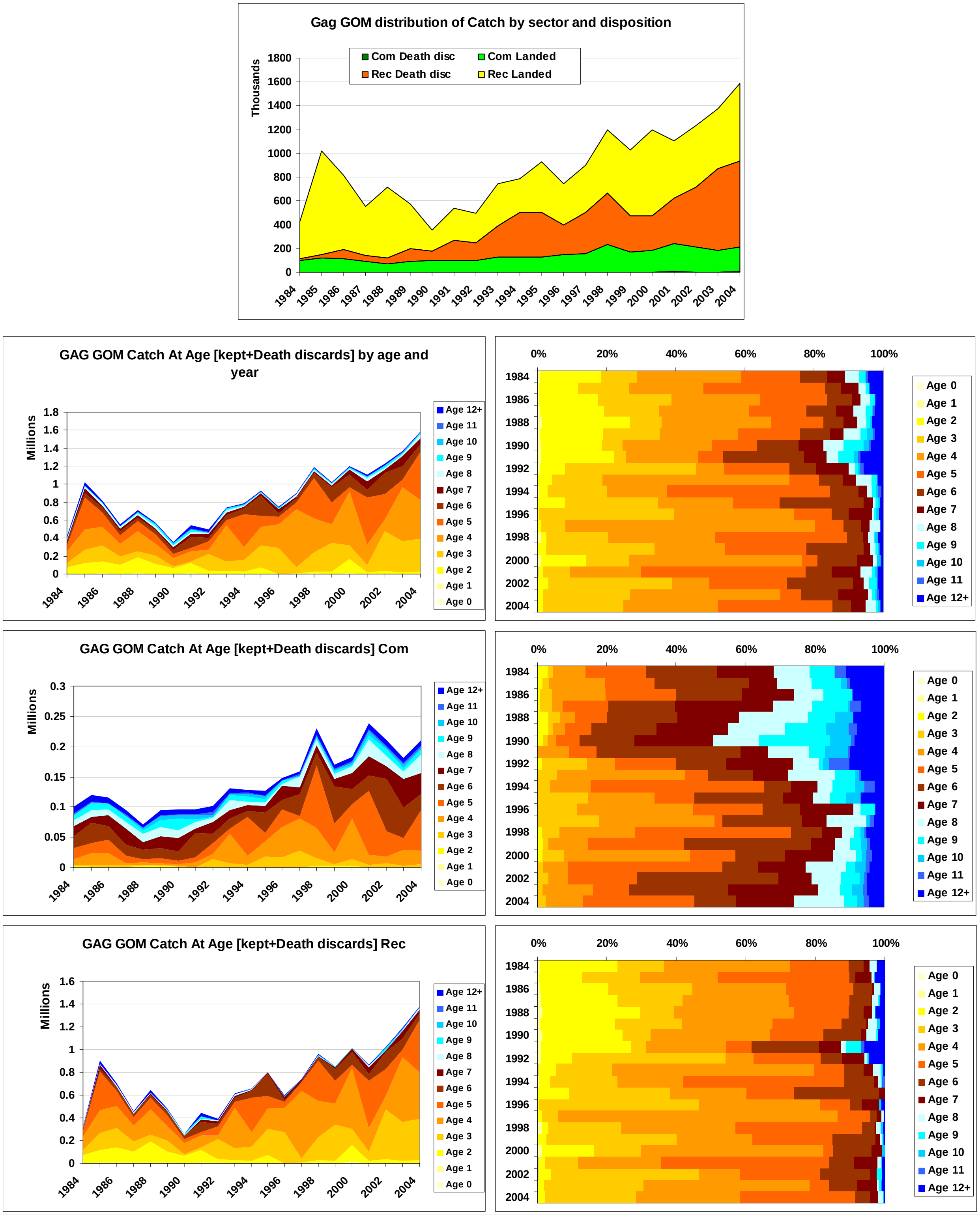


Figure 16. Estimated CAA gag GOM of kept and death discards 1984-2004 assuming a fixed mortality of discards. Left column total catch in millions of fish, right column plots of age proportions by year, 2nd row all sector, 3rd row commercial, and bottom row recreational fisheries.

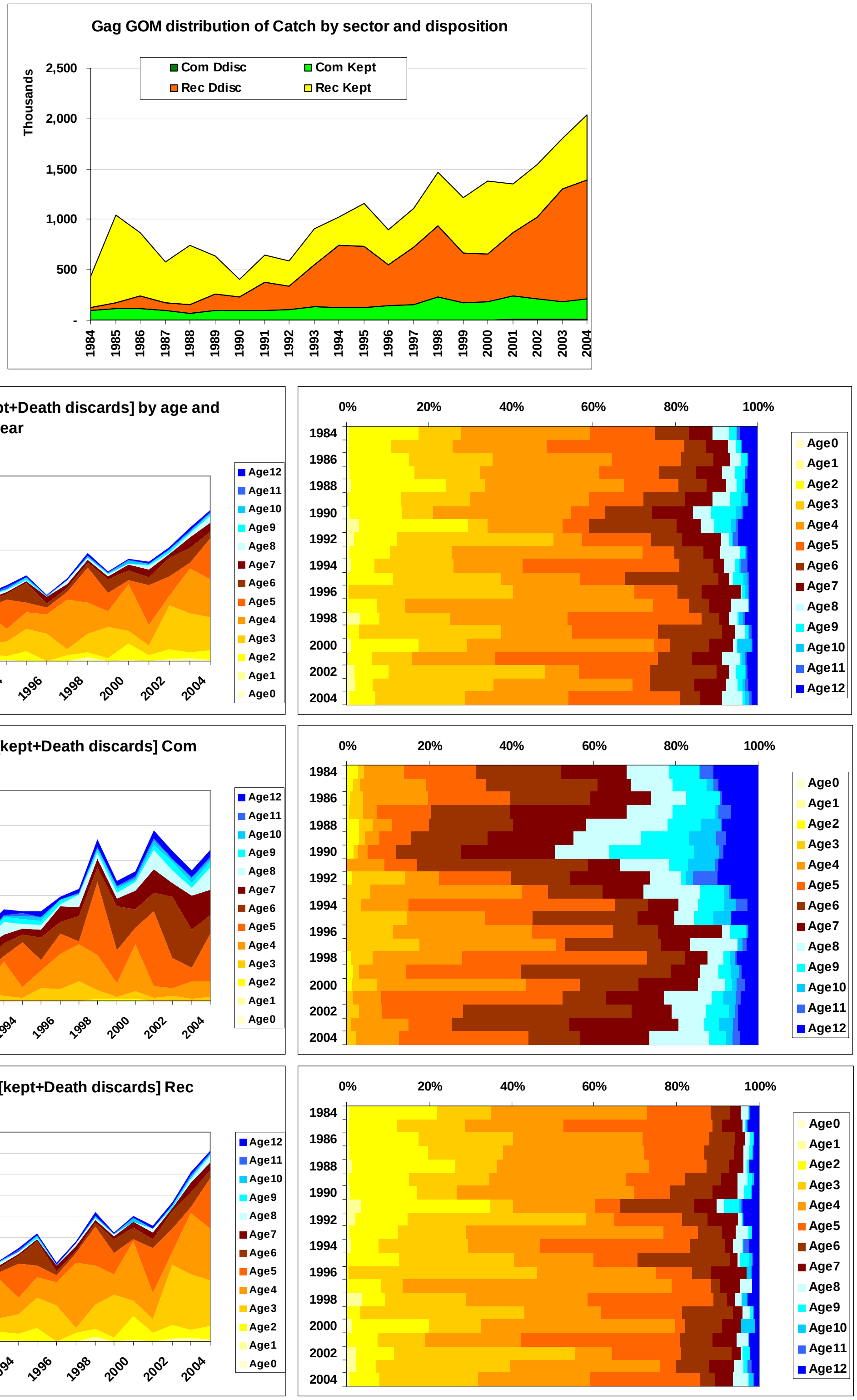


Figure 17. Estimated CAA gag GOM of kept and death discards 1984-2004 assuming a depth dependent mortality of discards. Left column total catch in millions of fish, right column plots of age proportions by year, 2nd row all sector, 3rd row commercial, and bottom row recreational fisheries.

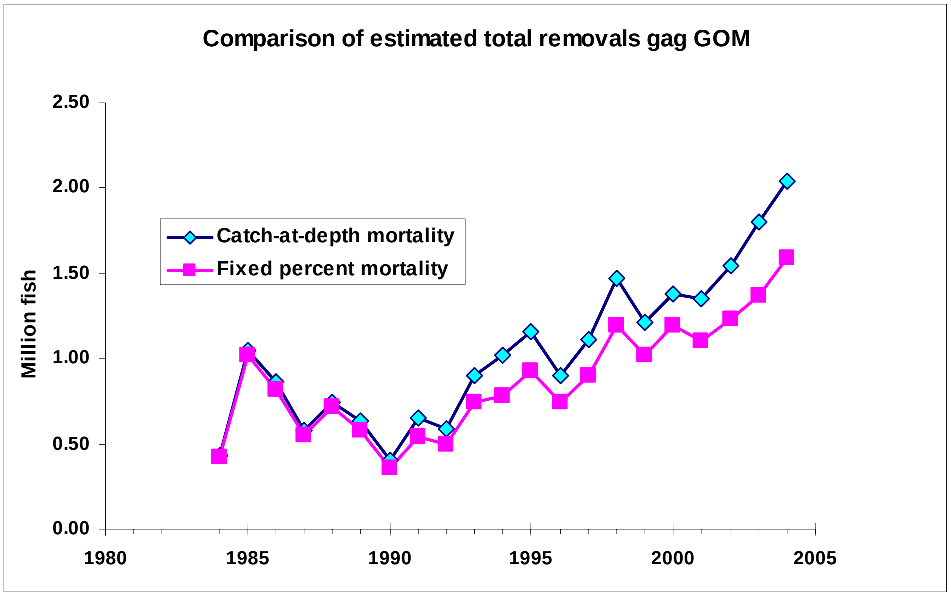
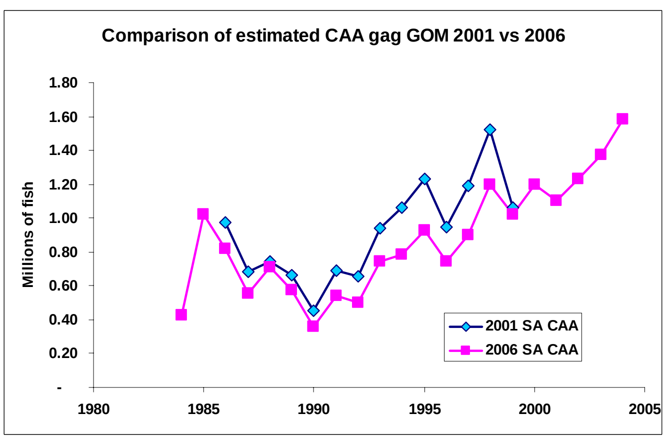


Figure 18. Comparison of estimated total removals gag GOM for the two methods of estimating death discards.



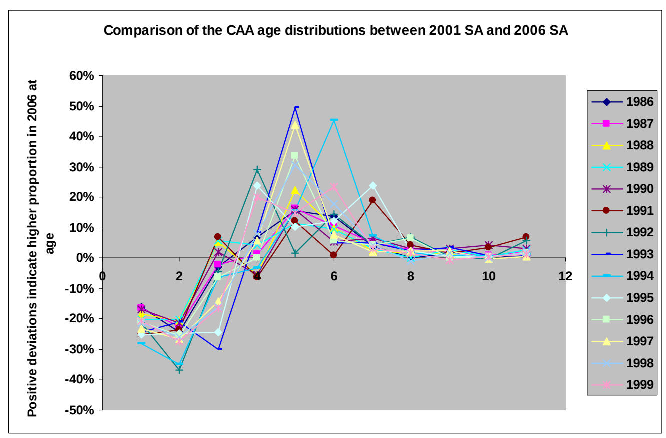
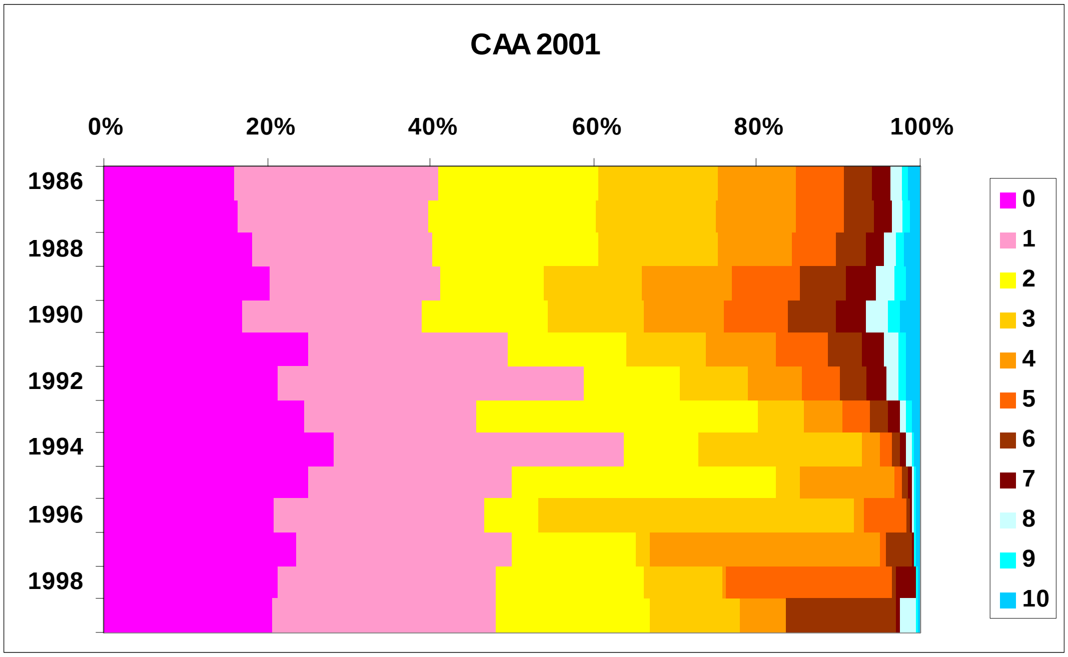


Figure 19. Comparison of estimated CAA gag GOM between 2001 and 2006 assessments (left panel), and deviations of catch proportions by age (right panel).



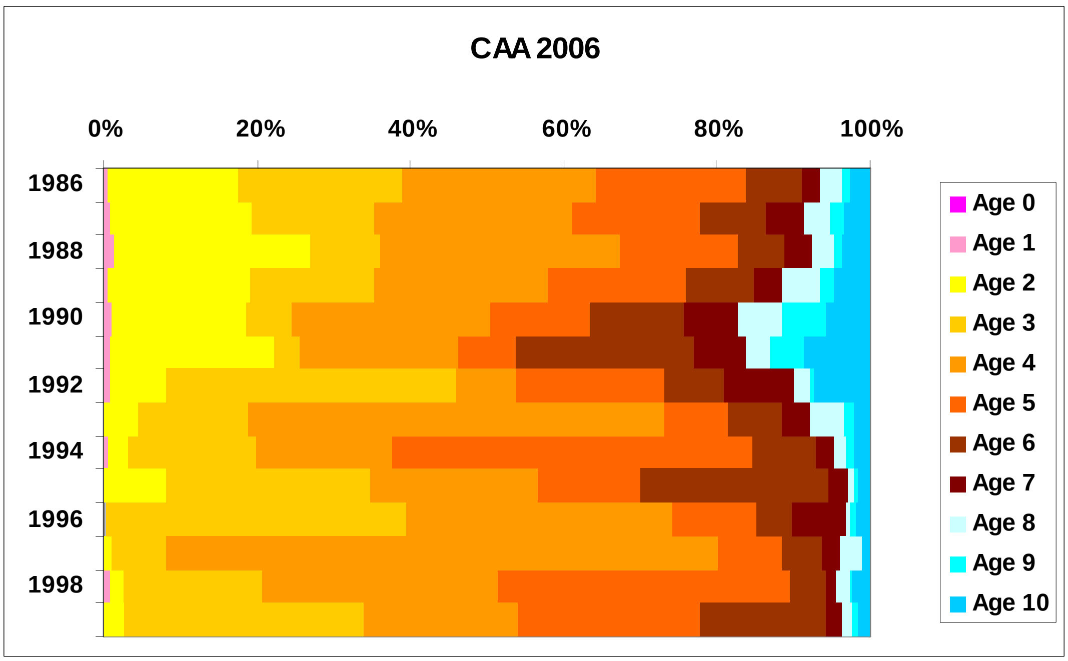


Figure 20. Proportion of ages by year for gag GOM from the estimated CAA between 2001 and 2006 assessments.

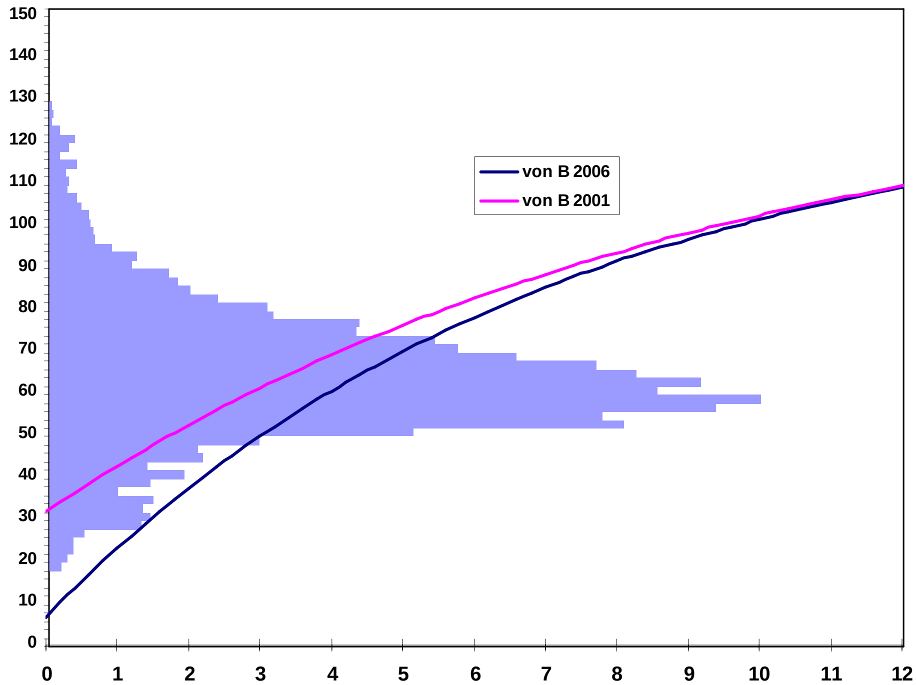


Figure 21. Size frequency distribution of all gag GOM catch (vertical histogram) all years, compared to the estimated mean size at age from the von Bertalanffy growth models 2001 and 2006 SA.

GAG protogynous hermaphrodites [inmature --> female --> male]

GOM

	size mm	age
50%Mat **Fem**	585	3.7
Model	Gompertz	Mat = exp(-exp(-(k+beta*TL)))
	Size mm	Age
k	-9.02	-6.42
beta	0.016	1.81

	size mm	age
50%Mat **Mal**	1100	10.8
Model	Gompertz	Mat = exp(-exp(-(k+beta*TL)))
	Size mm	Age
k	14.39	6.89
beta	-0.01	-0.637

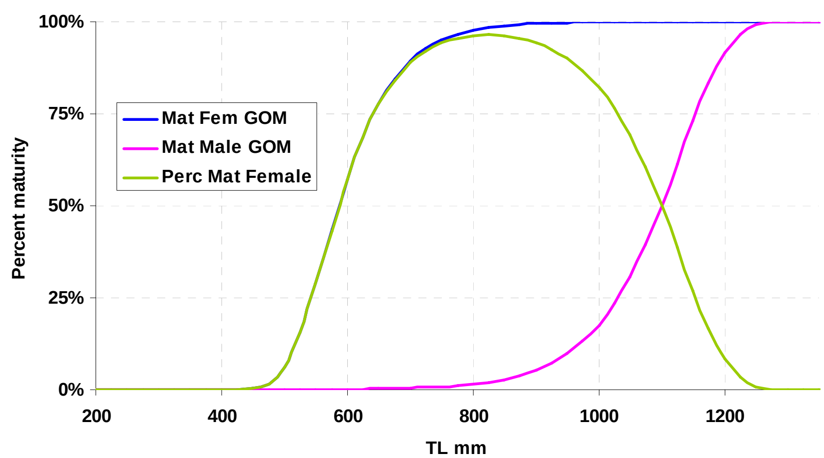
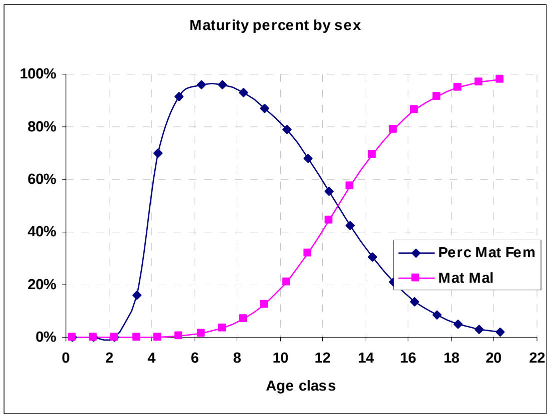


Figure 22. Maturity functions for gag GOM 2006 size based.



