Updated Catch per Unit of Effort (CPUE) Indices and Effort Time-series for Lane Snapper from the Gulf of Mexico Recreational Headboat Fishery (1986 - 2018)

Nancie Cummings, Sustainable Fisheries Division (SFD)

NOAA Fisheries, Southeast Fisheries Science Center (SEFSC),

Miami Laboratory, Miami FL 33149

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Background and Purpose

Catch per unit effort (CPUE) indices of abundance for the headboat fishery for lane snapper for 1986-2015 were reported by Smith and Rios (2016). The SEDAR 49 Gulf of Mexico Data Limited Stock (DLS) Data Workshop reviewed the usefulness of the headboat CPUE indices for lane snapper stock. The SEDAR 49 DW review found that:

> *"The results and model diagnostics indicate that the headboat data can be used to develop reliable nominal and standardized indices for Lane Snapper and Almaco Jack. In general the headboat data for Lane Snapper had good spatial and temporal coverage as the survey was intended to be census of the headboat fishing activity. Spatially, the bulk of the records are from fishing trips occurring in the eastern Gulf of Mexico; however, sample sizes from the western Gulf were large enough to warrant inclusion in the analysis (1560 Almaco Jack, 11,873 Lane Snapper)"*

Following the SEDAR 49 DW, the lane snapper headboat CPUE indices were used in the Data Limited Modeling (DLM) evaluations using the DLMtool package (Carruthers et al. 2014). This report updates the lane snapper headboat fishery CPUE indices through 2018.

Procedures used in the 2019 Headboat CPUE Index Update

The approach employed in updating the lane snapper headboat indices (through 2018) followed the methods described by Smith and Rios (2016). Reported information for each reported headboat fishing trip included: landing date and location, vessel identification, the number of anglers, fishing location, trip duration and type (AM/PM/Both), and catch by species in numbers and weight. Briefly the approach was:

1. *Quality control edits:*

Carry out quality control and assurance procedure as described by Smith and Rios:

- Calculate effort (angler hours) as the number of anglers times the hours fished
- Correct to dates that are incomplete or do not exist (e.g., record indicating trip occurred on Feb 31 of a given year)
- Remove trips with 0 anglers reported
- Remove duplicated data entries

2. *Index Standardization*
   a. *Apply the Stephens MacCall (2004)* sub-stetting method to identify target trips for lane snapper

      The SEDAR 49 DW recommended use of the Stephens McCall procedure to identity a subset of fishing trips (catch and effort) observations to construct an index from. This procedure is routinely applied prior to index standardization for the purpose of identifying CPUE observations (i.e. fishing trips) for which the species of interest was the target species or was likely to be encountered during the trip. From a practical modeling approach of fishing trip observations this type of exercise is considered important prior to index standardization due to the multi-species nature of fisheries data, particularly recreational fishing data sets. Other data sub-setting methods have also been applied to identify target trips such as identifying a suite of species thought to co-occur on a single fishing trip (i.e., the guild approach). The guild approach was also applied in SEDAR 49 however the Stephens McCall method was ultimately selected by the SEDAR 49 DW as the '*preferred subsetting approach*'.

   b. *Carry out Generalized Linear Modeling* (GLM) on the resulting subsetted data (from step 2a) to develop standardized indices, adjusted for variation in the nominal (raw) CPUE observations, using a delta log-normal generalized linear model (Lo et al., 1992). The Lo method (Lo et al. 1992) is a common approach utilized in fisheries CPUE modeling exercise to remove variability in CPUE due to possible temporal (year, month), spatial (area/fishing location, depth, etc..), and/or environmental (lunar period, etc.) effects. These factors are referred to as 'standardizing factors' in the modeling process and are considered independent factors. For the update- the factors were as in Smith and Rios (2016). Year was included as a factor in the binomial portion of the standardization procedure, while year, month, and sub region were included in the log-normal portion of the delta log-normal standardization procedure.

3. *Calculate normalized effort time series* as the sum of the annual angler hours (# anglers per trip * hours fished) divided by the mean of the time series

Results

Results of the updated index standardization and updated estimates of normalized annual effort are provided in Table 1 and Figures 1 - 4.

Annually, lane snapper occurred in between 38 and 68% of trips when the Stephens MacCall procedure was used to subset generally showing an increasing trend in the number of successful (positive) headboat trips for lane snapper (Table 1, Figure 1)

The nominal index and standardized headboat index show similar trends throughout the time series (Table 1, Figures 2 and 3). Lane snapper standardized CPUE increased from 1986-1993, declined thereafter through 2001, and increased again through 2005. Standardized CPUE varied without trend from 2006-2014 and indicated a brief short three year but strong increasing trend (through 2016). Subsequently standardized CPUE declined in 2017 and 2018.

Diagnostic results for QQ-plot and KS test results did not indicate any major divergence of normality for model residuals suggesting reasonable goodness-of-fit of the GLM standardizing model to the data.

