Gulf of Mexico Red Grouper

SEDAR 61 Executive Summary

October 2021

This document serves as a summary of the Stock Assessment Report (SAR), which can be found at *http://sedarweb.org/docs/sar/S61_Final_SAR.pdf*. Final projections shown account for the revised allocations finalized in Amendment 53 and the mean weight adjustment to recreational landings projected by the SEDAR 61 assessment model.

Stock

This assessment documents the status of the Red Grouper (*Epinephelus morio*) resource in the Gulf of Mexico (Gulf) through 2017 and projects the quotas starting in 2020. Red Grouper are most abundant in the eastern Gulf.

Stock Status

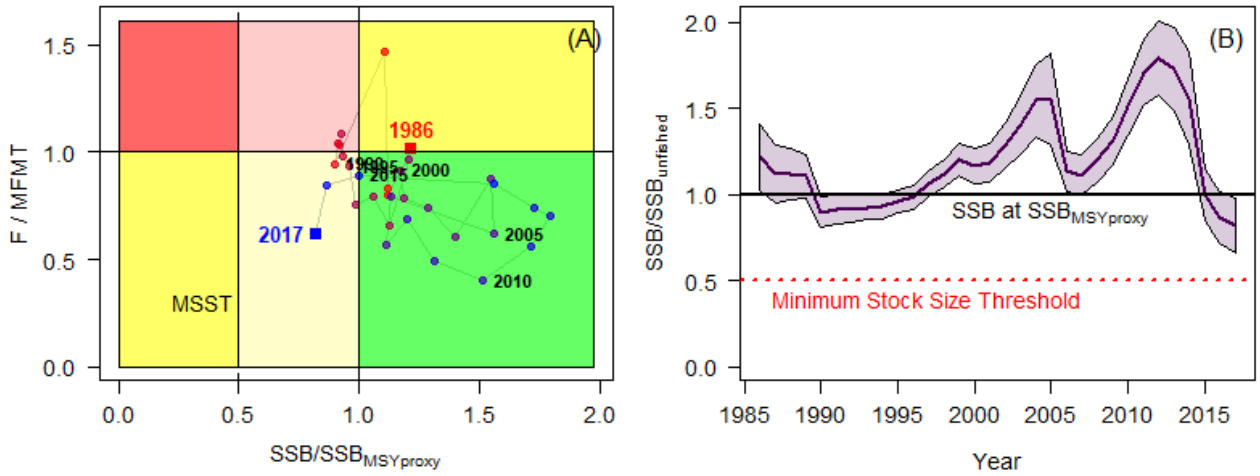

Figure 1: (A) Kobe plot showing the progression of exploitation status for Gulf Red Grouper from 1986 to 2017, with the Minimum Stock Size Threshold (MSST) denoted. Each point reflects a single year, labels are specified every 5 years, and colors gradually change from red (1986) through purple and ultimately blue (2017). (B) Ratio of Spawning Stock Biomass (SSB) to unfished SSB relative to the MSY$_{Proxy}$ with 95% asymptotic confidence intervals (shaded region).

Projections were to be completed by forecasting fishing mortality (F) at maximum sustainable yield (F_{MSY}) from the terminal year (2017) using the base assessment model configuration. However, it was not possible to calculate MSY and its associated reference points (F_{MSY} and biomass at MSY; B_{MSY}) since the spawner-recruit relationship was deemed unreliable; therefore, a proxy for F_{MSY} was required. Using an MSY$_{Proxy}$ of 30% spawning potential ratio (SPR) as the benchmark in defining the MSST and maximum fishing mortality threshold (MFMT) in Table 1, the assessment results indicate that Gulf Red Grouper is not overfished ($SSB_{Current}$/MSST = 1.64) nor undergoing overfishing ($F_{Current}$/MFMT = 0.77), but remains below the SPR of 30% at the $SSB_{MSYproxy}$ in 2017 (Figure 1), where SPR is the ratio of SSB to its unfished state (SSB_0). Relative spawning biomass (i.e., SPR) was below the 30% from 1990 through 1996, gradually increased as the 1998 cohort matured, but declined considerably in 2005 following a severe red tide event that killed roughly 29.5% of the population. The SSB increased from 2006 and peaked in 2012, likely due to the 2005

cohort moving through the population in combination with management measures (e.g., a reduction in the commercial size limit in 2009, the implementation of the commercial Individual Fishing Quota (IFQ) program in 2010). Relative spawning biomass has been decreasing since 2012, due in part to a severe red tide event that killed roughly 21.3% of the population in 2014, reaching a low of 0.246 in 2017 (Table 1).

