Assessing Size-Selective Mortality of Juvenile Yukon River Chinook Salmon Using Retrospective Scale Analysis

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Introduction

A size-selective mortality model of Yukon River Chinook salmon (Oncorhynchus tshawytscha) was constructed from juvenile size distributions and a retrospective analysis of adult scale growth measurements. The Bering Aleutian Salmon International Survey (BASIS) and later surface trawl surveys in the Northeastern Bering Sea capture Yukon River juvenile Chinook salmon with varying freshwater life histories and across a wide range of sizes (93-316 mm, Figure 1). The smallest size classes overlap with outmigrating smolt sizes documented in the Yukon River Delta, while the largest individuals are roughly three times larger. Size selective mortality of juvenile Chinook salmon was assessed by estimating juvenile fish size from scales of adult returns that were juveniles in 2002-2007.

Figure 1. Typical size range of juvenile Chinook salmon from Northeastern Bering Sea surveys.

Methods

Adult scales randomly selected for analysis from in-river test fisheries were stratified based on observed maturity schedules for 2002-2007 juvenile year classes, to best represent the range of growth and life history strategies of survivors. Scale size was estimated through mid-September of the fish's first summer at sea, using the timing of the survey as a reference point on adult scales (mean ocean circuli count = 22 ± 0.49). Paired scale growth and somatic growth relationships of juvenile salmon from Northeastern Bering Sea collections were used to translate adult scale growth up to this reference point into salmon lengths and weights.(Figure 2). A generalized additive model (GAM) compared juvenile length of successful adult returns to total juvenile length distributions present in 2002-2007 surveys.

Results

The smallest sized juveniles are notably absent in the reconstructed juvenile sizes of those fish that survived to adulthood (Figure 3). The GAM model indicates that neutral selection occurs at approximately 138 g weight or 240 mm length Chinook salmon: smaller fish experience higher mortality rates, and larger fish experience some survival advantage due to size (Figure 4).

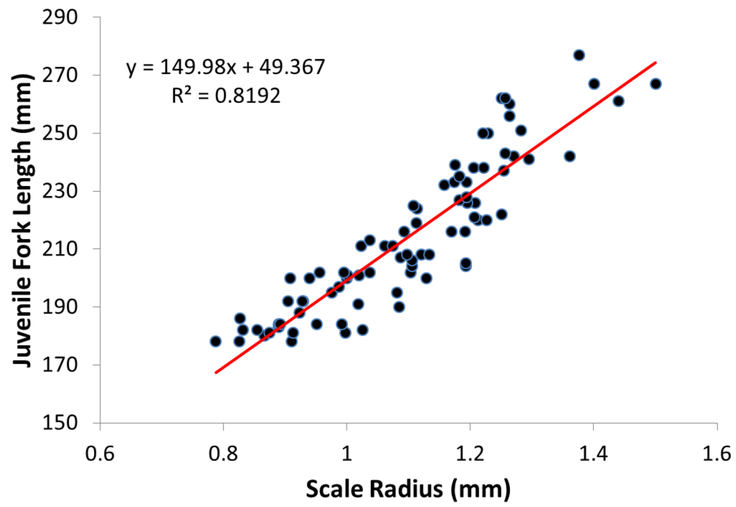

Figure 2. Relationship of total scale radius to juvenile Chinook salmon length.

