What is next? Lessons learned from sensitivity model runs using length compositions collected by the Sportfishing Association of California

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Summary

U.S. recreational fisheries have been the key component of the total catch of Pacific bluefin tuna (PBF) for about a decade. The catch and its catch-at-size data are used in the stock assessment. However, the Southwest Fisheries Science Center (SWFSC) port sampling program (PSP) that measured the length of fish discontinued in 2020 due to COVID-19. Common practices to fill the data gap are 1) to borrow the information from other similar fleet or 2) borrow the information from the most recent data in the same fleet. Recent work showed that a parallel on-board sampling program (OSP), conducted by the Sportfishing Association of California (SAC), measured the length of fish in a smaller percentage of catch than the PSP. As another option, sensitivity runs using the alternative length compositions were conducted and the results were compared to those based on common practices. Overall, the time series of population spawning biomass and recruitment were almost identical among the models examined. The difference in catch-at-age(/size) between the model fitting the OSP data and model fitting the PSP data was smaller compared to the differences 1) between the model fitting either OSP or PSP data and the model borrowing information from EPO commercial fleet and 2) in between-year catch-at-age(/size). This suggests that despite the variability in the PSP and OSP data, either PSP or OSP data provides more appropriate information on the catch-at-age(/size) than borrowed information from the EPO commercial fleet and borrowed the information from the most recent data in the same fleet.

Introduction

U.S. recreational fisheries have been the major source of the total catch for Pacific bluefin tuna since 2011, consisting of the for-profit public chartered boats (i.e., Commercial Passenger Fishing Vessels (CPFVs)) and private boats operating in U.S. and Mexican waters primarily using hook-and-line gears. Among the two, the CPFVs dominate the recreational catches and effort. The Southwest Fisheries Science Center, National Oceanic and Atmospheric Administration (NOAA) established a Pacific Bluefin Tuna Port Sampling Program (PSP) in 2014 to measure fork length (FL) from the CPFV landings during 2014-2019 (Heberer and Lee 2019, Heberer and Snodgrass 2021 described the detailed sampling design and protocol). This program sampled fish opportunistically from CPFV trips after PBF were unloaded at public landing ports in San Diego, where the CPFV fleet targets PBF in Mexican waters more than any other ports along the U.S. West Coast. The alternative NOAA-funded size sampling program by SAC has CPFV crews measuring FL of landed PBF on-board (OSP) since 2015 (https://www.californiasportfishing.org/bluefin-tuna-sampling-project). James et al. (2021) conducted an analysis to compare length distributions between PSP and OSP programs. They found that although median sizes and length distributions were significantly different in most of the overlapped years, both programs generally represent the total landings from CPFVs with respect to the spatial and temporal coverage.

The length distributions for 2014-2019 measured by the PSP program were used in the 2020 assessment to inform catch-at-size for the sport fishery. However, the program could not provide consistent port sampling procedure during COVID years (2020-2021) and possibly in 2022. This data gap increases the uncertainty of catch-at-size for the sport fishery. The purpose of this paper is to understand the effect on the 2020 assessment using length distributions measured under the OSP and make suggestion on how to treat the data gap.

Methods

Three model runs were conducted to compare the results in the 2020 stock assessment (used PSP data). The first two models are used to compare the effect of PSP data and OSP data on the assessment model. The first model removed the PSP length data entirely and used the OSP data so that length data are for 2015-2018 (Fishing Year, FY) instead of 2014-2018 (FY). The second model used PSP size data for 2014 (FY) and OSP size data for 2015-2018 (FY). The Input sample sizes for both models were calculated using the same procedure in the 2020 assessment. The third model is used to compare the effect of not having any length data for sport fishery. This model removed the PSP length data entirely from the 2020 assessment and borrowed the selectivity for EPO commercial fleet.

Selectivity for the sport fishery in the 2020 was assumed to be time-varying length-based selectivity. Double normal function with smooth transitions was used and is composed of three components: an ascending limb for small fish (asc), a flat top where selectivity equals 1.0 (top), and a descending limb for large fish (dsc). The three components are connected at two intersections using steep logistic functions (Methot and Wetzel 2013). These selectivity parameters (asc, top, and dsc) and logistic parameters were estimated annually to reflect annual spatial age-class availability. The same selectivity assumption was applied in the first and second model runs.

