Ecology and Demographics of Juvenile Chinook Salmon in the Chena River, Interior Alaska

Mark S. Wipfli[1], Matthew J. Evenson[2], Nicholas F. Hughes[3], Emily R. Benson[4], Elizabeth C. Green[4], Laura Gutierrez[4], Jason R. Neuswanger[4], and Megan T. Perry[4]

[1] U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska 99775
[2] Alaska Department of Fish and Game, Sport Fish Division, 1300 College Road, Fairbanks, Alaska 99701
[3] Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska 99775
[4] Alaska Cooperative Fish and Wildlife Research Unit, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska 99775

Background

The inability of most stock-recruitment models to incorporate environmental processes limits their rigor and reliability. In the Chena River, Chinook salmon (*Oncorhynchus tshawytscha)* population size seems to be regulated by density-dependent mortality during the juveniles' first summer, when environmental fluctuations influence competition for food and space, but in ways that are poorly understood.

Objectives

1) Determine how seasonal patterns of flow and temperature affect food production and the availability of safe, profitable foraging habitat.
2) Test whether these influences on food production and foraging affect fish growth and abundance.

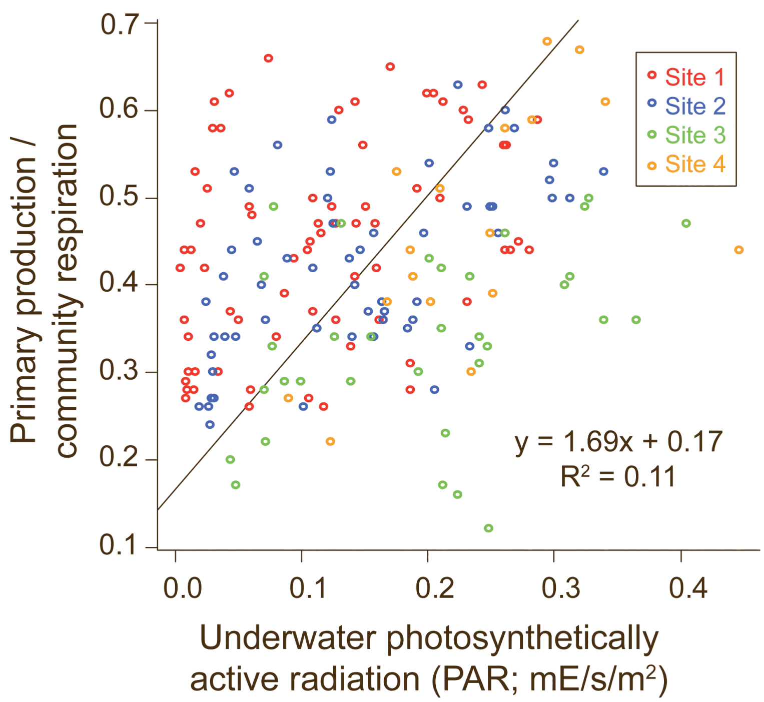
Methods

We measured temporal and spatial fluctuations in nutrient concentrations, chlorophyll-*a* and biofilm mass, stream metabolism, and prey (aquatic and terrestrial invertebrates) abundance and availability for juvenile Chinook on the Chena River. Further, we developed and used new stereo videogrammetric techniques to unobtrusively measure fish growth and foraging parameters. Food was supplemented via 24-hr feeders, and fish abundance at supplemented and control sites was estimated using mark-recapture. Research was conducted May through October, 2008 and 2009, on three focal study sites throughout a 100-km length of river.

Results
I. There was very high seasonal and spatial variability in basal food resources for juvenile Chinook salmon on the Chena River during the 2008 season.

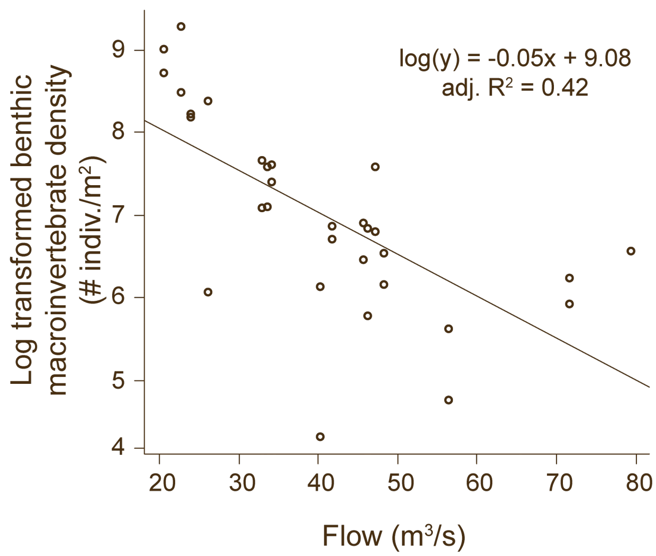
II. High flows and turbidity appeared to temporarily reduce food intake by fish, dramatically redistribute fish in the short term, and reorganized large woody debris and subsequently fish habitat.

