Certification Review of Florida's Proposed MRIP-SRFS Calibration Methodology for Mutton and Yellowtail Snapper

NOAA Fisheries Office of Science and Technology and the Southeast Fishery Science Center

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National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

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Subject: Florida State Reef Fish Survey Yellowtail Snapper (*Ocyurus chrysurus*) and Mutton Snapper (*Lutjanus analis*) catch estimates calibration review

In preparation for the upcoming SEDAR assessments for Yellowtail Snapper and Mutton Snapper, the Florida Fish and Wildlife Commission has developed ratio-based calibration to convert federal survey estimates of catch to State Reef Fish Survey (SRFS) equivalents throughout the historical time series prior to the implementation of SRFS.

A review of these methods, coordinated by NOAA Fisheries Office of Science and Technology (OST), was completed in June 2024. Findings were subsequently evaluated by NOAA Fisheries OST and the Southeast Fisheries Science Center (SEFSC) staff. Reviewers found the proposed methods reasonable and did not identify any major concerns that would preclude the use of the calibrations for their intended purpose. In email consultation between FWC and OST, FWC has addressed a documentation issue identified by one of the reviewers; communicated that they will implement a key reviewer recommendation to develop a plan for re-evaluating the assumption of a constant ratio when additional data are available; and confirmed that to the best of their knowledge, the calibrations provided by their agency were correctly calculated as presented. SEFSC confirmed that the stock assessment could proceed using the SRFS calibrated estimates.

Attached supporting documentation for consideration by the Councils' SSCs includes:

- Collated terms of reference for the review of calibrations and completed reviewer reports;
- FWC methodology report: “A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Mutton Snapper (*Lutjanus analis*) and Yellowtail Snapper (*Ocyurus chrysurus*)”
- 2022 Transition Plan for Gulf State Surveys

Certification Review Report for Florida's Proposed MRIP-SRFS Calibration Methodology for Mutton and Yellowtail Snapper

Lynne Stokes, MRIP Consultant
June 19, 2024

To prepare this report, I reviewed the materials provided by the Florida team (Ramsay, Cross, Shea, and Sauls), including the document describing their methodology ("A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Mutton Snapper (*Lutjanus analis*) and Yellowtail Snapper (*Ocyurus chrysurus*)," dated June 11, 2024) and associated documentation. I also reviewed summaries from the calibration workshop for Red Snapper and the review of a similar calibration proposed by Florida's team for Gag (from May of 2022).

In general, I found the methodology to be clearly explained and reasonable. Most of the suggestions for improvement from previous reviews of similar ratio-based calibrations have been implemented. In the remainder of this report, I will respond to each of the questions in the terms of reference.

1. **Provide "fit for purpose" documentation for the development of calibrations (ratio scalars).**
    a. *Calibrated estimates should be reproducible by a third party, using the information provided.*

The documentation is complete. The authors have provided both the code for calculation of the proposed ratios and their estimated variances, as well as the mathematical expressions for them (in Appendix C). They have also provided numerical values of the component parts for each species x area x variable estimator and its estimated variance.

   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.*

The report notes that future data will be available since the two data collection programs will continue to overlap. However, the report states only that the calibration ratio "may be routinely updated and shared as needed," but no detail is provided. I believe that will be important to consider, since the three-year period from which the ratios are computed is shorter than other similar calibration procedures that have been previously approved, as the authors note. Also, most of the estimated ratios are quite variable from year to year.

The table below is an edited version of Table 2 showing calibration ratios for Yellowtail Snapper. I have amended the ratio column to show *annual* calibration factors and have added a column to show the (conservative) SE's calculated from [c3]. Note that the 2023 calibration factor is quite different from the other two years for all three variables. Five of six hypothesis tests for a common calibration ratio between 2023 and either 2021 or 2022 are significant (at $\alpha = .05$) for all variables/years[1]. We know that the variance estimates may not reflect all the uncertainty in either the SRFS or MRIP sum, since many non-sampling errors are unaccounted for in the variance estimate. Thus it is possible that the significant differences between years do not contradict the assumption of a common calibration ratio. Still, it would be prudent to revisit the calibration ratio estimation when a longer time series is available, and to have a plan about how to determine if a single calibration factor is justified, or if not, how to incorporate the additional variability.

Amended Table 2: Annual and 3-year Calibration factors for Yellowtail Snapper

Year	SRFS sum	SRFS variance	MRIP sum	MRIP variance	Ratio	se(Ratio)
			Landings (lbs)			
2021	917,031	7,048,106,989	809,176	5,344,546,867	1.13	0.15
2022	1,033,522	8,322,411,261	1,748,683	8,729,285,445	0.59	0.06
2023	530,718	2,373,123,439	1,360,786	13,078,779,910	0.39	0.05
Total	2,481,270	17,743,641,689	3,918,645	27,152,612,222	0.63	0.04
			Landings (no fish)			
2021	953,254	16,087,828,519	921,182	18,997,509,844	1.03	0.21
2022	744,795	6,928,504,937	1,261,604	11,257,247,897	0.59	0.08
2023	550,656	5,489,422,986	1,419,984	31,528,741,205	0.39	0.07
Total	2,248,705	28,505,756,441	3,602,770	61,783,498,946	0.62	0.06
			Releases (no fish)			
2021	1,351,912	25,035,855,142	1,706,444	37,556,854,689	0.79	0.13
2022	1,062,409	10,842,476,048	1,619,241	40,304,532,815	0.66	0.10
2023	1,043,359	18,497,000,219	3,010,455	235,432,332,669	0.35	0.07
Total	3,457,681	54,375,331,409	6,336,140	313,293,720,173	0.55	0.06

c. *For variance estimates, please describe the methods used.*

The authors have explained the type of variance estimators they have implemented: the delta method for ratio and Goodman's method of variance estimation for a product of independent random variables[2].

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[1] The exception is for 2023 vs. 2022 Landings in number of fish.

[2] In Appendix C, the authors displayed what they described as the "approximate variance" and delta method variance estimates and showed empirically that they are equal. That is unnecessary because the expression they display in [c2] actually *is* the delta method variance, and when substituted in Goodman's exact expression, it is the delta method estimator for the variance of the backcast total.

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?*

The variance estimator estimates sampling variance only. It does not explicitly incorporate temporal variation, as the model for the calibration method assumes a constant calibration ratio.

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)*

The report states that a constant calibration factor was assumed over time for each species, due to the fact that the data were not sufficient to support estimation of factors by wave. However, separate calibration factors were estimated for geographical areas defined by stock boundaries for Mutton Snapper, as requested by analysts from SEDAR 79. The report includes an appendix describing a sensitivity analysis conducted to see if finer geographies produced different results. They found that the results were similar to the proposed method using coarser boundaries. Therefore, a single calibration factor for geography was proposed for Yellowtail and two for Mutton Snapper.

b. *List justification of why the specific years were selected for adjustment and others were not selected.*

The report did provide this information. It noted the SRFS has included the two species that are the subject of this report only since 2020, so it was not possible to base a calibration on a longer time series. Further, the first six months of the data collection period were deemed insufficient due to the difficulty of data collection during the global pandemic.

c. *For the purposes of development and application of calibrations, are estimation domains aligned spatially and temporally to provide equivalent ratio terms?*

Yes.

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).*

N/A

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), etc.*

The authors used the delta method to estimate the variance of the backcast totals of catch and discards. The variance for the ratio portion of this product was calculated as though the numerator and denominator (SRFS and MRIP estimator sums) are independent. The authors noted that the assumption of independence is likely incorrect since the two estimators share some data, but explained that this substitution for the unknown correlation will at least provide a conservative estimate of variance (i.e., one with an upward bias). It was also the recommended approach made in a previous review for a similar calibration.

    b. *Evaluate tradeoffs of the approach compared to other potential approaches with respect to the characterization of uncertainty in recreational landings in stock assessments.*

The delta method approximation for estimators of ratios is standard methodology, as is the (exact) method of Goodman for independent variables. It is simple and easy to implement. The only concern is the previously mentioned problem with an unaccounted for correlation between SRFS and MRIP estimators. There is no obvious method for easy assessment of this correlation due to an overlapping subsample whose size is likely to change from period to period. I believe the conservative assumption of a 0 correlation is a reasonable workaround for this problem. In the present implementation, the estimated standard errors, even if biased upward, provide comfortably narrow confidence intervals for the estimated ratios in most cases.

As previously mentioned, there is some evidence that the calibration ratio is not constant over time. If the lack of constancy can be attributed to some observable cause (e.g., season), then it may be that with additional data, a more tailored calibration ratio would be possible. Alternatively, a method that incorporates the temporal variability (rather than only sampling variability) into the variance estimate may provide a more realistic assessment of the uncertainty in the calibration ratio. One way to approach this would be to add a between-year variance component to the expression that now includes only the sum of the sampling variance within years to the expression for the ratio variance. This would require more years of data than the three currently available to ensure a stable estimate of this component.

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)?**

Yes.

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?)**

Yes.

6. **Provide a review report summarizing the Review Panel's evaluation of the calibration methodology and documenting whether each Term of Reference was met.**

The report is clear and well-written[3], and the method is well-documented and is basically the same as methods approved for calibrating other species. However, the time series in this case is not as long, so that there is less ability to observe whether temporal differences in the calibration ratio are persistent and indicate an unaccounted-for source of variability. I recommend that a plan for re-evaluating the assumption of a constant ratio be required, when sufficient data are available. If a modification to either the estimate or its variance is needed at that time, the current method should be updated.

[3] Three minor errors noted in the manuscript are the following: (i) The indices for the summation sign in equations [1] and [2] are incorrect. They should be *y,w,a*; (ii) The authors refer to independent random variables as having "0% correlation" on several pages of the report. The units of correlation are not %'s, and so the % should be dropped; (iii) The subscripts in [c3] and [c4] should be SRFS instead of GRFS.

Review of A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Mutton Snapper (*Lutjanus analis*) and Yellowtail Snapper (*Ocyurus chrysurus*)

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The following review evaluates the report "A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Mutton Snapper (*Lutjanus analis*) and Yellowtail Snapper (*Ocyurus chrysurus*)" and supporting documents against the Terms of reference for the use of calibrated estimates for stock assessment and Management (Appendix A). Overall the documentations meets the requirements outlines in the TOR except 1.b. where I was unable to reproduce the ratios presented in Table 1. **This discrepancy should be checked**.

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.*

Sufficient documentation was provided to fully understand the calibration procedures implemented. A minor clarification on terms is needed for equation 4 the designation *hind* is not clearly defined. I have assumed this is referring to the hindcasting but this should be indicated. I was not able to reproduce the ratios presented in Table 1 with code and data provided. It is unclear why. For example, in table 1 for Mutton Snapper in the atl region landing_lb, I am able to obtain the same total SRFS sum over years of 1,386,026 and MRIP sum of 2,575,371 from the *forratio* table generated by the R code and data files provided. This results in a ratio of 0.5381850 = 1,386,026 / 2,575,371. The ratio in the table is 0.58 and it is not clear how this value was generated. **This discrepancy needs to be checked as well as the potential cascading effects on the hind casting and variance estimates**. Documentation indicates that the methods provided are to be used for the hindcasting of MRIP prior to the SRFS survey only and will not be used for future years. The delta method was used to generate variance estimates and this is a Taylor's series approximation. As identified by the authors, 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 were used to create a single ratio for hindcasting. The data in this time period is continuous but was aggregated as the authors felt data at a finer spatial and temporal scale would be contrary to each surveys design.

2. *Identify underlying assumptions for developing and applying calibrations to the recreational catch time series of landings and discards.*

The time period selected represents a period of overlap between the SFRS and MRIP surveys once the SFRS survey had been expanded and following an initial period where the data was influenced by the global COVID pandemic. The data in this time period is continuous but was aggregated to larger areas over all time periods as the authors felt data at a finer spatial and temporal scale would be contrary to each surveys design. The time series are not fully independent of one another. However, following the recommendation of statistical consultants, the covariation between the data sets was assumed to be 0. If the correlation between the surveys is high the variances estimated from the hind casting would be smaller. For the areas and aggregated time periods the data sets are aligned.

3. *Identify underlying assumptions for development of variance approximations.*

The time series are not fully independent of one another. However, following the recommendation of statistical consultants, the covariation between the data sets was assumed to be 0. If the correlation between the surveys is high the variances estimated from the hind casting would be smaller. The delta method was used to generate variance estimates and this is a Taylor's series approximation and the authors demonstrate an exact match with Goodman's approach. This is a suitable approach to estimating the variance.

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)?*

Yes, the method presented is a simple ratio-based approach and would fit with the guidance provided in the Fifth Red Snapper Workshop (2020)

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?)*

Given the generality of the method provided it could be applied to other time series.

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.
    b. Calibrated estimates should be reproducible by a third party, using the information provided.
    c. 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.
    d. 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).

   e. 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.
   b. 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.**

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

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In preparation for

Peer Review

For potential use in

SEDAR 79 Southeastern U.S. Mutton Snapper

&

SEDAR 96 Southeastern U.S. Yellowtail Snapper

June 11, 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 statistical consultants and NOAA Fisheries. 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*) and Mutton Snapper (*Lutjanus analis*) are not frequently targeted by recreational anglers along the Gulf coast of Florida north of Monroe County (Fig. 2 & 3), 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, and 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, 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, which require long-term time-series of landings and discards on an annual scale that are measured consistently through time. For this, 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 Mutton Snapper and 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 Mutton Snapper and 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 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 variable years and waves 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. The below methods were completed separately for two species that are currently undergoing stock assessments: Yellowtail Snapper and Mutton Snapper. Separate conversion factors are also provided for landings in numbers, landings in pounds, and releases in numbers. As requested by assessment analysts for SEDAR 79, recreational estimates for Mutton Snapper were calculated and calibrated separately for two stock boundaries: all Gulf coast counties and both coasts of Monroe County, and all Atlantic coast counties excluding Monroe County. This is identical to how MRIP produces estimates, with both coasts of Monroe County included in Gulf estimates. Estimates for Yellowtail Snapper were calculated and calibrated for the whole state of Florida, which is considered the Southeastern U.S. stock boundary for SEDAR 96. For this calibration, MRIP estimates from the Gulf and Atlantic coasts of Florida were also combined to generate identical spatial distributions and align estimation domains.

Given the limited spatial distributions for these species, we also tested the utility of using smaller sub-region scales to improve calibration methods. When the calibrated sub-region estimates were aggregated, it was determined that this method generated results similar to the overall aggregated calibration method presented here (see appendix B).

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 combination of species (*s*) and variable (*v*: number landed, pounds landed, number released) [1, 2].

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

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

This resulted in 9 pairs of SRFS and FCAL sums (3 variables, 2 species, 2 regions for Mutton Snapper and 1 for Yellowtail Snapper; Tables 1 & 2). 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].

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

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 ($\hat{V}(\hat{R}_{s,v})$) 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. The delta method provides identical results to an approximation of the ratio's variance assuming 0% correlation (Cochran 1977; see appendix C).

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

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

Variance was once again approximated using the delta method with 0% correlation. These results are identical to using Goodman's formula (Goodman 1960) to calculate variance with 0% correlation (see appendix C).

Findings and Conclusions

For the years in which the SRFS and MRIP overlap, annual Mutton Snapper and 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&2. Yearly and average annual estimates are shown in Figures 3&4. The ratios in the Gulf with the Keys were generally lower (range 0.19-0.44) than the ratios in the Atlantic (range 0.55-0.58). The ratios for statewide Yellowtail Snapper estimates ranged from 0.55-0.63 and were higher for landings than releases. Also, the median PSE values for the calibrated estimates were 24% and 20% for Mutton Snapper and Yellowtail Snapper, respectively. Calibrated estimates for Mutton Snapper in the Gulf with the Keys (Fig. 6, Table 3), in the Atlantic Ocean (Fig. 7, Table 4), and for Yellowtail Snapper in the whole state (Fig. 8, Table 5) are provided.

The purpose of this report was to establish an accepted method for producing converted FCAL estimates for potential use in future stock assessments and fisheries management for Mutton Snapper and Yellowtail Snapper species in the southeastern US. Results presented in this report include data collected over 36 months, which is a shorter time span than was used in the previous, approved method in the Gulf (Cross et al. 2020). However, as the two surveys continue to run concurrently in Florida, the calibration factors may be routinely updated and shared as needed.

This report was generated specifically to address a MRIP-SRFS calibration of Mutton Snapper and Yellowtail Snapper in the Southeastern US. However, this method closely matches the methodology that has been approved for use to calibrate the SRFS survey for the original GRFS reef species in the Gulf (Cross et al. 2020). If this method passes peer review, we expect that this methodology will be considered acceptable as a generalized SRFS-MRIP calibration procedure for all SRFS species statewide.

References

Cochran, W. G. 1977. Sampling Techniques: 3rd edition. John Wiley & Sons, Inc. pg. 153.

Cross, T. A., C.P. Shea, and B. Sauls. 2020. A ratio-based method for calibrating GRFS and MRIP-FCAL estimates of total landings (numbers and pounds of fish), and releases (numbers of fish). Florida Fish and Wildlife Conservation Commission. Report prepared for the Gulf of Mexico Fishery Management Council Scientific and Statistical Committee, August 11-12, 2020. https://gulfcouncil.org/wp-content/uploads/2020_08-Stg-RF-Eco-Socio.zip

Foster, J. 2018. Integration of GRFS Intercept and APAIS. Presentation given at the Florida Gulf Reef Fish Survey Review Workshop. February 6, 2018, St. Petersburg, FL. Available on request.

Gulf of Mexico Fishery Management Council (GMFMC). 2022. Standing, Reef Fish, Shrimp, and Socioeconomic SSC Meeting Summary. July 7-8, 2022. https://gulfcouncil.org/wp-content/uploads/Gulf-Standing-RF-Socio-and-Eco-SSC-Summary-July-2022-07232022.pdf

Gulf States Marine Fisheries Commission (GSMFC) and NOAA Fisheries. 2020. GSMFC-NOAA Fisheries Workshop on Red Snapper. August 5, 2020. https://gulfcouncil.org/wp-content/uploads/B-8b-Gulf_Calibration_Wrkshp_report_2020_v1.21.pdf

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 15:708–713. https://www.cs.cmu.edu/~cga/var/2281592.pdf

Jackson, C. H. 2011. Multi-State Models for Panel Data: The msm Package for R. Journal of Statistical Software 38(8): 1-29. http://www.jstatsoft.org/v38/i08/ See also: https://cran.r-project.org/web/packages/msm/msm.pdf

NOAA Fisheries, 2019. Recommended Use of the Current Gulf of Mexico Surveys of Marine Recreational Fishing in Stock Assessments. Office of Science and Technology, Southeast Fisheries Science Center, Southeast Regional Office. July 2019.

NOAA Fisheries, 2022. Florida State Reef Fish Survey gag (*Mycteroperca microlepis*) catch estimates calibration review. Office of Science and Technology, Southeast Fisheries Science Center, Southeast Regional Office. July 2022.

R Core Team. 2023. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. http://www.R-project.org/

Stokes, L., G. Lesser, and J. Opsomer. 2020. Gulf States Marine Fisheries Commission and Science and Technology Calibration Workshop for Red Snapper. August 2020.