Results and Discussion

Like the 2020 stock assessment model, the fits of the OSP length observations were generally good, where 1) the effective sample sizes (N eff.) used in the McAllister-Ianelli tuning method were greater than the input sample sizes (Figure 1), and 2) there is no clear residual pattern (Figure 2) for both model 1 and model 2. The only difference is the noticeable positive residuals (observed – expected = 4) in 2016 and 2018 in the 2020 assessment.

The estimated double normal length-based selectivity was similar between model 1 and model 2 (Figure 3). Compared to the estimated selectivity in the 2020 stock assessment model using PSP data, smaller and younger fish were selected in 2015 and 2016 for the OSP data than the PSP data (Figure 3 and Figure 4) resulting in catching in more small fish in 2015-2016 (Figure 5). Despite the differences in the selection and catch-at-age, the global scaling parameters (SSB_0 and $\ln(R_0)$), the time series of population spawning biomass and recruitment were almost identical (Figure 6) among the 2020 assessment, model 1, and model 2.

Overall, the difference in catch-at-age(/size) between the model fitting either OSP or PSP data and the model borrowing information from EPO commercial fleet was greater than the difference between the model fitting the OSP data and model fitting the PSP data (Figure 6). This suggests that despite the variability in the PSP and OSP data, either PSP or OSP data provides more appropriate information on the catch-at-age(/size) than borrowed information from the EPO commercial fleet (Figure 5). The other choice to fill the data gap is to borrow the most recent selectivity. The difference in between-year catch-at-age(/size) was greater than the difference between the model fitting the OSP data and model fitting the PSP data. These analyses suggested using best available data (i.e., SAC/OSP) that represent the sport fishery catch-at-size when the PSP data are not available.

References

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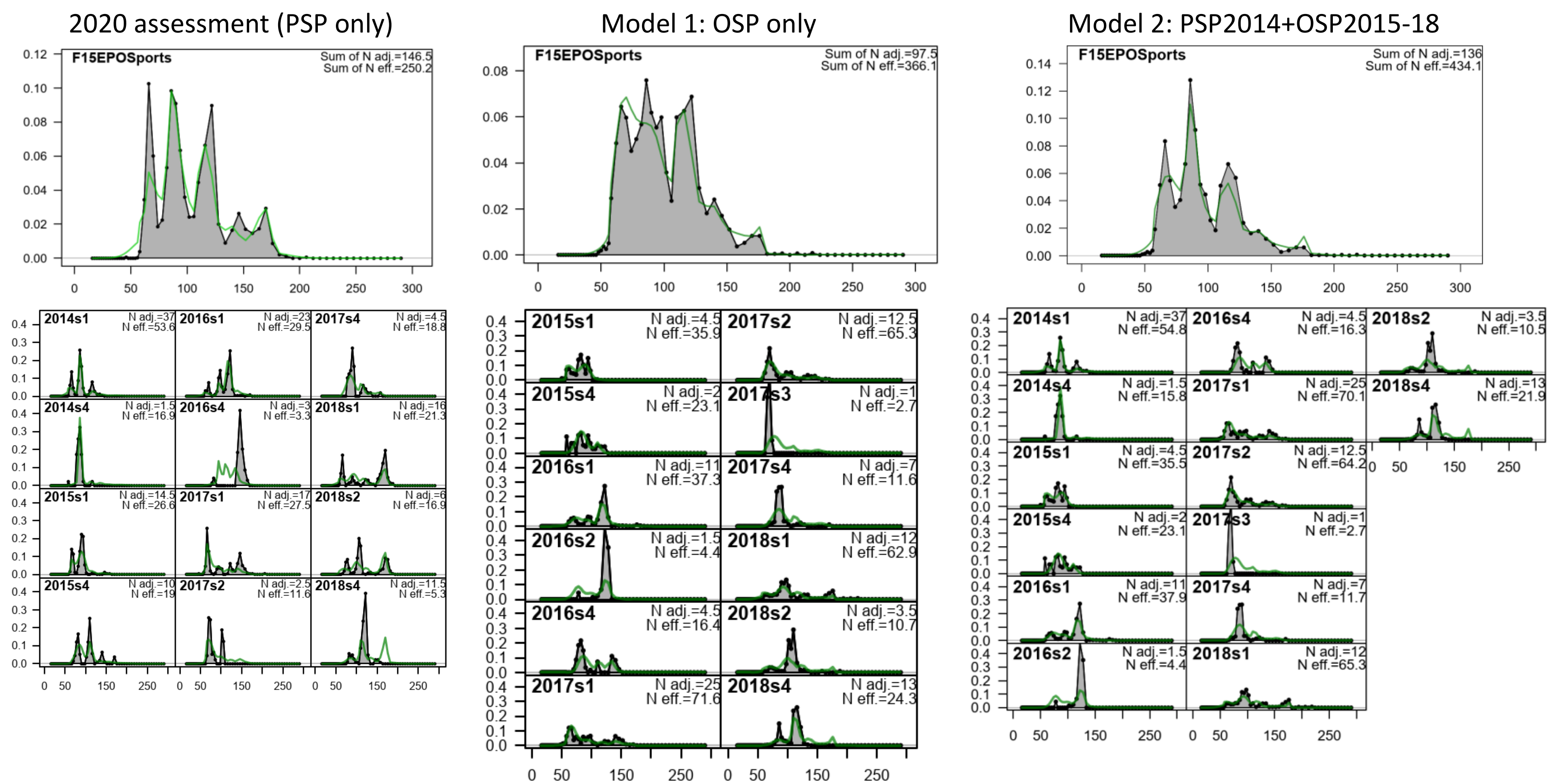

