Ricker spawner-recruitment model fits for Harrison and Cowichan chinook salmon populations

Catarina Wor

May 1, 2023

Contents

1 Background

The goal of this document is to examine spawner-recruitment dynamics for Harrison and Cowichan Chinook Salmon populations. We fit a various forms of the Ricker curve in order to examine potential parameter trajectories for the alpha and beta parameters.

2 Models

We considered a set of eight estimation models that represent alternative forms of either time-invariant or time-varying stock-recruitment dynamics. All these models are based on the Ricker spawner-recruitment curve and include: stationary versions with and without auto-correlation in residuals, three versions with time-varying parameters described bya random walk (RWa, RWb, RWab). and three versions of regime shift models described by a hidden markov structure (Shift a, Shift b and Shift ab). For the purpose of this

summary we ommit further description of the methods, but more details, including the R package used and detailed methods write-up are available upon request.

We present results from model selection criteria for completeness. However, our preliminary research finds indicate that commonly used model selection criteria are often mislead in selecting the true underlying dynamics of the resource. We found that AIC and BIC tend to favour time-varying dyamics. Whereas cross-valiation methods, such as leave-future-out (LFO) tend to favour stationary model.

3   Results

3.1   Harrison

Model predictions are in Figure 1 and parameter trajectories are in Figure 2. Model selection criteria are shown in Table 3.1.
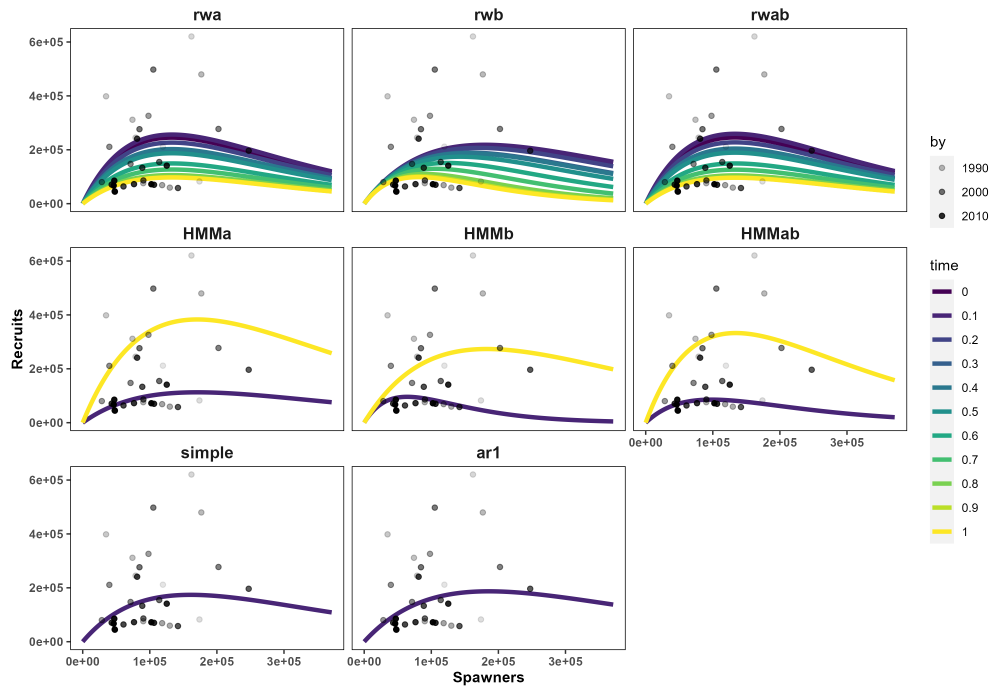

