SEDAR 10 RW-01

Status review of Gag Grouper

In the U.S. Gulf of Mexico, SEDAR 10

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NOTE: This report is duplicated in the Assessment Workshop Report, Section 3.2
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Gag GOM model runs and stock evaluation

Review of catch and effort input data

The assessment workshop (AW) group reviewed the catch and effort input data for gag Gulf of Mexico (GOM) stock and concluded the following:

Historic Recreational Catch

The recreational historic data (1963-1981) estimated by the recreational group of the data workshop was inconsistent with historic trends of other grouper fisheries, and experience of scientist/fisherman present at the meeting. The AW considered that recreational catches in the 1960's were not of the same or higher magnitude compared to the catches in the 1990's (Fig 4 Sedar 10-AW-3). Discussion of the group centered about the number of recreational Headboat vessels during 1960's years, and the perception of limited travel of recreational vessels to offshore areas particularly on the west coast of Florida.

The AW requested estimating recreational historical catch 1960-1980 using regressors that take into account human coastal population, number of vessels and estimated total expend in dollars for recreational fisheries. Figure 1 presents a comparison of the estimated "updated" recreational catch (AW) and the initial (DW) estimates for Gag GOM 1963-2004. Historical estimated of recreational catch were expanded back to 1900 year, but the AW agreed to use 1945 as the initial year for any significant recreational landings of gag grouper in the Gulf of Mexico. Estimates of historical recreational catch were provided in number of fish, as landings and dead discards, conversion to biomass landings and biomass dead discards used the mean weight or recreational catches from 1981-1989. Table 1 and Figures 3 shows the 'final' working estimates of recreational catch for gag GOM 1944-2004.

Historic Commercial Catch

The AW group requested to extend the historic catches of gag grouper as further as possible. Following the protocol for reconstructing commercial catch trends of red snapper, the AW presented gag GOM commercial catch from 1880 to 2004. Figure 2 and Table 1 shows the 'final' working estimates of commercial catch. See text in AW report (section #) for further details in the procedures for estimation of historical commercial catch.

The AW group concluded that release mortality based on depth of capture was a better and more realistic estimate than a fixed proportion as used in 2001 assessment. Therefore dead discards estimated using catch-at-size and depth for both commercial and

recreational sectors were selected as part of the total removals component of catch for gag GOM grouper.

The AW also discussed the recent report of NRC regarding MRFSS estimates, and concluded that available estimates of recreational catch and indices of abundance were the best available information. They recommended running sensitivity analyses where MRFSS total estimated catch was increased or decreased by 25% for the whole time series. Figure 4 presents the final catch series for gag GOM including commercial and recreational historic estimates.

Gag GOM CASAL runs

Assessment model assumptions

The AW group adopted the following assumptions for the CASAL assessment model runs of Gag GOM:

- An age structured model, starting with age 1 to age 12+, where age 12 represent the plus group.
- Natural mortality vector age dependent, based on the Lorenzen method.
- Size at age following a von Bertalanffy growth model (2006 DW estimate)
- Beverton-Holt stock recruitment relationship.
- Maturity vector at age for females only, estimating spawning biomass as the product of maturity times the average weight at size. The AW recommended estimating also the equivalent male spawning biomass component for each run.
- Four indices of abundance fisheries dependent 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, and thus the CPUE series.
- Two indices of abundance fisheries independent Video SEAMAP survey and the Copper belly video survey.
- Five major fisheries; three commercial Handline, Longline and others (Trap, spear, trawl, others), and two recreational Headboat and MRFSS.
- Five catch at age proportions for Handline, Longline, MRFSS, Headboat and Other fisheries 1984-2004.
- 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 recruitment deviations to be one.

Scenarios

The AW recommended extending the analysis of catch trends as much in time as possible. The AW also recommended including potential changes of catchability in the evaluation, assuming a 2% annual increase of catchability since 1984 to reflect for improvements in gear and fishing electronics that were available to recreational and commercial operations. The AW agreed to include the changes in catchability as a constant reduction of the standardized indices (fisheries dependent) by a similar 2% annual change. With CASAL the following runs were performed;

1. Catch 1963 – 2004 with Commercial/Recreational catch 1963-04 assuming a constant catchability.
2. Catch 1963 – 2004 with Commercial/Recreational catch 1963-04 assuming an increasing catchability 2% annually.
3. Catch 1880 – 2004 with Commercial catch 1880-04 and Recreational catch 1945-04, assuming a constant catchability.
4. Catch 1880 – 2004 with Commercial catch 1880-04 and Recreational catch 1945-04, assuming an annual increase of catchability of 2% since 1984.
5. Catch 1963 – 2004 with 25% increase of total MRFSS catch assuming a constant catchability.
6. Catch 1963 – 2004 with 25% decrease of total MRFSS catch assuming a constant catchability.

All runs were estimated using maximum likelihood estimation (ML), initial guess estimates and bounds for model parameters were consistent through all scenarios. In the case of the extended time runs [1880-04] it was assumed that the stock in 1880 reflected an unexploited stock (virgin stock), therefore no initial biomass parameter was estimated in these runs.

Table 2 presents a summary of the runs performed with CASAL for the gag GOM stock and their corresponding objective function and estimated AIC value. Other stock indicators included virgin stock (SSB_0) or spawning stock biomass unexploited, spawning initial stock ($SSB_{initial}$), steepness parameter, mean recruitment of unexploited stock (R_0), terminal year spawning stock biomass (SSB_{2004}), and fishing mortality rates of terminal year (F_{2004}). All references of spawning biomass are of gag GOM female spawning biomass component in metric tons, unless otherwise specified.

Other sensitivity analysis included a retrospective run, where the base case 1 [constant q's] was run removing consecutively up to 5 years of recent data (both catch and indices of abundance).

Results

Base case scenario(s)

The AW group decided to present runs 1 and 2 (see above) as base case scenarios, and the rest as sensitivity runs. Tables 2 and 3 presents a summary of main stock indicators for the fit of run 1 (base 1). Spawning biomass of unexploited stock was estimated at 87,514 MT, while SSB in 1963 was 22,295 MT and SSB in 2004 was 18,592 MT. The stock population indicated an initial stock with few individuals in ages 1 through 11 and a larger plus group (age 12+), this age-structure was continue until 1973/74, when increase recruitments start to move through the stock, by early 1990, recruitment pick up greatly, and larger cohorts enter in the early 1990, with largest recruitments in 1990, 1994, 1997 and 2000 (Fig 5). Figure 5 shows the biomass trends of females and males components, with clear decline in the 1963-1979 period, and stable low values until 1995, and increase trend since 1996. However, male biomass proportion remains low compare to the early period. Fishing mortality show an increasing trend from 1963 through 1983, reaching the highest rate in 1983 (Fig 5). Thereafter F remains high through the 1990's, latest years there is increasing trend since a low in 1999. Figure 5 also shows the estimated selectivity patterns by age for each fishery, the handline fishery shows'logistic' type selectivity similar to the longline fishery although with higher selectivity towards younger age classes. Headboat, MRFSS, and Others fisheries show a dome shape type selectivity.

Tables 2 and 4 show the summary of main stock indicators for the fit of the run 2 (base A) case. There were small differences in the fit, estimates and trend between the two base cases. Assuming an increase of catchability since 1984, the model tends to estimate lower spawning biomass in 1963 and 2004, with higher initial unexploited biomass (SSB_0). Stock age-structure, recruitment pattern, and fishing mortality trends were similar between the two base scenarios (Fig 6). For the base scenarios, steepness was estimated at about 0.75, however the recruitment trend indicated a negative deviate trend of recruitment in the early period (1963-1980) and large positive deviates particularly in the 1990's. Fig A1 shows the fit to indices of abundance from the base run 1. The fit to Headboat index in the last period [2000-04] was poor. The fit of catch-at-age shows larger deviates also for the headboat fishery. Similar plots are presented for the fit of the base run 2 (Fig A2). Figure 7 shows the trend of percent males in relation to the mature population both in numbers of males and biomass of male component. Male spawning component has decreased from a 20-30% in the 1960-70's to a 5-10% in recent years. Although spawning biomass has increased steady since 1996, the rate of increase is much slower for males compare to females.

Sensitivity runs

1880-2004 catch

The fit and results of the runs using the extended historic catch trends are presented in Table 5 and Table 6. Spawning biomass of unexploited stock was estimated at 70,000 MT in both runs (constant catchability, run 3 and increase catchability, run 4). Spawning biomass in 2004 was estimated at 18,548 and 17,220 MT respectively. SSB in 1963 was estimated at 29,320 MT. Steepness parameter were 0.74 and 0.72 respectively, mean recruitment of unexploited stock (R0) was estimated at 2.13 million fish. Fit of indices of abundances and catch-at age proportions by fishery were similar to the base case scenarios. Headboat indices show poor fitting, as well the catch at age proportions. Estimated selectivity patterns by fishery were also similar to the base scenarios, with a logistic type selectivity for the longline and handline fishery of the early period (1980-1989), while dome shape for Headboat, MRFSS and handline fishery of the later periods (1990-04) (Fig 8).

Biomass trends show an increase in the 1900-1950 period, with total mature biomass around 110,000 MT, that decline sharply since the 1960 to a low values in the 1980's, at less than 20,000 MT. Follow by a stable biomass in the 1980'-1990's, and an increase since 1996 to about 23,000 MT in 2004 (Fig 8 and 9). This trend is opposite to the fishing mortality rate trend, with very low exploitation rates in the 1880-1960 period when it start to increase to reach a peak in 1983, and remaining oscillating and high since then. Recruitment show a stable pattern in the 1880-1920 period, follow by a decline, prior to the decline of spawning biomass in early 1950's to a lowest recruitment in the 1960's. Then recruitment increase first in the 1980's, then again in the 1990's with the highest peak in 1997 of about 5.7 million recruits.

Fit and parameter estimates were similar between the runs assuming a constant catchability or an increasing catchability since 1984 (Fig 8 and 9).

MRFSS Catch bias

The AW recommendation for examining possible bias of MRFSS estimates was evaluated with runs 5 and 6. In run 5 total MRFSS catch was increased by 25% of the base scenario run, for all years (1963-04), while in run 6 MRFSS catch was decreased by 25% of the base scenario. Tables 2 and 7 presents a summary of stock indicators when MRFSS catch was increase 25%, fit and parameters estimated did change with respect to the base scenario (case 1 constant q's), the more obvious was the increase in stock recruitment steepness, up to 0.99 compared to 0.75 in the base case. Spawning virgin biomass estimate was lower 64,362 MT and the SSB_{1963}, however final SSB_{2004} was slightly higher 22,213 MT.

Trends of biomass and fishing mortality, as well fit of indices and catch-at-age proportions were similar as in the base scenario (Fig 11). Recreational fisheries are the main component of total removals, particularly in the latest years (Fig 17 Sedar 10-AW-3), with an increase of 25% MRFSS catch the model increase the productivity of the

stock with a higher recruitment steepness, increasing the average number of recruits in the 1963-2004 period.

When recreational catch was decreased, MRFSS by 25%, the model decrease the productivity of the stock by lowering the steepness parameter, 0.66 compared to 0.75 in the base case. Virgin biomass was estimated higher (107,757 MT), but SSB_{1963} and SSB_{2004} were lower compared to the base case (19,393 MT and 15,046 MT, respectively). Otherwise, trends of biomass, fishing mortality, and fit indices were similar as in the base case (Fig 10 and 11).

Retrospective Analysis

Table 9 presents main gag GOM indicators of the base case scenario (constant catchability) for the retrospective analysis. In this case data input, catch and indices, proportions at age, etc were removed from 2004 up to 2000 year. The Estimates of virgin biomass (SSB_0) increase as latest years of information were eliminated, from 87,514 MT with all data to 95,476 MT with data up to 2001. Fig 12 shows the trends of total stock population, there was a trend to estimate lower stock size in the latest years, with the removal of information. Similar trend was observed with total biomass estimates (Fig 12). The model also estimated lower steepness parameters as information was removed back in time, from 0.75 in 2004 to 0.67 in 2001.

Spawning biomass estimates also show a trend to lower estimates in the final years as data was removed (Fig 12). In contrary, fishing mortality rates estimates were higher in the latest years, as data was removed from the model (Fig 12).

Gag GOM Stock Status

Table 10 presents the estimated benchmark statistics from the base scenarios and sensitivity runs of CASAL model. These correspond to deterministic estimates from the final runs, projections assumed a Beverton & Holt Stock recruitment relationship for all years in the model. Estimated maximum sustainable yield (MSY) was 3,748 MT (8.25 million lbs) and 3,788 MT (8.34 million lbs) for the base scenarios. Corresponding fishing rates F_{MSY} were 0.132 and 0.131, respectively. $F_{30\%SPR}$ estimates were slight higher than F_{MSY} [0.167] and F at maximum yield per recruit F_{max} was estimated as 0.237 and 0.235, respectively.

All references of spawning biomass in this table correspond to the female component of the stock exclusively, were spawning biomass is defined as the mean weight of females times the maturity vector at age for females. Spawning biomass in final year 2004 was estimated at 18,592 MT and 17,247 MT for the base scenarios, these SSB_{2004} were about 21.2% and 19.3% of their respective virgin biomass estimates. Compared to SSB_{MSY} the SSB2004 were about 69.5% and 62.9%. The estimated fishing

rates in 2004 were between 0.389 and 0.419 for the base scenarios, and above 0.38 in all the sensitivity runs. Overall the F_{2004} was much higher than F_{MAX}, F_{MSY}, or $F_{30\%SPR.}$

Figure 13 show the yield per recruit (YPR) and spawner per recruit deterministic trends from the base case 1. Figure 14 shows similar plots for the base case 2 (increasing catchability). Plots of catch (MT) versus fishing rates are shown in Figure 12. These plots also show the percent SSB females versus F in equilibrium conditions and the corresponding estimated F benchmark, $F_{0.1}$, F_{MSY}, $F_{30\%SPR}$, F_{max}, and F_{2004}.

Table 11 presents the estimated benchmark statistics from deterministic estimates assuming a Beverton & Holt stock recruitment relationship for the 1983-2004 years only. Stock recruitment fit for those series (1983-2004) were done externally using ML, estimated steepness and virgin biomass then were projected with CASAL to estimate benchmarks. Figure 13 is a preliminary phase plot showing the status of gag GOM stock, base on SBB_{2004}/SBB_{MSY} ratio and F_{2004} compared to $F_{30\%SPR}$.

Literature Cited

SEDAR 10-AW-3. 2006. Preliminary status of gag grouper in the Gulf of Mexico, SEDAR 10. Ortiz, Mauricio. SFD 2006-019.

Table 1. Final working estimates of catch commercial recreational historic generated at the AW Sedar 10.

Year	Headboat	Handline	Longline	MRFSS	Others	Total MT	Total MLbs
1880		106.3				106.3	0.234
1881		96.2				96.2	0.212
1882		86.0				86.0	0.189
1883		75.9				75.9	0.167
1884		65.8				65.8	0.145
1885		55.6				55.6	0.123
1886		45.5				45.5	0.100
1887		35.0				35.0	0.077
1888		23.6				23.6	0.052
1889		26.9				26.9	0.059
1890		25.8				25.8	0.057
1891		29.1				29.1	0.064
1892		32.9				32.9	0.073
1893		36.6				36.6	0.081
1894		40.3				40.3	0.089
1895		44.0				44.0	0.097
1896		47.7				47.7	0.105
1897		51.4				51.4	0.113
1898		51.9				51.9	0.114
1899		55.7				55.7	0.123
1900		59.5				59.5	0.131
1901		63.3				63.3	0.139
1902		67.0				67.0	0.148
1903		72.2				72.2	0.159
1904		77.4				77.4	0.171
1905		82.5				82.5	0.182
1906		87.6				87.6	0.193
1907		92.8				92.8	0.205
1908		98.0				98.0	0.216
1909		124.0				124.0	0.273
1910		149.9				149.9	0.330
1911		176.0				176.0	0.388
1912		201.9				201.9	0.445
1913		228.0				228.0	0.502
1914		253.9				253.9	0.559
1915		280.0				280.0	0.617
1916		305.9				305.9	0.674
1917		331.9				331.9	0.731
1918		357.9				357.9	0.788
1919		342.2				342.2	0.754
1920		326.6				326.6	0.719
1921		311.0				311.0	0.685
1922		295.4				295.4	0.651
1923		279.7				279.7	0.616
1924		281.0				281.0	0.619
1925		282.3				282.3	0.622
1926		283.5				283.5	0.624
1927		284.8				284.8	0.627
1928		255.7				255.7	0.563
1929		253.8				253.8	0.559
1930		198.5				198.5	0.437
1931		160.7				160.7	0.354
1932		190.8				190.8	0.420
1933		211.2				211.2	0.465
1934		204.1				204.1	0.450
1935		258.0				258.0	0.568
1936		301.8				301.8	0.665
1937		316.9				316.9	0.698
1938		276.5				276.5	0.609
1939		406.4				406.4	0.895
1940		292.6				292.6	0.644
1941		324.5				324.5	0.715
1942		353.5				353.5	0.779
1943		383.9				383.9	0.845
1944		414.2				414.2	0.912
1945		444.5		0.0		444.5	0.979
1946		458.0		9.2		467.2	1.029
1947		471.5		18.5		489.9	1.079
1948		477.7		27.7		505.4	1.113
1949		506.3		37.0		543.2	1.196
1950		339.0		46.2		385.1	0.848
1951		353.4		55.4		408.8	0.901
1952		278.1		64.7		342.8	0.755
1953		258.6		73.9		332.5	0.732
1954		298.1		83.1		381.2	0.840
1955		295.3		92.4		387.7	0.854
1956		365.5		103.1		468.6	1.032
1957		401.6		115.0		516.7	1.138
1958		264.8		128.4		393.2	0.866
1959		372.6		143.3		515.9	1.136
1960		382.3		159.9		542.2	1.194
1961		409.9		172.7		582.6	1.283
1962		453.8		186.5		640.3	1.410
1963		585.1		201.4	0.7	787.2	1.734
1964		741.1		217.6	4.1	962.8	2.121
1965		824.3		235.0	0.3	1059.5	2.334
1966		661.3		253.8	0.6	915.7	2.017
1967		524.6		274.1	4.5	803.2	1.769
1968		541.3		296.1	2.0	839.4	1.849
1969		624.9		319.8	1.5	946.2	2.084
1970		582.8		345.4	1.1	929.3	2.047
1971		624.9		394.7	1.3	1020.9	2.249
1972		663.0		451.1	1.8	1115.9	2.458
1973		490.9		515.5	2.2	1008.6	2.222
1974		537.6		589.1	0.6	1127.4	2.483
1975		656.8		673.1	2.0	1331.9	2.934
1976		544.1		770.5	4.1	1318.7	2.905
1977		443.7		881.9	3.4	1329.0	2.927
1978		397.4		1010.6	5.0	1412.9	3.112
1979		609.4	0.6	1158.3	4.4	1772.7	3.905
1980		598.3	40.5	1320.7	5.4	1964.9	4.328
1981		680.4	212.0	1116.2	7.1	2015.8	4.440
1982		605.9	458.5	1593.1	6.4	2663.9	5.868
1983		471.9	309.2	3386.8	8.0	4175.9	9.198
1984		498.6	196.7	968.9	8.4	1672.5	3.684
1985		634.8	172.9	3163.2	12.7	3983.6	8.774
1986	140.0	524.4	234.9	1935.5	13.2	2848.0	6.273
1987	104.7	387.1	297.8	1283.5	13.4	2086.4	4.596
1988	74.7	359.1	182.6	1917.5	10.5	2544.5	5.605
1989	153.4	560.9	193.4	1482.0	14.2	2403.9	5.295
1990	139.7	513.0	283.6	903.8	18.5	1858.6	4.094
1991	50.6	450.7	231.4	2198.7	28.6	2960.0	6.520
1992	71.0	455.2	269.1	1793.6	31.1	2620.1	5.771
1993	95.9	581.4	219.0	2666.9	48.0	3611.1	7.954
1994	143.9	521.2	159.7	2931.7	54.0	3810.7	8.394
1995	88.6	525.6	178.7	3291.7	47.5	4132.1	9.102
1996	80.3	502.4	180.2	2411.1	30.6	3204.7	7.059
1997	76.2	499.9	190.6	3084.3	37.5	3888.5	8.565
1998	194.2	839.3	276.5	3903.3	37.0	5250.3	11.565
1999	143.1	672.5	249.6	3292.2	31.0	4388.5	9.666
2000	122.9	728.9	289.1	3802.4	36.9	4980.1	10.969
2001	75.8	948.1	477.9	3980.0	45.8	5527.7	12.175
2002	66.0	877.8	481.0	4830.8	28.0	6283.6	13.840
2003	109.1	670.4	540.1	5547.6	30.5	6897.7	15.193
2004	148.6	797.5	540.6	6228.0	33.1	7747.7	17.066

Table 2. Description and summary of scenarios fitted with CASAL to catch and effort data for gag GOM. Stock indicators: unexploited spawning stock biomass (SSB_0), spawning initial stock ($SSB_{initial}$), steepness parameter, mean recruit of unexploited stock (R_0), terminal year spawning stock biomass (SSB_{2004}), and fishing mortality rate of terminal year (F_{2004}). All references of spawning biomass are of gag GOM female component in metric tons.

Scenario	Model Run	Age initial	Age final	M	q's estimation	N Parameters	Objective function	AIC	SSB0 (MT)	SSBinitial (MT)	SSB2004 (MT)	steepness	R0	F 2004
Case 1	1963-2004 final MRFSS	1	12+	M(age)	constant	82	7554.78	15273.56	87,514	22,295	18,592	0.751401	2.66E+06	0.3889
Case 2	1963-2004 final MRFSS increase 2% q's	1	12+	M(age)	constant	82	7546.18	15256.36	89,391	22,098	17,247	0.741762	2.72E+06	0.4186
Case 3	1880-2004 final MRFSS 45-04	1	12+	M(age)	constant	164	7555.56	15439.12	70,000	70,000	18,548	0.74292	2.13E+06	0.3894
Case 4	1880-2004 ... increase 2% annual of q's	1	12+	M(age)	constant	164	7546.98	15421.96	70,000	70,000	17,221	0.719875	2.13E+06	0.4189
Case 5	1963-2004 Increse 25% MRFSS	1	12+	M(age)	constant	82	7561.97	15287.94	64,362	20,240	22,214	0.99	1.96E+06	0.3883
Case 6	1963-2004 Decrese 25% MRFSS	1	12+	M(age)	constant	82	7548.03	15260.06	107,757	19,393	15,046	0.66338	3.28E+06	0.3852
Retrospective	Case 1 [1963-2004]	1	12+	M(age)	constant		7554.78		87,514	22,295		0.751401	2.66E+06	
	Case 1 [1963-2003]	1	12+	M(age)	constant		7378.96		87,478	23,088		0.721231	2.66E+06	
	Case 1 [1963-2002]	1	12+	M(age)	constant		7118.50		89,596	22,688		0.715864	2.72E+06	
	Case 1 [1963-2001]	1	12+	M(age)	constant		6819.95		95,477	22,653		0.667183	2.90E+06	
	Case 1 [1963-2000]	1	12+	M(age)	constant		6543.61		92,926	21,978		0.693605	2.83E+06	

Table 3. Base case 1 summary of main stock indicators from CASAL fit for gag GOM.

Estimated Biomass

Year	Biomass MT	SSB fem	SSB mal
1963	32,603	22,295	9,393
1964	31,433	21,751	9,168
1965	29,961	21,036	8,888
1966	28,363	19,897	8,574
1967	26,773	18,597	8,300
1968	25,133	17,239	8,057
1969	23,370	15,805	7,791
1970	21,547	14,315	7,452
1971	19,703	12,907	7,055
1972	17,804	11,555	6,546
1973	15,966	10,288	5,913
1974	14,565	9,233	5,237
1975	13,219	8,167	4,580
1976	12,116	7,245	3,912
1977	11,438	7,175	3,333
1978	11,105	6,884	2,841
1979	11,016	6,721	2,411
1980	11,110	6,843	1,976
1981	11,592	7,126	1,625
1982	12,219	7,793	1,319
1983	11,935	8,324	1,044
1984	11,739	7,728	843
1985	11,863	9,306	810
1986	11,002	8,409	707
1987	10,991	8,120	687
1988	11,137	8,442	732
1989	10,866	8,422	796
1990	11,638	8,331	859
1991	12,503	8,554	936
1992	13,164	7,983	964
1993	13,737	9,490	977
1994	14,513	9,765	931
1995	15,356	9,521	889
1996	16,484	9,528	824
1997	18,910	12,213	827
1998	20,620	13,953	844
1999	21,710	14,057	833
2000	23,555	16,887	905
2001	24,924	18,422	1,079
2002	25,525	18,384	1,200
2003	25,002	18,963	1,339
2004	23,101	18,592	1,509

Stock Recruitment

Year	SSB fem	Recruits
1963	22,295	214,586
1964	21,751	214,574
1965	21,036	213,181
1966	19,897	211,267
1967	18,597	208,019
1968	17,239	203,970
1969	15,805	199,294
1970	14,315	193,783
1971	12,907	187,283
1972	11,555	180,294
1973	10,288	172,637
1974	9,233	1,393,800
1975	8,167	202,205
1976	7,245	721,440
1977	7,175	1,267,200
1978	6,884	1,216,470
1979	6,721	1,541,900
1980	6,843	1,712,720
1981	7,126	2,094,330
1982	7,793	1,972,460
1983	8,324	1,364,890
1984	7,728	1,358,380
1985	9,306	1,252,910
1986	8,409	1,476,470
1987	8,120	1,192,730
1988	8,442	1,086,810
1989	8,422	793,166
1990	8,331	3,761,120
1991	8,554	1,602,020
1992	7,983	1,916,250
1993	9,490	2,119,320
1994	9,765	4,814,020
1995	9,521	2,712,410
1996	9,528	2,033,390
1997	12,213	5,741,390
1998	13,953	3,062,170
1999	14,057	1,833,230
2000	16,887	5,007,130
2001	18,422	3,467,710
2002	18,384	2,789,170
2003	18,963	2,452,980
2004	18,592	2,344,190

Fishing mortality rate

Year	fishing_pressures
1963	0.0295
1964	0.0364
1965	0.0413
1966	0.0393
1967	0.0393
1968	0.0448
1969	0.0544
1970	0.0612
1971	0.0756
1972	0.0935
1973	0.1050
1974	0.1309
1975	0.1675
1976	0.1828
1977	0.1935
1978	0.2098
1979	0.2445
1980	0.2594
1981	0.2432
1982	0.2965
1983	0.4283
1984	0.1944
1985	0.3841
1986	0.3060
1987	0.2308
1988	0.2745
1989	0.2630
1990	0.2076
1991	0.3180
1992	0.2702
1993	0.3339
1994	0.3444
1995	0.3677
1996	0.2667
1997	0.2704
1998	0.3292
1999	0.2572
2000	0.2657
2001	0.2808
2002	0.3053
2003	0.3293
2004	0.3889

Selectivity at age

Age	Headboat 1	Headboat 2	Headboat 3	Handline 1	Handline 3	Longline	MRFSS	Others
1	0.01216	0.00331	0.01034	0.00047	0.00005	0.00011	0.01919	0.00140
2	0.25136	0.15978	0.19853	0.00685	0.00168	0.00129	0.20211	0.01454
3	0.75434	0.70067	0.68720	0.06545	0.03618	0.01143	0.62558	0.13684
4	0.91569	0.91954	0.90252	0.29382	0.27408	0.07015	0.86925	0.67993
5	0.87562	0.93759	0.89440	0.59092	0.62010	0.24597	0.92371	0.89203
6	0.74521	0.90797	0.78887	0.78858	0.82612	0.48694	0.89130	0.75093
7	0.57981	0.83928	0.63622	0.88474	0.88379	0.68858	0.80335	0.58437
8	0.42570	0.73542	0.48329	0.92426	0.84882	0.82215	0.68257	0.41749
9	0.30398	0.61821	0.35589	0.93974	0.77091	0.90103	0.55774	0.27565
10	0.21553	0.50755	0.25941	0.94605	0.67593	0.94448	0.44666	0.17097
11	0.15379	0.41278	0.18969	0.94883	0.58426	0.96772	0.35554	0.10151
12	0.11146	0.33584	0.14038	0.95015	0.50250	0.98027	0.28393	0.05860

Estimated Stock Population

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12+	Total
1963	214,586	524,709	410,346	336,397	283,590	243,507	211,809	185,996	164,513	146,333	130,745	1,257,610	4,110,141
1964	214,574	166,043	409,121	332,980	278,396	237,376	205,719	180,516	159,815	142,367	127,390	1,228,020	3,682,317
1965	213,181	166,028	129,418	331,500	274,584	231,710	199,176	174,067	153,999	137,340	123,102	1,191,150	3,325,255
1966	211,267	164,943	129,348	104,703	272,630	227,644	193,499	167,680	147,749	131,693	118,193	1,149,830	3,019,179
1967	208,019	163,453	128,430	104,484	86,008	226,062	190,350	163,239	142,707	126,745	113,731	1,113,830	2,767,058
1968	203,970	160,929	127,174	103,510	85,599	71,190	188,902	160,623	139,072	122,629	109,705	1,081,510	2,554,813
1969	199,294	157,782	125,088	102,179	84,413	70,469	59,148	158,515	136,146	118,961	105,712	1,045,990	2,363,697
1970	193,783	154,147	122,488	100,083	82,745	68,862	57,959	49,133	133,078	115,430	101,714	1,004,050	2,183,472
1971	187,283	149,863	119,486	97,539	80,502	67,006	56,230	47,831	41,018	112,308	98,325	961,540	2,018,931
1972	180,294	144,804	115,886	94,404	77,500	64,240	53,879	45,724	39,400	34,209	94,672	913,855	1,858,867
1973	172,637	139,360	111,633	90,645	73,840	60,694	50,654	43,002	37,036	32,377	28,466	860,596	1,700,939
1974	1,393,800	133,394	107,026	86,280	69,791	56,968	47,248	40,018	34,579	30,299	26,886	760,322	2,786,612
1975	202,205	1,076,490	101,955	81,423	64,851	52,344	43,066	36,303	31,390	27,684	24,693	663,433	2,405,837
1976	721,440	156,090	818,166	76,084	59,264	46,718	37,902	31,741	27,417	24,299	21,898	565,832	2,586,851
1977	1,267,200	556,712	118,183	602,885	54,352	41,853	33,208	27,495	23,670	21,023	19,088	481,661	3,247,330
1978	1,216,470	977,539	420,023	86,089	424,170	37,819	29,359	23,829	20,338	18,050	16,461	410,268	3,680,416
1979	1,541,900	938,051	734,528	301,798	59,362	288,850	25,995	20,698	17,377	15,340	14,018	348,075	4,305,992
1980	1,712,720	1,188,710	702,920	522,057	203,192	38,946	189,814	17,489	14,426	12,558	11,442	284,653	4,898,927
1981	2,094,330	1,320,160	888,954	496,013	347,140	131,077	25,089	125,086	11,948	10,233	9,207	229,281	5,688,518
1982	1,972,460	1,615,850	997,599	649,230	345,345	232,916	86,528	16,674	84,981	8,336	7,318	178,345	6,195,583
1983	1,364,890	1,520,670	1,210,980	708,578	433,441	219,627	143,938	53,456	10,526	55,282	5,585	131,113	5,858,085
1984	1,358,380	1,048,500	1,095,140	746,160	380,853	218,147	109,215	74,309	29,533	6,252	34,972	95,153	5,196,613
1985	1,252,910	1,048,940	799,705	825,601	546,955	272,169	153,857	77,262	53,341	21,597	4,654	99,861	5,156,851
1986	1,476,470	963,427	763,804	513,099	472,136	295,430	145,815	85,303	45,434	33,374	14,264	75,003	4,883,558
1987	1,192,730	1,137,330	713,650	521,675	325,286	287,581	178,338	89,852	54,647	30,367	23,167	65,665	4,620,288
1988	1,086,810	920,076	856,281	515,900	361,559	219,701	192,421	120,504	62,149	38,845	22,140	67,394	4,463,780
1989	793,166	837,259	683,075	590,195	333,743	227,884	138,648	124,505	81,095	43,584	28,250	68,663	3,950,067
1990	3,761,120	611,511	625,906	481,670	393,012	215,250	146,078	90,485	83,919	56,595	31,373	72,979	6,569,899
1991	1,602,020	2,904,240	465,252	466,239	347,318	276,129	149,247	101,645	63,988	60,588	41,687	79,417	6,557,771
1992	1,916,250	1,233,400	2,142,620	312,782	288,352	206,739	163,813	90,936	64,806	42,824	42,326	89,655	6,594,502
1993	2,119,320	1,477,160	922,295	1,508,810	207,226	184,680	131,233	105,580	60,492	44,680	30,504	98,545	6,890,525
1994	4,814,020	1,631,710	1,089,550	618,368	923,763	121,064	106,998	77,969	65,673	39,543	30,523	93,916	9,613,096
1995	2,712,410	3,704,780	1,196,990	715,944	368,281	526,923	69,034	63,097	48,498	43,184	27,291	91,905	9,568,337
1996	2,033,390	2,086,250	2,702,730	771,876	413,664	202,731	289,788	39,390	38,176	31,183	29,269	86,961	8,725,408
1997	5,741,390	1,567,290	1,558,440	1,897,500	509,974	265,015	129,309	188,449	26,511	26,673	22,529	88,258	12,021,338
1998	3,062,170	4,424,060	1,167,310	1,083,940	1,239,570	323,938	168,187	83,943	126,985	18,590	19,377	84,907	11,802,977
1999	1,833,230	2,357,920	3,266,250	784,859	668,221	730,227	189,004	100,445	52,388	83,157	12,708	75,992	10,154,401
2000	5,007,130	1,413,200	1,763,500	2,302,630	523,039	433,210	471,799	124,443	68,363	36,964	60,605	68,065	12,272,947
2001	3,467,710	3,859,300	1,055,670	1,240,890	1,526,500	335,438	276,682	308,415	84,709	48,637	27,381	100,398	12,331,730
2002	2,789,170	2,672,670	2,882,450	742,229	818,475	966,224	209,830	176,349	204,429	58,716	35,146	98,373	11,654,062
2003	2,452,980	2,148,130	1,980,330	1,972,180	471,080	498,374	583,859	130,033	114,472	139,655	42,025	102,199	10,635,317
2004	2,344,190	1,887,860	1,578,740	1,316,630	1,202,230	275,732	290,730	351,325	82,477	76,835	98,616	109,277	9,614,642

Table 4. Base case 2 summary of main stock indicators from CASAL fit for gag GOM.

