Modeling the Effects of Stream Microhabitat on Group Size and Foraging Success of Juvenile Coho Salmon

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Introduction

In 1966 coho salmon (*Oncorhynchus* kisutch) from the Columbia River in Washington were introduced into Michigan tributary streams of Lake Superior. Since then coho have spread throughout the Lake Superior drainage. However, little is known about the behavioral and ecological differences between the introduced coho and those native to the northern Pacific Coast. It is improbable that models describing the behavior and ecology of native range coho are applicable to those introduced into Lake Superior (Healy and Lonzarich 2000). The primary goal of this study was to quantify the effects of microhabitat on group size and foraging success of juvenile coho salmon in a natural system in northern Wisconsin. We also wanted to determine how group size affects foraging success and how our system changes over the peak growing season.

Methods

- **Our study was conducted on the Onion River, a tributary to Lake Superior, in Bayfield County, Wisconsin from 22 May to 15 June (early summer) and 13 to 23 August (late summer) 2007.**
- **We conducted field observations via snorkeling (Fig. 1).**
- **Five focal individuals chosen at random were observed for 150s in each group and feeding events were recorded. For groups < 5 fish, observations were made for each group member.**
- **A feeding event was defined as a fish ingesting a food particle without regurgitation.**
- **After observations for a group were finished, a flag was placed in the center of the group for microhabitat analysis.**
- **Microhabitat analysis consisted of measuring surface velocity (SV; m/s), distance to bank (DTB; cm), distance to cover (DTC; cm), and depth (cm).**
- **We constructed a structural equation model (SEM) for each study period using Amos™ 5.**

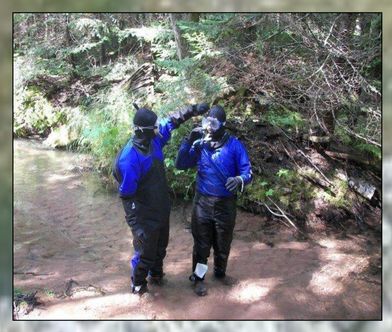


Figure 1. To conduct observations on the coho salmon in their natural environment we used dry suits and thermal undergarments. The fish acclimate quickly (< 1 min.) to the presence of the observer and observer presence appears to have no effect on the behavior of the fish.

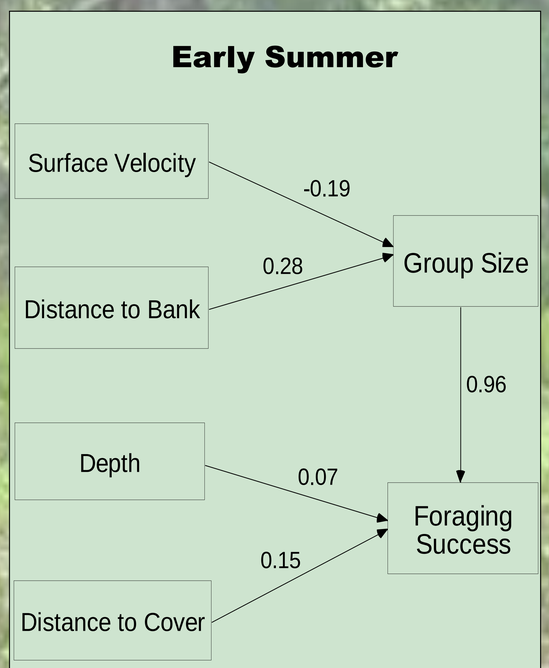


Figure 2. Structural equation model for the early summer study period. Values represent standardized regression coefficients. Goodness of Fit Index (GFI)=.997, d.f.=5, p=.80 (values for GFI above .90 indicates good fit to the data).

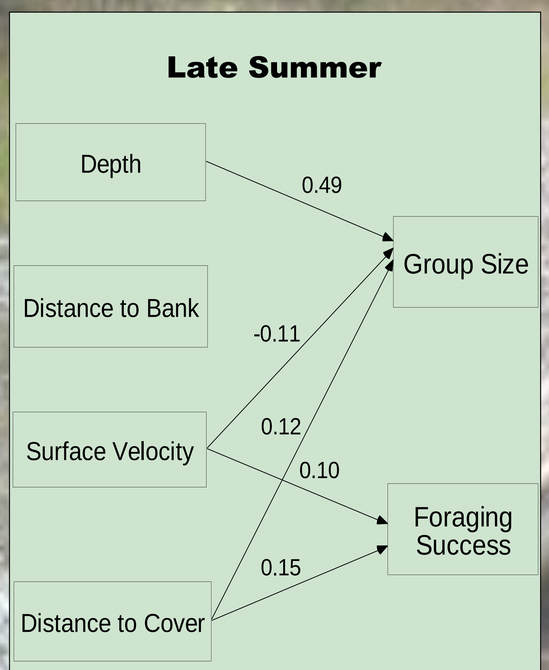
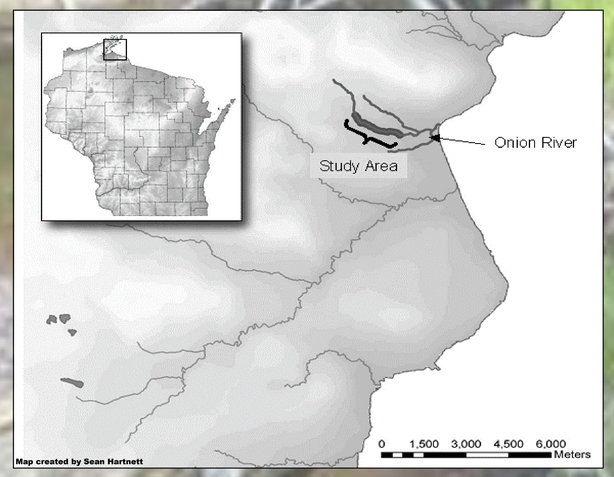


Figure 3. Structural equation model for the late summer study period. Values represent standardized regression coefficients. Goodness of Fit Index (GFI)=.979, d.f.=7, p=.07.

Results and Conclusions

- **Group size strongly affected foraging success in early summer. This relationship was not linear, but parabolic (R^2=.93, p<.001) revealing perhaps an optimal group size range (15-20 fish) where forging success is maximized. No effect of group size was found for the latter part of the summer (R^2=.09, p=.525) when the fish have increased significantly in size.**
- **SV was associated negatively with respect to group size in both study periods but had a positive effect on foraging success in August. This suggests that as the fish grow, they are able to access greater food availability associated with increased velocity (data collected in this study, R^2=.76, p<.05).**
- **DTB was positively associated with group size in the early summer. River otters, a primary predator in this system, can decimate pools of juvenile salmon (Bugert et al. 1991). Larger groups in deeper water would therefore reduce predation risk to an individual fish. We believe this to be the case in late summer regarding depth and group size because of a strong correlation between depth and DTB in both study periods.**
- **The tandem effects of DTC and depth on group size in late summer demonstrates the benefits fish gain from associating with larger group sizes further from cover and in deeper water where predation risk is highest (e.g. Grand and Dill 1999).**



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