Analyses of Gulf of Mexico Gag Grouper in Response to the Recommendations of the SEDAR Grouper Assessment Review Evaluation Panel

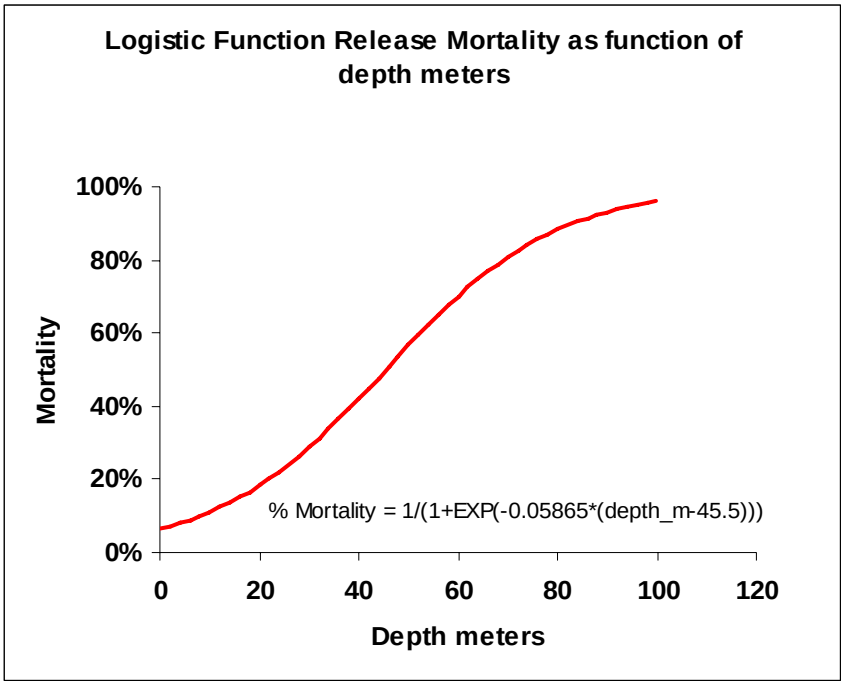
April, 2007

SEDAR Grouper Assessment Review Document

SEDARS1-RW01

1. Spatio-temporal distribution of size-depth samples for gag GOM used to generate size-depth distribution matrices to estimate dead discard of recreational and commercial fisheries.

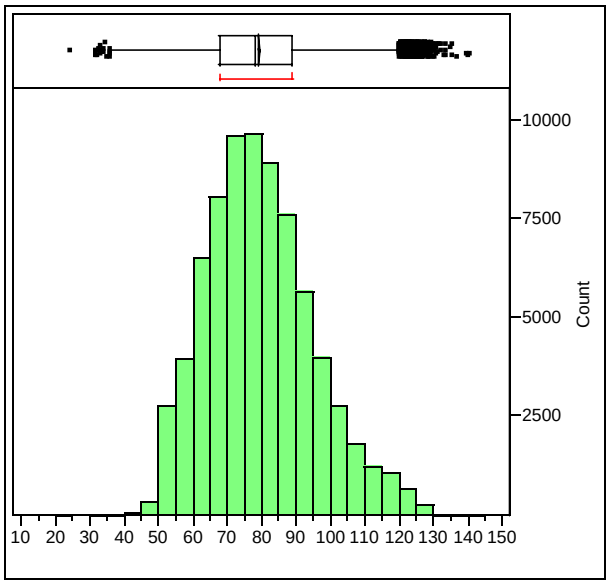
The SEDAR 10 participants recommended modeling the discard mortality of gag in the Gulf of Mexico (GOM) as a function of the depth of capture. A logistic function was fitted to data from different experiments (shown below). The estimated curve suggests dead discards increase with depth, with 50% mortality at about 45 m and 95% mortality at 100 m depth. The available data were insufficient to establish a similar relationship between discard mortality and size.



To apply this depth-release mortality function, the catch of gag must be partitioned by depth. Account must also be taken of the distribution of size at depth inasmuch as small fish tend to live in shallow waters and larger older fish tend to move toward deeper water. The Trip Interview Program (TIP) data included information on both the size and depth of capture for fish that are randomly sampled from the catch. Most of the samples are from commercial fisheries (75000), but there are also 382 samples from recreational fisheries. All size records were converted to total length (TL) measurements in cm. The information on depth of capture often included both the minimum depth and maximum depth fished, in which case the value used here was the average of these values (when only one depth was recorded, this value was used). The grouper evaluation panel was concerned about whether the data were sufficient to construct a reliable size at depth matrix and recommended "tabulating the number of samples available for determining depth of recreational discards for Gulf of Mexico gag grouper."

The following plots show the distribution of size-depth samples for the commercial and recreational fisheries from the TIP data.

Gag GOM size samples with depth information commercial fisheries
Frequency distribution of size (TL_pred_cm)



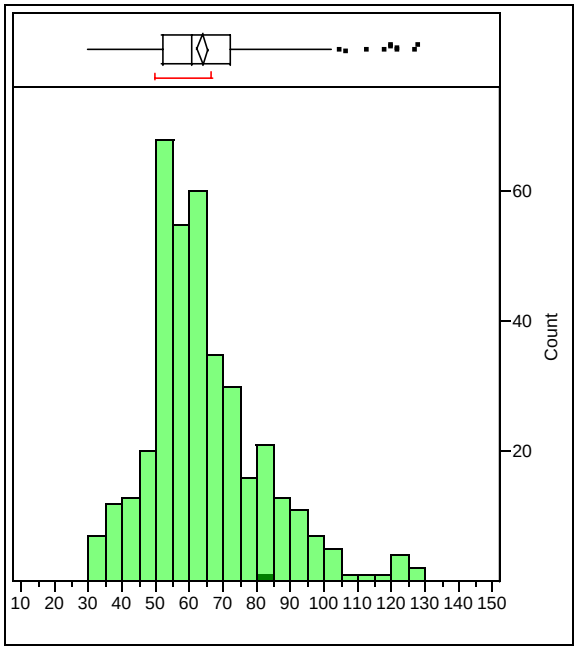
Quantiles

100.0%	maximum	255.10
75.0%	quartile	89.10
50.0%	median	78.20
25.0%	quartile	68.20
0.0%	minimum	24.50

Moments

Mean	79.489948
Std Dev	15.79022
N	75102

Gag GOM size samples with depth information recreational fisheries
Frequency distribution of size (TL_pred_cm)

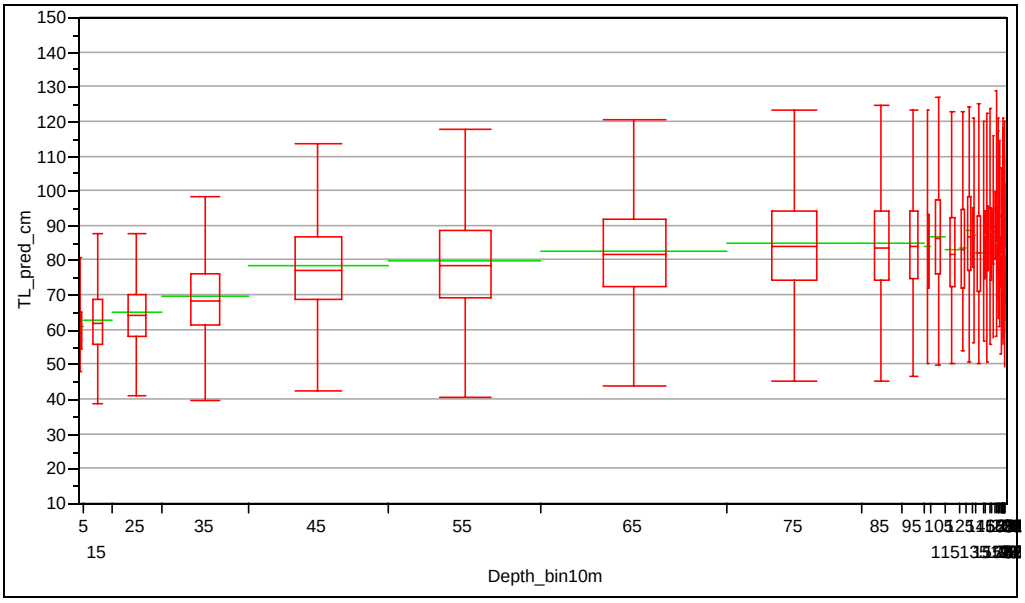


Quantiles

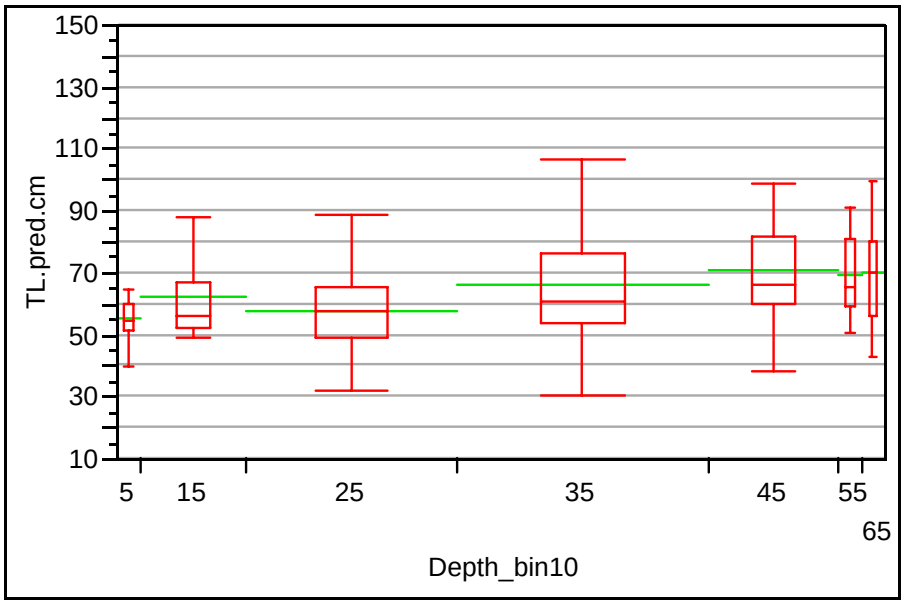
100.0%	maximum	128.20
75.0%	quartile	72.50
50.0%	median	60.90
25.0%	quartile	52.50
0.0%	minimum	30.50

Moments

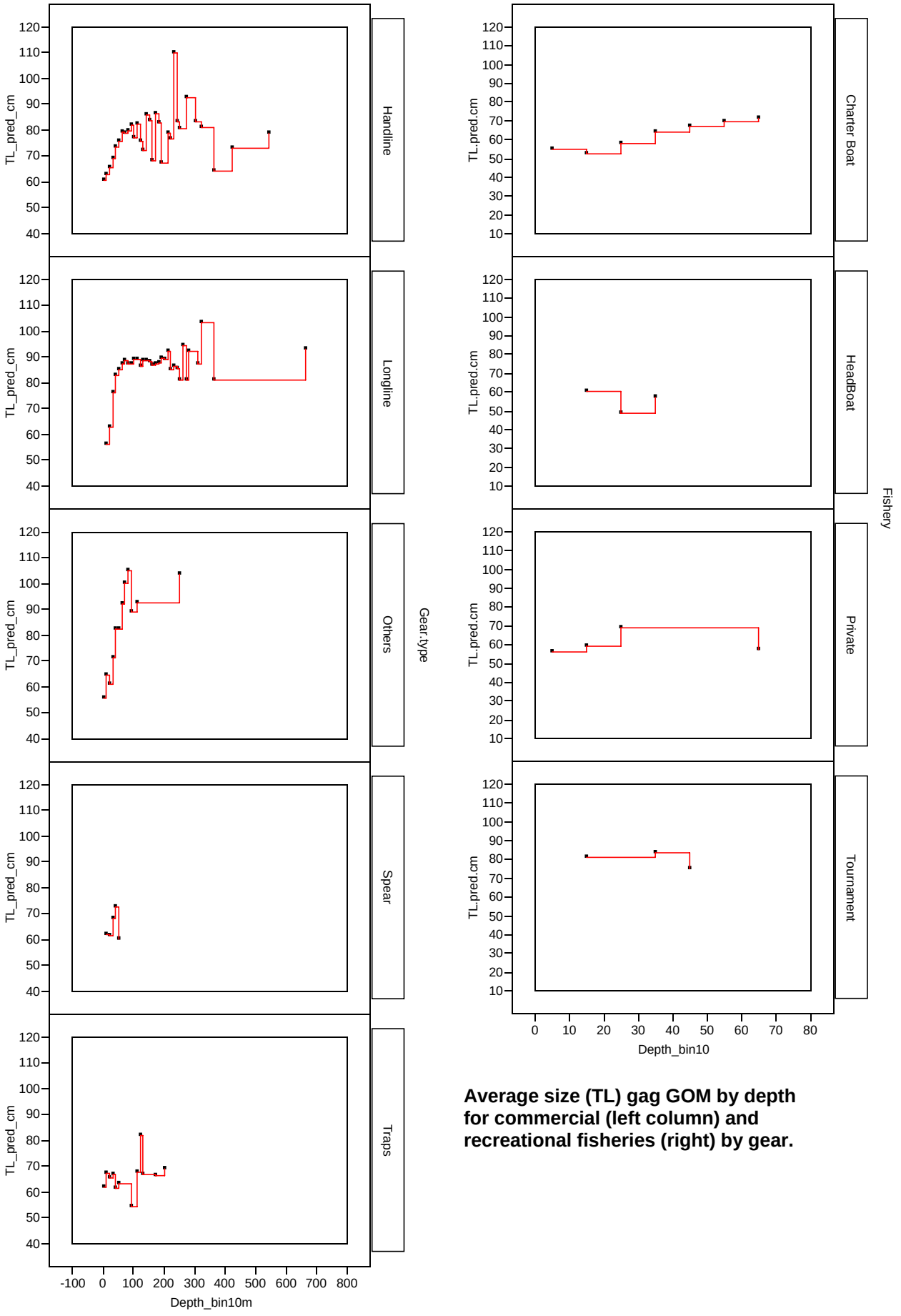
Mean	64.137173
Std Dev	17.126999
N	382



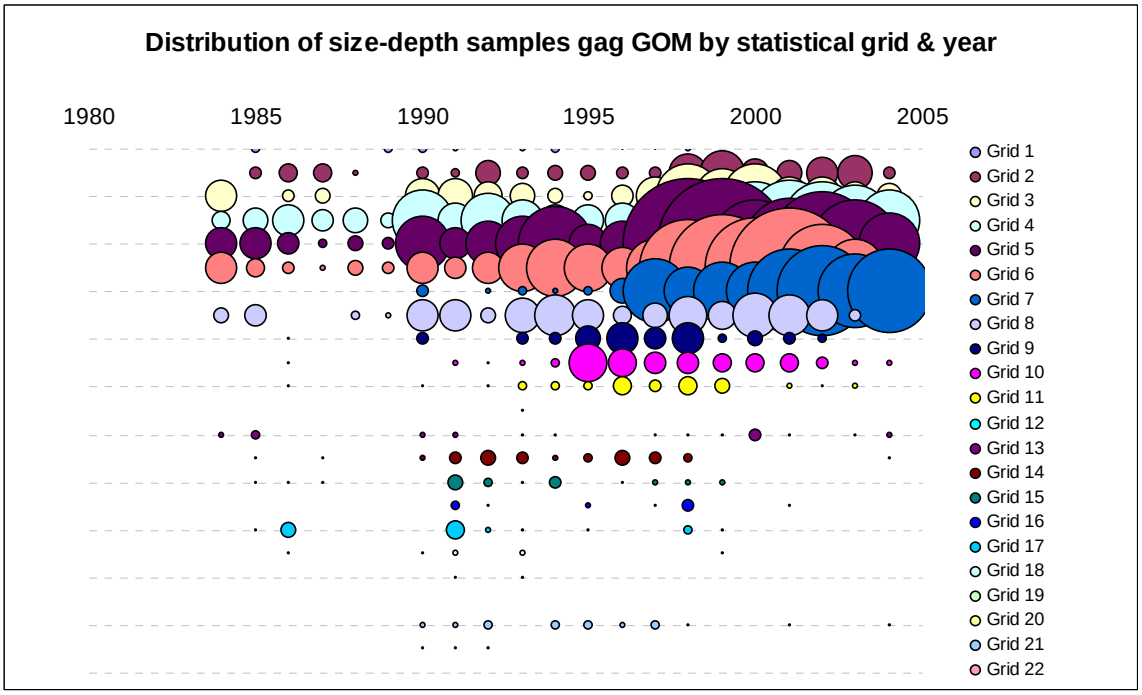
Boxplot size distribution by depth (bin 10 m) commercial gag GOM samples. Box width is proportional to number of samples by bin.



