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Sampling within heterogeneous systems: choosing a robust model

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Sampling Programmes

- Typically based around a statistical distribution
- Sampling biological systems is inherently difficult
- Natural environmental variation

NTbiosecurity





Sampling stored grains

- Variation may be driven by a number of factors
 - Species behaviour
 - Climatic conditions
 - Human induced factors



Difficult to find representative dist



Sampling stored grains

How do we overcome this????





Fitting statistical distributions

- Find the distribution that best describes the system
- Make assumptions that may not be 100% correct
 - Binomial
 - Poisson

NTbiosecurity

- Negative Binomial





Grains sampling

- Early sampling protocols based on poor assumptions
- Did not consider insect ecology and behaviour





Experimental data





Model Comparisons

- Poisson
- Negative Binomial
- Our Model (Elmouttie et al. 2010)
- Parameter estimates for each model generated from sampling data
- Used parameter estimates to populate models to determine n



Model Comparisons

- Data used in Monte carol simulations
 - 10000 iteration
 - 95% probability of detection
 - Percentage success recorded.





Data description	Our model	Negative Binomial	Poisson
$L_{density} L_{infestation}$	97-98	92-97	84-97
M _{density} M _{infestation}	93-97	92-99	64-78
M density H infestation	93-95	92-94	71-80
$H_{density} H_{infestation}$	93-97	97-99	90-97
H _{density} L _{infestation}	94-95	72-91	12-24
$M_{density} L_{infestation}$	95-97	82-99	69-79

**80+ Sampling events



Poisson Approach

 Does not consider heterogeneity rather rarity

- 1 1 0 4 4 1 2 3 0 1 0 0 5 0 1 1 2 1 7 0 Med density 2 1 7 0 Med infestation 1 1 14 2 5 2 1 4 1 1 2 0 1 16 3 0 1 1 0 0 0 0
 - 0 0 0 0 0 0 0 0 11 18 1 0 0 0 0 0 0 0 0 11 18 1 Low infestation 0 0 0 3 1 1 0 0 0 0 0 0 0 0 179 151 15 0 0 0 0

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Negative binomial

Considers species aggregation

Low density Med density High density Low infestation 2170 Med infestation Low infestation 1 1 1 4 196 33



Our approach

- Based on a two step model
 - Probability of sampling infested portion of the lot
 - Once in the infested portion determining the probability of drawing a positive sample
 - Explicitly considers heterogeneity

CRC PLANT biosecurity

Elmouttie *et al.* 2010

Our approach

- Performs well over a broad range of data
- Is not highly influenced by inflated means or large differences in meanvariance



Elmouttie *et al.* 2010

Discussion

Important to develop a flexible robust sampling programmes

 Here we have demonstrated that over a broad range of scenarios our model out performs traditional techniques



Elmouttie *et al.* 2010

Future

 Consider variation throughout the distribution and supply chain





Acknowledgements

- CRCNPB
- Graincorp, Viterra & CBH
- Growers
- Mr Philip Burrill (Deedi)
- US collaborators (USDA & Kansas State)
 - Dr. Paul Flynn,
 - Prof. Bhadriraju Subramanyam,
 - Dr. Dave Hagstrum



Thank you

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