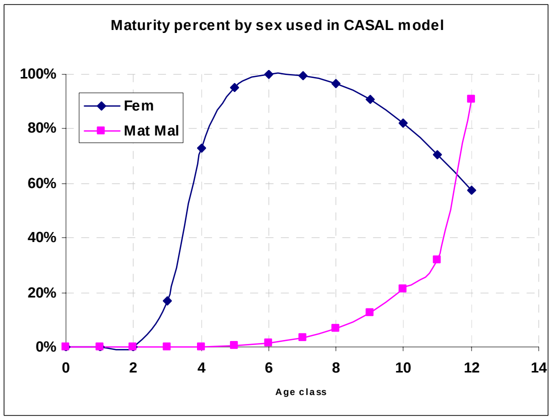


Figure 23. Estimated maturity at age proportions for gag GOM.

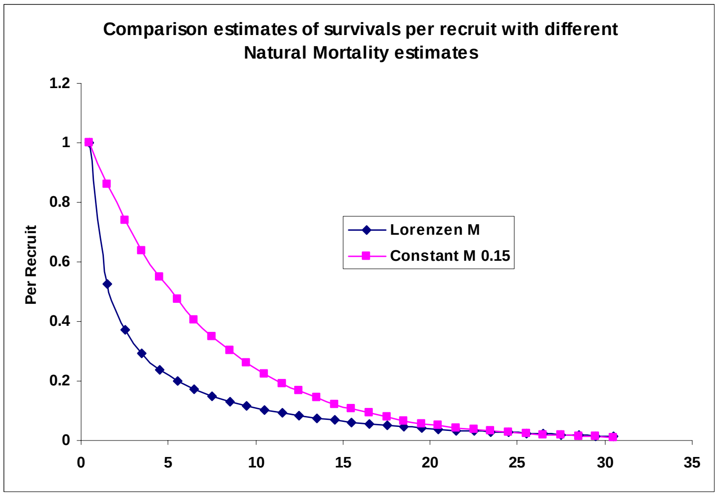


Figure 24. Comparison of estimated survival per recruit of different natural mortality estimates.

Appendix 1.

Example of CASAL input files for gag GOM assessment runs.

G06-population.cls

```
# ===============================================================================
# Input file for GAG GOM (Death Disc Catch-at-depth) 1963-2004 run MOrtiz 2006 ok
# ===============================================================================

# SETTING THE INITIAL STAGE
#INITIALIZATION (the starting value for B0 is set as 10000 t)
@initialization
B0       50000.0                                           # Initial guess for B0
Binitial 35000.0                                           # Biomass at start (1963) with reference to B0, ie 50%

# PARTITION
@size_based false                     # Define the model as age-based
@min_age 0                            # Min age
@max_age 12                       # The partition keeps account of fish aged 0-12
@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 2004                     # to the current year, 2004
@final 2010                       # Projections are run up to the year 2010

@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 3
growth_props 0.00 0.167 0.50      # proportion  of growth that occurs at each time step, so in step one 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 Headboat    Handline LonglineMRFSS     Trap            # Fishery(ies) and names
fishery_times 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 0                         # Recruits enter at age 0
@standardise_YCS true              # Use the "Haist" parameterisation of YCS
@recruitment                       # the two following lines define the starting values for recruitment for the years 1986-1999
YCS_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
YCS     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      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
first_free 1964                    # with standardisation occurring over the years
last_free 2001                     # 1984-2001
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 0.80                     # with a steepness parameter of 0.5

# RECRUITMENT VARIABILITY
@randomisation_method lognormal    # Use the lognormal distribution when assigning YCS to unknown years during projections
@first_random_year 2002            # Defines the first unknown YCS as 2002

#MATURATION
@maturity_props                    # maturity proportion at Age block command when maturity is NOT a partition character
all allvalues             0       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
all 0.15                           # Define the average natural mortality of males & females as 0.15

# FISHERIES DEFINITIONS
@fishery Headboat                  # Define the catch from the Headboat for years 1986-2004  Enter values in MT using the depth matrix discards!
years           1986     1987     1988     1989     1990     1991     1992     1993     1994     1995     1996     1997     1998     1999     2000     2001     2002
        2003     2004
catches         140.027  104.665  74.731   153.360  139.706  50.564   71.023   95.851   143.917  88.580   80.307   76.180   194.167  143.136  122.858  75.779   65.971
        109.120  148.581
selectivity HeadboatSel            # Defines that the catch is removed from the population using the selectivity defined by the label "HeadboatSell"
U_max 0.80                         # with a maximum possible exploitation rate of 0.5
future_years   2005 2006 2007 2008 2009 2010              # Defines the future years and
future_catches 0 0 0 0 0 0                                # catches for use in projections

@fishery Handline                  # Define the catch from the Handline for years 1963-2004
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
```

```
catches         585.109  741.137  824.277  661.281  524.618  541.297  624.940  582.779  624.932  663.013  490.875  537.586  656.766  544.091  443.679  397.369  609.380
        598.308  680.430  605.916  471.899  498.623  634.847  524.376  387.071  359.147  560.889  512.964  450.671  455.237  581.360  521.247  525.553  502.384  499.900
        839.318  672.536  728.863  948.081  877.844  670.373  797.489
selectivity HandlineSel           # Defines that the catch is removed from the population using the selectivity defined by the label "HandlineSel"
U_max 0.8                          # with a maximum possible exploitation rate of 0.5
future_years   2005 2006 2007 2008 2009 2010       # Defines the future years and
future_catches 0 0 0 0 0 0                         # catches for use in projections

@fishery Longline                 # Define the catch from the Longline for years 1979-2004
years           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
catches         0.628    40.544   212.049  458.539  309.203  196.654  172.906  234.902  297.843  182.619  193.412  283.595  231.407  269.142  218.977  159.724  178.716
        180.249  190.606  276.485  249.615  289.115  477.946  480.968  540.122  540.611
selectivity LonglineSel           # Defines that the catch is removed from the population using the selectivity defined by the label "LonglineSel"
U_max 0.8                         # with a maximum possible exploitation rate of 0.4
future_years   2005 2006 2007 2008 2009 2010       # 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 1963-2004
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
catches         2645.955 4132.755 4828.188 3286.052 2050.317 2153.921 2860.327 2457.294 2792.513 3088.033 1606.346 1961.455 2926.074 1997.553 1160.202 791.870  2429.430
        2626.723 1116.188 1593.051 3386.764 968.855  3163.178 1935.506 1283.458 1917.520 1481.953 903.780  2198.678 1793.619 2666.863 2931.734 3291.735 2411.124 3084.272
        3903.324 3292.203 3802.413 3980.038 4830.790 5547.582 6228.010
selectivity MRFSSSel              # Defines that the catch is removed from the population using the selectivity defined by the label "MRFSSSel"
U_max 0.8                         # with a maximum possible exploitation rate of 0.4
future_years   2005 2006 2007 2008 2009 2010       # Defines the future years and
future_catches 0 0 0 0 0 0                         # catches for use in projections

@fishery Trap                     # Define the catch from the trap for years 1986-1999
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
catches         0.656    4.126    0.260    0.557    4.467    2.004    1.455    1.136    1.263    1.807    2.224    0.615    2.027    4.138    3.411    4.972    4.397
        5.387    7.086    6.430    8.014    8.357    12.657   13.176   13.413   10.523   14.244   18.531   28.643   31.121   48.015   54.047   47.520   30.647   37.516
        37.037   30.998   36.892   45.816   27.993   30.461   33.055
selectivity TrapSel               # Defines that the catch is removed from the population using the selectivity defined by the label "TrapSel"
U_max 0.8                         # with a maximum possible exploitation rate of 0.4
future_years  2005 2006 2007 2008 2009 2010        # Defines the future years and
future_catches 0 0 0 0 0 0                         # catches for use in projections

# SELECTIVITIES DEFINITIONS
@selectivity_names  HeadboatSel  HandlineSel  LonglineSel  MRFSSSel  TrapSel                  # Define the selectivities used

@selectivity HeadboatSel                  # Headboat  size base
all size_based  double_logistic  10 5  80 10 1.0       # curve (males + females), with double logistic max 1.0
@selectivity HandlineSel                  # Handline size base
all size_based  logistic  85 30       # curve (males + females), with double logistic max 0.8
@selectivity LonglineSel                  # Longline size base
```

```
all size_based logistic  85 30            # curve (males+females) logistic
@selectivity     MRFSSSel                 # Recreational fisheries size base
all size_based logistic  85 30    # curve (males+females) double logistic max 0.8
@selectivity     TrapSel          # Trap fishery  this one is age based
all double_logistic 1 1.0 8.0 3.0 0.95        # curve (males+females) double logistic max 0.8


# 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   UPDATE 2006 values
t0                                -0.37
Linf                              131.00
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                        1.33824e-8
b                        2.97685
verify_size_weight 50 1.3 1.8     # Check that these values are correct, by confirming that a 50 cm fish has a weight between 0.8 and 1.5 kgs
```

G06-estimation.csl

```
# ESTIMATION
@estimator likelihood    # Use the ML estimation method
@max_iters 300           # With maximum of 300 iterations for the point estimates [these are default values of CASAL]
@max_evals 1000          # and 1000 function evaluations
@grad_tol 0.002          # Set the tolerance for the convergence test at 0.001


{
@MCMC
start 0          # Start the MCMC at 0
length 110000   # 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 100      # The MCMC has a burn-in period of 100*100=10000 steps
}

# OBSERVATIONS:        CPUE standardized series
@relative_abundance HeadboatCPUE          # Define a relative abundance series "HeadboatCPUE"
biomass false                             # This time series is a number of fish index
q                HeadboatCPUEq            # 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 HeadboatSel                           # and is applied with the selectivity "HeadboatSel"
years           1986     1987     1988     1989     1990     1991     1992     1993     1994     1995     1996     1997     1998     1999
1986     1.14                               # year and index value
1987     1.317
1988     1.057
1989     0.993
1990     0.72
1991     0.597
1992     0.718
1993     0.826
1994     0.836
1995     0.853
1996     1.35
1997     1.327
1998     1.26
1999     1.237
2000     1.048
2001     0.778
2002     0.825
2003     1.039
2004     1.078
cv_1986  0.156                              # and each point has a cv of
cv_1987  0.119
cv_1988  0.147
cv_1989  0.157
cv_1990  0.177
cv_1991  0.218
cv_1992  0.214
cv_1993  0.179
cv_1994  0.187
cv_1995  0.2
cv_1996  0.113
cv_1997  0.11
cv_1998  0.121
cv_1999  0.115
cv_2000  0.151
cv_2001  0.208
cv_2002  0.209
cv_2003  0.155
cv_2004  0.144
dist lognormal                                      # where the CVs have lognormal distribution
cv_process_error 0.0                                # and there is no process error applied

@relative_abundance HandlineCPUE                    # Define a relative abundance series "HandlineCPUE"
biomass true                                        # This time series is an abundance index
q HandlineCPUEq                                     # 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 HandlineSel                        # and is applied with the selectivity "HandlineSel"
years 1990      1991    1992    1993    1994    1995    1996    1997    1998    1999    2000    2001    2002    2003    2004
1990    0.537535449                 #  year and index value
1991    0.379607251
1992    0.476513861
1993    0.761432621
1994    0.594985256
1995    0.741422183
1996    0.867145119
1997    0.927312489
1998    1.524325644
1999    1.063982128
2000    1.129660624
2001    1.543227123
2002    1.510135631
2003    1.256533041
2004    1.686181579
cv_1990  0.116657863                # and each point has a cv of
cv_1991  0.110118609
cv_1992  0.098972363
cv_1993  0.061532352
cv_1994  0.064418946
cv_1995  0.060743194
cv_1996  0.053345885
cv_1997  0.051667329
cv_1998  0.047189276
cv_1999  0.048192468
cv_2000  0.048608123
cv_2001  0.047121544
cv_2002  0.047585983
cv_2003  0.048358512
cv_2004  0.047619676
dist lognormal                      # where the CVs have lognormal distribution
cv_process_error 0.0                # and there is no process error applied

@relative_abundance LonglineCPUE         # Define a relative abundance series "LonglineCPUE"
biomass true                             # This time series is an abundance index
q LonglineCPUEq                          # 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 LonglineSel                        # and is applied with the selectivity "LonglineSel"
years 1990      1991    1992    1993    1994    1995    1996    1997    1998    1999    2000    2001    2002    2003    2004
1990    0.849883366
1991    0.562190283
1992    0.452355835
1993    0.624425122
1994    0.355157008
1995    0.498558244
1996    0.585552052
```

```
1997    0.585366928
1998    1.028643485
1999    0.779554532
2000    1.014401186
2001    1.832232763
2002    1.752185995
2003    1.951392003
2004    2.128101198
cv_1990 0.45
cv_1991 0.463
cv_1992 0.606
cv_1993 0.251
cv_1994 0.326
cv_1995 0.278
cv_1996 0.208
cv_1997 0.21
cv_1998 0.157
cv_1999 0.181
cv_2000 0.16
cv_2001 0.11
cv_2002 0.112
cv_2003 0.104
cv_2004 0.097
dist lognormal                       # where the CVs have lognormal distribution
cv_process_error 0.0                 # and there is no process error applied

@relative_abundance MRFSSCPUE                # Define a relative abundance series "MRFSSCPUE"
biomass false                                # This time series is an abundance index
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
1981    0.953276055
1982    0.420313784
1983    0.806032873
1984    0.292446769
1985    1.141781845
1986    1.025289503
1987    0.274561076
1988    0.311116922
1989    0.423686963
1990    0.668673889
1991    0.5067613
1992    0.450044826
1993    1.141860291
1994    1.520989914
1995    1.452898767
```

```
1996     1.258117295
1997     0.939155771
1998     1.899178185
1999     1.591120657
2000     0.906365334
2001     0.714564811
2002     1.407164737
2003     1.539895405
2004     1.534325738
cv_1981  0.414
cv_1982  0.456
cv_1983  0.471
cv_1984  0.599
cv_1985  0.392
cv_1986  0.342
cv_1987  0.376
cv_1988  0.388
cv_1989  0.385
cv_1990  0.397
cv_1991  0.372
cv_1992  0.34
cv_1993  0.324
cv_1994  0.319
cv_1995  0.313
cv_1996  0.322
cv_1997  0.315
cv_1998  0.303
cv_1999  0.301
cv_2000  0.307
cv_2001  0.31
cv_2002  0.299
cv_2003  0.299
cv_2004  0.301
dist lognormal                         # where the CVs have lognormal distribution
cv_process_error 0.0                   # 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 3
proportion_mortality 0.5               # after all mortality has been recorded in that time step
area GOM                               # Occurs in the area "GOM"
ogive LonglineSel                      # and is applied with the selectivity "LonglineSel"
years  1993      1994     1995     1996     1997     2002     2004
1993     0.662867
1994     0.512612
1995     0.445969
1996     0.879396
1997     0.932022
2002     1.58665
```

```
2004    1.980485
cv_1993  0.424467
cv_1994  0.528376
cv_1995  0.360877
cv_1996  0.28771
cv_1997  0.30967
cv_2002  0.189639
cv_2004  0.186472
dist lognormal                          # where the CVs have lognormal distribution
cv_process_error 0.0                    # 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 LonglineSel                       # and is applied with the selectivity "LonglineSel"
years  1993     1994    1995    1996    1997    2002    2004
1993    1.24373
1994    0.843636
1995    0.670346
1996    0.757523
1997    0.54385
2002    0.963539
2004    1.977376
cv_1993  0.40344727
cv_1994  0.5859226
cv_1995  0.49734794
cv_1996  0.45720844
cv_1997  0.573801
cv_2002  0.37100684
cv_2004  0.29729623
dist lognormal                          # where the CVs have lognormal distribution
cv_process_error 0.0                    # and there is no process error applied


#OBSERVATIONS:   Proportions at age for each fishery [partial catches in VPA2Box program]
@catch_at HandlineCAA                   # Partial catch-at-age for the handline fishery
years 1984      1985    1986    1987    1988    1989    1990    1991    1992    1993    1994    1995    1996    1997    1998    1999    2000    2001
        2002    2003    2004    # index years
fishery Handline                        # Apply to the fishery Handline
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 0                             # Mininum age class
max_class 12                            # Maximum age class
#Year   Age0    Age1    Age2    Age3    Age4    Age5    Age6    Age7    Age8    Age9    Age10   Age11   Age12
1984    0       0       0.038850905     0.008715044     0.079843892     0.153466944     0.196440623     0.172863053     0.101015288     0.097816837
        1.46718E-05     0.019264063     0.131708677
```

1985	0	0	0.015182583	0.016112586	0.121415846	0.114480039	0.300424664	0.09220478	0.115824622	0.103936267	0.021423689	0.012448598	0.086546326
1986	0	0	0.007103681	0.0270216	0.200434253	0.201601466	0.148813334	0.181783953	0.032845112	0.113282378	0	0	0.087114224
1987	0	0	0.011444525	0.033131806	0.021687282	0.142474162	0.203302087	0.301384806	0.087026457	0.126610831	0.004991957	0.038345628	0.029600459
1988	0	0	0.03730157	0.043333406	0.007948087	0.109748928	0.187553078	0.195588267	0.221588311	0.039675108	0.078043682	0.002939703	0.07627986
1989	0	0	0.037792388	0.007349762	0.010122695	0.071455193	0.178824336	0.232583449	0.166882836	0.110127167	0.092893242	0.016354339	0.075614592
1990	0	0	0.024190627	0.005302506	0.007410335	0.075634819	0.172232652	0.242367355	0.164328294	0.118861773	0.093534894	0.017290782	0.078845964
1991	0	0	0	0	0.085967448	0.082322629	0.457283353	0.076007038	0.110868472	0.041302708	0.058379941	0.006315591	0.081552818
1992	0	0	0.012068623	0.155639408	0.082967965	0.187613621	0.147069158	0.189248232	0.070899342	0.013107441	0.01348936	0.046945416	0.080951435
1993	0	0	0.002206007	0.05676226	0.394302562	0.067484728	0.136539114	0.093564398	0.126580265	0.050515442	0.008930087	0.004899881	0.058215255
1994	0	0	0	0.033772617	0.114217338	0.528664334	0.080981305	0.069552059	0.03977163	0.056931596	0.024425318	0.026024339	0.025659462
1995	0	0	0	0.169306867	0.193467391	0.113916548	0.255258847	0.088193457	0.043547136	0.041327212	0.035130825	0.001691883	0.058159834
1996	0	0	0.000190949	0.130826115	0.370796952	0.195193292	0.099519156	0.132136719	0.017419758	0.032522089	0.000642283	0.001197771	0.019554915
1997	0	0	0	0.199600669	0.358302355	0.022352807	0.237610181	0.058463062	0.093331494	0	0.00698018	0.005462396	0.017896856
1998	0	0	0.013989587	0.054796584	0.231917343	0.47775973	0.088310277	0.045142101	0.029700308	0.011316452	0.008126977	0.005039694	0.033900949
1999	0	0	0.020673102	0.014076428	0.124453736	0.297537191	0.372651727	0.064585519	0.038598848	0.023080813	0.012076292	0.006053241	0.026213101
2000	0	0	0.0148215	0.065321779	0.403586211	0.13726458	0.145034938	0.130685865	0.053884827	0.01068248	0.007826768	0.01253693	0.018354122
2001	0	0	0.000281371	0.017083269	0.07632058	0.497987333	0.107495392	0.129706512	0.097526802	0.02140146	0.022124986	0.007551092	0.022521203
2002	0	0	0.003043283	0.031042827	0.058251386	0.226081069	0.43901033	0.087853011	0.071041218	0.042894202	0.00900919	0.005805029	0.025968454
2003	0	0	0.000514951	0.013317707	0.168344698	0.1211645	0.304531572	0.255620072	0.051468499	0.025765324	0.02236487	0.007528944	0.029378862
2004	0	0	0.001088108	0.024343757	0.117721942	0.360711466	0.124911991	0.163002895	0.133638193	0.031668931	0.01290084	0.009913876	0.020098001

