

Diversity of juvenile Chinook salmon life history pathways

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Abstract Life history variability includes phenotypic variation in morphology, age, and size at key stage transitions and arises from genotypic, environmental, and genotype-by-environment effects. Life history variation contributes to population abundance, productivity, and resilience, and management units often reflect life history classes. Recent evidence suggests that past Chinook salmon (*Oncorhynchus tshawytscha*) classifications (e.g., ‘stream’ and ‘ocean’ types) are not distinct evolutionary lineages, do not capture the phenotypic variation present within or among populations, and are poorly aligned with underlying ecological and developmental processes. Here we review recently reported variation in juvenile Chinook salmon life history traits and provide a refined conceptual framework for understanding the causes and consequences of the observed variability. The review reveals a broad continuum of individual juvenile life history pathways, defined primarily by transitions among developmental stages and habitat types used during freshwater rearing and emigration.

Life history types emerge from discontinuities in expressed pathways when viewed at the population scale. We synthesize recent research that examines how genetic, conditional, and environmental mechanisms likely influence Chinook salmon life history pathways. We suggest that threshold models hold promise for understanding how genetic and environmental factors influence juvenile salmon life history transitions. Operational life history classifications will likely differ regionally, but should benefit from an expanded lexicon that captures the temporally variable, multi-stage life history pathways that occur in many Chinook salmon populations. An increased mechanistic awareness of life history diversity, and how it affects population fitness and resilience, should improve management, conservation, and restoration of this iconic species.

Keywords Biocomplexity · Migration · Plasticity · Resiliency · Phenotypic Diversity · Environment · Conditional strategy

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Introduction

Chinook salmon (*Oncorhynchus tshawytscha*) are one of the most commercially and culturally important fish species in North America (Healey 1991; NRC 1996). However, approximately 54 % of spring- and summer-run populations, and 21 % of fall- and winter-run