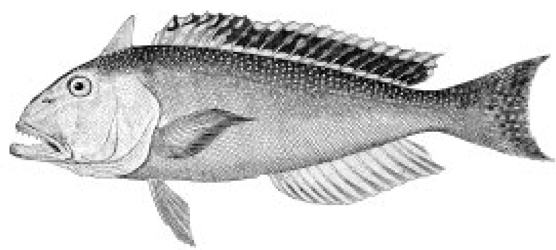
Golden Tilefish, *Lopholatilus chamaeleonticeps,* Management Track Assessment through 2020 in the Middle Atlantic-Southern New England Region



Paul Nitschke
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA 02543
June 23, 2021

This information is distributed solely for the purpose of pre-dissemination peer review. It has not been formally disseminated by NOAA. It does not represent any final agency determination or policy.

State of Stock: This assessment of Golden tilefish is an update through 2020 of commercial fishery landings and size and age data, commercial catch per unit effort (CPUE) indices of abundance, and the analyses of those data. The Golden tilefish stock was not overfished and overfishing was not occurring in 2020 relative to the newly updated biological reference points (Figure 1).

The 2017 operational assessment ASAP model was updated with landings, catch at length distributions, catch at age and mean weights at age using updated pooled and year specific age-length keys, and commercial CPUE data from 2017-2020 (Figures 2 to 7). The ASAP model developed at the SARC 58 benchmark assessment and updated at the 2017 operational assessment used a pool age-length-key due to the lack of age data during the development of the analytical model. Increases in available age data with this management track assessment allowed for the use of additional age data within the pooled age-length-key and the use of year specific age keys for more recent years.

The F_{MSY} proxy was updated using the new average of the fishing mortality during 2002-2012 (a period when the stock was rebuilding under constant quota = 905 mt or metric ton), providing an updated F_{MSY} proxy of 0.261 (equal to $F_{40\%}$), compared to the 2017 operational assessment value of 0.310 (equal to $F_{38\%}$). The SSB_{MSY} and MSY proxies were also updated using the same procedures as in the SARC 58 assessment. The updated SSB target = SSB_{MSY} = $SSB_{40\%}$ = 10,995 mt (compared to the 2017 operational assessment $SSB_{38\%}$ = 9,492 mt) and the updated SSB threshold = one-half $SSB_{40\%}$ = 5,498 mt (compared to the 2017 operational assessment one-half $SSB_{38\%}$ = 4,746 mt). The updated $MSY_{40\%}$ = 935 mt (compared to the 2017 operational assessment $MSY_{38\%}$ = 957 mt).

Based on the ASAP model the stock was at high biomass and lightly exploited during the early 1970s. As the longline fishery developed during the late 1970s, fishing mortality rates increased and stock biomass decreased to a time series low by 1998. Since the implementation of constant landings quota of 905 mt in 2002, the stock has increased approaching the biomass target reference point (SSB_{MSY} proxy).

The fishing mortality rate was estimated to be 0.160 in 2020, below the updated reference point F_{MSY} proxy = 0.261. There is a 90% probability that the fishing mortality rate in 2020 was between 0.110 and 0.222 (Figures 8 and 9). SSB was estimated to be 10,562 mt in 2020, 96% of the updated biomass target reference point SSB_{MSY} proxy = 10,995 mt. There is a 90% chance that SSB in 2020 was between 6,238 and 16,438 mt (Figures 8 and 9). Average recruitment from 1971 to 2020 was 1.48 million fish at age-1. Recent large year classes occurred in 1998 (3.0 million), 1999 (2.9 million) and 2005 (2.6 million). A recent large year class is estimated at 2.5 million in 2014. This year class has started to recruit to the large-medium market category in 2020. The updated 2020 final run had a minor retrospective pattern in fishing mortality (Mohn's Rho = -0.09), spawning stock biomass (Mohn's Rho = +0.02) and age-1 recruitment (Mohn's Rho = +0.03) (Figures 10 to12).

Catch: Total commercial landings (live weight) increased from less than 125 mt during 1967-1972 to more than 3,900 mt in 1979 during the development of the directed longline fishery (Figure 2). Landings prior to the mid-1960s were landed as a bycatch in the trawl fishery. Annual landings ranged between 454 and 1,838 mt from 1988 to 1998. Landings from 1999 to 2002 were below 900 mt (ranging from 506 to 874 mt). An annual quota of 905 mt was implemented in November of 2001. Landings in 2003 and 2004 were slightly above the quota at 1,130 mt and 1,215 mt, respectively. Landings from 2005 to 2009 were at or below the quota, while landings in 2010 at 922 mt were slightly above the quota (Figure 2). Since 2010 landings have been below the quota and decreased to an estimated 494 mt in 2016. The landings have increase slightly to an average of 698 mt from 2017 to 2020. The Total Allowable Landings (TAL) was reduced for the first time in 2015 to 796 mt from the TAL of 905 mt which was in place from 2001-2014. The TAL in 2016 and 2017 was increased to 856 mt based on projections from the SARC 58 assessment. The TAL was then reduced to 738 mt from 2018 to 2021 based on the 2017 operational assessment.

During the late 1970s and early 1980s Barnegat, NJ was the principal tilefish port; more recently Montauk, NY has accounted for most of the landings. Most of the commercial landings are taken by the directed longline fishery. Discards in the trawl and longline fishery appear to be a minor component of the catch. Recreational catches are estimated to be low and were not included as a component of the removals in the assessment model.

Catch and Status Table: Golden Tilefish. Landings, SSB, Recruitment (age-1), and Fishing Mortality (FMULT) (weights in '000 mt live, recruitment in millions)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Max[1]	Min[1]	Mean[1]
Commercial landings	0.9	0.8	0.8	0.8	0.6	0.5	0.7	0.7	0.7	0.6	4.0	0.1	1.3
SSB	9.8	9.9	9.0	7.2	8.1	10.0	8.4	9.2	9.5	10.6	31.9	3.0	9.4
Recruitment	0.8	0.5	0.9	2.2	2.5	0.8	0.7	2.1	1.4	1.2	4.0	0.4	1.5
Fishing mortality	0.199	0.207	0.264	0.400	0.313	0.220	0.267	0.191	0.159	0.160	1.058	0.005	0.375

[1] Over period 1971-2020.

Commercial CPUE, market category and size composition data: Changes in the CPUE can be generally explained by the impact of strong incoming year classes that track through the landings size composition over time. Since the SARC 58 assessment there appear to be increases in CPUE due to one or two new strong year classes. In general, strong year classes and proportion of larger fish in the catch appear to persist longer in the fishery after the FMP's quota based management came into effect, which is evident in both the CPUE and size composition data. The decrease in the CPUE from 2011 to 2016 is consistent with the ageing of the strong year class in 2005. The CPUE has increased since 2016 with another strong year class in 2014.

A recent broad size distribution and market category proportions show evidence of small fish while also showing the presence of larger fish in the catch. The increases in CPUE from the last strong year class in 2014 appears to be persisting longer than past increases cause by year class effects.

Projections: The projections are conditioned on the ABC being taken (742 mt) in 2021 and fishing at the F_{MSY} proxy = 0.261 from 2022 to 2026. Overfishing is not projected to occur in 2021 at a 17% probability with the removals of 742 mt.

Catch, Fishing Mortality (F), Spawning Stock Biomass (SSB),
Probability of $F>F_{MSY}$ and $SSB<SSB_{MSY}/2$
Catch and SSB in metric tons

Year	Total Catch	F	SSB	$P(F>F_{MSY})$	$P(SSB<SSB_{MSY}/2)$
2021	742	0.207	10,061	0.172	0.026
2022	1,011	0.261	10,491	-	0.015
2023	991	0.261	11,165	-	0.004
2024	949	0.261	11,586	-	0.001

Stock Distribution and Identification: Golden Tilefish, *Lopholatilus chamaeleonticeps,* inhabit the outer continental shelf from Nova Scotia to South America and are relatively abundant in the Southern New England to Mid-Atlantic region at depths of 80 to 440 m. Tilefish have a relatively narrow temperature preference of 9 to 14 °C. The Virginia- North Carolina border defines the boundary between the northern and southern Golden Tilefish management units.

Data, Assessment Model and Model Sensitivity Runs: The surplus production model ASPIC was used to assess the Golden Tilefish stock in assessments previous (Nitschke et al. 1998, NEFSC 2005, 2009) to SARC 58 (NEFSC 2014). The availability of length and age data facilitated application of a forward projecting age-structured model ASAP (Legault and Restrepo 1998; NFT 2013) using a pooled age-length key in the SARC 58 stock assessment. The same pooled age-length key was used in the 2017 model update. However, new age data was available through 2020 for this 2021 management track assessment. Due to the additional age information the pooled age-length-key was updated to provide a more comprehensive key for use in years where age data did not exist. Actual year specific keys were used for 2007, 2009 to 2012, and 2014 to 2020 since improvements in age data now exists with efforts made towards production aging for golden tilefish (run2).

First, a bridge year run was made which used the existing data through 2016 from the 2017 operational assessment and used all available age data in the pooled age-length-key for years 2017 through 2020 (Figure 13). Then the first updated run used the new updated pooled age-length-key for all years (run 1, Figure 1). The final run takes one step further and used the updated pooled age-length-key for years with age data gaps and uses the year specific information in the recent years as production aging continues for golden tilefish. In general, there were similar trends among the model runs (Figure 1). The final run 2 does produce slightly lower Fishing mortality, a larger buildup of SSB in recent years with a slight shift to higher recruitment. The final run 2 that uses the available year specific data results in slightly more optimistic stock status (F/F_{MSY} = 0.615 and SSB/SSB_{MSY} = 0.961) relative to run one which used the update pooled age key for all year (F/F_{MSY} = 0.670 and SSB/SSB_{MSY} = 0.852). An additional sensitivity model run was made to determine the sensitivity of the model results to the estimated dome shaped selectivity assumption through an assumed shift of the age of full selection. This sensitivity tested the influence of a shift in fully selection from age 5 to 6 in the second selectivity block (Figure 14). However, the sensitivity run 3 still estimated full selectivity at age 5 (Figure 15). Forcing full selectivity at age 6 resulted in a shift to lower estimates of SSB. Not surprising, the scaling of SSB estimates will be sensitivity to assumptions surrounding the dome shaped selectivity since the commercial CPUE index of abundance possesses the same selectivity assumption. Run 3 is only used to illustrate the uncertainty with regards to the selectivity assumption since there is no justification to change full selection to age 6 and because the model still estimates full selection at age 5 in the second selectivity block.

