TEMPERATURE AND FISH BIOMASS DATA SUPPORT A TOOL FOR PREDICTING SALMON MORTALITY IN SCOTLAND

Alexander G Murray & Meadhbh Moriarty
Marine Scotland Science, Aberdeen

marine scotland science

Scottish Government
Riaghaltas na h-Alba
gov.scot

Salmon Aquaculture and Salmon Mortality

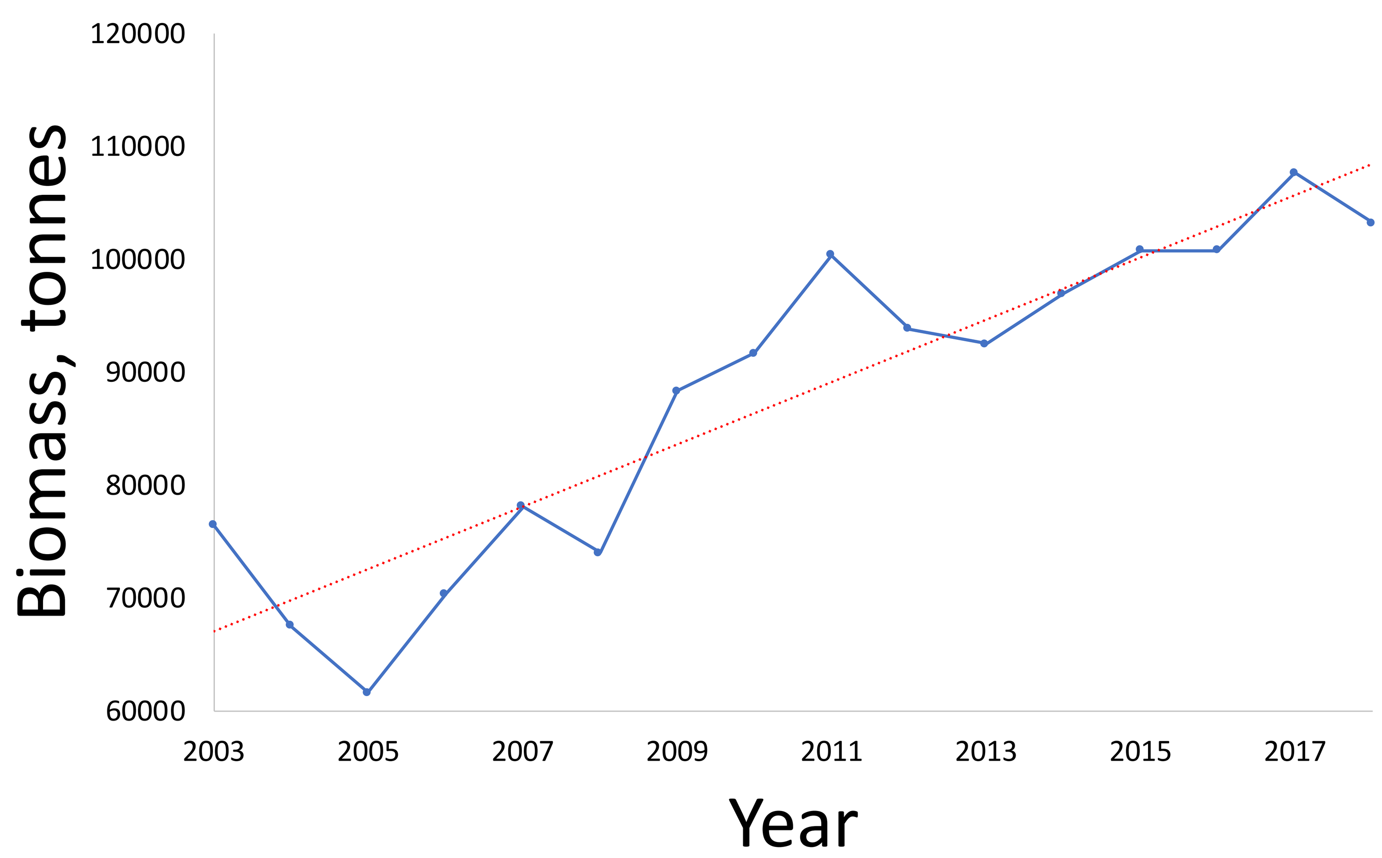
Salmon aquaculture produces over £1BN for the Scottish economy, its expansion is supported by both government and industry provided this is sustainable.

However, losses of biomass has increased from 0.7% month^{-1} in 2003 to 2% month^{-1} in 2017.

