Some issues and questions regarding sardine model fits and associated Markov chains

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27 November 2025

Summary

A version of the sardine model was developed by OLSPS Marine using ADMB. The model is S_0 in FISHERIES/2025/SEP/SWG-PEL/49. The model is complex and there were some ambiguities in model specifications which may have affected the details of results produced here. The questions raised are however at a high level and perhaps unlikely to have been impacted by these details.

The main questions are how to address the following in the sardine MSE process: (1) apparently more than one local minimum with very similar values of nLLF, (2) from the inverse of the Hessian, some parameter estimates are highly correlated, (3) based on a sample of 60 from the Markov chain, the chain seems to have avoided the region of the mode of the posterior.

Local minima

Model fits were carried out using jittering. There were two different points in parameter space at which ADMB reported a positive definite Hessian based on separate jittering runs. These points are very close to each other in nLLF terms: A: -897.192 and B: -897.269. The parameter values also seem quite close to each other and are compared in Figure 1. In percentage terms some of the parameters are however quite different.

Correlations between parameter estimates

The inverse of the positive definite Hessian for local minimum B shows a small number of perfect or near perfect correlations, as well as a larger number of correlations larger than 0.6 or less than -0.6. These are presented in Table 1. 54 parameters (out of a total parameter count of 319) are involved in correlations of less than -0.6 or larger than 0.6. The almost perfect correlations suggest that 6 parameters are confounded in some way and cannot be uniquely determined. One of each of the pair of parameters involved in these correlations have been highlighted in yellow in the correlation matrices in Table 1.

Comment: Many of the parameters which are strongly correlated based on the Hessian are also those that show the largest differences in percentage terms between the two apparent local minima A and B.

MCMC Results

For local minimum B, the mean 1984 to 2023 recruitment values for CTS, and WTS excluding 2000, 2001 and 2002, are 10.14 and 42.82 billion respectively (de Moor pers. comm. Oct 2025 - 11.46 and 38.09 billion respectively). The 60 elements from the Markov chain reported in FISHERIES/2025/OCT/SWG-PEL/56 (based

on a reading of values from Figures 3a and 3b of FISHERIES/2025/OCT/SWG-PEL/56) have a mean recruitment for CTS and WTS of 27.96 and 97.91 billion respectively (1984 to 2023, excluding for WTS only 2000, 2001 and 2002).

The MCMC seems (see Figure 2) to have avoided the region of the mode of the posterior distribution. This area may of course not contain much probability so this outcome may not be problematic for the use of the Markov chain in MSEs. It is also possible that the extract of 60 elements of the Markov chain, made for illustrative purposes only in FISHERIES/2025/OCT/SWG-PEL/56, may not be a reliable characterisation of the full Markov chain. This could of course be checked by calculating mean recruitments over all elements of the Markov chain.

Table 1. A table of correlations between parameter estimates provided by ADMB. These have been filtered to show only those correlations larger than 0.6 or smaller than -0.6. The orange highlighted correlations are either 1 or very close to 1. Ry_CTS and Ry_WTS are recruitment estimates. pS is the proportion of WTS recruitment which recruit to the West Coast. moveSVwts is the proportion of WTS which moves from the West Coast to the South Coast in the middle of the 3rd quarter. t0Ss_ and t0Sw_ are growth rate parameters for the South and West Coast respectively (age at which the length is zero). lnkSac is the logarithm of the multiplicative bias associated with the hydro-acoustic survey. LS1diffsMw and kappaSw are growth rate parameters. S50Ssur is the length at which survey selectivity is 50%. deltaSsur is the inverse of the slope of survey selectivity-at-length ogive when selectivity is 50%. The upper matrix contains the large negative correlations < -0.6, and the lower matric contains the large positive correlations >0.6

		Ry_CTS													Ry_WTS				t0Ss_
		1984	1990	1991	1995	1996	1997	1998	2006	2007	2011	2022	2023	2024	1984	1991	2000	2014	
Ry_WTS	1984	-0.81																	
	1990		-0.89																
	1991			-0.79															
	1996					-0.64													
	1997						-0.68												
	2006								-0.68										
	2007									-0.80									
	2011										-0.66								
	2022											-0.81							
	2023												-0.99						
	2024													-1.00					
pS	1995				-0.87														
	1998							-0.86											
	2007									-0.70									
	2014																	-0.61	
	2023												-0.99						
	2024													-1.00					
	LS1diffsMw_																		-0.78
	lnkSac_																-0.60		
	moveSVwts_1985														-0.73				
	moveSVwts_1992														-0.78				

