OMAFRA Emergency Management Research Expo
Guelph, September 19., 2011

Diagnostic Misclassification in Geographic Epidemiology*

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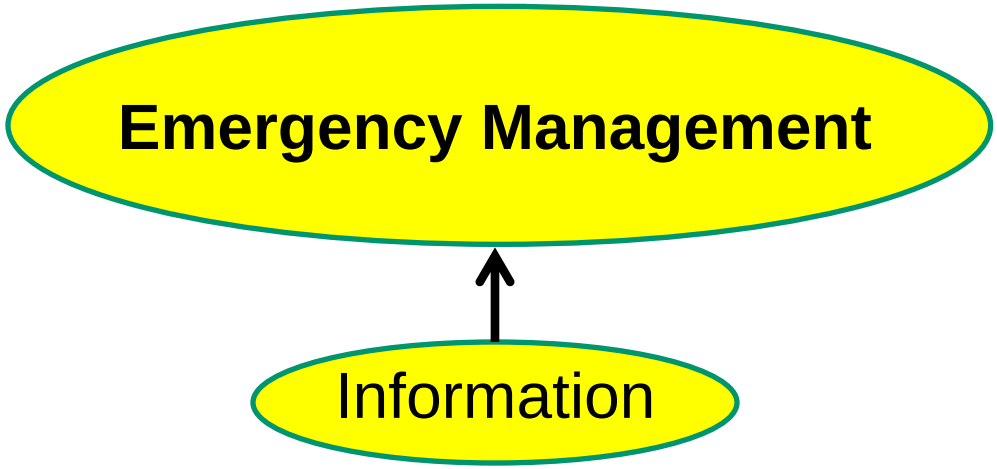
*Supported through OMAFRA grants 200017 & 200375

