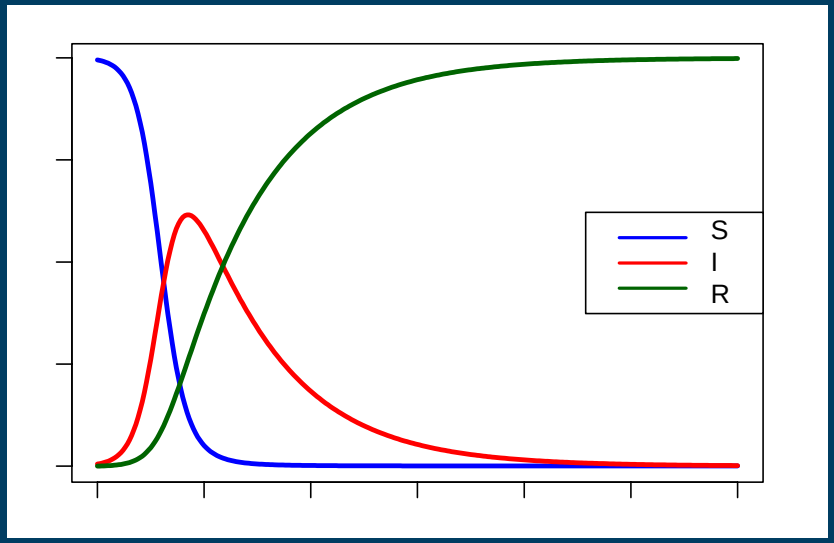
Patterns in mice, patterns in humans?

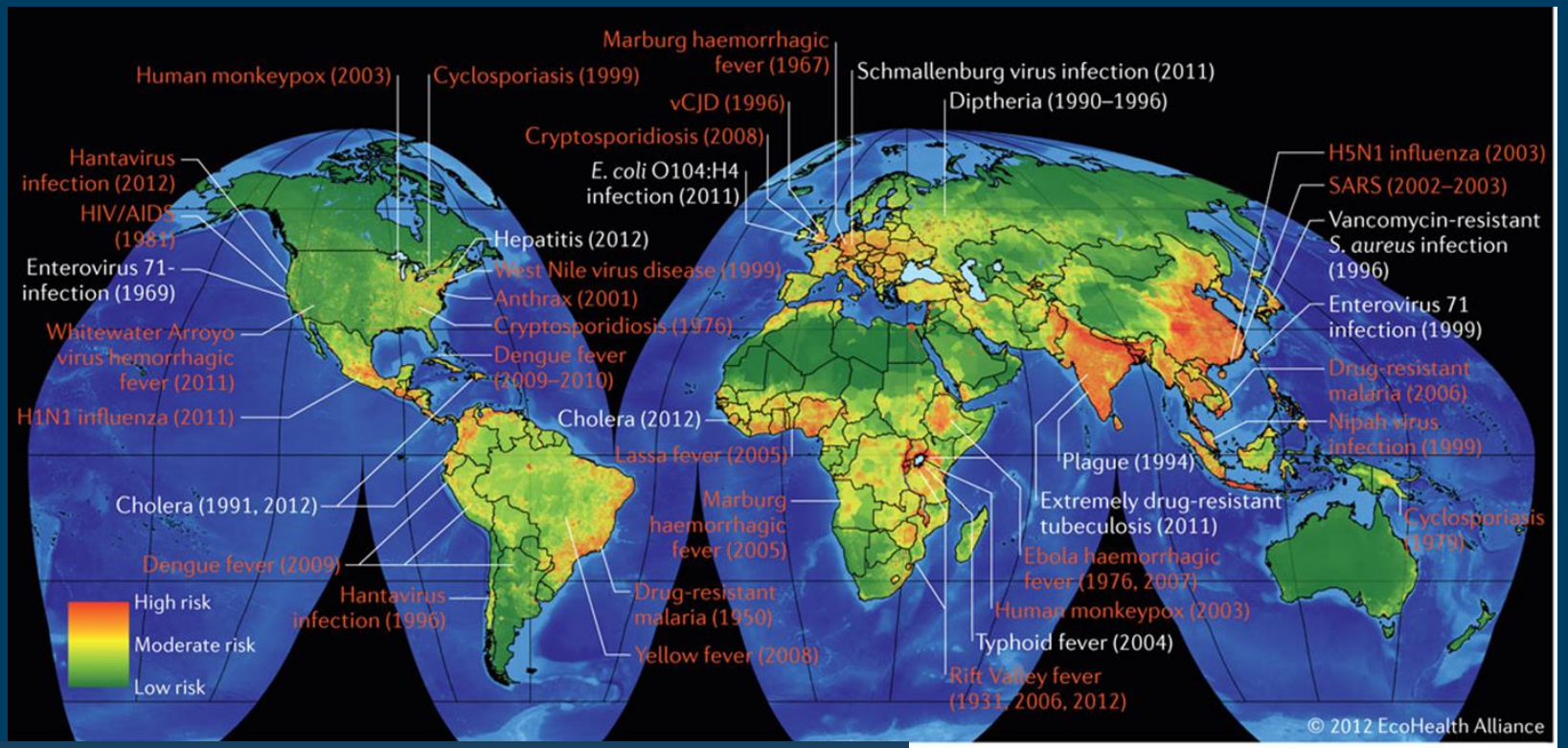


Herwig LEIRS & collaborators
ASCID, Universiteit Antwerpen
Evolutionary Ecology Group

Universiteit Antwerpen

Mice (and other small mammals) source of infections

New and (re-)emerging infectious diseases (EID)
70% vector-borne or zoonotic



Nature Reviews | Microbiology

Reason for increase of EID:

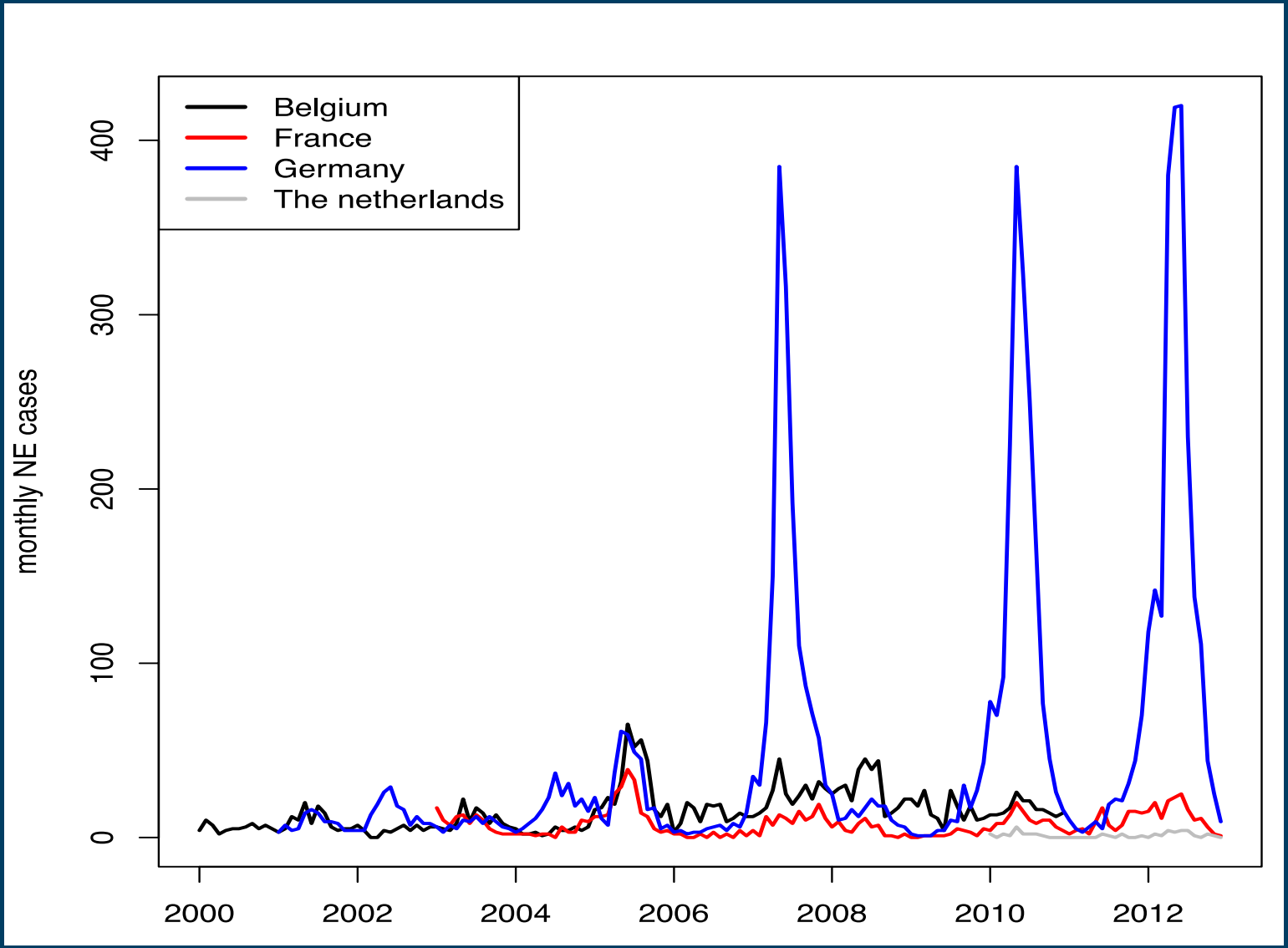
- changing ecological conditions
- jumping host species

Hantavirus

- rodent borne viruses (Bunyaviridae)
- in Western Europe: mostly Puumala virus
- reservoir PUUV: Bank vole *Myodes glareolus*
- asymptomatic infection in rodents
- virus excreted in urine, faeces, saliva

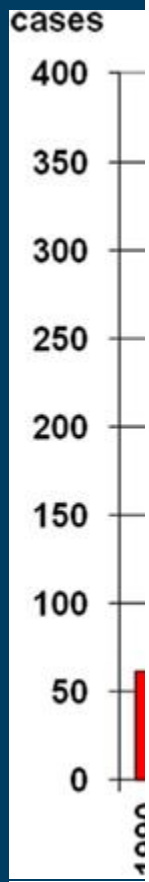
- humans infected through inhalation of infectious particles
- Hemorrhagic Fever with Renal Syndrome (*Nephropathia Epidemica*)
- potentially serious kidney problems