Figure 1. Aggregated (top row) and quarterly (bottom row) length compositions for EPO sport fleet (F15) in the 2020 stock assessment model fit the PSP size data (left column), the model fit the OSP size data (middle column), and the model fit the PSP in 2014 (FY) and OSP in 2015-2018 (FY) size data (F15) (right column). “N adj.” is the input sample size and “N eff.” is the calculated effective sample size used in the McAllister-Ianelli tuning method.

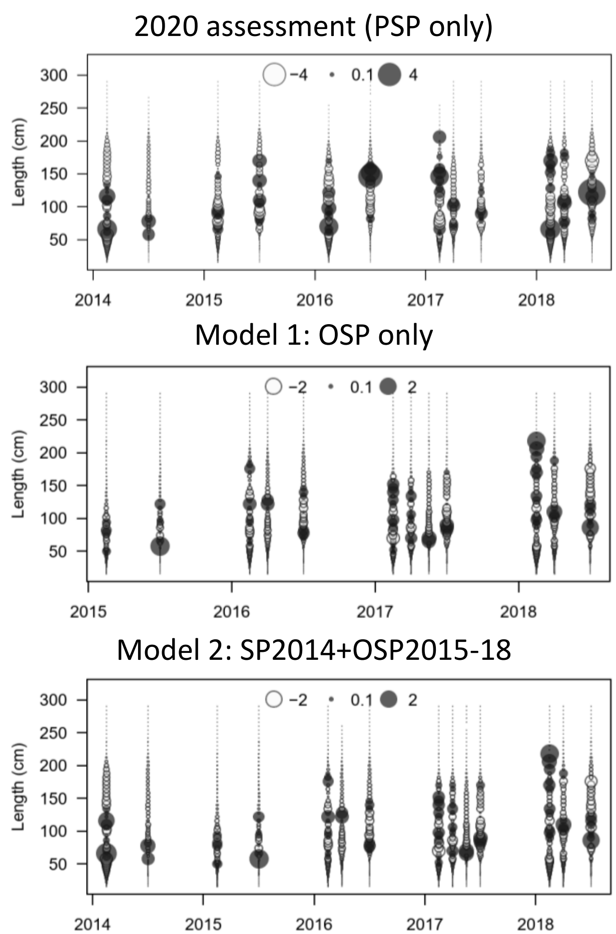

Figure 2. The residuals of the length compostions for EPO sport fleet (F15) in the 2020 stock assessment model fit the PSP size data (top column), the model fit the OSP size data (middle column), and the model fit the PSP in 2014 (FY) and OSP in 2015-2018 (FY) size data (bottom column). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

