# Analysis of Censored, Ordered Responses from a U.K. Sheep Health Study

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## Introduction

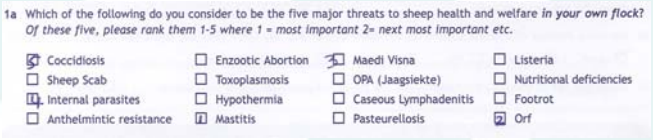
As part of a survey of farmers' perceptions of the risks associated with different health problems in sheep, participants were asked to rank the top five health threats facing their flocks from a closed list of 16 options. These data are ordered, in that a ranking is imposed on the five responses; and censored, in that a maximum of five responses are allowed per participant.

## Survey

The target population was the population of UK sheep farmers sufficiently motivated to join an animal health organisation or attend animal health events. Questionnaires were distributed by post to farming members of the Moredun Foundation, a farming charity which promotes high standards of animal health and welfare, and also at agricultural shows over a six-month period in 2004. 510 questionnaires were completed and returned during the lifetime of the study.

## Data

Participants recorded their responses by assigning an integer between 1 and 5 to five fields, and leaving the other 11 fields blank.


1a Which of the following do you consider to be the five major threats to sheep health and welfare *in your own flock? Of these five, please rank them 1-5 where 1 = most important 2= next most important etc.*

| | | | |
|---|---|---|---|
| Coccidiosis | Enzootic Abortion | Maedi Visna | Listeria |
| Sheep Scab | Toxoplasmosis | OPA (Jaagsiekte) | Nutritional deficiencies |
| Internal parasites | Hypothermia | Caseous Lymphadenitis | Footrot |
| Anthelmintic resistance | Mastitis | Pasteurellosis | Orf |

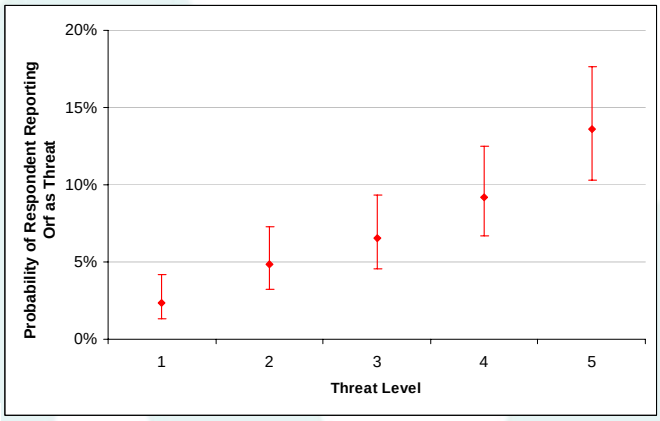
These data were restructured into sets of 80 Bernoulli random variables, indicating whether each disease option was or was not selected during each of the 5 possible ranking occasions. It is assumed that the ranking progresses sequentially, and that once a disease has been ranked as a high risk option, it is no longer available to be selected as a lower risk. Such random variables are recorded as missing values.

## Analysis

Data restructured into this form were analysed using generalised linear models (GLMs), with a Binomial response term. A factor defining the ranking associated with each datum allows a model to be fitted which identifies diseases with a variable threat profile: i.e., where a disease is more or less likely to be reported as a high risk option. Other factors examined included those defining geographical position, and factors reflecting the reporting of other health problems as risks.

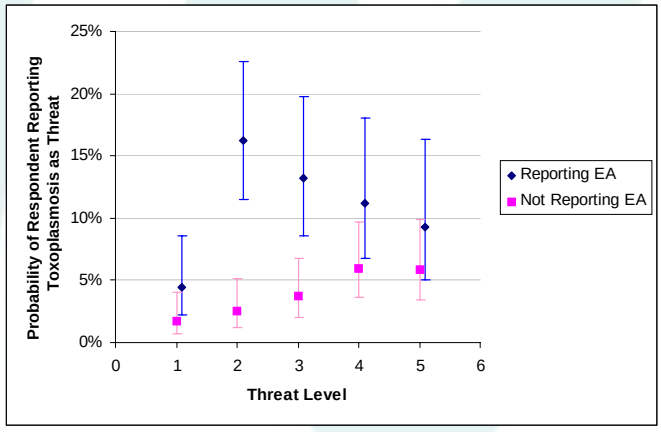
## Threat Profiling

An example of a disease with a variable threat profile is Orf, where respondents were statistically significantly more likely to report this infection as a low level risk than as a high level problem ($p<0.001$).




## Interaction with Other Threats

Enzootic Abortion and Toxoplasmosis tend to be reported together on farms. The threat profile is different depending on the absence/presence of the other disease ($p<0.001$).




## Conclusions

The use of GLMs to analyse ranked responses from a closed list allows estimation of the mean probability of respondents reporting each option as a threat. The modelling approach allows the analyst to identify diseases with different threat profiles, or with different threat profiles in different regions or under different conditions. The use of a GLM is a powerful approach which extracts maximal information from this type of data.

### Acknowledgements

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