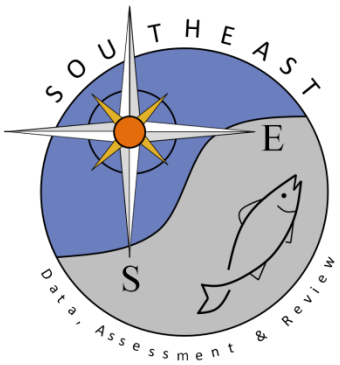
A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Yellowtail Snapper (*Ocyurus chrysurus*)

Chloe Ramsay, Tiffanie A. Cross, Colin P. Shea, and Beverly Sauls

SEDAR96-AP-05

9 August 2024



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A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Yellowtail Snapper (*Ocyurus chrysurus*)

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SEDAR 96 Southeastern U.S. Yellowtail Snapper

August 9, 2024

SRFS Background

In response to a need for more precise estimates of recreational catch for reef fishes, particularly from private boats, the Florida Fish and Wildlife Conservation Commission developed and implemented a new survey that runs side-by-side with the historic Marine Recreational Information Program (MRIP). The MRIP is a general survey of all saltwater recreational fishing in both state and federal waters, whereas the State Reef Fish Survey (SRFS) is a supplemental, more specialized survey that directly targets participants in the reef fish fishery to collect information on effort and catch. The SRFS is the result of a decade of development and testing in Florida, in collaboration with independent statistical consultants and NOAA Fisheries scientists. The survey provides year-round, monthly estimates of fishing effort, landings, and discards for a suite of reef fish species commonly targeted by recreational anglers fishing from private boats in Florida. Initially named the Gulf Reef Fish Survey (GRFS), the methodology was implemented in May 2015 and was only conducted on the west coast of Florida, north of Monroe County (Fig. 1). In 2018, the survey design and estimation methods were peer-reviewed and subsequently certified by NOAA Fisheries as statistically valid and suitable for use (SRFS Certification Memo and design documentation, available online: https://www.fisheries.noaa.gov/recreational-fishing-data/transitioning-new-recreational-fishing-survey-designs).

Yellowtail Snapper (*Ocyurus chrysurus*) are not frequently targeted by recreational anglers along the Gulf coast of Florida north of Monroe County (Fig. 2), and thus were not included in the survey when it was initially tested in Florida. However, following successful certification, the survey was expanded statewide in July 2020 to include Monroe County and the Atlantic coast of Florida. At this point the SRFS began collecting data for three additional reef fish species targeted by recreational anglers primarily in the Keys and Southeast Florida: Hogfish (*Lachnolaimus maximus*), Mutton Snapper (*Lutjanus analis*), and Yellowtail Snapper.

The SRFS continues to run concurrent with the legacy MRIP survey in Florida, which has provided vital statistics on recreational fishing effort and catch in the Gulf of Mexico and Atlantic Ocean off the coast of Florida since 1981. This overlap has facilitated the use of the newer SRFS time-series in regional stock assessments. These assessments require long-term, consistent, time-series of landings and discards and consequently a calibration method is necessary to convert the historic MRIP time-series to a common currency. The first stock assessment to incorporate SRFS estimates was SEDAR 72 for Gag in the Gulf of Mexico (https://sedarweb.org/assessments/sedar-72/). This assessment incorporated SRFS estimates from 2016 forward, and MRIP estimates prior to 2016 were converted into SRFS currency (Cross et al. 2020). 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 deemed fit for use in stock assessments (NOAA 2022). The Gulf SSC also found that the assessment was consistent with the best scientific information available (GMFMC 2022) and SRFS estimates are now used by NOAA's Southeast Regional Office (SERO) to track

recreational catch for Gag in the Gulf. Additionally, the Gag calibration method is consistent with the simple ratio-based approach deemed reasonable in the Fifth Red Snapper Workshop (Cross et al. 2020; GSMFC-NOAA 2020) and is similar to the method we provide here to calibrate MRIP estimates to SRFS currency for Yellowtail Snapper.

