

# Interim Analysis for Gulf of Mexico Red Grouper using an index derived from a reduced area in the Eastern Gulf of Mexico

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## Keywords

Interim Analysis, Index of Abundance, Red Grouper, Gulf of Mexico, Reduced Spatial Area

## Abstract

An Interim Analysis was conducted for Red Grouper following the Standard SEDAR61 stock assessment (<http://sedarweb.org/sedar-61>) using a reduced index which was produced to allow an evaluation of how the reduced spatial coverage of the survey in 2020 would impact the derived catch advice. The previous Interim Analysis cautioned the use of the 2020 index value because of reduced spatial coverage due to COVID, mechanical issues, and weather delays (SEFSC 2020). Data from the NMFS MSLABS 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. 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 as discussed in Pollack (2021). Trends in the indices were similar with the exception of the last few years, where the reduced area index did not reveal a large increase in relative abundance in 2020 when compared to the index developed using the full area.

## Introduction

Interim analyses 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). Recent concerns have

been raised over the status of Red Grouper in the Gulf of Mexico due to an inability to harvest the current quotas (**Figure 1**).

## 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 MSLABS 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

Here we adjusted the harvest recommendation for 2021 by applying the harvest control rule (HCR) presented and recommended by the Gulf of Mexico Fishery Management Council's Scientific and Statistical Committee (SSC) at their October 2018 meeting based on the following formulation:

$$ABC_y = ABC_{assessment} * (O_y + \beta) / (F_y + \beta)$$

where:

$ABC_{assessment}$  = 4.9 million pounds gutted weight, as recommended by the SSC at their September 2019 meeting following review of the Standard SEDAR61 stock assessment (**Table 1**). This ABC is based on an allocation of 76% commercial and 24% recreational (GMFMC 2008), and is subject to change pending a redistribution of allocation.

$O_y$  = observed index value in year  $y$  for the reduced spatial area, as presented in Pollack (2021) (**Table 1**; and at the end of this document)

$F_y$  = forecasted index value in year  $y$  by the SEDAR61 assessment model (assuming 2018 red tide mortality was similar to 2005) (**Table 1**)

$\beta$  = scalar (ranges from 1 to 9) to adjust the responsiveness of the HCR times the root mean squared error of the index obtained from the SEDAR61 stock assessment output (NMFS MSLABS Bottom Longline Survey RMSE = 0.3622).

The chosen HCR adjusts the ABC recommendation (adjusted ABC referred to as TAC herein) based on deviations between projected and observed index values and can be adjusted, using a parameter  $\beta$ , to be more or less sensitive to these deviations. During their September 2019 meeting, the SSC recommended a  $\beta = 1$ , which results in the interim catch advice being strongly driven by the index deviations. This specification was chosen by the SSC as a realistic and conservative (with respect to risk of overfishing) scenario for the provision of interim management advice as requested by the Council.

## Results

### Index of Abundance

**Figure 2** provides a comparison of the updated index for the full and reduced areas 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. The index forecasted by the SEDAR61 assessment model, which assumed that red tide mortality in 2018 was similar to 2005, showed similar relative abundance between 2018 and 2020 when compared to the reduced area index (**Table 1, Figure 3**). The observed index value for 2020 based on the full area was high compared to the reduced area index value and the forecasted index value, likely an artifact of the incomplete survey coverage as discussed in SEFSC (2020) and Pollack (2020).

### Interim Analysis

**Table 2** summarizes the updated harvest recommendations. For  $\beta = 1$ , where the catch advice is strongly driven by the index deviations (**Figure 4**), the TAC for 2021 would be 5.948 million pounds gutted weight.

## Discussion

Future work is underway to develop an MSE framework where specifications of the interim analysis can be fully tested, such as the design of the harvest control, the selection of the index where more than one index is available, and the  $\beta$  value.

