Gulf of Mexico Fishery Management Council
Scientific and Statistical Committee

Stock Assessment Review Summary:
SEDAR 43 – Gulf Gray Triggerfish

Jeff Isely presented a review of the gray triggerfish assessment. This assessment was conducted using Stock Synthesis 3, and used data updated through 2013. Rather than use a fixed natural mortality rate (M) for all age groups, this assessment used a Lorenzen function in which M varies with age, averaging M = 0.28. A new growth curve was calculated, which resulted in larger fish at age-0, a faster growth rate than previously calculated and maximum size achieved at a young age. The assessment used coefficient of variation at age of CV = 0.22. There was little relationship between age and length beyond age-2. Because of the variable growth, there is no fecundity-age relationship, but there is a length-fecundity relationship which was used in the assessment. Ages were calculated from annual age-length keys. Consistent with previous assessments, landings and indices were calculated for eastern and western regions, but one population model was constructed for the entire Gulf of Mexico. Shrimp effort was used as a proxy for shrimp trawl bycatch. Size composition data from gray triggerfish captured in shrimp trawls suggested that > 90% of fish were age-0. The annual fraction of age-1 fish could not be determined accurately, so all shrimp trawl bycatch fish were entered as age-0. Modeled landings were fit to observed landings using an assumed coefficient of variance of 0.05. Landings showed a good fit to the model, but discards showed a high variability. Most indices of abundance showed a general downward trend, as did the estimate of total biomass (Figure 1).

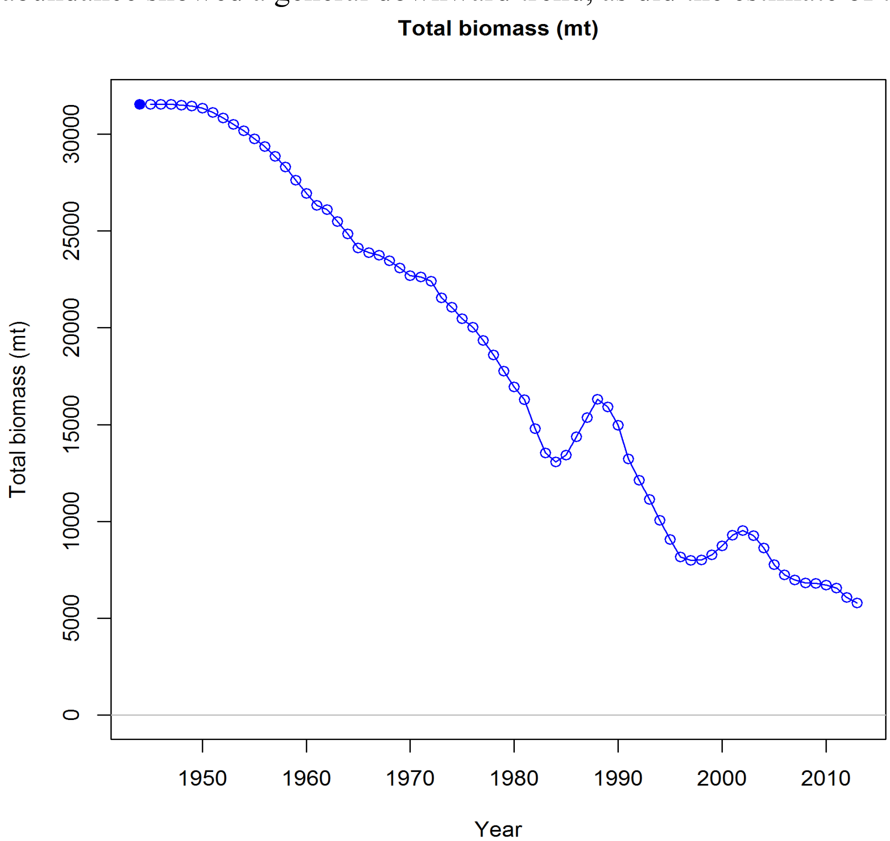

Figure 1. Estimated biomass (metric tons) of gray triggerfish by year.

The fishing mortality rate has been below the overfishing threshold since 2008 (Figure 2), but the spawning stock biomass has continued to be at or below the minimum stock size threshold, and below the MSY biomass level, since at least 1993 (Figure 3).

