A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), releases (numbers of fish), and total trips from MRIP-FCAL to SRFS for Red Grouper (*Epinephelus morio*) in the Gulf of Mexico

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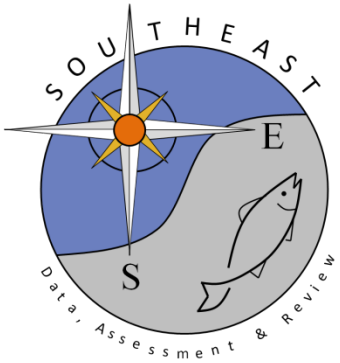

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SEDAR 88 Gulf of Mexico Red Grouper

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Background

The Marine Recreational Information Program (MRIP) has provided vital statistics on recreational fishing effort and catch in the eastern U.S. Gulf of Mexico since 1981. In order to remain useful for regional stock assessments, the time-series has undergone several calibrations to account for the effects of survey design improvements in more recent years. For example, when MRIP made the transition from the coastal household telephone survey (CHTS) to the fishing effort survey (FES) the historic estimates CHTS were calibrated into FES currency. This calibration is currently used for generating historic MRIP estimates and is termed FCAL. Stock assessments require long-term time-series of landings and discards on an annual scale that are measured consistently through time.

In response to a region-wide need for more precise and timely estimates of recreational catch, Florida's Gulf Reef Fish Survey (GRFS) was developed in May 2015 in collaboration with NOAA Fisheries alongside similar efforts in other states. The GRFS generated recreational catch estimates for the Gulf of Mexico, excluding Monroe County (Detailed methodology of the GRFS is described in detail in Appendix A, *Results from the first year of an exempted fishing permit (18-SERO-01) for state management of Red Snapper recreational harvest in Florida*. Beginning July 1, 2020, the Gulf Reef Fish Survey was expanded statewide in Florida and is now known as the State Reef Fish Survey (SRFS). The SRFS runs concurrent with the MRIP survey in Florida and produces estimates that are consistently lower. The current stock assessment for Gag in the Gulf of Mexico (SEDAR 72) incorporated a long-term time series of estimates of landings and discards from recreational private boats, which replaced MRIP FES estimates with MRIP estimates converted into SRFS currency for the time series prior to 2016 and SRFS estimates for recent years (Cross et al. 2020). The Gulf SSC deemed the assessment consistent with the best scientific information available (GMFMC 2022) and starting in 2024 the SRFS will be used in place of MRIP to monitor landings and discards from private boats and track the recreational ACL (GMFMC 2023). The method that was developed to calibrate historic MRIP-FCAL estimates to SRFS currency for use in SEDAR 72 was peer-reviewed by NOAA OS&T statistical consultants and approved for use. The method used for gag closely matches the method described herein to calibrate MRIP estimates to SRFS currency for Gulf Red Grouper, which will facilitate the use of SRFS estimates in this assessment.

Objectives

The objective is to develop conversion factors that may be applied to annual, fully calibrated MRIP estimates, and produce a historic time series in the same currency as the SRFS for Red Grouper (*Epinephelus morio*) in the Gulf, including the Keys. "The Keys" is defined as all trips taken off of mainland Monroe county and all trips taken from the Keys in the Gulf (i.e., north of U.S. 1/the island chain; Fig. 1 region D).

Methods

Prior to producing a calibrated time series, SRFS estimates during the early years require an adjustment to account for effort and catch from the Gulf Keys (Fig. 1; region D), because this region was not included in the SRFS survey until June 2020. To do this, data from the three most recent years, years 2021-2023, were used to produce separate recreational catch estimates for the Gulf coast with the Gulf Keys included (Gulfk; Fig. 1 regions A-D) and excluded (Gulf; Fig. 1 regions A-C), and a ratio was calculated. Application of this ratio resulted in an increase in 2016-2020 SRFS estimates because they accounted for additional landings and discards from the Gulf Keys. Next, another ratio was calculated to calibrate MRIP estimates for the Gulf (excluding the Keys; provided by NOAA Fisheries Southeast Science Center) down to the SRFS Gulfk estimates using the available overlapping years (2016-2022). This method was used to produce a calibrated time series for total landings (numbers and pounds of fish), releases (numbers). The same method was used to produce a calibrated time series for reef fish effort. For this calculation, effort estimates for SRFS and MRIP included trips that targeted and/or caught one or more of the following from the suite of reef fish species covered by the SRFS survey: red grouper, gag, black grouper, red snapper, vermilion snapper, gray triggerfish and amberjacks (greater, lesser, almaco and banded rudderfish). The estimated ratios and associated uncertainty were used to convert the historical MRIP time series (1981-2015) to a common currency with SRFS. For the years 2016-2022, SRFS Gulfk estimates are provided in place of MRIP.