Table 1: Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points for SEDAR 61. SSB is in relative number of eggs, whereas F is a harvest rate (total biomass killed / total biomass), and $F_{Current}$ is the geometric mean of F from 2015 - 2017.

Reference Point Criteria		Current Benchmarks	
SPR at $SSB_{MSYproxy}$	30%	SSB_{2017}	613,517
Base natural mortality (M)	0.144	$F_{Current\ (geom.\ mean:\ 2015\text{-}2017)}$	0.20
Steepness	0.99	SSB_{2017} / SSB_0 (SPR_{2017})	0.25
Generation Time	11.17	SSB_{2017} / $SSB_{MSYproxy}$	0.82
SSB_0 (Unfished)	2,494,130	SSB_{2017} / MSST	1.64
$SSB_{MSYproxy}$	748,240	--MSST Overfished?	No
MSST = (0.5)*$SSB_{MSYproxy}$	374,120	$F_{Current}$ / MFMT	0.77
MFMT = $F_{MSYproxy}$	0.259	--Overfishing?	No
F_{OY} (F at optimum yield)	0.194		

Scientific and Statistical Committee (SSC) Recommendations

The SEDAR 61 stock assessment and projections were first reviewed by the Gulf SSC on September 17, 2019. Updated projections based on different allocation scenarios under development for Amendment 53 were reviewed by the Gulf SSC on January 9, 2020. The final set of projections were reviewed on August 9, 2021, and included a mean weight adjustment to the recreational landings projected by the SEDAR 61 assessment model based on the mean weight derived from the ACL monitoring dataset. Under the assumptions of added mortality for the 2018 red tide, achieving 30% SPR in equilibrium, the allocation finalized in Amendment 53 (59.3% commercial: 40.7% recreational), and the mean weight adjustment to recreational landings projected by the SEDAR 61 assessment model, the OverFishing Limit was set as the average projected yield between 2020-2024: 5.99 million pounds gutted weight [mp gw]. The Acceptable Biological Catch was based on a 30% probability of overfishing: 5.57 mp gw.

Socioeconomic and Ecosystem Considerations

Impacts of red tide blooms, *Karenina brevis*, have been an increasing cause of concern for fisheries management on the West Florida Shelf. A red tide pseudo-fishing fleet (i.e., discard only) was used to drive mortality, with two red tide events (2005, 2014) incorporated into the model. While this assessment only included data through 2017, there has been growing evidence that a severe red tide event occurred in 2018 and has important implications for the projections.

The Gulf of Mexico Fishery Management Council's "Something's Fishy" tool is designed to gather information from fishermen for scientists and managers about fish stocks being assessed. Ninety-seven responses spanning from the Florida Keys north to the Mississippi/Louisiana border, with a few response from the Louisiana/Texas border, were received for Red Grouper in advance of SEDAR 61 and presented at the Data Workshop. Most responses came from private anglers targeting Red Grouper from central Florida, who observed dead Red Grouper and primarily indicated a negative trend in abundance (Figure 2). Specifically, anglers indicated observing fewer Red Grouper ≥ 20 inches (50.8 cm) total length, and only finding fish in deeper waters than in past years. Displacement by red snapper or major storms, and substantial mortality due to the 2018 red tide event, have been proffered as possible reasons for the decrease in observed abundance. Concurrently, anglers claimed to have observed more undersized Red Grouper than in recent years.

