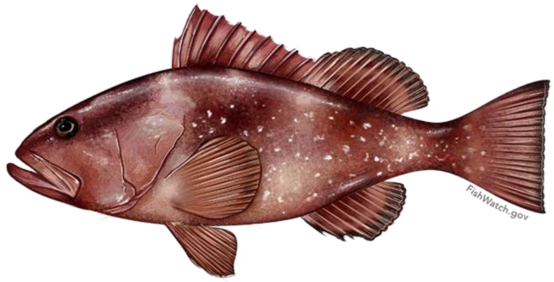

Updated Interim Analysis for Gulf of Mexico Red Grouper

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Keywords

Interim Analysis, Index of Abundance, Red Grouper, Gulf of Mexico, Reduced Spatial Area, 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 updated IA applies an index-based harvest control rule tested through simulation and recently implemented in the 2020 IAs for both Red Snapper and Gray Triggerfish. Data from the NMFS Bottom Longline Survey were used to produce an index of relative abundance updated through 2020 following the same methodology and approach described in Pollack et al. (2018), with the exception of reduced spatial coverage. The reduced spatial coverage index of abundance was ultimately utilized because 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). Adjusted catch advice is presented and takes into account 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. While IAs have been conducted regularly since the first application, none have been formally used to adjust catch advice (**Table 1**). Further, the projection-based approach applied for Red Grouper to date has not yet been simulation tested to ensure adequate performance.

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 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 previously applied projection-based harvest control rule for Red Grouper, 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) due to an inability to harvest quotas (**Figure 1**). In 2020, both the commercial and recreational fisheries harvested about 80% of their quotas.

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 (2021) (at the end of this document). A new index was created where the data were limited to those stations completed in the eastern GOM (east of 87° W and south of 28.5° N) and at depths less than 118 m through the entire time series. 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 (2021).

Interim Approach

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

where:

C_{y+1} = Adjusted catch recommendation for year *y+1* (2021; considered for implementation starting in 2022)

C_{ref} = reference level 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 2018-2020 or 5-year 2016-2020) for the reduced spatial area.

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

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 reduced area of the Eastern Gulf of Mexico through 2020 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**). For the reduced area index, relative abundance peaked in 2011 and was lowest in 2008, but did not show as large of an increase in relative abundance in 2020 as compared to the full area index (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 slightly below the reference index values for both the 3-year (**Figure 3**) and 5-year scenarios (**Figure 4**), with index ratios of 0.89 and 0.91, respectively (**Table 2**). Multiplying each index ratio by the reference catch resulted in adjusted catch recommendations from 5.57 million pounds gutted weight to 4.96 million pounds gutted weight using the 3-yr average and 5.07 million pounds gutted weight using the 5-yr average (**Table 3**). Implementing either of the presented IA variations will reduce the ABC from its reference value, but will be higher than the ABC of 4.26 million pounds gutted weight implemented by Amendment 53, which was prior to adjusting the ABC for recreational weight estimates (SEFSC 2021).

Discussion

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 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.

References

Campbell, M., A. Pollack, T. Henwood, J. Provaznik and M. Cook. 2012. Summary report of the red snapper (*Lutjanus campechanus*) catch during the 2011 congressional supplemental sampling program (CSSP). SEDAR31-DW17. 27 pp.

Gulf of Mexico Fishery Management Council (GMFMC). 2021. Revised Draft Reef Fish Amendment 53. Red Grouper Allocations and Annual Catch Levels and Targets. National Marine Fisheries Service, NA15NMF4410011, Tampa, Florida.

Huynh, Q.C., A. R. Hordyk, R.E. Forrest, C.E. Porch, S.C. Anderson and T.R. Carruthers. 2020. The interim management procedure approach for assessed stocks: Responsive management advice and lower assessment frequency. Fish Fish 21: 663–679.

Lo, N.C. L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

Miller, S.K., A. Anganuzzi, D.S. Butterworth, C.R. Davies, G.P. Donovan, A. Nickson et al. 2019. Improving communication: the key to more effective MSE processes. Can. J. Fish. Aquat. Sci. 76(4): 643-656

Pollack, A.G. 2020. An Updated Index of Relative Abundance for Red Grouper Captured During the NMFS Bottom Longline Survey. 10 pp.