There are no fishery independent surveys available for this stock, so commercial CPUE is relied upon for indications of population abundance. Over the last twenty years, the commercial length and more recent age data indicate that increases in fishery CPUE and model estimated biomass are predominantly due to the influence of strong year classes in 1998, 1999, 2005 and 2014 (Figure 3). The 2014 year class is now passing through the fishery with predicted lower selection as the year class ages. Given the historical pattern, CPUE would be expected to decline in next few years with the aging of the strong 2014 year class if another new strong year class does not materialize. Review of commercial fishery practices and markets help justify the use of a dome-shaped selectivity pattern used in the assessment model developed at SARC 58. There is an indication for a dome shape selectivity pattern from spatial effects and from possible gear hook size selection from the 2017 pilot and 2020 tilefish longline surveys. This work has not been fully completed at this time. Uncertainty remains with the ability to quantify the degree of doming in the fishery.

Biological Reference Points (BRPs): Golden Tilefish are estimated to live about 40 years, and this information along with the SARC 58 likelihood profiles of the ASAP model indicated that a value for instantaneous natural mortality (M) of 0.15 was appropriate (NEFSC 2014). The long lifespan and relatively low M would suggest that a fishing mortality rate BRP of $F_{40\%}$ or higher %MSP would be appropriate. Under a management regime using a constant landings quota of 905 mt from 2002-2012, with actual landings close to the quota each year, the stock increased to 9,883 mt in 2012. SARC 58 (NEFSC 2014) therefore recommended using the average of the fishing mortality during 2002-2012, a period when the stock was rebuilding under constant quota = 905 mt, as the F_{MSY} proxy for Golden Tilefish.

This update indicates that fishing mortality rates have averaged 0.261 from 2002-2012, and by coincidence the updated yield per recruit analysis shows that this fishing rate now corresponds to $F_{40\%}$, compared to the $F_{38\%}$ estimate calculated in the 2017 operational assessment. Therefore, the updated BRPs proxies using the same average F calculations as in SARC 58 and the 2017 operational assessment produced a F_{MSY} proxy = 0.261 (overfishing threshold), with corresponding SSB_{MSY} proxy = 10,995 mt (SSB target), one-half SSB_{MSY} = 5,498 mt (SSB threshold), and MSY = 935 mt. SSB_{MSY} was calculated from median estimates of long term (100 years) stochastic projections fishing at the F_{MSY} proxy = 0.261 which resampled from the CDF of empirical recruitment from 1971-2020.

Fishing Mortality: Fishing mortality on the fully selected age class (age 5, F_{MULT}) increased with the development of the directed longline fishing from near zero in 1971 to 1.058 in 1987 (Figure 8). Fishing mortality then remained relatively high through the 1990s. Fishing mortality has been lower since 1999 and was estimated to be 0.160 in 2020. F_{MULT} 90% confidence intervals were 0.110 and 0.222 in 2020 (Figure 9).

Spawning Stock Biomass: Spawning stock biomass decreased substantially early in the time series from 31,876 mt in 1974 to 4,375 mt in 1998, lowest in the time series (Figure 8). SSB has since increased to 10,562 mt in 2016. Spawning stock biomass 90% confidence intervals were 6,238 and 16,438 mt in 2020 (Figure 9).

Recruitment: Average recruitment from 1971 to 2020 was 1.48 million fish at age 1. Recent large year classes occurred in 1998 (3.0 million), 1999 (2.9 million) and 2005 (2.6 million). A recent large year class is estimated at 2.5 million in 2014 (Figure 1). An above average year class is estimated at 2.1 million in 2017. However, the size of the 2017 year class remains highly uncertain since it just began to enter the fishery in 2020.

References and Further Information:

Freeman B, Turner S. 1977. Biological and fisheries data on tilefish, *Lopholatilus chamaeleonticeps* Goode and Bean. NEFSC Tech Rep. 5.

Legault CM, Restrepo VR. 1998. A flexible forward age-structured assessment program. ICCAT. Col. Vol. Sci. Pap. 49:246-253.

Nitschke, P., G. Shepherd, and M. Terceiro. 1998. Assessment of tilefish in the middle Atlantic – southern New England region. NEFSC. 1-12.

NEFSC. 2005. Northeast Regional Stock Assessment Workshop (41st SAW). 41st SAW Assessment Report. U.S. Dept. Commerce, Northeast Fisheries Science Center Ref. Doc. 05-14; 237 p.

NEFSC. 2009. Northeast Regional Stock Assessment Workshop (48st SAW). 48st SAW Assessment Report. U.S. Dept. Commerce, Northeast Fisheries Science Center Ref. Doc. 09-15; 834 p.

NEFSC. 2014. 58th Northeast Regional Stock Assessment Workshop (58th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-04; 784 p. (Internet address: http://nefsc.noaa.gov/publications/)

Turner, S.C. 1986. Population dynamics of and, impact of fishing on tilefish, *Lopholatilus chamaeleonticeps*, in the Middle Atlantic-Southern New England region during the 1970's and early 1980's. New Brunswick, N.J.: Rutgers University. Ph.D. dissertation.

NOAA Fisheries Toolbox (NFT) 2013. Age Structured Projection Model (AGEPRO) version 4.2.2 [Internet address: https://nmfs-fish-tools.github.io/].

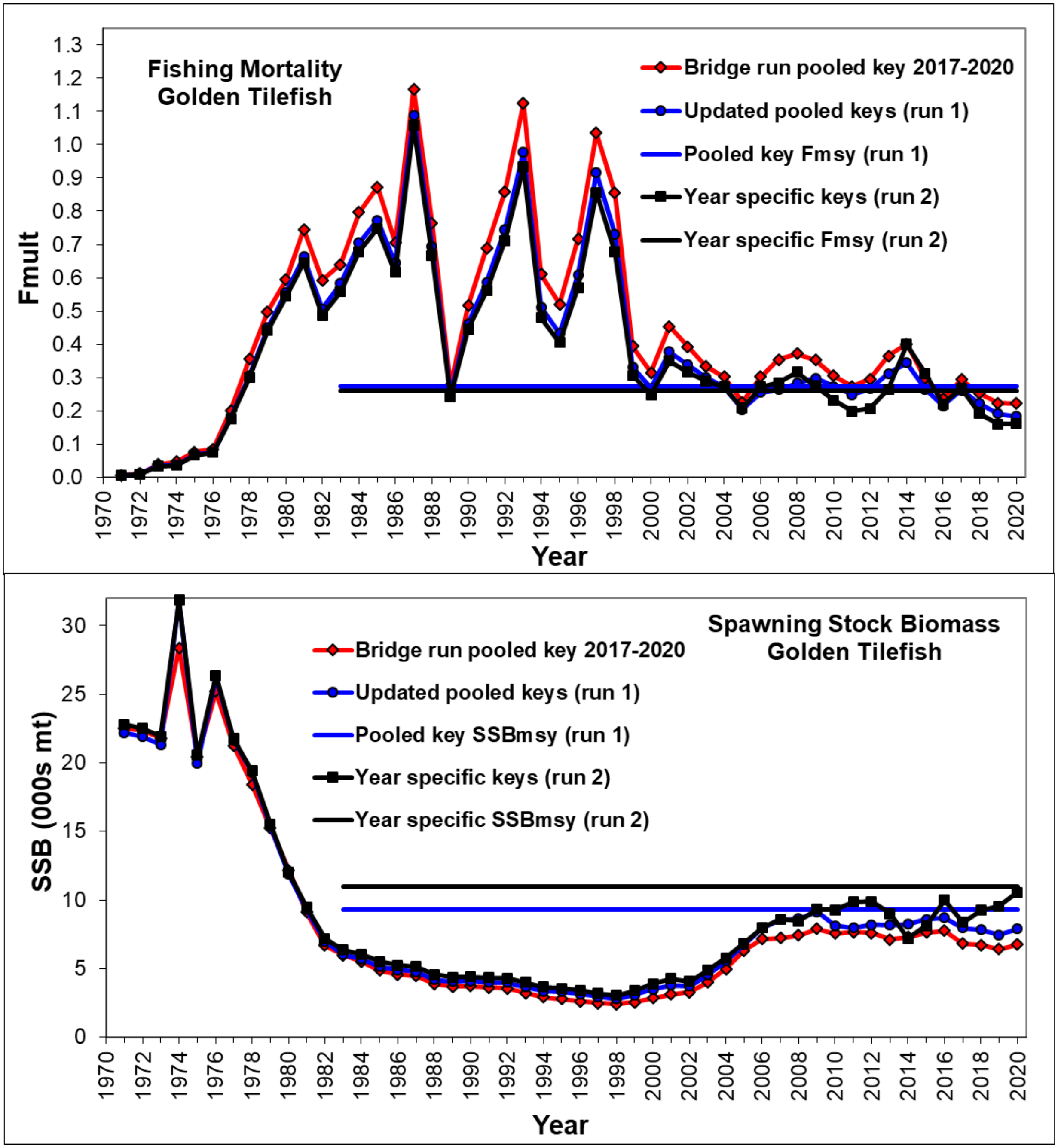


Figure 1. F_{MULT}, spawning stock biomass (SSB), and age-1 recruitment comparison of the 2017 operational assessment model bridge ASAP model, updated pooled age key run (run 1) and the final update run 2 using the updated pooled-age-key and year specific keys for years where age data is available. The updated pooled key run 1 and final year specific key run 2 estimated F_{MSY} and SSB_{MSY} biological reference points during the second selectivity block are also shown for comparison.