Temporal variation in Nephropathia Epidemica in W Europe



Temporal variation in number of cases

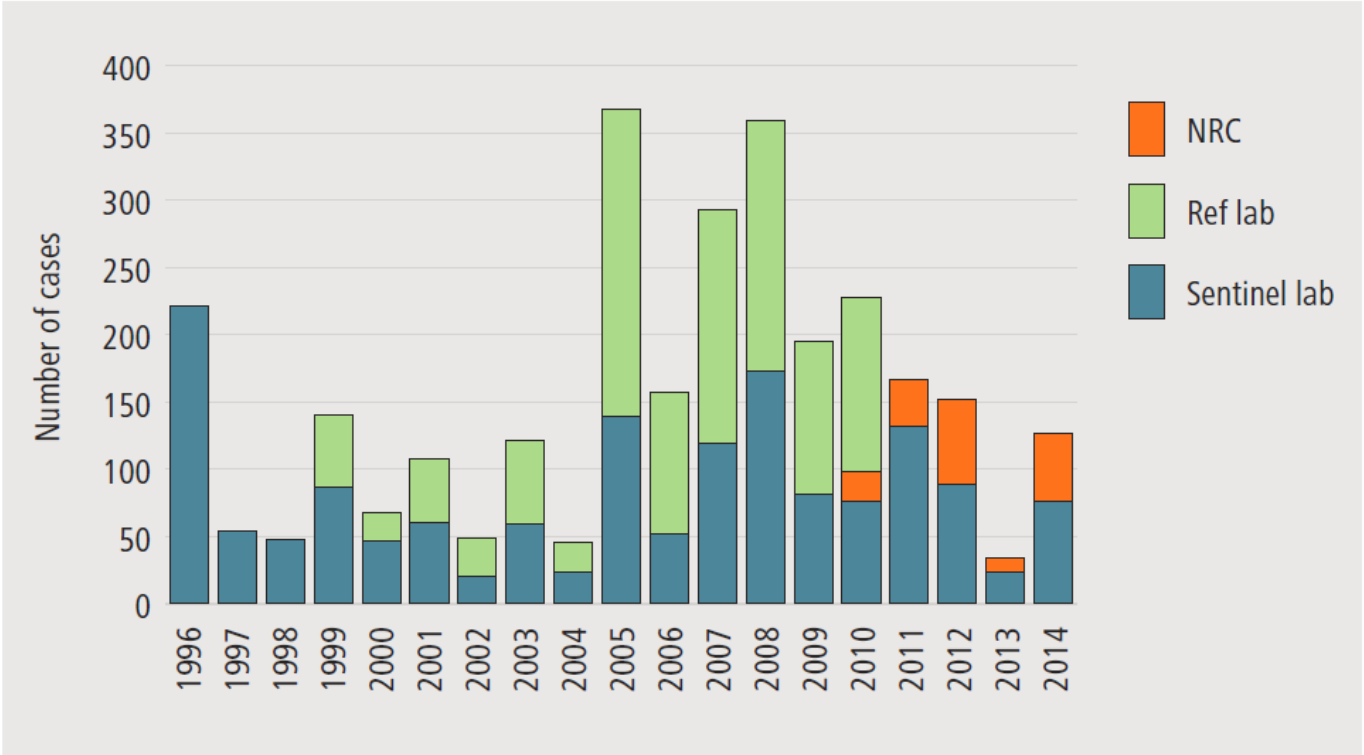
Link with vole abundance?



Heyman

Figuur 1 | Aantal gerapporteerde gevallen van hantavirose per gegevensbron en per jaar, België 1996-2014

(Bronnen: netwerk van peillaboratoria, referentielaboratorium en NRC)



Rebolledo et al. (2015). Zoönosen en vector overdraagbare ziekten. Epidemiologische surveillance in België, 2013 en 2014. WIV, Brussels.

Effect of mast years on rodents: important delay

Bud formation
(Summer year t)

Dry warm Summer

Flowering
(Spring year t+1)

No late frost
Little rain during pollination

Seed production
(Autum year t+1)

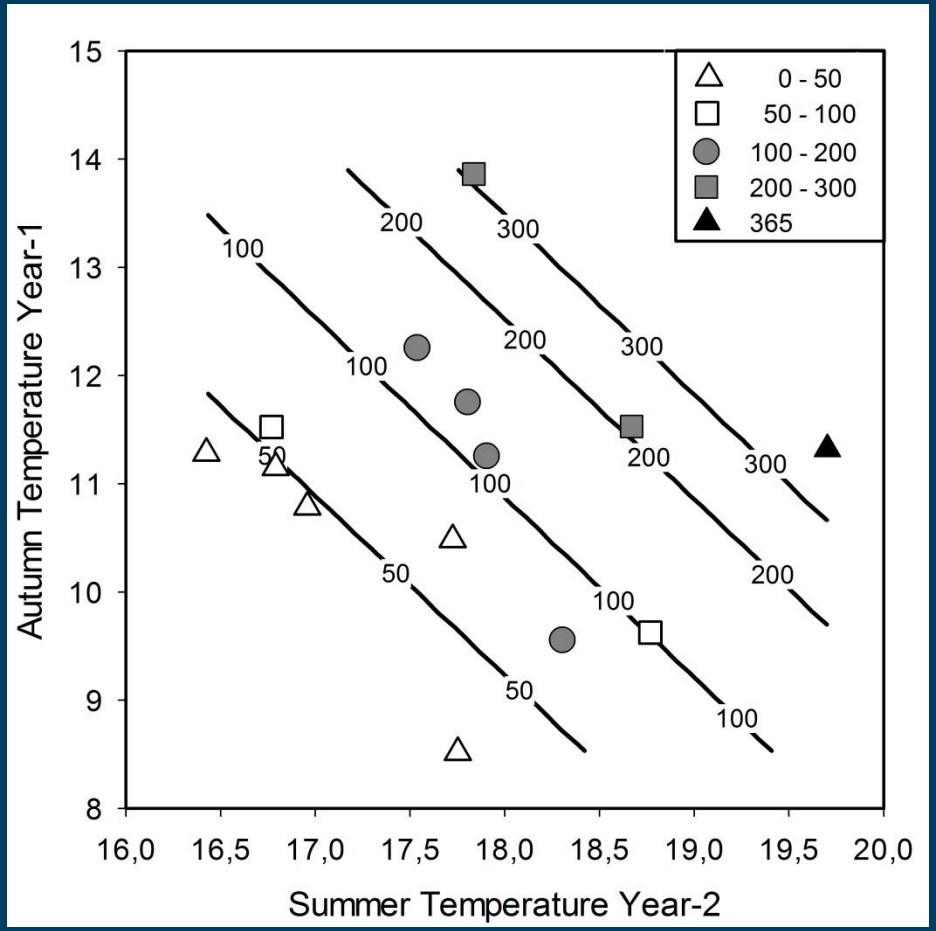
High vole densities
(year t+1)

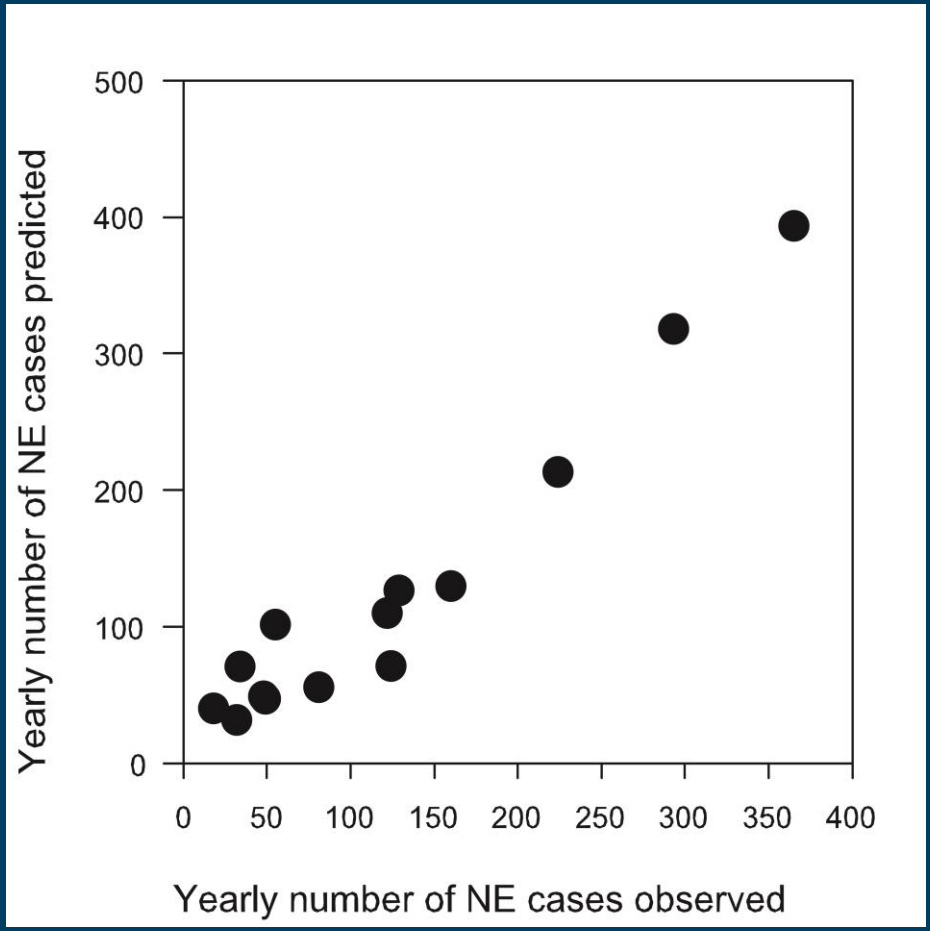
Intense transmission

High infection risk
for humans

Hantavirosis
incidence
(jaar t+2)