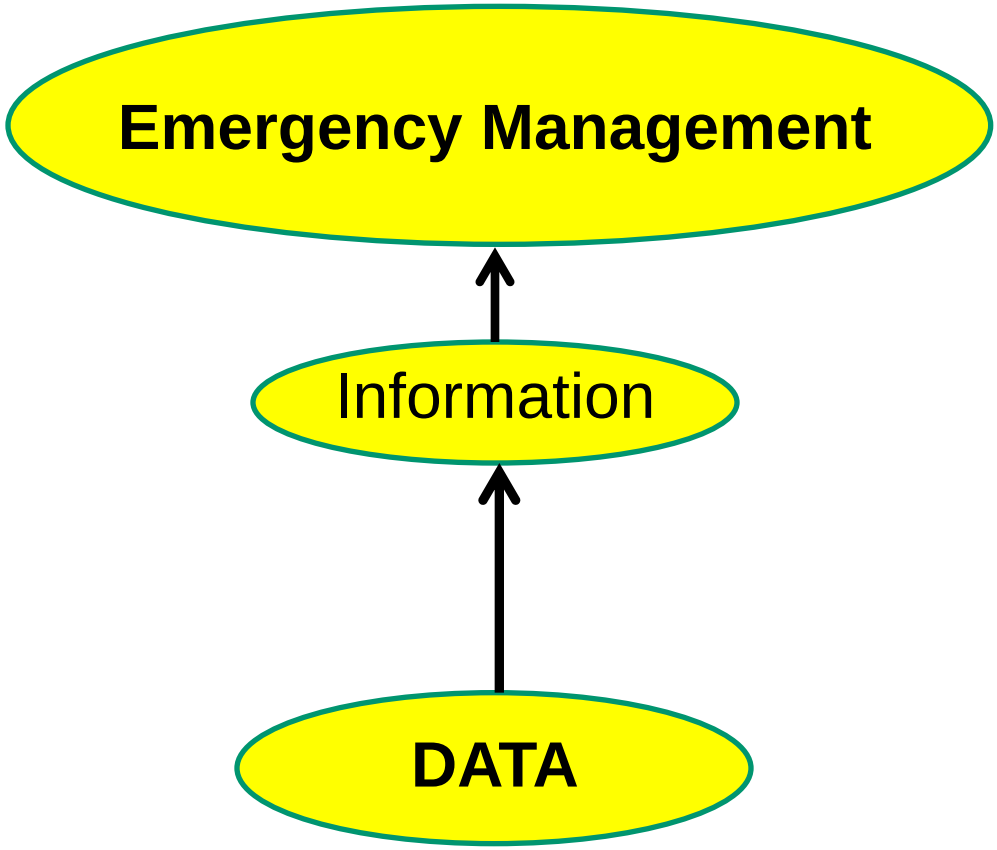
Motivation

Emergency Management

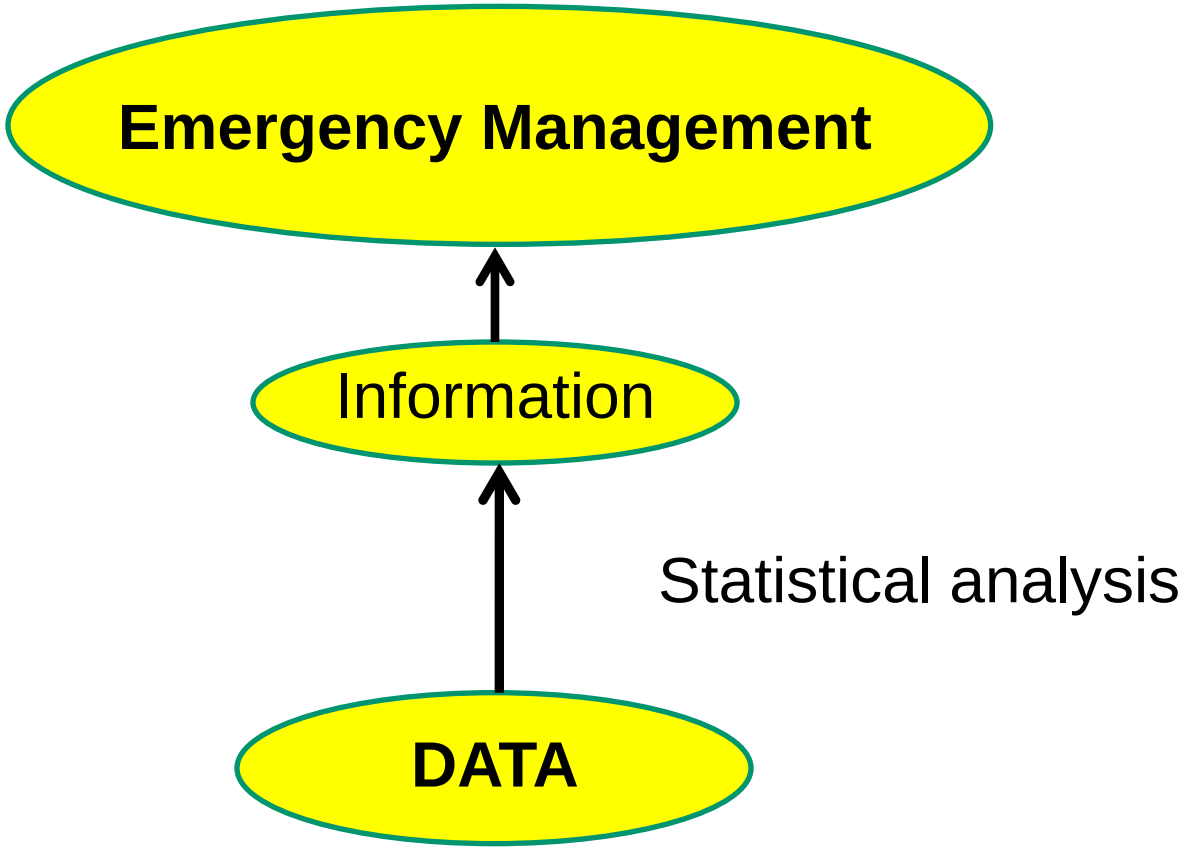
Motivation



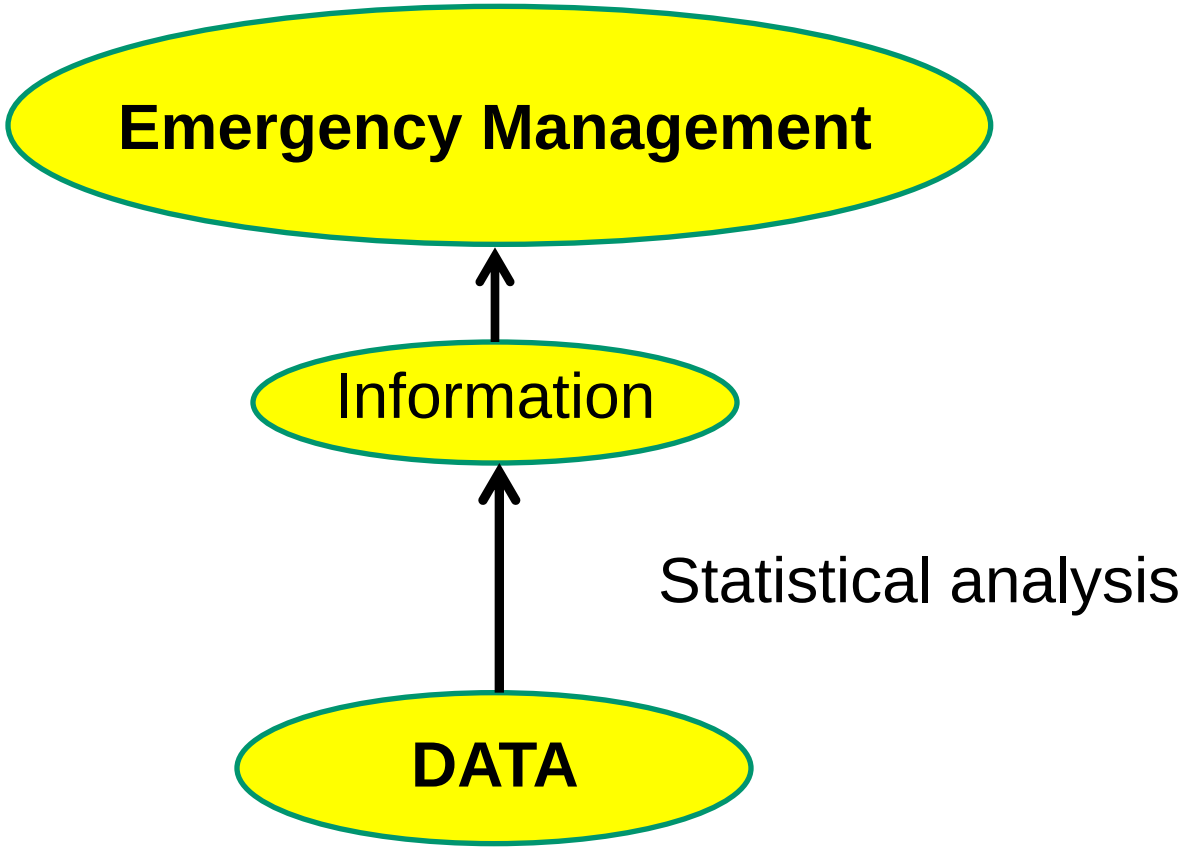
Motivation



Motivation


Emergency Management
Information
Statistical analysis
DATA

Motivation



What, if the DATA are unreliable?

GeoEpi ~ Emergency

- Geographic Epidemiology
  - ... study of spatial patterns (cluster, clustering, trend)
  - ...is often used with emerging diseases to generate hypotheses about disease aetiology
  - ...assume correct data (diagnoses, location, exposure)
- Emerging infectious disease (invasive species)
  - previously unknown / new agents
  - known agents occuring in deemed unsusceptible species
  - known agents of increasing incidence
  - known agents occuring in new geographic areas / populations
- Problem:
  - Diagnostic tests are imperfect, i.e. not established / calibrated
  - Sensitivity and / or specificity < 100%

Brown (2004) Emerging zoonoses and pathogens of public health…*Rev. Sci. Tech. Off. Int. Epiz.* 23:435-442.

1. Introduction and Motivation

Geographic Epidemiology

- mapping
- clustering
- cluster detection

Problem

- emerging diseases
- no perfect diagnostics

  SE/SP $\leq$ 100%

Question

- effect on statistics?

