

Appendix

Appendix 1: Additional work requested by the SARC

Model result sensitivity to the assumption for M

The SARC requested a fuller examination of the sensitivity of the model run S60_BASE_18 results to a range of values assumed for the instantaneous natural mortality rate (M). The model results changed in a predictable way, with stock sizes through model age 5 (true age 4) generally scaled upward as M was increased from 0.1 to 0.3 (0.2 was assumed for run 18; Figures 1-5). The pattern changes for model ages 6-8+ (true ages 5-7+) as the relative importance of M and F changes with the increase in M due to the domed fishery selection pattern. This changing pattern over ages of the relationship between M and F is also why the SSB (which by weight is composed mostly of true age 3 and older) is lower for higher M (Figure 6). Recent fishing mortality (F) estimates increase by about 10% for each increase in M (Figure 7).

Fishing mortality and SSB reference points were calculated for each M assumption and stock status determined for each assumption. Under all three assumptions for M, the stock was not overfished and overfishing was not occurring, as F in 2014 was below the F threshold and SSB was above the SSB target (Figure 8). These results indicated to the SARC that the status evaluation for scup was robust to the assumption for M.

Model result sensitivity to the length of included time series

The SARC requested a fuller examination of the sensitivity of the model run S60_BASE_18 results to the length of the time series included in the model, given the model configuration (i.e., Lambda settings, selectivity settings, catch and survey CV settings). The 2014 SSB estimate for the model run starting in 1963 was about 40% higher than the estimate for the model run starting in 1989 (Figure 9); the 2014 total stock numbers (N) estimate was about 50% higher (Figure 10); the 2014 fishing mortality (F) estimate was about 65% lower (Figure 11). Patterns were similar for estimated stock sizes at age (Figures 12-15).

Model fit to survey data

Given the need to set priors on starting conditions, set priors on fishery selectivity, and adjust survey CVs to account for additional process error, the SARC reviewed a plot of normalized survey time series of aggregate and true age 0 survey indices compared with normalized model estimates of total stock size. These plots indicated that, even given the influence of prior (Lambda) settings and the fishery catch data, the model estimates were still in general following the trends indicated by the survey data (Figures 16-17).

Model result sensitivity to the configuration of fishery selectivity

The SARC requested a fuller examination of the sensitivity of the model run S60_BASE_18 results to assumptions for and estimation of the fishery selectivity. The selectivity (S) for the commercial and recreational landings was initially set fixed at $S = 1$ for model age 4 (true age 3) in all three time blocks (1963-1996, 1997-2005, 2006-2014). In subsequent ‘tuning’ of the

model, S at some adjacent ages and /or older ages were also fixed at 1 for the landings if the estimated parameters were constrained at the upper bound of $S = 1$. The total fishery estimated selectivity pattern for run S60_BASE_18 was:

0.07, 0.31, 0.71, 1.00, 0.96, 0.94, 0.57, and 0.18 for model ages 1-8+ (true ages 0-7+).

In run S60_BASE_18_FLATL, the commercial and recreational landings selectivities were set at $S = 1$ for model ages 4-8+ (true ages 3-7+) in all three time blocks. The total fishery estimated selectivity pattern for run S60_BASE_18_FLATL was:

0.06, 0.40, 0.83, 1.00, 0.91, 0.88, 0.88, and 0.87 for model ages 1-8+ (true ages 0-7+).

The resulting pattern estimated in the sensitivity run both rises more steeply and is flatter at older ages than in the accepted model.

Comparative results are provided in Figures 18-20. This sensitivity run of the choice of selectivity pattern used in the accepted model highlighted some additional risk. The accepted model has a strong domed selectivity pattern which could result in an increasing cryptic biomass given current stock trajectory. Conclusions regarding current stock status are robust to alternative selectivity patterns but decreased recruitment or increased F in the future could lead to divergence between domed and flattop selectivity model results.

Appendix 1: Figures

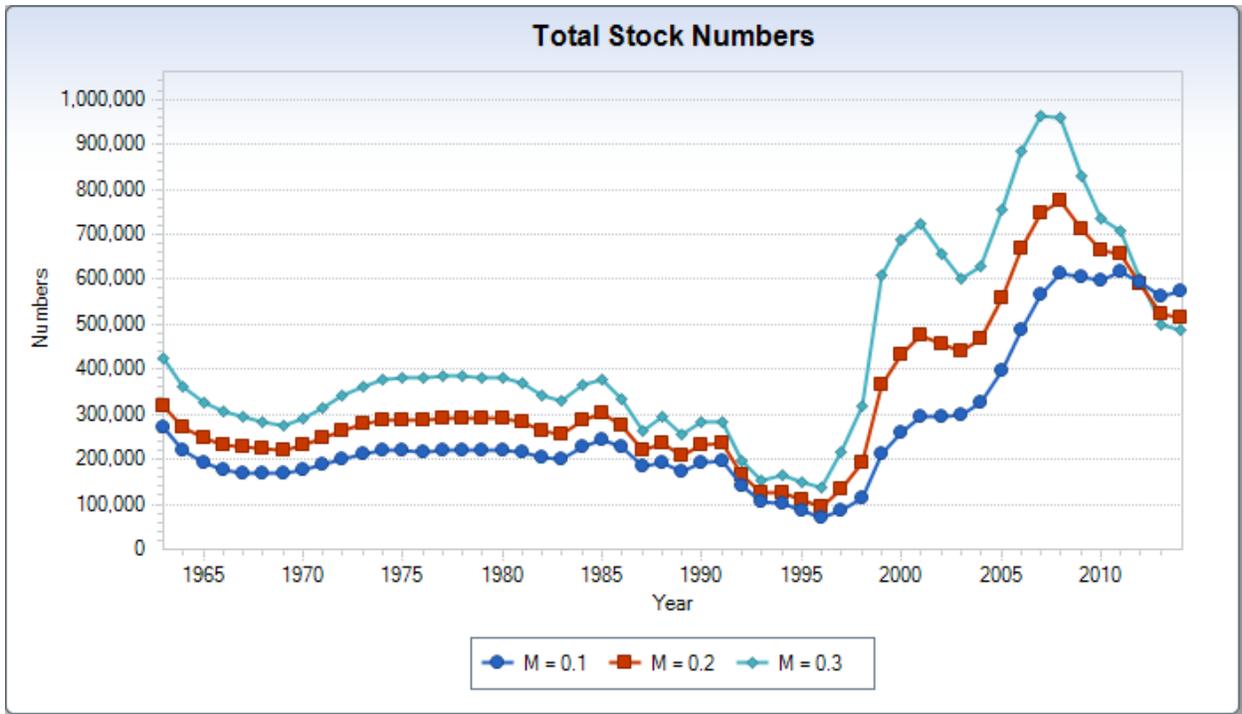


Figure 1. Comparison of run S60_BASE_18 estimates of total stock numbers for three values of M.

