CRC PLANT biosecurity

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Estimating the probability of detection under cryptic heterogeneity

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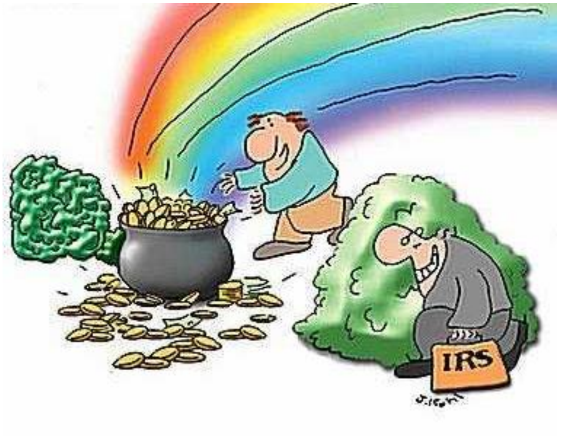
Probability of detection

- Essential to the study of Ecology

  - What is present
  - How many are present
  - Management
  - EIS

Detectability

- Everything has a detection probability



- Detection probabilities for flora and fauna are often < 1

MacKenzie *et al.* (2002), Wintle *et al.* (2004)

Probability of Detection

- Bernoulli or Binomial distribution

$$D = 1 - (1 - d)^{v}$$

Wintle *et al.* 2005

- v = number of visits/samples
- d = single visit detectability

Heterogeneity and detection

- Although single visit detectability is considered, models do not consider heterogeneity

- Consideration of spatial scale
  - Landscape
  - Local area or habitat patch
  - Confined area *i.e.* grain silo

Heterogeneity and detection

- Irrespective of spatial scale species detection will be influenced by:-

  - Proportion of site/habitat utilised
  - Density of individuals
  - Individual species detectability
  - Sampling intensity

Cryptic Heterogeneity

- It is often difficult to determine how heterogeneous an environment is

  - Species dependent
  - Temporal influence
  - Microclimatic factors

Elmouttie *et al.* 2010 *in press*

Considering heterogeneity

$$P1(d) = 1 - (1 - p + pe^{-\alpha\lambda d})^n$$

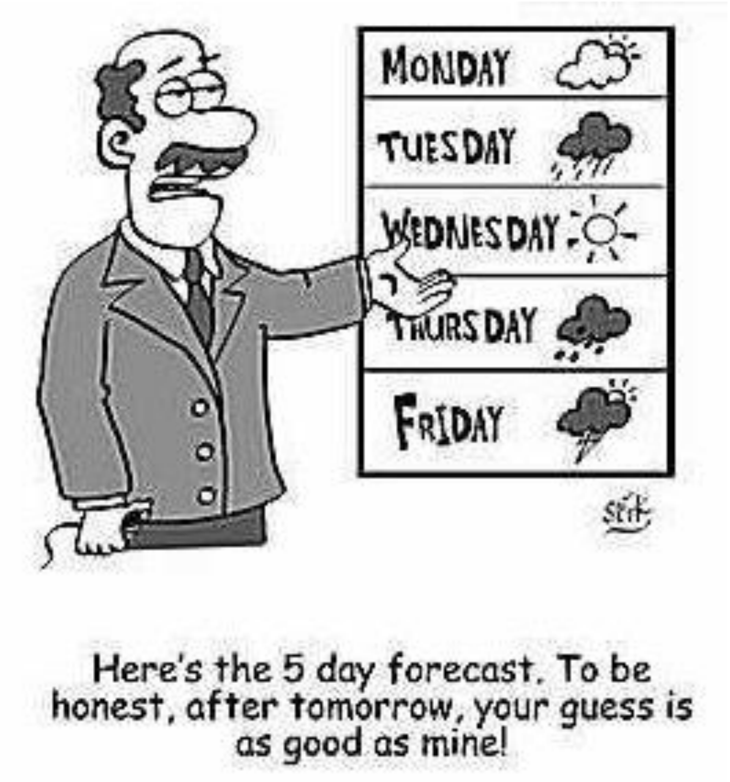
- p represents the proportion of the site utilised
- α represents the sub sample size (area)
- λ density of what is being sampled the populated portion of the site
- d single visit detectability
- n number of subsamples

Elmouttie *et al.* 2010 *in press*

Parameter estimates

- generating parameter estimates

  - p (heterogeneity)
  - λ (density)
  - d (detectability)



Elmouttie *et al.* 2010 *in press*

Example – insects in grain

- Insect pest are major problem in stored grains

- Detection probabilities typically based on assumption of homogeneity

i.e. Love *et al.* 1983 – $P2(d) = 1 - (1 - \theta)^{v}$

θ = *Sample fraction* & v = *number of insects*

Elmouttie *et al.* 2010 *in press*

Example - insects in grain

- Develop parameter estimates (p, λ)

  - Intensive sampling
    (25 x 3 samples drawn)

  - *Sitophilus oryzae, Rhyzopertha dominica, Cryptolestes spp.*

Elmouttie *et al.* 2010 *in press*

Model Validation

- Use parameter estimates to populate both models (Homogeneous/ Heterogeneous)

  - (0.75,0.85,0.95)
  - Sample surrounding silo's
  - Replicated in each test silo

