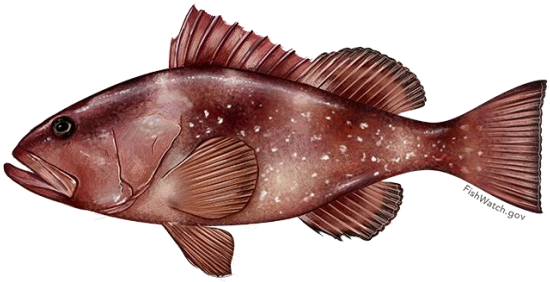

Interim Analysis for Gulf of Mexico Red Grouper

Gulf Fisheries Branch
Sustainable Fisheries Division
NOAA Fisheries - Southeast Fisheries Science Center

November 2022

Keywords

Interim Analysis, Index of Abundance, Red Grouper, Gulf of Mexico, Recreational Landings Weight-Adjusted ABC

Abstract

An Interim Analysis (IA) was conducted for Red Grouper following the Standard SEDAR61 stock assessment (*http://sedarweb.org/sedar-61*). This IA applies an index-based harvest control rule tested through simulation and implemented in the 2021 IA for Red Grouper. Data from the NMFS Bottom Longline Survey were used to produce an index of relative abundance updated through 2022 following the same methodology and approach described in Pollack et al. (2018). This analysis uses the index for the entire eastern Gulf of Mexico, as opposed to the reduced spatial coverage index of abundance which was ultimately utilized in the 2021 IA. Adjusted catch advice is presented, which takes into account the most recent survey trends in relative abundance, the allocations finalized in Amendment 53 and a post-SEDAR61 assessment adjustment to the Acceptable Biological Catch (ABC).

Introduction

Interim analyses (IA) are designed to occur between regular stock assessments conducted through the Southeast Data Assessment and Review process (SEDAR) to provide the opportunity to adjust harvest recommendations based on current stock conditions. For example, unpredictable events can occur such as a change in recruitment (e.g., pulse or failure), environmental disasters (e.g., red tides or hurricanes) or man-made disasters (e.g., Deepwater Horizon). The first IA for Red Grouper occurred in 2018. IAs have been conducted regularly since the first application in 2018, with the 2021 IA using the reduced spatial area index (Pollack 2021) formally accepted by the SSC to adjust the catch advice (**Table 1**). The adjusted catch advice from the 2021 IA took into account the updated allocations specified in Amendment 53

(GMFMC 2021) and was implemented in a Framework Action (GMFMC 2022). In 2022, the IA was used to gauge the health of the stock.

Recently, support has grown for an index-based harvest control rule that relies solely on the observed index and uses the ratio between recent and reference time periods to adjust the catch advice. This approach has been simulation tested for Vermilion Snapper (Hunyh et al. 2020) and was formally accepted by the Gulf of Mexico Fishery Management Council's Scientific and Statistical Committee for the 2021 IA for Red Grouper and the 2020 IAs for both Red Snapper and Gray Triggerfish. In addition to documenting acceptable performance for this index-based approach, Hunyh et al. (2020) showed that this approach performed well when circumstances arise that are not accounted for in projections, such as episodic natural mortality (e.g., red tide mortality). Therefore, this updated approach was preferred over the projection-based harvest control rule applied for Red Grouper between 2018 and early 2021, which compared the observed index of abundance to the index of abundance projected and expected by the SEDAR61 assessment model. The new approach removes the reliance on projected abundance from the SEDAR61 assessment model and its inherent assumptions (e.g., assumed red tide mortality in 2018 during the projection).

Concerns were raised over the status of Red Grouper in the Gulf of Mexico following the Standard SEDAR61 stock assessment (terminal year of 2017) due to an inability to harvest quotas (**Figure 1**). As of November 9, 2022, the commercial fishery has harvested about 73% of its quota in 2022 with about two months remaining. The recreational fishery exceeded its quota in both 2021 and 2022.

Materials and Methods

Index Data Source

The NMFS Mississippi Laboratories have conducted standardized bottom longline surveys in the Gulf of Mexico, Caribbean, and Western North Atlantic since 1995. The objective of these surveys is to provide fisheries independent data for stock assessment purposes. These surveys are conducted annually and provide an important source of fisheries independent information on large coastal sharks, snappers and groupers from the GOM and Atlantic. In 2011, a Congressional Supplement Sampling Program was conducted where high levels of survey effort were maintained from April through October (Campbell et al. 2012). For this analysis of Red Grouper, only Congressional Supplement Sampling Program data collected during the same time period as the annual survey (August/September) were used to supplement missing data from the NMFS Bottom Longline Survey in 2011.

Index of Abundance

A standardized index was developed using NMFS Bottom Longline Survey data using delta-lognormal generalized linear model methods described in Pollack et al. (2018). Data were limited to those stations completed in the eastern GOM (east of 87° W) and at depths less than 118 m. The index computed by this method is a mathematical combination of yearly abundance estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the nonzero abundance data (cf. Lo et al. 1992). Additional

details on survey design, data filtering and exclusions and modeling approach are provided in Pollack et al. (2018) and Pollack (2022; see Appendix).

Interim Approach

This IA of Red Grouper sought to quantify a target ABC adjustment through the use of a harvest control rule that utilizes recent trends in observed indices of abundance following the general methodology proposed by Huynh et al. (2020). Following the 2020 IA for Red Snapper, the approach presented in Huynh et al. (2020) was modified to add an additional source of tolerance for changing the catch advice. The harvest control rule takes the following forms depending on the number of years used in the moving average:

3-year moving average: $C_{y+1} = C_{ref} * (\frac{1}{3}\sum_{k=y-2}^{y} I_k)/(\frac{1}{3}\sum_{ref=yref-1}^{yref+1} I_{ref})$ (Equation 1)

5-year moving average: $C_{y+1} = C_{ref} * (\frac{1}{5}\sum_{k=y-4}^{y} I_k)/(\frac{1}{5}\sum_{ref=yref-3}^{yref+1} I_{ref})$ (Equation 2)

where:

C_{y+1} = Adjusted catch recommendation for year *y+1* (2023; considered for implementation starting in 2024)

C_{ref} = reference catch level (5.57 million pounds gutted weight) to be adjusted. This ABC is based on finalized allocations of 59.3% commercial and 40.7% recreational from Amendment 53 (GMFMC 2021) and a post-SEDAR61 assessment adjustment to the Acceptable Biological Catch (ABC). This ABC adjustment adjusted the projected recreational landings in weights using a mean weight scalar. The mean weight scalar was obtained by dividing the mean weight of Red Grouper landed by the recreational fishery based on the ACL monitoring dataset to the mean weight expected by the SEDAR61 assessment model (SEFSC 2021). This IA assumes that this ABC would have been implemented a year after the 2017 terminal year of SEDAR61 (Y_{ref} = 2018).

I_k = average of the observed index values during the recent period (3-year 2020-2022 or 5-year 2018-2022). Note that another version was developed which excluded the 2020 index value from the recent 3-year or 5-year mean. As discussed in detail during the 2021 IA, the 2020 index value for the full spatial area index was considered an overestimate due to reduced spatial coverage from COVID, mechanical issues, and weather delays (SEFSC 2020a).

I_{ref} = average of the observed index values during the reference period (3-year 2017-2019 or 5-year 2015-2019).

The time period of the moving average for I_{ref} and I_k was either 3 or 5 years to provide results with two ranges of tolerance for changes in catch advice.

Splitting the adjusted catch from the IA by sector was completed by using the allocation fractions listed above from Amendment 53 (GMFMC 2021).

