Agenda Item D.3.a
SRWCW Report 1
November 2017

Further evaluation of Sacramento River winter Chinook control rules: addendum to Ad Hoc SRWC Workgroup (2017)

The Ad Hoc Sacramento River Winter Chinook Workgroup

October 18, 2017

1 Introduction

At the September 2017 Pacific Fishery Management Council (Council) meeting in Boise, ID, the Ad Hoc Sacramento River Winter Chinook Workgroup (Workgroup) presented an evaluation of nine alternative Sacramento River winter Chinook (SRWC) control rules to the Council and relevant advisory bodies (Ad Hoc SRWC Workgroup, 2017). Guidance was given by the Council to further consider three of the original set of nine control rules (control rules 4, 5, and 7) and a new control rule (control rule 10) which represents a blend of existing control rule shapes. Furthermore, the Council instructed the Workgroup to evaluate these control rules using the median of the abundance forecast distribution for management strategy evaluation (MSE) simulations[1]. This report is an addendum to Ad Hoc SRWC Workgroup (2017) that addresses the Council guidance.

Figure 1 displays the control rules considered here. The MSE methods used to evaluate those control rules were described in O'Farrell (2017a); Ad Hoc SRWC Workgroup (2017); O'Farrell (2017b); O'Farrell et al. (2016) and previously in Winship et al. (2012, 2013). The MSE results presented for control rules 4, 5, and 7 are identical to those previously presented in Ad Hoc SRWC Workgroup (2017) while results for control rule 10 have been developed since the September 2017