Normalized headboat effort for trips identified as fishing in areas where Lane Snapper are likely to occur indicate a steady increase since the beginning of the time series (1986), peaking in 1993. Lane snapper headboat effort subsequently declined through 1999. After 1999 normalized lane snapper headboat effort again showed a steady increasing trend through 2016 to about the same level predicted in1993, afterwards declining. Also, of note is that lane snapper normalized effort showed a similar trend to total headboat (normalized effort) across the time series with only minor divergence in some years (Table 1, Figure 4).

References

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

Stephens, A. and MacCall, A. 2004. A multispecies approach to sub-setting logbook data for purposes of estimating CPUE. *Fish. Res.* 70:299-310.

Smith, M.S. and A. Rios. 2016. Catch per unit effort indices and Effort Time-series for SEDAR 49 Data Limited Species captured in the Gulf of Mexico Recreational Headboat Fishery (1986 – 2015). SEDAR49-DW-02. SEDAR, North Charleston, SC. 16 pp.

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.

YEAR	SEDAR 49 Standardized CPUE	SEDAR 49 Updated Standardized CPUE	SEDAR 49 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

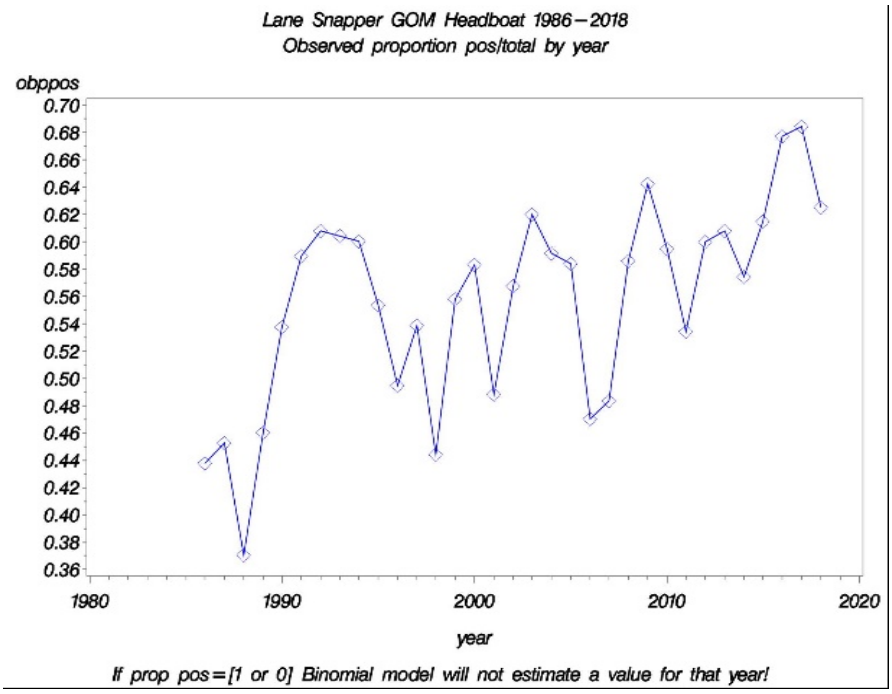

Figure 1. Annual proportion positive CPUE for lane snapper from the headboat fishery 1986-2018.