Objectives

The objective of this report is to describe the development and application of simple ratio-based conversion factors that may be applied to annual, fully calibrated MRIP estimates (FCAL), and produce a historic time series in the same currency as the SRFS for use in regional assessments for Yellowtail Snapper stocks in the southeastern US. This report was written following Terms of Reference (TORs; Appendix A) developed by NOAA Fisheries, OS&T for the use of calibrated estimates for stock assessment and management.

Methods

This analysis used private boat mode recreational estimates of total landings (numbers and pounds of fish) and releases (numbers) derived from SRFS and MRIP from January 2021 through December 2023. Overlapping estimates from the first six months of SRFS implementation (July-December 2020) were not included in this analysis due to challenges related to the global pandemic, which coincided with initial expansion of the survey. To our knowledge there are no biases in 2021-2023 data.

The SRFS and MRIP surveys use independent methods to estimate fishing effort (angler trips); however, catch estimates derived from each method are not completely independent. To estimate catch-per-unit-effort (CPUE), both surveys use data collected in the Access Point Angler Intercept Survey (APAIS), and SRFS 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).

We did not apply calibrations at a fine scale back in time (*i.e.,* by month or area fished), as neither survey was designed to generate precise estimates at this scale. Instead, we quantified the overall differences between SRFS and FCAL estimates across the years over which the two surveys overlap. This allowed for a single calibration factor to be applied to annual FCAL estimates back in time for landings and releases. Separate conversion factors are provided for landings in numbers, landings in pounds, and releases in numbers. As requested by assessment analysts for SEDAR 96, recreational estimates for Yellowtail Snapper were calculated and calibrated as one combined value for the whole state of Florida.

All MRIP-FCAL estimates used in this calibration were generated by the NOAA Southeast Fisheries Science Center. MRIP-FCAL estimates were generated for the whole assessment region and not separated by state. Landings and releases in Florida make up more than 99.9% of

the total landings and releases. Therefore, in order the generate estimates for Florida for use in this calibration, the additional Yellowtail Snapper landed and released in states outside of Florida were subtracted from the whole estimate in each year. PSE values were used as provided. Authors, stock assessment analysts, and representatives from the Southeast Fisheries Science Center decided that removal of the data from other states would change PSE values very minimally or not at all due to the extremely small proportion of landings and releases that came from other states. Variances for use in this calibration process were back calculated using the PSE and estimates values.

To assess overall differences between SRFS and FCAL estimates the estimates ($\hat{E}$) and variances ($\hat{V}$) for each estimation method (*m: SRFS, FCAL*) were summed across years (*y*), two-month waves (*w*), and areas fished (*a*: federal or state waters) for each variable (*v*: number landed, pounds landed, number released) [1, 2].

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

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

This resulted in 3 pairs of SRFS and FCAL sums (3 variables; Table 1). For each of the paired sums, the ratio was calculated as the total SRFS estimate divided by the total FCAL estimate (landings and releases) [3].

$$\hat{R}_v = \frac{\hat{E}_{SRFS,v}}{\hat{E}_{FCAL,v}} \text{ [3]}$$

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. To calculate the variance of the ratio above, we assumed a 0% correlation as this is the most conservative approximation of variance if correlation between the two survey estimates is ignored (Cross et al. 2020). This correlation percentage was recommended by peer review (Stokes et al. 2020). A delta method approximation for the variance of two independent variables was used to calculate the variance of the ratio above ($\hat{V}(\hat{R}_v)$) because this method incorporates error associated with both the numerator (SRFS estimates) and denominator (FCAL estimates). The R statistical software package 'msm' and the function deltamethod (R Core Team 2023; Jackson 2011) were used to carry out these calculations.

Historic estimates were converted to SRFS currency by multiplying the annual FCAL estimate for each year and variable type (number landed, pounds landed, number released) [4] with the corresponding ratio [3]:

$$\hat{E}_{GRFS-hind,y,v} = \hat{R}_v \hat{E}_{FCAL,y,v} \quad [4]$$

Variance was again approximated using the delta method and, once again, a 0% correlation was assumed.

