Status of Gulf of Mexico Gag Grouper:
Results and Projected Implications of the Revisions and Sensitivity Runs
Suggested by the Grouper Review Panel

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Status of Gulf of Mexico Gag Grouper:

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Southeast Fishery Science Center

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The Grouper Review Panel (RP) that met May 8-10, 2007 in St. Petersburg, FL, recommended additional analyses for the stock of gag grouper in the Gulf of Mexico. Briefly, the RP concluded that minimum size restrictions are the primary reason recreational anglers discard gag grouper and that the assumed size distribution of these discards should reflect this. They also concluded that the spatial distribution of the size-at-depth information used previously for the recreational fishery was not representative of the distribution of the fishery as a whole (coming mostly from the Florida Panhandle where deeper waters are closer to shore). In contrast, the MRFSS B2 estimates indicate a high proportion of the recreational fishery takes place in state waters (inside 10 miles) off peninsular Florida, where the average depth is on the order of 10 meters. Thus the original depth-at-size matrix is likely biased. Therefore, the RP recommended instead partitioning discards (B2 MRFSS/Headboat) by regions (< 10 miles or > 10 miles) and assigning average depths to each of these regions based on examination of depth contour plots and consultations with fishermen. The RP also requested sensitivity analyses regarding the age range used to scale the Lorenzen natural mortality at age (M(age)) curve. The following text reviews the major inputs for the stock assessment model (CASAL) and associated projections.

Review of catch and effort input data

The following is a brief explanation of the data inputs and modifications for the current CASAL Gag GOM model evaluation.

Commercial landings

Commercial landings were available since 1963. All commercial landings were converted to gutted weight and partitioned into the following fisheries: commercial longline (1979-2004), commercial handline (1963-2004), and “other commercial fisheries” (1963-2004). The last category included landings from trawls, traps, spear fishing, and “unclassified” from several years. The handline fishery also groups several gears (electric reels, hand reels, handlines and commercial rod and reel). Commercial landings also reflected the conversion of black grouper landings to gag grouper due to miss-identification problems, particularly for the North Gulf of Mexico (see data workshop for further details).

The AW group recommended extending the historical landing series as far back as possible, following the protocol(s) for reconstructing commercial catch trends of red snapper. The earliest estimated Gag Gulf catches are from 1880; however the SEDAR10 assessment workshop (AW), the review workshop (RW) and the Grouper Review Panel (RP) recommended using the commercial catch series starting in 1963 owing to the lack of information on the water body of capture prior to that time (i.e., the inability to distinguish landings of fish that were originally caught in Mexico). Table 1 shows the 'final' working estimates of commercial catch; there were no modifications in the commercial catch series proposed by the RP. [See text in SEDAR10-AW report for further details in the procedures for estimation of historical commercial catch.]

Commercial Discards

A preliminary report of commercial discards was presented at the SEDAR10-DW, from logbooks submitted by fisherman. The Catch group concluded that those estimated were limited and of few years/vessels and recommended not to use them for estimating commercial discards. The DW concluded that commercial discards are exclusively due to minimum size regulations, which started in 1990 in Federal waters. Thus it was assumed that commercial fisheries did not discard Gag grouper prior to 1990 and after that discarded only fish below the legal size limit. The size distribution of discarded fish was estimated from the cumulative size frequency distribution observed for the respective commercial sectors (handline, longline, other) during 1984-1989 up to the corresponding minimum size. From 1990 to June-2000 the minimum size regulation of Gag for commercial fisheries was 20 inches (51 cm TL). From Jul-2000 to the present the minimum size increased to 24 inches (61 cm TL).

Recreational Catch

Estimates of recreational retained catch (A+B1) and live discards (B2) were available for the Gulf of Mexico from MRFSS since 1981 and from the Headboat survey since 1986. Texas Parks and Wildlife Division (TPWD) provided estimates of recreational landings in Texas, but not discards. For modeling purposes, the recreational fisheries were classified into two sectors, Headboat (1986-2004) and other recreational (MRFSS; 1981-2004). There were some adjustments to the estimates of AB1 (kept recreational catch) and B2 (discards) in response to the re-assignment of black grouper as gag grouper for most of the Gulf with exception of the Florida Keys catches. Also ratios of discards to retained catch for the Headboat fishery are based on the ratios of discards from the MRFSS estimates. Finally it was known that a substantial recreational fishery existed for Gag in 1963, therefore the AW recommended extrapolating back to 1960 using indicators that take into account human coastal population, commercial catch, number of vessels and estimated total expenditure in dollars for recreational fisheries (see RW report and supporting documentation). The historical discards (back to 1960) were determined from the extrapolated historical recreational catch using the ratios of 1981-1989 discards/kept fish. The size composition of the AB1 retained catch was determined from size samples collected by MRFSS. Very little size data has been collected on discarded fish.

Estimation of Dead Discards

The SEDAR10-DW concluded that the mortality of discarded gag grouper is highly dependent on the depth of capture of the fish. Based on several research studies, a depth-mortality function was estimated (Fig 1). Gag grouper show an ontogenic migration pattern, where larger fish move offshore to greater depths, while young and smaller fish tend to concentrate in shallow waters. Size-at depth data was available from the TIP survey, GULFIN and other survey data (Mote Marine Laboratory). In general most of the size-depth information came from commercial samples (about 72 thousand samples), while very few from recreational fisheries (382 samples). Appendix 3.2 in the SEDAR Grouper Assessment Review (supplement 1, June 2007) summarize the spatio-temporal distribution of the size-depth samples available. In general the information corroborates the notion of larger fish at greater depths; however it is also clear that all sizes are represented even at the greatest depths (65+ meters).

The size-at-depth data allows the estimation of two probability matrices of size at depth, one for the commercial fisheries and one for recreational fisheries (in both cases assumed to be constant through the years). These size-at-depth matrices allow converting Discards-at-size (DAS) into Discards-at-size-at-depth (DAS-AD). Once DAS-AD is available, the depth-mortality function can be applied to estimate the portion of dead-discards-at-size (DDAS). For the commercial discards, the frequency size distribution was assumed to be that of the illegal size fish (below minimum size regulations) of 1984-1989. Recall, that it was assumed that prior to 1990 there were no discards on commercial fisheries, so this size frequency and dead discards estimation is only for 1990 forward.

In the case of the recreational fisheries the RP considered that the size-at-depth information was limited, and restricted to a small area (off the Panhandle coast, FL) where deep water is close to shore, and this sample did not represent the main recreational fisheries operations of the rest of the Florida West Coast (where the shallow waters extend for several miles off the coast, Fig 2). Therefore the RP concluded that the size-at-depth recreational matrix was likely biased and recommended an alternative procedure to estimate average depth of discards for these fisheries. The alternative method was based on an analysis of the distribution of B2 MRFSS discards between 3 zones (inshore, ocean < 10 m, ocean >10 m) in two regions (Panhandle FL and Peninsular FL, including the Florida Keys). The RP recommended using these strata to partition all recreational discards (B2) and assigning an average depth for each stratum based on depth-contour plots and information from recreational anglers and scientists familiar with these fisheries. Table 2 shows the assigned depth and correspondent mortality-at-depth for each stratum. Furthermore, as most of the recreational catch of gag is from the Florida West coast, discards from Alabama, Mississippi and Louisiana were treated similar to those from the Panhandle region and discards from Texas were treated similar to those from the Peninsula region. The partitioning of B2 discards was done for each year-area-region (1981-2004). For the years prior to 1981; it was assumed that dead-discards were the same proportion as the 1981-1989 average of dead-discard/kept fish of the overall recreational estimates.

The Grouper RP concluded that discards from recreational fisheries were due primarily to size regulations, thus recommending that discards size distributions are of fish below 20" (51 cm TL) from 1990 to 1999 and fish below 22" (56 cm TL) from 2000-2004. Prior to 1990, when no federal size regulations were in effect, size distribution of discards was assumed to be of fish below 16" (46 cm TL) in accordance with consultations with recreational fisherman after the RP meeting. Because no direct samples are available from discarded fish, the size frequency distribution was estimated from samples of sub-legal sized fish included in data sets from the TIP, Headboat bioprofile, GULFIN, and Mote Marine. It was found during the RP that the distribution of sub-legal size fish in these samples was similar to those collected during the 2005 and 2006 FWC headboat survey. Table 1 shows the 'final' working estimates of recreational catch. These are somewhat less than the values estimated for the SEDAR 12 RW owing to the reduced average weight (the fish now being assumed smaller) and reduced mortality rate (the fish now being assumed to have been caught in shallower water on average). Figure 3 shows the differences in terms of the total biomass of removals, and Figure 4 shows the differences in terms of the total number of removals.

Catch At Age

CAS tables from commercial and recreational kept, and commercial/recreational dead discards were converted to Catch at Age (CAA) following the procedures described in SEDAR10-AW02 document. Briefly, age-length-keys (ALK) were used when sufficient age samples were available (1991-2004), otherwise a stochastic length deconvolution method (SAR) was used (1984-1990) (Table 6 SEDAR10-AW02). In the assessment model CASAL, partial CAAs were input for each of the five fisheries, 3 commercial (handline, longline, others) and 2 recreational (Headboat, MRFSS).

Given the changes in assumptions regarding the size distribution of dead-discards in the recreational fisheries, and their significant contribution to the total removals, the annual recreational CAA distributions shift towards younger ages compared to the CAA of the final model in SEDAR10-RW (Fig 7 and Fig 8). The proportion classified as ages 1, 2 and 3 increased, while the proportion classified as ages 4 and older decreased. In addition total number of removals by year also decreases, as more recreational discard fish were allocated to shallow mean depths, thus reducing their discard mortality.

Maturity

No changes were recommended for Gag Gulf maturity vector. As previously indicated, spawning biomass results represent female biomass only for this stock. Gag is a protogynous species, maturing first as females (50% mature females at 3.7 year old) and then becoming males (50% mature males at 10.8 year old).

Natural Mortality

Following the recommendations of the SEDAR10-AW and RW, the natural mortality rate (M) of Gulf of Mexico gag grouper was modeled as a declining 'Lorenzen' function of size, translated to age by use of a growth curve. The Lorenzen curve was rescaled such that the average value of M over a selected age range was the same as the point estimate from Hoenig's (1983) regression (using age 30 as the maximum, see the Grouper assessment review, Supplement 1, for more details). The scaling was originally conducted over all ages (0-30); i.e., the cumulative mortality rate from ages 0 to 30 was equal to 31 times the Hoenig point estimate.. The RP recommended evaluating the effects of alternative M vectors that result with modifications of the age range (first age to include) used to scale the Lorenzen curve. Sensitivity runs were conducted with M vectors estimated by rescaling the Lorenzen curve over the following age ranges: i) Age 1-30, ii) Age 2-30, iii) Age 3-30, iv) Age 4-30 and v) Age 5-30. Table 3 and Figure 5 present the estimated M(age) vector for each case, and Figure 5 also shows the per recruit survival under each one of the M(age) cases. The estimated total removals (landings and dead discards) peak between ages 2 and 4 during the years 1984-2004 (depending on the cohort strength). The average for the full cohorts available in the series (cohorts 1984-

1992) is age 3 (Fig 6). Thus, age 3 likely represents the ‘fully-selected’ age that would have been used for catch curve analyses of the sort upon which Hoenig’s regression was based.

Size at age

Size at age follows the von Bertalanffy growth model estimated and adopted by the SEDAR10-DW. This model includes a modification to estimate growth parameters from samples subject to biases due to minimum size restrictions.

Indices of Abundance

Relative indices of abundance were derived from SEAMAP Video Surveys (for all gag and for mature male gag) and fishery dependent sources (MRFSS 1981-2004, Headboat 1986-2004, Handline 1990-2004, and Longline 1990-2004). No modifications were recommended for these indices. Detailed description of the standardization methods and estimation are provided in the SEDAR10-DW report CPUE section. Because of the changes in minimum size regulations (1990, and 2000) some of the fishery dependent indices were split at these years. In the assessment model CASAL, each time period is associated with a different catchability coefficient for the catch and fishery-index.

Application of CASAL Model

The CASAL model used to assess the Gulf of Mexico gag stock was configured exactly as described in the SEDAR 10 RW report:

- An age structured model, starting with age 1 to age 12+, where age 12 represents ages 12 and older (a plus group).
- Age dependent, Lorenzen natural mortality vector.
- Size at age following a von Bertalanffy growth model SEDAR10- DW.
- Beverton-Holt stock recruitment relationship, but with large recruitment deviations allowed.
- Reproductive potential measured in terms of female spawning biomass (maturity at age * proportion female at age * average weight at age).
- Four fishery-dependent CPUE series (indices of abundance): Handline, Longline, Headboat, and MRFSS. Handline, Longline and Headboat indices were split at 1989/90 and 1999/00 when management regulations of minimum size were implemented and considered to affect the landings of those fisheries.
- Two fishery independent indices of abundance: Video SEAMAP survey and the Copper belly (adult male) video survey.
- Five major fisheries; three commercial (Handline, Longline and Others) and two recreational (Headboat and MRFSS).
- Five series of age-composition data, one for each fishery, from 1984 to 2004.
- Constant catchability coefficients q’s within fishery and associated index time series. Thus Handline, Longline and Headboat fisheries were split similar to their respective indices of abundance.

- Selectivity by fishery/index was assumed to follow a parametric function; double logistic for all; except Longline fishery logistic. Function parameters were estimated by the model.
- Penalties for total catch in each fishery to be realized, and for the average log-scale recruitment deviations to be one.

The two main input differences between the final model adopted by the SEDAR10-RW (Jul-06) and the model recommended by the Grouper Review Panel (RP) (May-07) boil down to:

1. Discards from the recreational fisheries are now assumed to be due primarily to the minimum size restrictions (20" from 1990 to 1999 and below 22" thereafter). Prior to 1990 a practical size limit of 16" was assumed based on discussions with anglers after the Review panel meeting.
2. Discards from recreational fisheries (B2) are now partitioned between areas (inshore, ocean<10, ocean>10) and regions (Panhandle, Peninsula+FLKeys) for each year based on the proportions of B2 derived from the MRFSS estimates of Florida West coast (Web MRFSS estimates). Then for each stratum an average depth was assigned based on consultations with recreational anglers and scientists familiar with these fisheries. Dead-discards were then estimated by multiplying the yearly B2 estimates for each stratum by the discard mortality rate associated with the average depth of that stratum.