Recreational harvest seasons for Red Grouper off the Gulf coast of Florida have varied over recent years and across state and federal jurisdictions. For example, in 2021 recreational harvest of Red Grouper in the Gulf was only allowed in state waters during February and March and was permitted in both state and federal waters throughout the remainder of the year. Whereas in 2022, harvest seasons in state and federal waters were both open in February and March, but both closed in late August for the remainder of the year. Rather than apply calibrations at a fine scale back in time (e.g. by month or area fished), it is more appropriate to quantify the overall differences between SRFS and FCAL estimates and between SRFS Gulf and SRFS Gulfk estimates across the variable years and waves over which the two surveys overlap so that a single calibration factor may be applied to annual FCAL estimates back in time.

To calculate the calibration ratios, SRFS estimates ($\hat{E}$) and variances ($\hat{V}$) for each estimation method (where *m = SRFS Gulf or SRFS Gulfk*) were summed across years (*y*), two-month waves (*w*), and areas fished (*a*: federal or state waters) for each combination of species (*s*) and estimate type variable (*v*: number landed, pounds landed, number released, angler trips) [1, 2].

$$\hat{E}_{m,s,v} = \sum_{m,s,v} \hat{E}_{y,w,a,m,s,v} \quad [1]$$

$$\hat{V}(\hat{E}_{m,s,v}) = \sum_{m,s,v} \hat{V}(\hat{E}_{y,w,a,m,s,v}) \text{ [2]}$$

This resulted in four paired overall sums for each estimate type from SRFS Gulf and SRFS Gulfk (Table 1). For each of the paired sums, the ratio was calculated as the SRFS Gulfk estimate divided by the SRFS Gulf estimate [3].

$$\hat{R}_{Gulfk\ s,v} = \frac{\hat{E}_{SRFS\ Gulfk\ s,v}}{\hat{E}_{SRFS\ Gulfs,v}} \text{ [3]}$$

This first ratio was applied as a multiplier to SRFS estimates for the years 2016-2020, to account for catch in the Gulf Keys before data were collected in this region [4].

$$\hat{E}_{SRFS,y,s,v} = \hat{R}_{Gulfk\ s,v}\hat{E}_{Gulf,y,s,v} \text{ [4]}$$

The delta method was used to approximate the variance of the ratios ($\hat{V}(\hat{R}_{s,v})$), and incorporates error associated with both the numerator (SRFS Gulfk estimates) and denominator (SRFS Gulf estimates).

Once the full SRFS time series was calibrated to Gulf with the Keys currency, estimates and variances for each estimation method (where *m = SRFS or FCAL*) were summed, using equation 1 above, across years (*y*), two-month waves (*w*), and areas fished (*a*: federal or state waters) for each combination of species (*s*) and estimate type variable (*v*: number landed, pounds landed, number released, angler trips). This resulted in four paired overall sums for SRFS Gulfk and FCAL Gulf estimates (Table 2). For this calibration, the SRFS sum was divided by the MRIP-FCAL sum to produce a second ratio that could be applied to MRIP-FCAL estimates prior to 2016, before SRFS estimates were available.

$$\hat{R}_{s,v} = \frac{\hat{E}_{SRFS,s,v}}{\hat{E}_{FCAL,s,v}} \text{ [5]}$$

Historic MRIP FES estimates were converted to SRFS currency by multiplying the annual FCAL estimate for each year and variable type (number landed, pounds landed, number released, number of trips) [6] with the corresponding ratio [5]:

$$\hat{E}_{SRFS-hind,y,s,v} = \hat{R}_{s,v}\hat{E}_{FCAL,y,s,v} \text{ [6]}$$

The delta method was once again used to approximate the variance of the ratios ($\hat{V}(\hat{R}_{s,v})$), and incorporates error associated with both the numerator (SRFS estimates) and denominator (FCAL estimates). The R statistical software package 'msm' (R Core Team 2023; Jackson 2011) was used to carry out variance calculations.

MRIP and SRFS use separate methods to calculate fishing effort (angler trips); however, catch estimates from the two surveys are not completely independent. To estimate catch-per-unit-effort (CPUE), the MRIP survey uses data from the Access Point Angler Intercept Survey (APAIS),

whereas the GRFS uses a combination of data from the APAIS and supplemental reef fish angler intercepts. Assignments for both intercept surveys are drawn together so that sample weights are compatible (Foster, 2018). Although SRFS and MRIP estimates are derived from survey data that are not completely independent, the strength of correlation between estimates from the two surveys is unknown. Additionally, SRFS Gulf and SRFS Gulfk estimates are correlated as both are generated by the same survey and generate estimates for a highly overlapped spatial distribution. For both of these calibrations we assumed a 0% correlation as this is the most conservative approximation of variance if correlation between the two estimates are ignored (Cross et al. 2020).