[1] `https://www.pcouncil.org/wp-content/uploads/2017/09/0917decisions.pdf`

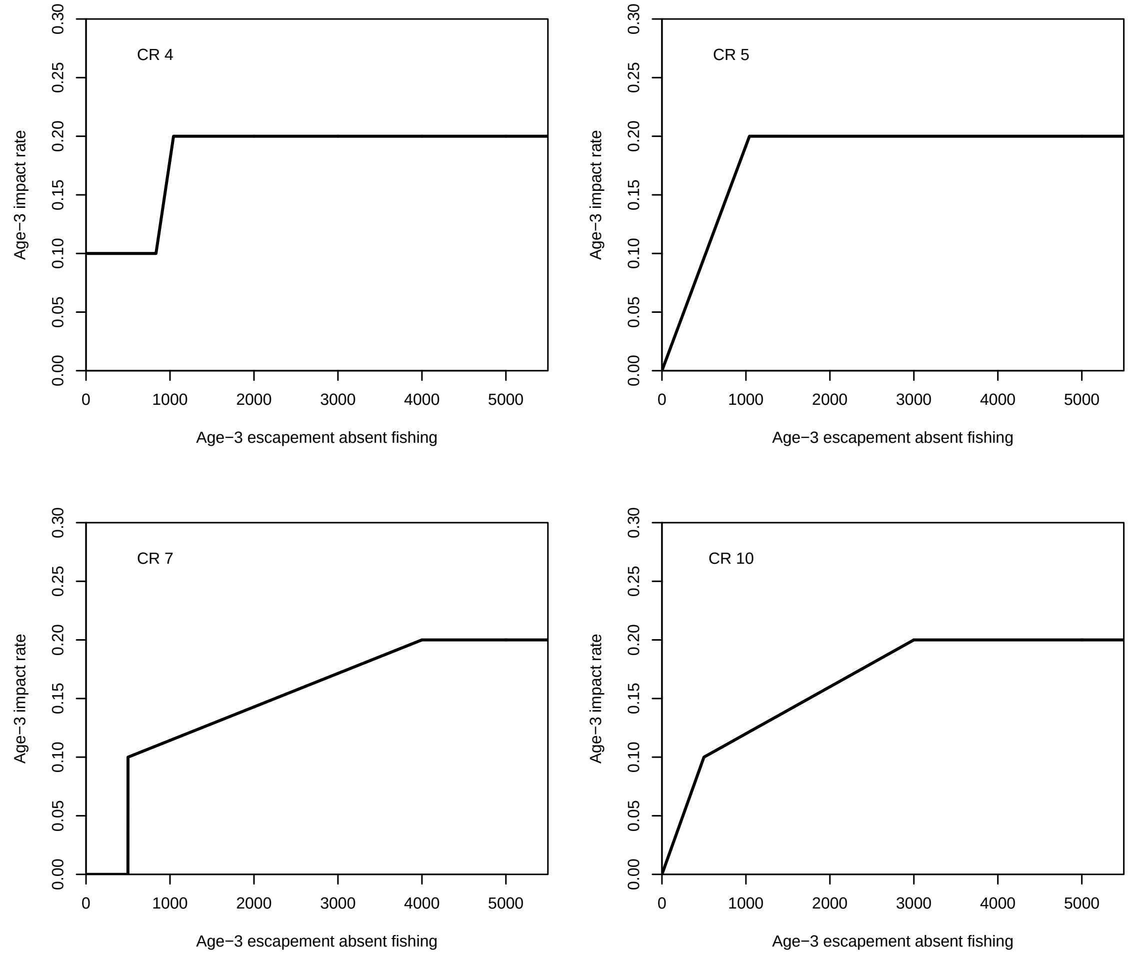

Figure 1. Sacramento River winter Chinook control rules selected for further evaluation.

Council meeting. Each of the control rules specify an allowable age-3 impact rate as a function of the forecasted age-3 escapement in the absence of fisheries (E_3^0; O'Farrell et al., 2016). The median of the E_3^0 forecast distribution was used as the input variable to the control rules for all MSE simulations. The performance of each control rule was assessed with regard to the SRWC population and costs to ocean fisheries in the same manner as Ad Hoc SRWC Workgroup (2017).

2 Results

Under the Base scenario, the mean number of spawners varied little between the control rules (Figure 2). This same pattern was observed for each of the alternative scenarios (Autocorrelation,

