

**TESTING THE PREDICTIONS FROM A SPATIALLY-EXPLICIT
BIOENERGETIC MODEL FOR AGE-0 ATLANTIC SALMON
USING FLUXES OF TRACE ELEMENTS**

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EXTENDED ABSTRACT ONLY - DO NOT CITE

Our inability to directly measure the consumption rates of fish in the field generally precludes validation of models that relate foraging opportunity to growth and survival. In spite of this, population models implicate the importance of food and habitat availability in determining growth and survival for many juvenile fish (Elliott 1989, Nislow et al. 1999). Consumption and growth rates of stream-dwelling salmonids are frequently modeled as a function of prey abundance and hydrologic conditions (Hughes and Dill 1990, Hill and Grossman 1993). In the case of juvenile Atlantic salmon, spatially-explicit bioenergetic models implicate the importance of early-season foraging habitat for salmon fry growth and survival (Nislow et al. 2000). However, exactly how these factors interact to determine prey consumption, growth and survival under a range of habitat conditions is often complex and difficult to ascertain without reliable field-based techniques for measuring consumption rates. Building upon earlier models of radiocaesium accumulation in fish (Forseth et al. 1992, Rowan and Rasmussen 1996), the goal of this study was to use the turnover of naturally occurring stable Cs to compare *in situ* consumption rates of stocked Atlantic salmon (*Salmo salar*) fry in tributaries of the Connecticut River. We related these consumption measurements to 1) predictions from a bioenergetics model

over the same time period and 2) growth and survival of age-0 salmon at these sites.

Atlantic salmon were stocked as unfed fry into tributaries of the West and White River Vermont, USA in early May 1991 and 1992. In six sites fish were destructively sampled at approximately two-week intervals during the growing season. To calibrate bioenergetic models, habitat and macroinvertebrate measurements were taken both at salmon feeding locations as well as at random sites along the stream bed. Gut contents were separated for diet analysis. For trace element analysis, fish and insect samples were digested in a microwave under class 100 ultra-clean laboratory conditions. To parameterize the trace metal consumption model, we analyzed fish, common prey taxa and stomach contents for Cs, Rb and K using high-resolution inductively-coupled plasma mass spectrometry.

Field-based estimates for assimilation efficiencies showed no differences among sites, however interspecific differences in the Cs concentrations of common prey taxa emphasize the importance of quantifying fish diet composition before applying this model. Our estimates of early season (2 to 3 weeks) consumption rates using Cs were significantly lower than those of the spatially-explicit bioenergetics model. However, the relative rankings of sites were similar using both methods (Fig.1). In both cases, significant differences in consumption rates across sites during the early season were correlated with underyearling survival. During the late season (10 to 12 weeks) Cs-based consumption rates compared more favorably with model predictions. Consistent with model predictions, late season consumption rates were not correlated with survival. Our results support a hypothesized resource and habitat limitation during the early season. Specifically, high variability in consumption rates and decoupling of growth and consumption when fish are less than 6 weeks old suggests that this a challenging time for fry when habitats are limiting and energetic demands are high.

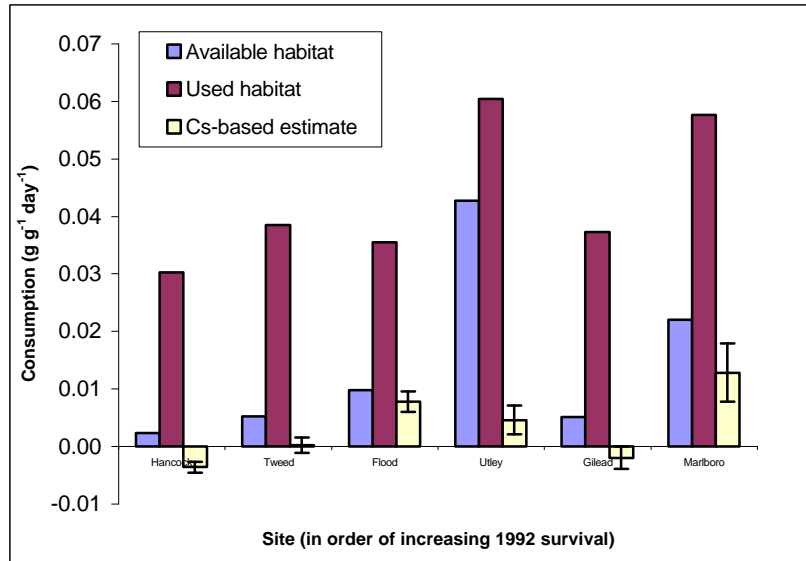


Figure 1. Early season consumption rates (two to three weeks post stocking of Atlantic salmon fry in six tributaries of the Connecticut River estimated by 1) a spatially-explicit bioenergetic model and 2) a technique that employs the passive turnover of trace metal (Cs) turnover in tissues. The bioenergetics model makes separate predictions for available habitat (random sampling points in the stream) and used habitat (actual foraging locations of salmon fry).

References

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