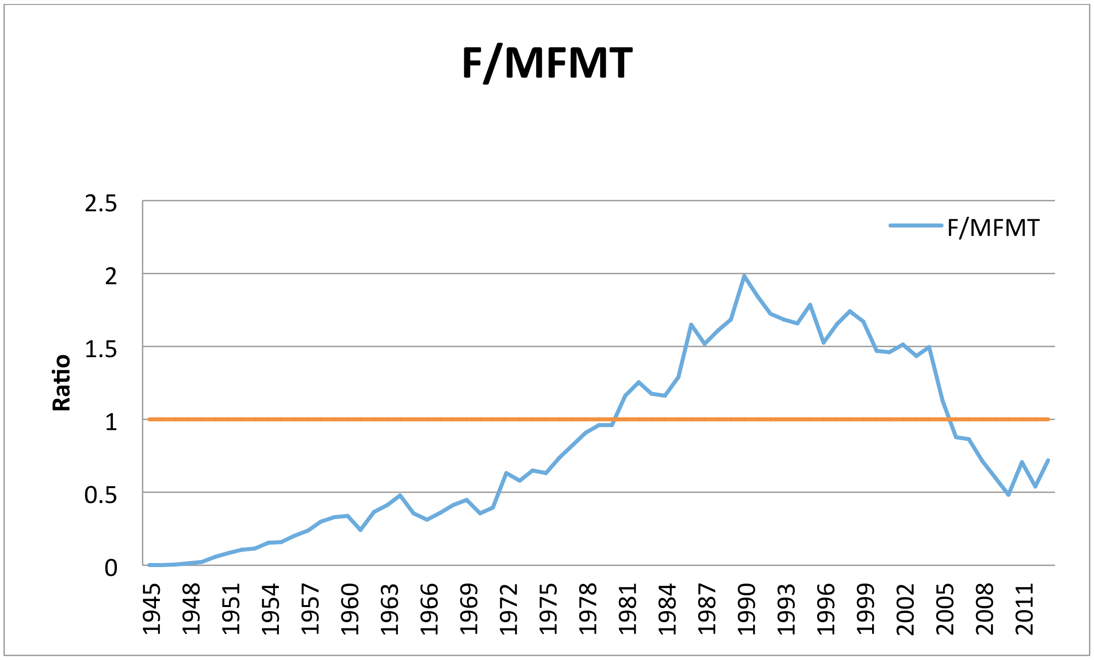

Figure 2. Gray triggerfish fishing mortality rate relative to maximum fishing mortality threshold, 1945-2013.