In all other matters, the CASAL runs were identical to those adopted by the SEDAR 10 review panel for Gulf of Mexico gag. For comparison purposes, the final model SEDAR10 will be labeled as SEDAR-Jul06, while the recommended run by the RP will be label MinSz DDB2P (Minimum size dead discards with partition of B2 recreational estimates).

Model fits and parameter estimates

The CASAL assessment model the for MinSz-DDB2P scenario estimated a somewhat smaller gag stock than was estimated by the SEDAR10-Jul06 model, both in terms of unexploited biomass and initial biomass (1963) (Table 3). The overall trends estimated by the two models are comparable prior to 1988, with a rapid decline of total biomass. However, the trends differ between the scenarios after 1988. In the case of the SEDAR10-Jul06 run, the stock biomass starts to increase in 1990 and rapidly reaches a peak in 2002. In the case of the MinSz-DDB2P run, stock biomass shows continued declines until 1993 and then begins to increase, but not nearly to the levels estimated by the Jul06 run (Fig 9). Similar trends are estimated for the spawing stock biomass (SSB) component, however in the SEDAR-Jul06 run, the SSB in the 2000's is much higher than any historical estimates, while the MinSz-DDB2P run shows a much smaller SSB, about half of what it was in 1963 (Fig 10).

Trends of the stock size in numbers of fish shows similar patterns and levels for both runs between 1963 and 1982, but slightly higher numbers in the SEDAR10_Jul06 run. However, the magnitude of stock size differs from 1983 forward; the SEDAR10 Jul06 run estimates a total stock of about 12.3 million fish in 2002, while the MinSz-DDB2P run estimates a total stock of about 6.9 million fish (Fig 11). Trends of recruits (age 1 class) are similar up to 1982, when they diverge, with larger recruitments predicted in the SEDAR10-Jul06 run than the MinSz-DDB2P scenario. The geometric mean recruitment from 1984 to 2004 was estimated at 2.1

million fish in the SEDAR10-Jul06 run, and 1.6 million fish in the MinSz-DDB2P run. Peaks of recruitments are similar between scenarios but the magnitude of them is much lower in the MinSz-DDB2P run (Fig 12).

In terms of exploitation rates, both models estimated similar rates and trends. Figure 13 shows the estimated annual fishing mortality rate (F) for both scenarios. The MinSz-DDB2P run estimated consistent higher F in the early time 1963-1982, but slightly lower F in more recent years (the estimate for F in 2004 is about 0.49 for the SEDAR10-Jul06 run and 0.41 for the MinSz-DDB2P scenario).

Fits to indices and partial Catch-at-age were similar between scenarios (Fig 14 and 15). The estimated selectivity by fishery shows the expected patterns. In the case of the MinSz-DDB2P run, the estimated selectivity's of the recreational fisheries were shifted towards smaller-younger age classes (Fig 16). Selectivity for the commercial components was similar between scenarios (Fig 17).

Stock status estimates

Following the recommendations of the SEDAR10-AW and RW, estimates of benchmarks were calculated based on recruitment estimates for the period when relative indices of abundance and age composition data were available [1984-2004]. Specifically, the expected future recruitment was estimated as the geometric mean of the estimates for 1984-2004 (2.12 million recruits SEDAR10-Jul06 case, and 1.47 million recruits MinSz-DDB2P case). Future selectivity was assumed to remain similar to the patterns estimated for the last 4 years (2001-2004). Projections and benchmark estimates were calculated using the age-structured software (PRO-2BOX).

Table 4 summarizes the estimated benchmarks. Overall the MinSz-DDB2P scenario estimated lower fishing mortality benchmarks (F_{MSY}, F_{MAX}, $F_{30\%SPR,}$ $F_{40\%SPR}$) and lower SSB benchmarks than the SEDAR10-Jul06 case. MSY was estimated at 4.3 million pounds (MP) for the SEDAR10-Jul06 case and 5.3 MP for the MinSz-DDB2P case. Note that MSY and yield per recruit statistics were computed by optimizing the landings (kept catch) component of the fisheries. All references of spawning biomass in this table correspond to the female component of the stock exclusively, where spawning biomass is defined as the mean weight times the proportion female times the proportion mature. Spawning biomass in the final year 2004 was estimated at 40,550 MP and 19,839 MP for the SEDAR10-Jul06 and MinSz-DDB2P scenarios, respectively. These SSB_{2004} were about 35.8% and 26.2% of their respective virgin biomass estimates.

The ratio of SSB_{2004} to the suggested proxy for SSB_{MSY} (SSB_{Max}) was estimated to be 1.16 for the SEDAR10-Jul06 run and 0.67 for the new MinSz-DDB2P run. Hence, the SEDAR10-Jul06 run suggests the stock is well above the MSY level, but the MinSz-DDB2P run is less optimistic. In that case the interpretation of stock status depends on the definition of MSST. If the lower limit allowed by law (half the MSY level) were to be adopted, then the stock would not be deemed overfished, but if the default control rule of (1-M) SSB_{MSY} were adopted, the stock would be deemed overfished. Both models suggest the stock is currently experiencing overfishing. The ratio of F_{2004} to the suggested proxy for F_{MSY} (F_{Max}) was estimated to be 1.99 for the SEDAR10-Jul06 run and 2.50 for the new MinSz-DDB2P run.

Natural Mortality Sensitivity Runs

The sensitivity runs with alternative M(age) vectors were run with the new base model recommended by the RP. Note that the natural mortality rate of all age classes increases as the first age-class used in the rescaling procedure is moved from age 0 towards age 5.. Table 6 presents a summary of the estimated population parameters under each scenario. Increase of natural mortality on all ages implies a lower survival per recruit, thus the model in general estimated larger recruitment of age 1 gag, from 1.92 (base) to 9.52 (age5-30) million fish. The increase is particularly larger when M(age) moves from age (3-30) to age(4-30). The population model also estimated lower steepness as M(age) increased from 0.77 (base) to 0.56 (age5-30). The lower steepness was compensated by a large virgin biomass estimated, and also greater initial biomass.

Estimated fishing mortality at the end year, 2004 was slightly lower as the first ages class for M increases (5-30) from 0.42 to 0.36 (Table 7). Table 7 also shows the estimated benchmarks assuming a constant recruitment (geometric mean of the model estimated Age 1 numbers 1984-2004) for each case. Biomass references decreased as M(age) increased. MSY estimates ranged from 5.3 million lbs (Base) to 3.3 million lbs (age5-30). Similarly, estimates of spawning biomass at different references (MSY, Fmax, $F_{0.1}$, SPR20%, SPR30%, SPR40%) were all lower as M increased. For example, SSB_{Fmax} was estimated 29.6 million lbs (Base) and 17.0 million lbs M(age5-30). Estimates of yield per recruit did also decrease as M(age) increase. Reference points of fishing mortality instead, increase with increase M(age). Fmax was estimated in the base case M(age0-30) at .017, and for M(age5-30) at 0.20

The methodology Hoenig used to estimate a constant natural mortality rate was based largely on catch curve analyses that started with the first fully selected age, usually regarded in practice as the most abundant age class in the analysis. The only catch at age (CAA) information available for Gulg gag is after 1984, from the ALK and ageing of catch by slicing based on age size sampling. Analysis of catch curves for the 1984 – 1992 cohorts, which have being through the fishery at least up age 11+, suggest the fully selected age varies from ages 2 to 4, with an overall average of age 3. The run where the M vector was rescaled from age 3 suggests the stock in 2004 was experiencing a fishing mortality rate of 0.37, or 1.92 times higher than the benchmark of Fmax (0.19). Similarly, the spawning stock biomass was estimated at 25.3 million lbs, 1.32 times higher than the corresponding SSB_{Fmax} (19.1 million lbs). Thus, the age3-30 model, like the base RP model, still gives the perception that overfishing is occurring, but unlike the base RP model, does not suggest the stock is overfished.

Projections

The following describes deterministic projections from the base run (Lorenz curve scaled for all ages) and for two of the sensitivity runs (Lorenz curve scaled over ages 3-30 and Lorenz curve rescaled over ages 5-30). The projections use the software package PRO-2BOX, with input from the CASAL fitting model outputs. Projections, assume the following conditions:

a) Recruitment in the future, from 2005 forward, was assumed constant at a value corresponding to the geometric mean of the estimated recruits (Age 1) by CASAL from the period 1984-2004 as agreed to by the Review and Assessment SEDAR groups.
b) Selectivity remains, on average, about the same as the average selectivity estimated over the last 4 years when data were available (2001-2004).
c) Observed landings were used for 2005 and 2006 and it is assumed that the landings in 2007 would be at about 2006 levels (because 2007 is not yet complete).
d) Random fluctuations in recruitment and parameter uncertainty were not modeled for this exercise, therefore these deterministic results should be regarded as equivalent to the 50^{th} percentile, i.e., there is a 50% chance that the actual stock will be in worse condition than the projections indicate and a 50% chance that it will be in better condition than the projections indicate.

Projections of constant catch start in 2008 with values ranging 0 to 6 million pounds of landed catch. Projections were also carried out for the fishing mortality rate that maximizes yield per recruit (Fmax, the RP-recommended proxy for MSY) and Fmax75% (75% of Fmax, the recommended OY). The predicted trends of total biomass, spawning stock biomass, F, yields, and ratios of SSB/SSBFmax and F/Fmax are summarize in Table 8 and Figure 18. There a several important results to highlight:

1) The M(0-30) run would suggest the stock was overfished in 2004 if MSST was defined as (1-M)SSBmax, but would not be considered overfished if a more liberal MSST were defined such as 0.5SSBmax. The runs with higher levels of M (0-30 and 5-30) suggest, in contrast, that the spawning biomass was above SSBmax and therefore would not be considered overfished regardless of how MSST is defined.
2) The results for all values of M suggest that, even though the estimated catch for 2005-07 was slightly below the 2004 catch, the spawning stock biomass has decreased relative to the 2004 level. Thus, regardless of whether the stock is considered overfished, it is unlikely that gag stock can continue to support the high catch levels of the recent past in the absence of a fortuitous strong year classes.
3) The projections for all levels of M suggest that constant catch allocations at or below 3 million pounds (total landings) are required to halt the projected decline of the SSB.
4) The projections for all levels of M suggest that, if the objective is to end overfishing immediately (fish at Fmax), then landings will likely need to be reduced to about 3 million pounds, and if the objective is to fish at 75%Fmax (OY) levels, then landings will need to be reduced to nearly 2 million pounds.
5) Once the stock is recovered, the maximum long-term equilibrium yield is expected to be between 3.4 and 5.3 mp. The optimum long-term equilibrium yield (OY) is expected to be between 3.3 and 5.2 mp.

Table 1. Final estimates of total removals (landings + dead discards) from commercial and recreational fisheries 1963-2004 Grouper Review Panel May-07 (MinSz-DDB2P case) . Discards of recreational fisheries B2 were partitioned by year/area/region and assigned a mortality rate based on average depth to estimate the number of discards that died. Values in thousand pounds

Year	Longline	Handline	Others	MRFSS	Headboat	Total
1963	-	1,289	1	444	-	1,734
1964	-	1,632	9	479	-	2,121
1965	-	1,816	1	514	-	2,331
1966	-	1,457	1	547	-	2,004
1967	-	1,156	10	581	-	1,746
1968	-	1,192	4	617	-	1,814
1969	-	1,377	3	655	-	2,035
1970	-	1,284	3	696	-	1,982
1971	-	1,377	3	781	-	2,161
1972	-	1,460	4	877	-	2,341
1973	-	1,081	5	984	-	2,070
1974	-	1,184	1	1,104	-	2,290
1975	-	1,447	4	1,238	-	2,689
1976	-	1,198	9	1,390	-	2,598
1977	-	977	8	1,561	-	2,545
1978	-	875	11	1,753	-	2,639
1979	1	1,342	10	1,969	-	3,322
1980	89	1,318	12	2,199	-	3,618
1981	467	1,499	16	1,852	-	3,834
1982	1,010	1,335	14	3,234	-	5,592
1983	681	1,039	18	6,414	-	8,152
1984	433	1,098	18	1,962	-	3,512
1985	381	1,398	28	6,592	-	8,399
1986	517	1,155	29	3,377	277	5,355
1987	656	853	30	2,284	190	4,012
1988	402	791	23	3,631	150	4,998
1989	426	1,235	31	2,058	292	4,042
1990	623	1,130	41	1,156	193	3,142
1991	510	993	63	2,773	107	4,445
1992	593	1,003	69	2,258	124	4,046
1993	480	1,280	106	2,771	172	4,808
1994	352	1,148	119	2,058	176	3,853
1995	391	1,157	105	2,937	125	4,715
1996	394	1,106	68	2,510	109	4,187
1997	415	1,101	83	2,694	98	4,391
1998	603	1,848	82	3,667	240	6,439
1999	549	1,481	68	3,799	196	6,094
2000	621	1,596	81	5,096	211	7,605
2001	1,011	2,065	101	4,305	123	7,604
2002	1,041	1,910	62	4,866	86	7,965
2003	1,138	1,461	67	4,358	126	7,150
2004	1,138	1,737	73	5,782	193	8,924

Table 2. Assigned average depth (m) and corresponding discard mortality (% mort) for each of the regions (Panhandle and Peninsula plus Florida Keys) and depth zones (inshore, Ocean < 10 miles, and Ocean > 10 miles).

Region	Zone	Average depth (m)	%mort
Panhandle	Inshore	10	11
Panhandle	Ocean<10	20	18
Panhandle	Ocean>10	40	42
Peninsula/Keys	Inshore & Ocean<10	10	11
Peninsula/Keys	Ocean>10	30	29

Table 3. Estimated natural mortality at age M(age) vectors obtained by rescaling the Lorenzen curve over different age ranges. The original 'Base' case used all ages (ages 0 -30).