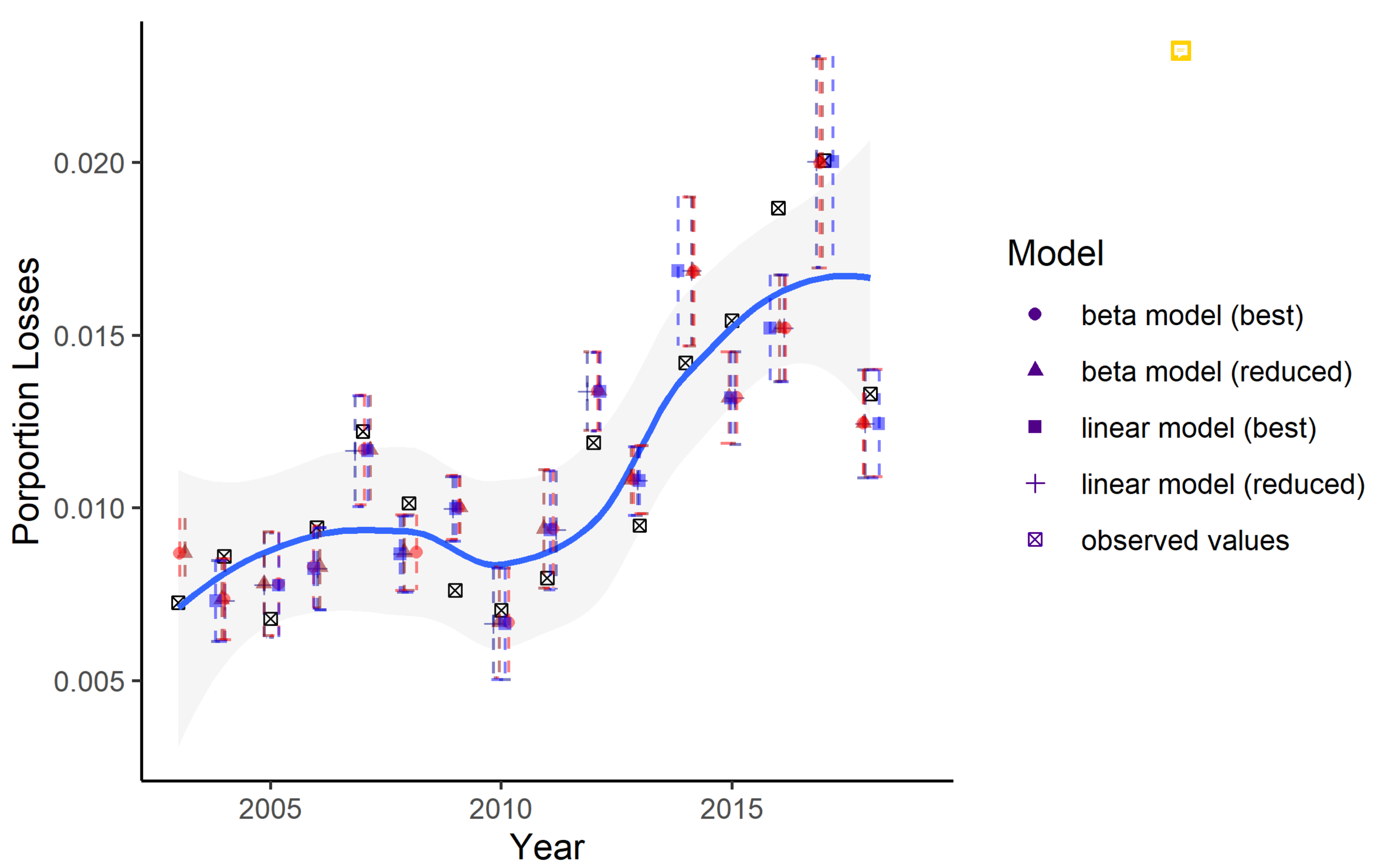
Drivers of mortality include diseases and parasites which are expected to be associated with temperatures and fish density and these are investigated here

Data

1. Biomass (B) and mortality (m) data obtained from Scotland's Aquaculture website.
2. Proportion of biomass lost or Mortality rate (M) was calculated from m/B
3. Winter minimum (Aw) and summer maximum (As) air temperatures were obtained from Met Office website