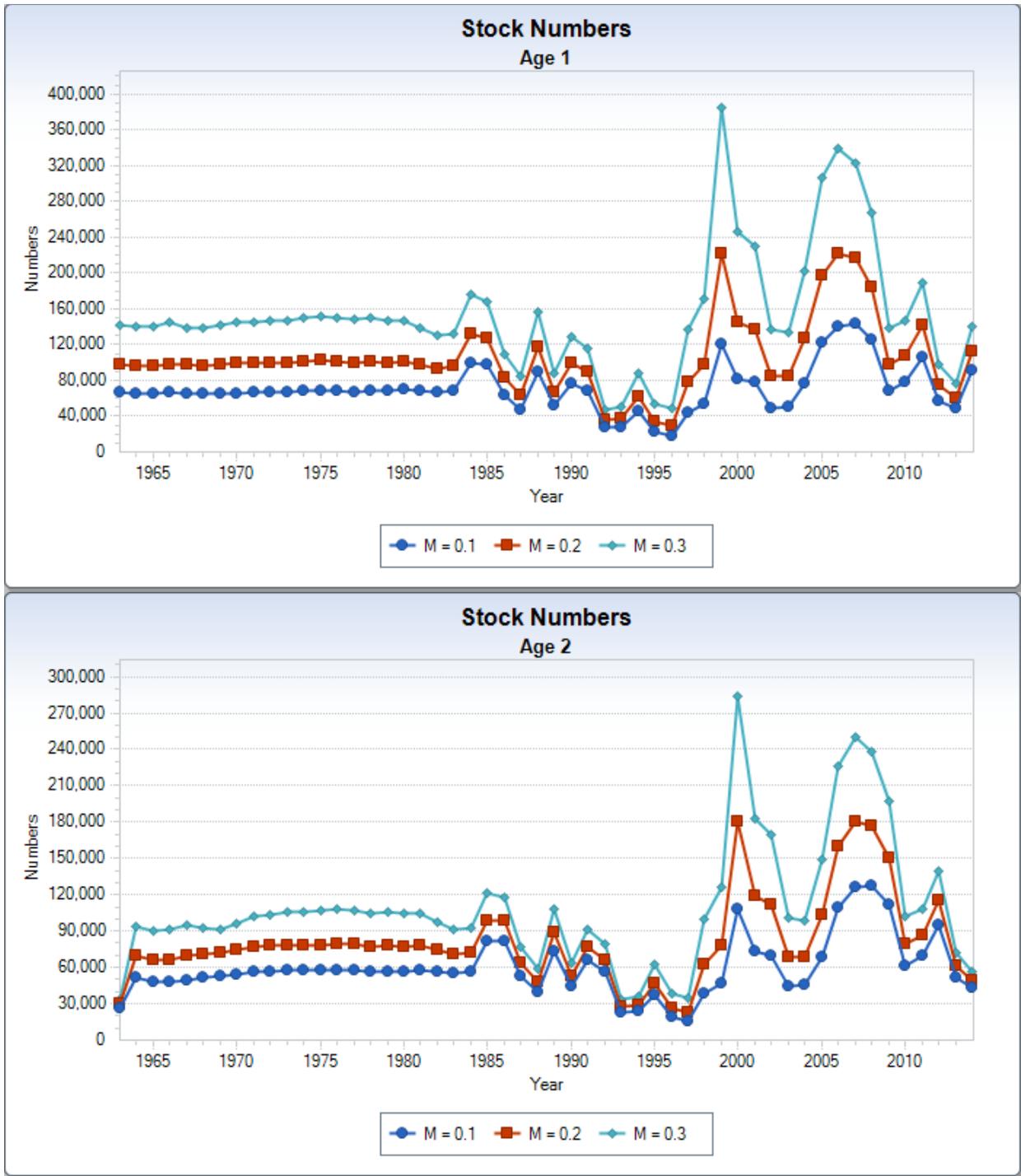


Figure 2. Comparison of run S60_BASE_18 estimates of model ages 1 and 2 (true ages 0 and 1) stock numbers for three values of M.

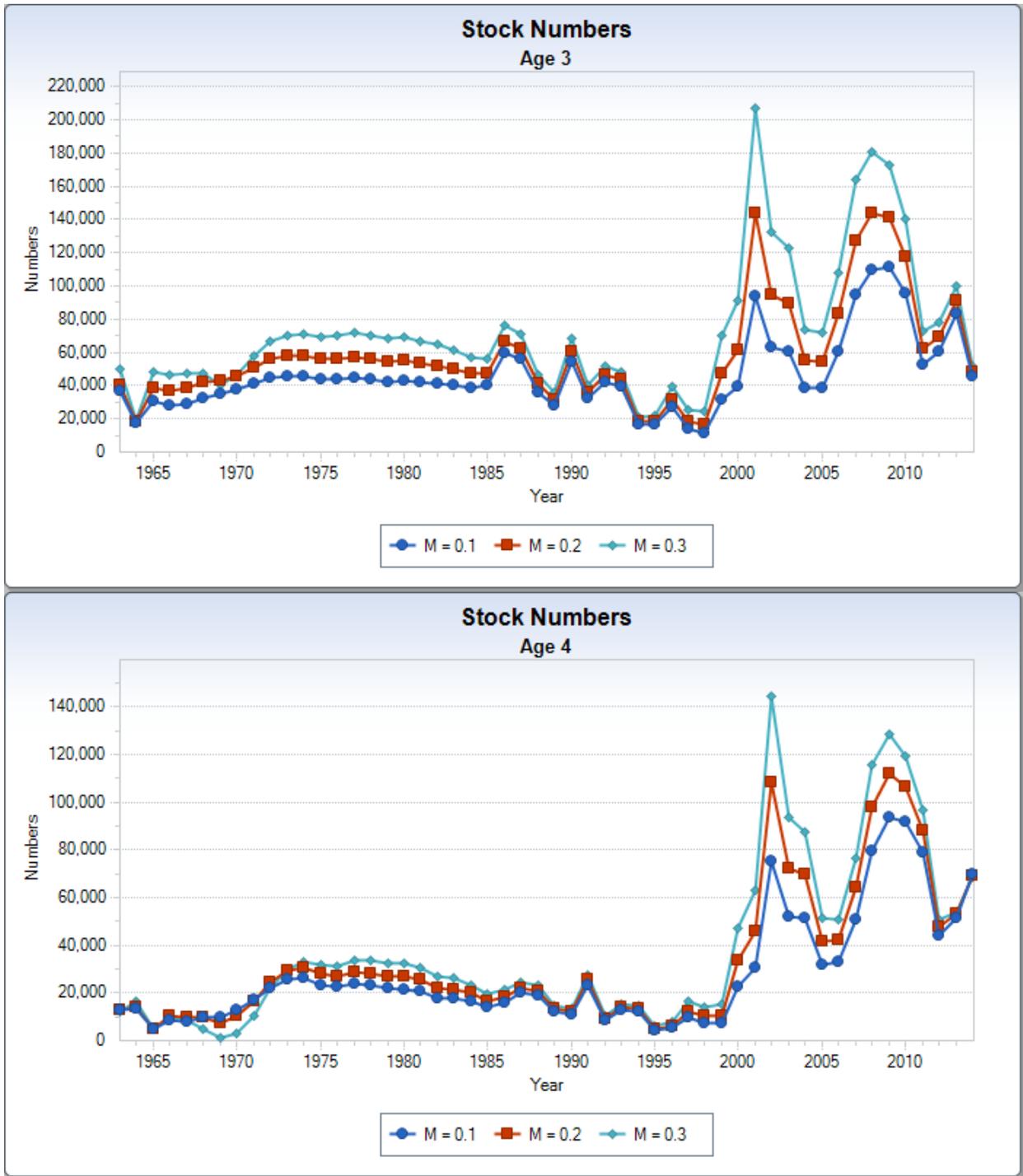


Figure 3. Comparison of run S60_BASE_18 estimates of model ages 3 and 4 (true ages 2 and 3) stock numbers for three values of M.



Figure 4. Comparison of run S60_BASE_18 estimates of model ages 5 and 6 (true ages 4 and 5) stock numbers for three values of M.