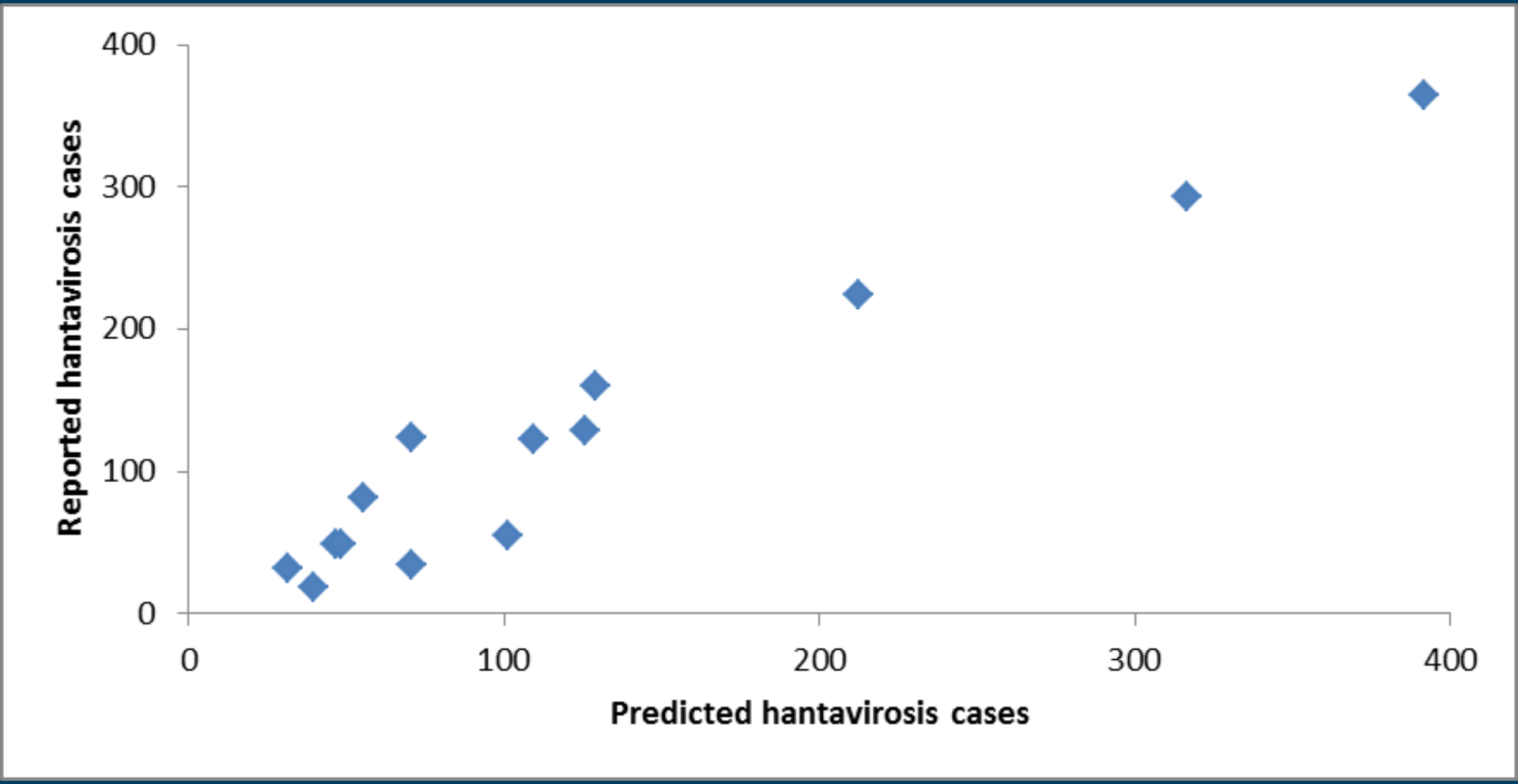
Hantavirosis case numbers relate to climate