Findings and Conclusions

Figures 2 and 3 show the different time-series of estimates that are discussed throughout this document.

For the years in which SRFS estimates included the Gulf Keys, the ratios of Red Grouper estimates with and without the Gulf Keys are provided in Table 1. When converting SRFS Gulf to SRFS Gulfk currency to account for additional trips, landings, and releases from the Gulf Keys, estimates were increased by 21-27% for the estimates of landings and releases and only 9% for the estimates of effort (Table 2). The average PSE value for this calibration was 20% for landings and releases and 6% for effort (Table 2).

For the years in which the SRFS and MRIP overlap, ratios of summed SRFS and FCAL estimates, and approximated variance for each ratio are provided in Table 3. When converting MRIP FES estimates to SRFS currency, estimates decreased between 36-42% for landings and releases and by 52% for effort. The average PSE value for this calibration was 30% for landings and releases and 9% for effort. The PSEs for MRIP-FES estimates calibrated to SRFS currency are skewed right due to higher PSEs in FCAL estimates from the 1980s, primarily for releases (Table 4).

The purpose of this report was to document the method used to convert FCAL estimates to SRFS estimates for use in the SEDAR 88 Red Grouper stock assessment in the Gulf of Mexico. Results presented in this report include data collected over 96 months (2016-2023). The two surveys continue to run concurrently in Florida. Calibration factors that include the complete available time-series of overlapping data may be routinely updated and shared as needed.

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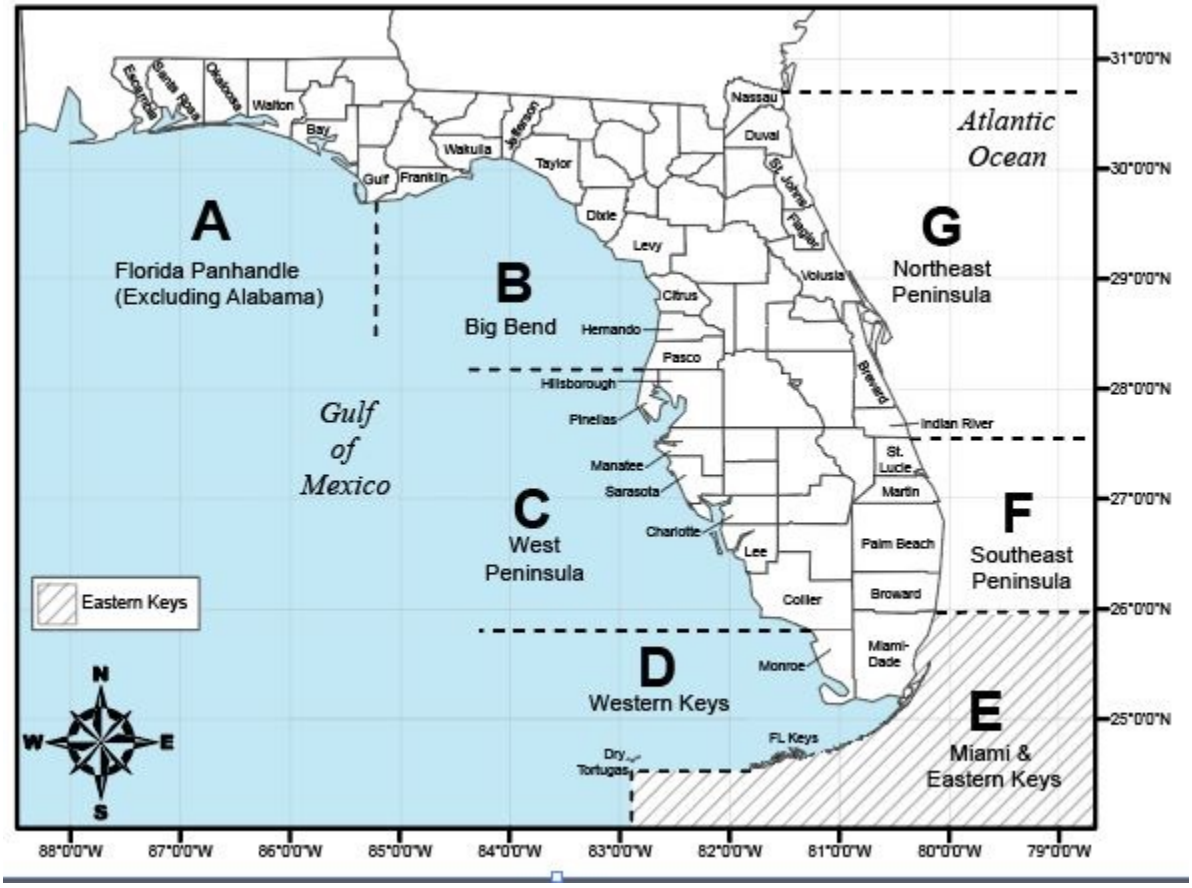

Figure 1. Regions of the state of Florida as designated by the State Reef Fish Survey (SRFS). For the purposes of this calibration, the Gulf with the Keys is defined as regions A-D.