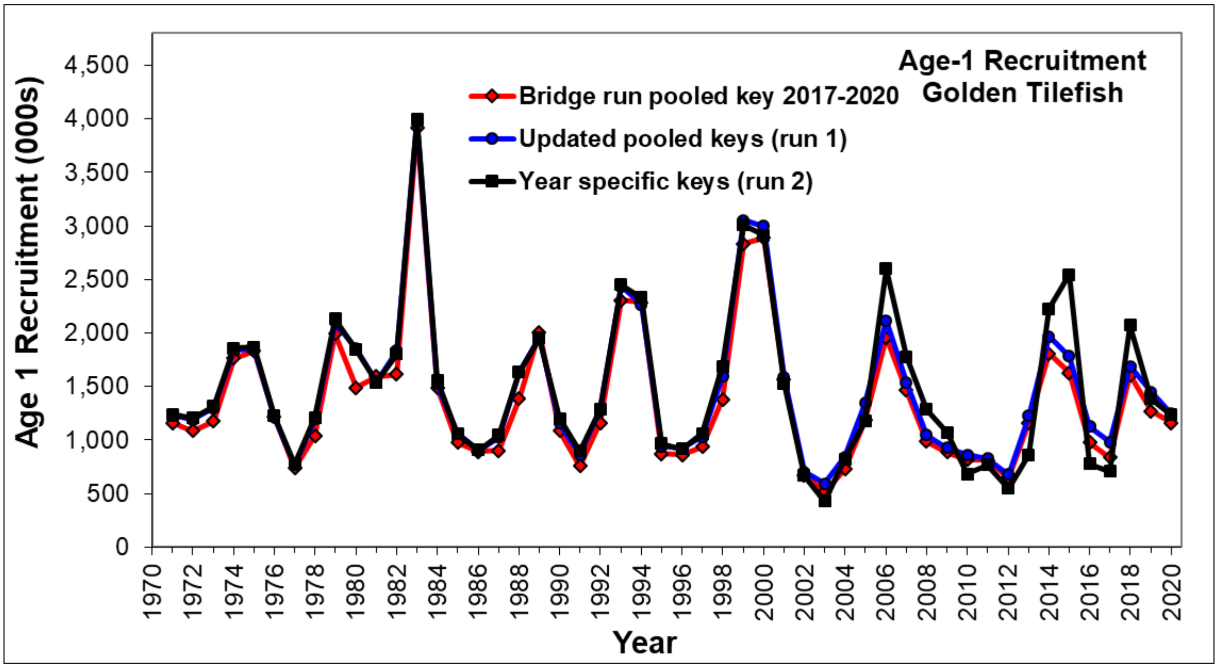
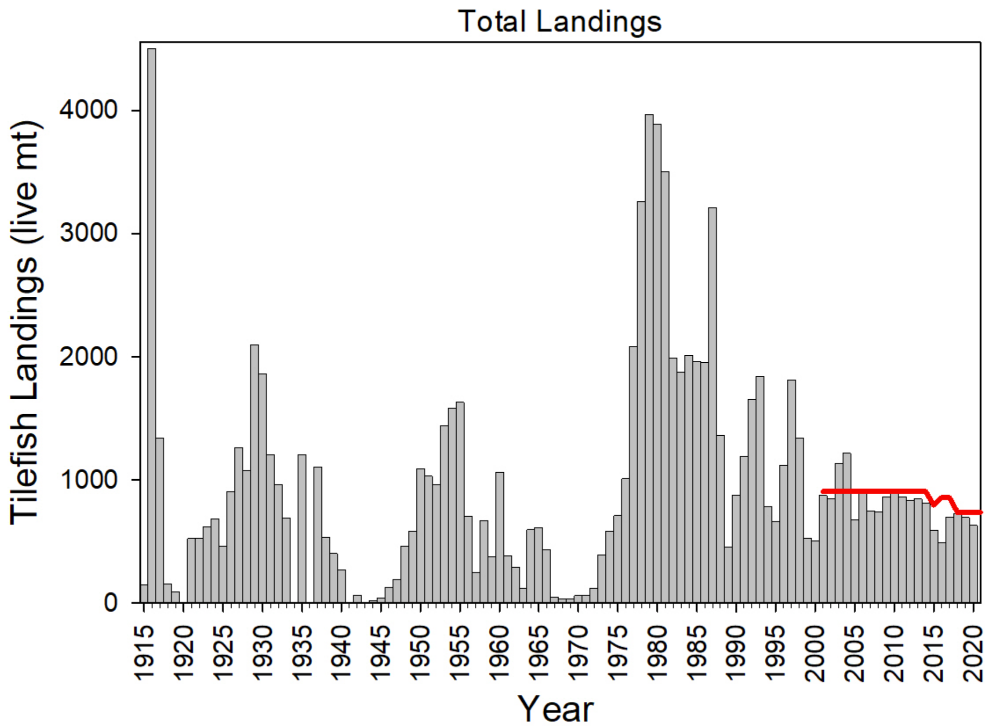


Figure 1. Cont. F_{MULT}, spawning stock biomass (SSB), and age-1 recruitment comparison of the 2017 operational assessment model bridge ASAP model, updated pooled age key run (run 1) and the final update run 2 using the updated pooled age key and year specific keys for years where age data is available. The updated final run 2 estimated F_{MSY} and SSB_{MSY} biological reference points during the second selectivity block are also shown for comparison.



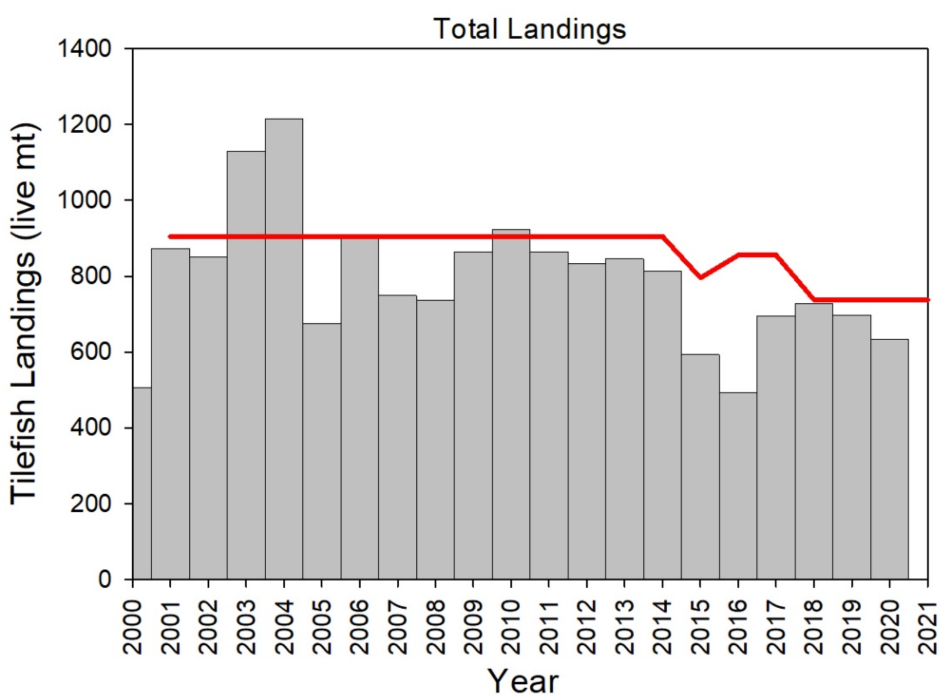


Figure 2. Landings of tilefish in metric tons from 1915-2020 (top) and from 2000-2020 (bottom). Landings in 1915-1972 are from Freeman and Turner (1977), 1973-1989 are from the general canvas data, 1990-1993 are from the weighout system, 1994-2003 are from the dealer reported data, and 2004-2020 is from dealer electronic reporting. Red line is the Total Allowable Landings (TAL) from 2001-2021.

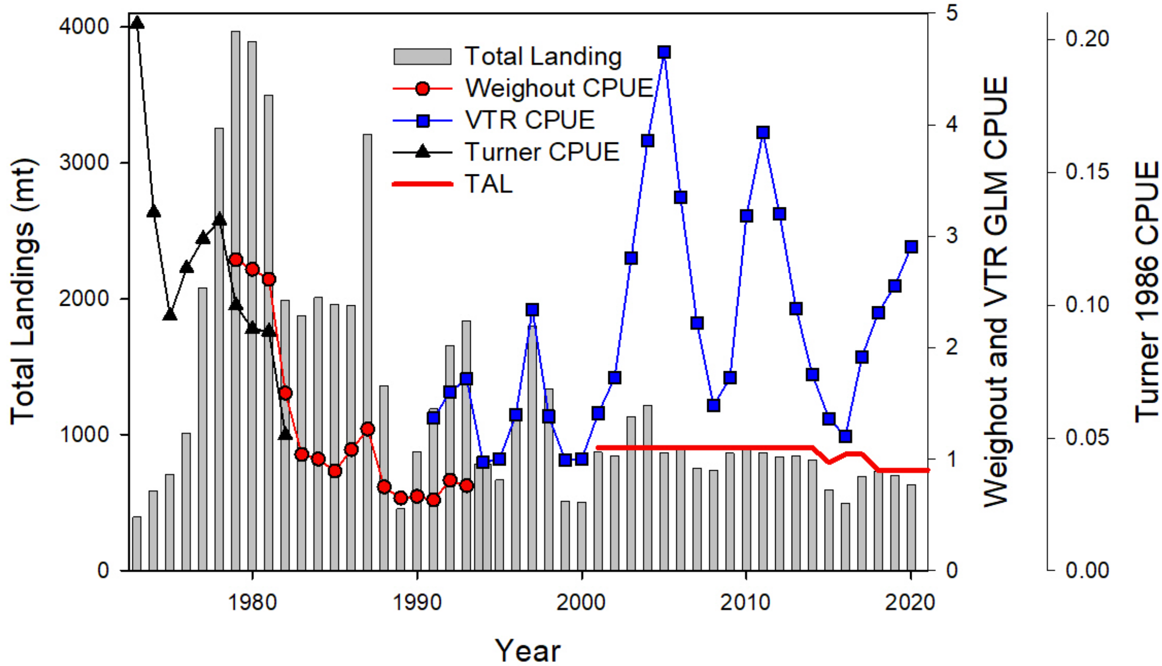


Figure 3. General Linear Model (GLM) Catch Per Unit Effort (CPUE) for the Weighout and Vessel Trip report (VTR) data split into two series with additional New York logbook CPUE data from three vessels (1991-1994) added to the VTR series. Four years of overlap between the Turner (1986) and Weighout CPUE series can also be seen. ASAP relative changes in qs among CPUE series were not incorporated into the plot. Assumed total landings are also shown. Landings in 2005 were taken from the Interactive Voice Reporting (IVR) system. Red line is the Total Allowable Landings (TAL).