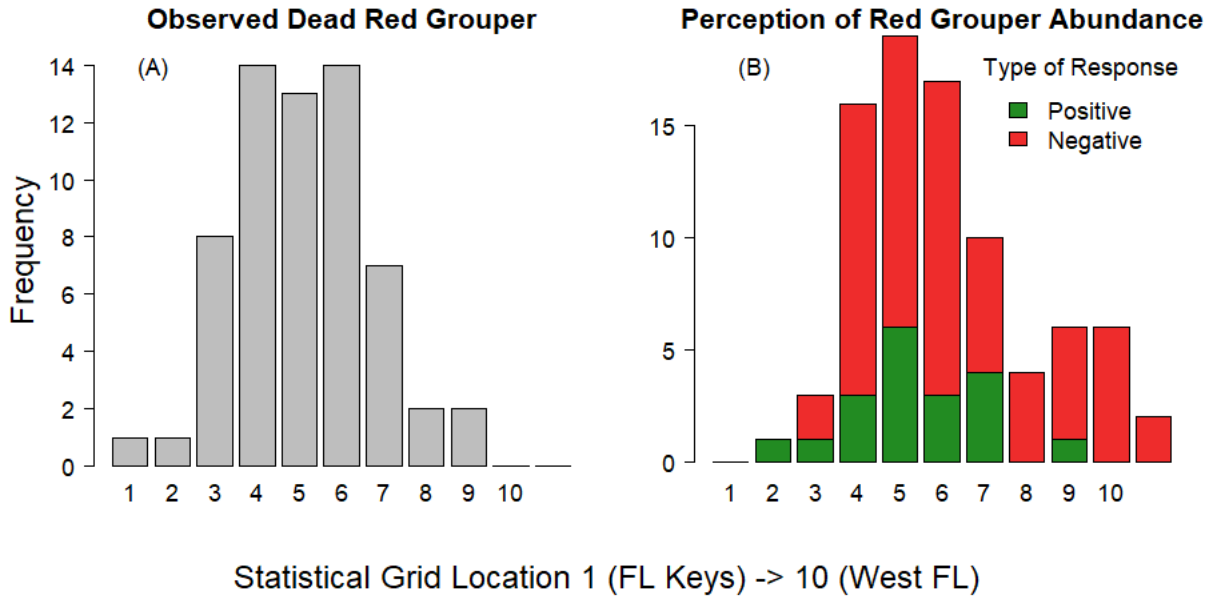

Figure 2: Information collected on (A) Red Grouper deaths due to suspected red tide and (B) angler perception of Red Grouper abundance.

Projections

Projected retained yields (mp gw) and associated ratios of SSB to SSB_0 were projected under the assumption that all recent fishery dynamics would continue indefinitely (e.g., relative fishing effort, selectivity, and retention) at the average of the 2015-2017 estimated values, recruitment would remain constant at the mean value from 2010 to 2017 (17.41 million fish per year), catch allocations would remain at 59.3% commercial and 40.7% recreational, and red tide mortality in 2018 was similar to 2005. Forecasts begin in 2020 and were carried out at the $F_{MSYproxy}$ with a P* of 0.5 in order to determine the OverFishing Limit (Figure 3). Final projections shown also included a mean weight adjustment to the recreational landings projected by the SEDAR 61 assessment model based on the mean weight derived from the ACL monitoring dataset.

