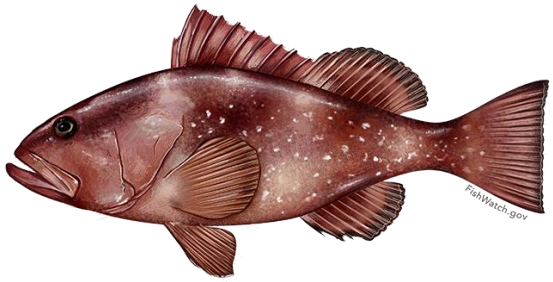

Gulf of Mexico Red Grouper

SEDAR 61 Executive Summary

October 2019

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

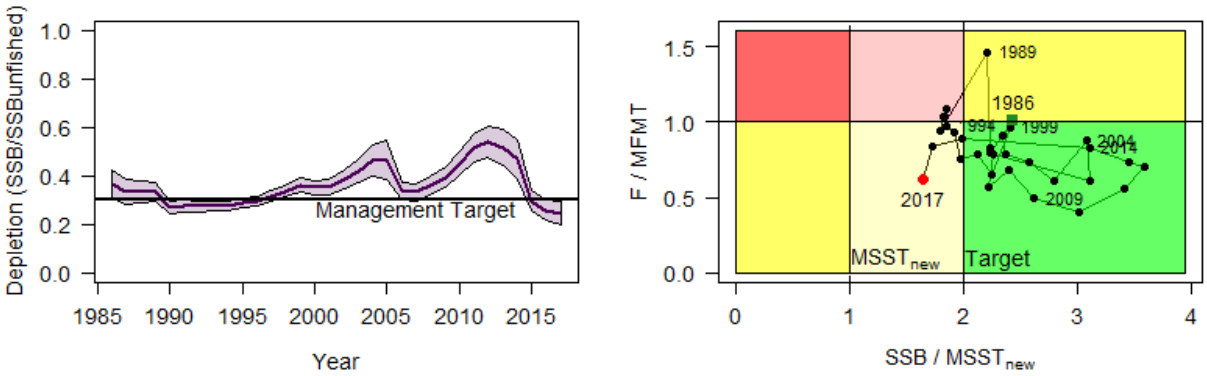

Figure 1: Stock depletion for Red Grouper with 95% asymptotic confidence intervals (shaded region) [left panel]. Kobe plot showing the progression of exploitation status from 1986 to 2017, with Target SSB and MSST$_{New}$ denoted [right panel].

The assessment found that Red Grouper is not overfished nor undergoing overfishing (Figure 1), but remains below the target Spawning Stock Biomass (SSB) of 30% Spawning Potential Ratio (SPR) in 2017, where SPR is the ratio of SSB to its unfished state (SSB_0). Relative spawning biomass (i.e., SPR) was below the 30% management target 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 MSRA benchmarks and reference points for SEDAR 61. SSB is displayed in relative number of eggs, whereas F is a harvest rate (total biomass killed / total biomass).

Reference Point Criteria		Current Benchmarks	
Base M	0.144	SSB_{2017}	748,241
Steepness	0.99	$F_{Current}$ (Geometric mean: 2015-2017)	0.203
Generation Time	11.17	SSB_{2017} / SSB_0 (SPR_{2017})	0.3
SSB_0 (Unfished)	2,494,130	SSB_{2017} / $SSB_{SPR30\%}$	0.82
Target SSB = $SSB_{SPR30\%}$	748,241	SSB_{2017} / $MSST_{Old}$	0.96
$MSST_{Old}$=(1-M)*$SSB_{SPR30\%}$	640,494	--$MSST_{Old}$ Overfished?	Yes
$MSST_{New}$=0.5*$SSB_{SPR30\%}$	374,120	SSB_{2017} / $MSST_{New}$	1.64
F_{MSY}	Not Estimable	--$MSST_{New}$ Overfished?	No
MFMT = $F_{SPR30\%}$	0.259	$F_{Current}$ / MFMT	0.78
F_{OY}	0.194	--Overfishing?	No

Scientific and Statistical Committee (SSC) Recommendations

The Gulf of Mexico Fishery Management Council's (Council) SSC decided to treat the 2018 red tide event as similar to the event observed in 2005 for projections. Under the assumptions of added mortality and achieving 30% SPR in equilibrium, the overfishing limit was set based on a 50% probability of overfishing as the average projected yield between 2020-2024 at 5.35 million pounds gutted weight [mp gw]. The acceptable biological catch was based on a 30% probability of overfishing and set at 4.9 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 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 $\geq$ 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.