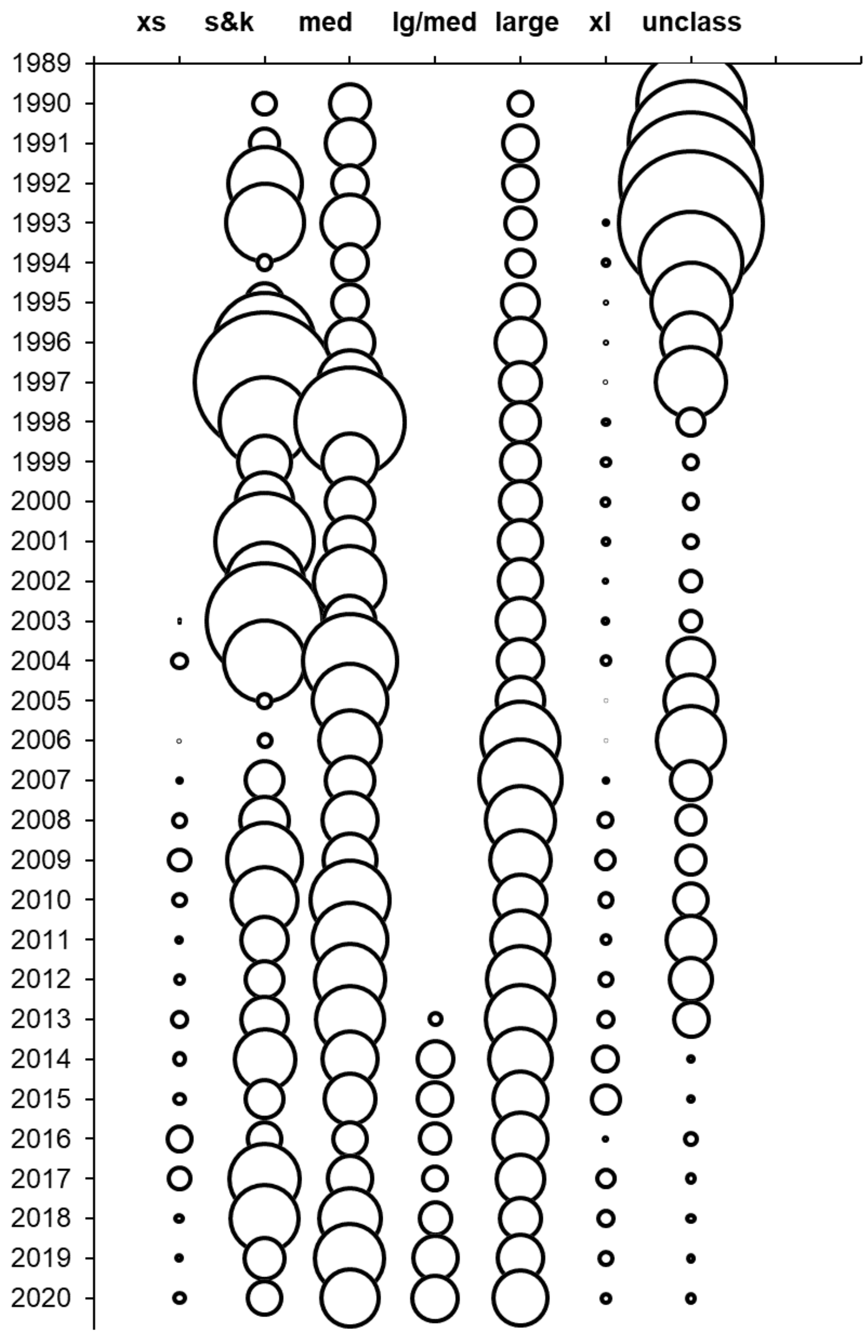


Figure 4. Bubble plot of Golden tilefish landings by market category. Large-medium market category code was added in 2013 which appears to have resulted in a decrease in the unclassified. Smalls and Kittens (s&k) were combined since these categories possess similar size fish.

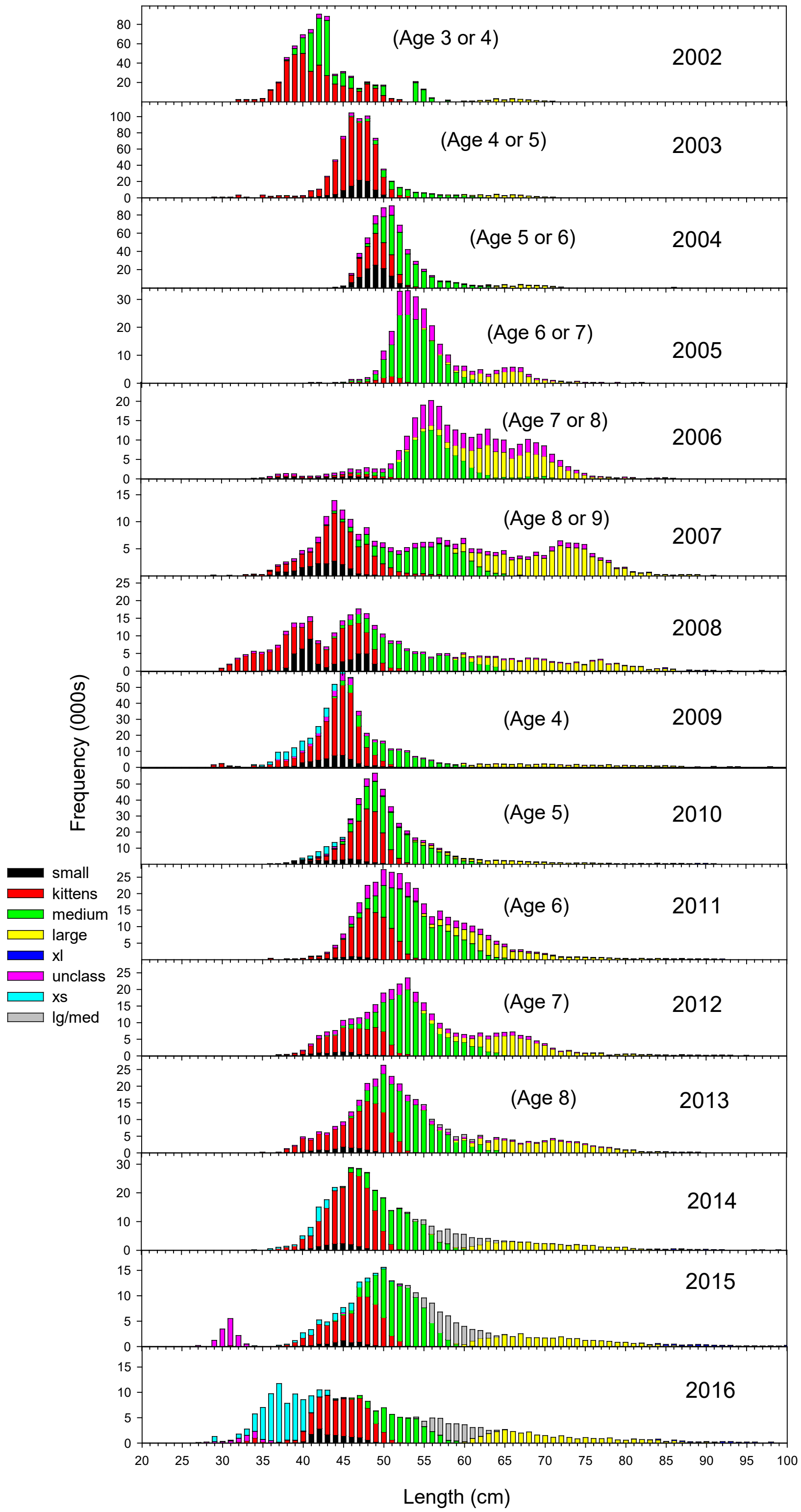


Figure 5. Expanded length frequency distributions from 2002 to 2016. Kittens lengths were used to characterize the extra small category in 2013. **Y-axis is allowed to rescale.**