Results

Index of Abundance

Figure 2 provides a comparison of the updated index for the Gulf of Mexico through 2022 to the SEDAR61 index with 95% confidence intervals. All updated index values fell within the confidence interval for the SEDAR61 index and the trends between indices were similar (**Figure 2**). Relative abundance peaked in 2011, was lowest in 2016, and has remained low in recent years, notably in 2022. Note that the 2020 index value shown for the full survey area was considered artificially high due to reduced spatial coverage of the survey in 2020 (SEFSC 2020a; Pollack 2020).

Interim Analysis

Adjustments to the SEDAR61-adjusted ABC (5.57 million pounds gutted weight; SEFSC 2021) were made using two separate moving average periods of 3- or 5- years. Recent index values were above the reference index values for the 3-year scenario (**Figure 3**) but nearly identical for the 5-year scenario (**Figure 4**), with index ratios of 1.18 and 1.03, respectively (**Table 2A**). Multiplying each index ratio by the reference catch resulted in adjusted catch recommendations from 5.57 million pounds gutted weight to 6.58 million pounds gutted weight using the 3-yr average and 5.75 million pounds gutted weight using the 5-yr average (**Table 3A**). Excluding the 2020 index value from the recent mean led to slightly smaller ratios (**Table 2B**) and therefore lower catch advice (**Table 3B**). Implementing any of the presented IA variations will increase the ABC from its reference value (5.57 million pounds gutted weight), unless the 5-year moving average is used while excluding the 2020 index value from the recent mean.

Discussion

This IA provides support for increasing the ABC beyond the current value of 4.96 million pounds gutted weight specified in the Framework Action (GMFMC 2022). However, the magnitude of increase is largely dependent upon the length of the moving time period for the recent index mean. When including the last 5 years, the recent index mean is very similar to the reference index mean, which leads to a smaller increase in the ABC compared to the 3-year moving average.

This IA provides updated recommendations for Gulf of Mexico Red Grouper using an approach vetted through simulations and recently implemented for Red Snapper (SEFSC 2020b) and Gray Triggerfish (SEFSC 2020c). Prior to 2021, IAs for Red Grouper applied a projection-based management procedure, however this approach was discontinued for numerous reasons. First, the simulation study by Hunyh et al. (2020) supported the application of this approach using vermilion snapper as an example species. Second, the results derived from the projection-based approach previously applied were strongly dependent upon assumptions made during the SEDAR61 assessment projections, such as the impact of the 2018 red tide event (assumed similar to the 2005 red tide event) and the catches input for 2019 (assumed removal of the commercial ACL in 2019 (realized catches were lower) and recreational landings similar to 2018 (realized 2019 catches were higher). Removing the reliance on projected abundance and instead comparing reference and recent index trends from the observed index is preferred because the observed index more accurately represents “real-time” trends in the population. Third, the

projection-based approach applied previously used a static ABC projection but was designed to work off of projected ABC values (i.e., varying annually).

Future simulation work focused on Red Grouper can provide additional support for base index selection and harvest control rule parameterization decisions on output obtained from a Management Strategy Evaluation (MSE). In the southeast, these MSEs will be conducted using an extension to the Stock Synthesis (SS) assessment software being developed by the SSMSE research program (*https://github.com/nmfs-fish-tools/SSMSE*). The SSMSE tool is still under active development, which creates an opportunity for stakeholders to suggest specific performance metrics (e.g., probability of overfishing, average yield, catch stability, etc.) that would facilitate the process of selecting the index/harvest control rule combination that best achieves the desired management outcome for any species in the fisheries management plan. Many MSE tradeoffs are fundamentally about balancing varied and sometimes competing management goals while sustaining the natural resource, and thus necessitate the involvement of management stakeholders. In these situations, the fundamental tradeoff is usually between total yield and interannual stability of yield (Miller et al. 2019). Often, stakeholders prefer management procedures that result in greater stability (usually less than a 20% change in quota from one period to the next) over the management procedures that give the highest potential yield due to preferring market stability and predictability. While we have not conducted a full stakeholder-inclusive MSE, as this requires an extended period of time, preferences for stability are generally universal.

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Tables

Table 1. History of interim analyses (IA) conducted and outcomes for Gulf of Mexico Red Grouper.

Year	Outcome
2018-Oct	Projection-based IA deemed suitable by SSC for interim catch advice but ultimately not used to set 2019 ACL in Emergency Rule or Framework Action (2017 landings used because they were lower)
2019-Dec	Projection-based IA used as a health check by SSC to evaluate assumption of 2018 red tide on population but not used to set catch advice due to allocation decisions needed
2020-Dec	Projection-based IA not recommended for use in setting catch advice by SSC due to concerns over the 2020 index value and allocation decisions needed
2021-Mar	Projection-based IA using reduced area index not recommended for use in setting catch advice by SSC due to allocation decisions needed
2021-Aug	IA using reduced area index and revised allocations accepted for use by SSC; Framework Action implemented results of IA which set ABC at 4.96 mp gw. The SSC chose to use the 3-year moving index average because it was slightly more conservative and thought to be more representative of recent population trends than the 5-year moving average, and because of uncertainty regarding the impacts of the 2021 red tide event on the West Florida Shelf.
2022-Mar	IA used as a health check by SSC
2023-Jan	IA for adjusting catch advice undergoing review by SSC

Table 2A. Index reference (I_{ref}), index recent (I_k), and index ratios (I_{ratio}) for the 2022 NMFS Bottom Longline Survey index averaged over 3- and 5-year time periods. The reference value I_{ref} was the average of index values from 2017-2019 or 2015-2019. The recent index value, I_k, was the average of index values for 2020-2022 or 2018-2022.

Value	3-year moving average	5-year moving average
Iref	0.60	0.60
Ik	0.71	0.62
Iratio	1.18	1.03

Table 2B. Index reference (I_{ref}), index recent (I_k), and index ratios (I_{ratio}) for the 2022 NMFS Bottom Longline Survey index averaged over 3- and 5-year time periods while excluding 2020 in the recent period. The reference value I_{ref} was the average of index values from 2017-2019 or 2015-2019. The recent index value, I_k, was the average of index values for 2021-2022 or 2018-2019 & 2021-2022.

Value	3-year moving average	5-year moving average
Iref	0.60	0.60
Ik	0.70	0.60
Iratio	1.16	0.99

Table 3A. 2023 Interim Assessment (IA) Acceptable Biological Catch (ABC) catch advice using the NMFS Bottom Longline Survey index, with a 3-or 5-year moving average for reduced tolerance to changes in catch advice. Values presented are in millions of pounds gutted weight.

Value	3-year moving average	5-year moving average
ABC	6.58	5.75
Commercial	3.9	3.41
Recreational	2.68	2.34

Table 3B. 2023 Interim Assessment (IA) Acceptable Biological Catch (ABC) catch advice using the NMFS Bottom Longline Survey index, with a 3-or 5-year moving average for reduced tolerance to changes in catch advice. Values presented are in millions of pounds gutted weight. Note that 2020 was not included in the recent mean.

