

Title: Assessing and reducing ecological risks of hatchery operations in freshwater using the PCD RISK 1 model

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We developed a model called PCD RISK 1 that can be used to assess and reduce ecological risks to natural origin fish in fresh water from hatchery fish releases. PCD RISK 1 simulates predation, competition, and disease impacts on naturally produced salmonids caused by hatchery smolts as they move downstream or residualize after release. It is an individual based model that relies upon user specified inputs of up to 45 variables, such as number and size of hatchery and wild fish, and water temperature. The model generates hatchery and natural fish of specified size distributions, then randomly pairs hatchery and natural fish for interactions for a specified number of days and encounters. Wild fish have the potential to be eaten if they are less than 50% the length of hatchery fish and competition if they are greater than 50% the length of hatchery fish. After all of the allowable competition and predation occurs, disease is allowed to impact the wild fish that survive. Two types of output are available from the model, 1) deterministic, and 2) probabilistic. Deterministic output of the model includes the number, percentage, and standard deviation of wild fish that die from predation, competition, disease, and from all interactions combined. The primary output of the probabilistic approach is a range of probabilities that certain mortalities will occur. Probabilistic output requires a range of inputs and the selection of either uniform or triangular distributions. The model also quantifies impacts by age or size class so that risks to different age classes can be assessed. Simulations of a variety of hatchery programs reveal that risks are highly diverse and that a variety of options are available to reduce risks.