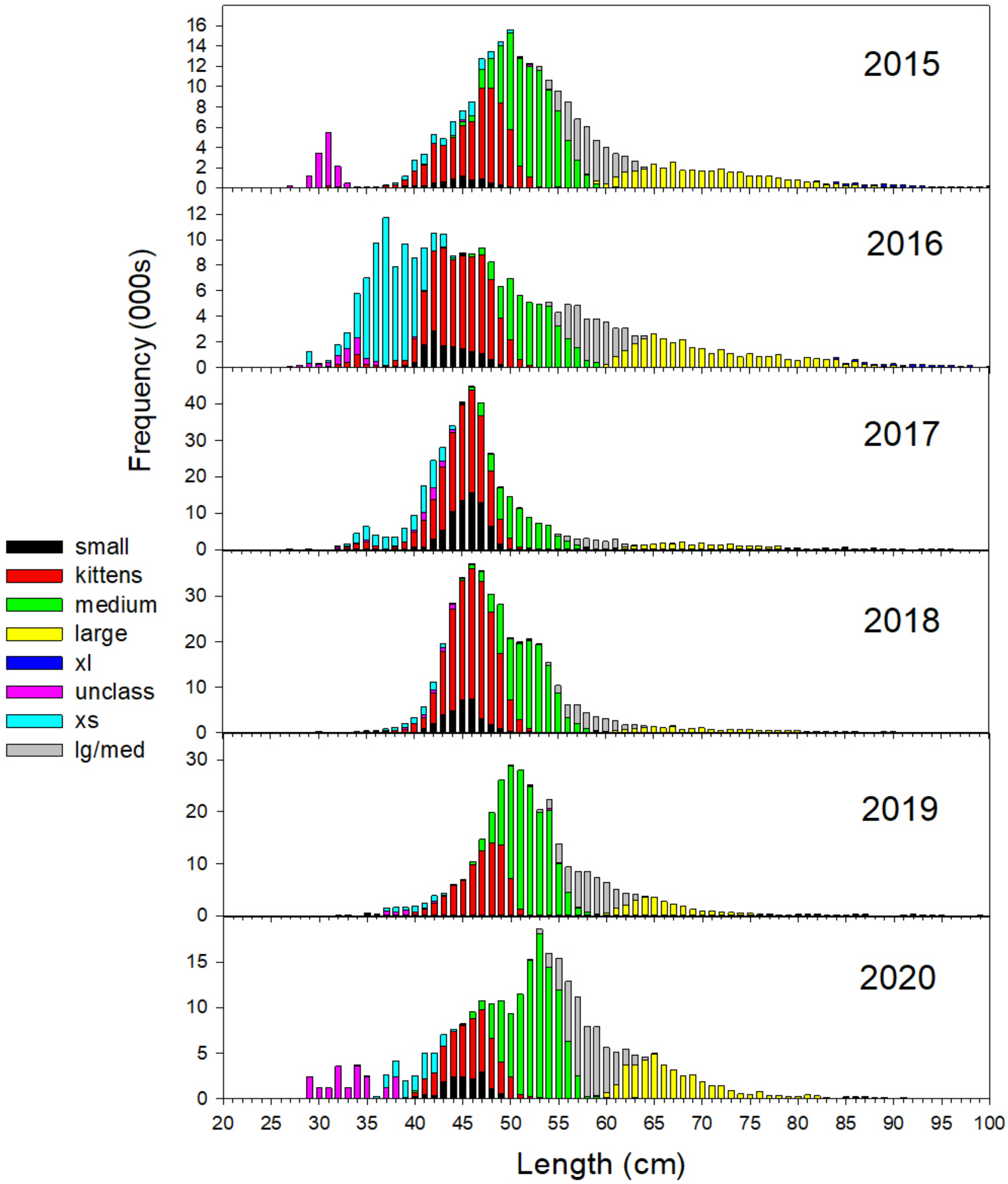


Figure 6. Expanded length frequency distributions from 2015 to 2020. Unclassifieds in 2015 and 2020 are based on two samples. **Y-axis is allowed to rescale.**

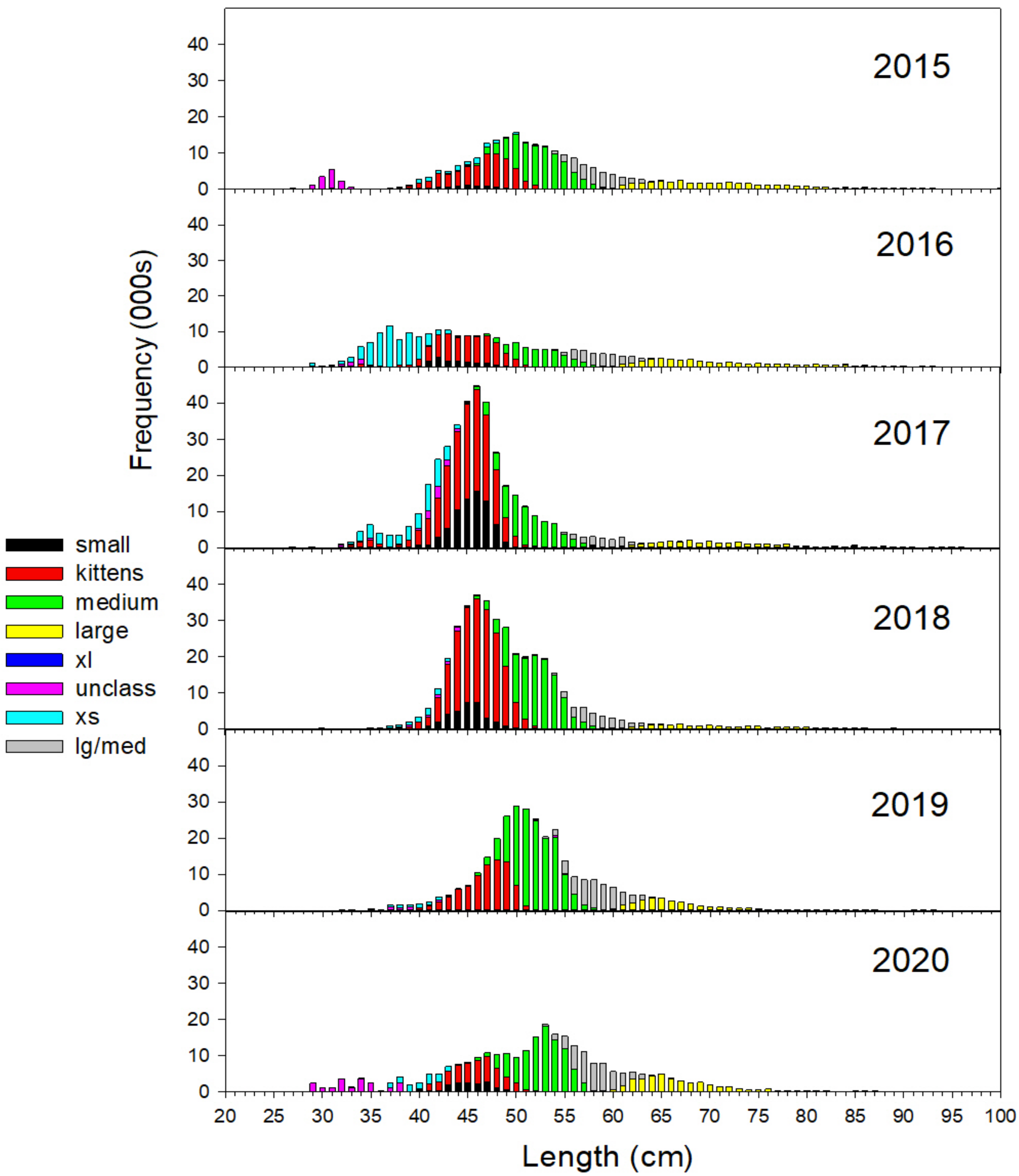


Figure 7. Expanded length frequency distributions from 2015 to 2020. Unclassifieds in 2015 and 2020 are based on two samples. **Y-axis is fixed to the same scale across years.**

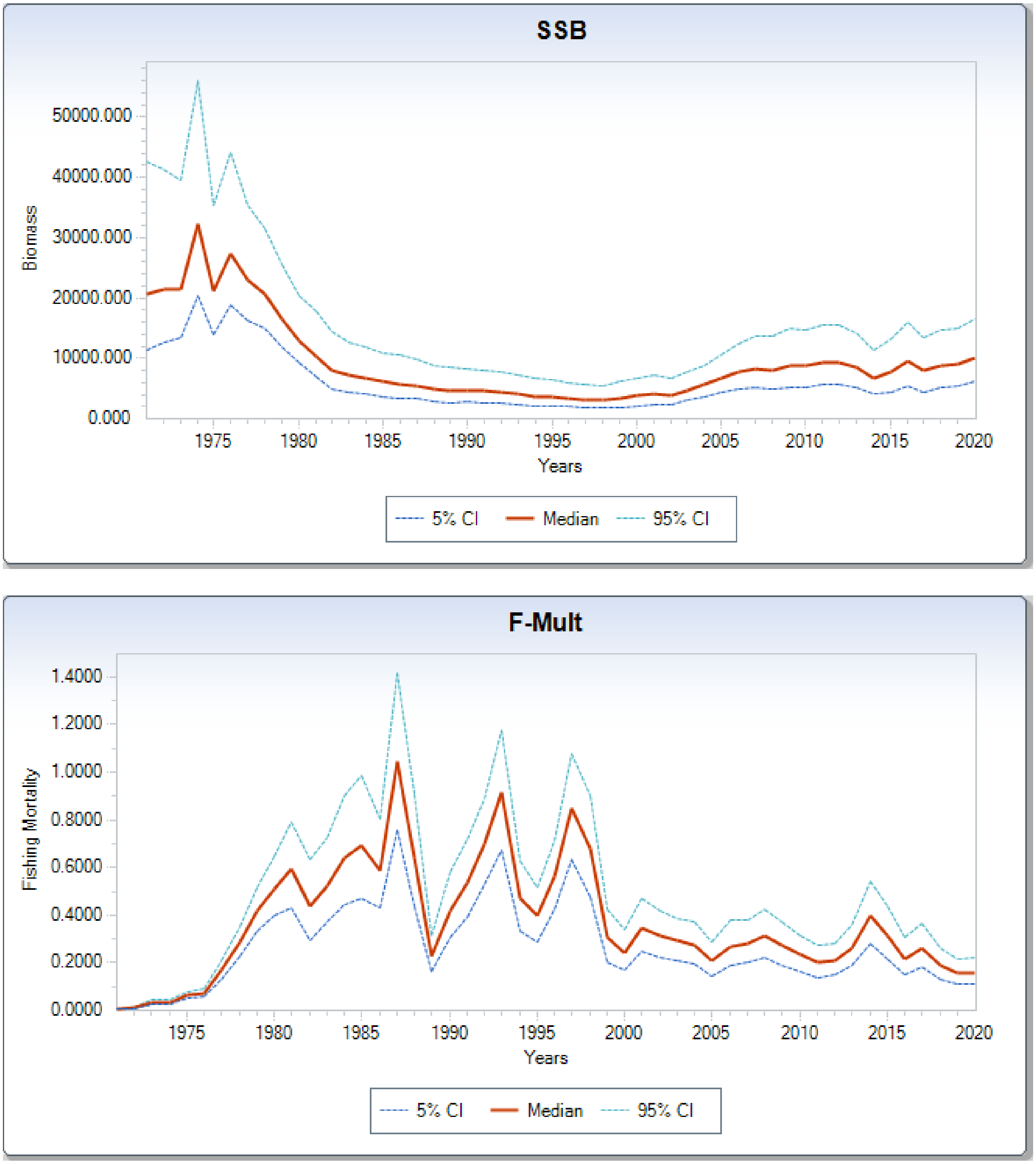
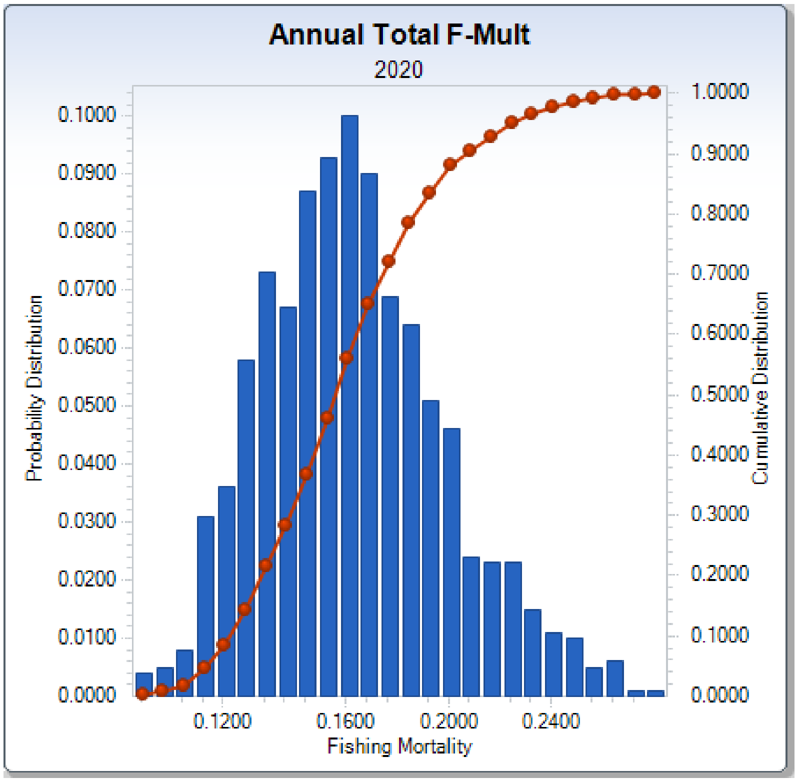