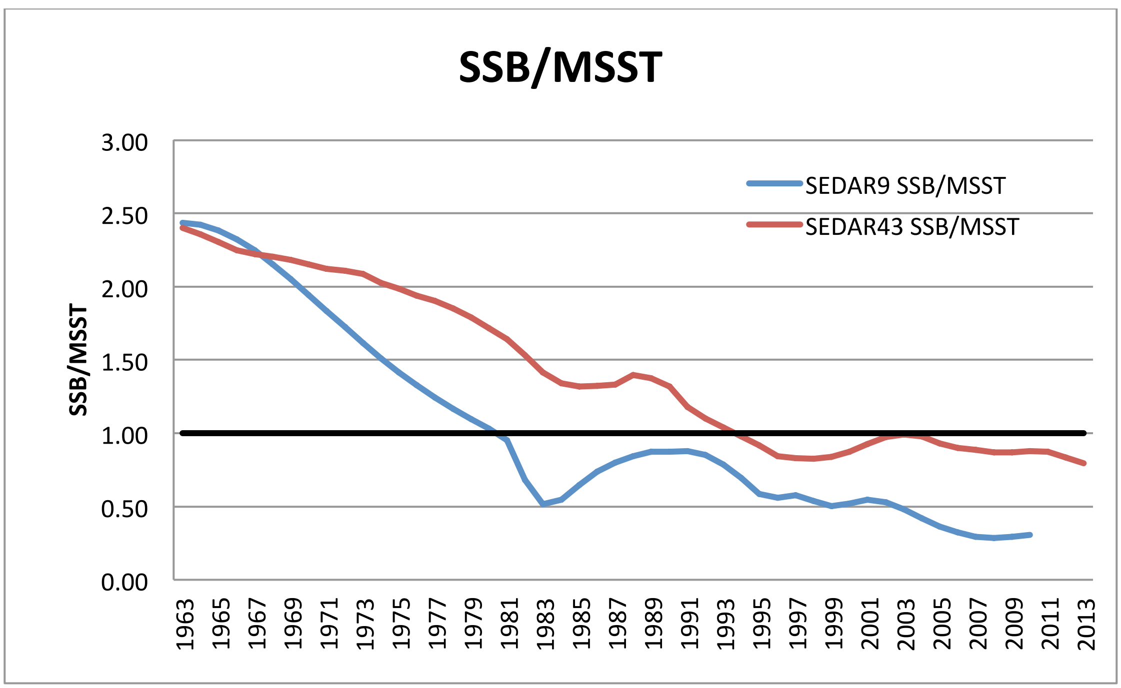

Figure 3. Gray triggerfish spawning stock biomass estimates from both SEDAR 9 and SEDAR 43 relative to minimum stock size threshold.

During and after the stock assessment presentation, several concerns were brought up by SSC members.

- A pooled growth rate was used for male and female gray triggerfish combined, but the sexes have different growth rates. The combined growth rate may be overestimating SSB. As sex is not determined I the field by port samplers, there is little that can be done to correct this.

- Stock-recruit steepness was estimated at 0.45. However, the likelihood profiles suggest that any values above 0.4 are equally likely.

- Shrimp trawl bycatch mortality was assigned entirely to age-0 fish, but age-0 fish are still in the pelagic environment and are closely associated with *Sargassum* habitat. The age-0 assumption for shrimp trawl bycatch may be overestimating the proportion of discard mortality occurring on age-0 fish and underestimating age-1 mortality.

- Shrimp trawl bycatch estimates assumed 100% mortality, but this may be an overestimate. Texas estimates a 50% mortality rate from shrimp trawls, but these data were unavailable at the time of the assessment. However, when using a Lorenzen mortality curve, the natural mortality on age-0 fish is so high that the bycatch mortality should not have much additional impact.

- The minimum size limit from 1999 to 2008 was 12 inches total length, but in 2008 it was changed to 14 inches fork length The assessment assumed that all size limits were in fork length (this was later determined not to be a significant source of error).

- There are questions as to how long the recent low recruitment from the six previous years will continue. Due to the unique life history of gray triggerfish spending 4 to 7 months up in the pelagic environment before recruiting the benthic reefs and the neuston plankton tow information stopping in 2007 little information about recruitment is available for the model. Some SSC members suggested a regime shift in recruitment could be occurring, possibly attributed to predation by increasing populations of red snapper and lionfish.

- The stock-recruit relationship assumes the spawning stock is 50% female:50% male based on sampling from commercial sources, but the assessment document states that 56% female based upon histology and 64% female based upon macroscopic observation. Gray triggerfish are known to form harem groups when spawning with one dominate male and up to three females on active nests. The fishery-dependent landings may not be accurately capturing the ratio of males to females in the population. However, as the proportion females is used as a scaler, it has little effect on conclusions drawn from the assessment.

SSC members were in agreement that the results of the assessment were not useful for management. However, the assessment was conducted properly and produced the best results possible given the uncertainties of the data inputs. The SSC was split on whether to accept the assessment as the best available science, but passed the following motion.

> **By a vote of 12 to 8, the Committee accepts the SEDAR 43 Gray Triggerfish Assessment as the best available science.**

Although the SEFSC provided OFL and ABC projections based on the assessment, SSC members felt that they could not use the assessment to make recommendations. However, the SSC was concerned about several negative trends in the assessment, including the continuing decline in SSB despite the fishing mortality rate being below MFMT (i.e., overfishing is not occurring).

> **By a vote of 19 to 1, the Committee expressed concerns about continued estimated low gray triggerfish recruitment, declining or level indices of abundance, and declining SSB estimates, despite nearly a decade of F being well below MFMT. Therefore, the Committee recommends OFL and ABC to continue at the current rebuilding levels and not based on assessment results that would produce much higher levels.**

Finally, the SSC voted on status determination.

