IT'S SEASONAL

Christian Schnier | University of Helsinki | Faculty of Veterinary Medicine | Finland

THE PROBLEM

Seasonality is evident in the incidences of metritis, ketosis, ovarian disorders, parturient paresis and early mastitis of Finnish dairy cattle. Seasonal effects are dissimilar in distinct regions (Figures 1a-5a). The traditional way to model seasonal effects – inclusion of a categorical variable – ignores any area effect and assumes that at 3-4 points in time incidence risks change suddenly for all cows in the target population. Alternative ways to model seasonal effects fit better to both theory and data.

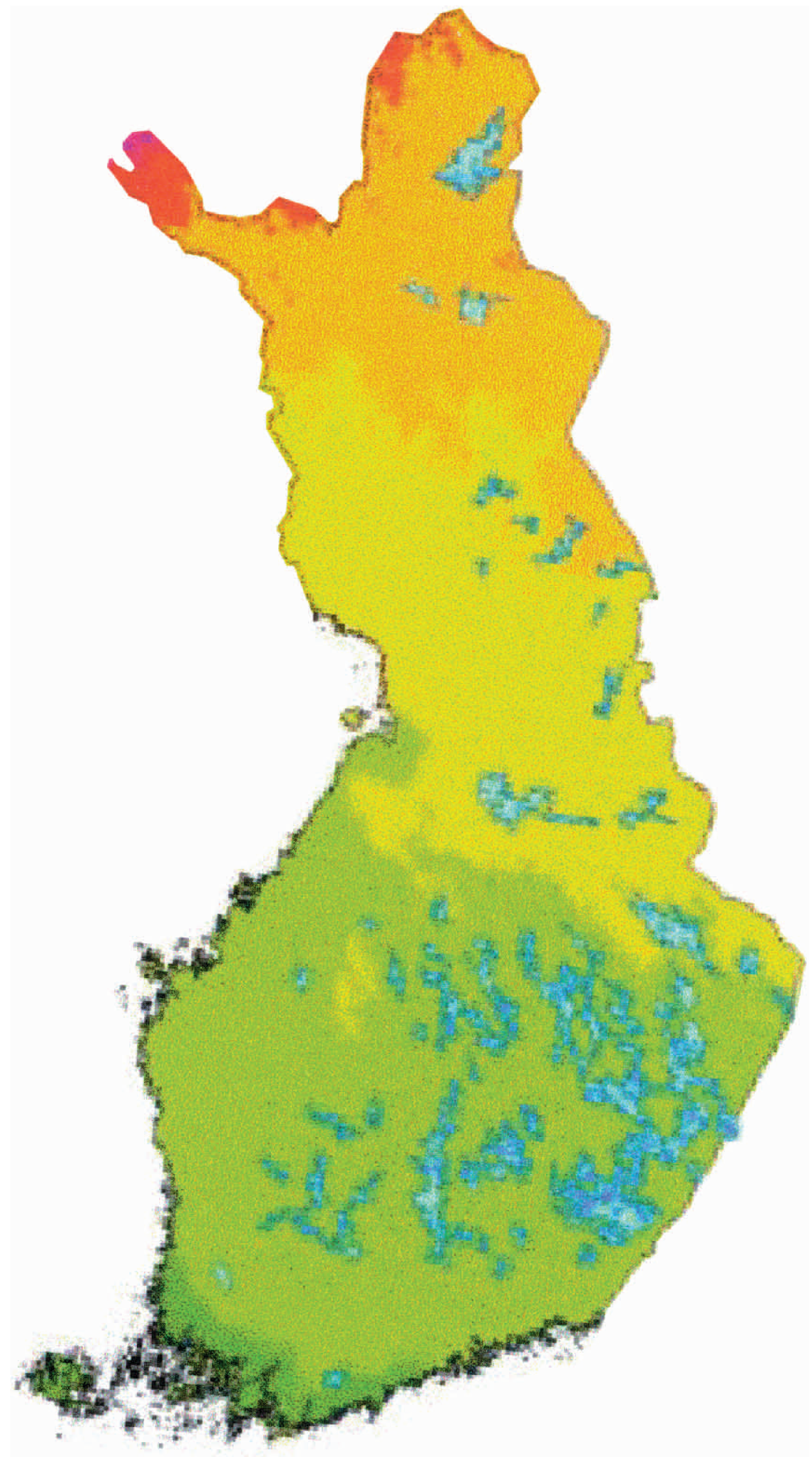
MATERIALS AND METHODS

STUDY POPULATION: 11800 cows from all over Finland (12 veterinary districts).

