Updated Calculations of OFL and ABC for Gulf of Mexico Lane Snapper using the Itarget Data Limited Method (DLM)

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Executive Summary
This analysis updates the Itarget data-limited approach to providing ABC and OFL advice for lane snapper. The Itarget method uses the recent (2014-2018) headboat index which showed a 57% increase over the reference period (1999-2008). The resulting OFL was 603,195 lbs (50% percentile) with an ABC (588,965 lbs whole weight, based on the 30th percentile of the OFL. This represents a 66% increase from the current OFL, commensurate with the increase in the recent indices over the reference time period.

Background and Purpose
Anon (2017) summarized a review of the approach and data-limited methods used in SEDAR 49 to establish overfishing limits (OFL) and allowable biological catches (ABC) and also the (status quo) methods for setting Overfishing Limits (OFL) and Allowable Biological Catch (ABC) under the Gulf of Mexico Fishery Management Council (GMFMC) ABC Tier 3a and 3b control rule as of 2011[1] (GMFMC 2011). It was noted that the status quo method, which was based on the mean catch of a static reference period, did not provide estimates of OFL/ABC that had any inherent guarantee of sustainability (i.e., based on MSY). Requirements for the status quo method include that the reference period removals (landings plus discards) have no trend and are relatively small relative to the stock biomass. Anon. (2017) noted for the GOM lane snapper stock:

> "*A catch reference period of 1999-2008 was previously selected by the SSC (in 2011) for use in calculating OFL and ABC using Tier 3a of the ABC control rule. This was a period when there was no significant trend in landings. The mean of the landings during this period could be considered sustainable, but does not guarantee maximum sustainable yield. OFL and ABC for lane snapper for the status quo method were determined as the mean catch for the reference period + two (2) standard deviations (OFL) and mean catch for the reference period + one (1) standard deviation respectively (ABC).*"

[1] "Tier 3 of the status quo ABC control rule is divided into two sub-tiers. Tier 3is used when only landings data are available. Tier 3a is for stocks that, in the expert opinion of the SSC, are unlikely to undergo overfishing at current or slightly higher landings level. A mean and standard deviation (SD) of the landings is calculated for a period when there is no upward or downward trend (preferably 10 years, but not essential). Typically, the OFL is then set at the mean plus 2 SD, and the ABC is set at the mean plus 1 SD, although ABC can be set at some other multiplier of OFL as long as it does not exceed OFL " . See: GMFMC 2011.

The Southeast Data and Assessment Review (SEDAR) 49 approach for estimating OFL/ABC utilized the Data-Limited Methods Toolkit ('DLMtool', Carruthers et al. 2015, available at http://www.datalimitedtoolkit.org/). A feature of the 'Toolkit" includes the ability to make use of auxiliary data (e.g., indices of abundance and mean length statistics) often considered useful in stock assessment analyses in tracking population abundance. The DLMtool also allows evaluation of multiple management methods using a process known as Management Strategy Evaluation (MSE) to identify the most appropriate data-limited method for the specific case under evaluation (i.e., lane snapper). MSE procedures and steps have been described in Holland (2010).

The SEDAR 49 data limited analyses of lane snapper were conducted in three (3) steps: 1) conduct **feasibility** of data review, 2) carry out **application of MSE** for identification of most relevant method(s), and 3) perform **catch estimation** for most relevant method(s). The SEDAR 49 Data Workshop (DW) reviewed the available data and determined that the time series of catch (1986-2014), the abundance information for the headboat fishery (1986-2014) and length data time series from private recreational vessels and headboats were adequate for application of the DLM methods. In particular for the headboat index of abundance, the DW noted:

> *"The index received a good quality score and was recommended for analysis because of a high proportion positive of observations, large sample size, and a relatively low CV."*

The SEDAR 49 MSE evaluations identified four (4) l methods for catch estimation for lane snapper that used information on abundance and mean length (i.e., Islope, Itarget, Ltarget, and Lstep, as described in the DLM Toolkit (http://www.datalimitedtoolkit.org/) and also at SEDAR 49 SAR, Section 3.1, and Pages 351-371).