Figure 8. Updated 2021 final run 2 ASAP model estimated fishing mortality (FMULT) and SSB with MCMC estimated 90% confidence intervals.



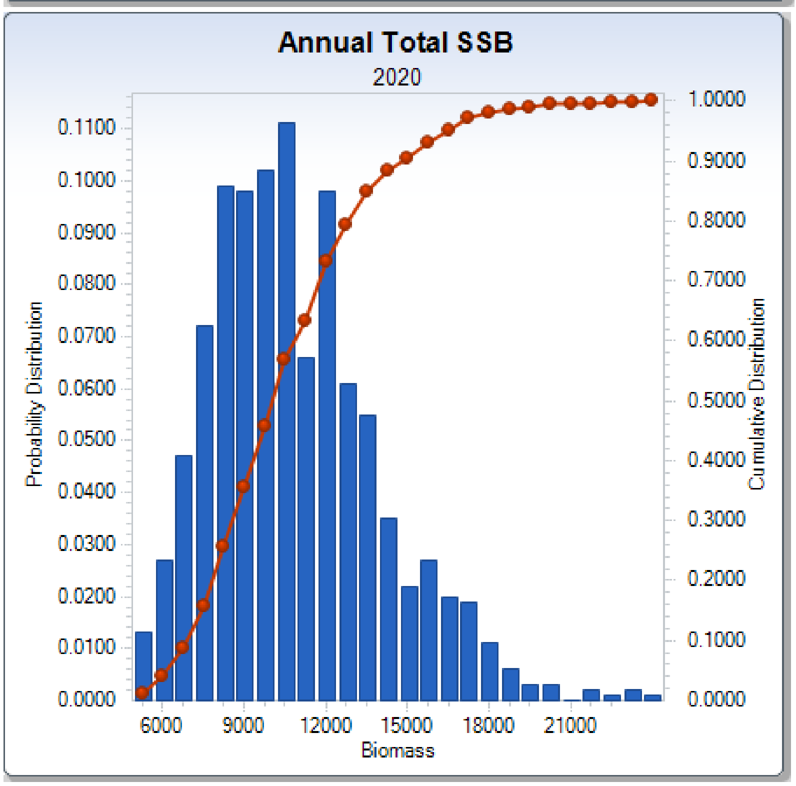
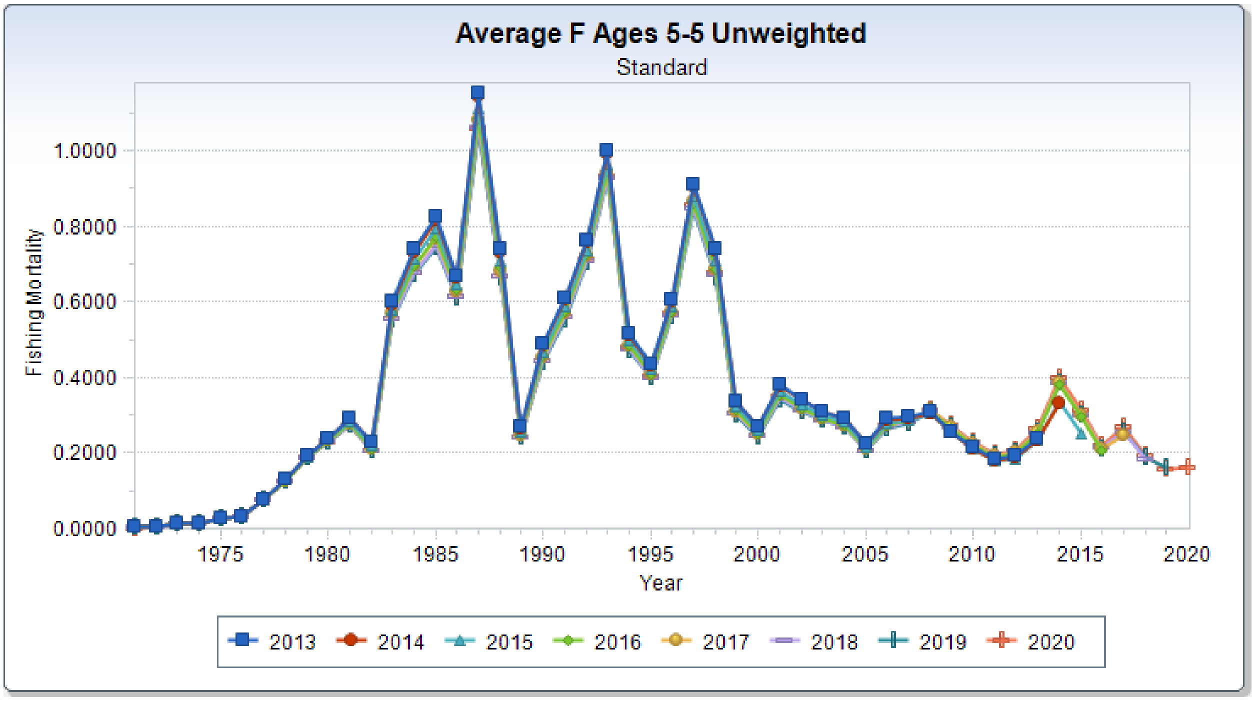


Figure 9. MCMC 2020 distributions for fishing mortality (FMULT) and SSB. The percent confidence intervals can be taken from the cumulative frequency. The 2016 point estimate for fishing mortality = 0.160 and SSB = 10,562 mt.



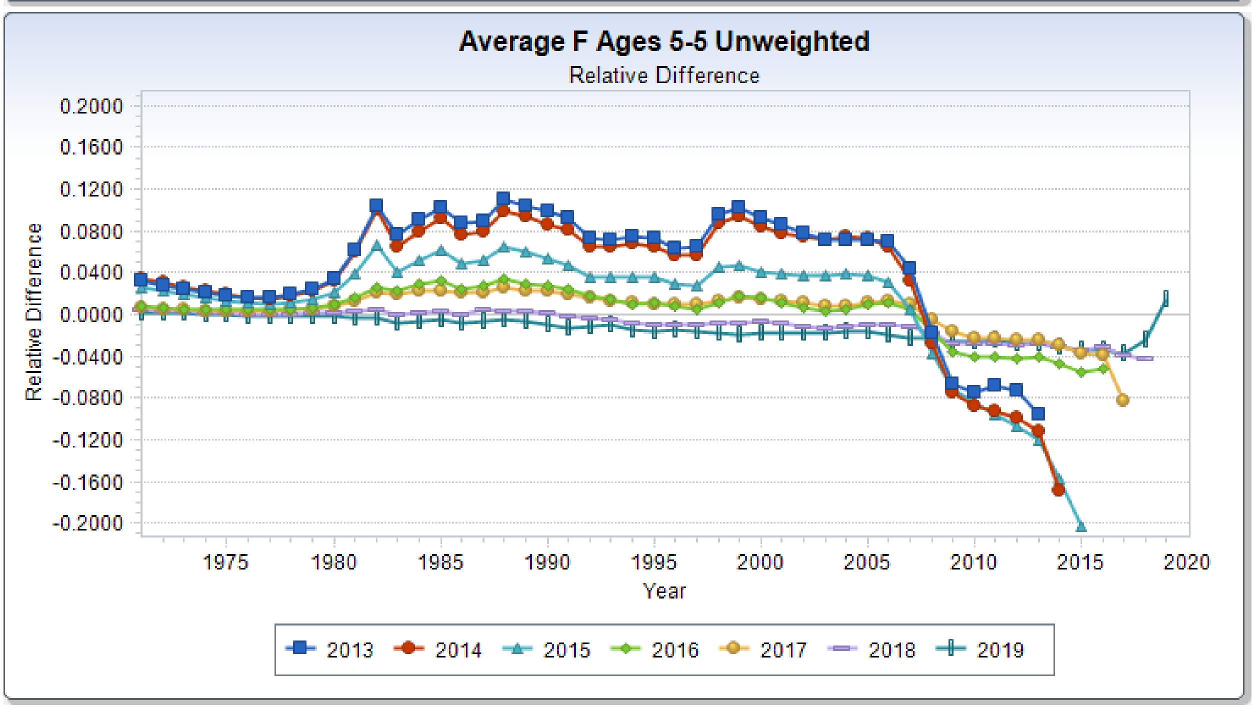


Figure 10. Updated 2017 model 7 peel retrospective analysis: fully recruited F age 5 = F_{Mult}; Mohn's Rho = -0.09.