Value	3-year moving average	5-year moving average
ABC	6.45	5.49
Commercial	3.82	3.26
Recreational	2.63	2.23

Figures

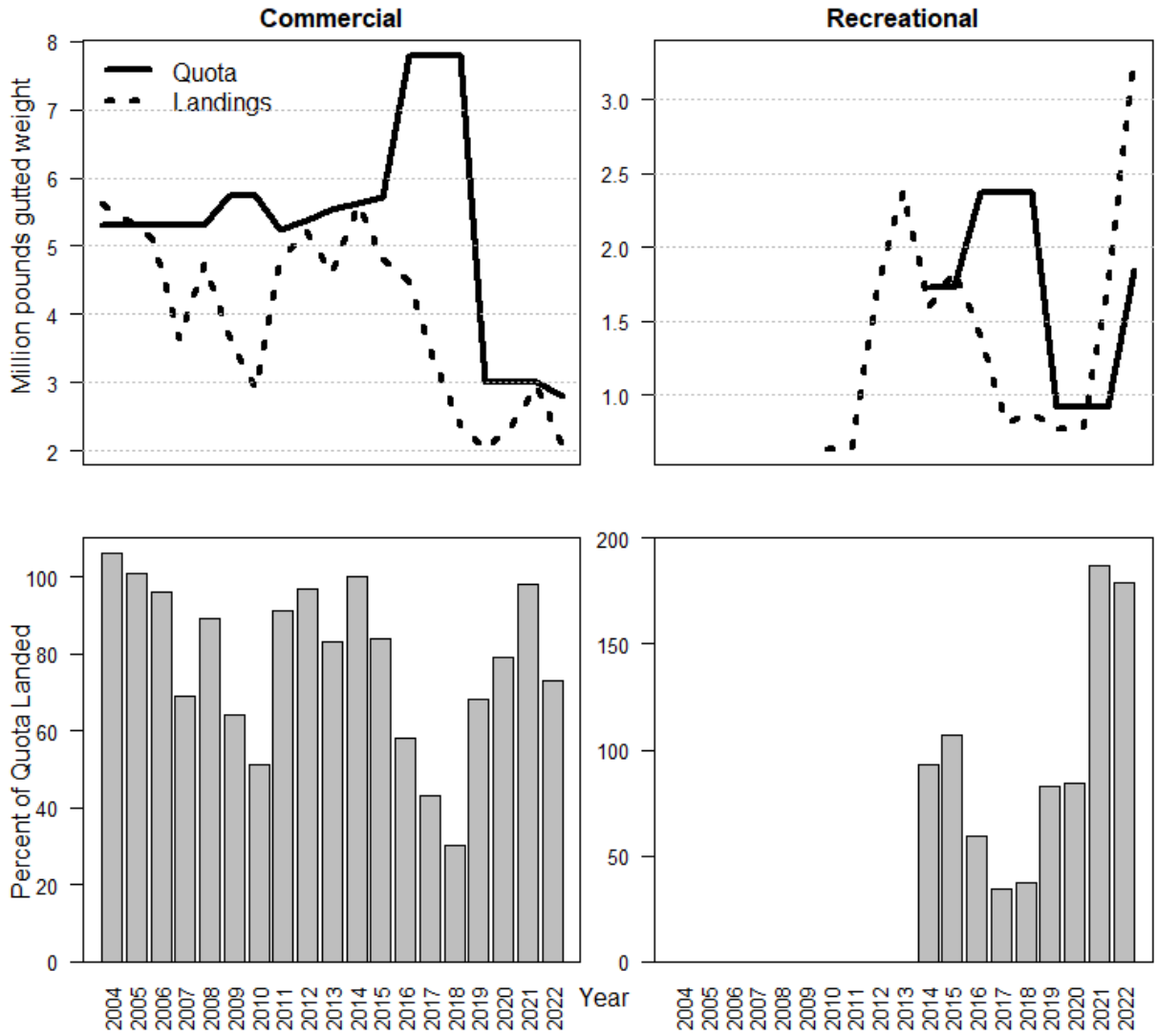

Figure 1. Commercial and recreational landings (dashed line) and quotas (thick line) for Gulf of Mexico Red Grouper. Bars represent the percent of quota landed. Note that y-axes differ between panels and **2022 landings are incomplete**. Commercial data from 2010 to **2022 (through 11/9)** were obtained from the Quotas and Catch Allowances, accessed November 9, 2022 (*https://secatchshares.fisheries.noaa.gov/additionalInformation* [select Commercial Quotas/Catch Allowances (all years)]), remaining years were obtained from the Gulf of Mexico Historical Commercial Landings and Annual Catch Limits (ACLs), updated October 23, 2020 (*https://www.fisheries.noaa.gov/southeast/gulf-mexico-historical-commercial-landings-and-annual-catch-limit-monitoring*). Recreational data from 2010 through 2020 were obtained from recreational historical landings, accessed November 9, 2022 (*https://www.fisheries.noaa.gov/southeast/recreational-fishing-data/gulf-mexico-historical-recreational-landings-and-annual-catch*), preliminary data from 2021 and **2022 (through August)** were obtained November 9, 2022 from *https://www.fisheries.noaa.gov/southeast/2021-and-2022-gulf-mexico-recreational-landings-and-annual-catch-limits-acls-and-annual*.

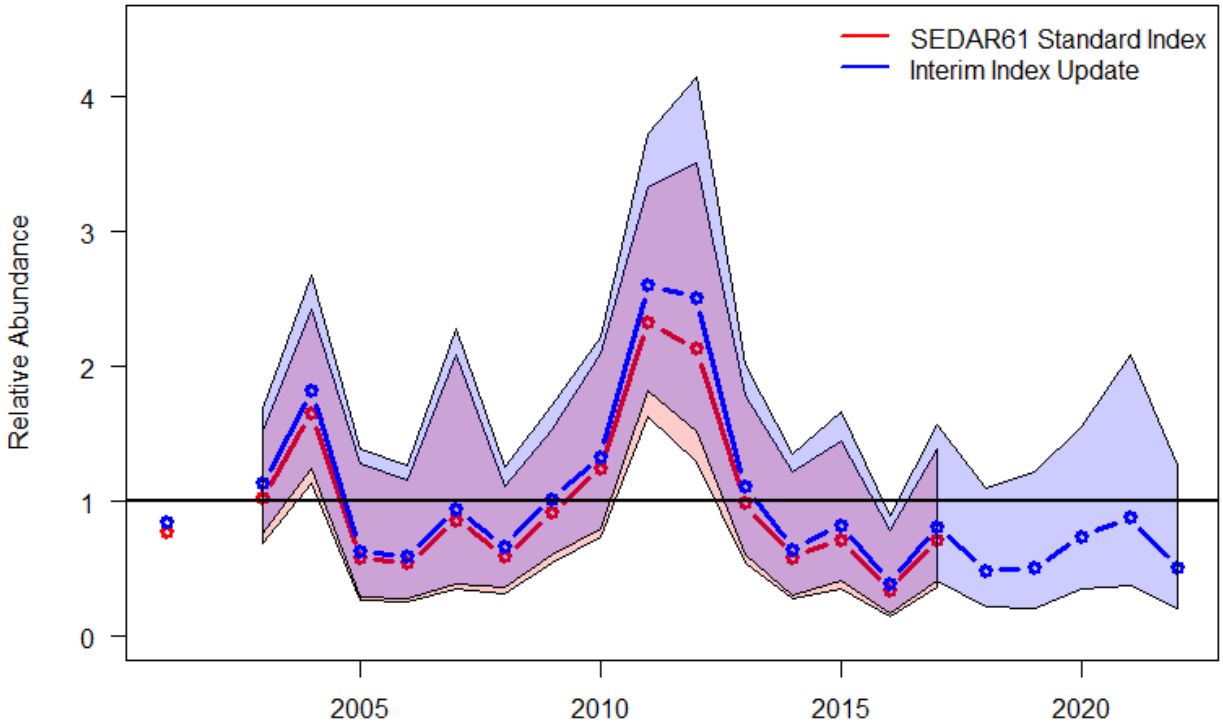

Figure 2. Comparison of NMFS Bottom Longline Survey index of abundance derived for Red Grouper in the Gulf of Mexico for SEDAR61 compared to the index updated through 2022 with confidence intervals. All indices have been standardized to a mean of 1.