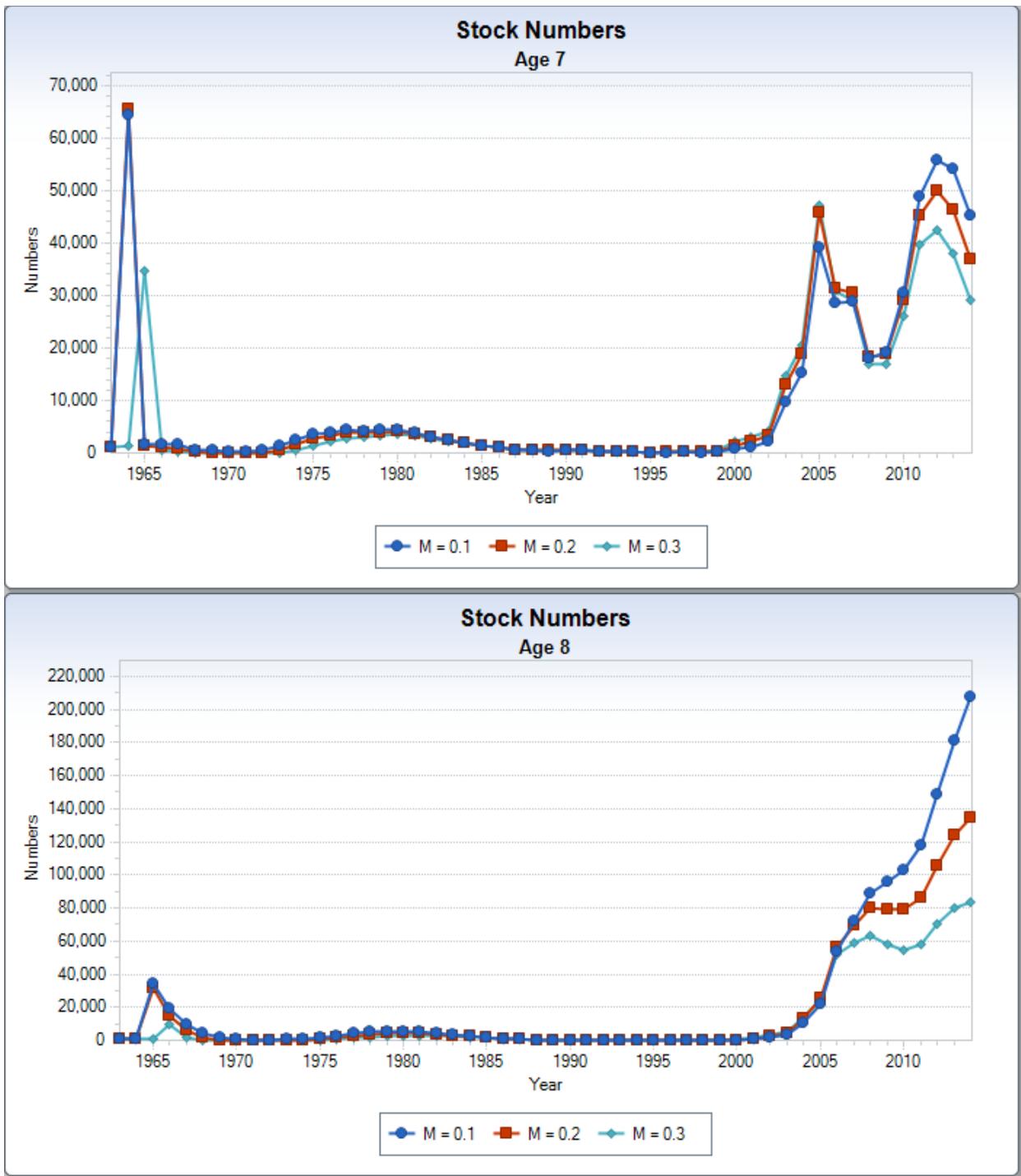


Figure 5. Comparison of run S60_BASE_18 estimates of model ages 7 and 8+ (true ages 6 and 7+) stock numbers for three values of M.

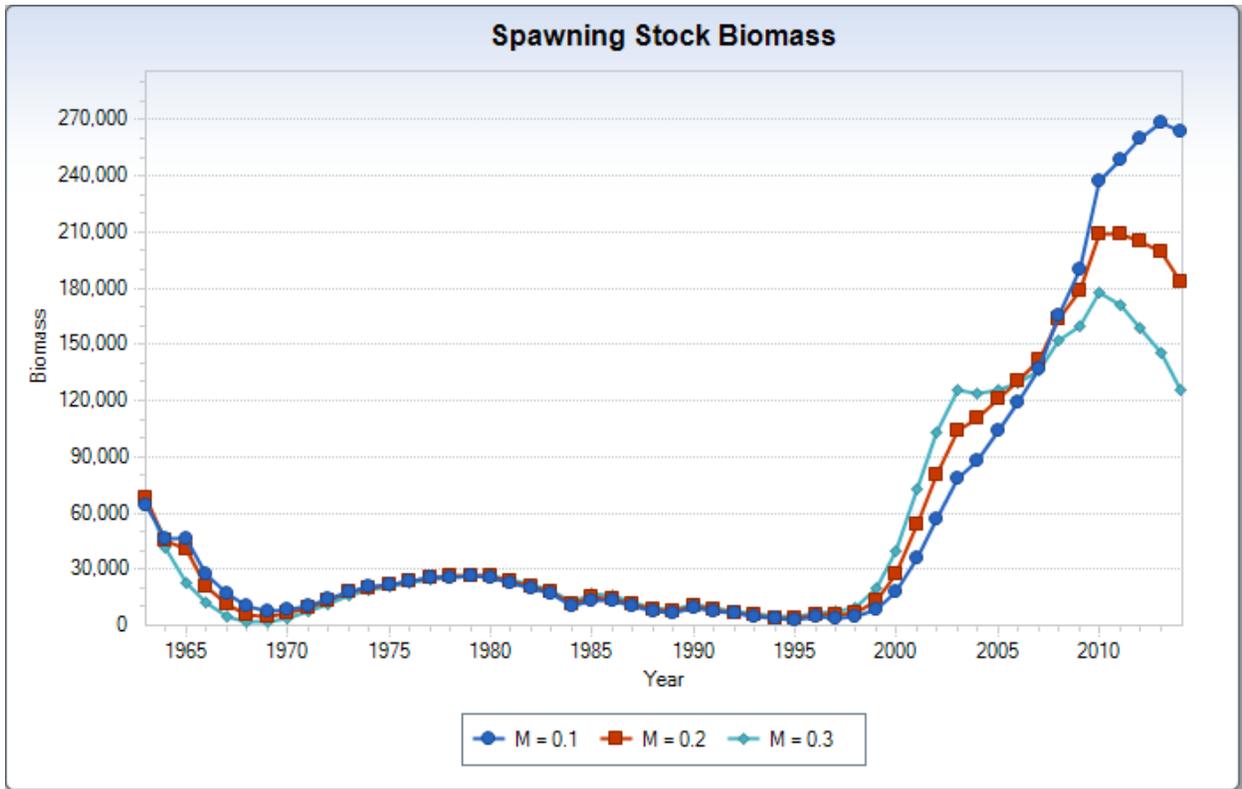


Figure 6. Comparison of run S60_BASE_18 estimates of Spawning Stock Biomass (SSB) for three values of M.

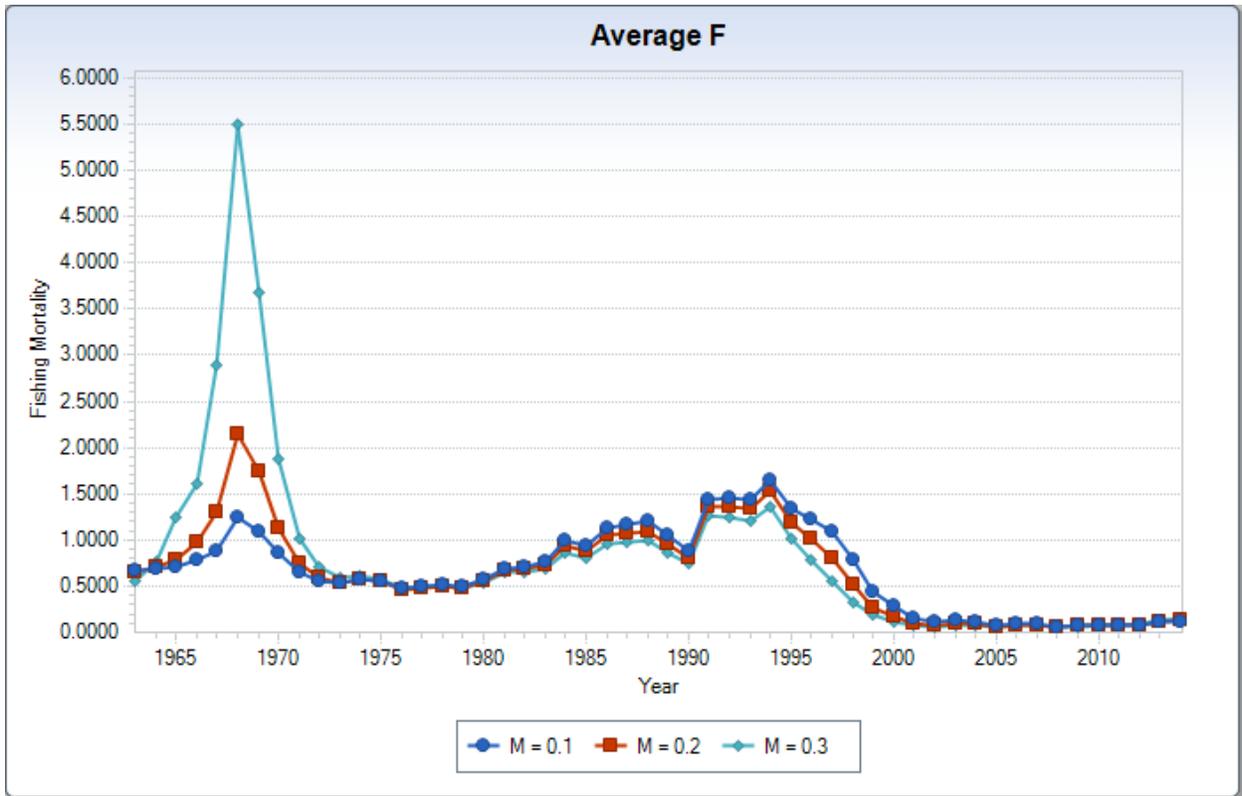


Figure 7. Comparison of run S60_BASE_18 estimates of peak Fishing Mortality (F) at model age 4 (true age 3) for three values of M.