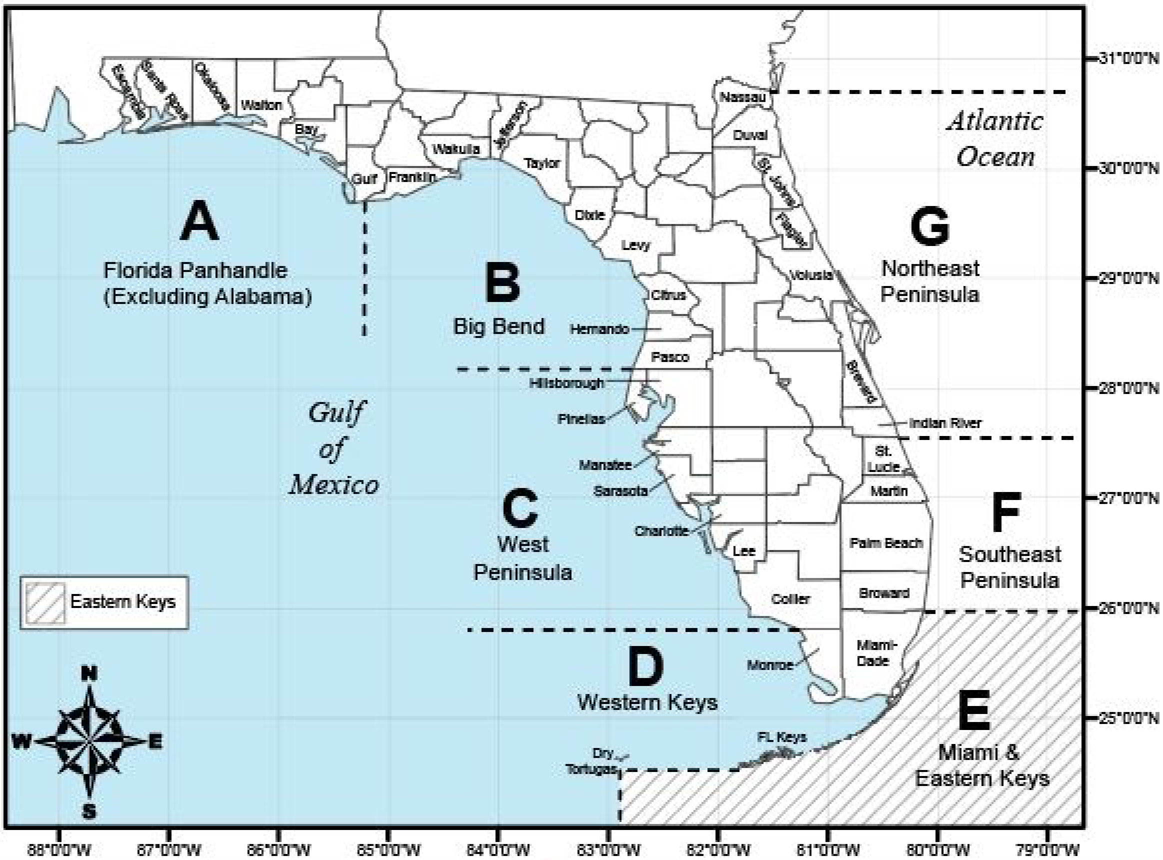

Figure 1. Regions of the state of Florida as designated by the State Reef Fish Survey (SRFS). The Gulf Reef Fish Survey (GRFS) which ran from May 2015-June 2020 covered regions A-C. The expansion to the SRFS included the remaining regions, which is also when Hogfish (*Lachnolaimus maximus*), Mutton Snapper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

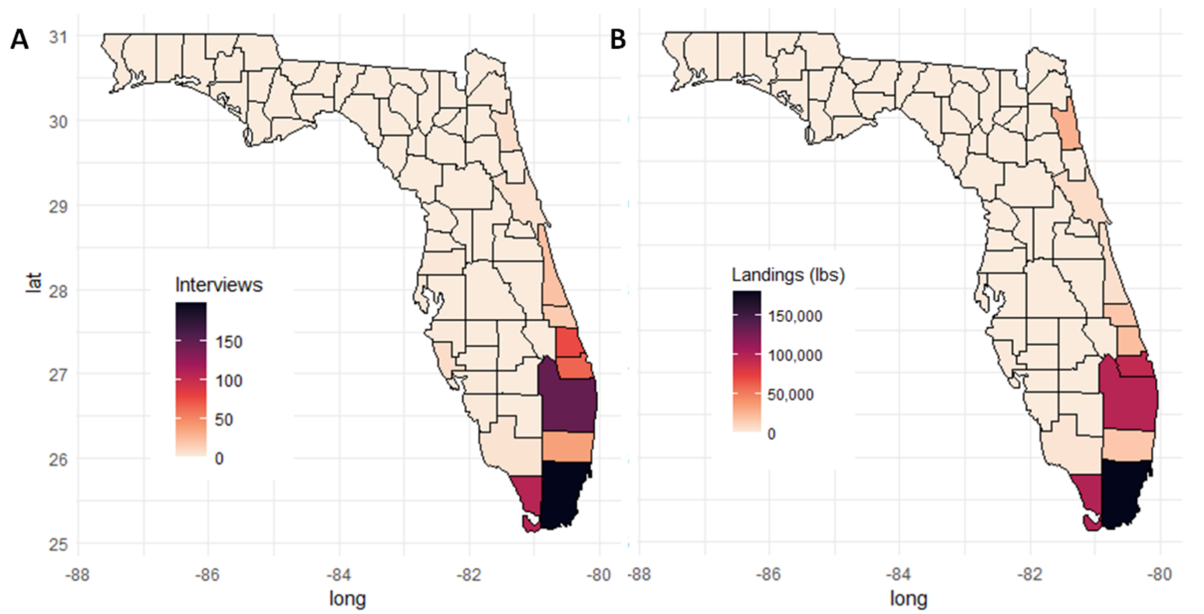

Figure 2. The spatial distribution of the number of interviews conducted where anglers caught or targeted Mutton Snapper (*Lutjanus analis*) per year (**A**) and the spatial distribution of the amount of Mutton Snapper landed per year (lbs; **B**) are shown.

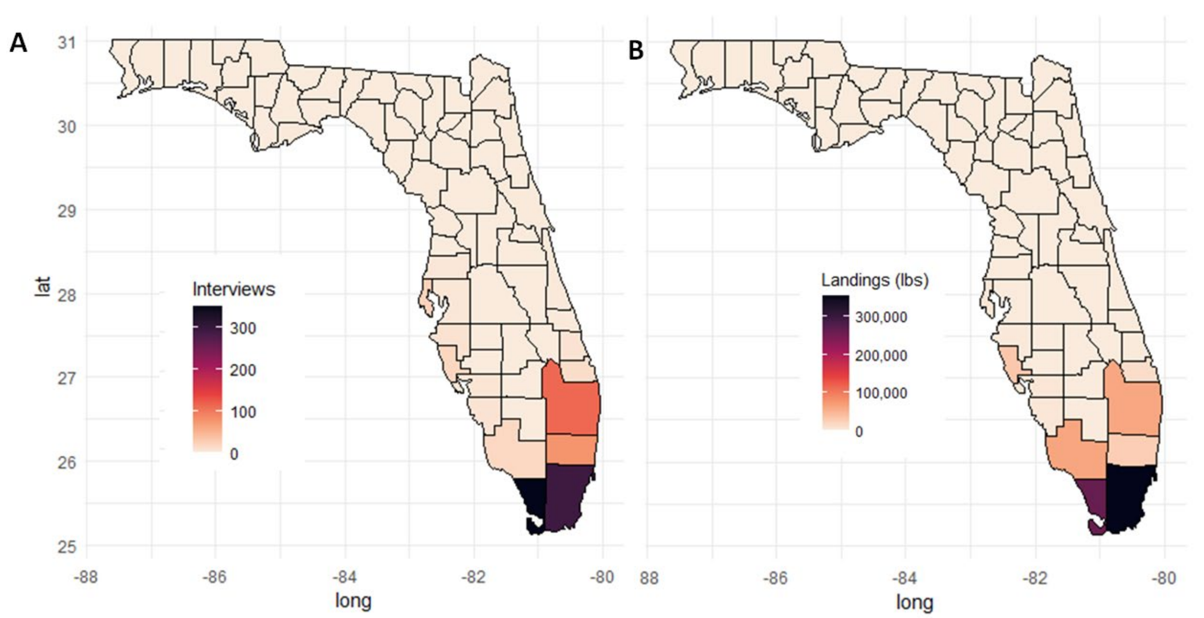

Figure 3. The spatial distribution of the number of interviews conducted where anglers caught or targeted Yellowtail Snapper (*Ocyurus chrysurus*) per year (**A**) and the spatial distribution of the amount of Yellowtail Snapper landed per year (lbs; **B**) are shown.

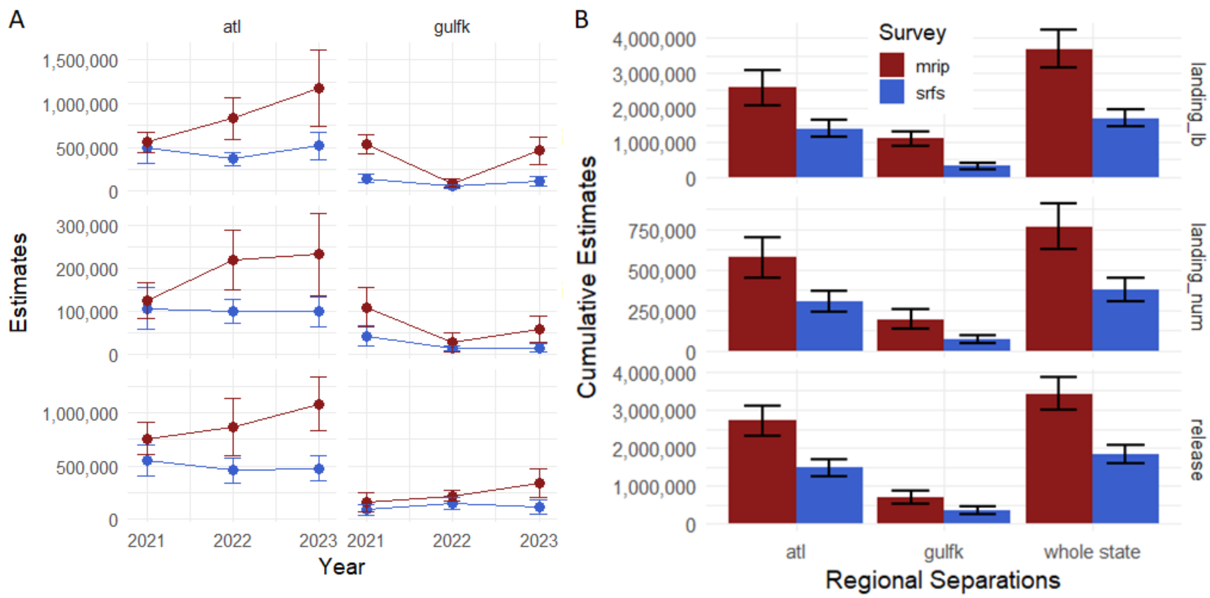

Figure 4. Estimates of landings and releases of Mutton Snapper (*Lutjanus analis*) across years (**A**) or with all the years combined (**B**; 2021-2023). The stock assessment regions are all Gulf coast counties plus both coasts of Monroe County (gulfk) and all Atlantic coast counties excluding Monroe (atl). Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

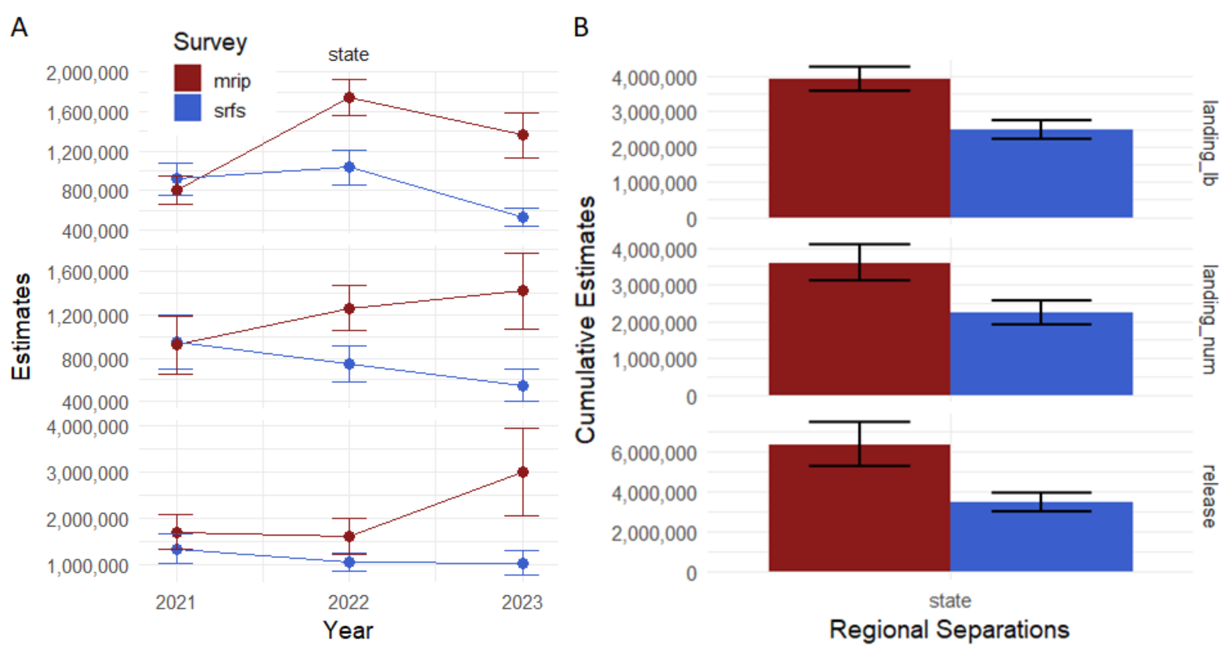

Figure 5. Estimates of landings and releases of Yellowtail Snapper (*Ocyurus chrysurus*) across years (**A**) or with all the years combined (**B**; 2021-2023) for the whole state of Florida. Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

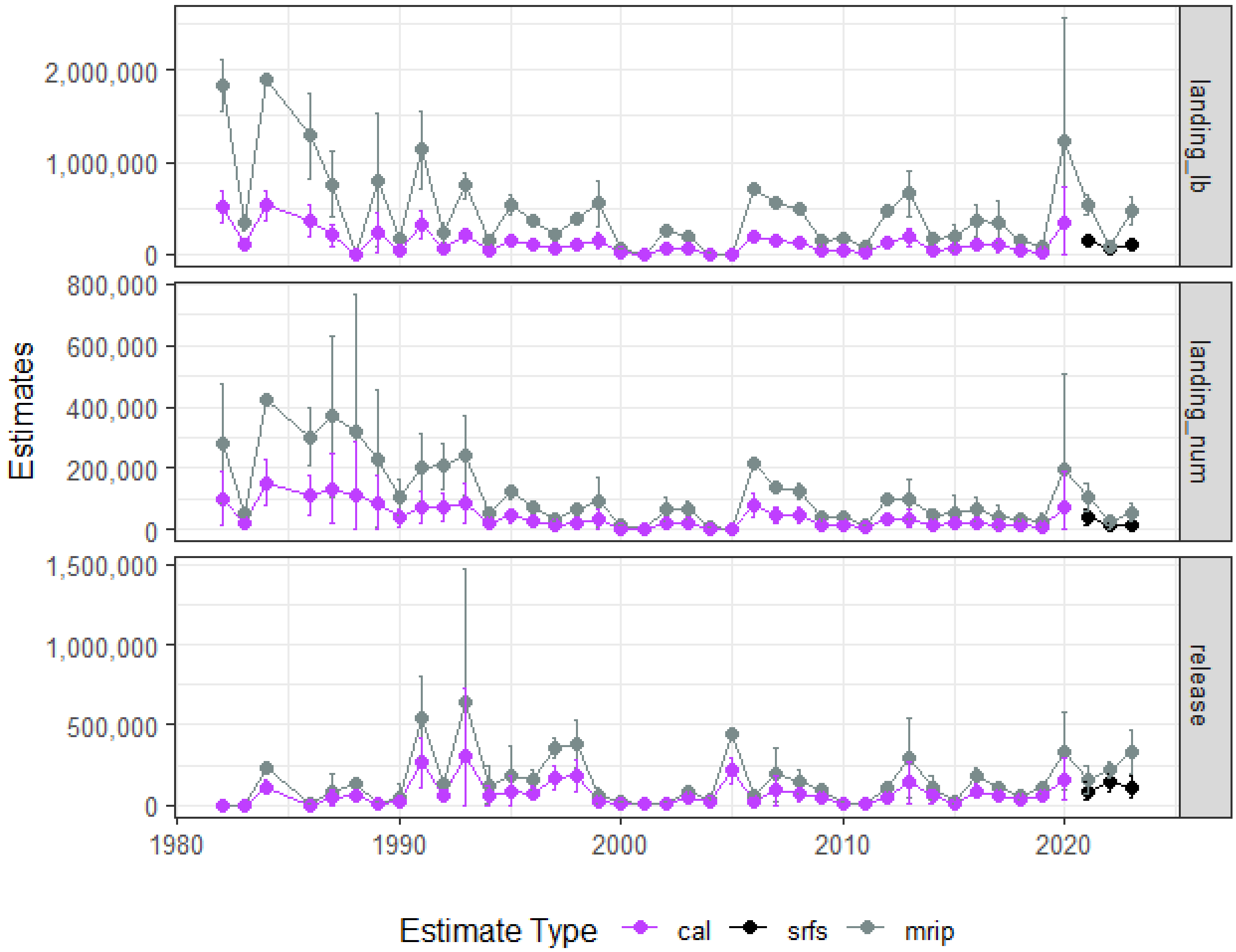

Figure 6. Mutton Snapper (*Lutjanus analis*) estimates for the Gulf of Mexico including both coasts of the Keys including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip), and MRIP-FCAL time-series calibrated to SRFS currency (cal). Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limit.