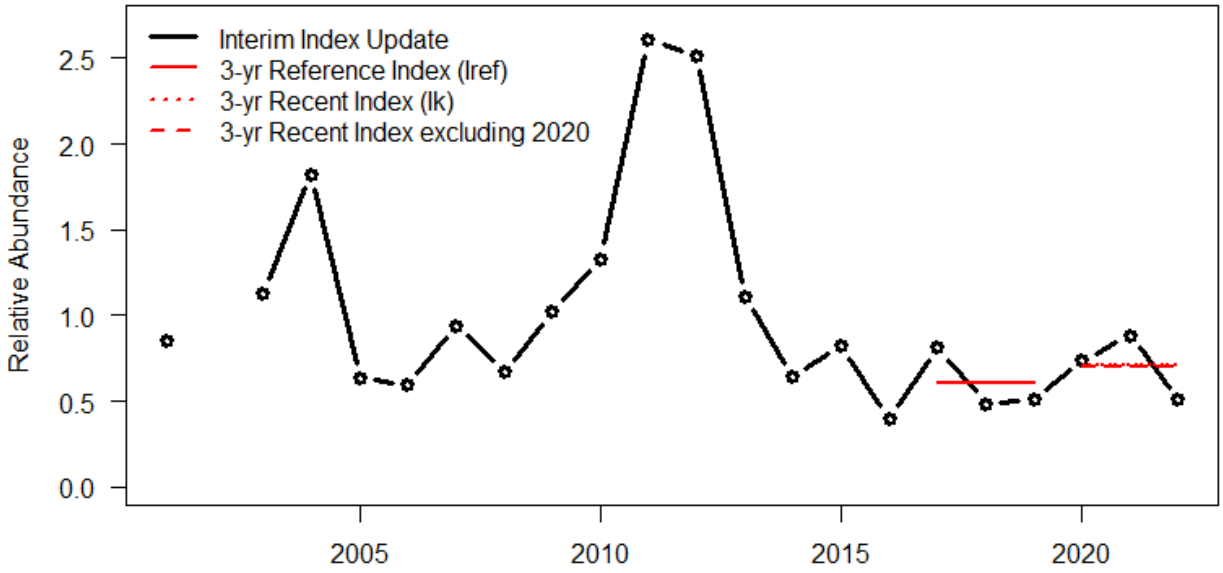

Figure 3. Comparison of the index of abundance derived for Red Grouper in the Gulf of Mexico through 2022 with the reference index value (solid line) and recent index value (dashed line) using a 3-year moving average for the recent period.

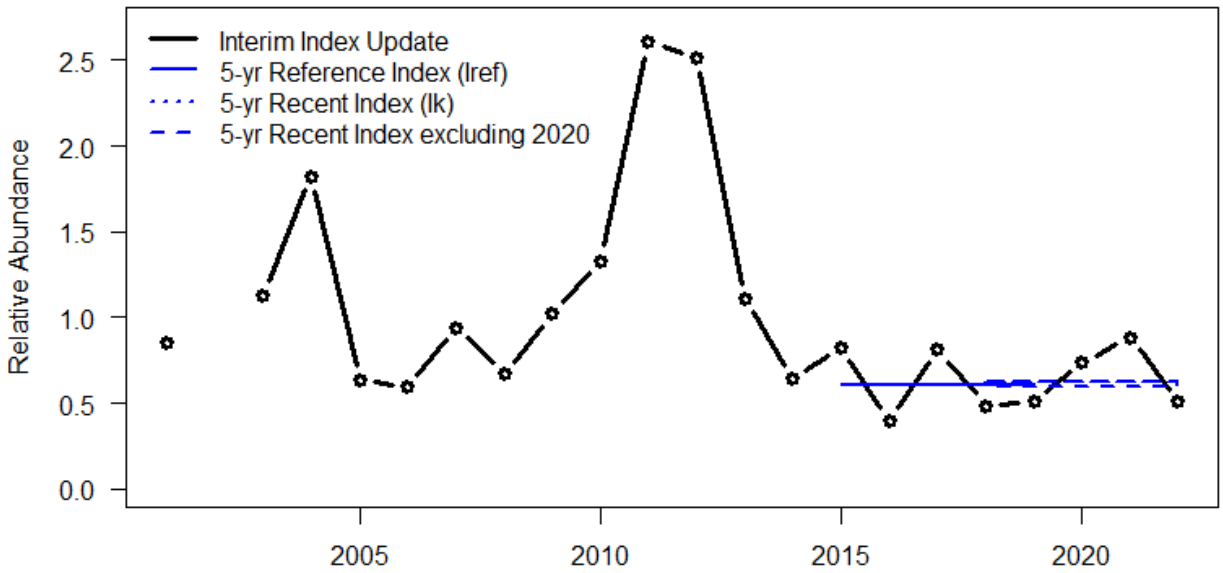

Figure 4. Comparison of the index of abundance derived for Red Grouper in the Gulf of Mexico through 2022 with the reference index value (solid line) and recent index value (dashed line) using a 5-year moving average for the recent period.

Appendix

An Updated Index of Relative Abundance for Red Grouper Captured During the NMFS Bottom Longline Survey in the Northern Gulf of Mexico

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November 2022

This document serves to update the index of relative abundance for red grouper (*Epinephelus morio*) captured during the NMFS Bottom Longline Survey in the Gulf of Mexico (GOM) through 2022. Data were limited to those stations completed in the eastern GOM (east of 87° W) and at depths less than 118 m (Figure 1). To date, only four red grouper have been captured westward of this boundary and no red grouper have been captured in the western GOM (west of 89.15° W). The analysis follows the same methodology (delta-lognormal model) as outlined in Pollack et al. (2018).

The final delta-lognormal NMFS Bottom Longline Survey index of red grouper abundance retained year, area, and depth in the binomial submodel, and year and area in the lognormal submodel. The updated annual abundance index is shown in Table 1 and Figure 2. Figure 3 shows the comparison between the updated index and the index presented for SEDAR 61. Yearly distribution and catches of red grouper are shown in Appendix 1.

Literature Cited

Pollack, A.G., David S. Hanisko and G. Walter Ingram, Jr. 2018. An Index of Relative Abundance for Red Grouper Captured During the NMFS Bottom Longline Survey in the Northern Gulf of Mexico. SEDAR61-WP-02. SEDAR, North Charleston, SC. 19 pp.

Table 1. Index of red grouper abundance developed using the delta-lognormal (DL) model for 2001-2022 for the NMFS Bottom Longline Survey. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per 100 hook hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
2001	0.21505	93	0.74337	0.84739	0.29078	0.47932	1.49811
2002							
2003	0.34188	117	0.99083	1.12949	0.20250	0.75641	1.68658
2004	0.41837	98	1.59984	1.82372	0.19345	1.24299	2.67576
2005	0.25000	40	0.55518	0.63288	0.40697	0.28926	1.38469
2006	0.28205	39	0.51909	0.59173	0.39321	0.27719	1.26319
2007	0.19048	42	0.82512	0.94059	0.46525	0.38808	2.27973
2008	0.26667	60	0.58777	0.67002	0.32179	0.35764	1.25525
2009	0.34921	63	0.89436	1.01952	0.26440	0.60619	1.71468
2010	0.34328	67	1.16656	1.32980	0.26010	0.79718	2.21828
2011	0.40164	122	2.28392	2.60354	0.18121	1.81734	3.72985
2012	0.46939	49	2.20397	2.51239	0.25471	1.52165	4.14819
2013	0.34043	47	0.97185	1.10786	0.30465	0.61054	2.01025
2014	0.26190	42	0.56366	0.64254	0.38424	0.30590	1.34967
2015	0.25000	52	0.72554	0.82707	0.35923	0.41204	1.66016
2016	0.18000	50	0.34360	0.39169	0.43434	0.17055	0.89954
2017	0.31818	44	0.71068	0.81013	0.34042	0.41777	1.57100
2018	0.18750	48	0.42551	0.48505	0.42667	0.21408	1.09902
2019	0.21053	38	0.44374	0.50584	0.46147	0.21007	1.21801
2020	0.31429	35	0.64733	0.73792	0.38574	0.35035	1.55420
2021	0.21622	37	0.77466	0.88307	0.44992	0.37417	2.08411
2022	0.16667	42	0.44544	0.50778	0.48353	0.20302	1.27001