SARC Work: Run 18 Sensitivity to M Reference Points

M = 0.1: F40 = 0.172, F2014 = 0.111

M = 0.2: F40 = 0.220, F2014 = 0.127

M = 0.3: F40 = 0.261, F2014 = 0.146

M = 0.1: SSB40 = 194 kmt, SSB2014 = 264 kmt

M = 0.2: SSB40 = 87 kmt, SSB2014 = 183 kmt

M = 0.3: SSB40 = 56 kmt, SSB2014 = 126 kmt

M = 0.1: MSY40 = 13 kmt, CAT2014 = 11 kmt

M = 0.2: MSY40 = 12 kmt, CAT2014 = 11 kmt

M = 0.3: MSY40 = 11 kmt, CAT2014 = 11 kmt

Figure 8. Comparison of the proxy reference points and model estimates for three assumptions for M in the S60_BASE_18 model. For all three assumptions the stock is not overfished and overfishing is not occurring in 2014. Maximum sustainable yield (MSY40) is similar for the three assumptions

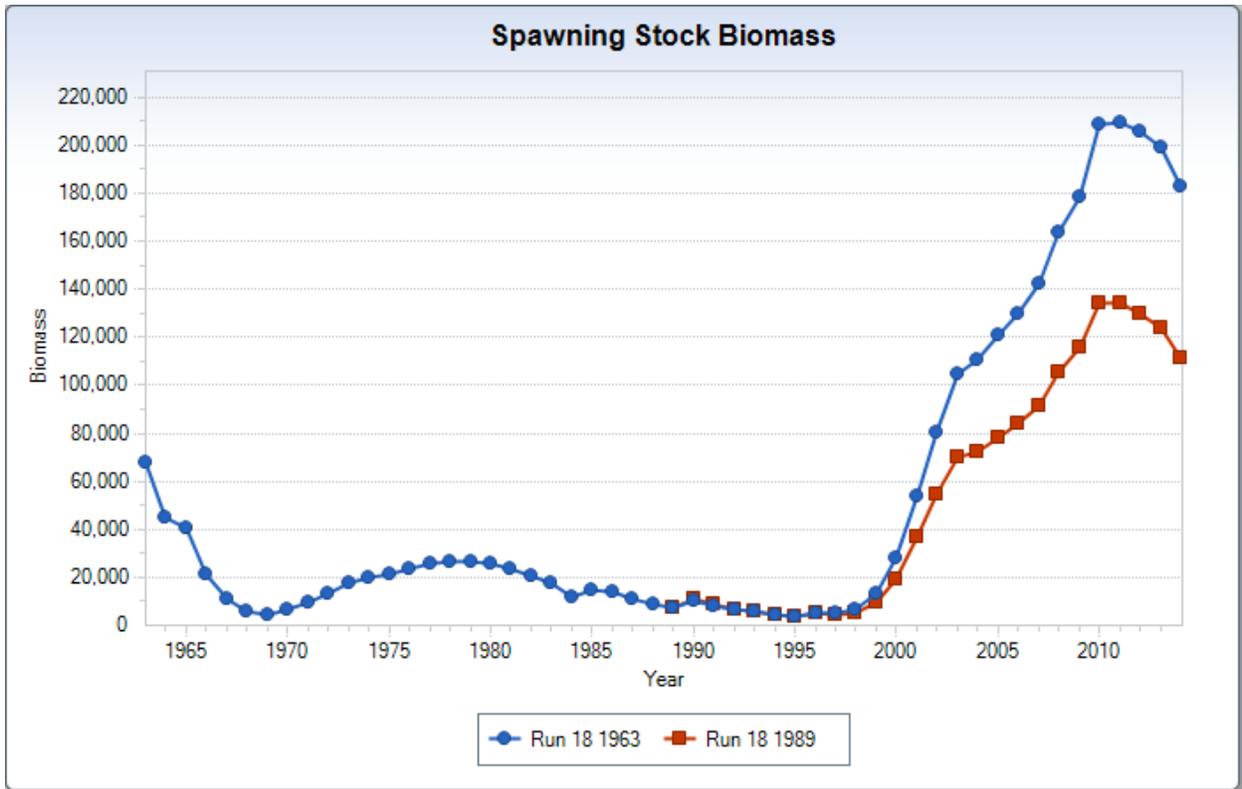


Figure 9. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: Spawning Stock Biomass.

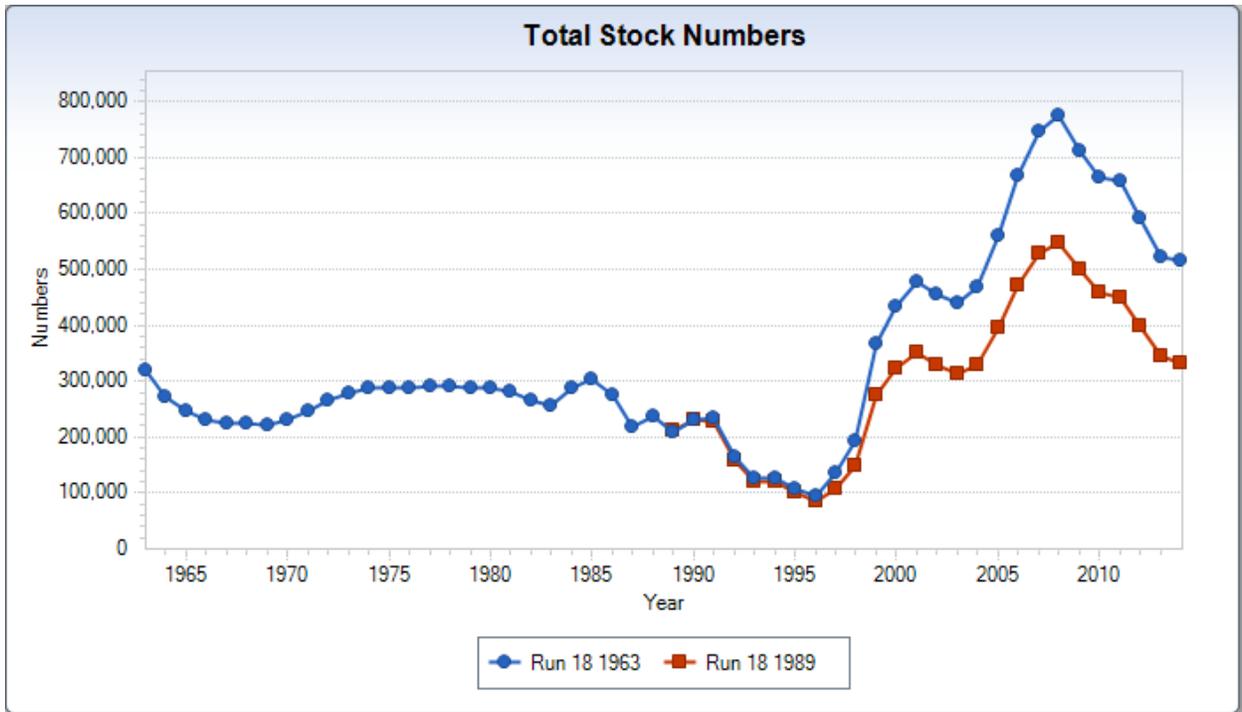


Figure 10. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: total stock numbers.

