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# Preliminary Comparisons of the Stock Synthesis assessment model for North Pacific Swordfish[1]

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## Abstract

This working paper is provided as a reference for preparing for the 2018 benchmark North Pacific swordfish stock assessment by the ISC Billfish Working Group. It details the parameters and model structure explored in the 2009 benchmark assessment and compares outputs of that assessment using the Stock Synthesis (SS) version SS3.24f used in 2009, with outputs using the most current version of SS, SS3.30. Results from this comparison show that there are no differences in model output from the SS3.24f version to the SS3.30 version; therefore, the working group could use the SS3.30 version without continuity concerns.

## Introduction

This document is intended to review and summarize the structured Stock Synthesis model explored during the 2009 benchmark stock assessment (Methot and Wetzel, 2013; Courtney and Piner, 2009), and compare the results of the newest SS version 3.30 with the previously used version 3.24f.

## Comparison of SS 3.24 and SS 3.30

A substantial update to the Stock Synthesis was released in 2017 which included changes to the input files and a large number of new features. To evaluate how these changes may affect the results of the swordfish stock assessment, the 2009 SS model for the Western and Central North Pacific Ocean swordfish stock (Courtney and Piner, 2009, was run in both SS 3.24f and SS 3.30 and the results compared. Model files from the 2009 two-stock scenario were run using only the Western Central North Pacific Ocean swordfish CPUE and catch data in SS 3.24f and transferred into SS 3.30 format using the SS_trans.exe program provided by the model developers (available from https://vlab.ncep.noaa.gov/group/stock-synthesis). Once transferred into the new format, the files were checked manually to ensure that all data were correct and then run with the SS 3.30 executable. Model results were then compared in R (version 3.4.0) using the r4ss package (R Core Team, 2017; Taylor *et al.*, 2017).

## Results and Conclusions

Table 1 provides a list of the life history parameters used in the 2009 age-structured assessment base case models in SS. Table 2 shows the derived parameter estimates from each of the two stock synthesis versions. Results are the same for both models. The figures show annual Spawning potential ratio (Figure 1), Harvest rate (Figure 2), Recruitment deviations (Figure 3), relative spawning biomass (Figure 4), and spawning stock output (Figure 5). Figures 6 and 7 show the fit to the CPUE series, and Figures 8 and 9 are the posterior probability plots for Virgin spawning biomass and $R_0$, respectively. For all the figures, there is no difference between the means and variability for results from SS3.24f compared to SS3.30. Therefore the working group could use the SS3.30 version in the 2018 benchmark assessment without substantial concerns about continuity.

**Literature Cited**


Brodziak, J. 2009. Potential Natural Mortality Rates of North Pacific Swordfish, *Xiphias gladius*. ISC/09/BILLWG-1/13

Courtney D. and Piner K. 2009. Preliminary Stock Synthesis Model Sensitivity Runs for a North Pacific Swordfish (Xiphias gladius) Stock Assessment. ISC/09/BILLWG-2/05.

Methot Jr, R. D. and C. R. Wetzel (2013). Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142: 86-99.

R Core Team 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Taylor, I.G., Stewart, I.J., Hicks, A.C., Garrison, T.M., Punt, A.E., Wallace, J.R. Wetzel, C.R., Thorson, J.T., Takeuchi, Y., Ono, K., Monnahan, C.C., Stawitz, C.C., A'mar, Z.T., Whitten, A.R., Johnson, K.F., Emmet, R.L., Anderson, S.C., Lambert, G.I., Stachura, M.M., Cooper, A.B., Stephens, A. and Klaer, N. 2017. R4ss: R Code for Stock Synthesis. https://github.com/r4ss