Anon (2017) also reviewed the results of these four separate DLM methods and determined in the context of using DLM methods for establishing catch advice vs the status quo method that:

> *"the data limited approach provided the best scientific information available, and that the "Itarget" method (Geromont and Butterworth (2014)) provided the best management advice for lane snapper".*

Briefly, the Itarget method estimates a catch recommendation by adjusting mean catch during a reference period to achieve a target CPUE. SEDAR 49 assumed the reference period of 1999-2008 recommended by the GMFMC SSC for lane snapper was appropriate after confirming no trend in landings. Itarget assumes any trend in the index of abundance is a reliable indicator of the trend in resource biomass. The application of the Itarget method for the SEDAR 49 evaluation utilized a slightly modified approach as described in SEDAR 49 SAR (Section 3, page 361). Specifically, the I^{ave} and I^{target} scalars of 0.7 and 1.0 respectively as selected by the SEDAR 49 Assessment Panel (AP) were used to adjust the recent index (for 2014-2018) to the target CPUE. The justification for these decisions were based on the assumed stock condition of near MSY during the reference period (following the GMFMC SSC's determination of lane snapper falling into Tier 3A). The final calculations of TAC utilized the DLMTool version 3.2.2 and use of the open source R software environment (https://www.r-project.org/).

The TAC was calculated for lane snapper as:

If $I_y^{recent} \geq \mathbf{0.7} \times I^{ave}$:

0

$$\mathrm{TAC}_{y+1} = C^{ave}\left[\mathbf{w} + (1-\mathbf{w})\,\frac{(I_y^{recent} - \mathbf{0.7} \times I^{ave})}{(I^{target} - \mathbf{0.7} \times I^{ave})}\right]$$

Else

If $I_y^{recent} < \mathbf{0.7} \times I^{ave}$:

$$\mathrm{TAC}_{y+1} = \boldsymbol{w} \times C^{ave}\left[\frac{I_y^{recent}}{\mathbf{0.7} \times I^{ave}}\right]^2$$

Where:

$\mathbf{C^{ave}}$ = average catch over reference time series (1999-2008)
$\mathbf{I^{ave}}$ = ^{average} index over reference time series (1999-2008)
$\mathbf{I^{recent}}$ = average index over 5 most recent years (2014-2018)
$\mathbf{I^{target}}$ = I^{ave} x Imulti - where the “Imulti” scalar on I^{ave} was set as 1.0 for SEDAR 49 evaluations based on the assumption that the stock was near MSY during the reference period.
w = 0.5, where *w* is the smoothing parameter that defines the catch advice when $I^{recent} = 0.7\ I^{ave}$.

Appendix 1 provides the R script for the Itarget_0.5_0.7_1.0 method used to estimate updated TACs for lane snapper.

Additionally, the question of whether the catch level produced by the DLM method could be considered OFL or ABC was addressed at the March 2017 SSC. Anon (2017) noted:

> *“NMFS provides the following guidance in making this determination. If the stock is considered to be overexploited or near MSY, the resulting catch level recommendation should be OFL. If the stock is considered to be underexploited, the resulting catch level recommendation should be ABC. Lane snapper was assumed to be at or near MSY during the reference period.”*

Anon (2017) reported that the catch results from the Itarget method for the 30^{th} and 50th percentile of the PDF provided the best estimate of ABC and OFL respectively for lane snapper.

This report updates the calculation of catch levels for OFL and ABC for lane snapper using the modified Itarget data limited method of Geromont and Butterworth (2014) recommended for use following the SSC review of SEDAR 49 (Anon 2017). Results for Itarget (‘Itarget_0.5_0.7_1.0’) are based on the updated headboat fishery index of abundance through 2018 (Cummings, 2019).