Pollack, A.G. 2021. An Updated Index of Relative Abundance for Red Grouper Captured During the NMFS Bottom Longline Survey from a Reduced Area in the Eastern Gulf of Mexico. 4 pp.

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, South Carolina. 19 pp.

Southeast Fisheries Science Center (SEFSC). 2020a. Interim Analysis for Gulf of Mexico Red Grouper. 19 pp.

Southeast Fisheries Science Center (SEFSC). 2020b. A “Traditional” Interim Assessment for Gulf of Mexico Red Snapper. 14 pp.

Southeast Fisheries Science Center (SEFSC). 2020c. An Interim Assessment for Gulf of Mexico Gray Triggerfish. 10 pp.

Southeast Fisheries Science Center (SEFSC). 2021. Adjustment of SEDAR61 Gulf Red Grouper Projected Catch Streams Using Mean Weight of Recreationally Landed Fish from ACL Monitoring. 10 pp.

Tables

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

Year	Outcome
18-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)
19-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
20-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
21-Mar	Projection-based IA using reduced area index not recommended for use in setting catch advice by SSC due to allocation decisions needed
21-Aug	IA using reduced area index and revised allocations undergoing review by SSC

Table 2. Index reference (I_{ref}), index recent (I_k), and index ratios (I_{ratio}) for the 2020 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 2018-2020 or 2016-2020.

Value	3-year moving average	5-year moving average
I_{ref}	0.68	0.72
I_k	0.61	0.65
I_{ratio}	0.89	0.91

Table 3. 2021 Interim Assessment (IA) Acceptable Biological Catch (ABC) catch advice using the NMFS Bottom Longline Survey index for a reduced spatial area, 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	4.96	5.07
Commercial	2.94	3.01
Recreational	2.02	2.06