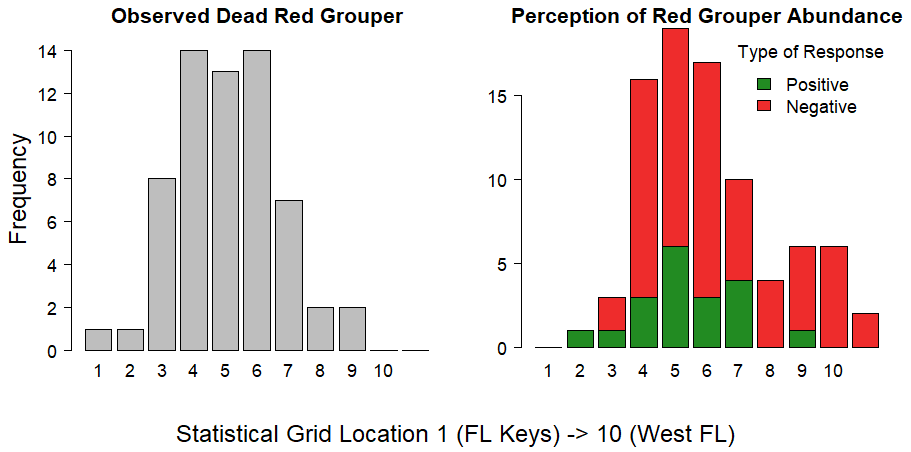

Figure 2: The "Something Fishy" Tool collected information on Red Grouper deaths due to suspected red tide (left), and angler perception of Red Grouper abundance (right).

Projections

The retained yield and associated depletion were projected under assumed conditions (e.g. recent average recruitment and catch allocations of 76% commercial and 24% recreational) for five 2018 red tide scenarios under (1) maintaining 2017 landings and (2) achieving 30% SPR in equilibrium (Figure 3). The red tide scenarios included: (a) no red tide mortality in 2018, (b) half 2014 magnitude (0.1285), (c) same as 2014 (0.257), (d) same as 2005 (0.339), and (e) double 2005 magnitude (0.678). If the worst case red tide severity occurred in 2018, fishing to maintain 2017 landings leads to an overfished state over the 2020–2024 interval (Figure 3, right panel, yellow solid line).

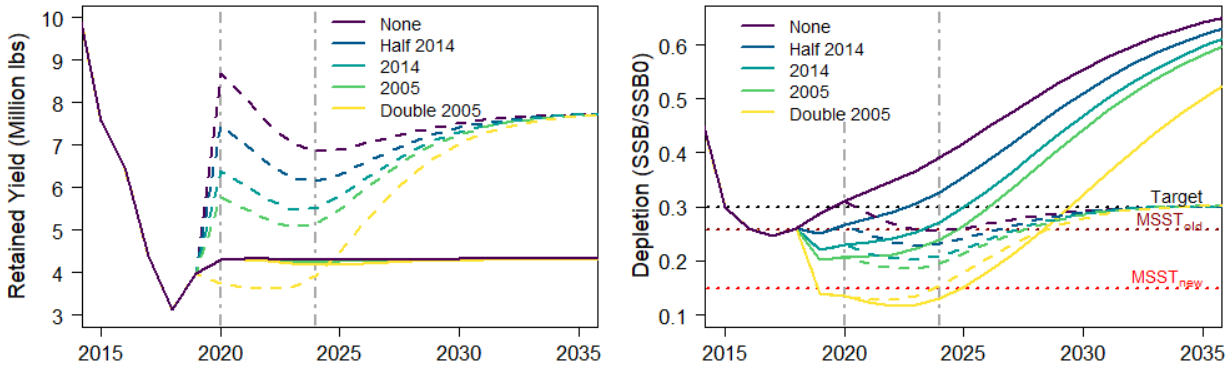

Figure 3: Retained Yield (left panel) and resulting Depletion (right panel) for projections with landings fixed at 2017 levels (solid lines) and fishing at $F_{SPR30\%}$ (dashed lines) where line colors represent various red tide scenarios. All scenarios assume recent average recruitment (2010-2017), and reference points are marked with horizontal dotted lines.

Maintaining landings observed in 2017 resulted in a low probability of overfishing in 2020–2024 under all red tide scenarios with the exception of the most severe simulation of double the 2005 red tide mortality, which had an 83% chance of overfishing (Table 2). The projections that achieve 30% SPR in equilibrium ($F_{SPR30\%}$) resulted in a relatively high probability of overfishing for all simulated scenarios that included red tide mortality in 2018.