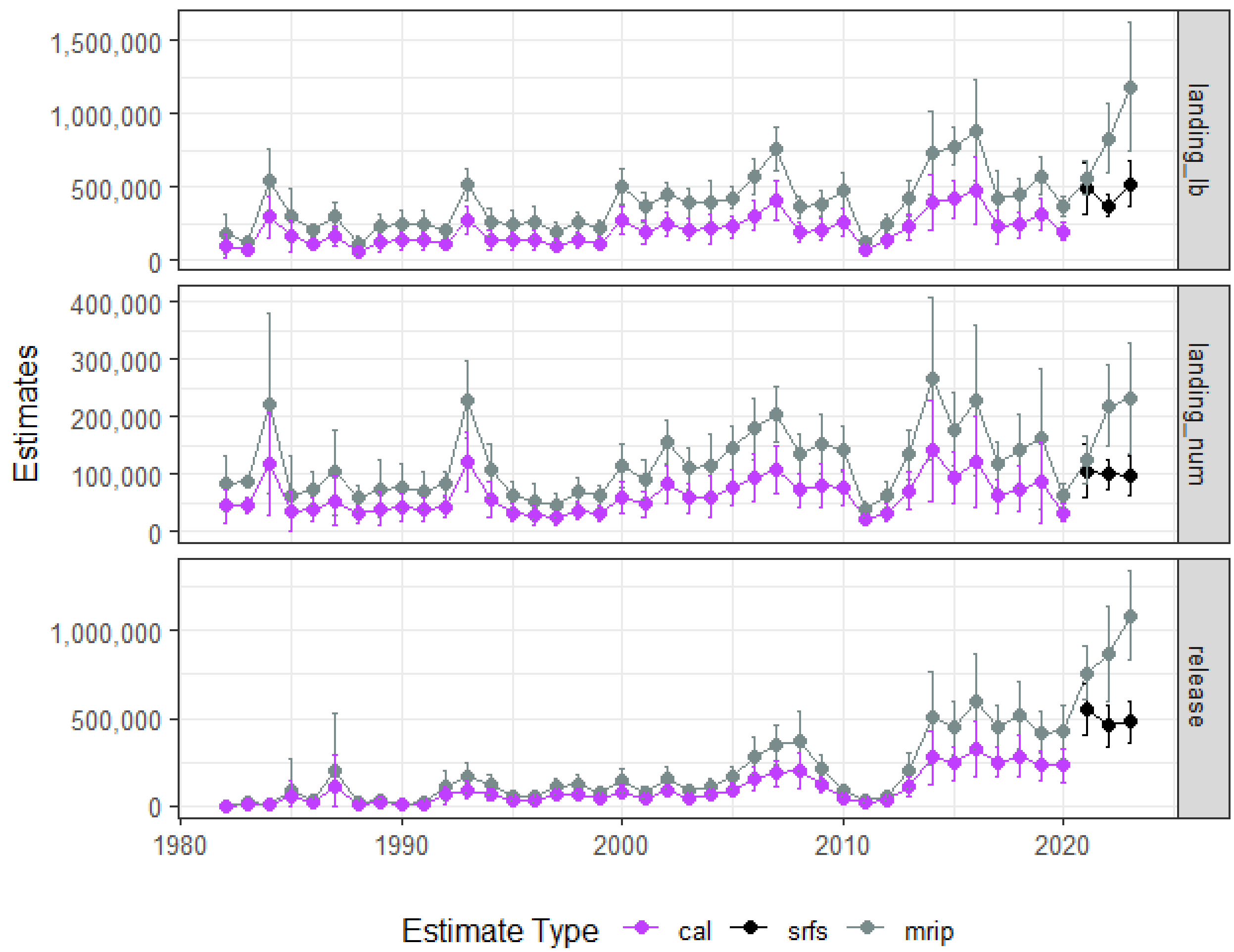

Figure 7. Mutton Snapper (*Lutjanus analis*) hindcast estimates for the Atlantic Ocean including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip), and MRIP-FCAL time-series calibrated to SRFS currency (cal). Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limit.

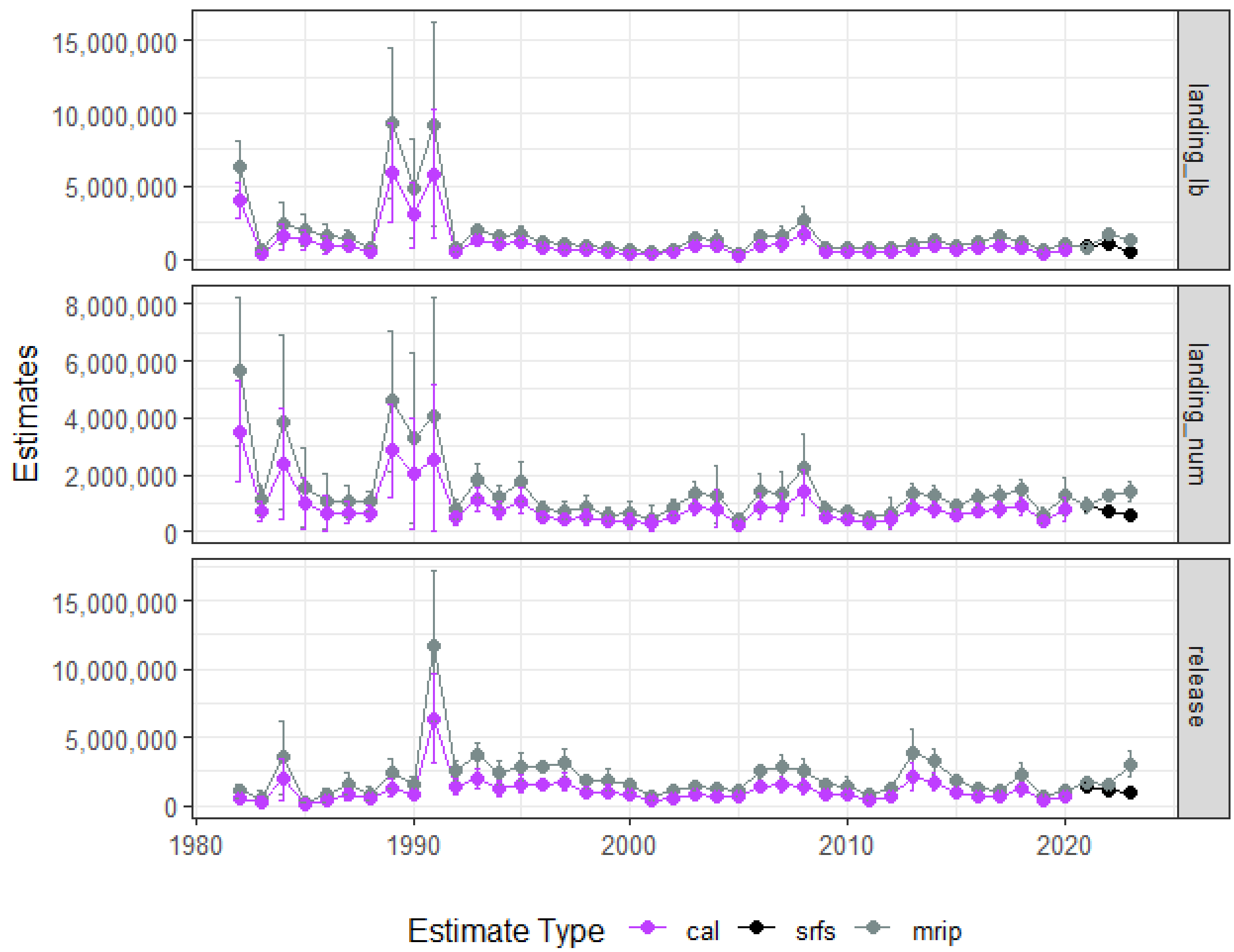

Figure 8. Yellowtail Snapper (*Ocyurus chrysurus*) hindcast estimates for the state of Florida including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip), and MRIP-FCAL time-series calibrated to SRFS currency (cal). Landings in pounds (landing_lb), landings in numbers 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 Mutton Snapper (*Lutjanus analis*) with the state broken down by assessment region. Assessment regions are all Gulf coast counties plus both coasts of Monroe County (gulfk), and all Atlantic coast counties excluding Monroe County (atl).

Estimate Type	Region	Year	SRFS sum	SRFS variance	MRIP sum	MRIP variance	Ratio
Landings (lbs)	atl	2021	495,094	7,997,594,898	559,236	3,526,866,043	0.54
		2022	371,306	1,526,526,092	832,459	14,442,400,476	
		2023	519,626	6,346,192,103	1,183,676	49,342,545,590	
		Total	1,386,026	15,870,313,093	2,575,371	67,311,812,109	
	gulfk	2021	146,585	663,406,530	540,582	2,888,628,503	0.28
		2022	54,727	102,455,906	94,349	511,096,872	
		2023	109,041	785,055,311	468,202	6,378,331,927	
		Total	310,353	1,550,917,747	1,103,133	9,778,057,302	
Landings (no. fish)	atl	2021	106,055	596,176,848	124,009	436,433,373	0.53
		2022	99,519	190,692,545	218,823	1,290,159,473	
		2023	98,765	311,993,833	231,785	2,417,098,863	
		Total	304,339	1,098,863,226	574,618	4,143,691,709	
	gulfk	2021	42,227	154,072,585	108,345	545,889,785	0.36
		2022	13,529	10,415,543	27,709	133,011,414	
		2023	14,478	24,964,659	57,194	257,808,074	
		Total	70,234	189,452,787	193,247	936,709,273	
Releases (no. fish)	atl	2021	549,434	5,588,414,429	759,708	5,769,523,181	0.55
		2022	457,746	3,724,392,053	868,277	18,848,059,692	
		2023	477,399	3,492,037,554	1,086,346	16,863,167,508	
		Total	1,484,579	12,804,844,036	2,714,331	41,480,750,381	
	gulfk	2021	86,574	765,777,171	154,770	2,108,304,728	0.48
		2022	142,420	809,117,529	219,796	568,918,150	
		2023	111,997	1,164,325,456	334,097	4,783,581,224	
		Total	340,991	2,739,220,156	708,663	7,460,804,102	

Table 2. 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
Landings (lbs)	2021	917,031	7,048,106,989	809,176	5,344,546,867	0.63
	2022	1,033,522	8,322,411,261	1,748,683	8,729,285,445	
	2023	530,718	2,373,123,439	1,360,786	13,078,779,910	
	Total	2,481,270	17,743,641,689	3,918,645	27,152,612,222	
Landings (no. fish)	2021	953,254	16,087,828,519	921,182	18,997,509,844	0.62
	2022	744,795	6,928,504,937	1,261,604	11,257,247,897	
	2023	550,656	5,489,422,986	1,419,984	31,528,741,205	
	Total	2,248,705	28,505,756,441	3,602,770	61,783,498,946	
Releases (no. fish)	2021	1,351,912	25,035,855,142	1,706,444	37,556,854,689	0.55
	2022	1,062,409	10,842,476,048	1,619,241	40,304,532,815	
	2023	1,043,359	18,497,000,219	3,010,455	235,432,332,669	
	Total	3,457,681	54,375,331,409	6,336,140	313,293,720,173	

Table 3. Historic FCAL (MRIP-FCAL) estimates and estimates converted to SRFS currency (Calibrated: FCAL to SRFS) for Mutton Snapper (*Lutjanus analis*) for the Gulf of Mexico including the Keys.

	MRIP - FCAL		Calibrated: FCAL to SRFS		MRIP - FCAL		Calibrated: FCAL to SRFS		MRIP - FCAL		Calibrated: FCAL to SRFS	
Year	Landings (lbs)	PSE	Landings (lbs)	PSE	Landings (no. fish)	PSE	Landings (no. fish)	PSE	Releases (no. fish)	PSE	Releases (no. fish)	PSE
1982	1,822,713	7.9	512,798	17.4	281,404	35.0	102,274	43.1	0	NA	0	NA
1983	344,634	13.8	96,959	20.8	51,106	12.6	18,574	28.2	0	NA	0	NA
1984	1,885,895	0.0	530,574	15.5	421,883	0.0	153,330	25.2	234,463	0.0	112,818	19.6
1985	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1986	1,283,410	18.1	361,072	23.9	301,663	16.1	109,637	29.9	3,472	0.0	1,671	19.6
1987	758,770	23.8	213,471	28.4	368,433	36.0	133,904	43.9	86,035	63.7	41,398	66.6
1988	7,807	0.0	2,196	15.5	316,636	72.7	115,079	77.0	133,090	2.7	64,040	19.8
1989	805,275	45.8	226,554	48.3	229,681	49.6	83,476	55.6	9,144	100.0	4,400	101.9
1990	163,286	11.9	45,939	19.6	106,217	29.3	38,604	38.7	48,582	82.4	23,376	84.7
1991	1,135,655	19.0	319,503	24.5	200,662	28.1	72,929	37.7	547,934	23.5	263,652	30.6
1992	230,607	26.2	64,879	30.5	208,097	17.9	75,631	30.9	129,211	12.9	62,173	23.5
1993	748,724	9.4	210,644	18.2	239,559	27.4	87,066	37.2	638,531	66.7	307,246	69.5
1994	159,363	18.6	44,835	24.2	55,638	18.7	20,221	31.4	123,183	49.3	59,272	53.1
1995	543,046	10.2	152,779	18.6	123,454	9.4	44,868	26.9	184,865	51.9	88,953	55.5
1996	365,443	9.0	102,813	17.9	76,529	10.4	27,814	27.3	158,756	20.5	76,390	28.4
1997	209,623	2.4	58,975	15.7	37,524	10.4	13,638	27.2	355,014	8.4	170,824	21.3
1998	379,352	5.6	106,726	16.5	67,147	1.9	24,404	25.3	383,506	19.3	184,534	27.5
1999	554,533	22.9	156,011	27.7	89,928	45.8	32,684	52.3	56,231	41.9	27,057	46.3
2000	69,398	0.0	19,524	15.5	13,573	0.0	4,933	25.2	17,674	0.0	8,504	19.6
2001	2,027	0.0	570	15.5	3,670	0.0	1,334	25.2	12,989	0.0	6,250	19.6
2002	253,436	10.4	71,301	18.7	66,422	28.9	24,141	38.3	8,657	65.1	4,165	68.0
2003	195,907	6.1	55,116	16.7	64,806	22.6	23,553	33.8	86,007	18.1	41,384	26.7
2004	9,474	6.4	2,665	16.8	9,818	5.2	3,568	25.7	31,320	21.7	15,071	29.2
2005	1,012	0.0	285	15.5	113	0.0	41	25.2	448,533	0.0	215,823	19.6
2006	704,562	0.0	198,220	15.5	214,909	0.0	78,107	25.2	54,772	0.0	26,355	19.6
2007	556,895	6.5	156,676	16.8	138,102	7.3	50,192	26.2	189,616	45.7	91,239	49.7

Table 3. Continued

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	492,970	5.2	138,691	16.4	126,763	10.9	46,071	27.5	142,776	26.1	68,700	32.6
2009	145,575	17.4	40,956	23.4	39,163	21.2	14,234	33.0	93,706	13.2	45,089	23.6
2010	166,673	1.4	46,891	15.6	39,723	7.4	14,437	26.2	12,613	36.4	6,069	41.4
2011	80,312	0.0	22,595	15.5	14,956	0.0	5,436	25.2	8,938	0.0	4,301	19.6
2012	482,239	4.9	135,672	16.3	102,479	2.8	37,245	25.4	104,090	16.9	50,086	25.9
2013	660,127	19.3	185,719	24.8	99,894	32.7	36,306	41.3	292,692	43.0	140,836	47.2
2014	170,982	19.4	48,104	24.9	45,420	22.8	16,508	34.0	110,564	33.6	53,201	38.9
2015	189,471	37.2	53,305	40.3	51,533	61.5	18,729	66.5	22,245	40.6	10,704	45.1
2016	362,485	24.8	101,981	29.3	66,425	30.1	24,142	39.2	182,840	15.5	87,978	25.0
2017	350,248	32.9	98,538	36.4	43,316	43.8	15,743	50.5	112,327	12.4	54,049	23.2
2018	160,034	13.6	45,024	20.6	37,575	12.7	13,656	28.2	58,113	21.0	27,963	28.7
2019	78,365	26.1	22,047	30.4	31,191	39.7	11,336	47.1	112,532	17.5	54,148	26.3
2020	1,222,658	55.5	343,980	57.7	195,530	81.4	71,064	85.2	335,332	37.4	161,354	42.2

Table 4. Historic FCAL (MRIP-FCAL) estimates, and estimates converted to SRFS currency (Calibrated: FCAL to SRFS) for Mutton Snapper (*Lutjanus analis*) for the Atlantic Ocean.

	MRIP - FCAL		Calibrated: FCAL to SRFS		MRIP - FCAL		Calibrated: FCAL to SRFS		MRIP - FCAL		Calibrated: FCAL to SRFS	
Year	Landings (lbs)	PSE	Landings (lbs)	PSE	Landings (no. fish)	PSE	Landings (no. fish)	PSE	Releases (no. fish)	PSE	Releases (no. fish)	PSE
1982	177,863	39.1	95,723	41.4	84,113	30.0	44,550	33.8	0	NA	0	NA
1983	132,219	0.8	71,158	13.6	87,083	3.0	46,122	15.9	21,758	0.0	11,900	10.7
1984	548,377	19.4	295,128	23.6	222,392	35.9	117,787	39.1	4,386	100.0	2,399	100.6
1985	305,002	30.9	164,147	33.8	63,912	53.2	33,850	55.5	90,711	100.0	49,614	100.6
1986	203,342	11.1	109,435	17.5	74,202	19.9	39,300	25.3	31,470	37.3	17,212	38.8
1987	307,433	14.7	165,456	20.0	102,766	36.4	54,429	39.6	202,822	81.4	110,932	82.1
1988	105,541	28.8	56,801	31.8	58,111	20.2	30,778	25.6	17,872	54.8	9,775	55.8
1989	226,825	20.7	122,074	24.8	74,855	33.7	39,646	37.2	27,034	35.8	14,786	37.4
1990	250,420	19.3	134,772	23.6	78,441	25.0	41,546	29.5	4,497	0.0	2,460	10.7
1991	249,598	19.6	134,330	23.9	71,045	23.7	37,628	28.4	21,738	34.7	11,889	36.3
1992	201,133	10.8	108,247	17.4	82,716	13.2	43,809	20.5	112,941	38.7	61,772	40.1
1993	516,468	10.5	277,955	17.1	228,748	14.9	121,154	21.6	164,526	26.1	89,986	28.2
1994	256,065	18.7	137,811	23.1	106,252	22.9	56,275	27.7	120,448	23.9	65,878	26.2
1995	246,588	18.6	132,710	23.0	63,422	20.4	33,591	25.7	50,927	17.9	27,854	20.9
1996	264,667	20.4	142,440	24.5	52,903	28.4	28,019	32.4	51,349	28.7	28,085	30.6
1997	193,423	17.1	104,097	21.9	45,486	22.1	24,091	27.1	110,990	18.8	60,705	21.6
1998	257,466	14.5	138,564	19.8	70,169	16.4	37,164	22.7	125,037	21.4	68,388	23.9
1999	215,594	13.5	116,029	19.1	61,555	15.3	32,602	21.8	75,657	16.2	41,380	19.4
2000	500,753	12.1	269,498	18.2	115,611	16.7	61,232	22.9	142,046	24.4	77,691	26.6
2001	362,579	14.9	195,135	20.1	90,270	20.1	47,810	25.4	74,528	20.6	40,762	23.2
2002	453,804	9.1	244,230	16.3	155,796	12.2	82,515	19.8	157,984	19.3	86,408	22.1
2003	389,973	13.0	209,878	18.8	110,025	17.2	58,273	23.2	82,805	14.2	45,290	17.8
2004	396,851	18.2	213,579	22.7	114,623	25.2	60,708	29.7	114,551	20.3	62,653	23.0
2005	425,363	8.9	228,924	16.2	145,621	13.7	77,126	20.8	165,354	19.0	90,439	21.8
2006	571,517	11.1	307,582	17.5	178,895	15.3	94,749	21.9	283,351	18.8	154,976	21.6
2007	761,291	9.8	409,715	16.7	203,607	12.3	107,838	19.9	343,474	16.7	187,860	19.9

Table 4. Continued.

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	364,839	10.7	196,351	17.3	136,350	12.9	72,216	20.3	369,604	23.0	202,152	25.4
2009	386,879	11.6	208,213	17.9	152,023	17.1	80,517	23.1	215,635	17.3	117,940	20.3
2010	476,249	13.0	256,310	18.8	143,418	14.4	75,960	21.2	83,527	17.1	45,685	20.2
2011	129,601	13.2	69,749	18.9	38,768	18.0	20,533	23.8	36,243	28.3	19,823	30.3
2012	248,468	12.7	133,722	18.6	63,795	17.7	33,788	23.6	57,526	19.3	31,464	22.0
2013	422,382	14.3	227,319	19.7	133,599	17.0	70,759	23.1	202,726	25.7	110,879	27.8
2014	734,715	20.0	395,413	24.2	265,989	27.2	140,878	31.4	500,692	27.0	273,849	29.1
2015	775,192	8.5	417,197	16.0	176,941	18.4	93,715	24.1	445,619	17.3	243,728	20.4
2016	884,905	19.8	476,242	24.0	228,901	29.2	121,234	33.1	596,600	22.9	326,305	25.3
2017	428,288	21.3	230,498	25.2	117,391	17.4	62,175	23.4	454,281	13.1	248,465	16.9
2018	448,413	12.9	241,329	18.8	140,990	23.0	74,674	27.8	519,080	19.2	283,906	22.0
2019	577,649	10.9	310,882	17.4	161,708	38.5	85,647	41.5	418,633	14.9	228,968	18.3
2020	370,145	9.6	199,207	16.6	62,975	18.0	33,354	23.9	421,587	18.3	230,583	21.2

Table 5. 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.