> **With one opposed, the Committee concludes that the gray triggerfish stock is not experiencing overfishing, but is overfished. The Committee further notes that the stock does not appear to be recovering under the current rebuilding plan.**

The SSC noted that gray triggerfish is projected to miss its rebuilding deadline of 2017 even if the stock is closed to fishing. With the caveat that the yield projections were not accepted by the SSC, and are provided for reference only, projections from the SEFSC indicate that, if the stock is closed to all fishing, it will rebuild to the SSB at 30% SPR between 2020 and 2023. If fished at the maximum rate allowed under Amendment 37 (the yield when fishing at 75% of $F_{30\%\ SPR}$), the stock is projected to rebuild between 2028 and 2035. This fishing rate is also consistent with the guidance in the National Standard 1 guidelines for stocks that have missed their rebuilding target date.

SSC members suggested that the most appropriate course of action is to establish a new rebuilding schedule. However, in order to provide OFL and ABC guidance, the SSC needs a benchmark assessment that produces credible reference points that adequately capture the productivity and dynamics of the stock. An alternative might be to use Tier 3b of the ABC control rule. This would set the OFL at the recent average catch level, and would set ABC at some level below the recent level. The SSC would like guidance from the Council on how to proceed.

Projections

Dr. Shannon Cass-Calay presented the results of analyses requested by the Council in order to establish rebuilding time frames and yield streams for a new gray triggerfish rebuilding plan. Specifically, the following analyses were requested by the Council:

1. Project $T_{REBUILD}$ (or T_{MIN}) in the absence of fishing mortality. This should be calculated under two projected recruitment scenarios:
   a. Assume low recruitment for the years 2014-2018 (5 years from 2013).
   b. Assume low recruitment for the years 2014-2021 (5 years from 2016, 8 years total).

2. Project the annual overfishing levels (OFLs) associated with the constant fishing mortality rate that allows the stock to rebuild by 2026 ($F_{REBUILD}$), assuming the first year harvest levels can be set is 2017 and:
   a. Low recruitment from 2014-2018 and subsequent recruitment determined by the stock-recruitment relationship in 2019-2026.
   b. Low recruitment from 2014-2021 and subsequent recruitment determined by the stock-recruitment relationship in 2022-2026

3. Project the annual overfishing levels (OFLs) associated with the constant fishing mortality rate that allows the stock to rebuild by 2024 ($F_{REBUILD}$), assuming the first year harvest levels can be set is 2017 and:
   a. Low recruitment from 2014-2018 and subsequent recruitment determined by the stock-recruitment relationship 2019-2024.
   b. Low recruitment from 2014-2021 and subsequent recruitment determined by the stock-recruitment relationship 2022-2024.

   If T_{MIN} under this recruitment scenario is 8 years, then calculate rebuilding to occur in 2025.

4. The probability density function of each OFL (2a and b, 3a and b) will also be made available to facilitate the estimation of the acceptable biological catch (pending the Scientific and Statistical Committee's designation of P*).

The analyses were conducted using the Stock Synthesis 3 model used in the SEDAR 37 assessment but with updated 2014 and provisional 2015 landings data. The SEDAR 37 stock assessment used landings data through 2013. For these projections, finalized 2014 commercial and recreational landings were available at the time of the Council request. The 2015 provisional landings were available for the commercial sector and partially available for the recreational sector, with the remainder of the 2015 recreational landings estimated based on prior years' landings. Total landings for 2016 were set at the combined commercial and recreational ACL of 305,300 lbs ww. Selectivity, discard, and retention functions were held constant for all years of the projections.

Selection of Recruitment Scenario

The initial decision for the SSC was which of the two recruitment scenarios to accept. Analysis shows that there is a 5-year auto-correlation recruitment indices, which suggests that there is information to support five years of low recruitment. Beyond that, there is no way to determine future recruitment. However, if the 5-year auto-correlation is part of a longer time-series, there is no support for assuming continued low recruitment. For this reason, the SSC decided that the 5-year low recruitment scenario was less arbitrary than the longer low recruitment scenario.