Age	Base	M(age1-30)	M(age2-30)	M(age3-30)	M(age4-30)	M(age5-30)
1	0.342	0.389	0.414	0.432	0.446	0.456
2	0.246	0.280	0.298	0.311	0.321	0.328
3	0.199	0.226	0.241	0.251	0.259	0.265
4	0.171	0.194	0.207	0.216	0.223	0.228
5	0.152	0.173	0.185	0.193	0.199	0.204
6	0.139	0.159	0.169	0.176	0.182	0.186
7	0.130	0.148	0.158	0.164	0.170	0.174
8	0.123	0.140	0.149	0.155	0.160	0.164
9	0.117	0.133	0.142	0.148	0.153	0.156
10	0.113	0.128	0.137	0.143	0.147	0.150
11	0.109	0.124	0.132	0.138	0.142	0.146
12	0.098	0.112	0.119	0.125	0.129	0.132

Table 4. CASAL estimates of total biomass, female spawning biomass, recruits (age 1), fishing mortality rate and removals from the Gulf of Mexico gag stock for the SEDAR10-Jul06 model and the MinSz DDB2P model recommended by the Grouper Review Panel May 07.

	SEDAR10-Jul06					MinSz DDB2P				
Year	**Total Biomass**	**Spawning Stock Biomass**	**Recruits**	**F**	**Yield (landings + Dead Disc)**	**Total Biomass**	**Spawning Stock Biomass**	**Recruits**	**F**	**Yi (lan + D D**
	1000 lbs	1000 lbs	millions Age1	annual rate	1000 lbs	1000 lbs	1000 lbs	millions Age1	annual rate	100(
1963	74,075	37,225	0.2146	0.030	1,736	69,600	30,600	0.1796	0.037	
1964	71,432	36,322	0.2146	0.037	2,126	66,844	29,652	0.1801	0.046	
1965	68,128	35,088	0.2132	0.042	2,341	63,427	28,418	0.179	0.052	
1966	64,559	33,062	0.2113	0.040	2,023	59,789	26,544	0.178	0.052	
1967	61,013	30,683	0.208	0.040	1,770	56,240	24,427	0.1755	0.055	
1968	57,357	28,260	0.204	0.046	1,856	52,602	22,245	0.1727	0.064	
1969	53,414	25,749	0.1993	0.056	2,107	48,722	19,983	0.1684	0.079	
1970	49,361	23,238	0.1938	0.063	2,070	44,710	17,765	0.1661	0.091	
1971	45,220	20,956	0.1873	0.079	2,289	40,653	15,734	0.1599	0.114	
1972	40,969	18,877	0.1803	0.098	2,504	36,487	13,871	0.1576	0.144	
1973	36,850	17,018	0.1726	0.111	2,262	32,496	12,240	0.1525	0.171	
1974	33,502	15,207	1.394	0.140	2,526	29,233	10,688	1.355	0.217	
1975	30,352	13,410	0.2022	0.183	2,982	26,169	9,151	0.1911	0.257	
1976	27,687	11,826	0.7214	0.202	2,921	23,634	7,943	0.7361	0.258	
1977	25,991	11,742	1.267	0.215	2,896	22,035	7,897	1.166	0.265	
1978	25,088	11,447	1.216	0.236	3,115	21,226	7,657	1.112	0.268	
1979	24,714	11,487	1.542	0.280	3,815	20,893	7,743	1.443	0.293	
1980	24,736	12,267	1.713	0.300	4,167	21,083	8,389	1.747	0.298	
1981	25,639	13,436	2.094	0.279	4,355	22,179	9,389	2.075	0.281	
1982	26,828	15,507	1.972	0.352	5,615	23,347	10,882	1.996	0.378	
1983	25,837	17,289	1.365	0.559	8,758	22,509	11,810	1.331	0.539	
1984	25,705	16,388	1.358	0.216	3,504	22,179	12,214	1.197	0.232	
1985	25,661	19,914	1.253	0.485	8,231	21,577	13,841	1.136	0.546	
1986	23,877	18,141	1.476	0.365	5,306	19,114	12,403	0.9398	0.383	
1987	23,943	17,577	1.193	0.262	3,989	18,444	11,949	0.898	0.293	
1988	24,207	18,273	1.087	0.321	4,872	17,670	11,799	0.7717	0.402	
1989	23,634	18,205	0.7932	0.305	4,079	16,301	10,807	0.5569	0.342	
1990	25,352	17,930	3.761	0.233	3,196	16,277	10,199	1.681	0.274	
1991	27,181	18,337	1.602	0.383	4,317	16,484	9,720	1.212	0.413	
1992	28,700	16,952	1.916	0.315	3,921	16,305	8,598	1.028	0.379	
1993	29,824	20,372	2.119	0.406	4,760	16,025	8,785	1.218	0.465	
1994	31,432	21,029	4.814	0.422	3,700	16,740	8,849	2.492	0.370	
1995	33,282	20,478	2.712	0.458	4,447	18,102	9,081	1.562	0.420	
1996	35,903	20,610	2.033	0.310	3,890	19,584	9,632	1.499	0.335	
1997	41,057	26,806	5.741	0.315	4,531	22,862	12,158	3.609	0.302	
1998	44,670	30,727	3.062	0.399	6,610	25,684	14,013	1.866	0.399	
1999	47,181	31,057	1.833	0.297	5,914	27,337	15,139	1.16	0.324	
2000	51,035	37,665	5.007	0.309	7,963	28,836	18,417	2.885	0.382	
2001	54,097	40,639	3.468	0.330	6,980	29,652	19,114	2.18	0.386	
2002	54,868	40,463	2.125	0.364	8,009	29,851	18,473	1.467	0.390	
2003	52,841	41,784	2.125	0.400	7,214	29,696	19,222	1.467	0.339	
2004	47,489	40,551	2.125	0.493	7,628	28,418	19,839	1.467	0.415	

Table 5. Estimated benchmarks from the SEDAR10-Jul06 based model of Gulf gag grouper compared with those from the new base model recommended model by the Review Panel (MinSz DDB2P). Benchmarks assume constant recruitment (geometric mean 1984-2004) and average selectivity of last four years (2001-04). Units of biomass are million pounds (MSY, SSB, Yield, Biomass, SSB virgin) and units of maximum yield per recruit (YPRmax) are pounds. The proxy for MSY is the equilibrium yield (weight of landings) associated with fishing to maximize the yield per recruit. Yield 2004 refers to the weight of the landings observed in 2004. The term virgin refers to the status of the stock before fishing commenced.

Benchmark	SEDAR10-Jul06	MinSz DDB2P
Fmax	0.25	0.17
MSY	4.27	5.30
SSBmax	35.02	29.64
YPRmax	2.01	3.61
$F_{20\%SPR}$	0.37	0.32
$F_{30\%SPR}$	0.25	0.22
$F_{40\%SPR}$	0.18	0.16
$YPR_{20\%SPR}$	1.92	3.16
$YPR_{30\%SPR}$	2.01	3.52
$YPR_{40\%SPR}$	1.95	3.61
$SSB_{20\%SPR}$	23.12	15.50
$SSB_{30\%SPR}$	34.64	23.20
$SSB_{40\%SPR}$	46.11	30.93
F2004	0.49	0.42
SSB2004	40.55	19.84
Yield 2004	7.63	6.69
Recruits (geomean 84-04)	2,124,871	1,467,473
Recruits virgin	2,660,980	1,918,740
Biomass virgin	192.76	139.12
SSB virgin	113.24	75.69
F2004/Fmax	1.99	2.50
SSB2004/SSBmax	1.16	0.77

Table 6. CASAL estimates of selected population parameters under the different natural mortality at age vectors, M(age), estimated by recalling the Lorenzen curve over the given age ranges. Biomass units are in pounds

Estimate	M(age0-30)	M(age1-30)	M(age2-30)	M(age3-30)	M(age4-30)	M(age5-30)
Unfished Biomass	139,119,202	114,027,727	107,740,583	112,602,438	358,207,131	369,567,553
Biomass 1963	42,803,856	52,208,337	57,399,562	58,695,660	56,308,494	58,344,905
SSB 2004	22,751,047	23,966,676	24,721,539	25,296,064	25,731,477	26,096,342
F 2004	0.42	0.39	0.38	0.37	0.37	0.36
Virgin Recruitment	1.92	2.05	2.23	2.56	8.72	9.50
Steepness	0.7679	0.7438	0.7199	0.6829	0.5406	0.5287
Obj Function	8841.05	8843.12	8844.7	8845.98	8847.04	8847.95

Table 7. Sensitivity runs. Reference points for different vectors of natural mortality at age M(age) runs. Base case is M(age0-30). Biomass units in pounds. Note that benchmark estimates of Fmax and Fmsy, and SSBmax and SSBmsy are identical because of the assumption of constant recruitment.

Reference Point	M(age0-30)	M(age1-30)	M(age2-30)	M(age3-30)	M(age4-30)	M(age5-30)
MSY	5,299,032	4,469,123	3,996,474	3,704,781	3,502,859	3,352,063
F at max. Y/R	0.17	0.18	0.19	0.19	0.20	0.20
Y/R maximum	3.6	2.9	2.6	2.4	2.3	2.2
S/R at Fmax	9.16	7.11	6.23	5.69	5.33	5.06
SPR at Fmax	0.39	0.38	0.38	0.38	0.37	0.37
SSB at Fmax	29,639,612	23,942,425	20,970,263	19,175,744	17,943,668	17,033,622
F 0.1	0.11	0.12	0.12	0.13	0.13	0.13
Y/R at F0.1	3.4	2.8	2.5	2.3	2.2	2.1
S/R at F0.1	12.35	9.61	8.46	7.73	7.26	6.87
SPR at F0.1	0.52	0.51	0.51	0.51	0.51	0.51
SSB at F0.1	39,957,247	32,379,517	28,494,751	26,019,841	24,465,582	23,145,675
F 20% SPR	0.32	0.35	0.36	0.36	0.37	0.37
Y/R at F20	3.2	2.6	2.3	2.2	2.0	2.0
S/R at F20	4.79	3.77	3.32	3.05	2.87	2.73
SSB at F20	15,496,603	12,694,836	11,170,031	10,272,749	9,677,611	9,203,022
F 30% SPR	0.22	0.24	0.24	0.25	0.25	0.25
Y/R at F30	3.5	2.9	2.6	2.4	2.3	2.2
S/R at F30	7.17	5.65	4.98	4.57	4.30	4.09
SSB at F30	23,204,318	19,020,164	16,759,543	15,381,434	14,486,731	13,779,025
F 40% SPR	0.16	0.17	0.17	0.18	0.18	0.18
Y/R at F40	3.6	2.9	2.6	2.4	2.3	2.2
S/R at F40	9.56	7.53	6.64	6.09	5.72	5.45
SSB at F40	30,925,348	25,360,439	22,368,986	20,518,646	19,264,282	18,350,950
F 90% max Y/R	0.09	0.10	0.10	0.11	0.11	0.11
Y 90% max Y/R	4,766,571	4,021,695	3,589,699	3,330,634	3,146,085	3,013,565
Y/R 90% max Y/R	3.2	2.6	2.3	2.2	2.1	2.0
S/R 90% max Y/R	13.47	10.53	9.28	8.50	7.98	7.58
SSB 90% max Y/R	43,577,238	35,452,321	31,265,521	28,632,320	26,887,581	25,527,329
F 75% of Fmax	0.12	0.14	0.14	0.15	0.15	0.15
Y 75% of Fmax	5,173,456	4,363,037	3,901,323	3,616,331	3,419,084	3,271,771
Y/R at 75% Fmax	3.5	2.9	2.6	2.4	2.2	2.1
S/R at 75% Fmax	11.21	8.74	7.68	7.03	6.59	6.26
SSB at 75% Fmax	36,280,597	29,439,432	25,850,086	23,680,296	22,187,325	21,083,404

Table 8. Summary of projection results. Biomass units in millions of pounds. F_{apex} is the fishing mortality rate on the most vulnerable age class. F_{max} is the value of F_{apex} that maximizes the yield per recruit and $F_{max75\%}$ is 75% of F_{max}.

Table 8a. Lorenzen M rescaled over ages 0-30

Scenario	2004	2005	2006	2007	2008	2009	2010
Total Biomass							
Catch_0	28.42	26.30	26.48	28.51	32.67	39.57	47.05
Catch_1	28.42	26.30	26.48	28.51	32.08	37.61	43.61
Catch_2	28.42	26.30	26.48	28.51	31.46	35.65	40.17
Catch_3	28.42	26.30	26.48	28.51	30.84	33.64	36.66
Catch_4	28.42	26.30	26.48	28.51	30.23	31.64	33.14
Catch_5	28.42	26.30	26.48	28.51	29.59	29.61	29.56
Catch_6	28.42	26.30	26.48	28.51	28.95	27.56	25.93
Fmax	28.42	26.30	26.48	28.51	30.86	33.47	35.91
Fmax75%	28.42	26.30	26.48	28.51	31.31	34.88	38.38
F apex							
Catch_0	0.42	0.38	0.21	0.20	0.00	0.00	0.00
Catch_1	0.42	0.38	0.21	0.20	0.05	0.04	0.04
Catch_2	0.42	0.38	0.21	0.20	0.11	0.09	0.08
Catch_3	0.42	0.38	0.21	0.20	0.17	0.15	0.14
Catch_4	0.42	0.38	0.21	0.20	0.23	0.22	0.20
Catch_5	0.42	0.38	0.21	0.20	0.29	0.29	0.29
Catch_6	0.42	0.38	0.21	0.20	0.36	0.38	0.41
Fmax	0.42	0.38	0.21	0.20	0.17	0.17	0.17
Fmax75%	0.42	0.38	0.21	0.20	0.12	0.12	0.12
Spawning Stock Biomass							
Catch_0	19.84	18.00	17.03	18.18	20.04	25.22	31.09
Catch_1	19.84	18.00	17.03	18.18	19.82	23.94	28.62
Catch_2	19.84	18.00	17.03	18.18	19.59	22.66	26.15
Catch_3	19.84	18.00	17.03	18.18	19.35	21.37	23.66
Catch_4	19.84	18.00	17.03	18.18	19.11	20.08	21.18
Catch_5	19.84	18.00	17.03	18.18	18.86	18.78	18.69
Catch_6	19.84	18.00	17.03	18.18	18.60	17.47	16.19
Fmax	19.84	18.00	17.03	18.18	19.35	21.30	23.21
Fmax75%	19.84	18.00	17.03	18.18	19.52	22.22	24.98
SSB/SSBmax							
Catch_0	0.67	0.61	0.57	0.61	0.68	0.85	1.05
Catch_1	0.67	0.61	0.57	0.61	0.67	0.81	0.97
Catch_2	0.67	0.61	0.57	0.61	0.66	0.76	0.88
Catch_3	0.67	0.61	0.57	0.61	0.65	0.72	0.80
Catch_4	0.67	0.61	0.57	0.61	0.64	0.68	0.71
Catch_5	0.67	0.61	0.57	0.61	0.64	0.63	0.63
Catch_6	0.67	0.61	0.57	0.61	0.63	0.59	0.55
Fmax	0.67	0.61	0.57	0.61	0.65	0.72	0.78
Fmax75%	0.67	0.61	0.57	0.61	0.66	0.75	0.84
Landings							
Catch_0	6.69	6.02	3.27	3.27	0.00	0.00	0.00
Catch_1	6.69	6.02	3.27	3.27	1.00	1.00	1.00
Catch_2	6.69	6.02	3.27	3.27	2.00	2.00	2.00
Catch_3	6.69	6.02	3.27	3.27	3.00	3.00	3.00
Catch_4	6.69	6.02	3.27	3.27	4.00	4.00	4.00
Catch_5	6.69	6.02	3.27	3.27	5.00	5.00	5.00
Catch_6	6.69	6.02	3.27	3.27	6.00	6.00	6.00
Fmax	6.69	6.02	3.27	3.27	3.00	3.29	3.59
Fmax75%	6.69	6.02	3.27	3.27	2.28	2.59	2.91
F/Fmax							
Catch_0	2.50	2.31	1.26	1.18	0.00	0.00	0.00
Catch_1	2.50	2.31	1.26	1.18	0.32	0.26	0.22
Catch_2	2.50	2.31	1.26	1.18	0.65	0.56	0.49
Catch_3	2.50	2.31	1.26	1.18	1.00	0.91	0.82
Catch_4	2.50	2.31	1.26	1.18	1.37	1.30	1.23
Catch_5	2.50	2.31	1.26	1.18	1.75	1.76	1.76
Catch_6	2.50	2.31	1.26	1.18	2.15	2.29	2.48
Fmax	2.50	2.31	1.26	1.18	1.00	1.00	1.00
Fmax75%	2.50	2.31	1.26	1.18	0.75	0.75	0.75