Primary production and benthic invertebrates:



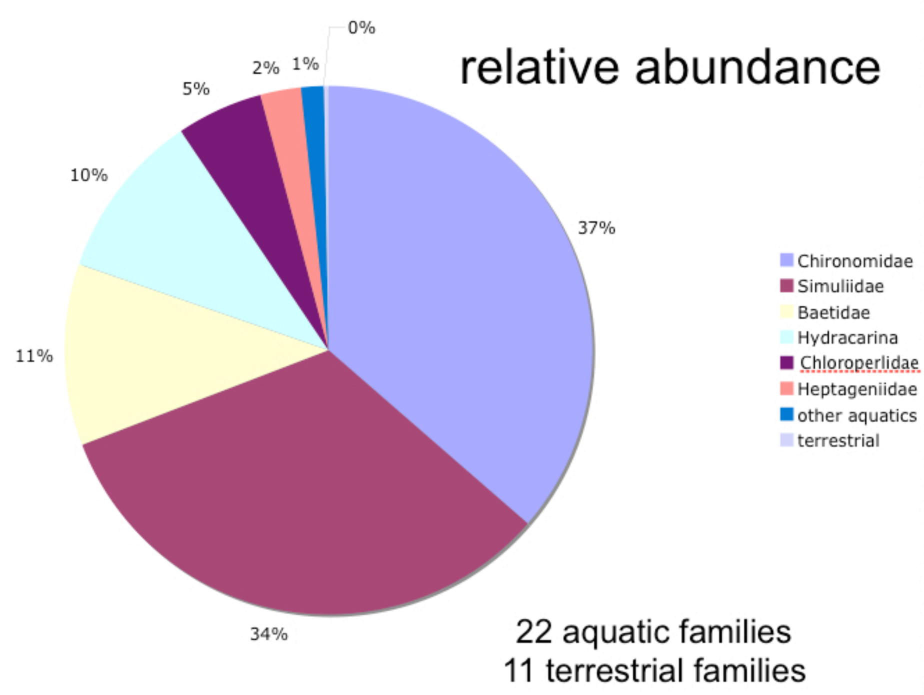
• Respiration exceeded production in summer and fall, suggesting allochthonous (wood, leaf litter) energy sources largely drove basal trophic production.

• Production to respiration ratios were positively related to light, likely because of increased production rates at high light levels.



• Benthic macroinvertebrate abundance was negatively related to stream flow.

Drifting invertebrates:

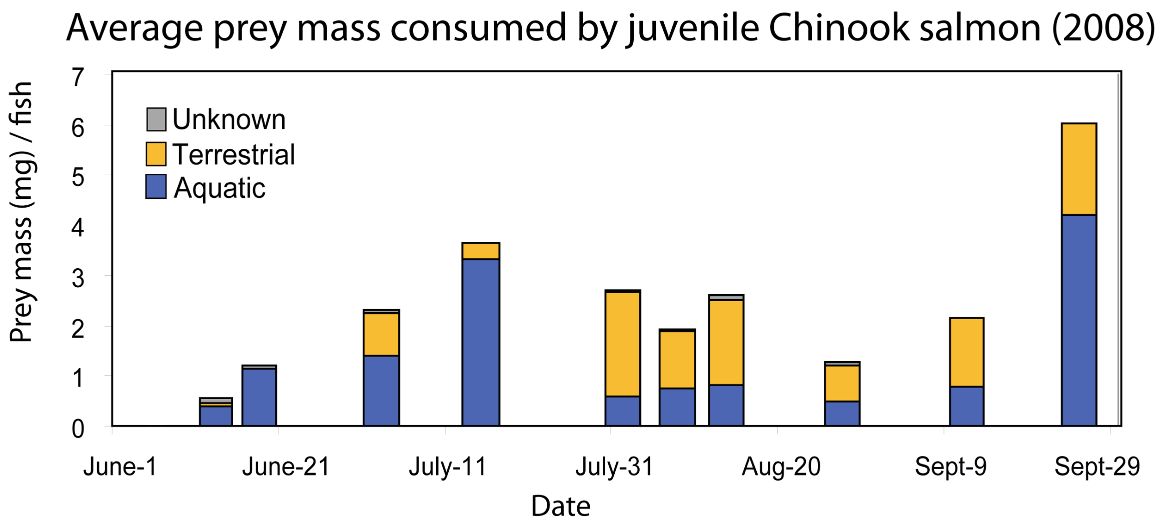


• Among the drift samples processed to date, invertebrate drift biomass ranged from 0.02-0.12 mg dry mass/m3 water, and 0.7-4.6 individuals/m3 water.

• Drift was comprised mostly of black flies, chironomid midges, baetid mayflies and aquatic mites

Terrestrial invertebrate infall and juvenile Chinook diet:

• Inputs (infall) of terrestrial prey into the Chena River were substantial spring through fall, and were comprised mostly of flies, spiders, hoppers, and beetles.