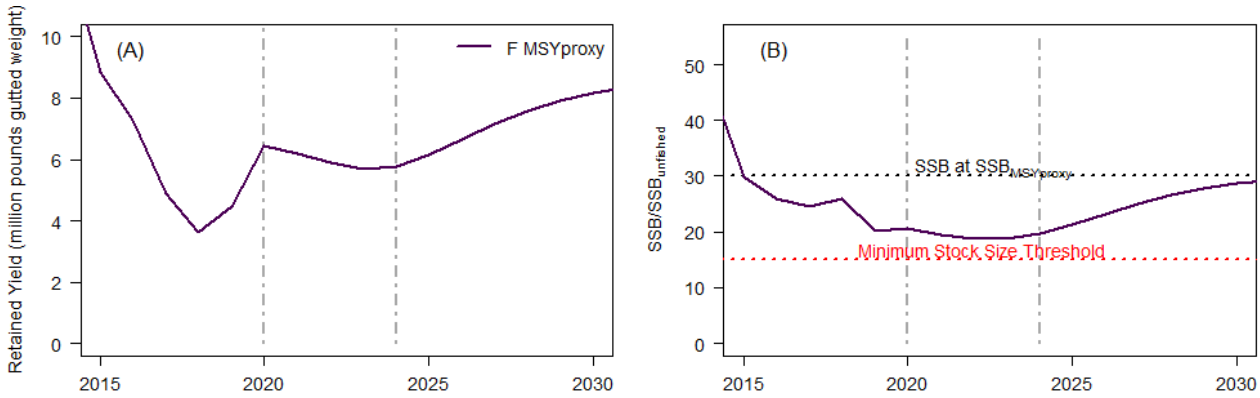

Figure 3: (A) Retained Yield and (B) resulting ratios of SSB to unfished SSB (expressed as a percentage) for projections fishing at $F_{MSYproxy}$. All scenarios assume recent average recruitment (2010-2017), and reference points (defined in Table 1) are marked with horizontal dotted lines. Vertical dashed lines identify the first five years of projected yields: 2020 through 2024.

Data and Assessment

The assessment model used was Stock Synthesis version 3.30_13. The model includes three commercial fishing fleets (vertical line, longline, and trap) and one combined recreational fishing fleet, with associated data inputs including landings, discards, catch-per-unit-effort indices, age compositions, and discard length compositions where available. Four fishery-independent surveys are included with relative abundance and length compositions. Nearly all indices of relative abundance show clear declines in abundance over the last few years (Figure 4). Time-varying retention functions were used to allow for varying discards at size due to the impacts of fishery minimum size limits and bag limits.

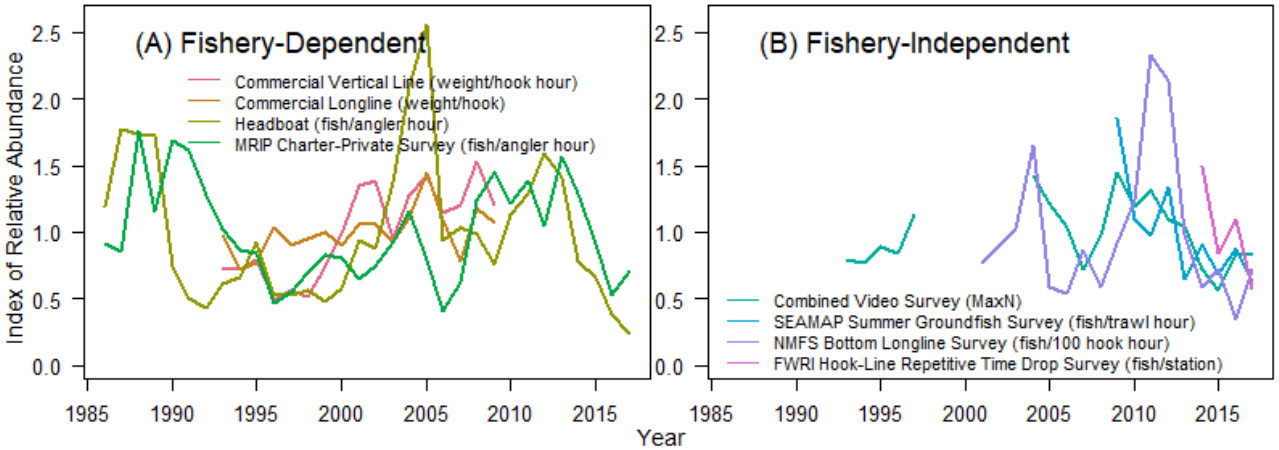

Figure 4: Gulf Red Grouper observed indices from SEDAR 61 by (A) fishery and (B) survey, 1986-2017.

Life history equations and parameters used in SEDAR 61 are reported in Table 2. A fixed length-weight relationship was used to convert body length (cm) to body weight (kg). Growth was modeled externally using a single size-modified von Bertalanffy growth curve for both sexes combined, which considers the non-random sampling due to minimum size restrictions (Table 2). An age-specific vector of natural mortality was obtained using the Lorenzen estimator and a target M of 0.144 $year^{-1}$. Total fecundity-at-age was modeled as a function of proportion female,

proportion mature, and batch fecundity. SSB was defined as the number of eggs in the assessment model (relative number rather than an absolute number due to the derivation of fecundity-at-age). The Beverton-Holt stock-recruitment model was used in this assessment, and following the recommendation of SEDAR 42, steepness was fixed at 0.99.