Figure 1: Model predictions. Top row indicate random walk models. Middle row regime shift models and bottom row conatin the stationary models with and withour autocorrelated residuals.
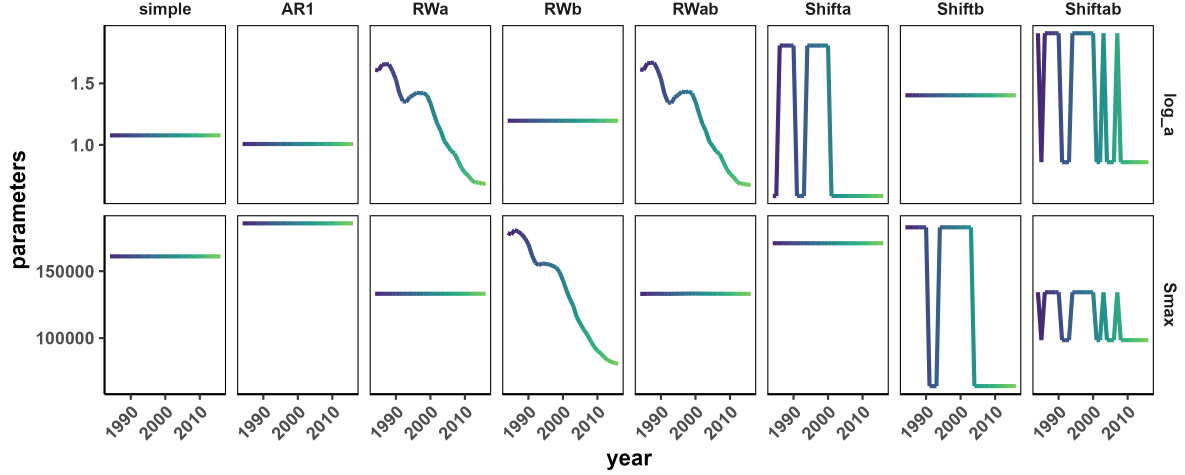
Figure 2: Parameter trajectories for stationary and time varying models considered for Harrison Chinook.

Table 1: Parameter trajectories for stationary and time varying models considered for Harrison Chinook. Minimum AIC and BIC value indicate preferred model, while maximum LFO indicate preferred model. Missing values indicate lack of model convergence

	model	AIC	BIC	LFO
1	simple	11.14	10.24	-20.56
2	AR1	11.05	11.05	**-19.44**
3	RW a	**0**	**0**	-
4	RW b	7.06	7.06	-
5	RW a and b	-	-	-
6	Shift a	9.43	10.87	-31.21
7	Shift b	19.41	20.85	-38.91
8	Shift a and b	14.35	15.77	-42.72

Suggestions of scenarios to be explored for the Harrison stocks in closed-loop simulations:

- AR 1 stationary model.

- RW a declining trajectory.

- RW b declining trajectory (would it be possible?) - could be very interesting "what if?" scenario, even if less biologically plausible.