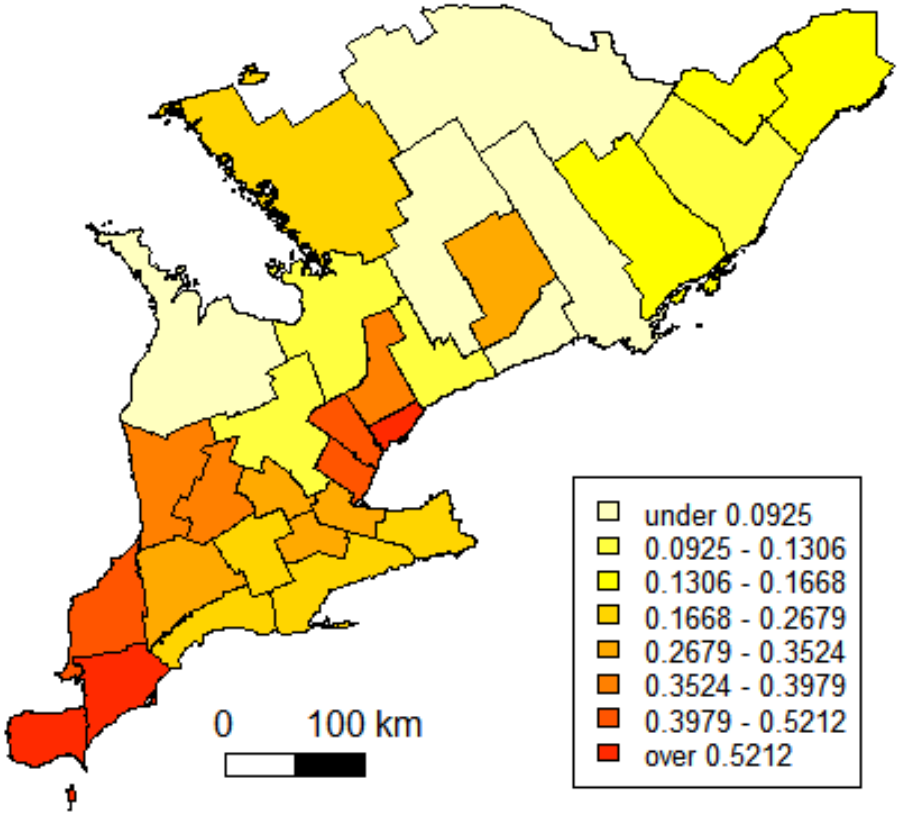


Fig 1: Dead bird mortality fraction due to WNV in 30 PHU's, southern Ontario, 2005

1. Introduction and Motivation

Example: WNv among dead birds
from 30 PHU's in Ontario, 2005

Submitted dead birds (Crow, Blue Jay, Raven) are screened using the VecTest© on oropharyngeal swabs.

Lindsay et al. (2003): SE = **83.9**% and SP = **93.6**%

Stone et al. (2005): SE = **82.1%** and SP = **100%**

⇨ Diagnostic misclassification

Lindsay et al. (2003) Rapid Antigen-capture assay to detect West Nile virus…*Emerging Infectious Diseases* 9, 1406-10.
Stone et al. (2005) Assays to detect West Nile virus in dead birds. *Emerging Infectious Diseases* 11, 1770-73.