Table 2: Overview of life history equations and recommended parameters used in SEDAR 61. All lengths and weights were reported in Fork Length (FL) and gutted weight (gw), respectively.

Definition	Equation	Parameters
Total to Fork	$FL = a + b * TL$	a= 0.535 cm , b= 0.95
Length to Weight	$W(t) = a * L(t)^b$	a= 5.99E-06 $kg*cm^{-b}$, b= 3.25
Age to Length	$L(t)=L_{inf}*[1-e^{-K(t-t0)}]$	L_{inf}= 79.99 cm , K= 0.131 yr^{-1} , t_0= -0.87 yr
Base M	$M=exp[1.46 - 1.01 * ln(t_{max})]$	t_{max}= 29 yr , M= 0.144
Maturity	$P_f(t) = exp(-exp[-(f_0+f_1* t)])$	f_0= -2.55 yr , f_1= 1.05
	$P_f(t) = 0.50$	t_{50}= 2.8 yr , L_{50}= 29.2 cm
Sexual Transition	$P_m(t) = exp(-exp[-(m_0+m_1* t)])$	m_0= 2.14 yr , m_1= -0.16
	$P_m(t) = 0.50$	t_{50}= 11.2 yr , L_{50}= 70.7 cm
Batch Fecundity	$BF(t) = a * L(t)^b$	a= 4.47E-05 $eggs*cm^{-3*b}$, b= 5.48
Age to Fecundity	$Fec(t) = P_f(t) * P_m(t) * BF(t)$	relative eggs
Recruitment	$R_{yr}=[4hR_0SSB_{yr}]*[SSB_0(1-h)+SSB_{yr}(5h-1)]^{-1}$	h=0.99, R_0= 20.44 million recruits

Recruitment

With steepness fixed at 0.99, the recruit variance term was estimated at 0.815 and virgin recruitment was estimated at 20.44 million fish. Gulf Red Grouper have low recruitment with occasional large year-classes (Figure 5). Large year classes in 1995, 1998, 2001, 2005, and 2013 supported many of the fisheries catches, as evident by clear cohorts moving through the composition data used in the assessment. The lowest recruitment estimate occurred in 1997, with only 5.22 million recruits in comparison to the 120.01 million recruits estimated in 2005. Recent recruitment is lower on average than the mean recruitment throughout the time series. With the exception of a relatively high recruitment event in 2013, recent recruitment has generally remained below the average recruitment since 2007.

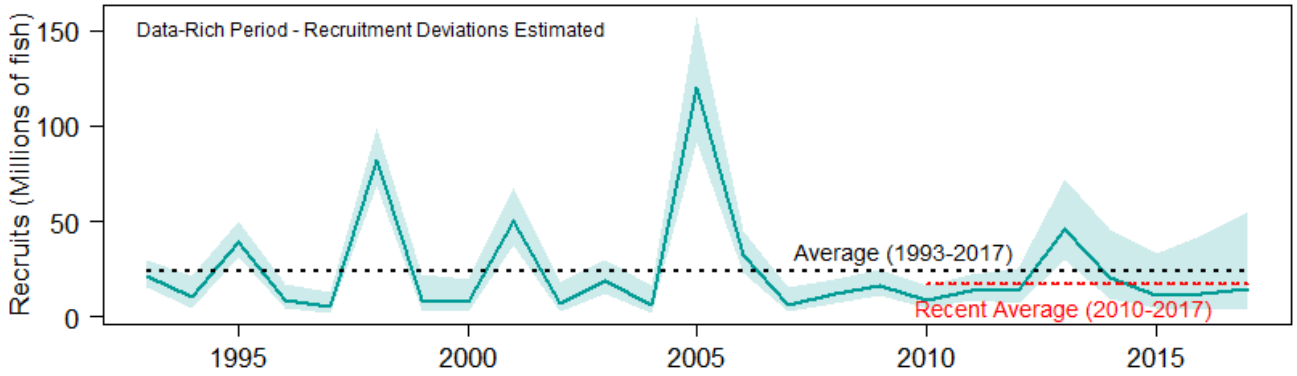

Figure 5: Estimated recruitment (millions of fish) for Gulf Red Grouper with 95% asymptotic confidence intervals (shaded region). Dashed horizontal lines represent average recruitment during the time series where recruitment was estimated (black line) and the recent period used for projections (2010-2017; red line).