**Tables**

Table 1. Summary of parameters used in the 2014 Stock Synthesis Model

| Parameters | | Value | Notes |
|---|---|---|---|
| # of Areas | | 1 | - |
| # of Genders | | 1 | Averaged LH Parameters between males and females due to lack of sex specific length data |
| # of Seasons | | 1 | - |
| **LH Parameters** | | | - |
| Mortality | Male | 0.25 | Used average of age 0–1 natural mortality for male/females for the 5 age-estimates proposed in Brodziak 2009 |
| | Female | 0.25 | |
| **Growth** | Female L1 | 98 | $L_1$ = age 1 |
| | Male L1 | 98 | $L_1$ = age 1 |
| | Female L2 | 216 | $L_2 = L_{inf}$ |
| | Male L2 | 216 | $L_2 = L_{inf}$ |
| | Female K | 0.25 | - |
| | Male K | 0.25 | - |
| | Female Weight-Length a | 1.35E-06 | - |
| | Male Weight-Length a | 1.35E-06 | - |
| | Female Weight-Length b | 3.4297 | - |
| | Male Weight-Length b | 3.4297 | - |
| **Maturity** | Female L50 | 143.68 | - |
| | Female Slope | - 0.1034 | - |
| | | | - |
| **Stock recruitment** | ln(Ro) | 7.0553 | 2009 Estimated |
| | BH Steepness | 0.9 | 2017 NA SWO assessment estimated steepness at 0.88 |
| | Sigma R | 0.1 | - |
| | | | - |
| **Fishing Parameters** | | | - |
| Initial F | | 0.140553 | For JPN LL Only, Estimated |

Table 2. Results of 2009 SWO Stock synthesis model run in SS3.30 and SS3.24f

| Label | SS3.30 | SS3.24F |
|---|---|---|
| Total likelihood | 86.845 | 89.1475 |
| Survey likelihood | 100.095 | 100.095 |
| Parameter priors likelihood | 0.00127781 | 0.00127781 |
| Virgin recruitment (millions) | 1.18348 | 1.18348 |
| Stock Recruit: ln($R_0$) | 7.07621 | 7.07621 |
| Stock Recruit: BH steepness | 0.9 | 0.9 |
| SPB virgin (1000 mt) | 91.7195 | 91.7195 |

**Figures**

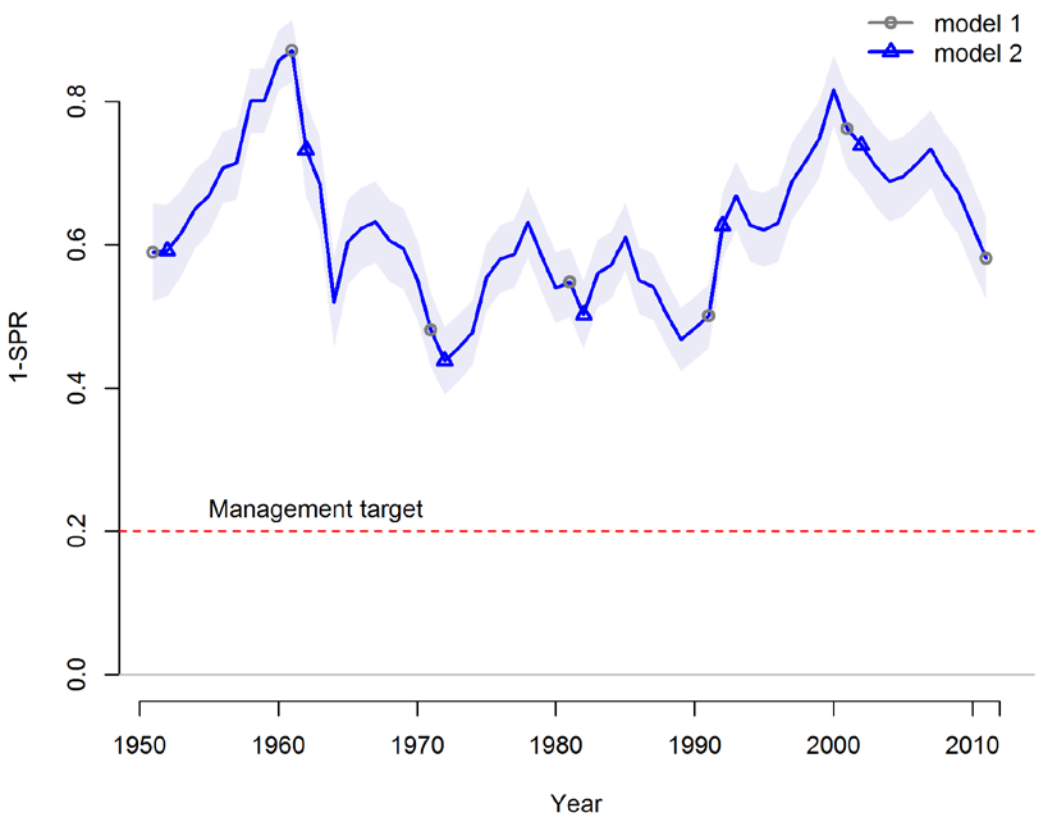


Figure 1. Spawning Potential Ratio by year estimated for the 2009 SWO Stock synthesis model using two different SS versions. Grey line and circles are results from the model run in SS3.30, grey shading is the 95% confidence interval, blue lines and triangles are results from the model run in SS3.24, blue shading is the uncertainty. Grey and blue lines and shading overlap, grey and blue points are plotted offset by one year.