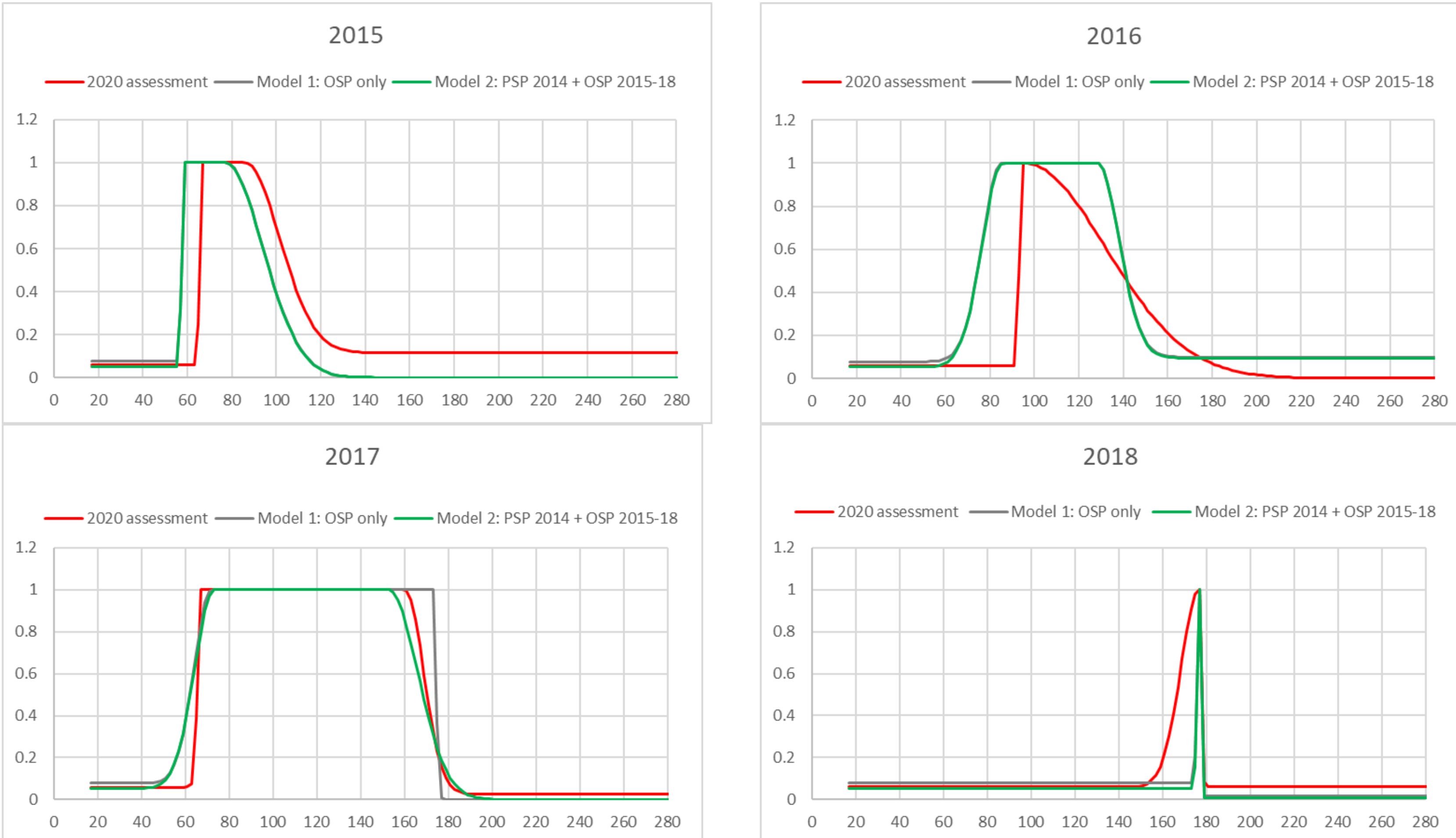

Figure 3. Double normal length-based selectivity estimated for EPO sport fleet (F15) in the 2020 stock assessment model fit the PSP size data (red line), the model fit the OSP size data (grey line), and the model fit the PSP in 2014 (FY) and OSP in 2015-2018 (FY) size data (green line).