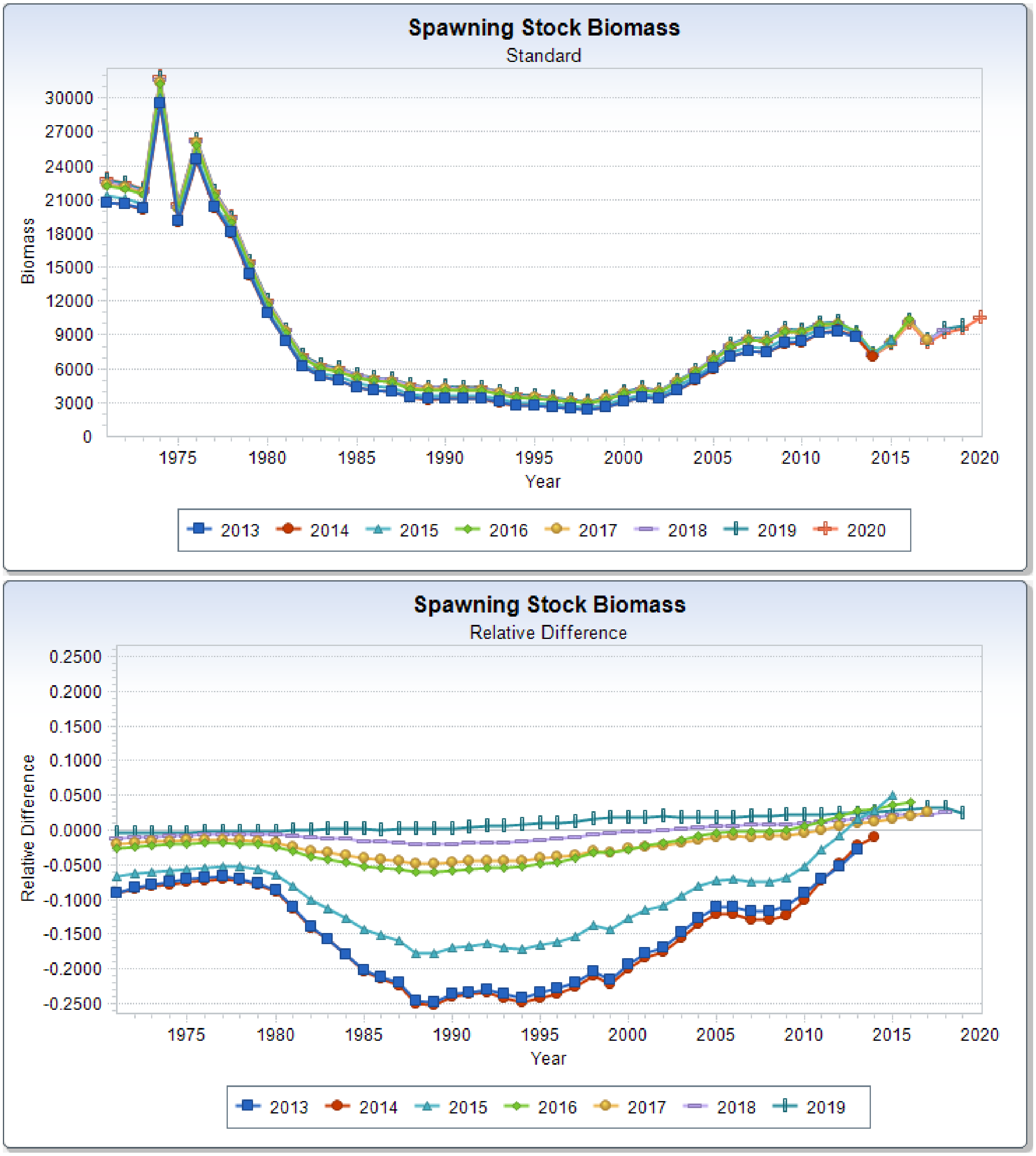


Figure 11. Updated 2017 model 7 peel retrospective analysis: Spawning Stock Biomass; Mohn's Rho = +0.02.

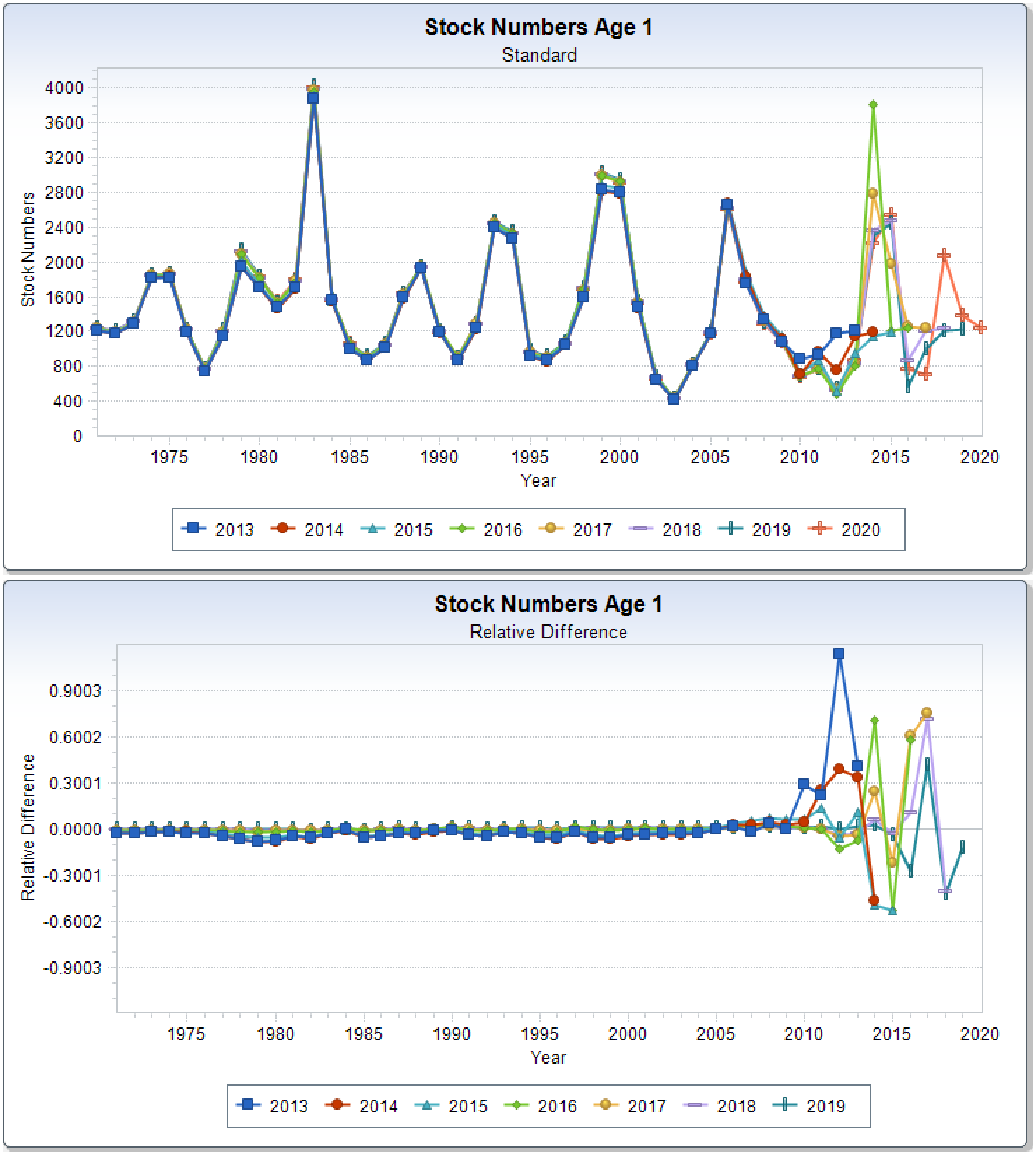


Figure 12. Updated 2017 model 7 peel retrospective analysis: Age-1 Recruitment; Mohn's Rho = +0.03.