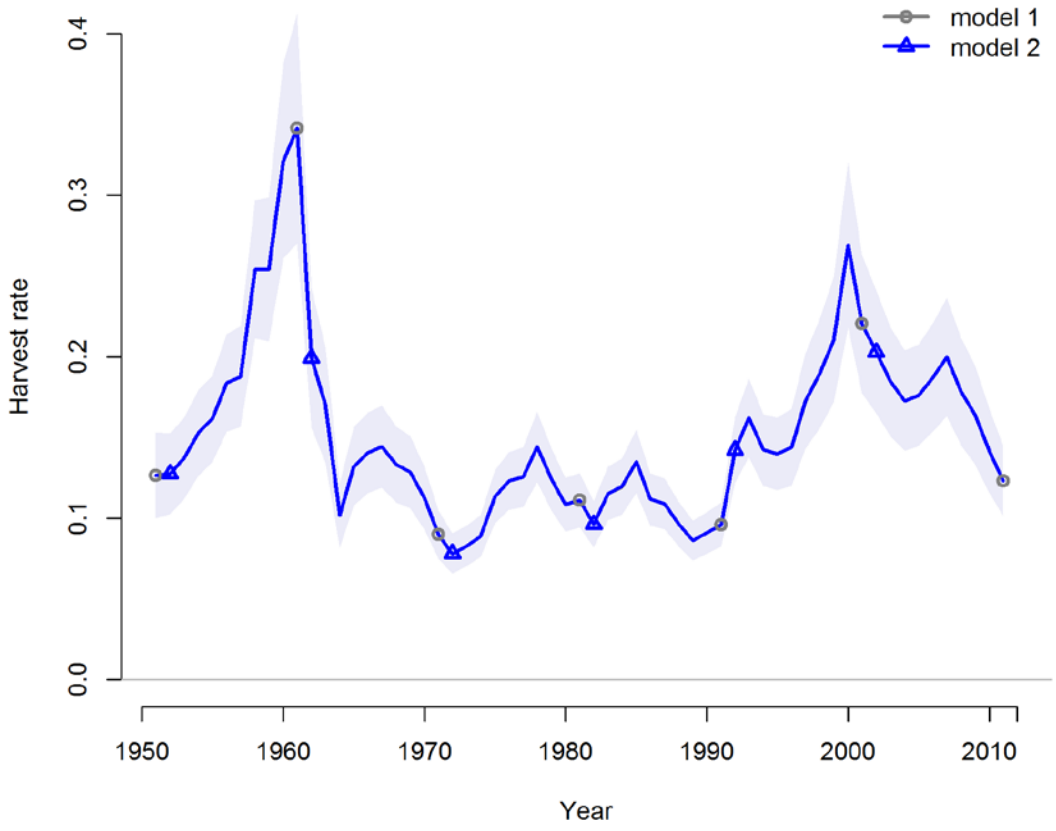


Figure 2. Harvest rate for each year with 95% confidence intervals estimated for the swordfish stock assessment using two different SS versions. Grey line and circles are results from the model run in SS3.30, grey shading is the uncertainty; blue lines and triangles are results from the model run in SS3.24, blue shading is the uncertainty. Grey and blue lines and shading overlap, grey and blue points are offset by a year for clarity.