Estimated Biomass

Year	Biomass MT	SSB fem	SSB mal
1963	32,314	22,098	9,310
1964	31,152	21,554	9,085
1965	29,695	20,840	8,805
1966	28,116	19,715	8,491
1967	26,548	18,436	8,217
1968	24,935	17,104	7,974
1969	23,200	15,698	7,709
1970	21,406	14,237	7,372
1971	19,590	12,854	6,980
1972	17,718	11,523	6,477
1973	15,905	10,273	5,855
1974	14,526	9,229	5,192
1975	13,195	8,172	4,546
1976	12,102	7,256	3,889
1977	11,431	7,185	3,318
1978	11,102	6,892	2,831
1979	11,015	6,727	2,405
1980	11,110	6,847	1,973
1981	11,593	7,129	1,624
1982	12,221	7,795	1,319
1983	11,937	8,326	1,044
1984	11,741	7,730	843
1985	11,865	9,309	809
1986	11,005	8,412	707
1987	10,993	8,124	687
1988	11,137	8,446	731
1989	10,864	8,424	796
1990	11,629	8,331	859
1991	12,482	8,551	936
1992	13,126	7,973	964
1993	13,677	9,462	976
1994	14,416	9,716	929
1995	15,212	9,447	886
1996	16,284	9,418	818
1997	18,626	12,040	818
1998	20,231	13,711	831
1999	21,199	13,736	815
2000	22,868	16,435	879
2001	24,007	17,824	1,040
2002	24,327	17,624	1,145
2003	23,476	17,940	1,262
2004	21,221	17,247	1,399

Stock Recruitment

Year	SSB fem	Recruits
1963	22,098	221,055
1964	21,554	221,443
1965	20,840	219,668
1966	19,715	217,674
1967	18,436	213,896
1968	17,104	209,381
1969	15,698	204,090
1970	14,237	198,288
1971	12,854	191,196
1972	11,523	183,816
1973	10,273	175,674
1974	9,229	1,391,490
1975	8,172	199,698
1976	7,256	721,216
1977	7,185	1,266,290
1978	6,892	1,216,570
1979	6,727	1,541,410
1980	6,847	1,712,030
1981	7,129	2,094,440
1982	7,795	1,972,970
1983	8,326	1,364,480
1984	7,730	1,358,050
1985	9,309	1,252,630
1986	8,412	1,474,880
1987	8,124	1,191,390
1988	8,446	1,084,290
1989	8,424	790,499
1990	8,331	3,743,460
1991	8,551	1,592,440
1992	7,973	1,902,250
1993	9,462	2,100,870
1994	9,716	4,766,780
1995	9,447	2,682,420
1996	9,418	2,006,970
1997	12,040	5,647,190
1998	13,711	2,996,820
1999	13,736	1,781,490
2000	16,435	4,819,970
2001	17,824	3,298,630
2002	17,624	2,624,170
2003	17,940	2,286,580
2004	17,247	2,210,040

Fishing mortality rate

Year	fishing_pressures
1963	0.0297
1964	0.0368
1965	0.0417
1966	0.0396
1967	0.0396
1968	0.0451
1969	0.0547
1970	0.0614
1971	0.0757
1972	0.0935
1973	0.1049
1974	0.1306
1975	0.1671
1976	0.1823
1977	0.1932
1978	0.2095
1979	0.2444
1980	0.2593
1981	0.2432
1982	0.2965
1983	0.4283
1984	0.1944
1985	0.3840
1986	0.3059
1987	0.2307
1988	0.2744
1989	0.2630
1990	0.2077
1991	0.3182
1992	0.2708
1993	0.3352
1994	0.3464
1995	0.3708
1996	0.2699
1997	0.2743
1998	0.3350
1999	0.2631
2000	0.2730
2001	0.2902
2002	0.3184
2003	0.3479
2004	0.4186

Selectivity at age

Age	Headboat 1	Headboat 2	Headboat 3	Handline 1	Handline 3	Longline	MRFSS	Others
1	0.01225	0.00333	0.01072	0.00047	0.00005	0.00011	0.01936	0.00140
2	0.25113	0.15993	0.19989	0.00683	0.00167	0.00128	0.20213	0.01464
3	0.75358	0.70056	0.68618	0.06538	0.03603	0.01139	0.62455	0.13806
4	0.91540	0.91947	0.90202	0.29377	0.27393	0.06987	0.86857	0.68225
5	0.87509	0.93763	0.89590	0.59095	0.62015	0.24520	0.92361	0.89323
6	0.74407	0.90807	0.79263	0.78864	0.82621	0.48596	0.89150	0.75415
7	0.57830	0.83934	0.64141	0.88479	0.88385	0.68770	0.80379	0.58891
8	0.42416	0.73532	0.48882	0.92430	0.84882	0.82149	0.68313	0.42221
9	0.30260	0.61794	0.36103	0.93976	0.77086	0.90057	0.55834	0.27959
10	0.21437	0.50715	0.26386	0.94606	0.67589	0.94419	0.44724	0.17380
11	0.15284	0.41230	0.19341	0.94883	0.58422	0.96753	0.35608	0.10334
12	0.11071	0.33532	0.14343	0.95015	0.50246	0.98014	0.28442	0.05972

Estimated Stock Population

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12+	Total
1963	221,055	520,066	406,715	333,420	281,080	241,353	209,935	184,351	163,058	145,038	129,588	1,246,490	4,082,149
1964	221,443	171,048	405,491	330,011	275,893	235,225	203,846	178,870	158,359	141,071	126,233	1,216,880	3,664,370
1965	219,668	171,342	133,315	328,533	272,088	229,565	197,307	172,424	152,544	136,045	121,944	1,180,010	3,314,785
1966	217,674	169,961	133,484	107,847	270,137	225,505	191,636	166,041	146,298	130,400	117,036	1,138,690	3,014,709
1967	213,896	168,410	132,333	107,815	88,574	223,929	188,497	161,609	141,262	125,457	112,578	1,102,710	2,767,070
1968	209,381	165,474	131,026	106,647	88,313	73,295	187,062	159,008	137,640	121,352	108,560	1,070,420	2,558,178
1969	204,090	161,967	128,617	105,267	86,958	72,686	60,878	156,922	134,735	117,701	104,581	1,034,980	2,369,382
1970	198,288	157,855	125,734	102,904	85,236	70,922	59,765	50,554	131,698	114,198	100,606	993,177	2,190,936
1971	191,196	153,346	122,360	100,126	82,766	69,012	57,900	49,309	42,193	111,113	97,249	950,881	2,027,451
1972	183,816	147,828	118,581	96,683	79,558	66,042	55,484	47,072	40,608	35,181	93,643	903,514	1,868,009
1973	175,674	142,082	113,968	92,770	75,634	62,309	52,073	44,278	38,122	33,364	29,269	850,702	1,710,244
1974	1,391,490	135,739	109,124	88,112	71,452	58,368	48,514	41,143	35,607	31,187	27,703	752,446	2,790,884
1975	199,698	1,074,690	103,758	83,056	66,263	53,614	44,139	37,285	32,277	28,509	25,417	657,427	2,406,134
1976	721,216	154,153	816,915	77,477	60,500	47,769	38,844	32,546	28,167	24,991	22,552	561,463	2,586,592
1977	1,266,290	556,531	116,731	602,329	55,390	42,755	33,974	28,190	24,278	21,602	19,634	478,613	3,246,318
1978	1,216,570	976,818	419,928	85,078	424,053	38,563	30,006	24,388	20,858	18,517	16,916	408,214	3,679,909
1979	1,541,410	938,109	734,040	301,876	58,697	288,900	26,515	21,159	17,787	15,733	14,381	346,760	4,305,367
1980	1,712,030	1,188,300	702,991	521,914	203,327	38,520	189,882	17,841	14,748	12,855	11,735	283,883	4,898,026
1981	2,094,440	1,319,580	888,665	496,230	347,154	131,187	24,817	125,131	12,188	10,461	9,423	228,887	5,688,163
1982	1,972,970	1,615,890	997,169	649,164	345,566	232,952	86,606	16,493	85,007	8,502	7,480	178,195	6,195,995
1983	1,364,480	1,521,010	1,211,000	708,455	433,495	219,796	143,969	53,501	10,411	55,290	5,695	131,099	5,858,201
1984	1,358,050	1,048,120	1,095,370	746,574	380,955	218,204	109,292	74,306	29,548	6,181	34,966	95,190	5,196,755
1985	1,252,630	1,048,660	799,413	825,900	547,329	272,260	153,900	77,314	53,335	21,606	4,601	99,875	5,156,822
1986	1,474,880	963,158	763,611	513,173	472,523	295,695	145,870	85,317	45,455	33,363	14,266	74,962	4,882,273
1987	1,191,390	1,136,060	713,462	521,733	325,441	287,876	178,519	89,888	54,653	30,379	23,157	65,630	4,618,187
1988	1,084,290	919,017	855,330	515,890	361,681	219,842	192,641	120,632	62,173	38,847	22,147	67,354	4,459,844
1989	790,499	835,281	682,295	589,738	333,835	227,997	138,747	124,645	81,175	43,597	28,249	68,630	3,944,688
1990	3,743,460	609,435	624,426	481,231	392,778	215,328	146,155	90,547	84,008	56,646	31,380	72,948	6,548,341
1991	1,592,440	2,890,540	463,667	465,192	347,033	275,975	149,299	101,692	64,026	60,646	41,721	79,390	6,531,621
1992	1,902,250	1,225,960	2,132,390	311,769	287,704	206,525	163,663	90,927	64,806	42,830	42,350	89,632	6,560,806
1993	2,100,870	1,466,300	916,618	1,501,370	206,465	184,144	130,995	105,396	60,438	44,649	30,491	98,499	6,846,235
1994	4,766,780	1,617,390	1,081,270	614,229	918,133	120,423	106,491	77,685	65,450	39,452	30,465	93,787	9,531,554
1995	2,682,420	3,668,120	1,186,020	709,744	365,050	522,262	68,462	62,616	48,198	42,944	27,179	91,645	9,474,660
1996	2,006,970	2,062,960	2,674,320	763,359	408,631	200,033	285,817	38,882	37,731	30,884	29,025	86,507	8,625,119
1997	5,647,190	1,546,800	1,540,160	1,874,280	502,792	260,753	127,036	185,078	26,068	26,273	22,248	87,523	11,846,201
1998	2,996,820	4,351,030	1,151,220	1,068,820	1,219,620	317,801	164,601	82,041	124,132	18,205	19,020	83,897	11,597,207
1999	1,781,490	2,307,290	3,209,050	771,399	654,912	712,847	183,830	97,479	50,814	80,755	12,375	74,660	9,936,902
2000	4,819,970	1,373,140	1,723,880	2,254,720	511,133	421,508	456,935	120,099	65,876	35,631	58,534	66,496	11,907,922
2001	3,298,630	3,714,490	1,024,470	1,208,120	1,484,360	324,852	266,558	295,856	81,064	46,534	26,236	97,123	11,868,291
2002	2,624,170	2,541,910	2,770,030	716,625	789,809	928,569	200,556	167,718	193,850	55,636	33,347	94,383	11,116,603
2003	2,286,580	2,020,540	1,879,040	1,880,150	448,663	472,595	550,562	122,045	107,146	130,667	39,381	96,981	10,034,351
2004	2,210,040	1,759,140	1,479,670	1,233,650	1,122,100	255,779	268,064	322,630	75,658	70,566	90,845	102,160	8,990,302

Table 5. 1800-2004 Catch sensitivity run stock indicator of model fit.

Estimated Biomass

Year	Biomass MT	SSB fem	SSB mal
1880	103,933	70,000	29,490
1881	103,803	69,930	29,457
1882	103,669	69,864	29,427
1883	103,530	69,768	29,400
1884	103,389	69,652	29,377
1885	103,249	69,527	29,358
1886	103,113	69,401	29,343
1887	102,984	69,280	29,329
1888	102,864	69,170	29,313
1889	102,750	69,077	29,290
1890	102,637	68,997	29,252
1891	102,640	68,936	29,201
1892	102,792	68,880	29,154
1893	103,107	68,889	29,111
1894	103,581	69,220	29,072
1895	104,196	69,805	29,035
1896	104,928	70,546	29,001
1897	105,749	71,380	28,972
1898	106,638	72,254	28,976
1899	107,570	73,119	29,041
1900	108,525	73,921	29,198
1901	109,485	74,619	29,469
1902	110,444	75,188	29,867
1903	111,320	75,712	30,228
1904	112,121	76,195	30,555
1905	112,855	76,640	30,852
1906	113,526	77,048	31,124
1907	114,140	77,422	31,372
1908	114,700	77,763	31,599
1909	115,201	78,075	31,807
1910	115,635	78,343	31,992
1911	116,006	78,572	32,153
1912	116,318	78,763	32,293
1913	116,573	78,918	32,412
1914	116,775	79,041	32,511
1915	116,926	79,133	32,592
1916	117,028	79,194	32,655
1917	117,084	79,227	32,701
1918	117,094	79,232	32,733
1919	117,081	79,208	32,750
1920	117,064	79,185	32,766
1921	117,042	79,159	32,781
1922	117,012	79,129	32,797
1923	116,972	79,091	32,814
1924	116,911	79,043	32,831
1925	116,816	78,970	32,842
1926	116,684	78,871	32,848
1927	116,512	78,743	32,847
1928	116,311	78,585	32,838
1929	116,079	78,413	32,830
1930	115,823	78,205	32,812
1931	115,555	77,995	32,802
1932	115,227	77,763	32,792
1933	114,804	77,461	32,760
1934	114,300	77,092	32,708
1935	113,694	76,671	32,643
1936	112,956	76,155	32,544
1937	112,100	75,549	32,413
1938	111,163	74,869	32,258
1939	110,084	74,147	32,093
1940	108,891	73,267	31,866
1941	107,629	72,386	31,651
1942	106,218	71,400	31,402
1943	104,652	70,307	31,119
1944	102,927	69,101	30,798
1945	101,036	67,779	30,438
1946	98,979	66,338	30,037
1947	96,755	64,778	29,596
1948	94,365	63,099	29,114
1949	91,802	61,302	28,589
1950	89,149	59,374	28,015
1951	86,417	57,444	27,452
1952	83,559	55,392	26,839
1953	80,601	53,284	26,205
1954	77,495	51,088	25,528
1955	74,249	48,783	24,788
1956	70,868	46,410	23,999
1957	67,354	43,943	23,138
1958	63,835	41,427	22,218
1959	60,296	38,989	21,302
1960	56,690	36,493	20,309
1961	53,086	34,023	19,279
1962	49,498	31,591	18,216
1963	45,904	29,204	17,122
1964	42,279	26,829	15,973
1965	38,674	24,471	14,772
1966	35,271	22,203	13,557
1967	32,177	20,174	12,427
1968	29,301	18,351	11,377
1969	26,537	16,641	10,355
1970	23,917	15,001	9,342
1971	21,445	13,498	8,393
1972	19,064	12,059	7,471
1973	16,866	10,676	6,581
1974	15,220	9,456	5,796
1975	13,675	8,260	5,029
1976	12,423	7,248	4,254
1977	11,638	7,137	3,583
1978	11,232	6,836	3,016
1979	11,093	6,682	2,527
1980	11,156	6,819	2,046
1981	11,619	7,116	1,664
1982	12,235	7,792	1,337
1983	11,945	8,329	1,051
1984	11,747	7,735	845
1985	11,869	9,314	811
1986	11,008	8,416	708
1987	10,995	8,126	688
1988	11,139	8,447	732
1989	10,865	8,425	796
1990	11,630	8,332	859
1991	12,481	8,552	937
1992	13,125	7,974	964
1993	13,675	9,461	976
1994	14,411	9,715	929
1995	15,204	9,446	885
1996	16,272	9,414	818
1997	18,607	12,031	817
1998	20,206	13,696	830
1999	21,167	13,714	814
2000	22,832	16,405	877
2001	23,970	17,789	1,037
2002	24,294	17,585	1,141
2003	23,450	17,904	1,257
2004	21,202	17,221	1,392

Stock Recruitment

Year	SSB fem	Recruits
1880	70,000	2,080,490
1881	69,930	2,081,060
1882	69,864	2,081,450
1883	69,768	2,081,860
1884	69,652	2,082,220
1885	69,527	2,082,560
1886	69,401	2,082,930
1887	69,280	2,083,370
1888	69,170	2,083,900
1889	69,077	2,084,510
1890	68,997	2,085,200
1891	68,936	2,454,360
1892	68,880	2,455,190
1893	68,889	2,456,060
1894	69,220	2,457,160
1895	69,805	2,459,330
1896	70,546	2,462,290
1897	71,380	2,465,690
1898	72,254	2,469,280
1899	73,119	2,472,850
1900	73,921	2,476,260
1901	74,619	2,479,320
1902	75,188	2,481,940
1903	75,712	2,484,040
1904	76,195	2,485,850
1905	76,640	2,487,360
1906	77,048	2,488,550
1907	77,422	2,489,410
1908	77,763	2,489,910
1909	78,075	2,490,020
1910	78,343	2,489,710
1911	78,572	2,488,900
1912	78,763	2,487,540
1913	78,918	2,485,580
1914	79,041	2,482,960
1915	79,133	2,479,620
1916	79,194	2,475,490
1917	79,227	2,470,490
1918	79,232	2,464,530
1919	79,208	2,457,510
1920	79,185	2,449,320
1921	79,159	2,439,950
1922	79,129	2,429,270
1923	79,091	2,417,120
1924	79,043	2,403,370
1925	78,970	2,387,880
1926	78,871	2,370,450
1927	78,743	2,350,940
1928	78,585	2,329,190
1929	78,413	2,305,050
1930	78,205	2,278,330
1931	77,995	2,248,760
1932	77,763	2,216,260
1933	77,461	2,180,550
1934	77,092	2,141,220
1935	76,671	2,098,150
1936	76,155	2,051,250
1937	75,549	2,000,190
1938	74,869	1,944,980
1939	74,147	1,885,530
1940	73,267	1,821,700
1941	72,386	1,752,890
1942	71,400	1,679,820
1943	70,307	1,602,070
1944	69,101	1,519,920
1945	67,779	1,433,620
1946	66,338	1,343,880
1947	64,778	1,251,770
1948	63,099	1,157,990
1949	61,302	1,063,560
1950	59,374	969,427
1951	57,444	876,431
1952	55,392	786,369
1953	53,284	700,299
1954	51,088	619,469
1955	48,783	545,192
1956	46,410	477,290
1957	43,943	415,774
1958	41,427	360,678
1959	38,989	312,750
1960	36,493	271,730
1961	34,023	237,815
1962	31,591	211,396
1963	29,204	199,337
1964	26,829	189,250
1965	24,471	168,905
1966	22,203	162,043
1967	20,174	153,620
1968	18,351	148,595
1969	16,641	141,949
1970	15,001	142,378
1971	13,498	134,321
1972	12,059	136,063
1973	10,676	130,923
1974	9,456	1,393,760
1975	8,260	203,892
1976	7,248	729,860
1977	7,137	1,269,520
1978	6,836	1,219,320
1979	6,682	1,541,200
1980	6,819	1,711,720
1981	7,116	2,093,990
1982	7,792	1,972,150
1983	8,329	1,363,300
1984	7,735	1,357,080
1985	9,314	1,251,930
1986	8,416	1,474,850
1987	8,126	1,191,200
1988	8,447	1,084,170
1989	8,425	790,066
1990	8,332	3,742,550
1991	8,552	1,591,890
1992	7,974	1,901,340
1993	9,461	2,099,210
1994	9,715	4,762,360
1995	9,446	2,678,930
1996	9,414	2,004,300
1997	12,031	5,641,670
1998	13,696	2,994,870
1999	13,714	1,781,380
2000	16,405	4,823,110
2001	17,789	3,306,640
2002	17,585	2,633,520
2003	17,904	2,290,620
2004	17,221	2,212,620

Fishing mortality rate

Year	fishing_pressures
1880	0.0011
1881	0.0010
1882	0.0009
1883	0.0008
1884	0.0007
1885	0.0006
1886	0.0005
1887	0.0004
1888	0.0003
1889	0.0003
1890	0.0003
1891	0.0003
1892	0.0004
1893	0.0004
1894	0.0004
1895	0.0005
1896	0.0005
1897	0.0005
1898	0.0005
1899	0.0006
1900	0.0006
1901	0.0006
1902	0.0007
1903	0.0007
1904	0.0008
1905	0.0008
1906	0.0009
1907	0.0009
1908	0.0009
1909	0.0012
1910	0.0014
1911	0.0017
1912	0.0019
1913	0.0022
1914	0.0024
1915	0.0026
1916	0.0029
1917	0.0031
1918	0.0034
1919	0.0032
1920	0.0031
1921	0.0029
1922	0.0028
1923	0.0026
1924	0.0026
1925	0.0027
1926	0.0027
1927	0.0027
1928	0.0024
1929	0.0024
1930	0.0019
1931	0.0015
1932	0.0018
1933	0.0020
1934	0.0020
1935	0.0025
1936	0.0029
1937	0.0031
1938	0.0027
1939	0.0040
1940	0.0029
1941	0.0033
1942	0.0036
1943	0.0040
1944	0.0043
1945	0.0047
1946	0.0051
1947	0.0054
1948	0.0058
1949	0.0064
1950	0.0048
1951	0.0053
1952	0.0048
1953	0.0050
1954	0.0060
1955	0.0065
1956	0.0081
1957	0.0094
1958	0.0084
1959	0.0112
1960	0.0127
1961	0.0147
1962	0.0173
1963	0.0223
1964	0.0290
1965	0.0344
1966	0.0348
1967	0.0371
1968	0.0427
1969	0.0518
1970	0.0587
1971	0.0728
1972	0.0908
1973	0.1037
1974	0.1309
1975	0.1691
1976	0.1856
1977	0.1963
1978	0.2120
1979	0.2456
1980	0.2597
1981	0.2430
1982	0.2963
1983	0.4281
1984	0.1943
1985	0.3839
1986	0.3058
1987	0.2306
1988	0.2743
1989	0.2630
1990	0.2076
1991	0.3181
1992	0.2707
1993	0.3351
1994	0.3464
1995	0.3709
1996	0.2700
1997	0.2745
1998	0.3353
1999	0.2634
2000	0.2735
2001	0.2908
2002	0.3189
2003	0.3484
2004	0.4189

Selectivity at age

Age	Headboat 1	Headboat 2	Headboat 3	Handline 1	Handline 3	Longline	MRFSS	Others
1	0.01236	0.00323	0.01058	0.00047	0.00005	0.00011	0.01939	0.00146
2	0.24768	0.15918	0.19920	0.00688	0.00166	0.00128	0.20228	0.01476
3	0.74870	0.70122	0.68564	0.06559	0.03593	0.01137	0.62465	0.13512
4	0.91398	0.91984	0.90239	0.29393	0.27382	0.06987	0.86857	0.67077
5	0.87298	0.93714	0.89968	0.59086	0.62018	0.24534	0.92370	0.89036
6	0.73961	0.90690	0.80100	0.78846	0.82626	0.48623	0.89188	0.74471
7	0.57248	0.83831	0.65221	0.88463	0.88388	0.68800	0.80459	0.57516
8	0.41829	0.73547	0.49959	0.92419	0.84883	0.82174	0.68423	0.40782
9	0.29738	0.61953	0.37045	0.93970	0.77084	0.90077	0.55958	0.26755
10	0.21003	0.50991	0.27157	0.94603	0.67587	0.94433	0.44848	0.16517
11	0.14935	0.41583	0.19950	0.94881	0.58421	0.96763	0.35724	0.09775
12	0.10794	0.33926	0.14816	0.95014	0.50245	0.98021	0.28547	0.05632

Table 6. 1880-2004 Catch increasing catchability sensitivity run stock indicators of model fit

Estimated Biomass

Year	Biomass M	SSB fem	SSB mal
1880	103,933	70,000	29,490
1881	103,803	69,930	29,457
1882	103,669	69,864	29,427
1883	103,530	69,768	29,400
1884	103,389	69,652	29,377
1885	103,249	69,527	29,358
1886	103,113	69,401	29,343
1887	102,984	69,280	29,329
1888	102,864	69,170	29,313
1889	102,750	69,077	29,290
1890	102,637	68,997	29,252
1891	102,640	68,936	29,201
1892	102,792	68,880	29,154
1893	103,107	68,889	29,111
1894	103,581	69,220	29,072
1895	104,196	69,805	29,035
1896	104,928	70,546	29,001
1897	105,749	71,380	28,972
1898	106,638	72,254	28,976
1899	107,570	73,119	29,041
1900	108,525	73,921	29,198
1901	109,485	74,619	29,469
1902	110,444	75,188	29,867
1903	111,320	75,712	30,228
1904	112,121	76,195	30,555
1905	112,855	76,640	30,852
1906	113,526	77,048	31,124
1907	114,140	77,422	31,372
1908	114,700	77,763	31,599
1909	115,201	78,075	31,807
1910	115,635	78,343	31,992
1911	116,006	78,572	32,153
1912	116,318	78,763	32,293
1913	116,573	78,918	32,412
1914	116,775	79,041	32,511
1915	116,926	79,133	32,592
1916	117,028	79,194	32,655
1917	117,084	79,227	32,701
1918	117,094	79,232	32,733
1919	117,081	79,208	32,750
1920	117,064	79,185	32,766
1921	117,042	79,159	32,781
1922	117,012	79,129	32,797
1923	116,972	79,091	32,814
1924	116,911	79,043	32,831
1925	116,816	78,970	32,842
1926	116,684	78,871	32,848
1927	116,512	78,743	32,847
1928	116,311	78,585	32,838
1929	116,079	78,413	32,830
1930	115,823	78,205	32,812
1931	115,555	77,995	32,802
1932	115,227	77,763	32,792
1933	114,804	77,461	32,760
1934	114,300	77,092	32,708
1935	113,694	76,671	32,643
1936	112,956	76,155	32,544
1937	112,100	75,549	32,413
1938	111,163	74,869	32,258
1939	110,084	74,147	32,093
1940	108,891	73,267	31,866
1941	107,629	72,386	31,651
1942	106,218	71,400	31,402
1943	104,652	70,307	31,119
1944	102,927	69,101	30,798
1945	101,036	67,779	30,438
1946	98,979	66,338	30,037
1947	96,755	64,778	29,596
1948	94,365	63,099	29,114
1949	91,802	61,302	28,589
1950	89,149	59,374	28,015
1951	86,417	57,444	27,452
1952	83,559	55,392	26,839
1953	80,601	53,284	26,205
1954	77,495	51,088	25,528
1955	74,249	48,783	24,788
1956	70,868	46,410	23,999
1957	67,354	43,943	23,138
1958	63,835	41,427	22,218
1959	60,296	38,989	21,302
1960	56,690	36,493	20,309
1961	53,086	34,023	19,279
1962	49,498	31,591	18,216
1963	45,904	29,204	17,122
1964	42,279	26,829	15,973
1965	38,674	24,471	14,772
1966	35,271	22,203	13,557
1967	32,177	20,174	12,427
1968	29,301	18,351	11,377
1969	26,537	16,641	10,355
1970	23,917	15,001	9,342
1971	21,445	13,498	8,393
1972	19,064	12,059	7,471
1973	16,866	10,676	6,581
1974	15,220	9,456	5,796
1975	13,675	8,260	5,029
1976	12,423	7,248	4,254
1977	11,638	7,137	3,583
1978	11,232	6,836	3,016
1979	11,093	6,682	2,527
1980	11,156	6,819	2,046
1981	11,619	7,116	1,664
1982	12,235	7,792	1,337
1983	11,945	8,329	1,051
1984	11,747	7,735	845
1985	11,869	9,314	811
1986	11,008	8,416	708
1987	10,995	8,126	688
1988	11,139	8,447	732
1989	10,865	8,425	796
1990	11,630	8,332	859
1991	12,481	8,552	937
1992	13,125	7,974	964
1993	13,675	9,461	976
1994	14,411	9,715	929
1995	15,204	9,446	885
1996	16,272	9,414	818
1997	18,607	12,031	817
1998	20,206	13,696	830
1999	21,167	13,714	814
2000	22,832	16,405	877
2001	23,970	17,789	1,037
2002	24,294	17,585	1,141
2003	23,450	17,904	1,257
2004	21,202	17,221	1,392

Stock Recruitment

Year	SSB fem	Recruits
1880	70,000	2,080,490
1881	69,930	2,081,060
1882	69,864	2,081,450
1883	69,768	2,081,860
1884	69,652	2,082,220
1885	69,527	2,082,560
1886	69,401	2,082,930
1887	69,280	2,083,370
1888	69,170	2,083,900
1889	69,077	2,084,510
1890	68,997	2,085,200
1891	68,936	2,454,360
1892	68,880	2,455,190
1893	68,889	2,456,060
1894	69,220	2,457,160
1895	69,805	2,459,330
1896	70,546	2,462,290
1897	71,380	2,465,690
1898	72,254	2,469,280
1899	73,119	2,472,850
1900	73,921	2,476,260
1901	74,619	2,479,320
1902	75,188	2,481,940
1903	75,712	2,484,040
1904	76,195	2,485,850
1905	76,640	2,487,360
1906	77,048	2,488,550
1907	77,422	2,489,410
1908	77,763	2,489,910
1909	78,075	2,490,020
1910	78,343	2,489,710
1911	78,572	2,488,900
1912	78,763	2,487,540
1913	78,918	2,485,580
1914	79,041	2,482,960
1915	79,133	2,479,620
1916	79,194	2,475,490
1917	79,227	2,470,490
1918	79,232	2,464,530
1919	79,208	2,457,510
1920	79,185	2,449,320
1921	79,159	2,439,950
1922	79,129	2,429,270
1923	79,091	2,417,120
1924	79,043	2,403,370
1925	78,970	2,387,880
1926	78,871	2,370,450
1927	78,743	2,350,940
1928	78,585	2,329,190
1929	78,413	2,305,050
1930	78,205	2,278,330
1931	77,995	2,248,760
1932	77,763	2,216,260
1933	77,461	2,180,550
1934	77,092	2,141,220
1935	76,671	2,098,150
1936	76,155	2,051,250
1937	75,549	2,000,190
1938	74,869	1,944,980
1939	74,147	1,885,530
1940	73,267	1,821,700
1941	72,386	1,752,890
1942	71,400	1,679,820
1943	70,307	1,602,070
1944	69,101	1,519,920
1945	67,779	1,433,620
1946	66,338	1,343,880
1947	64,778	1,251,770
1948	63,099	1,157,990
1949	61,302	1,063,560
1950	59,374	969,427
1951	57,444	876,431
1952	55,392	786,369
1953	53,284	700,299
1954	51,088	619,469
1955	48,783	545,192
1956	46,410	477,290
1957	43,943	415,774
1958	41,427	360,678
1959	38,989	312,750
1960	36,493	271,730
1961	34,023	237,815
1962	31,591	211,396
1963	29,204	199,337
1964	26,829	189,250
1965	24,471	168,905
1966	22,203	162,043
1967	20,174	153,620
1968	18,351	148,595
1969	16,641	141,949
1970	15,001	142,378
1971	13,498	134,321
1972	12,059	136,063
1973	10,676	130,923
1974	9,456	1,393,760
1975	8,260	203,892
1976	7,248	729,860
1977	7,137	1,269,520
1978	6,836	1,219,320
1979	6,682	1,541,200
1980	6,819	1,711,720
1981	7,116	2,093,990
1982	7,792	1,972,150
1983	8,329	1,363,300
1984	7,735	1,357,080
1985	9,314	1,251,930
1986	8,416	1,474,850
1987	8,126	1,191,200
1988	8,447	1,084,170
1989	8,425	790,066
1990	8,332	3,742,550
1991	8,552	1,591,890
1992	7,974	1,901,340
1993	9,461	2,099,210
1994	9,715	4,762,360
1995	9,446	2,678,930
1996	9,414	2,004,300
1997	12,031	5,641,670
1998	13,696	2,994,870
1999	13,714	1,781,380
2000	16,405	4,823,110
2001	17,789	3,306,640
2002	17,585	2,633,520
2003	17,904	2,290,620
2004	17,221	2,212,620