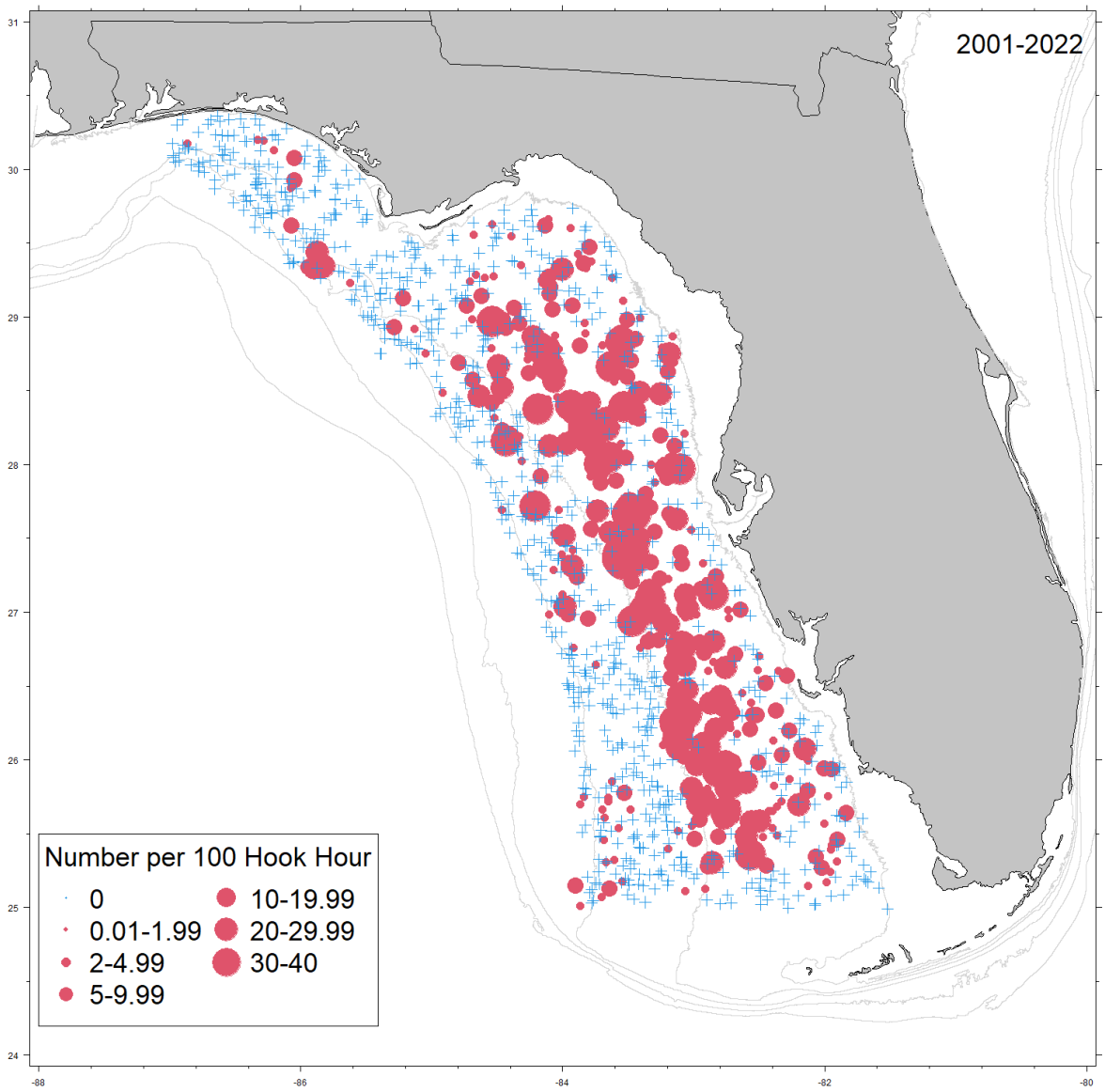


Figure 1. Stations sampled from 2001 to 2022 (limited to the area used for the index) during the NMFS Bottom Longline Survey with the CPUE for red grouper.

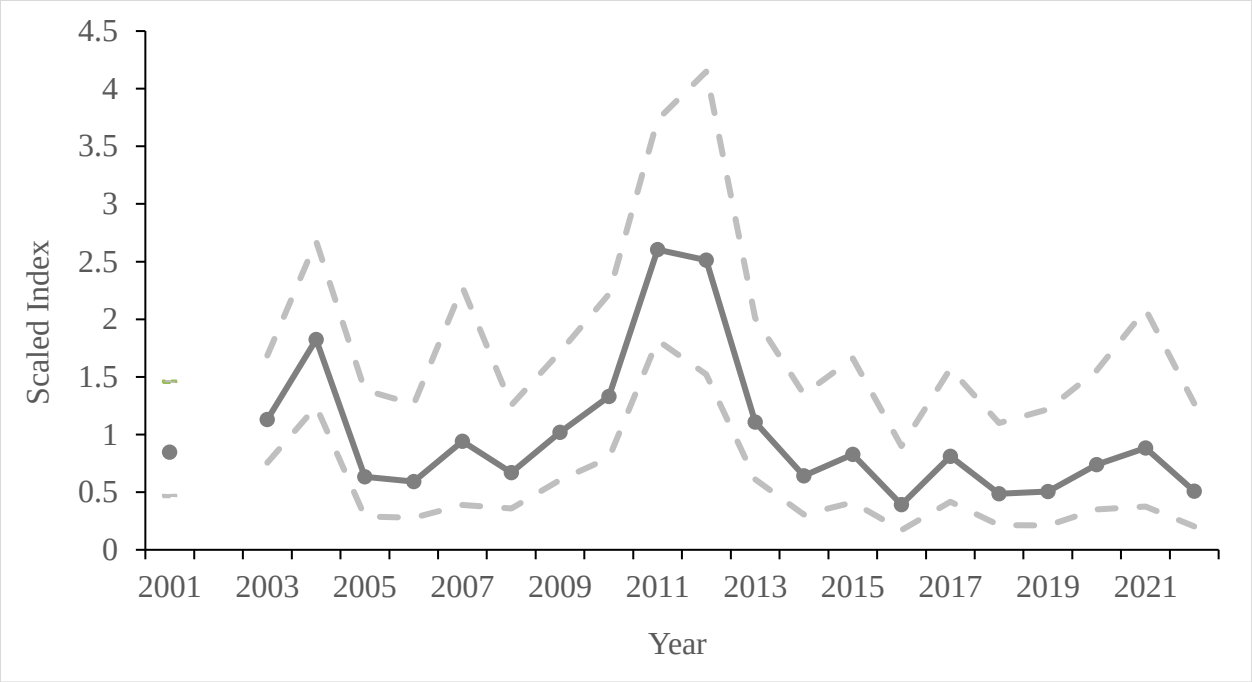


Figure 2. Annual index of abundance (solid line) with the 95% confidence interval (dashed lines) for red grouper from the NMFS Bottom Longline Survey from 2001 – 2022.