STUDY PERIOD: Cows calving in the year 2000.

DESCRIPTIVES: Weekly cumulative incidences were calculated for 4 climatically distinct areas (Lapland, upper middle Finland, lower middle Finland and South Finland; see map). Weekly incidences were then smoothed (using LOWESS-smoothing procedure).

MODELLING: Logistic regression models (GEE) with different seasonal predictors were compared using AIC and the log-likelihood ratio.



Source: NORDKLIM-REPORT, Norwegian Meteorological Institute

Mean length (days) of the growing season (>5°C).

175–200 | 150–175 | 125–150 | 100–125 | 75–100

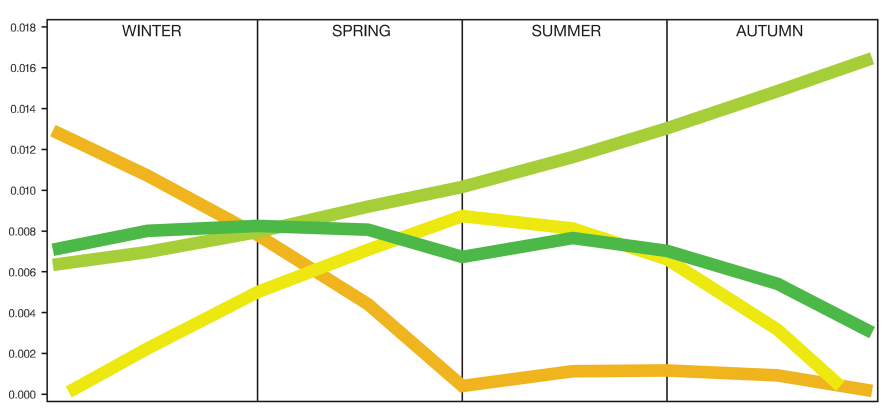


Figure 1a: Smoothed incidence of metritis.

MODEL 1: Traditionally, seasonal effects are modelled using a categorical area unspecific time-dependent predictor. Incidence risks are assumed to change suddenly for all cows in the target population at 4 pre-specified points in time (Figure 1b). This assumption is unrealistic for most 'seasonal' predictors in a larger target population like cows in Finland (the end of the milk-quota year would fit). Using this model, seasonal effects were only shown for ketosis and ovarian disorders.

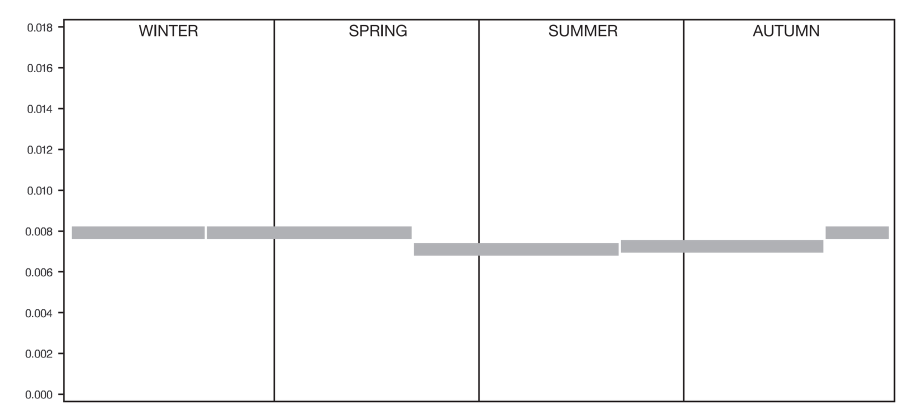


Figure 1b: Predicted incidence of metritis.