Fishing mortality rate

Year	fishing_pressures
1880	0.0011
1881	0.0010
1882	0.0009
1883	0.0008
1884	0.0007
1885	0.0006
1886	0.0005
1887	0.0004
1888	0.0003
1889	0.0003
1890	0.0003
1891	0.0003
1892	0.0004
1893	0.0004
1894	0.0004
1895	0.0005
1896	0.0005
1897	0.0005
1898	0.0005
1899	0.0006
1900	0.0006
1901	0.0006
1902	0.0007
1903	0.0007
1904	0.0008
1905	0.0008
1906	0.0009
1907	0.0009
1908	0.0009
1909	0.0012
1910	0.0014
1911	0.0017
1912	0.0019
1913	0.0022
1914	0.0024
1915	0.0026
1916	0.0029
1917	0.0031
1918	0.0034
1919	0.0032
1920	0.0031
1921	0.0029
1922	0.0028
1923	0.0026
1924	0.0026
1925	0.0027
1926	0.0027
1927	0.0027
1928	0.0024
1929	0.0024
1930	0.0019
1931	0.0015
1932	0.0018
1933	0.0020
1934	0.0020
1935	0.0025
1936	0.0029
1937	0.0031
1938	0.0027
1939	0.0040
1940	0.0029
1941	0.0033
1942	0.0036
1943	0.0040
1944	0.0043
1945	0.0047
1946	0.0051
1947	0.0054
1948	0.0058
1949	0.0064
1950	0.0048
1951	0.0053
1952	0.0048
1953	0.0050
1954	0.0060
1955	0.0065
1956	0.0081
1957	0.0094
1958	0.0084
1959	0.0112
1960	0.0127
1961	0.0147
1962	0.0173
1963	0.0223
1964	0.0290
1965	0.0344
1966	0.0348
1967	0.0371
1968	0.0427
1969	0.0518
1970	0.0587
1971	0.0728
1972	0.0908
1973	0.1037
1974	0.1309
1975	0.1691
1976	0.1856
1977	0.1963
1978	0.2120
1979	0.2456
1980	0.2597
1981	0.2430
1982	0.2963
1983	0.4281
1984	0.1943
1985	0.3839
1986	0.3058
1987	0.2306
1988	0.2743
1989	0.2630
1990	0.2076
1991	0.3181
1992	0.2707
1993	0.3351
1994	0.3464
1995	0.3709
1996	0.2700
1997	0.2745
1998	0.3353
1999	0.2634
2000	0.2735
2001	0.2908
2002	0.3189
2003	0.3484
2004	0.4189

Selectivity at age

Age	Headboat 1	Headboat	Headboat	Handline 1	Handline 2	Longline	MRFSS	Others
1	0.01236	0.00323	0.01058	0.00047	0.00005	0.00011	0.01939	0.00146
2	0.24768	0.15918	0.19920	0.00688	0.00166	0.00128	0.20228	0.01476
3	0.74870	0.70122	0.68564	0.06559	0.03593	0.01137	0.62465	0.13512
4	0.91398	0.91984	0.90239	0.29393	0.27382	0.06987	0.86857	0.67077
5	0.87298	0.93714	0.89968	0.59086	0.62018	0.24534	0.92370	0.89036
6	0.73961	0.90690	0.80100	0.78846	0.82626	0.48623	0.89188	0.74471
7	0.57248	0.83831	0.65221	0.88463	0.88388	0.68800	0.80459	0.57516
8	0.41829	0.73547	0.49959	0.92419	0.84883	0.82174	0.68423	0.40782
9	0.29738	0.61953	0.37045	0.93970	0.77084	0.90077	0.55958	0.26755
10	0.21003	0.50991	0.27157	0.94603	0.67587	0.94433	0.44848	0.16517
11	0.14935	0.41583	0.19950	0.94881	0.58421	0.96763	0.35724	0.09775
12	0.10794	0.33926	0.14816	0.95014	0.50245	0.98021	0.28547	0.05632

Table 7. Sensitivity case 5 25% increase of MRFSS catch estimates summary of main stock indicators from CASAL fit for gag GOM.…

Estimated Biomass

Year	Biomass MT	SSB fem
1963	29,554	20,240
1964	28,394	19,658
1965	27,152	18,916
1966	25,900	17,829
1967	24,781	16,742
1968	23,647	16,063
1969	22,383	15,327
1970	21,038	14,470
1971	19,613	13,503
1972	18,079	12,417
1973	16,539	11,313
1974	15,416	10,292
1975	14,270	9,184
1976	13,317	8,176
1977	12,715	8,141
1978	12,451	7,810
1979	12,445	7,623
1980	12,656	7,781
1981	13,340	8,126
1982	14,214	8,987
1983	13,913	9,698
1984	13,658	8,922
1985	13,798	10,834
1986	12,734	9,695
1987	12,739	9,355
1988	12,913	9,765
1989	12,595	9,705
1990	13,598	9,639
1991	14,696	9,997
1992	15,511	9,324
1993	16,230	11,161
1994	17,164	11,500
1995	18,151	11,199
1996	19,474	11,175
1997	22,355	14,375
1998	24,394	16,406
1999	25,726	16,548
2000	27,969	19,951
2001	29,686	21,804
2002	30,512	21,856
2003	29,941	22,631
2004	27,727	22,214

Stock Recruitment

Year	SSB fem	Recruits
1963	20,240	244,975
1964	19,658	244,059
1965	18,916	836,716
1966	17,829	379,478
1967	16,742	434,122
1968	16,063	248,863
1969	15,327	243,496
1970	14,470	318,953
1971	13,503	244,527
1972	12,417	280,608
1973	11,313	244,012
1974	10,292	1,607,510
1975	9,184	242,302
1976	8,176	848,983
1977	8,141	1,501,690
1978	7,810	1,450,390
1979	7,623	1,848,320
1980	7,781	2,054,500
1981	8,126	2,503,670
1982	8,987	2,349,390
1983	9,698	1,621,860
1984	8,922	1,605,600
1985	10,834	1,478,820
1986	9,695	1,743,600
1987	9,355	1,410,170
1988	9,765	1,289,320
1989	9,705	945,864
1990	9,639	4,497,010
1991	9,997	1,918,830
1992	9,324	2,296,390
1993	11,161	2,538,260
1994	11,500	5,760,040
1995	11,199	3,247,000
1996	11,175	2,435,940
1997	14,375	6,887,690
1998	16,406	3,683,750
1999	16,548	2,213,920
2000	19,951	6,061,470
2001	21,804	4,202,720
2002	21,856	3,384,530
2003	22,631	2,992,240
2004	22,214	2,968,710

Fishing mortality rate

Year	fishing_pressures
1963	0.0353
1964	0.0434
1965	0.0494
1966	0.0478
1967	0.0476
1968	0.0524
1969	0.0609
1970	0.0658
1971	0.0788
1972	0.0955
1973	0.1065
1974	0.1322
1975	0.1684
1976	0.1850
1977	0.1979
1978	0.2166
1979	0.2511
1980	0.2662
1981	0.2422
1982	0.2934
1983	0.4394
1984	0.1900
1985	0.3933
1986	0.3095
1987	0.2308
1988	0.2811
1989	0.2630
1990	0.2003
1991	0.3220
1992	0.2694
1993	0.3343
1994	0.3471
1995	0.3728
1996	0.2674
1997	0.2729
1998	0.3297
1999	0.2572
2000	0.2648
2001	0.2775
2002	0.3036
2003	0.3290
2004	0.3883

Selectivity at age

Age	Headboat 1	Headboat 2	Headboat 3	Handline 1	Handline 3	Longline	MRFSS	Others
1	0.01211	0.00320	0.01017	0.00044	0.00004	0.00010	0.01884	0.00139
2	0.24750	0.15866	0.19777	0.00659	0.00162	0.00124	0.19918	0.01436
3	0.74929	0.69979	0.68711	0.06437	0.03563	0.01114	0.62138	0.13463
4	0.91563	0.91914	0.90291	0.29298	0.27342	0.06897	0.86725	0.67303
5	0.88014	0.94223	0.89686	0.59141	0.62009	0.24383	0.92493	0.89350
6	0.75495	0.92140	0.79483	0.78959	0.82645	0.48491	0.89773	0.75287
7	0.59224	0.85895	0.64471	0.88562	0.88428	0.68718	0.81707	0.58651
8	0.43820	0.75221	0.49245	0.92484	0.84932	0.82135	0.70185	0.41949
9	0.31509	0.62712	0.36446	0.94008	0.77126	0.90064	0.57956	0.27723
10	0.22481	0.50829	0.26686	0.94625	0.67611	0.94434	0.46863	0.17207
11	0.16129	0.40688	0.19594	0.94894	0.58423	0.96769	0.37628	0.10221
12	0.11744	0.32533	0.14552	0.95022	0.50228	0.98028	0.30286	0.05903

Table 8. Sensitivity case 5 25% decrease of MRFSS catch estimates summary of main stock indicators from CASAL fit for gag GOM.

Estimated Biomass

Year	Biomass MT	SSB fem
1963	28,343	19,393
1964	27,287	18,889
1965	25,971	18,230
1966	24,568	17,227
1967	23,204	16,122
1968	21,816	14,990
1969	20,321	13,797
1970	18,774	12,546
1971	17,208	11,364
1972	15,591	10,219
1973	14,033	9,134
1974	12,834	8,236
1975	11,658	7,320
1976	10,672	6,502
1977	10,052	6,382
1978	9,728	6,105
1979	9,589	5,945
1980	9,587	5,996
1981	9,879	6,185
1982	10,264	6,635
1983	9,999	6,978
1984	9,862	6,567
1985	9,969	7,814
1986	9,313	7,163
1987	9,285	6,927
1988	9,401	7,161
1989	9,177	7,179
1990	9,715	7,060
1991	10,342	7,145
1992	10,845	6,675
1993	11,269	7,843
1994	11,885	8,051
1995	12,586	7,867
1996	13,521	7,910
1997	15,493	10,080
1998	16,878	11,532
1999	17,731	11,604
2000	19,184	13,864
2001	20,212	15,084
2002	20,597	14,963
2003	20,129	15,358
2004	18,610	15,046

Stock Recruitment

Year	SSB fem	Recruits
1963	19,393	215,311
1964	18,889	215,314
1965	18,230	212,756
1966	17,227	209,324
1967	16,122	203,838
1968	14,990	197,392
1969	13,797	190,317
1970	12,546	182,263
1971	11,364	173,092
1972	10,219	163,644
1973	9,134	153,660
1974	8,236	1,125,250
1975	7,320	160,640
1976	6,502	581,035
1977	6,382	1,016,330
1978	6,105	971,788
1979	5,945	1,228,250
1980	5,996	1,368,650
1981	6,185	1,689,930
1982	6,635	1,595,600
1983	6,978	1,107,410
1984	6,567	1,110,370
1985	7,814	1,025,100
1986	7,163	1,207,070
1987	6,927	973,649
1988	7,161	881,504
1989	7,179	638,639
1990	7,060	3,016,930
1991	7,145	1,282,690
1992	6,675	1,535,330
1993	7,843	1,701,190
1994	8,051	3,867,620
1995	7,867	2,177,930
1996	7,910	1,632,470
1997	10,080	4,596,020
1998	11,532	2,439,450
1999	11,604	1,454,540
2000	13,864	3,960,080
2001	15,084	2,736,560
2002	14,963	2,192,020
2003	15,358	1,914,910
2004	15,046	1,908,600

Fishing mortality rate

Year	fishing_pressures
1963	0.0307
1964	0.0384
1965	0.0436
1966	0.0407
1967	0.0395
1968	0.0445
1969	0.0540
1970	0.0595
1971	0.0727
1972	0.0892
1973	0.0972
1974	0.1204
1975	0.1547
1976	0.1680
1977	0.1773
1978	0.1918
1979	0.2284
1980	0.2445
1981	0.2413
1982	0.2976
1983	0.4077
1984	0.1987
1985	0.3673
1986	0.2978
1987	0.2306
1988	0.2621
1989	0.2601
1990	0.2164
1991	0.3087
1992	0.2681
1993	0.3303
1994	0.3380
1995	0.3571
1996	0.2631
1997	0.2646
1998	0.3264
1999	0.2551
2000	0.2649
2001	0.2836
2002	0.3048
2003	0.3261
2004	0.3852

Selectivity at age

Age	Headboat 1	Headboat 2	Headboat 3	Handline 1	Handline 3	Longline	MRFSS	Others
1	0.01224	0.00340	0.01060	0.00052	0.00005	0.00011	0.01904	0.00145
2	0.25311	0.16061	0.19973	0.00729	0.00180	0.00137	0.21233	0.01495
3	0.75718	0.70041	0.68764	0.06727	0.03722	0.01202	0.64683	0.13943
4	0.91359	0.91919	0.90178	0.29521	0.27519	0.07269	0.87953	0.68734
5	0.86262	0.93619	0.88882	0.59010	0.61975	0.25103	0.92456	0.88663
6	0.71974	0.90268	0.77567	0.78689	0.82553	0.49223	0.88666	0.74006
7	0.54808	0.82702	0.61794	0.88325	0.88337	0.69262	0.79357	0.57020
8	0.39443	0.71624	0.46393	0.92329	0.84881	0.82478	0.66974	0.40337
9	0.27662	0.59491	0.33802	0.93916	0.77118	0.90255	0.54374	0.26412
10	0.19299	0.48288	0.24404	0.94571	0.67617	0.94530	0.43290	0.16283
11	0.13580	0.38859	0.17694	0.94862	0.58446	0.96814	0.34276	0.09628
12	0.09730	0.31311	0.12999	0.95001	0.50267	0.98049	0.27242	0.05545

Table 9. Retrospective analysis results applied to base case 1..

Retrospective Analysis Case 1

	2004	2003	2002	2001	2000
Biomass unexploited	87514.3	87478.2	89596.4	95476.7	92925.7
Biomass 1963	22295.4	23087.6	22687.7	22653.4	21977.5
steepness	0.75140	0.72123	0.71586	0.66718	0.69361

Total Population

Year	2004	2003	2002	2001	2000
1963	3895560	4033980	3964110	3958110	3840010
1964	3467740	3572010	3519860	3517940	3435920
1965	3112070	3189830	3151410	3152650	3099010
1966	2807910	2864170	2836600	2840250	2808810
1967	2559040	2597530	2578710	2584130	2570850
1968	2350840	2374290	2362590	2369000	2370570
1969	2164410	2175010	2169060	2175710	2189710
1970	1989690	1989110	1987910	1993900	2018530
1971	1831650	1821670	1823920	1828980	1862610
1972	1678570	1660320	1665330	1668480	1710120
1973	1528300	1503810	1509940	1511520	1559360
1974	1392810	1363500	1369630	1369460	1422580
1975	2203630	2183600	2192780	2192250	2206500
1976	1865410	1853490	1856980	1856810	1864680
1977	1980130	1973120	1976740	1975270	1976150
1978	2463950	2460030	2464740	2464680	2454820
1979	2764090	2761110	2766880	2767860	2753260
1980	3186200	3183120	3191290	3193830	3174710
1981	3594190	3590860	3599810	3602050	3585490
1982	4223120	4222090	4231350	4233470	4217440
1983	4493190	4489950	4499780	4503450	4480460
1984	3838230	3830090	3837370	3838850	3821420
1985	3903940	3894350	3901500	3904220	3883380
1986	3407090	3393500	3399830	3403190	3380910
1987	3427560	3410690	3416490	3419670	3391480
1988	3376970	3358310	3363580	3367070	3333180
1989	3156900	3135020	3139360	3143030	3104930
1990	2808780	2785370	2788700	2791600	2752660
1991	4955750	4913220	4914130	4914690	4831530
1992	4678250	4627280	4625810	4623430	4540310
1993	4771200	4705590	4701950	4716020	4605100
1994	4799070	4707670	4706630	4743500	4630910
1995	6855920	6708540	6749500	6853580	6657340
1996	6692020	6498290	6530280	6622430	6296720
1997	6279950	6025110	5990650	6043870	5652750
1998	8740810	8162830	7914340	7829800	6740520
1999	8321170	7480980	6892880	6577470	5486330
2000	7265820	6319000	5842730	5741010	6412800
2001	8864030	7111170	6346310	4479640	
2002	8864890	6873610	5447410		
2003	8182330	5420080			
2004	7270450				

Total Biomass

Year	2004	2003	2002	2001	2000
1963	32603	33766	33179	33130	32140
1964	31433	32566	31994	31949	30991
1965	29961	31046	30499	30459	29554
1966	28363	29381	28869	28836	28002
1967	26773	27708	27238	27215	26467
1968	25133	25975	25551	25538	24889
1969	23370	24110	23737	23734	23191
1970	21547	22179	21859	21865	21433
1971	19703	20225	19957	19970	19650
1972	17804	18217	18001	18018	17809
1973	15966	16275	16105	16126	16022
1974	14565	14780	14654	14676	14656
1975	13219	13359	13269	13289	13328
1976	12116	12201	12138	12156	12229
1977	11438	11484	11441	11457	11544
1978	11105	11124	11097	11112	11198
1979	11016	11015	11003	11017	11094
1980	11110	11097	11097	11111	11173
1981	11592	11572	11582	11597	11643
1982	12219	12195	12215	12231	12256
1983	11935	11907	11934	11952	11957
1984	11739	11704	11737	11756	11744
1985	11863	11821	11858	11879	11847
1986	11002	10950	10990	11014	10962
1987	10991	10926	10969	10995	10921
1988	11137	11058	11103	11130	11031
1989	10866	10772	10816	10846	10720
1990	11638	11521	11564	11595	11424
1991	12503	12357	12398	12427	12204
1992	13164	12979	13015	13048	12759
1993	13737	13498	13529	13577	13214
1994	14513	14191	14233	14332	13858
1995	15356	14921	14980	15142	14493
1996	16484	15892	15945	16162	15280
1997	18910	18011	17961	18172	16738
1998	20620	19241	18902	18981	16852
1999	21710	19712	19030	18994	16776
2000	23555	20538	19350	18482	16935
2001	24924	20618	18600	16321	
2002	25525	19470	17333		
2003	25002	17803			
2004	23101				

SSB females

Year	2004	2003	2002	2001	2000
1963	22295.4	23087.6	22687.7	22653.4	21977.5
1964	21751.4	22543.5	22143.5	22109.3	21434.9
1965	21035.5	21820	21423.5	21390.3	20725.9
1966	19896.9	20635.9	20262.6	20235	19620.4
1967	18596.6	19261.2	18926.1	18907.4	18373.2
1968	17238.9	17812.7	17524	17515.9	17078.2
1969	15805	16279.6	16041.2	16044	15710
1970	14315.4	14689.6	14501.5	14514.3	14283.5
1971	12907	13185.3	13044.2	13064.9	12931.2
1972	11554.9	11747.7	11647.3	11672.7	11624.5
1973	10288.3	10410.3	10341.7	10368.3	10390.7
1974	9233.11	9298.81	9253.29	9277.56	9356.44
1975	8166.66	8184.59	8156.43	8176.54	8303.76
1976	7245.28	7227.76	7212.12	7227.27	7384.05
1977	7175.06	7139.79	7133.99	7144.74	7290.4
1978	6884.28	6843.56	6840.44	6849.6	6980.59
1979	6721.32	6682.2	6681.35	6688.45	6801.84
1980	6842.91	6808.3	6810.2	6817.15	6905.35
1981	7125.88	7094.96	7100.87	7109.99	7172.82
1982	7792.77	7764.17	7776	7787.99	7825.12
1983	8324.31	8297.76	8315.97	8330.56	8348.79
1984	7727.71	7702.9	7727.14	7745.18	7753.54
1985	9306.27	9276.14	9304.14	9323.92	9313.1
1986	8408.69	8371.79	8403.89	8425.05	8402.21
1987	8119.61	8073.2	8107.01	8130.12	8093.34
1988	8442.02	8383.99	8418.6	8443.23	8388.12
1989	8421.54	8350.41	8385.28	8411.05	8334.25
1990	8330.85	8245.5	8279.36	8306.43	8205.03
1991	8554.24	8454.15	8485.96	8513.71	8385.51
1992	7983.23	7867.63	7897.89	7927.4	7767.81
1993	9489.7	9336.5	9359.96	9384.37	9159.92
1994	9764.86	9565.37	9581.33	9606.69	9312.36
1995	9521.29	9262.62	9271.77	9319.73	8942.71
1996	9528.3	9184.03	9202.05	9308.97	8837.07
1997	12212.7	11723.1	11780.1	11990.1	11321.9
1998	13953.4	13271.5	13341.3	13630.1	12636.5
1999	14057.1	13076.8	13040.4	13323	11811.7
2000	16886.6	15282.3	14871.9	14962.9	12376.2
2001	18422.4	15974.5	14928.5	14681.1	
2002	18384.3	14923.6	13356.6		
2003	18962.6	13848.9			
2004	18591.6				

Recruits

Year	2004	2003	2002	2001	2000
1963	214586	194653	205512	209727	235244
1964	214574	194815	205527	209680	235483
1965	213181	193529	203801	207775	232399
1966	211267	191805	201668	205339	229539
1967	208019	188549	198021	201031	224552
1968	203970	184502	193519	195692	218839
1969	199294	179591	188332	189294	212345
1970	193783	174421	182265	182609	205231
1971	187283	167677	175170	173917	196744
1972	180294	161762	167587	166175	187994
1973	172637	155057	159364	157209	178505
1974	1393800	1393830	1401890	1401300	1365580
1975	202205	204783	202688	203081	195324
1976	721440	723927	727260	724876	711676
1977	1267200	1269960	1274210	1275680	1253310
1978	1216470	1218610	1223250	1225110	1206330
1979	1541900	1543550	1550400	1553260	1532980
1980	1712720	1714500	1720030	1721300	1708810
1981	2094330	2098810	2103480	2104790	2093610
1982	1972460	1972590	1978090	1981860	1961110
1983	1364890	1363130	1365820	1365320	1356180
1984	1358380	1355960	1358150	1360130	1348660
1985	1252910	1248690	1250870	1252710	1239060
1986	1476470	1471080	1472590	1473540	1456500
1987	1192730	1188100	1189140	1190490	1173690
1988	1086810	1080770	1081330	1082290	1065050
1989	793166	788147	787972	787596	774922
1990	3761120	3732900	3730570	3728550	3660220
1991	1602020	1585850	1584530	1582770	1555540
1992	1916250	1889480	1886980	1906950	1849470
1993	2119320	2075490	2078690	2113220	2080910
1994	4814020	4725740	4781940	4884220	4746930
1995	2712410	2625730	2631890	2653820	2438840
1996	2033390	1916040	1841700	1815600	1653520
1997	5741390	5269920	4981380	4812080	3810980
1998	3062170	2576450	2054020	1714410	1400230
1999	1833230	1482970	1444150	1605500	3611490
2000	5007130	3733970	3227430	900619	2732670
2001	3467710	2702450	1639560	173308	
2002	2789170	1300560	3688920		
2003	2452980	4346640			
2004	2344190				

Fishing mortality rate

Year	2004	2003	2002	2001	2000
1963	0.0295	0.0285	0.0290	0.0290	0.0296
1964	0.0364	0.0352	0.0358	0.0359	0.0366
1965	0.0413	0.0399	0.0406	0.0407	0.0415
1966	0.0393	0.0380	0.0387	0.0387	0.0394
1967	0.0393	0.0381	0.0389	0.0388	0.0389
1968	0.0448	0.0436	0.0444	0.0443	0.0440
1969	0.0544	0.0532	0.0540	0.0539	0.0532
1970	0.0612	0.0602	0.0610	0.0608	0.0594
1971	0.0756	0.0747	0.0755	0.0752	0.0728
1972	0.0935	0.0929	0.0937	0.0933	0.0897
1973	0.1050	0.1052	0.1058	0.1053	0.0999
1974	0.1309	0.1317	0.1323	0.1318	0.1242
1975	0.1675	0.1691	0.1695	0.1689	0.1589
1976	0.1828	0.1848	0.1849	0.1846	0.1740
1977	0.1935	0.1955	0.1956	0.1954	0.1859
1978	0.2098	0.2116	0.2116	0.2113	0.2029
1979	0.2445	0.2458	0.2457	0.2455	0.2379
1980	0.2594	0.2603	0.2601	0.2599	0.2536
1981	0.2432	0.2436	0.2430	0.2428	0.2403
1982	0.2965	0.2968	0.2958	0.2954	0.2936
1983	0.4283	0.4288	0.4274	0.4270	0.4227
1984	0.1944	0.1947	0.1937	0.1934	0.1931
1985	0.3841	0.3849	0.3835	0.3831	0.3809
1986	0.3060	0.3071	0.3059	0.3053	0.3041
1987	0.2308	0.2319	0.2309	0.2303	0.2307
1988	0.2745	0.2762	0.2751	0.2745	0.2737
1989	0.2630	0.2651	0.2641	0.2634	0.2636
1990	0.2076	0.2095	0.2084	0.2077	0.2101
1991	0.3180	0.3212	0.3201	0.3190	0.3206
1992	0.2702	0.2736	0.2725	0.2718	0.2742
1993	0.3339	0.3388	0.3378	0.3373	0.3421
1994	0.3444	0.3510	0.3503	0.3493	0.3572
1995	0.3677	0.3770	0.3760	0.3732	0.3846
1996	0.2667	0.2755	0.2741	0.2709	0.2819
1997	0.2704	0.2811	0.2795	0.2752	0.2898
1998	0.3292	0.3463	0.3456	0.3397	0.3669
1999	0.2572	0.2772	0.2808	0.2779	0.3155
2000	0.2657	0.2947	0.3058	0.3063	0.3589
2001	0.2808	0.3258	0.3502	0.3623	
2002	0.3053	0.3800	0.4311		
2003	0.3293	0.4533			
2004	0.3889				

Table 10. Estimated deterministic benchmark statistics from the base scenarios and sensitivity run for gag GOM, assuming a Beverton & Holt Stock recruitment relationship for all time series.

	Base Run	Base A Run	Case 3	Case 4	Case 5	Case 6
Model	**1963-04 final MRFSS**	**1963-04 final MRFSS 2% inc q's**	**1880-04 MRFSS 45-04**	**1880-04 MRFSS 45-04 2% inc q's**	**1963-04 25% Inc MRFSS catch**	**1963-04 25% dec MRFSS catch**
steepness	0.7514	0.7418	0.7429	0.7199	0.9900	0.6634
SSB_0	87,514	89,391	70,000	70,000	64,362	107,757
MSY	3,748	3,788	2,975	2,898	3,492	4,110
SSB_{MSY}	26,732	27,419	21,533	21,951	14,310	35,276
Fmsy	0.132	0.131	0.131	0.125	0.228	0.110
$F_{30\%SPR}$	0.167	0.167	0.167	0.167	0.168	0.166
Fmax	0.237	0.235	0.236	0.237	0.255	0.524
$F_{0.1}$	0.126	0.126	0.125	0.125	0.126	0.124
$SSB_{30\%SPR}$						
SSB_{2004}	18,592	17,247	18,548	17,221	22,214	15,046
F_{2004}	0.389	0.419	0.389	0.419	0.388	0.385
F_{2004}/F_{msy}	2.936	3.207	2.983	3.355	1.704	3.490
$F_{2004}/F_{30\%SPR}$	2.332	2.511	2.335	2.512	2.306	2.325
F_{2004}/F_{max}	1.642	1.780	1.650	1.769	1.522	0.735
SSB_{2004}/SSB_0	21.2%	19.3%	26.5%	24.6%	34.5%	14.0%
SSB_{2004}/SSB_{MSY}	69.5%	62.9%	86.1%	78.5%	155.2%	42.7%

Table 11. Estimated deterministic benchmark statistics from the base scenarios and sensitivity run for gag GOM, assuming a Beverton & Holt Stock recruitment relationship for 1983-2004 years.

	Base Run	Base A Run	Case 3	Case 4	Case 5	Case 6
Model	**1963-04 final MRFSS**	**1963-04 final MRFSS 2% inc q's**	**1880-04 MRFSS 45-04**	**1880-04 MRFSS 45-04 2% inc q's**	**1963-04 25% Inc MRFSS catch**	**1963-04 25% dec MRFSS catch**
steepness	0.7032	0.7110	0.7006	0.7098	0.7013	0.6995
SSB_0	219,209	194,744	226,547	197,111	287,040	167,258
MSY	8,877	7,964	9,165	8,065	11,702	6,681
SSB_{MSY}	69,726	61,578	72,486	62,358	91,918	53,329
Fmsy	0.120	0.122	0.120	0.122	0.120	0.119
$F_{30\%SPR}$	0.167	0.167	0.167	0.167	0.168	0.166
Fmax	0.236	0.638	0.616	0.633	0.634	0.649
$F_{0.1}$	0.125	0.125	0.125	0.125	0.126	0.124
$SSB_{30\%SPR}$						
SSB_{2004}	18,592	17,247	18,548	17,221	22,214	15,046
F_{2004}	0.389	0.419	0.389	0.419	0.388	0.385
F_{2004}/F_{msy}	3.229	3.422	3.255	3.424	3.224	3.249
$F_{2004}/F_{30\%SPR}$	2.333	2.511	2.335	2.512	2.306	2.325
F_{2004}/F_{max}	1.647	0.656	0.632	0.662	0.613	0.594
SSB_{2004}/SSB_0	8.5%	8.9%	8.2%	8.7%	7.7%	9.0%
SSB_{2004}/SSB_{MSY}	26.7%	28.0%	25.6%	27.6%	24.2%	28.2%

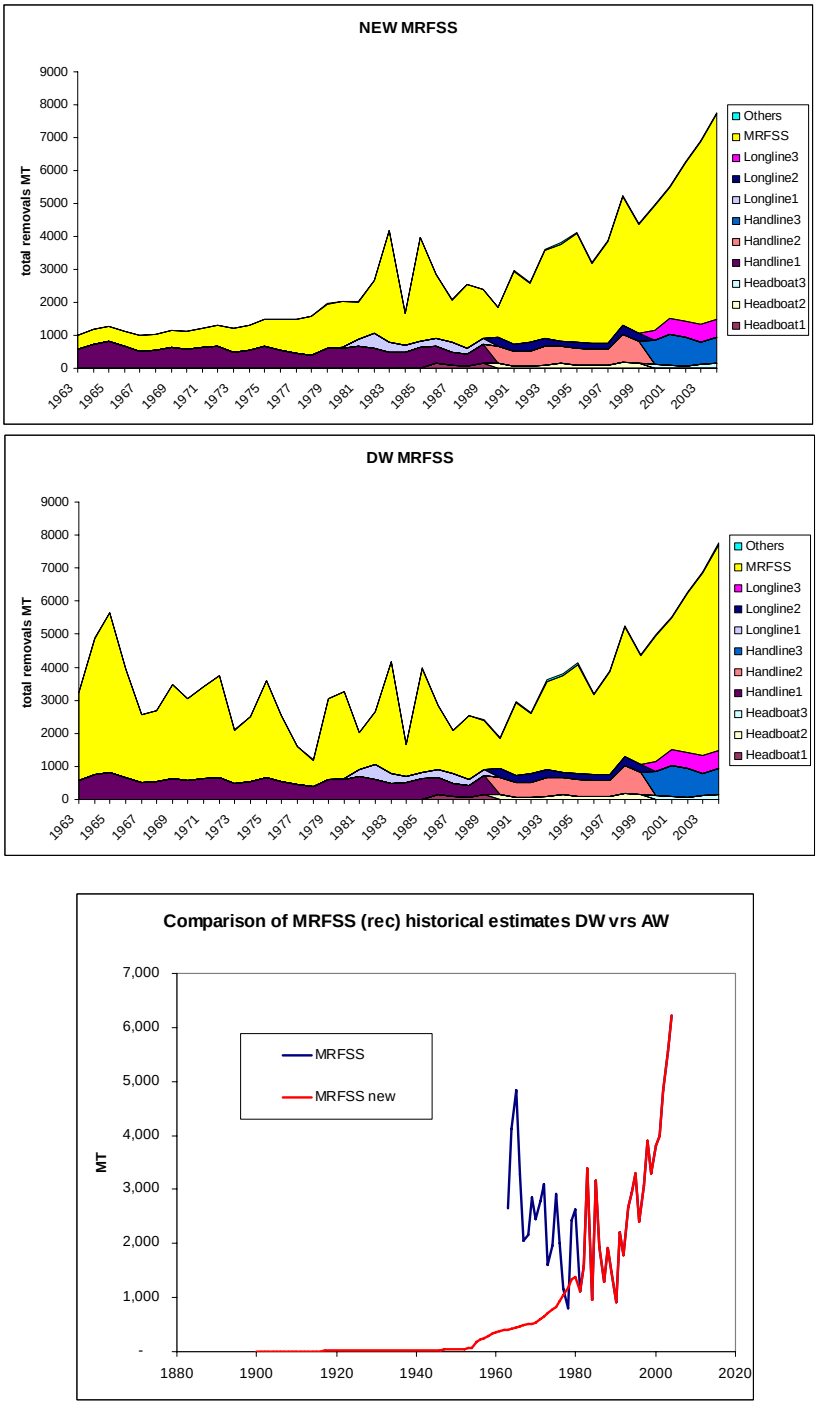


Figure 1. Comparison of recreational historic catch estimated by the recreational group Data Workshop and the Assessment workshop group for gag GOM .