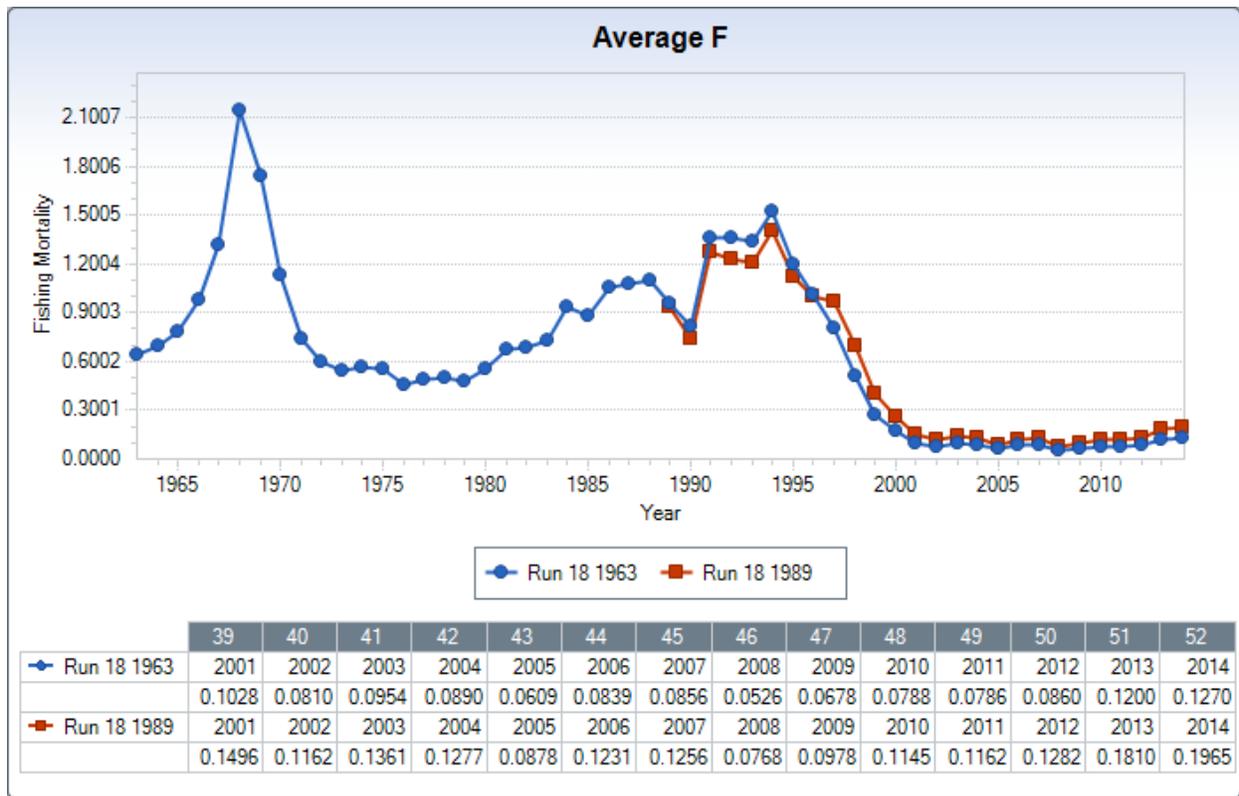


Figure 11. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: peak F at model age 4 (true age 3).

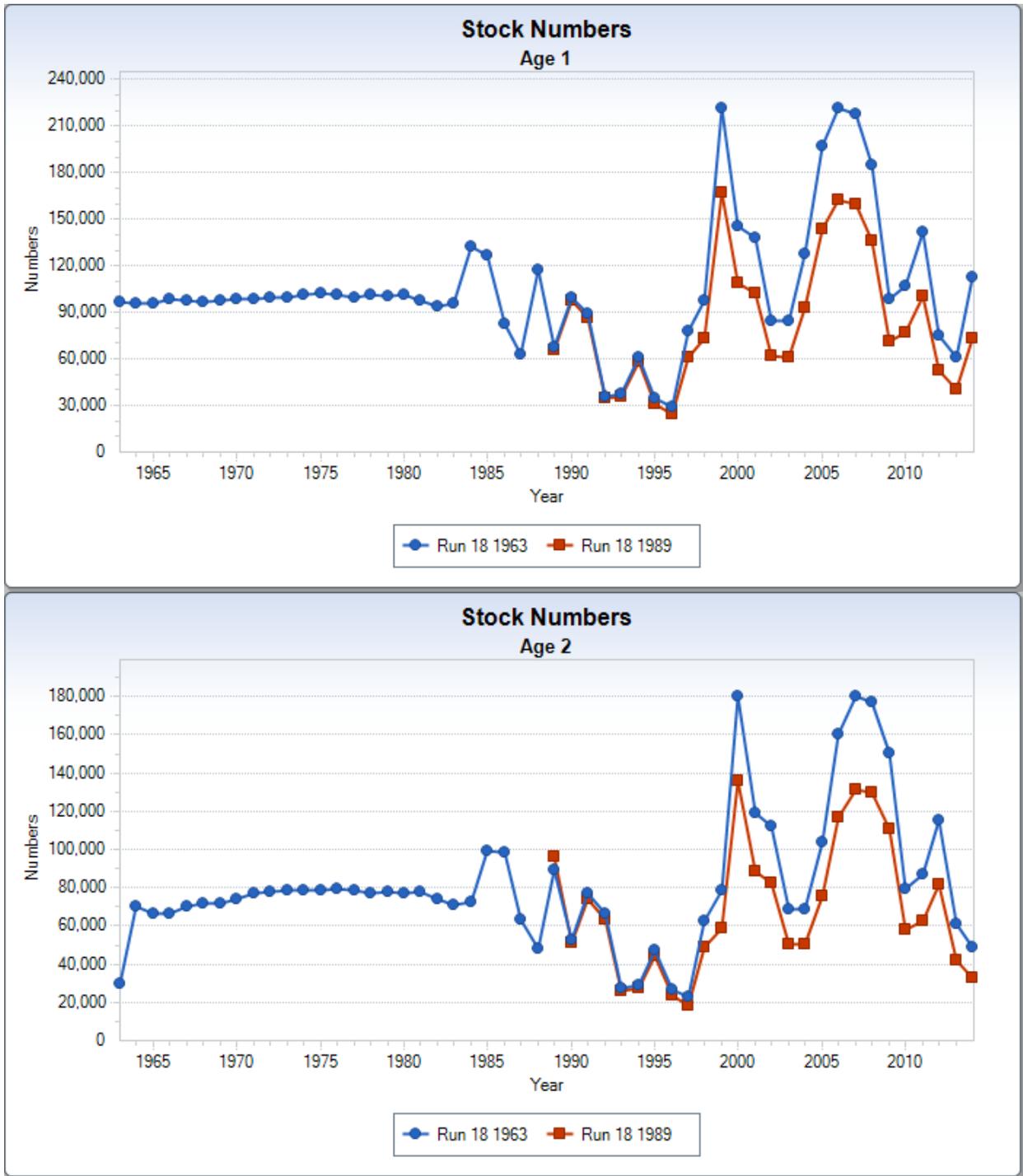


Figure 12. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: stock size at model ages 1 and 2 (true ages 0 and 1).