N_1984 500 # effective sample size
N_1985 500
N_1986 500
N_1987 500
N_1988 500
N_1989 500
N_1990 500
N_1991 500
N_1992 500
N_1993 500

```
N_1994  500
N_1995  500
N_1996  500
N_1997  500
N_1998  500
N_1999  500
N_2000  500
N_2001  500
N_2002  500
N_2003  500
N_2004  500
dist multinomial
r 0.00001

@catch_at HeadboatCAA                   # Partial catch-at-age for the headboat fishery
years 1986      1987    1988    1989    1990    1991    1992    1993    1994    1995    1996    1997    1998    1999    2000    2001    2002    2003
        2004    # index years
fishery Headboat                        # Occurs in the fishery headboat
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 0                             # Mininum age class
max_class 12                            # Maximum age class
# Year  Age0    Age1    Age2    Age3    Age4    Age5    Age6    Age7    Age8    Age9    Age10   Age11   Age12
1986    0       0.006139416     0.079386058     0.401556171     0.087721168     0.304284801     0.017501599     0.058686847     0.011362183
        0.008079301     0.020123641     0       0.005158815
1987    0       0.011588964     0.100074425     0.30524693      0.358540216     0.075248525     0.071367817     0.046807719     0       0.020254107
        0.000212642     0       0.010658657
1988    0       0       0.104897326     0.264589655     0.510373298     0       0.029355726     0.079987298     0       0.002575683     0       0
        0.008221015
1989    0       0.025830527     0.106036008     0.278077976     0.12583295      0.156194722     0.147277618     0.061038552     0.057088856
        0.010855606     0.008941336     4.84625E-05     0.022777387
1990    0       0       0.037116245     0.111376875     0.400624701     0.079325773     0.200213862     0.101556125     0.035202746     0.026676422
        0       0       0.007907252
1991    0       0.013497847     0.250165618     0.072126532     0.191950977     0.069228221     0.2639947       0.05158993      0.02285525
        0.030556476     0       0.002815502     0.031218947
1992    0       0.011802634     0.098136714     0.443199825     0.073220043     0.168897874     0.070925086     0.088519753     0.00628381
        0.002240315     0.001475329     0       0.035298618
1993    0       0.004284627     0.080246666     0.137908942     0.525087094     0.088095143     0.062067032     0.029591959     0.043006447
        0.007247828     0.001561687     0       0.020902575
1994    0       0.007950335     0.045861654     0.201187643     0.180649277     0.389198341     0.094005349     0.022501411     0.019213309
        0.00279734      0       0.017888254     0.018747086
1995    0       0       0.128506174     0.301834273     0.195846121     0.101598744     0.212190422     0.016308615     0.005959603     0.020590964
        0.005888231     0.0028549       0.008421954
1996    0       0       0.005505506     0.461807962     0.324747825     0.084892585     0.046123046     0.05982906      0.0003465       0
        0.006198506     0.000654501     0.00989451
1997    0       0       0.061704406     0.054645676     0.710155847     0.085775469     0.016972677     0.040924773     0.019827894     0       0
        0       0.009993259
1998    0       0.030311778     0.050182833     0.213192841     0.308121632     0.306036695     0.035171286     0.014209648     0.014209648     0
        0.007473698     0       0.021089941
```

```
1999	0	0	0.043484474	0.4728171	0.177000184	0.167078374	0.091991099	0.019945695	0.012575792	0.004838413
	0	0.001939448	0.00832942
2000	0	0.01405188	0.187358399	0.129750783	0.495863351	0.017208462	0.084667668	0.040831912	0	0
	0.02224881	0	0.008018736
2001	0	0.002453811	0.042147806	0.094062741	0.232438414	0.446641647	0.080687067	0.06091224	0.025404157	0
	0.00428214	0	0.010969977
2002	0	0.012444444	0.067802469	0.504148148	0.11362963	0.160493827	0.099753086	0.014765432	0.002074074
	0.010320988	0.000691358	0	0.013876543
2003	0	0.015273535	0.038631244	0.32602055	0.398778117	0.043413867	0.071214786	0.05665093	0.01721744
	0.012619951	0	0.006263692	0.013915888
2004	0	0.007535502	0.065689418	0.277485112	0.250480989	0.265025195	0.035868071	0.049129638	0.032272103
	0.003114979	0.005245076	0.001213926	0.006939991
N_1986	500		#  effective sample size
N_1987	500
N_1988	500
N_1989	500
N_1990	500
N_1991	500
N_1992	500
N_1993	500
N_1994	500
N_1995	500
N_1996	500
N_1997	500
N_1998	500
N_1999	500
N_2000	500
N_2001	500
N_2002	500
N_2003	500
N_2004	500
dist multinomial
r 0.00001

@catch_at LonglineCAA			# Partial catch-at-age for the Longline fishery
years 1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	2002	2003	2004	# index years
fishery Longline			# Occurs in the fishery headboat
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 0			# Mininum age class
max_class 12			# Maximum age class
#		Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12
1984	0	0	0.010085312	0.016963164	0.125355466	0.207559024	0.230408042	0.140400767	0.117948548	0.018484227
	0.007373851	0.061040936	0.064380663
1985	0	0	0.019035397	0.010515809	0.274658682	0.208783374	0.199301322	0.047267672	0.061169928	0.028232275
	0.005739137	0.005953018	0.139343386
1986	0	0	0.012195847	0.035814147	0.044083527	0.180230829	0.29948242	0.080254625	0.215033613	0.02376703
	0.000624665	0.014575525	0.093937771
```

1987 0 0 0 0.027399468 0.020039219 0.099685712 0.182206463 0.277271873 0.158540844 0.076906546
0.012249174 0.023585032 0.122115669
1988 0 0 0.023288514 0.001186396 0.090122155 0.018674752 0.245276386 0.156252746 0.175454785 0.16991827
0.000175762 0 0.119650233
1989 0 0 0.017752235 0.012005109 0.062494679 0.049851 0.214942529 0.161430396 0.175138357 0.162962963
8.51426E-05 0.050787569 0.092550021
1990 0 0 0.003927344 0.004418262 0.009949272 0.011422026 0.135591556 0.223465881 0.091867125 0.408378334
0.004712813 0 0.106267387
1991 0 0 0 0 0.015798895 0.050782162 0.329286326 0.097906452 0.160946377 0.06848782 0.10339326
0.011246011 0.162152697
1992 0 0 0.001622003 0.017242595 0.022284908 0.151410437 0.164844852 0.22651622 0.101763047 0.016748942
0.025246827 0.105465444 0.166854725
1993 0 0 0.000746671 0.02281495 0.138341561 0.055378106 0.130916331 0.154353507 0.215580537 0.122329614
0.026009043 0.013523043 0.120006637
1994 0 0 0 0.013401916 0.062904063 0.371761597 0.076825067 0.113727526 0.089188807 0.121891369
0.058940116 0.05478741 0.03657213
1995 0 0 0 0.032093779 0.121613909 0.099793651 0.257013654 0.107740264 0.084427273 0.084690697
0.090486017 0.002634236 0.11950652
1996 0 0 0 0.030248814 0.136681368 0.196679704 0.148456353 0.294624282 0.03690605 0.092410751
0.002246817 0.005908297 0.055837563
1997 0 0 0 0.054974866 0.173900902 0.031676374 0.183316046 0.142264422 0.248623634 0 0.037939839
0.031796058 0.095507859
1998 0 0 0.001439458 0.022269263 0.126220717 0.30127011 0.109455264 0.113209145 0.089754445 0.0425628
0.036042901 0.006717471 0.151058425
1999 0 0 0.000808625 0.005121294 0.048753369 0.148551213 0.354177898 0.107378706 0.087735849 0.073247978
0.043328841 0.020923181 0.109973046
2000 0 0 0.001558069 0.007447571 0.117416098 0.123679536 0.149481163 0.222242996 0.140163909 0.043345486
0.03779876 0.05016983 0.106696582
2001 0 0 3.53788E-05 0.005501406 0.028939874 0.228016487 0.111213317 0.181970954 0.194265093 0.052219136
0.0607985 0.026976349 0.110063505
2002 0 0 0.000319075 0.005211565 0.018648184 0.119812809 0.34219063 0.131618599 0.125768883 0.092797759
0.029798096 0.019020439 0.114813961
2003 0 0 0.000186257 0.002933553 0.042016546 0.068806556 0.270259363 0.298058267 0.095193009 0.054371614
0.055023515 0.022537135 0.090614183
2004 0 0 0.000289908 0.008224236 0.049604809 0.203240868 0.126003235 0.193460283 0.195718514 0.057325521
0.032103512 0.031249046 0.102780067
N_1984 500 # effective sample size
N_1985 500
N_1986 500
N_1987 500
N_1988 500
N_1989 500
N_1990 500
N_1991 500
N_1992 500
N_1993 500
N_1994 500
N_1995 500
N_1996 500
N_1997 500

```
N_1998   500
N_1999   500
N_2000   500
N_2001   500
N_2002   500
N_2003   500
N_2004   500
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    # index years
fishery MRFSS                             # Occurs in the fishery headboat
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 0                               # Mininum age class
max_class 12                              # Maximum age class
#  Year  Age0     Age1     Age2     Age3     Age4     Age5     Age6     Age7     Age8     Age9     Age10    Age11    Age12
1984     0        0.007703874      0.211032715      0.130761774      0.379467541      0.153852387      0.047009535      0.025830635      0.019300199
        0.002421903      1.50056E-05      0.00040215       0.022202281
1985     0        0.004455699      0.117469223      0.166020309      0.238580374      0.360135795      0.022864716      0.051208034      0.00696203
        0.002245187      0.000940551      0.00011486       0.029003221
1986     0        0.005876148      0.17470491       0.217270628      0.329128414      0.15200861       0.065052461      0.02144466       0.015327593
        0.006145578      7.12779E-06      0.000212408      0.012821463
1987     0        0.00789798       0.197198108      0.171379499      0.340098157      0.152548934      0.071003956      0.020810622      0.016243142
        0.005461843      0.002505106      0.000269199      0.014583454
1988     0        0.013650807      0.257207093      0.09501415       0.362221181      0.145175204      0.053247148      0.033341919      0.00808839
        0.007051935      4.65474E-06      0.000148952      0.024848566
1989     0        0.001838641      0.15088599       0.188130416      0.34810813       0.14205892       0.083670119      0.038466207      0.018615248
        0.011726313      0.006234268      0.00030445       0.009961297
1990     0        0.010484203      0.17711473       0.093335068      0.436845415      0.088188737      0.087462324      0.058134744      0.011788856
        0.016331649      2.1684E-05       6.50519E-05      0.020227537
1991     0        0.035497188      0.315068772      0.054930617      0.198155471      0.061694013      0.175444895      0.056013131      0.017242496
        0.039618141      0.002039196      0.004798218      0.039497862
1992     0        0.022107821      0.126880689      0.432817463      0.066713564      0.165345015      0.06158044       0.073302637      0.00772953
        0.004086462      0.002208437      0                0.037227942
1993     0        0.007883127      0.118242891      0.166295224      0.477228453      0.082019256      0.059218315      0.032549296      0.031635388
        0.005444702      0.002097713      0                0.017385635
1994     0        0.012534466      0.067596163      0.215897188      0.174864838      0.362098566      0.084281775      0.018932046      0.02332862
        0.002645695      0                0.015038071      0.022782572
1995     0        0        0.128026391      0.277560164      0.192151745      0.106107267      0.225934673      0.017495621      0.005831209      0.022803427
        0.006541043      0.003656843      0.013891617
1996     0        0        0.005803009      0.456727373      0.286530106      0.086709127      0.048267979      0.084368093      0.000520536      0
        0.01156746       0.001118188      0.01838813
1997     0        0        0.08500396       0.052727531      0.648520435      0.097325418      0.020961222      0.048246218      0.030240252      0        0
        0        0.016974963
1998     0        0.038423718      0.05646378       0.193990569      0.295067105      0.303870942      0.033444856      0.017831116      0.01837949       0
        0.014616773      0        0.027911649
```

```
1999	0	0	0.031782464	0.396533664	0.184354394	0.197826094	0.124340528	0.024512295	0.01919526	0.006058642
	0	0.00405922	0.01133744
2000	0	0.014774002	0.184880816	0.126519791	0.470462805	0.023272987	0.090305934	0.043739208	0	0	0.037606
	0	0.008438457
2001	0	0.002623394	0.072365103	0.117136157	0.231496773	0.38604004	0.07800102	0.05779397	0.027357067	0
	0.004212184	0	0.022974293
2002	0	0.023339791	0.093807303	0.437397016	0.088257396	0.167446845	0.124193846	0.020415458	0.00362093
	0.019490219	0.001364232	0	0.020666964
2003	0	0.023560323	0.047196979	0.3259831	0.361557314	0.037385383	0.084658695	0.058169339	0.023821495
	0.009185164	0	0.010676491	0.017805717
2004	0	0.008183507	0.071288714	0.23918987	0.27050383	0.267543527	0.038083013	0.041855265	0.036336143
	0.003819419	0.009057223	0.002344322	0.011795166
N_1984	500
N_1985	500
N_1986	500
N_1987	500
N_1988	500
N_1989	500
N_1990	500
N_1991	500
N_1992	500
N_1993	500
N_1994	500
N_1995	500
N_1996	500
N_1997	500
N_1998	500
N_1999	500
N_2000	500
N_2001	500
N_2002	500
N_2003	500
N_2004	500
dist multinomial
r 0.00001

@catch_at TrapCAA			# 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	# index years
fishery Trap				# Occurs in the fishery headboat
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 0				# Mininum age class
max_class 12				# Maximum age class
#  Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12
1984	0	0	0.002054443	0.136106831	0.231638418	0.382639959	0.137134052	0.049820236	0.026194145	0.005649718
	0.004108885	0.001540832	0.023112481
1985	0	0	0.00224	0.14272	0.26464	0.37248	0.1296	0.03968	0.02336	0.00544	0.0016	0.00096	0.01728
```

1986	0	0	0.001873244	0.119887605	0.282547612	0.374960974	0.130814861	0.04402123	0.023727755	0.002809866	0.002185451	0.003122073	0.014049329
1987	0	0	0.001770434	0.112422544	0.324579522	0.353496607	0.128356447	0.042195338	0.018589554	0.003540868	0.001180289	0.002360578	0.011507819
1988	0	0	0.001876877	0.127627628	0.31493994	0.351351351	0.128378378	0.038288288	0.021021021	0.002627628	0.000750751	0.001876877	0.011261261
1989	0	0	0.002195992	0.130936042	0.305517431	0.365358221	0.124622564	0.038704365	0.021410925	0.000548998	0.000823497	0.000548998	0.009332967
1990	0	0	0.0022931	0.134667501	0.321450907	0.345632687	0.124661247	0.039399625	0.02126329	0.000416927	0.000625391	0.000416927	0.009172399
1991	0	0	0	0	0.402576271	0.138711864	0.375728814	0.034847458	0.022237288	0.005423729	0.007186441	0.00040678	0.012881356
1992	0	0	0.059975816	0.308948005	0.264449819	0.162515115	0.063240629	0.117775091	0.005441354	0.002781137	0.001451028	0.005441354	0.007980653
1993	0	0	0.006512301	0.100337675	0.618588197	0.058691108	0.101784853	0.037385432	0.054027979	0.005467117	0.001366779	0.000884387	0.014954173
1994	0	0	0.000369686	0.089833641	0.209833641	0.514676525	0.075046211	0.044288355	0.015083179	0.021146026	0.00702403	0.010277264	0.012421442
1995	0	0	0	0.180656934	0.301841407	0.15087923	0.250165893	0.058808892	0.01658925	0.01459854	0.008211679	0.000331785	0.01791639
1996	0	0	0	0.115651679	0.396812749	0.270688674	0.104154809	0.085828116	0.010017075	0.011383039	0.00011383	0.00011383	0.005236198
1997	0	0	0	0.194865164	0.405338013	0.021518286	0.26256003	0.047192464	0.059567787	0	0.000461766	0.001570004	0.006926487
1998	0	0	0.025732666	0.077708567	0.266312672	0.475850097	0.079036046	0.030021444	0.016236087	0.005309915	0.00326764	0.004697233	0.015827632
1999	0	0	0.022506154	0.025319423	0.186613527	0.413081702	0.287656781	0.029539327	0.013714688	0.006798734	0.002813269	0.001758293	0.010198101
2000	0	0	0.040673626	0.160429387	0.534567658	0.086763837	0.083809336	0.059090014	0.016052787	0.003348434	0.003643884	0.003348434	0.008272602
2001	0	0	0.001399407	0.065525189	0.147184722	0.588409615	0.070958182	0.059269015	0.036466908	0.007737899	0.007161673	0.002716497	0.013170892
2002	0	0	0.025034422	0.147452748	0.17962198	0.27562899	0.31355614	0.025034422	0.015521342	0.007760671	0.001376893	0.000625861	0.008386531
2003	0	0	0.008758958	0.060402685	0.473780002	0.135365715	0.181663064	0.113752702	0.009782732	0.005573882	0.002616312	0.000796269	0.007507678
2004	0	0	0.014821	0.089239119	0.2503914	0.438889469	0.079741154	0.070347563	0.03997495	0.005636155	0.002191838	0.001461225	0.007306127

N_1984	50
N_1985	50
N_1986	50
N_1987	50
N_1988	50
N_1989	50
N_1990	50
N_1991	50
N_1992	50
N_1993	50
N_1994	50
N_1995	50

```
N_1996   50
N_1997   50
N_1998   50
N_1999   50
N_2000   50
N_2001   50
N_2002   50
N_2003   50
N_2004   50
dist multinomial
r 0.00001


# RELATIVITY CONSTANTS
@q_method nuisance                         # Use the "nuisance" method for estimating q

@estimate
parameter q[HeadboatCPUEq].q      # Estimate the parameter q[HeadboatCPUEq].q when fitting the model
lower_bound 1e-10                 # with a lower bound
upper_bound 1e-2                  # and upper bound
prior uniform-log                 # and use a uniform-log prior

@estimate
parameter q[HandlineCPUEq].q      # Estimate the parameter q[HandlineCPUEq].q when fitting the model
lower_bound 1e-8                  # with a lower bound
upper_bound 1e-2                  # and upper bound
prior uniform-log                 # and use a uniform-log prior

@estimate
parameter q[LonglineCPUEq].q      # Estimate the parameter q[LonglineCPUEq].q when fitting the model
lower_bound 1e-8                  # with a lower bound
upper_bound 1e-2                  # 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 1e-12                 # with a lower bound
upper_bound 1e-4                  # 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 1e-8                  # with a lower bound
upper_bound 1e-2                  # and upper bound
prior uniform-log                 # and use a uniform-log prior

#FREE PARAMETERS
@estimate
parameter initialization.B0       # Estimate B0
phase 2                           # Use two-phase estimation, and only try to "fit" this parameter after fitting all other parameters first
```

```
lower_bound   5000.0              # Define the lower bound
upper_bound  85000.0              # Define the upper bound
prior uniform-log                 # and use a uniform-log prior

@estimate
parameter initialization.Binitial         # Estimate Binitial
phase 2                           # Use two-phase estimation, and only try to "fit" this parameter after fitting all other parameters first
lower_bound   5000.0                      # Define the lower bound
upper_bound  50000.0                      # Define the upper bound
prior uniform-log

@estimate
parameter recruitment.YCS                 # Estimate YCS when fitting the model
#YCS_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
lower_bound   1  1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
        1       1       1       1       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
upper_bound   1  1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
        1       1       1       1       1       100     100     100     100     100     100     100     100     100     100     100     100     100
        100     100     100     100     100     100
prior lognormal                           # Use a lognormal prior, with parameters
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 # with μ=1, and c.v.=1.1
cv     0.1      0.1     0.1     0.1     0.1     0.1     0.1     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       1

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

@estimate
parameter selectivity[HeadboatSel].all            # Estimate the "HeadboatSel" ogive. Size base (cm)
lower_bound        1.0    0.8       40.0      1.0   0.5              # the five double_logistic parameters have lower and
upper_bound    50.0       20.0      150.0   20.0   1.0               # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[HandlineSel].all            # Estimate the "HandlineSel" ogive. Size base (cm)
lower_bound        20.0    1.0                    # the five double_logistic parameters have lower and
upper_bound    150.0      50.0                    # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[LonglineSel].all            # Estimate the "LonglineSel" ogive. Size base (cm)
```

