USING HABITAT SELECTION THEORY TO PREDICT THE MIGRATORY BEHAVIOUR OF STREAM FISH

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Introduction

In this extended abstract I will explain how the logic of a habitat selection model for drift-feeding stream salmonids (Hughes, 1998; 2000) can be used to predict how the probability of long-distance inter-annual movement will change as body size increases. The model predicts that movement probability will decrease as fish get bigger and that the largest fish in the population will not move at all. I also test these two predictions using data on the movement of Arctic grayling (*Thymallus arcticus*) in the lower 160~km of a 240~km long sub-arctic river in Interior Alaska.

Model Background and Development

The model described by Hughes (1998; 2000) represents the stream habitat as a series of feeding positions that can be ranked in order of profitability (potential growth rate). All sizes of fish under consideration are assumed to rank these positions in the same order, and competition for profitable positions is assumed to sort fish so that the rank-size of each fish matches the rank desirability of its position. This means that the largest fish in the population will occupy the most profitable position, the second largest fish the second most profitable position, and so on. The result is a stable distribution in which each fish occupies the most profitable position that it is large enough to defend.

Under these assumptions the only reason a fish should move is to occupy a more profitable position, the only way these become available is when larger fish die. This means that the opportunity a fish has to obtain a better position by moving will be proportional to the number of larger fish multiplied by the annual mortality rate. It follows that the smallest fish in the population will be the most likely to change feeding positions from one summer to the next, that the probability of movement will decrease with fish size, and that the largest fish in the population will have a movement probability of zero.

Testing Predictions

I tested the model's predictions using data on long distance inter-annual movements of Arctic grayling in the lower 140 km of the 260 km long Chena River, Yukon River drainage, Alaska. These data were collected by the Alaska Department of Fish and Game between 1991 and 1995 during their annual abundance assessments using an electrofishing boat (pulsed direct current). In all years both banks of the entire 140~km section were fished twice each summer during July and August and in most year fish were marked with individually numbered tags. All fish sampled were assigned a capture location with a precision of 5 km or better.

I analyzed data on fish that were captured in two consecutive years. The sample size for this analysis was 974 fish. I divided this sample into five length groups 150-199 mm, 200-249 mm, 250-299 mm, 300-349 mm, and >349mm and then calculated the proportion of fish in each group making inter-annual movements of at least 10~km. The number of fish in each of the length groups was 67, 393, 342, 143, and 29 fish respectively. I used linear regression to test the hypothesis that the probability of long-distance movement declined with fish size, and the hypothesis that the movement probability of the largest fish in the population was zero.

Results and Discussion

The model's predictions were well supported. The slope of a simple linear regression of the probability of fish movement on fish length was negative and crossed the x-axis at a length close to that of the largest fish in the population**.** The regression equation was: p-move = 0.277 – 0.00075 fish length ($p<0.001$; R squared 0.99). The largest fish captured between 1991 and 1995 was

410~mm, and this point on the x-axis lies above the upper 95% confidence band of the movement vs. body-size regression. The regression line itself crosses the x-axis at 370mm, only 0.5% of the fish sampled between 1991 and 1995 were larger than this. These results suggest that, at least for Arctic grayling, habitat selection theory can be developed to make useful predictions about migratory behavior.

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References

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