2. Observed & True Disease Frequency

AP = apparent / observed prevalence

TP = true prevalence

$$TP = (AP+SP-1)/(SE+SP-1)$$

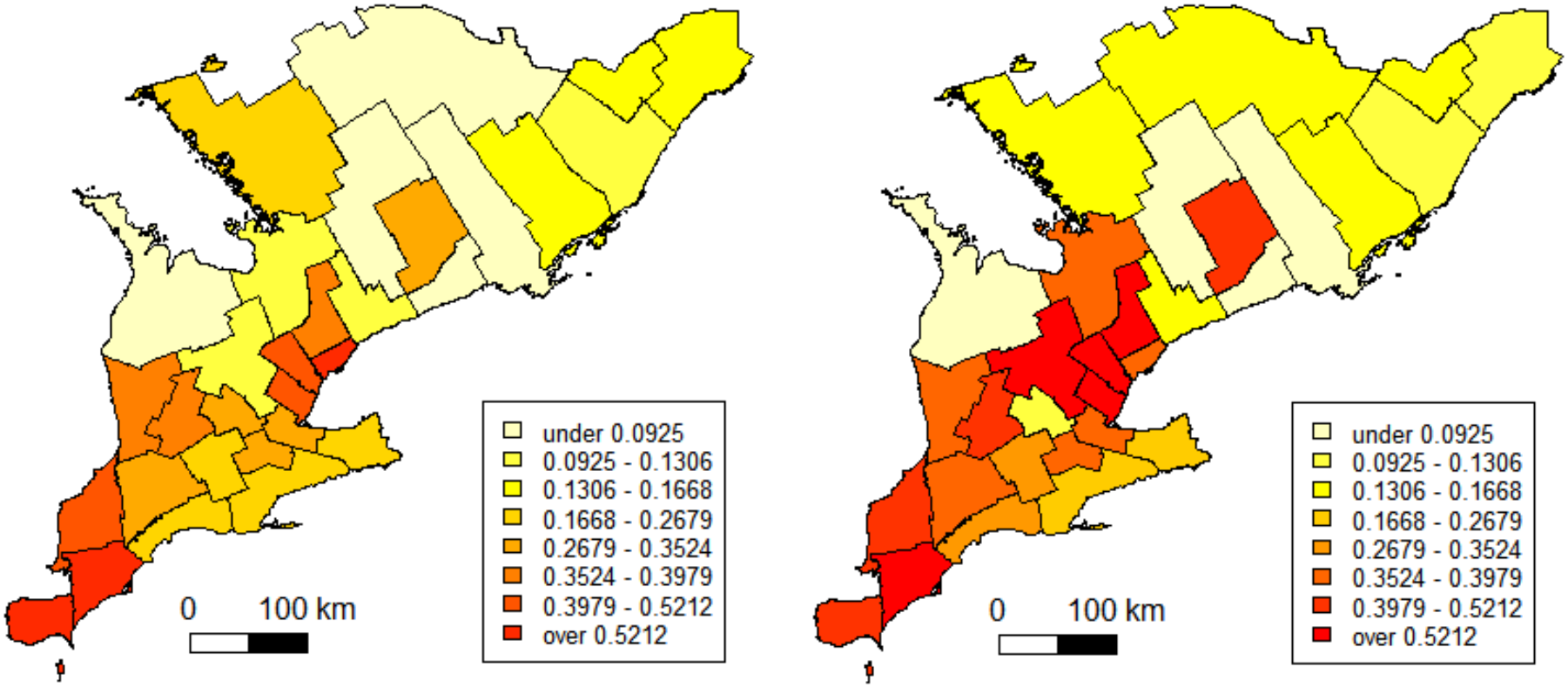
- TP can be negative, with Lindsay's SE/SP!
- Apply Stone's SE = **82.1%** and SP = **100%**

⇨ sample size = 1017
positive = 272
false negative = **59**

Rogan and Gladen (1978) *American Journal of Epidemiology* 107(1), 71-76
Noodhuizen et al. (2001) *Application of Quantitative Methods in Veterinary Epidemiology*. Wageningen Pers, p. 75.