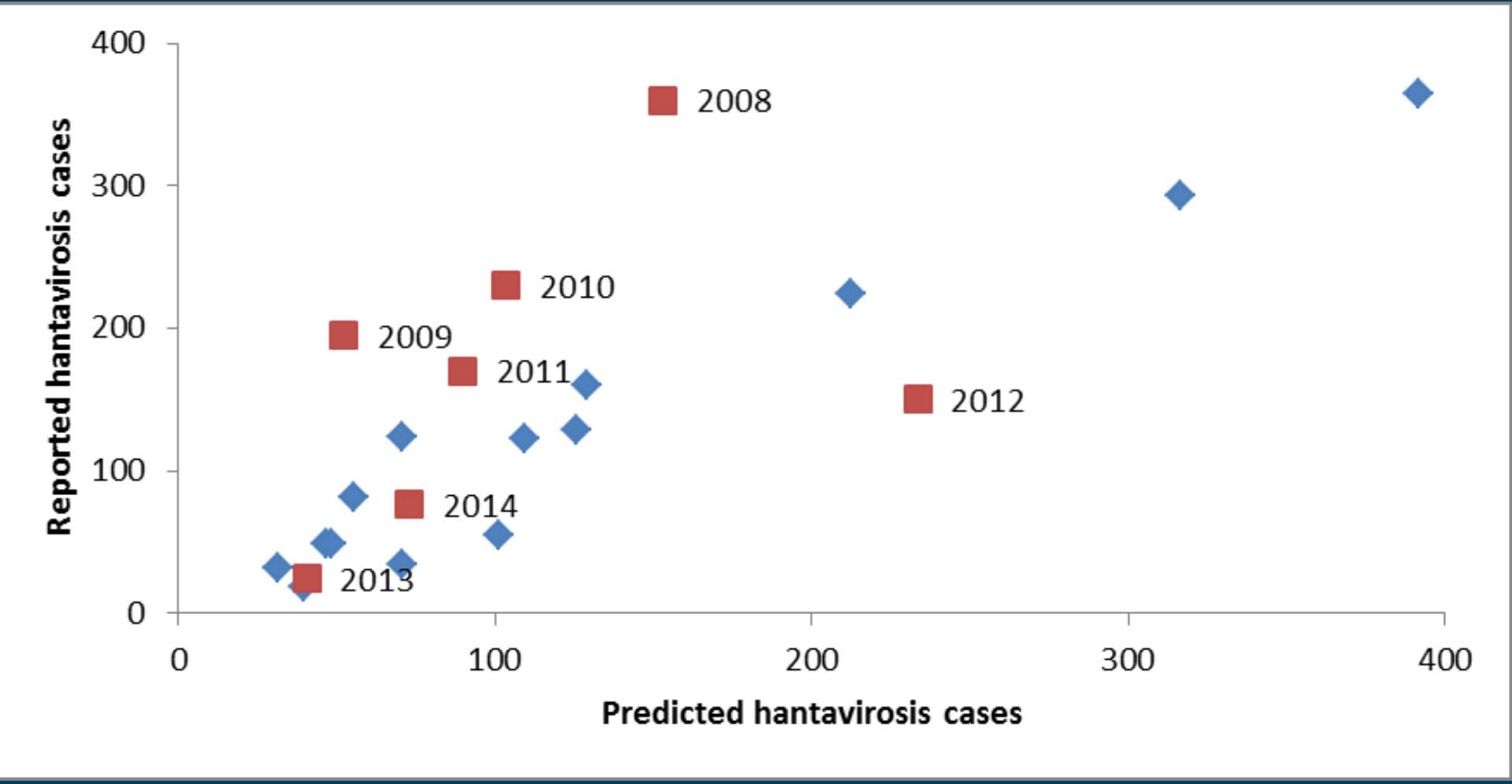


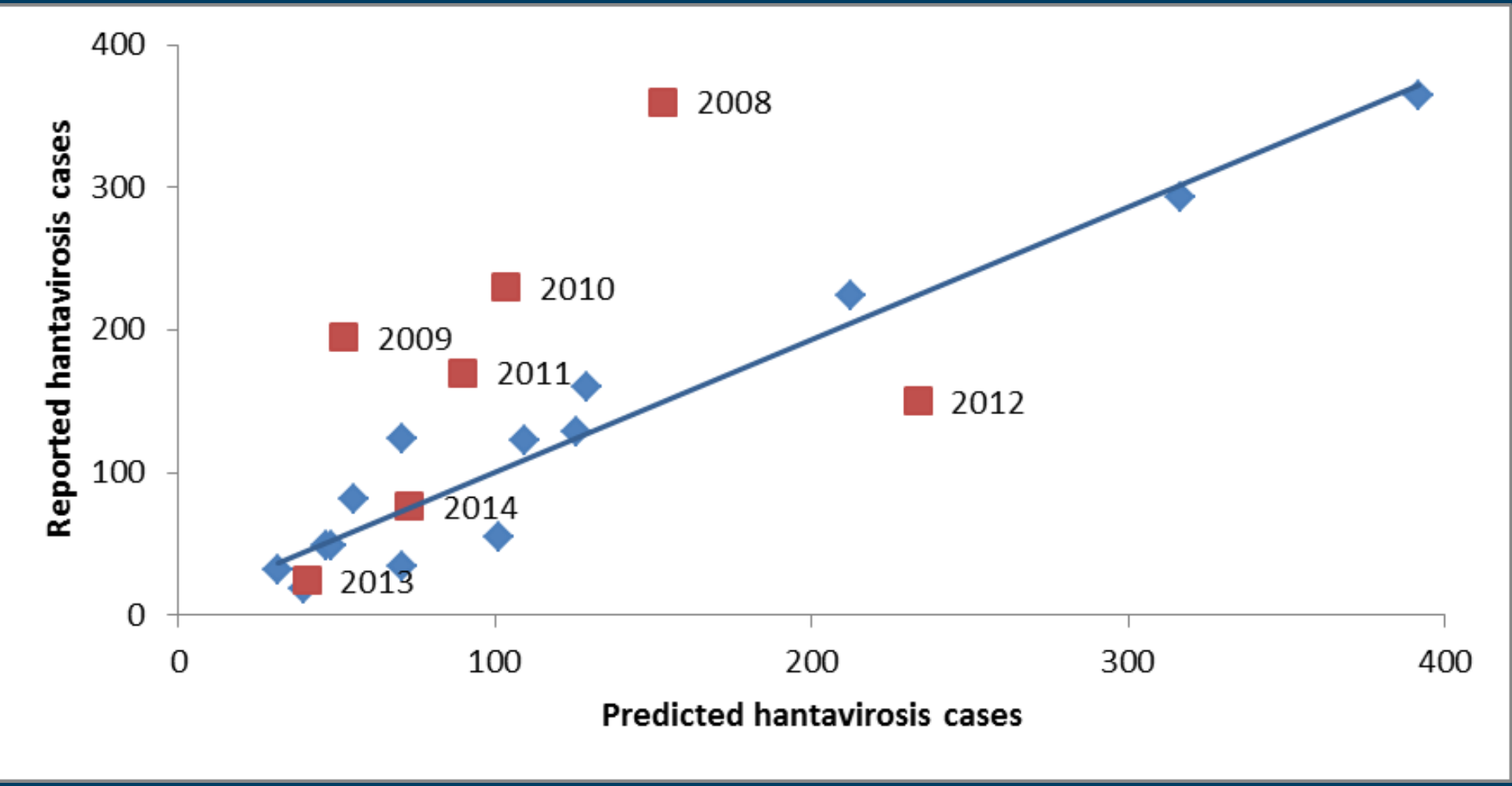


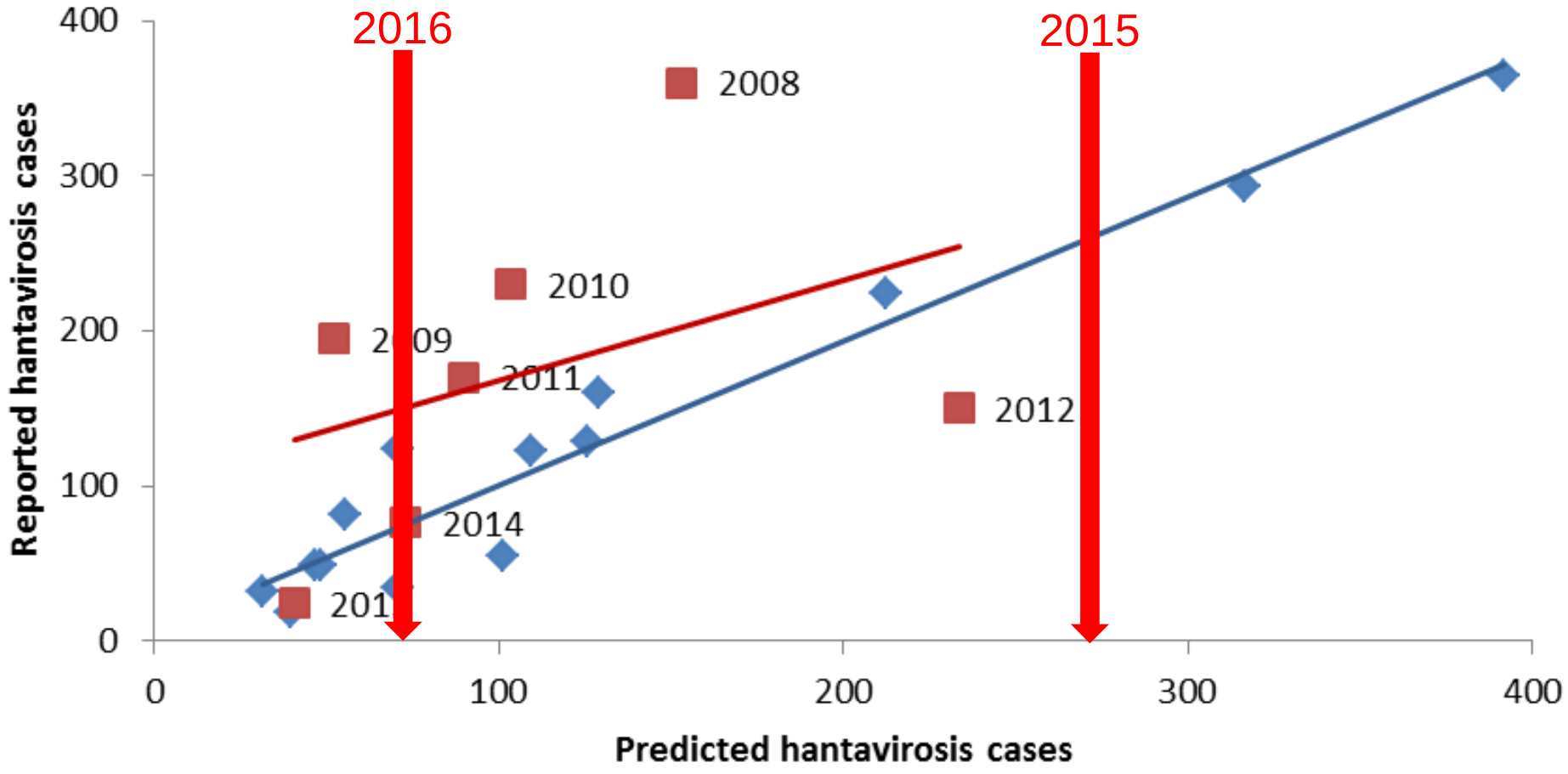
Tersago et al. (2008). *Epidemiol.Infect.* 137, 250–256.