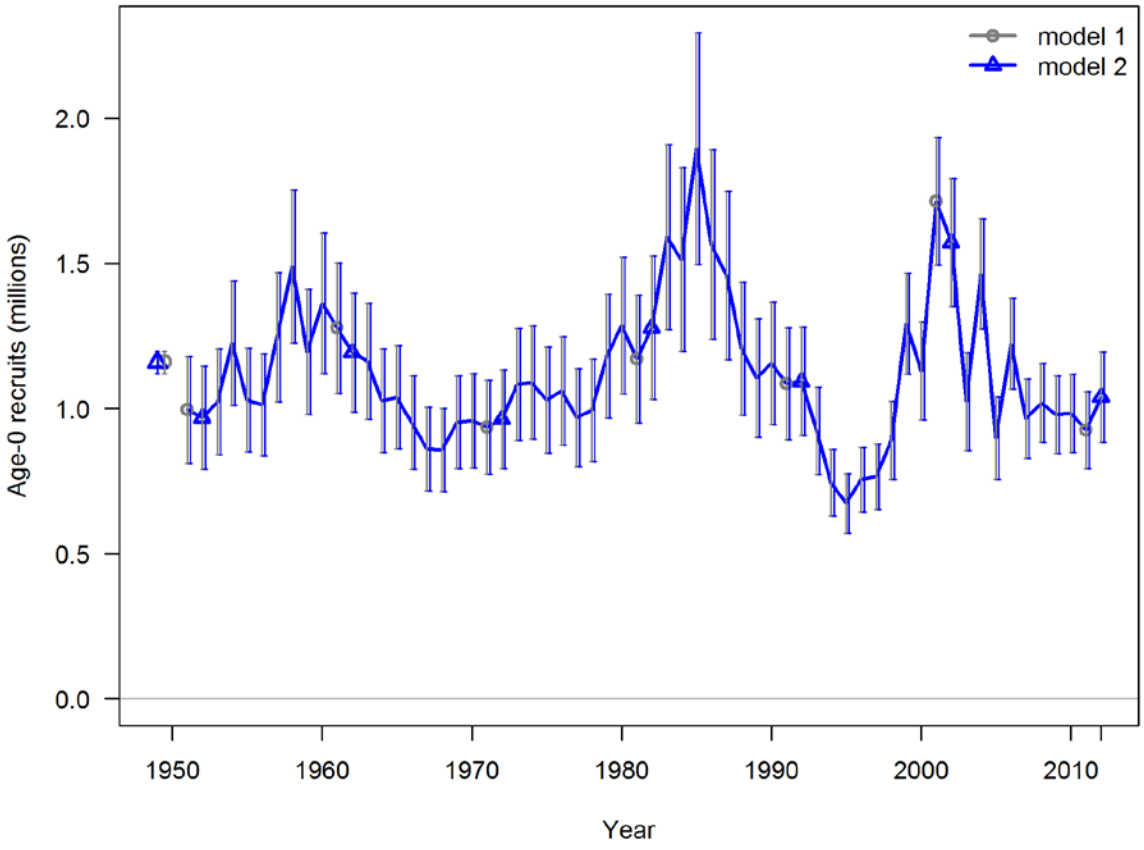


Figure 3. Recruitment deviations with 95% confidence intervals for each year estimated for the swordfish stock assessment in each of the two SS versions. Grey line and circles are results from the model run in SS3.30, blue lines and triangles are results from the model run in SS3.24f. Grey and blue lines overlap, points are jittered due to the overlap.