Figures

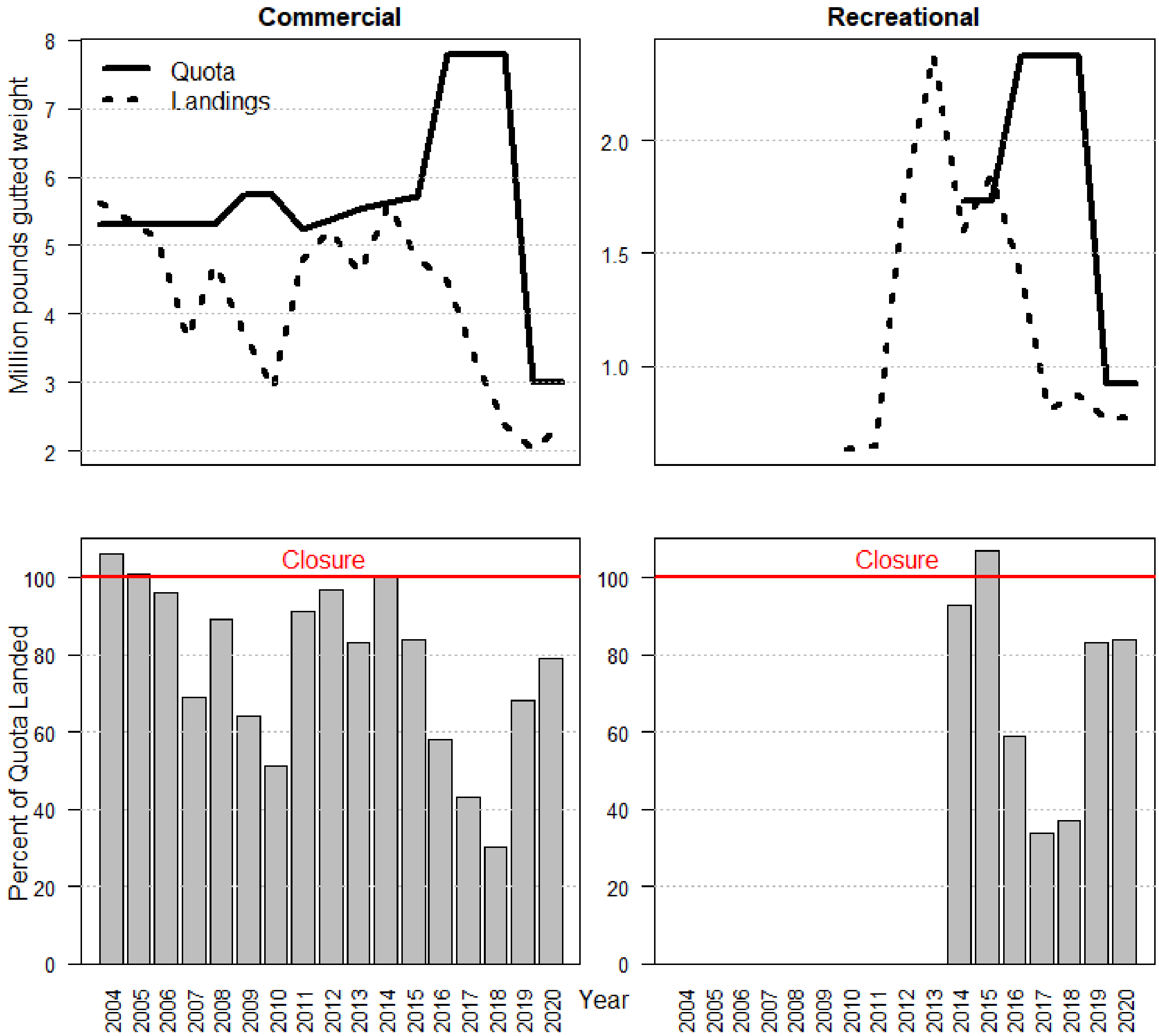

Figure 1. Commercial and recreational landings (dashed line) and quotas (thick line) for Red Grouper in the Gulf of Mexico. Bars represent the percent of quota landed, with the thick red line indicative of closures due to the quota being exceeded. Commercial data from 2010 were obtained from the Quotas and Catch Allowances, accessed June 30, 2021 (*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 2019 were obtained from recreational historical landings, accessed June 23, 2021 (*https://www.fisheries.noaa.gov/southeast/recreational-fishing-data/gulf-mexico-historical-recreational-landings-and-annual-catch*), preliminary data from 2020 were obtained June 23, 2021 from *https://www.fisheries.noaa.gov/southeast/2020-and-2021-gulf-mexico-recreational-landings-and-annual-catch-limits-acls-and-annual*.