Table 8b. Lorenzen M rescaled over ages 3-30

Scenario	2004	2005	2006	2007	2008	2009	2010
Total Biomass							
Catch_0	30.58	27.29	26.26	26.85	29.39	34.30	39.46
Catch_1	30.58	27.29	26.26	26.85	28.79	32.39	36.18
Catch_2	30.58	27.29	26.26	26.85	28.20	30.47	32.87
Catch_3	30.58	27.29	26.26	26.85	27.58	28.53	29.52
Catch_4	30.58	27.29	26.26	26.85	26.94	26.57	26.12
Catch_5	30.58	27.29	26.26	26.85	26.30	24.58	22.66
Catch_6	30.58	27.29	26.26	26.85	25.66	22.55	19.09
Fmax	30.58	27.29	26.26	26.85	27.51	28.31	29.01
Fmax75%	30.58	27.29	26.26	26.85	27.98	29.67	31.28
F apex							
Catch_0	0.41	0.35	0.20	0.21	0.00	0.00	0.00
Catch_1	0.41	0.35	0.20	0.21	0.06	0.05	0.05
Catch_2	0.41	0.35	0.20	0.21	0.12	0.11	0.10
Catch_3	0.41	0.35	0.20	0.21	0.19	0.18	0.18
Catch_4	0.41	0.35	0.20	0.21	0.26	0.26	0.27
Catch_5	0.41	0.35	0.20	0.21	0.33	0.36	0.40
Catch_6	0.41	0.35	0.20	0.21	0.41	0.48	0.60
Fmax	0.41	0.35	0.20	0.21	0.19	0.19	0.19
Fmax75%	0.41	0.35	0.20	0.21	0.15	0.15	0.15
Spawning Stock Biomass							
Catch_0	22.07	19.36	17.33	17.24	17.68	21.14	25.09
Catch_1	22.07	19.36	17.33	17.24	17.46	19.93	22.80
Catch_2	22.07	19.36	17.33	17.24	17.24	18.72	20.50
Catch_3	22.07	19.36	17.33	17.24	17.00	17.51	18.20
Catch_4	22.07	19.36	17.33	17.24	16.76	16.28	15.89
Catch_5	22.07	19.36	17.33	17.24	16.51	15.05	13.58
Catch_6	22.07	19.36	17.33	17.24	16.25	13.81	11.23
Fmax	22.07	19.36	17.33	17.24	16.98	17.38	17.88
Fmax75%	22.07	19.36	17.33	17.24	17.15	18.25	19.45
SSB/SSBmax							
Catch_0	1.15	1.01	0.90	0.90	0.92	1.10	1.31
Catch_1	1.15	1.01	0.90	0.90	0.91	1.04	1.19
Catch_2	1.15	1.01	0.90	0.90	0.90	0.98	1.07
Catch_3	1.15	1.01	0.90	0.90	0.89	0.91	0.95
Catch_4	1.15	1.01	0.90	0.90	0.87	0.85	0.83
Catch_5	1.15	1.01	0.90	0.90	0.86	0.79	0.71
Catch_6	1.15	1.01	0.90	0.90	0.85	0.72	0.59
Fmax	1.15	1.01	0.90	0.90	0.89	0.91	0.93
Fmax75%	1.15	1.01	0.90	0.90	0.89	0.95	1.01
Landings							
Catch_0	6.74	6.02	3.27	3.27	0.00	0.00	0.00
Catch_1	6.74	6.02	3.27	3.27	1.00	1.00	1.00
Catch_2	6.74	6.02	3.27	3.27	2.00	2.00	2.00
Catch_3	6.74	6.02	3.27	3.27	3.00	3.00	3.00
Catch_4	6.74	6.02	3.27	3.27	4.00	4.00	4.00
Catch_5	6.74	6.02	3.27	3.27	5.00	5.00	5.00
Catch_6	6.74	6.02	3.27	3.27	6.00	6.00	6.00
Fmax	6.74	6.02	3.27	3.27	3.09	3.16	3.26
Fmax75%	6.74	6.02	3.27	3.27	2.36	2.51	2.67
F/Fmax							
Catch_0	2.13	1.82	1.05	1.06	0.00	0.00	0.00
Catch_1	2.13	1.82	1.05	1.06	0.31	0.27	0.24
Catch_2	2.13	1.82	1.05	1.06	0.63	0.58	0.53
Catch_3	2.13	1.82	1.05	1.06	0.97	0.94	0.90
Catch_4	2.13	1.82	1.05	1.06	1.33	1.36	1.40
Catch_5	2.13	1.82	1.05	1.06	1.70	1.87	2.08
Catch_6	2.13	1.82	1.05	1.06	2.10	2.49	3.09
Fmax	2.13	1.82	1.05	1.06	1.00	1.00	1.00
Fmax75%	2.13	1.82	1.05	1.06	0.75	0.75	0.75

Table 8c. Lorenzen M rescaled over ages 5-30

Scenario	2004	2005	2006	2007	2008	2009	2010
Total Biomass							
Catch_0	31.22	27.58	26.21	26.41	28.51	32.89	37.48
Catch_1	31.22	27.58	26.21	26.41	27.91	31.00	34.26
Catch_2	31.22	27.58	26.21	26.41	27.32	29.10	30.97
Catch_3	31.22	27.58	26.21	26.41	26.70	27.16	27.67
Catch_4	31.22	27.58	26.21	26.41	26.06	25.22	24.32
Catch_5	31.22	27.58	26.21	26.41	25.42	23.26	20.87
Catch_6	31.22	27.58	26.21	26.41	24.78	21.24	17.32
Fmax	31.22	27.58	26.21	26.41	26.63	26.98	27.34
Fmax75%	31.22	27.58	26.21	26.41	27.09	28.33	29.52
F apex							
Catch_0	0.44	0.35	0.20	0.21	0.00	0.00	0.00
Catch_1	0.44	0.35	0.20	0.21	0.06	0.06	0.05
Catch_2	0.44	0.35	0.20	0.21	0.13	0.12	0.11
Catch_3	0.44	0.35	0.20	0.21	0.19	0.19	0.19
Catch_4	0.44	0.35	0.20	0.21	0.27	0.28	0.30
Catch_5	0.44	0.35	0.20	0.21	0.34	0.39	0.45
Catch_6	0.44	0.35	0.20	0.21	0.42	0.52	0.67
Fmax	0.44	0.35	0.20	0.21	0.20	0.20	0.20
Fmax75%	0.44	0.35	0.20	0.21	0.15	0.15	0.15
Spawning Stock Biomass							
Catch_0	22.77	19.80	17.45	17.01	17.07	20.09	23.57
Catch_1	22.77	19.80	17.45	17.01	16.85	18.90	21.32
Catch_2	22.77	19.80	17.45	17.01	16.63	17.71	19.07
Catch_3	22.77	19.80	17.45	17.01	16.40	16.52	16.82
Catch_4	22.77	19.80	17.45	17.01	16.16	15.32	14.57
Catch_5	22.77	19.80	17.45	17.01	15.90	14.11	12.31
Catch_6	22.77	19.80	17.45	17.01	15.64	12.88	10.01
Fmax	22.77	19.80	17.45	17.01	16.38	16.41	16.60
Fmax75%	22.77	19.80	17.45	17.01	16.55	17.26	18.11
SSB/SSBmax							
Catch_0	1.34	1.16	1.02	1.00	1.00	1.18	1.38
Catch_1	1.34	1.16	1.02	1.00	0.99	1.11	1.25
Catch_2	1.34	1.16	1.02	1.00	0.98	1.04	1.12
Catch_3	1.34	1.16	1.02	1.00	0.96	0.97	0.99
Catch_4	1.34	1.16	1.02	1.00	0.95	0.90	0.86
Catch_5	1.34	1.16	1.02	1.00	0.93	0.83	0.72
Catch_6	1.34	1.16	1.02	1.00	0.92	0.76	0.59
Fmax	1.34	1.16	1.02	1.00	0.96	0.96	0.97
Fmax75%	1.34	1.16	1.02	1.00	0.97	1.01	1.06
Landings Yield							
Catch_0	6.75	6.02	3.27	3.27	0.00	0.00	0.00
Catch_1	6.75	6.02	3.27	3.27	1.00	1.00	1.00
Catch_2	6.75	6.02	3.27	3.27	2.00	2.00	2.00
Catch_3	6.75	6.02	3.27	3.27	3.00	3.00	3.00
Catch_4	6.75	6.02	3.27	3.27	4.00	4.00	4.00
Catch_5	6.75	6.02	3.27	3.27	5.00	5.00	5.00
Catch_6	6.75	6.02	3.27	3.27	6.00	6.00	6.00
Fmax	6.75	6.02	3.27	3.27	3.09	3.10	3.14
Fmax75%	6.75	6.02	3.27	3.27	2.36	2.46	2.59
F/Fmax							
Catch_0	2.18	1.72	1.01	1.03	0.00	0.00	0.00
Catch_1	2.18	1.72	1.01	1.03	0.31	0.27	0.24
Catch_2	2.18	1.72	1.01	1.03	0.63	0.59	0.55
Catch_3	2.18	1.72	1.01	1.03	0.97	0.96	0.94
Catch_4	2.18	1.72	1.01	1.03	1.33	1.40	1.47
Catch_5	2.18	1.72	1.01	1.03	1.71	1.93	2.21
Catch_6	2.18	1.72	1.01	1.03	2.11	2.57	3.36
Fmax	2.18	1.72	1.01	1.03	1.00	1.00	1.00
Fmax75%	2.18	1.72	1.01	1.03	0.75	0.75	0.75

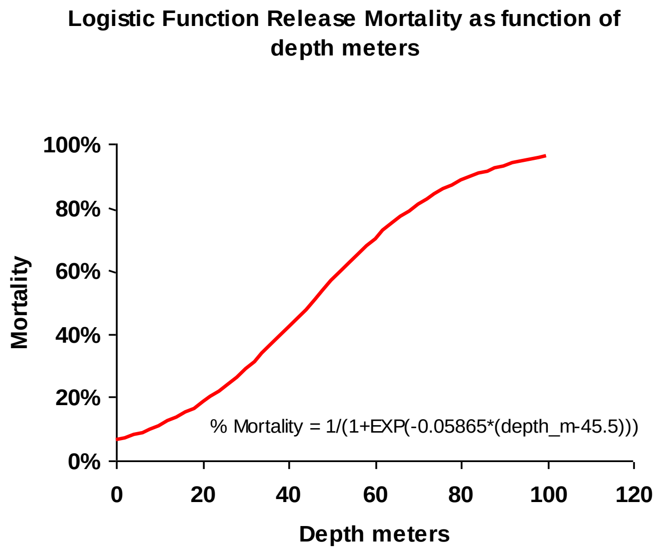

Figure 1. Estimated depth-mortality function for Gag Gulf of Mexico stock from research data compiled by the life historic group at the SEDAR10-Data Workshop.

