**Columbia River steelhead life cycle modeling based on PIT tags**

Dan Rawding (WDFW), Thomas Buehrens, and Charlie Cochran

Empirical life stage and reach scale steelhead survival estimates are currently lacking but are needed for Columbia River recovery and adaptive management plans.  We developed a Bayesian Cormack-Jolly-Seber life cycle model to estimate stage-specific survival for 11 different life stages by spatial reach combinations. The model started at the parr stage and measured survival up to the 3rd spawning run of adult steelhead over 9 out migrant years from 2003-2011 for an ESA listed population of summer steelhead. The model was parameterized with Passive Integrated Transponder (PIT) tagging, recapture and detection data from the Wind and Columbia rivers. Using model selection criteria, the best model was a hierarchical model of both survival and detection probabilities across cohorts.  Since our reaches coincided with life stages, we provided preliminary estimates for the mean survival for 1) tributary spring parr to smolts in the Wind River (10%), 2) smolts migrating in the Columbia River to the estuary (78%), 3) smolt to adult returns from the estuary & ocean to Bonneville Dam (BON)  (6%), 4) adult pre-spawners in the BON pool (63%), 4) adult entry into the Wind River to kelts in the estuary (59%), and 5) kelts from the estuary to first time repeat spawners to BON (17%).  Kelt to adult return survival estimates after second spawning were imprecise due to low tagging and recovery rates. The survival from smolt to adult return explained most of the annual variation in survival for the life stages we modeled.  Iteroparity resulted in increased life history diversity and population resilience for this population. Our estimates rates of iteroparity were more than double previous published rates of Columbia River summer steelhead above BON.