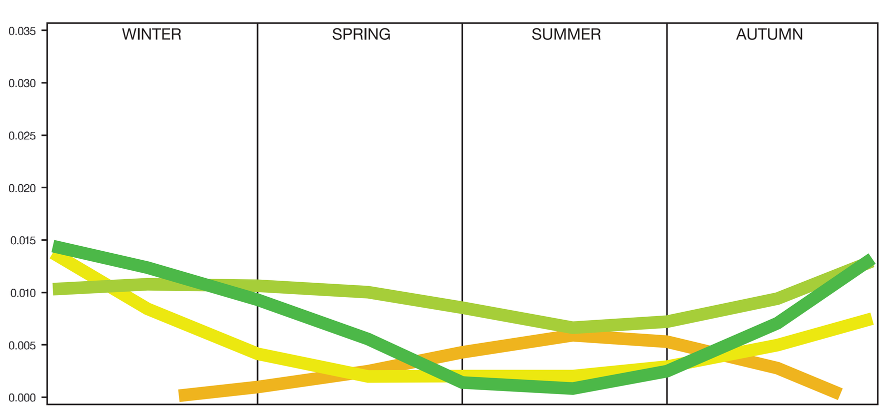


Figure 2a: Smoothed incidence of ketosis.

MODEL 2: To allow for area effects and to give the seasonal effects more meaning seasons can be defined having different length in different areas. One possibility is to define 'growing seasons' (see map). Growing seasons are closely related to pasture period and different feeding regimes, so interpretation of seasonal effects is more straight-forward. Compared to Model 1, this model had better fit (lower AIC) for diseases with strong seasonal pattern (ovarian disorders and parturient paresis). Seasonal effects were shown for of parturient paresis, ketosis and ovarian disorders.

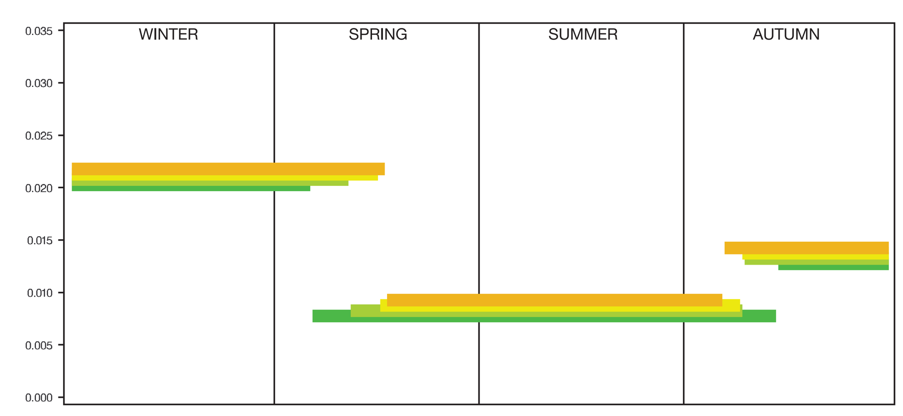


Figure 2b: Predicted incidence of ketosis.

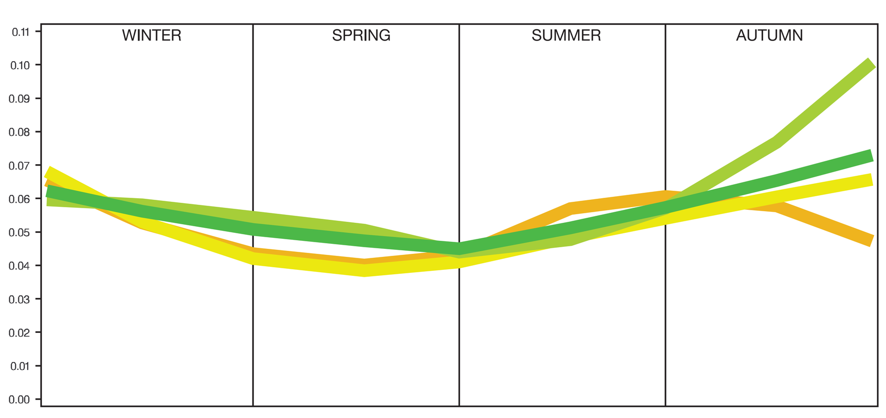


Figure 3a: Smoothed incidence of ovarian disorders.