Boxplot size distribution by depth (bin 10 m) recreational gag GOM samples. Box width is proportional to number of samples by bin.



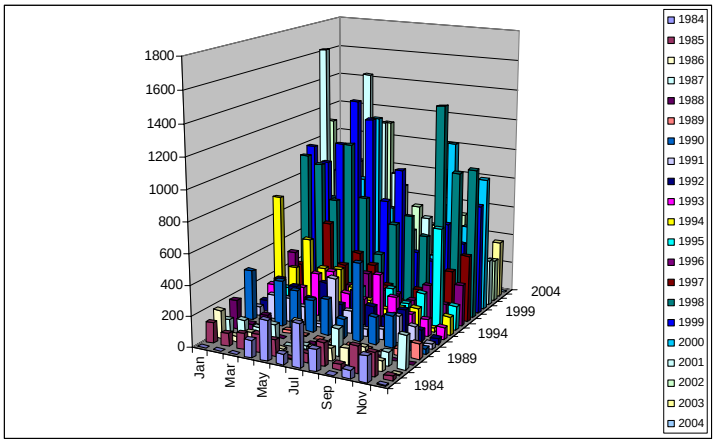
Average size (TL) gag GOM by depth for commercial (left column) and recreational fisheries (right) by gear.

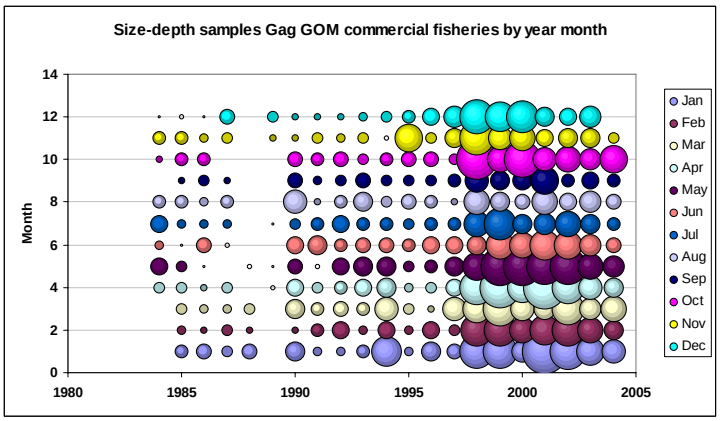


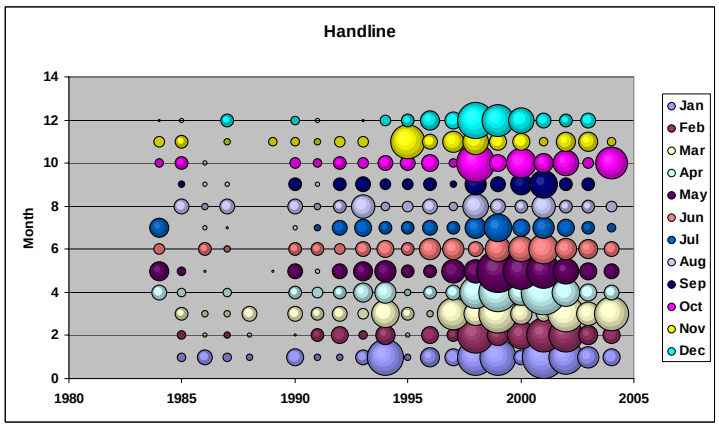
Number of samples with size-depth of capture information for gag GOM commercial fisheries from the TIP data. Grid numbers correspond to the NMFS Shrimp statistical grid sampling codes, Grid 1 Lower Keys FL, Grid 21 Southern county of Texas.

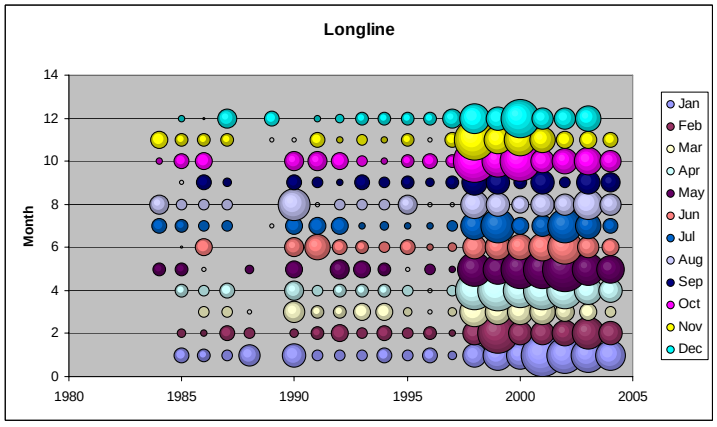
Year	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5	Grid 6	Grid 7	Grid 8	Grid 9	Grid 10	Grid 11	Grid 12	Grid 13	Grid 14	Grid 15	Grid 16	Grid 17	Grid 18	Grid 19	Grid 20	Grid 21	Grid 22
1984	0	0	226	105	252	235	0	64	0	0	0	0	11	0	2	0	0	2	0	0	1	0
1985	20	44	0	147	255	86	0	123	0	0	0	0	26	3	7	0	4	1	0	0	0	0
1986	0	89	44	247	106	51	0	0	4	8	3	0	1	0	6	0	55	5	0	0	0	0
1987	0	84	72	107	33	10	0	0	0	0	0	0	2	6	4	1	1	0	0	0	0	0
1988	0	15	0	165	72	57	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	21	0	0	60	42	48	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	21	37	305	778	674	252	44	260	52	0	6	0	11	11	1	1	2	7	0	0	17	6
1991	9	34	269	266	255	129	0	216	0	10	2	0	11	50	59	23	88	12	5	0	13	7
1992	1	143	195	656	462	240	15	70	0	6	4	0	1	64	30	4	10	0	0	0	28	3
1993	18	47	171	422	634	493	32	279	46	11	30	3	4	41	8	0	7	11	8	1	0	0
1994	24	60	72	242	1149	744	14	415	53	23	25	0	3	15	35	2	1	0	0	0	32	0
1995	2	74	27	219	314	549	25	232	167	353	20	0	2	32	2	12	8	0	0	0	20	0
1996	6	39	123	307	425	369	145	81	243	184	103	0	2	54	3	1	0	0	0	0	15	0
1997	8	37	316	156	257	736	869	145	118	126	48	0	8	38	17	3	0	1	0	0	21	0
1998	10	315	945	1179	3554	2066	540	327	251	111	92	0	7	23	18	44	23	2	0	0	8	0
1999	0	430	637	1318	3469	2404	724	185	22	88	59	0	8	0	15	1	4	3	0	0	2	0
2000	0	186	888	1282	1622	2095	726	445	58	79	2	0	36	0	0	2	0	0	0	0	0	0
2001	1	168	338	1413	1769	3021	1504	410	46	96	14	0	5	1	0	6	0	0	0	0	3	0
2002	0	216	321	1250	2212	1639	1712	236	33	43	7	0	1	0	0	2	1	0	0	0	0	0
2003	0	271	180	1070	1682	724	1154	41	2	11	13	0	3	0	0	0	0	2	0	0	1	0
2004	0	42	146	821	782	316	1556	1	1	9	1	0	19	7	1	0	0	0	0	0	6	0
Total	141	2331	5275	12210	20020	16264	9060	3572	1096	1158	429	3	161	345	208	102	204	46	13	1	167	16

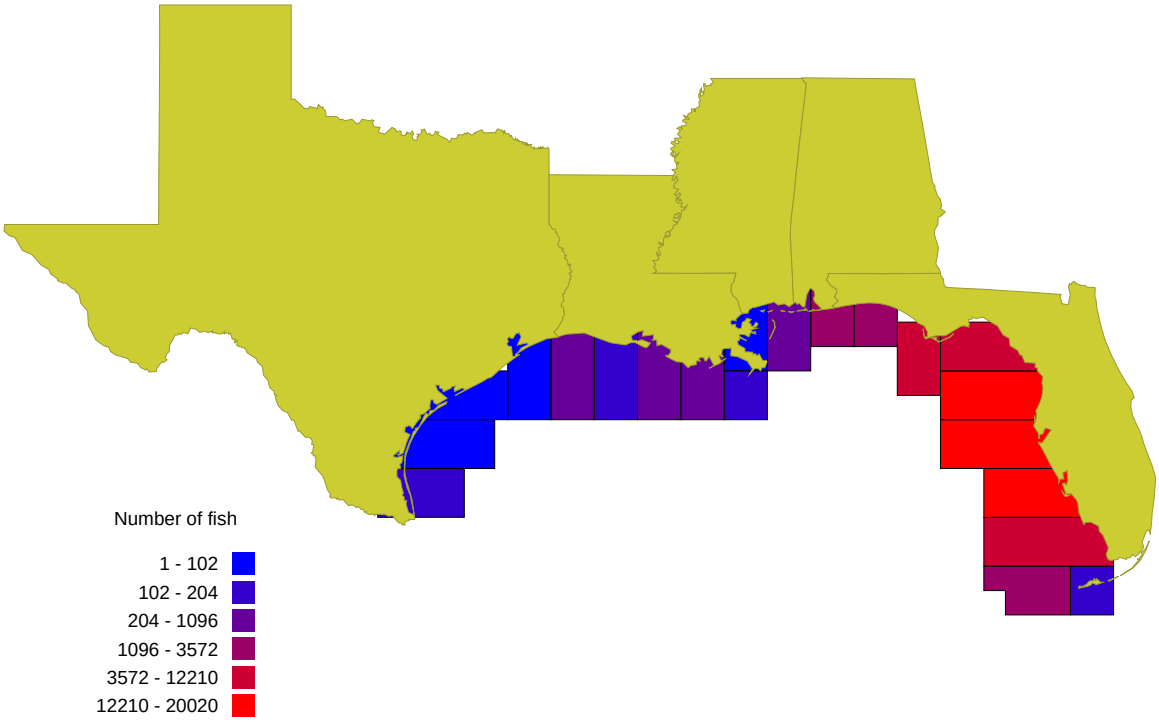
Distribution of size-depth samples of gag GOM commercial fisheries by month and year, and for the main gears.







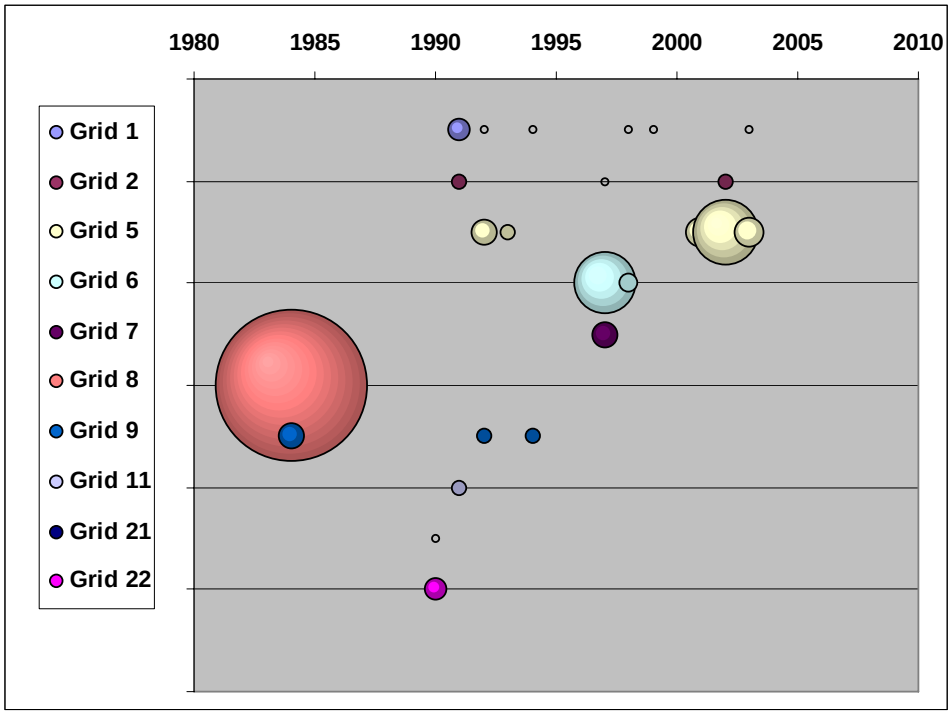




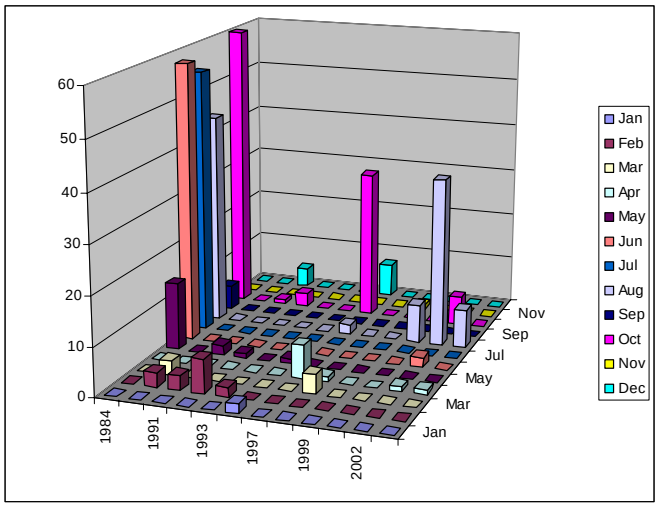
Gag GOM size-depth samples from commercial fisheries 1984-2004

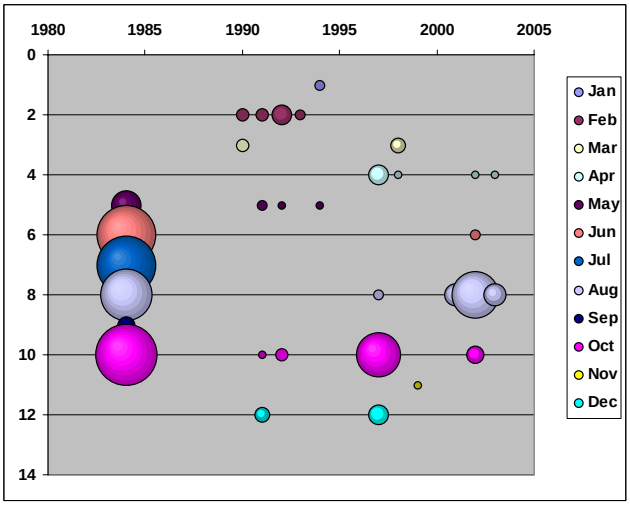
Size-depth samples for gag GOM by state and county from the TIP database.

