The CSS began in 1996 with the objective of establishing a long-term dataset of the survival rate of annual generations of salmon from their outmigration as smolts to their return to freshwater as adults to spawn (smolt-to-adult return rate; SAR), and with the goal of evaluating the efficacy of transportation

Key objectives:

Developing a consistent approach for monitoring SARs

Develop more appropriate SARs for in-river migrants

Common starting point for comparing SARs of transported and in-river migrants

Challenges:

Needed a way to estimate the number of smolts that were experiencing the same treatment as untagged smolts at transportation collector dams

Several lines of evidence suggested that bypass or multiple-bypass introduced a negative bias in SARs

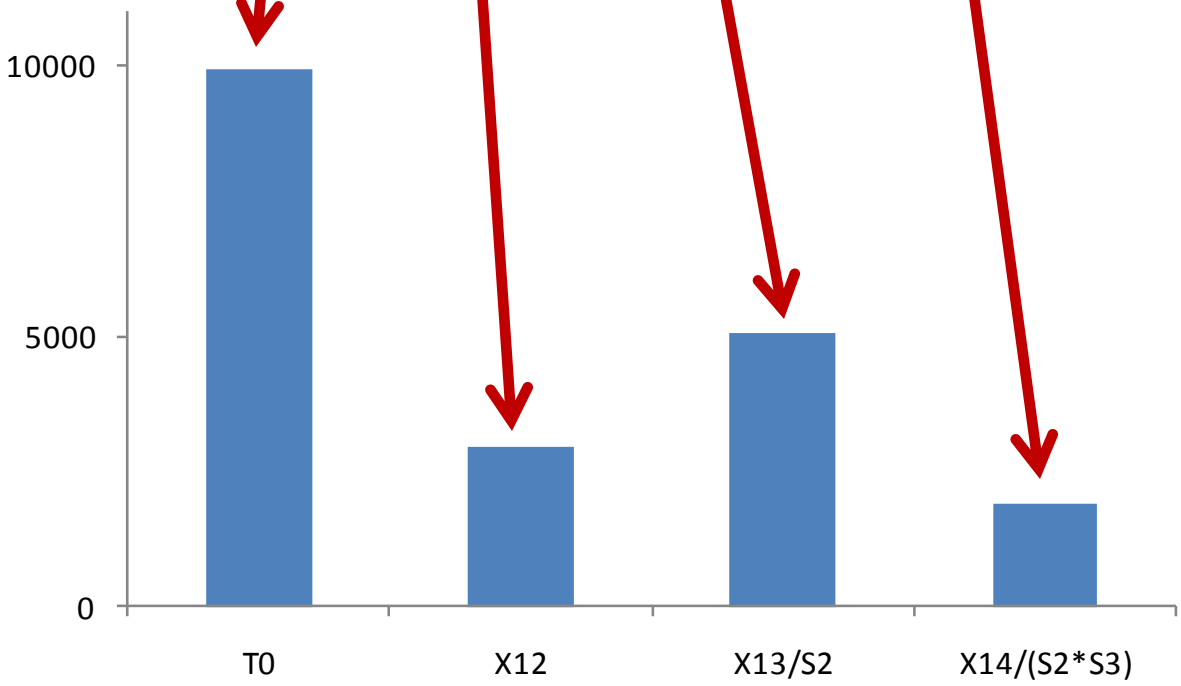
Developed three equations for estimating the number of smolts with different passage experiences through the collector dams:

T_0 – the number of smolts transported upon first detection at a collector dam, expressed in LGR equivalents