Results

Table 1 and Figure 1 provide the updated standardized and nominal lane snapper headboat CPUE index. The results indicate that standardized headboat CPUE increased by approximately 63% from 2014 to 2018 and showed a declining trend the subsequent two (2) years. Standardized CPUE in 2018 (1.42) remained fairly high and just slightly below the level estimated for 2005 (1.54) and ~ 36% higher than the average across the entire time series (1986-2018). Standardized CPUE for the recent time series (2014-2018) used to adjust the calculation of TAC was 1.53 or ~ 57% higher than the CPUE estimated (0.974) for the catch reference period (1999-2008). This contrasts with the estimated 13% higher CPUE estimated for SEDAR 49 for the recent index period (2010-2014) vs the catch reference period (1999-2008).

It is worth noting that although total catch (recreational and commercial combined) showed a strong increase between 2016 and 2017 (of ~ 93% by weight) that the total 2017 catch was ~ 39% lower than the maximum catch (820,506 pounds ww for 1989) reported across the entire time series (1986-2018) (Table 2, Figure 2). Additionally, the 2017 total catch was ~ 88% higher than the reference period (1999-2008) total catch. As expected the recreational component dominated the landings time series in all years, averaging 86% by weight across all years. Cummings (1999) noted that the proportion of positive headboat trips landing lane snapper and the normalized lane snapper headboat effort has shown a steady since about 1999 (see Figures 1 and 4 of Cummings, 1999).

As a reminder SEDAR 49 Assessment Panel selected the time period of 1999-2008 as the reference time period against which to adjust the target CPUE and agreed to adjust the average CPUE for the reference period using CPUE from the most recent five years (i.e., 2014-2018). The reference period, 1999-2008, compares to the reference period agreed by the GMFMC SSC for setting OFL/ABC levels (in 2011) for lane snapper using the status quo method (i.e., mean catch during reference period + 2 (OFL) standard deviations, and mean catch + 1 standard deviation (ABC), GMFMC 2011).

Table 3 provides updated catch levels (pounds whole weight) for lane snapper at 30%, 40%, and 50% probabilities of exceeding OFL for the updated Itarget 0.5_0.7_1.0 data limited method using updated standardized CPUE index information through calendar year 2018. The 2019 updated ABC (30%) and OFL (50%) catches are: 588,965 and 603, 195 pounds ww and compare to the previous 2017 reported TACs of 355,501 (30%) and 364,082 (50%) pounds ww that used standardized CPUE index information through calendar year 2014. Supplemental information is also provided for the SD and CV for the updated TAC distribution. Figure 3 provides the relative standardized frequency of TAC for the 2019 updated lane snapper Itarget0.5_0.7_1.0 data limited method.

References

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Table 1. Updated lane snapper catch per unit of effort (CPUE) standardized indices of abundance from the headboat fishery 1986-2018. Indices from Smith and Rios (2016, SEDAR 49) included for comparison. Source: Cummings, 2019.

YEAR	SEDAR 49 Standardized CPUE	SEDAR 49 Updated Standardized CPUE	SEDAR 49 Updated Nominal CPUE	SEDAR 49 Update Normalized Effort
1986	0.730	0.738	0.454	0.571
1987	0.860	0.881	0.371	0.677
1988	0.420	0.433	0.228	0.941
1989	0.650	0.620	0.392	0.822
1990	1.040	1.102	0.721	1.116
1991	1.330	1.324	0.898	1.212
1992	1.270	1.269	1.148	1.342
1993	1.570	1.602	1.819	1.442
1994	1.250	1.347	1.198	1.202
1995	0.860	0.880	0.821	0.964
1996	0.660	0.697	0.543	0.813
1997	0.600	0.584	0.351	0.804
1998	0.590	0.599	0.515	0.688
1999	0.510	0.515	0.243	0.641
2000	0.760	0.793	0.438	0.805
2001	0.590	0.589	0.399	0.846
2002	0.880	0.888	0.617	0.891
2003	1.150	1.134	1.076	0.817
2004	1.140	1.123	0.701	0.967
2005	1.520	1.549	1.125	0.945
2006	1.110	1.002	0.965	0.856
2007	1.090	0.980	0.751	0.954
2008	1.230	1.169	0.812	0.948
2009	1.410	1.330	1.134	1.108
2010	1.110	1.043	0.998	0.727
2011	1.050	1.063	1.328	1.027
2012	1.100	1.098	1.301	1.072
2013	1.120	1.093	1.425	1.209
2014	1.130	1.133	1.424	1.308
2015	1.270	1.422	1.833	1.359
2016		1.857	2.467	1.441
2017		1.812	2.743	1.228
2018		1.417	1.761	1.261