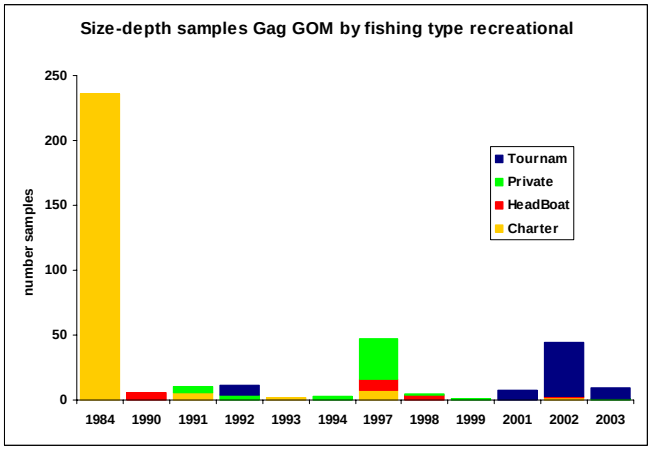
Year	State	County	nmfs_cty	fips_cty	Samples	Mean TL
1984	FL	Bay	1	5	236	62.3635593
1990	TX	Cameron	7	61	6	46.4166667
1991	FL	Monroe	29	87	8	56.3875
1991	MS	Harrison	3	47	2	45.95
1992	FL	Monroe	29	87	1	69.3
1992	FL	Okaloosa	31	91	3	92.6
1992	FL	Pinellas	35	103	7	72.1571429
1993	FL	Pinellas	35	103	2	52.5
1994	FL	Monroe	29	87	1	50.8
1994	FL	Okaloosa	31	91	2	69
1997	FL	Citrus	5	17	31	55.8967742
1997	FL	Lee	23	71	1	71.3
1997	FL	Levy	25	75	7	57.5857143
1997	FL	Pinellas	35	103	8	58.5
1998	FL	Monroe	29	87	1	53.9
1998	FL	Pinellas	35	103	4	60.625
1999	FL	Monroe	29	87	1	64.6
2001	FL	Pinellas	35	103	8	80.975
2002	FL	Monroe	29	87	2	66.9
2002	FL	Pinellas	35	103	42	76.6571429
2003	FL	Monroe	29	87	1	57.4
2003	FL	Pinellas	35	103	8	90.0375



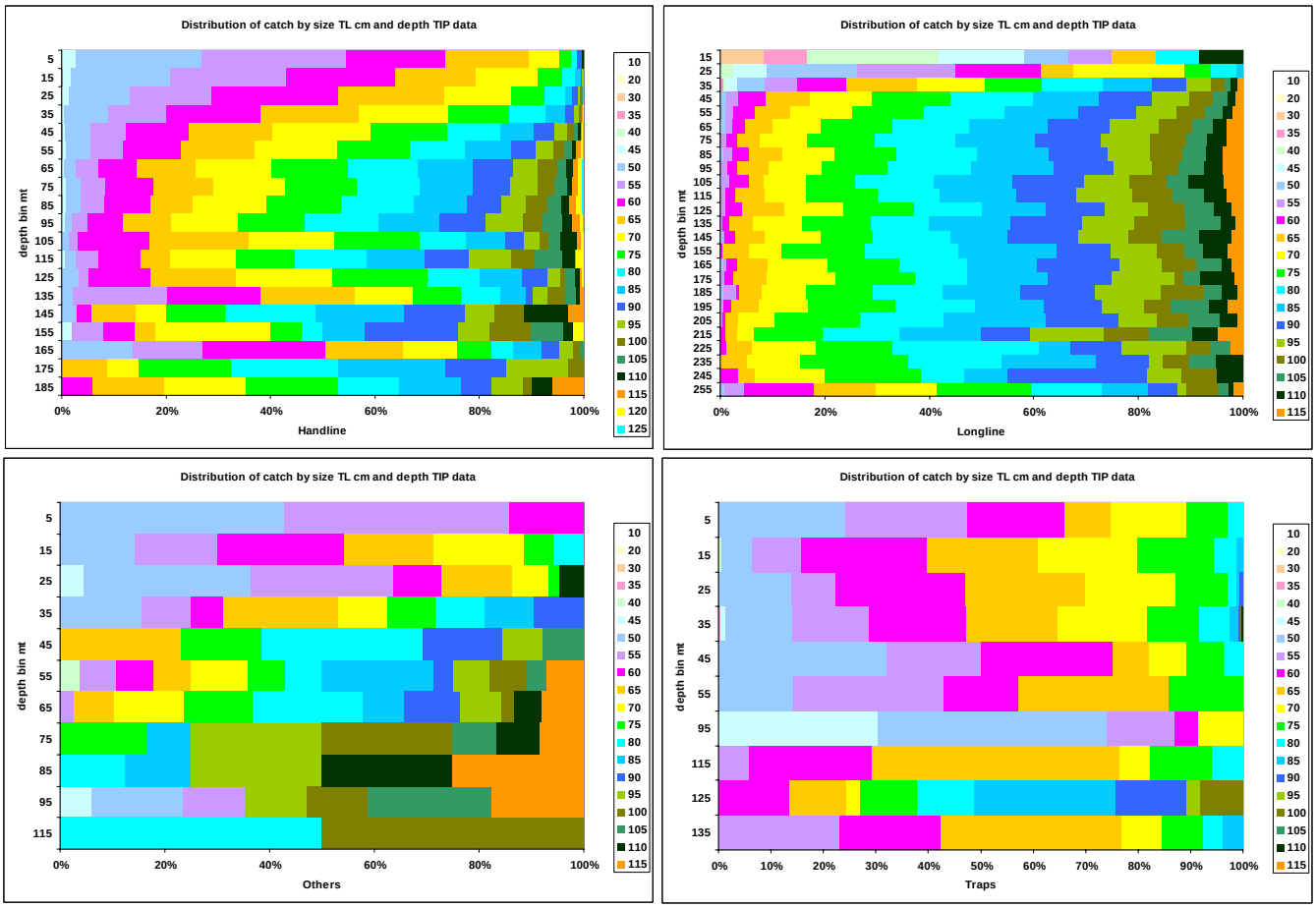
Spatial distributions of size-depth samples from TIP recreational fisheries, not all records were allocated to specific Statistical grid.



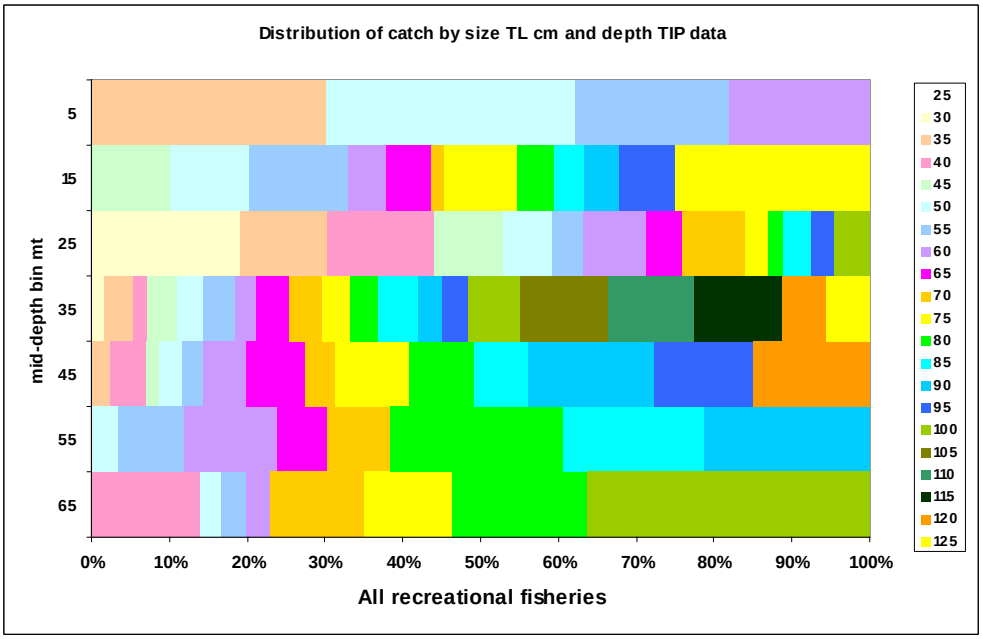




Temporal distribution of size-depth samples for recreational fisheries from the TIP database, by month and by mean type of fishery.



These plots show the matrices of size-at-depth for gag GOM derived from the commercial fisheries TIP samples. The data corroborate the assumption of larger size fish being caught primarily in deeper waters, while smaller fish are predominant in shallow water.



Size-at-depth matrix for recreational fisheries (all modes combined) Even sample size is much smaller than commercial fisheries, the spatial distribution of fish by depth is similar to the commercial size-at-depth.

The SEDAR 10 participants suggested constructing two average size-at-depth matrices; one for commercial fisheries and one for recreational fisheries. Owing to the limited number of observations, average size-at-depth matrices were constructed with all years combined (implicitly assuming that the distribution of length at depth changes little from year to year). Depths were aggregated into 10 m bins from the surface down to 60 m, with the last bin being 60 m and deeper. Lengths were aggregated by 5 cm bins, but the catch-at-size data from commercial and recreational fisheries were aggregated at 2 cm size bin intervals, therefore the size-depth matrix was interpolated for the 2 cm bin size.

The two size-at-depth matrices were used to convert the assumed size composition of the commercial and recreational discards into estimates of discards-at-depth, which in turn were multiplied by the estimated depth-mortality function and total number discarded to obtain the total number of dead discards.

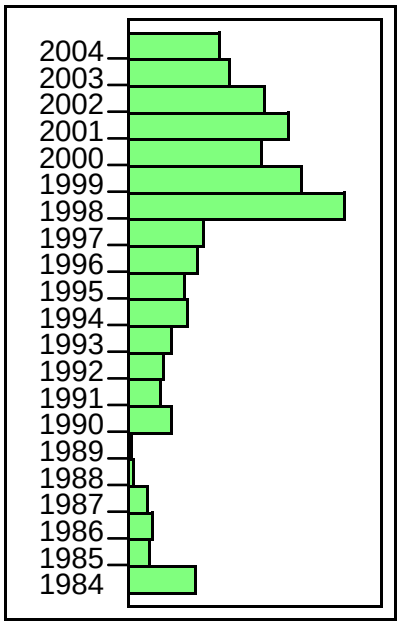
Commercial discards were assumed to be negligible prior to the minimum size regulations. Estimates for the years after the minimum size regulations were obtained by assuming the proportion of the catch that is below the size limit in each year is the same as it would have been during the years prior to the size limit regulations. The size composition of the discards was therefore computed from the difference in size-frequency distributions between the base period (1984-1989, years with no minimum size restrictions) and the phase1 period (1990-2000, 51 cm minimum size limit) or phase 2 period (2000-2004, 61 cm minimum size limit).

In the case of the recreational fishery, the B2 MRFSS estimates of the total number of gag discarded were used. Information on the size of discarded gag in the Gulf of Mexico recreational fishery was limited to a survey out of the Mote Marine laboratory (covering mostly the region offshore of Tampa) and larger samples from GULFIN and TIP (which included landed fish). The assessment models examined by SEDAR 10 assumed that the size composition of recreational discards was similar to the size composition from these combined data sets, which effectively implies that most recreationally-caught gag were discarded because of the bag limit and a smaller fraction were discarded because they were below the legal size. Section 3 presents an alternative run that uses only those length observations that were below the size limit, thus implying that essentially all discards occur in response to the minimum size regulation.

2. Spatio-temporal distribution of size samples for converting catch to Catch-at-Size data for Gag GOM.

Size or length samples were available for most commercial and recreational fisheries by year, season, area, and/or wave to allow converting catch into Catch-at-Size (CAS) for landing of gag GOM during 1981-2004 period. For commercial fisheries about 95 thousand samples were collected, the following is the distribution of these samples by year, month, state, fishing mode, and season (trimester). Most of the samples are from the longline and handline fishing modes (1 and 2), and sample size increase substantially in 1998. About 98% of samples come from Florida, where equivalently the bulk of the catch is taken. .