Findings and Conclusions

For the years in which the SRFS and MRIP overlap, annual Yellowtail Snapper estimates derived from SRFS and FCAL and associated variances, observed ratios of summed SRFS to FCAL estimates, and approximated variance for each ratio are provided in Tables 1. Yearly and average annual estimates are shown in Figure 3. The Yellowtail Snapper ratios were marginally larger for landings (number of fish = 0.63; lbs of fish = 0.67) than for releases (0.55). Median PSE values for the calibrated estimates were 34%. Calibrated estimates for Yellowtail Snapper are provided (Fig. 4, Table 2).

The purpose of this report was to calibrate the historic FCAL estimates to SRFS currency for use in the SEDAR 96 southeastern US Yellowtail Snapper stock assessment. Results presented in this report include data collected over 36 months. However, as the two surveys continue to run concurrently in Florida, the calibration factors may be routinely updated and shared for future assessments.

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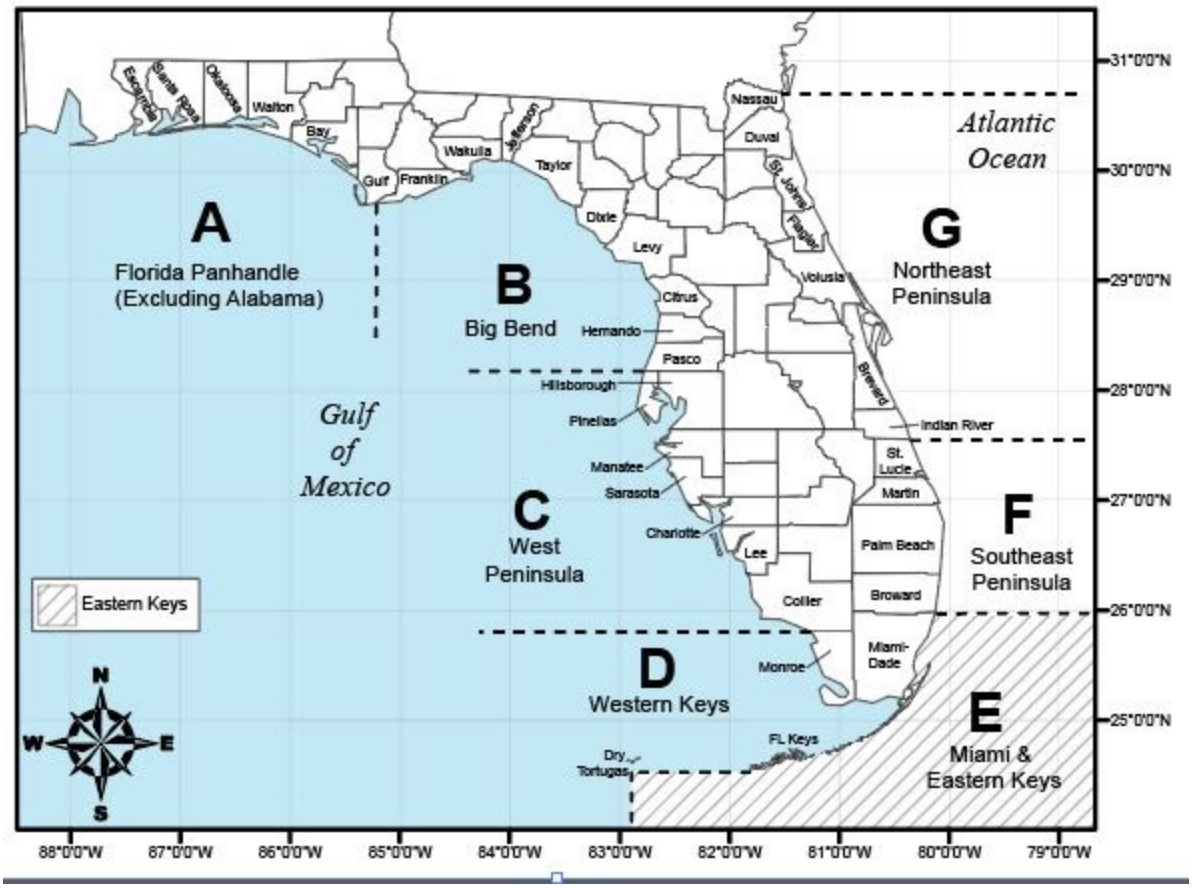

Figure 1. Regions of the state of Florida as designated by the State Reef Fish Survey (SRFS). The Gulf Reef Fish Survey (GRFS) which ran from May 2015-June 2020 covered regions A-C. The expansion to the SRFS included the remaining regions, which is also when Hogfish (*Lachnolaimus maximus*), Mutton Snapper (*Lutjanus analis*), and Yellowtail Snapper (*Ocyurus chrysurus*) were added to the survey.