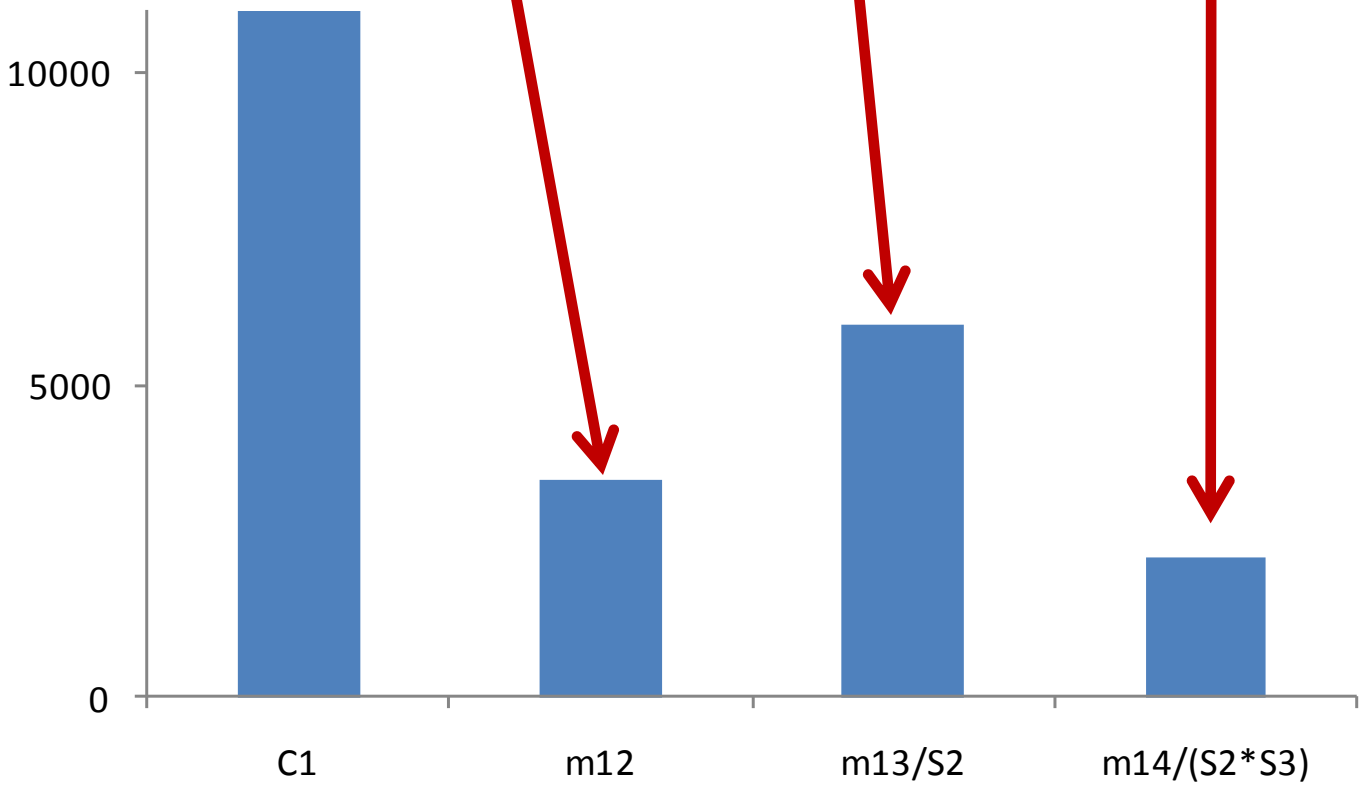
C_0 – the number of smolts not detected at any of the collector dams, expressed in LGR equivalents. Most representative of untagged, in-river migrants.

C_1 – the number of smolts bypassed at one or more of the collector dams, expressed in LGR equivalents