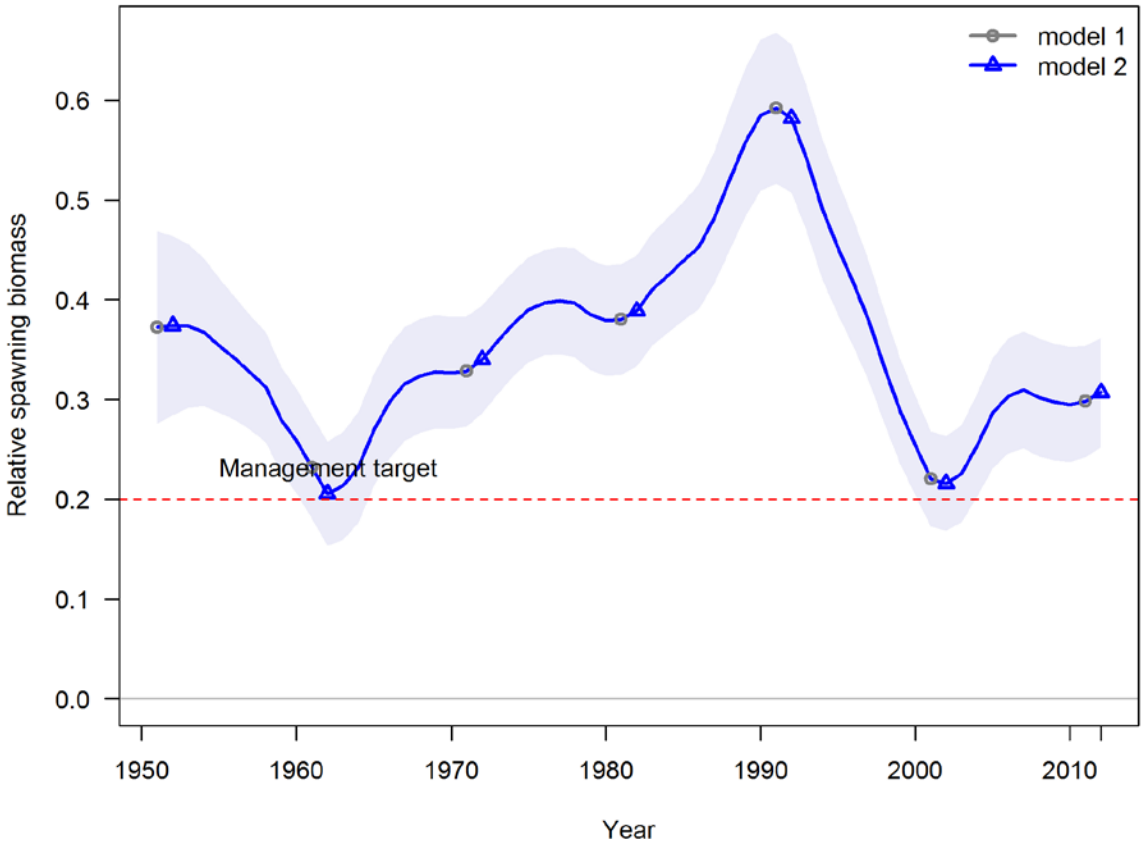


Figure 4. Relative spawning biomass by year with 95% confidence intervals for each year estimated for the swordfish stock assessment using two different SS versions. Grey line and circles are results from the model run in SS3.30, grey shading is the uncertainty; blue lines and triangles are results from the model run in SS3.24, blue shading is the uncertainty. Grey and blue lines and shading overlap, data points are plotted offset by one year.