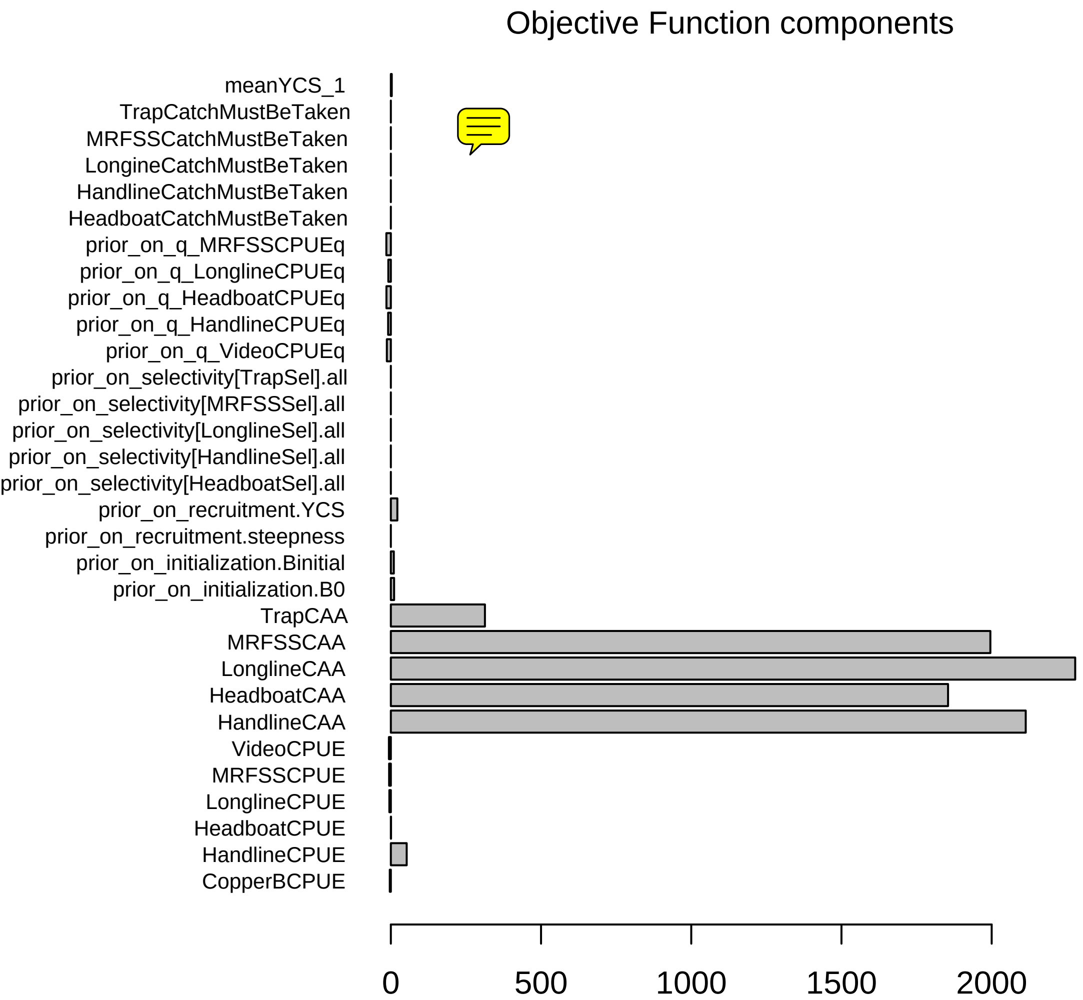
```
lower_bound        20.0      5.0                    # the two logistic parameters have lower and
upper_bound    140.0       50.0                    # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[MRFSSSel].all                # Estimate the "MRFSSSel" ogive. Size base (cm)
lower_bound        20.0    1.0                     # the five double_logistic parameters have lower and
upper_bound    160.0      50.0                     # upper bounds
prior uniform       # and they have uniform priors

@estimate
parameter selectivity[TrapSel].all                 # Estimate the "TrapSel" ogive. Age base
lower_bound       0.0     0.1      2.0      0.1      0.0              # the five double_logistic parameters have lower and
upper_bound    4.0       5.0      12.0      8.0      1.0                     # upper bounds
prior uniform       # and they have uniform priors

{
# This is a comment block
}

# PENALTIES
@catch_limit_penalty                       # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label HeadboatCatchMustBeTaken
fishery Headboat
log_scale true
multiplier 1000

@catch_limit_penalty                       # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label HandlineCatchMustBeTaken
fishery Handline
log_scale true
multiplier 10000

@catch_limit_penalty                       # Penalise model fits that do not allow the Commercial Fishing catch to be taken
label LongineCatchMustBeTaken
fishery Longline
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 TrapCatchMustBeTaken
fishery Trap
log_scale true
multiplier 1000
```

```
@vector_average_penalty
label meanYCS_1
vector recruitment.YCS
k 1
multiplier 20
```

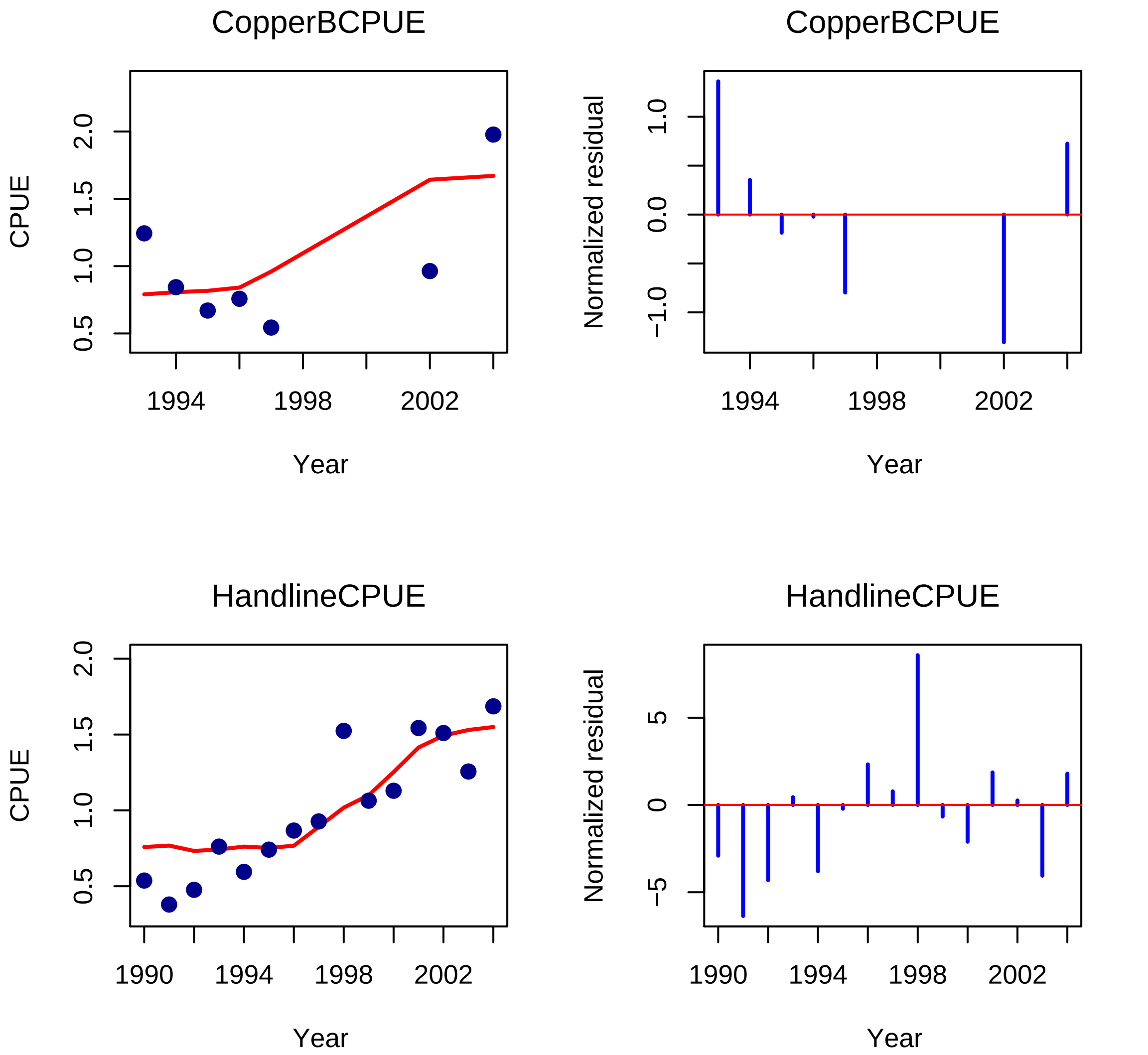
G06-Output.csl

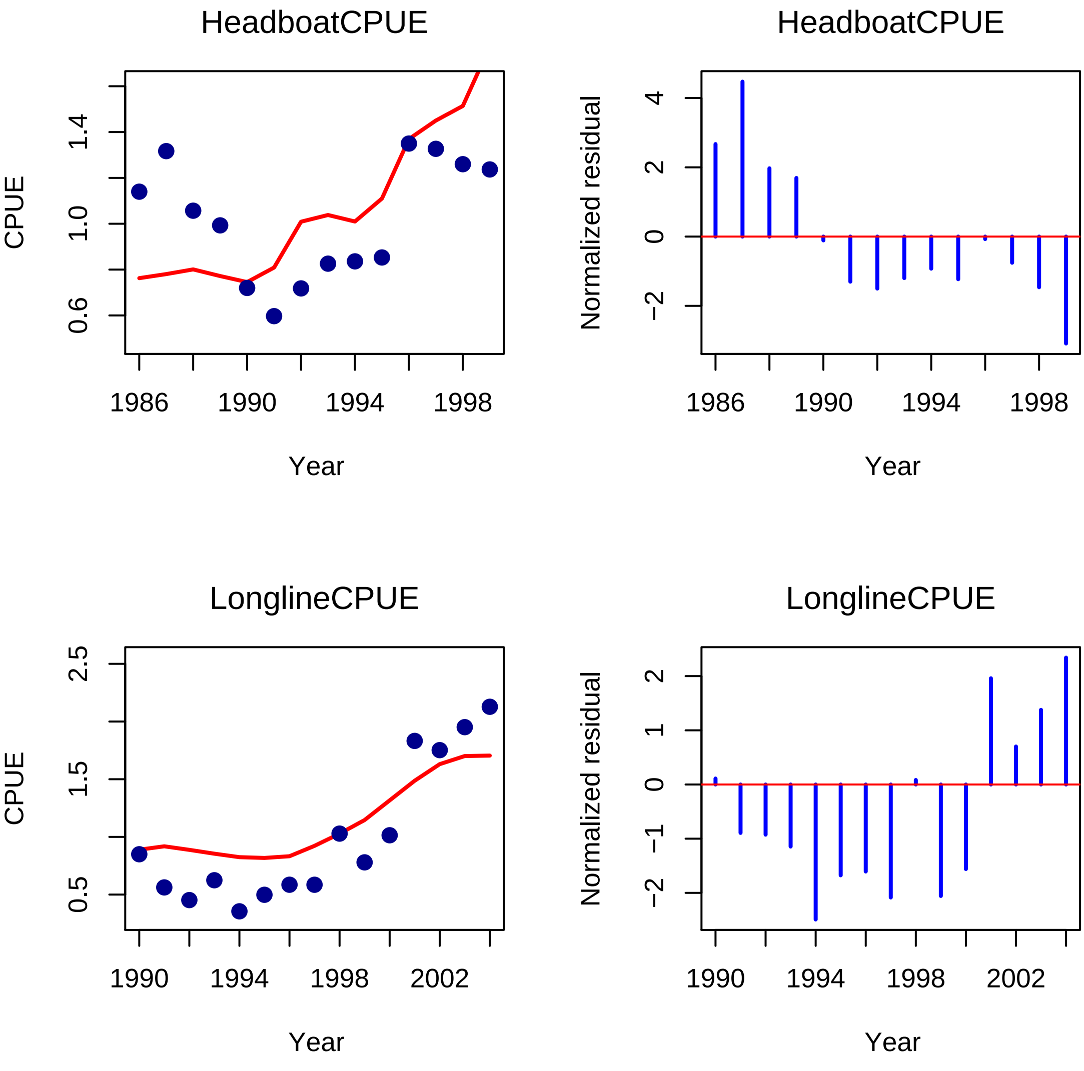
```
@print                    # Specifies the outputs that CASAL should generate
# estimation section
parameters true
unused_parameters true
fits_every_eval false
objective_every_eval false
parameters_every_eval false
parameter_vector_every_eval false
fits true
resids false
pearson_resids false
normalised_resids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

# population section
requests true
initial_state false
state_annually false
state_every_step false
final_state true
results false

#output section
yields true

@print_sizebased_ogives_at 10	12	11	13	12	14	13	15	14	16	15	17	16	18	17	19
	18	20	19	21	20	22	21	23	22	24	23	25	24	26	25	27	26	28
	27	29	28	30	29	31	30	32	31	33	32	34	33	35	34	36	35	37
	36	38	37	39	38	40	39	41	40	42	41	43	42	44	43	45	44	46
	45	47	46	48	47	49	48	50	49	51	50	52	51	53	52	54	53	55
	54	56	55	57	56	58	57	59	58	60	59	61	60	62	61	63	62	64
	63	65	64	66	65	67	66	68	67	69	68	70	69	71	70	72	71	73
	72	74	73	75	74	76	75	77	76	78	77	79	78	80	79	81	80	82
	81	83	82	84	83	85	84	86	85	87	86	88	87	89	88	90	89	91
	90	92	91	93	92	94	93	95	94	96	95	97	96	98	97	99	98	100
	99	101	100	102	101	103	102	104	103	105	104	106	105	107	106	108	107	109
	108	110	109	111	110	112	111	113	112	114	113	115	114	116	115	117	116	118
	117	119	118	120	119	121	120	122	121	123	122	124	123	125	124	126	125	127
	126	128	127	129	128	130	129	131	130	132	131	133	132	134	133	135	134	136
```

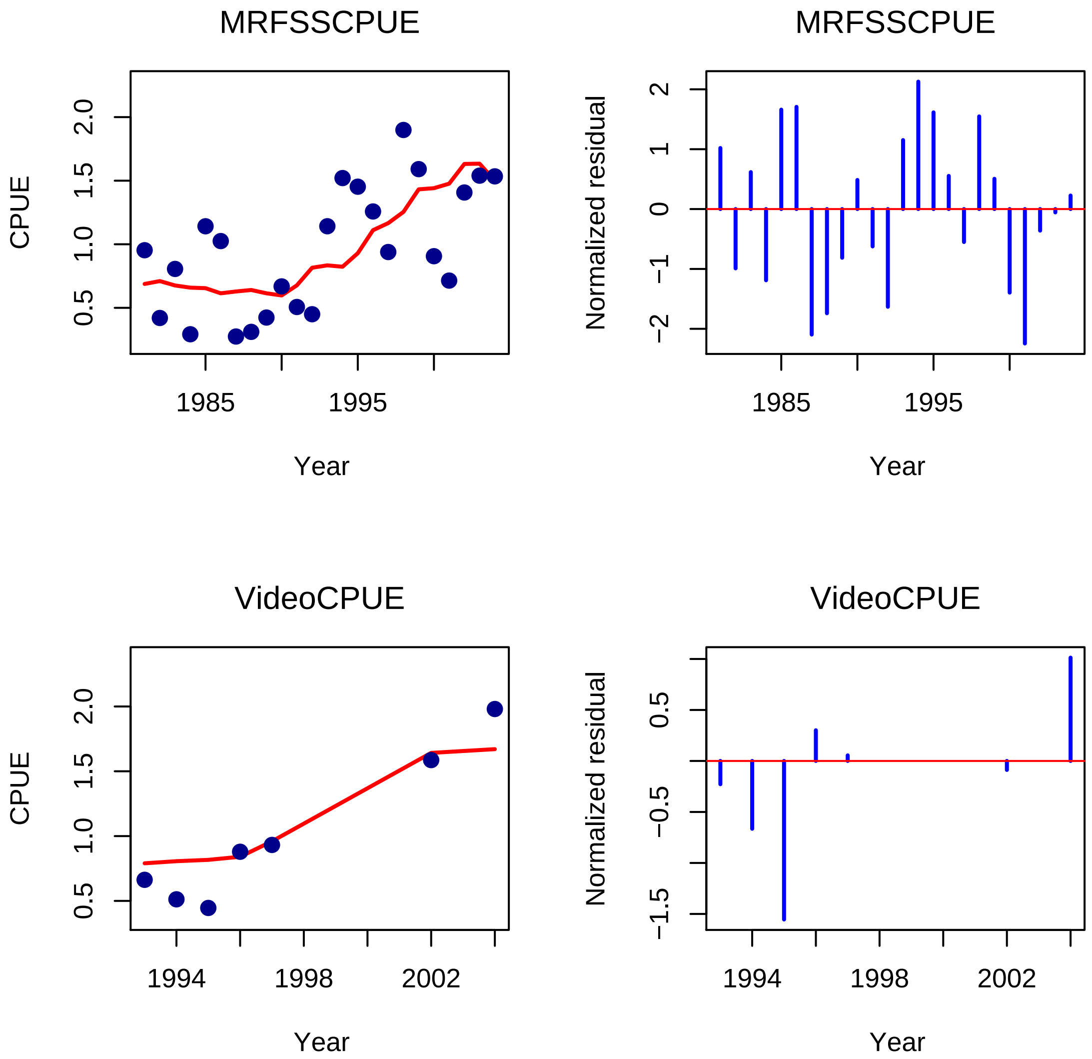
```
@quantities
all_free_parameters true
fishing_pressures true
nuisance_qs true
true_YCS true
B0 true
Binitial true
R0 true
SSBs true
YCS true
actual_catches true
recruitments true
ogive_parameters selectivity[HeadboatSel].all selectivity[HandlineSel].all selectivity[LonglineSel].all selectivity[MRFSSSel].all selectivity[TrapSel].all

{
@MCY_CAY
do_MCY true
MCY_guess 10000
n_discard 100
n_keep 100
n_simulations 100
do_CAY true
F_CAY_guess 0.2
interactive false
```

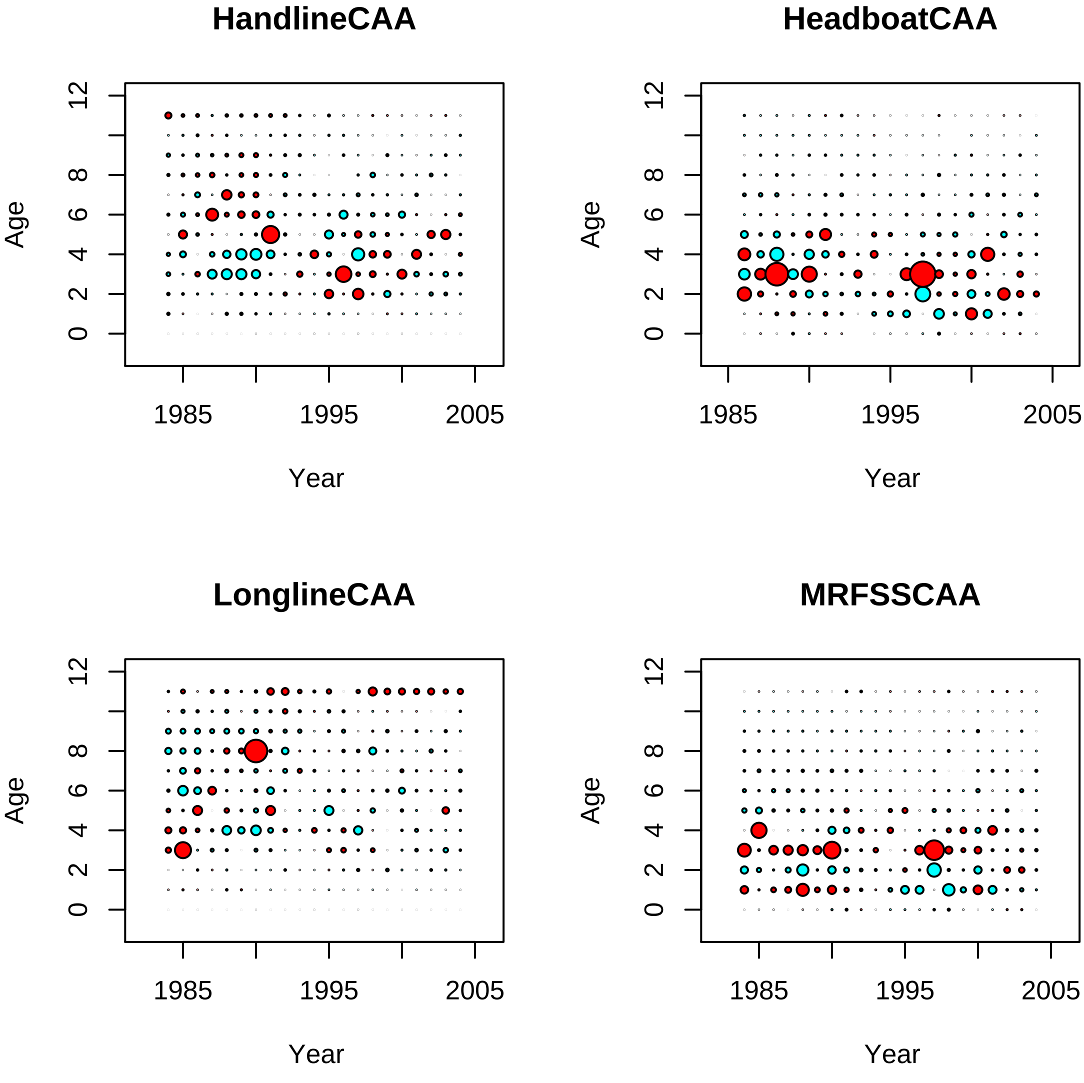


Objective Function components
meanYCS_1
TrapCatchMustBeTaken
MRFSSCatchMustBeTaken
LongineCatchMustBeTaken
HandlineCatchMustBeTaken
HeadboatCatchMustBeTaken
prior_on_q_MRFSSCPUEq
prior_on_q_LonglineCPUEq
prior_on_q_HeadboatCPUEq
prior_on_q_HandlineCPUEq
prior_on_q_VideoCPUEq
prior_on_selectivity[TrapSel].all
prior_on_selectivity[MRFSSSel].all
prior_on_selectivity[LonglineSel].all
prior_on_selectivity[HandlineSel].all
prior_on_selectivity[HeadboatSel].all
prior_on_recruitment.YCS
prior_on_recruitment.steepness
prior_on_initialization.Binitial
prior_on_initialization.B0
TrapCAA
MRFSSCAA
LonglineCAA
HeadboatCAA
HandlineCAA
VideoCPUE
MRFSSCPUE
LonglineCPUE
HeadboatCPUE
HandlineCPUE
CopperBCPUE
0
500
1000
1500
2000