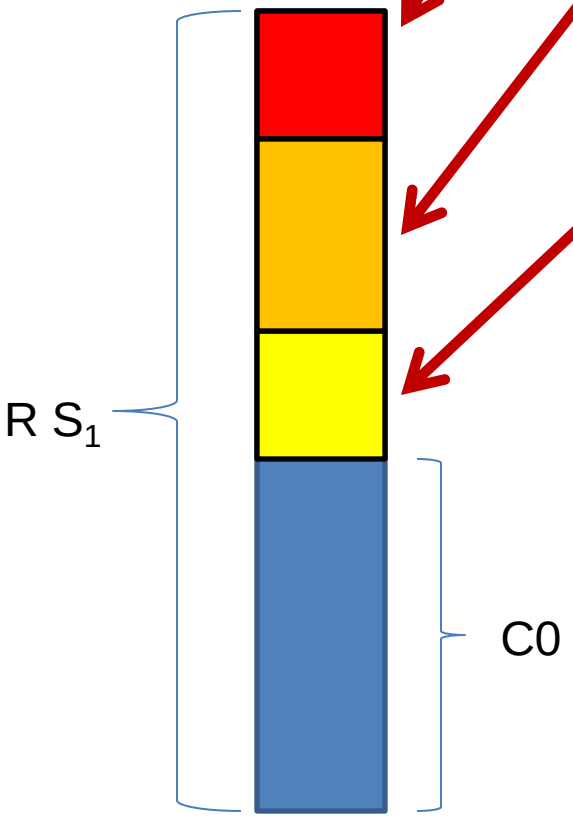
$$T_0 = X_{12} + \frac{X_{13}}{S_2} + \frac{X_{14}}{S_2 \cdot S_3}$$



$$C_1 = (m_{12} - d_2) + \left\lfloor \frac{(m_{13} - d_3)}{S_2} \right\rfloor + \left\lfloor \frac{(m_{14} - d_4)}{S_2 \cdot S_3} \right\rfloor - d_1$$

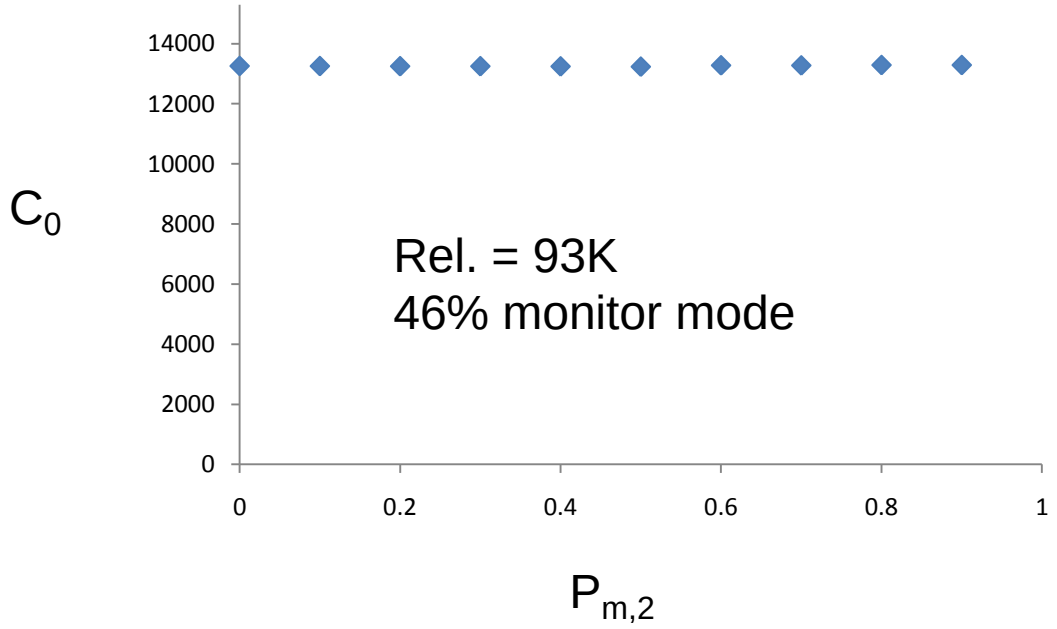


$$C_0 = R \cdot S_1 - \left[m_{12} + \frac{m_{13}}{S_2} + \frac{m_{14}}{S_2 \cdot S_3} \right] - d_0$$



How does holdover behavior affect the C_0, T_0 and C_1 smolt estimates?