> **By a unanimous vote, the SSC accepts the low recruitment for 2014-2018 scenario as the basis for projections for gray triggerfish.**

T_{MIN}

Using the selected recruitment scenario, with no fishing mortality beginning in 2017, the gray triggerfish stock is projected to recover to a biomass at 30% SPR (i.e., spawning biomass is 30% of virgin biomass) in 6 years, by 2022. This is T_{MIN}.

OFL

$F_{REBUILD}$ is the fishing mortality rate at which there is a 50% probability of rebuilding the stock within the desired time frame. However, this is not the OFL. OFL is the yield corresponding to the maximum fishing mortality threshold, which was defined in Amendment 30A as the yield corresponding to the F_{MSY} proxy of $F_{30\% \ SPR}$. The OFL at $F_{30\% \ SPR}$ is shown below in Table 1. The OFL is used to determine if overfishing is occurring annually.

ABC - Rebuilding Yield Streams

Because OFL is higher than the yield at $F_{REBUILD}$, the stock will not rebuild within 10 years under this fishing mortality rate. Therefore, the ABC was calculated as a reduction from the $F_{REBUILD}$ yield based on the P* (probability of overfishing) value determined by the SSC and the PDF constructed by the SEFSC.

Rebuilding yields streams ($F_{REBUILD}$) were constructed for 8, 9, or 10 year rebuilding scenarios. A 7-year rebuilding scenario could not be constructed in the model because, at any level of directed harvest, the accompanying discard mortality would increase overall fishing mortality above the levels needed to rebuild in that time frame.

P* was determined using the ABC control rule Tier 1 spreadsheet. This spreadsheet is used to assign scores to several factors regarding assessment information and characterization of uncertainty in the assessment. These scores are summed and scaled to a P* value between 0.3 and 0.5. The P* analysis for gray triggerfish, shown in Figure 1 resulted in a P* of 0.398, which the SSC rounded off to 0.40.

$$P^* = \exp\left[-a - b \sum_{i\ dimension} Dimension\ score_i\right]$$

P* = 0.398

Gray Triggerfish - 2016

S_{hi}= 3.998

Maximum Risk **0.50** a= 0.693

Minimum Risk **0.30** b= 0.1277703

$$a = -\ln(0.50) \qquad b = -\frac{a + \ln(0.30)}{S_{hi}} \qquad S_{hi} = highest\ possible\ score$$

Element scores are scaled from zero to a maximum. In this example the maximum is 2.00, but this can be changed

Dimension	Dimension Wt	Tier No.	Tier Wt	Element Score	Element	Score it	Element Result	Tier Result	Dimension Result
Assessment Information	**1**	1	1	0.00	Quantitative, age-structured assessment that provides estimates of exploitation and biomass; includes MSY-derived benchmarks.		0.67	0.67	0.67
				0.67	Quantitative, age-structured assessment provides estimates of either exploitation or biomass, but requires proxy reference points.	x			
				1.33	Quantitative, non-age-structured assessment. Reference points may be based on proxy.				
				2.00	Quantitative assessment that provides relative reference points (absolute measures of status are unavailable) and require proxies.				
Characterization of Uncertainty	**1**	1	.333	0.0	The OFL pdf provided by the assessment model includes an appropriate characterization of "within model" and "between model/model structure" error. The uncertainty in important inputs (such as natural mortality, discard rates, discard mortality, age and growth parameters, landings before consistent reporting) has been described with using Bayesian priors and/or bootstrapping and/or Monte Carlo simulation and the full uncertainty has been carried forward into the projections.		1.33	0.4429	1.11
				0.67	The OFL pdf provided by the assessment model includes an approximation of observation and process error. The uncertainty in important inputs (such as natural mortality, discard rates, discard mortality, age and growth parameters, landings before consistent reporting) has been described with ***SENSITIVITY RUNS*** and the full uncertainty has been carried forward into the projections.				
				1.33	The OFL pdf provided by the assessment model includes an incomplete approximation of observation and process error. The uncertainty in important inputs (such as natural mortality, discard rates, discard mortality, age and growth parameters, landings before consistent reporting) has been described with ***SENSITIVITY RUNS*** but the full uncertainty ***HAS NOT*** been carried forward into the projections.	x			
				2.0	The OFL provided by the assessment ***DOES NOT*** include uncertainty in important inputs and parameters.				
		2	.333	0.0	Retrospective patterns have been described, and are not significant.	X	0.0	0	
				1.0	Retrospective patterns have been described and are moderately significant.				
				2.0	Retrospective patterns ***have not*** been described ***or*** are large.				
		3	0				0	0	
					NOT USED				
						z			
		4	.333	0.0	Known environmental covariates are accounted for in the assessment.		2.0	0.666	
				1.0	Known environmental covariates are **partially** accounted for in the assessment.				
				2.0	Known environmental covariates ***are not*** accounted for in the assessmen	x			

Figure 4. ABC control rule Tier 1 P* analysis for gray triggerfish.