Predicted number of NE cases

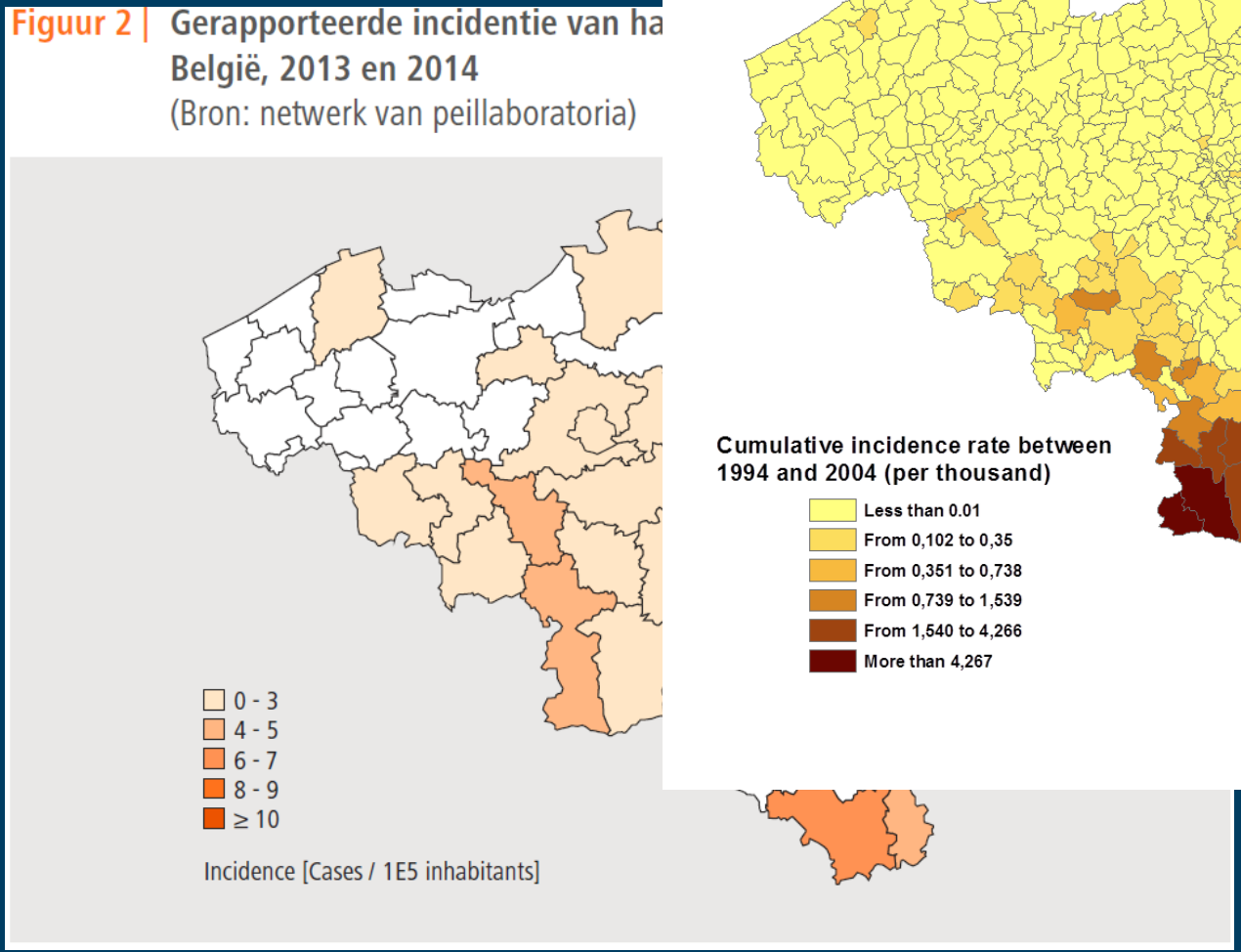


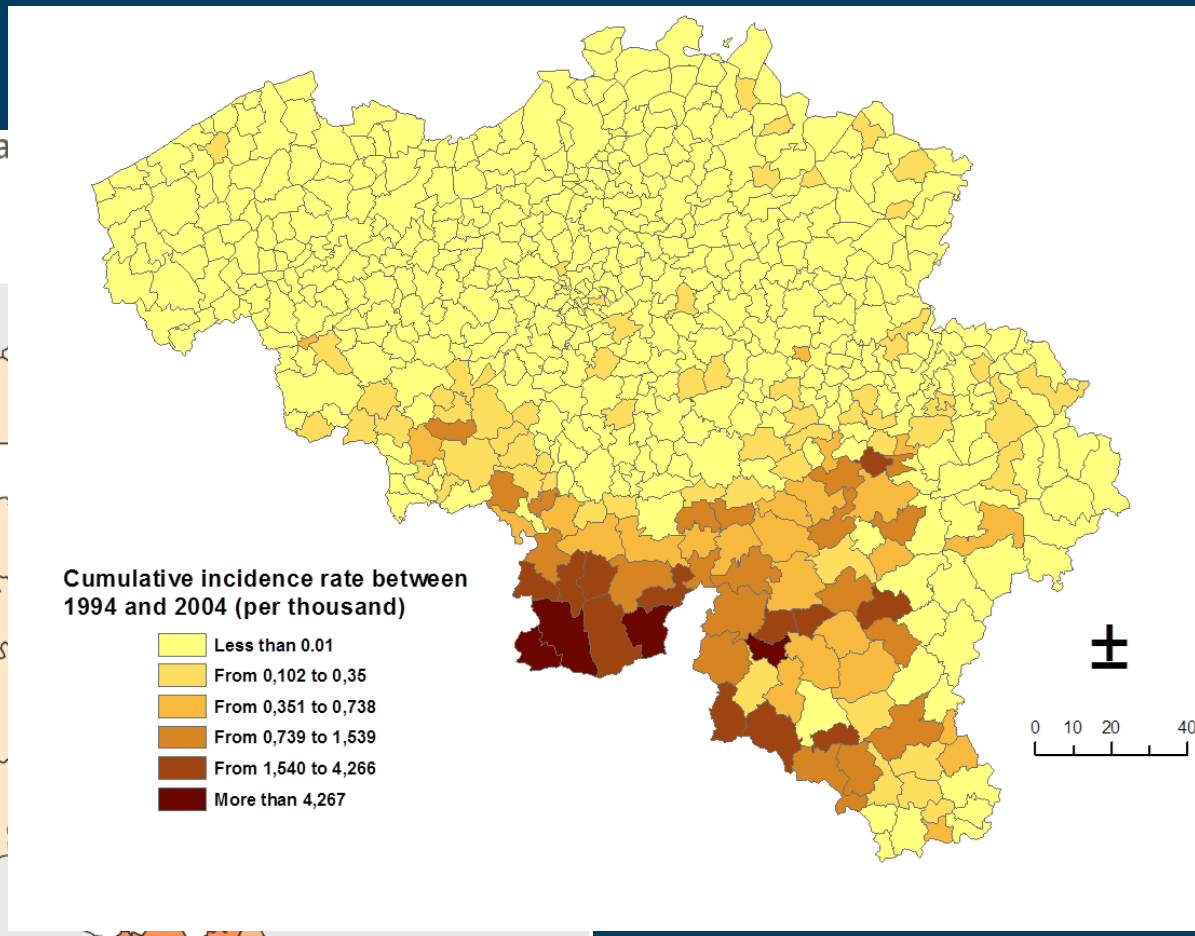

Reported hantavirosis cases
Predicted hantavirosis cases
0
100
200
300
400
2008
2010
2009
2011
2012
2014
2013


Reported hantavirosis cases
Predicted hantavirosis cases
0
100
200
300
400
2008
2010
2009
2011
2012
2014
2013


2016
2015
2008
2010
2009
2011
2012
2014
201
Reported hantavirosis cases
Predicted hantavirosis cases
0
100
200
300
400

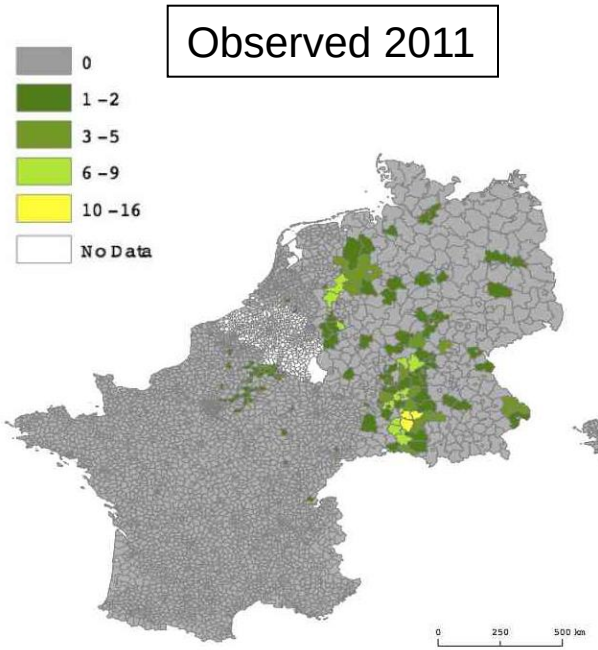
Spatial patterns vary over time...

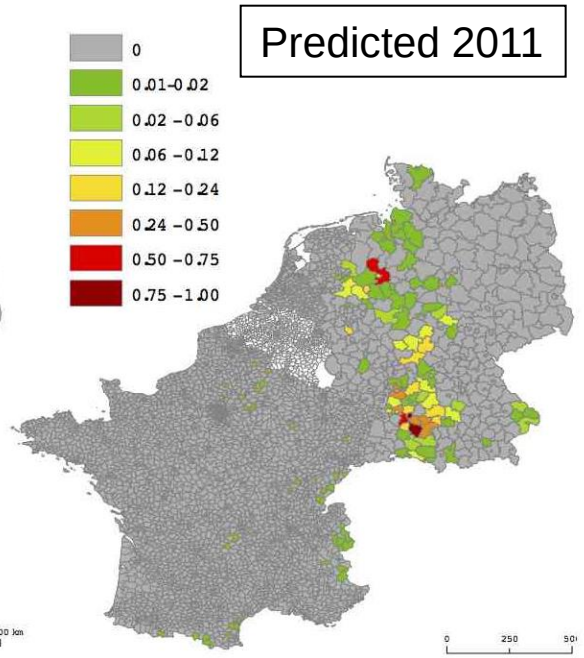


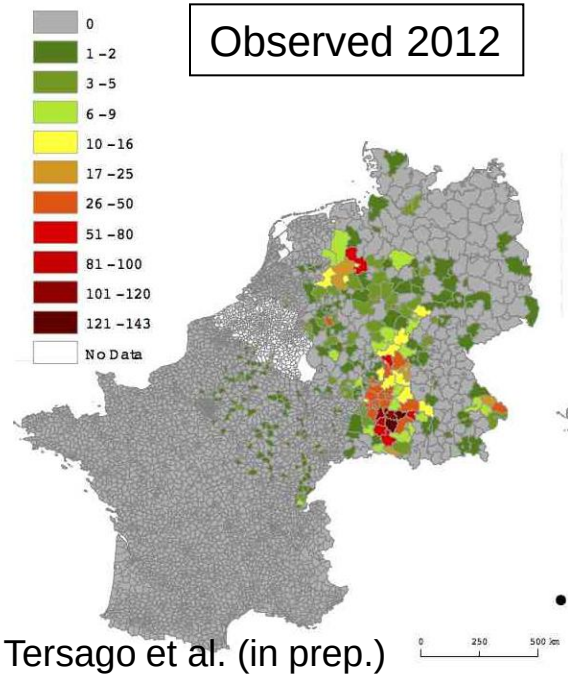


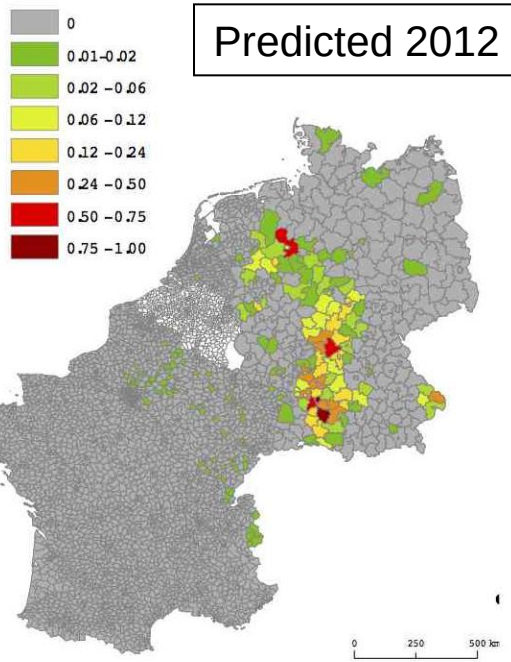
Rebolledo et al. (2015). Zoönosen en vector overdraagbare ziekten. Epidemiologische surveillance in België, 2013 en 2014. WIV, Brussels.

Space-time model predicting probability of hantavirosis in Western Europe





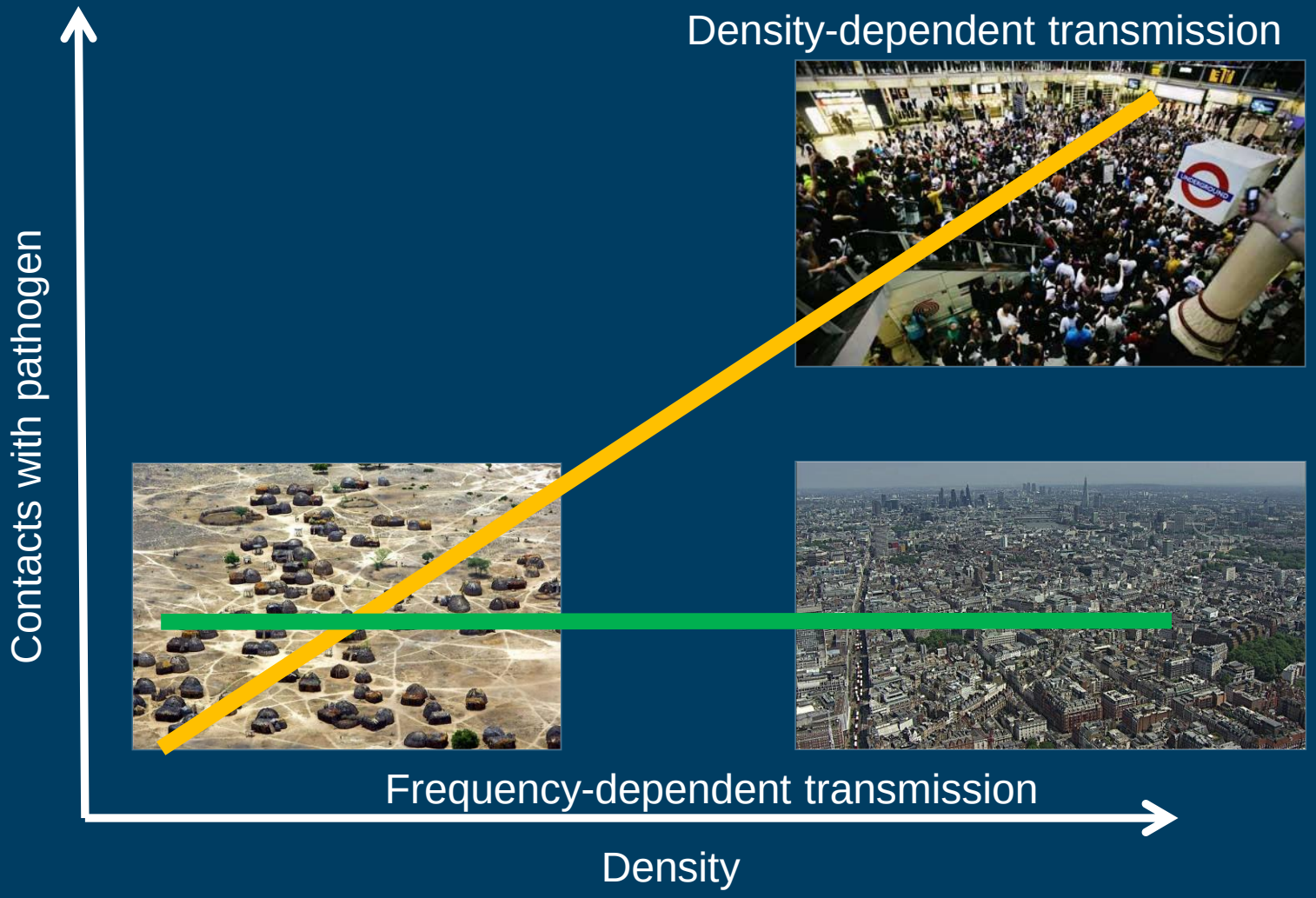




Tersago et al. (in prep.)

