Modelling sources of variation and risk factors for spinal deformity in farmed Atlantic salmon using hierarchical and cross-classified multilevel models

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Sources of variation and risk factors for spinal deformity were investigated in a 2002-2004 year-class database of farmed Atlantic salmon using multilevel modelling (Aunsmo et al., submitted 2008). The prevalence of spinal deformity, recorded on subsamples of Atlantic salmon at individual days of harvest, was used as the outcome variable in the study. The dataset consisted of a multilevel structure with days of harvest (n = 1441) nested within sea water pens (n = 544), which were nested within sea water sites (n = 39), which again were cross-classified with fresh water plants (n = 21). A four level combined hierarchical and cross-classified model was built in MLwiN using Markov chain Monte Carlo (MCMC) estimation of variance components and fixed effects.

Results revealed that a large part of the variance could be explained as sampling and classification random errors, accounting for 32% of the variation in the random intercept model and 41% of the variation in the final mixed effect model. Of the remaining "biological variation", 32% were explained by fixed effects where both the use half-year and one-and-a-half year old photo-manipulated autumn smolts (compared to using one year old spring smolt), and the use of six component vaccines (compared to using four and five component vaccines), were significantly associated with spinal deformity. The results suggest that the physiological changes at time of smoltification make Atlantic salmon susceptible to stressors causing vertebral deformation and that this is most evident in photo-manipulated fish smoltifying when temperature and growth is at its peak. The study further shows the potential of using multilevel modelling in epidemiological studies based on data from industrial aquaculture.

References

Aunsmo, A., Øvretveit, S., Breck, O., Valle, P.S., Larssen, R.B., Sandberg, M. Modelling sources of variation and risk for spinal deformity in farmed Atlantic salmon using hierarchical and cross-classified multilevel models. Prev. Vet. Med. (submitted 2008).