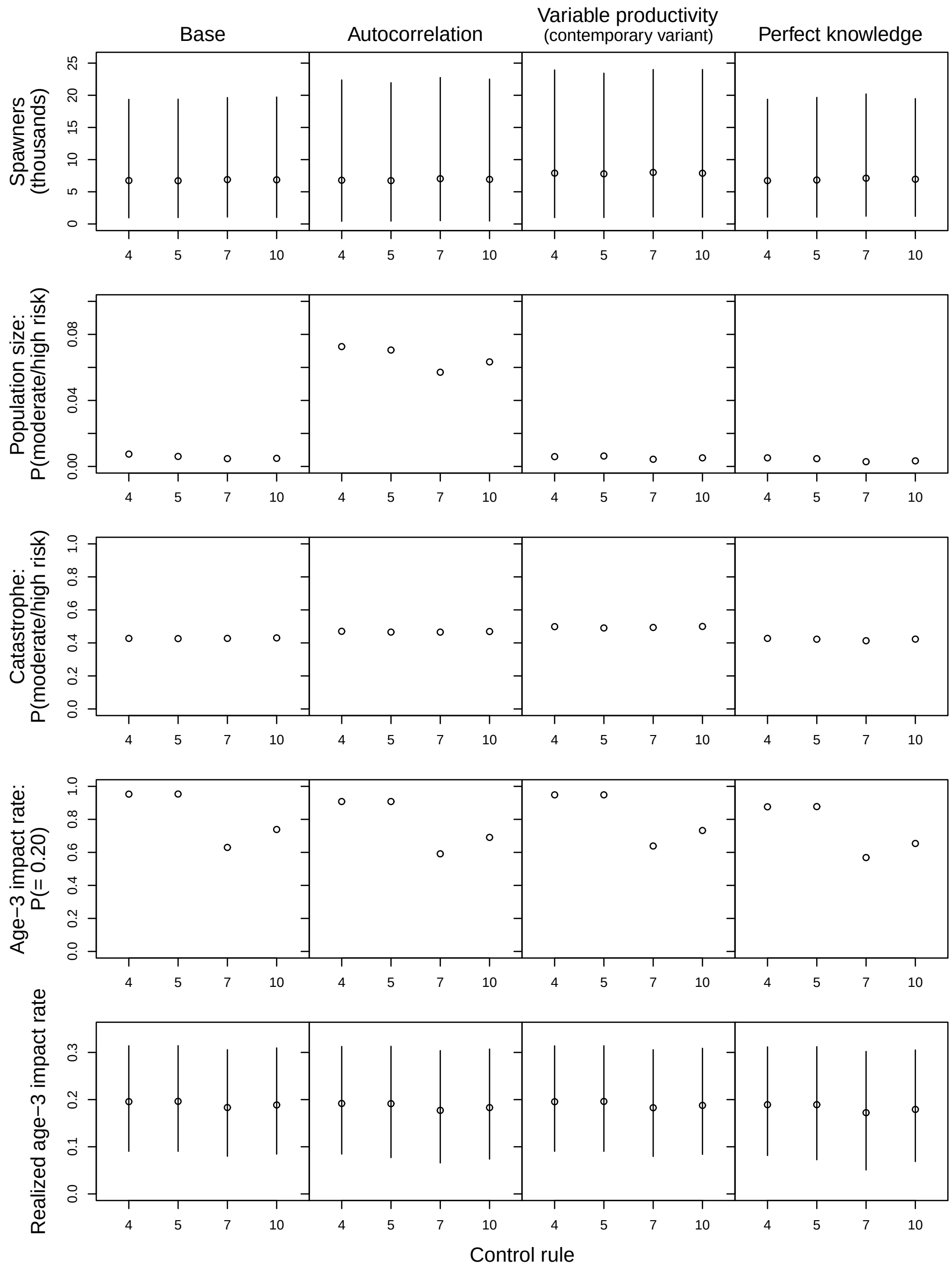

Figure 2. Performance measures evaluated for each of the control rules and alternative scenarios. For "Spawners" and "Realized age-3 impact rate" the circles represent mean values and vertical lines denote the 95 percent intervals of the distribution. Circles for the other performance measures denote point estimates. The "Age-3 impact rate" performance measure denotes the allowable impact rate specified by the control rule. The "Realized age-3 impact rate" is the rate experienced by the population after accounting for implementation error.

Variable productivity, and Perfect knowledge). With regard to extinction risk for the population size criterion, the majority of simulations resulted in a low risk of extinction. Under the Autocorrelation scenario, the proportion of simulations with moderate or high risk of extinction was substantially higher than the Base case. There was visible contrast in extinction risk among the control rules for the Autocorrelation scenario, with control rules 4 and 5 having the highest risk, control rule 7 having the lowest risk, and control rule 10 having an intermediate level of risk. For the Variable productivity and Perfect knowledge scenarios the proportion of simulations resulting in moderate or high risks of extinction were very similar to the Base case and there was little contrast among the control rules. For the catastrophe criterion, there was very little difference in extinction risk between the control rules under each of the scenarios.

The proportion of simulations where the control rule specified impact rate equalled 0.20 varied substantially between control rules across all four scenarios (Figure 2). For control rules 4 and 5, impact rates were specified at the maximum level of 20 percent for a high proportion of the simulations. In contrast, impact rates were scaled back much more frequently for control rule 7, and to a lesser degree, control rule 10. This general pattern held across each of the four simulation scenarios. Mean realized impact rates were similar across control rules, though the highest mean impact rates were associated with control rules 4 and 5, the lowest with control rule 7, and intermediate values for control rule 10.

The effect of longer droughts, more frequent droughts, and more intense droughts was to increase extinction risk based on the population size criterion (Figure 3). There was some contrast between the control rules, where control rules 4 and 5 had the highest risk, control rule 7 had the lowest risk, and control rule 10 had an intermediate level of risk. Fisheries were most constrained under control rule 7 and least constrained under control rules 4 and 5. For control rule 10, fisheries were constrained to a lesser degree than control rule 7.