## References

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## Tables

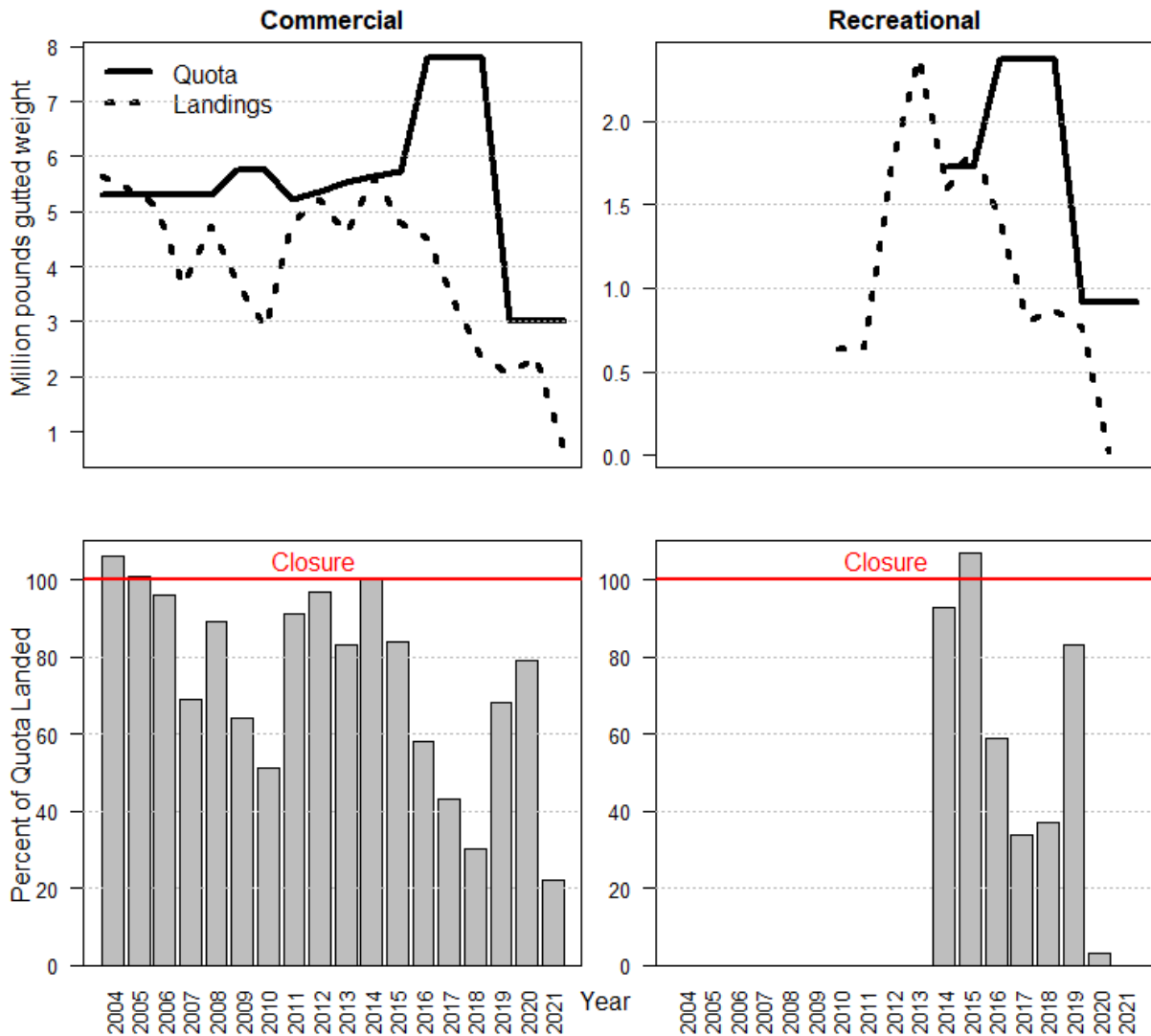
**Table 1.** Observed and forecasted indices of abundance for Red Grouper from the NMFS MSLABS Bottom Longline Survey and ABC recommendations (million pounds, gutted weight). ABC\_Assessment refers to ABCs set following assessments and is the value adjusted in the harvest control rule. Note that the observed index here reflects relative abundance for Red Grouper from a reduced area in the Eastern Gulf of Mexico whereas the forecasted index from the SEDAR61 assessment model is for the entire region and not for the reduced area.