• Juvenile Chinook food intake sharply declined from a mean high of 18 invertebrates/fish pre-flood, down to 4 invertebrates/fish during and immediately after a major flood in late July, then returned to pre-flood levels in Aug.

• Prey commonly ingested by juvenile Chinook included both terrestrial and aquatic invertebrates such as flies, beetles, spiders, mayflies, stoneflies and midges. Consumption of terrestrial invertebrates increased in late summer.

Effects of food abundance on fish growth:

Average difference in mean daily temperature between upstream and downstream reaches was 1˚C.

• Fish in upstream reaches were significantly smaller than fish rearing in downstream reaches ($F(2,321)=6.074$, p-value < 0.01).

• Using a linear mixed effects model, fish size was not significantly different between food-supplemented and control sites (response variable = log(weight) / log(length), df=774, p-value = 0.73).

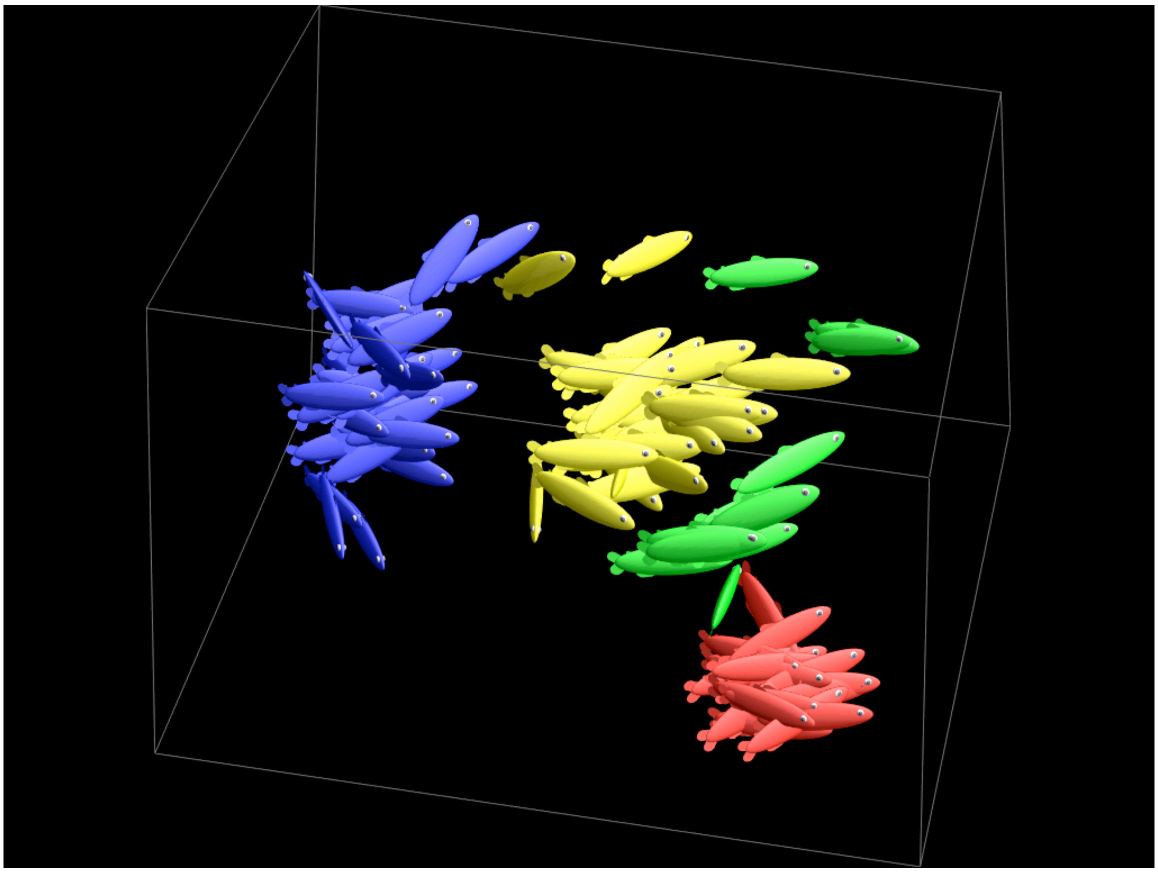
• Preliminary results from mark-recapture abundance estimation suggest open populations of fish and movement of individual fish up to 25 km.

Fish foraging behavior:

• Juvenile Chinook inhabited woody cover (all summer) and open shallows (early summer only).

• Upstream, large logjams concentrated Chinook. Downstream, fish used more dispersed wood.

• Diel periodicity in juvenile Chinook activity was negligible in June. By late July, many fish left cover for twilight feeding.



• Larger juvenile Chinook frequently defended feeding territories, which were tightly spaced but rarely overlapped.

• Chinook overwhelmingly drift-fed, and occasionally cruise-fed.

Application

The eventual output from this study and subsequent analyses will aid biologists and managers in predicting optimal escapements and forecasting future returns.

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