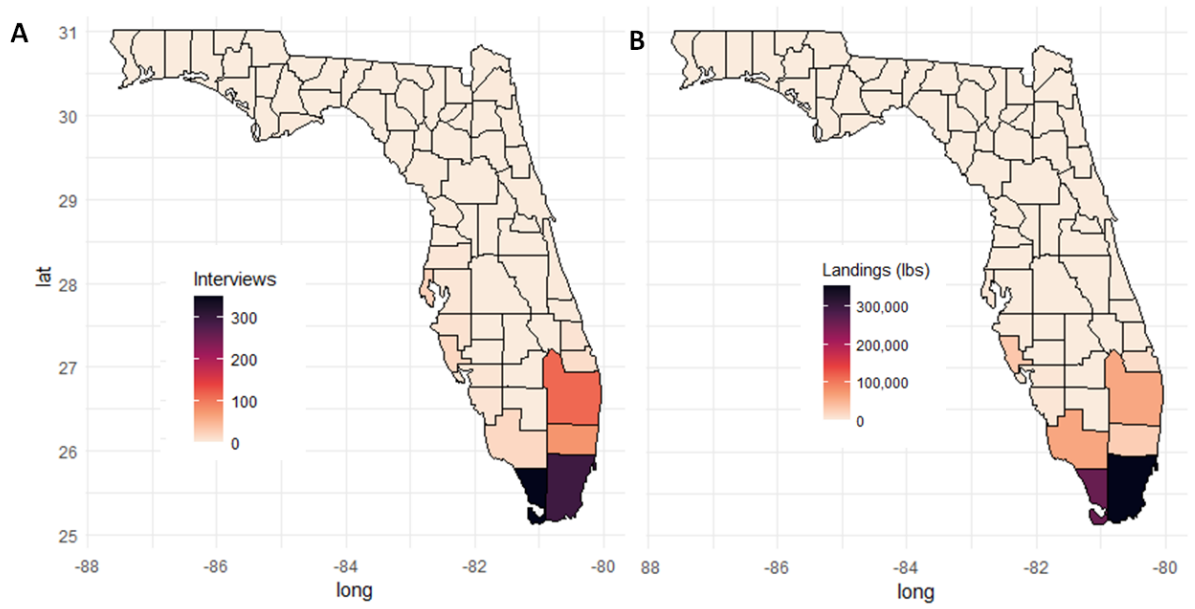

Figure 2. The spatial distribution of the number of interviews conducted where anglers caught or targeted Yellowtail Snapper (*Ocyurus chrysurus*) per year (**A**) and the spatial distribution of the amount of Yellowtail Snapper landed per year (lbs; **B**) are shown.