Distributions of the minimum number of spawners differed little among the control rules, particularly under the Base, Autocorrelation, and Variable productivity scenarios (Figure 4). However, minimum spawner distributions for control rules 7 and 10 suggested slightly higher values relative

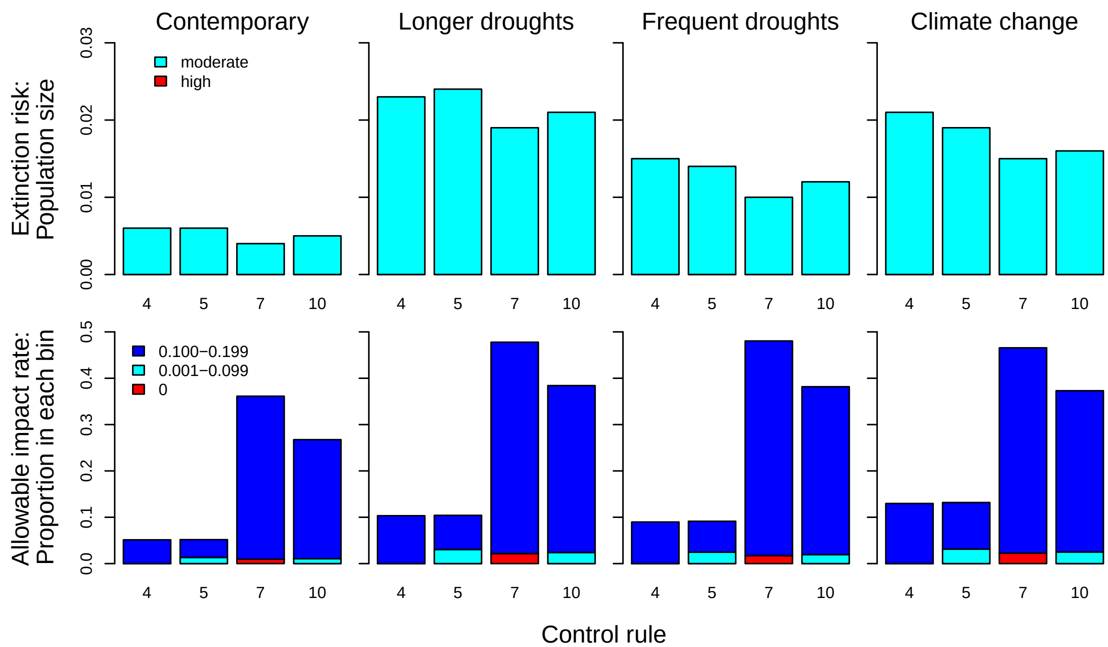

Figure 3. Proportion of simulations resulting in a moderate or high risk of extinction for the population size criterion (top panel) and allowable age-3 impact rates (bottom panel) for the four variants of the Variable productivity scenario.

to control rules 4 and 5. There were larger differences between the control rules when abundance was known without error.

If the simulated number of spawners fell to 100 fish or less, the resulting geometric mean of spawners computed over the following three years tended to be greater than 100 fish (Figure 5). A coherent pattern among the control rules in the response to crossing a low spawner threshold was not readily apparent. However, there were some substantial differences in the number of times spawner levels crossed the 100 fish threshold. The number of spawners fell below the threshold more frequently for control rules 4 and 5 relative to control rules 7 and 10. The threshold was crossed more for control rule 10 relative to control rule 7, except for the Perfect knowledge scenario, where the number of crossings was similar.