Distributions of gag GOM commercial size samples from 1984-2004
YEAR

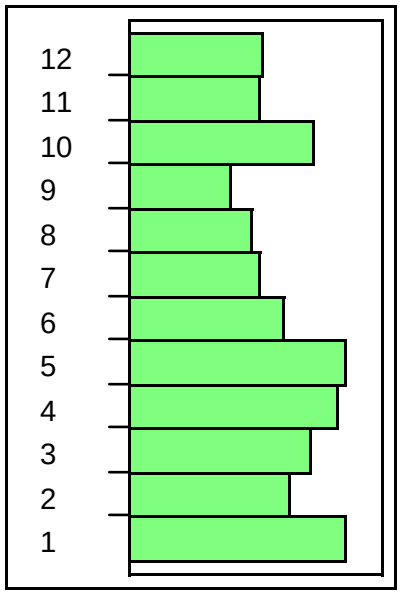


Frequencies

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

21 Levels

MONTH



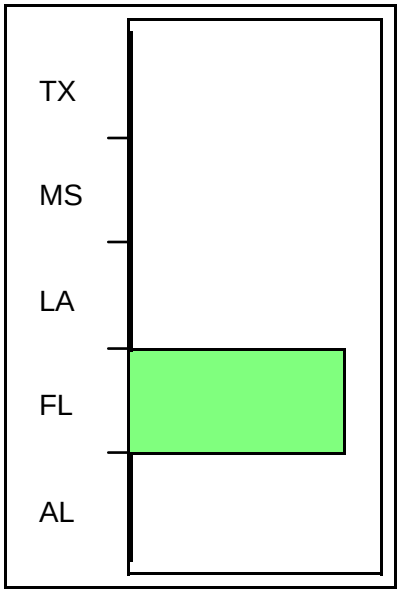
Frequencies

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

Level	Count	Prob
Total	95122	1.00000

12 Levels

state

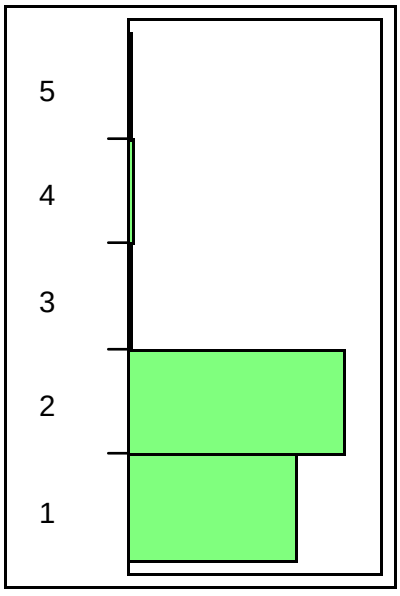


Frequencies

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

5 Levels

mode

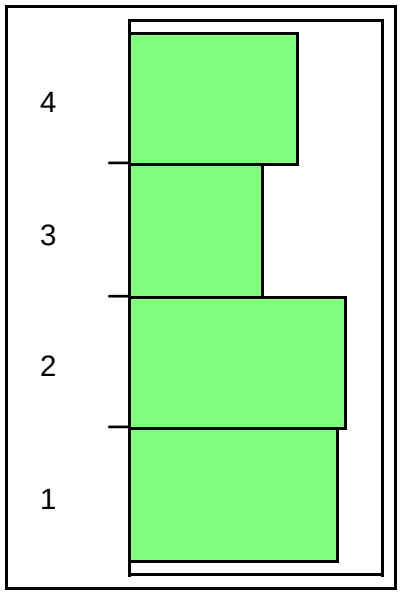


Frequencies

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

5 Levels

season

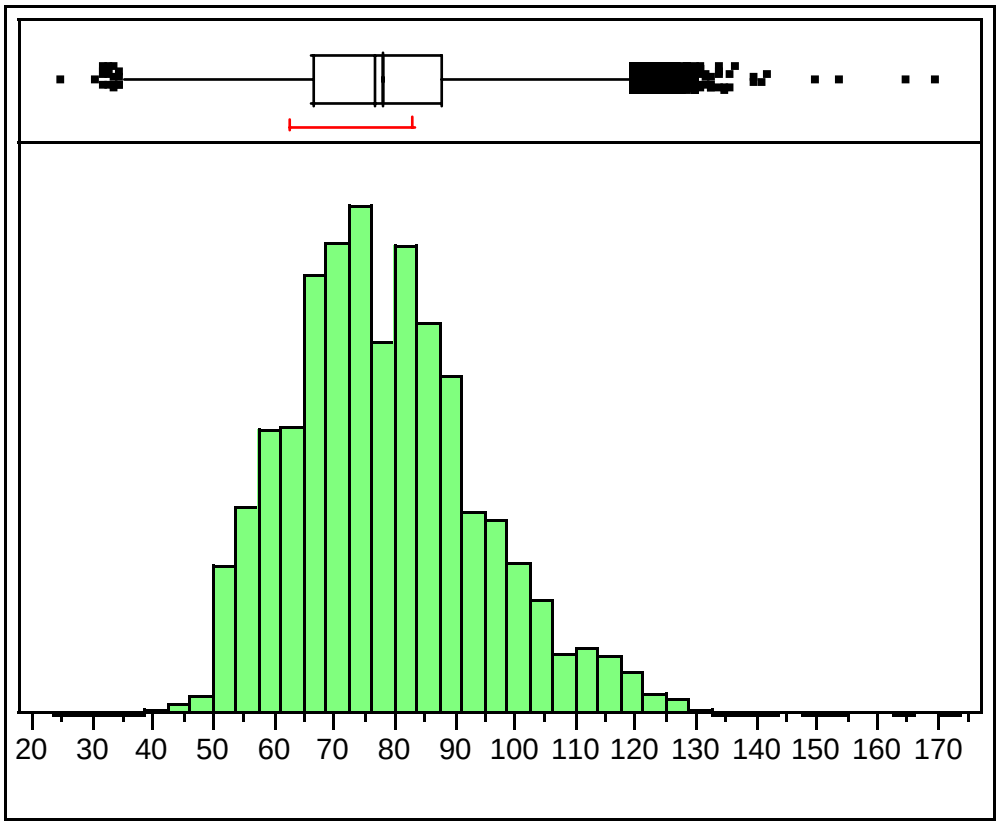


Frequencies

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

The overall size frequency distribution of size samples shows a mode of 70-85 cm (TL) catch for gag GOM in commercial fisheries, with a range from 25 to 170 cm. 50% quartile is between 67 and 88 cm.

Frequency distribution of gag GOM size samples from commercial fisheries
TLcm



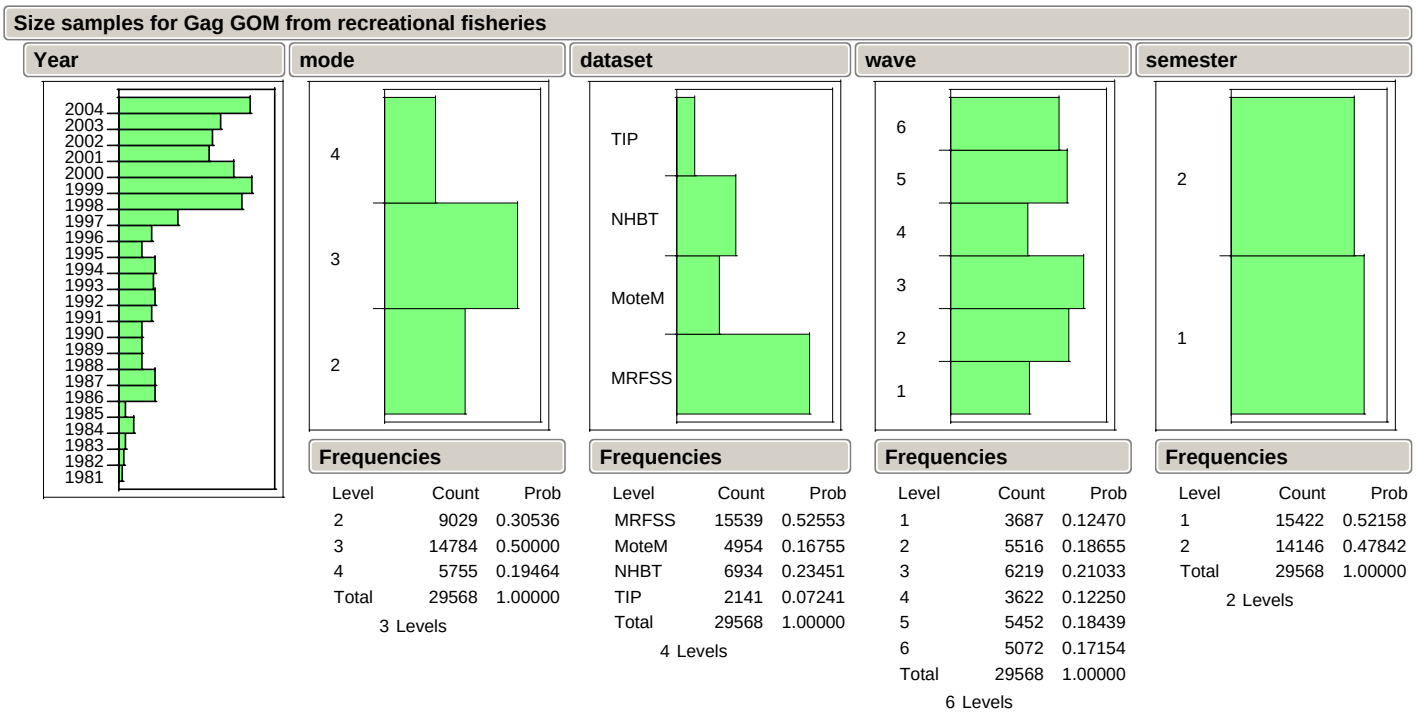
Quantiles

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

Moments

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

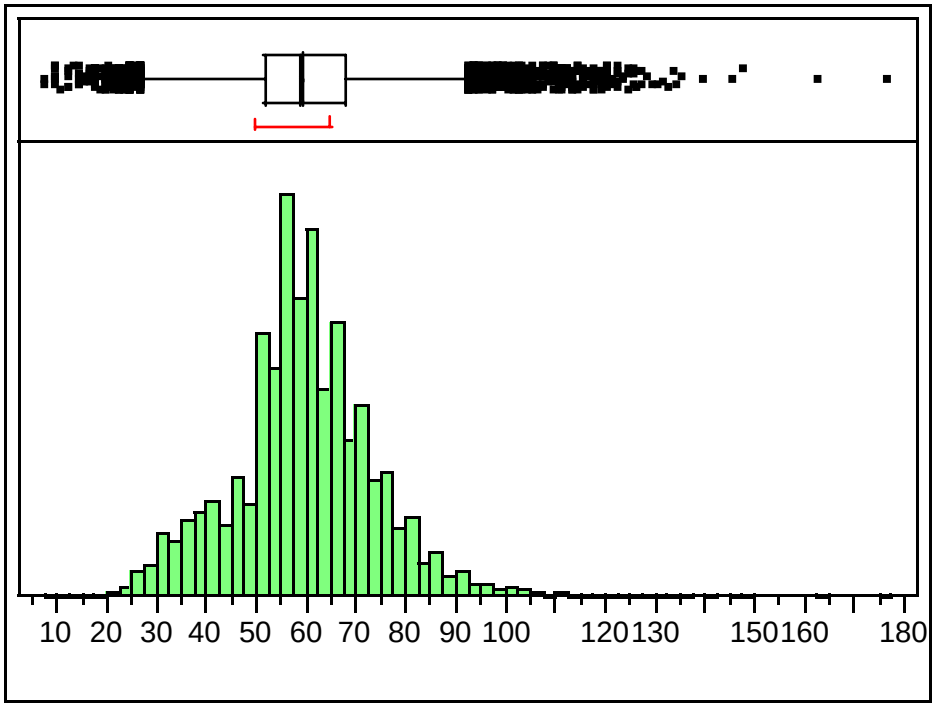
For recreational fisheries, about 30 thousand size samples were available since 1981. the following plots shows the distribution of these samples by year, semester, wave, fishing mode (Headboat, private, charter), and source of data.



Size samples increase in number in 1998 also, however distribution by mode, wave and semester is well balanced. The overall size frequency distribution of size samples for recreational gag GOM shows a mode at 60 cm., with a clear cut at the 50-51 cm, likely in respond to the minimum size restrictions.

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

TLcm



Quantiles

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

Moments

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

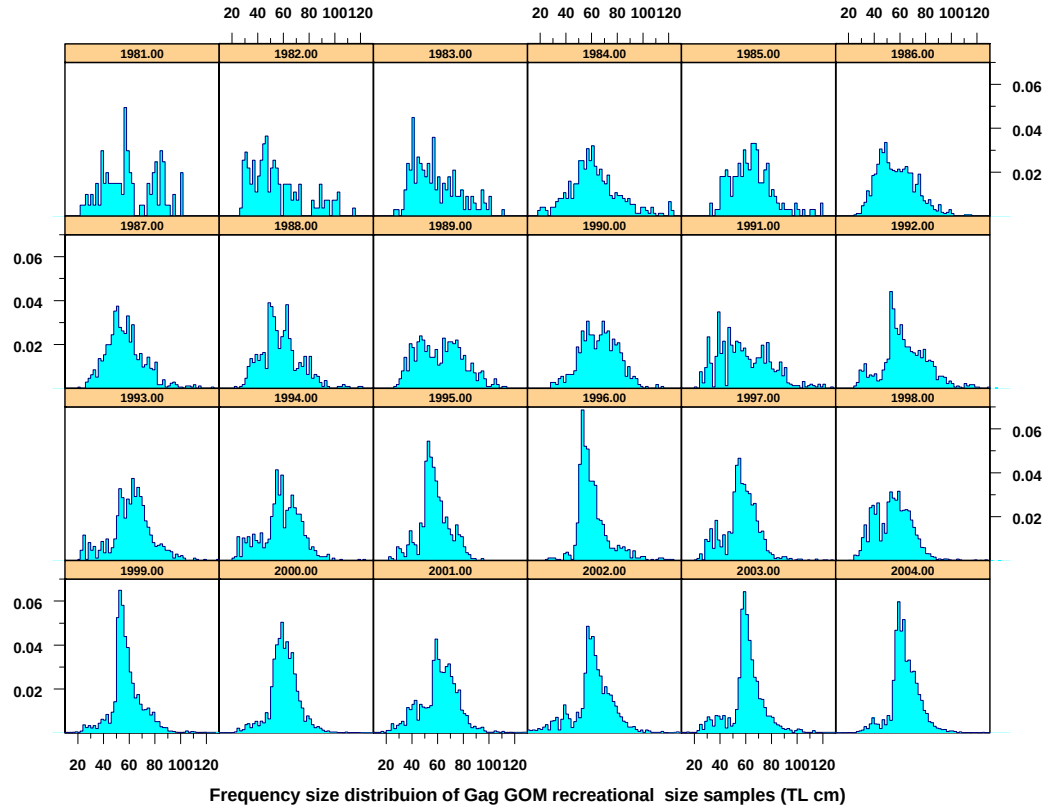
The next tables presents the size samples available for each stratum, a minimum of 150 length samples were required to used for converting catch to CAS by strata, if not available substitutions were done, see SEDAR10-AW-02 document for further detail (Ortiz 2006) by fishery type.