Elmouttie *et al.* 2010 *in press*

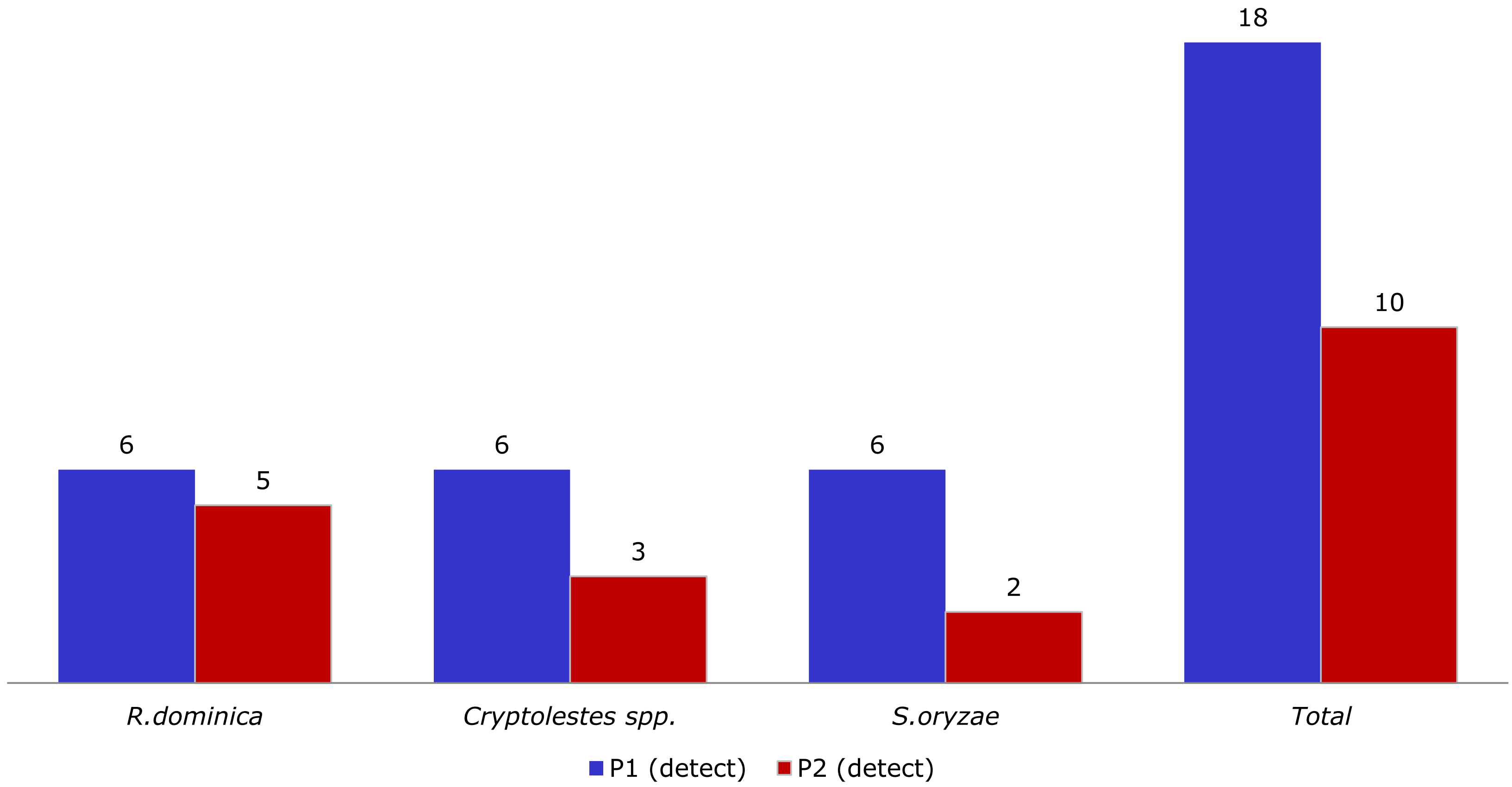
Results

Predictions of Two models. *P1(d)* – predictions assuming heterogeneity and *P2(d)* – prediction for model which does not consider heterogeneity

		P1(d)	***P2(d)***
	Probability of Detection(%)	Model Prediction – Sampling intensity	Model Prediction – Sampling intensity
R. dominica *p = 0.61; λ = 13.1*	95	3	1
	85	2	1
	75	1	1
Cryptolestes Spp. p = 0.5; λ = 17.4	95	5	1
	85	3	1
	75	2	1
S. oryzae p = 0.2; λ = 13.04	**95**	**13**	**1**
	85	9	1
	75	6	1

Elmouttie *et al.* 2010 *in press*

Results



Elmouttie *et al.* 2010 *in press*

Example – detectability < 1

- Two Australian tropical Rainforest plants

  - *Acronychia acidula, Acronychia vestita*
  - Patchily distributed
  - Not in equal densities
  - Can be difficult to identify

Parameter Estimation

- p & λ estimated from single rainforest site
- d estimated from proportion of *A.vestita* – *A.acidula* and expert opinion
- Paramaters used to populate model for two detection probabilities (0.85,0.95)

Parameter estimates

- p = 56% of sample units
- λ = mean density of 1.1 individuals per sample unit
- d = 0.16 ‘real ratio’
  = 0.2 expert opinion

Results

Detection success (15 replicate trials) for *Acronychia vestita* under intensity (n), predicted when species detectability is incorporated and when it is not.

P1(d)	***n*** ***d= 0.16***	**S1**	**S2**	***n*** ***d= 0.2***	**S1**	**S2**	**n** ***d*=1**	**S1**	**S2**
85	20	15	13	17	13	12	4	3	0
95	32	15	15	28	15	13	7	6	3

Discussion

- Considering species distribution improves detection probability estimates
- Misidentification needs to be considered
- Expert opinion can provide robust estimates for certain model parameters

Thank you

- For more information, please email

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