	MRIP - FCAL		Calibrated: FCAL to SRFS		MRIP - FCAL		Calibrated: FCAL to SRFS		MRIP - FCAL		Calibrated: FCAL to SRFS	
Year	Landings (lbs)	PSE	Landings (lbs)	PSE	Landings (no. fish)	PSE	Landings (no. fish)	PSE	Releases (no. fish)	PSE	Releases (no. fish)	PSE
1982	6,404,701	13.7	4,055,430	15.3	5,627,105	23.7	3,512,214	25.8	1,045,386	24.3	570,475	26.7
1983	588,782	17.2	372,815	18.5	1,113,852	24.3	695,222	26.3	467,036	71.2	254,865	72.1
1984	2,444,545	29.5	1,547,876	30.3	3,815,673	40.9	2,381,590	42.2	3,536,618	39.1	1,929,960	40.7
1985	2,031,748	27.3	1,286,494	28.2	1,570,557	45.2	980,279	46.3	215,981	1.1	117,863	11.2
1986	1,532,219	30.2	970,195	30.9	1,047,086	47.0	653,549	48.1	767,197	37.7	418,665	39.3
1987	1,446,231	18.0	915,748	19.2	1,088,170	25.8	679,192	27.7	1,612,071	23.5	879,719	26.0
1988	784,926	1.9	497,012	7.1	1,060,090	17.0	661,666	19.8	892,738	29.7	487,174	31.8
1989	9,326,900	28.2	5,905,755	29.0	4,591,442	27.4	2,865,794	29.2	2,372,095	24.1	1,294,470	26.5
1990	4,844,488	36.4	3,067,510	37.0	3,273,721	46.9	2,043,326	48.0	1,564,314	16.6	853,658	20.0
1991	9,256,266	38.2	5,861,029	38.8	4,036,275	52.8	2,519,281	53.8	11,691,255	24.0	6,380,008	26.4
1992	838,989	19.5	531,244	20.7	775,817	23.7	484,234	25.8	2,570,450	15.3	1,402,715	18.9
1993	1,991,149	10.1	1,260,787	12.2	1,795,885	16.3	1,120,919	19.2	3,675,977	13.3	2,006,009	17.3
1994	1,599,074	13.3	1,012,527	14.9	1,182,065	18.4	737,797	21.0	2,385,941	18.4	1,302,027	21.5
1995	1,781,625	13.1	1,128,118	14.8	1,758,398	19.7	1,097,521	22.2	2,879,028	18.2	1,571,108	21.3
1996	1,140,143	13.5	721,934	15.1	792,490	18.8	494,641	21.4	2,870,471	8.5	1,566,438	14.0
1997	999,537	16.7	632,902	18.1	743,325	21.2	463,953	23.5	3,175,411	16.7	1,732,846	20.1
1998	905,971	17.6	573,657	18.8	844,331	25.3	526,997	27.3	1,770,389	16.6	966,115	20.0
1999	740,286	14.8	468,746	16.3	613,353	18.6	382,830	21.2	1,868,766	21.2	1,019,800	24.0
2000	597,400	20.0	378,271	21.1	640,955	34.0	400,058	35.5	1,485,844	18.3	810,837	21.4
2001	503,492	34.0	318,809	34.7	448,161	51.9	279,724	52.9	736,511	24.3	401,920	26.8
2002	702,957	11.2	445,110	13.1	841,306	16.0	525,110	19.0	1,093,557	15.2	596,763	18.9
2003	1,427,775	9.9	904,061	12.1	1,368,061	14.6	853,889	17.8	1,408,414	8.3	768,583	13.9
2004	1,341,952	22.8	849,719	23.8	1,294,749	39.2	808,130	40.5	1,329,119	13.7	725,310	17.7
2005	423,966	16.7	268,453	18.0	424,258	23.4	264,805	25.5	1,133,592	18.3	618,610	21.4
2006	1,528,385	17.1	967,767	18.4	1,401,336	23.2	874,658	25.3	2,519,819	10.7	1,375,085	15.4
2007	1,614,039	22.6	1,022,003	23.6	1,367,274	27.4	853,398	29.2	2,864,653	16.1	1,563,264	19.6

Table 5. Continued

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	2,680,014	17.6	1,696,974	18.8	2,221,233	28.0	1,386,405	29.8	2,521,215	18.7	1,375,846	21.8
2009	781,132	8.4	494,609	10.8	813,889	14.3	507,997	17.6	1,535,052	13.0	837,690	17.1
2010	752,828	14.1	476,688	15.6	688,166	16.0	429,526	19.0	1,442,850	22.4	787,375	25.0
2011	803,875	15.0	509,010	16.5	506,206	21.2	315,953	23.6	768,577	27.2	419,418	29.4
2012	710,276	27.6	449,744	28.5	662,936	39.0	413,778	40.4	1,217,864	18.8	664,598	21.9
2013	1,078,207	9.5	682,716	11.7	1,354,857	12.9	845,647	16.5	3,896,486	22.7	2,126,342	25.2
2014	1,380,437	9.2	874,087	11.5	1,264,803	13.6	789,440	17.0	3,229,733	15.3	1,762,490	18.9
2015	954,281	8.1	604,247	10.6	941,561	10.9	587,684	15.0	1,787,124	15.1	975,248	18.8
2016	1,119,074	10.5	708,593	12.5	1,188,881	13.2	742,052	16.7	1,243,011	18.7	678,321	21.7
2017	1,533,532	9.5	971,026	11.7	1,263,207	13.6	788,444	17.0	1,168,907	12.6	637,881	16.8
2018	1,232,492	8.4	780,409	10.8	1,457,172	13.7	909,508	17.1	2,234,346	20.0	1,219,300	22.8
2019	576,901	16.4	365,291	17.7	586,532	25.8	366,090	27.7	709,305	16.8	387,073	20.1
2020	1,104,697	16.1	699,490	17.5	1,255,995	26.1	783,942	28.0	1,147,231	20.7	626,053	23.5

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.**

APPENDIX B:
Evaluating Different Regional Distributions

Methods

For both species, we tested calibrating catch estimates by two different spatial distributions. One spatial distribution separated the state by the stock assessment regions and the other spatial distribution focused on separating the state into a region where most of the fish of that species are caught (i.e., a high-pressure region) and then remaining lower pressure regions. The Mutton Snapper stock is assessed in two regions, the Atlantic coast, and the Gulf coast including the Keys. We additionally did a spatial analysis using 2021-2023 SRFS data and found that the average number of dockside interviews where samplers encountered anglers who caught Mutton Snapper per year as well as the counties with the highest estimated landings in pounds per year were Miami-Dade, followed by Palm Beach, Monroe, St. Lucie, and then Martin and Broward counties (Fig B1). Therefore, we generated estimates based on three regions: South Atlantic (Miami-Dade, Broward, Palm Beach, Martin, and St. Lucie), Gulf with Keys (Monroe and all Gulf coast counties), North Atlantic (all Atlantic coast counties north of St. Lucie). This generates a high-pressure region (South Atlantic) and two lower pressure regions. After the calibration was complete the calibrated estimates from the North Atlantic and South Atlantic were added to generate the final Atlantic estimates for assessment purposes. Monroe County was included in the Gulf region even though it is a popular county for catching this fish species because the comparisons still need to align with the stock assessment regions. The Yellowtail Snapper stock is assessed as one region, the whole state of Florida. When looking at the counties in Florida with the highest number of dockside interviews where samplers encountered anglers who caught Yellowtail Snapper as well as the counties with the highest number of landed fish in pounds were Monroe, Miami-Dade, Palm Beach, and Broward counties (Fig. B2). Therefore, we generated estimates according to 3 regions: South Florida (Miami-Dade, Monroe, Palm Beach, and Broward counties), Gulf (all Gulf counties except Monroe), and Atlantic (all Atlantic Counties north of Palm Beach). After the calibrated estimates were generated all three of these regions were added to generate a final statewide estimate for assessment purposes. For both species, the final calibrated estimates were compared for each of the two spatial distributions. Estimates for state and federal waters were derived for both Mutton Snapper and Yellowtail Snapper. To generate the different spatial distributions described above, values for landings in pounds, landings in numbers, releases in numbers, and their associated variances were summed for the counties in the spatial distribution to generate a total estimate for that region. Methods for calibrating these different spatial distributions otherwise match the methods described in the main body of the paper. Ratios and values calculated using equations 1 and 2 resulted in 24 pairs of SRFS and FCAL sums (3 variables, 2 species, 5 regions for Mutton Snapper and 3 for Yellowtail Snapper; Tables 1, 2, B1, & B2).

Findings and Conclusions

For the years in which the SRFS and MRIP overlap, annual Mutton Snapper and 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 B1-4. Yearly and average annual estimates are shown in Figures B3-6. The ratios for Mutton Snapper ranged from 0.19-0.60. The ratios in the Gulf with the Keys were generally lower (0.19-0.44) than the ratios in the Atlantic (0.51-0.60), regardless of tested spatial distribution. The median PSE values were 24% and 26% for the calibrated estimates using the assessment and pressure spatial distributions, respectively. The ratios for Yellowtail Snapper ranged much more broadly for the fishing pressure spatial distribution (0.38-5.21) than for the stock assessment region spatial distribution (0.55-0.63). Also, the median PSE values were higher for the calibrated estimates using the fishing pressure (25%) than the stock assessment region (20%) subregions. This is likely because there was a lot more variability when the Yellowtail Snapper regions were broken down, due to fish being caught rarely in the northern part of Florida.

After adding the calibrated pressure regions so that the total estimates between the stock assessment and pressure calibrations were comparable, we found that the two sets of calibrated estimates are identical for the Gulf of Mexico (Table B3, Fig. B7). This is because these spatial delineations are identical. However, the two sets of calibrated estimates were also extremely similar for Mutton Snapper in the Atlantic Ocean (Table B4, Fig. B8., Fig. B9). For Yellowtail Snapper the differences between the two sets of calibrated estimates were slightly larger. The calibration using the stock assessment spatial delineation generated mostly larger estimates than the pressure spatial delineations (especially in the 1980s). However, errors for these two sets of calibrations overlapped for all points except for releases in 2005 (Table B5, Fig. B10, Fig. B11).

Given minimal differences in the overall calibrated estimates using the two spatial distributions, we recommend using the largest spatial distribution possible. For both species this means we recommend using the stock assessment spatial distribution. We recommend this because larger spatial distributions have more data for each region. This reduces variability in the summed estimates used for calibration. This reduced variability helps support the ratio method of calibration used here as it generates the most consistent patterns between SRFS and MRIP.

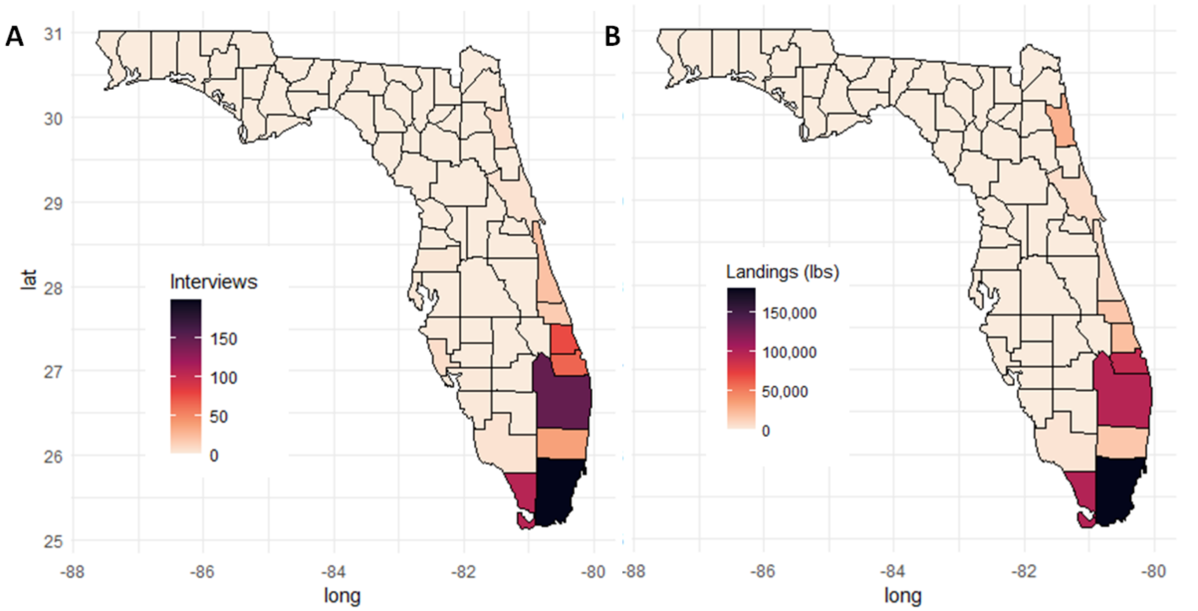

Figure B1. The spatial distribution of the number of interviews conducted where anglers caught or targeted Mutton Snapper (*Lutjanus analis*) per year (**A**) and the spatial distribution of the amount of Mutton Snapper landed per year (lbs; **B**) are shown. Counties selected for the 'high pressure' region of South Atlantic (satl) are (from south to north) Miami-Dade, Broward, Palm Beach, Martin, and St. Lucie. The northern Atlantic Ocean region (natl) is all counties north of St. Lucie and the Gulf with Keys region (gulfk) is all counties in the Gulf of Mexico including Monroe County.

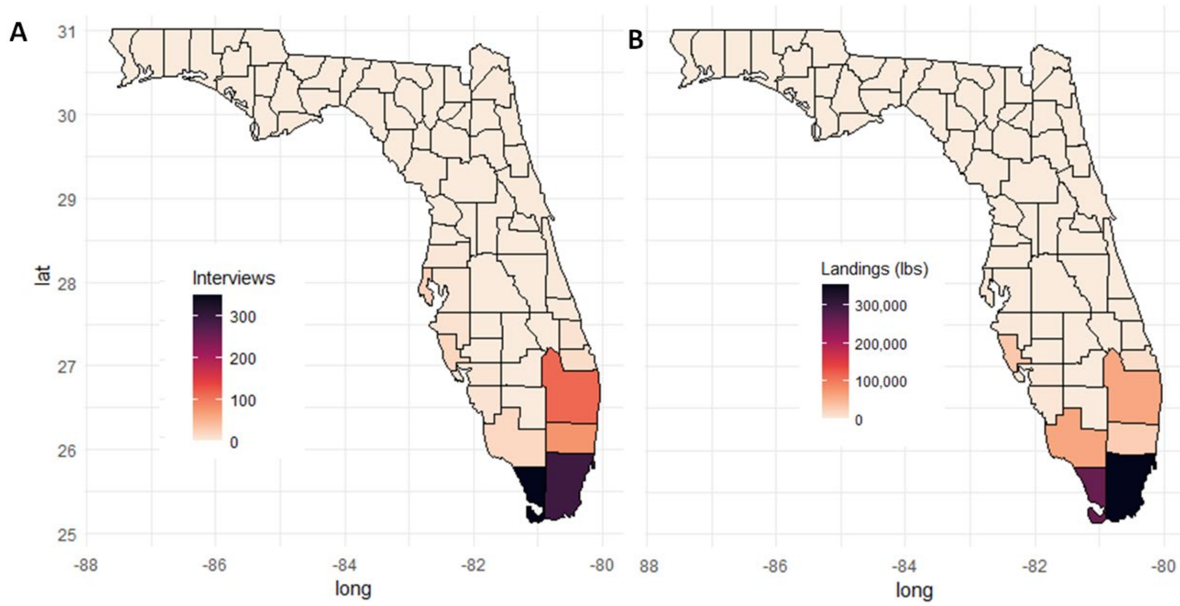

Figure B2. The spatial distribution of the number of interviews conducted where anglers caught or targeted Yellowtail Snapper (*Ocyurus chrysurus*) per year (**A**) and the spatial distribution of the amount of Yellowtail Snapper landed per year (lbs; **B**) are shown. Counties selected for the 'high pressure' region of South Florida (sfl) are (from left to right) Monroe, Miami-Dade, Broward, and Palm Beach. The Atlantic Ocean region (atl) is all counties north of Palm Beach and the Gulf region (gulf) is all counties north of Monroe in the Gulf of Mexico.