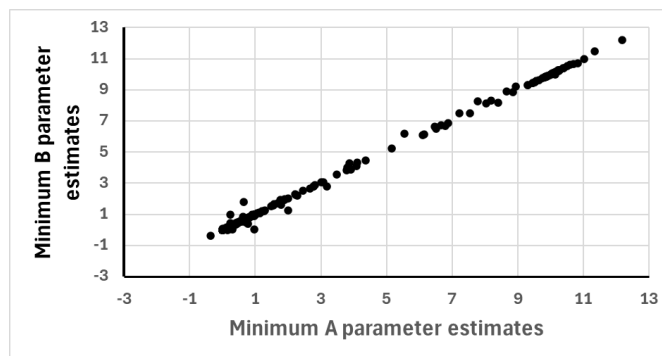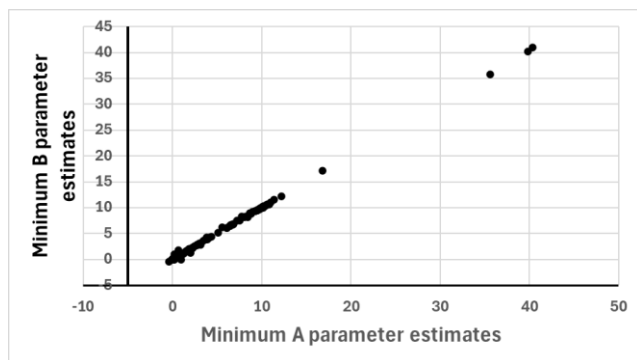|		Ry_CTS				Ry_WTS								t0Sw	S50Ssur
		1984	1991	2006	2022	1987	1993	1994	1997	2017	2020	2023	2024		
pS	1987					0.96									
	1993						0.96								
	1994							0.72							
	1997								0.66						
	2020										0.84				
	2023											0.98			
	2024												1.00		
	kappaSw													0.73	
	deltaSsur														0.63
moveSVwts	1985	0.97													
	1992		0.70												
	2007			0.68											
	2018									0.61					
	2023				0.70										

Figure 1. LH – parameter estimates for Minimum A on the x-axis, vs parameter estimates for Minimum B on the y-axis, all values. RH – only parameters estimates with a value less than 13 are shown to focus on the lower left portion of the LH panel.
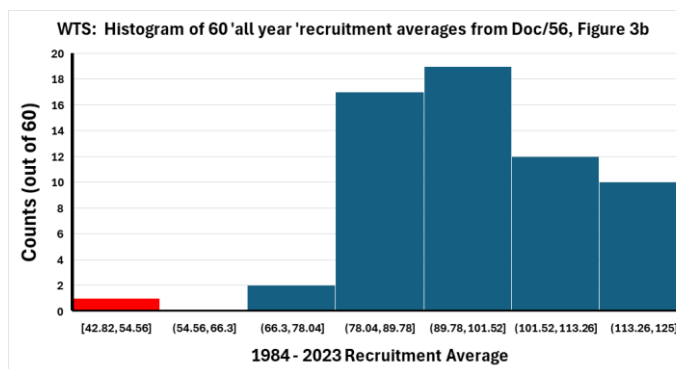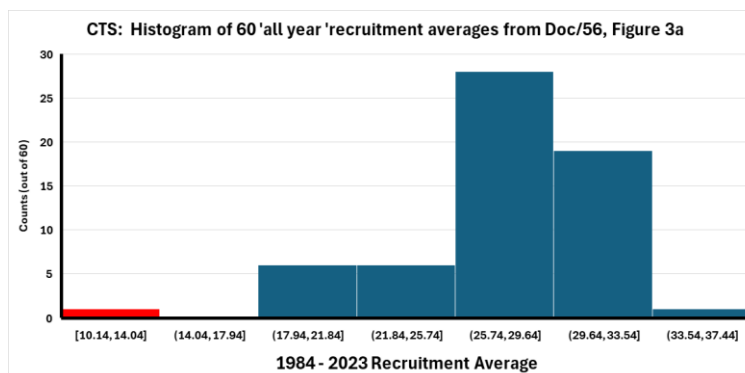

Figure 2. Histograms of the 1984 – 2023 recruitment average estimates for the 60 Markov chain results reported in FISHERIES/2025/OCT/SWG-PEL/56, in blue. The red bar indicates the single value for minimum B, although for this histogram bar that value is the lower bound of the bar value, so the plotting limitations understate the discrepancy between the Markov chains and the best fitted value.