Table 2. Updated commercial and recreational landings of Gulf of Mexico lane snapper 1986-2018. Source of data: SEDAR 49 SAR (1986-2014) and Ryan Rindone (email of 7August 2019). Recreational dead discards for 2015-2018 estimated as average for 2012-2014 using inputs from SEDAR 49. Recreational landings are in MRIP units.

Landings (whole weight)			
Year	Commercial	Recreational	Total
1986	60,174	337,741	397,915
1987	51,972	503,523	555,495
1988	57,659	389,105	446,764
1989	93,596	726,910	820,506
1990	81,358	199,003	280,361
1991	119,289	689,172	808,461
1992	99,127	501,489	600,616
1993	107,136	419,689	526,825
1994	91,729	428,976	520,705
1995	71,294	462,958	534,252
1996	54,581	210,779	265,360
1997	61,251	450,618	511,869
1998	31,750	284,505	316,255
1999	49,233	197,024	246,257
2000	47,684	149,614	197,298
2001	48,782	346,925	395,707
2002	52,970	213,264	266,234
2003	50,584	315,508	366,092
2004	50,755	309,772	360,527
2005	39,951	368,364	408,315
2006	49,340	297,855	347,195
2007	29,222	226,375	255,597
2008	25,475	234,931	260,406
2009	35,848	292,569	328,417
2010	17,262	100,942	118,204
2011	14,365	110,074	124,439
2012	28,928	215,811	244,739
2013	23,189	269,524	292,713
2014	29,948	294,521	324,469
2015	44,840	239,579	284,419
2016	34,142	272,610	306,752
2017	42,419	542,273	584,692
2018	25,974	339,454	365,428

Table 3. Updated Lane snapper catch levels (pounds whole weight) at 30%, 40% and 50% probabilities of exceeding OFL for the Itarget 0.5_0.7_1.0 data-limited methods.

Method	**ABC**		**OFL**	**SD**	**SE**	**CV**
	30%	**40%**	**50%**			
Updated Itarget0.5_0.7_1.0 September 2019	588,965	596,349	603,195	27,616	276	0.046
Itarget0.5_0.7_1.0 SEDAR 49, March 2017	355,501	360,059	364,082	16,965	170	0.047

