AN INDIVIDUAL APPROACH TO MODELLING EFFECTS OF ENVIRONMENTAL FACTORS ON FEED INTAKE AND GROWTH OF ATLANTIC SALMON

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Introduction

This paper explains how results from investigations based on using individually identifiable fish can be used to model the effects of environmental factors on growth performance and feeding of Atlantic salmon, *Salmo salar* L. at different stages of its life cycle. Special reference will be made to potential applications of these findings in production planning of farmed salmon and in different approaches to experimental design.

The main aim of these studies was to produce a more detailed understanding of the inter-relationships between feed intake and growth for individual fish held in groups so that this knowledge could then be used by those working on growth related studies of salmonids and be helpful to the salmon farming industry in the development of efficient rearing protocols.

Materials and methods

A series of experiments was designed to determine the effects of photoperiod (using artificial lighting), ration level, sea water and sexual maturation on feed intake and growth rates of Atlantic salmon, *Salmo salar* L. at various stages of the life cycle.

Fork lengths (mm) and wet weights (g) were measured at regular intervals throughout each of the experiments. Specific growth rates (SGR, percent body weight per day) of individual fish between sampling dates were calculated using the following equation (Ricker, 1979): $SGR = ((\ln(W_t) - \ln(W_0)) \times 100)/t$, where W_0 and W_t are the initial and final weights of each fish (g) and t is the number of days between weighings.

X-radiography (Talbot and Higgins, 1983; Stead et al., 1996) was employed to measure feed intake of individual fish and radioimmunoassays (Stead et al. 1999) were used to determine levels of the male and female steroid hormones, 11-Ketotestosterone and estradiol-17β, respectively.

Food intake of individual fish was estimated as the mean of three measurements made at approximately biweekly intervals over a defined period of growth (Stead et al., 1996).

At each sampling date throughout each experiment, the weight, specific growth rates, food intake, weight-specific food conversion ratios (data not shown) and condition factors (data not shown) were compared. Analysis of variance (ANOVA) was used to examine differences within and between treatments where appropriate otherwise the antedependence method of Kenward (1987) was employed.

Results

Freshwater growth of Atlantic salmon parr may be increased or decreased during autumn and winter by manipulation of different photoperiod regimes, that is, under extended or shortened day lengths of 16 and 8 hours of light, respectively, when applied over consecutive time periods. Fish reared under extended day lengths had significantly greater weights, lengths, specific growth rates and food intake rates than those fish on shorter day lengths ($P<0.05$).

In Atlantic salmon smolts, fed at ration levels of 0.5, 1.0 and 3.0 percent body weight per day, growth performance in fresh water was not a significant determinant of subsequent seawater growth ($P>0.05$). Specific growth rates increased with increasing ration level in both freshwater and sea water ($P>0.05$). Salinity appeared to effect the feed intake-growth relationship more at higher rations than at lower ration levels.

During the early stages of reproductive development, immature fish had similar feeding rates and growth rates to those fish that were maturing. Thereafter, immature fish had higher growth rates. Two phases of sexual maturation were identified for maturing fish: an early phase (October – April) was characterised by slowly rising hormone levels concomitant with relatively high rates of feed intake and growth, and a late phase (May-October), steroid levels increased more rapidly and growth rates decreased in association with inappetence.

Discussion

The results illustrate the complexity of the interrelationships of feed intake and growth rate with photoperiod, ration, seawater and sexual maturation.

Although many underlying mechanisms which are involved in the regulation of a response to an environmental change are still to be answered, this paper seeks to explain how using individual based models can provide useful information that may be considered as part of a production plan for farmed salmon.

The findings presented in this paper also raise some interesting questions regarding best approaches to experimental design and statistical analyses when using groups of individual fish reared under culture.

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