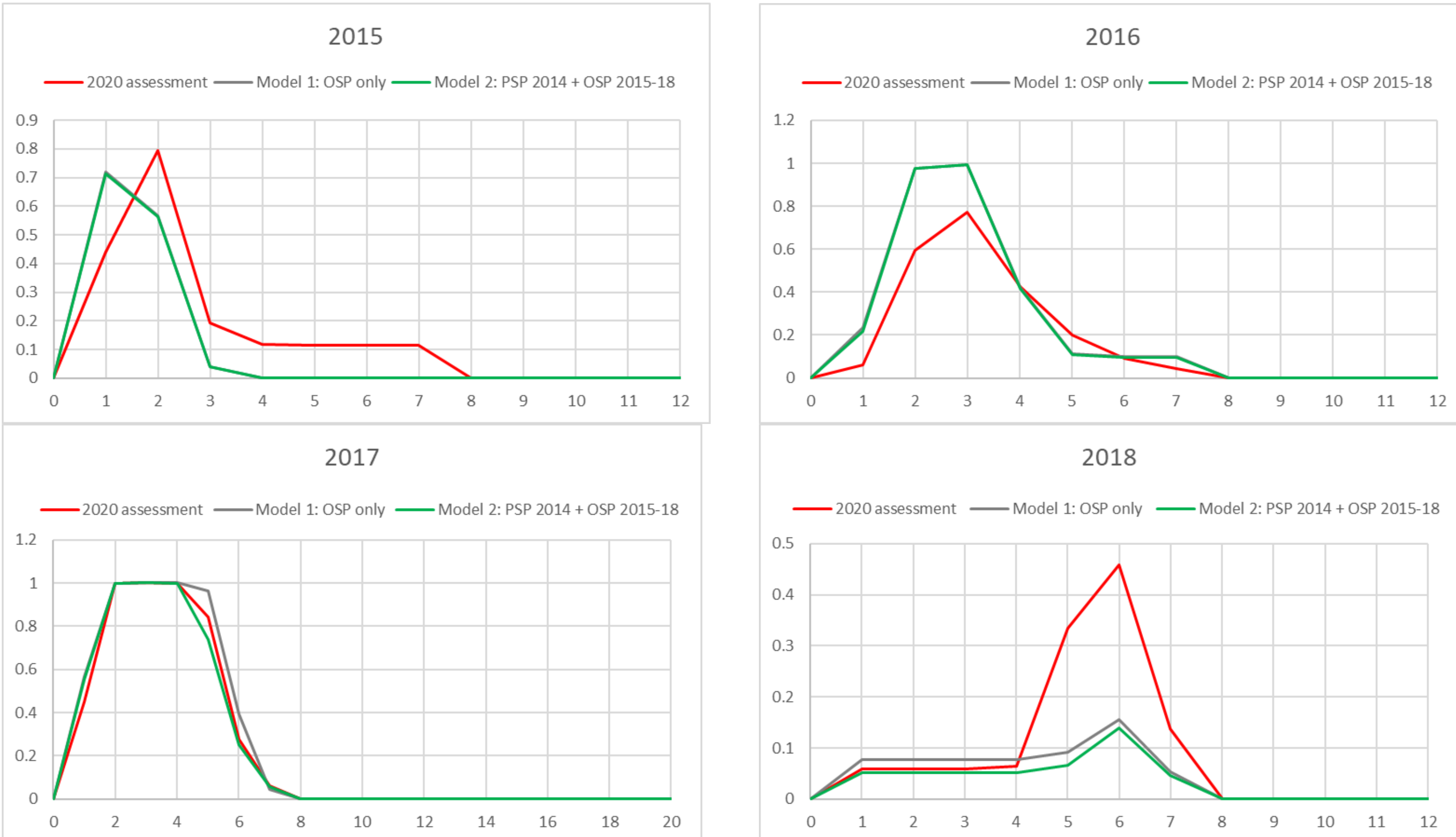

Figure 4. Conveted selectivity-at-age (length selectivity*length-at-age) for EPO sport fleet (F15) in the 2020 stock assessment model fit the PSP size data (red line), the model fit the OSP size data (grey line), and the model fit the PSP in 2014 (FY) and OSP in 2015-2018 (FY) size data (green line).