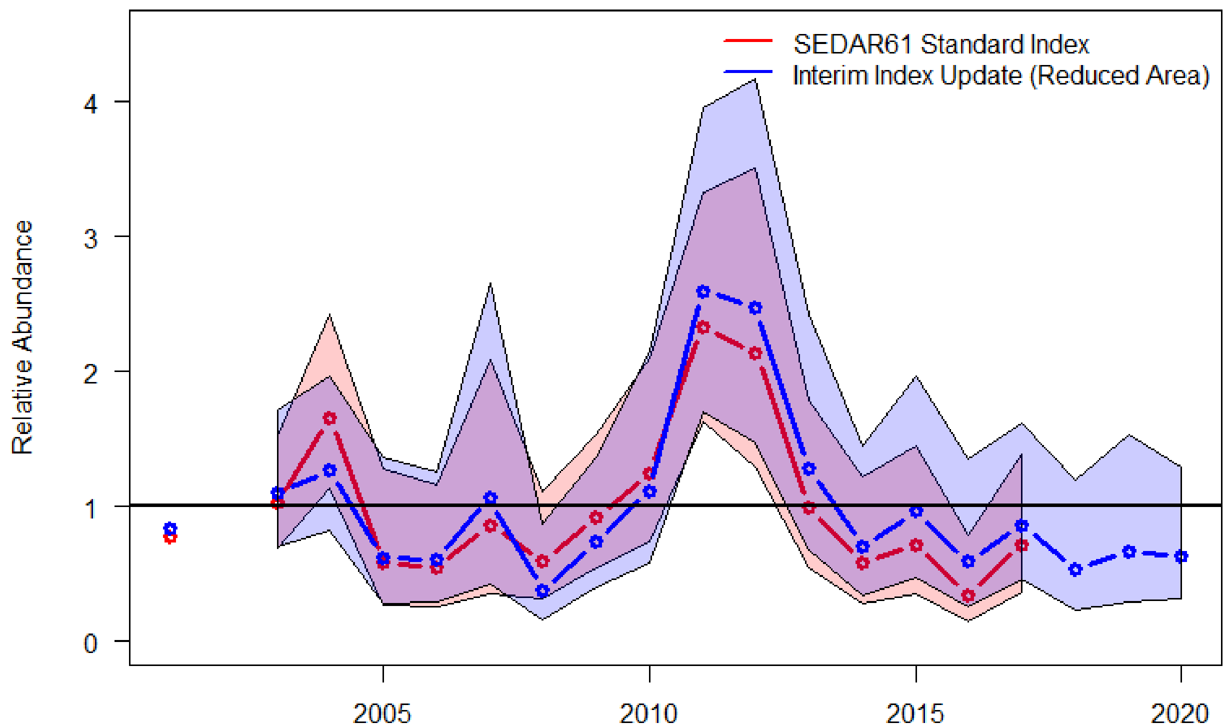

Figure 2. Comparison of NMFS Bottom Longline Survey index of abundance derived for Red Grouper in the Gulf of Mexico for SEDAR61 (full spatial area) compared to the index updated through 2020 for the reduced area in the Eastern Gulf of Mexico with confidence intervals. All indices have been standardized to a mean of 1.

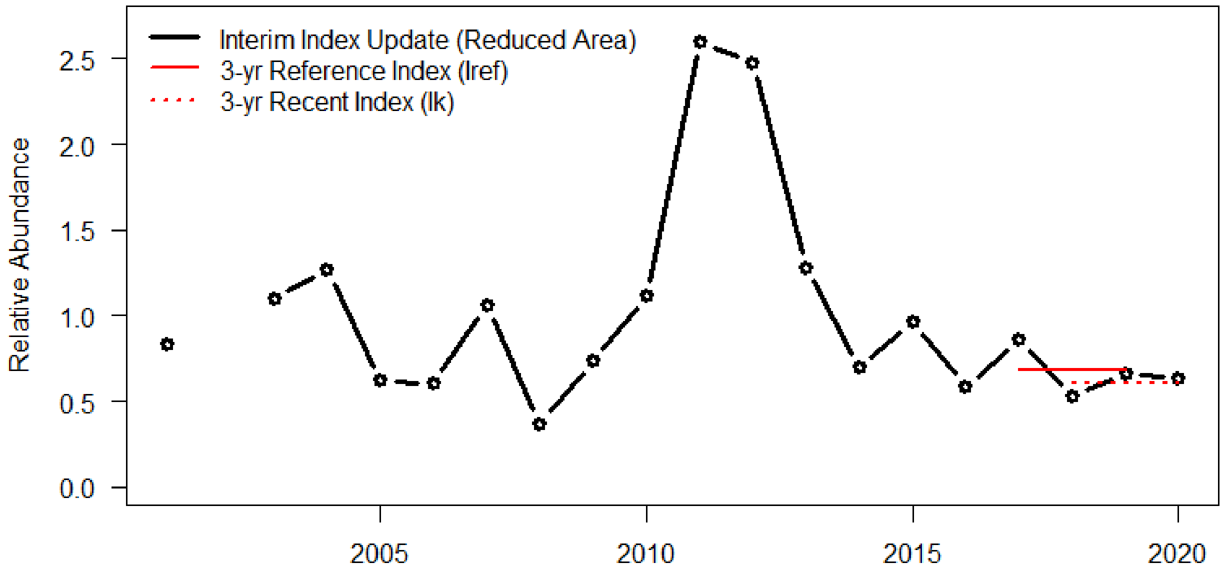

Figure 3. Comparison of the index of abundance derived for Red Grouper in the Gulf of Mexico through 2020 for the reduced area in the Eastern Gulf of Mexico with the reference index value (solid line) and recent index value (dashed line) using a 3-year moving average.