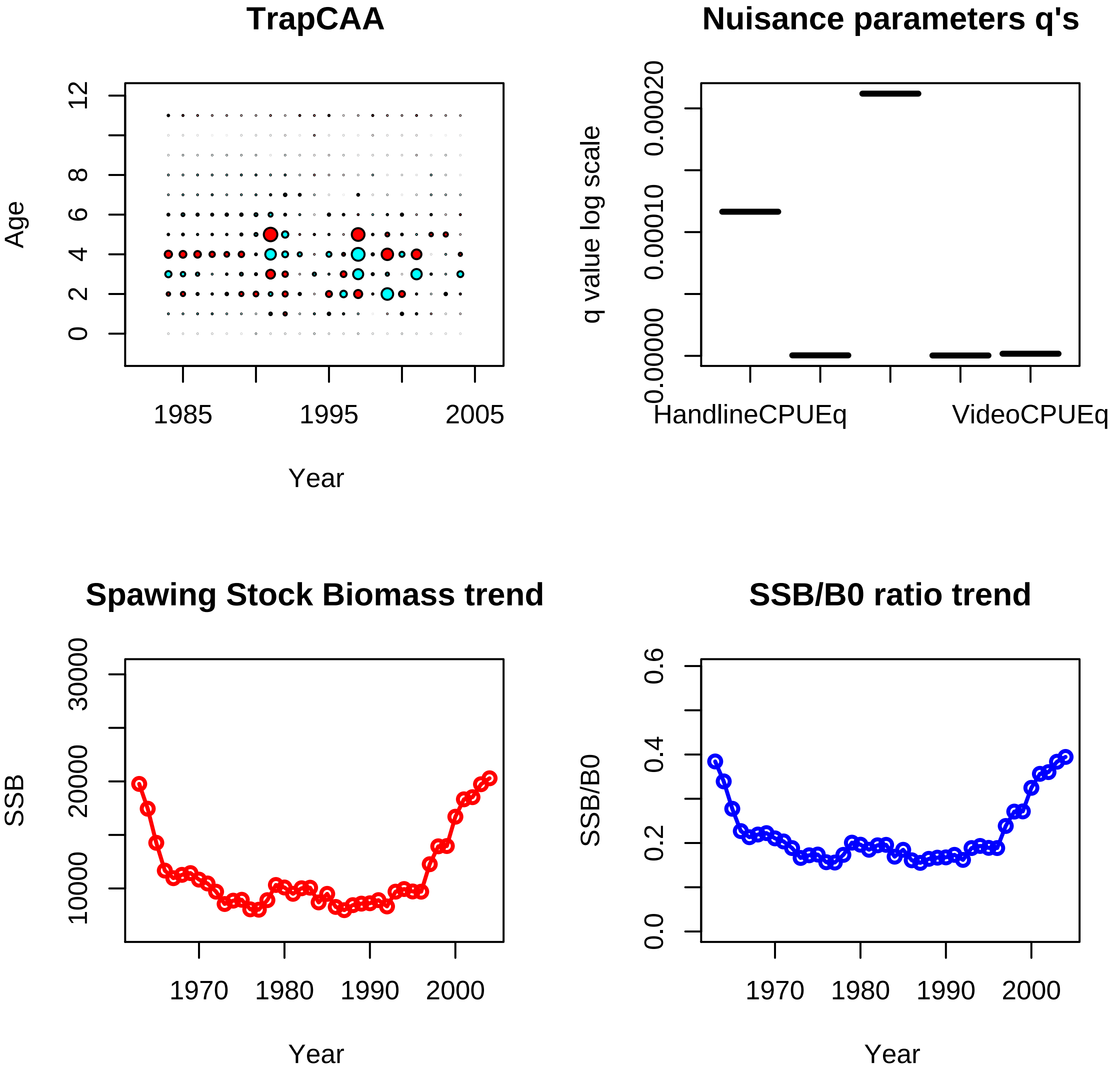

CopperBCPUE
CPUE
2.0
1.5
1.0
0.5
1994
1998
2002
Year
CopperBCPUE
Normalized residual
1.0
0.0
−1.0
1994
1998
2002
Year
HandlineCPUE
CPUE
2.0
1.5
1.0
0.5
1990
1994
1998
2002
Year
HandlineCPUE
Normalized residual
5
0
−5
1990
1994
1998
2002
Year


HeadboatCPUE
CPUE
Year
1986
1990
1994
1998
0.6
1.0
1.4
HeadboatCPUE
Normalized residual
Year
−2
0
2
4
LonglineCPUE
CPUE
Year
1990
1994
1998
2002
0.5
1.5
2.5
LonglineCPUE
Normalized residual
Year
−2
−1
0
1
2

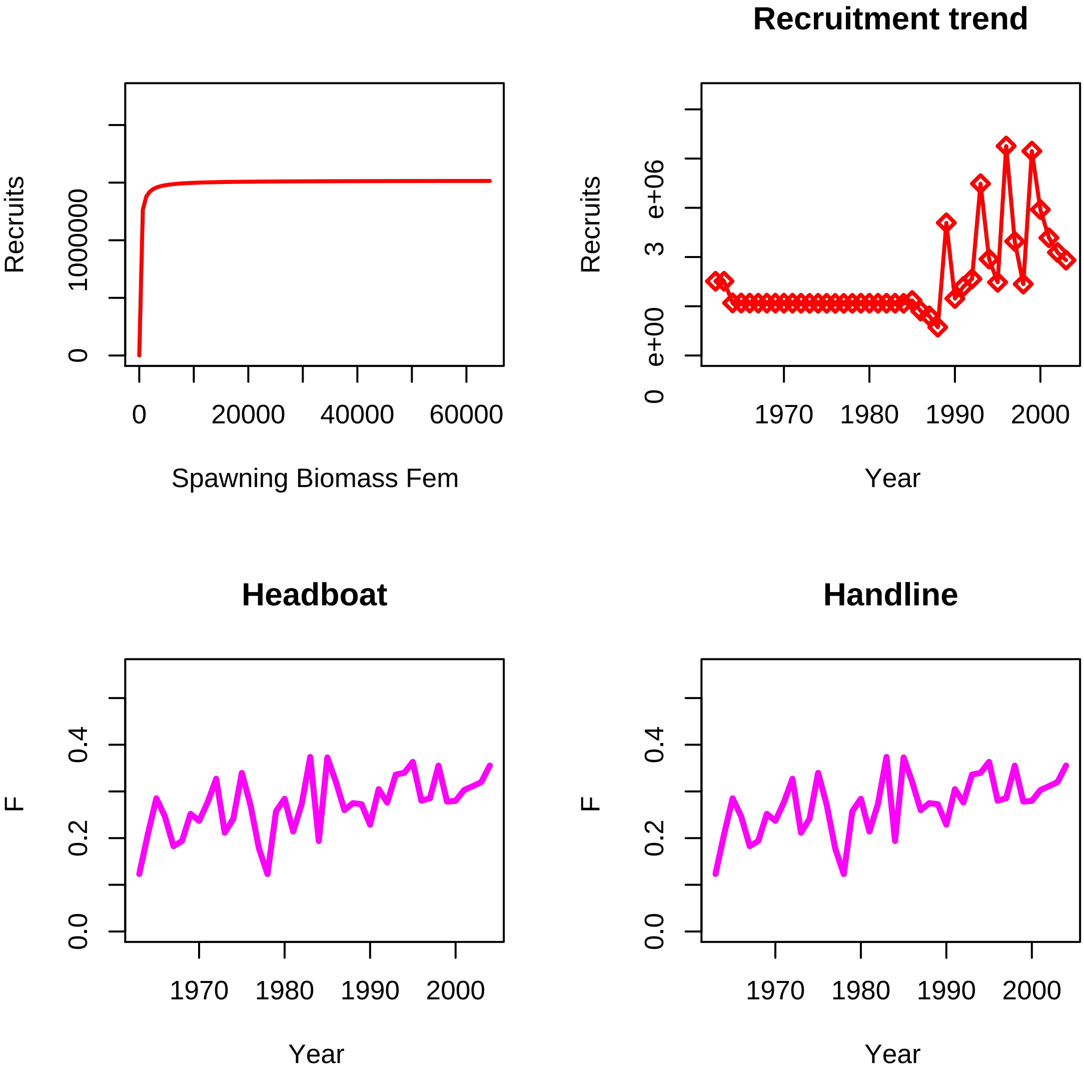

MRFSSCPUE
CPUE
0.5
1.0
1.5
2.0
1985
1995
Year
MRFSSCPUE
Normalized residual
−2
−1
0
1
2
1985
1995
Year
VideoCPUE
CPUE
0.5
1.0
1.5
2.0
1994
1998
2002
Year
VideoCPUE
Normalized residual
−1.5
−0.5
0.5
1994
1998
2002
Year

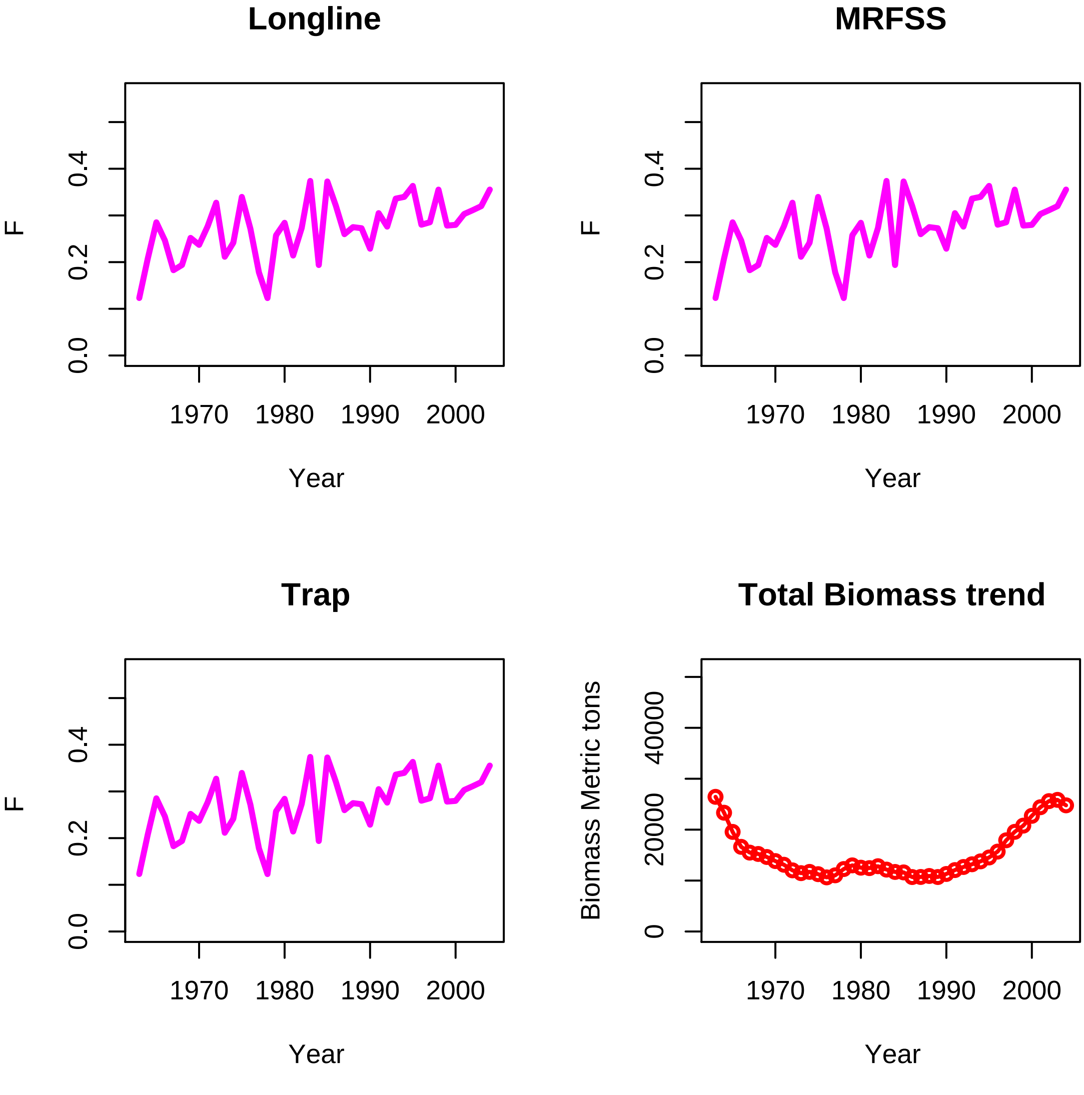


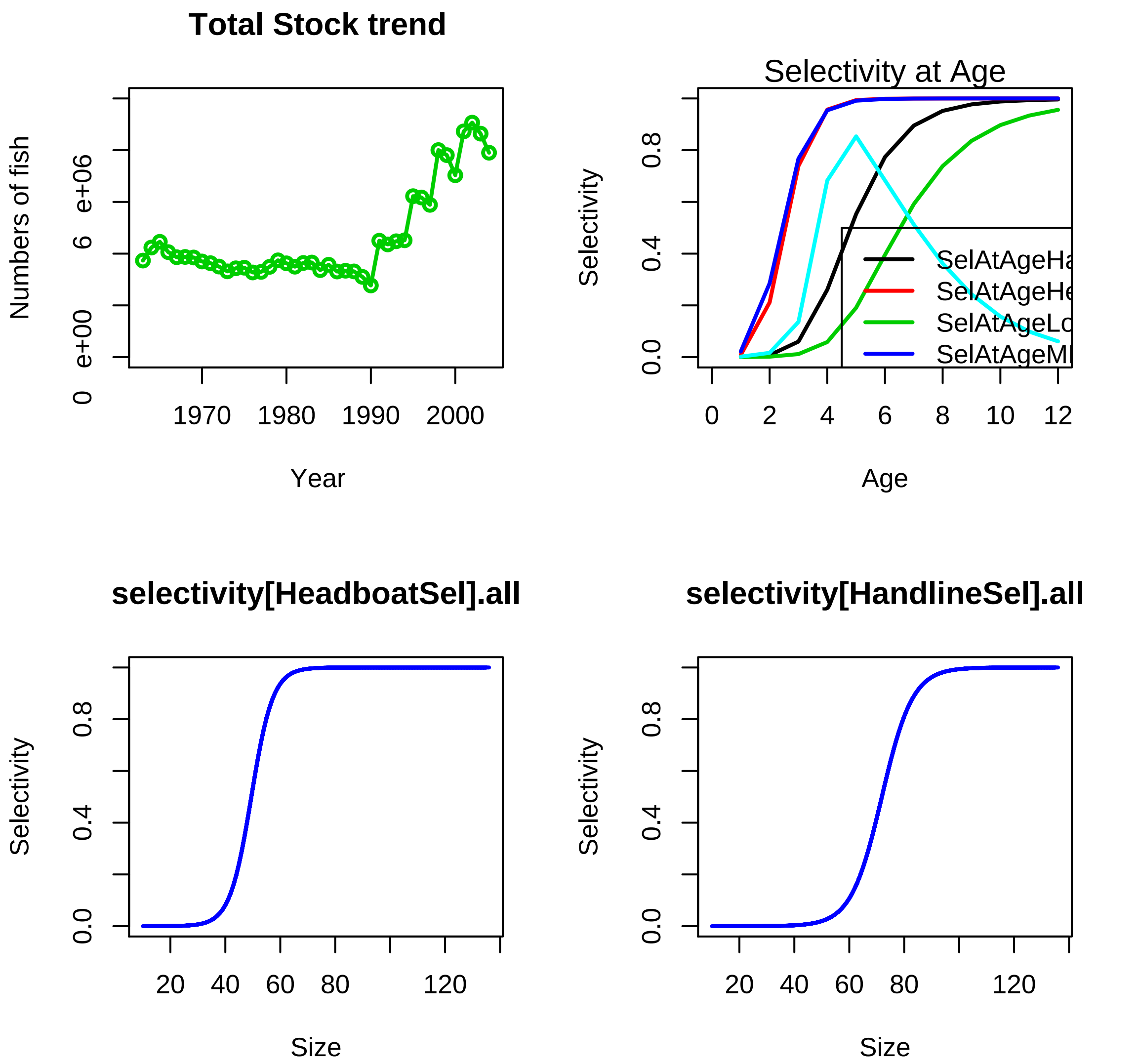
HandlineCAA
HeadboatCAA
LonglineCAA
MRFSSCAA
Age
Year
0
2
4
6
8
12
1985
1995
2005



TrapCAA
Age
0
2
4
6
8
12
1985
1995
2005
Year
Nuisance parameters q's
q value log scale
0.00000
0.00010
0.00020
HandlineCPUEq
VideoCPUEq
Spawing Stock Biomass trend
SSB
10000
20000
30000
1970
1980
1990
2000
Year
SSB/B0 ratio trend
SSB/B0
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year


Recruitment trend
Headboat
Handline
Recruits
Spawning Biomass Fem
0
1000000
20000
40000
60000
0 e+00
3 e+06
Year
1970
1980
1990
2000
F
0.0
0.2
0.4


Longline
MRFSS
Trap
Total Biomass trend
F
0.0
0.2
0.4
1970
1980
1990
2000
Year
Biomass Metric tons
0
20000
40000



Total Stock trend
Numbers of fish
0 e+00
6 e+06
1970
1980
1990
2000
Year
Selectivity at Age
Selectivity
0.0
0.4
0.8
0
2
4
6
8
10
12
Age
SelAtAgeHa
SelAtAgeHe
SelAtAgeLo
SelAtAgeMI
selectivity[HeadboatSel].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size
selectivity[HandlineSel].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