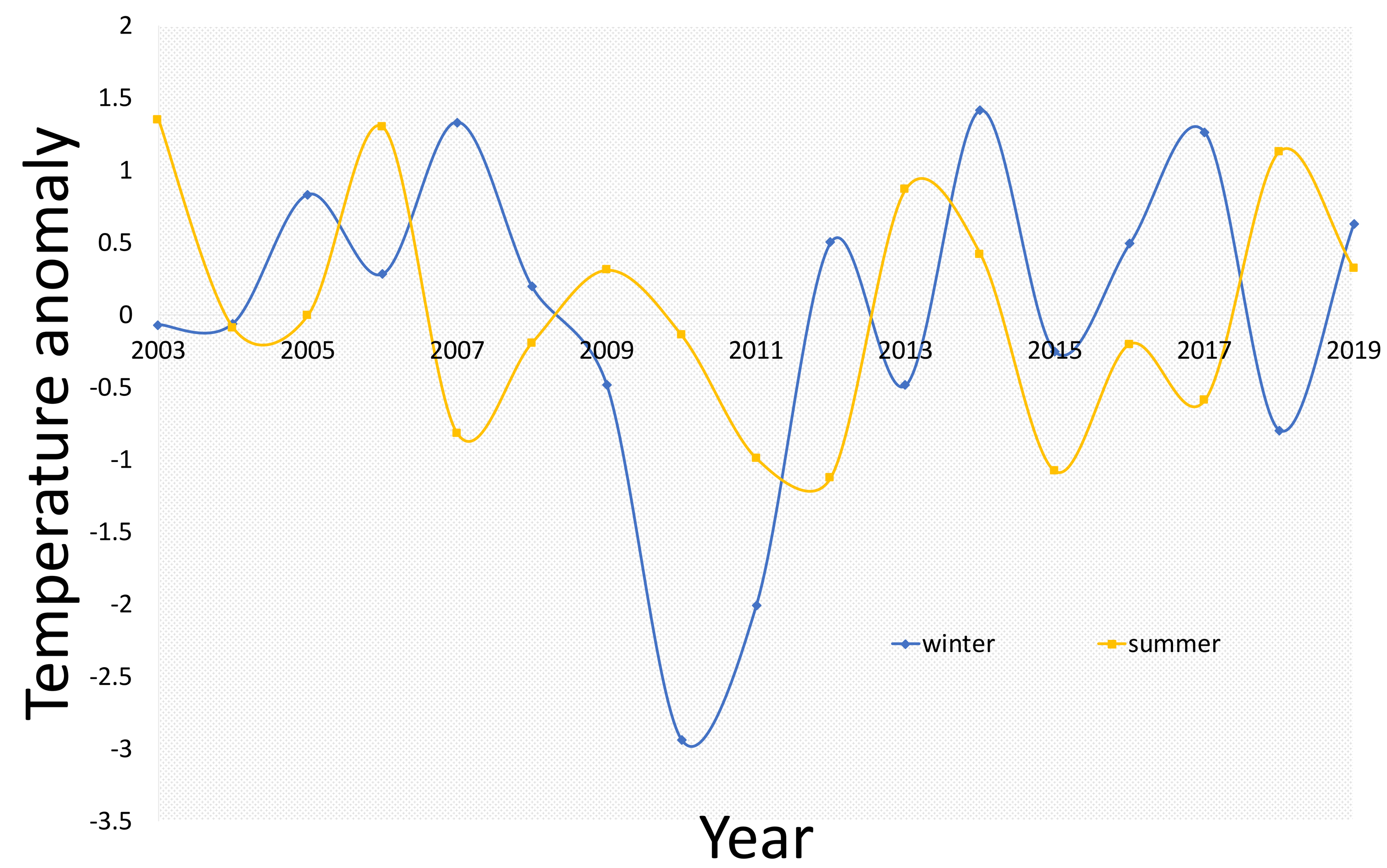


Biomass increased almost linearly



Model results and observed losses 2003-2018

Temperature anomaly varied, with particularly cold winters 2010 and 2011



Models

Both generalized linear and beta regression and logistic regression models were developed to compare the inference from both and to estimate the covariate effects on the proportion of biomass lost (M). Aw and B explain 82% of variation in M at national level. Although As has a small effect at the regional level models its exclusion (reduced model) can allow predictions to be made early in the year.

	National Model				Regional Model			
	Linear Regression		Beta Regression		Linear Regression		Beta Regression	
	best fit	reduced fit	best fit	reduced fit	best fit	reduced fit	best fit	reduced fit
Explanatory variables								
Biomass	✓	✓	✓	✓	✓	✓	✓	✓
Air temperature winter	✓	✓	✓	✓	✓	✓	✓	✓
Air temperature summer	×	Not applicable	×	Not applicable	✓	Not applicable	✓	Not applicable
Region	Not applicable				✓	✓	✓	✓
Region : Biomass	Not applicable				✓	✓	✓	✓
Region : Air temperature winter	Not applicable				✓	✓	✓	✓
Region : Air temperature summer	Not applicable				✓	Not applicable	✓	Not applicable
Biomass : Air temperature summer	×	×	×	×	✓	✓	✓	✓
Biomass : Air temperature summer	×	×	×	Not applicable	✓	Not applicable	✓	Not applicable
Model Performance								
r^2	82.4%	82.4%	81.8%	81.8%	69.6%	63.07%	68.9%	61.4%
MAPE	0.137%	0.137%	0.137%	0.137%	0.249%	0.283%	0.245%	0.281%
MPE	-0.021%	-0.021%	-0.025%	-0.025%	-0.095%	-0.11%	-0.091%	-0.11%

Diseases as drivers of mortality

Increased mortality with milder winters and higher biomass fits with patterns expected for disease problems. Milder winters mean more pathogens survive. Mortality actually occurs in late summer/autumn, but winter is the driver. Higher host population density leads to more spread of pathogens, including sea lice.

Conclusion

Winter minimum temperatures allow mortality to be forecast with a high degree of accuracy (biomass changes less). Since winter temperature data are published in March, this tool allows mortality to be predicted 9 months in advance. It also allows longer term identification of vulnerability to milder winters that are predicted in Marine Climate Change Impact Partnership assessments for the UK.