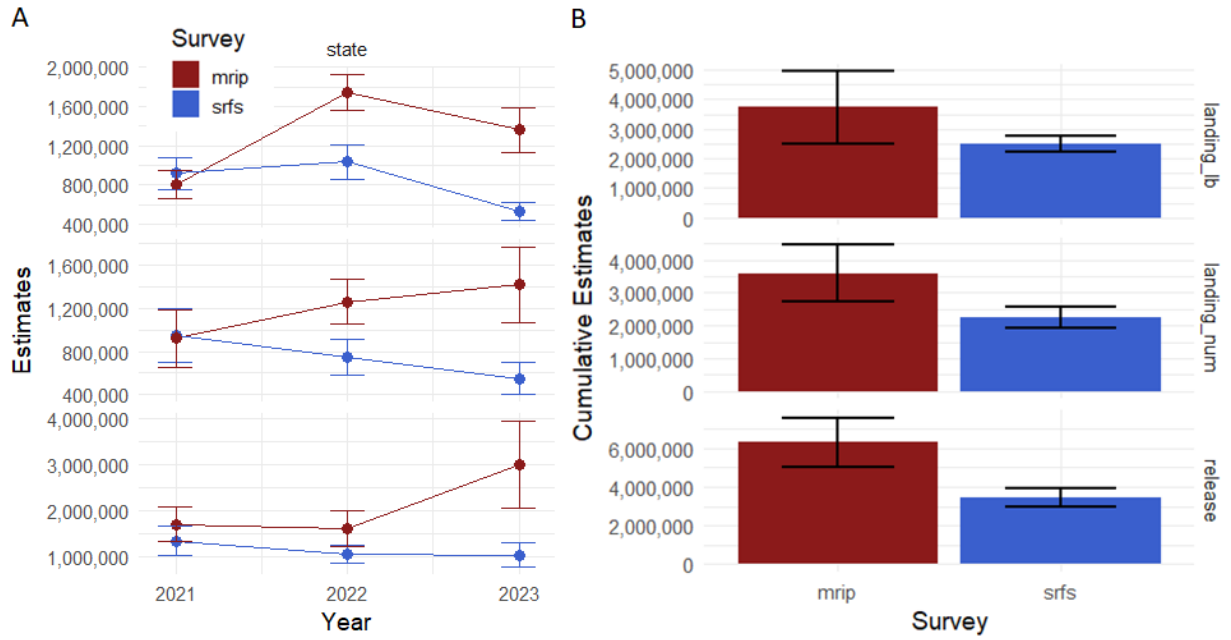

Figure 3. Estimates of landings and releases of Yellowtail Snapper (*Ocyurus chrysurus*) across years (**A**) or with all the years combined (**B**; 2021-2023) for the whole state of Florida. Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