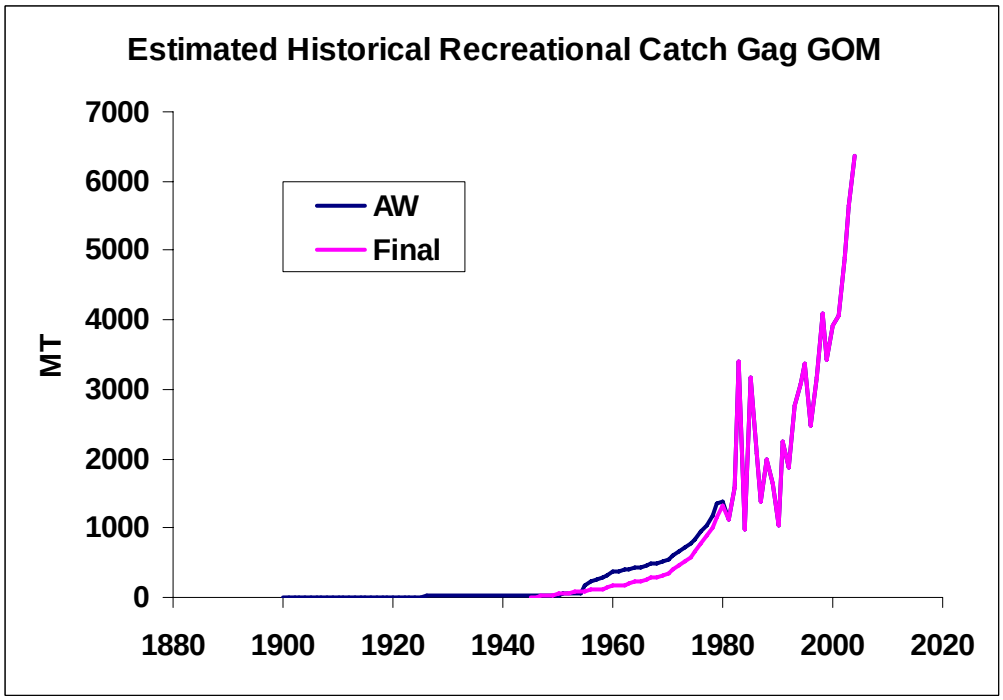


Figure 3. Final estimates of recreational historic catch for gag GOM and initial version during the AW meeting.

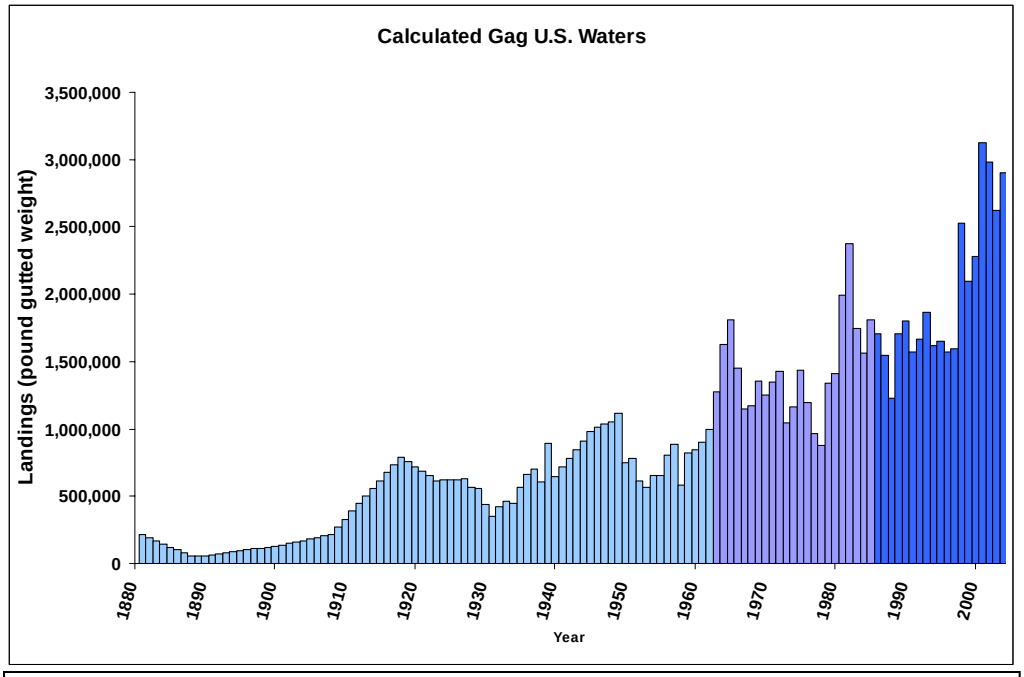


Figure 2. Estimated historic commercial catch for gag GOM from 1880 to 1962.

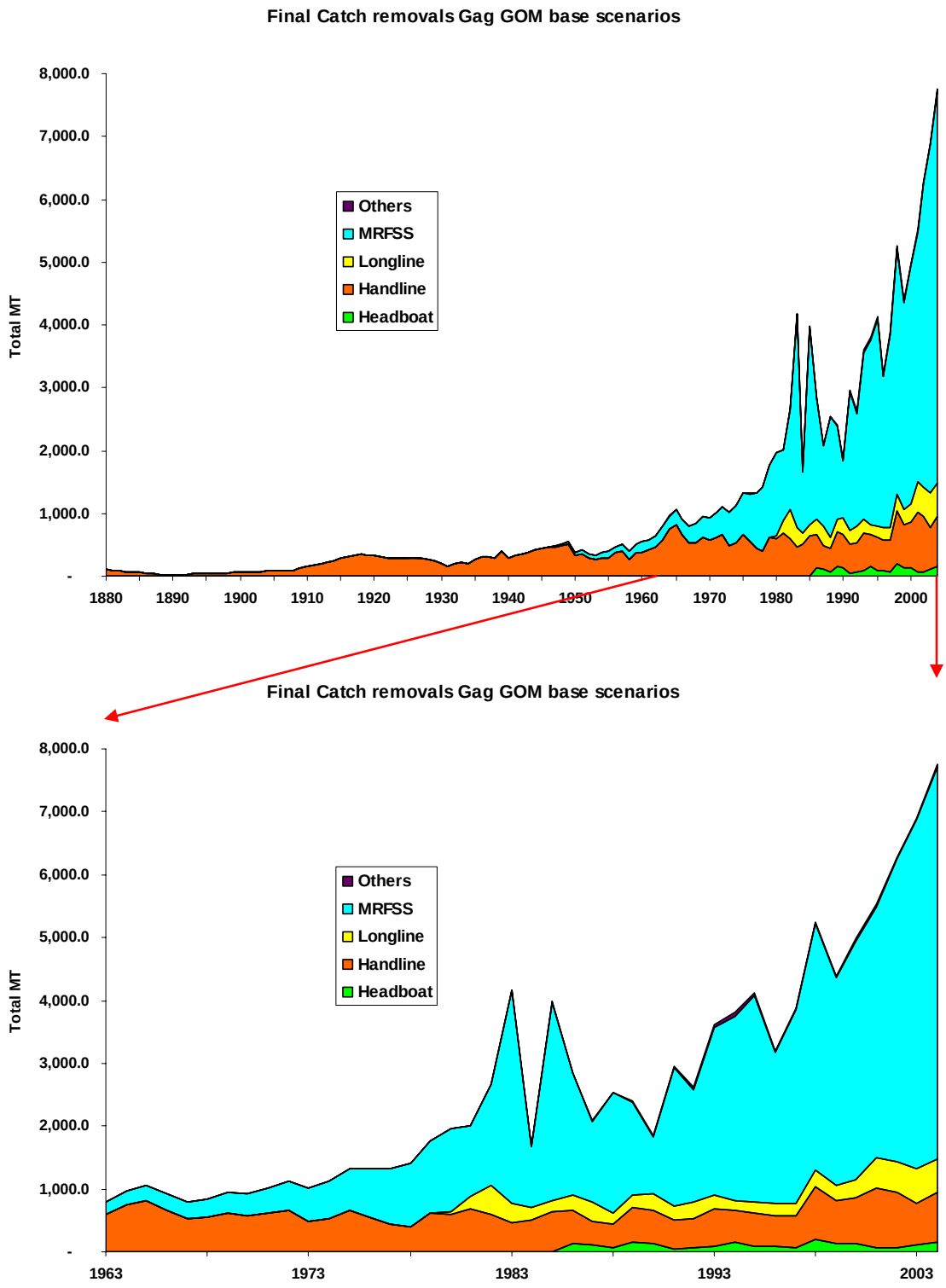
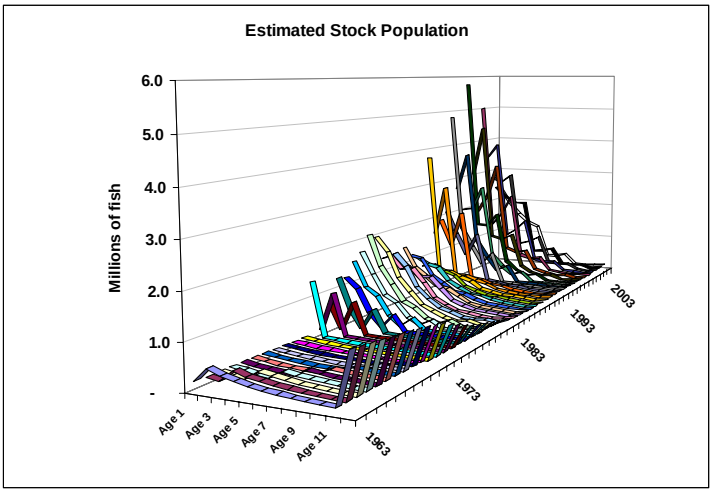
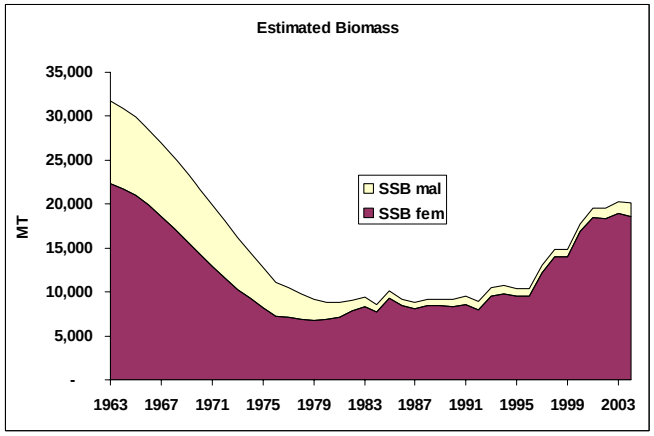
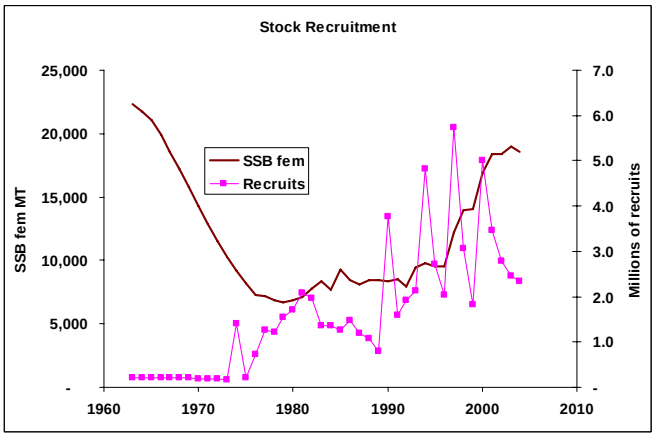
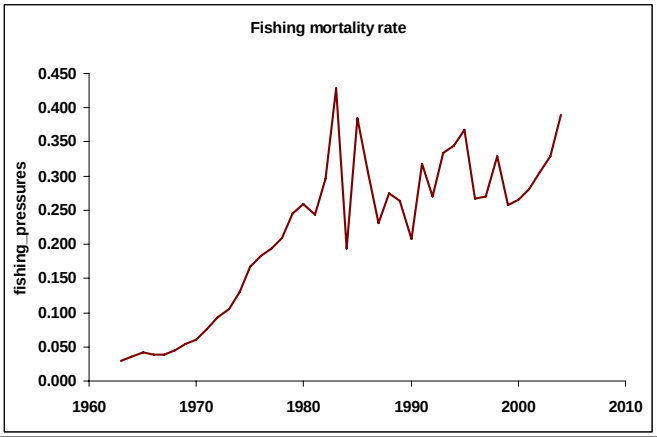


Figure 4. Final catch series for gag GOM including commercial and recreational historic estimates.









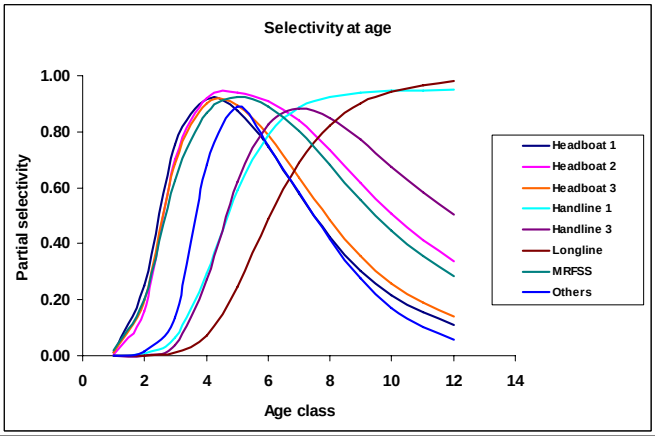
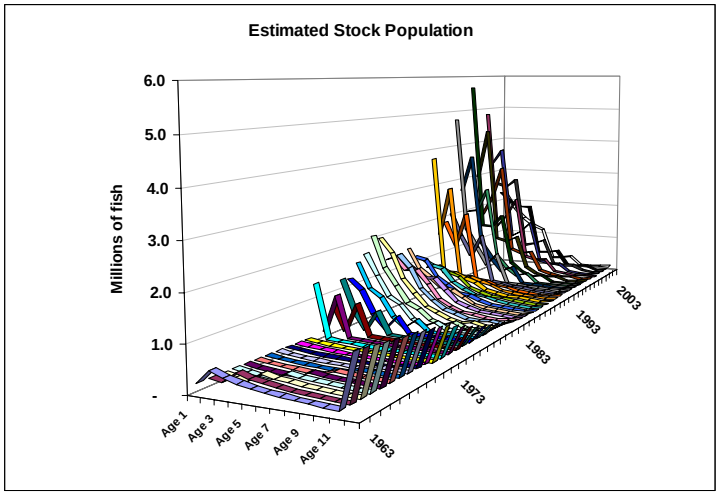
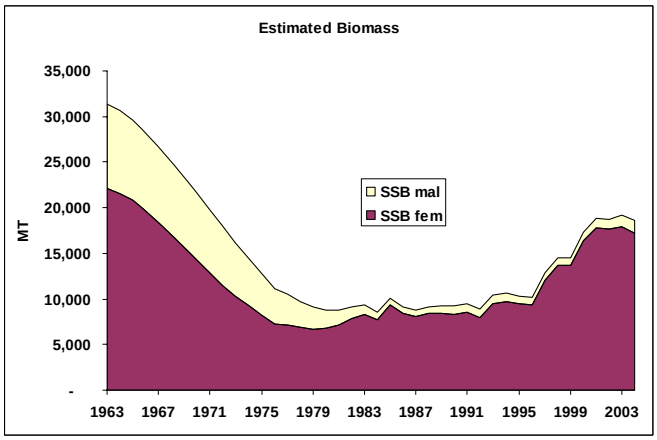
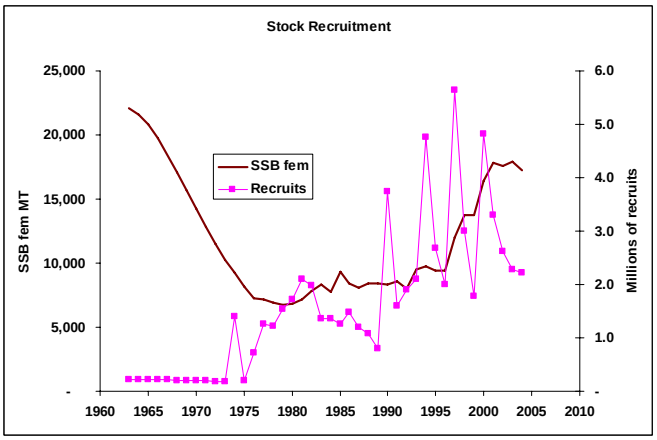
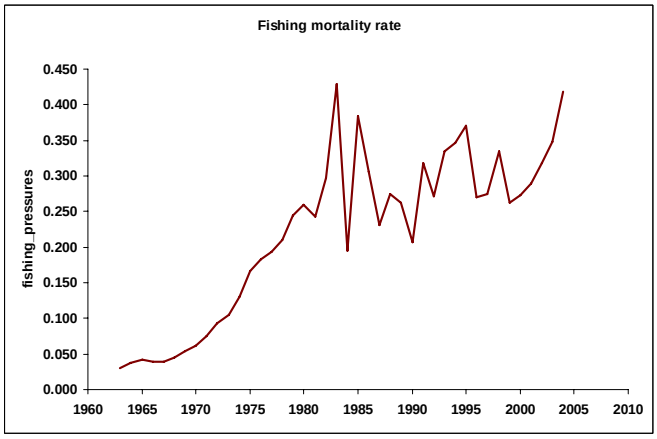


Figure 5. Gag GOM trends of stock size, spawning biomass by sex, recruits, fishing mortality and selectivity at age patterns estimated by the base case 1 scenario.









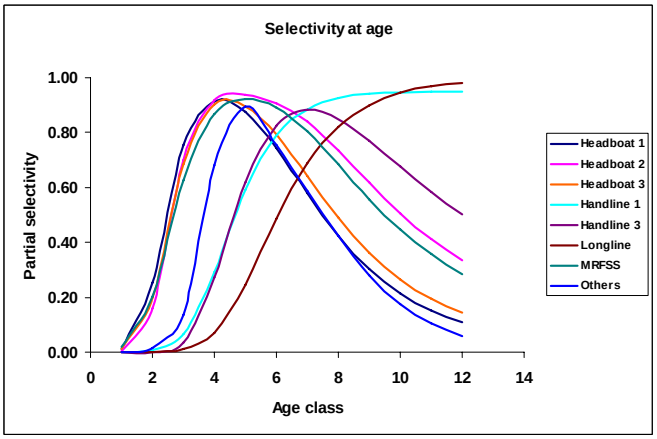
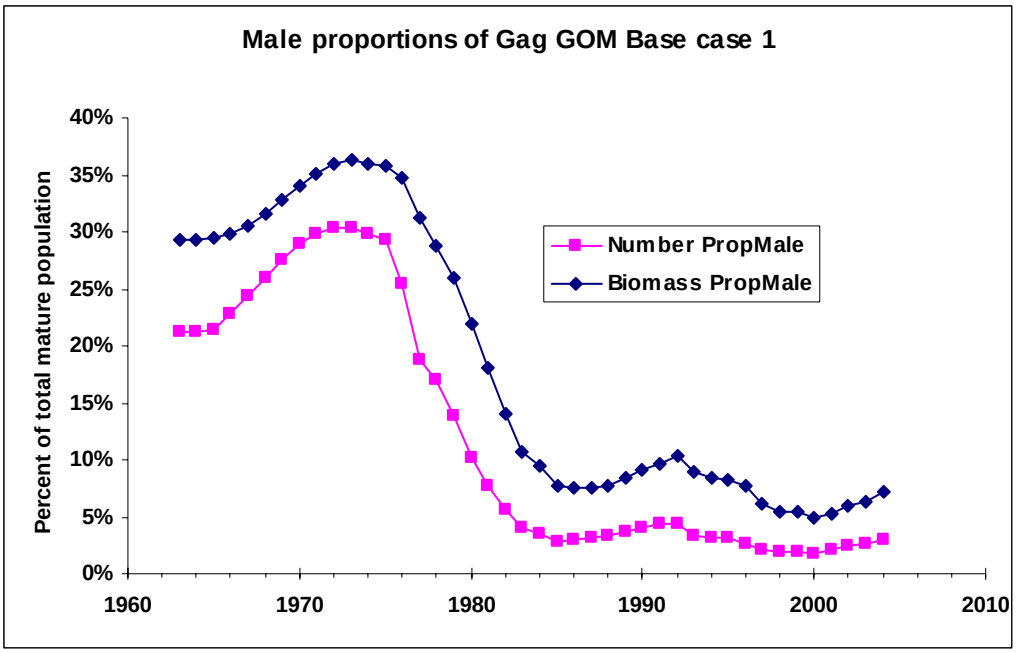


Figure 6. Gag GOM trends of stock size, spawning biomass by sex, recruits, fishing mortality and selectivity at age patterns estimated by the base case 2 scenario.



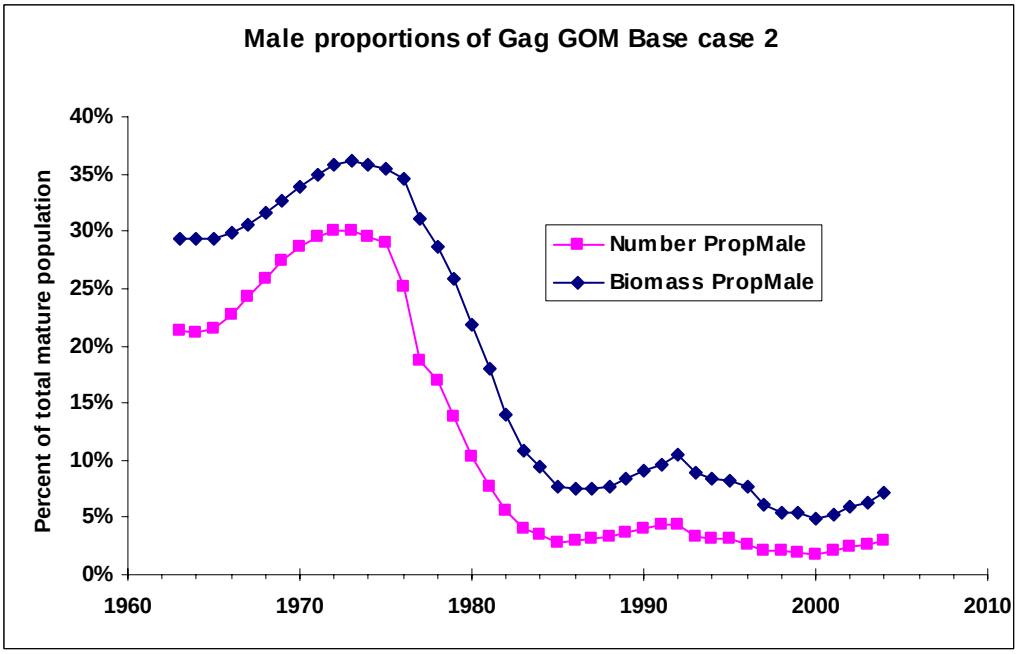


Figure 7. Trends of percent males of mature population in numbers and biomass for gag GOM base case scenarios.

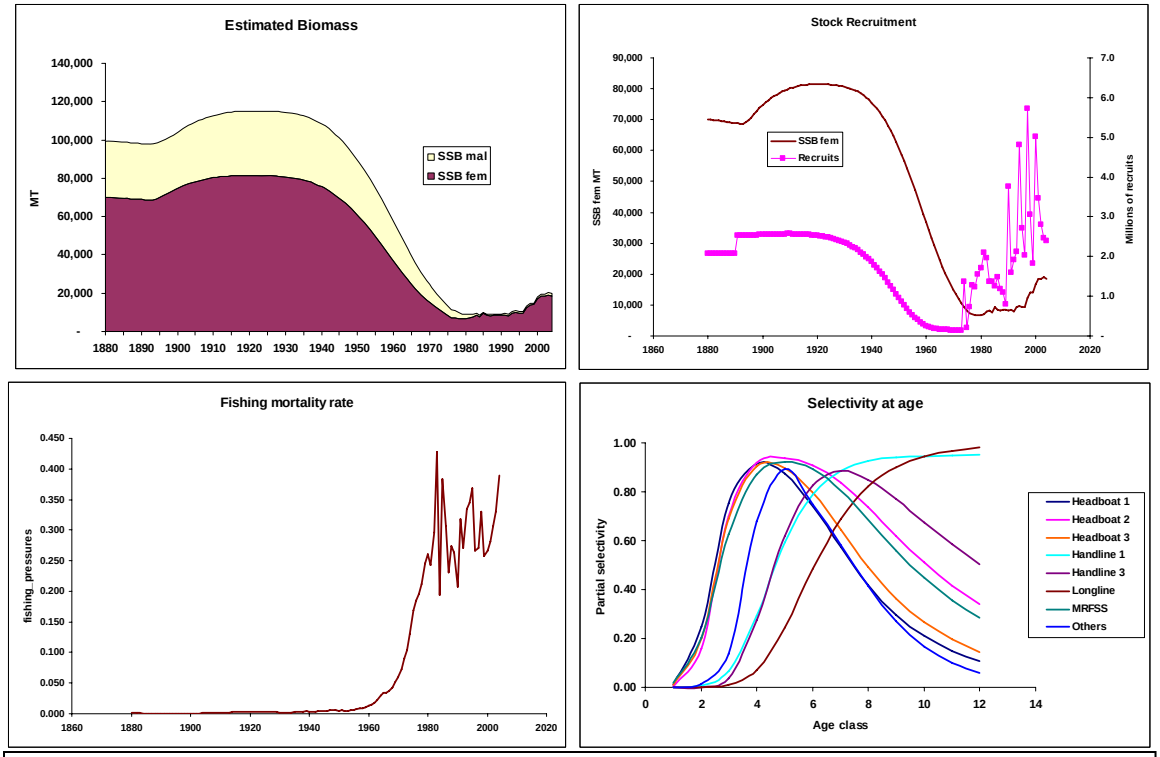


Figure 8. Gag GOM trends of stock size, spawning biomass by sex, recruits, fishing mortality and selectivity at age patterns estimated by the case 3 extended historic catch series 1880-2004.

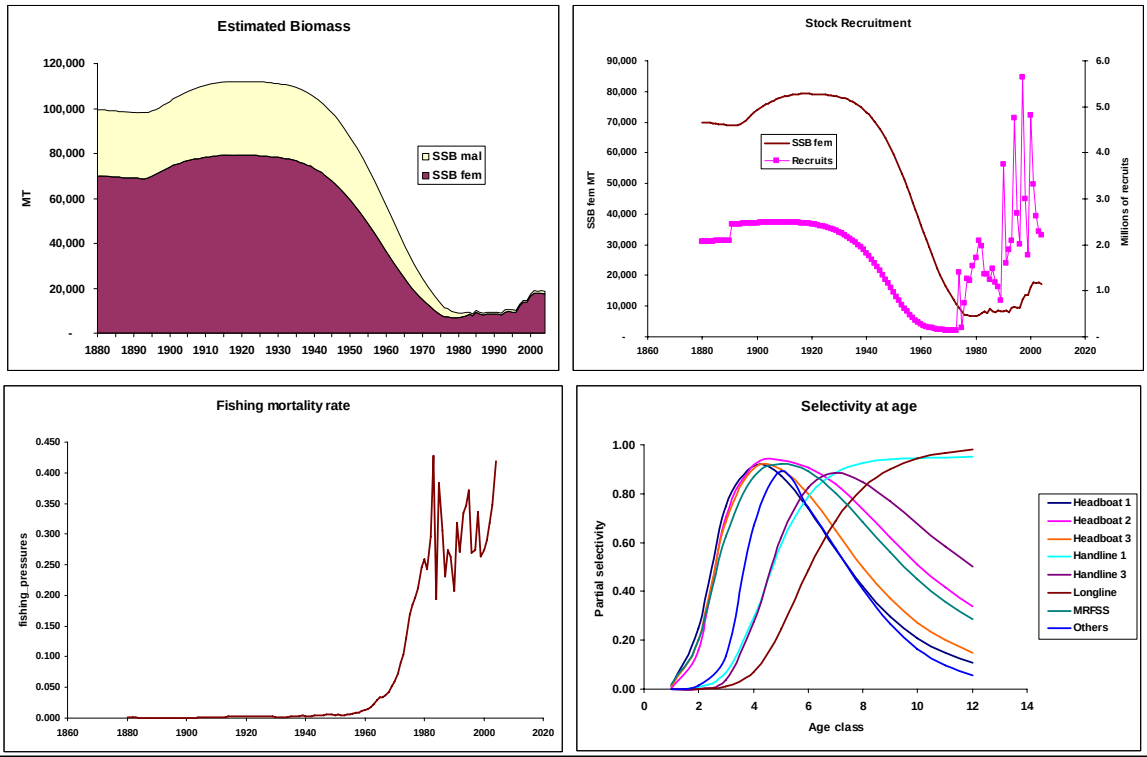


Figure 9. Gag GOM trends of stock size, spawning biomass by sex, recruits, fishing mortality and selectivity at age patterns estimated by the case 4 extended historic catch series 1880-2004 increasing catchability.

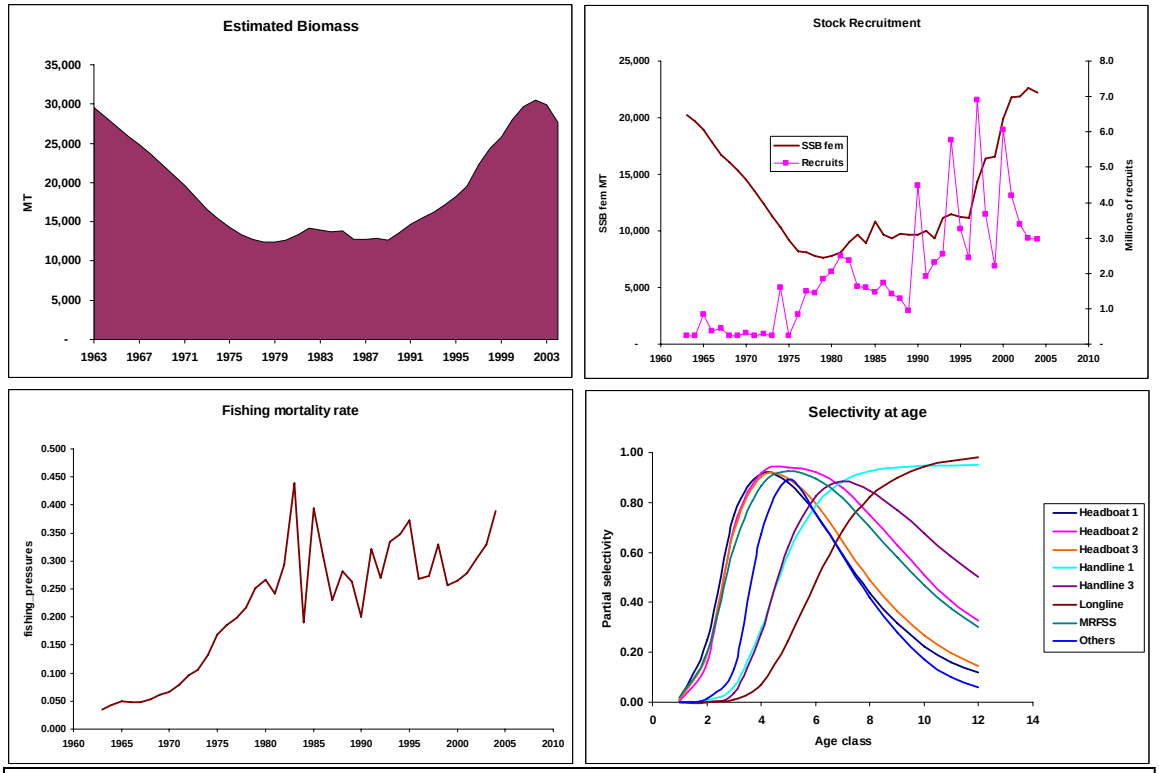


Figure 11. Gag GOM trends of stock size, spawning biomass, recruits, fishing mortality and selectivity at age patterns estimated by the case5 increase MRFSS catch by 25% 1963-2004.