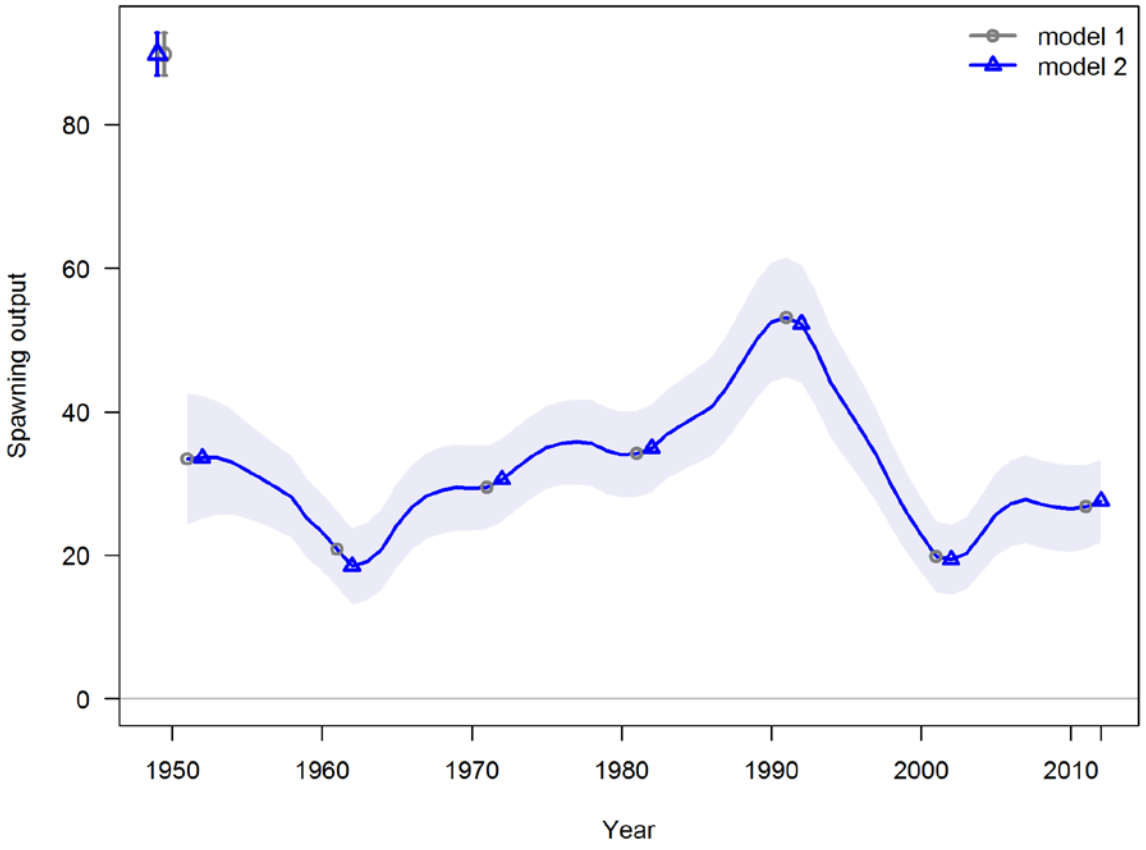


Figure 5. Spawning stock output by year with associated uncertainty for each year estimated for the swordfish stock assessment using two different SS versions. Grey line and circles are results from the model run in SS3.30, grey shading is the uncertainty; blue lines and triangles are results from the model run in SS3.24, blue shading is the uncertainty. Grey and blue lines and shading overlap, data point are offset by one year. Points in the upper left corner are spawning output prior to the start of the model and their 95% confidence intervals for each model.

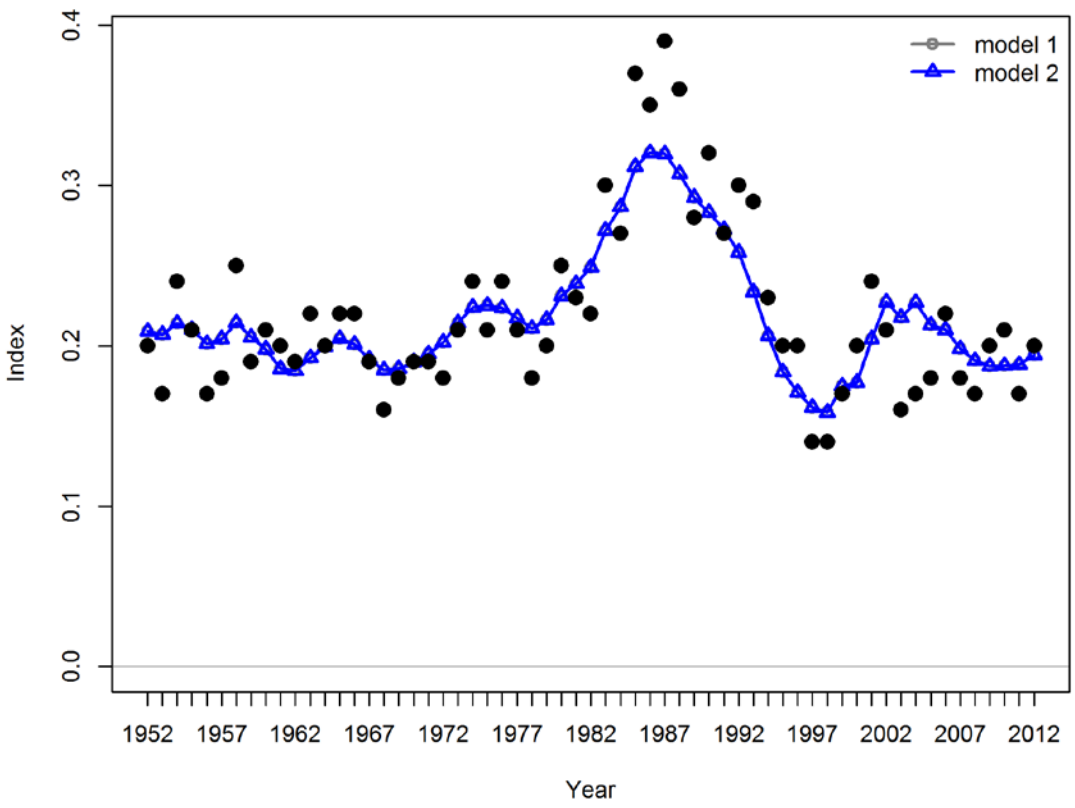


Figure 6. Overall fit to indices, normal scale. Black circles are standardized CPUE values. Grey line and circles are results from the model run in SS3.30, and blue lines and triangles are results from the model run in SS3.24. Grey and blue lines overlap.