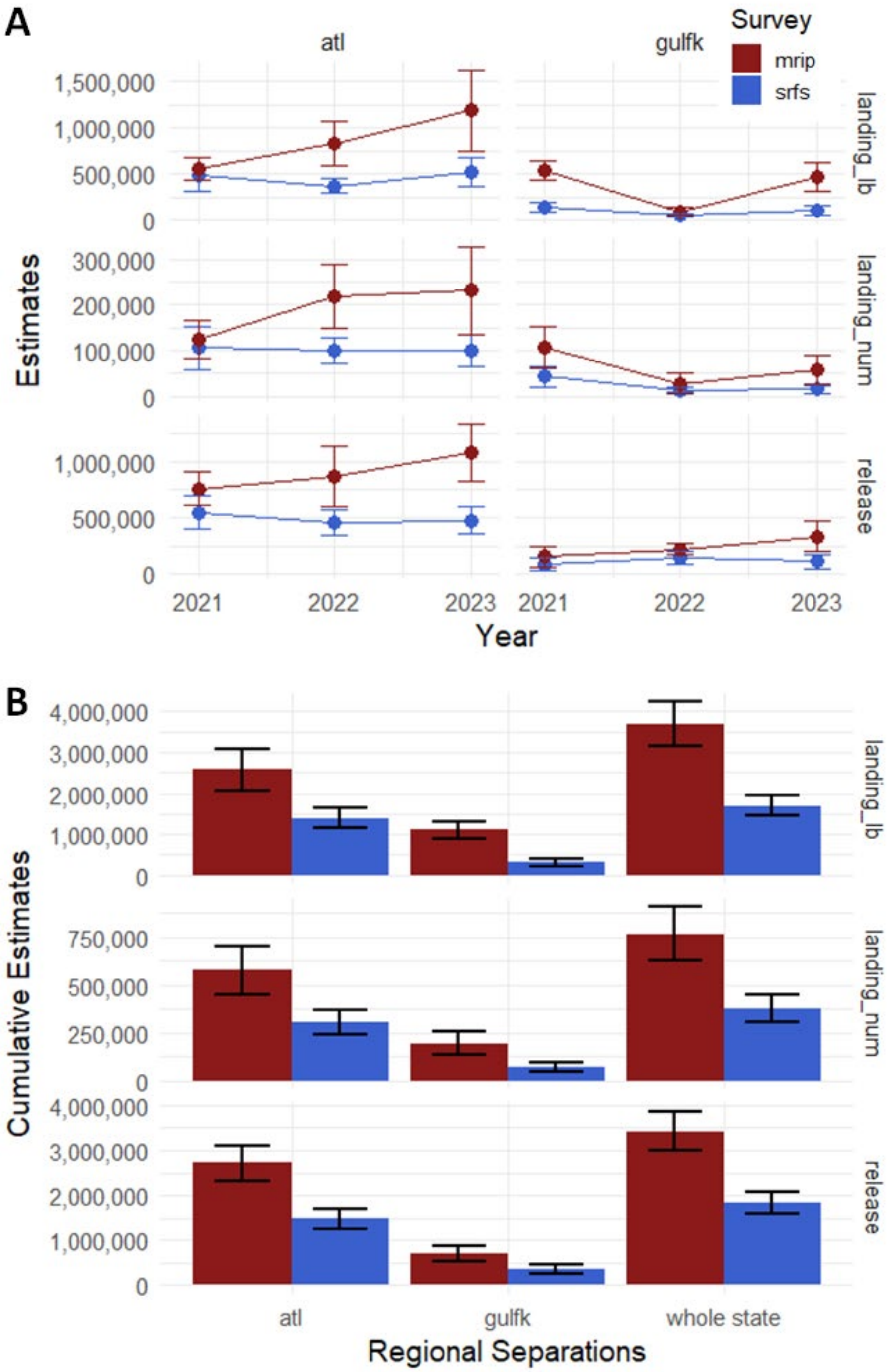

Figure B3. Estimates of landings and releases of Mutton Snapper (*Lutjanus analis*) across years (**A**) or with all years combined (**B**; 2021-2023) on the Atlantic coast (atl) or the Gulf with the Keys (gulfk). These are the stock assessment regions for this species. Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

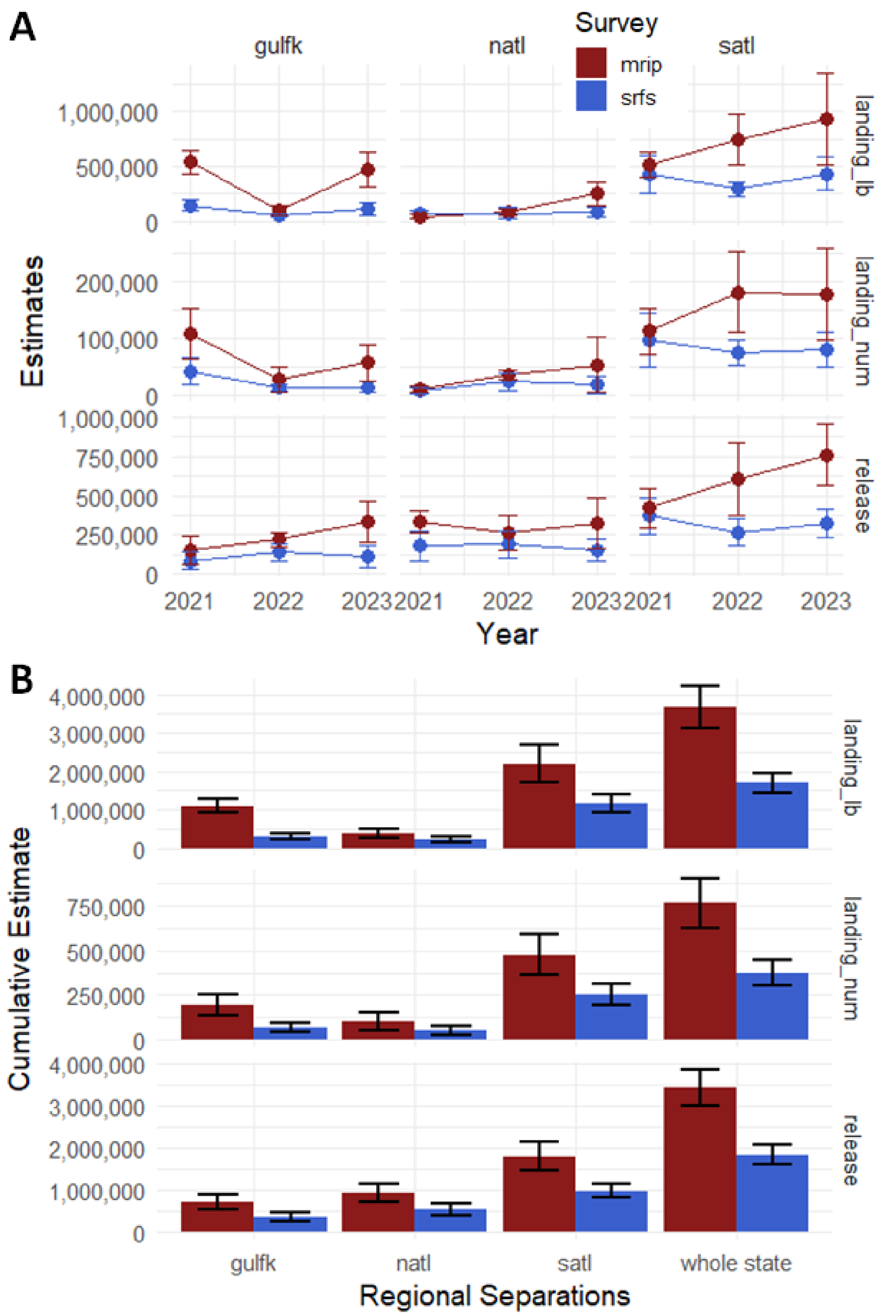

Figure B4. Estimates of landings and releases of Mutton Snapper (*Lutjanus analis*) across years (**A**) or with all years combined (**B**; 2021-2023) Fishing regions determined by fishing pressure are all Atlantic coast counties north of St. Lucie County (natl), Miami-Dade to St. Lucie County (satl) and all Gulf of Mexico counties including the Keys (gulfk).Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

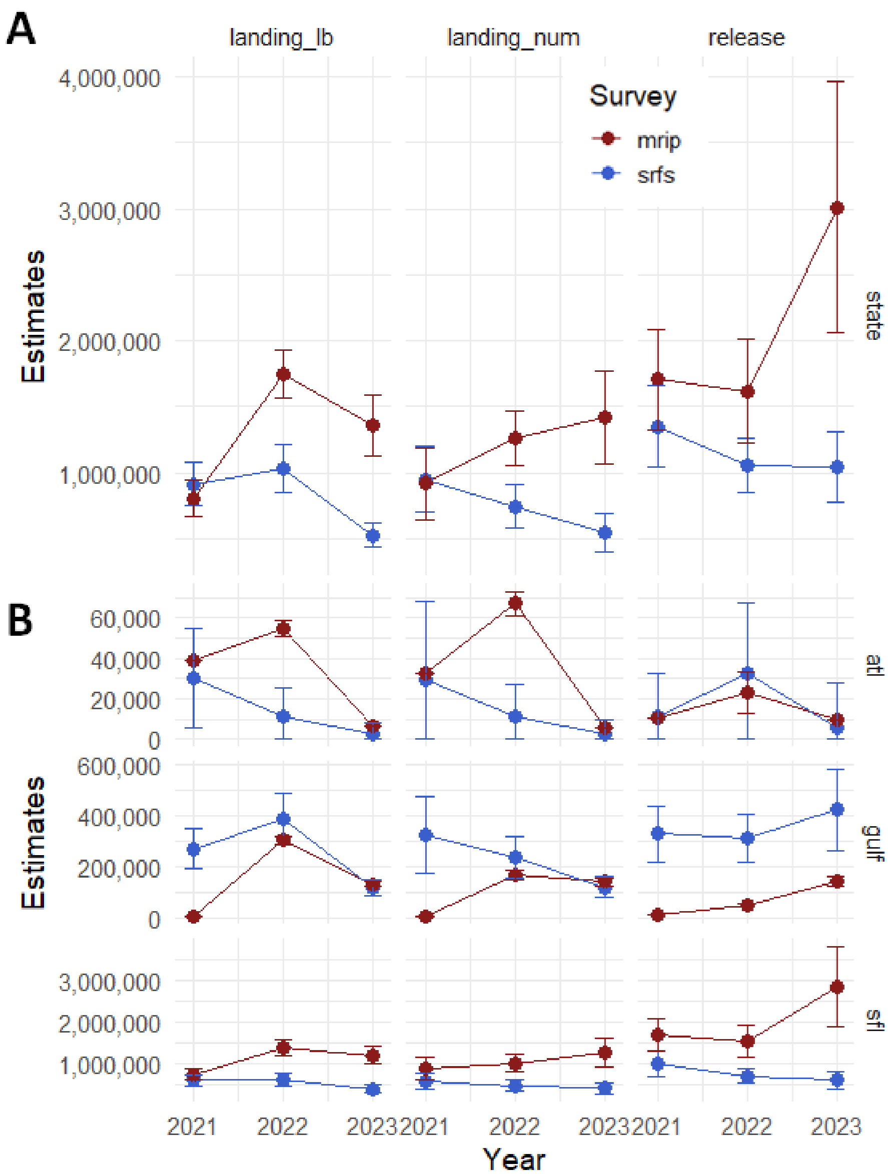

Figure B5. Estimates of landings and releases of Yellowtail Snapper (*Ocyurus chrysurus*) across years (2021-2023) for the whole state, which is the stock assessment region for this species (**A**) and for the state broken down by higher and lower fishing pressure regions. Fishing regions determined by fishing pressure are all Atlantic coast counties north of Palm Beach County (atl), all Gulf of Mexico counties north of Monroe County (gulf), and Monroe, Miami-Dade, Broward, and Palm Beach counties (sfl; **B**). Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

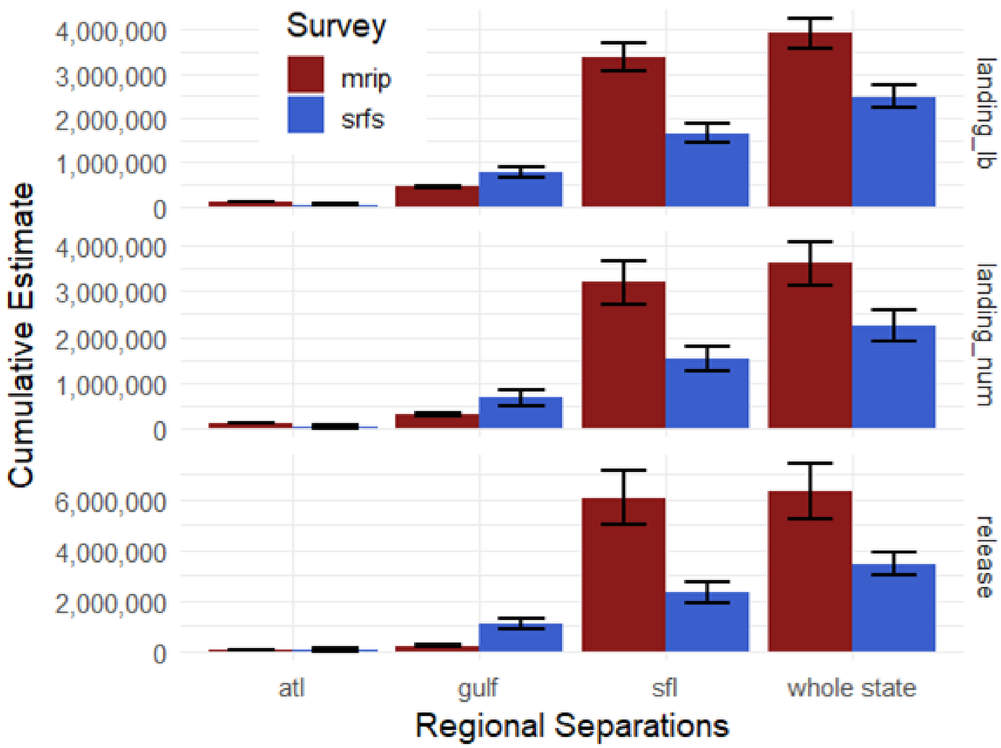

Figure B6. Estimates of landings and releases of Yellowtail Snapper (*Ocyurus chrysurus*) averaged across 2021-2023 for the whole state, which is the stock assessment region for this species and for the state broken down by higher and lower fishing pressure regions. Fishing regions determined by fishing pressure are all Atlantic coast counties north of Palm Beach County (atl), all Gulf of Mexico counties north of Monroe County (gulf), and Monroe, Miami-Dade, Broward, and Palm Beach counties (sfl). Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

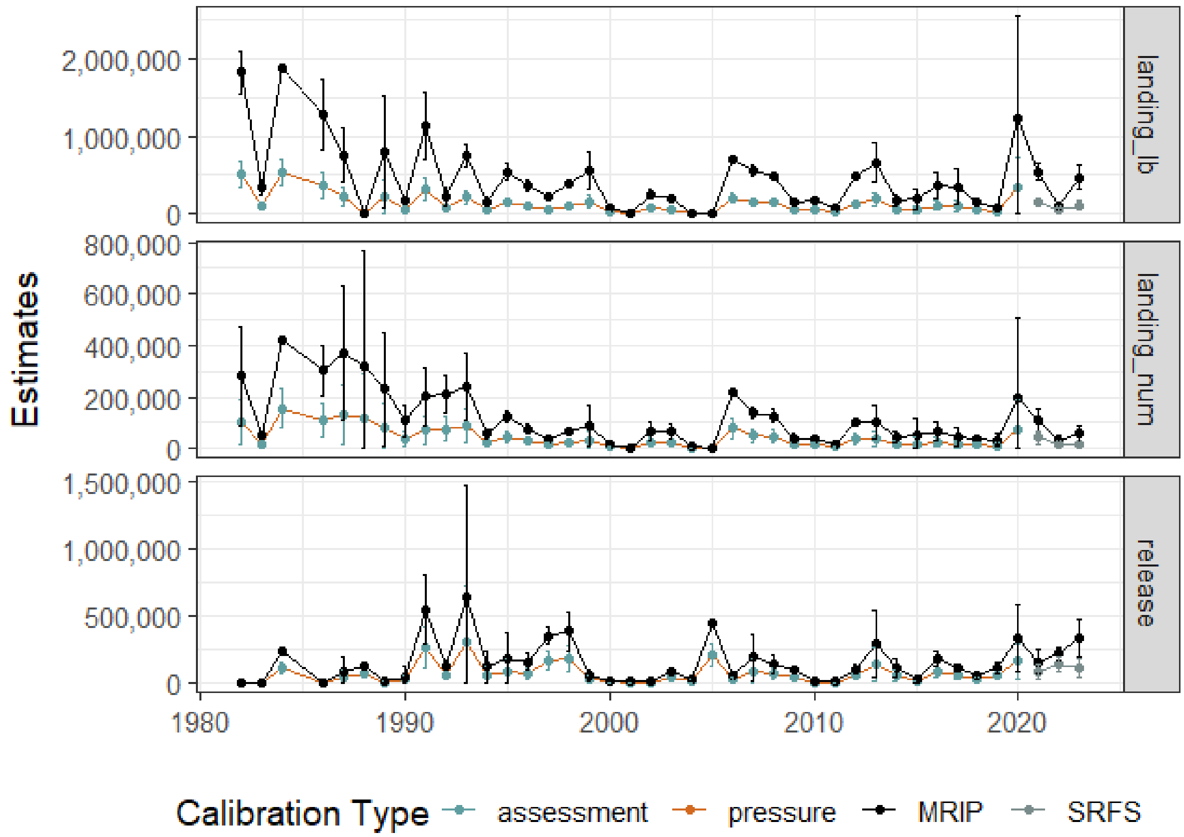

Figure B7. Mutton Snapper (*Lutjanus analis*) estimates in the Gulf of Mexico including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip and MRIP-FCAL time-series calibrated to SRFS currency using assessment region (assessment) or fishing pressure regions (pressure). Landings 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.

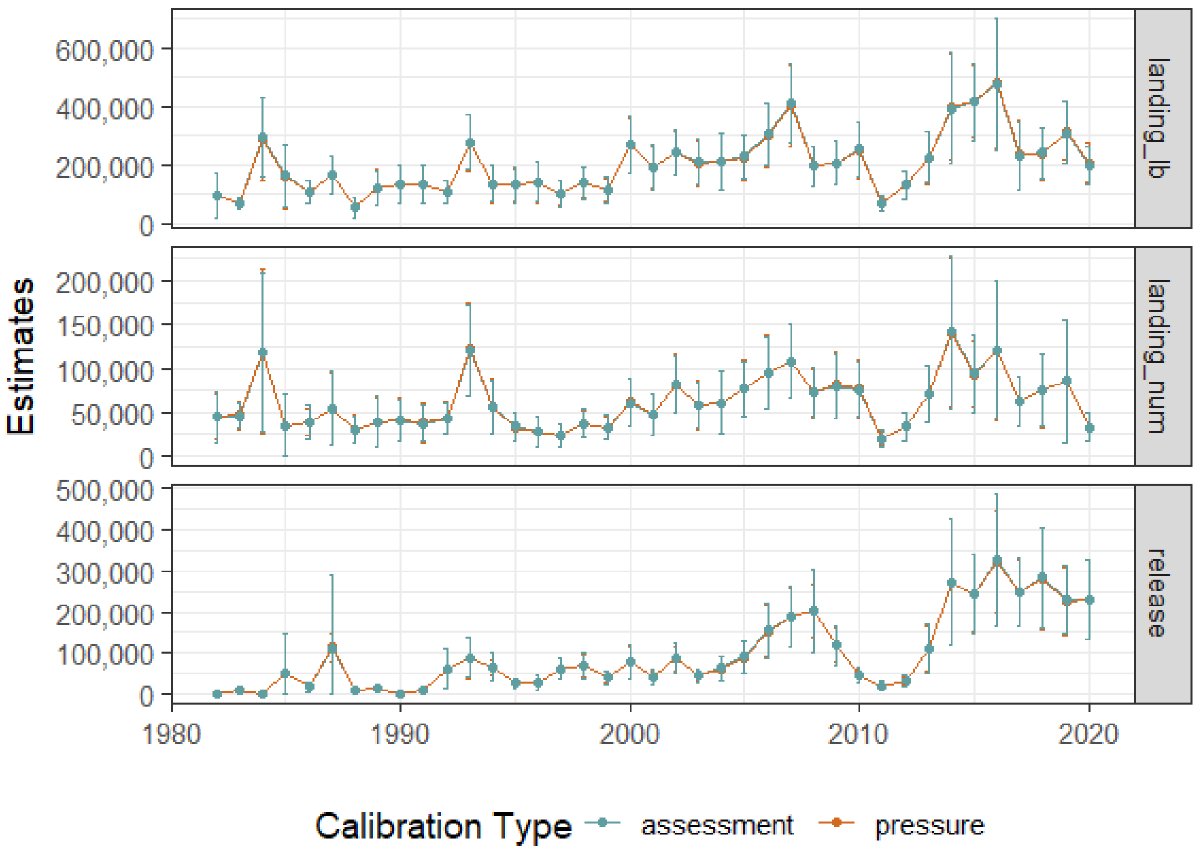

Figure B8. Calibrated estimates for Mutton Snapper (*Lutjanus analis*) for the Atlantic Ocean either by generating one calibration ratio for the entire Atlantic Coast of Florida (the stock assessment region; assessment) or by calibrating separately for regions determined by fishing pressure (pressure) and adding the final calibrated estimates and their variance up to generate a final calibrated estimate for this coast. The different calibration types generated similar final estimates. Estimates for the Gulf with the Keys are not shown because the spatial delineations of this region was the same for both calibration types.