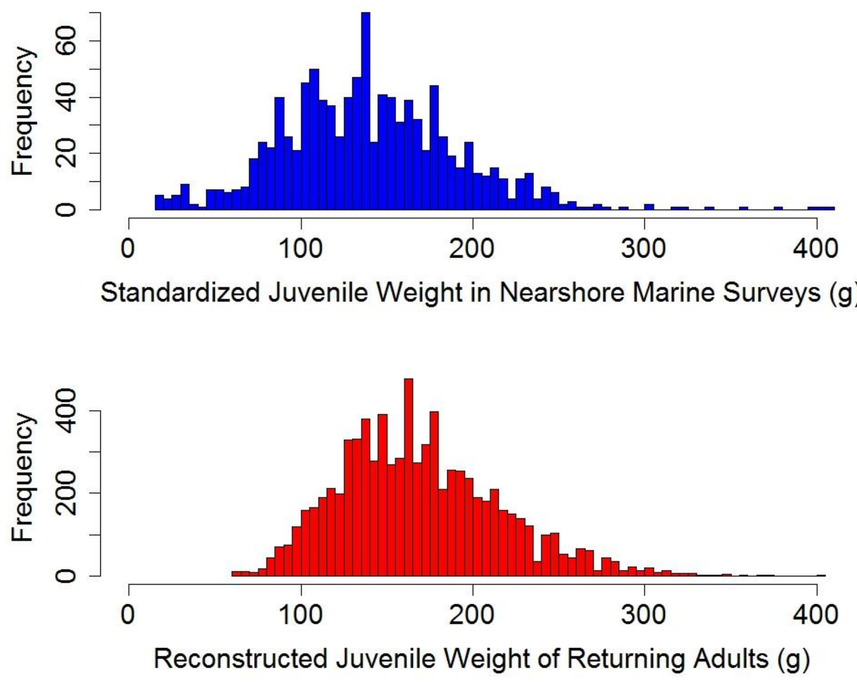

Figure 3. Size distribution of juvenile Chinook salmon observed in the survey (blue) compared to those sizes reconstructed from scale of adult returns(red). All weights are standardized to September 20 of the fish's first year in the ocean, assuming marine growth rates of 1mm length/day.

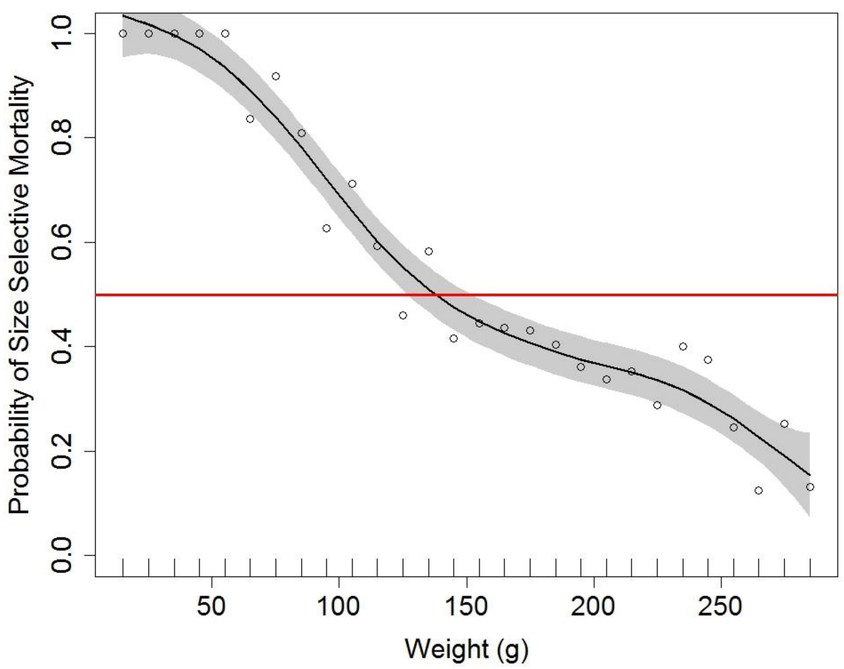

Figure 4. Generalized Additive Model of the probability of size selective mortality given weight, based on the differences in size distributions evident in Figure 3. Weight is of juvenile salmon near the end of their first summer in the ocean (September).

Discussion

Size-selective mortality is a feature of the juvenile life history stage that links ecosystem processes to salmon production dynamics. Neutral selection appears to occur at approximately the average juvenile Chinook salmon size across all years sampled. However, juvenile Chinook salmon sizes show interannual variability, indicating variable influence of size-selective mortality to individual juvenile year-classes. Additional research is needed to understand how size-selective mortality impacts specific stocks within the Yukon River. As Yukon River Chinook salmon are among the most northerly stocks of this species, research into the role of climate change and the loss of sea ice as drivers of growth and size-selective mortality is also needed.

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