Landings

Commercial landings of Gulf Red Grouper from 1986 through 2009 were obtained from the Accumulated Landings System for Texas, Louisiana, Mississippi and Alabama; and from the Florida Trip Ticket Program due to greater resolution in the data. Landings between 2010 and 2017 were obtained from the Grouper-Tilefish IFQ program. Since 1986, estimated vertical line fishery landings averaged 1.68 mp gw, with a low of 0.78 mp gw in 1998, and a peak of 3.78 mp gw in 1989 (Figure 6). Estimated longline fishery landings since 1986 averaged 2.97 mp gw and ranged from 1.25 mp gw in 2009 to 4.44 mp gw in 2014. Estimated trap fishery landings between 1986 and 2007 averaged 0.63 mp gw, with a low of 0.02 mp gw in 2007, and a peak of 1.06 mp gw in 2000. [See Table 2.8 of the full SEDAR 61 SAR for commercial landings used in the assessment.]

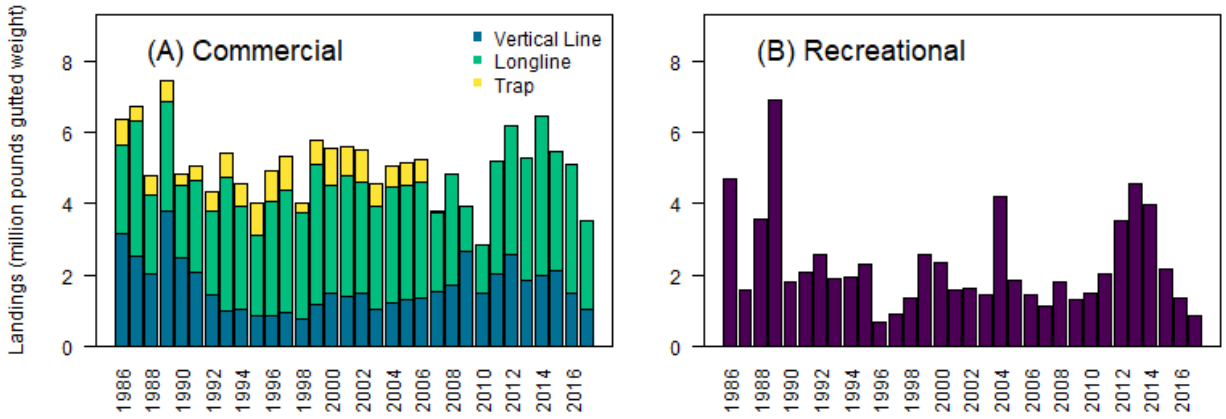

Figure 6: Final Gulf Red Grouper landings estimates from SEDAR 61 for commercial and recreational fisheries in millions of pounds gutted weight, 1986-2017.

Recreational landings of Gulf Red Grouper were obtained from the Marine Recreational Information Program (MRIP-Fishing Effort Survey [FES]-adjusted) and the Southeast Region Headboat Survey (SRHS). Following the three year transition period of MRIP, estimates of fishing effort for the private and shore modes were obtained from the FES and the 2013 design change in the Access Point Angler Intercept Survey was accounted for during the transition. A charter

calibration analysis was conducted by the Southeast Fisheries Science Center on the newly released MRIP data to correct for the change from the Coastal Household Telephone Survey to the For-Hire Telephone Survey. Recreational landings derived from MRIP were comprised of Gulf Red Grouper landed whole and observed by interviewers ("Type A") and those reported as killed by the fishers ("Type B1"). Since 1986, estimated recreational fishery landings averaged 2.29 mp gw and ranged from 0.66 mp gw in 1996 to 6.91 mp gw in 1989. [See Table 2.25 of the full SEDAR 61 document for recreational landings used in the assessment.]