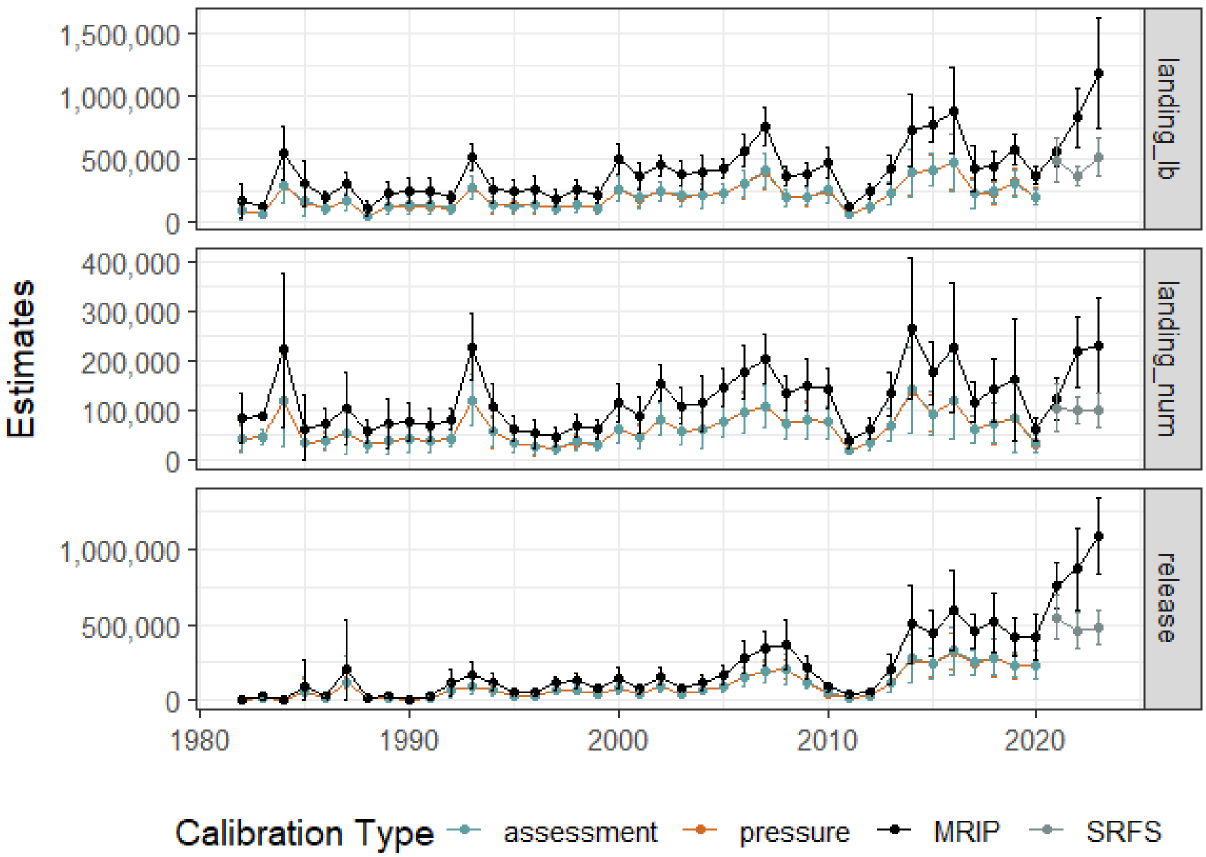

Figure B9. Mutton Snapper (*Lutjanus analis*) hindcast estimates in the Atlantic Ocean including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip), and MRIP-FCAL time-series calibrated to SRFS currency using assessment region (assessment) or fishing pressure regions (pressure). 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.

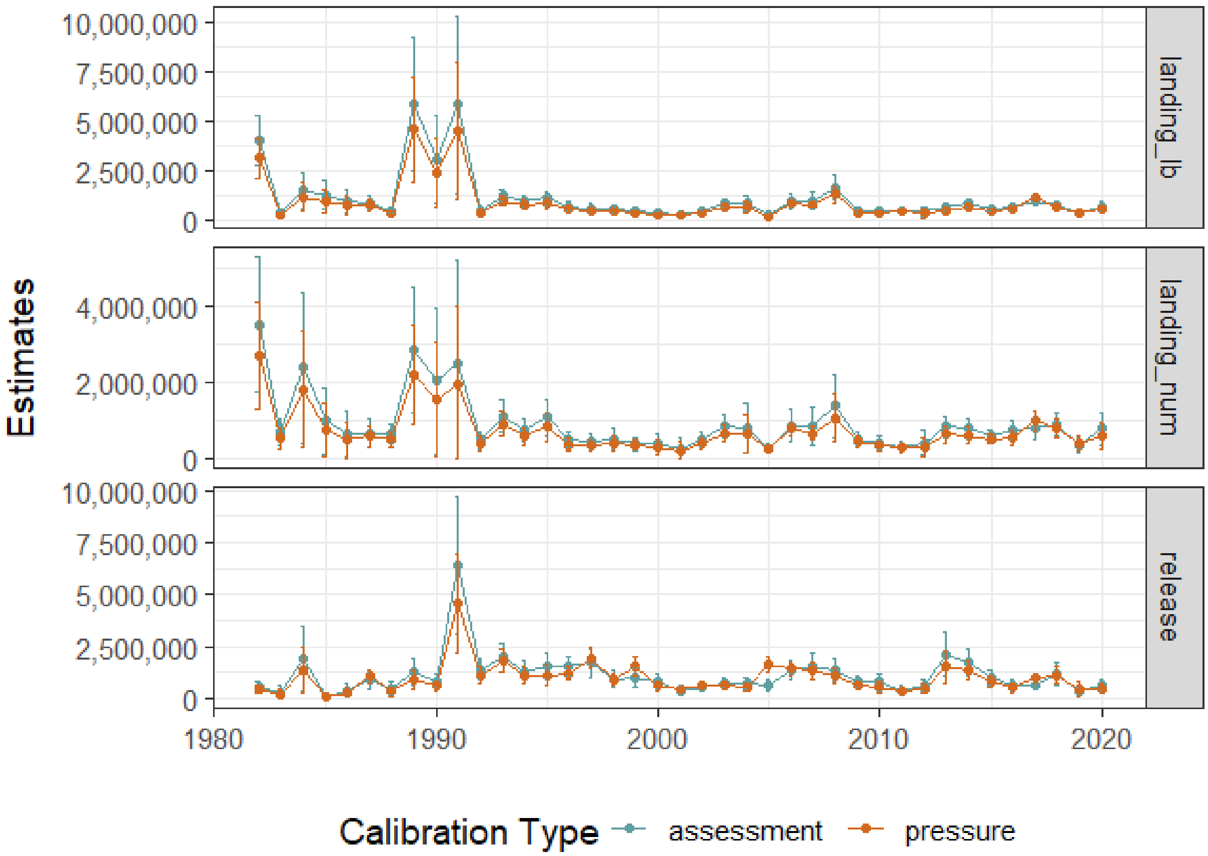

Figure B10. Calibrated estimates for Yellowtail Snapper (*Ocyurus chrysurus*) for the whole state by either generating one calibration ratio for the whole state (the stock assessment region; assessment) or by calibrating separately for regions determined by fishing pressure (pressure) and adding the final calibrated estimates and their variance up to generate a final calibrated estimate for the whole state. The different calibration generated similar final estimates.

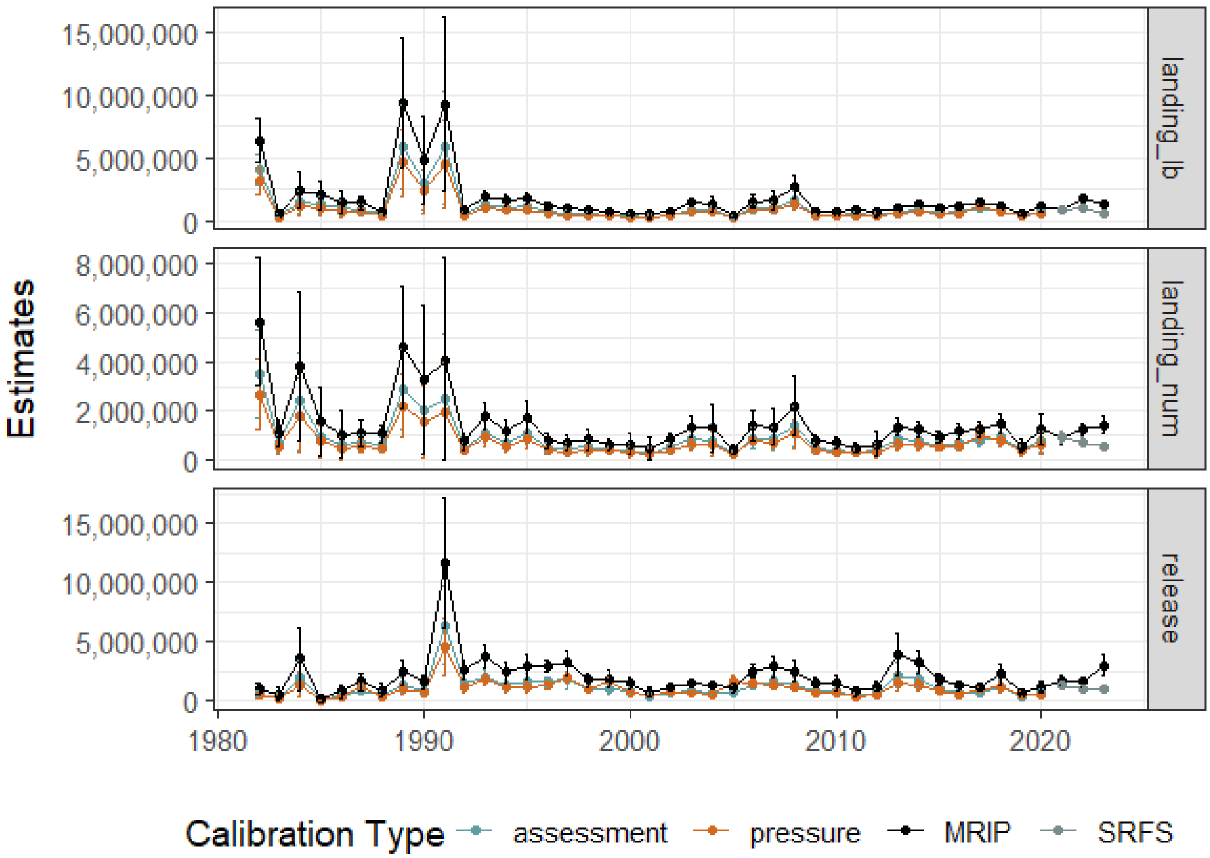

Figure B11. Yellowtail Snapper (*Ocyurus chrysurus*) hindcast estimates for the state of Florida including: original SRFS estimates (srfs; 2021-2023), original MRIP-FCAL time-series (mrip), and MRIP-FCAL time-series calibrated to SRFS currency using assessment region (assessment) or fishing pressure regions (pressure). 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 B1. Annual and summed FCAL and SRFS estimates and variances and ratios of SRFS to FCAL estimates are shown for Mutton Snapper (*Lutjanus analis*) with the state broken down by higher and lower fishing pressure regions. Fishing regions determined by fishing pressure are all Atlantic coast counties north of St. Lucie County (natl), Miami-Dade to St. Lucie County (satl) and all Gulf of Mexico counties including the Keys (gulfk).

Estimate Type	Region	Year	SRFS sum	SRFS variance	MRIP sum	MRIP variance	Ratio
Landings (lbs)	natl	2021	63,222	348,895,943	41,850	115,237,433	0.60
		2022	75,387	497,069,016	83,533	144,887,243	
		2023	86,125	435,603,606	251,150	3,053,981,127	
		Total	224,735	1,281,568,564	376,532	3,314,105,803	
	satl	2021	431,872	7,648,698,955	517,387	3,409,625,224	0.53
		2022	295,918	1,029,457,076	748,926	14,241,165,132	
		2023	433,501	5,910,588,497	932,526	45,370,207,108	
		Total	1,161,291	14,588,744,528	2,198,839	63,020,997,464	
	gulfk	2021	146,585	663,406,530	540,582	2,888,628,503	0.28
		2022	54,727	102,455,906	94,349	511,096,872	
		2023	109,041	785,055,311	468,202	6,378,331,927	
		Total	310,353	1,550,917,747	1,103,133	9,778,057,302	
Landings (no. fish)	natl	2021	8,103	9,446,543	10,324	6,967,365	0.51
		2022	24,812	61,462,020	36,402	15,042,802	
		2023	18,044	60,601,357	53,459	615,314,742	
		Total	50,959	131,509,919	100,185	637,324,909	
	satl	2021	97,952	586,730,306	113,685	428,911,368	0.53
		2022	74,708	129,230,525	182,421	1,274,845,950	
		2023	80,721	251,392,476	178,326	1,723,747,126	
		Total	253,381	967,353,307	474,432	3,427,504,444	
	gulfk	2021	42,227	154,072,585	108,345	545,889,785	0.36
		2022	13,529	10,415,543	27,709	133,011,414	
		2023	14,478	24,964,659	57,194	257,808,074	
		Total	70,234	189,452,787	193,247	936,709,273	
Releases (no. fish)	natl	2021	178,353	2,210,490,658	337,191	1,262,382,350	0.56
		2022	189,023	1,807,530,886	262,344	3,106,779,563	
		2023	153,292	1,322,766,580	324,728	6,581,611,394	
		Total	520,668	5,340,788,124	924,262	10,950,773,307	
	satl	2021	371,081	3,377,923,771	422,517	4,013,061,800	0.54
		2022	268,723	1,916,861,167	605,932	13,957,891,801	
		2023	324,107	2,169,270,975	761,616	10,375,597,338	
		Total	963,911	7,464,055,913	1,790,066	28,346,550,939	
	gulfk	2021	86,574	765,777,171	154,770	2,108,304,728	0.48
		2022	142,420	809,117,529	219,796	568,918,150	
		2023	111,997	1,164,325,456	334,097	4,783,581,224	
		Total	340,991	2,739,220,156	708,663	7,460,804,102	

Table B2. Annual and summed FCAL and SRFS estimates and variances and ratios of SRFS to FCAL estimates are shown for Yellowtail Snapper (*Ocyurus chrysurus*) with the state broken down by higher and lower fishing pressure regions. Fishing regions determined by fishing pressure are all Atlantic coast counties north of Palm Beach County (atl), Monroe, Miami-Dade, Broward, and Palm Beach counties (sfl), and all Gulf of Mexico counties north of Monroe County (gulf).

Estimate Type	Region	Year	SRFS sum	SRFS variance	MRIP sum	MRIP variance	Ratio
Landings (lbs)	atl	2021	30,208	152,984,021	39,251	0	0.44
		2022	11,221	54,818,653	54,604	4,546,701	
		2023	2,844	6,453,252	6,810	0	
		Total	44,272	214,255,926	100,664	4,546,701	
	sfl	2021	615,882	5,248,294,370	765,743	5,344,546,867	0.49
		2022	634,349	5,739,390,845	1,388,464	8,657,263,814	
		2023	410,295	2,138,860,797	1,221,138	13,060,326,032	
		Total	1,660,527	13,126,546,012	3,375,345	27,062,136,713	
	gulf	2021	270,941	1,646,828,598	4,182	0	1.75
		2022	387,952	2,528,201,763	305,615	67,474,929	
		2023	117,578	227,809,389	132,838	18,453,878	
		Total	776,471	4,402,839,751	442,635	85,928,807	
Landings (no. fish)	atl	2021	29,724	383,245,608	32,918	0	0.41
		2022	11,054	65,251,326	67,099	8,836,340	
		2023	2,498	12,573,314	5,990	0	
		Total	43,276	461,070,248	106,007	8,836,340	
	sfl	2021	596,449	9,785,275,895	884,517	18,997,509,844	0.48
		2022	496,987	5,188,964,376	1,026,861	11,176,756,404	
		2023	427,993	4,997,758,016	1,272,477	31,459,776,110	
		Total	1,521,428	19,971,998,287	3,183,855	61,634,042,358	
	gulf	2021	327,081	5,919,307,015	3,748	0	2.19
		2022	236,754	1,674,289,234	167,644	71,655,154	
		2023	120,165	479,091,656	141,515	68,965,095	
		Total	684,000	8,072,687,906	312,906	140,620,249	
Releases (no. fish)	atl	2021	11,141	122,545,026	10,257	0	1.14
		2022	32,280	317,732,586	23,099	29,222,616	
		2023	5,766	129,977,132	9,973	0	
		Total	49,186	570,254,743	43,330	29,222,616	
	sfl	2021	1,012,027	21,643,588,005	1,685,117	37,556,854,689	0.38
		2022	715,187	8,178,793,804	1,547,655	40,264,659,122	
		2023	614,536	11,596,905,521	2,855,147	235,341,149,945	
		Total	2,341,751	41,419,287,329	6,087,920	313,162,663,756	
	gulf	2021	328,744	3,269,722,112	11,070	0	5.21
		2022	314,942	2,345,949,658	48,486	10,651,078	
		2023	423,057	6,770,117,567	145,338	91,182,723	
		Total	1,066,744	12,385,789,337	204,894	101,833,801	

Table B3. Historic FCAL (MRIP-FCAL) estimates, and estimates converted to SRFS currency either by assessment region (Calibrated by Assessment: FCAL to SRFS) or by fishing pressure regions (Calibrated by Pressure: FCAL to SRFS) for Mutton Snapper (*Lutjanus analis*) in the Gulf of Mexico with the Keys. The different calibration types are redundant for this region due to identical spatial delineation.