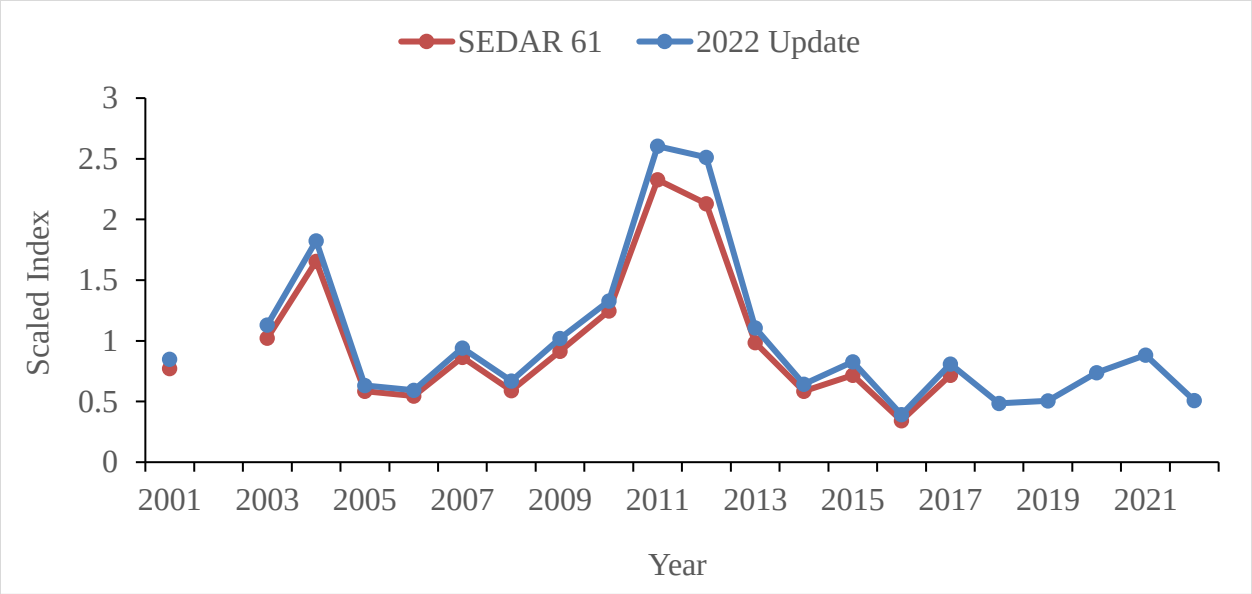
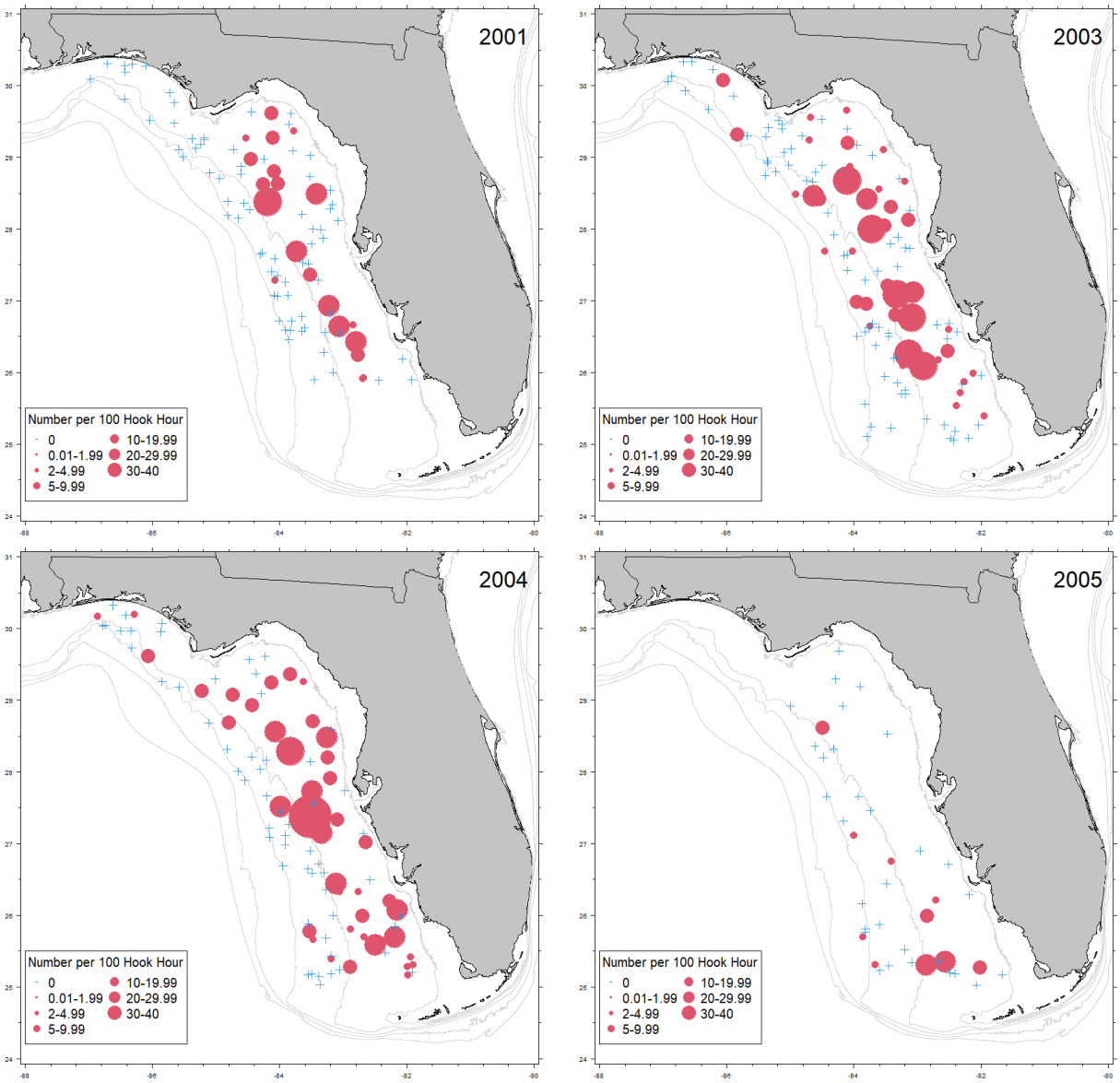
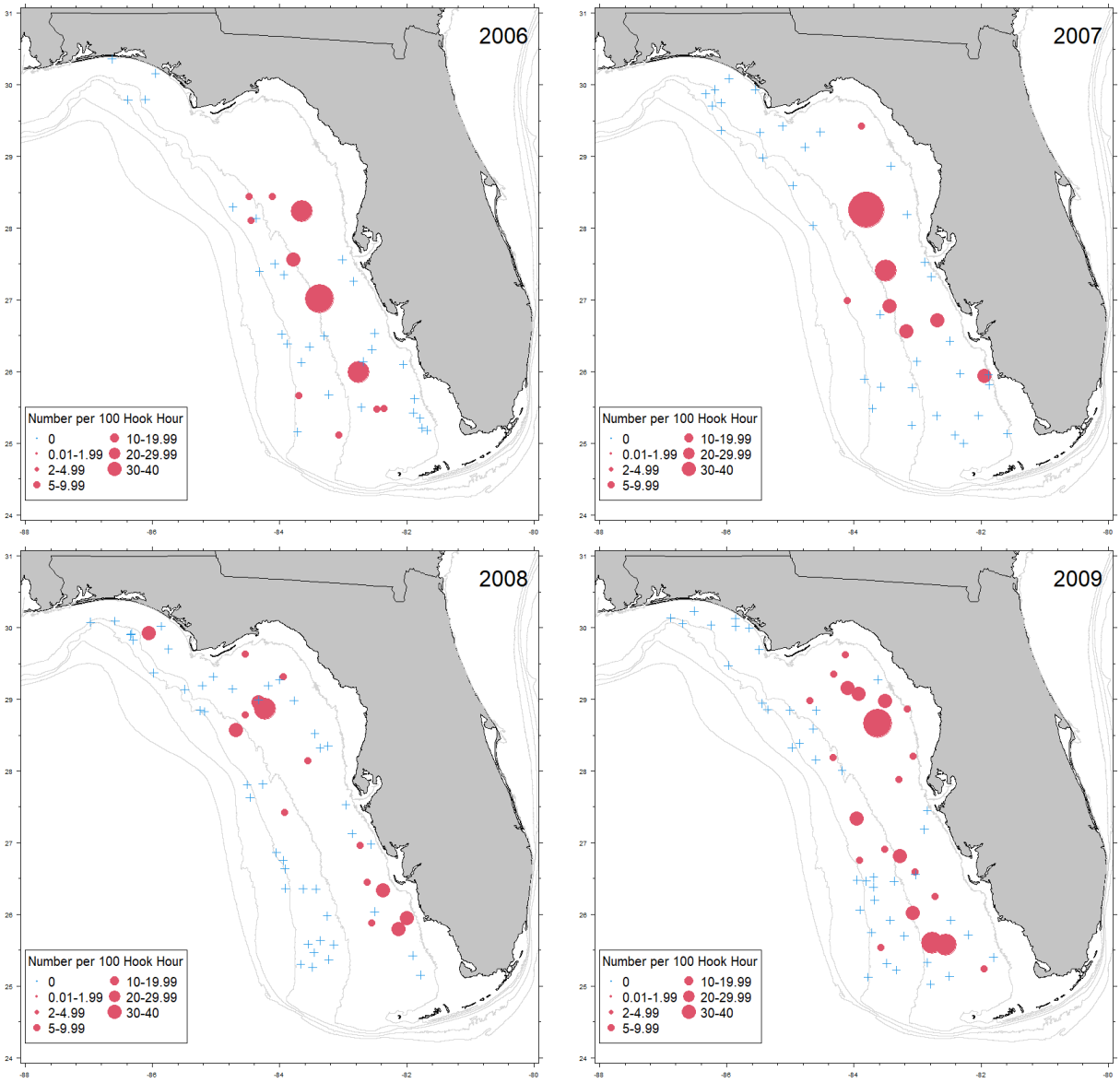