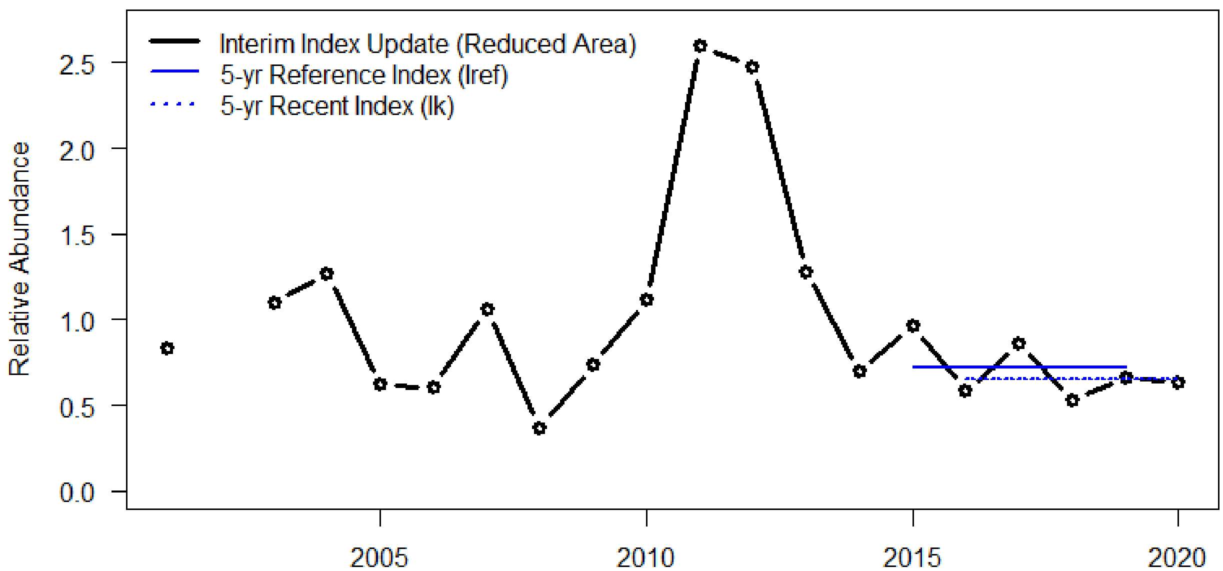

Figure 4. Comparison of the index of abundance derived for Red Grouper in the Gulf of Mexico through 2020 for the reduced area in the Eastern Gulf of Mexico with the reference index value (solid line) and recent index value (dashed line) using a 5-year moving average.

Appendix

An Updated Index of Relative Abundance for Red Grouper Captured During the NMFS Bottom Longline Survey from a Reduced Area in the Eastern Gulf of Mexico

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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 2020. As noted in the previous document, sampling in 2020 was limited to an area roughly south of 28.5° N in the eastern GOM due to complications from COVID-19, weather (i.e. hurricanes), and mechanical issues. A question was raised about how the index was affected by this limited coverage, considering the data typically extends further north to the Florida panhandle. Therefore, a new index was created where the data were limited to those stations completed in the eastern GOM (east of 87° W and south of 28.5° N) and at depths less than 118 m (Figure 1) through the entire time series. The analysis follows the same methodology (delta-lognormal model) as outlined in Pollack et al. (2018), except that the area variable was removed due to the reduced survey area.

The final delta-lognormal NMFS Bottom Longline Survey index of red grouper abundance retained year and depth in the binomial and lognormal submodels. The updated annual abundance index is shown in Table 1. Figure 2 shows the comparison between the updated index from the reduced spatial area and the indices from the previous 2020 Update and SEDAR 61. When examining the original 2020 Update index and the 2020 Update index from the reduced area, there does not appear to be any difference in the trends of red grouper abundance.