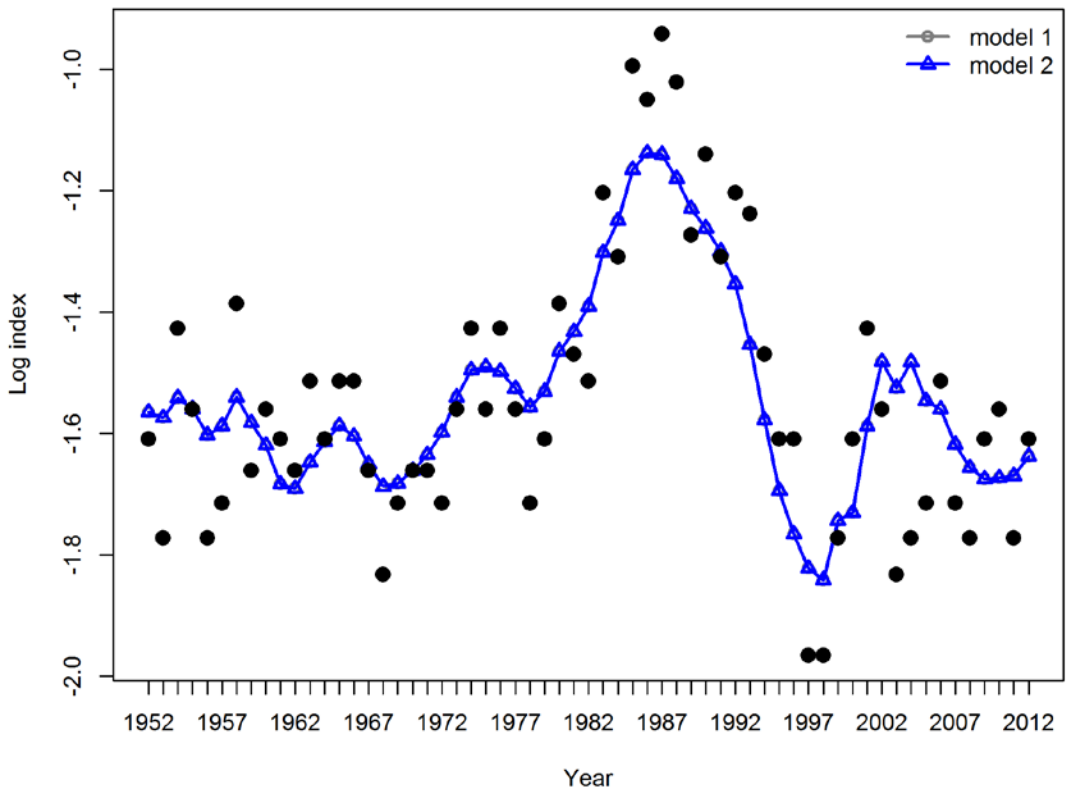


Figure 7. Overall fit to indices, in lognormal scale. Black circles are standardized CPUE values. Grey line and circles are results from the model run in SS3.30, blue lines and triangles are results from the model run in SS3.24. Grey and blue lines overlap.