Table 1. Annual and summed SRFS Gulf and SRFS Gulf with the Gulf Keys (Monroe County & the Keys north of the island chain/U.S. 1; Gulfk) estimates (sum) and variances (var) and ratios of SRFS Gulf to SRFS Gulfk estimates are shown for Red Grouper (*Epinephelus morio*) in Florida. Estimates for effort (number of trips) are for the whole suite of species covered by the original GRFS survey, including Red Grouper.

Estimate Type	Year	SRFS Gulfk Sum	SRFS Gulfk Var	SRFS Gulf Sum	SRFS Gulf Var	Ratio
Landings (lbs)	2021	2,075,833	98,902,672,095	1,482,635	85,180,998,209	1.21
	2022	922,310	25,780,024,069	880,261	23,906,109,309	
	2023	728,896	10,453,167,296	706,585	9,991,378,375	
	Total	3,727,040	135,135,863,461	3,069,481	119,078,485,893	
Landings (no. fish)	2021	253,500	2,085,045,041	165,801	1,055,045,672	1.26
	2022	124,426	1,038,967,696	118,593	956,174,048	
	2023	81,445	283,846,868	78,831	273,171,448	
	Total	459,371	3,407,859,605	363,225	2,284,391,168	
Releases (no. fish)	2021	1,811,816	54,565,109,886	1,101,375	20,195,146,982	1.27
	2022	1,069,473	14,608,752,264	1,012,504	13,212,190,222	
	2023	965,403	14,170,767,677	922,774	13,585,905,638	
	Total	3,846,692	83,344,629,827	3,036,652	46,993,242,842	
Effort (no. trips): for all SRFS species	2021	1,438,996	4,038,381,306	1,331,775	3,621,186,936	1.09
	2022	1,055,244	2,572,288,867	965,273	2,374,659,029	
	2023	836,443	2,122,973,015	752,436	1,932,072,033	
	Total	3,330,683	8,733,643,188	3,049,483	7,927,917,998	

Table 2. Historic SRFS Gulf estimates and estimates converted to SRFS Gulf with the Gulf Keys (Monroe County & the Keys north of the island chain/U.S. 1; Gulfk) currency (Calibrated: SRFS Gulf to SRFS Gulfk) for Red Grouper (*Epinephelus morio*) in the Florida. Estimates for effort (number of trips) are for the whole suite of species covered by the original GRFS survey, including Red Grouper. Associated standard error (PSE) is presented for the 0% correlation used to calculate variance for the calibration factor (ratio of SRFS Gulf to SRFS Gulfk).

	SRFS Gulf		SRFS Gulf - SRFS Gulfk calibration		SRFS Gulf		SRFS Gulf - SRFS Gulfk calibration	
Year	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE
2016	133,476	11.7	168,808	21.7	827,554	8.6	1,004,837	17.3
2017	65,774	14.6	83,185	23.4	491,551	9.7	596,853	17.8
2018	84,433	20.0	106,782	27.1	704,804	13.2	855,791	20.0
2019	80,181	15.6	101,405	24.0	679,226	12.9	824,733	19.8
2020	159,392	18.7	201,584	26.2	1,279,392	12.3	1,553,469	19.4

	SRFS Gulf		SRFS Gulf - SRFS Gulfk calibration		SRFS Gulf		SRFS Gulf - SRFS Gulfk calibration	
Year	Releases (no.fish)	PSE	Releases (no.fish)	PSE	Effort (no. trips)	PSE	Effort (no. trips)	PSE
2016	966,918	9.9	1,224,848	14.3	1,173,577	5.1	1,280,068	6.2
2017	849,979	12.0	1,076,714	15.9	1,326,813	4.6	1,447,209	5.9
2018	971,256	10.1	1,230,342	14.5	1,118,413	4.4	1,219,898	5.7
2019	520,340	10.1	659,143	14.5	1,027,168	4.8	1,120,374	6.0
2020	751,647	11.1	952,152	15.2	1,201,331	3.5	1,310,341	5.0

Table 3. Annual and summed SRFS Gulf with the Keys (Monroe County; Gulfk) and MRIP estimates (sum) and variances (var) and ratios of MRIP to SRFS estimates are shown for Red Grouper (*Epinephelus morio*) in Florida. Estimates for effort (number of trips) are for the whole suite of species covered by the original GRFS survey, including Red Grouper.