2. Observed & True Disease Frequency

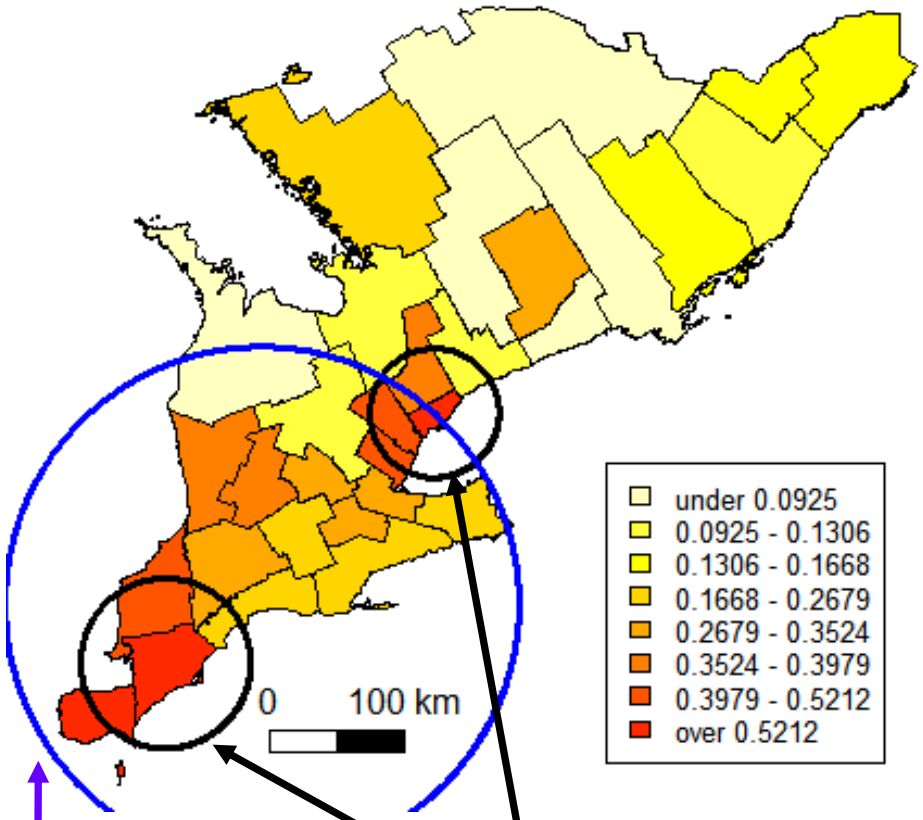
Smoothed observed and true DBMF Ontario 2005



Martuzzi & Elliott P (1996). Empirical Bayes estimation of small-area prevalence of non-rare conditions. *Stat Med* 15, 1867-1873.

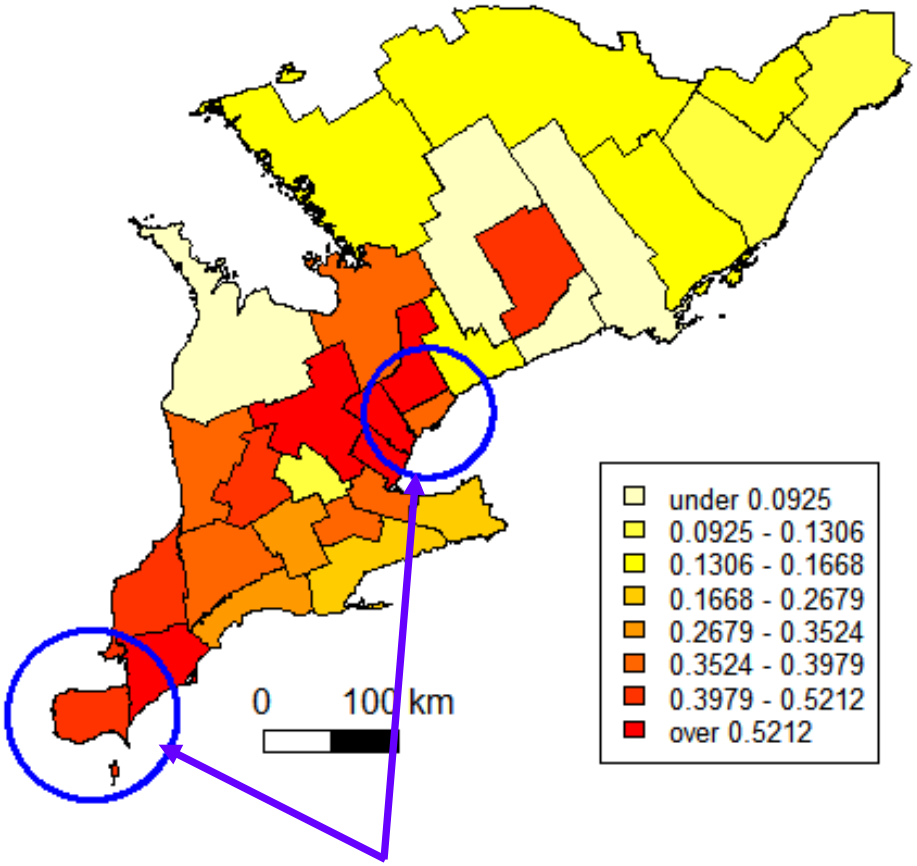
2. Observed & True Disease Frequency

Cluster locations for observed and true DBMFs



50% max pop

30 or 40% max. pop.