By a unanimous vote, the SSC recommends a P* of .40 for gray triggerfish to be applied to the yield at $F_{REBUILD}$ PDF to compute the ABC.

ABC yield streams were constructed by applying the P* of 0.40 to the probability distribution functions (PDFs) constructed for the 8, 9, and 10-year rebuilding yield streams. The SSC discussed what value to use for the coefficient of variance (C.V.) in the PDF. The C.V. calculated for gray triggerfish is approximately 0.1, and was calculated as within model variability. An alternative C.V. of 0.37 was calculated by Ralston et al (2011) for the Pacific based on a pooled value for a large number of stocks. After discussion, the SSC decided to use the C.V. of 0.1, although some members felt that it does not adequately reflect scientific uncertainty. The resulting yields are shown in Table 1 below along with the OFL yield stream, which is the same for all rebuilding scenarios. The OFL yields are much higher than the ABCs because they are based on a fixed MFMT that is independent of rebuilding, and are much higher than the fishing mortality rates needed to rebuild. The stock will not rebuild to 30% SPR in 10 years if fished at OFL (Table 2).

Table 1. OFL and ABC in pounds whole weight, assuming low recruitment will continue through 2018. OFL was the 50th percentile of annual retained yield from a projection of $F_{SPR30\%}$ (MFMT). ABC values were computed from the three $F_{REBUILD}$ projections using a P* = 0.4.

Year	OFL	ABC_{2024} 8-year rebuild	ABC_{2025} 9-year rebuild	ABC_{2026} 10-year rebuild
2017	1,309,000	216,000	399,000	546,000
2018	1,287,000	227,000	412,000	554,000
2019	1,218,000	233,000	417,000	555,000
2020	1,187,000	237,000	421,000	558,000
2021	1,221,000	251,000	444,000	586,000
2022	1,344,000	283,000	498,000	656,000
2023	1,462,000	320,000	560,000	733,000
2024	1,560,000	357,000	620,000	808,000
2025	1,635,000		674,000	873,000
2026	1,696,000			928,000

Table 2. SPR if stock is fished at OFL (yield at $F_{30\%\ SPR}$)

Year	OFL	SPR
2017	1,309,000	19%
2018	1,287,000	18%
2019	1,218,000	17%
2020	1,187,000	17%
2021	1,221,000	18%
2022	1,344,000	19%
2023	1,462,000	19%
2024	1,560,000	20%
2025	1,635,000	21%
2026	1,696,000	21%

The SSC decided to recommend yield streams for all three of the possible rebuilding scenarios so that the Council could decide which target date to adopt. Initially, some SSC members suggested recommending the full rebuilding yield streams, but given the uncertainties in the assessment and projections, other SSC members felt that it would not be appropriate to recommend ABC for more than 3 years (2017-2019). If there is no new assessment by 2019, the SSC will reevaluate the ABC yield stream based on updated landings and whatever other new information is available. The yields in Table 1 were rounded to 3 significant digits.

By a vote of 18 to 2, the SSC recommends that the OFL for Gulf gray triggerfish for years 2017-2019 is 1.31, 1.29, and 1.22 mp ww, respectively. Annual ABC for these years will be computed as the 40th percentile of the $F_{REBUILD}$ PDF, which is contingent upon the Council specifying the duration of the rebuilding plan.

Year	OFL	ABC_{2024} 8-year rebuild	ABC_{2025} 9-year rebuild	ABC_{2026} 10-year rebuild
2017	1,310,000	216,000	399,000	546,000
2018	1,290,000	227,000	412,000	554,000
2019	1,220,000	233,000	417,000	555,000

Yield are in pounds whole weight.