Butterfish OFL-CV Determination

Draft 7/16/20

Preamble

A butterfish stock assessment was conducted and peer reviewed as part of the 2020 Management Track Assessment process (Level 2, Expedited, June 2020). The 2020 assessment followed the approach used in the 2014 benchmark stock assessment (NEFSC 2014) and is second update of the benchmark assessment, with the first occurring in 2017. The assessment spanned the years 1989-2019, with omission of data from years prior to 1989 per reasons articulated in the 2014 benchmark assessment (chiefly, highly uncertain discard estimation due to no observer information or precision measures of the foreign fleet catches). The assessment model is a statistical catch-at-age model implemented in ASAP that assumes catchability of the NEFSC fall trawl survey is known. Accordingly, the assessment estimates the natural mortality rate.

The Peer Review Committee (PRC) concluded that the 2020 stock assessment for butterfish is technically sufficient to evaluate stock status and provide advice for management. However, the PRC expressed some concern about the assessment projections because biomass and recruitment show a declining trend in recent years.

1. <u>Data Quality</u>

- Landings were updated and showed an increasing trend since 2010 but have remained lower than peak values in the mid-1990s (~7500 mt) and late 1990s (~8500 mt). The recent increasing trend in landings is expected given that recent butterfish ABCs have been increased relative to those for the mid-2000s.
- Discards estimation was modified and followed the algorithm typically applied by the NEFSC, so the discards time series changed somewhat when compared to that included in the previous assessment. Discards continue to comprise an importance fraction of total catch, and have remained stable since 2011 (range: ~ 1500-2000 mt).
- Total catch (landings + discards) showed harvest of ages 0-3 fish, with the bulk being ages 1-2, particularly since 2015.
- Indices of relative abundance were based on the NEFSC fall offshore survey (1989-2019 with 2009-2019 calibrated to Albatross units and 2017 omitted due to insufficient sampling), NEFSC fall inshore survey (1989-2008), and NEAMAP fall survey (2007-2019).
- Trends in all survey indices showed slightly decreasing patterns over time, with the NEAMAP index being more variable.
- A NEAMAP age-length key was applied as opposed to using the NEFSC age-length key for NEAMAP survey data. This change was supported by the PRC. Age composition of all survey catches reflected high proportions of age-0 fish, far fewer age 1-2 fish, and virtually no age 3+ fish.

2. Model appropriateness and identification during the assessment process

- ASAP4, years 1989-2019, ages 0-4+
- Fishery: 1 fleet (landings + discards), 1 commercial selectivity time block, selectivity set to 1.0 (full) for ages 2+, and CVs based on variance estimates of discards.
- Surveys: NEFSC fall offshore catchability fixed as product of availability (A = 0.62, mean for 1989-2015, no longer updated) and efficiency (e = 0.2). Selectivity set to 1.0 (full) for age 0, design-based CV estimates were rescaled based on RMSE diagnostics.
- Recruitment CV was set to 0.6 and M was estimated.
- Model diagnostics indicated that the model results were stable and reliable.
- The PRC noted some inconsistencies in the input weights-at-age for cohorts, where mean weight appeared to decline for fish transitioning from age 3 to age 4+ or remained stable for fish transition from age 0 to age 1. The PRC recommended revisiting the approach used to calculate mean weights-at-age.
- The new estimate of M was slightly higher than the previous estimate (1.29 vs. 1.25), but within the range of expected estimation variability.
- The assessment model produced a decreasing trend in biomass, and decreasing trend in recruitment, and an increasing trend in fishing mortality. The latter pattern was expected given increased landings in recent years, but the PRC expressed concern regarding the biomass and recruitment patterns.

3. Informed by retrospective analysis

- A retrospective analysis was performed and no retrospective adjustments were made to assessment model results.

4. Informed by comparison with simpler analyses

- No simpler analyses were conducted.
- Because catchability is assumed known in the assessment, the results should be similar to simple swept area estimates of biomass.

5. Informed by ecosystem factors or comparisons with other species

- No formal ecosystem factors were included in the assessment or model.
- Natural mortality was freely estimated, and the value was fairly high (M = 1.29) thus allowing the assessment model to produce estimates of biomass and fishing mortality with a high M, which is perhaps expected for a short-lived, pelagic forage species.
- No discussion of climate change was part of the assessment process.
- Changes in availability to the survey due to changes in habitat were considered previously, but the average availability is used in the assessment.