Discards

Commercial discards of Gulf Red Grouper for the vertical line and longline fleets were estimated using a CPUE expansion approach that used the coastal observer program (2007-2017) in conjunction with total fishing effort from the commercial reef logbook program (1993-2017). Discard mortality rates of 19% and 41.5% were applied for the commercial vertical line and longline fleets, respectively, following the SEDAR 42 recommended methodology. The trap fishery estimated discards and discard mortality rate of 10% remained unchanged from SEDAR 42. Gulf Red Grouper commercial dead discards were estimated beginning in 1990 with the implementation of federal minimum size limits. Commercial vertical line fleet dead discards estimated by the assessment model averaged 0.08 mp gw from 1990-2017, with a low of 0.02 mp gw in 2016 and a peak of 0.21 mp gw in 1990 (Figure 7). Commercial longline fleet dead discards estimated by the assessment model averaged 0.45 mp gw from 1990-2017, with a low of 0.08 mp gw in 2009 and a peak of 0.85 mp gw in 1993 (Figure 7). Commercial trap fleet dead discards estimated by the assessment model averaged 0.04 mp gw from 1990-2006, with a low of 0.01 mp gw in 1998 and a peak of 0.05 mp gw in 1995 (Figure 7).

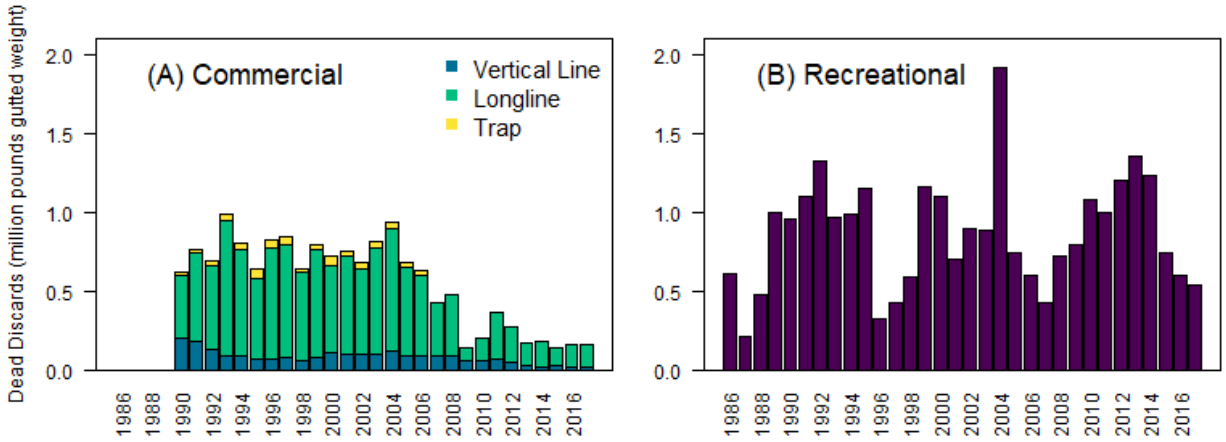

Figure 7: Final Gulf Red Grouper discard estimates from SEDAR 61 assessment for commercial (A, by fleet) and recreational (B) fisheries in millions of pounds gutted weight, 1986-2017.

Gulf Red Grouper recreational discards were derived from MRIP estimates of live released fish (B2) between 1986 and 2017 and self-reported discards in the SRHS logbook since 2007. Red Grouper discards from headboats for years prior to 2007 in Florida were estimated using the MRIP Charter:SRHS discard ratio as a proxy. The discard mortality for the recreational discards remained unchanged from SEDAR 42 at 11.6%. Dead discard estimates from the recreational fleet averaged 0.87 mp gw from 1986 to 2017, with a low of 0.22 mp gw in 1987 and a peak of 1.92 mp gw in 2004 (Figure 7).

Table A1: Red Grouper landings in pounds gutted weight for the Commercial fleets [Vertical Line (VL), Longline (LL), and Trap], Recreational fleets [Charter, Private, and Headboat], and Total landings. Commercial landings provided for SEDAR 61 by NMFS Fisheries Statistics Division. Recreational landings were provided by NMFS Fisheries Statistics Division (FES-calibrated MRIP landings and effort data) and NMFS Beaufort (Headboat) in pounds whole weight and were converted to gutted weight using the equation Gutted Weight (pounds) = Whole Weight (pounds)/1.048.