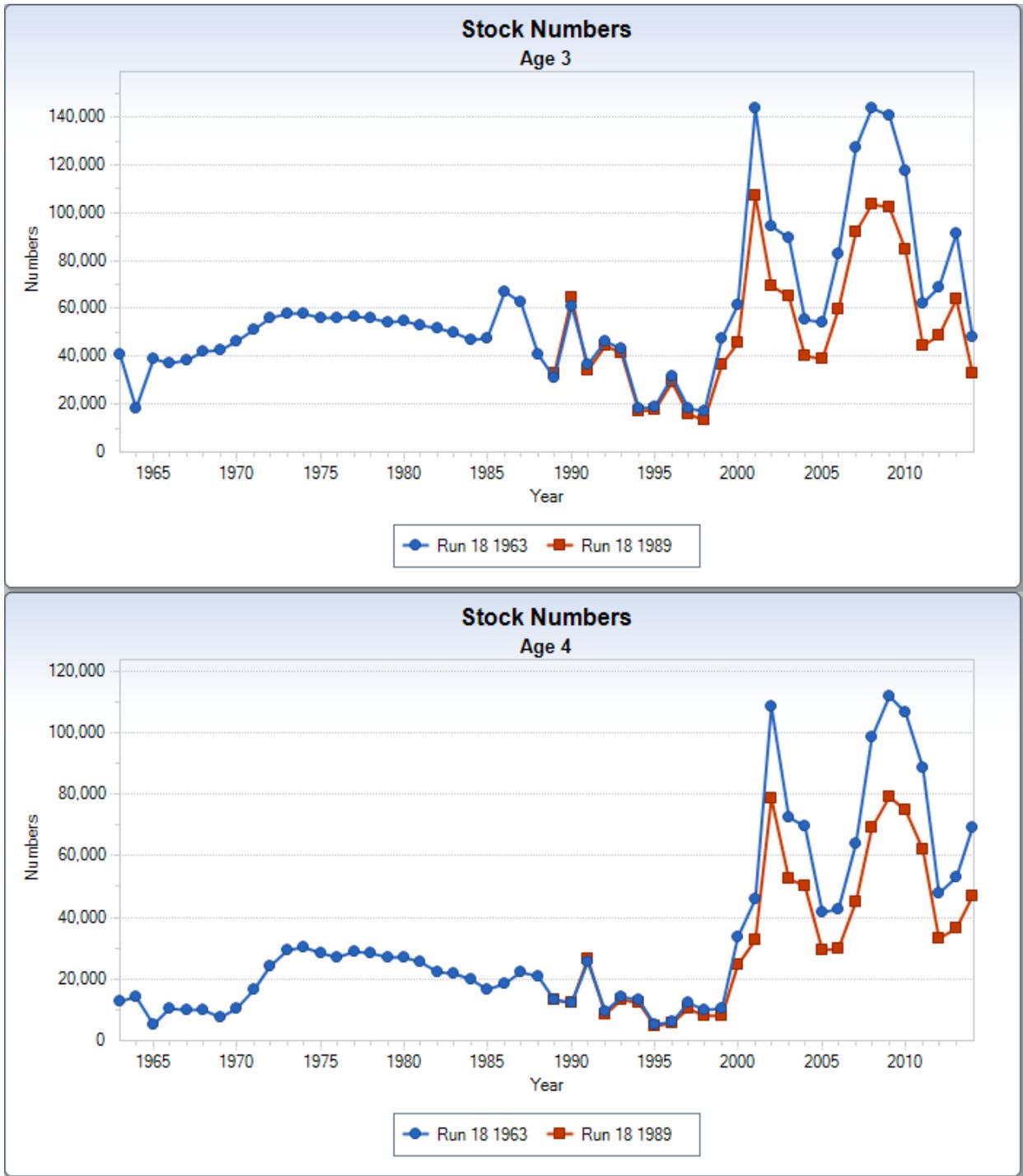


Figure 13. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: stock size at model ages 3 and 4 (true ages 2 and 3).

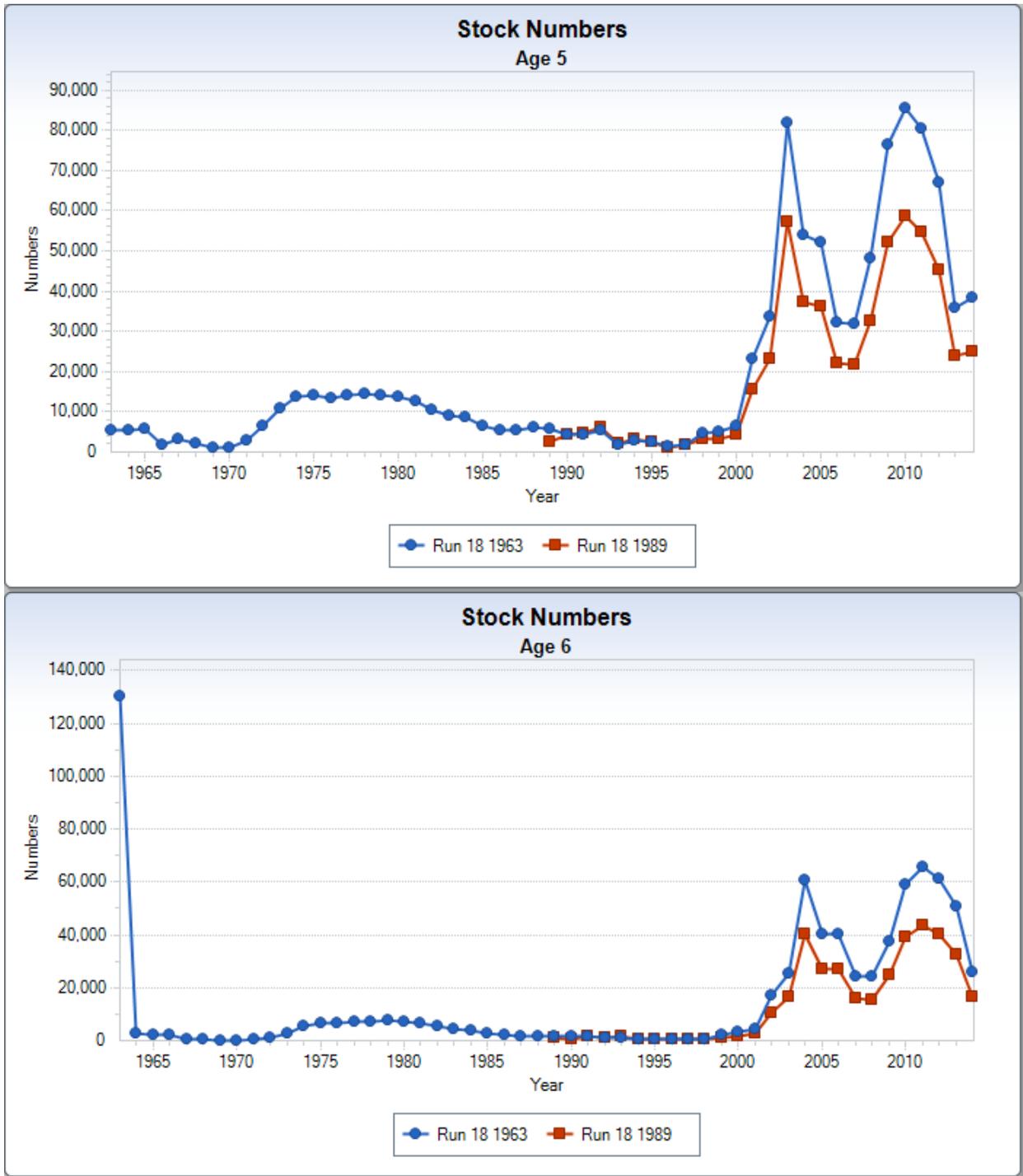


Figure 14. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: stock size at model ages 5 and 6 (true ages 4 and 5).

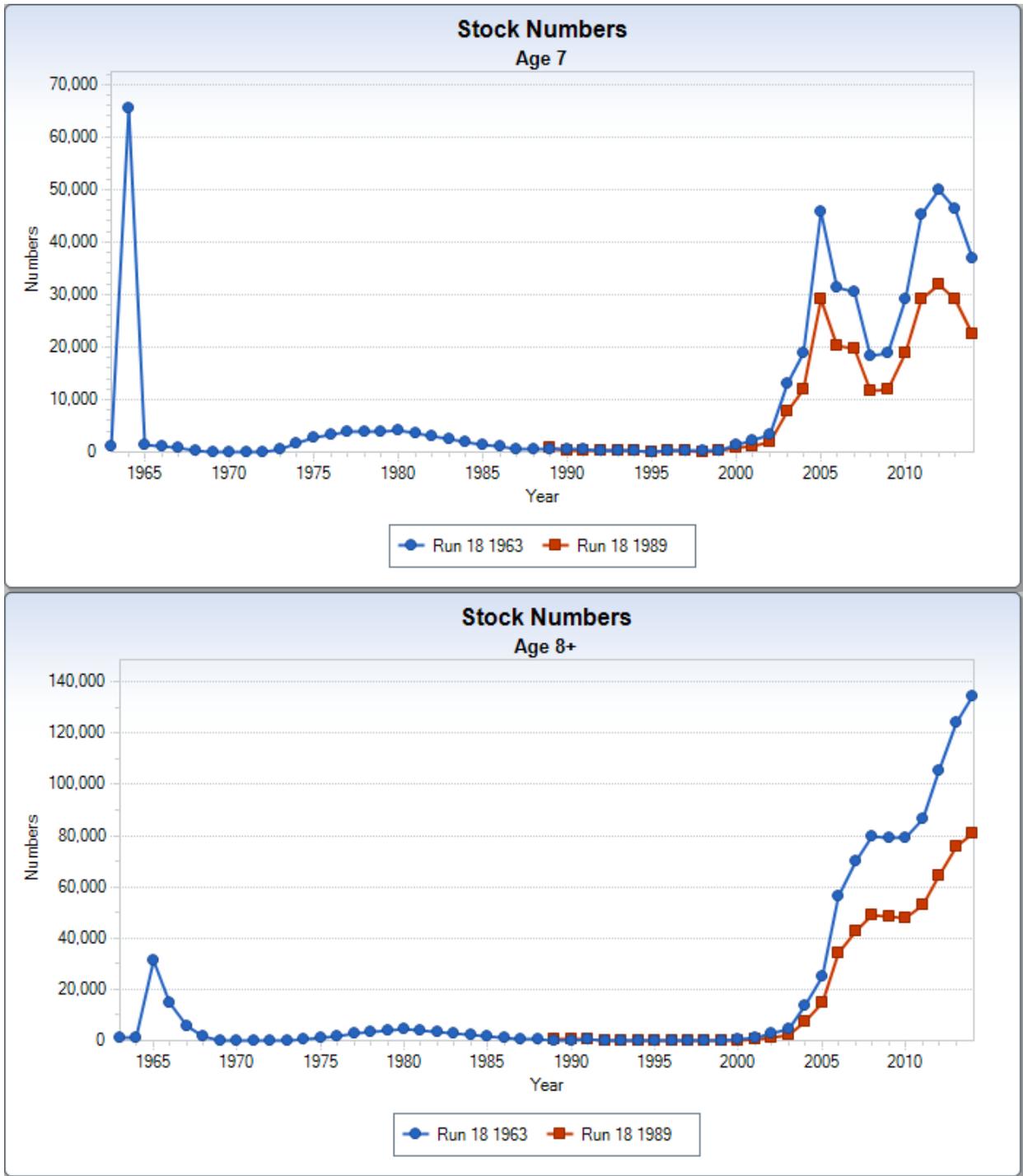


Figure 15. Comparison of results for versions of model S60_BASE_18 starting in 1963 and 1989: stock size at model ages 7 and 8+ (true ages 6 and 7+).