Commercial Length Frequency Samples used in converting Catch to CAS

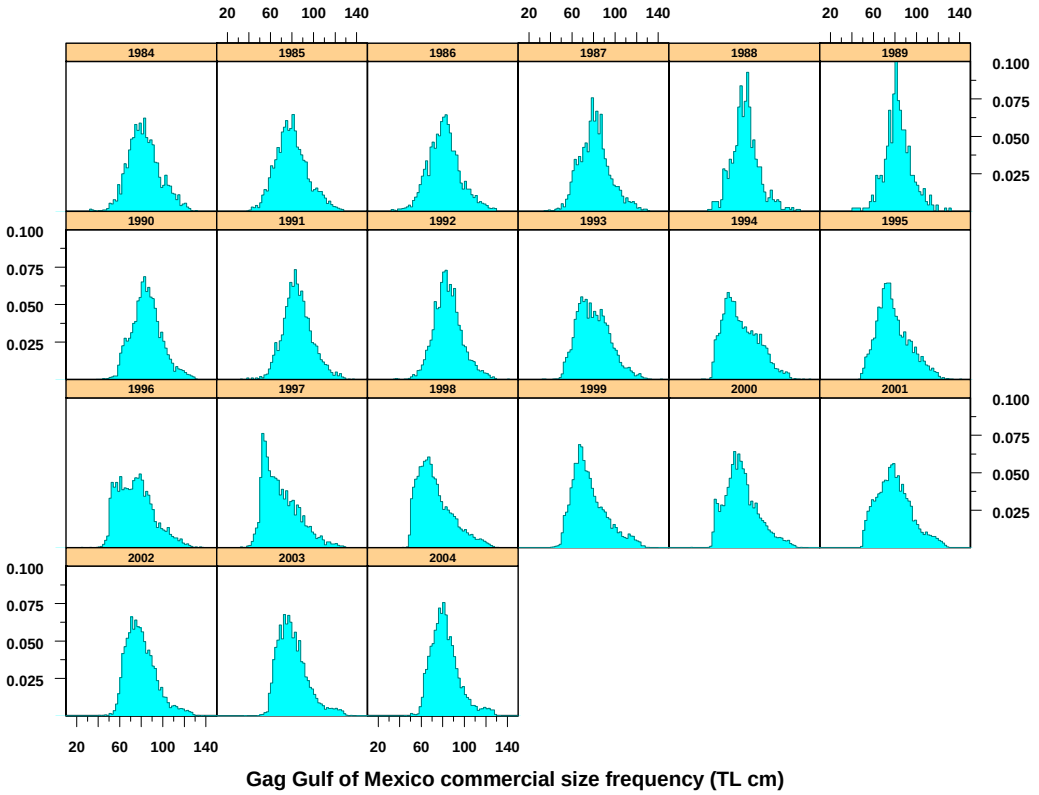
Year	Semester	Season	Mode1 Longline	Mode2 Handline	Mode3 Spear	Mode4 Traps	Mode5 Others
1984	1	1	0	0	81	284	334
1984	1	2	59	444	166	416	237
1984	2	3	242	195	121	309	193
1984	2	4	157	190	138	307	154
1985	1	1	128	299	0	0	0
1985	1	2	146	118	0	0	0
1985	2	3	151	152	0	0	0
1985	2	4	172	206	0	0	0
1986	1	1	145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

Recreational Length Frequency Samples used in converting Catch to CAS

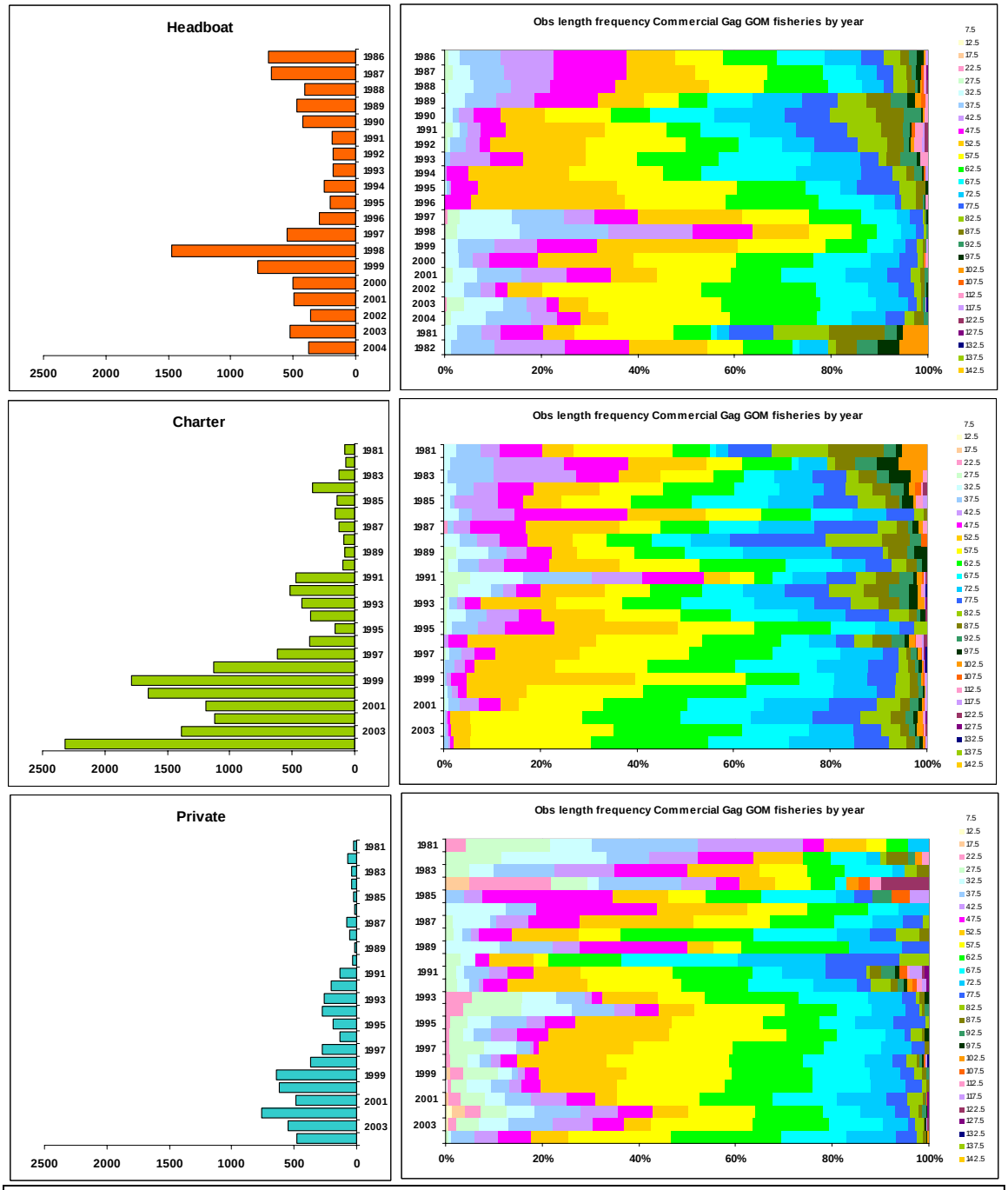
Year	Semester	Wave	Mode2 Headboat	Mode3 Charter	Mode4 Private
1981	1	1	0	15	0
1981	1	2	0	16	0
1981	1	3	0	13	0
1981	2	4	0	13	5
1981	2	5	0	12	8
1981	2	6	0	9	10
1982	1	1	0	7	1
1982	1	2	0	33	8
1982	1	3	0	5	24
1982	2	4	0	8	16
1982	2	5	0	4	4
1982	2	6	0	11	16
1983	1	1	0	10	0
1983	1	2	0	33	16
1983	1	3	0	31	14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



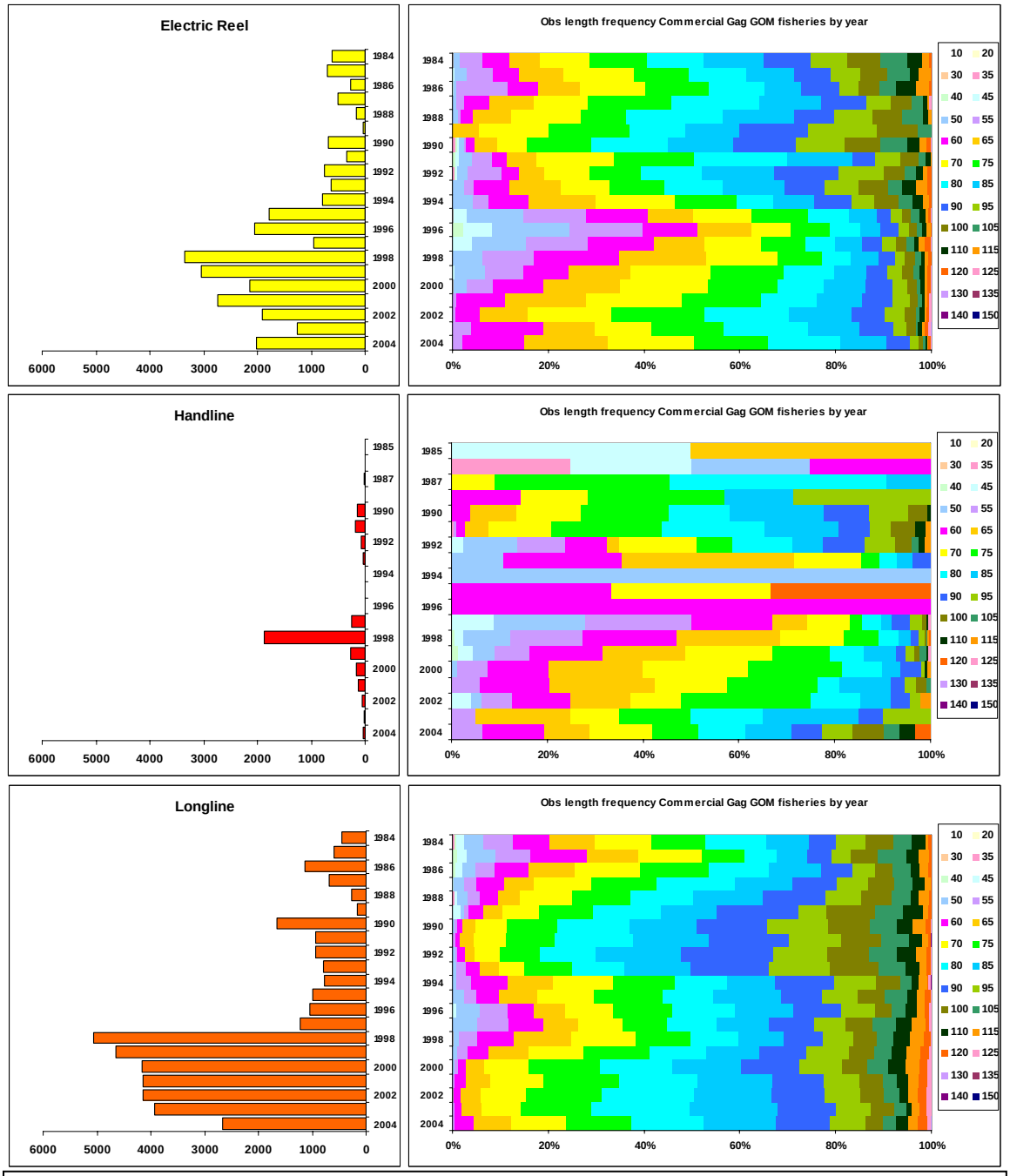
Frequency distribution of size samples from recreational fisheries for gag GOM by year.



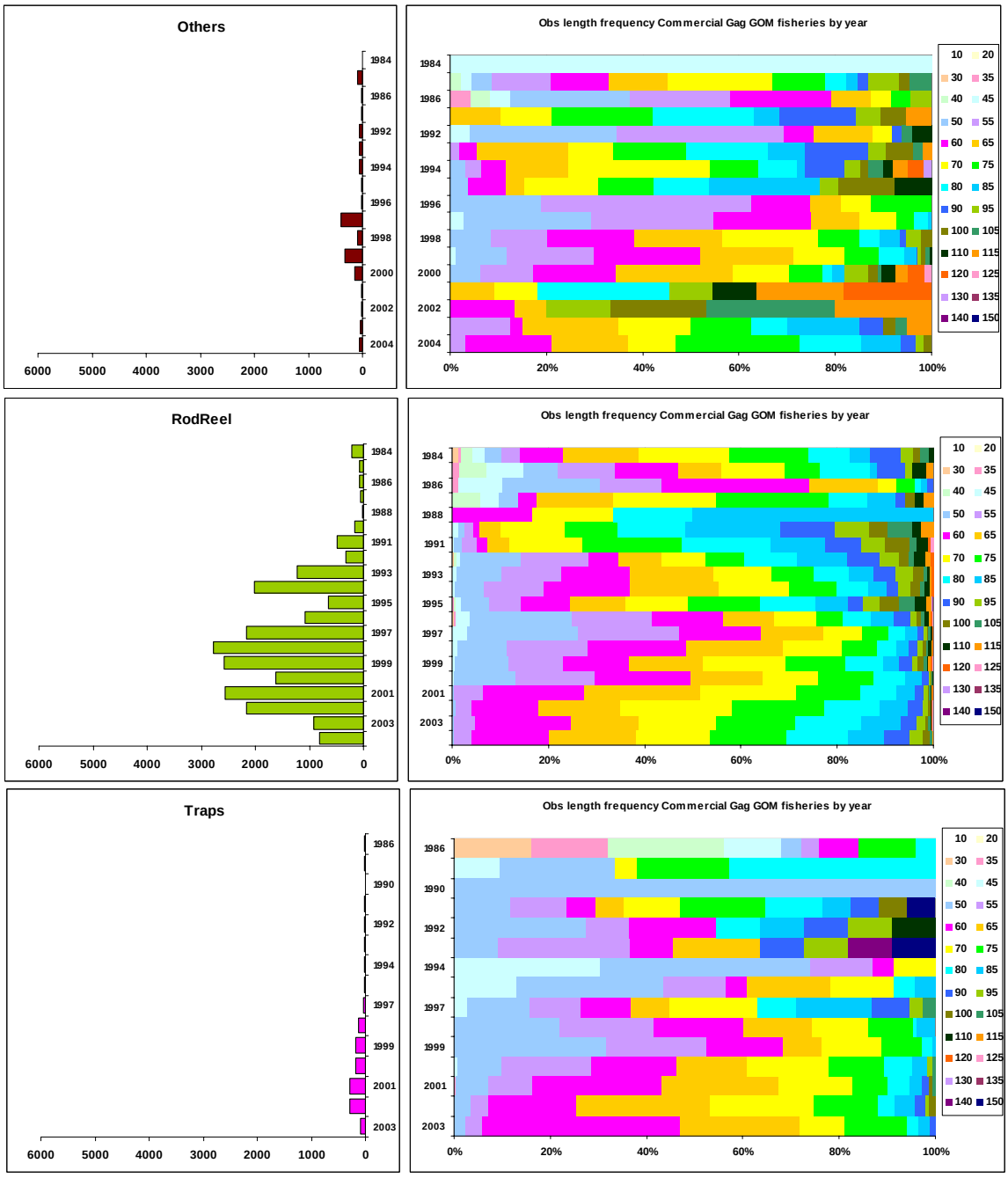
Frequency distribution of size samples from commercial fisheries for gag GOM by year.