Year	Observed	Forecasted	ABC	ABC_Reference	ABC_Assessment
2008	0.372	0.752	6.560	Amendment 30B	6.560
2009	0.735	0.756	7.570	73 FR 68390	7.570
2010	1.113	0.927	7.570	75 FR 63780	7.570
2011	2.597	1.190	6.310	76 FR 58456	7.570
2012	2.479	1.302	7.930	76 FR 66672	7.570
2013	1.280	1.211	7.930		7.570
2014	0.700	0.885	7.930		7.570
2015	0.961	0.622	7.930		7.570
2016	0.588	0.514	13.920	81 FR 70365	7.930
2017	0.859	0.483	13.920		7.930
2018	0.527	0.461	13.920		7.930
2019	0.665	0.453	4.900	SSC (Sep 2019)	4.900
2020	0.635	0.459	4.900		4.900
2021			4.900		4.900

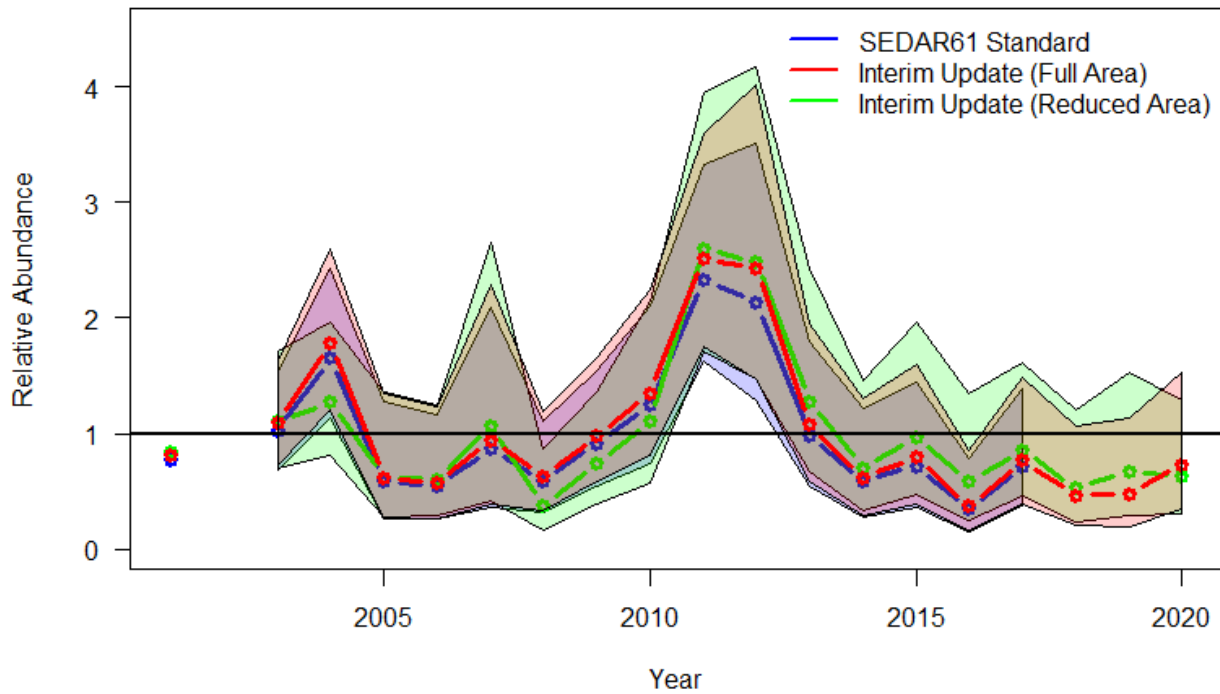
**Table 2.** Adjusted harvest recommendations (million pounds, gutted weight) across different  $\beta$  levels for Red Grouper after Interim Analysis using the updated index of abundance for a reduced area in the Eastern Gulf of Mexico derived from the NMFS MSLABS Bottom Longline Survey. Catch advice for 2021 is highlighted in red.

Year	beta1	beta3	beta5	beta7	beta9
2008	6.560	6.560	6.560	6.560	6.560
2009	6.560	6.560	6.560	6.560	6.560
2010	8.664	8.270	8.085	7.977	7.907
2011	8.664	8.270	8.085	7.977	7.907
2012	12.923	11.299	10.432	9.891	9.523
2013	12.923	11.299	10.432	9.891	9.523
2014	6.445	6.858	7.049	7.160	7.231
2015	6.445	6.858	7.049	7.160	7.231
2016	8.598	8.295	8.182	8.122	8.085
2017	8.598	8.295	8.182	8.122	8.085
2018	8.572	8.271	8.162	8.106	8.072
2019	8.572	8.271	8.162	8.106	8.072
2020	5.948	5.457	5.279	5.187	5.131
2021	5.948	5.457	5.279	5.187	5.131