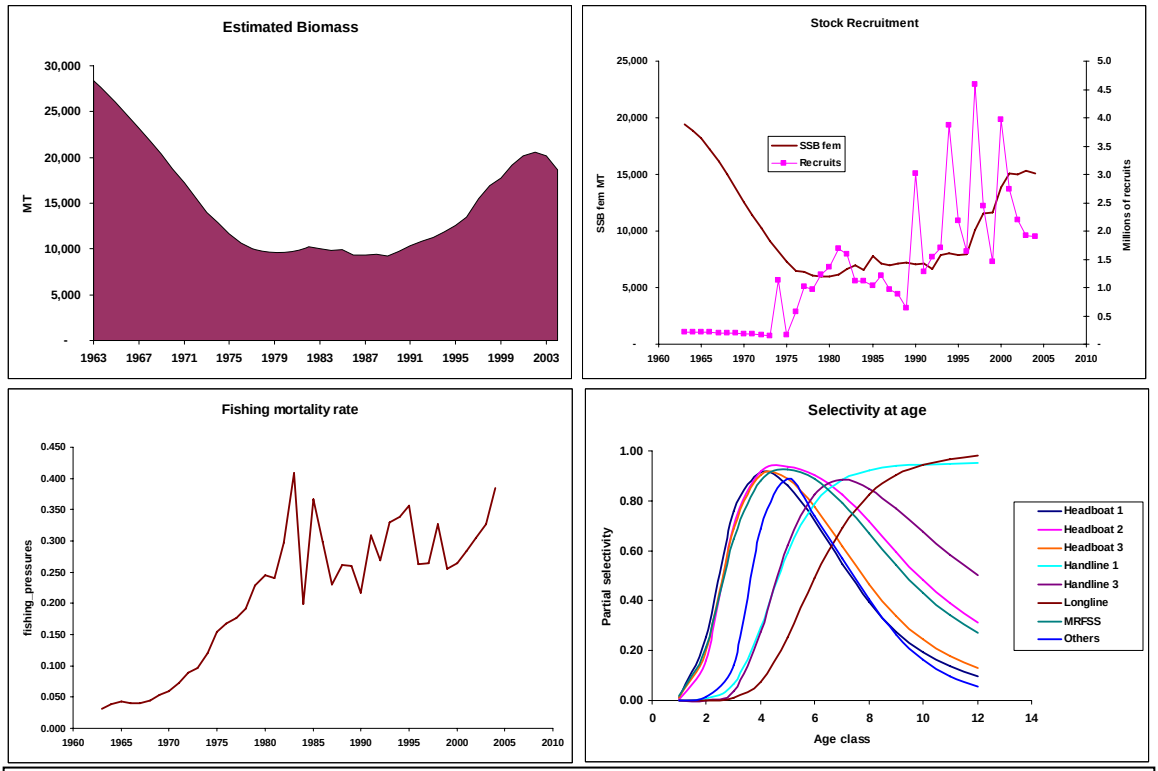


Figure 10. Gag GOM trends of stock size, spawning biomass, recruits, fishing mortality and selectivity at age patterns estimated by the case5 decrease MRFSS catch by 25% 1963-2004.

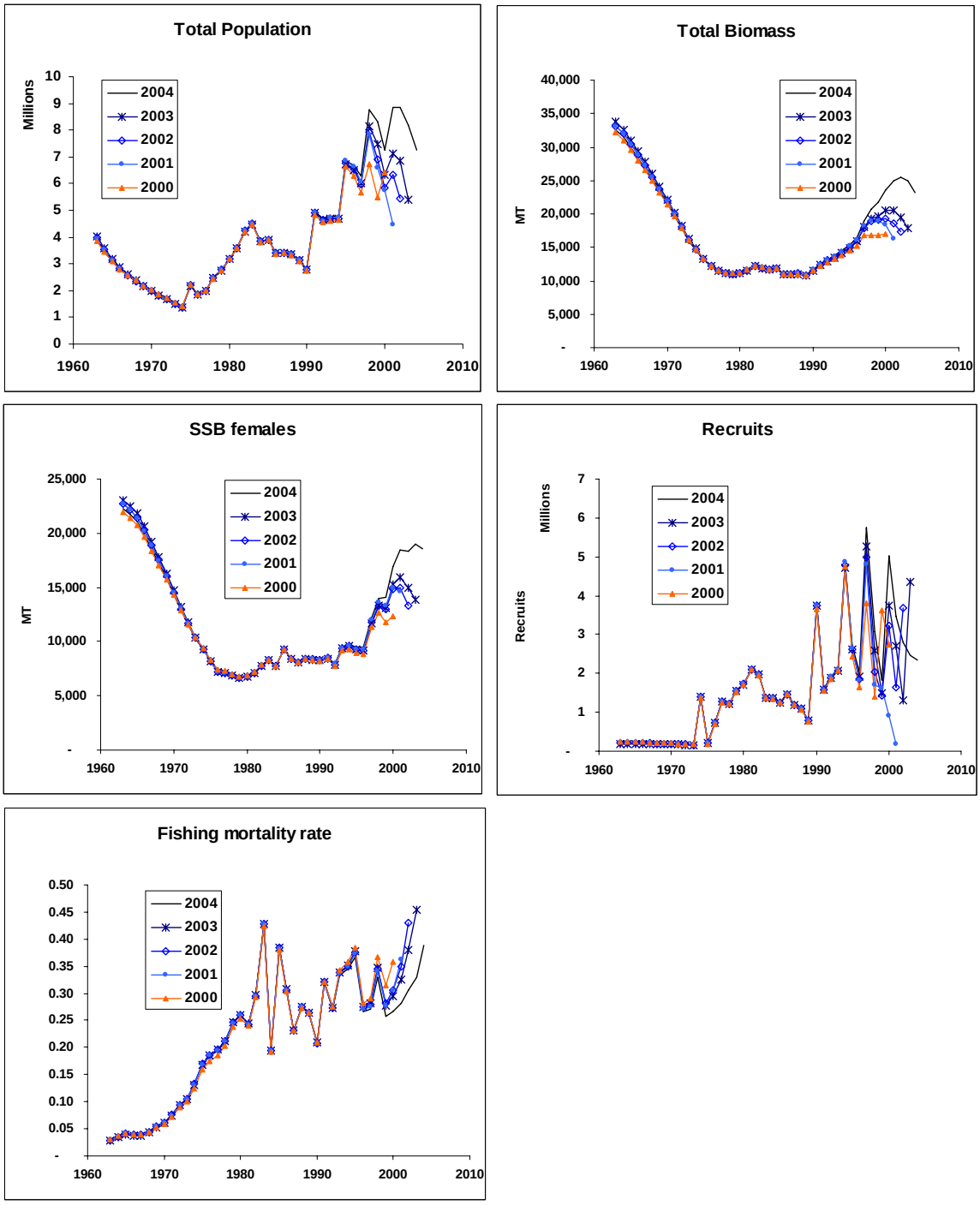


Figure 12. Retrospective analysis plots. Comparison of estimated total population, biomass, spawning biomass, recruits and fishing mortality rates for the base case 1 scenario.

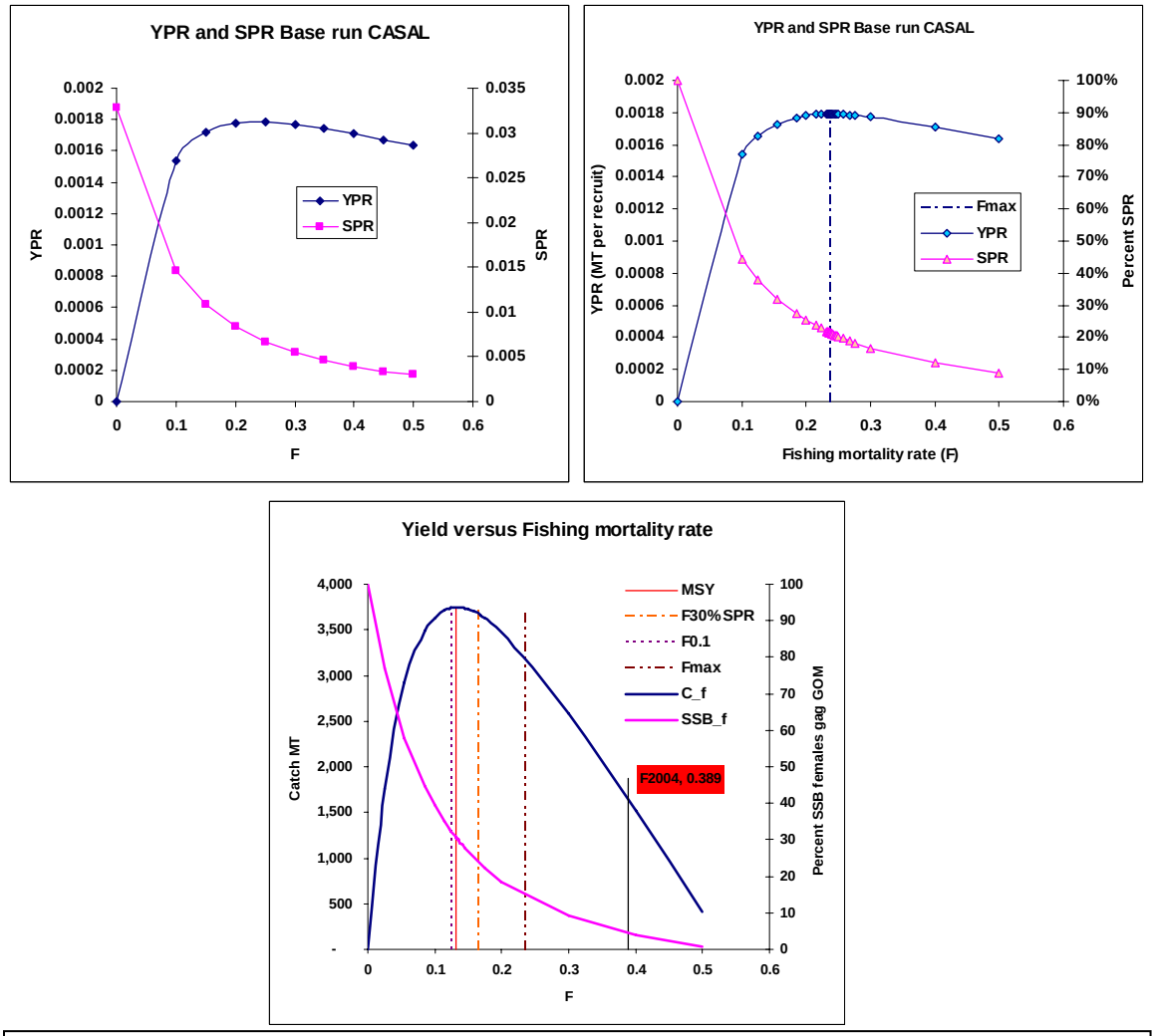


Figure 13. Yield per recruit and spawner per recruit deterministic plots for gag GOM estimated from the base case 1 scenario with projections of Beverton & Holt SR relationship all years. Bottom plot shows the catch and percent spawning biomass versus F with estimated F benchmarks, $F_{0.1}$, F_{MSY}, $F_{30\%SPR}$ and F_{Max}, also plotted is the F_{2004}.

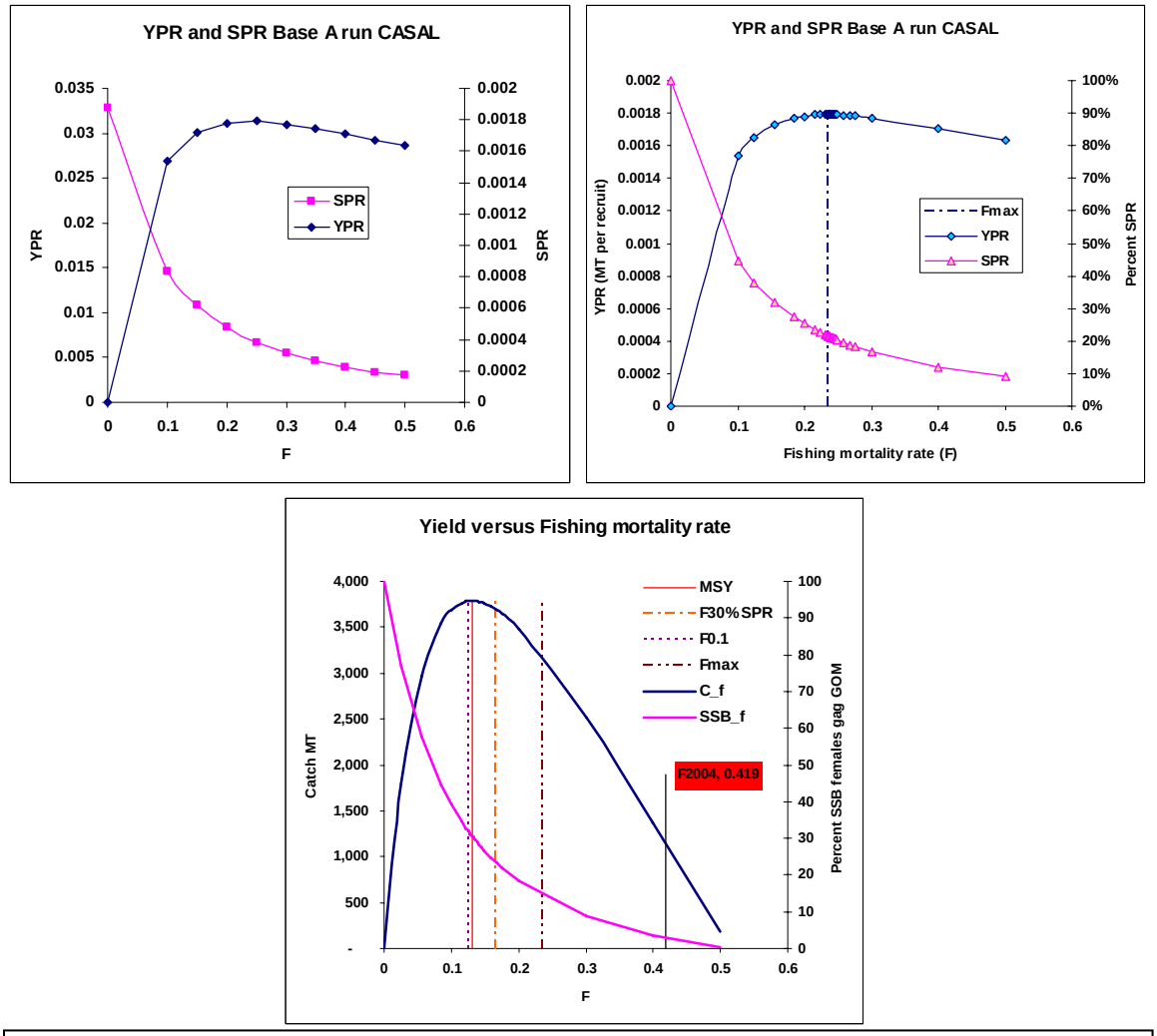


Figure 14. Yield per recruit and spawner per recruit deterministic plots for gag GOM estimated from the base case 2 scenario with projections of Beverton & Holt SR relationship all years. Bottom plot shows the catch and percent spawning biomass versus F with estimated F benchmarks, $F_{0.1}$, F_{MSY}, $F_{30\%SPR}$ and F_{Max}, also plotted is the F_{2004}.

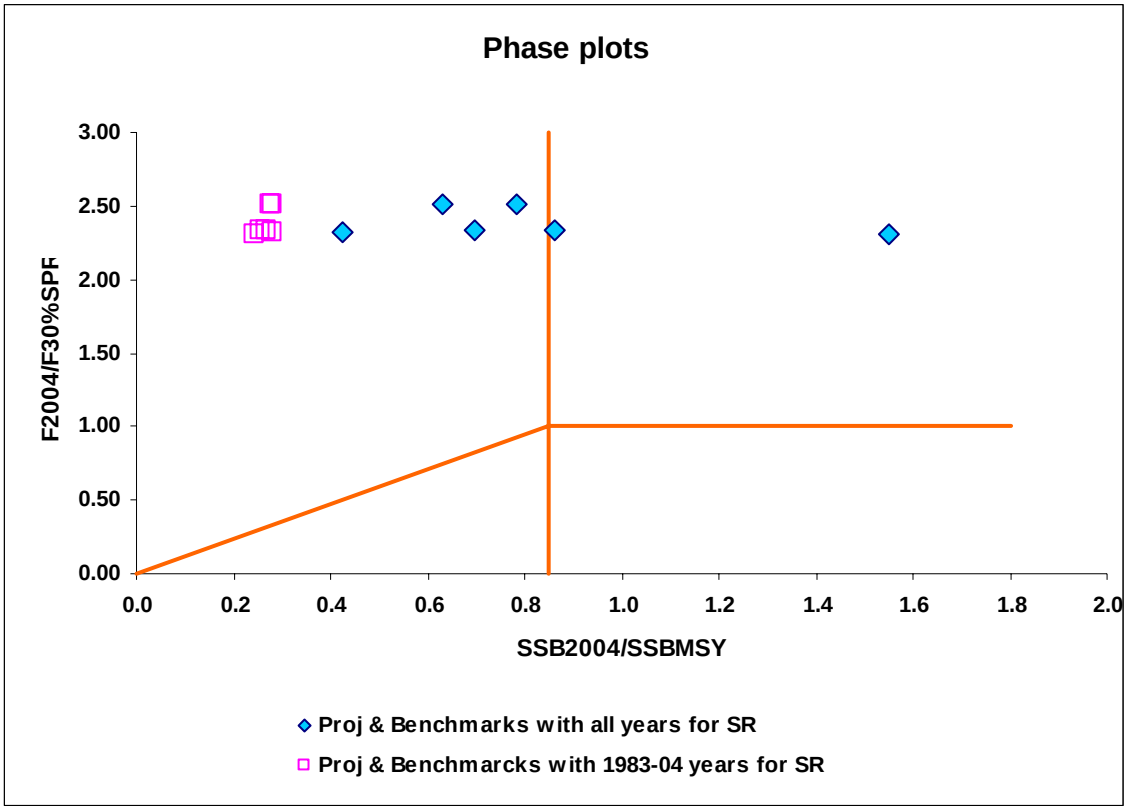
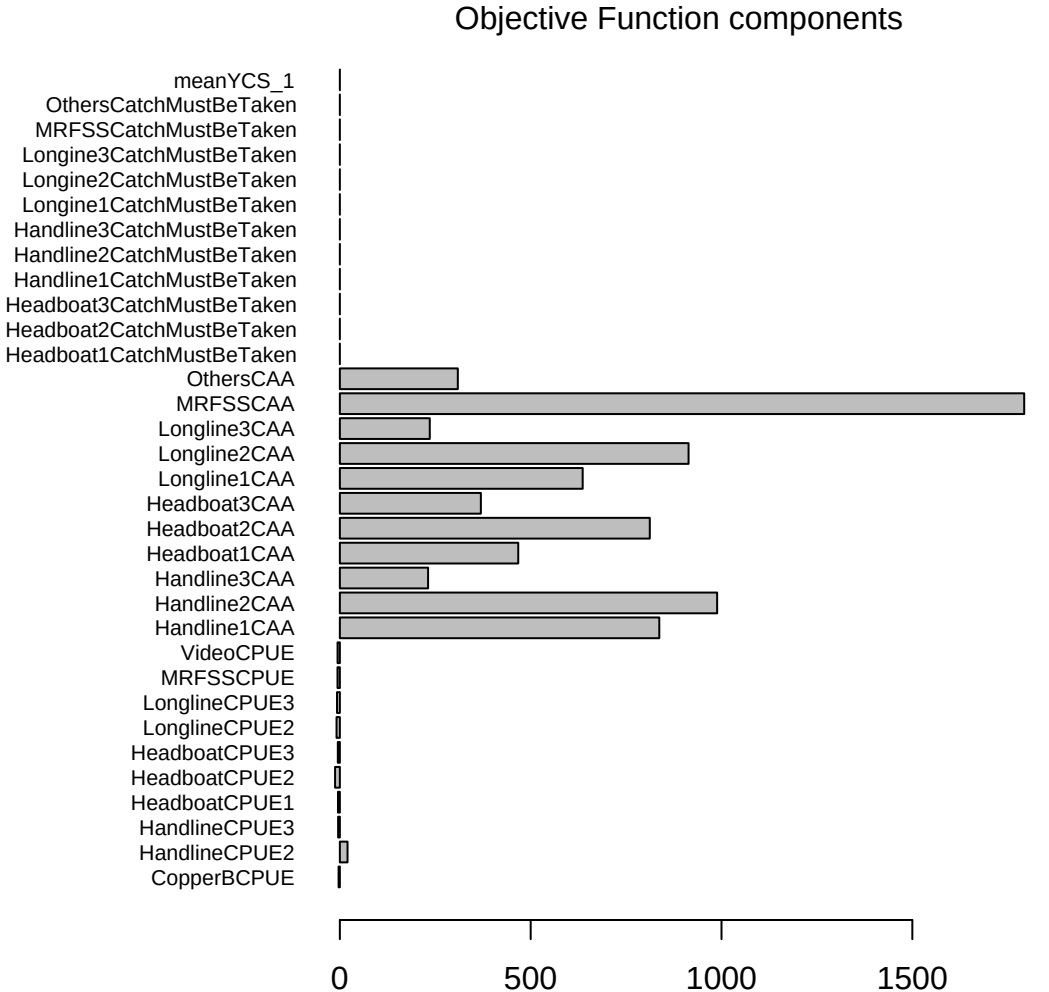
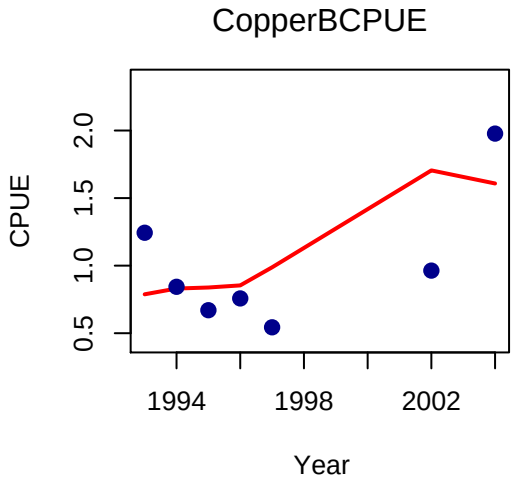
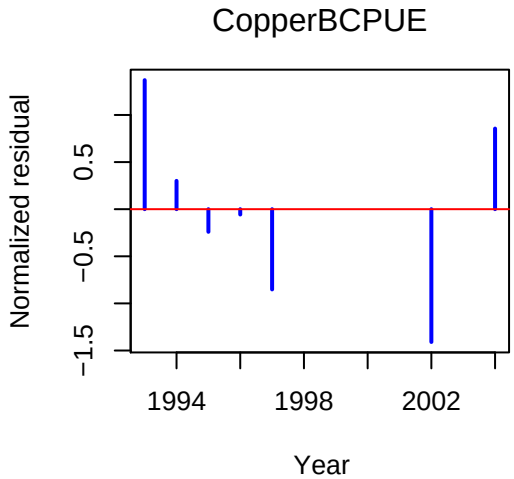
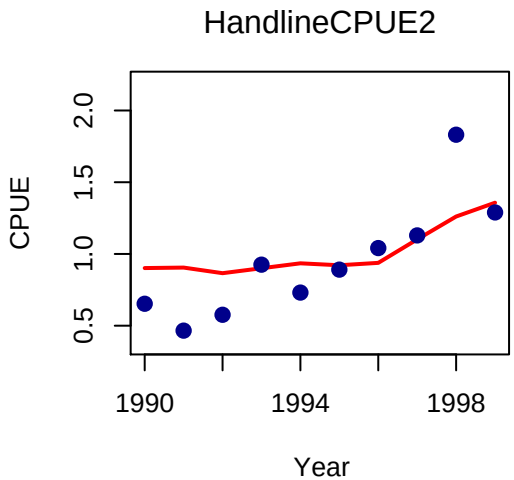


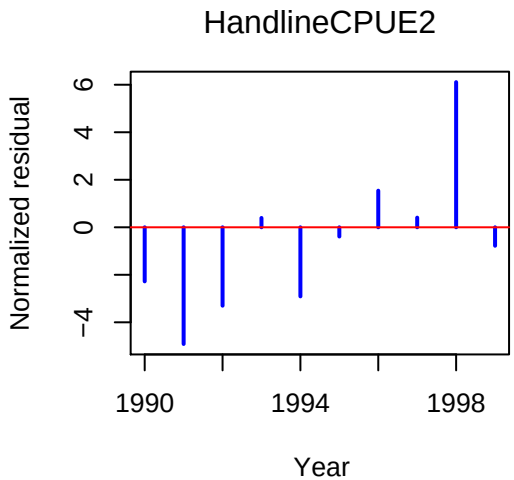
Figure 15. Preliminary phase plot of gag GOM status. Diamonds represent status based on projections and estimation of benchmarks using B&H SR with all years in time series. Squares represent status based on projections and estimation of benchmarks using B&H SR with 1983-2004 years only. Spawning biomass refers to female component.

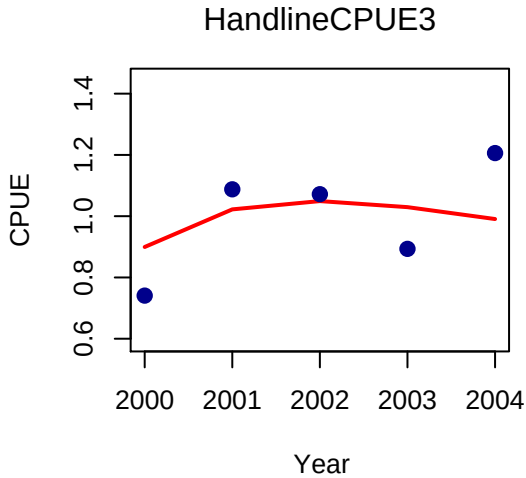

Objective Function components
meanYCS_1
OthersCatchMustBeTaken
MRFSSCatchMustBeTaken
Longine3CatchMustBeTaken
Longine2CatchMustBeTaken
Longine1CatchMustBeTaken
Handline3CatchMustBeTaken
Handline2CatchMustBeTaken
Handline1CatchMustBeTaken
Headboat3CatchMustBeTaken
Headboat2CatchMustBeTaken
Headboat1CatchMustBeTaken
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