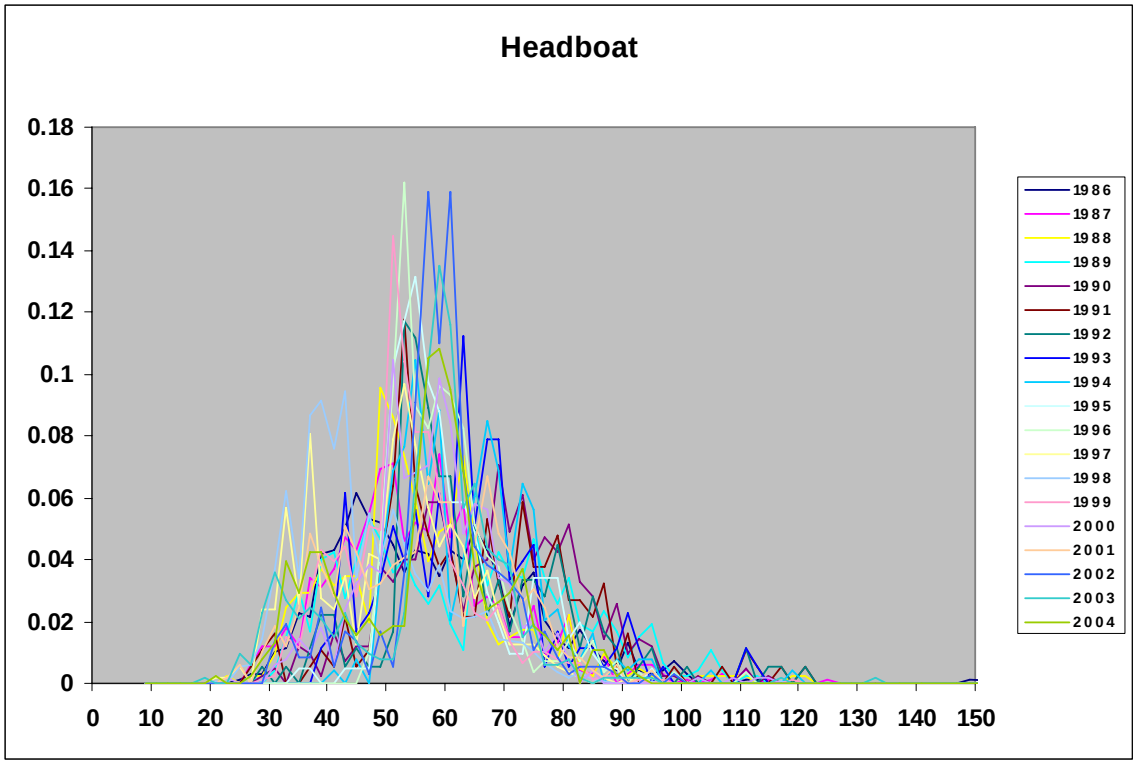
Size proportions (right column) and sample size (left column) by year and mode of gag GOM from recreational fisheries.

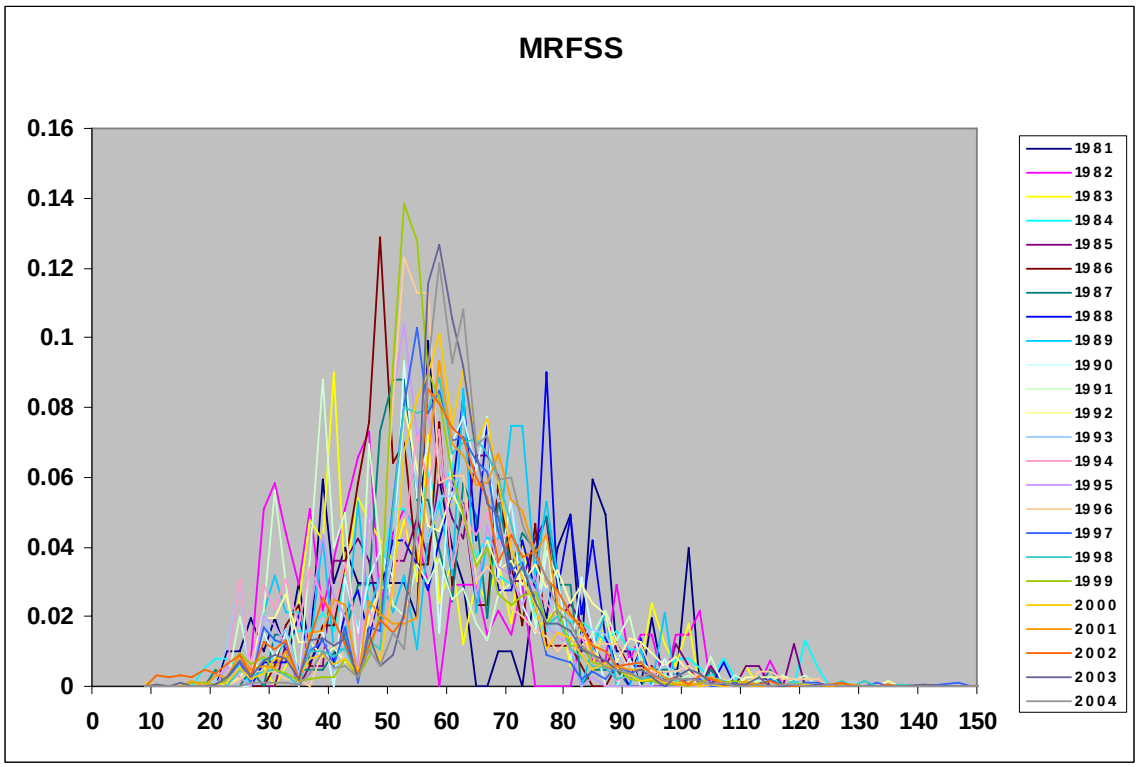


Size proportions (right column) and sample size (left column) by year and mode of gag GOM from commercial fisheries.

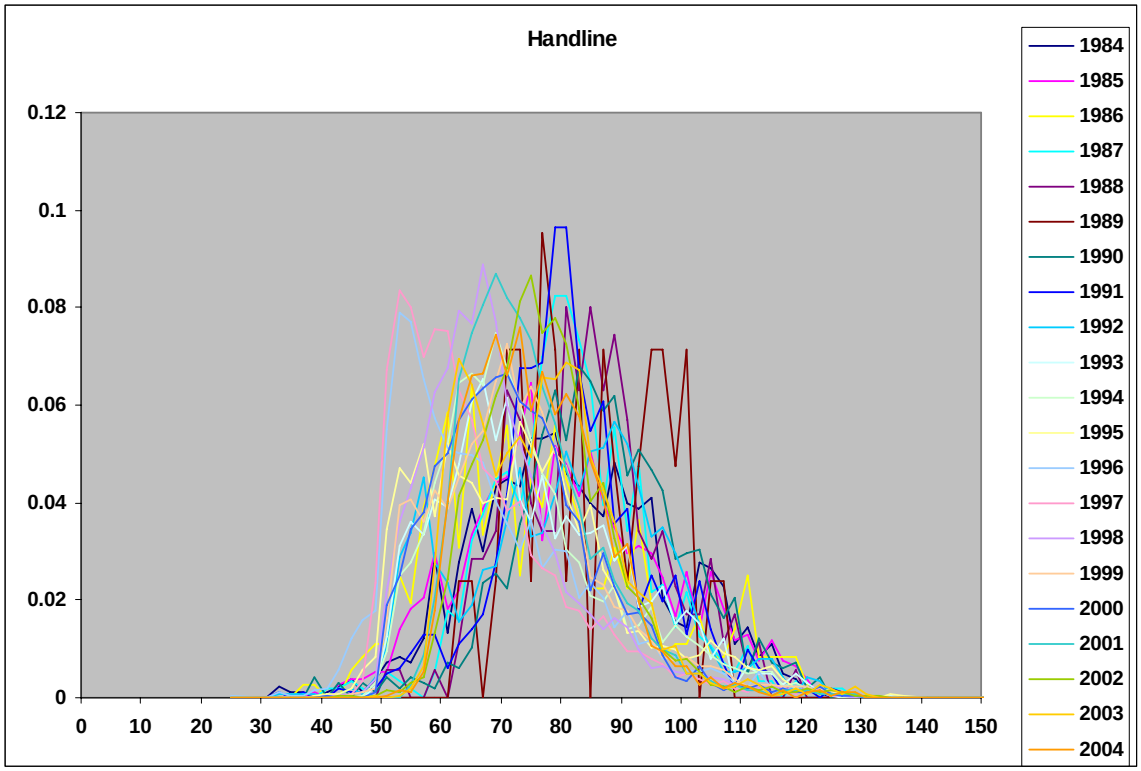


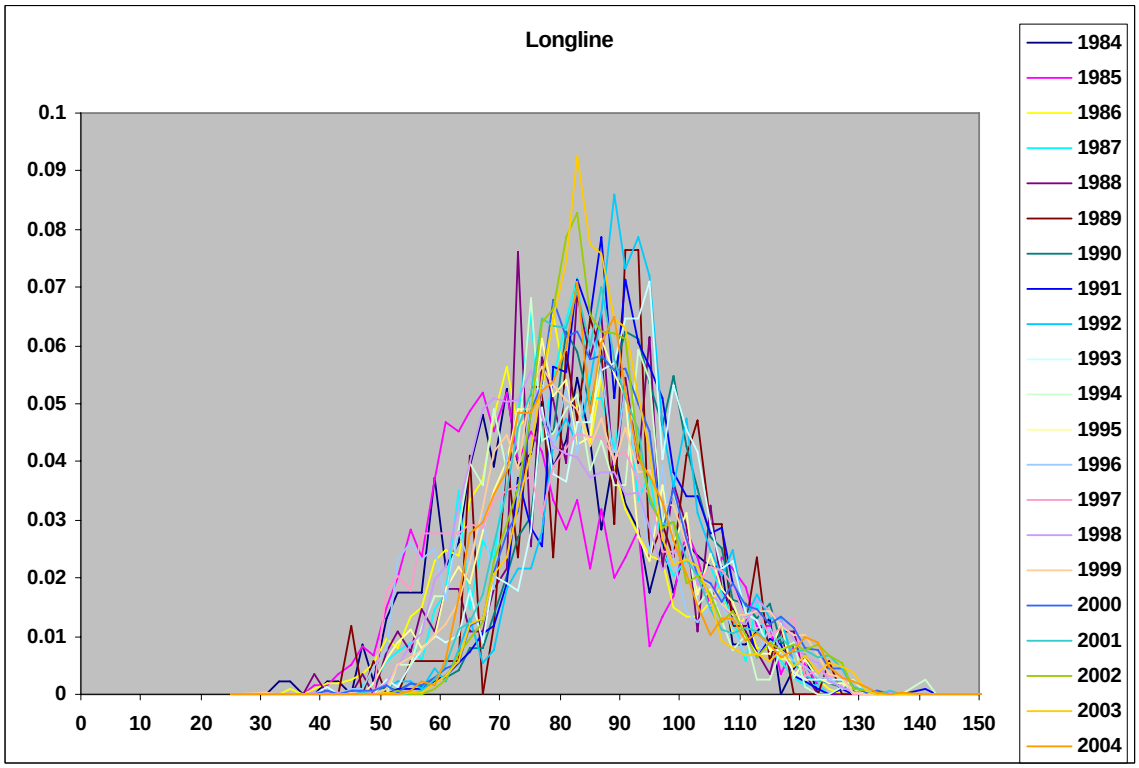
Size proportions (right column) and sample size (left column) by year and mode of gag GOM from commercial fisheries.





Estimated CAS for the recreational fisheries gag GOM by year and main fishery type.

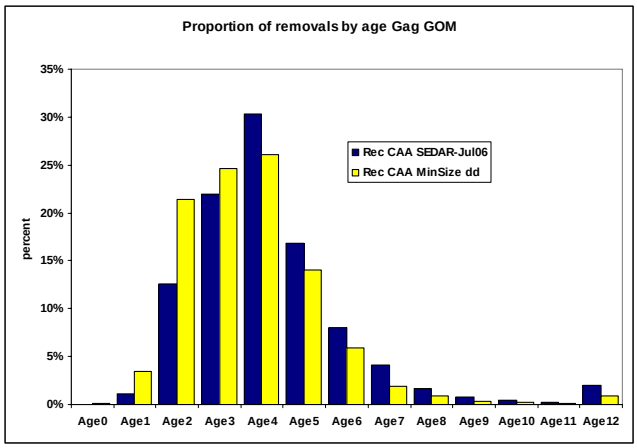


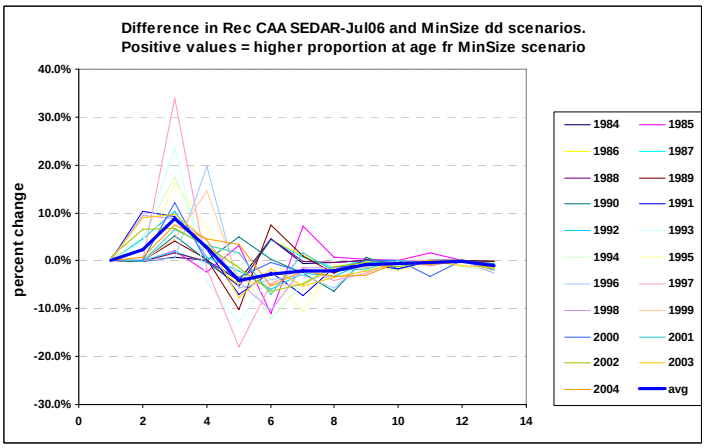


Estimated CAS for the commercial fisheries gag GOM by year and main fishery type

3. The panel recommends constructing an analysis of Gulf of Mexico gag grouper based on assigning discarded fish to sizes below the minimum limit.

Following the recommendations from the review panel, the final (SEDAR-Jul06) run for Gag GOM was modified such that all discarded fish from recreational fisheries were below the applicable minimum size limits. Thus all B2 estimates from MRFSS and Headboat were assumed to be less than 20 inches (51 cm TL) from Jan-1990 to Jun-2000, and less than 22 inches (56 cm TL) from Jul-2000 to Dec-2004. Discards prior to 1990 were treated as in the base case, i.e. assuming the same size distribution as of landed fish for those years. The estimation of dead discards as a function of depth was otherwise accomplished as describer earlier for the final SEDAR-Jul06 run. The total number of discards was set to the MRFSS B2 estimates as before, but the total number of dead discards decreased in comparison to the original base run because gag larger than the size limit are no longer assumed to be released (larger gag tend to reside in deeper water and therefore have higher mortality rates). Moreover, the age composition of the removals was shifted towards younger fish as shown in the following plots of recreational catch at age (CAA).





As expected, assuming that discards were only fish below minimum size, the age distribution of total removals was different. For the recreational CAA (the commercial CAA did not change), assuming a discards of fish below min-size implied that more fish ages 1, 2 and 3 were removed from the stock, while for older ages, 4 and above the proportion at age decreased. The right plot shows the same information but for each year since 1984. Because smaller size fish have a higher probability of survive if discarded (i.e. lower mortality at depth), the total numbers of removals between the scenarios were also different. Tables 1 and 2 show the total estimated catch removals in weight units by year and fishery for the two scenarios:

Table 1. Estimated final catch removals (landings + dead discards) SEDAR Jul06. The highlighted show the differences in weight when it is assumed that all discards are below minimum size regulations.