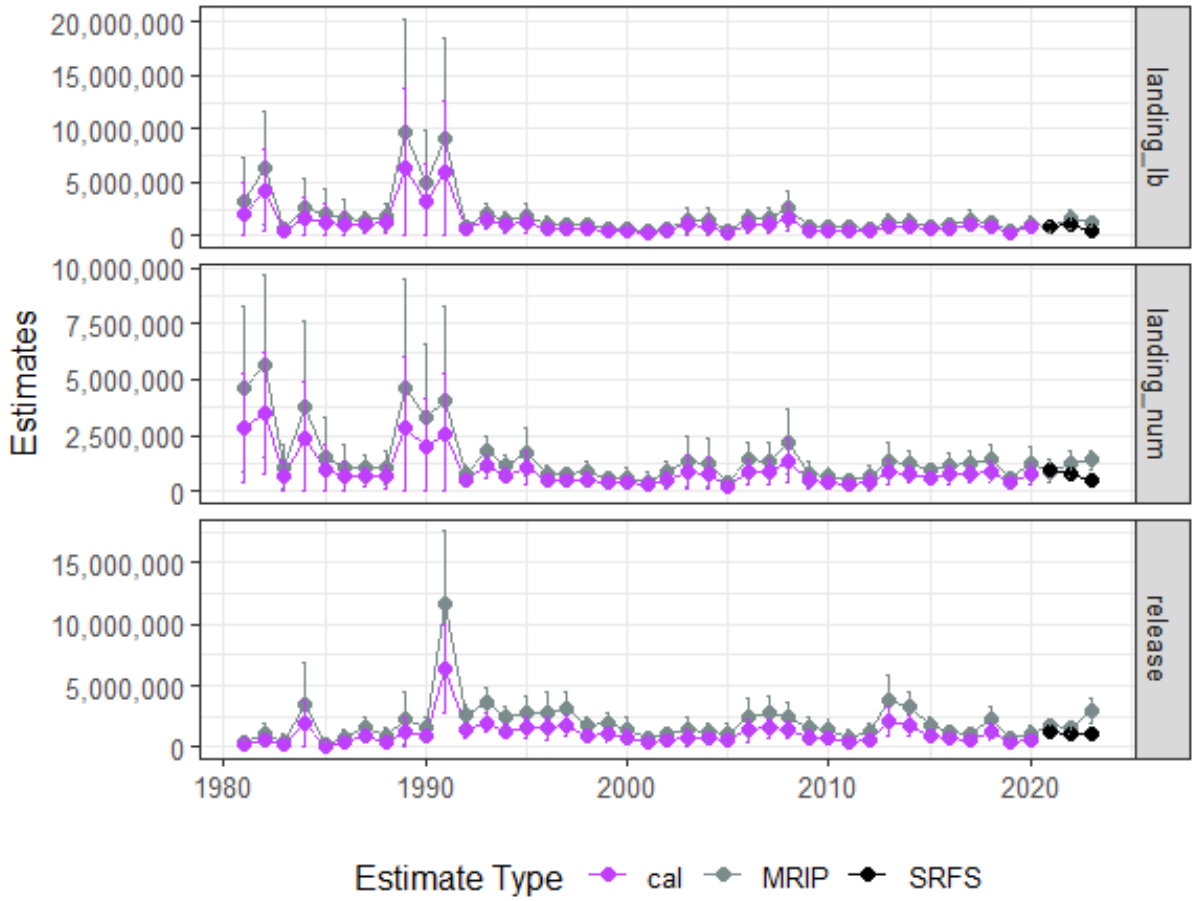

Figure 4. Yellowtail Snapper (*Ocyurus chrysurus*) hindcast estimates for the state of Florida including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip), and MRIP-FCAL time-series calibrated to SRFS currency (cal). Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits.

Table 1. Annual and summed FCAL and SRFS estimates and variances and ratios of SRFS to FCAL estimates are shown for Yellowtail Snapper (*Ocyurus chrysurus*) for the whole state of Florida, which is the stock assessment region for this species.

Estimate Type	Year	SRFS sum	SRFS variance	MRIP sum	MRIP variance	Ratio
Landing (lbs)	2021	917,031	7,048,106,989	825,672	67,914,728,918	0.665588
	2022	1,033,522	8,322,411,261	1,561,707	232,000,000,000	
	2023	530,718	2,373,123,439	1,340,561	83,169,099,893	
Landing (no. fish)	2021	953,254	16,087,828,519	921,184	61,861,514,074	0.625323
	2022	744,795	6,928,504,937	1,261,603	91,678,568,225	
	2023	550,656	5,489,422,986	1,413,282	44,940,705,067	
Release (no. fish)	2021	1,351,912	25,035,855,142	1,706,442	94,346,969,008	0.547875
	2022	1,062,409	10,842,476,048	1,619,242	58,993,754,778	
	2023	1,043,359	18,497,000,219	2,985,394	258,000,000,000	

Table 2. Historic FCAL (MRIP-FCAL) estimates, and estimates converted to SRFS currency (Calibrated: FCAL to SRFS) for Yellowtail Snapper (*Ocyurus chrysurus*) off the coast of Florida.

