# Chinook harvest-population diversity tradeoffs

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**Abstract:**

Declines in Kuskokwim Chinook have put immense pressure on the nearly 16,000 residents that depend upon these salmon for subsistence. These Chinook spawn in over 26 distinct tributaries of the Kuskokwim River Basin each of which is likely to differ in productivity and carrying capacity due to local adaptation and finite rearing and spawning habitat. This biocomplexity is critical to maintaining resilience to environmental change and dampening variability in harvest for fisheries. However, it also means that populations will vary in the harvest rates they can sustainably withstand. Because Kuskokwim fisheries for these populations overlap in space and time there can be an inherent conflict between harvest rates and population diversity (i.e., the number of viable populations): high harvest rates, which can be sustained by the most productive populations, come at the cost of increased risk of over-fishing for less productive populations. This harvest-biodiversity tradeoff is not currently considered in Kuskokwim Chinook fisheries management. We propose to combine empirically grounded statistical and simulation modeling with fishery and stakeholder engagement and harvest policy analysis to answer four interrelated questions: (1) what is the tradeoff relationship between long-term harvest and population diversity?; (2) how might the loss of population diversity affect long-term harvest under changing environmental conditions?; (3) what is the optimal harvest policy when conservation constraints on exploitation rates from harvest-diversity tradeoffs, persistent productivity changes, and consideration of economic and fishery objectives are simultaneously accounted for?; and (4) what are the harvest and population diversity costs of incorrectly assuming recruitment is driven by (1) overcompensation or (2) environmental forcing, when the alternative hypothesis is in fact true? This research will provide critical information to inform harvest policy decisions that seek to balance subsistence harvest and population diversity under changing environmental conditions in the face of uncertainty.

**Project Objectives:**

Objective 1: To determine the shape of the relationship between spawner abundance and adult recruitment for each individual Chinook spawning population in the Kuskokwim watershed.

Objective 2: To determine the predicted average annual fishery yield across all Kuskokwim Chinook populations - the sum of the equilibrium harvest that each population could sustain, and the proportion of populations that are predicted to not be overexploited - in order to evaluate the tradeoff between harvest and conservation of population diversity across a range of mixed-population harvest rates.

Objective 3: To determine the extent to which the erosion of population diversity resulting from overharvest of weak populations may limit long-term fishery yield under changing environmental conditions that might favor what are now weak populations over those that are currently strong

Objective 4: To determine both fishery manager and stakeholder perspectives on acceptable conservation constraints (i.e., which point[s] on the curve in Figure 1 is acceptable) and fishery objectives (e.g., minimize frequency of fishery closures) in order to inform the estimation of optimal harvest policies in objective 5.

Objective 5: To determine optimal harvest policies for Kuskokwim Chinook based upon the magnitude of persistent productivity changes in Kuskokwim Chinook and the conservation constraints and fishery objectives from Objective 4.

Objective 6: To determine the harvest and population diversity costs of assuming Kuskokwim Chinook recruitment is driven by (1) over-compensatory processes or (2) extrinsic environmental forcing when the alternative hypothesis is true.