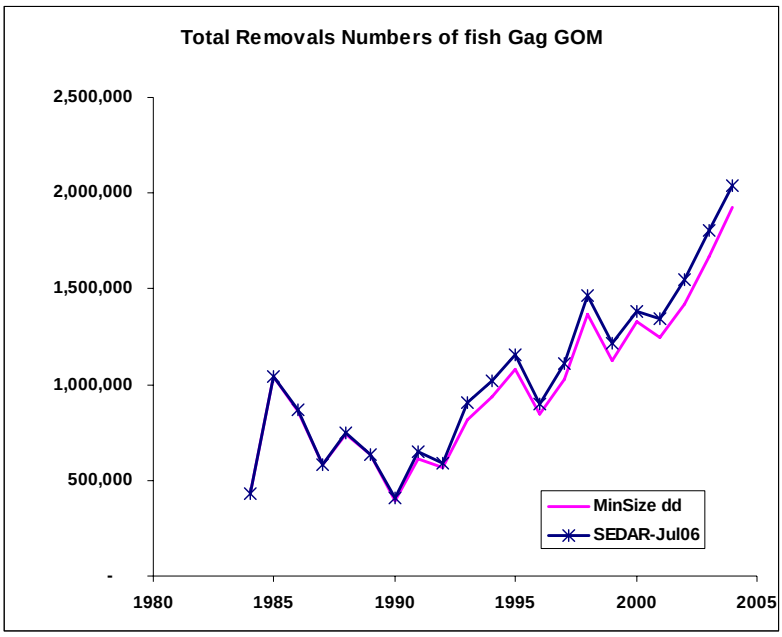
thousand lbs

Year	Longline	Handline	Others	MRFSS	Headboat	Total
1963	-	1,289	1	444	-	1,734
1964	-	1,632	9	479	-	2,121
1965	-	1,816	1	518	-	2,334
1966	-	1,457	1	559	-	2,017
1967	-	1,156	10	604	-	1,769
1968	-	1,192	4	652	-	1,849
1969	-	1,377	3	704	-	2,084
1970	-	1,284	3	761	-	2,047
1971	-	1,377	3	869	-	2,249
1972	-	1,460	4	994	-	2,458
1973	-	1,081	5	1,136	-	2,222
1974	-	1,184	1	1,298	-	2,483
1975	-	1,447	4	1,483	-	2,934
1976	-	1,198	9	1,697	-	2,905
1977	-	977	8	1,942	-	2,927
1978	-	875	11	2,226	-	3,112
1979	1	1,342	10	2,551	-	3,905
1980	89	1,318	12	2,909	-	4,328
1981	467	1,499	16	2,459	-	4,440
1982	1,010	1,335	14	3,509	-	5,868
1983	681	1,039	18	7,460	-	9,198
1984	433	1,098	18	2,134	-	3,684
1985	381	1,398	28	6,967	-	8,774
1986	517	1,155	29	4,263	308	6,273
1987	656	853	30	2,827	231	4,596
1988	402	791	23	4,224	165	5,605
1989	426	1,235	31	3,264	338	5,295
1990	625	1,130	41	1,991	308	4,094
1991	510	993	63	4,843	111	6,520
1992	593	1,003	69	3,951	156	5,771
1993	482	1,281	106	5,874	211	7,954
1994	352	1,148	119	6,458	317	8,394
1995	394	1,158	105	7,251	195	9,102
1996	397	1,107	68	5,311	177	7,059
1997	420	1,101	83	6,794	168	8,565
1998	609	1,849	82	8,598	428	11,565
1999	550	1,481	68	7,252	315	9,666
2000	637	1,605	81	8,375	271	10,969
2001	1,053	2,088	101	8,767	167	12,175
2002	1,059	1,934	62	10,641	145	13,840
2003	1,190	1,477	67	12,219	240	15,193
2004	1,191	1,757	73	13,718	327	17,066

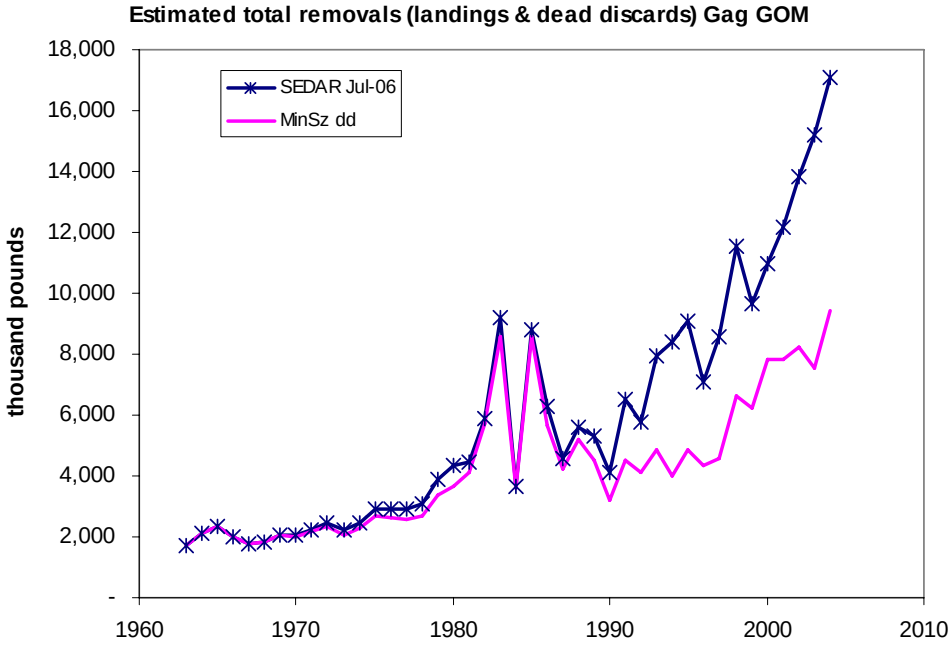
Table 2. Estimated total biomass removals (landings + death discards) gag GOM Depth-release mortality MinSize discards only (thousand lbs). The highlighted show the differences in weight when it is assumed that all discards are below minimum size regulations.

Year	Longline	Handline	Others	MRFSS	Headboat	Total
1963	-	1,289	1	444	-	1,734
1964	-	1,632	9	479	-	2,121
1965	-	1,816	1	514	-	2,331
1966	-	1,457	1	547	-	2,005
1967	-	1,156	10	582	-	1,748
1968	-	1,192	4	620	-	1,816
1969	-	1,377	3	659	-	2,039
1970	-	1,284	3	701	-	1,987
1971	-	1,377	3	789	-	2,168
1972	-	1,460	4	887	-	2,351
1973	-	1,081	5	997	-	2,084
1974	-	1,184	1	1,121	-	2,307
1975	-	1,447	4	1,260	-	2,711
1976	-	1,198	9	1,418	-	2,625
1977	-	977	8	1,595	-	2,580
1978	-	875	11	1,796	-	2,682
1979	1	1,342	10	2,022	-	3,376
1980	89	1,318	12	2,265	-	3,684
1981	467	1,499	16	2,108	-	4,089
1982	1,010	1,335	14	3,341	-	5,699
1983	681	1,039	18	6,820	-	8,558
1984	433	1,098	18	2,023	-	3,573
1985	381	1,398	28	6,750	-	8,557
1986	517	1,155	29	3,671	289	5,662
1987	656	853	30	2,483	204	4,225
1988	402	791	23	3,850	155	5,221
1989	426	1,235	31	2,507	318	4,517
1990	625	1,130	41	1,179	198	3,173
1991	510	993	63	2,857	107	4,530
1992	593	1,003	69	2,339	125	4,129
1993	482	1,281	106	2,828	173	4,870
1994	352	1,148	119	2,204	188	4,011
1995	394	1,158	105	3,055	129	4,841
1996	397	1,107	68	2,633	114	4,319
1997	420	1,101	83	2,843	102	4,548
1998	609	1,849	82	3,820	246	6,605
1999	550	1,481	68	3,907	201	6,207
2000	637	1,605	81	5,263	214	7,801
2001	1,053	2,088	101	4,436	125	7,803
2002	1,059	1,934	62	5,093	91	8,238
2003	1,190	1,477	67	4,652	132	7,518
2004	1,191	1,757	73	6,215	199	9,434

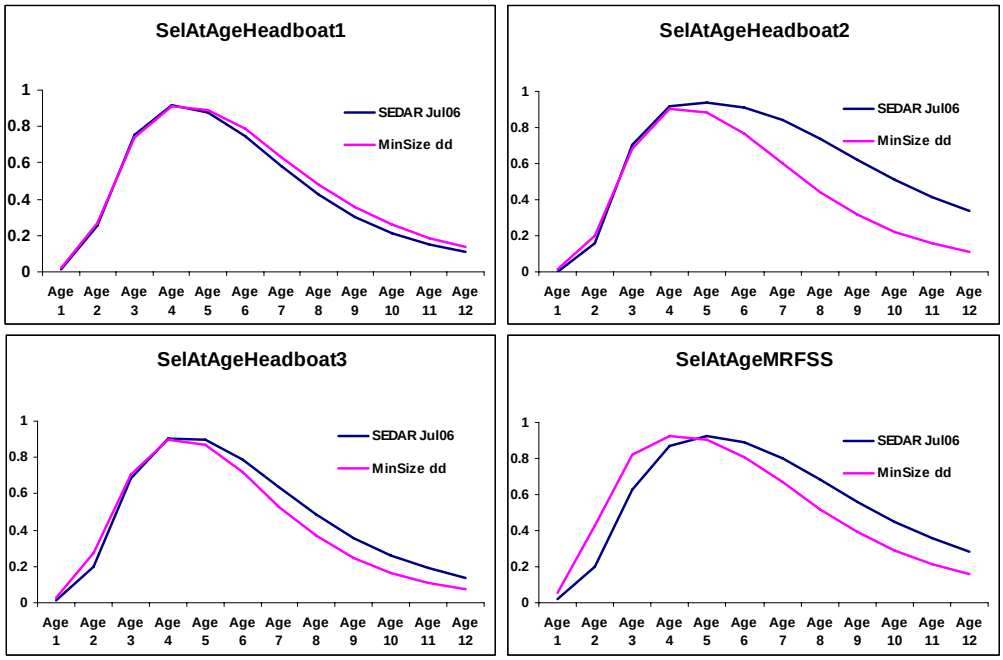
Minimum size regulations only started in 1990, changes of recreational discards prior to 1989 were also different because for those years, due to the lack of B2 estimates, it was assumed that discards were proportional to the average of 1989-1990, plus average weight of discards for 1984-1989 were used to convert estimated numbers of fish to weight removals. The following plot shows the estimated total removals for the two scenarios in numbers of fish. Differences are notable from 1990 on, ranging from 4 to 10% by year, with fewer removals under the minimum size (MinSize dd) scenario.



The estimated removals in terms of weight units shows a larger differences(30 to 100%) between scenarios, particularly in the latest years, when the proportion of B2 fish discarded fish from recreational fisheries) has increase significantly.



Under the minimum size scenario, the CASAL model estimated selectivity patterns of the recreational fisheries (Headboat and MRFSS) that were shifted towards younger age-classes and reduced selectivity of older age classes, particularly in the years of the minimum size implementations.

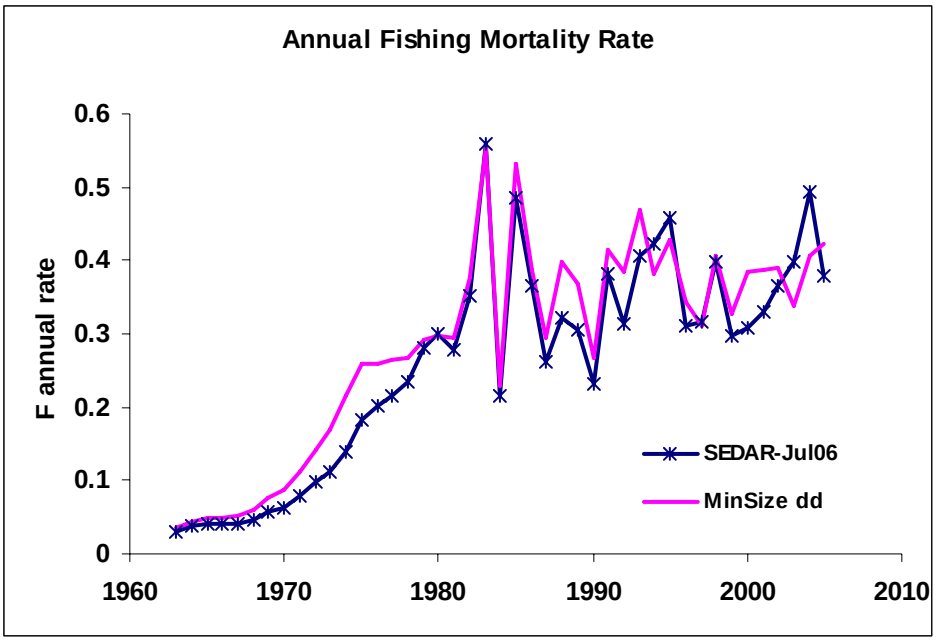


The model also estimated larger fishing mortality rates for younger age-classes and overall for all ages. Table 3 shows the percent change in FAA by year for the

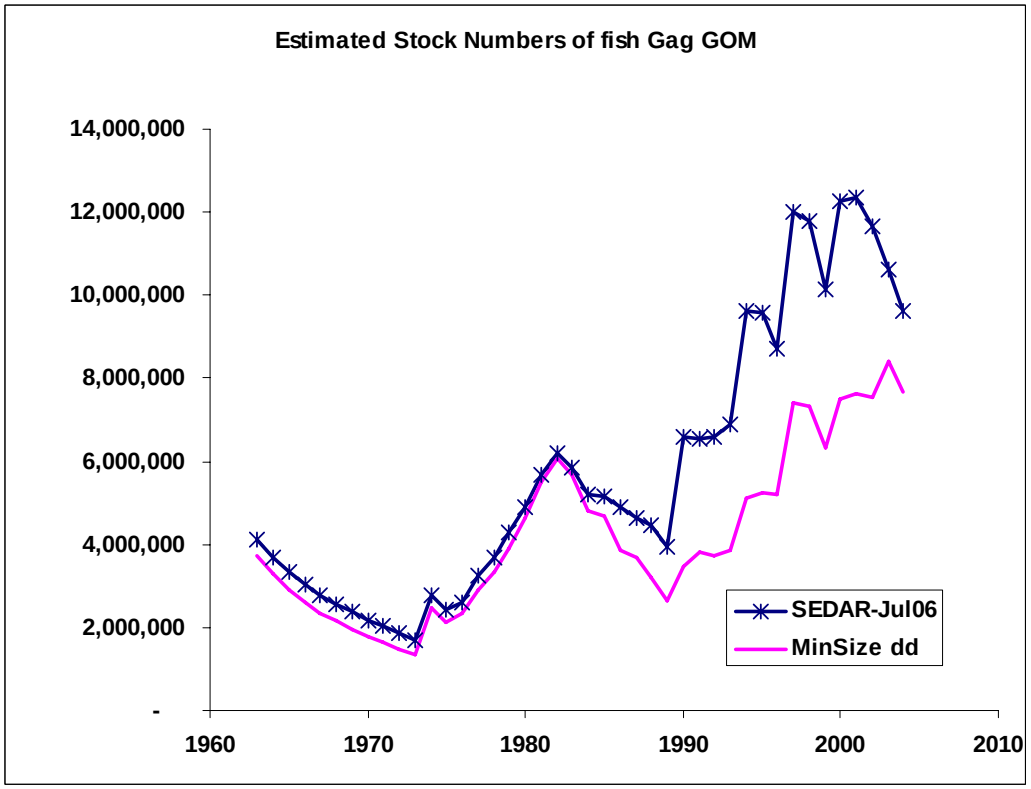
Table 3. Percent difference between FAA SEDAR-Jul06 and FAA MinSize dd scenarios by age and year.