Year	MRIP-FCAL		Calibrated: FCAL to SRFS		MRIP-FCAL		Calibrated: FCAL to SRFS		MRIP-FCAL		Calibrated: FCAL to SRFS	
	Landings (lbs)	PSE	Landings (lbs)	PSE	Landings (no. fish)	PSE	Landings (no. fish)	PSE	Releases (no. fish)	PSE	Releases (no. fish)	PSE
1981	3,194,099	65.1	2,125,953	67.4	4,595,595	41	2,873,732	43.5	350,642	46	192,108	47.6
1982	6,398,186	42.5	4,258,554	46.0	5,627,107	37	3,518,760	39.7	1,045,387	40	572,741	41.8
1983	599,939	58.3	399,312	60.8	1,113,853	47	696,518	49.2	467,036	76	255,877	77.0
1984	2,600,609	54.1	1,730,933	56.9	3,815,675	51	2,386,030	53.0	3,536,617	49	1,937,623	50.5
1985	2,005,990	60.3	1,335,162	62.7	1,570,557	58	982,106	59.8	215,981	59	118,331	60.2
1986	1,705,294	50.1	1,135,023	53.1	1,047,088	49	654,768	51.1	767,195	41	420,327	42.8
1987	1,443,521	31	960,790	35.6	1,088,170	27	680,458	30.6	1,612,069	28	883,212	30.6
1988	1,770,553	36.3	1,178,458	40.2	1,060,088	36	662,898	38.8	892,739	42	489,109	43.8
1989	9,636,632	56.7	6,414,024	59.3	4,591,441	54	2,871,134	55.9	2,372,095	46	1,299,611	47.6
1990	4,915,868	52.2	3,271,941	55.1	3,273,719	51	2,047,132	53.0	1,564,316	28	857,049	30.6
1991	9,023,370	54	6,005,844	56.7	4,036,275	53	2,523,976	55.0	11,691,255	26	6,405,343	28.7
1992	924,445	29.3	615,299	34.1	775,816	25	485,136	28.9	2,570,452	19	1,408,286	22.6
1993	2,102,925	23.8	1,399,681	29.5	1,795,887	19	1,123,010	23.9	3,675,978	16	2,013,975	20.1
1994	1,480,469	27	985,382	32.2	1,182,063	20	739,171	24.7	2,385,943	21	1,307,198	24.3
1995	1,842,017	34.3	1,226,024	38.5	1,758,399	31	1,099,568	34.2	2,879,031	23	1,577,348	26.0
1996	1,100,620	29.6	732,559	34.3	792,490	25	495,562	28.9	2,870,471	29	1,572,658	31.5
1997	1,001,735	26	666,742	31.3	743,325	24	464,818	28.0	3,175,409	22	1,739,726	25.2
1998	1,011,241	32.6	673,070	37.0	844,331	29	527,980	32.4	1,770,389	22	969,951	25.2
1999	737,280	27.8	490,724	32.8	613,354	22	383,544	26.3	1,868,764	24	1,023,849	26.9
2000	582,917	39	387,982	42.8	640,956	36	400,805	38.8	1,485,846	33	814,057	35.2
2001	475,810	52.6	316,693	55.4	448,160	52	280,245	54.0	736,512	27	403,516	29.6
2002	734,137	32.6	488,633	37.0	841,307	31	526,089	34.2	1,093,559	25	599,133	27.8
2003	1,434,861	42	955,026	45.5	1,368,061	41	855,480	43.5	1,408,416	39	771,636	40.9
2004	1,400,347	41.7	932,054	45.3	1,294,750	41	809,637	43.5	1,329,118	26	728,190	28.7
2005	410,515	27.6	273,234	32.7	424,258	25	265,298	28.9	1,133,593	36	621,067	38.1
2006	1,566,695	30.2	1,042,773	34.9	1,401,335	29	876,287	32.4	2,519,821	31	1,380,546	33.3

Table 2 cont.

Year	MRIP-FCAL Landings (lbs)	PSE	Calibrated: FCAL to SRFS Landings (lbs)	PSE	MRIP-FCAL Landings (no. fish)	PSE	Calibrated: FCAL to SRFS Landings (no. fish)	PSE	MRIP-FCAL Releases (no. fish)	PSE	Calibrated: FCAL to SRFS Releases (no. fish)	PSE
2008	2,549,617	34.1	1,696,994	38.3	2,221,232	33	1,388,988	36.0	2,521,214	23	1,381,309	26.0
2009	792,129	32.9	527,231	37.3	813,890	31	508,944	34.2	1,535,050	33	841,015	35.2
2010	801,109	31.3	533,208	35.9	688,166	30	430,326	33.3	1,442,850	31	790,501	33.3
2011	798,114	32.4	531,215	36.8	506,206	32	316,542	35.1	768,575	39	421,083	40.9
2012	721,367	43.1	480,133	46.5	662,937	40	414,550	42.5	1,217,864	30	667,237	32.3
2013	1,226,448	35.9	816,309	39.8	1,354,854	30	847,221	33.3	3,896,488	25	2,134,787	27.8
2014	1,263,411	30.3	840,911	35.0	1,264,804	22	790,911	26.3	3,229,733	20	1,769,489	23.4
2015	942,727	23.1	627,467	29.0	941,561	19	588,780	23.9	1,787,122	18	979,119	21.7
2016	1,122,977	25	747,440	30.5	1,188,881	22	743,435	26.3	1,243,011	21	681,014	24.3
2017	1,538,435	26.8	1,023,963	32.0	1,263,207	21	789,913	25.5	1,167,080	20	639,414	23.4
2018	1,252,090	24.5	833,376	30.1	1,457,173	22	911,204	26.4	2,234,347	25	1,224,142	27.8
2019	547,186	35.6	364,200	39.6	586,532	29	366,772	32.4	709,306	20	388,611	23.4
2020	1,137,603	33.2	757,175	37.5	1,255,996	29	785,403	32.4	1,147,231	25	628,539	27.8