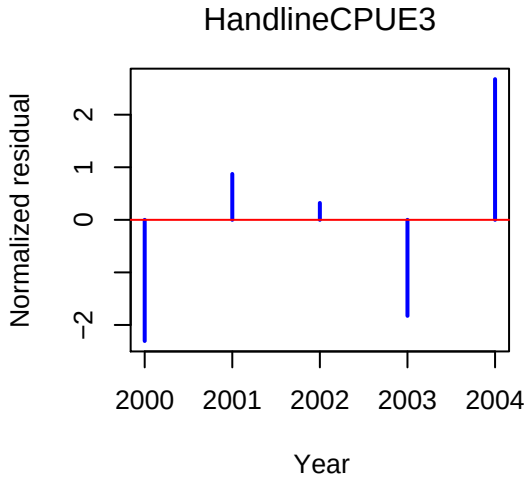

CopperBCPUE
CPUE
0.5
1.0
1.5
2.0
1994
1998
2002
Year

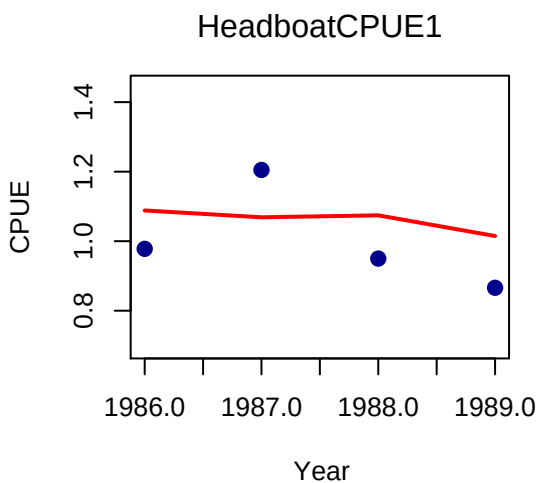

CopperBCPUE
Normalized residual
−1.5
−0.5
0.5
1994
1998
2002
Year

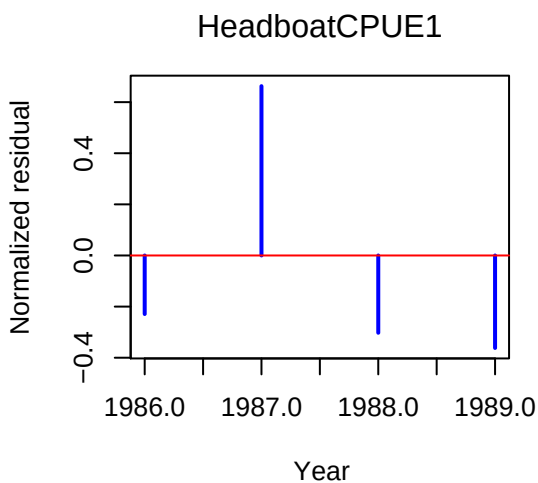

HandlineCPUE2
CPUE
0.5
1.0
1.5
2.0
1990
1994
1998
Year

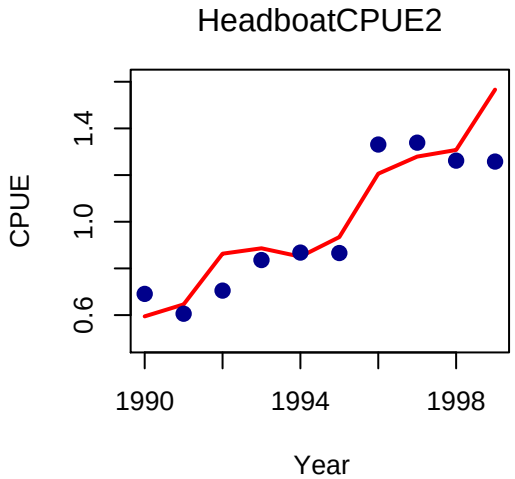

HandlineCPUE2
Normalized residual
−4
0
2
4
6
1990
1994
1998
Year

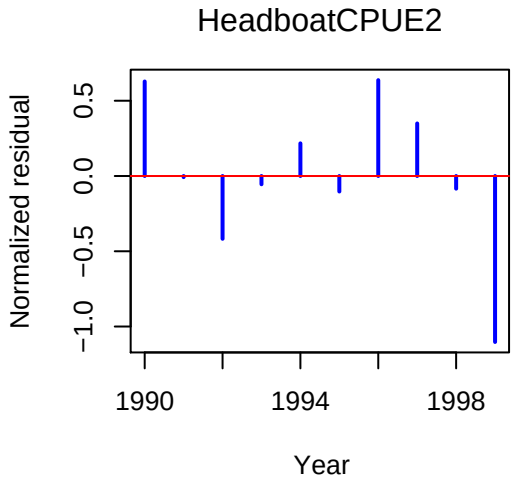

HandlineCPUE3
CPUE
0.6
0.8
1.0
1.2
1.4
2000
2001
2002
2003
2004
Year

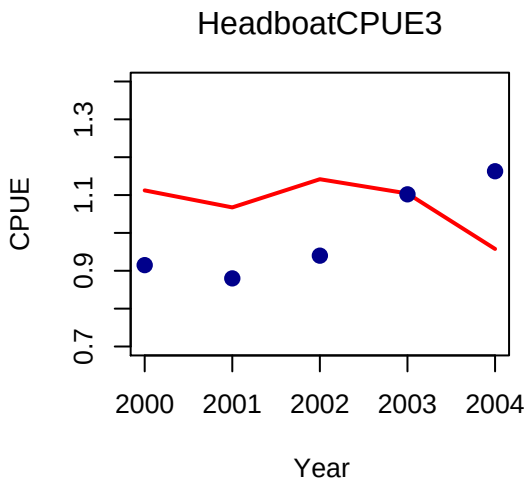

HandlineCPUE3
Normalized residual
−2
0
1
2
2000
2001
2002
2003
2004
Year

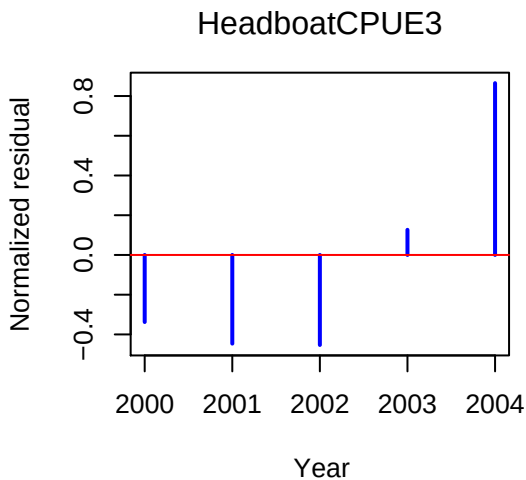

HeadboatCPUE1
CPUE
0.8
1.0
1.2
1.4
1986.0
1987.0
1988.0
1989.0
Year

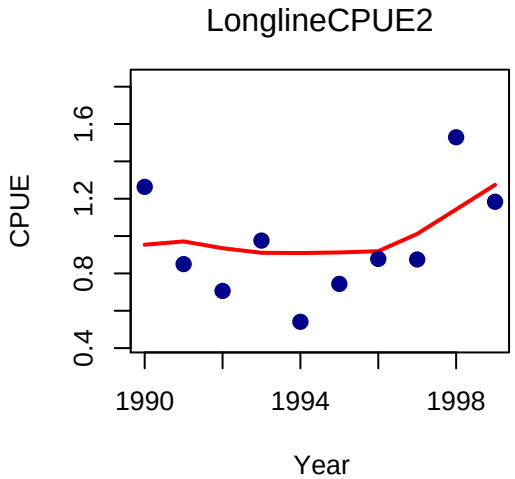

HeadboatCPUE1
Normalized residual
−0.4
0.0
0.4
1986.0
1987.0
1988.0
1989.0
Year

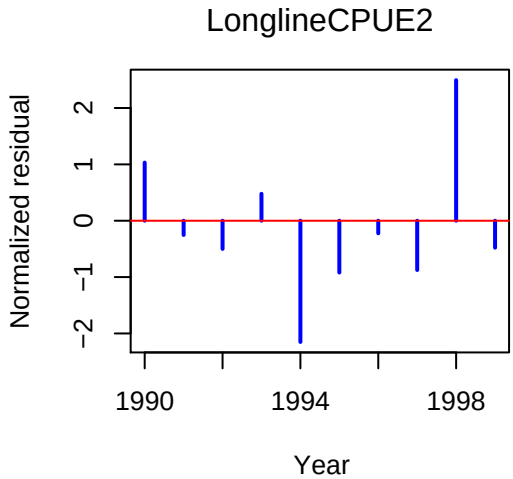

HeadboatCPUE2
CPUE
0.6
1.0
1.4
1990
1994
1998
Year

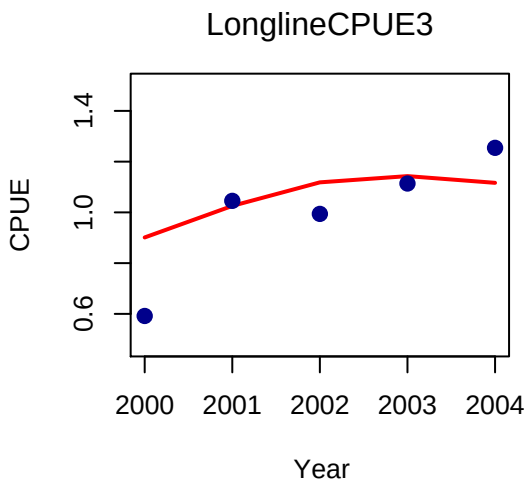

HeadboatCPUE2
Normalized residual
−1.0
−0.5
0.0
0.5
1990
1994
1998
Year

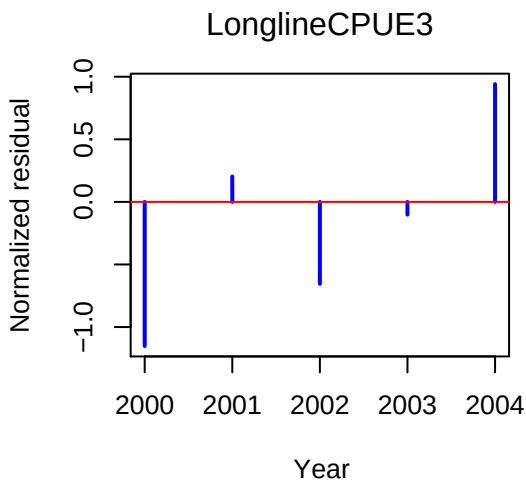

HeadboatCPUE3
CPUE
0.7
0.9
1.1
1.3
2000
2001
2002
2003
2004
Year


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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Normalized residual
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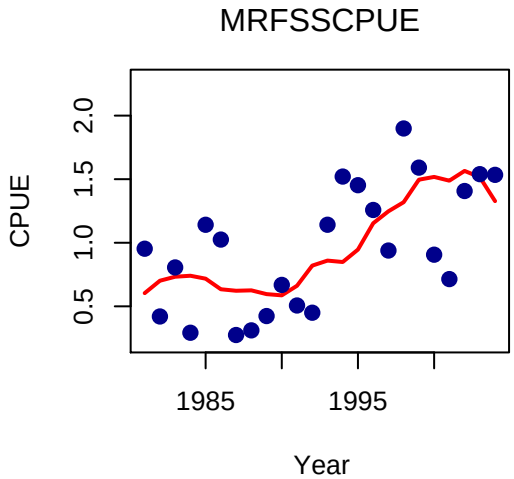
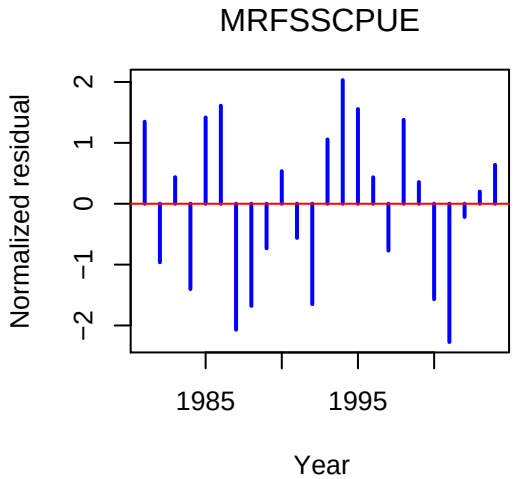
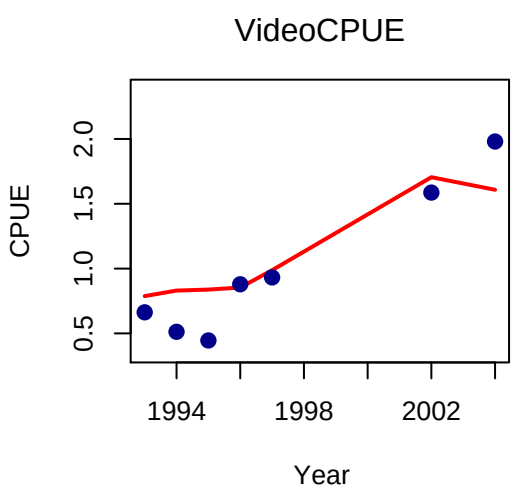
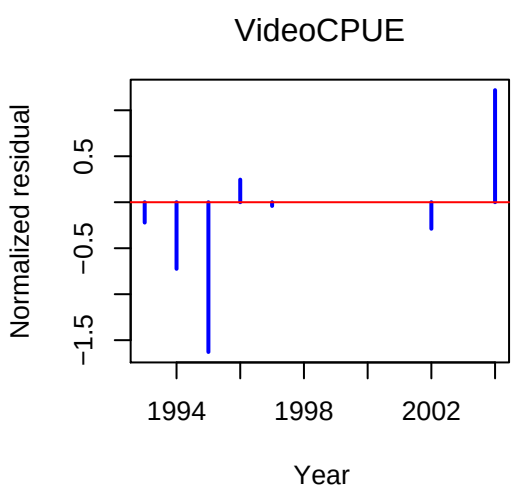
0.0
0.5
1.0
2000
2001
2002
2003
2004
Year


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
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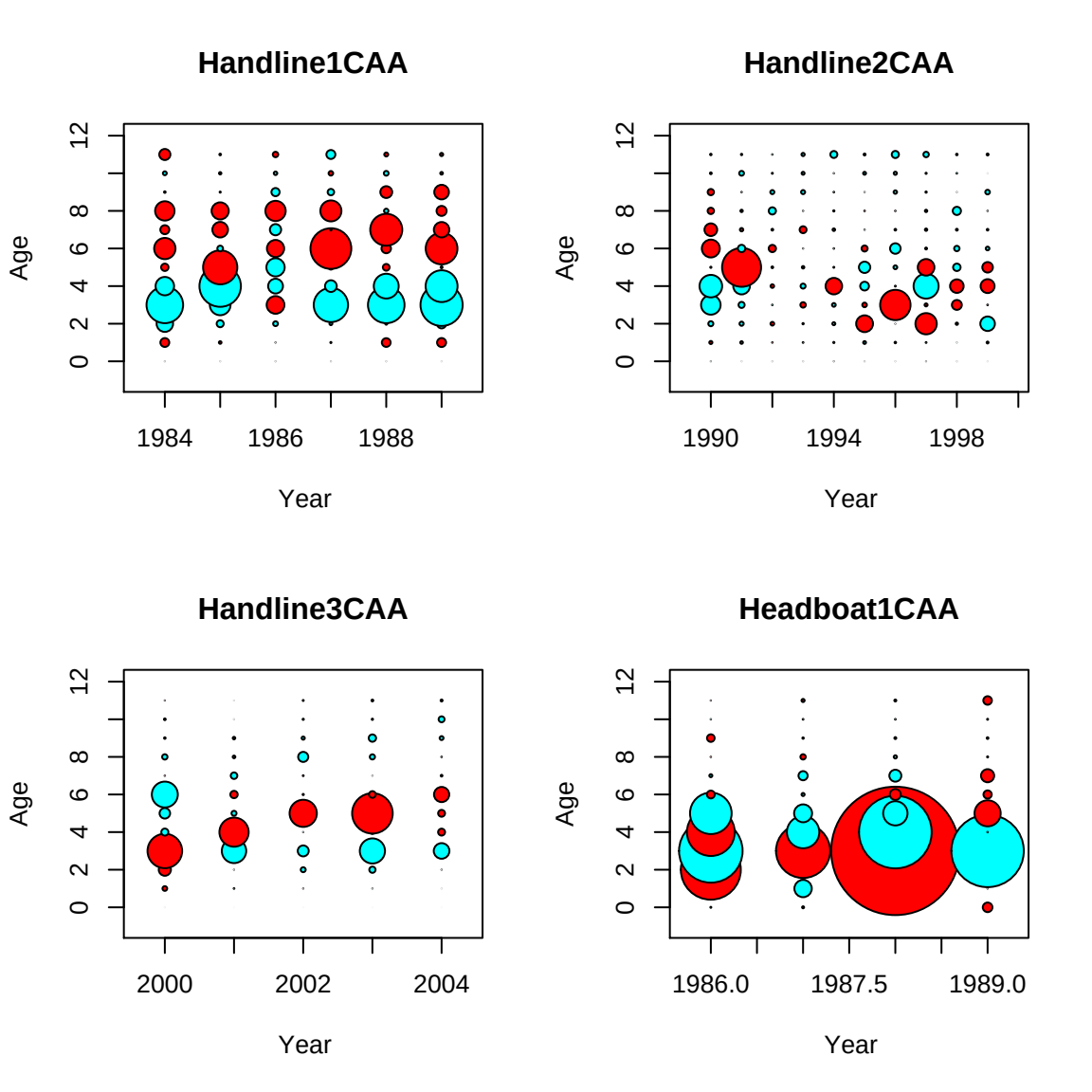
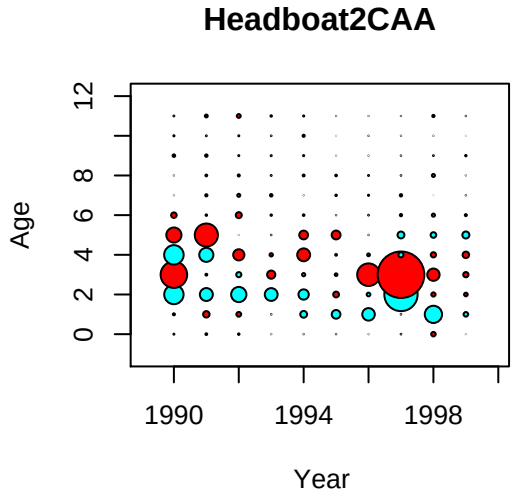
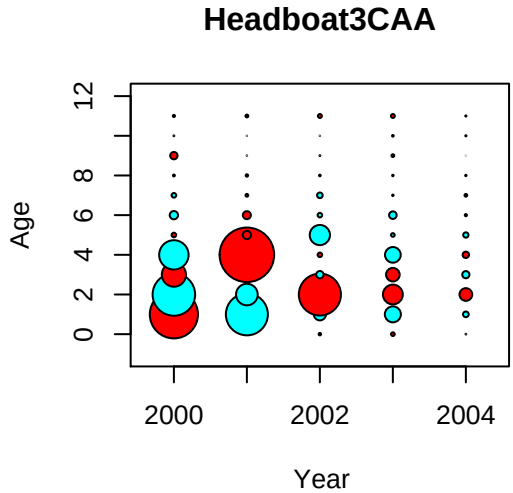
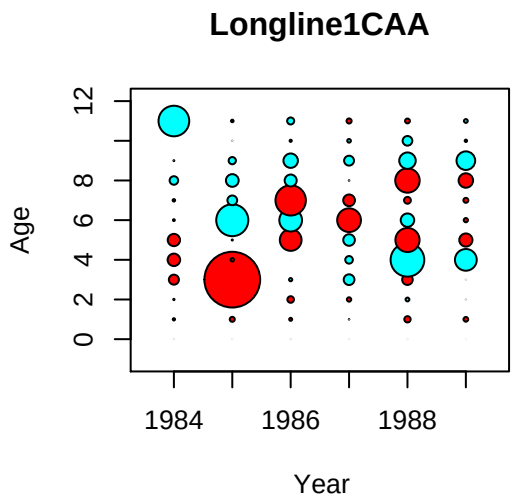
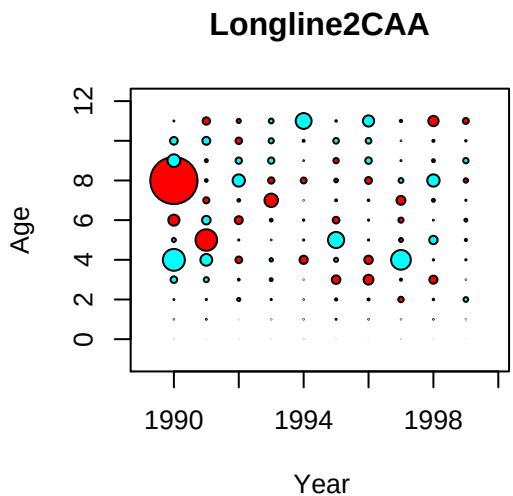
−0.5
0.5
1994
1998
2002
Year


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


Headboat2CAA
Age
0
2
4
6
8
12
1990
1994
1998
Year


Headboat3CAA
Age
0
2
4
6
8
12
2000
2002
2004
Year


Longline1CAA
Age
0
2
4
6
8
12
1984
1986
1988
Year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Age
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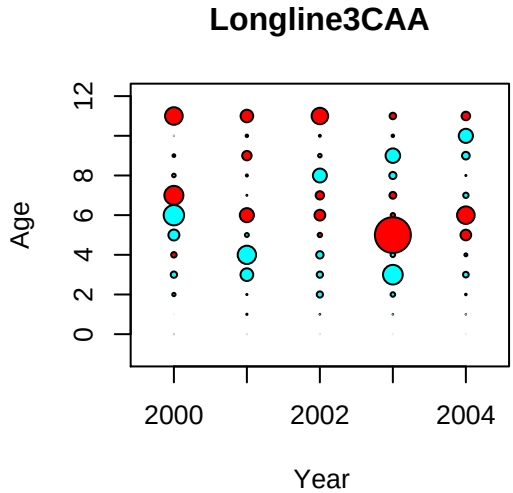
2
4
6
8
12
1990
1994
1998
Year


Longline3CAA
Age
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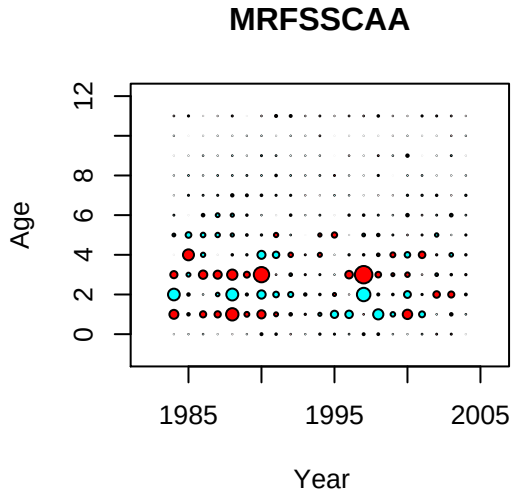
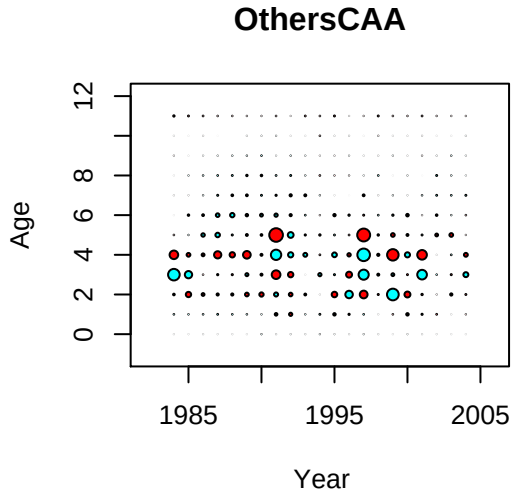
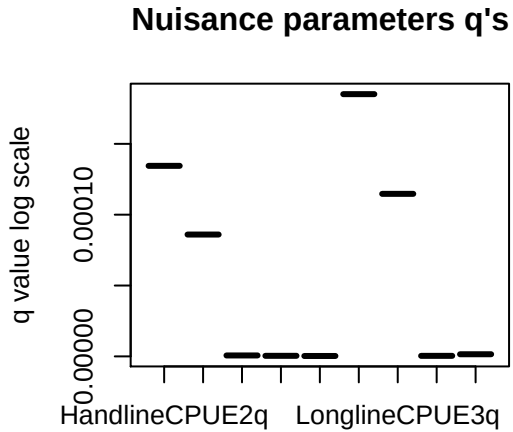
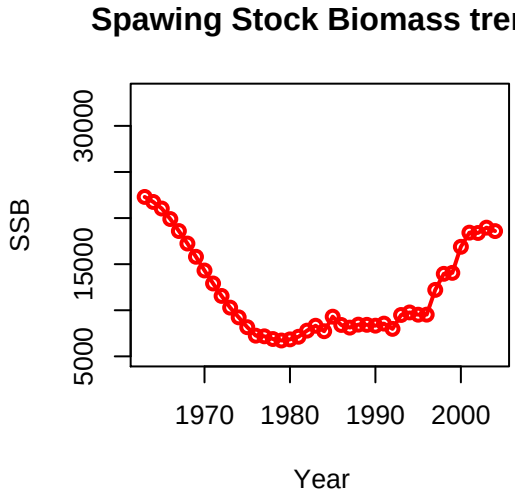
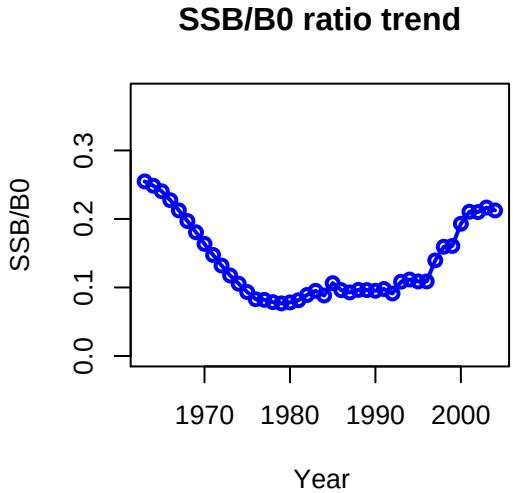
2
4
6
8
12
2000
2002
2004
Year

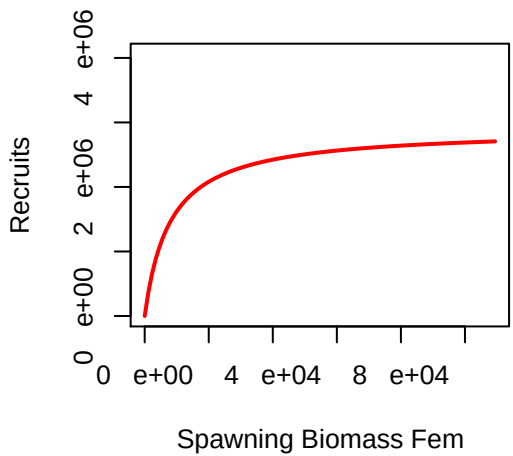

MRFSSCAA
Age
0
2
4
6
8
12
1985
1995
2005
Year

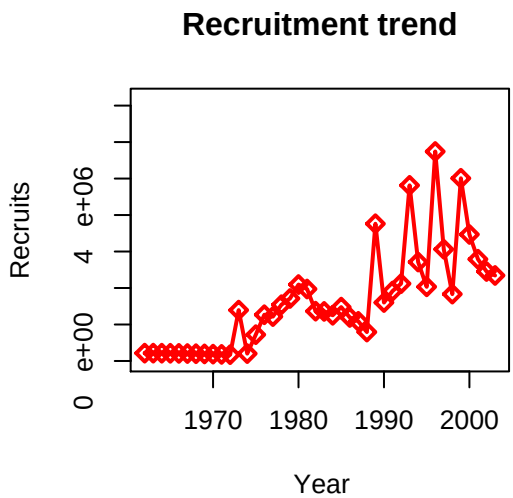

OthersCAA
Age
0
2
4
6
8
12
1985
1995
2005
Year

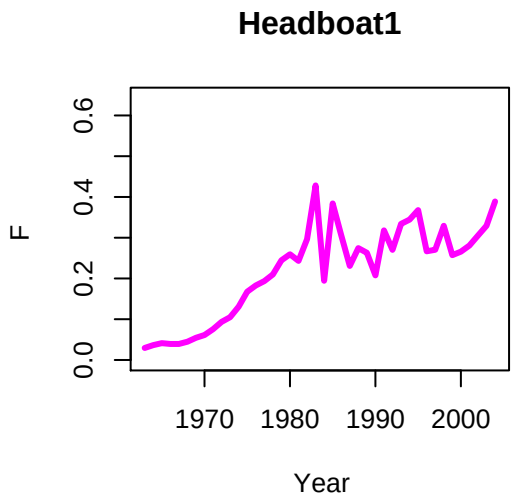

Nuisance parameters q's
q value log scale
0.00000
0.00010
HandlineCPUE2q
LonglineCPUE3q