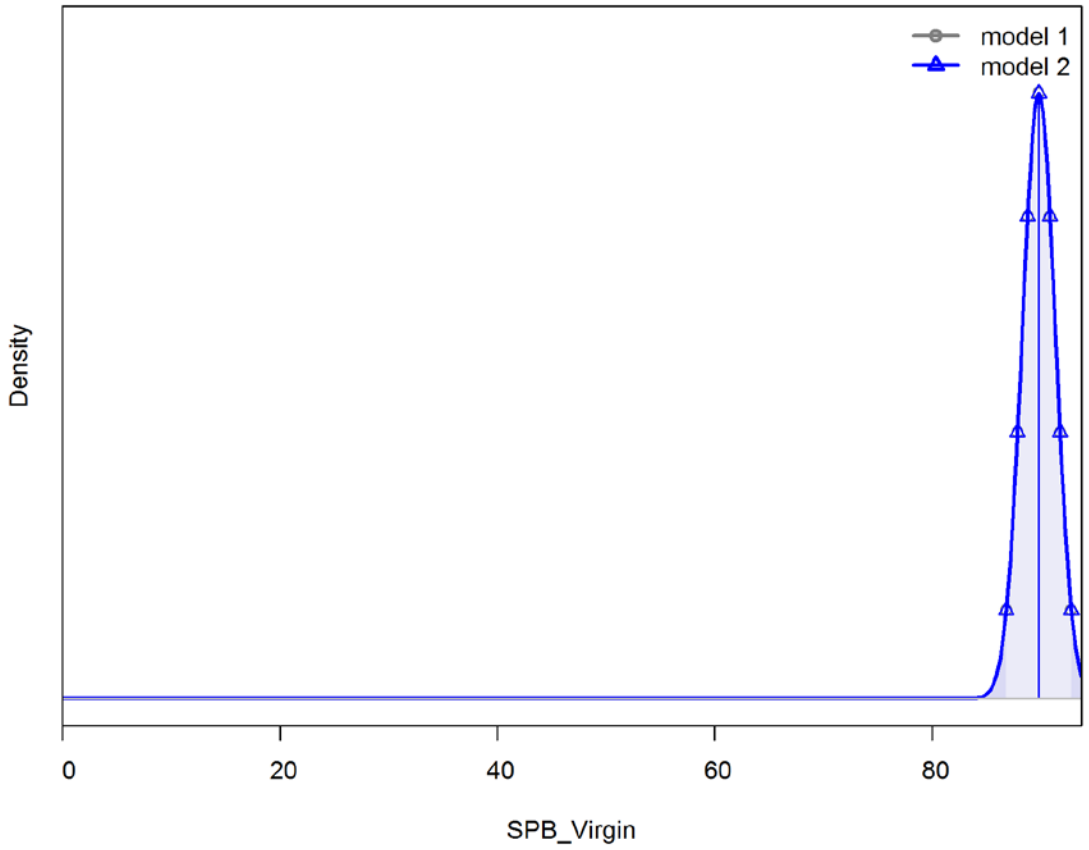


Figure 8. Posterior parameter estimate for virgin spawning biomass estimated by the swordfish stock assessment using two different SS versions. Grey line and circles are results from the model run in SS3.30; blue lines and triangles are results from the model run in SS3.24. Grey and blue lines overlap, tails outside of the 95% confidence interval are indicated by the darker shades of grey and blue.

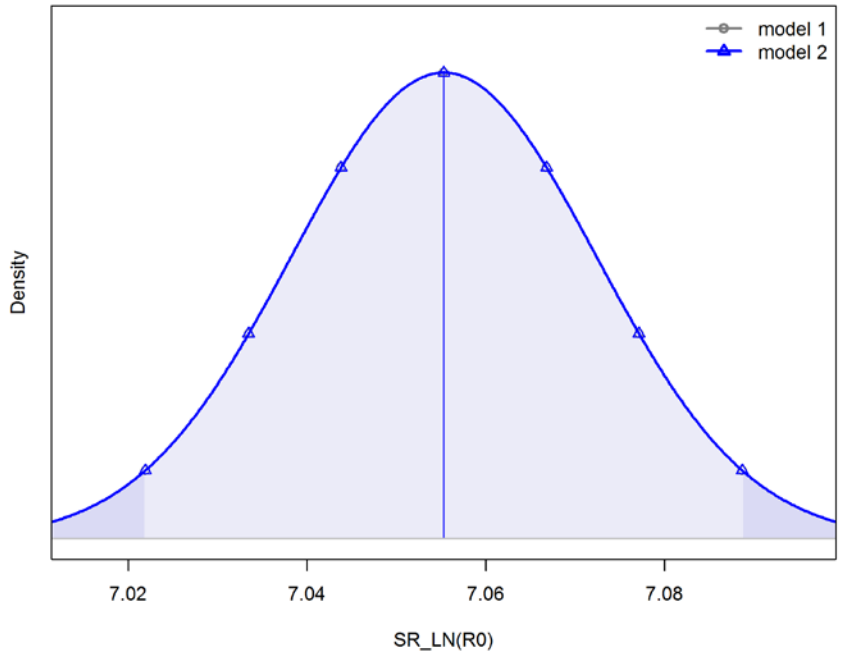


Figure 9. Posterior parameter estimate for the log of $R_0$ (virgin recruitment) estimated by the swordfish stock assessment using two different SS versions. Grey line and circles are results from the model run in SS3.30; blue lines and triangles are results from the model run in SS3.24. Grey and blue lines overlap, tails outside of the 95% confidence interval are indicated by the darker shades of grey and blue.