Estimate Type	Year	SRFS Gulfk Sum	SRFS Gulfk Var	MRIP Gulf Sum	MRIP Gulf Var	Ratio
Landings (lbs)	2016	1,004,837	30,057,754,810	2,273,969	410,615,129,523	0.64
	2017	596,853	11,336,395,849	1,391,673	165,702,404,552	
	2018	855,791	29,175,678,664	1,749,232	270,949,638,782	
	2019	824,733	26,537,329,414	1,378,144	176,087,273,272	
	2020	1,553,469	90,746,687,096	1,716,665	371,791,256,637	
	2021	2,075,833	98,902,672,095	1,466,517	282,251,238,706	
	2022	922,310	25,780,024,069	2,264,434	771,748,538,259	
	Total	7,833,827	312,536,541,998	12,240,634	2,449,145,479,731	
Landings (no. fish)	2016	168,808	1,345,704,704	335,392	8,817,710,016	0.62
	2017	83,185	379,312,131	196,206	3,237,586,080	
	2018	106,782	835,835,641	234,158	4,611,206,120	
	2019	101,405	592,920,219	211,269	4,017,122,432	
	2020	201,584	2,787,383,089	248,453	7,561,817,731	
	2021	253,500	2,085,045,041	158,594	3,081,112,927	
	2022	124,426	1,038,967,696	300,271	13,019,081,704	
	Total	1,039,690	9,065,168,520	1,684,344	44,345,637,010	
Releases (no. fish)	2016	1,224,848	30,655,472,802	2,164,044	206,524,095,051	0.58
	2017	1,076,714	29,145,838,223	2,203,563	214,135,890,961	
	2018	1,230,342	31,729,921,072	3,147,628	436,923,618,446	
	2019	659,143	9,132,381,522	1,596,921	159,384,838,069	
	2020	952,152	20,842,563,017	1,265,358	70,609,919,202	
	2021	1,811,816	54,565,109,886	1,786,646	268,456,067,755	
	2022	1,069,473	14,608,752,264	1,643,261	130,694,915,885	
	Total	8,024,487	190,680,038,785	13,807,423	1,486,729,345,368	
Effort (no. trips): for all GRFS species	2016	1,280,068	6,298,423,683	2,719,820	30,699,783,318	0.47
	2017	1,447,209	7,223,394,432	3,169,129	72,532,201,799	
	2018	1,219,898	4,836,874,259	2,991,914	96,607,387,606	
	2019	1,120,374	4,508,628,127	2,533,501	51,549,098,658	
	2020	1,310,341	4,337,895,426	2,693,137	39,129,432,386	
	2021	1,438,996	4,038,381,306	2,150,342	31,072,503,286	
	2022	1,055,244	2,572,288,867	2,449,734	45,952,245,492	
	Total	8,872,130	33,815,886,100	18,707,577	367,542,652,546	

Table 4. Original and calibrated MRIP-FCAL estimates for Red Grouper (*Epinephelus morio*) landings in Florida.