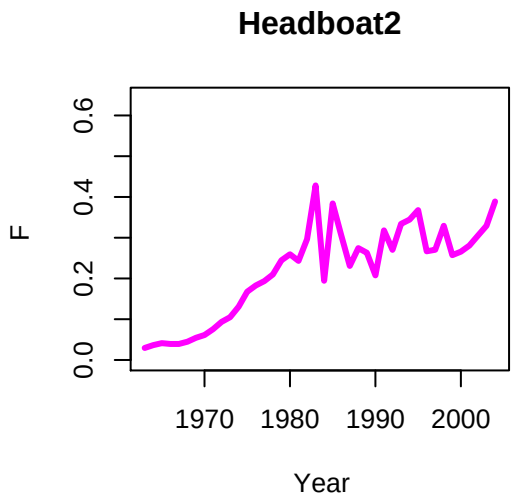

Spawing Stock Biomass trend
SSB
30000
15000
5000
1970
1980
1990
2000
Year

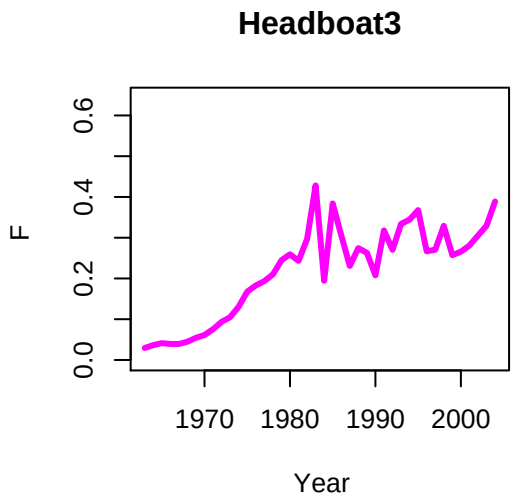

SSB/B0 ratio trend
SSB/B0
0.3
0.2
0.1
0.0
1970
1980
1990
2000
Year

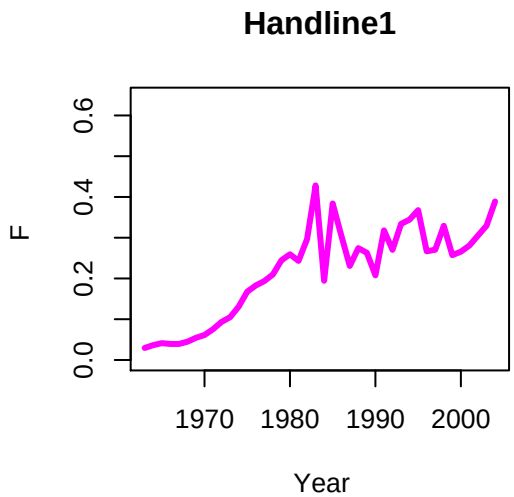

Recruits
4 e+06
2 e+06
0 e+00
0 e+00
4 e+04
8 e+04
Spawning Biomass Fem

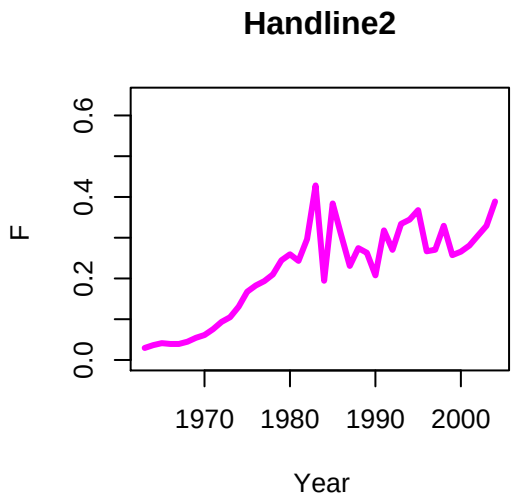

Recruitment trend
Recruits
4 e+06
0 e+00
1970
1980
1990
2000
Year

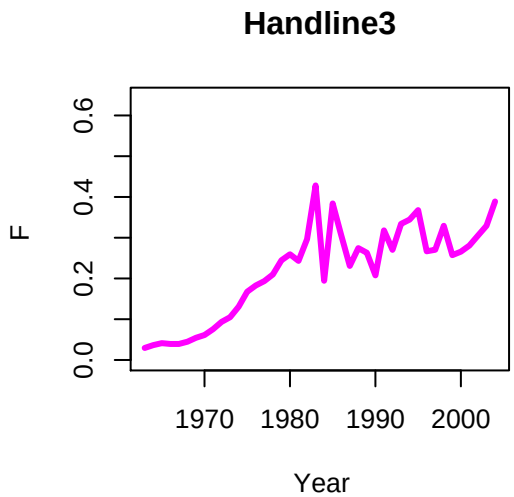

Headboat1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

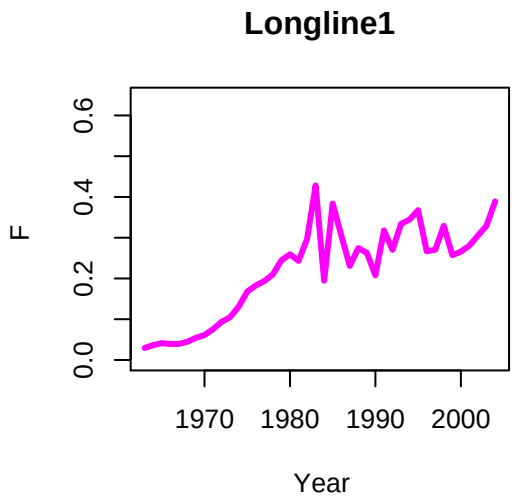

Headboat2
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

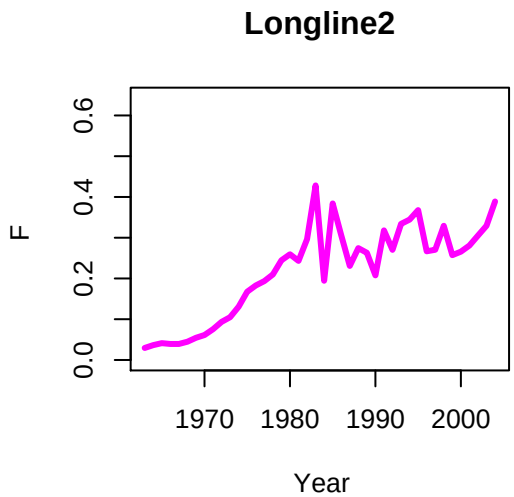

Headboat3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

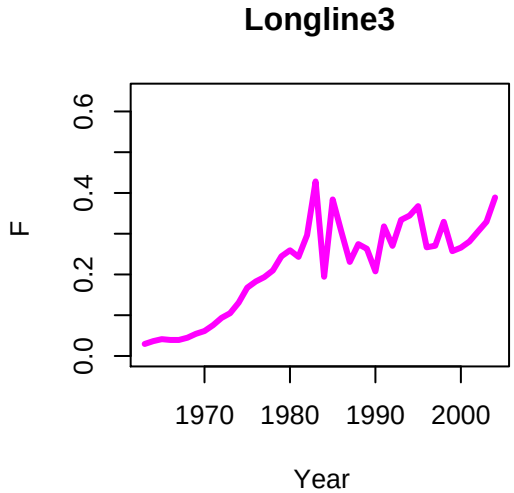

Handline1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

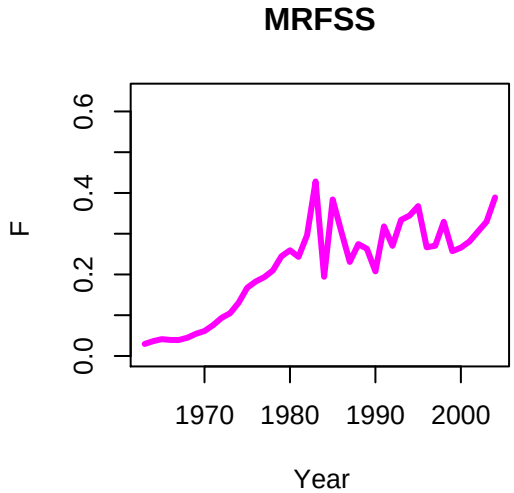

Handline2
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

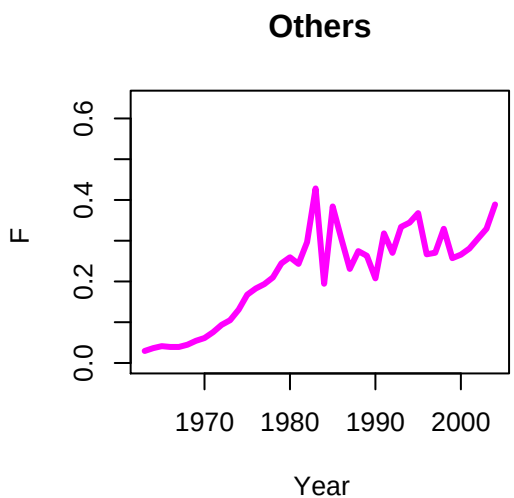

Handline3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

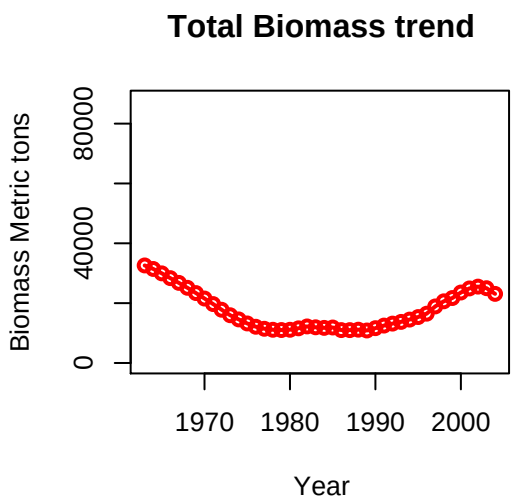

Longline1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

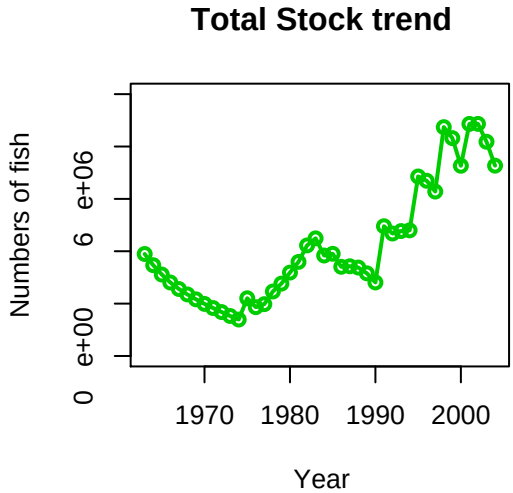

Longline2
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

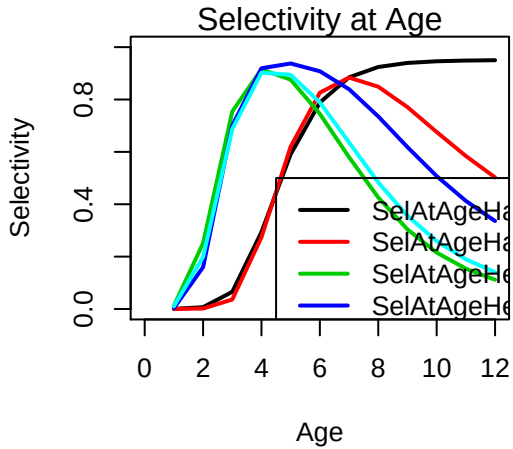

Longline3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

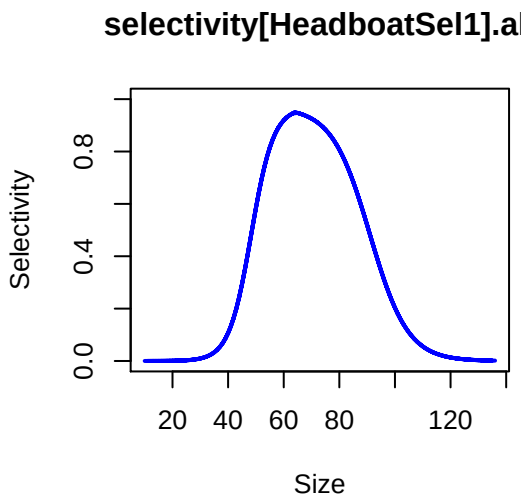

MRFSS
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

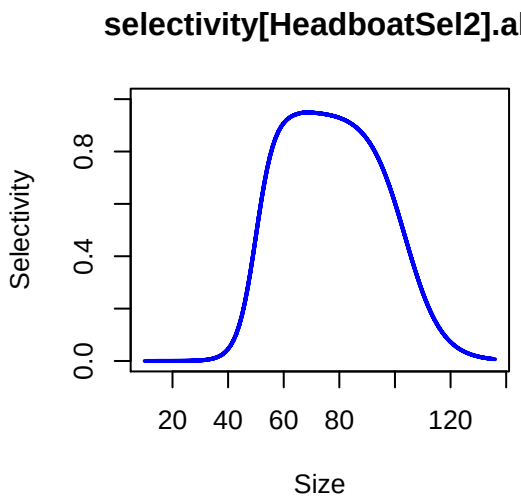

Others
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

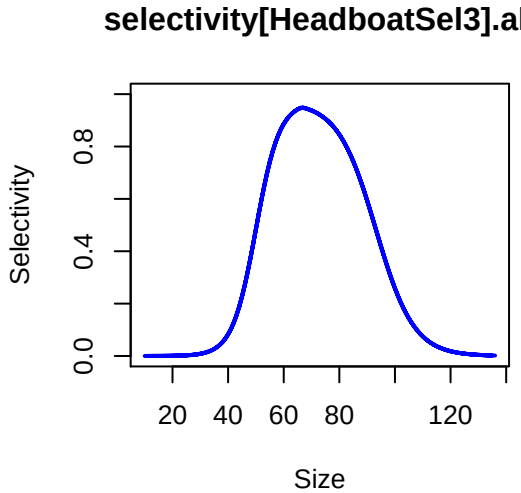

Total Biomass trend
Biomass Metric tons
0
40000
80000
1970
1980
1990
2000
Year

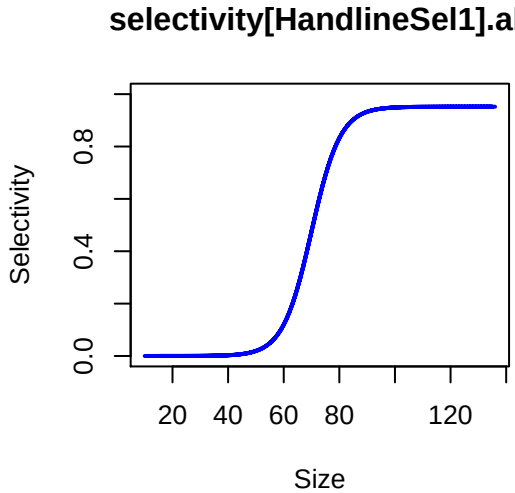

Total Stock trend
Numbers of fish
0 e+00
6 e+06
1970
1980
1990
2000
Year

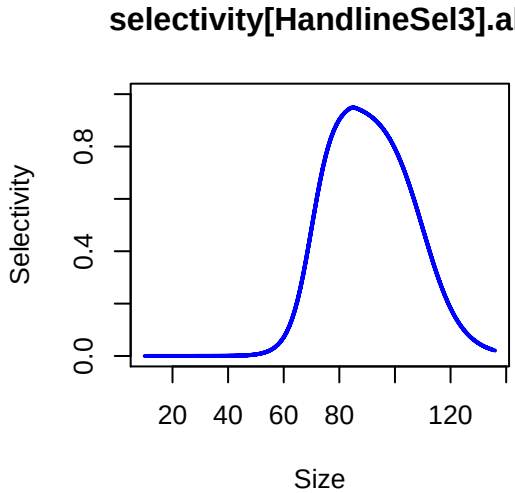

Selectivity at Age
Selectivity
0.0
0.4
0.8
0
2
4
6
8
10
12
Age
SelAtAgeHa
SelAtAgeHa
SelAtAgeHe
SelAtAgeHe

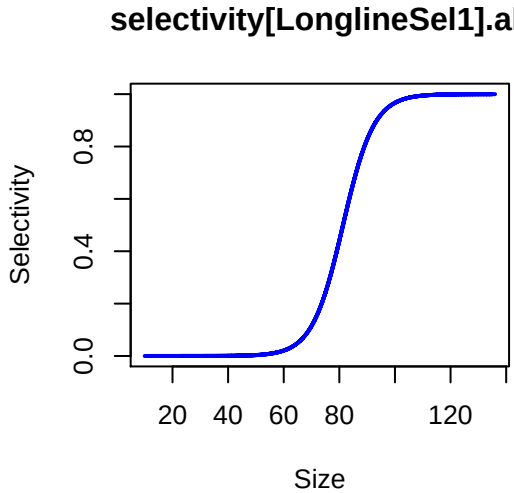

selectivity[HeadboatSel1].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

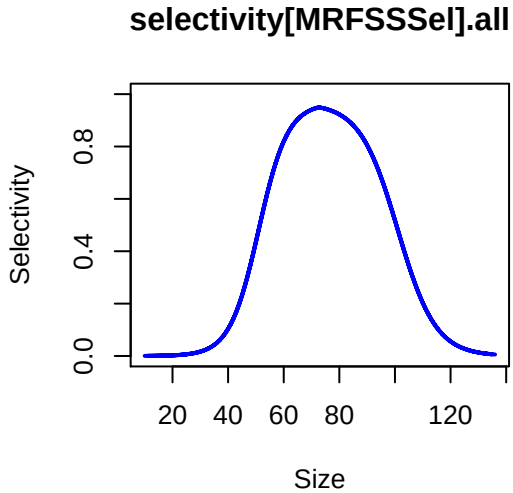

selectivity[HeadboatSel2].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

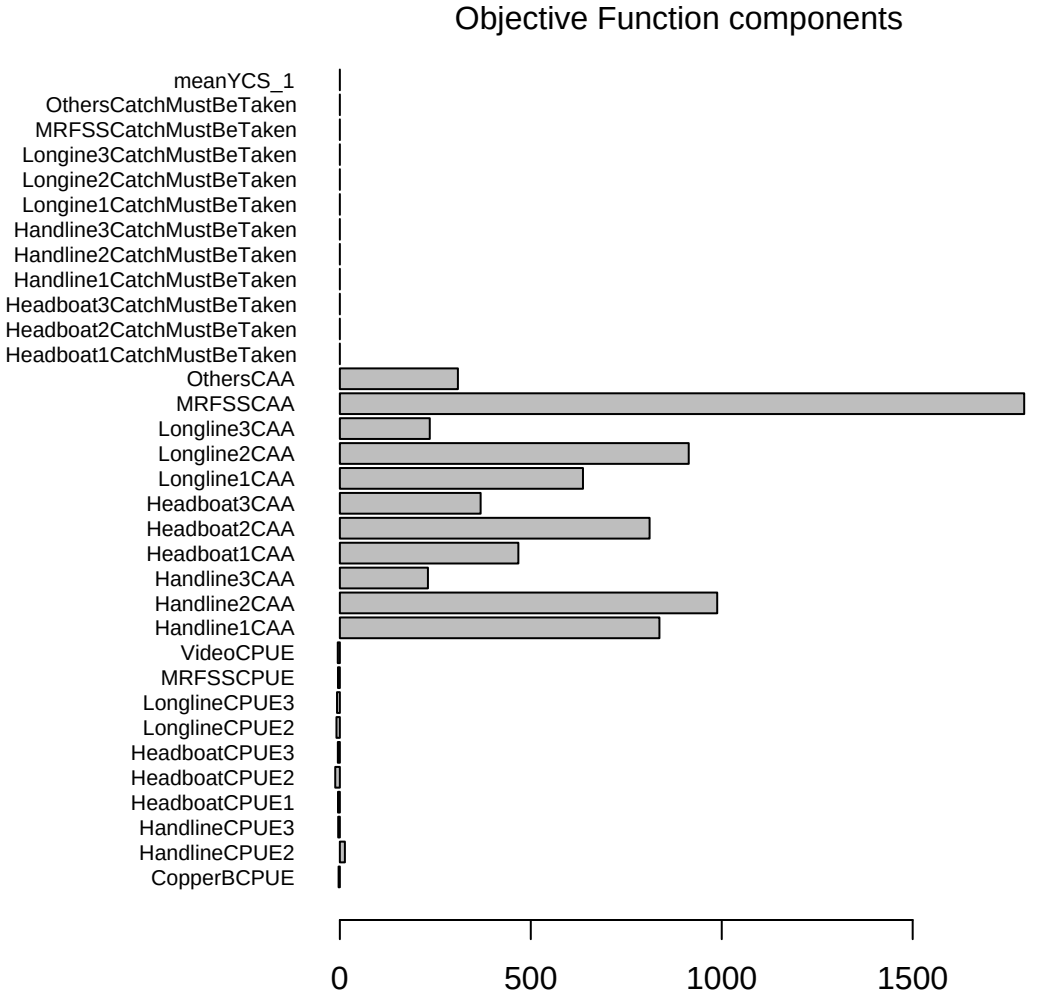

selectivity[HeadboatSel3].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

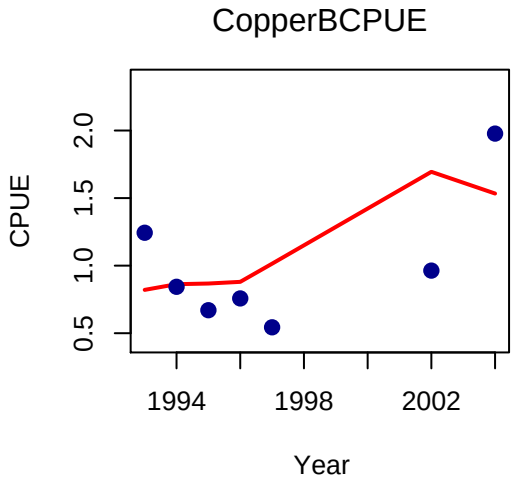

selectivity[HandlineSel1].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

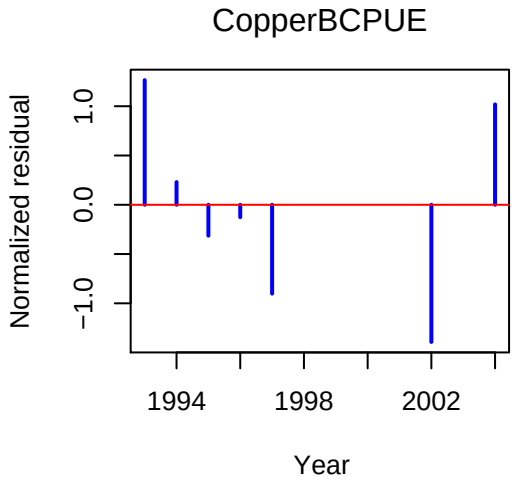

selectivity[HandlineSel3].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

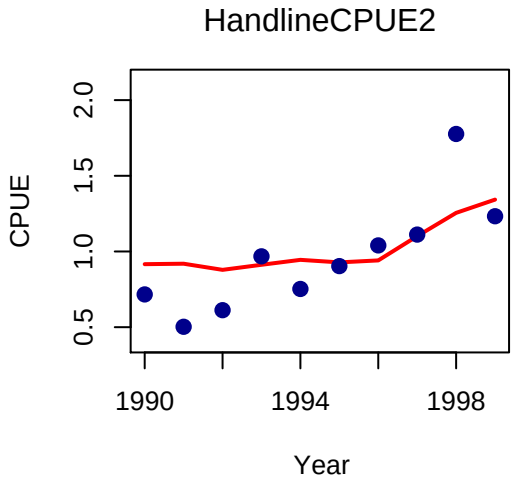

selectivity[LonglineSel1].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

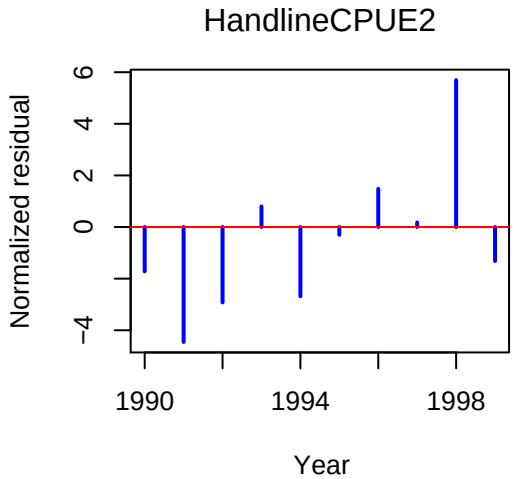

selectivity[MRFSSSel].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

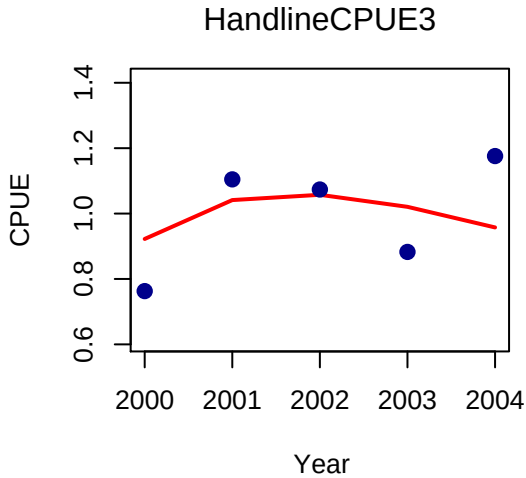

Objective Function components
meanYCS_1
OthersCatchMustBeTaken
MRFSSCatchMustBeTaken
Longine3CatchMustBeTaken
Longine2CatchMustBeTaken
Longine1CatchMustBeTaken
Handline3CatchMustBeTaken
Handline2CatchMustBeTaken
Handline1CatchMustBeTaken
Headboat3CatchMustBeTaken
Headboat2CatchMustBeTaken
Headboat1CatchMustBeTaken
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