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 2001-2020 for the NMFS Bottom Longline Survey (reduced area). 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	0.22222	54	1.12113	0.83603	0.36061	0.41545	1.68238
2002							
2003	0.39189	74	1.47565	1.10039	0.22531	0.70512	1.71725
2004	0.42647	68	1.70252	1.26958	0.22227	0.81831	1.96971
2005	0.27273	33	0.83131	0.61991	0.40836	0.28263	1.35969
2006	0.31429	35	0.81096	0.60474	0.37568	0.29239	1.25074
2007	0.26923	26	1.42127	1.05985	0.48346	0.42380	2.65046
2008	0.24242	33	0.49831	0.37159	0.44741	0.15814	0.87316
2009	0.35000	40	0.98529	0.73473	0.31744	0.39536	1.36541
2010	0.31707	41	1.49276	1.11316	0.33651	0.57819	2.14311
2011	0.44444	72	3.48325	2.59747	0.21226	1.70693	3.95263
2012	0.52941	34	3.32402	2.47873	0.26427	1.47417	4.16785
2013	0.42857	28	1.71615	1.27973	0.32803	0.67522	2.42545
2014	0.37037	27	0.93856	0.69989	0.37742	0.33733	1.45210
2015	0.35484	31	1.28871	0.96099	0.37050	0.46903	1.96899
2016	0.30769	26	0.78804	0.58764	0.43497	0.25559	1.35109
2017	0.43333	30	1.15140	0.85860	0.32492	0.45564	1.61796
2018	0.29630	27	0.70685	0.52710	0.42932	0.23155	1.19989
2019	0.29630	27	0.89194	0.66512	0.43571	0.28892	1.53119
2020	0.32353	34	0.85120	0.63474	0.36666	0.31196	1.29148