	MRIP - FCAL		Calibrated by Assessment: FCAL to SRFS		Calibrated by Pressure: FCAL to SRFS	
Year	Estimates	PSE	Estimates	PSE	Estimates	PSE
	Landings (lbs)					
1982	1,822,713	7.9	512,798	17.4	512,798	17.4
1983	344,634	13.8	96,959	20.8	96,959	20.8
1984	1,885,895	0.0	530,574	15.5	530,574	15.5
1985	NA		NA		NA	
1986	1,283,410	18.1	361,072	23.9	361,072	23.9
1987	758,770	23.8	213,471	28.4	213,471	28.4
1988	7,807	0.0	2,196	15.5	2,196	15.5
1989	805,275	45.8	226,554	48.3	226,554	48.3
1990	163,286	11.9	45,939	19.6	45,939	19.6
1991	1,135,655	19.0	319,503	24.5	319,503	24.5
1992	230,607	26.2	64,879	30.5	64,879	30.5
1993	748,724	9.4	210,644	18.2	210,644	18.2
1994	159,363	18.6	44,835	24.2	44,835	24.2
1995	543,046	10.2	152,779	18.6	152,779	18.6
1996	365,443	9.0	102,813	17.9	102,813	17.9
1997	209,623	2.4	58,975	15.7	58,975	15.7
1998	379,352	5.6	106,726	16.5	106,726	16.5
1999	554,533	22.9	156,011	27.7	156,011	27.7
2000	69,398	0.0	19,524	15.5	19,524	15.5
2001	2,027	0.0	570	15.5	570	15.5
2002	253,436	10.4	71,301	18.7	71,301	18.7
2003	195,907	6.1	55,116	16.7	55,116	16.7
2004	9,474	6.4	2,665	16.8	2,665	16.8
2005	1,012	0.0	285	15.5	285	15.5
2006	704,562	0.0	198,220	15.5	198,220	15.5
2007	556,895	6.5	156,676	16.8	156,676	16.8
2008	492,970	5.2	138,691	16.4	138,691	16.4
2009	145,575	17.4	40,956	23.4	40,956	23.4
2010	166,673	1.4	46,891	15.6	46,891	15.6
2011	80,312	0.0	22,595	15.5	22,595	15.5
2012	482,239	4.9	135,672	16.3	135,672	16.3
2013	660,127	19.3	185,719	24.8	185,719	24.8
2014	170,982	19.4	48,104	24.9	48,104	24.9
2015	189,471	37.2	53,305	40.3	53,305	40.3
2016	362,485	24.8	101,981	29.3	101,981	29.3
2017	350,248	32.9	98,538	36.4	98,538	36.4
2018	160,034	13.6	45,024	20.6	45,024	20.6
2019	78,365	26.1	22,047	30.4	22,047	30.4
2020	1,222,658	55.5	343,980	57.7	343,980	57.7

Table B3 cont.: Landings (no. fish)

Year	MRIP - FCAL Estimates	PSE	Calibrated by Assessment: FCAL to SRFS Estimates	PSE	Calibrated by Pressure: FCAL to SRFS Estimates	PSE
	Landings (no. fish)					
1982	281,404	35.0	102,274	43.1	102,274	43.1
1983	51,106	12.6	18,574	28.2	18,574	28.2
1984	421,883	0.0	153,330	25.2	153,330	25.2
1985	NA		NA		NA	
1986	301,663	16.1	109,637	29.9	109,637	29.9
1987	368,433	36.0	133,904	43.9	133,904	43.9
1988	316,636	72.7	115,079	77.0	115,079	77.0
1989	229,681	49.6	83,476	55.6	83,476	55.6
1990	106,217	29.3	38,604	38.7	38,604	38.7
1991	200,662	28.1	72,929	37.7	72,929	37.7
1992	208,097	17.9	75,631	30.9	75,631	30.9
1993	239,559	27.4	87,066	37.2	87,066	37.2
1994	55,638	18.7	20,221	31.4	20,221	31.4
1995	123,454	9.4	44,868	26.9	44,868	26.9
1996	76,529	10.4	27,814	27.3	27,814	27.3
1997	37,524	10.4	13,638	27.2	13,638	27.2
1998	67,147	1.9	24,404	25.3	24,404	25.3
1999	89,928	45.8	32,684	52.3	32,684	52.3
2000	13,573	0.0	4,933	25.2	4,933	25.2
2001	3,670	0.0	1,334	25.2	1,334	25.2
2002	66,422	28.9	24,141	38.3	24,141	38.3
2003	64,806	22.6	23,553	33.8	23,553	33.8
2004	9,818	5.2	3,568	25.7	3,568	25.7
2005	113	0.0	41	25.2	41	25.2
2006	214,909	0.0	78,107	25.2	78,107	25.2
2007	138,102	7.3	50,192	26.2	50,192	26.2
2008	126,763	10.9	46,071	27.5	46,071	27.5
2009	39,163	21.2	14,234	33.0	14,234	33.0
2010	39,723	7.4	14,437	26.2	14,437	26.2
2011	14,956	0.0	5,436	25.2	5,436	25.2
2012	102,479	2.8	37,245	25.4	37,245	25.4
2013	99,894	32.7	36,306	41.3	36,306	41.3
2014	45,420	22.8	16,508	34.0	16,508	34.0
2015	51,533	61.5	18,729	66.5	18,729	66.5
2016	66,425	30.1	24,142	39.2	24,142	39.2
2017	43,316	43.8	15,743	50.5	15,743	50.5
2018	37,575	12.7	13,656	28.2	13,656	28.2
2019	31,191	39.7	11,336	47.1	11,336	47.1
2020	195,530	81.4	71,064	85.2	71,064	85.2

Table B3 cont.; Releases (no. fish)

Year	MRIP - FCAL Estimates	PSE	Calibrated by Assessment: FCAL to SRFS Estimates	PSE	Calibrated by Pressure: FCAL to SRFS Estimates	PSE
	Releases (no. fish)					
1982	0	NA	0	NA	0	NA
1983	0	NA	0	NA	0	NA
1984	234,463	0.0	112,818	19.6	112,818	19.6
1985	NA		NA		NA	
1986	3,472	0.0	1,671	19.6	1,671	19.6
1987	86,035	63.7	41,398	66.6	41,398	66.6
1988	133,090	2.7	64,040	19.8	64,040	19.8
1989	9,144	100.0	4,400	101.9	4,400	101.9
1990	48,582	82.4	23,376	84.7	23,376	84.7
1991	547,934	23.5	263,652	30.6	263,652	30.6
1992	129,211	12.9	62,173	23.5	62,173	23.5
1993	638,531	66.7	307,246	69.5	307,246	69.5
1994	123,183	49.3	59,272	53.1	59,272	53.1
1995	184,865	51.9	88,953	55.5	88,953	55.5
1996	158,756	20.5	76,390	28.4	76,390	28.4
1997	355,014	8.4	170,824	21.3	170,824	21.3
1998	383,506	19.3	184,534	27.5	184,534	27.5
1999	56,231	41.9	27,057	46.3	27,057	46.3
2000	17,674	0.0	8,504	19.6	8,504	19.6
2001	12,989	0.0	6,250	19.6	6,250	19.6
2002	8,657	65.1	4,165	68.0	4,165	68.0
2003	86,007	18.1	41,384	26.7	41,384	26.7
2004	31,320	21.7	15,071	29.2	15,071	29.2
2005	448,533	0.0	215,823	19.6	215,823	19.6
2006	54,772	0.0	26,355	19.6	26,355	19.6
2007	189,616	45.7	91,239	49.7	91,239	49.7
2008	142,776	26.1	68,700	32.6	68,700	32.6
2009	93,706	13.2	45,089	23.6	45,089	23.6
2010	12,613	36.4	6,069	41.4	6,069	41.4
2011	8,938	0.0	4,301	19.6	4,301	19.6
2012	104,090	16.9	50,086	25.9	50,086	25.9
2013	292,692	43.0	140,836	47.2	140,836	47.2
2014	110,564	33.6	53,201	38.9	53,201	38.9
2015	22,245	40.6	10,704	45.1	10,704	45.1
2016	182,840	15.5	87,978	25.0	87,978	25.0
2017	112,327	12.4	54,049	23.2	54,049	23.2
2018	58,113	21.0	27,963	28.7	27,963	28.7
2019	112,532	17.5	54,148	26.3	54,148	26.3
2020	335,332	37.4	161,354	42.2	161,354	42.2

Table B4. Historic FCAL (MRIP-FCAL) estimates, and estimates converted to SRFS currency either by assessment region (Calibrated by Assessment: FCAL to SRFS) or by fishing pressure regions (Calibrated by Pressure: FCAL to SRFS) for Mutton Snapper (*Lutjanus analis*) in the Atlantic Ocean.

	MRIP - FCAL		Calibrated by Assessment: FCAL to SRFS		Calibrated by Pressure: FCAL to SRFS	
Year	Estimate	PSE	Estimate	PSE	Estimate	PSE
	Landings (lbs)					
1982	177,863	39.1	95,723	41.4	94,812	40.9
1983	132,219	0.8	71,158	13.6	69,830	15.5
1984	548,377	19.4	295,128	23.6	289,619	24.8
1985	305,002	30.9	164,147	33.8	161,083	34.6
1986	203,342	11.1	109,435	17.5	107,776	18.6
1987	307,433	14.7	165,456	20.0	165,136	19.9
1988	105,541	28.8	56,801	31.8	55,740	32.7
1989	226,825	20.7	122,074	24.8	124,713	25.5
1990	250,420	19.3	134,772	23.6	132,256	24.7
1991	249,598	19.6	134,330	23.9	131,979	24.9
1992	201,133	10.8	108,247	17.4	106,437	18.6
1993	516,468	10.5	277,955	17.1	276,679	17.4
1994	256,065	18.7	137,811	23.1	135,498	24.0
1995	246,588	18.6	132,710	23.0	134,223	20.8
1996	264,667	20.4	142,440	24.5	140,710	25.0
1997	193,423	17.1	104,097	21.9	104,686	20.5
1998	257,466	14.5	138,564	19.8	140,680	19.5
1999	215,594	13.5	116,029	19.1	115,287	18.1
2000	500,753	12.1	269,498	18.2	267,252	18.2
2001	362,579	14.9	195,135	20.1	192,687	19.3
2002	453,804	9.1	244,230	16.3	243,270	15.6
2003	389,973	13.0	209,878	18.8	206,268	19.8
2004	396,851	18.2	213,579	22.7	210,167	23.6
2005	425,363	8.9	228,924	16.2	225,671	17.2
2006	571,517	11.1	307,582	17.5	303,278	18.4
2007	761,291	9.8	409,715	16.7	404,273	17.5
2008	364,839	10.7	196,351	17.3	197,449	17.0
2009	386,879	11.6	208,213	17.9	206,251	18.2
2010	476,249	13.0	256,310	18.8	251,796	19.9
2011	129,601	13.2	69,749	18.9	68,987	17.4
2012	248,468	12.7	133,722	18.6	133,163	18.6
2013	422,382	14.3	227,319	19.7	224,834	20.1
2014	734,715	20.0	395,413	24.2	398,283	23.1
2015	775,192	8.5	417,197	16.0	416,880	14.8
2016	884,905	19.8	476,242	24.0	480,491	23.4
2017	428,288	21.3	230,498	25.2	236,011	26.0
2018	448,413	12.9	241,329	18.8	237,800	19.7
2019	577,649	10.9	310,882	17.4	318,384	16.4
2020	370,145	9.6	199,207	16.6	208,484	16.6

Table B4 cont.: Landings (no. fish)

Year	MRIP - FCAL Estimate	MRIP - FCAL PSE	Calibrated by Assessment: FCAL to SRFS Estimate	Calibrated by Assessment: FCAL to SRFS PSE	Calibrated by Pressure: FCAL to SRFS Estimate	Calibrated by Pressure: FCAL to SRFS PSE
	Landings (no. fish)					
1982	84,113	30.0	44,550	33.8	44,401	29.6
1983	87,083	3.0	46,122	15.9	46,508	17.7
1984	222,392	35.9	117,787	39.1	118,773	39.9
1985	63,912	53.2	33,850	55.5	34,134	56.0
1986	74,202	19.9	39,300	25.3	39,308	20.2
1987	102,766	36.4	54,429	39.6	53,636	39.2
1988	58,111	20.2	30,778	25.6	31,035	26.7
1989	74,855	33.7	39,646	37.2	39,281	36.7
1990	78,441	25.0	41,546	29.5	41,893	30.5
1991	71,045	23.7	37,628	28.4	37,899	29.2
1992	82,716	13.2	43,809	20.5	44,105	21.2
1993	228,748	14.9	121,154	21.6	121,612	21.7
1994	106,252	22.9	56,275	27.7	56,684	28.3
1995	63,422	20.4	33,591	25.7	33,525	25.8
1996	52,903	28.4	28,019	32.4	28,157	32.8
1997	45,486	22.1	24,091	27.1	24,105	26.1
1998	70,169	16.4	37,164	22.7	36,872	21.0
1999	61,555	15.3	32,602	21.8	32,462	21.5
2000	115,611	16.7	61,232	22.9	61,534	22.5
2001	90,270	20.1	47,810	25.4	48,118	24.9
2002	155,796	12.2	82,515	19.8	82,842	20.0
2003	110,025	17.2	58,273	23.2	58,693	24.0
2004	114,623	25.2	60,708	29.7	61,113	30.1
2005	145,621	13.7	77,126	20.8	77,565	21.1
2006	178,895	15.3	94,749	21.9	95,302	22.4
2007	203,607	12.3	107,838	19.9	108,333	20.0
2008	136,350	12.9	72,216	20.3	72,172	19.5
2009	152,023	17.1	80,517	23.1	80,919	23.4
2010	143,418	14.4	75,960	21.2	76,546	22.2
2011	38,768	18.0	20,533	23.8	20,612	19.7
2012	63,795	17.7	33,788	23.6	33,817	23.8
2013	133,599	17.0	70,759	23.1	71,131	23.4
2014	265,989	27.2	140,878	31.4	140,664	30.8
2015	176,941	18.4	93,715	24.1	93,524	20.0
2016	228,901	29.2	121,234	33.1	120,466	33.5
2017	117,391	17.4	62,175	23.4	61,862	23.1
2018	140,990	23.0	74,674	27.8	75,140	28.5
2019	161,708	38.5	85,647	41.5	85,504	41.8
2020	62,975	18.0	33,354	23.9	32,900	25.4

Table B4 cont.: Releases (no. fish)

Year	MRIP - FCAL		Calibrated by Assessment: FCAL to SRFS		Calibrated by Pressure: FCAL to SRFS	
	Estimates	PSE	Estimates	PSE	Estimates	PSE
	Releases (no. fish)					
1982	0	NA	0	NA	0	NA
1983	21,758	0.0	11,900	10.7	11,716	13.0
1984	4,386	100.0	2,399	100.6	2,362	100.8
1985	90,711	100.0	49,614	100.6	48,846	100.8
1986	31,470	37.3	17,212	38.8	16,946	39.5
1987	202,822	81.4	110,932	82.1	113,310	15.9
1988	17,872	54.8	9,775	55.8	9,624	56.3
1989	27,034	35.8	14,786	37.4	14,681	37.6
1990	4,497	0.0	2,460	10.7	2,421	13.0
1991	21,738	34.7	11,889	36.3	11,705	37.1
1992	112,941	38.7	61,772	40.1	60,932	40.4
1993	164,526	26.1	89,986	28.2	88,940	28.6
1994	120,448	23.9	65,878	26.2	66,281	14.5
1995	50,927	17.9	27,854	20.9	27,506	21.6
1996	51,349	28.7	28,085	30.6	28,009	30.7
1997	110,990	18.8	60,705	21.6	60,512	21.5
1998	125,037	21.4	68,388	23.9	68,287	20.8
1999	75,657	16.2	41,380	19.4	41,768	17.4
2000	142,046	24.4	77,691	26.6	76,686	26.9
2001	74,528	20.6	40,762	23.2	40,491	20.3
2002	157,984	19.3	86,408	22.1	86,179	18.3
2003	82,805	14.2	45,290	17.8	45,124	16.5
2004	114,551	20.3	62,653	23.0	61,731	23.7
2005	165,354	19.0	90,439	21.8	89,679	21.9
2006	283,351	18.8	154,976	21.6	154,399	21.1
2007	343,474	16.7	187,860	19.9	187,377	19.6
2008	369,604	23.0	202,152	25.4	203,657	16.0
2009	215,635	17.3	117,940	20.3	118,078	17.8
2010	83,527	17.1	45,685	20.2	45,271	19.2
2011	36,243	28.3	19,823	30.3	19,976	28.8
2012	57,526	19.3	31,464	22.0	31,642	16.4
2013	202,726	25.7	110,879	27.8	111,109	26.1
2014	500,692	27.0	273,849	29.1	272,225	28.9
2015	445,619	17.3	243,728	20.4	244,893	19.6
2016	596,600	22.9	326,305	25.3	323,299	19.4
2017	454,281	13.1	248,465	16.9	246,781	17.0
2018	519,080	19.2	283,906	22.0	280,150	22.8
2019	418,633	14.9	228,968	18.3	227,304	18.4
2020	421,587	18.3	230,583	21.2	230,551	21.0

Table B7. Historic FCAL (MRIP-FCAL) estimates, and estimates converted to SRFS currency either by assessment region (Calibrated by Assessment: FCAL to SRFS) or by fishing pressure regions (Calibrated by Pressure: FCAL to SRFS) for Yellowtail Snapper (*Ocyurus chrysurus*) in the Florida.

	MRIP - FCAL		Calibrated by Assessment: FCAL to SRFS		Calibrated by Pressure: FCAL to SRFS	
Year	Estimates	PSE	Estimates	PSE	Estimates	PSE
	Landings (lbs)					
1982	6,404,701	13.7	4,055,430	15.3	3,150,441	16.1
1983	588,782	17.2	372,815	18.5	288,719	19.1
1984	2,444,545	29.5	1,547,876	30.3	1,202,613	30.7
1985	2,031,748	27.3	1,286,494	28.2	999,233	28.6
1986	1,532,219	30.2	970,195	30.9	753,787	31.3
1987	1,446,231	18.0	915,748	19.2	758,476	18.5
1988	784,926	1.9	497,012	7.1	386,150	8.7
1989	9,326,900	28.2	5,905,755	29.0	4,600,229	29.4
1990	4,844,488	36.4	3,067,510	37.0	2,383,283	37.4
1991	9,256,266	38.2	5,861,029	38.8	4,557,471	39.1
1992	838,989	19.5	531,244	20.7	431,162	20.3
1993	1,991,149	10.1	1,260,787	12.2	1,021,253	12.4
1994	1,599,074	13.3	1,012,527	14.9	799,021	15.2
1995	1,781,625	13.1	1,128,118	14.8	876,484	15.5
1996	1,140,143	13.5	721,934	15.1	560,816	15.9
1997	999,537	16.7	632,902	18.1	492,974	18.6
1998	905,971	17.6	573,657	18.8	445,058	19.4
1999	740,286	14.8	468,746	16.3	421,404	13.9
2000	597,400	20.0	378,271	21.1	296,220	21.2
2001	503,492	34.0	318,809	34.7	260,063	33.2
2002	702,957	11.2	445,110	13.1	348,380	13.3
2003	1,427,775	9.9	904,061	12.1	710,538	12.4
2004	1,341,952	22.8	849,719	23.8	708,973	22.5
2005	423,966	16.7	268,453	18.0	249,879	10.0
2006	1,528,385	17.1	967,767	18.4	877,449	7.8
2007	1,614,039	22.6	1,022,003	23.6	814,637	9.6
2008	2,680,014	17.6	1,696,974	18.8	1,318,096	18.4
2009	781,132	8.4	494,609	10.8	423,674	11.9
2010	752,828	14.1	476,688	15.6	389,012	15.5
2011	803,875	15.0	509,010	16.5	460,901	14.7
2012	710,276	27.6	449,744	28.5	349,425	28.9
2013	1,078,207	9.5	682,716	11.7	535,076	12.6
2014	1,380,437	9.2	874,087	11.5	697,073	12.2
2015	954,281	8.1	604,247	10.6	527,006	10.2
2016	1,119,074	10.5	708,593	12.5	556,051	13.3
2017	1,533,532	9.5	971,026	11.7	1,144,113	9.4
2018	1,232,492	8.4	780,409	10.8	703,155	10.1
2019	576,901	16.4	365,291	17.7	374,578	18.1
2020	1,104,697	16.1	699,490	17.5	545,251	18.1

Table B7 cont. ; Landings (no. fish)