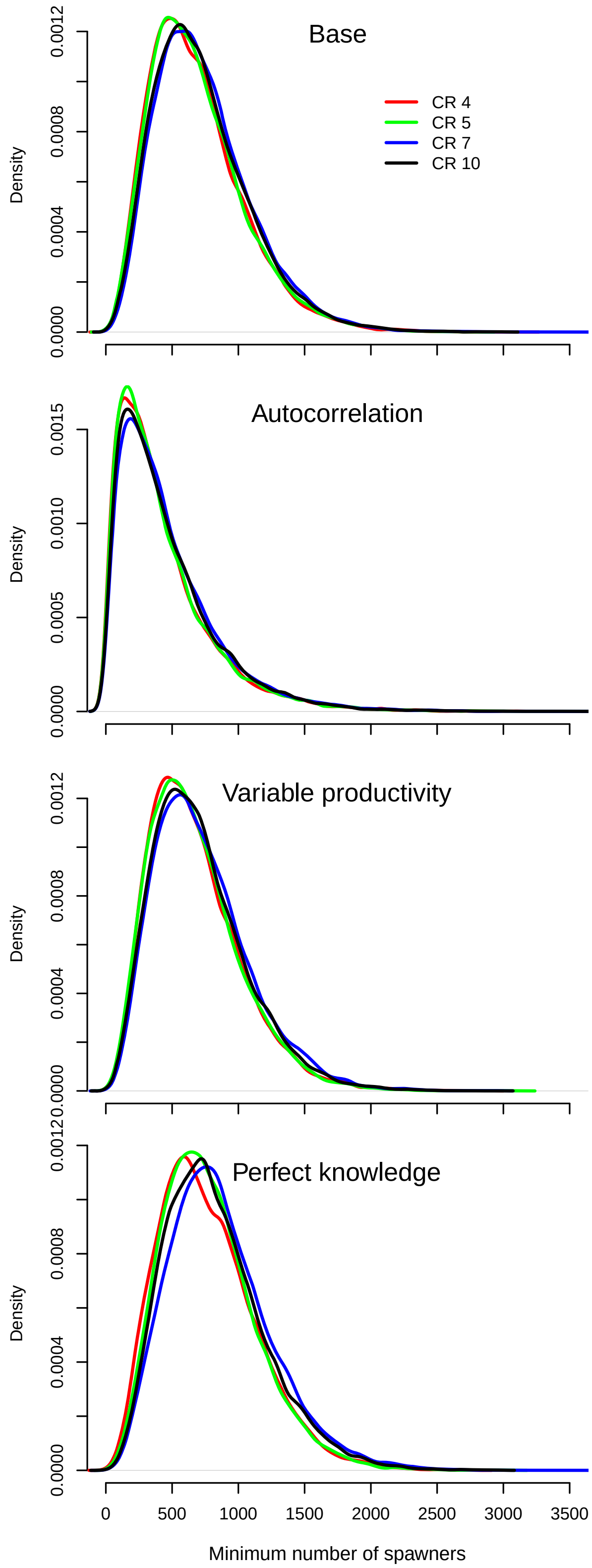

Figure 4. Distributions of the minimum number of spawners observed under each of the control rules and simulation scenarios.