3.2 Cowichan

Model predictions are in Figure 3 and parameter trajectories are in Figure 4. Model selection criteria are shown in Table 3.2.
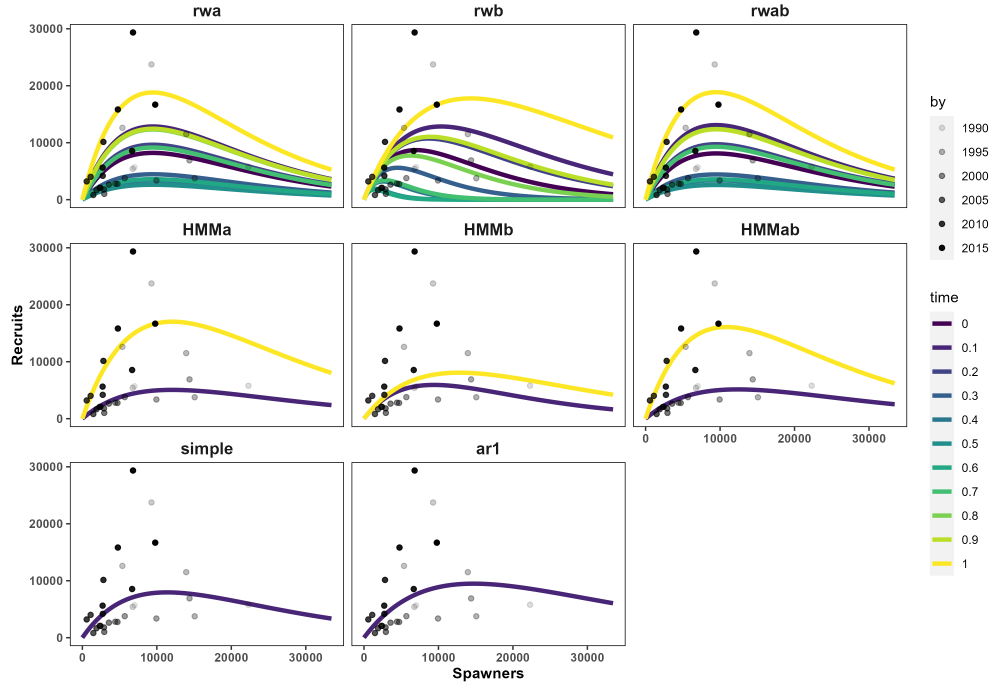
Figure 3: Model predictions. Top row indicate random walk models. Middle row regime shift models and bottom row conatin the stationary models with and withour autocorrelated residuals.
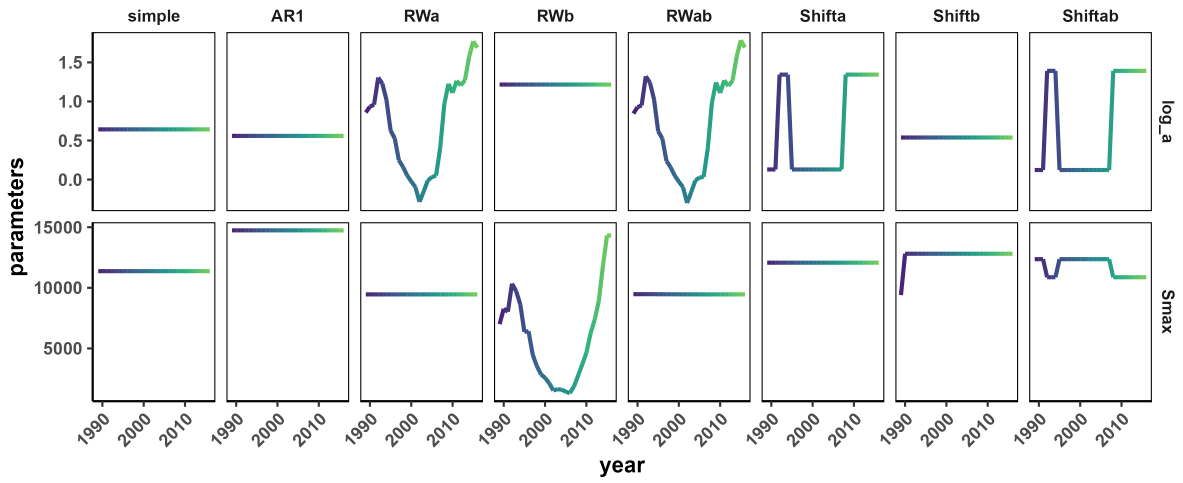

Figure 4: Parameter trajectories for stationary and time varying models considered for Cowichan Chinook.

4

Table 2: Parameter trajectories for stationary and time varying models considered for Cowichan Chinook. Minimum AIC and BIC value indicate preferred model, while maximum LFO indicate preferred model. Missing values indicate lack of model convergence

	model	AIC	BIC	LFO
1	simple	43.74	43.15	-
2	AR1	36.44	36.44	-
3	RW a	**0**	**0**	-21.13
4	RW b	6.37	6.37	-18.07
5	RW a and b	1.5	1.84	**-17.44**
6	Shift a	35.64	35.78	-
7	Shift b	-	-	-20.08
8	Shift a and b	39.33	38.82	-22.56

Suggestions of scenarios to be explored for the Cowichan stocks in closed-loop simulations:

- stationary model.

- Shift a trajectory.

- RW b declining trajectory (?).