Year	MRIP - FCAL Estimates	PSE	Calibrated by Assessment: FCAL to SRFS Estimates	PSE	Calibrated by Pressure: FCAL to SRFS Estimates	PSE
	Landings (no. fish)					
1982	5,627,105	23.7	3,512,214	25.8	2,688,522	26.6
1983	1,113,852	24.3	695,222	26.3	532,055	27.1
1984	3,815,673	40.9	2,381,590	42.2	1,823,347	42.7
1985	1,570,557	45.2	980,279	46.3	749,895	46.8
1986	1,047,086	47.0	653,549	48.1	500,358	48.6
1987	1,088,170	25.8	679,192	27.7	589,809	24.9
1988	1,060,090	17.0	661,666	19.8	510,860	20.7
1989	4,591,442	27.4	2,865,794	29.2	2,206,396	29.8
1990	3,273,721	46.9	2,043,326	48.0	1,564,371	48.4
1991	4,036,275	52.8	2,519,281	53.8	1,938,801	53.9
1992	775,817	23.7	484,234	25.8	399,349	24.6
1993	1,795,885	16.3	1,120,919	19.2	919,463	18.6
1994	1,182,065	18.4	737,797	21.0	583,087	21.1
1995	1,758,398	19.7	1,097,521	22.2	840,263	23.0
1996	792,490	18.8	494,641	21.4	378,587	22.3
1997	743,325	21.2	463,953	23.5	356,576	24.2
1998	844,331	25.3	526,997	27.3	402,337	27.9
1999	613,353	18.6	382,830	21.2	368,788	18.0
2000	640,955	34.0	400,058	35.5	310,538	35.2
2001	448,161	51.9	279,724	52.9	225,204	50.5
2002	841,306	16.0	525,110	19.0	408,339	19.0
2003	1,368,061	14.6	853,889	17.8	667,851	17.8
2004	1,294,749	39.2	808,130	40.5	663,259	38.1
2005	424,258	23.4	264,805	25.5	251,701	16.3
2006	1,401,336	23.2	874,658	25.3	785,962	11.4
2007	1,367,274	27.4	853,398	29.2	674,915	13.9
2008	2,221,233	28.0	1,386,405	29.8	1,061,801	29.7
2009	813,889	14.3	507,997	17.6	432,920	17.8
2010	688,166	16.0	429,526	19.0	346,218	18.9
2011	506,206	21.2	315,953	23.6	289,182	20.4
2012	662,936	39.0	413,778	40.4	316,789	40.9
2013	1,354,857	12.9	845,647	16.5	653,580	17.5
2014	1,264,803	13.6	789,440	17.0	618,627	17.7
2015	941,561	10.9	587,684	15.0	526,687	13.8
2016	1,188,881	13.2	742,052	16.7	577,031	17.6
2017	1,263,207	13.6	788,444	17.0	995,538	14.2
2018	1,457,172	13.7	909,508	17.1	811,508	15.6
2019	586,532	25.8	366,090	27.7	406,333	27.5
2020	1,255,995	26.1	783,942	28.0	603,023	28.6

Table B7 cont.; Releases (no. fish)

Year	MRIP - FCAL Estimates	MRIP - FCAL PSE	Calibrated by Assessment: FCAL to SRFS Estimates	Calibrated by Assessment: FCAL to SRFS PSE	Calibrated by Pressure: FCAL to SRFS Estimates	Calibrated by Pressure: FCAL to SRFS PSE
	Releases (no. fish)					
1982	1,045,386	24.3	570,475	26.7	466,618	22.8
1983	467,036	71.2	254,865	72.1	181,978	71.4
1984	3,536,618	39.1	1,929,960	40.7	1,360,379	41.1
1985	215,981	1.1	117,863	11.2	88,818	11.8
1986	767,197	37.7	418,665	39.3	311,715	37.6
1987	1,612,071	23.5	879,719	26.0	1,084,315	15.1
1988	892,738	29.7	487,174	31.8	343,397	32.2
1989	2,372,095	24.1	1,294,470	26.5	937,012	26.4
1990	1,564,314	16.6	853,658	20.0	620,127	20.2
1991	11,691,255	24.0	6,380,008	26.4	4,547,331	26.8
1992	2,570,450	15.3	1,402,715	18.9	1,128,803	18.4
1993	3,675,977	13.3	2,006,009	17.3	1,836,588	14.1
1994	2,385,941	18.4	1,302,027	21.5	1,136,620	17.9
1995	2,879,028	18.2	1,571,108	21.3	1,148,634	21.4
1996	2,870,471	8.5	1,566,438	14.0	1,236,931	13.5
1997	3,175,411	16.7	1,732,846	20.1	1,940,828	13.6
1998	1,770,389	16.6	966,115	20.0	946,691	15.2
1999	1,868,766	21.2	1,019,800	24.0	1,566,532	13.8
2000	1,485,844	18.3	810,837	21.4	614,013	20.8
2001	736,511	24.3	401,920	26.8	437,439	14.7
2002	1,093,557	15.2	596,763	18.9	646,576	12.9
2003	1,408,414	8.3	768,583	13.9	629,047	12.9
2004	1,329,119	13.7	725,310	17.7	572,750	17.2
2005	1,133,592	18.3	618,610	21.4	1,666,634	12.1
2006	2,519,819	10.7	1,375,085	15.4	1,440,686	10.3
2007	2,864,653	16.1	1,563,264	19.6	1,374,981	15.2
2008	2,521,215	18.7	1,375,846	21.8	1,091,098	16.1
2009	1,535,052	13.0	837,690	17.1	673,411	13.0
2010	1,442,850	22.4	787,375	25.0	585,909	24.4
2011	768,577	27.2	419,418	29.4	392,313	22.7
2012	1,217,864	18.8	664,598	21.9	504,253	21.1
2013	3,896,486	22.7	2,126,342	25.2	1,541,428	25.2
2014	3,229,733	15.3	1,762,490	18.9	1,371,150	17.9
2015	1,787,124	15.1	975,248	18.8	859,949	16.3
2016	1,243,011	18.7	678,321	21.7	528,499	20.4
2017	1,168,907	12.6	637,881	16.8	983,623	10.6
2018	2,234,346	20.0	1,219,300	22.8	1,141,401	18.7
2019	709,305	16.8	387,073	20.1	470,102	37.1
2020	1,147,231	20.7	626,053	23.5	501,044	21.4

APPENDIX C:
Evaluating Different Variance Calculation Methods

Methods

There are multiple methods available to calculate the variance of ratios and products. In this calibration we recommend the use of the delta method approximation because it can be used for both the variance of the ratio [c1] and the variance of the final calibrated estimates [c3], and we want to ensure consistency in this regard. The delta method and other tested methods also allow for correlation to be easily incorporated if, in the future, some percent correlation greater than 0% is recommended. Additionally, these methods incorporate error associated with both the numerator and denominator for the ratio and both the ratio and the FCAL estimate for the product calculation. The estimates ($\hat{E}$) and variances ($\hat{V}$) for each estimation method (*m: SRFS, FCAL*) for each combination of species (*s*) and variable (*v*: number landed, pounds landed, number released) are shown in the below equations.

To calculate the variance around the ratio of SRFS estimates to FCAL estimates [c1], the delta method was compared with an approximation of the ratio's variance.

$$\hat{R}_{s,v} = \frac{\hat{E}_{SRFS,s,v}}{\hat{E}_{FCAL,s,v}} \text{ [c1]}$$

The R statistical software package 'msm' and the function deltamethod (R Core Team 2023; Jackson 2011) was used to carry out the delta method calculations. The approximation of the ratio's variance was completed using the below equation (Cochran 1977) [c2]:

$$\hat{V}(\hat{R}_{s,v}) = \left(\frac{\hat{E}_{SRFS,s,v}}{\hat{E}_{FCAL,s,v}}\right)^2 \times \left(\frac{\hat{V}(\hat{E}_{FCAL,s,v})}{\hat{E}_{FCAL,s,v}{}^2} + \frac{\hat{V}(\hat{E}_{SRFS,s,v})}{\hat{E}_{SRFS,s,v}{}^2}\right) \text{ [c2]}$$

Historic estimates were converted to SRFS currency by multiplying the annual FCAL estimate for each year, species, region, and variable type (number landed, pounds landed, number released) [c3] with the corresponding ratio [c1]:

$$\hat{E}_{GRFS-hind,y,s,v} = \hat{R}_{s,v}\hat{E}_{FCAL,y,s,v} \text{ [c3]}$$

Variance around these estimates was calculated using the delta method (Jackson 2011) and compared with variance calculated using Goodman's formula (Goodman 1960) [c4].

$$\hat{V}(\hat{E}_{GRFS-hind,y,s,v}) = \left(\hat{E}_{FCAL,y,s,v}{}^2 \times \hat{V}(\hat{R}_{s,v})\right) + \left(\hat{R}_{s,v}{}^2 \times \hat{V}(\hat{E}_{FCAL,s,v})\right) \text{ [c4]}$$

For all variance calculations we assumed a 0% correlation. SRFS and MRIP estimates are derived from survey data that are not completely independent. However, the strength of correlation between estimates from the two surveys is unknown. Using a 0% correlation is the most conservative approximation of variance if correlation between the two survey estimates is ignored (Cross et al. 2020). This correlation percentage was also recommended by peer review (Stokes et al. 2020).

Findings & Conclusions

The delta method and the approximation of the variance of a ratio generated identical variances for all of the ratios calculated (Figure C1, Table C1). Goodman's formula and the delta method also generated identical standard deviations and percent standard errors (Figure C2, Table C2, supporting documentation).

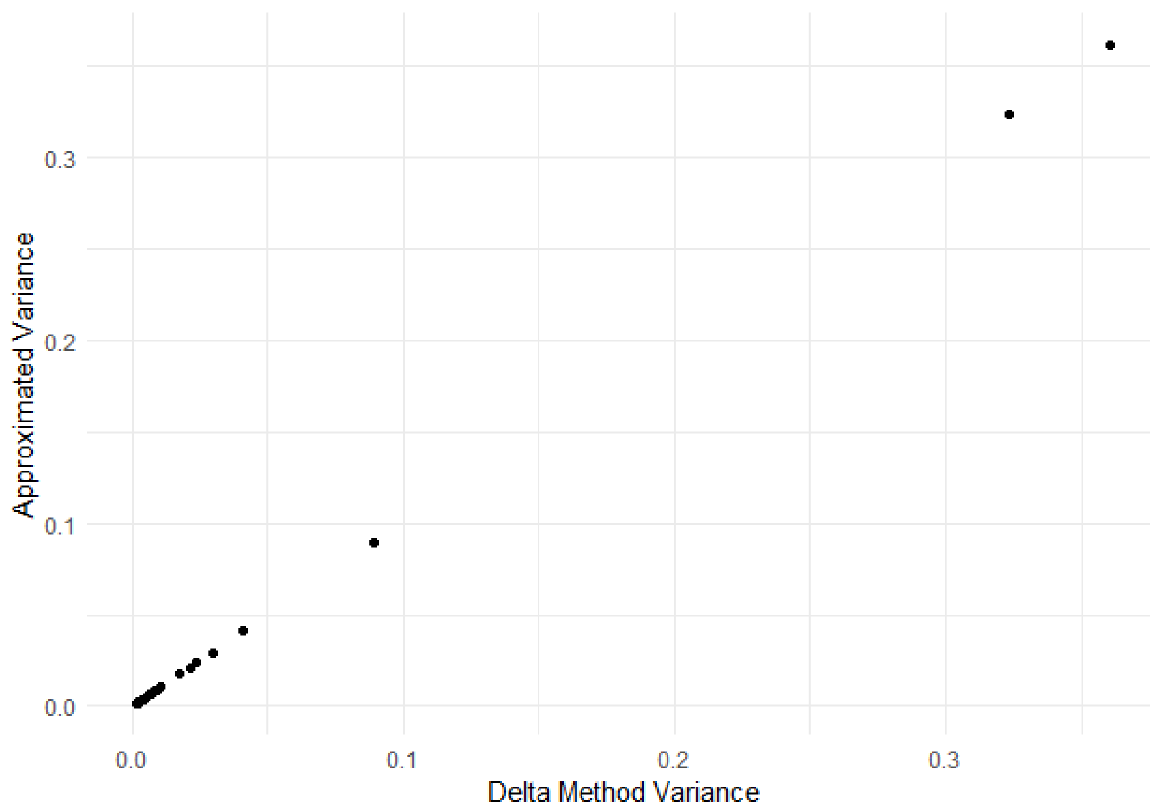

Figure C1. All of the variances around the calculated ratios for all species, regions, and estimate types calculated using either the delta method or the formula for approximating the variance around a ratio.

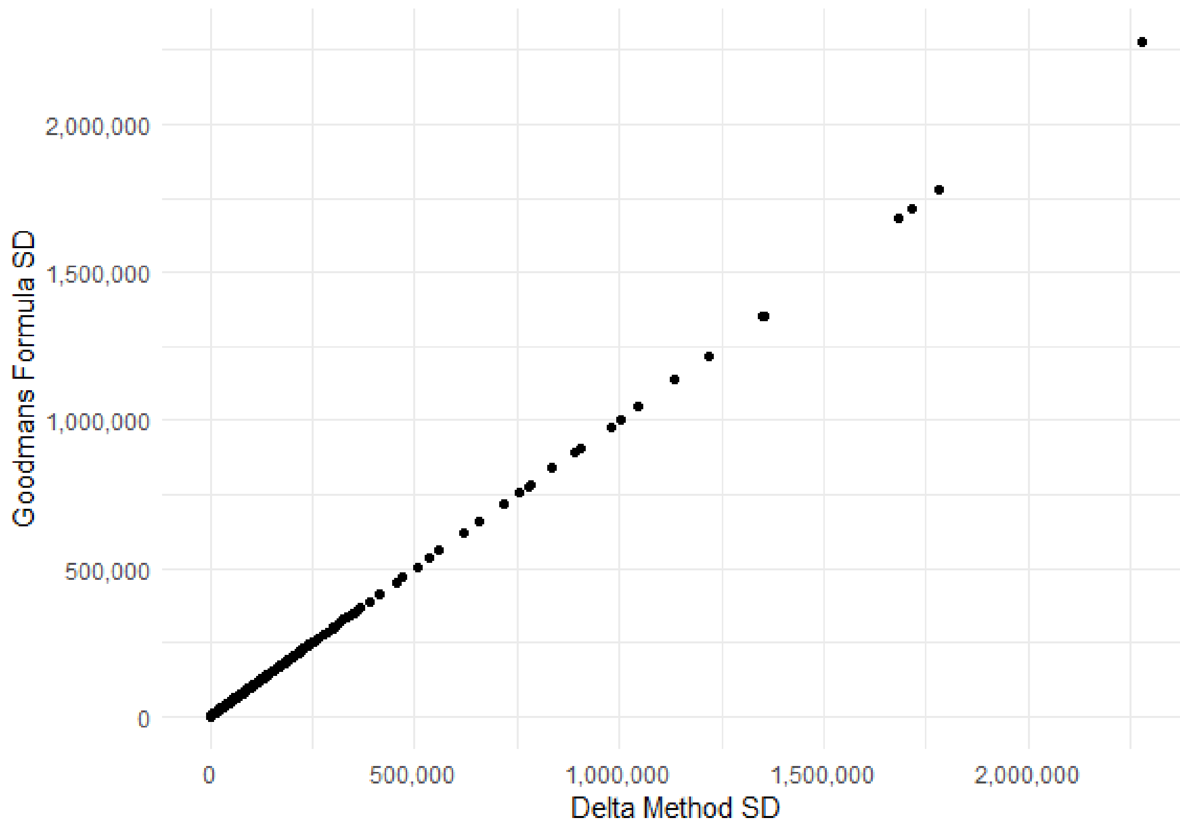

Figure C2. All of the standard deviations (SD) around the calibrated estimates for all species, regions, and estimate types calculated using either the delta method or the Goodman's formula.

Table C1. The variances for the estimate ratios using both the delta method and an approximation for the variance of a ratio are shown. A unique ratio and its variance were calculated for each species, calibrated region, and estimate type.

Common Name	Region	Estimate Type	delta method	approximation
Mutton Snapper	atl	Landing (lbs)	0.005332	0.005332
		Landing (no. fish)	0.006848	0.006848
		Releases (no. fish)	0.003422	0.003422
	gulfk	Landing (lbs)	0.001910	0.001910
		Landing (no. fish)	0.008386	0.008386
		Releases (no. fish)	0.008894	0.008894
Yellowtail Snapper	state	Landing (lbs)	0.001864	0.001864
		Landing (no. fish)	0.004050	0.004050
		Releases (no. fish)	0.003678	0.003678

Table C2. An example of how the error (as standard deviation; SD) and the percent standard error (PSE) is identical when calculated using the Goodman's formula compared to the delta method. Shown are the error for calibrated estimates of Mutton Snapper (*Lutjanus analis*) in the Atlantic.

	Landings (no. fish)				Releases (no. fish)			
year	delta SD	delta PSE	goodman SD	goodman PSE	delta SD	delta PSE	goodman SD	goodman PSE
1982	15,057	33.8	15,057	33.8	0	NA	0	NA
1983	7,338	15.9	7,338	15.9	1,273	10.7	1,273	10.7
1984	46,110	39.1	46,110	39.1	2,413	100.6	2,413	100.6
1985	18,777	55.5	18,777	55.5	49,897	100.6	49,897	100.6
1986	9,930	25.3	9,930	25.3	6,686	38.8	6,686	38.8
1987	21,550	39.6	21,550	39.6	91,078	82.1	91,078	82.1
1988	7,864	25.6	7,864	25.6	5,457	55.8	5,457	55.8
1989	14,739	37.2	14,739	37.2	5,524	37.4	5,524	37.4
1990	12,247	29.5	12,247	29.5	263	10.7	263	10.7
1991	10,688	28.4	10,688	28.4	4,318	36.3	4,318	36.3
1992	8,971	20.5	8,971	20.5	24,772	40.1	24,772	40.1
1993	26,148	21.6	26,148	21.6	25,374	28.2	25,374	28.2
1994	15,580	27.7	15,580	27.7	17,263	26.2	17,263	26.2
1995	8,633	25.7	8,633	25.7	5,813	20.9	5,813	20.9
1996	9,089	32.4	9,089	32.4	8,606	30.6	8,606	30.6
1997	6,529	27.1	6,529	27.1	13,105	21.6	13,105	21.6
1998	8,419	22.7	8,419	22.7	16,338	23.9	16,338	23.9
1999	7,120	21.8	7,120	21.8	8,027	19.4	8,027	19.4
2000	14,023	22.9	14,023	22.9	20,693	26.6	20,693	26.6
2001	12,157	25.4	12,157	25.4	9,456	23.2	9,456	23.2
2002	16,352	19.8	16,352	19.8	19,055	22.1	19,055	22.1
2003	13,521	23.2	13,521	23.2	8,041	17.8	8,041	17.8
2004	18,002	29.7	18,002	29.7	14,390	23.0	14,390	23.0
2005	16,032	20.8	16,032	20.8	19,706	21.8	19,706	21.8
2006	20,735	21.9	20,735	21.9	33,476	21.6	33,476	21.6
2007	21,471	19.9	21,471	19.9	37,315	19.9	37,315	19.9
2008	14,655	20.3	14,655	20.3	51,356	25.4	51,356	25.4
2009	18,624	23.1	18,624	23.1	23,994	20.3	23,994	20.3
2010	16,115	21.2	16,115	21.2	9,231	20.2	9,231	20.2
2011	4,889	23.8	4,889	23.8	5,998	30.3	5,998	30.3
2012	7,987	23.6	7,987	23.6	6,935	22.0	6,935	22.0
2013	16,362	23.1	16,362	23.1	30,833	27.8	30,833	27.8
2014	44,200	31.4	44,200	31.4	79,568	29.1	79,568	29.1
2015	22,631	24.1	22,631	24.1	49,612	20.4	49,612	20.4
2016	40,113	33.1	40,113	33.1	82,404	25.3	82,404	25.3
2017	14,543	23.4	14,543	23.4	41,930	16.9	41,930	16.9
2018	20,784	27.8	20,784	27.8	62,485	22.0	62,485	22.0
2019	35,580	41.5	35,580	41.5	41,930	18.3	41,930	18.3
2020	7,956	23.9	7,956	23.9	48,956	21.2	48,956	21.2