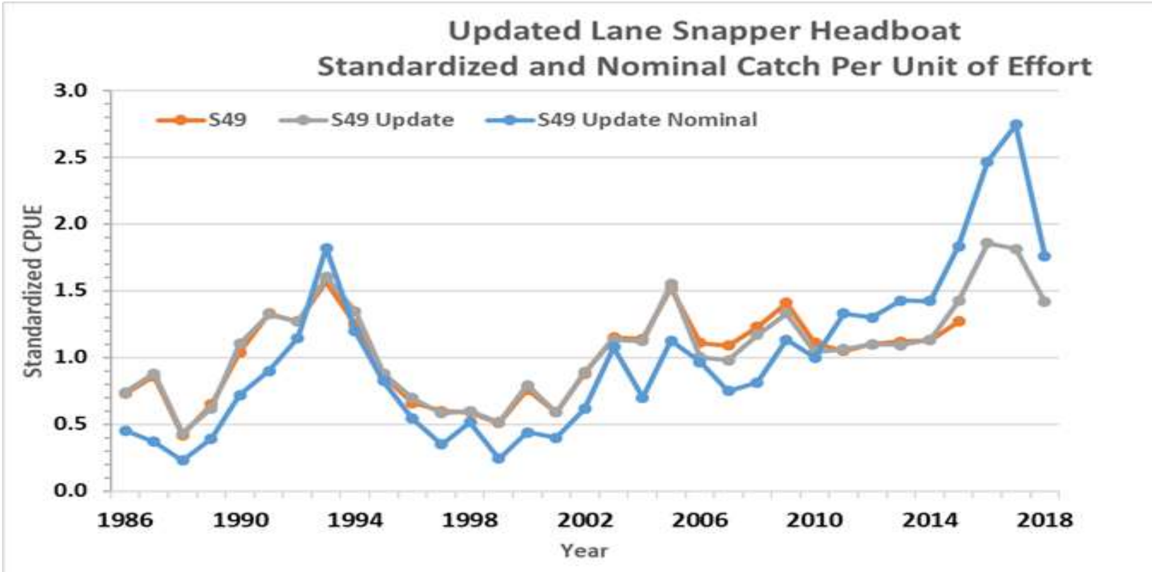

Figure 1. Updated Lane snapper standardized catch per unit of effort from the headboat fishery 1986 - 2018 (SEDAR 49 Update line). The standardized CPUE index from Smith and Rios (SEDAR 49) is included for comparison (S49 line). All time series scaled to the mean of the overlapping years (1986-2014).

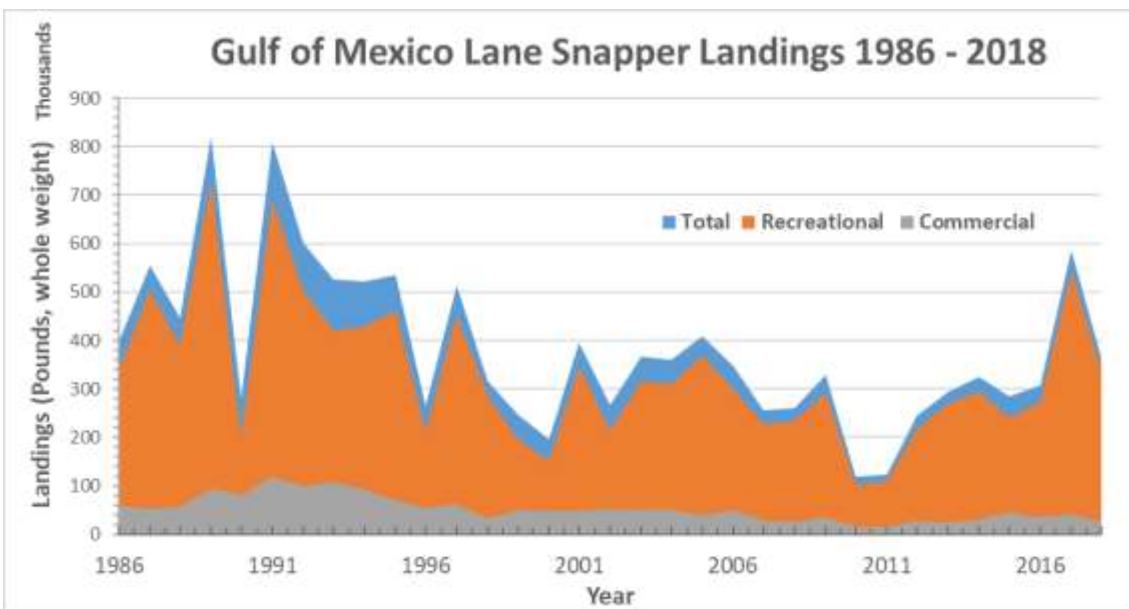

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Figure 2. Updated Gulf of Mexico lane snapper landings 1986-2018. Source of Information: NOAA Fisheries, SEDAR 49 SAR Report (Table 5.4.2) and Ryan Rindone (personal communication, 2015-2018 data).