Table 2: Estimated probability of overfishing in 2020–2024 for the SEDAR 61 base models under projections that achieve $SPR_{30\%}$ in equilibrium and maintain 2017 catch levels under five 2018 red tide scenarios.

Scenario	2018 Red Tide Magnitude				
	None	Half 2014	2014	2005	Double 2005
2017 Landings	**0.00**	**0.01**	**0.05**	**0.11**	**0.83**
$F_{SPR30\%}$	**0.50**	**0.82**	**0.98**	**1.00**	**1.00**

Data and Assessment

The assessment model used was Stock Synthesis version 3.30. 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).

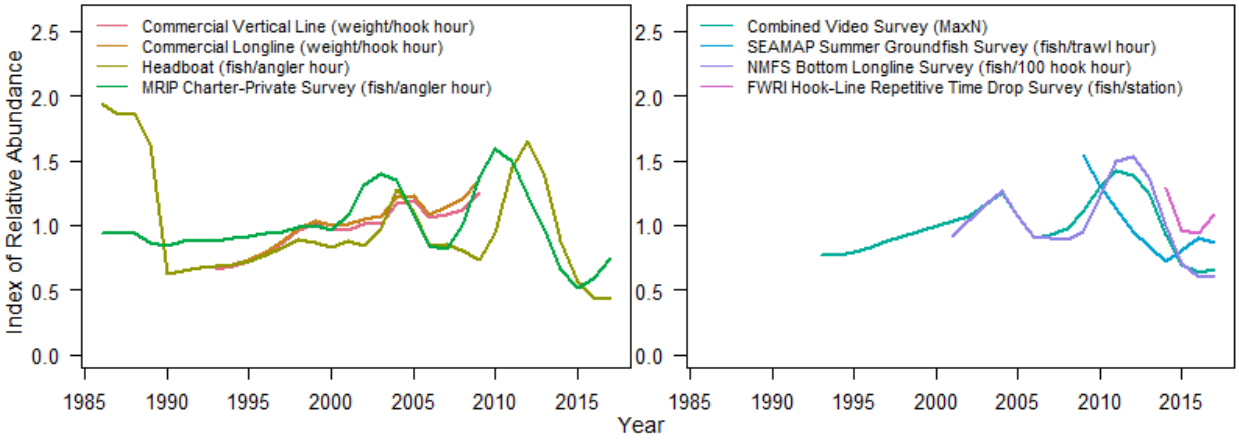

Figure 4: Final Red Grouper index estimates from SEDAR 61 assessment by fishery (left panel) and survey (right panel), 1986-2017.

Life history equations and parameters used in SEDAR 61 are reported in Table 3. 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 takes into account the non-random sampling due to minimum size restrictions. An age-specific vector of natural mortality (M) was obtained using the Lorenzen (2005) estimator and a target M of 0.144 $year^{-1}$ determined from the Hoenig (1983) teleost regression. Total fecundity-at-age was modeled as a function of proportion female, proportion mature, and batch fecundity. This approach accounts for a decrease in fecundity as females transition and become males. The 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 (the fraction of virgin recruits produced at 20% of the equilibrium SSB) was fixed at 0.99.

Table 3: 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

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.

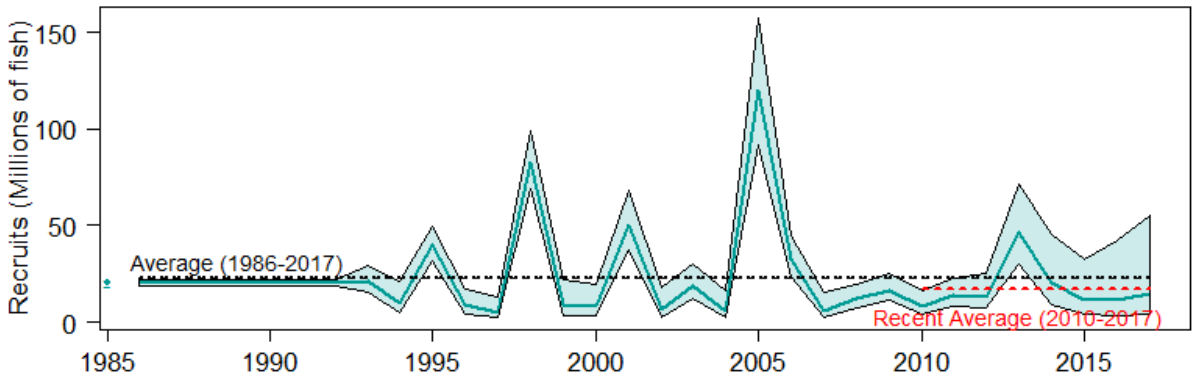

Figure 5: Estimated recruitment (millions of fish) for SEDAR 61 with 95% asymptotic confidence intervals (shaded region). Thin dashed lines represent average recruitment during the entire time series (upper line) and the recent period (2010-2017; lower line).