MODEL 3: To allow for continuous cyclic seasonal effects a model can be constructed that includes 2 continuous time-dependent variables:
$\cos(2 \times \pi \times T/P)$ and $\sin(2 \times \pi \times T/P)$
with T = calving-week and P = duration of 1 cycle (52 weeks).
Based on AIC and log-likelihood ratios, this model showed the best fit for the incidence of ovarian disorders (Figure 3b). Besides a good fit of observed and predicted incidences the beauty of the model stems from the low number of estimated parameters (2).

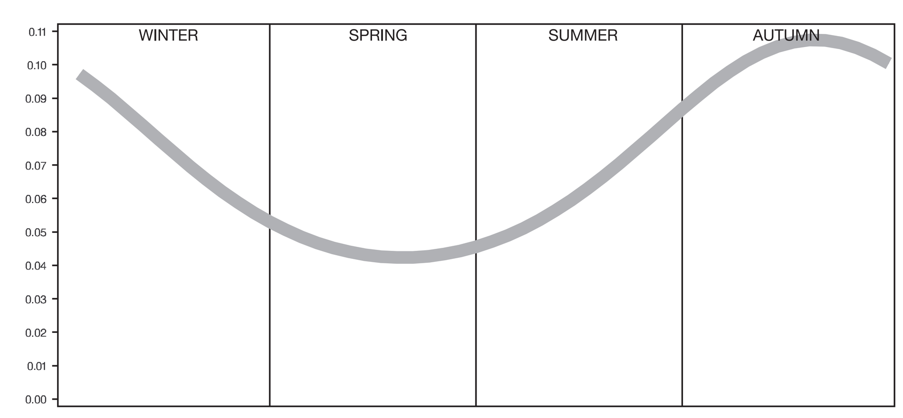


Figure 3b: Predicted incidence of ovarian disorders.

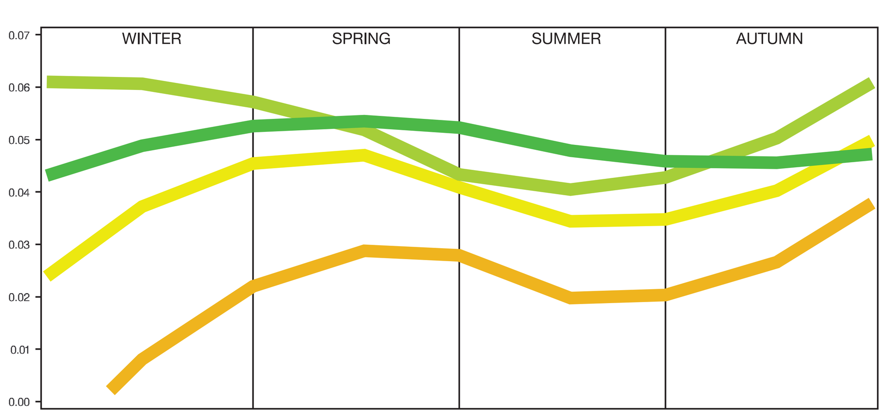


Figure 4a: Smoothed incidence of parturient paresis.

MODEL 4: The model with continuous time variables can be further developed by including an area specific intercept. The smoothed incidence of parturient paresis, for example, shows a parallel seasonal pattern (Figure 4a). Using AIC and log-likelihood ratios for comparison, this model had the best fit for parturient paresis, metritis and ketosis. The increased risk of parturient paresis towards the end of the year in the 2 northern areas (Figure 4a) is problematic because in this form the model assumes same risks at the beginning and the end of the year. Nevertheless, addition of an area specific linear time effect did not significantly improve model fit.