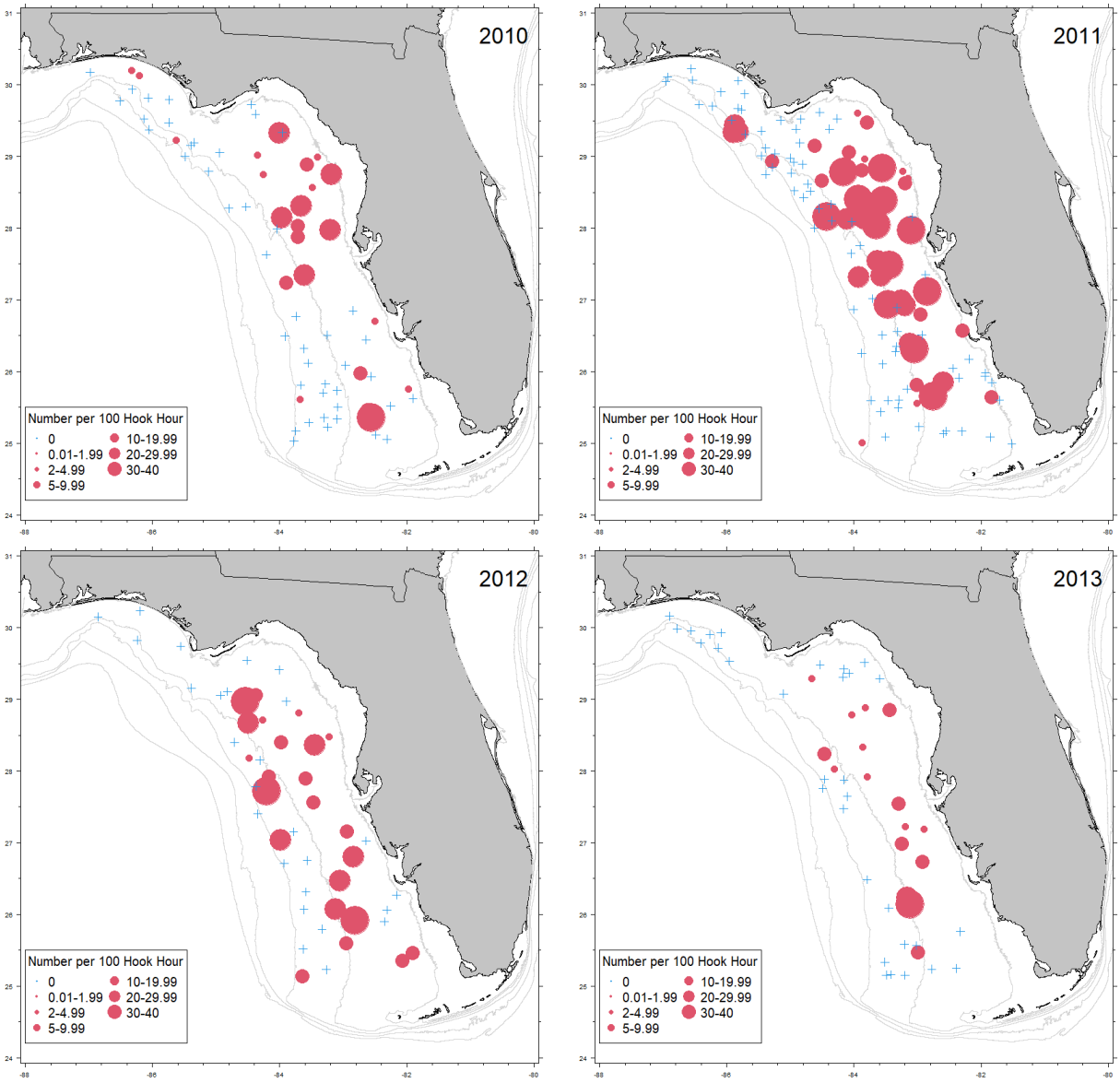
Figure 3. Annual index of abundance for red grouper from the NMFS Bottom Longline Survey from 2001 – 2022 compared to the index of abundance submitted for SEDAR 61.