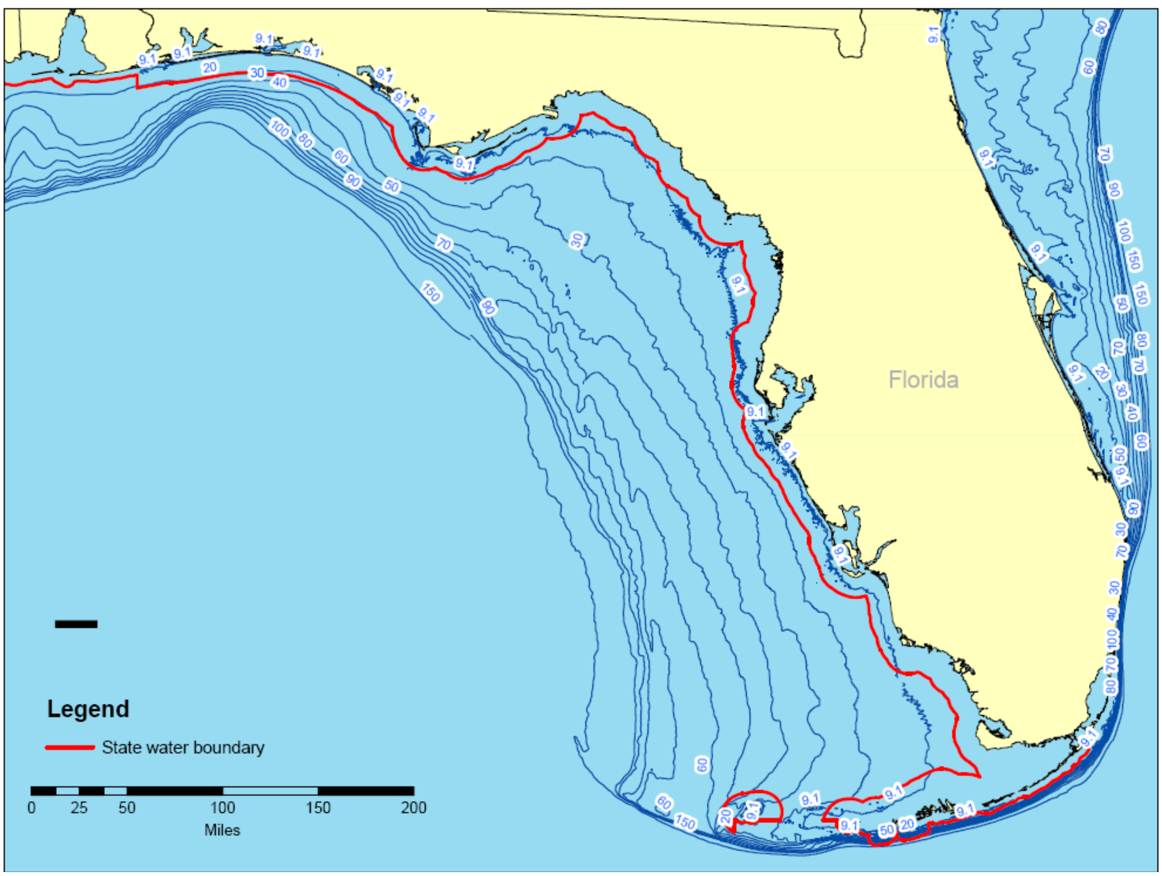

Figure 2. Depth contours for the Florida West coast. Red line defines the boundary for State waters. Courtesy of the SERO.

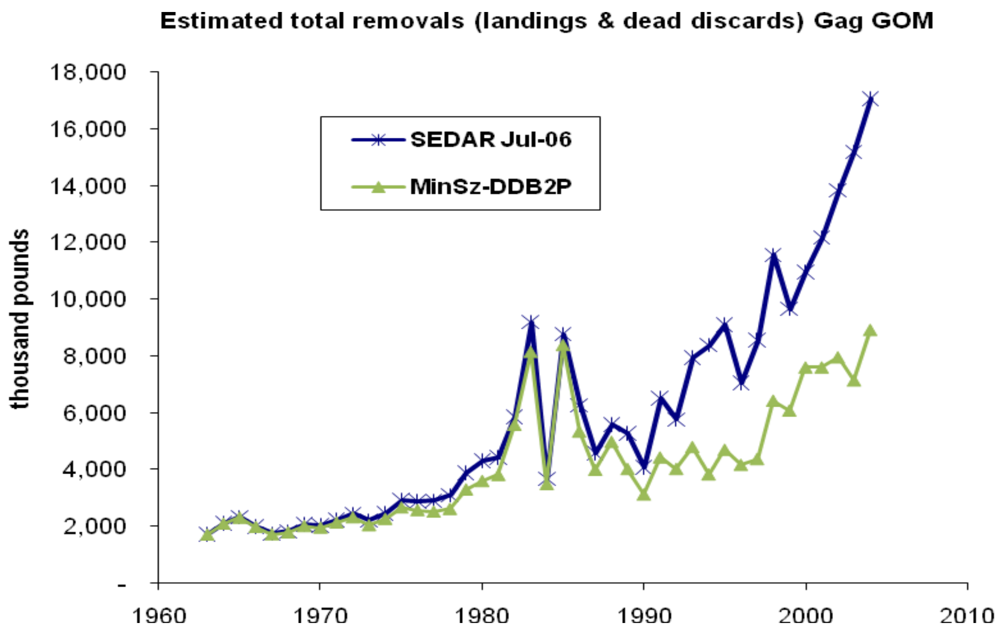

Figure 3. Comparison of estimated total removals (landings + dead discards) for Gulf of Mexico gag grouper between the final SEDAR10-Jul06 model and the approach recommended by the Grouper Review Panel (MinSz DDB2P, see text for details)

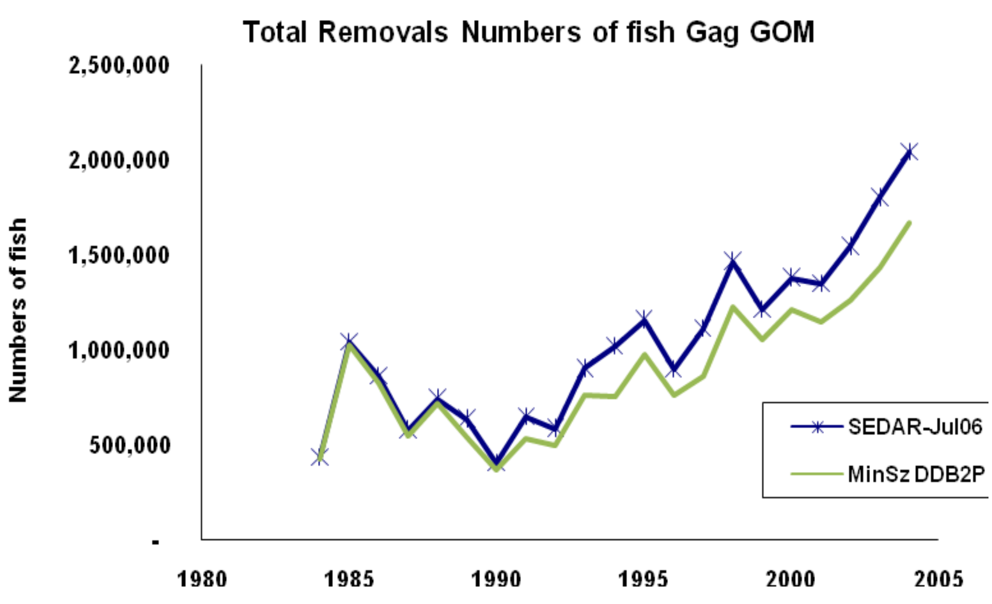

Figure 4. Comparison of estimated total removals in numbers of fish for (landings + dead discards) for Gulf of Mexico gag grouper between the final SEDAR10-Jul06 model and the approach recommended by the Grouper Review Panel (MinSz DDB2P).

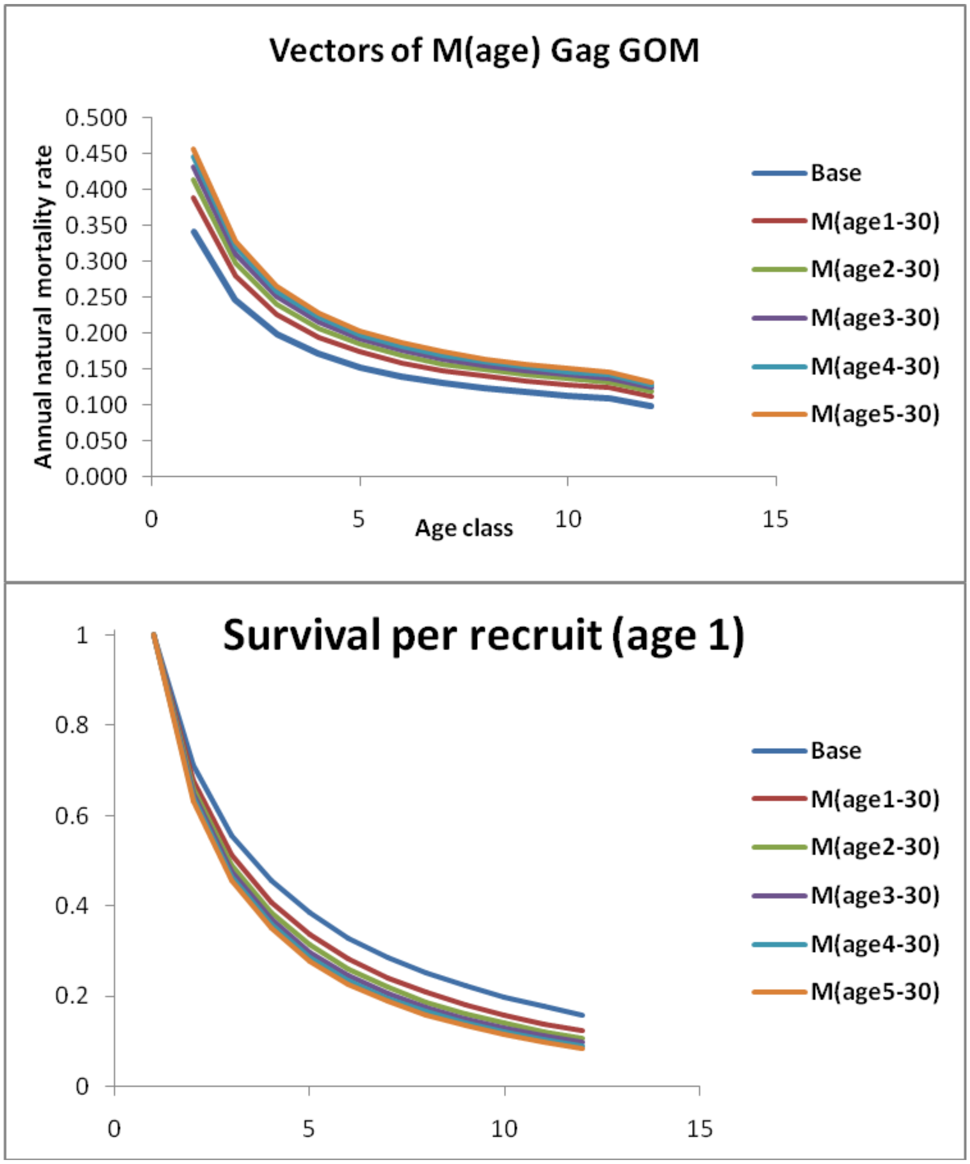

Figure 5. Upper plot show the natural mortality at age vector, M(age range), obtained by scaling the Lorenzen curve over the different age ranges. The original base case used all ages from 0 to 30. Bottom plot shows the survival per recruit (age-1) under the different natural mortality M(age) vectors.

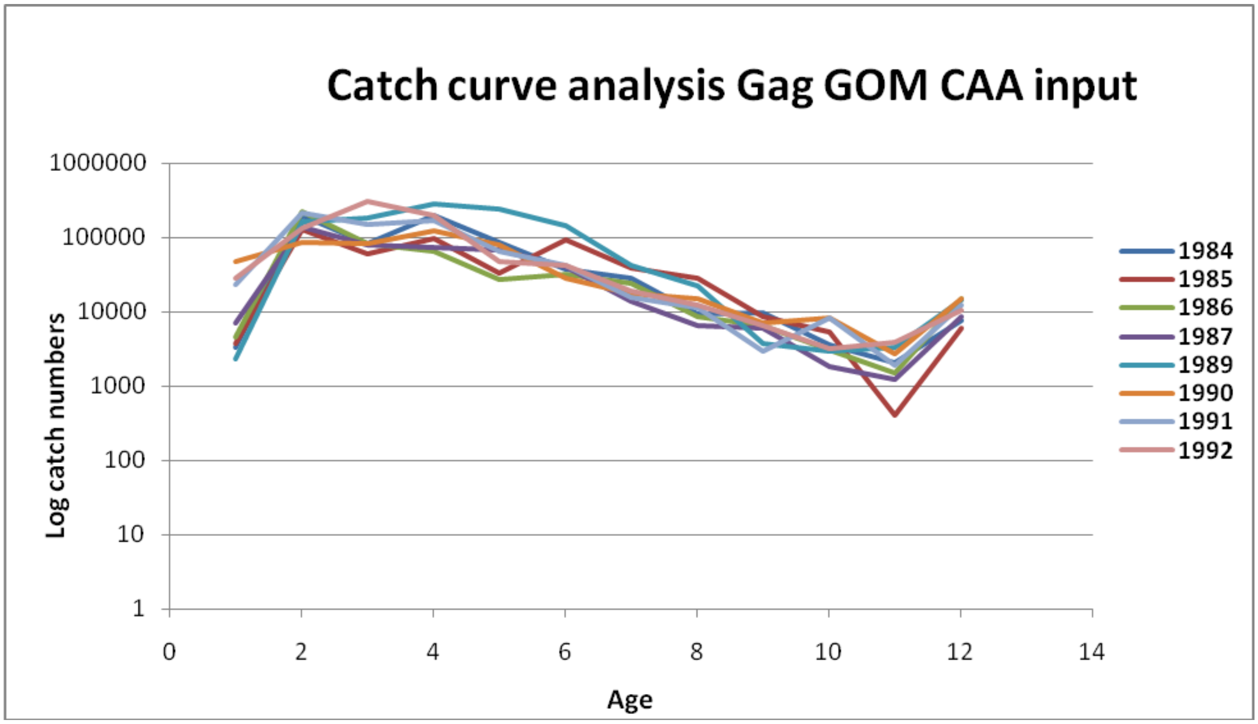

Figure 6. Catch curve analysis of cohorts 1984-1992 gag Gulf stock derived from the catch-at-age input to CASAL model.

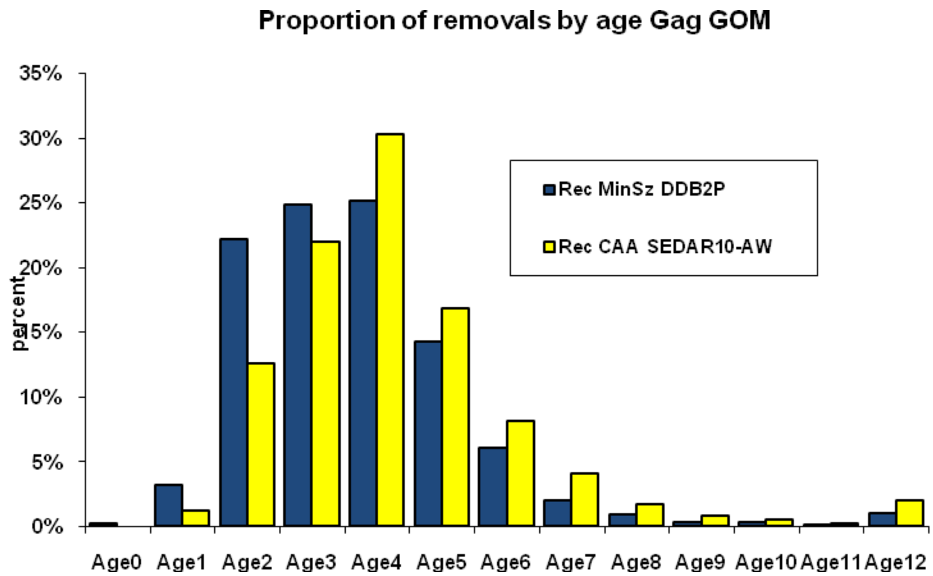

Figure 3. Average proportion of Catch at Age for the recreational fisheries removals (landings + dead discards) between the SEDAR10 model and the Grouper Review Panel recommendations (MinSz DDB2P).