## Figures

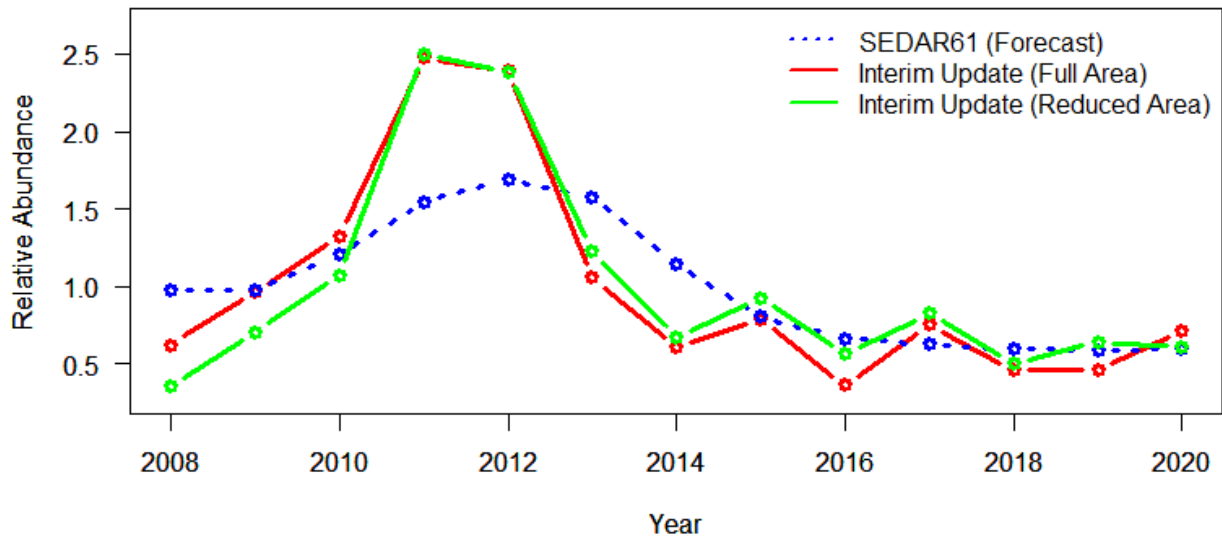


**Figure 1.** Commercial and recreational landings (dashed line) and quotas (thick line) for Red Grouper in the Gulf of Mexico. Bars represent the percent of quota landed, with the thick red line indicative of closures due to the quota being exceeded. Commercial data from 2010 through 2021 (**through March 9, 2021**) were obtained from the Quotas and Catch Allowances, accessed March 9, 2021 ([https://secatchshares.fisheries.noaa.gov/additionalInformation\[select Commercial Quotas/Catch Allowances \(all years\)\]](https://secatchshares.fisheries.noaa.gov/additionalInformation[select%20Commercial%20Quotas/Catch%20Allowances%20(all%20years)])), 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 2018 were obtained from recreational historical landings, updated October 13, 2020 (<https://www.fisheries.noaa.gov/southeast/recreational-fishing-data/gulf-mexico-historical-recreational-landings-and-annual-catch>), data from 2019 and 2020 (**through June 2020**) were obtained March 9, 2021 from <https://www.fisheries.noaa.gov/southeast/2019-and-2020-gulf-mexico-recreational-landings-and-annual-catch-limits-acls-and-annual>.