30, 40 or 50% max. pop.

?

Assumption:

all regions are equally affected!

Question:

What happens in small sample situations?

Monte Carlo simulation

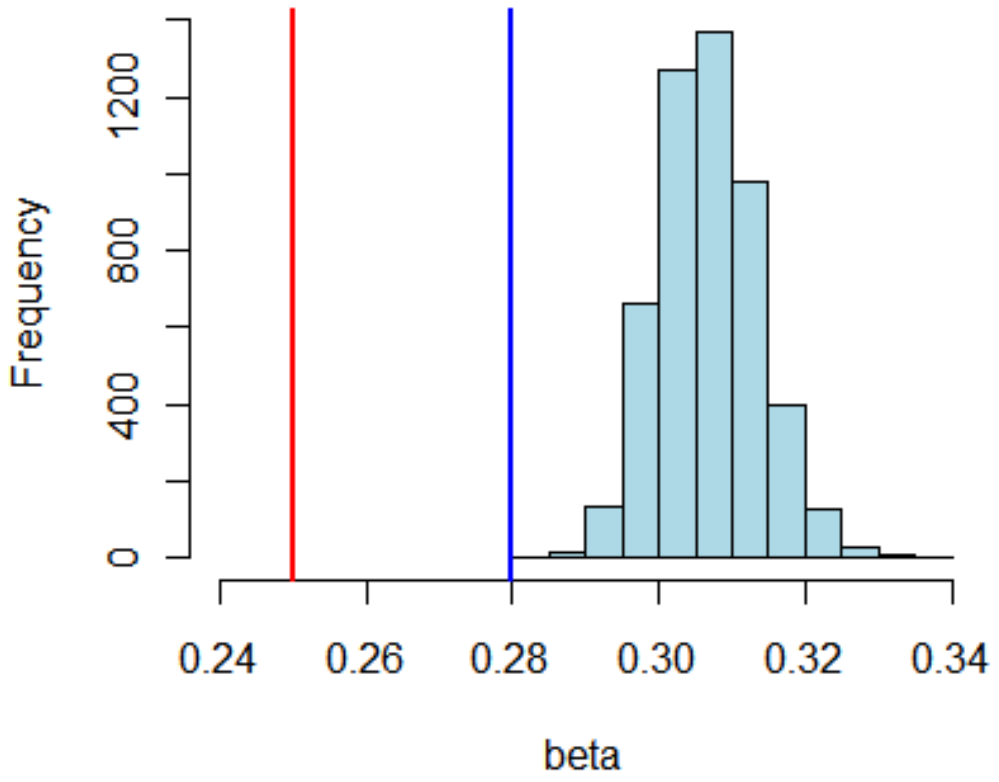
5000 random permutations of the 59 false negatives

3. Permutation Based Simulation Study

Effect on the **intercept** of a geostatistical model
MLE from smoothed data

Observed: $\beta = 0.25$
True: $\beta = 0.28$
Sims: $\beta = 0.31$

What we observe is a strong underestimation due to SP = 100%



Berke, O (2004) Exploratory disease mapping: kriging the spatial risk function from regional count data. *International Journal of Health Geographics* 2004; 3:18.

4. Conclusion & Outlook

Conclusion

- Similar spatial pattern are detected

  from "true" and "observed" data
- Permutations and true data results differ because

  true|(AP & n_i) vs. permutation|n_i
- Finite sample situations need further evaluation

Outlook

- More scenarios: p, sample size, SE and SP
- Investigate the scan statistic
- Investigate point pattern data => new project with farm locations

References

Berke, Waller (2010) On the effect of diagnostic misclassification bias on the observed spatial pattern in regional count data – A case study using West Nile virus mortality data from Ontario, 2005. *Spatial and Spatio-temporal Epidemiology* 1:117-121.

Beroll, Berke, Wilson and Barker (2007) Investigating the spatial risk distribution of West Nile virus disease in birds and humans in southern Ontario from 2002 to 2005. *Population Health Metrics* 5:3.

Berke (2004) Exploratory disease mapping: kriging the spatial risk function from regional count data. *International Journal of Health Geographic* 3:18