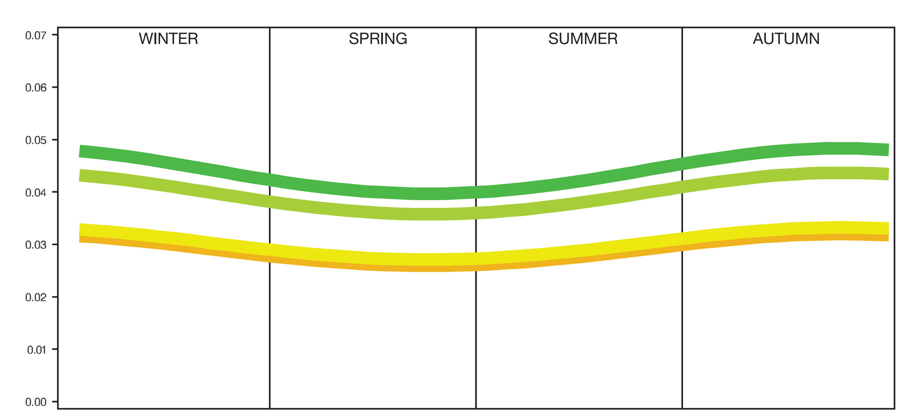


Figure 4b: Predicted incidence of parturient paresis.

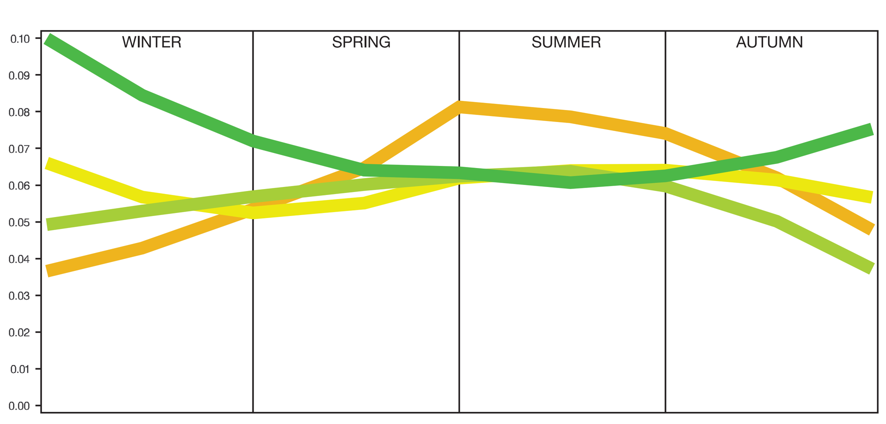


Figure 5a: Smoothed incidence of early mastitis.

MODEL 5: Finally, with inclusion of time × area interactions a model can be developed that allows area specific seasonal patterns. This model showed significant seasonal effects on the incidence of early mastitis – none of the other models showed such effects. Unfortunately, this model needs a large study population, because 11 parameters have to be estimated. Models 3, 4 and 5 are nested, so model fit can be compared using log-likelihood ratios. If lack of fit in any of the models was evident, additional time-dependent variables could be introduced (for example, $\cos(\pi \times T/P)$ and $\sin(\pi \times T/P)$). Using this model, seasonal effects were shown for all studied diseases.

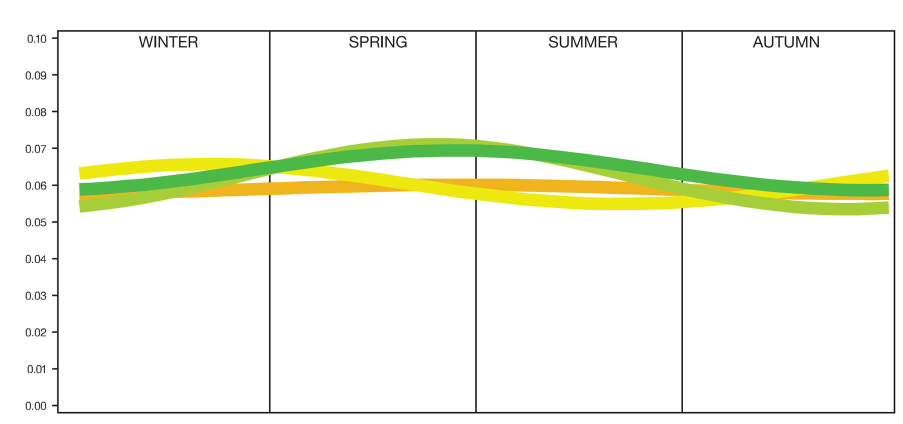


Figure 5b: Predicted incidence of early mastitis.