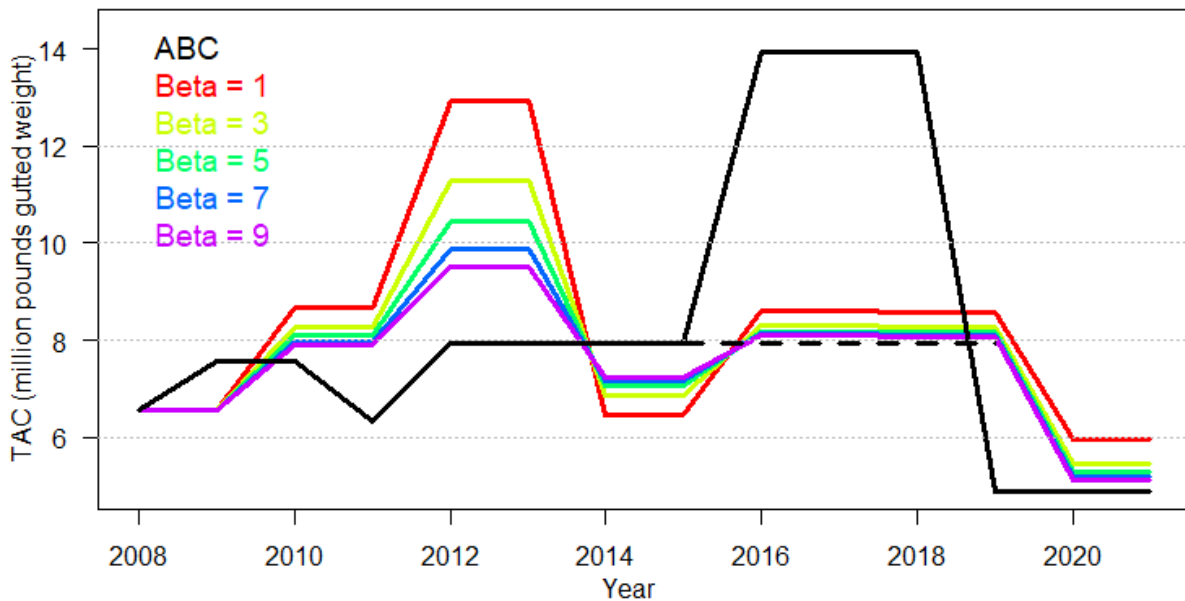


**Figure 2.** Comparison of NMFS MSLABS Bottom Longline Survey index of abundance derived for Red Grouper in the Gulf of Mexico for SEDAR61 compared to the index updated through 2020 for the full and reduced areas in the Eastern Gulf of Mexico with confidence intervals. All indices have been standardized 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 full and reduced areas in the Eastern Gulf of Mexico and the forecasted index from the SEDAR61 assessment model. All indices have been standardized to a mean of 1. Note that the forecasted index from the SEDAR61 assessment model is for the entire region and not for the reduced area, and therefore it is assumed that the general trend would be similar.



**Figure 4.** Application of the harvest control rule accepted for use by the SSC at their October 2018 meeting. Shown are the ABC over time (thick black line) and the HCR TAC over time across different  $\beta$  levels (denoted by different colors). The dashed black line starting in 2015 indicates ignoring the ABC increase that resulted from SEDAR42, which was supported by the SSC at their October 2018 meeting. Changes to the TAC are implemented every other year.