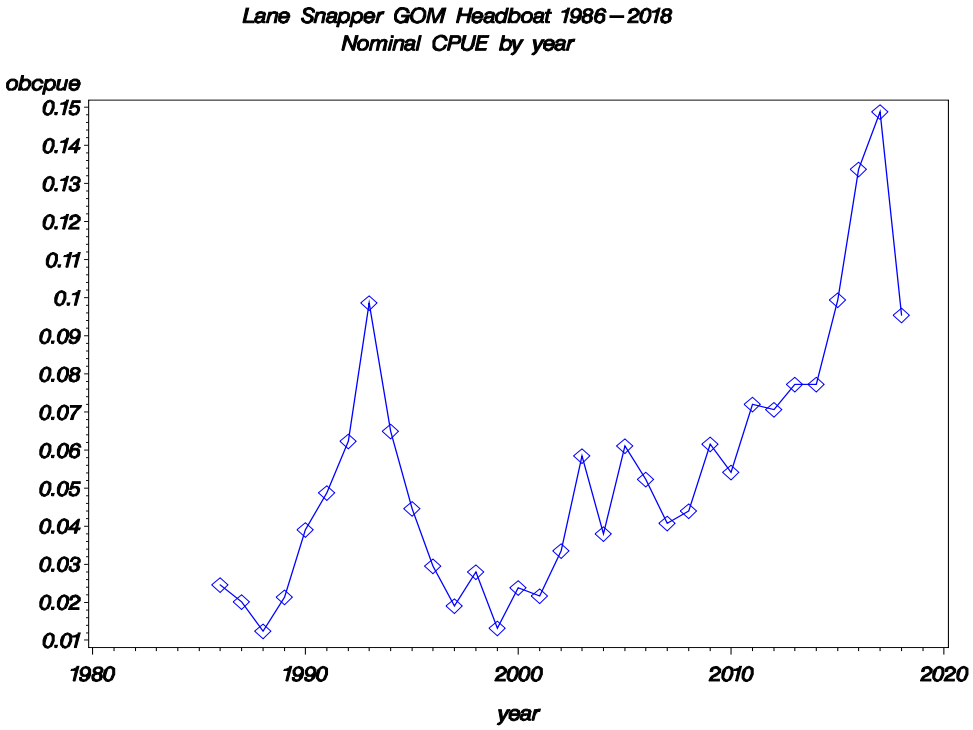

Figure 2. Nominal CPUE for lane snapper for the Headboat Fishery from 1986 – 2018.

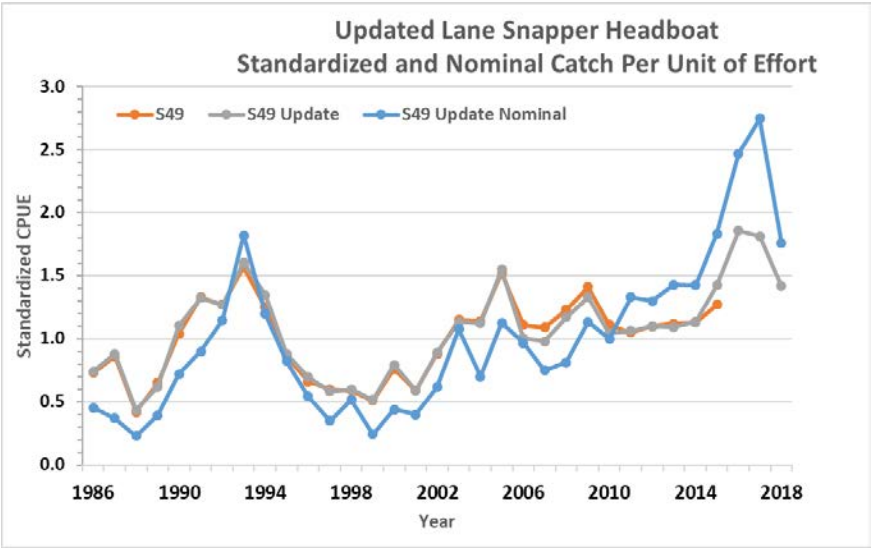

Figure 3. Updated Lane snapper standardized catch per unit of effort from the headboat fishery 1986 2018 (SEDAR 49 Update line). The standardized CPUE index from Smith and Rios (SEDAR 49) is included for comparison (S49 line). All time series scaled to the mean of the overlapping years (1986-2015)

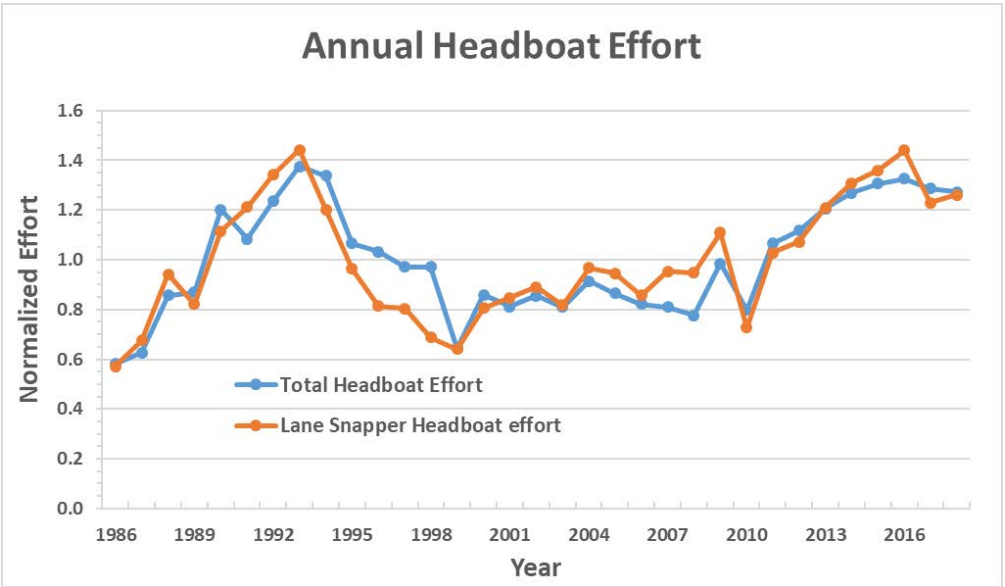

Figure 4. Estimated lane snapper normalized headboat effort 1986-2018.
(N*ormalized effort defined* as the sum of the annual angler hours (# anglers per trip * hours fished) divided by the mean of the time series).