	MRIP-FCAL Gulf		SRFS-FCAL calibration		MRIP-FCAL Gulf		SRFS-FCAL calibration	
Year	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE
1981	407,925	38.0	251,798	41.0	1,450,203	42.5	928,109	45.0
1982	592,060	35.0	365,459	38.3	2,641,339	40.8	1,690,418	43.4
1983	1,158,535	46.0	715,126	48.5	4,718,387	50.9	3,019,699	52.9
1984	261,162	39.0	161,207	42.0	923,477	44.0	591,012	46.4
1985	633,586	51.0	391,092	53.3	1,941,434	51.5	1,242,489	53.5
1986	1,075,513	31.0	663,879	34.7	2,998,759	31.6	1,919,162	34.8
1987	753,219	26.0	464,938	30.3	2,252,187	26.8	1,441,367	30.5
1988	1,532,243	20.0	945,803	25.3	4,521,756	22.2	2,893,858	26.6
1989	2,260,505	23.0	1,395,336	27.7	7,651,687	23.6	4,896,968	27.7
1990	459,845	25.0	283,847	29.4	3,146,033	25.7	2,013,415	29.6
1991	540,976	25.0	333,927	29.4	3,602,512	25.3	2,305,555	29.2
1992	857,064	19.0	529,037	24.5	5,653,946	19.2	3,618,443	24.1
1993	646,745	24.0	399,214	28.6	4,024,665	24.3	2,575,727	28.4
1994	526,039	22.0	324,706	26.9	3,628,977	22.2	2,322,492	26.6
1995	465,742	30.0	287,487	33.8	3,008,673	30.2	1,925,507	33.5
1996	106,962	23.0	66,024	27.7	687,852	23.3	440,215	27.5
1997	154,920	33.0	95,627	36.5	1,015,912	33.2	650,169	36.3
1998	183,081	20.0	113,010	25.3	1,356,404	20.7	868,079	25.3
1999	451,658	19.0	278,793	24.5	3,290,589	19.2	2,105,929	24.2
2000	506,805	20.0	312,834	25.3	3,546,025	20.3	2,269,404	25.1
2001	313,807	20.0	193,703	25.3	2,169,687	20.4	1,388,568	25.1
2002	410,559	22.0	253,425	26.9	3,019,037	22.2	1,932,139	26.6
2003	306,090	20.0	188,939	25.3	1,984,026	20.2	1,269,747	25.0
2004	1,133,056	21.0	699,399	26.1	7,753,599	21.2	4,962,190	25.7
2005	385,348	27.0	237,862	31.1	2,613,607	27.4	1,672,670	31.0
2006	332,549	35.0	205,272	38.3	2,480,863	35.2	1,587,716	38.1
2007	291,222	22.0	179,762	26.9	1,951,169	22.3	1,248,720	26.7
2008	208,239	19.0	128,539	24.5	1,334,261	19.4	853,907	24.3
2009	179,485	23.0	110,790	27.7	1,442,694	23.6	923,303	27.7
2010	282,634	26.0	174,460	30.3	1,688,428	26.3	1,080,569	30.1
2011	230,444	19.0	142,246	24.5	1,313,484	19.3	840,610	24.2
2012	588,211	19.0	363,083	24.5	3,639,504	19.4	2,329,230	24.3
2013	719,170	19.0	443,920	24.5	4,313,400	19.1	2,760,513	24.1
2014	760,444	25.0	469,397	29.4	4,964,553	25.1	3,177,241	29.1
2015	461,312	21.0	284,752	26.1	3,395,440	21.2	2,173,032	25.7

Table 5. Original and calibrated MRIP-FCAL estimates for Red Grouper (*Epinephelus morio*) releases and reef fish effort in Florida. Estimates for effort (number of angler trips) are for the whole suite of species covered by the original GRFS survey, including Red Grouper.

	MRIP-FCAL Gulf		SRFS-FCAL calibration		MRIP-FCAL Gulf		SRFS-FCAL calibration	
Year	Releases (no. fish)	PSE	Releases (no. fish)	PSE	Effort (no. trips)	PSE	Effort (no. trips)	PSE
1981	328,398	78.0	190,856	78.7				
1982	158,497	45.0	92,114	46.2	853,204	11.6	404,635	12.2
1983	83,896	72.0	48,758	72.7	1,133,988	18.2	537,798	18.6
1984	83,694	60.0	48,640	60.9	809,386	17.7	383,854	18.1
1985	74,415	69.0	43,248	69.8	843,684	20.6	400,120	21.0
1986	813,907	39.0	473,020	40.4	959,593	10.7	455,090	11.4
1987	690,377	22.0	401,228	24.3	1,176,868	10.1	558,133	10.8
1988	1,932,133	21.0	1,122,902	23.4	1,429,058	8.9	677,736	9.7
1989	5,872,992	26.0	3,413,219	28.0	2,023,590	7.6	959,694	8.5
1990	4,374,994	26.0	2,542,624	28.0	1,319,157	10.2	625,615	10.9
1991	5,426,844	20.0	3,153,930	22.5	1,819,994	9.1	863,138	9.9
1992	5,157,606	17.0	2,997,456	19.9	1,598,562	6.6	758,123	7.6
1993	3,158,040	20.0	1,835,364	22.5	1,939,765	7.9	919,940	8.8
1994	3,236,051	22.0	1,880,702	24.3	1,905,809	7.5	903,836	8.4
1995	3,835,677	23.0	2,229,188	25.2	2,028,361	7.5	961,957	8.4
1996	1,246,516	19.0	724,440	21.6	1,437,821	5.9	681,891	7.0
1997	2,014,957	24.0	1,171,037	26.1	1,972,541	6.5	935,484	7.5
1998	3,337,806	15.0	1,939,839	18.2	2,011,356	5.6	953,892	6.8
1999	5,405,117	13.0	3,141,303	16.6	2,797,424	5.2	1,326,687	6.5
2000	4,226,849	15.0	2,456,526	18.2	2,448,193	5.3	1,161,064	6.5
2001	3,502,720	13.0	2,035,683	16.6	3,617,870	7.1	1,715,787	8.1
2002	3,909,476	13.0	2,272,078	16.6	3,316,098	6.2	1,572,670	7.3
2003	3,752,560	13.0	2,180,883	16.6	3,405,723	6.2	1,615,175	7.3
2004	7,512,527	14.0	4,366,071	17.4	4,707,087	7.2	2,232,351	8.2
2005	2,701,327	15.0	1,569,936	18.2	3,562,986	7.2	1,689,758	8.1
2006	2,220,260	32.0	1,290,353	33.6	2,840,479	8.2	1,347,106	9.0
2007	1,599,693	22.0	929,697	24.3	3,294,412	7.2	1,562,386	8.1
2008	6,294,612	13.0	3,658,252	16.6	4,173,696	5.9	1,979,389	7.0
2009	6,276,296	14.0	3,647,607	17.4	3,527,545	5.8	1,672,950	6.9
2010	5,379,955	17.0	3,126,679	19.9	3,317,095	6.4	1,573,143	7.5
2011	6,021,306	18.0	3,499,414	20.8	2,858,990	6.2	1,355,885	7.3
2012	4,392,740	16.0	2,552,937	19.1	3,133,015	6.3	1,485,842	7.4
2013	4,895,361	17.0	2,845,047	19.9	3,865,350	13.9	1,833,155	14.4
2014	4,293,342	13.0	2,495,170	16.6	2,912,033	5.7	1,381,041	6.9
2015	2,550,817	14.0	1,482,463	17.4	2,396,673	6.5	1,136,630	7.5

