*TAM Rule Explainer*

Fraser River sockeye salmon are managed using a harvest control rule that adjusts total allowable catch (TAC) based on two fishery reference points (FRP). Both TACs and FRPs are defined at the management unit (MU) level (i.e. aggregates of conservation units) because MUs exhibit relatively consistent differences in migration timing that moderate their exposure to commercial marine fisheries. The overarching framework for this harvest control rule is referred to as a Total Allowable Mortality (TAM) rule because TAC (which is proportional to mortality due to fishing) is adjusted based on environmental conditions. Specifically, in-season estimates of recruit abundance are adjusted downwards to account for mortality that occurs in-river during migration to spawning grounds. This management adjustment is set as a proportion of the escapement target (referred to as a pMA) and attempts to ensure that a sufficiently large number of spawners are allowed to “escape” the fishery to reach spawning grounds, even if considerable en route mortality occurs.

The abundance estimates necessary to generate TACs are provided by test fisheries conducted at regular intervals as adult salmon migrate into nearshore areas (i.e. Johnston and Juan de Fuca straits). These test fisheries also are used to generate, estimates of abundance and migration timing. Total abundance is disaggregated into MU-specific abundance using genetic stock identification techniques (Beacham et al. 2005).

The Fraser River Panel of the Pacific Salmon Commission meets regularly to set TAC based on updated estimates of each MU’s abundance:

1. If a given MU is below its lower FRP the TAC is calculated using a minimum exploitation rate (0.05 or 0.10 depending on MU). These moderate values are used instead of closing the fishery entirely to incorporate mortality due to test fishing and bycatch in mixed stock fisheries (even though MUs differ in run timing, substantial overlap persists).
2. If a MU is between its lower and upper FRP, a constant escapement harvest strategy is used to calculate TAC. The escapement target is the lower FRP, adjusted upwards based on estimates of en route mortality. For example, if the FRP is 10,000 individuals and the pMA is 0.5 that year reflecting high levels of loss en route, the TAC will be calculated to allow 15,000 spawners to escape the mixed stock fishery. The exception to this rule being the target exploitation rate must be at least the minimum noted above and cannot exceed 0.6.
3. If a MU is above its upper FRP (after incorporating the pMA), the TAC is calculated using a target exploitation rate of 0.6.

Given that estimates of in-season abundance are updated throughout the migration period, multiple in-season TACs are produced for each MU and each year. Therefore when parameterizing forecast uncertainty, we compared the final in-season run size estimate generated after the estimate of migration timing was fixed (i.e. 50% migration date had been finalized) to post-season estimates of abundance, which incorporate data collected in freshwater migration corridors and on spawning grounds. MU-specific FRPs, which may vary by cycle line, are listed in Table A1 and an example TAM rule calculation is shown in Figure A1.

Table A1. MU-specific fishery reference points (in millions of fish) across cycle lines.

|  |  |  |  |
| --- | --- | --- | --- |
| **Management Unit** | **Cycle line** | **Lower FRP** | **Upper FRP** |
| Early Stuart | All cycle lines | 0.108 | 0.1512 |
| Early Summer | 1 | 0.11 | 0.154 |
| 2 | 0.18 | 0.252 |
| 3 and 4 | 0.1 | 0.14 |
| Summer | 1 | 0.885 | 1.239 |
| 2 | 1.02 | 1.428 |
| 3 | 0.76 | 1.064 |
| 4 | 0.64 | 0.896 |
| Late | 1 | 0.35 | 0.49 |
| 2 | 1.1 | 1.54 |
| 3 and 4 | 0.3 | 0.42 |

*Larkin model*

The Larkin model is a modified version of the Ricker that accounts for delayed density dependence between cycle lines. As a result, it includes multiple parameters and lagged spawner abundances.

Equation A1

where *i* represents a CU, *y* is a given year, *R* the number of recruits (number of offspring that return to spawn or are captured in the fishery), and *S* the number of spawners. The parameter represents the number of recruits produced per spawner at low abundance and the parametersrepresent density dependent interactions at different time lags.

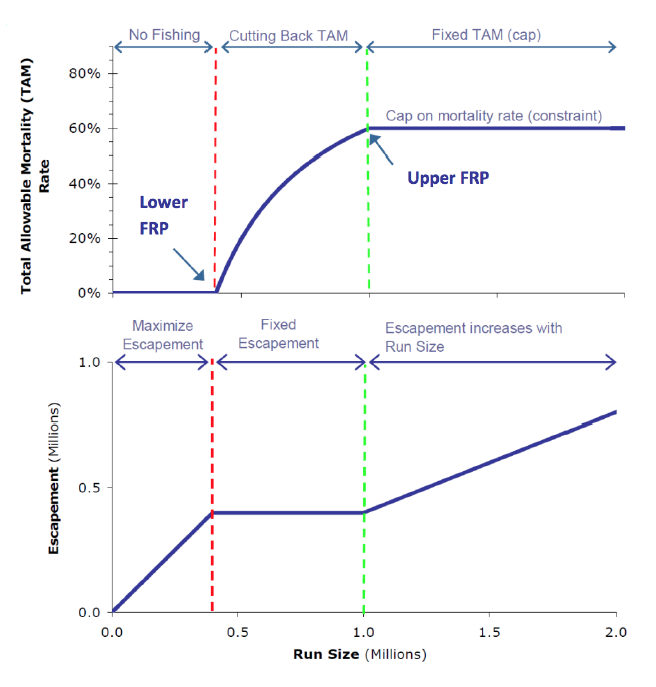


Figure 1. Changes in total allowable mortality (upper panel) and escapement target (lower panel) as a function of run size when using TAM rule harvest strategy. Here run size has been adjusted using pMA.