Landings

Commercial landings of 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. Commercial landings after 1993 were adjusted by self-reported logbook data to apportion annual state landings by gear type (longline, vertical line, trap, or other) and area. Landings between 2010 and 2017 were obtained from the Grouper-Tilefish IFQ program, and average landings over this time period were compared against recreational landings (Figure 6). Estimates of Red Grouper commercial landings averaged 5.09 million pounds [mp] gw from 1986 to 2017, with a low of 2.83 mp gw in 2010, and a peak of 7.45 mp gw in 1989. [See Table 2.8 of the full SEDAR61 document for commercial landings used in the assessment.]

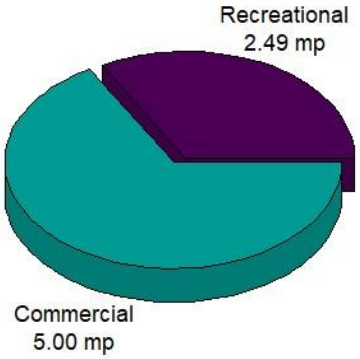

Figure 6: Final Red Grouper landings estimates from SEDAR 61 assessment for commercial and recreational fisheries in millions of pounds, 2010-2017 average.

Recreational landings of 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 Red Grouper landed whole and observed by interviewers ("Type A") and Red Grouper reported as killed by the fishers ("Type B1"). Estimates of Red Grouper recreational landings averaged 2.29 mp gw from 1986 to 2017, with a low of 0.66 mp gw in 1996 and a peak of 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 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 41.5% for the commercial bottom longline fleet and 19.0% for the commercial vertical line fleet were applied following the SEDAR 42 recommended methodology. The trap fishery estimated discards and discard mortality rate of 10.0% remained unchanged from SEDAR 42. Red Grouper commercial dead discards were estimated beginning in 1990 with the implementation of federal minimum size limits. Commercial longline fleet discards 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. Commercial vertical line fleet discards 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. Commercial trap fleet discards 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).

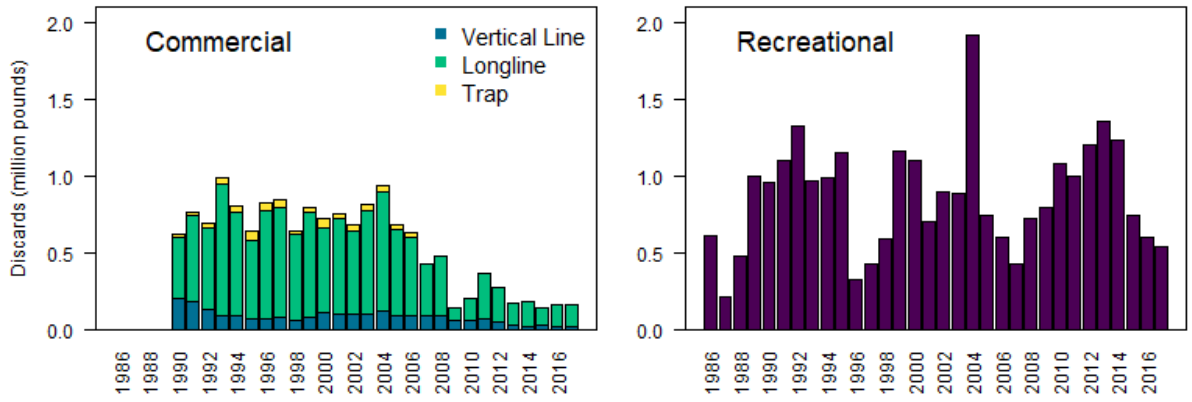

Figure 7: Final Red Grouper discard estimates from SEDAR 61 assessment for commercial (left panel, by fleet) and recreational (right panel) fisheries in millions of pounds, 1986-2017.

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%. Red Grouper recreational dead discard estimates 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).

The full SEDAR 61 Gulf Red Grouper stock assessment report can be found at *http://sedarweb.org/docs/sar/S61_Final_SAR.pdf*.