Reinterpret the survival parameters as the product of migration probability (P_m) and true survival (S_{true})



How can this be the case?

$$C_0 = R \cdot S_1 - \left[m_{12} + \frac{m_{13}}{S_2} + \frac{m_{14}}{S_2 \cdot S_3} \right] - d_0$$

$$m_{13} = R\ S_1\ (1\text{-}P_2)\ P_{m,2}\ S_{true,2}\ P_3$$

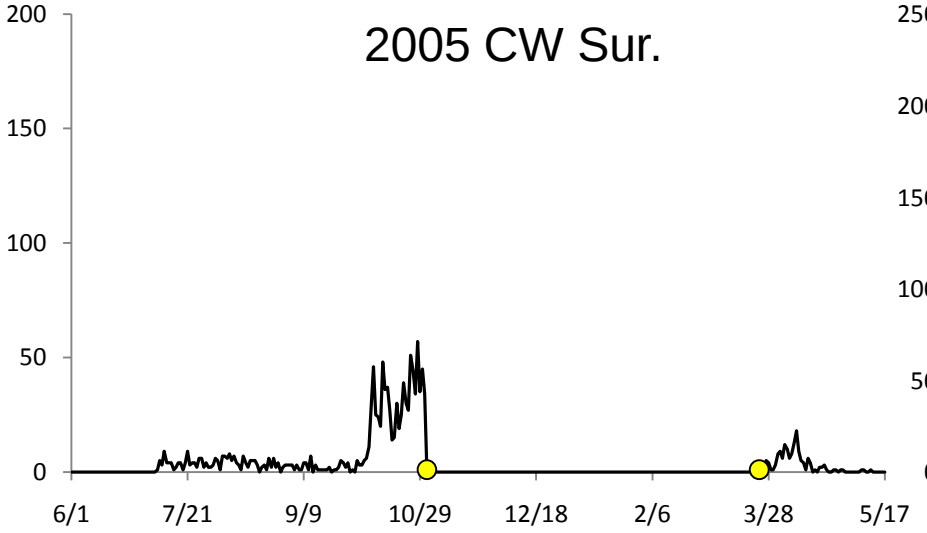
$$S_2 = P_{m,2}\ S_{true,2}$$

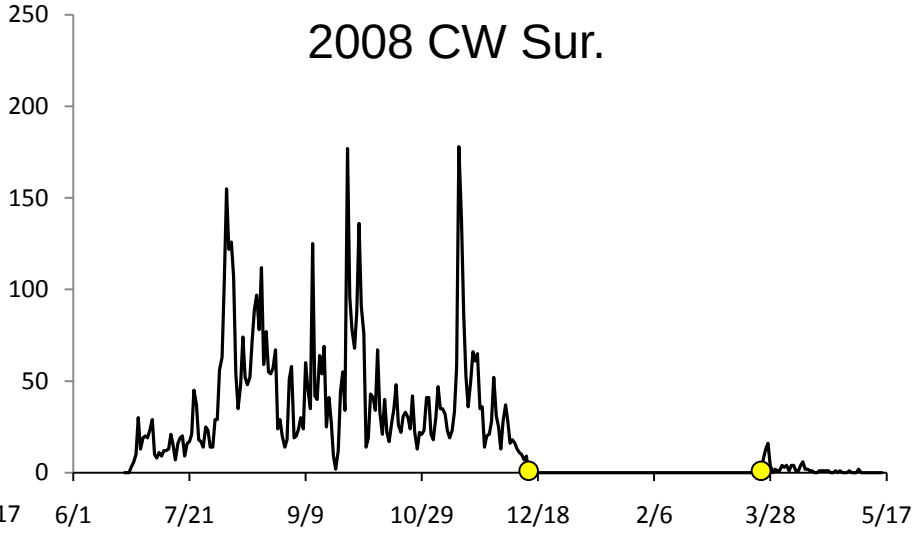
Holdover behaviors downriver of LGR do not appear to affect CSS estimators for the C_0, C_1 and T_0 study categories