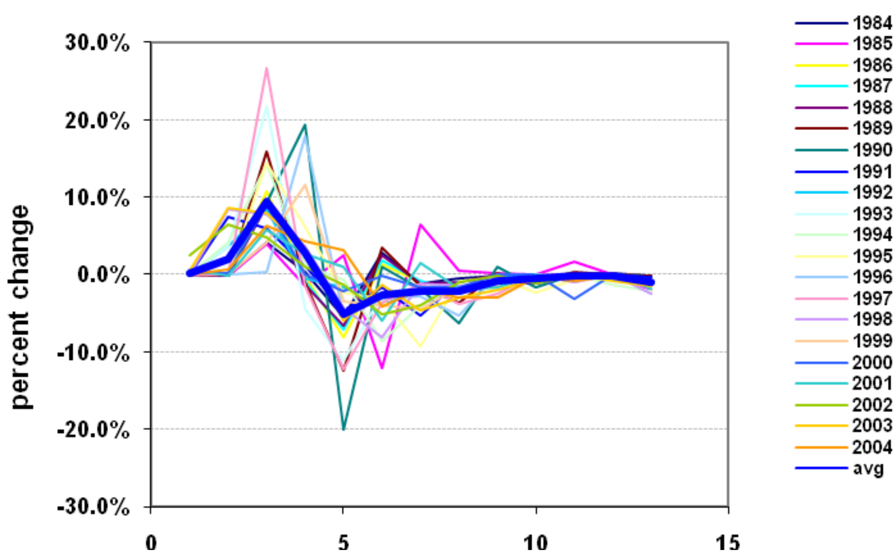

Figure 4. Differences in the recreational Catch-at-age (CAA) between the SEDAR10-Jul06 and RP recommended models by year. Positive deviations indicate a higher proportion at age in the MinSz DDB2P case. Thick line is the average over all years. The x-axis is the age-class.

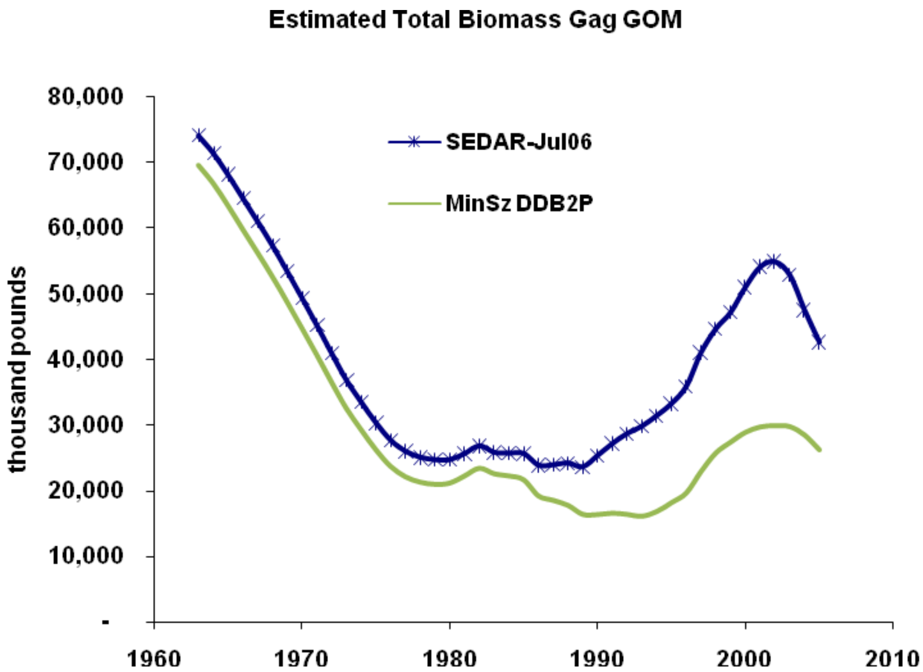

Figure 5. CASAL estimated total biomass trends for the SEDAR10-Jul06 model and the model recommended by the Grouper Review Panel (MinSz DDB2P) from 1963 to 2005 (2005 is projected based on average recruitment and recent F levels)

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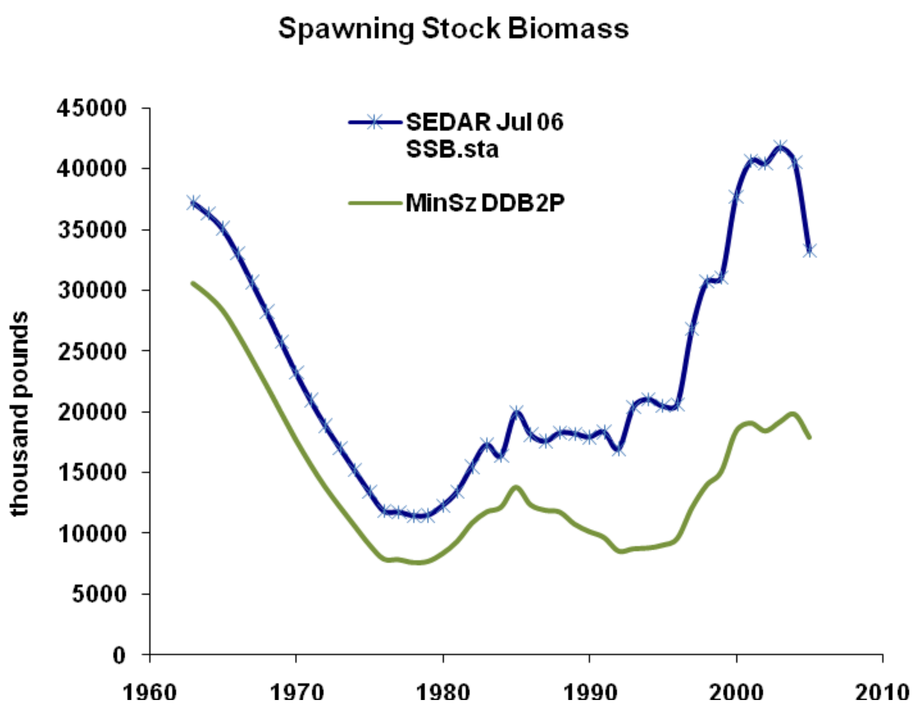


Figure 6. CASAL estimated spawning stock biomass (female component) trends for the SEDAR10-Jul06 model and the model recommended by the Grouper Review Panel (MinSz-DDB2P) from 1963-2005.

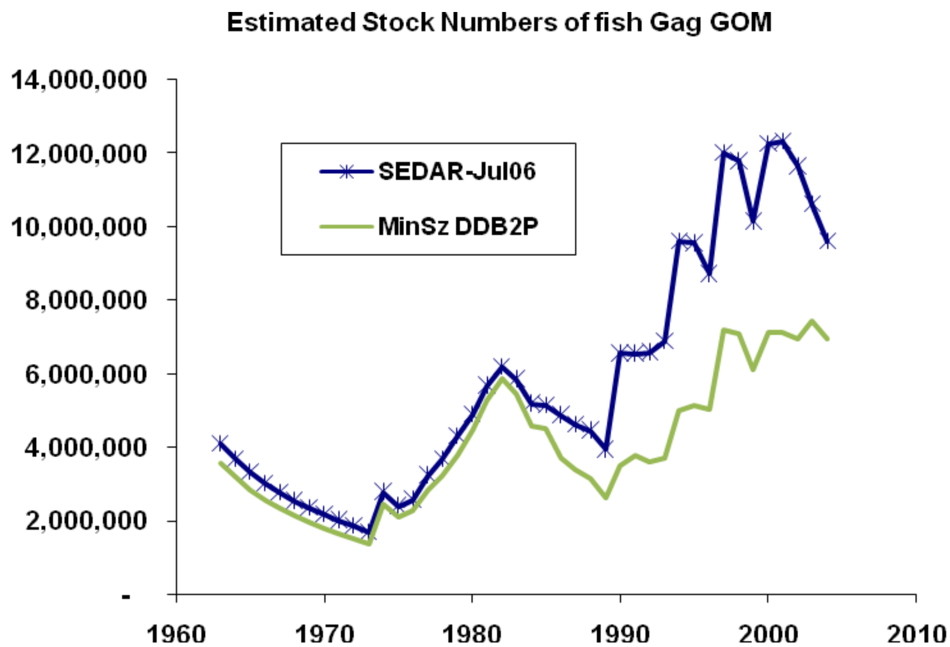


Figure 7. CASAL estimated stock size trends for the SEDAR10-Jul06 model and the recommended model by the Grouper Review Panel (MinSz DDB2P) from 1963-2005.

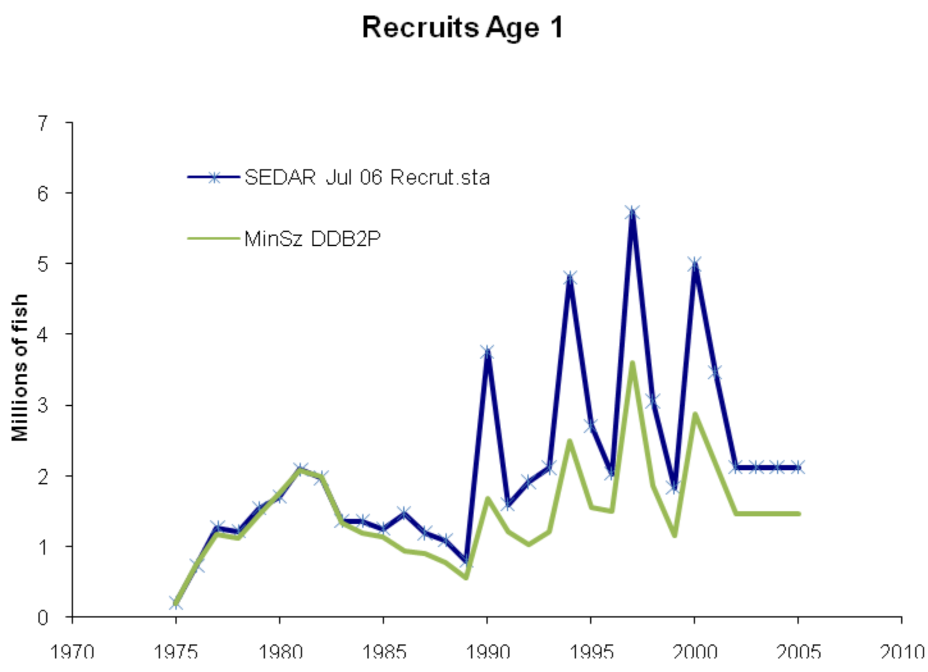


Figure 8. CASAL estimates of recruit trends (Age 1) for the SEDAR10-Jul06 model and the Grouper Review Panel model (MinSz DDB2P) from 1975-2005.

