EFFECTS OF GROWTH MANIPULATION ON GROWTH, SPACE USE AND DOMINANCE OF JUVENILE ATLANTIC SALMON IN THE WILD

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Introduction

Growth rates of organisms under natural conditions are considered to be the results of complex sets of trade-offs involving foraging, energy expenditure, risk of predation and competition (Stearns 1992). Growth manipulations can have a major effect on the social interactions and patterns of resource use of individual animals (Nicieza & Metcalfe, 1999). Our aim in these experiments was to examine the effects of manipulation of natural growth rates on patterns of space use and social dominance in wild, juvenile Atlantic salmon.

Methods

Experiments were conducted in a flow-regulated, semi-natural stream channel adjacent to the Girnock Burn, Scotland in which an array of Passive Integrated Transponder (PIT) tag detector plates was set. The areas between the PIT tag detectors were landscaped with gravel, cobbles and boulders to resemble natural riffle habitat.

Groups of eight size-matched wild fish (n=3 in 1998, n=4 in 1999) were caught, anaesthetised, measured and implanted with a PIT tag in the peritoneal cavity. Fish were given a dominance rank from 1 to 8 after testing using a serial removal procedure adapted from Metcalfe et al. (1990) in an in-stream flume.

After dominance testing, fish were all placed together into the middle of the experimental section of stream and left undisturbed for 14 d. All movements of fish over detectors were logged with a computer system. At the end of this period they were caught, re-measured and the four fish with the lowest dominance ranks were implanted with a slow-release growth hormone (gh) pellet while the four fish with the highest dominance ranks were given a placebo. They were left undisturbed for a further 14 d after which they were caught, re-measured and dominance tested a second time.

Specific growth rates (SGR) were calculated and used as the response variable in ANOVAs. PIT tag data were used to calculate rates of fish movement. Parametric and non-parametric correlations were performed between crossing rate, SGR and dominance rank. Change in dominance rank following GH implantation was analysed non-parametrically using Mann-Whitney U tests.

Results

Month, treatment and three 2-way interactions (table 1) significantly affected growth rate. Gh significantly increased sgr but this effect was only apparent during trials in june and july (significant month x gh interaction). Patterns of change in sgr were different between sexes across trials (significant month x sex interaction). Implantation of gh during august and september had no effect on sgr.

Table 1. Significant results only of 4-way anova for sgr post-gh implantation

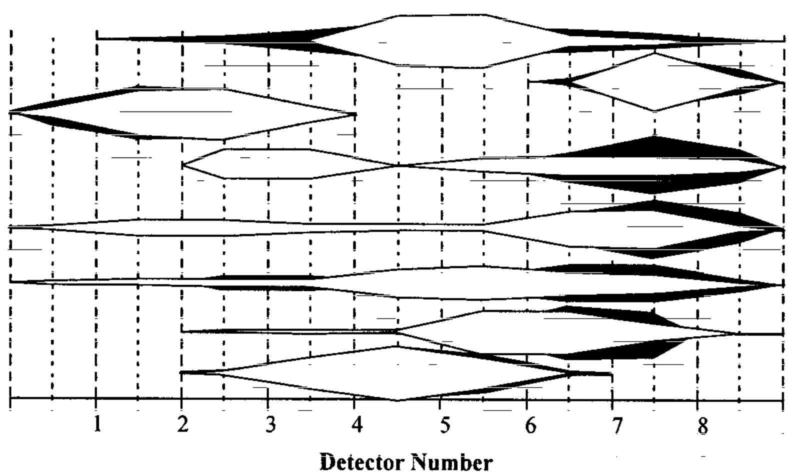
Source	df	F-value	p-value
Corrected model	26	4.38	<0.001
Intercept	1	44.58	<0.001
Month	3	14.64	<0.001
GH	1	9.96	0.005
Year x Month	2	4.08	0.033
Month x Sex	3	5.51	0.006
Month x GH	3	3.78	0.027
Error	20		
Total	47		

Post-implantation dominance rank showed no significant correlation with sgr but there were significant increases in the dominance ranks of fish receiving gh. Sixteen of 22 fish implanted with gh showed an increase in dominance rank (11 or which were greater than or equal to +3) while only four of 19 fish implanted with placebo showed increase in dominance rank (all of which were +1).

Since males and females did not show significantly different relationships between crossing rate and sgr in the pre-implantation period, data for both sexes post-implantation were pooled and analysed by gh treatment. There significant linear relationships between crossing rate and sgr for both placebo and gh fish and the regression lines were significantly different (ancova $f_{1,44}$=4.73, p=0.035).

Patterns of space use following implantation were almost exactly the same as before implantation (figure 1).

Figure 1. Patterns of space use exhibited by fish from trial 4 pre- and post-implantation. Fish are ranked in order of increasing dominance from top to bottom and width of polygon at any point is proportional to the time spent there. Post-implantation space use has been superimposed (in white) over the top of pre-implantation space use (in black).



Conclusions

We have demonstrated that growth rates can be experimentally increased in the wild, but only at certain times of year. We speculate that this is the result of decreasing food availability and increasing fish weight through the year. Furthermore, we have shown consequences of manipulated growth rate on social status. However, the lack of any relationships between social status, space use and growth rate suggests that these factors may be less important in the wild than exploratory movements in determining growth. We hypothesise that this is a result of high levels of spatio-temporal variation in food abundance.

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