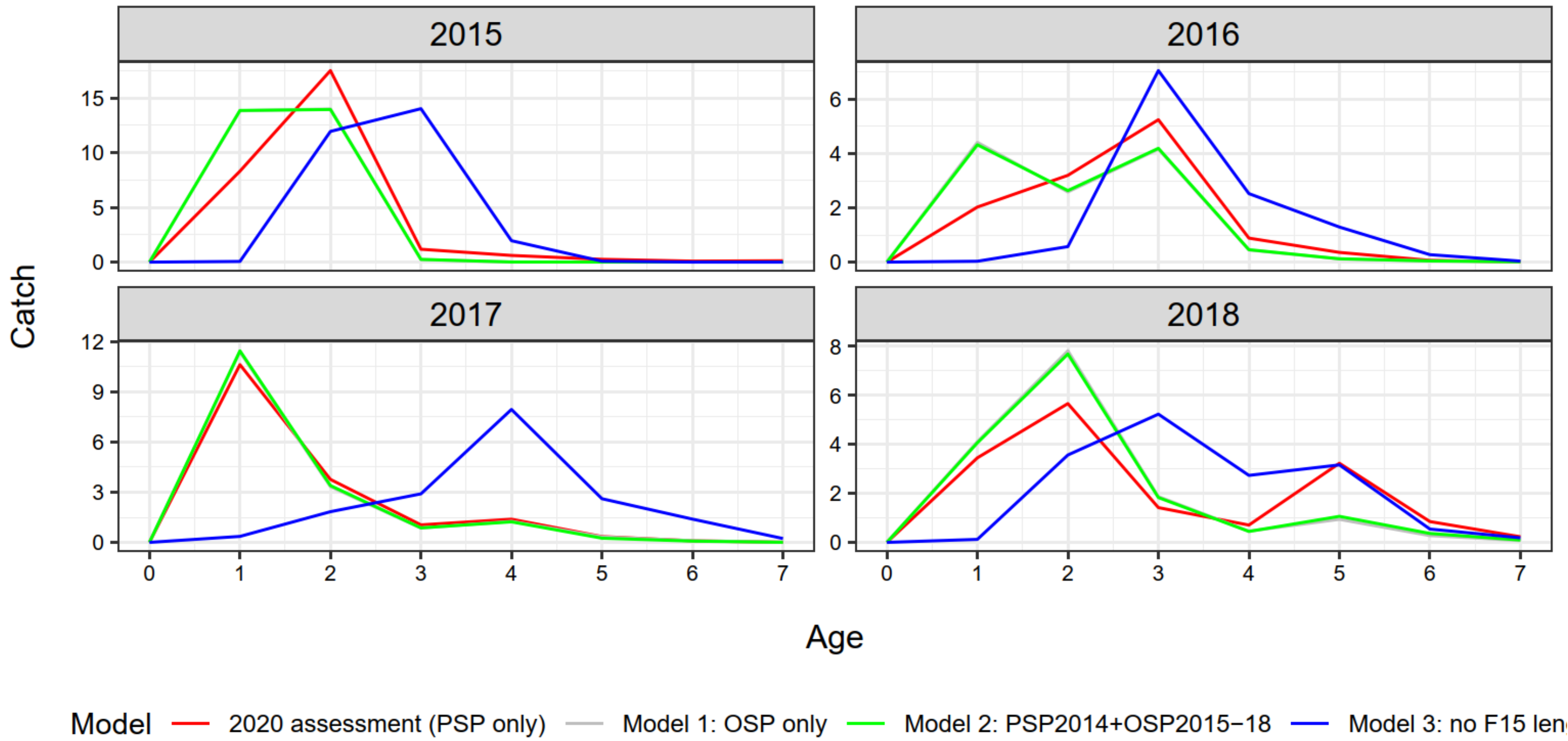

Figure 5. Annual catch-at-age for EPO sport fleet (F15) derived from the 2020 stock assessment model fit the PSP size data (red line), the model fit the OSP size data (grey line), the model fit the PSP in 2014 (FY) and OSP in 2015-2018 (FY) size data (green line), and the model did not fit any data but borrowed selectivity from the EPO commerical fleet (blue line).