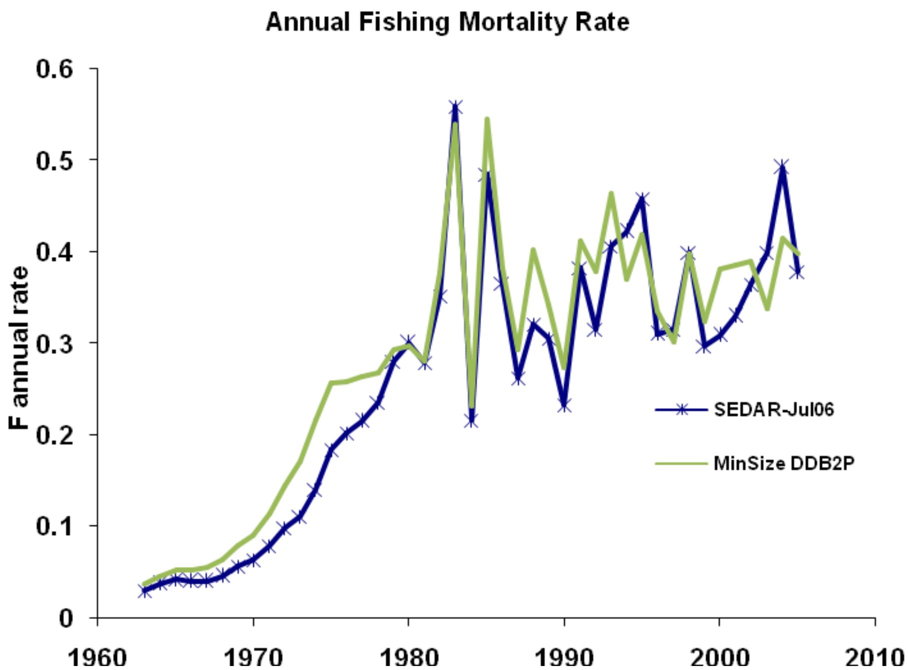
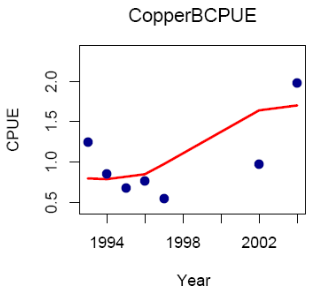
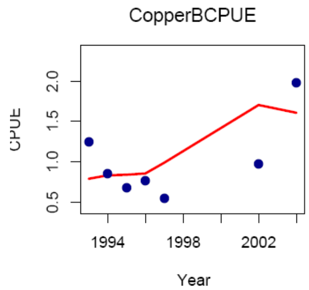
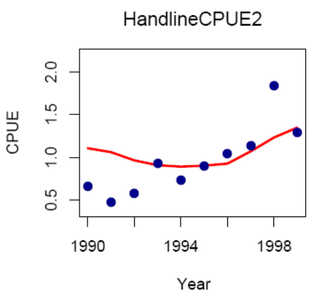
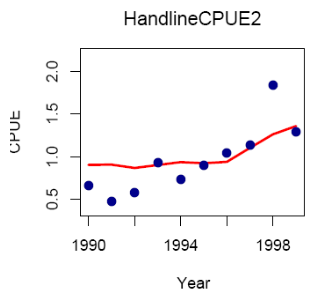
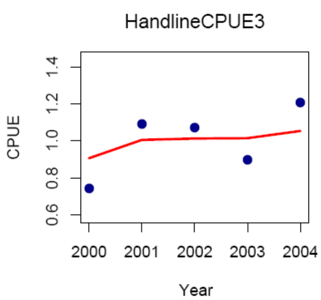
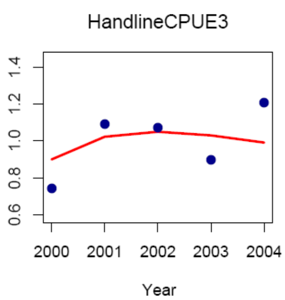
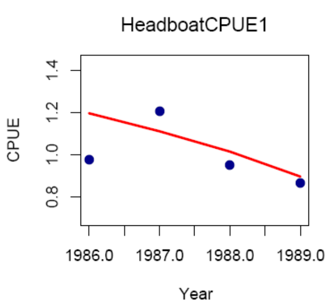
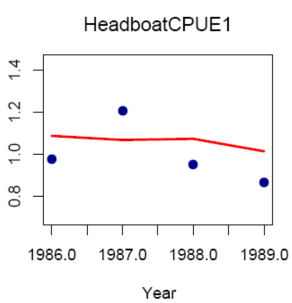
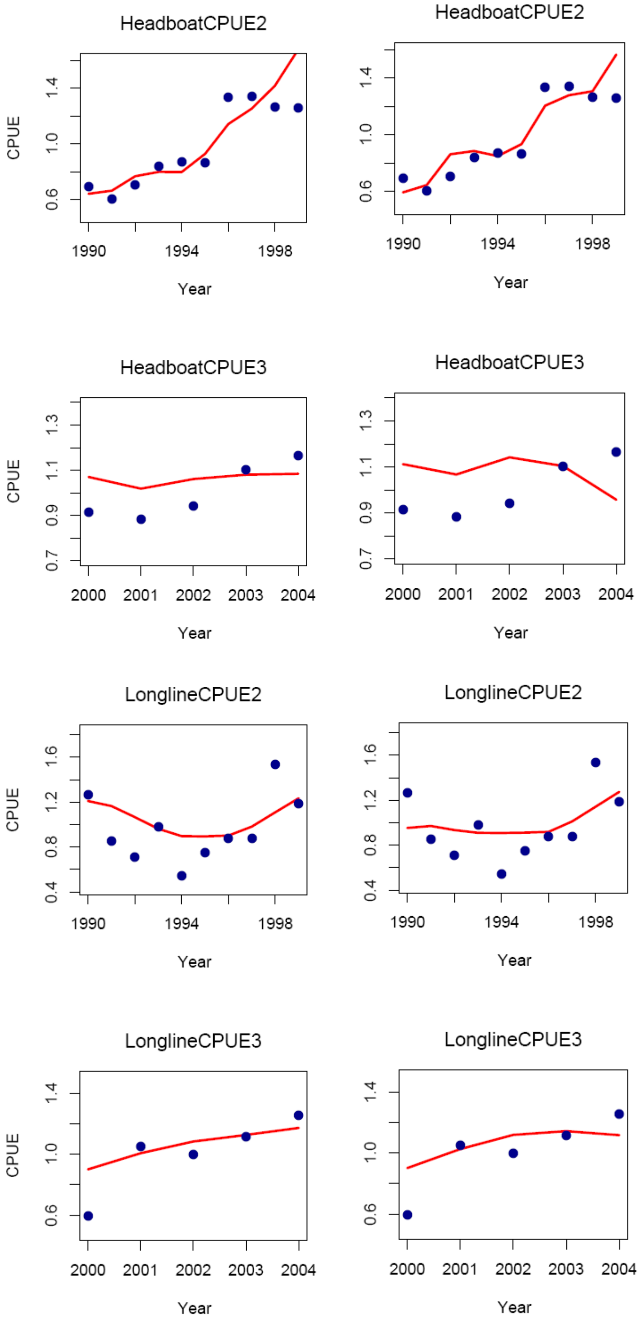


Figure 9. Estimates of annual trends of fishing mortality rate (F) by the CASAL model for the SEDAR10-Jul06 case and the Grouper Review Panel model (MinSz DDB2P).


CopperBCPUE
CPUE
0.5 1.0 1.5 2.0
1994 1998 2002
Year

CopperBCPUE
CPUE
0.5 1.0 1.5 2.0
1994 1998 2002
Year

HandlineCPUE2
CPUE
0.5 1.0 1.5 2.0
1990 1994 1998
Year

HandlineCPUE2
CPUE
0.5 1.0 1.5 2.0
1990 1994 1998
Year

HandlineCPUE3
CPUE
0.6 0.8 1.0 1.2 1.4
2000 2001 2002 2003 2004
Year

HandlineCPUE3
0.6 0.8 1.0 1.2 1.4
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
0.8 1.0 1.2 1.4
1986.0 1987.0 1988.0 1989.0
Year


HeadboatCPUE2
HeadboatCPUE2
HeadboatCPUE3
HeadboatCPUE3
LonglineCPUE2
LonglineCPUE2
LonglineCPUE3
LonglineCPUE3
CPUE
Year

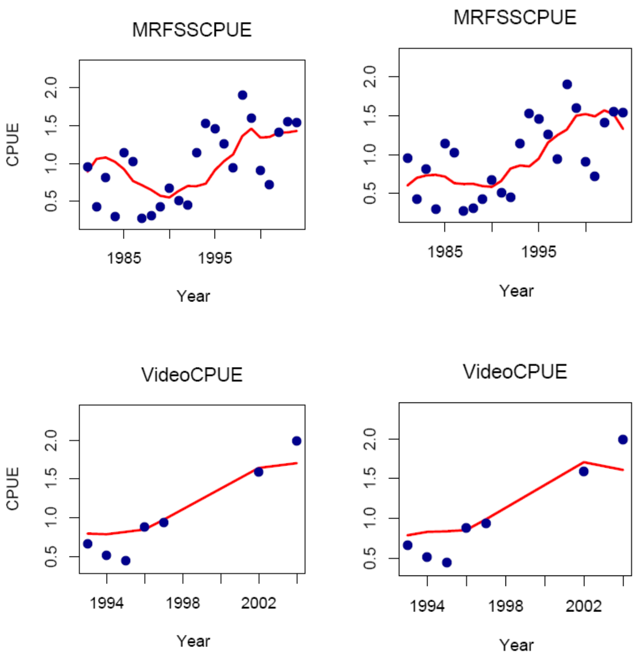


Figure 10. Comparison of fit to relative indices of abundance for Gag Gulf stock between SEDAR10-Jul06 model (right column) and the Grouper Review Panel model (MinSz DDB2P, left column).

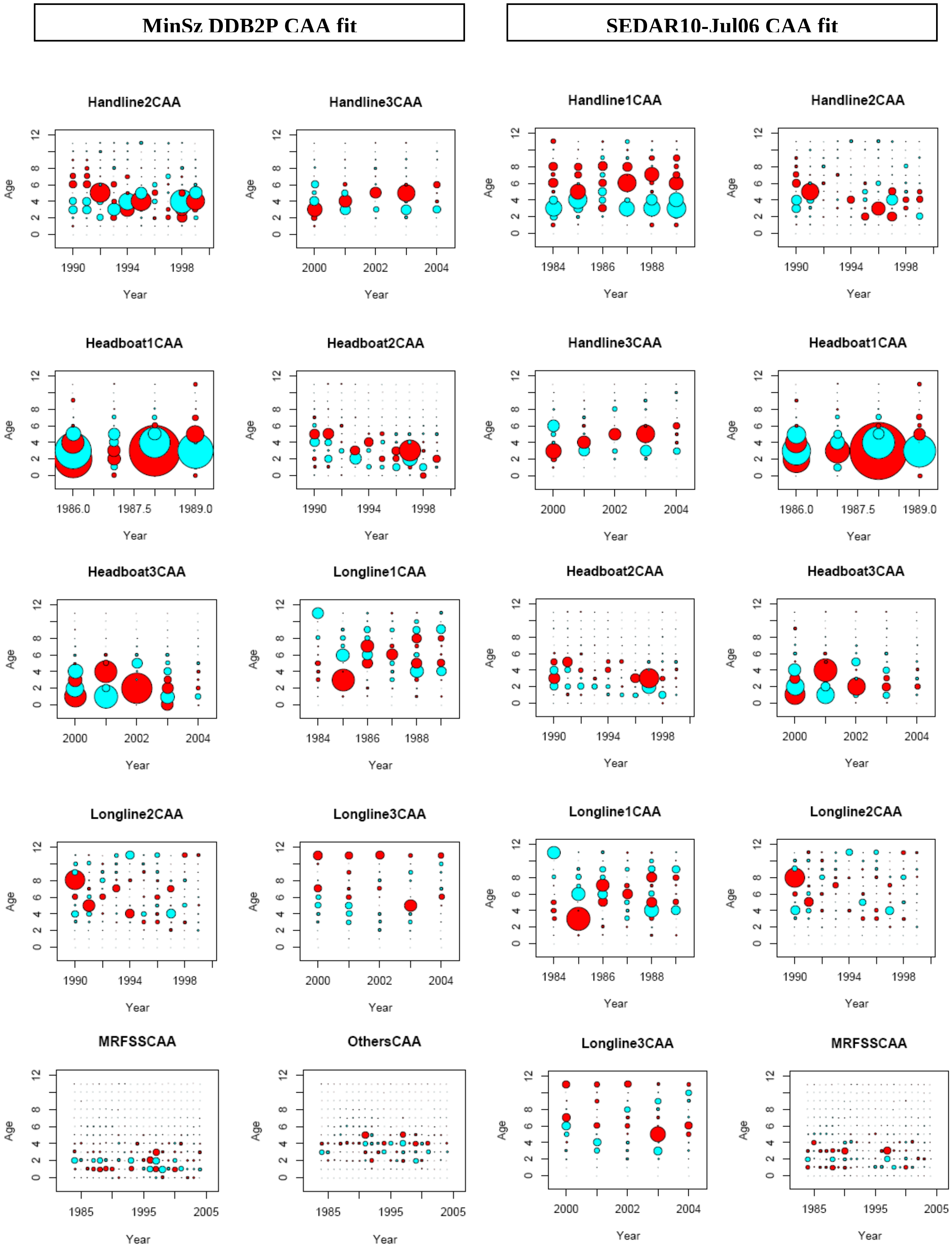


Figure 11. Comparison of fits to partial CAA inputs from the SEDAR10-Jul06 model (col 3 and 4) and the Grouper Review Panel model (MinSz DDB2P).

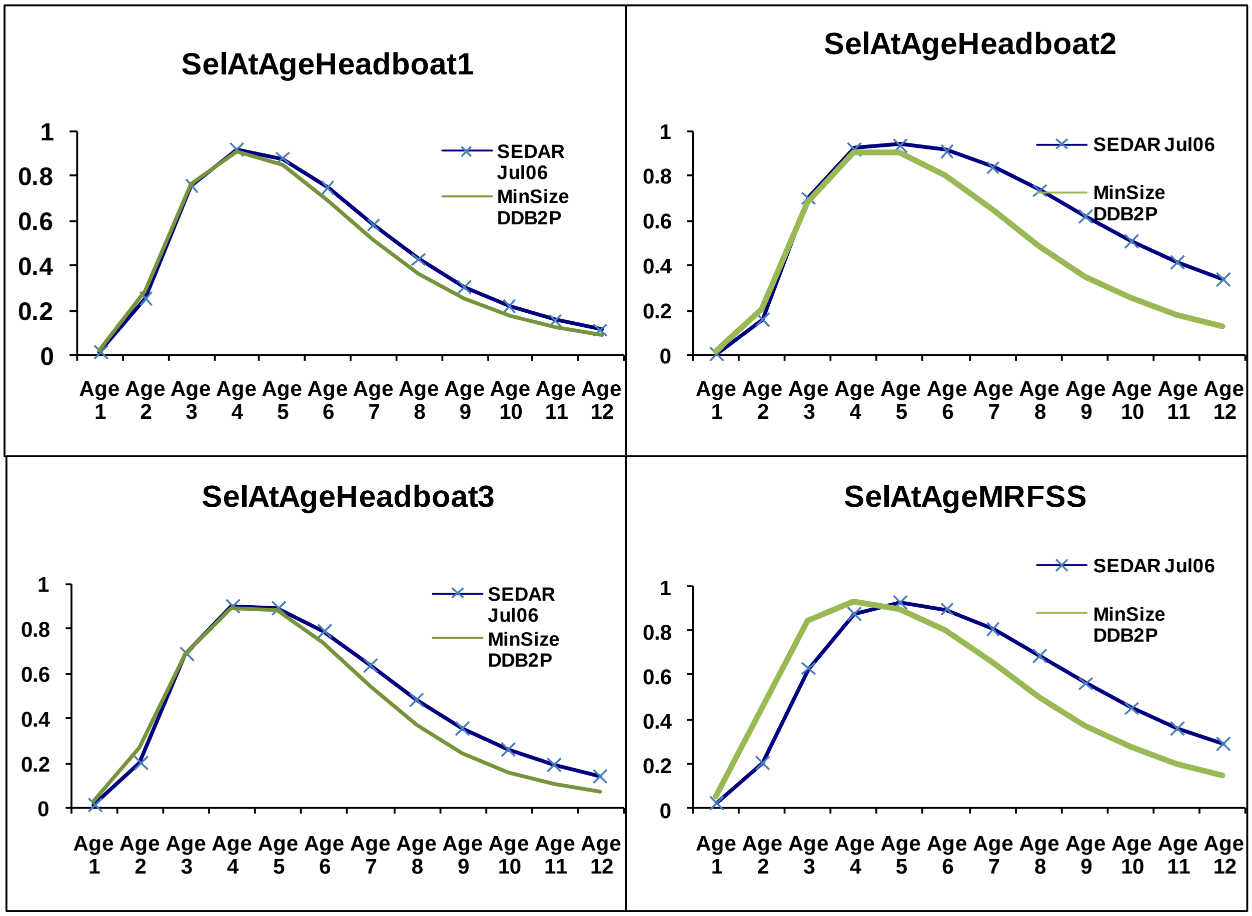


Figure 12. Model estimated selectivity for the recreational fisheries. Comparison of the selectivities between SEDAR10-Jul06 model Grouper Review Panel model (MinSz DDB2P).