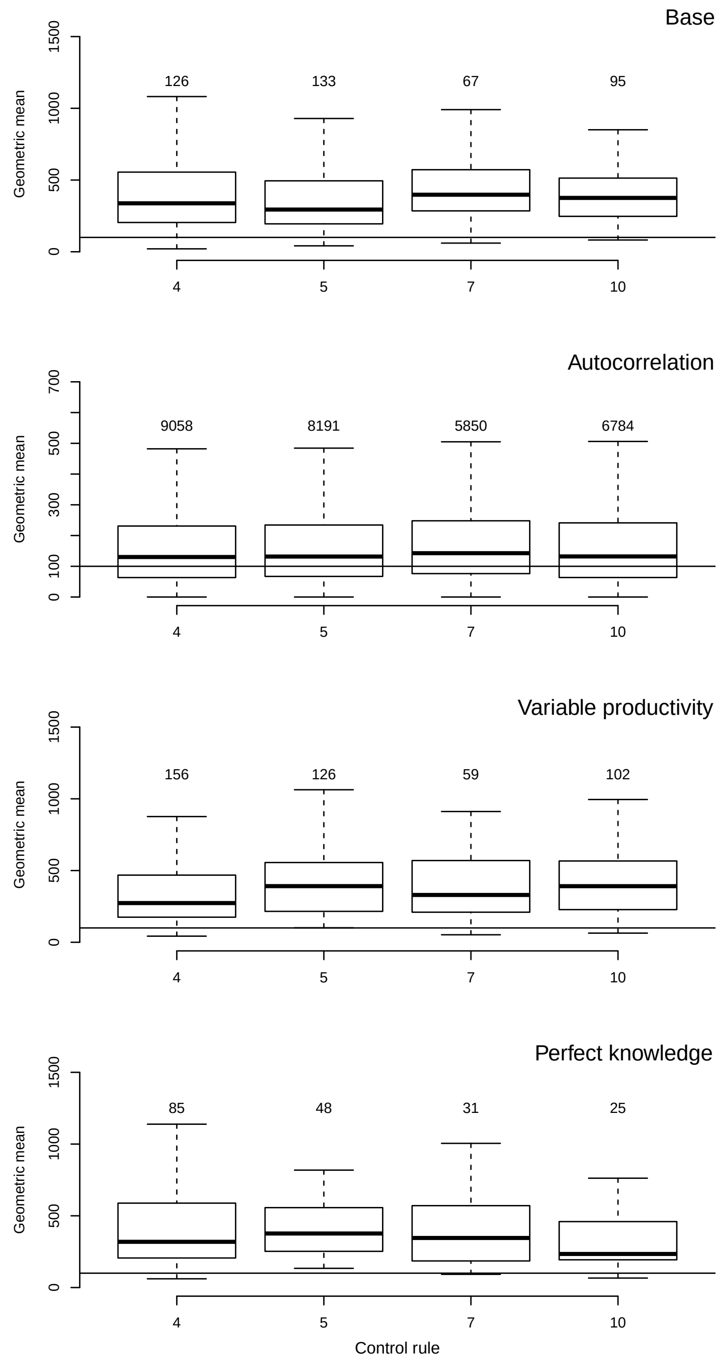

Figure 5. Boxplots summarizing the distribution of the geometric means of spawners computed over the three years following a simulated spawner level of ≤ 100 fish. Numbers above the boxplots denote the number of geometric means contributing to the boxplot (the number of instances when simulated escapement was ≤ 100 fish). Horizontal lines indicate the 100 fish threshold. Note differing y-axis scale for the Autocorrelation scenario.

3 Discussion

This addendum presents previous MSE results for control rules 4, 5, and 7, as well as new results for control rule 10. It is perhaps useful to note that each of these control rules results in substantially higher levels of mean spawner abundance and lower extinction risks for the population size criterion relative to historical levels of fishing (previous control rule 2). Furthermore, relative to simulations assuming no fishing (previous control rule 1), the control rules evaluated here result in lower mean spawner levels and higher extinction risks under the populations size criterion. Thus, the scale of several plots in this addendum differs from similar plots in Ad Hoc SRWC Workgroup (2017).

Simulation results for control rule 10 were generally intermediate between those for control rules 4 and 5 (which were very similar to each other) and control rule 7. This was true for the performance measures associated with the SRWC population (e.g., spawner abundance and extinction risk) as well as performance measures associated with the fishery (e.g., the frequency and magnitude of impact rate reductions). This same general ordering among the control rules with respect to the risk criteria and fishery performance measures was observed in all of the alternative simulation scenarios, with control rule 10 being intermediary to control rules 4 and 5 versus control rule 7.

References

Ad Hoc SRWC Workgroup (2017). Evaluation of Sacramento River winter Chinook salmon control rules: updated Managment Strategy Evaluation analysis. Report prepared by the Ad Hoc Sacramento River Winter Chinook Workgroup for the Pacific Fishery Managment Council and advisory bodies. https://www.pcouncil.org/wp-content/uploads/2017/08/F2a_SRWCW_Rpt1_SEPT2017BB.pdf.

O'Farrell, M., N. Hendrix, and M. Mohr (2016). An evaluation of preseason abundance forecasts for Sacramento River winter Chinook salmon. Report prepared for the 2016 PFMC Salmon Methodology Review. https://www.pcouncil.org/wp-content/uploads/2016/10/D2_Att1_SRWC_forecast_rev_doc_Oct032016_NOV2016BB.pdf.

O'Farrell, M. R. (2017a). MSE methods supplementary material. Report prepared for the Council and advisory bodies. https://www.pcouncil.org/wp-content/uploads/2017/03/E1a_SRWCW_Rpt2_MSE_MethodsAPR2017BB.pdf.

O'Farrell, M. R. (2017b). Preliminary evaluation of alternative Sacramento River winter Chinook salmon control rules. Report prepared for the Council and advisory bodies. https://www.pcouncil.org/wp-content/uploads/2017/03/E1a_SRWCW_Rpt1_prelim_MSE_APR2017BB.pdf.

Winship, A. J., M. R. O'Farrell, and M. S. Mohr (2012). Management Strategy Evaluation for Sacramento River winter Chinook salmon. Report to the Southwest Region, NMFS.

Winship, A. J., M. R. O'Farrell, and M. S. Mohr (2013). Management strategy evaluation applied to the conservation of an endangered population subject to incidental take. *Biological Conservation 158*, 155–166. http://dx.doi.org/10.1016/j.biocon.2012.08.031.