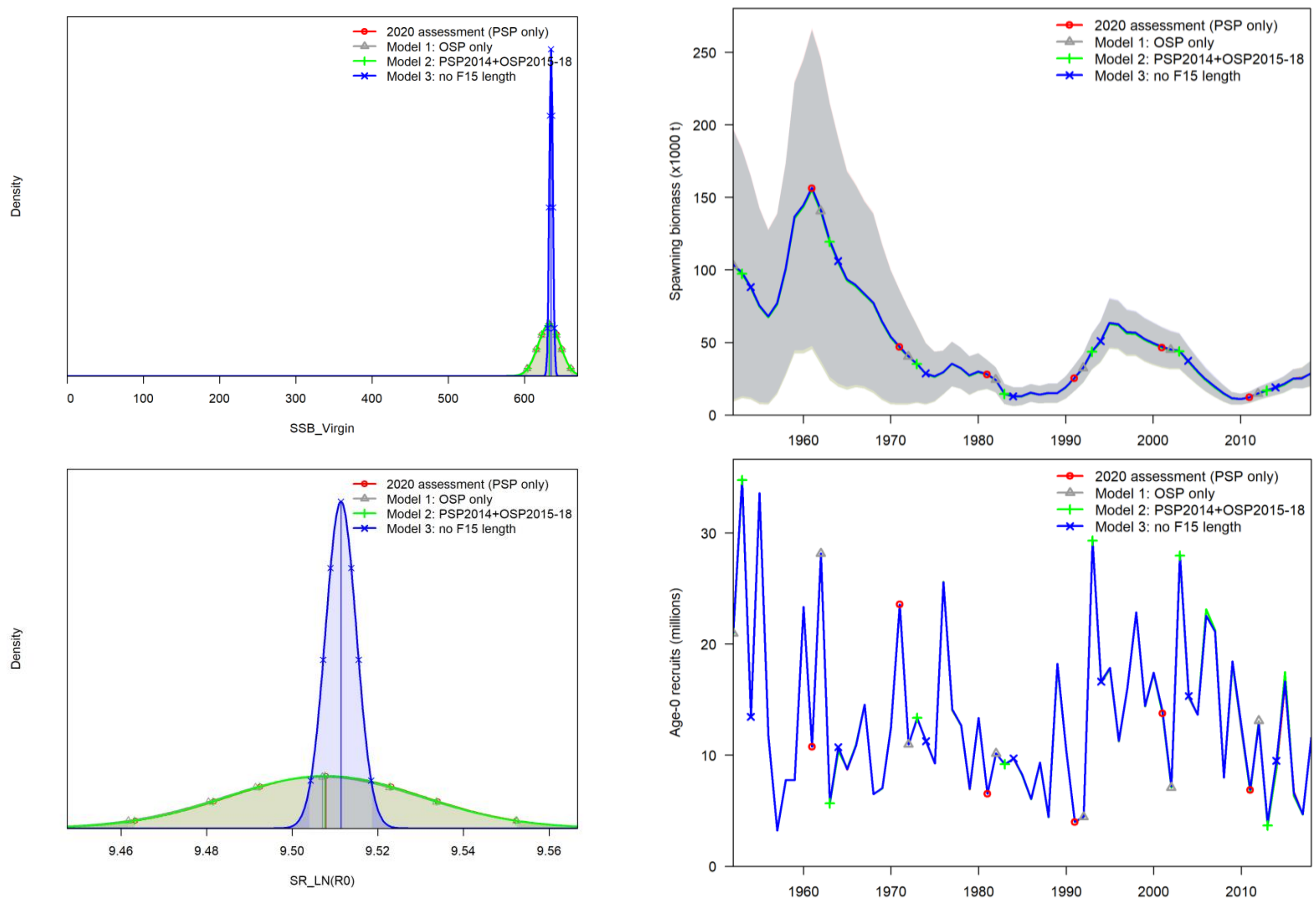

Figure 6. Estimated virgin spawning biomass (top left panel), time series of spawning biomass (top right panel), Ln(R0) (bottom left panel), and age-0 recruits (bottom right panel) from the 2020 stock assessment model fit the PSP size data (red line), the model fit the OSP size data (grey line), the model fit the PSP in 2014 (FY) and OSP in 2015-2018 (FY) size data (green line), and the the model did not fit any data but borrowed selectivity from the EPO commerical fleet (blue line). The shadow area indicates its associated 95% confidence intervals.