Table A1: Red Grouper landings in pounds provided for the Commercial fleets [Vertical Line (VL), Longline (LL), and Trap], Recreational fleets [Charter, Private, and Headboat], and Total landings. Recreational data use FES-calibrated MRIP landings and effort data.

Year	Commercial				Recreational				Total
	VL	LL	Trap	Com	Charter	Private	Headboat	Rec	
1986	3,134,864	2,505,841	721,461	6,362,165	392,191	2,918,122	118,331	3,428,644	9,790,809
1987	2,542,129	3,774,844	448,081	6,765,053	251,355	1,974,770	88,420	2,314,546	9,079,599
1988	2,049,120	2,192,793	540,227	4,782,140	228,281	4,617,405	103,879	4,949,565	9,731,705
1989	3,814,902	3,118,197	592,772	7,525,871	195,995	7,655,706	135,037	7,986,738	15,512,609
1990	2,460,955	2,025,694	340,896	4,827,545	494,310	3,644,883	91,512	4,230,704	9,058,248
1991	2,093,836	2,583,576	373,748	5,051,159	298,015	3,578,956	60,738	3,937,709	8,988,869
1992	1,444,967	2,409,543	602,186	4,456,696	578,633	6,037,608	52,651	6,668,892	11,125,588
1993	1,300,324	4,274,367	711,086	6,285,777	151,586	5,122,127	76,120	5,349,834	11,635,611
1994	1,241,428	2,699,076	913,825	4,854,329	310,418	3,735,379	55,351	4,101,148	8,955,477
1995	1,171,250	2,429,406	1,056,993	4,657,650	555,140	3,008,673	94,210	3,658,023	8,315,673
1996	865,154	2,907,192	539,359	4,311,705	181,788	705,043	84,369	971,199	5,282,904
1997	948,378	3,024,192	685,832	4,658,401	181,523	1,029,118	25,108	1,235,748	5,894,150
1998	741,607	2,662,281	297,549	3,701,436	215,232	1,343,268	23,339	1,581,839	5,283,275
1999	1,212,756	3,815,409	751,818	5,779,984	253,270	3,291,979	48,010	3,593,259	9,373,242
2000	1,720,988	2,909,331	1,024,810	5,655,129	849,068	3,529,601	51,056	4,429,725	10,084,854
2001	1,555,714	3,399,639	743,289	5,698,642	350,766	2,192,248	31,630	2,574,644	8,273,286
2002	1,628,178	3,130,565	980,292	5,739,035	281,585	2,981,086	24,636	3,287,307	9,026,342
2003	1,118,264	2,964,733	701,668	4,784,665	284,441	1,903,855	40,337	2,228,633	7,013,297
2004	1,376,657	3,383,479	745,209	5,505,345	548,316	7,700,271	68,272	8,316,860	13,822,205
2005	1,404,241	3,211,563	612,718	5,228,521	536,263	2,759,675	78,610	3,374,548	8,603,069
2006	1,375,689	3,012,661	586,846	4,975,197	272,693	2,534,048	26,703	2,833,444	7,808,641

Year	Commercial				Recreational				Total
	VL	LL	Trap	Com	Charter	Private	Headboat	Rec	
2007	1,561,080	1,984,386	24,476	3,569,942	152,151	2,014,188	25,858	2,192,197	5,762,139
2008	1,888,196	2,804,104	0	4,692,300	303,923	1,307,987	39,409	1,651,318	6,343,618
2009	2,445,478	1,124,979	0	3,570,457	188,560	1,451,008	31,003	1,670,571	5,241,029
2010	1,352,746	1,313,484	0	2,666,229	341,963	1,752,420	27,315	2,121,699	4,787,928
2011	1,683,964	3,049,501	15	4,733,479	255,808	1,332,079	38,459	1,626,346	6,359,826
2012	2,228,742	2,940,835	0	5,169,576	603,217	3,643,010	87,324	4,333,551	9,503,127
2013	1,532,418	3,025,911	0	4,558,329	838,518	4,329,767	81,255	5,249,540	9,807,869
2014	1,910,749	3,532,930	0	5,443,679	621,818	4,987,738	47,272	5,656,829	11,100,508
2015	1,854,306	2,837,063	0	4,691,369	528,974	3,360,536	53,052	3,942,561	8,633,931
2016	1,212,439	3,166,191	0	4,378,630	427,999	2,359,681	59,580	2,847,260	7,225,890
2017	990,341	2,297,305	0	3,287,646	364,334	1,353,964	22,451	1,740,749	5,028,395