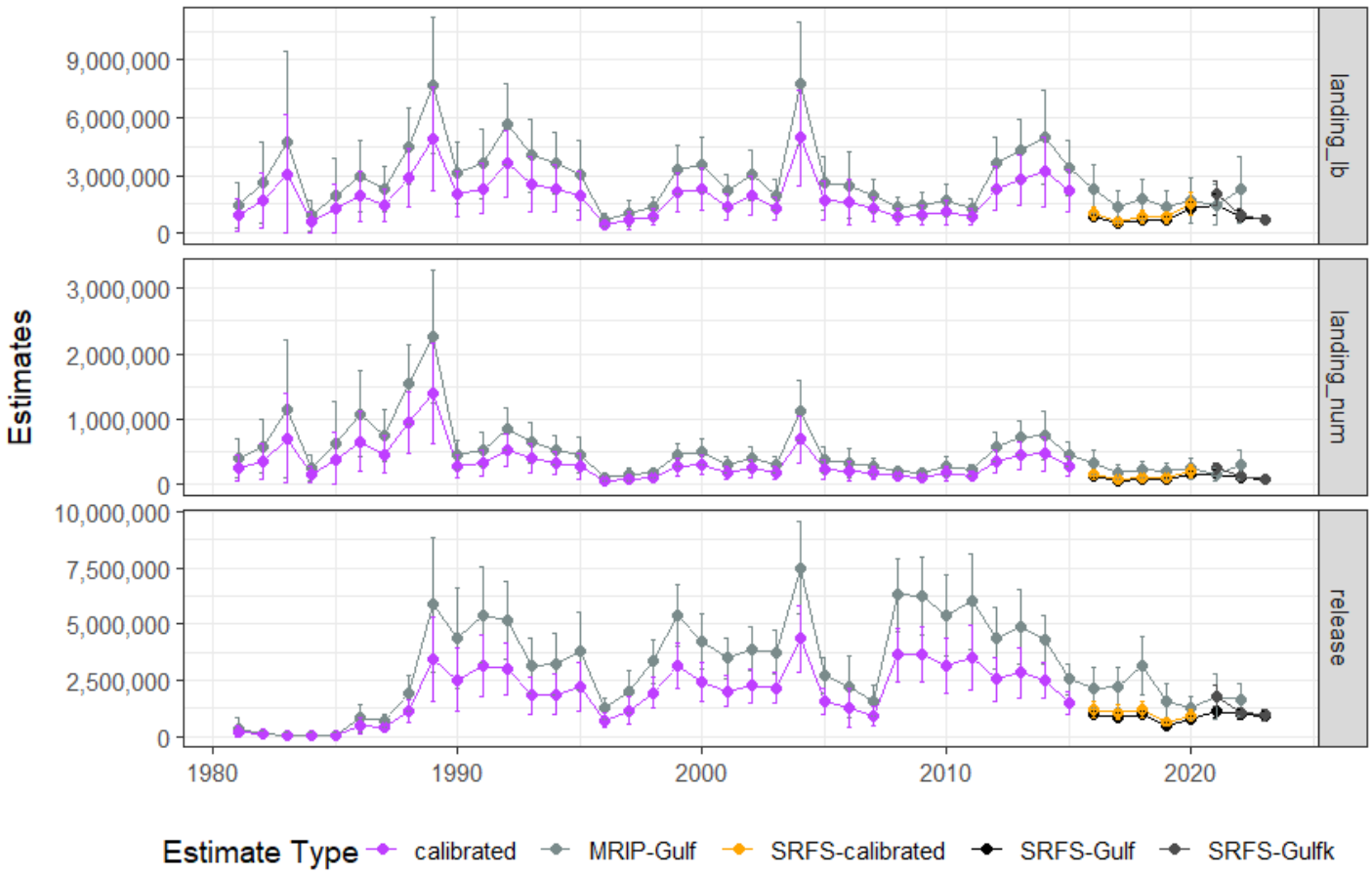

Figure 2. Red Grouper (*Epinephelus morio*) estimates in the Gulf of Mexico, including: original SRFS estimates excluding the Keys (2016-2023, SRFS-Gulf), original SRFS time-series including the Keys (2021-2023, SRFS-Gulfk), calibrated SRFS time-series accounting for years 2016-2020 before data were collected in the Keys (2016-2020, SRFS-calibrated), original MRIP-FCAL time-series (MRIP - Gulf), and MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits.

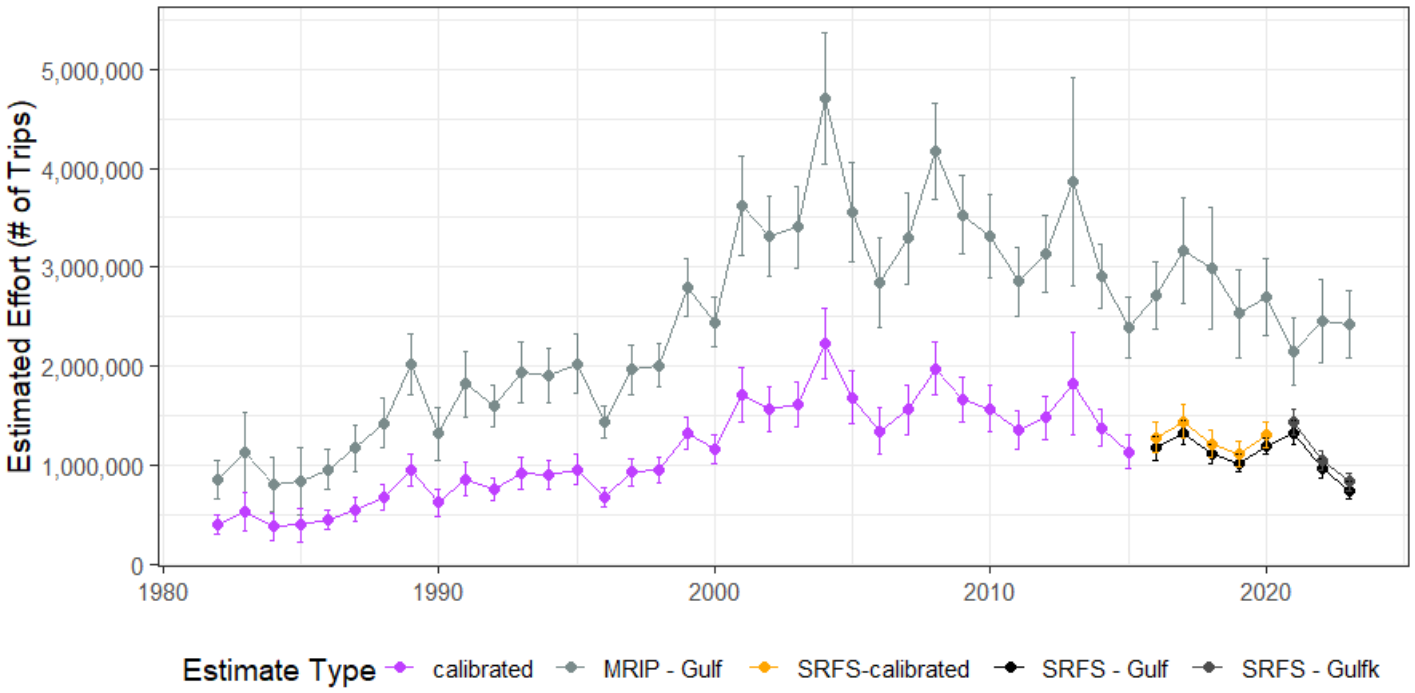

Figure 3. Private boat recreational effort estimates (in angler trips) off the Gulf coast of Florida for the original suite of GRFS species including: original SRFS time-series excluding the Keys (2016-2023, SRFS-Gulf), original SRFS time-series including the Keys (2021-2023, SRFS-Gulfk), full calibrated SRFS time-series accounting for years 2016-2020 before data were collected in the Keys (2016-2020, SRFS-calibrated), original MRIP-FCAL time-series (MRIP - Gulf), and MRIP-FCAL time-series calibrated to SRFS currency (calibrated).