The epidemiology of Red Mark Syndrome in Scottish farmed rainbow trout (*Oncorhynchus mykiss*)

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Introduction

Red Mark Syndrome (RMS) is a skin disease of farmed rainbow trout characterised by single to multifocal reddened lesions. It first occurred in Scotland in 2003 and has since spread to over 60% of Scottish farms. No aetiological agent has been consistently identified. RMS appears to have a complex, multifactorial aetiology and has been shown to be transmissible in laboratory trials (Verner-Jeffreys et al., 2008). The condition is non-lethal, but causes significant financial losses to farmers through downgrading and rejection of affected fish at harvest.

This study aims to model the spread of RMS in Scotland from 2003 to 2008.

Classical RMS lesions in farmed rainbow trout

Methods

- 42 rainbow trout farms in total in Scotland
  - 34 eligible for inclusion in model (remainder were fallow or unable to provide data)
  - 24 sites included in the final model (>4 sources of fish)
    - 8 sites had 4 or fewer contacts from 2003-08
    - No information on sources of fish for 2 sites.

- Date of first occurrence recorded during farm visits (and date of recovery, if applicable)

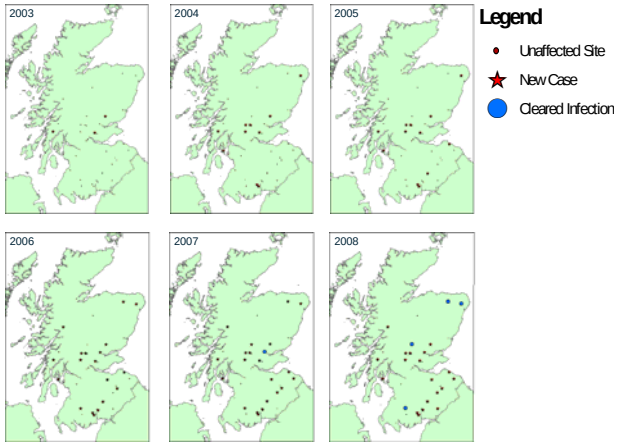
- Mapping of location and RMS status of each farm using ArcMap GIS software (ArcMap version 9.2, ESRI, 2006)

- Model structure:
  - Susceptible $\Longleftrightarrow$ Infectious (SIS model)

- The model is based on the following equations, where b=transmission coefficient and m=recovery rate:
  - $S_{t+1}=S_t-bIS_t+mI_t$
  - $I_{t+1}=I_t+bIS_t-mI_t$

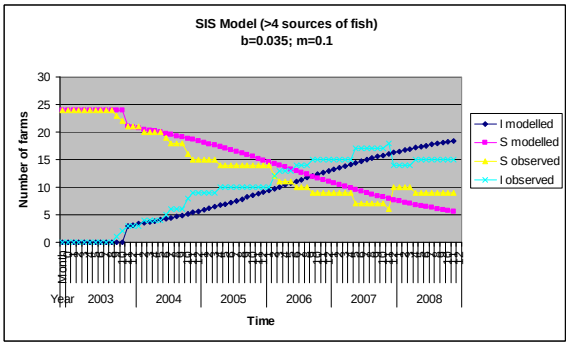
Results

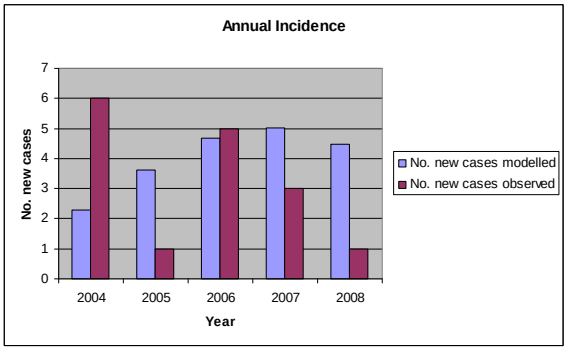
- Maps of cases by year



Results

- An SIS model where all sites were included gave a much higher incidence and recovery rate (b=0.06, m=0.8) than was indicated by the observed pattern of persistent infection on farms.
- The model assumes an equal probability of contact between all sites.
- In a separate univariate analysis of risk factors for RMS, sites with >4 sources of fish from 2003-2008 were at increased risk of RMS (odds ratio = 8, 90% CI = 1.437 - 46.149).
- When only sites with >4 sources of fish were included, a more representative model of the observed prevalence and incidence was obtained (b=0.035, m=0.1).





$R_0 = b(N-1)/m = 0.035(24-1)/0.1 = \underline{8.05}$

Conclusions

- An initial epidemic occurred after RMS was first observed in 2003
- RMS is now endemic in Scotland
- Some farms will have experienced unobserved recovery and reinfection during the study period, as the recovery rate is greater than 0.
- Sites with very few suppliers of live fish and ova have a lower probability of infection due to their limited contact with other sites.

Acknowledgements

Thank you to all of the staff and owners of the farms that took part in this study.

References

Verner-Jeffreys, D.W.; Pond, M.J.; Peeler, E.J.; Rimmer, G.S.E.; Oidtmann, B.; Way, K.; Mewett, J.; Jeffrey, K.; Bateman, K.; Reese, R.A.; Feist, S.W. Emergence of cold water strawberry disease of rainbow trout *Oncorynchus mykiss* in England and Wales: outbreak investigations and transmission studies. Diseases of Aquatic Organisms 79: 207-218. 2008.