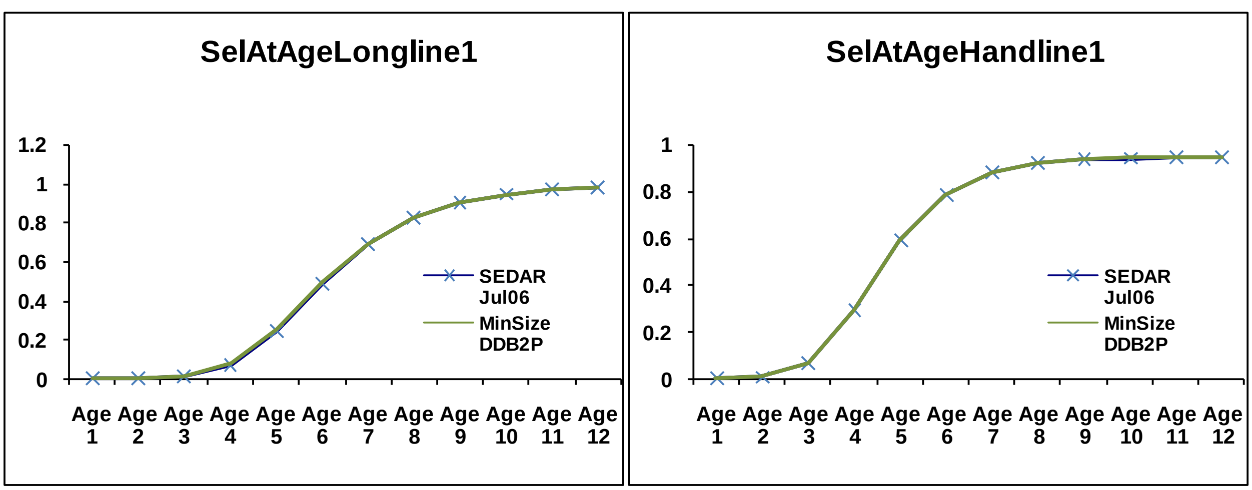


Figure 13. Comparison of model estimated selectivity for commercial fisheries between SEDAR10-Jul06 model and the Grouper Review Panel model (MinSz DDB2P).

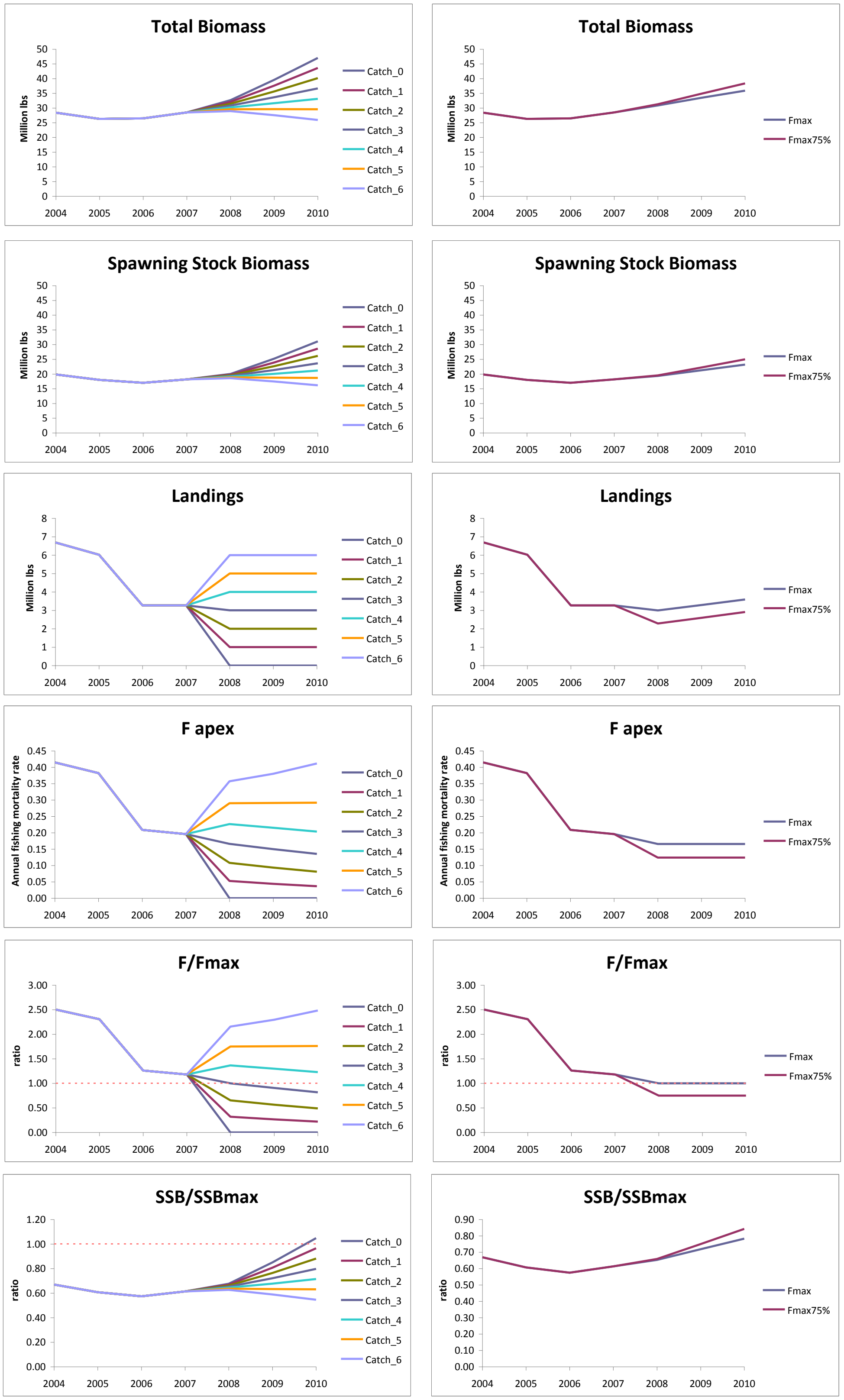


Figure 18a. Projections of run with M(age0-30) under scenarios of constant catch and constant fishing mortality rate starting in 2008 (see text for details).

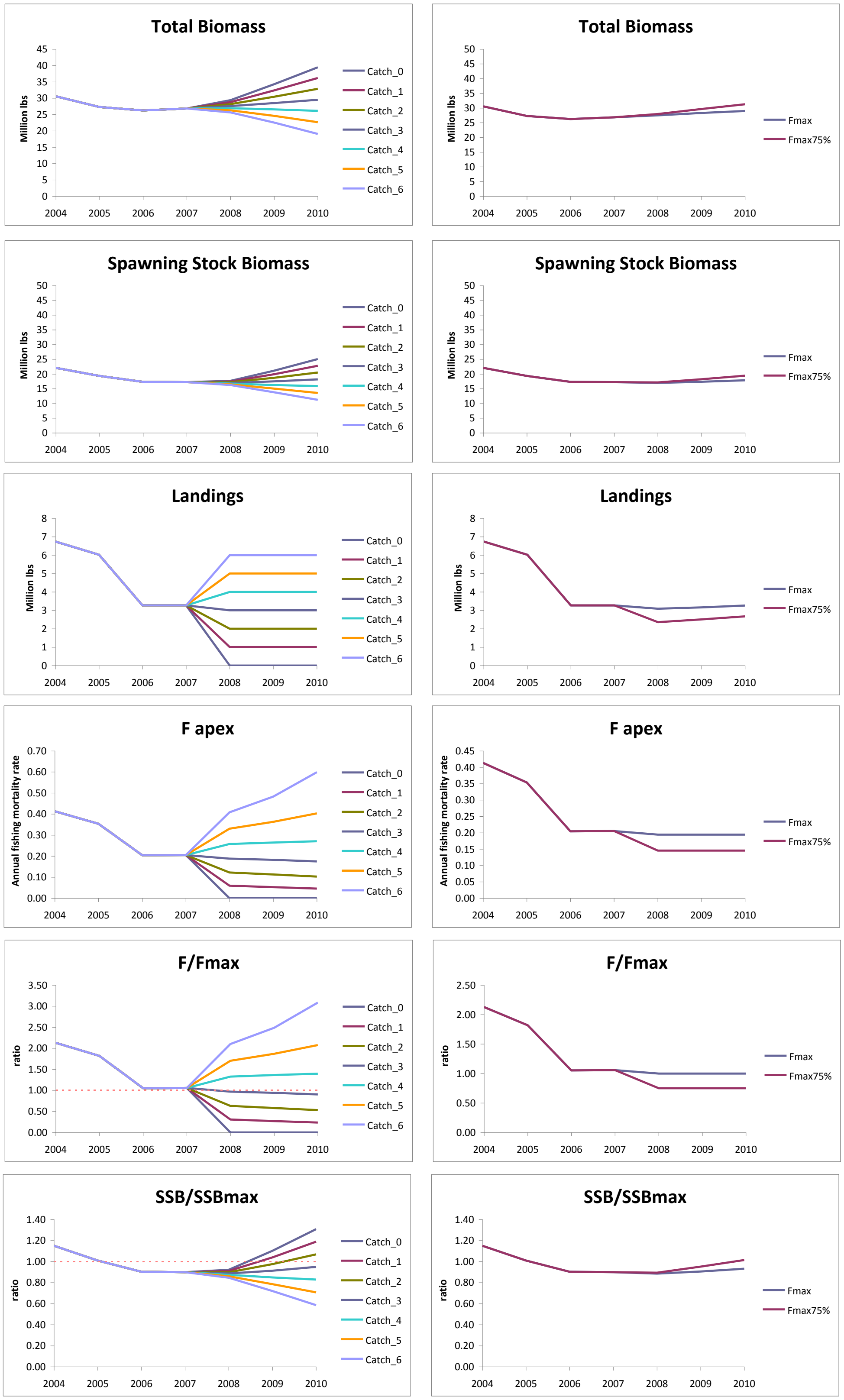


Figure 18b. Projections of run with M(age3-30) under scenarios of constant catch and constant fishing mortality rate starting in 2008 (see text for details).

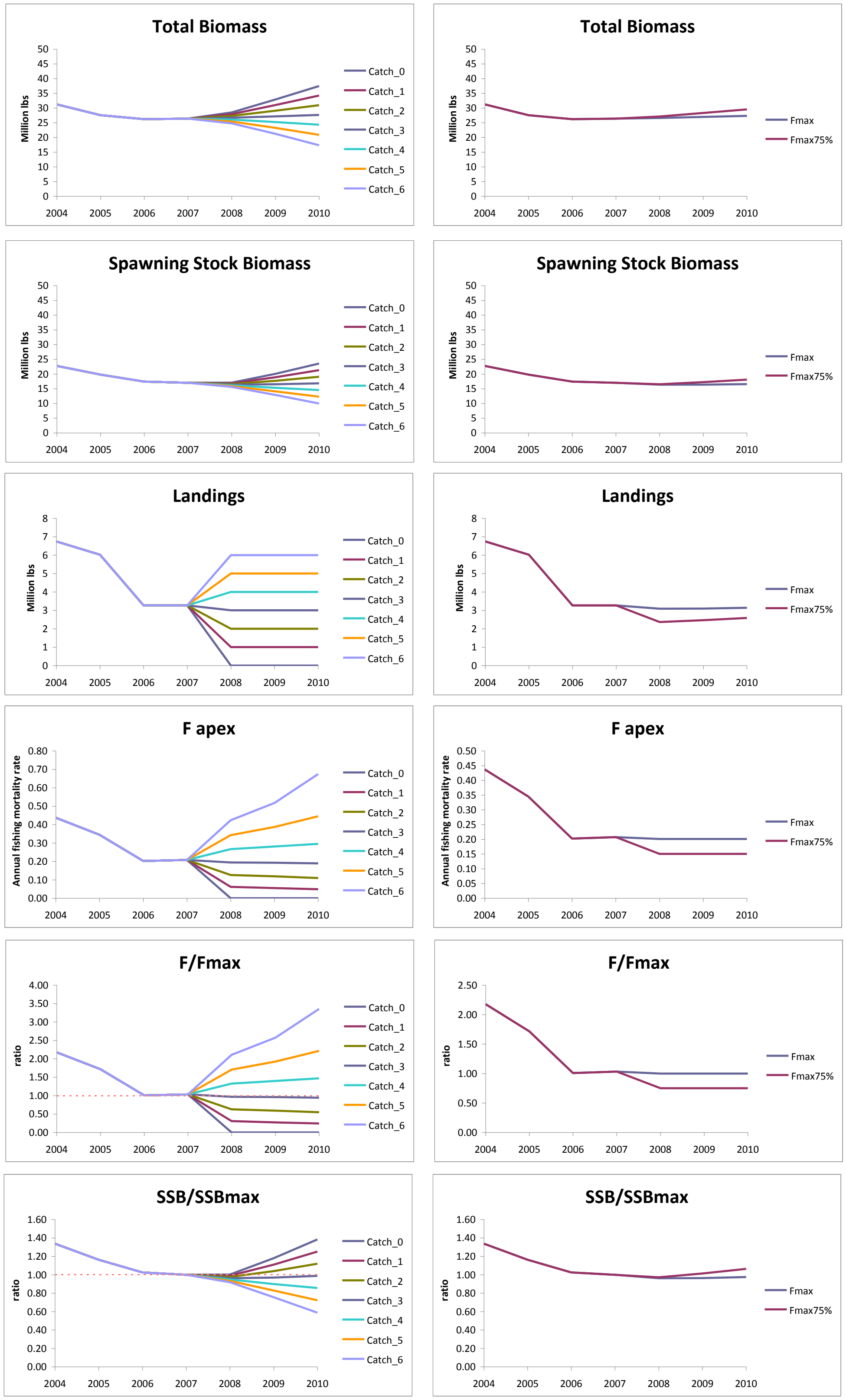


Figure 18c. Projections of run with M(age5-30) under scenarios of constant catch and constant fishing mortality rate starting in 2008 (see text for details).