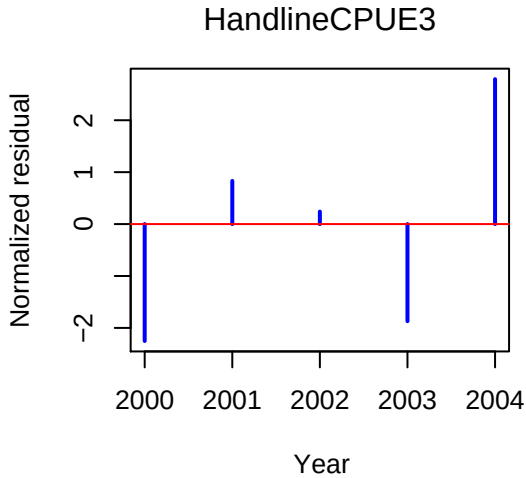

CopperBCPUE
CPUE
0.5
1.0
1.5
2.0
1994
1998
2002
Year

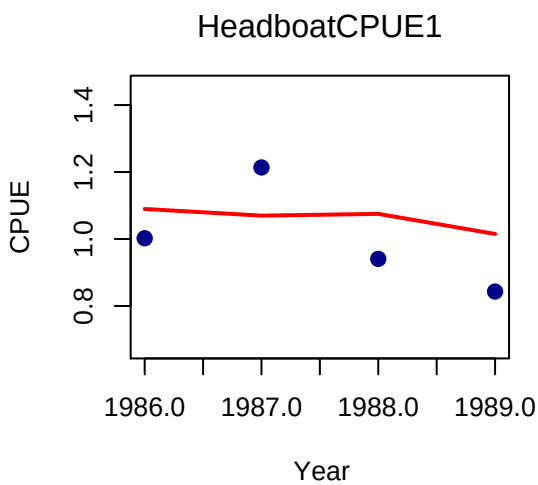

CopperBCPUE
Normalized residual
−1.0
0.0
1.0
1994
1998
2002
Year

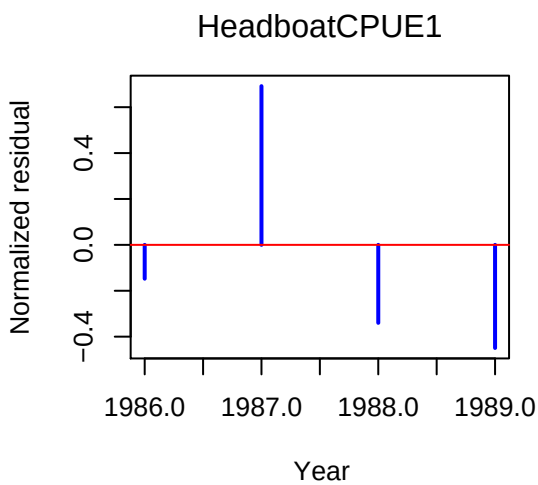

HandlineCPUE2
CPUE
0.5
1.0
1.5
2.0
1990
1994
1998
Year

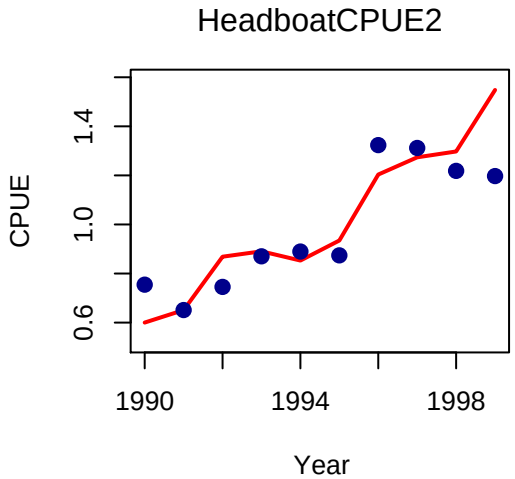

HandlineCPUE2
Normalized residual
−4
0
2
4
6
1990
1994
1998
Year

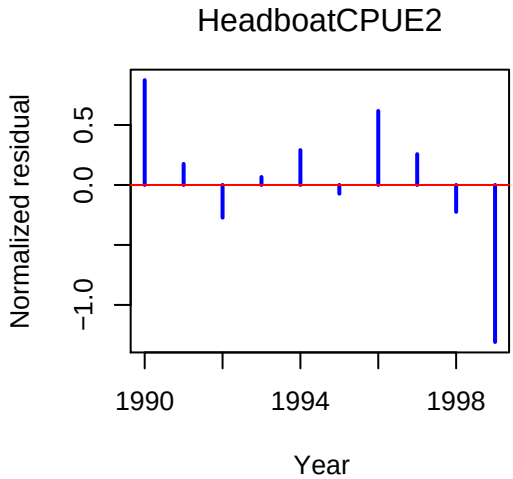

HandlineCPUE3
CPUE
0.6
0.8
1.0
1.2
1.4
2000
2001
2002
2003
2004
Year

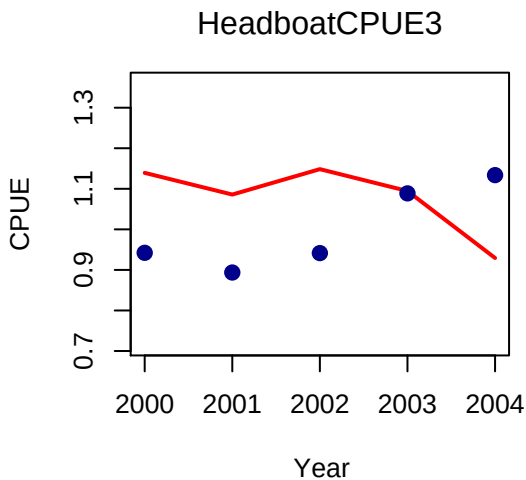

HandlineCPUE3
Normalized residual
−2
0
1
2
2000
2001
2002
2003
2004
Year

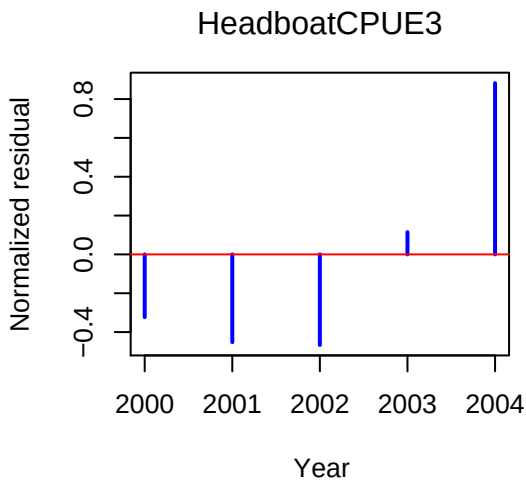

HeadboatCPUE1
CPUE
0.8
1.0
1.2
1.4
1986.0
1987.0
1988.0
1989.0
Year

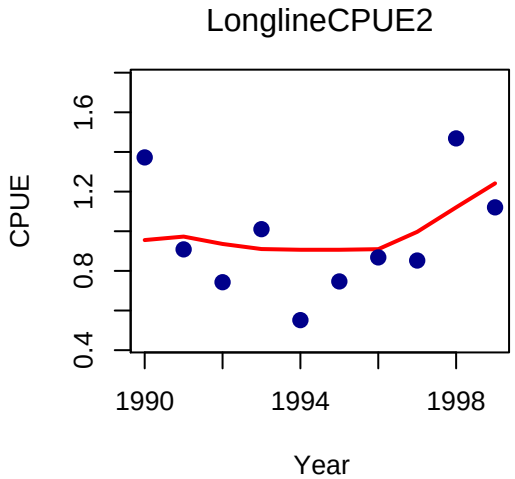

HeadboatCPUE1
Normalized residual
−0.4
0.0
0.4
1986.0
1987.0
1988.0
1989.0
Year

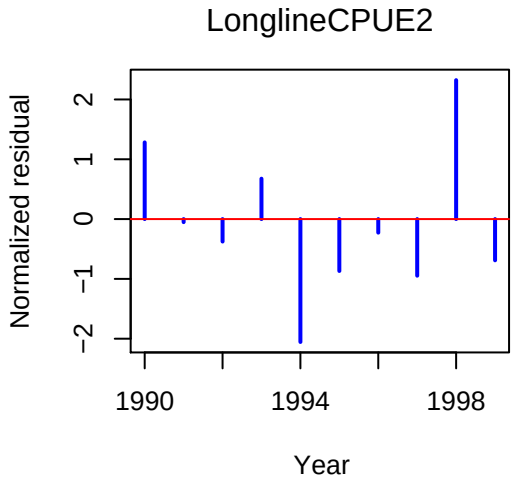

HeadboatCPUE2
CPUE
0.6
1.0
1.4
1990
1994
1998
Year

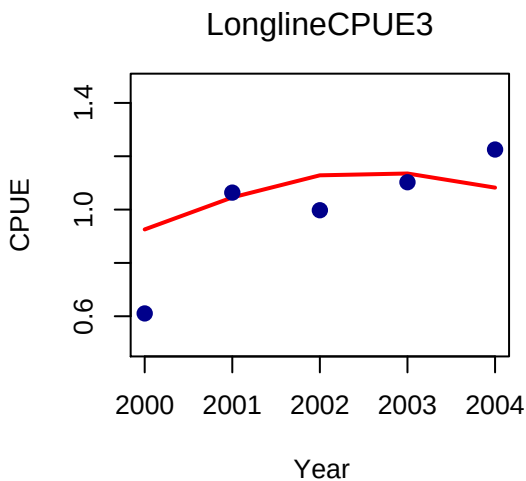

HeadboatCPUE2
Normalized residual
−1.0
0.0
0.5
1990
1994
1998
Year

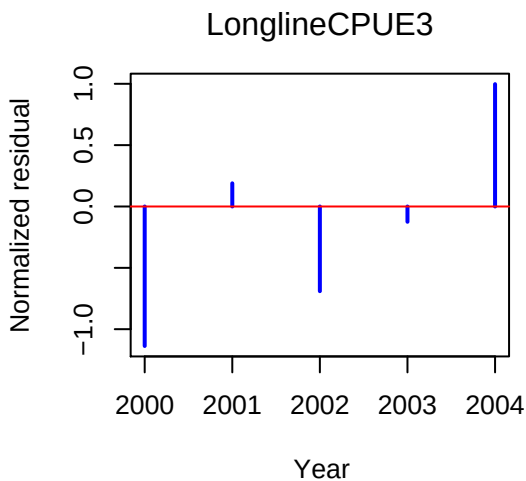

HeadboatCPUE3
CPUE
0.7
0.9
1.1
1.3
2000
2001
2002
2003
2004
Year

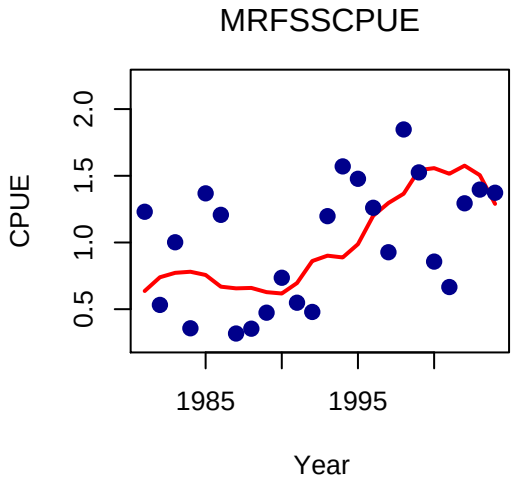

HeadboatCPUE3
Normalized residual
−0.4
0.0
0.4
0.8
2000
2001
2002
2003
2004
Year

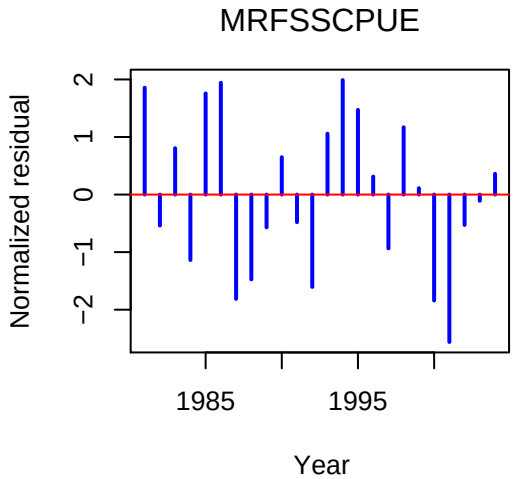

LonglineCPUE2
CPUE
0.4
0.8
1.2
1.6
1990
1994
1998
Year

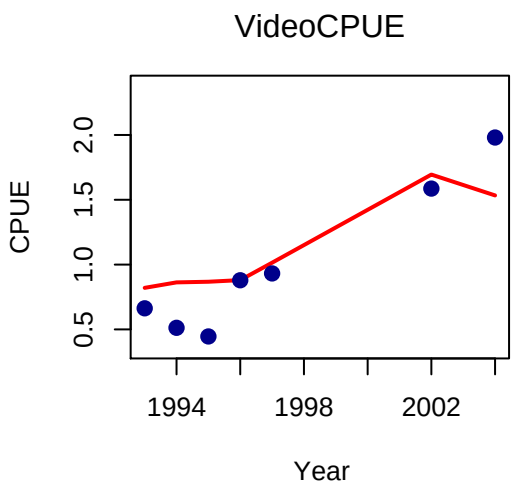

LonglineCPUE2
Normalized residual
−2
−1
0
1
2
1990
1994
1998
Year

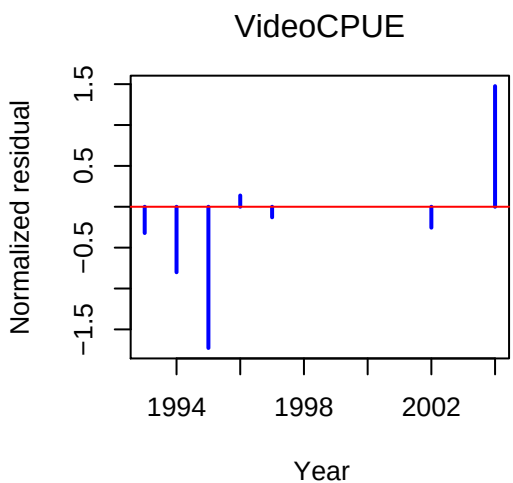

LonglineCPUE3
CPUE
0.6
1.0
1.4
2000
2001
2002
2003
2004
Year

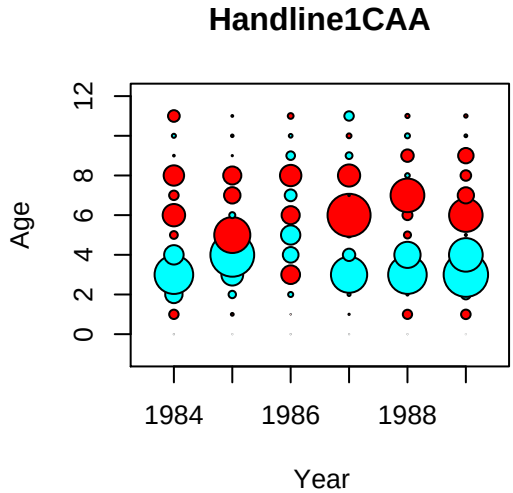

LonglineCPUE3
Normalized residual
−1.0
0.0
0.5
1.0
2000
2001
2002
2003
2004
Year

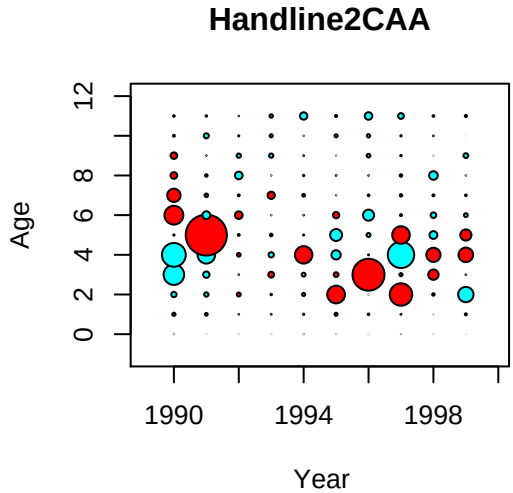

MRFSSCPUE
CPUE
0.5
1.0
1.5
2.0
1985
1995
Year

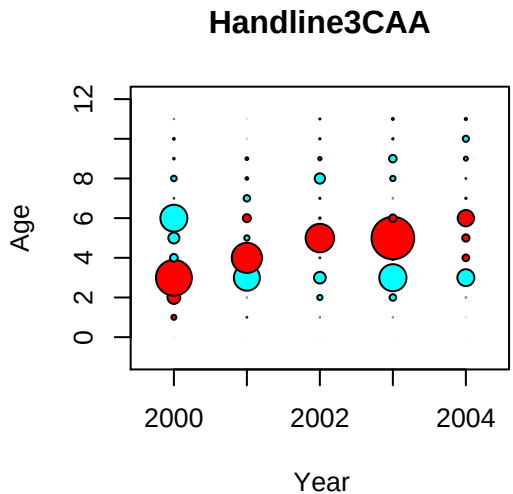

MRFSSCPUE
Normalized residual
−2
−1
0
1
2
1985
1995
Year

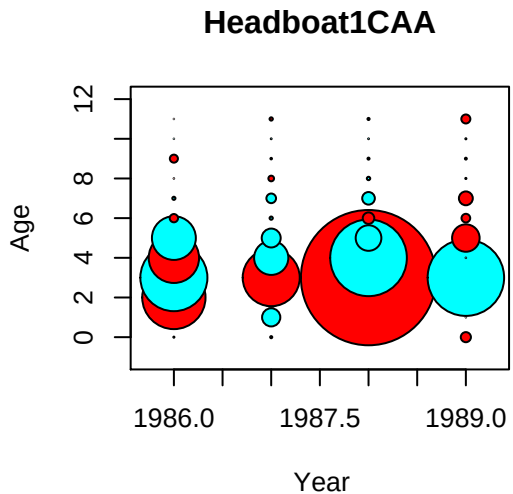

VideoCPUE
CPUE
0.5
1.0
1.5
2.0
1994
1998
2002
Year

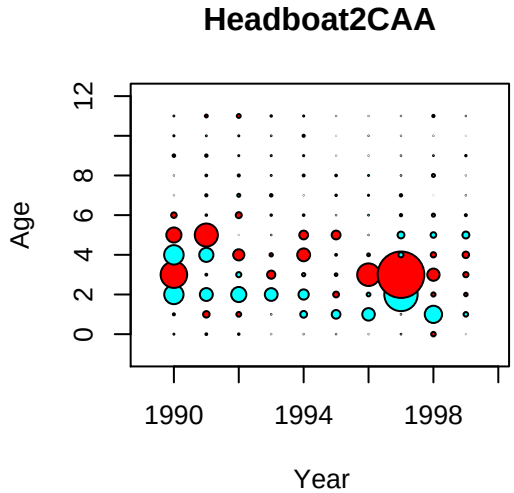

VideoCPUE
Normalized residual
−1.5
−0.5
0.5
1.5
1994
1998
2002
Year

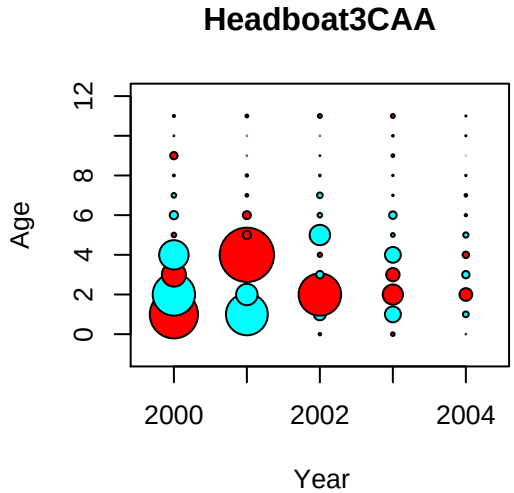

Handline1CAA
Age
0
2
4
6
8
12
1984
1986
1988
Year

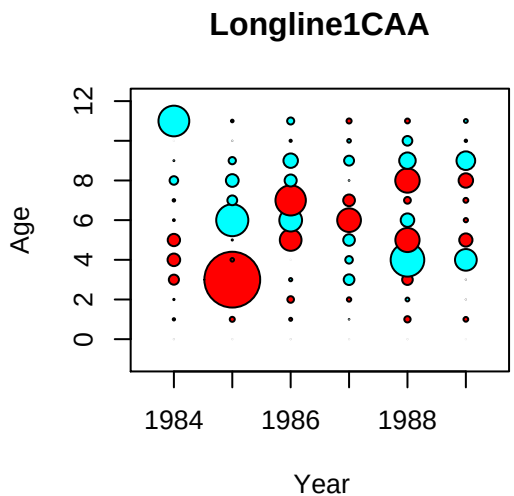

Handline2CAA
Age
0
2
4
6
8
12
1990
1994
1998
Year

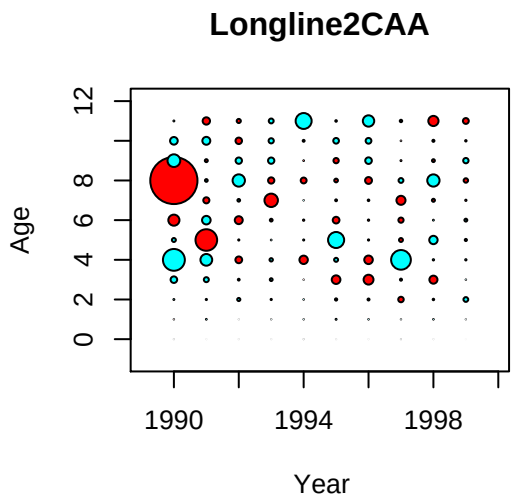

Handline3CAA
Age
0
2
4
6
8
12
2000
2002
2004
Year

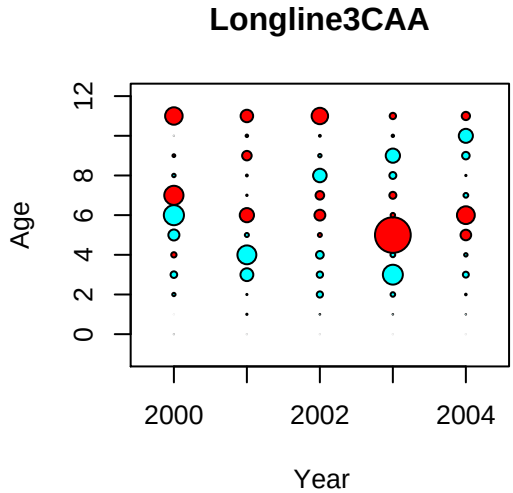

Headboat1CAA
Age
0
2
4
6
8
12
1986.0
1987.5
1989.0
Year

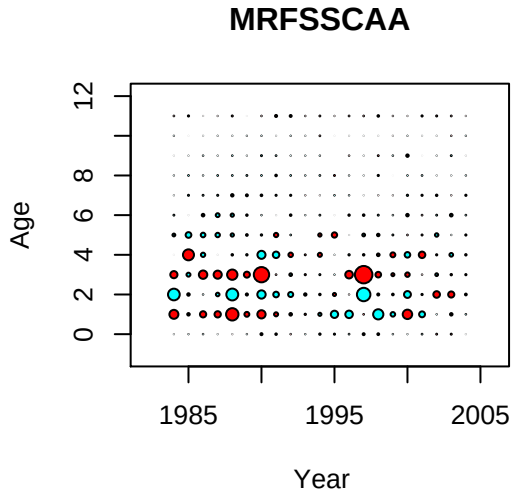

Headboat2CAA
Age
0
2
4
6
8
12
1990
1994
1998
Year

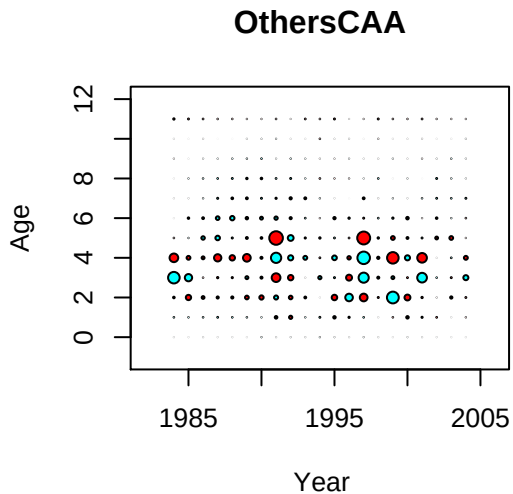

Headboat3CAA
Age
0
2
4
6
8
12
2000
2002
2004
Year

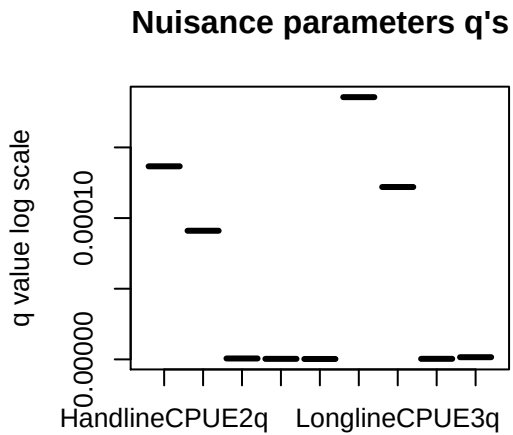

Longline1CAA
Age
0
2
4
6
8
12
1984
1986
1988
Year

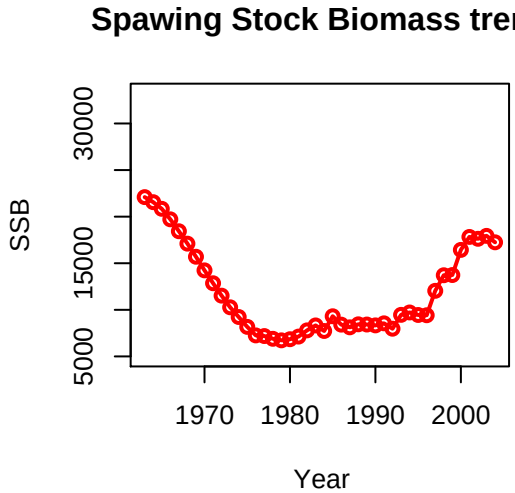

Longline2CAA
Age
0
2
4
6
8
12
1990
1994
1998
Year

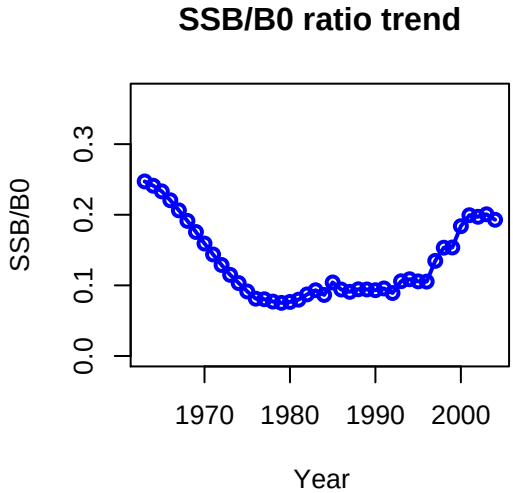

Longline3CAA
Age
0
2
4
6
8
12
2000
2002
2004
Year

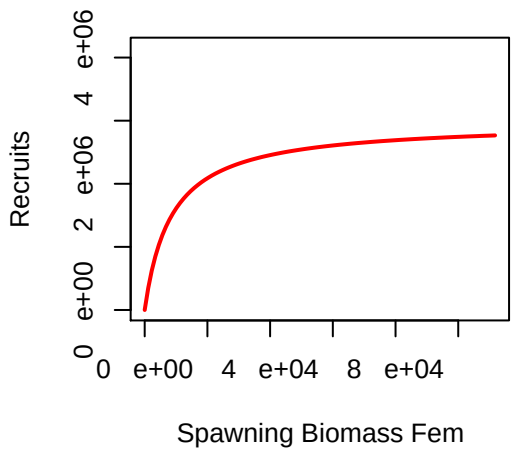

MRFSSCAA
Age
0
2
4
6
8
12
1985
1995
2005
Year

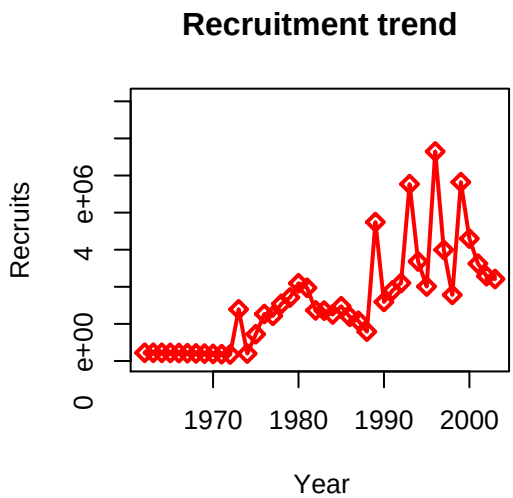

OthersCAA
Age
0
2
4
6
8
12
1985
1995
2005
Year

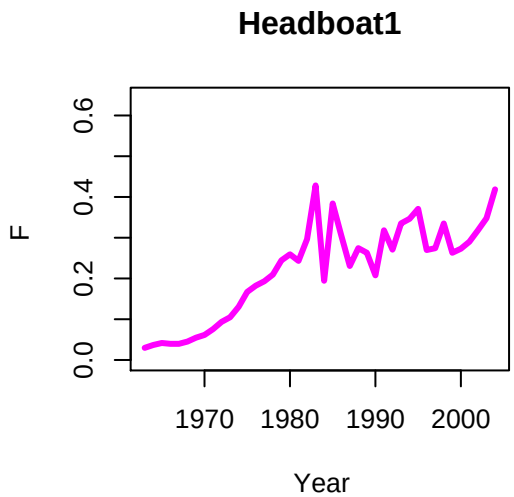

Nuisance parameters q's
q value log scale
0.00000
0.00010
HandlineCPUE2q
LonglineCPUE3q

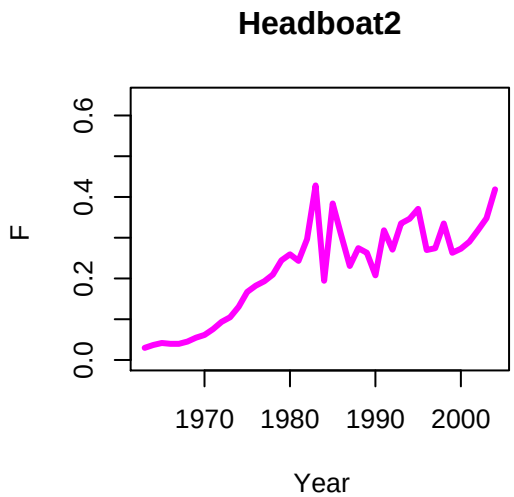

Spawing Stock Biomass trend
SSB
30000
15000
5000
1970
1980
1990
2000
Year

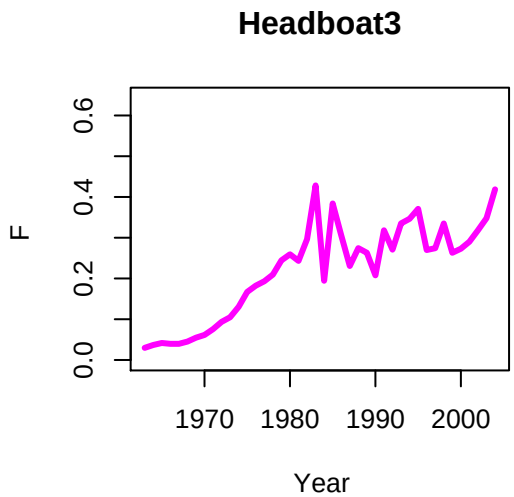

SSB/B0 ratio trend
SSB/B0
0.3
0.2
0.1
0.0
1970
1980
1990
2000
Year

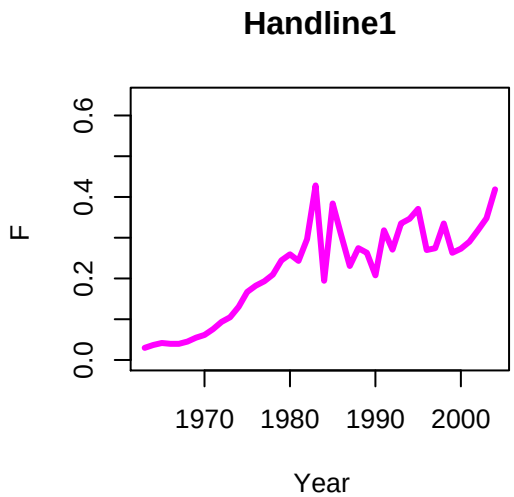

Recruits
4 e+06
2 e+06
0 e+00
0 e+00
4 e+04
8 e+04
Spawning Biomass Fem

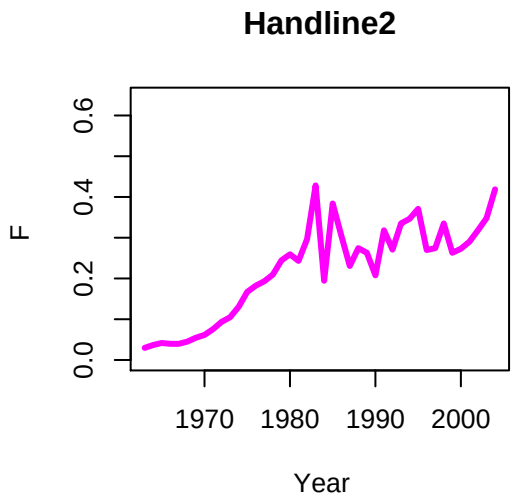

Recruitment trend
Recruits
4 e+06
0 e+00
1970
1980
1990
2000
Year

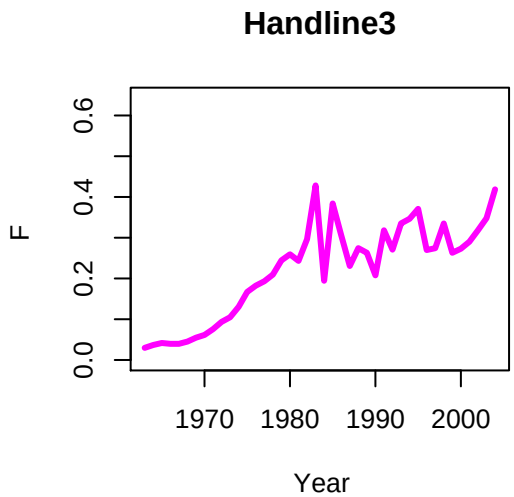

Headboat1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

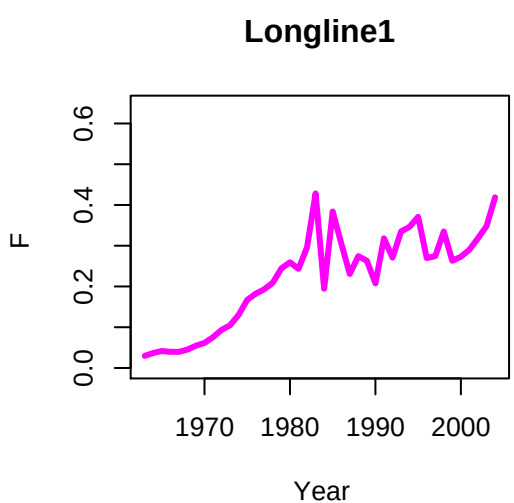

Headboat2
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

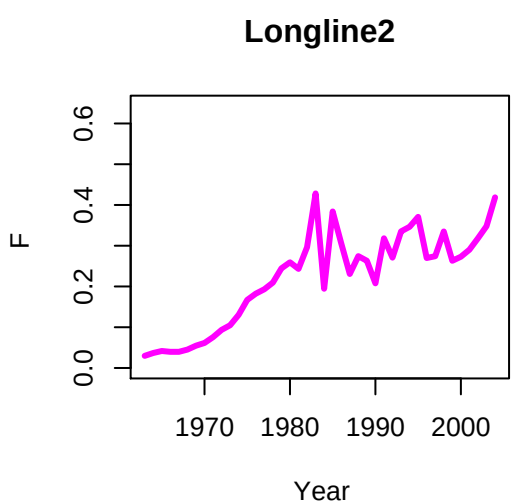

Headboat3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

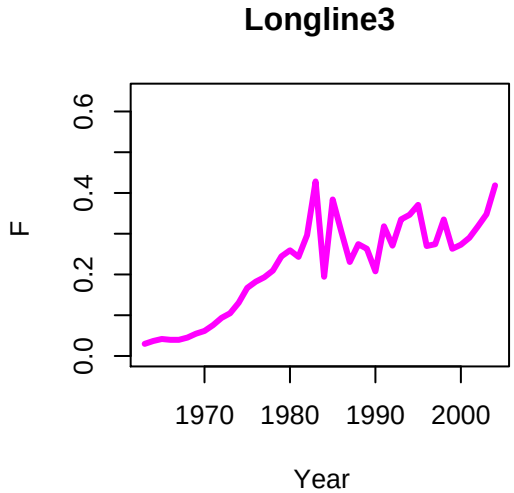

Handline1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

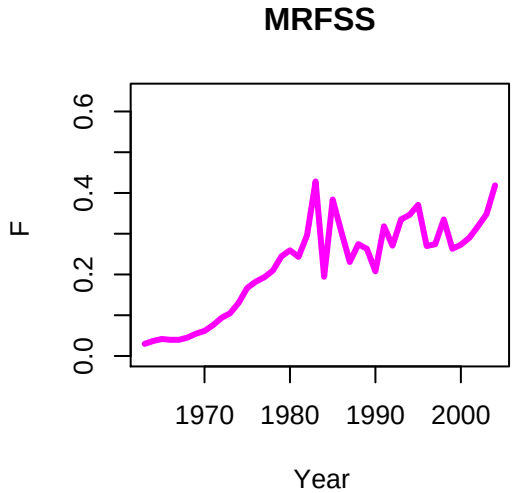

Handline2
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

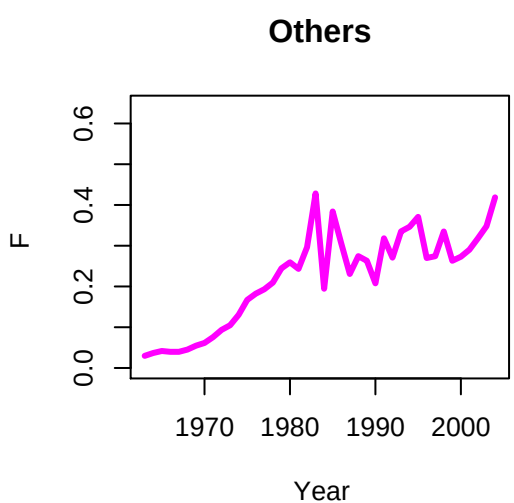

Handline3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

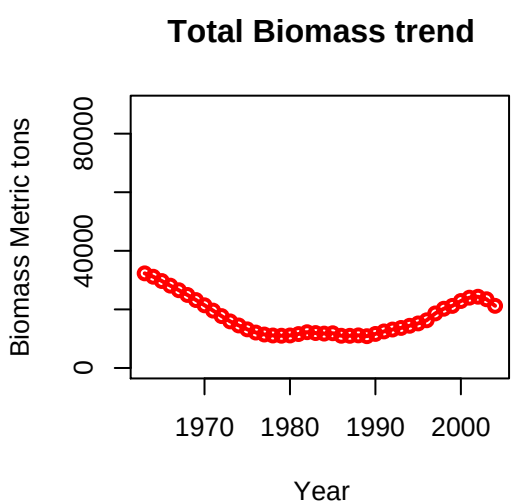

Longline1
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

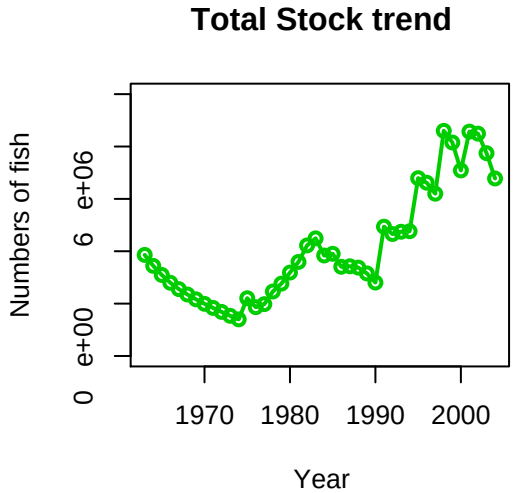

Longline2
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

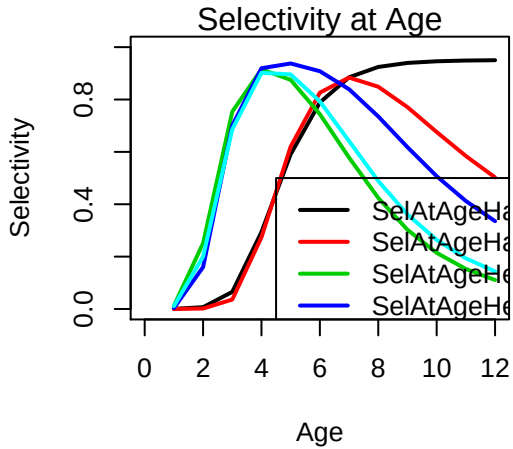

Longline3
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

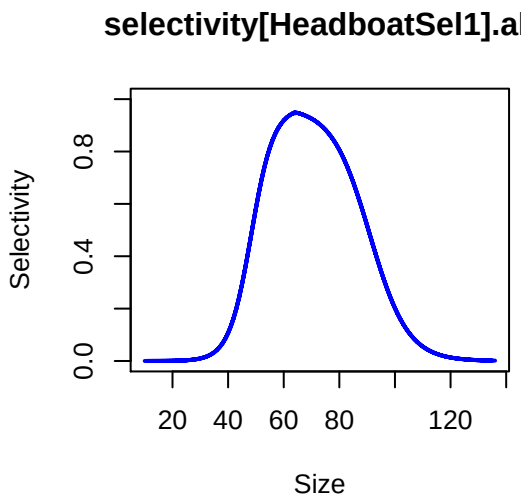

MRFSS
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

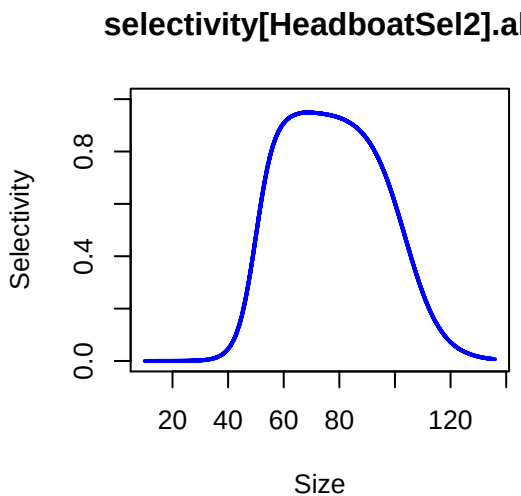

Others
F
0.0
0.2
0.4
0.6
1970
1980
1990
2000
Year

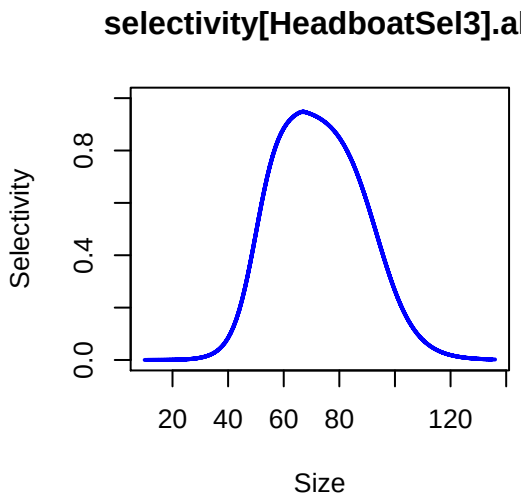

Total Biomass trend
Biomass Metric tons
0
40000
80000
1970
1980
1990
2000
Year

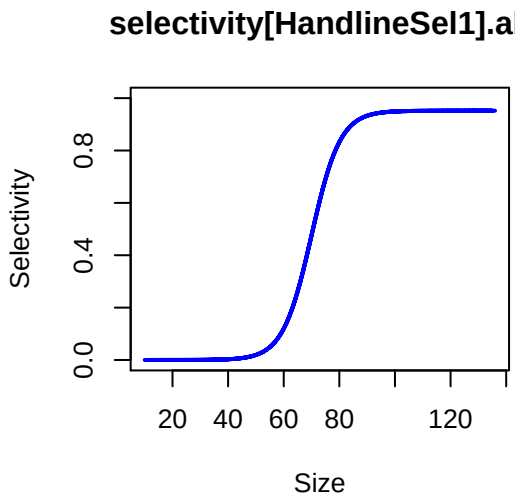

Total Stock trend
Numbers of fish
0 e+00
6 e+06
1970
1980
1990
2000
Year

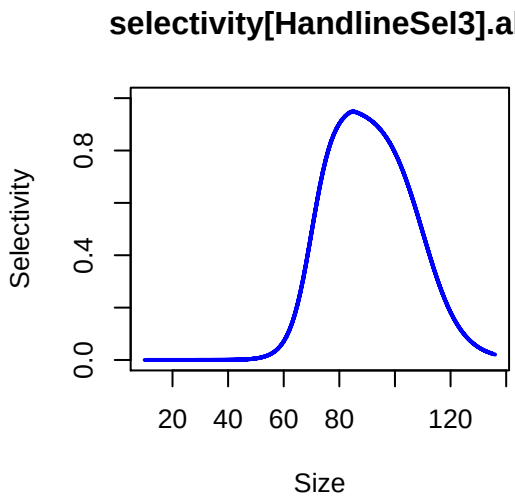

Selectivity at Age
Selectivity
0.0
0.4
0.8
0
2
4
6
8
10
12
Age
SelAtAgeHa
SelAtAgeHa
SelAtAgeHe
SelAtAgeHe

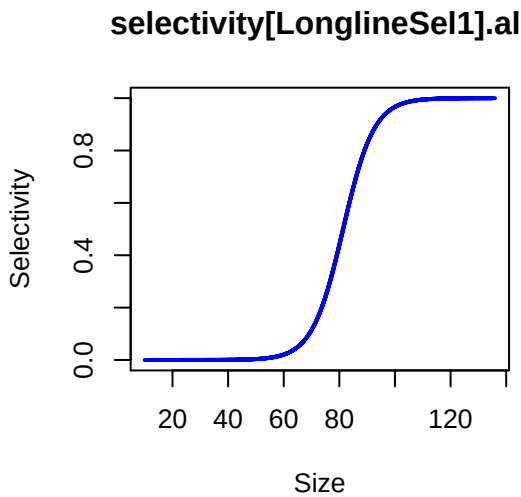

selectivity[HeadboatSel1].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size

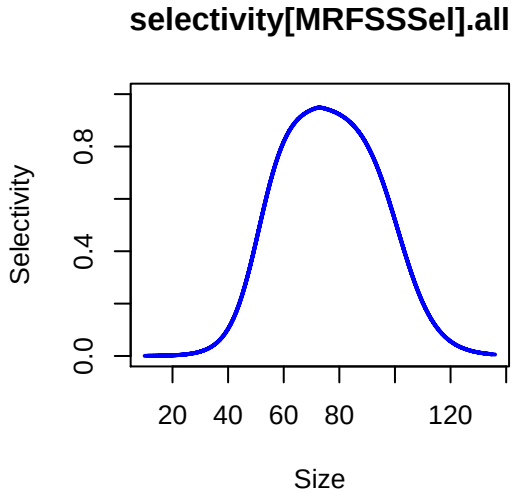

selectivity[HeadboatSel2].all
Selectivity
0.0
0.4
0.8
20
40
60
80
120
Size


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


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