**Retrospective Summary**

We examined temporal changes in Fraser River sockeye salmon productivity (log(R/S)) using three metrics of metapopulation variability: 1) the mean coefficient of variation of the components within in aggregate (CVC), 2) the synchrony index (), which reflects the degree of similarity in the dynamics of an aggregate’s components, and 3) aggregate variability (CVA) which represents the cumulative effects of CVc and on temporal variability. We used 10-year moving windows to calculate trends in each metric for two Fraser River datasets. The first contained 11 CUs with time series of productivity extending to 1948, the second contained 18 CUs with time series extending to 1973.

Mean Fraser River sockeye salmon productivity declined from the late 1980s to approximately 2005, the brood year coinciding with low returns in 2009. Subsequently the aggregate exhibited several years of higher productivity, but the trend remains variable with productivity declining again in the 2011 brood year (Fig. 2a). Mean CVC (i.e. the temporal variability of the “average” CU’s productivity) was relatively stable for most of the time series before showing an increase in the 1990s that steepened over several years (Fig. 2b). Productivity was highly synchronized in the first decade of the time series, followed by a variable, but generally asynchronous period. In the early 2000s, approximately when CVC reached unusually high levels, synchrony increased again (Fig. 2c). Changes in CVA mirror these patterns, showing a dramatic increase in the early 2000s (Fig. 2d).

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Figure 1. Temporal variation in Fraser River sockeye salmon productivity, log(recruits/spawner). (a) Trends in observed productivity for 18 CUs with time series beginning between 1948 and 1973; heavy black line represents the unweighted mean. 10-year moving windows of (b) the mean component coefficient of variation, weighted by abundance, (c) the synchrony index, and (d) the coefficient of variation of the aggregate. Solid blacks lines represent trends for 11 CUs with time series extending back to 1948, light red lines represent trends for 18 CUs beginning in 1973.

**Forward-Sim Summary**

*Model specification*

The closed-loop model forward simulates, with stochasticity, the dynamics of 19 Fraser River CUs. For CUs with evidence of cyclicity (based on the most recent WSP report), recruits are generated using a Larkin model; all other CUs use a Ricker model with autocorrelated process variance (correlation coefficient fixed at 0.2). To parameterize each CU’s stock-recruit relationship we used median estimates of , , and generated by FRSSI.

Within the model yearly recruitment deviations are drawn from a multivariate normal distribution with mean 0 and standard deviation described by the variance-covariance matrix

Where represents the variance for CUs *i* through *j* and the correlation among variance parameters.

To create operating models representing various CVC and scenarios (low, moderate, high) we manipulated

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Figure 2. Trends in mean component CV of productivity simulated with low, reference or high values of . Black line represents observed trend and vertical dotted line the beginning of the simulation period. Colored lines represent median values across 1000 trials.

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Figure 3. Trends in synchrony of productivity simulated with low, reference or high values of . Black line represents observed trend and vertical dotted line the beginning of the simulation period. Colored lines represent median values across 1000 trials.

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Figure 4. Status of the Fraser River aggregate relative to three abundance-based performance metrics at the end of 60-year simulation period. Points represent the median value of the performance metric during the simulation, then the median among 1000 trials with whiskers representing 90% posterior intervals.

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Figure 5. Status of the Fraser River aggregate relative to four benchmark-based performance metrics at the end of 60-year simulation period. CU proportions reflect status at the end of the 60 year simulation period. Points represent medians across 1000 trials and whiskers 90% posterior intervals.