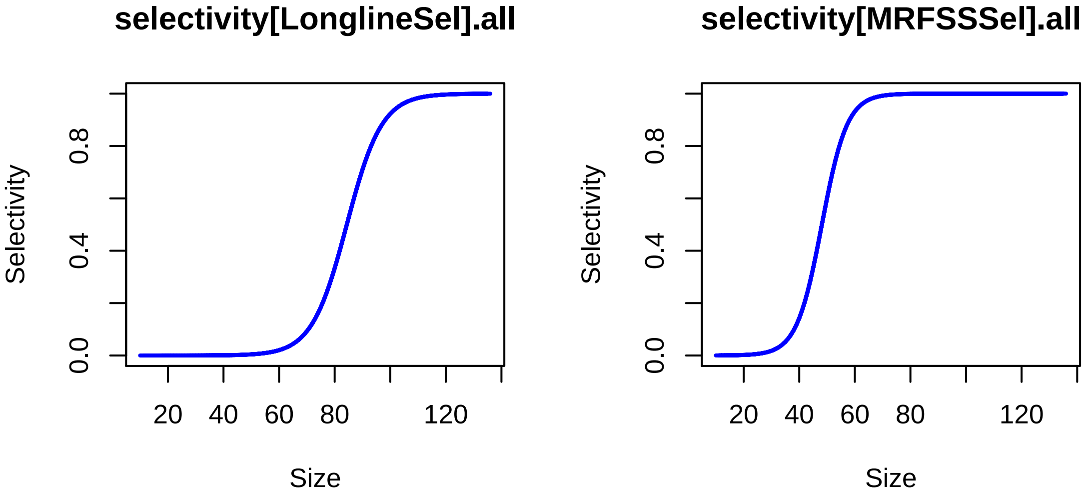
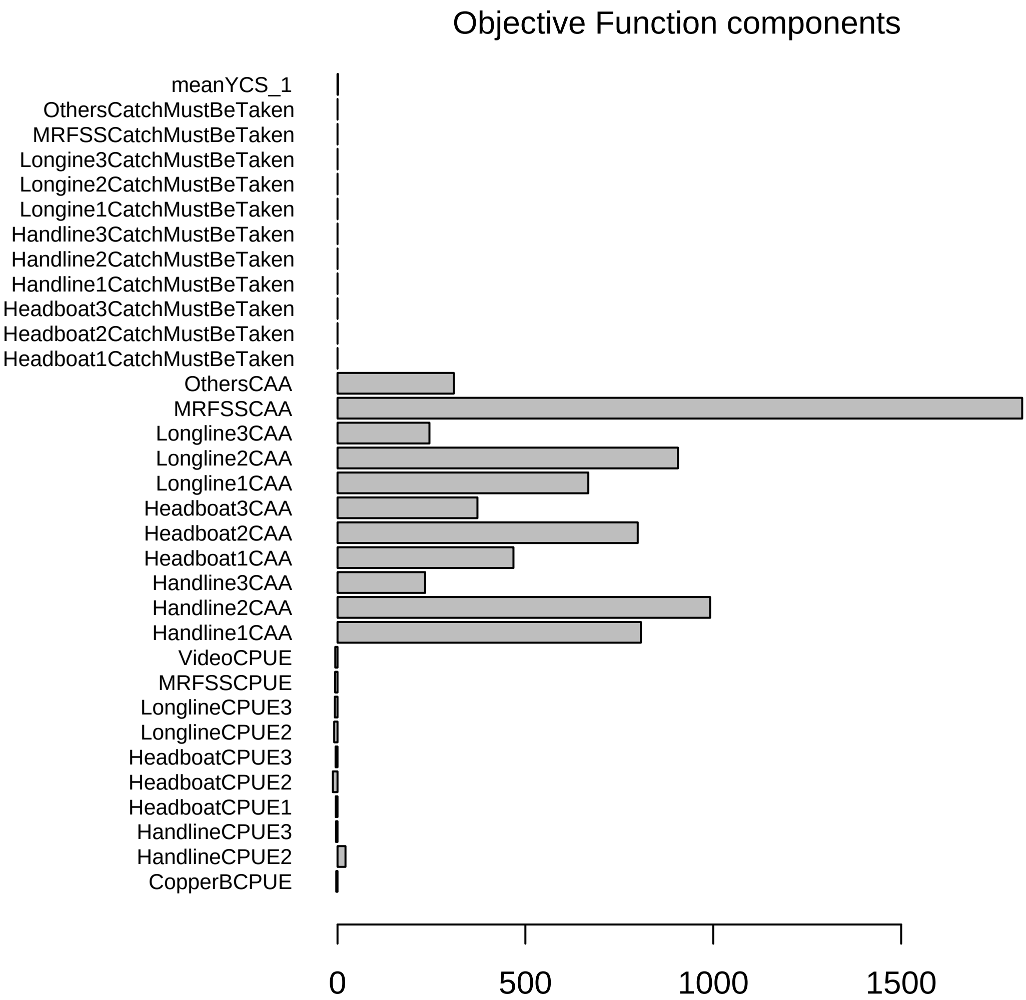
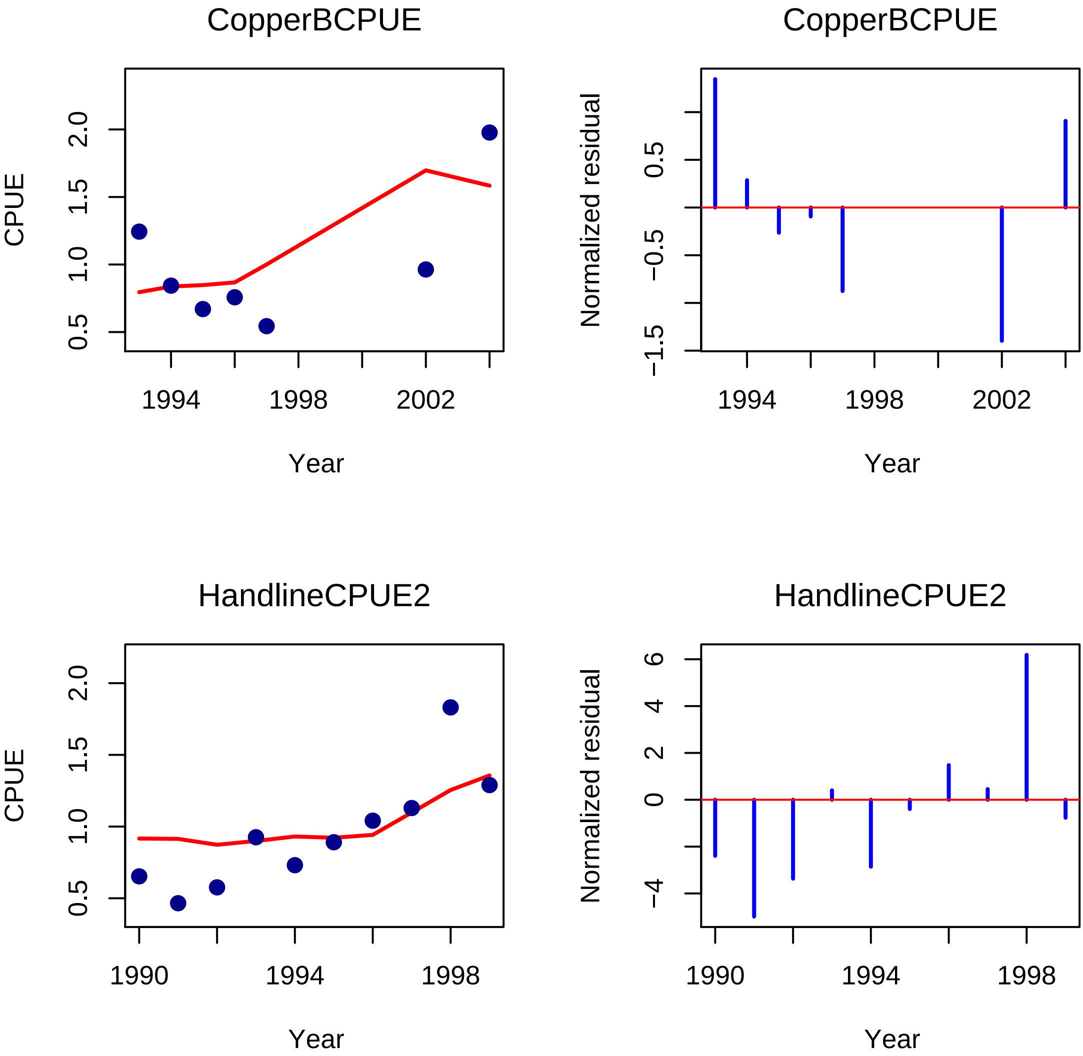
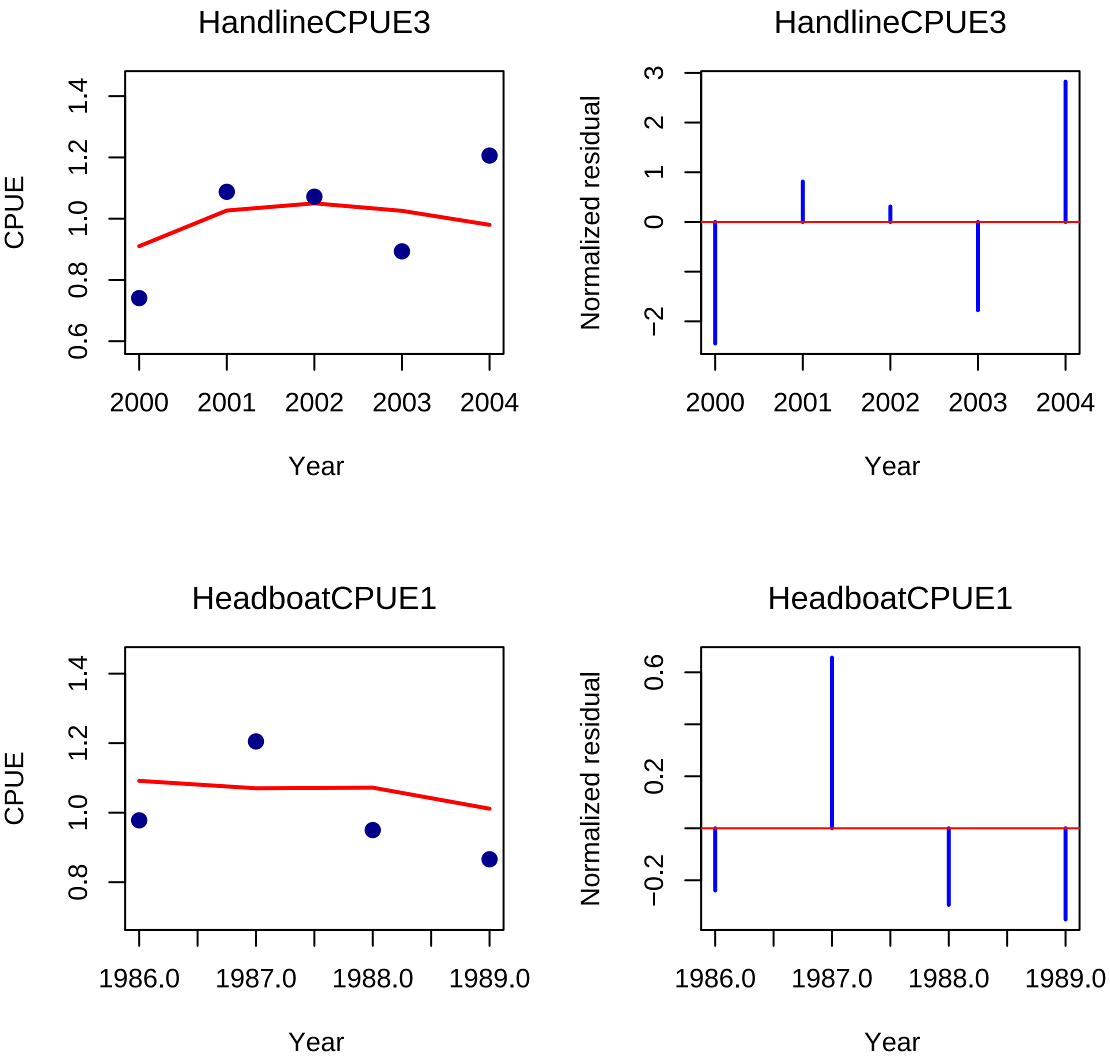
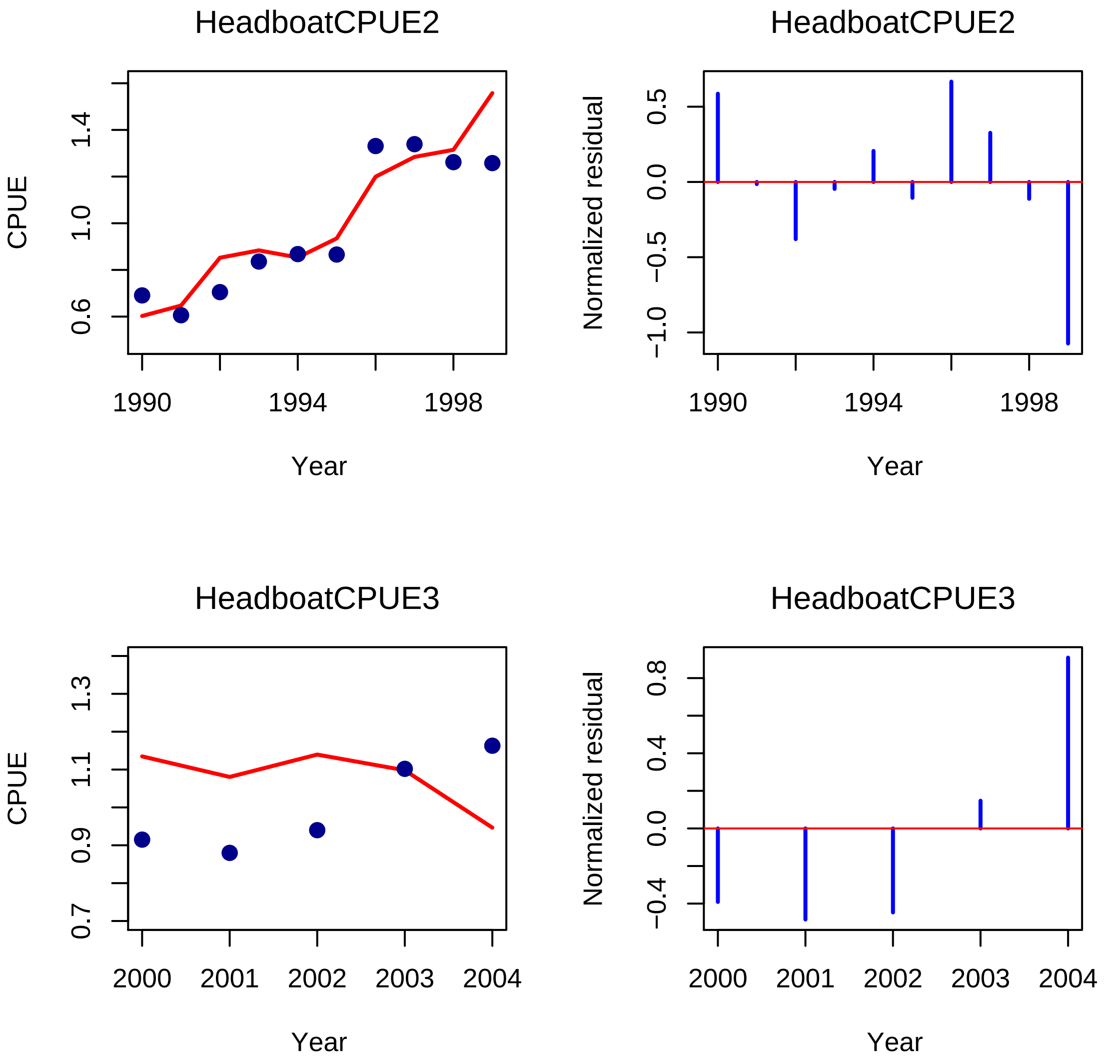


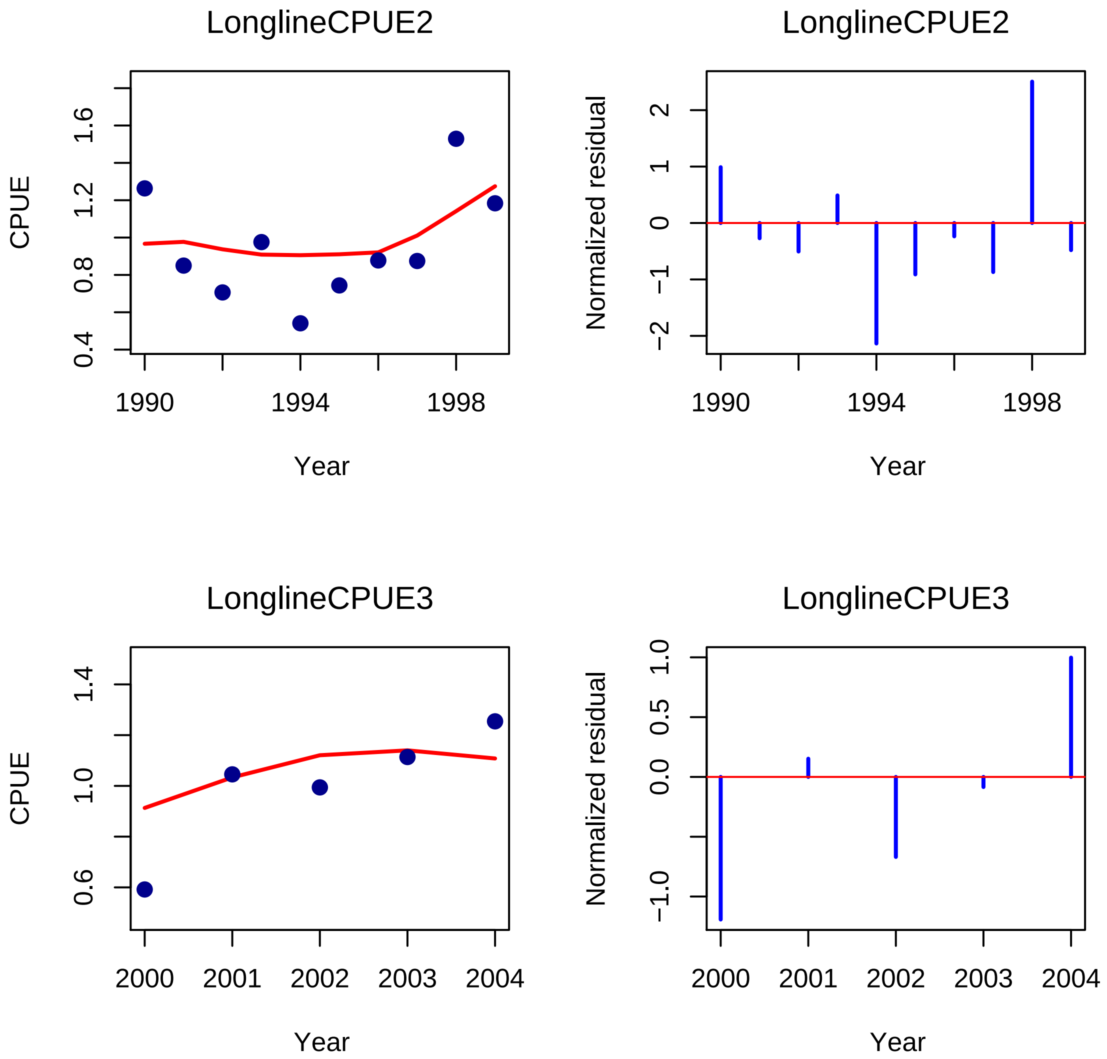
Figure 25. Example of CASAL run fit to gag GOM data.


Objective Function components
meanYCS_1
OthersCatchMustBeTaken
MRFSSCatchMustBeTaken
Longine3CatchMustBeTaken
Longine2CatchMustBeTaken
Longine1CatchMustBeTaken
Handline3CatchMustBeTaken
Handline2CatchMustBeTaken
Handline1CatchMustBeTaken
Headboat3CatchMustBeTaken
Headboat2CatchMustBeTaken
Headboat1CatchMustBeTaken
OthersCAA
MRFSSCAA
Longline3CAA
Longline2CAA
Longline1CAA
Headboat3CAA
Headboat2CAA
Headboat1CAA
Handline3CAA
Handline2CAA
Handline1CAA
VideoCPUE
MRFSSCPUE
LonglineCPUE3
LonglineCPUE2
HeadboatCPUE3
HeadboatCPUE2
HeadboatCPUE1
HandlineCPUE3
HandlineCPUE2
CopperBCPUE
0
500
1000
1500

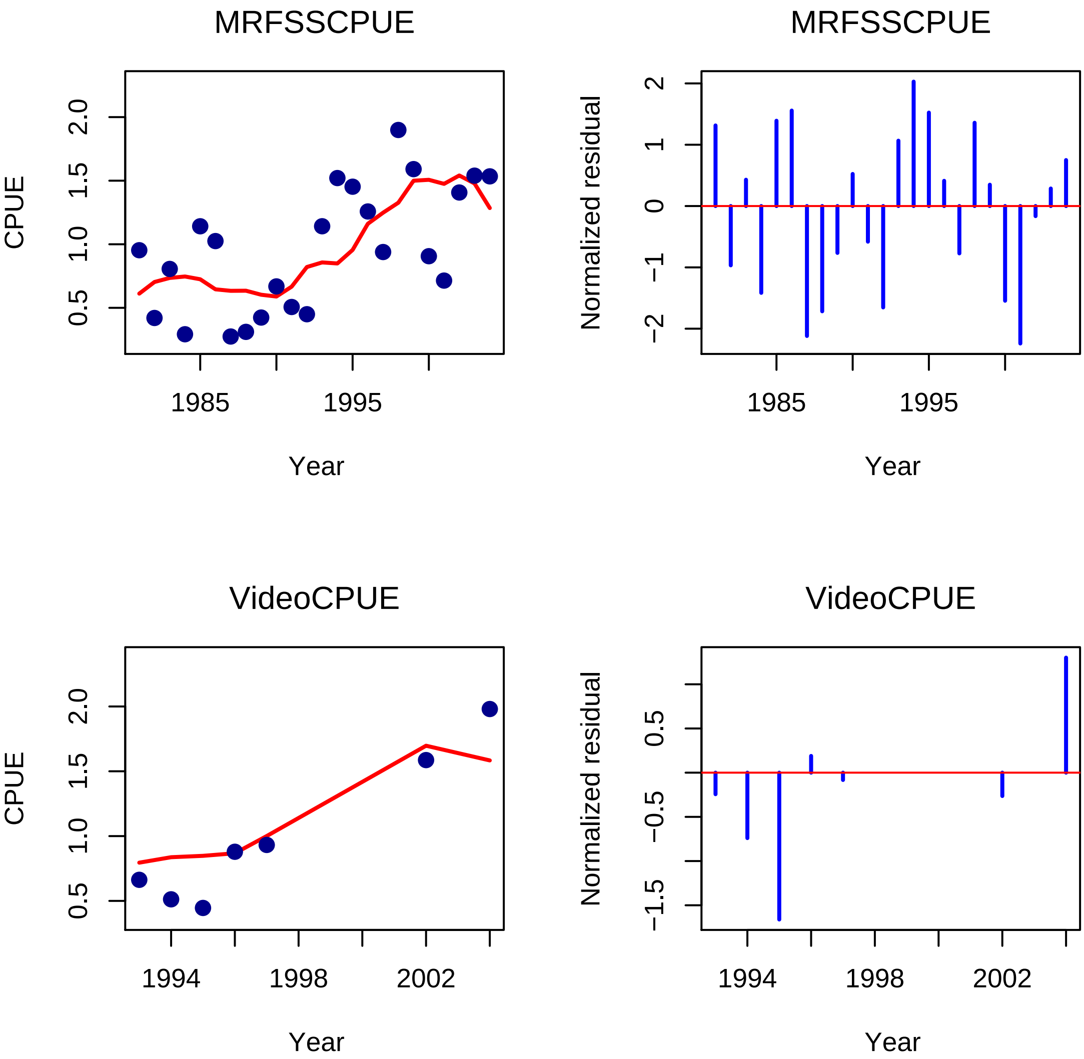

CopperBCPUE
CPUE
0.5
1.0
1.5
2.0
1994
1998
2002
Year
CopperBCPUE
Normalized residual
−1.5
−0.5
0.5
1994
1998
2002
Year
HandlineCPUE2
CPUE
0.5
1.0
1.5
2.0
1990
1994
1998
Year
HandlineCPUE2
Normalized residual
−4
0
2
4
6
1990
1994
1998
Year