EDENext

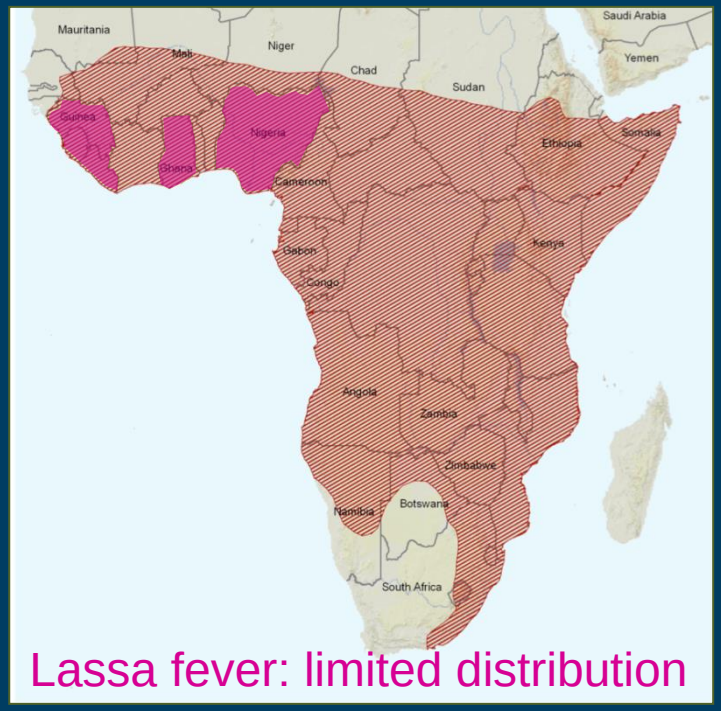
Contact-density function



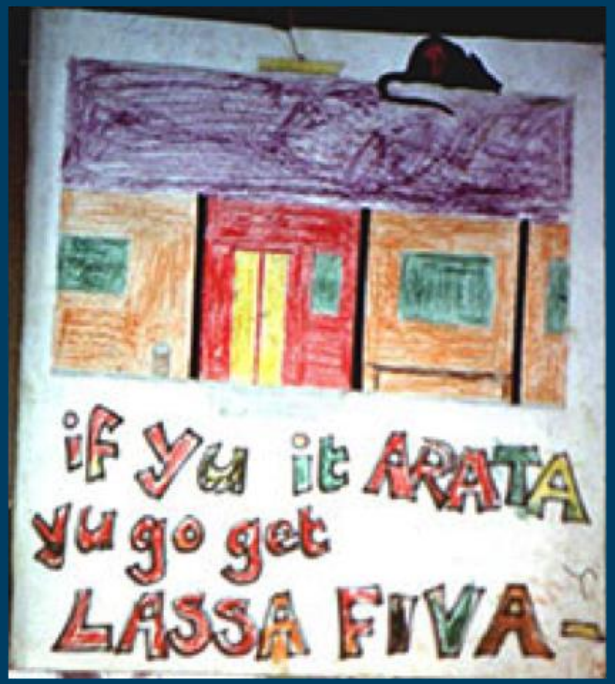
Relevant for models: e.g. host abundamce threshold

African arenaviruses

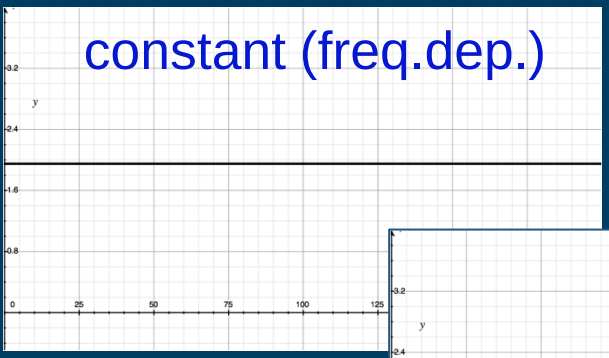
- Lassa virus causing Lassa fever in W Africa
- BSL4 virus
- Reservoir multimammate mouse *Mastomys natalensis*
- Host occurs all over Africa
- In E Africa, related viruses in same host species

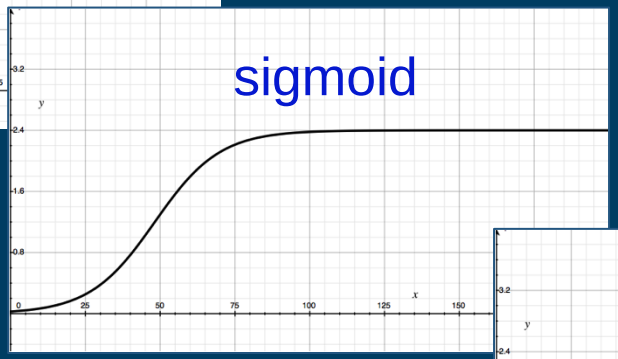


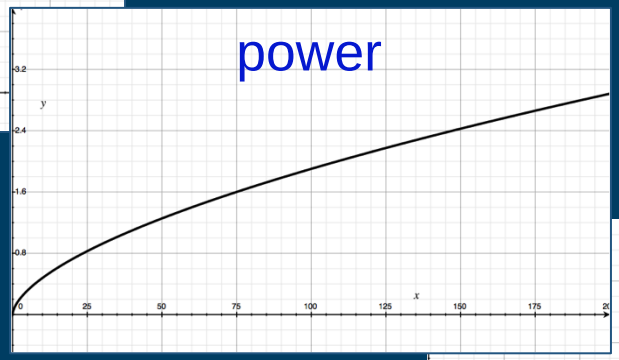
Lassa fever: limited distribution

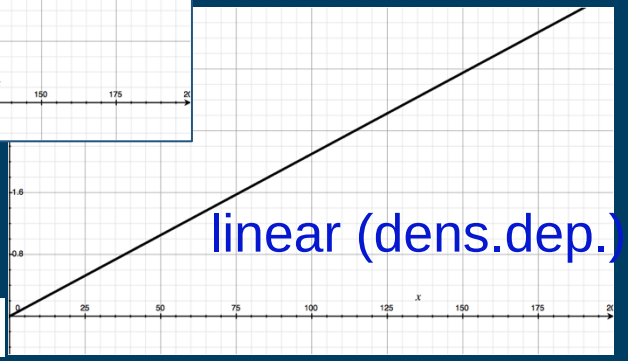


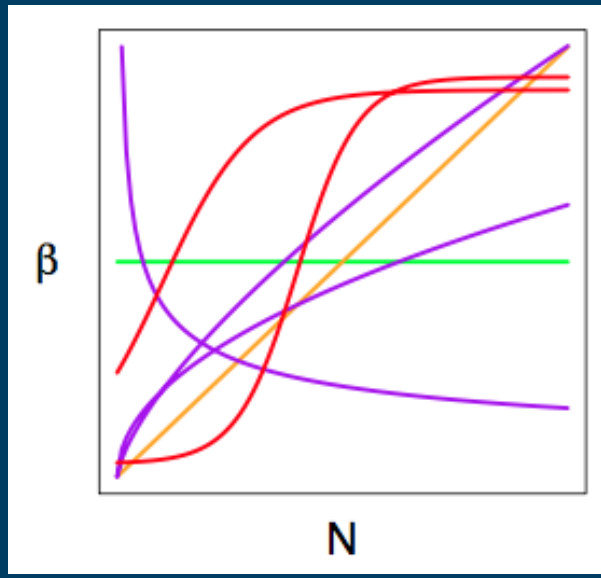
Exact shape of the contact-density function?