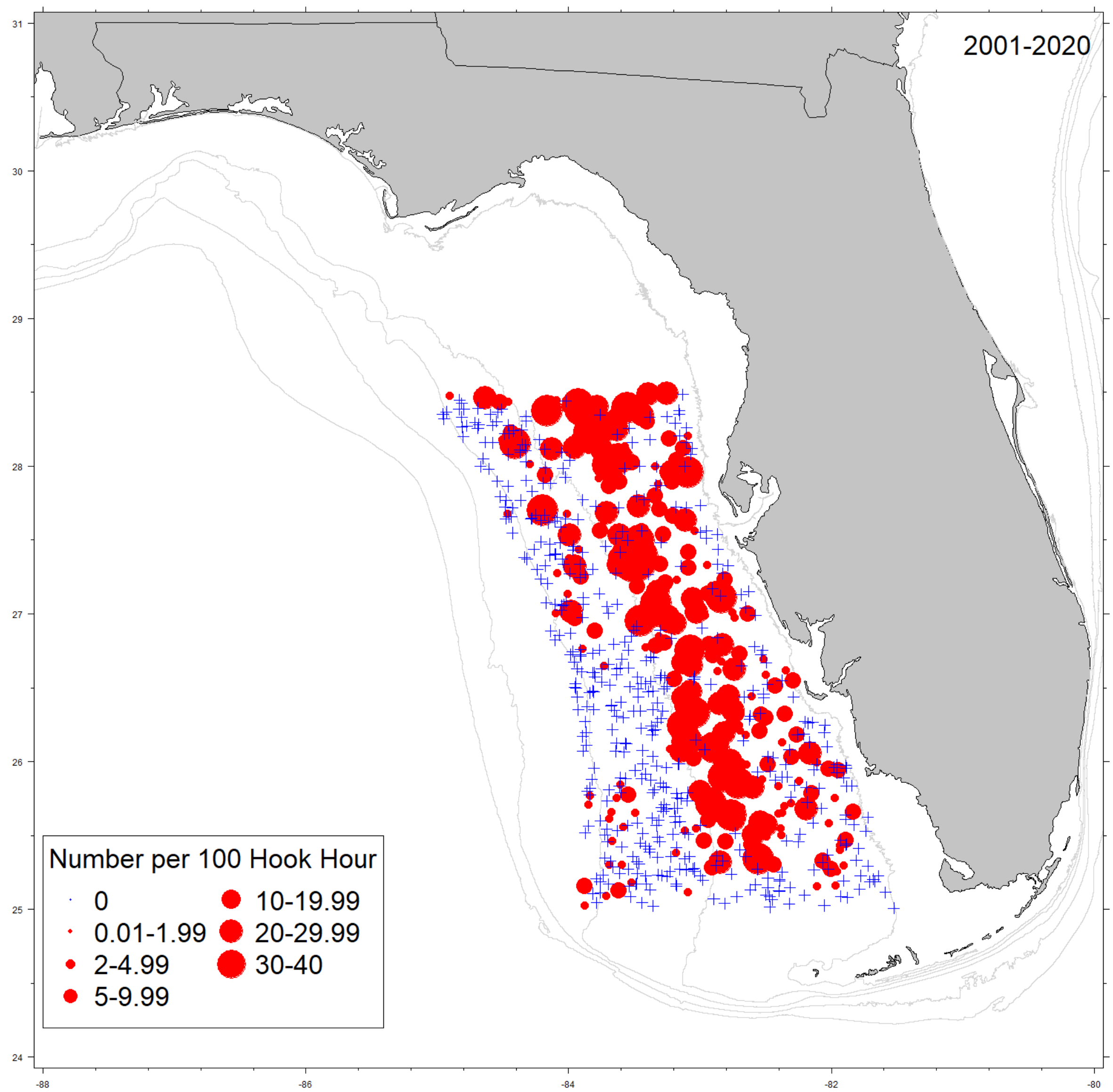

Figure 1. Stations sampled from 2001 to 2020 (limited to the area used for the index – reduced to match the sampling area covered in 2020) during the NMFS Bottom Longline Survey with the CPUE for red grouper.

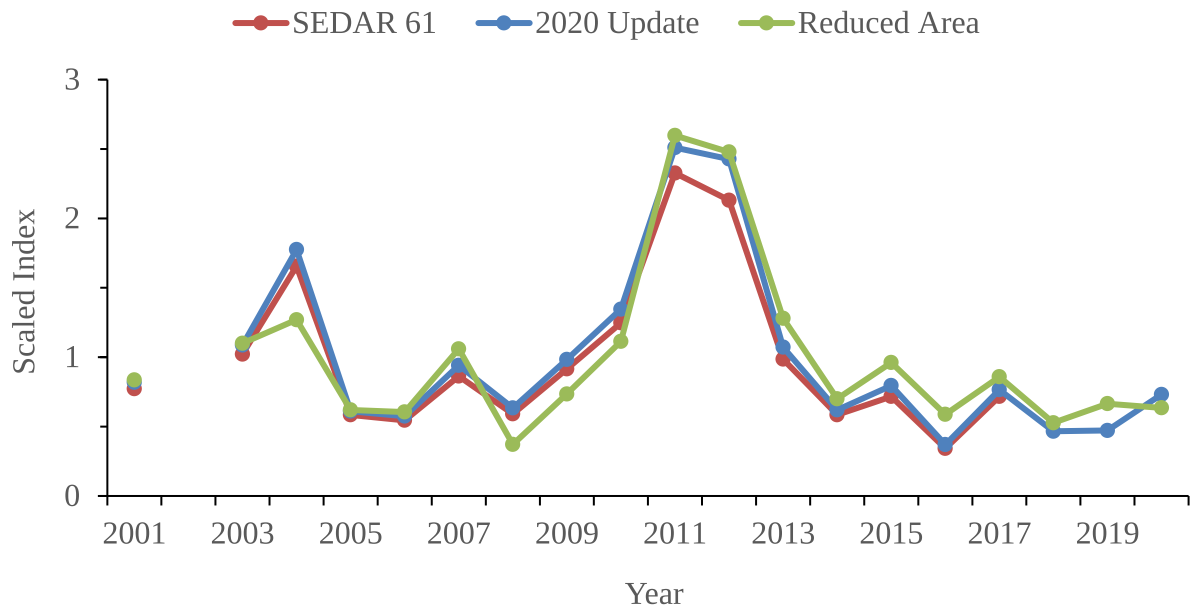

Figure 2. Annual index of abundance for red grouper from the NMFS Bottom Longline Survey from 2001 – 2020 from the reduced area compared to the indices of abundance submitted for the 2020 Update and SEDAR 61.