HandlineCPUE3
CPUE
0.6
0.8
1.0
1.2
1.4
2000
2001
2002
2003
2004
Year
HandlineCPUE3
Normalized residual
−2
0
1
2
3
2000
2001
2002
2003
2004
Year
HeadboatCPUE1
CPUE
0.8
1.0
1.2
1.4
1986.0
1987.0
1988.0
1989.0
Year
HeadboatCPUE1
Normalized residual
−0.2
0.2
0.6
1986.0
1987.0
1988.0
1989.0
Year

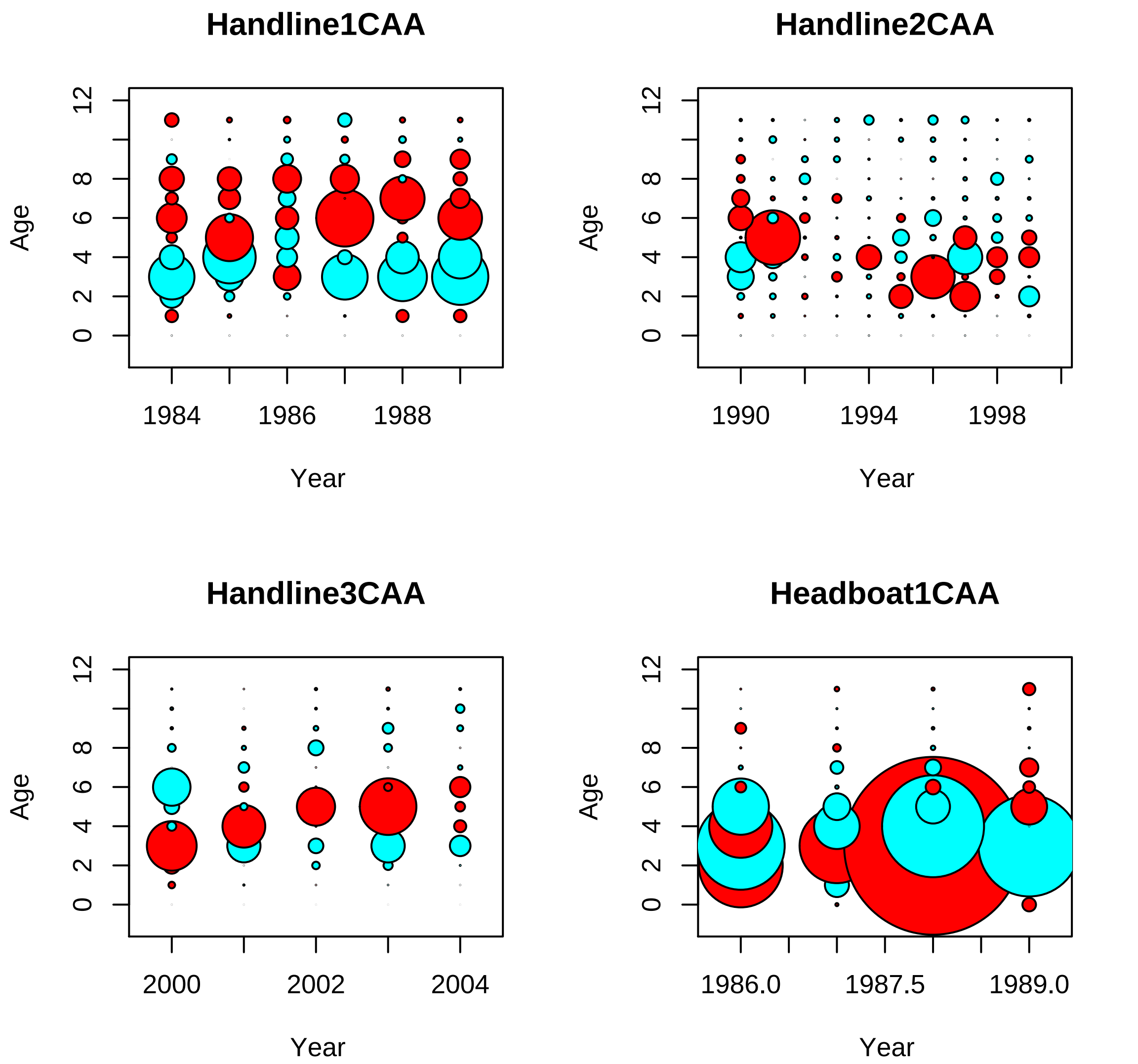

HeadboatCPUE2
CPUE
0.6
1.0
1.4
1990
1994
1998
Year
HeadboatCPUE2
Normalized residual
−1.0
−0.5
0.0
0.5
1990
1994
1998
Year
HeadboatCPUE3
CPUE
0.7
0.9
1.1
1.3
2000
2001
2002
2003
2004
Year
HeadboatCPUE3
Normalized residual
−0.4
0.0
0.4
0.8
2000
2001
2002
2003
2004
Year

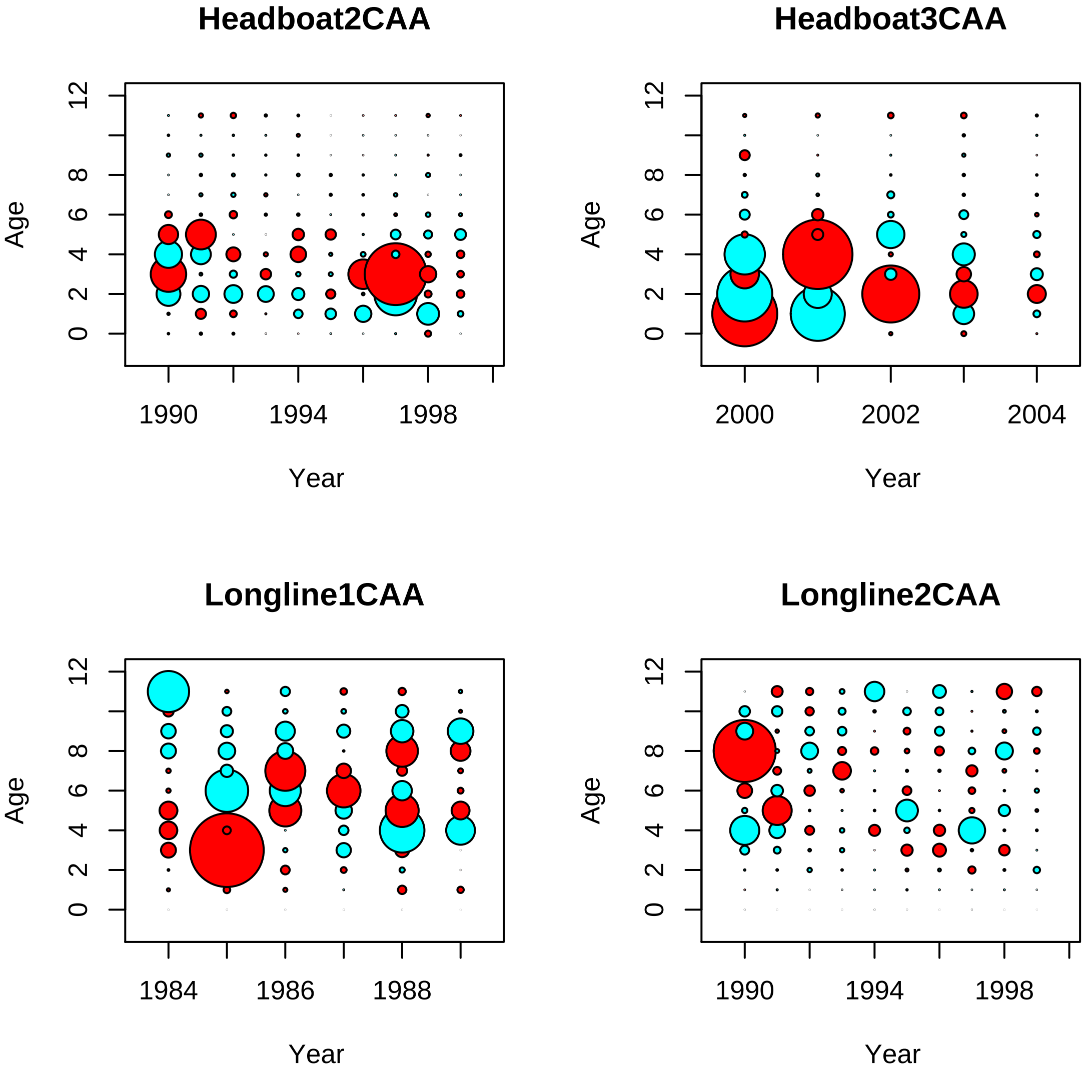


LonglineCPUE2
CPUE
0.4
0.8
1.2
1.6
1990
1994
1998
Year
LonglineCPUE2
Normalized residual
−2
−1
0
1
2
1990
1994
1998
Year
LonglineCPUE3
CPUE
0.6
1.0
1.4
2000
2001
2002
2003
2004
Year
LonglineCPUE3
Normalized residual
−1.0
0.0
0.5
1.0
2000
2001
2002
2003
2004
Year

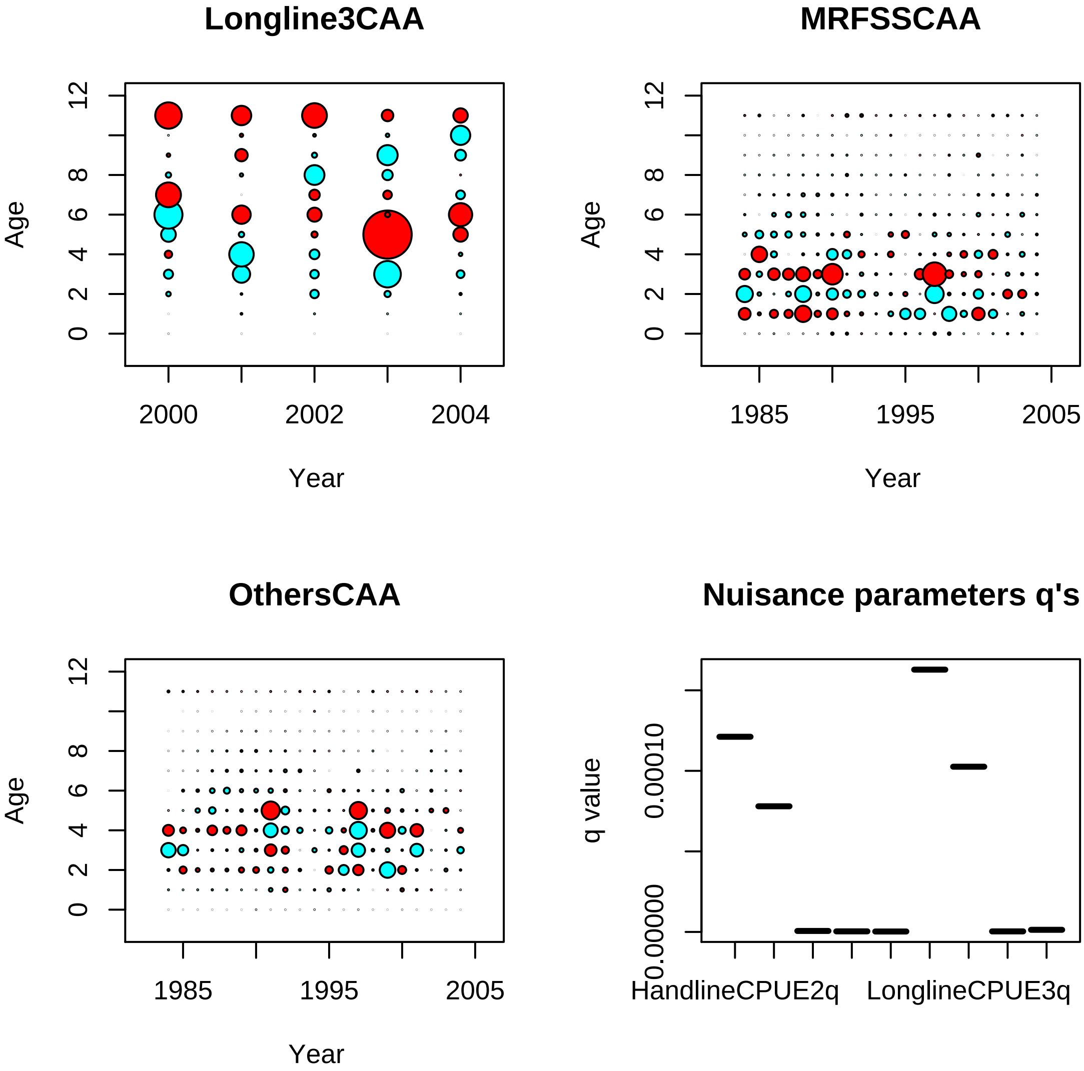


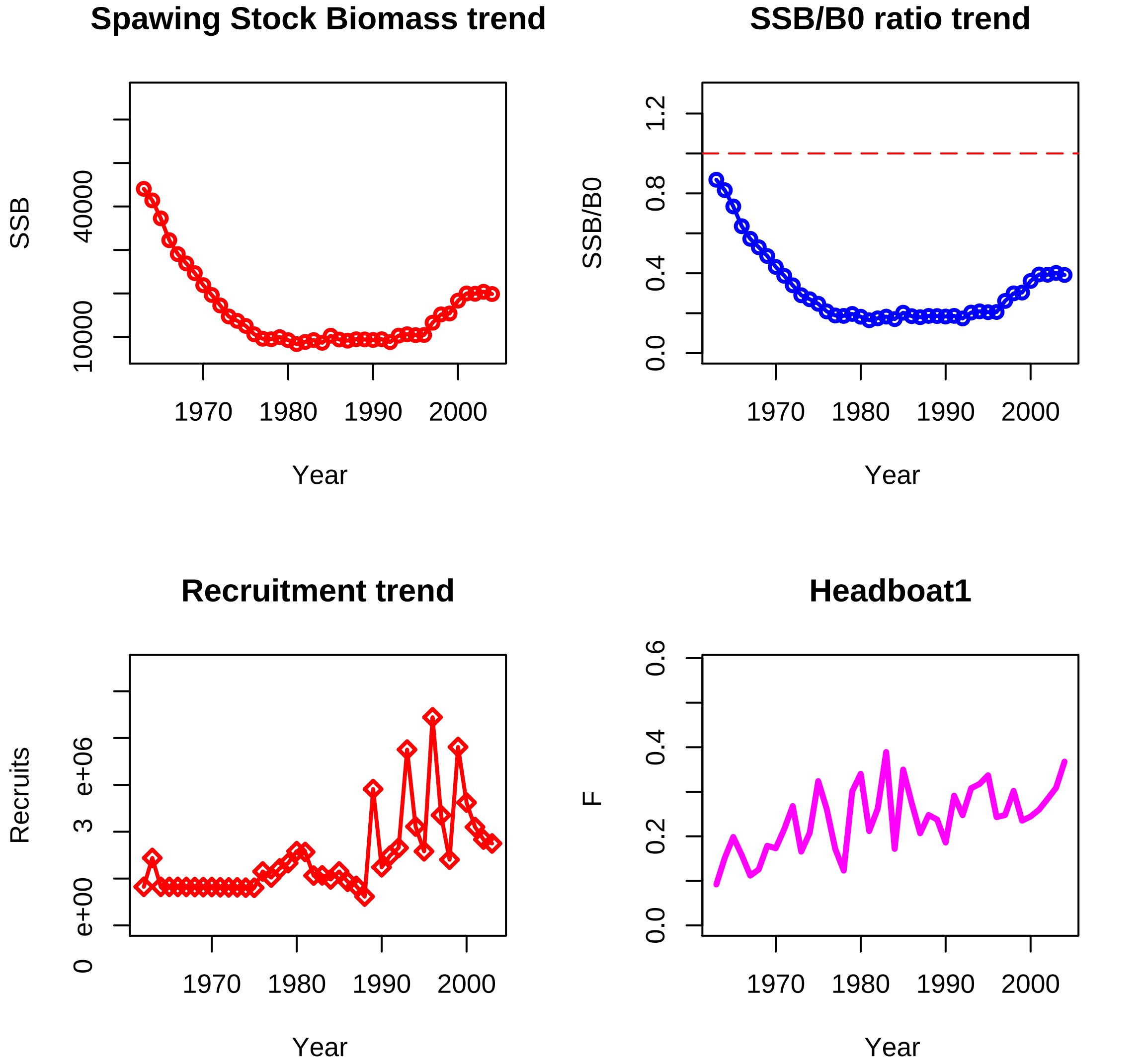
MRFSSCPUE
CPUE
0.5
1.0
1.5
2.0
1985
1995
Year
MRFSSCPUE
Normalized residual
−2
−1
0
1
2
1985
1995
Year
VideoCPUE
CPUE
0.5
1.0
1.5
2.0
1994
1998
2002
Year
VideoCPUE
Normalized residual
−1.5
−0.5
0.5
1994
1998
2002
Year

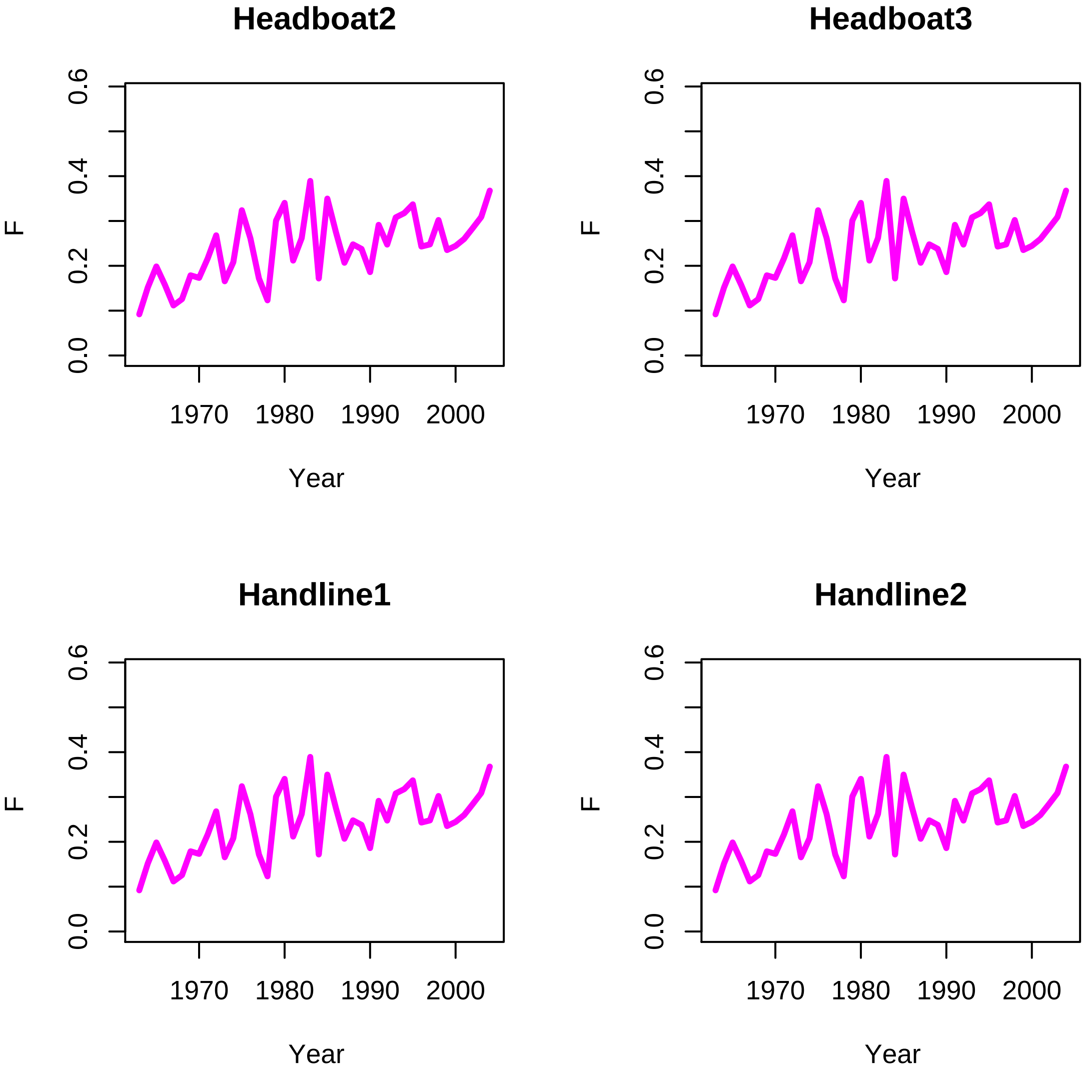

Handline1CAA
Age
0
2
4
6
8
12
1984
1986
1988
Year
Handline2CAA
Age
0
2
4
6
8
12
1990
1994
1998
Year
Handline3CAA
Age
0
2
4
6
8
12
2000
2002
2004
Year
Headboat1CAA
Age
0
2
4
6
8
12
1986.0
1987.5
1989.0
Year