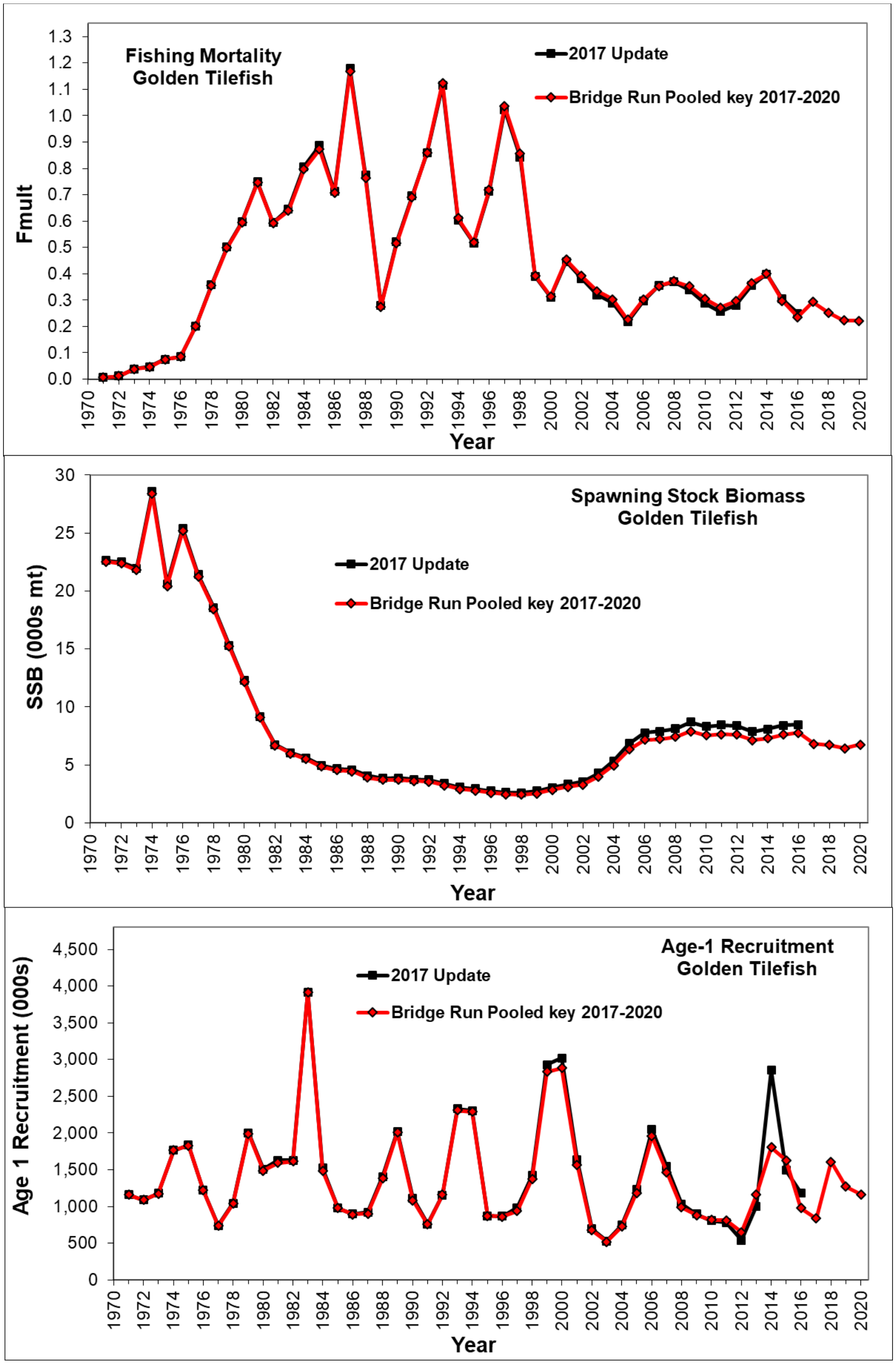


Figure 13. F_{MULT}, spawning stock biomass (SSB), and age-1 recruitment comparison of the 2017 operational run with the 2021 bridge run that added 2017 to 2020 data.

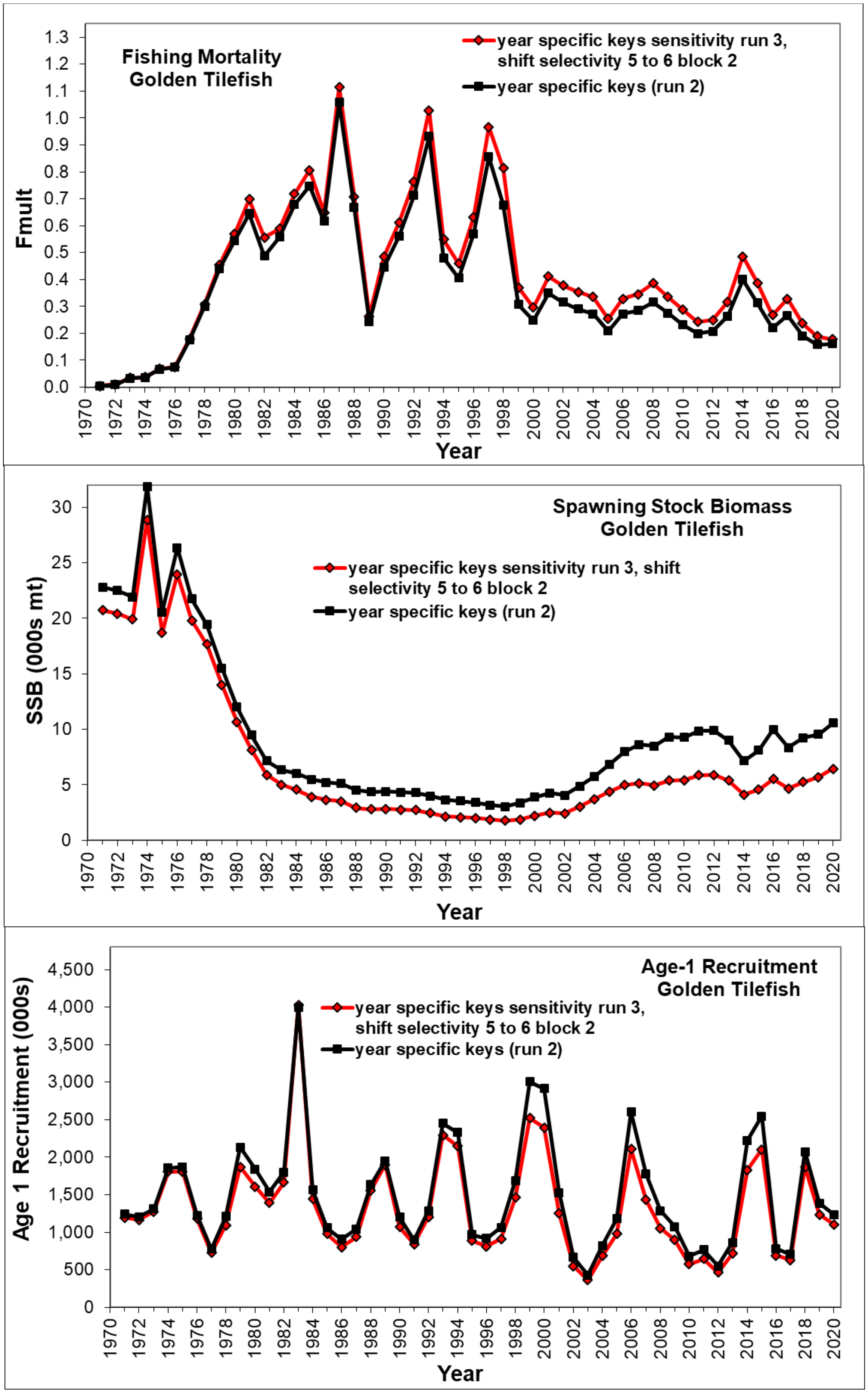


Figure 14. F_{MULT}, spawning stock biomass (SSB), and age-1 recruitment comparison of the 2021 final run 2 to a sensitivity run 3 which shifted the assumed age of full selectivity from age 5 to age 6 in the second selectivity block (1983-2020).

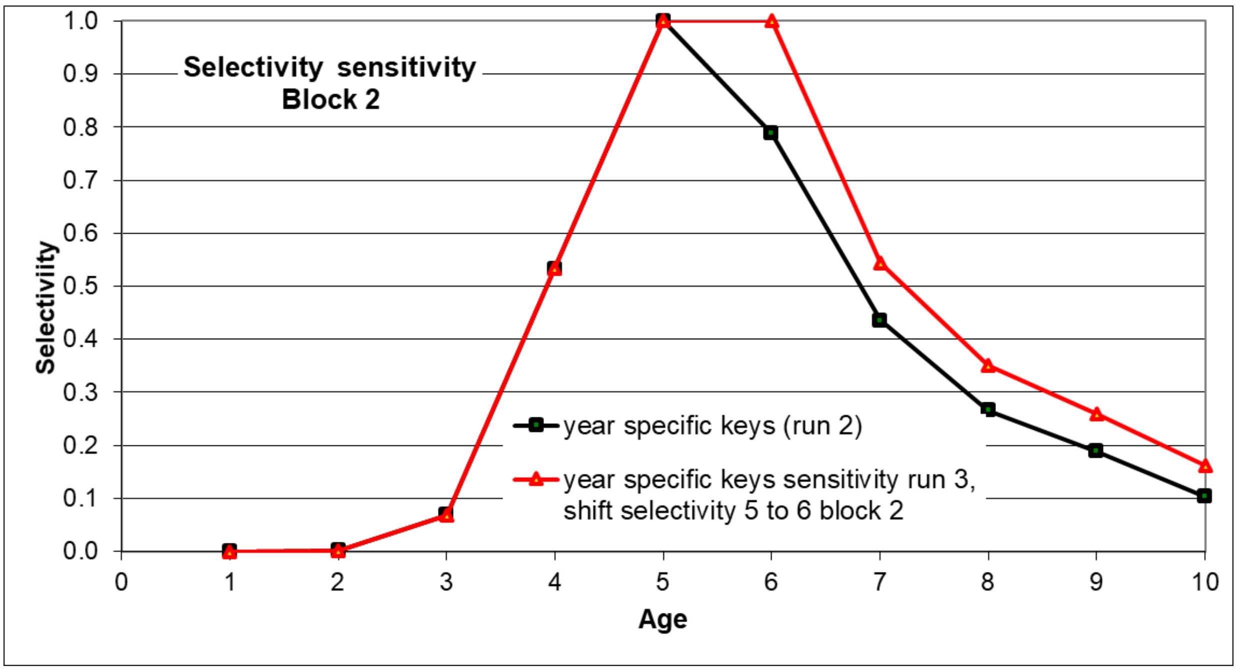


Figure 15. Estimated selectivity at age comparison of the 2021 final run 2 to a sensitivity run 3 which shifted the assumed age of full selectivity from age 5 to age 6 in the second selectivity block (1983-2020).