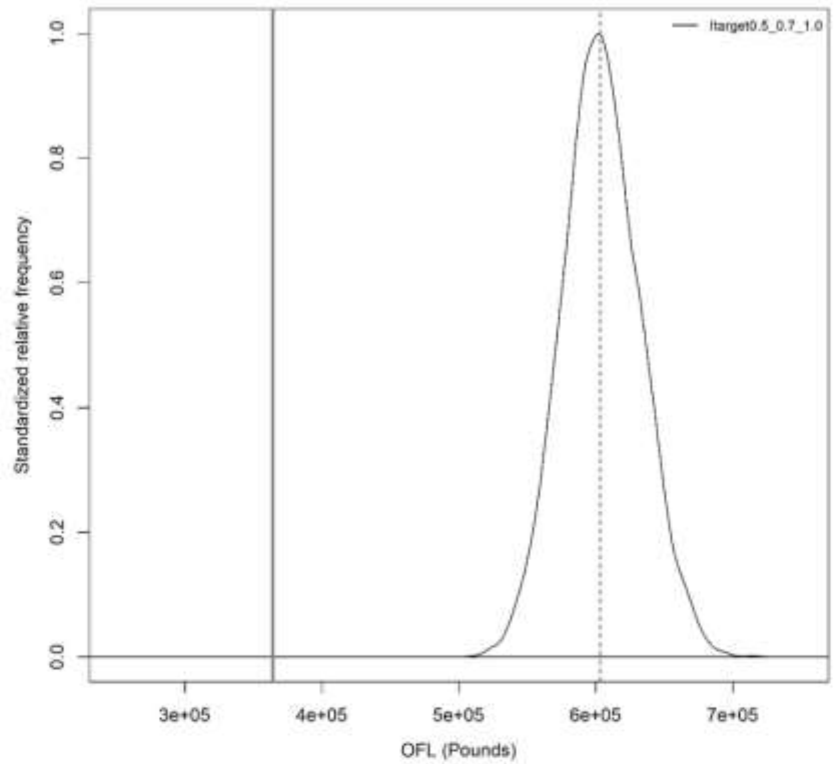

Figure 3. Standardized relative frequency of TAC for lane snapper for the updated Itarget0.5_0.7_1.0 data limited method using the Cummings (2019) updated headboat standardized CPUE index for 1986-2018. Thick gray line represents the calculated OFL (estimated TAC= 364,082 pounds ww) at the 50% probability of exceeding OFL from the March 2017 SSC Review of the SEDAR 49 data limited evaluation.

Appendix 1. R script for Itarget0.5_0.7_1.0 data limited method applied for updating TAC calculations for lane snapper September 2019.

```
#Near MSY (Itarget = Iref), I0 = 0.7
Itarget0.5_0.7_1.0<-function (x, DLM_data, reps = 100, yrsmth = 5, I0=0.7, xx = 0, Imulti = 1.0, w = 0.5)
{
 dependencies = "DLM_data@Cat, DLM_data@CV_Cat"
 ylast <- (DLM_data@LHYear - DLM_data@Year[1]) + 1
 ind <- c((ylast - 19): (ylast-10)) #Reference period for CATCH: 1999-2008
 ind2 <- ((ylast - (yrsmth - 1)):ylast) #period for index: last 5 years
 C_dat <- DLM_data@Cat[x, ind]
 TACstar <- (1 - xx) * trlnorm(reps, mean(C_dat,na.rm=T), DLM_data@CV_Cat/(yrsmth^0.5))
 Irecent <- mean(DLM_data@Ind[x, ind2],na.rm=T) #mean of recent Index
 Iave <- mean(DLM_data@Ind[x, ind],na.rm=T)     #mean of average Index - 1999-2008
 Itarget <- Iave * Imulti
 I0 <- I0 * Iave
 if (Irecent >= I0) {
  TAC <- TACstar * (w + (1-w)*((Irecent - I0)/(Itarget - I0)))
 }
 else {
  TAC <- w * TACstar * (Irecent/I0)^2
 }
 TACfilter(TAC)
}
```