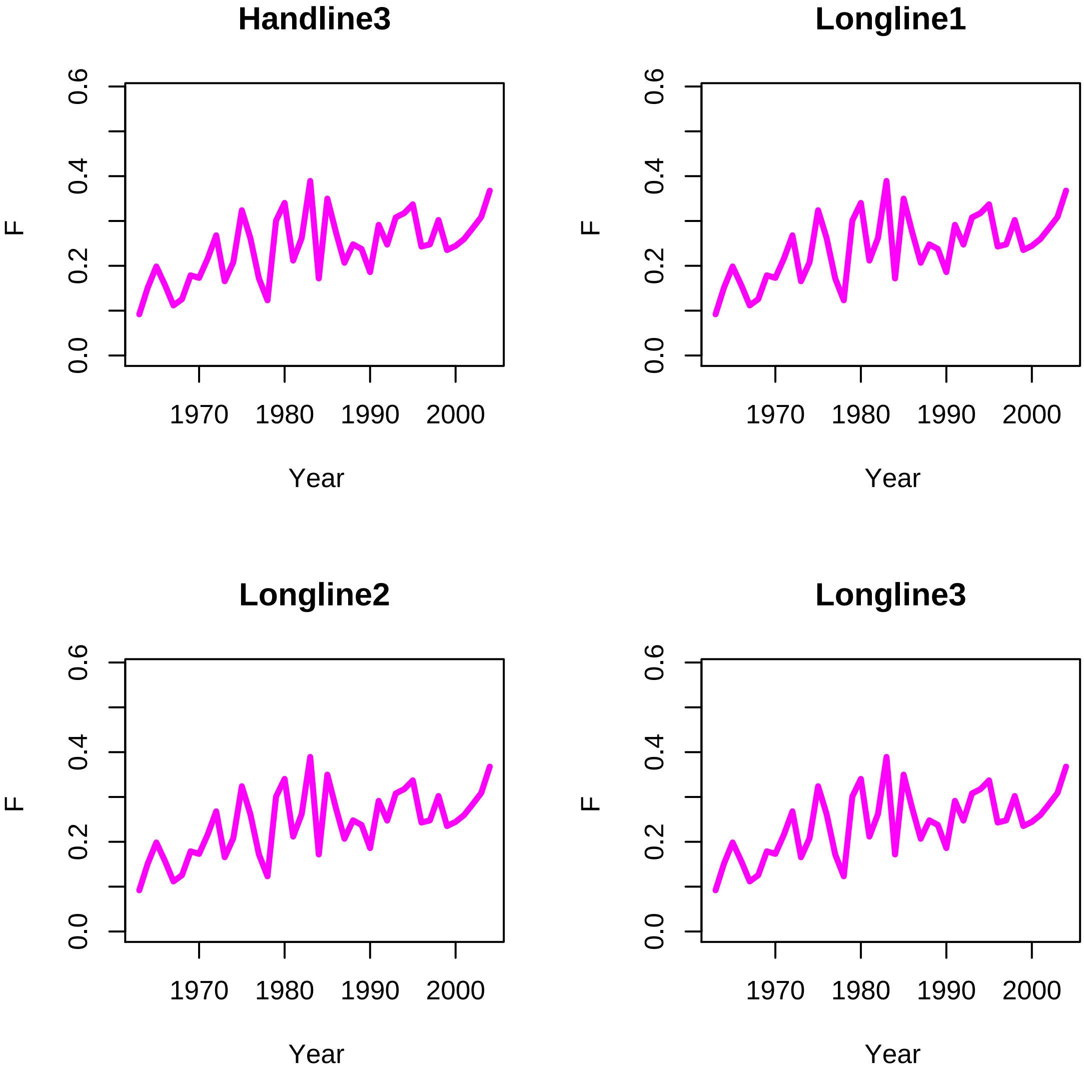
Headboat2CAA
Headboat3CAA
Longline1CAA
Longline2CAA
Age
Year
0
2
4
6
8
12
1990
1994
1998
2000
2002
2004
1984
1986
1988


Longline3CAA
MRFSSCAA
OthersCAA
Nuisance parameters q's
Age
Year
q value
0
2
4
6
8
12
2000
2002
2004
1985
1995
2005
0.00000
0.00010
HandlineCPUE2q
LonglineCPUE3q

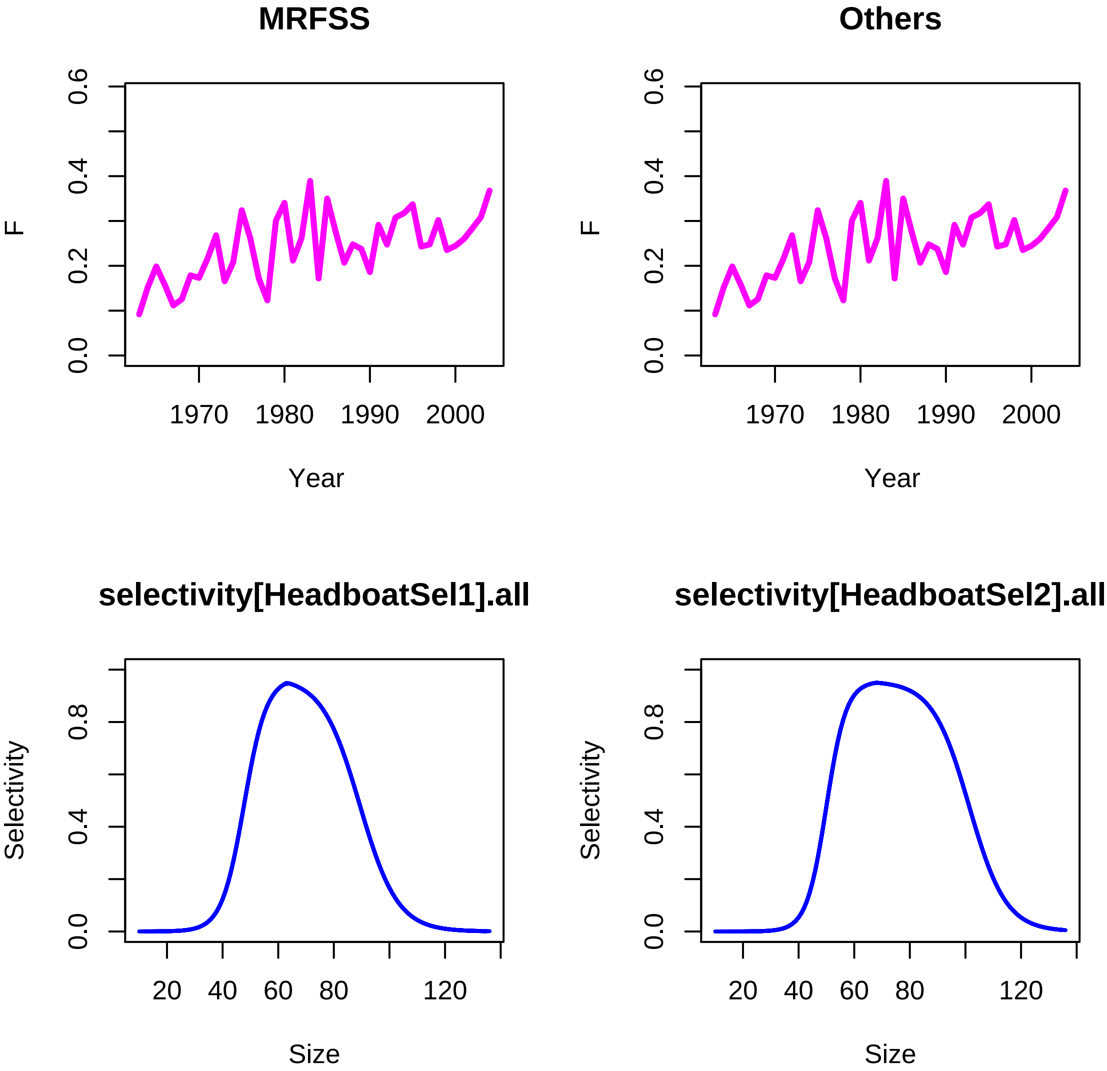

Spawing Stock Biomass trend
SSB
10000
40000
1970
1980
1990
2000
Year
SSB/B0 ratio trend
SSB/B0
0.0
0.4
0.8
1.2
1970
1980
1990
2000
Year
Recruitment trend
Recruits
0 e+00
3 e+06
1970
1980
1990
2000
Year
Headboat1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

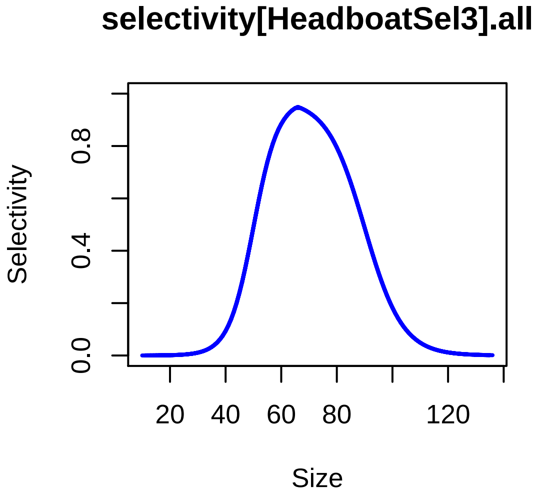


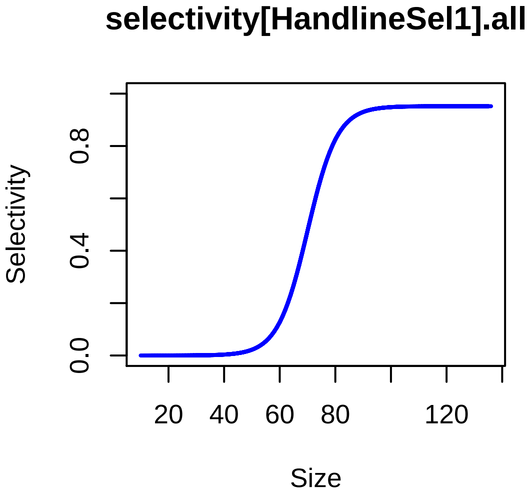
Headboat2
Headboat3
Handline1
Handline2
F
Year
0.0
0.2
0.4
0.6
1970
1980
1990
2000

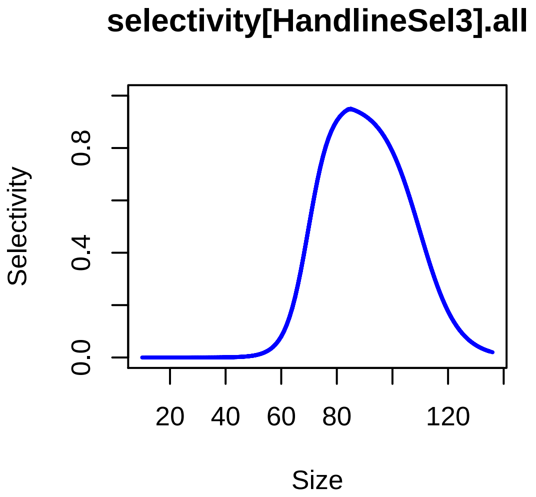


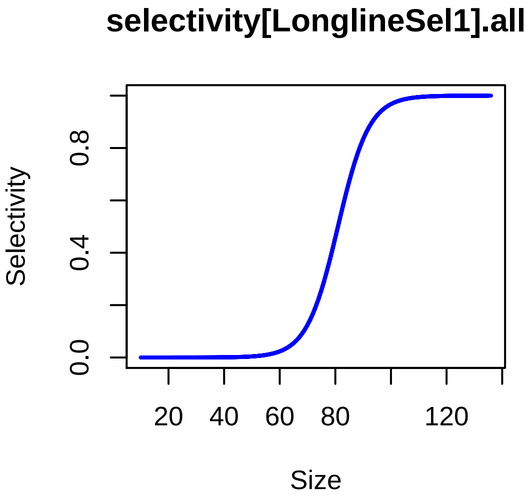
Handline3
Longline1
Longline2
Longline3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year


MRFSS
Others
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year
selectivity[HeadboatSel1].all
selectivity[HeadboatSel2].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size


selectivity[HeadboatSel3].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size


selectivity[HandlineSel1].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size


selectivity[HandlineSel3].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size


selectivity[LonglineSel1].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

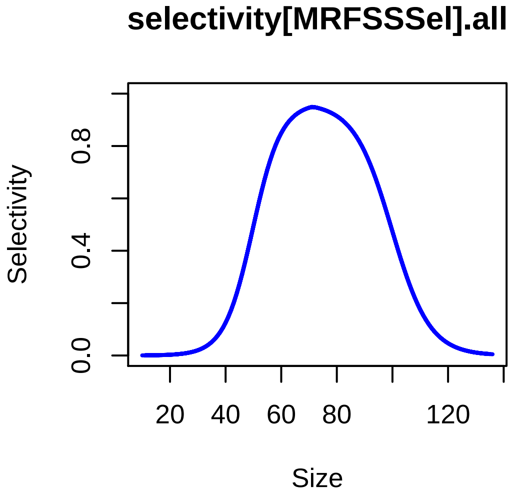
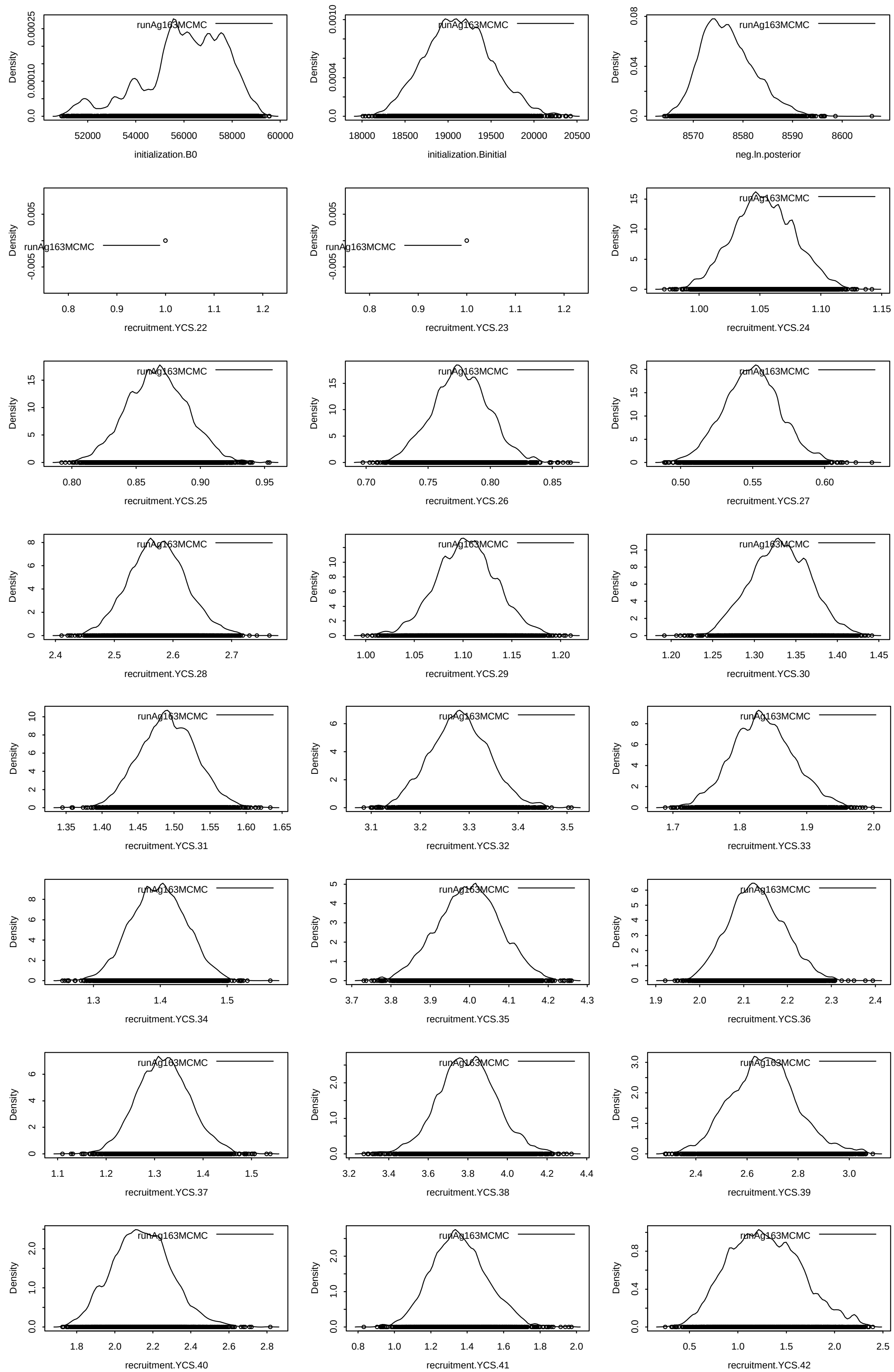


Figure 26. Example of CASAL run fit to gag GOM 1963-2004. age 1-12+, constant M, 11 fisheries, 8 selectivities.


runAg163MCMC
Density
initialization.B0
initialization.Binitial
neg.ln.posterior
recruitment.YCS.22
recruitment.YCS.23
recruitment.YCS.24
recruitment.YCS.25
recruitment.YCS.26
recruitment.YCS.27
recruitment.YCS.28
recruitment.YCS.29
recruitment.YCS.30
recruitment.YCS.31
recruitment.YCS.32
recruitment.YCS.33
recruitment.YCS.34
recruitment.YCS.35
recruitment.YCS.36
recruitment.YCS.37
recruitment.YCS.38
recruitment.YCS.39
recruitment.YCS.40
recruitment.YCS.41
recruitment.YCS.42

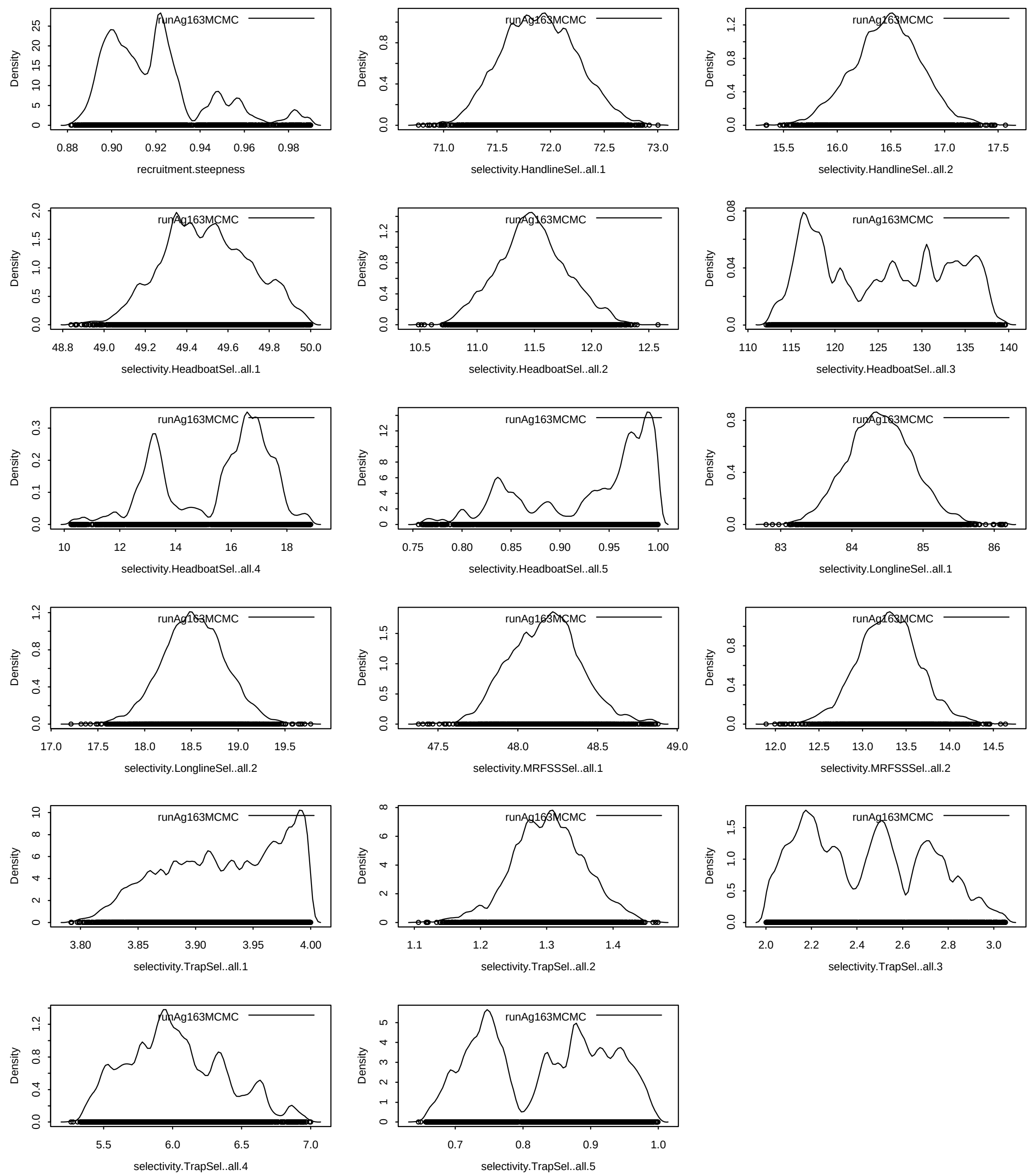


Figure 27. Posterior density estimates from MCMC Bayesian CASAL run Gag GOM 1963-2004 for free parameters. Run assumed 5 fisheries, 6 indices q's constant, M cte and uninformative priors.