6. Informed by measures of trend in recruitment (primarily affecting the accuracy of forecasts)

- The biological reference points were $F_{MSY\ Proxy}$ = 2M/3 (Patterson 1992, MAFMC SSC) and SSB_{MSY} was estimated from long-term projections.
- Long-term projections for determining $SSB_{MSY\ Proxy}$ were conducted as follows: i) it was assumed that full catch limits were realized (2020 landings = 23,752, 2021-2070 F = $F_{MSY\ Proxy}$ = 0.86), ii) the full time-series averages for selectivity, maturity, weights-at-age were applied, and iii) projection recruitments came from the full time-series of estimated recruitment values.
- Short-term projections were also conducted, again following the aforementioned configuration used to estimate $SSB_{MSY\ Proxy}$.
- The PRC noted that assuming full realization of catch limits is unlikely to occur so the short-term projections probably overestimate the effects of near-term fishing. Specifically, if the 2020 catch limit was achieved, the projections indicated that the stock would be overfished in 2021. Recent landings have been 5-8 times lower than observed catches. Also, use of the full recruitment time-series may be overly optimistic given that recent recruitment has been low and roughly 1/3 to 1/2 of the long-term average.

7. Informed by prediction error

- Three model runs were examined (bridging): Run 1 added data for 2017-2019 to the 2017 model; Run 2 used the newly estimated time series of discards; and Run 3 included application of the NEAMAP age-length key.
- No substantial differences in model outputs were detected across the three runs.
- Assessment model diagnostics were well considered and showed plausible fits and results.
- No uncertainty estimates of BRPs were provided (e.g., CVs absent for $F_{2019}/F_{MSY\ Proxy}$ or $SSB_{2019}/\ SSB_{MSY\ Proxy}$).
- Major sources of uncertainty appear to be:
    - Discard estimates were highly variable and imprecise.
    - Commercial catch data were aged with NEFSC age-length keys.
    - Estimation of M required the assumption that the daytime Bigelow survey efficiency was 100%.
    - Use of $F_{MSY\ Proxy}$ = 2M/3 may be problematic since the estimator is not tied to SSB.

8. Assessment accuracy under different fishing pressures

- Accuracy of assessment results were not characterized in relation to different fishing pressures.
- BRPs were recalculated to enable internal consistency with the estimate of M.

9. Informed by simulation analysis or full MSE

- The assessment results and subsequent management advice were not informed by simulation analysis or MSE.

Narrative

Based on the 2020 updated stock assessment results, the butterfish stock is not overfished and overfishing is not occurring. SSB in 2019 was estimated to be 29,308 mt, which is 69% of the biomass target ($SSB_{MSY\ Proxy}$ = 42,427 mt). The fully selected fishing mortality rate was estimated to be 0.21, which is 24% of the overfishing threshold ($F_{MSY\ Proxy}$ = 0.86). The PRC accepted the stock assessment model results and affirmed that they can be used to formulate management advice. However, concerns were raised regarding the approach used to estimate mean weights-at-age (some values were not consistent with expected growth), the configuration of the projections (assuming fully realized catches, sampling from the full recruitment time-series), and the general patterns in model outputs (declining trends in estimated biomass and recruitment, increasing trend in estimated fishing mortality). Given that estimated biomass and recruitment both showed decreasing patterns over time, it may be possible to estimate a stock-recruitment (S-R) relationship. Discards have consistently comprised an appreciable fraction of the total catch, yet estimated discards prior to 2010 were highly variable and imprecise (CV range: 0.23 – 1.44). The assumption of 100% daytime Bigelow gear efficiency is strong, necessary for the estimation of M, but conservative in terms of scaling population biomass. The estimated M is high and the PRC noted that the magnitude of M leaves little expected biomass by age 4 (M = 1.29 implies annual survival = 0.28 and cumulative survival to age 4 = 0.006). The fishing mortality reference point originated from deliberations of the MAMFC SSC when setting an ABC for butterfish required ad-hoc methods (~2013), and a valid criticism of the estimator used for the $F_{MSY\ Proxy}$ is that it does not functionally relate to SSB, which is important to consider in the context of the potential existence of an S-R relationship. The short-term projections are likely not informative about near-term fishing effects given the aforementioned points raised about how they were configured.