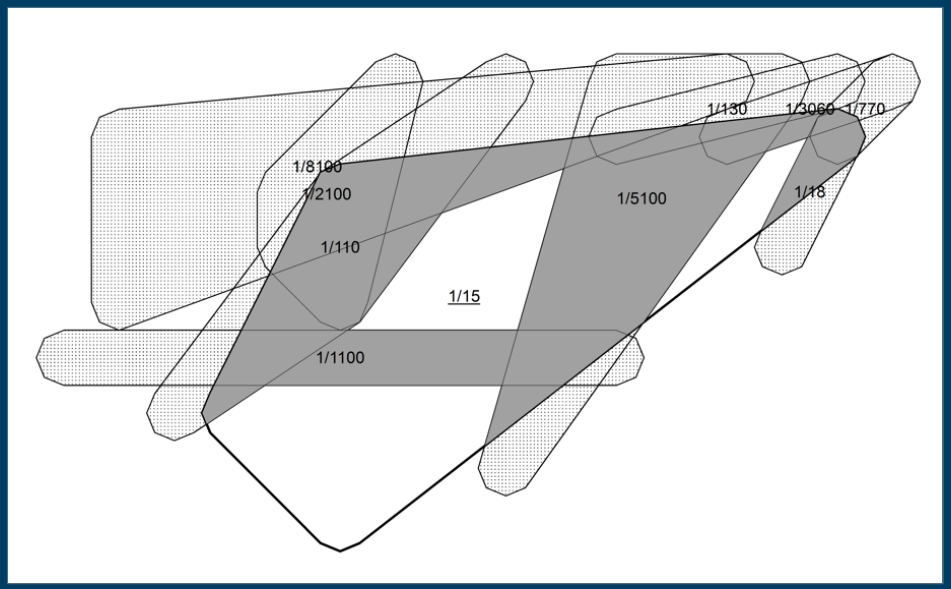


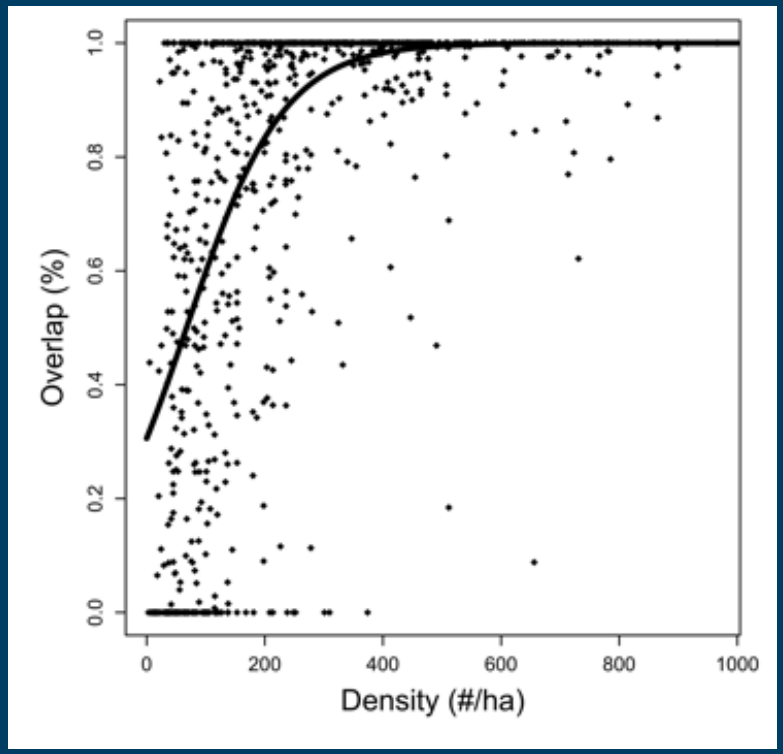




McCallum et al. 2001

How do mouse contacts change with density?



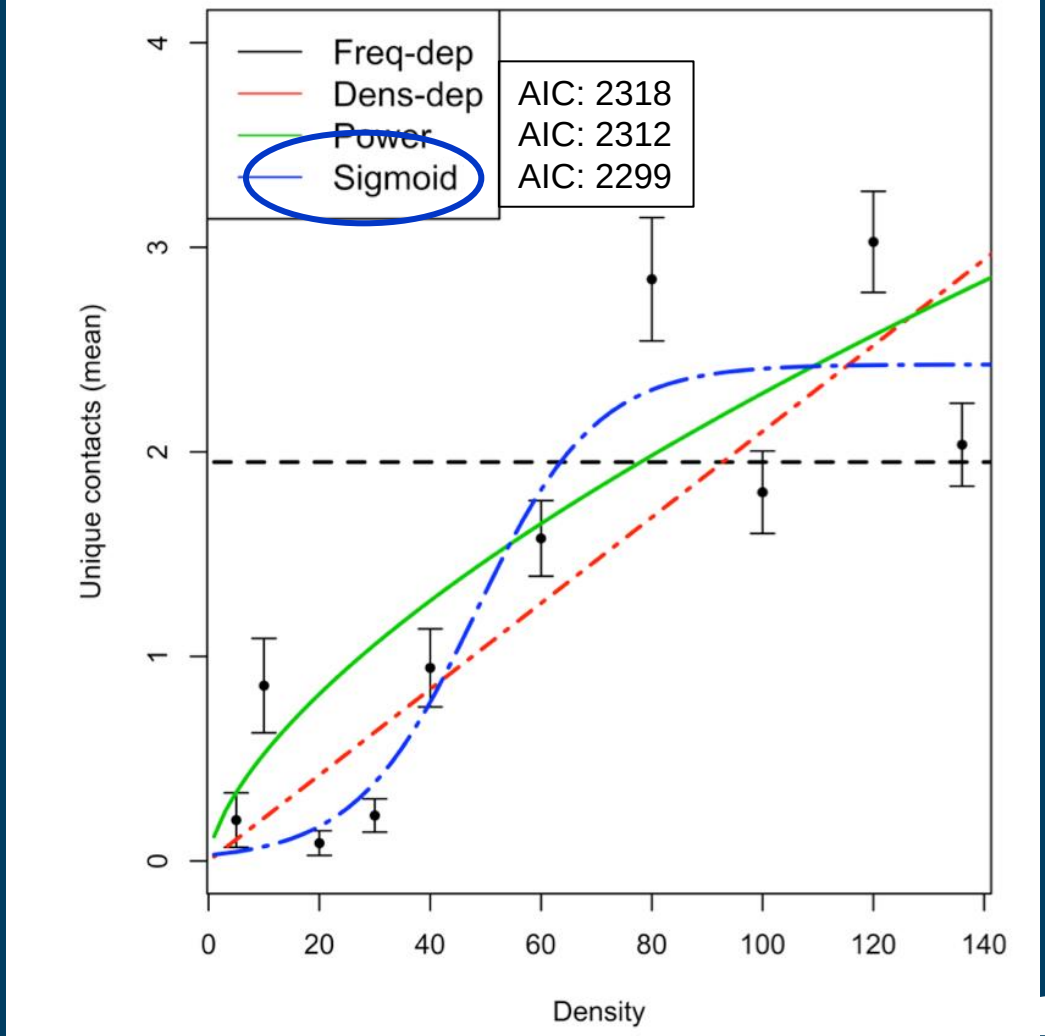


Happily together forever: temporal variation in spatial patterns and complete lack of territoriality in a promiscuous rodent

Benny Borremans · Nelika K. Hughes · Jonas Reijniers · Vincent Sluydts · Abdul A. S. Katakweba · Loth S. Mulungu · Christopher A. Sabuni · Rhodes H. Makundi · Herwig Leirs

Popul Ecol (2014) 56:109–118
DOI 10.1007/s10144-013-0393-2

Universiteit Antwerpen



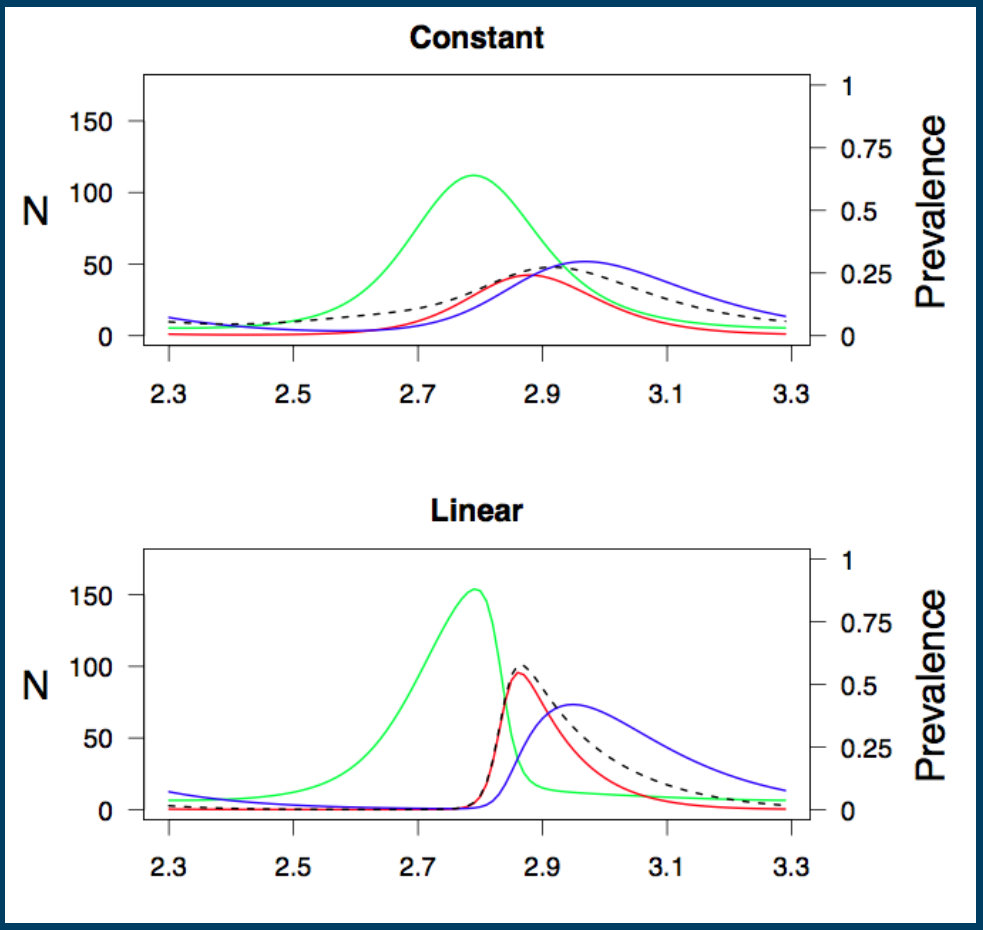
The shape of the contact-density function matters when modelling disease transmission in fluctuating populations