Year	Commercial				Recreational				Total
	VL	LL	Trap	Com	Charter	Private	Headboat	Rec	
1986	3,134,859	2,505,832	721,461	6,362,152	374,228	2,771,432	112,911	3,258,572	9,620,724
1987	2,542,122	3,774,849	448,081	6,765,052	239,843	1,884,323	84,373	2,208,539	8,973,591
1988	2,049,120	2,192,793	540,228	4,782,141	217,825	4,341,736	99,122	4,658,683	9,440,824
1989	3,814,892	3,118,201	592,772	7,525,865	187,018	7,305,063	128,852	7,620,933	15,146,798
1990	2,460,952	2,025,693	340,896	4,827,541	471,670	3,028,937	87,320	3,587,927	8,415,467
1991	2,093,837	2,583,586	373,747	5,051,171	284,366	3,334,875	57,956	3,677,196	8,728,367
1992	1,444,966	2,409,550	602,185	4,456,701	552,130	5,448,057	50,240	6,050,428	10,507,129
1993	1,300,324	4,274,356	711,086	6,285,767	144,643	3,785,688	72,633	4,002,965	10,288,732
1994	1,241,427	2,699,085	913,825	4,854,337	296,200	3,522,793	52,816	3,871,809	8,726,146
1995	1,171,250	2,429,416	1,056,993	4,657,659	529,713	2,870,871	89,895	3,490,480	8,148,140
1996	865,153	2,907,190	539,359	4,311,702	173,462	672,751	80,504	926,717	5,238,419
1997	948,379	3,024,185	685,831	4,658,395	173,209	981,983	23,958	1,179,149	5,837,544
1998	741,606	2,662,278	297,548	3,701,433	205,374	1,281,745	22,270	1,509,388	5,210,821
1999	1,212,757	3,815,403	751,819	5,779,980	241,670	3,141,201	45,811	3,428,682	9,208,662
2000	1,720,988	2,909,341	1,024,809	5,655,138	810,179	3,367,940	48,717	4,226,837	9,881,975
2001	1,555,714	3,399,634	743,289	5,698,637	334,700	2,091,840	30,181	2,456,721	8,155,358

Year	Commercial				Recreational				Total
	VL	LL	Trap	Com	Charter	Private	Headboat	Rec	
2002	1,628,178	3,130,561	980,293	5,739,032	268,688	2,844,547	23,508	3,136,743	8,875,775
2003	1,118,263	2,964,737	701,668	4,784,668	271,413	1,816,656	38,489	2,126,558	6,911,226
2004	1,376,656	3,383,468	745,209	5,505,332	523,203	7,347,587	65,145	7,935,935	13,441,267
2005	1,404,240	3,211,570	612,717	5,228,527	511,702	2,633,277	75,010	3,219,989	8,448,516
2006	1,375,688	3,012,663	586,847	4,975,198	260,204	2,417,985	25,480	2,703,668	7,678,866
2007	1,561,080	1,984,386	24,476	3,569,942	145,182	1,921,935	24,674	2,091,791	5,661,734
2008	1,888,195	2,804,101		4,692,296	290,002	1,248,079	37,604	1,575,685	6,267,981
2009	2,445,472	1,124,980		3,570,452	179,924	1,375,366	29,583	1,584,873	5,155,325
2010	1,352,746	1,313,484		2,666,230	326,301	1,672,156	26,064	2,024,522	4,690,751
2011	1,683,963	3,049,498	15	4,733,476	244,092	1,271,068	36,697	1,551,857	6,285,333
2012	2,228,739	2,940,844		5,169,583	575,589	3,476,154	83,325	4,135,068	9,304,651
2013	1,532,418	3,025,903		4,558,321	800,113	4,131,457	77,533	5,009,103	9,567,424
2014	1,910,749	3,532,923		5,443,672	593,338	4,759,292	45,107	5,397,737	10,841,410
2015	1,854,306	2,837,057		4,691,363	504,746	3,206,619	50,622	3,761,986	8,453,349
2016	1,212,438	3,166,180		4,378,618	408,396	2,251,604	56,851	2,716,851	7,095,469
2017	990,340	2,297,303		3,287,643	347,647	1,291,950	21,423	1,661,020	4,948,663