SARC Work: Run 18 ‘Feasibility’
How does the model fit the survey data?
Comparison to SV Index Trends – Total Stock N

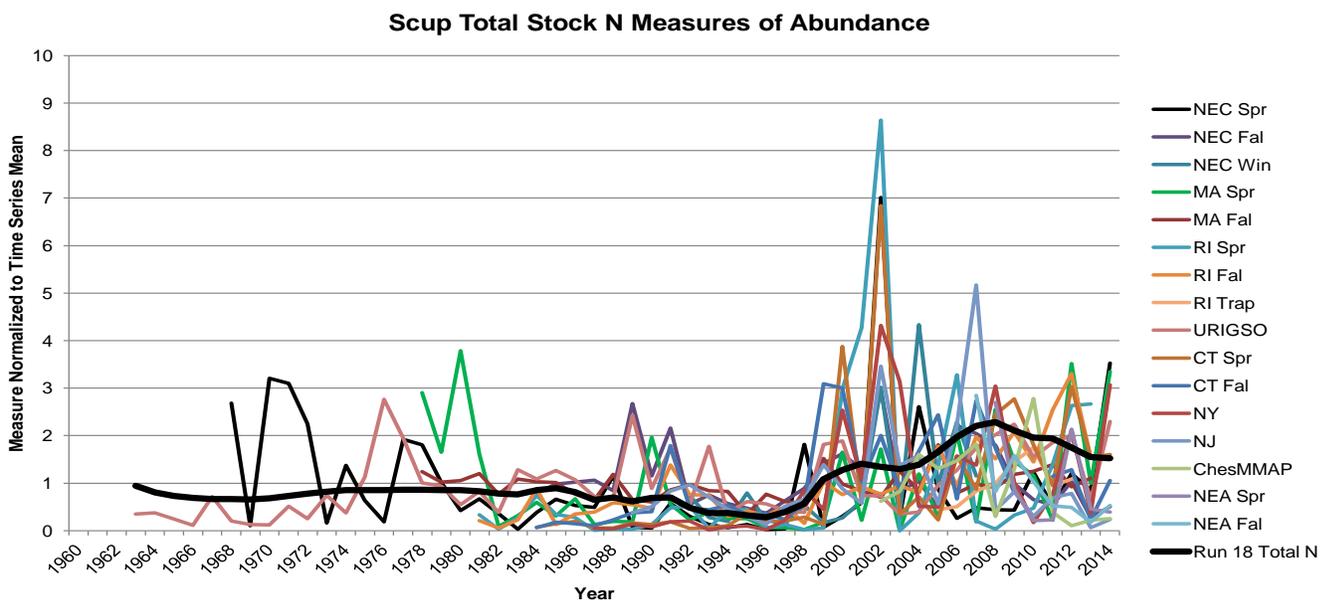


Figure 16. Trends in normalized aggregate survey indices in numbers with normalized run S60_BASE_18 total stock size numbers (N) estimates. Note that some of the indices (NEC Spr, MA Spr, RI Spr, RI Fal, ChesMMAP) were not included in the final model.

SARC Work: Run 18 'Feasibility'
Does the model fit the data?
Comparison to SV Index Trends – Age 0 N

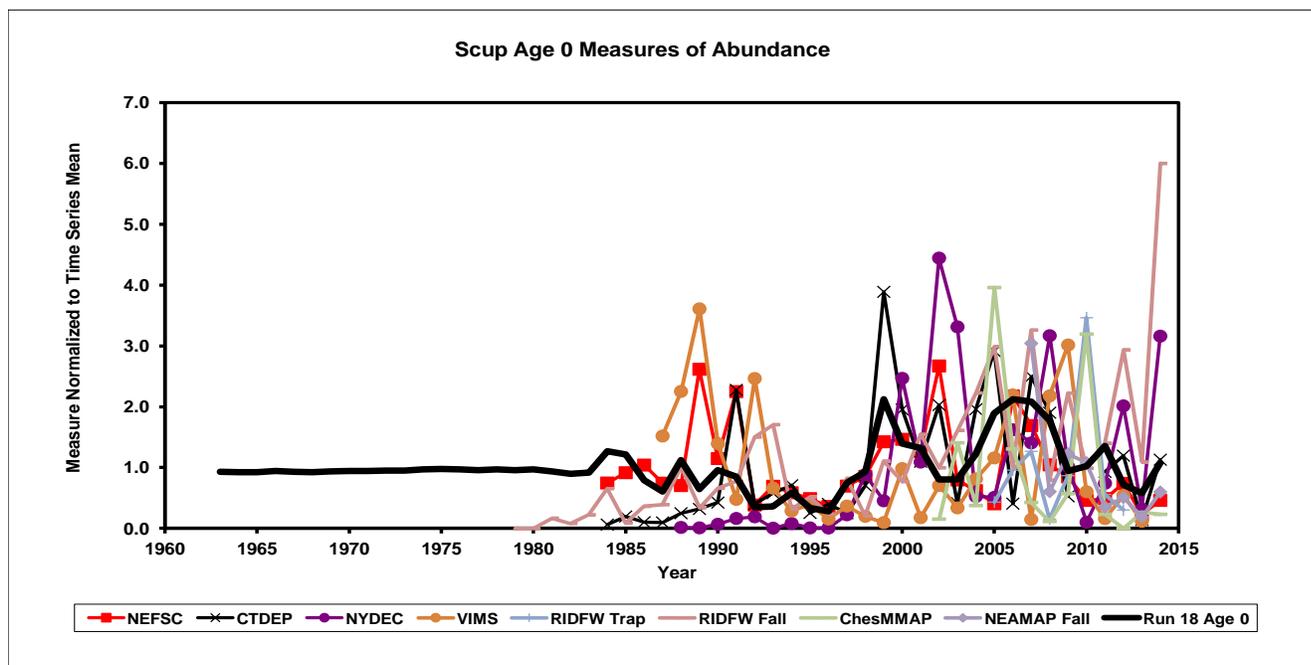


Figure 17. Trends in normalized survey true age 0 indices in numbers with normalized run S60_BASE_18 true age 0 stock size estimates. Note that some of the indices (RIDFW Fall, ChesMMAP) were not included in the final model.