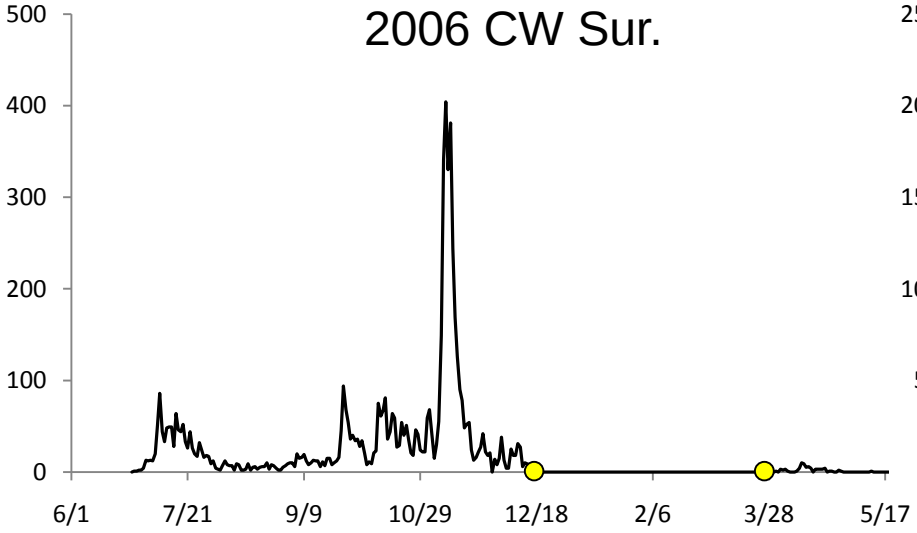
However, holdover behaviors upriver of LGR could affect the C_0 estimate, depending on the magnitude

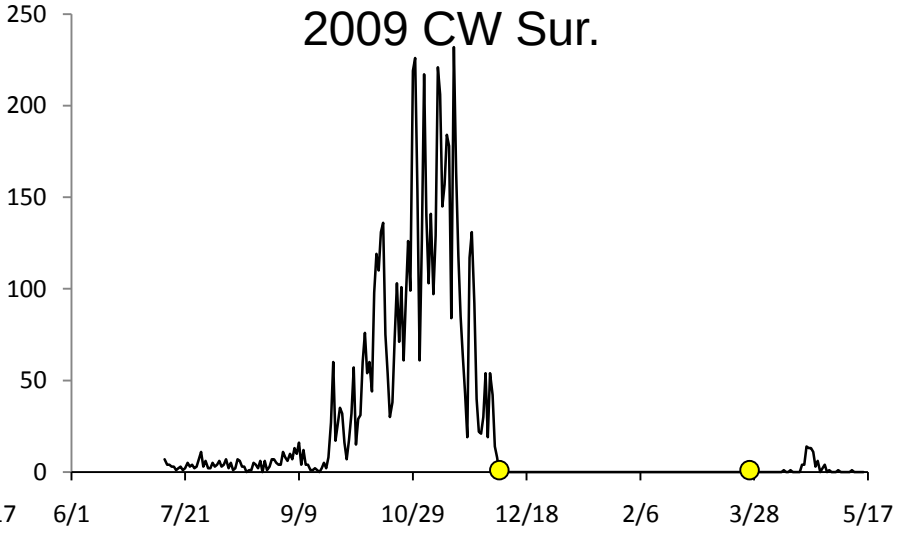
Which release groups might holdover upriver of LGR?

Clearwater surrogate detections at LGR









More simulations/testing of the CSS estimators would be useful to assess how high the holdover rates would need to be before there is substantial bias

At this point, most, if not all fall Chinook release groups appear to be estimable using the CSS methodology:

Snake yearlings
Clearwater yearlings
Snake production subyearlings
Clearwater production subyearlings
Snake surrogates
Snake naturals

More work is needed to examine Clearwater surrogates and Clearwater naturals (may be too few)