higher F-age MinSize dd | lower F-age MinSize dd

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
1963	75%	67%	45%	29%	21%	16%	12%	9%	7%	5%	5%	5%
1964	76%	67%	45%	28%	21%	16%	12%	9%	7%	6%	6%	6%
1965	76%	67%	46%	30%	22%	17%	13%	10%	8%	7%	6%	6%
1966	77%	68%	48%	32%	25%	20%	15%	11%	9%	7%	6%	6%
1967	77%	69%	50%	35%	28%	22%	18%	13%	10%	7%	6%	5%
1968	78%	70%	51%	37%	30%	25%	19%	15%	11%	8%	7%	6%
1969	78%	71%	52%	39%	31%	26%	21%	16%	12%	10%	8%	7%
1970	79%	71%	53%	40%	33%	28%	22%	18%	14%	11%	9%	8%
1971	79%	72%	54%	41%	34%	29%	24%	19%	14%	11%	10%	9%
1972	79%	72%	54%	42%	35%	30%	25%	19%	15%	12%	10%	9%
1973	79%	72%	55%	43%	37%	32%	26%	21%	16%	12%	10%	8%
1974	79%	72%	55%	44%	38%	32%	26%	21%	16%	12%	10%	9%
1975	77%	69%	51%	38%	32%	27%	22%	16%	12%	10%	8%	8%
1976	74%	65%	44%	31%	25%	20%	14%	9%	6%	3%	3%	3%
1977	72%	63%	41%	27%	21%	16%	10%	4%	1%	-1%	-2%	-1%
1978	69%	60%	35%	20%	14%	8%	2%	-3%	-7%	-8%	-8%	-7%
1979	67%	56%	29%	13%	8%	4%	-1%	-4%	-6%	-6%	-4%	-2%
1980	64%	53%	23%	7%	2%	-1%	-5%	-8%	-9%	-8%	-5%	-3%
1981	66%	54%	26%	11%	8%	6%	4%	3%	3%	4%	6%	8%
1982	68%	57%	31%	16%	11%	9%	7%	5%	5%	6%	8%	10%
1983	66%	56%	29%	11%	3%	-2%	-8%	-12%	-13%	-13%	-11%	-8%
1984	67%	56%	29%	14%	10%	8%	6%	5%	5%	6%	7%	8%
1985	69%	60%	36%	20%	13%	7%	1%	-5%	-8%	-9%	-8%	-6%
1986	67%	55%	30%	15%	9%	6%	2%	-1%	-3%	-2%	-1%	1%
1987	69%	57%	33%	19%	14%	11%	8%	6%	5%	5%	6%	8%
1988	72%	63%	42%	28%	22%	17%	12%	7%	4%	2%	2%	3%
1989	69%	58%	36%	24%	20%	17%	14%	12%	11%	11%	12%	13%
1990	65%	51%	24%	14%	14%	14%	13%	13%	14%	16%	18%	20%
1991	66%	55%	29%	14%	11%	8%	5%	3%	3%	4%	7%	10%
1992	68%	58%	33%	21%	20%	18%	16%	15%	16%	17%	19%	22%
1993	64%	52%	25%	13%	14%	14%	13%	12%	14%	17%	20%	24%
1994	50%	33%	-6%	-18%	-14%	-10%	-8%	-5%	0%	6%	12%	18%
1995	55%	40%	4%	-11%	-9%	-7%	-6%	-3%	1%	6%	12%	18%
1996	60%	47%	17%	5%	8%	10%	11%	13%	16%	19%	24%	27%
1997	55%	40%	4%	-8%	-5%	-1%	1%	4%	8%	13%	19%	24%
1998	55%	39%	4%	-7%	-2%	2%	5%	8%	12%	17%	22%	27%
1999	61%	47%	17%	5%	7%	9%	10%	12%	15%	19%	23%	27%
2000	68%	57%	31%	19%	20%	20%	19%	18%	18%	18%	20%	22%
2001	62%	49%	18%	7%	11%	15%	16%	17%	19%	21%	23%	26%
2002	59%	46%	12%	-1%	3%	6%	8%	9%	11%	14%	17%	20%
2003	48%	30%	-14%	-31%	-25%	-18%	-15%	-11%	-6%	-1%	5%	10%
2004	51%	34%	-7%	-27%	-25%	-21%	-19%	-17%	-13%	-9%	-4%	1%

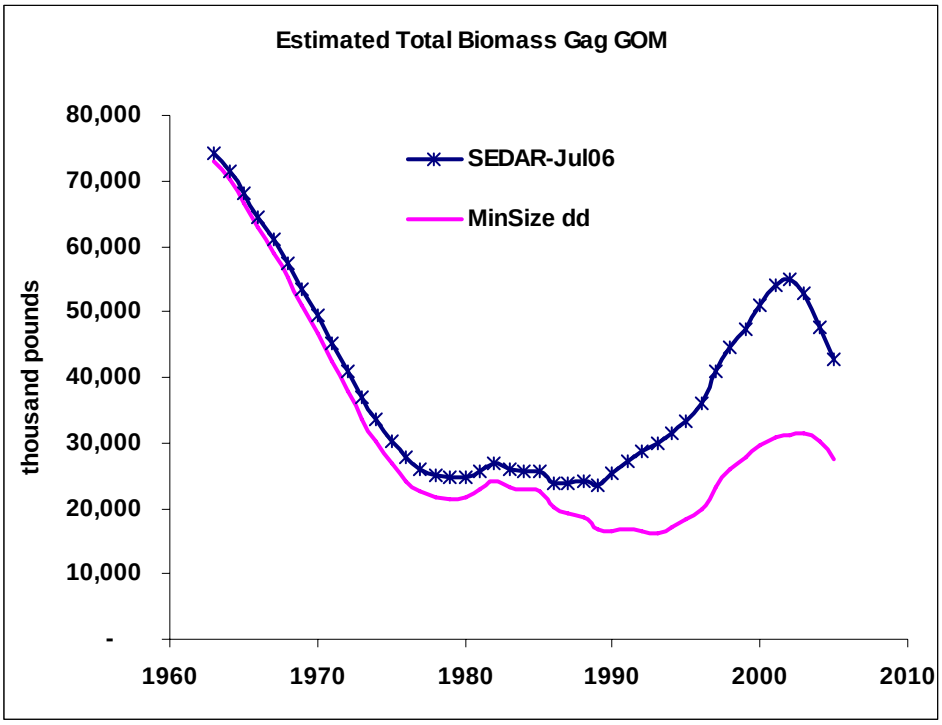


The overall annual fishing mortality rate (F) was larger with the MinSize dd scenario for the early years 1963-1979, and during 1985-1994, but lower in the latest years except in 2004.

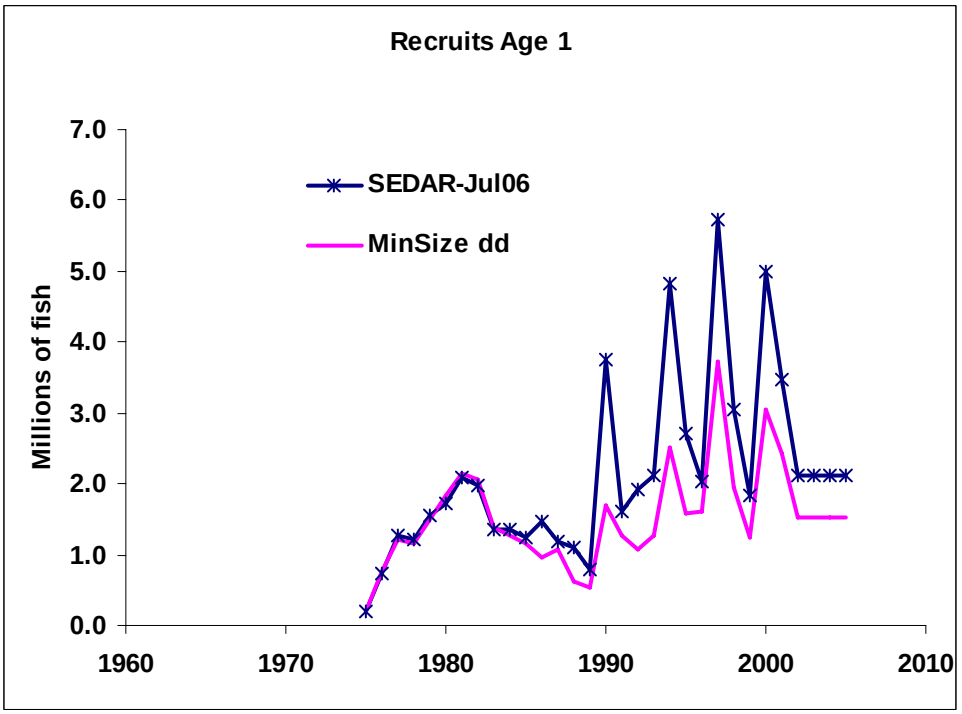


The CASAL model estimated overall lower number of fish for the gag GOM stock under the MinSize dd scenario compare to the SEDAR-Jul06 results. Differences were greater since 1985 on.

Consistently, the estimated total biomass of gag GOM stock was lower for the MinSize dd scenario, again mainly since 1990 on.



Estimated numbers of recruits (Age 1) were also lower under the minimum size scenario, especially for the strong year classes 1990, 1994, 1997 and 2000.



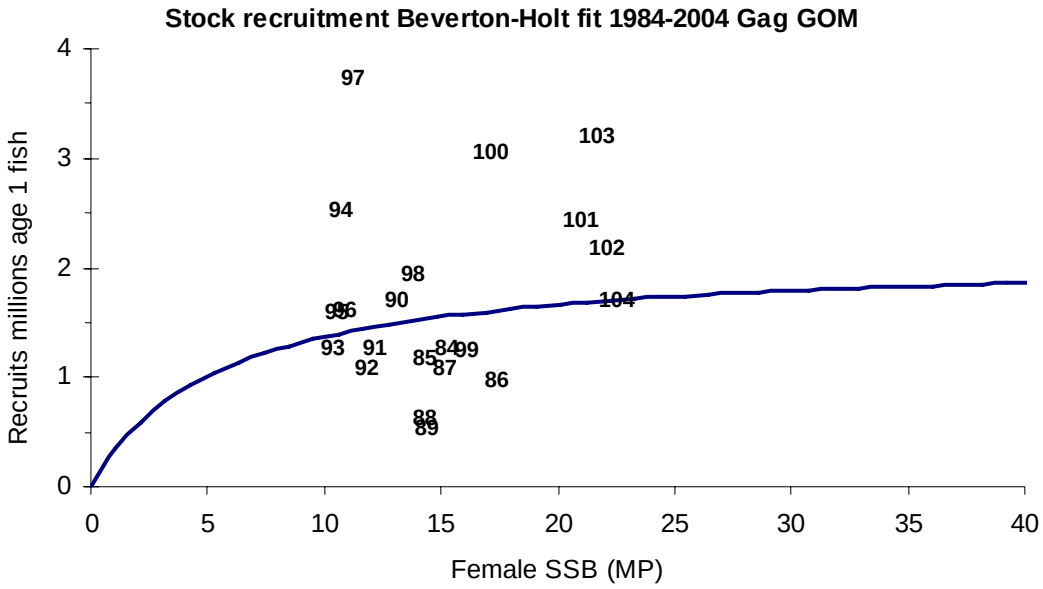
In summary, assuming that gag GOM discards were only of minimum size fish within the 1990-2004 period did change the perception of the status of the stock relative to that of the base run accepted by the SEDAR 10 RW. Overall the model predicted a smaller stock, fewer numbers and lower biomass, undergoing higher fishing mortality rates (affecting primarily younger age classes). Although survival of smaller fish is higher due to the size-depth distribution patterns, the main difference in inputs correspond to the age distribution of the removals (catch + dead discards) with higher percentages of ages 1 and 2 primarily, and lower proportions of older age classes. Thus, the biomass of removals was greatly reduced in the latest years. The model then estimated a lower recruitment levels. Trends of selectivity, and estimated yields were as expected, and patterns of CPUE fits were very similar between the two scenarios.

Table 4. benchmarks estimates assuming a constant recruitment projection. Landings refer to landed fish; all removals include landed and dead discards.

	Benchmarks			
	Landings		All removals	
	SEDAR (July06)	MinSz Discards	SEDAR (July06)	MinSz Discards
Fmsy	0.248	0.145763	0.2284	0.2007
MSY thousand lbs	4,269.96	4,944.41	8,661.21	6,327.49
SSBmsy	35,019.60	33,888.33	37,619.38	26,320.93
YPRmsy	2.01	3.24	4.08	4.14
Fmax	0.248	0.146	0.2284	0.201
YPRmax	2.01	3.24	4.08	4.14
$F_{20\%SPR}$	0.37	0.32	0.37	0.32
$F_{30\%SPR}$	0.25	0.22	0.25	0.22
$F_{40\%SPR}$	0.18	0.16	0.18	0.16
$YPR_{20\%SPR}$	1.92	2.58	3.88	3.94
$YPR_{30\%SPR}$	2.01	3.05	4.07	4.13
$YPR_{40\%SPR}$	1.95	3.23	4.02	4.08
$SSB_{20\%SPR}$	23,116.08	16,096.83		
$SSB_{30\%SPR}$	34,641.41	24,152.20		
$SSB_{40\%SPR}$	46,113.88	32,161.89		
F2004	0.4925	0.4067		
F2005	0.3780	0.4238		
SSB2004	40,550.66	21,169.60		
SSB2005	33,281.94	19,185.02		
Yield 2004	7,627.75	5,378.85		
Yield 2005	5,808.37	5,808.37		
GeoMean Rec84-04	2,124,871	1,527,669		
Steepness CASAL	0.75140	0.847733		

Table 4 summarizes the estimates of various benchmarks assuming a constant recruitment (geometric mean of estimated recruits 1984-2004). The benchmarks are given in terms of landings (only) or all removals (landings + dead discards). MSY estimates were lower for the MinSize dd scenario in terms of all removals, but higher in terms of landings (implying a larger yield per recruit in this scenario). The F reference

points are somewhat lower under the minimum size scenario, but the average F is somewhat higher. This implies a greater degree of overfishing than did the previous SEDAR 10 base run. CASAL estimated a higher steepness for the minimum size scenario (0.84) but lower on average recruitment (1.5 million recruits per year).



The stock-recruitment fit for the minimum size scenario showed a similar pattern as the SEDAR-Jul06 run, but with lower absolute values and without the cluster of low values just below 20 mp (which the SEDAR 10 RW used to justify their *ad hoc* recommendation of a 20 mp MSST). The estimates of recruitment for in recent years (2000-2004) continue to be larger than expected from the spawner-recruit curve.

If fishing rates are compare to the MSY benchmarks, at the end of 2004 the stock of gag GOM experience a larger F particularly with the minimum size only discard assumption, 2.8 times greater than the F at MSY. Similarly, the spawning stock biomass was below that estimated at MSY (0.62). Therefore the stock is estimated to be overfished and undergoing overfishing relative to MSY (maximum YPR) levels. This is in contrast to the results from the SEDAR 10 base run which suggested only that the stock was undergoing overfishing, and not overfished (see below)

	SEDAR-Jul06	MinSize dd
F2004/Fmsy	1.99	2.79
SSB2004/SSBmsy	1.16	0.62