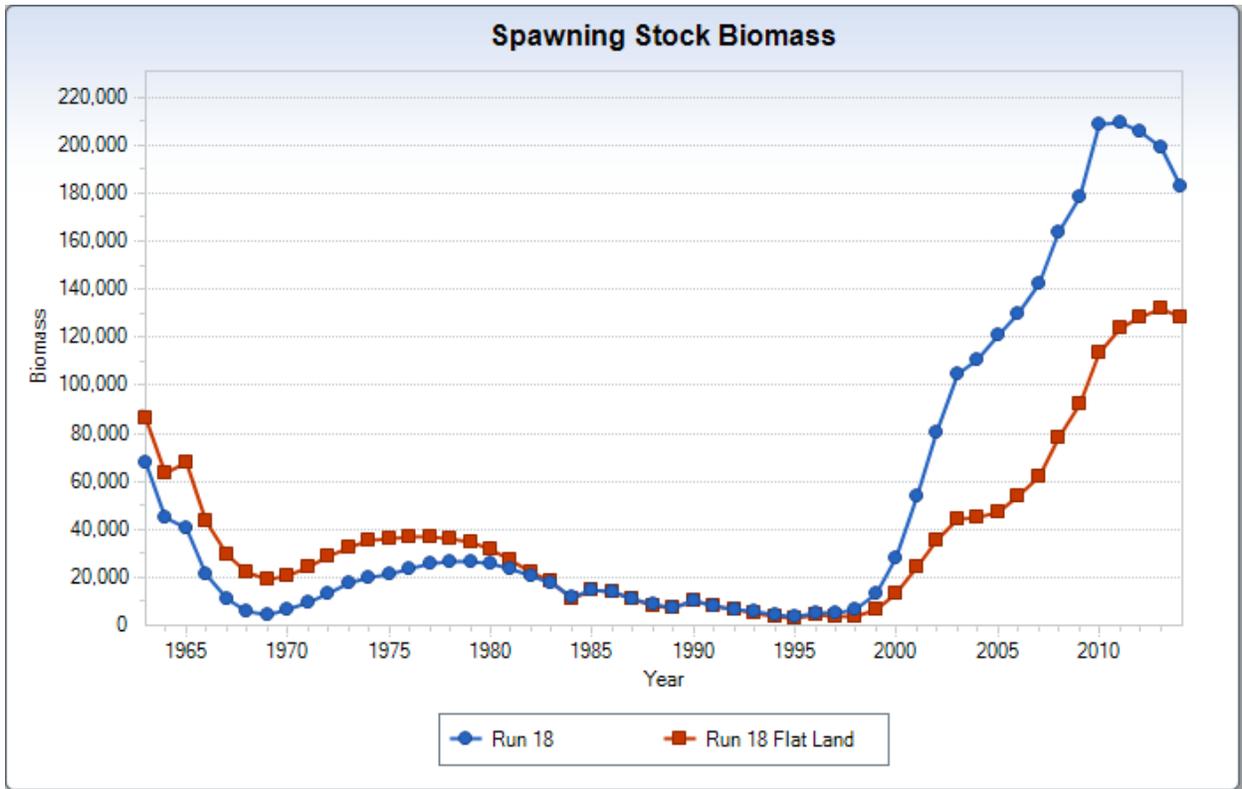


Figure 18. Comparison of estimates from the accepted model (Run 18) with a model with a fixed flattop fishery landings selection pattern (Run 18 Flat Land): Spawning Stock Biomass.

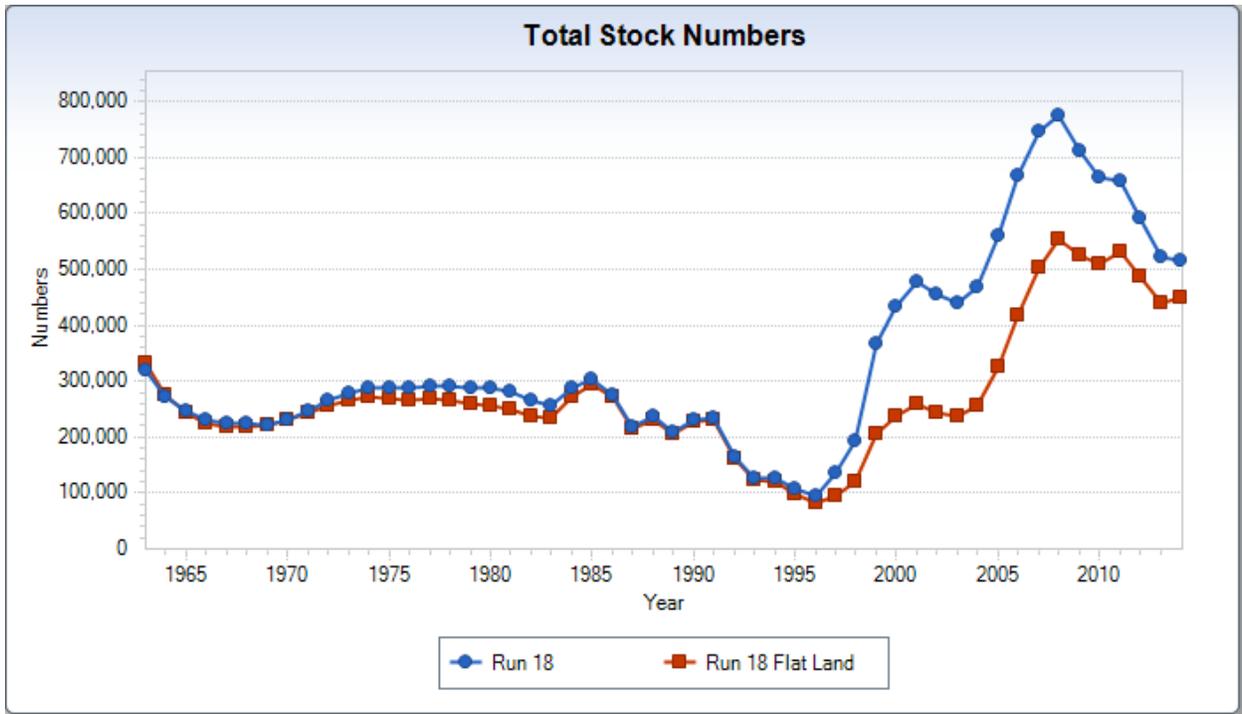


Figure 19. Comparison of estimates from the accepted model (Run 18) with a model with a fixed flattop fishery landings selection pattern (Run 18 Flat Land): Total Stock Numbers.

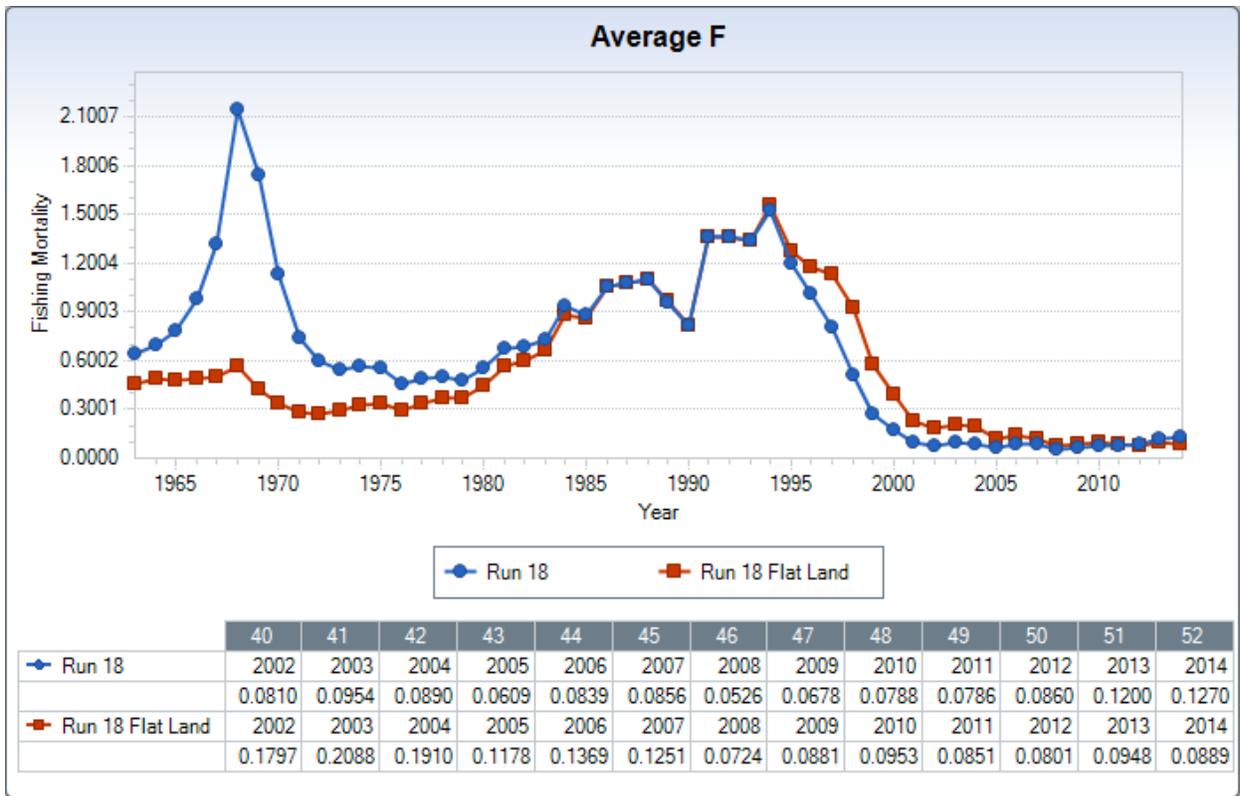


Figure 20. Comparison of estimates from the accepted model (Run 18) with a model with a fixed flattop fishery landings selection pattern (Run 18 Flat Land): peak F at model age 4 (true age 3).