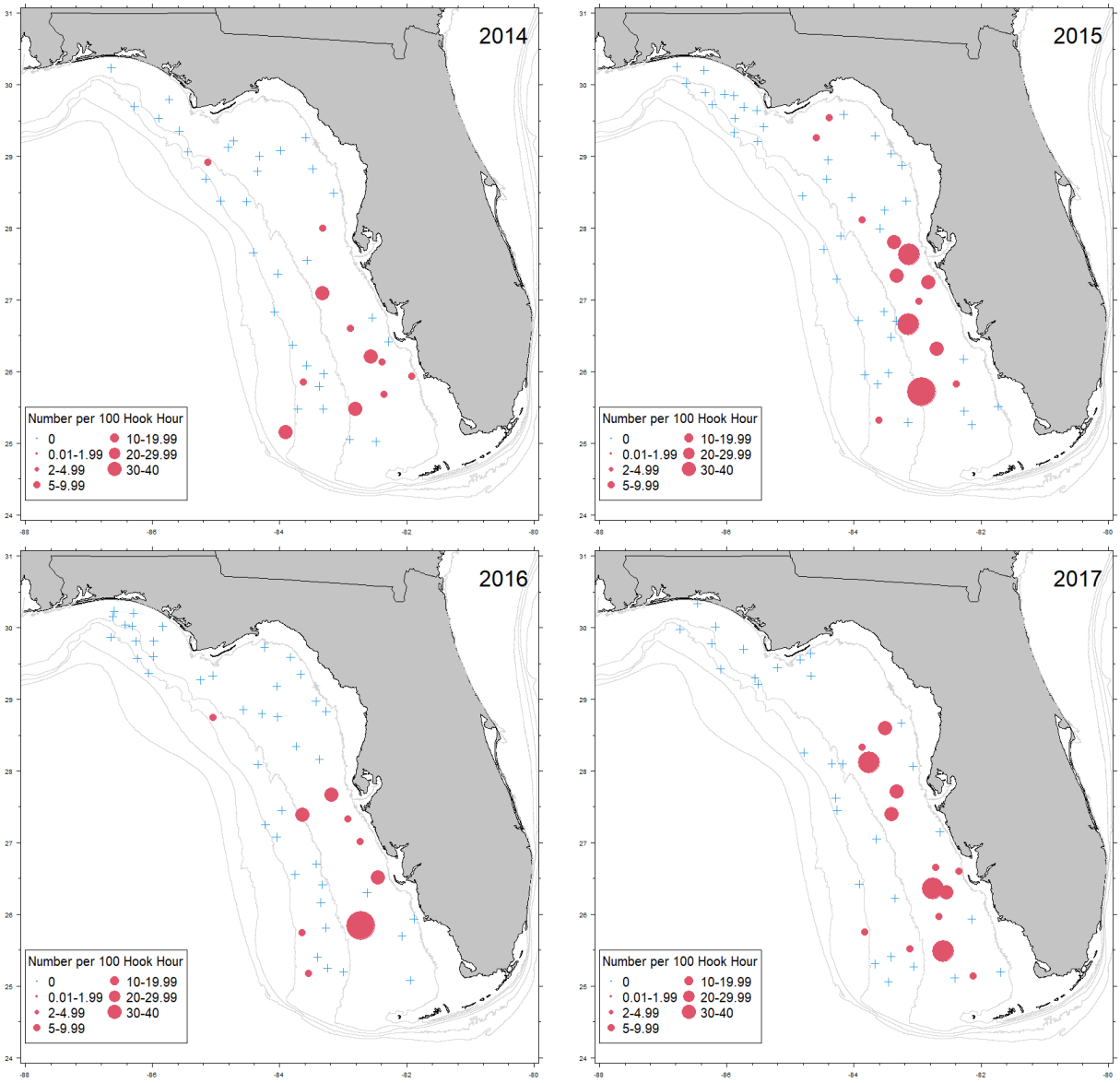
Appendix

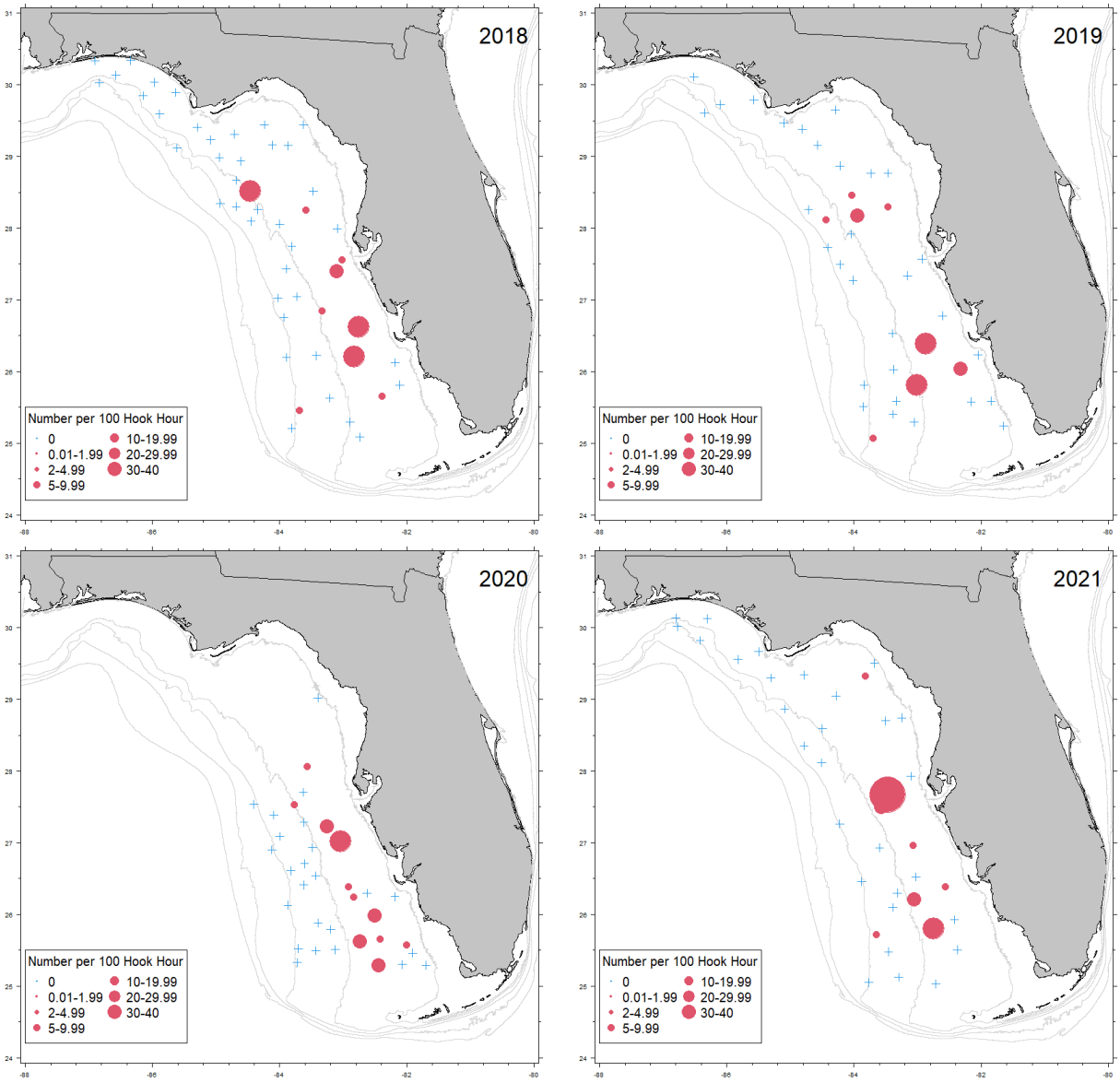
Appendix Figure 1. Annual survey effort and catch of red grouper from the NMFS Bottom Longline Survey (2001-2022).

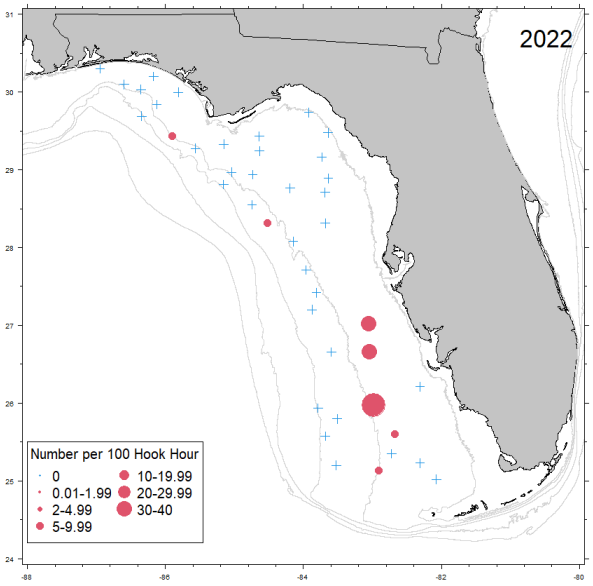



2006
2007
2008
2009
Number per 100 Hook Hour
0
0.01-1.99
2-4.99
5-9.99
10-19.99
20-29.99
30-40


2010
2011
2012
2013
Number per 100 Hook Hour
0
0.01-1.99
2-4.99
5-9.99
10-19.99
20-29.99
30-40


2014
2015
2016
2017
Number per 100 Hook Hour
0
0.01-1.99
2-4.99
5-9.99
10-19.99
20-29.99
30-40


2018
2019
2020
2021
Number per 100 Hook Hour
0
0.01-1.99
2-4.99
5-9.99
10-19.99
20-29.99
30-40


2022
Number per 100 Hook Hour
0
0.01-1.99
2-4.99
5-9.99
10-19.99
20-29.99
30-40