## 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

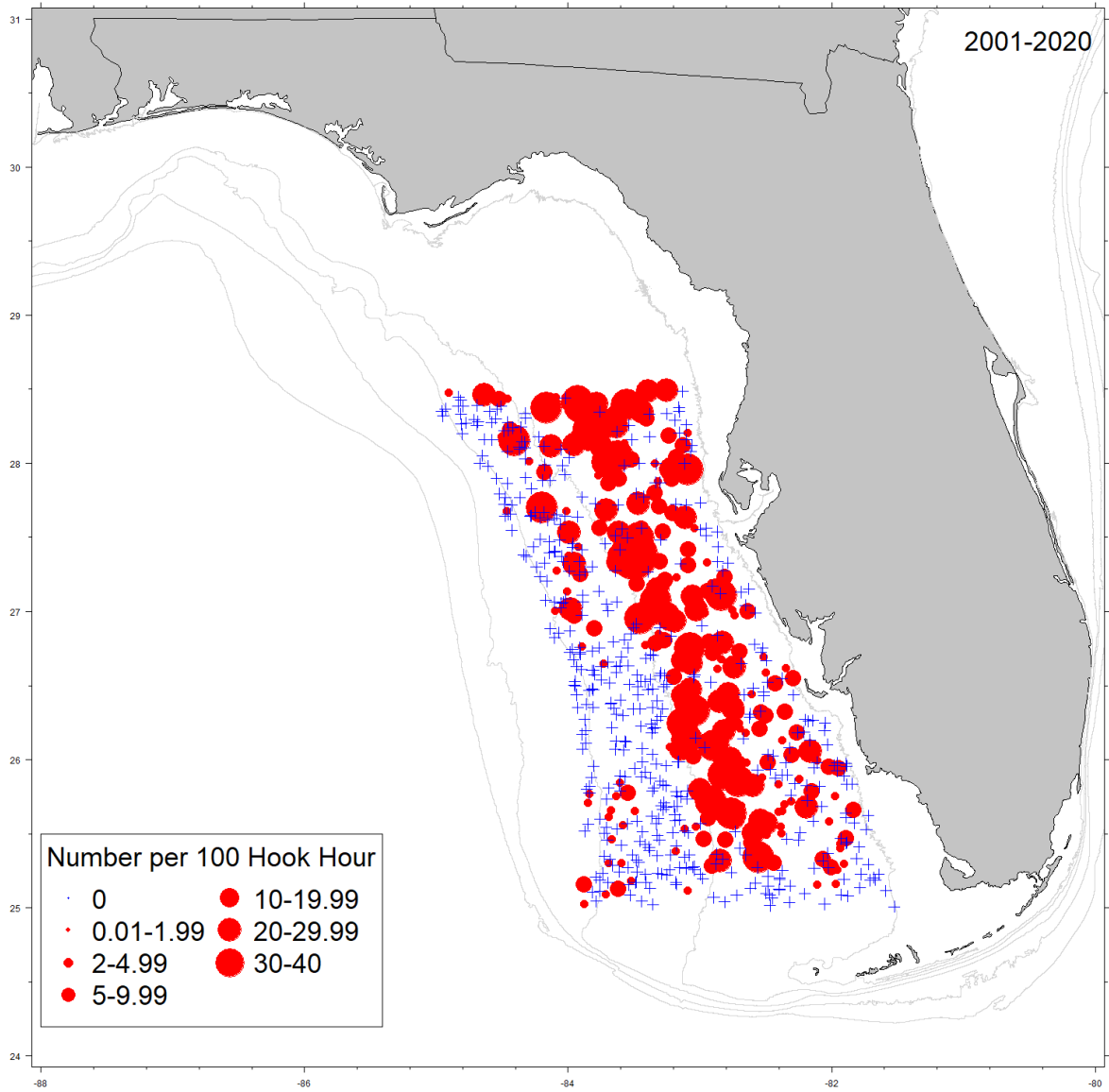


Figure 1. Stations sampled from 2001 to 2020 (limited to the area used for the index – reduced to match the sampling area covered in 2020) during the NMFS Bottom Longline Survey with the CPUE for red grouper.

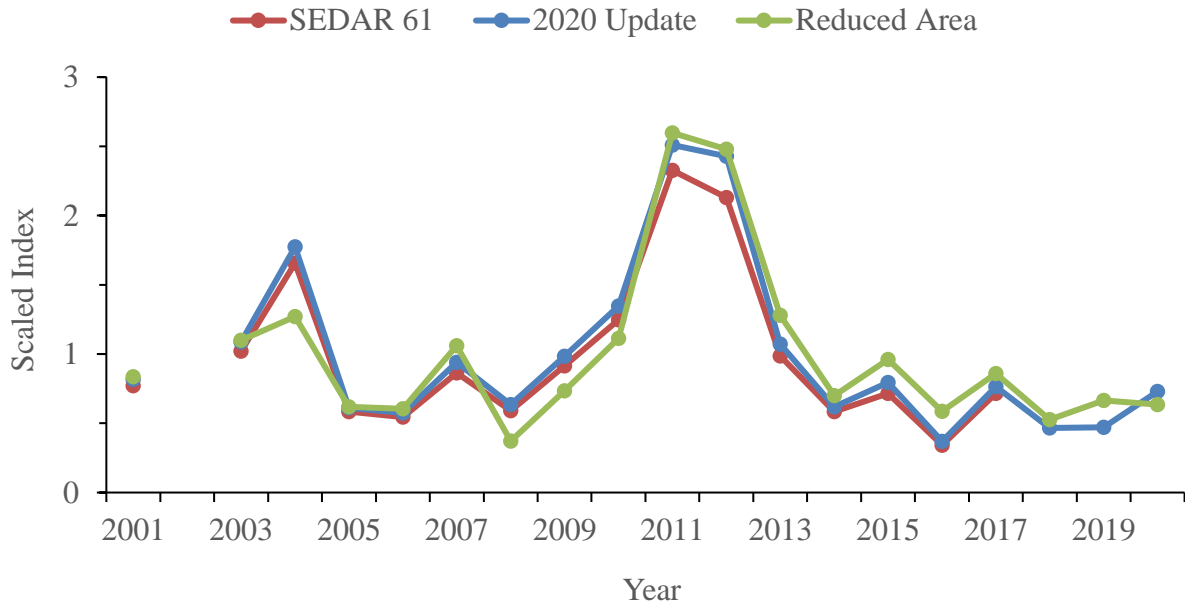


Figure 2. Annual index of abundance for red grouper from the NMFS Bottom Longline Survey from 2001 – 2020 from the reduced area compared to the indices of abundance submitted for the 2020 Update and SEDAR 61.