APPENDIX A:
TERMS OF REFERENCE

Terms of reference for the use of calibrated estimates for stock assessment and Management

May 13, 2024

The following provides guidance on species-specific simple ratio-based survey estimated calibrations for use in stock assessment and management. The Terms of Reference distinguish between review requirements for model-based approaches and other data treatments that may impact microdata as well as resulting estimates and the application of a simple ratio-based scalar to survey catch estimates. The Terms of Reference described herein pertain to the latter only.

Guidance and Procedures for the Transition Process for Modification of Recreational Fishing Catch and Effort Methods can be found in Procedural Directive 04-114-01 "Implementing Recreational Fishery Catch and Effort Survey Design Changes" which is available at: https://www.fisheries.noaa.gov/national/lawsand-policies/policy-directive-system.

The following terms of reference pertain to development and application of simple ratio-based scalars to adjust the scale of annual catch estimates produced from separate survey programs. The terms of reference provide guidance to the data provider and reviewer on documentation deemed necessary for a review of the development and application of calibrations to rescale estimates from one survey standard to the other.

1. **Provide "fit for purpose" documentation for the development of calibrations (ratio scalars), where "fit for purpose" documentation is defined as inclusive of all elements required to reproduce the calibrated time series.**
    a. Generally, documentation will include a complete description of calibration procedures, terms and time series application, datasets related to the development of calibration, source datasets (annual catch estimates) used to calculate ratios, metadata and other data sets, program code for the generation and application of calibrations.
        i. Calibrated estimates should be reproducible by a third party, using the information provided.
    b. Describe how the method is intended to be used in future years when new data become available, or how it is expected to be modified.
    c. For variance estimates, please describe the methods used, for example, Taylor's series approximation (linearization), jackknife or other replication method, other alternatives (e.g., Second or Multiple Derivative Methods, Goodman's).
    d. Evaluate whether the time series is continuous and whether the estimated variances reflect temporal variation in precision. Are there any particular biases in the time series?
2. **Identify underlying assumptions for developing and applying calibrations to the recreational catch time series of landings and discards.**

a. Assumptions should pertain to the choice of years selected, the relationship of survey estimates (for example but not limited to temporal, geographic and other coverage considerations such as fishing mode and catch type)
b. List justification of why the specific years were selected for adjustment and others were not selected.
c. For the purposes of development and application of calibrations, are estimation domains aligned spatially and temporally to provide equivalent ratio terms?
d. Describe specific assumptions related to the application of scalars to unaligned domains (e.g., assumptions related to but not limited to the application of ratio scalars to uncovered modes, catch types or effort).

3. **Identify underlying assumptions for development of variance approximations.**
    a. Assumptions should pertain to the choice and application of methods, relationship of survey estimates (dependence), the treatment of covariance terms (where applicable) in the generation of estimators
    b. Evaluate tradeoffs of the approach compared to other potential approaches with respect to the characterization of uncertainty in recreational landings in stock assessments.
4. **Is the methodology consistent with the simple ratio based approach that was presented and deemed reasonable for use in the Fifth Red Snapper Workshop (2020)?**
    a. If not, please describe modifications or deviations.
        i. The description should indicate where changes have been applied to the time series and include justification for said changes.
5. **Is the methodology broadly suitable for use in calibrating other estimate series derived from the survey program (e.g., for other species covered by the survey?)**
6. **Provide a review report summarizing the Review Panel's evaluation of the calibration methodology and documenting whether each Term of Reference was met.**