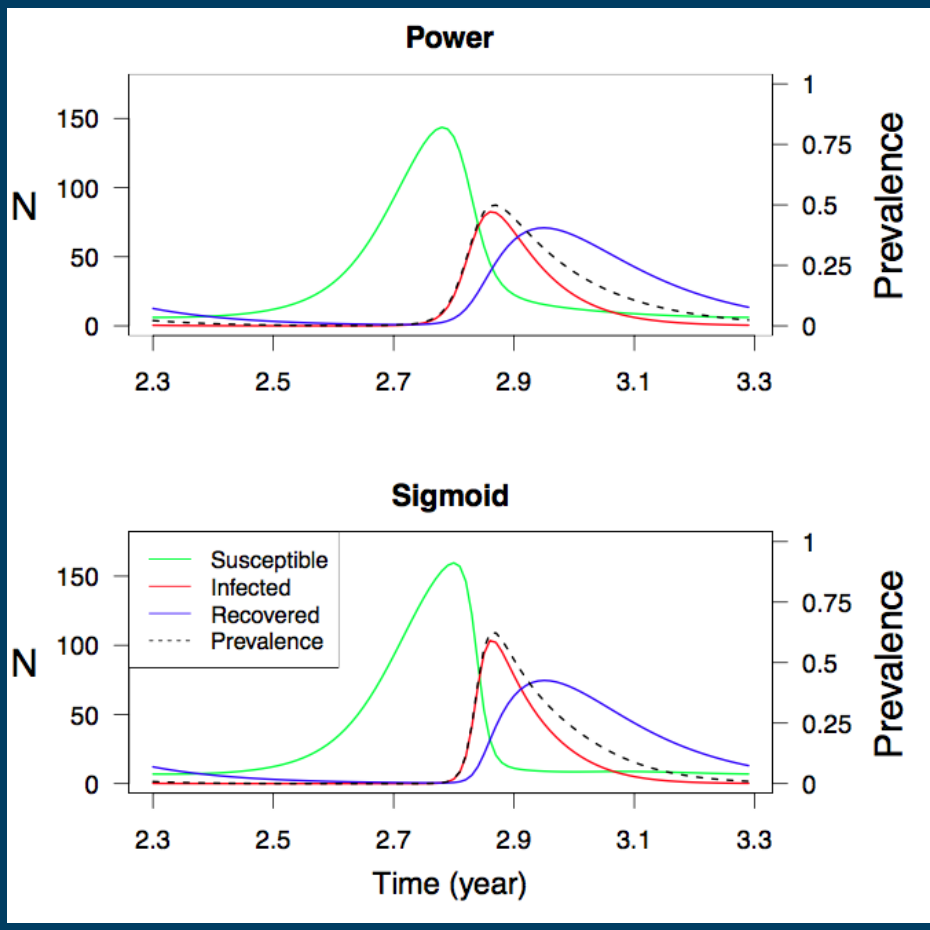
Benny Borremans[1], Jonas Reijniers[1], Herwig Leirs[1]

Manuscript submitted

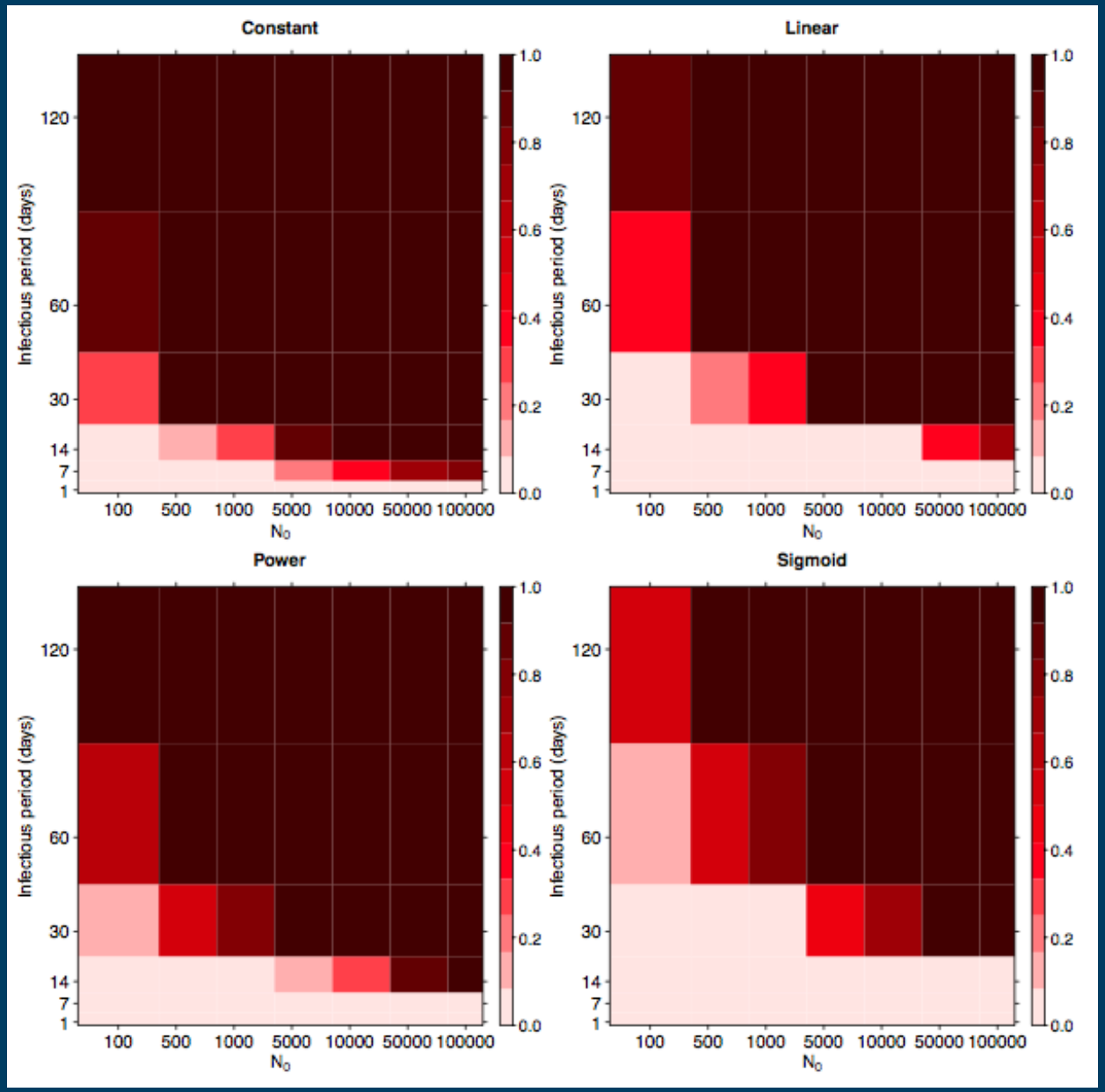
Universiteit Antwerpen

But does this matter?

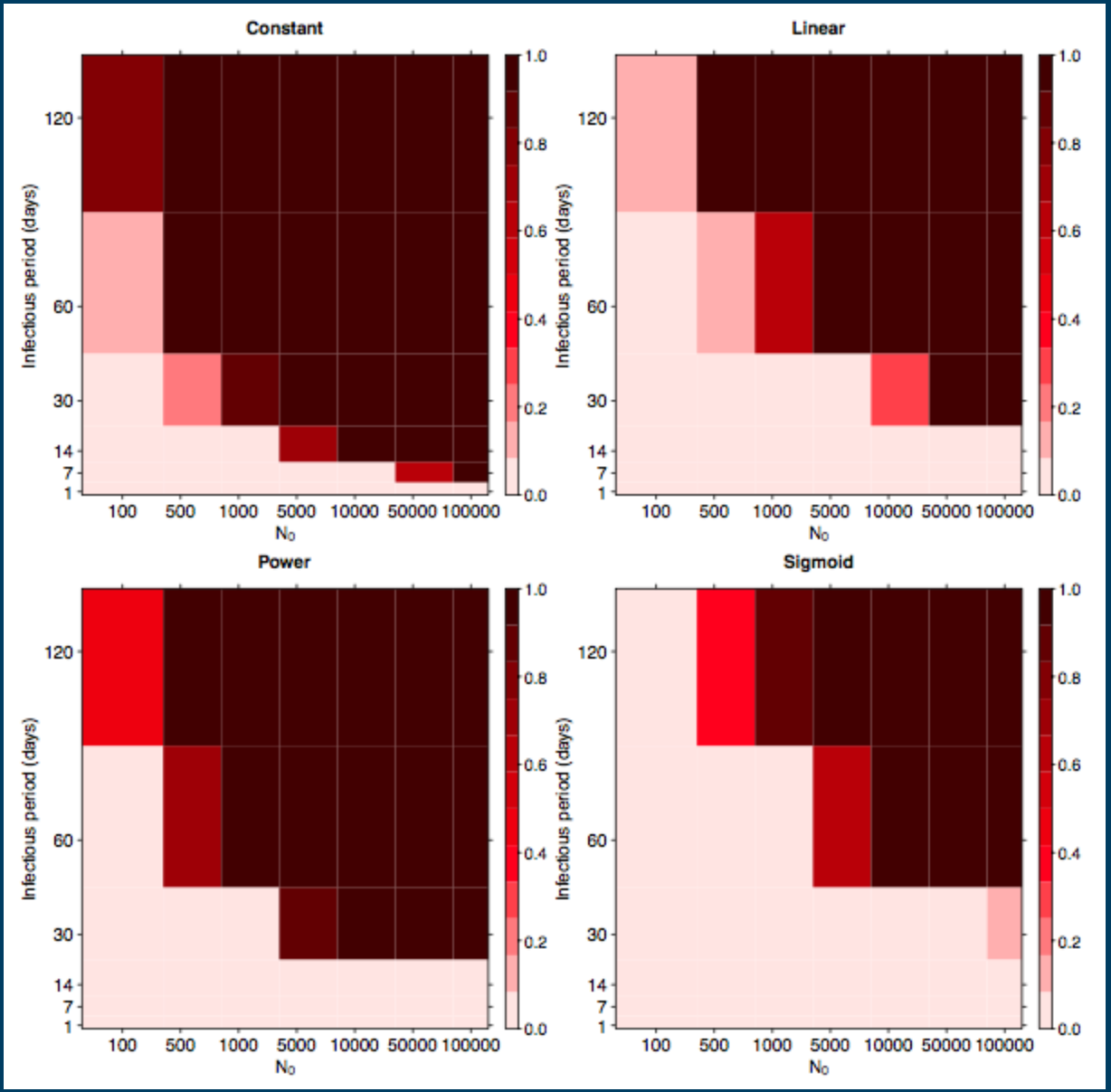




P(invasion)


Constant
Linear
Power
Sigmoid
Infectious period (days)
120
60
30
14
7
1
100
500
1000
5000
10000
50000
100000
N_0
1.0
0.8
0.6
0.4
0.2
0.0

P(persistence|invasion)

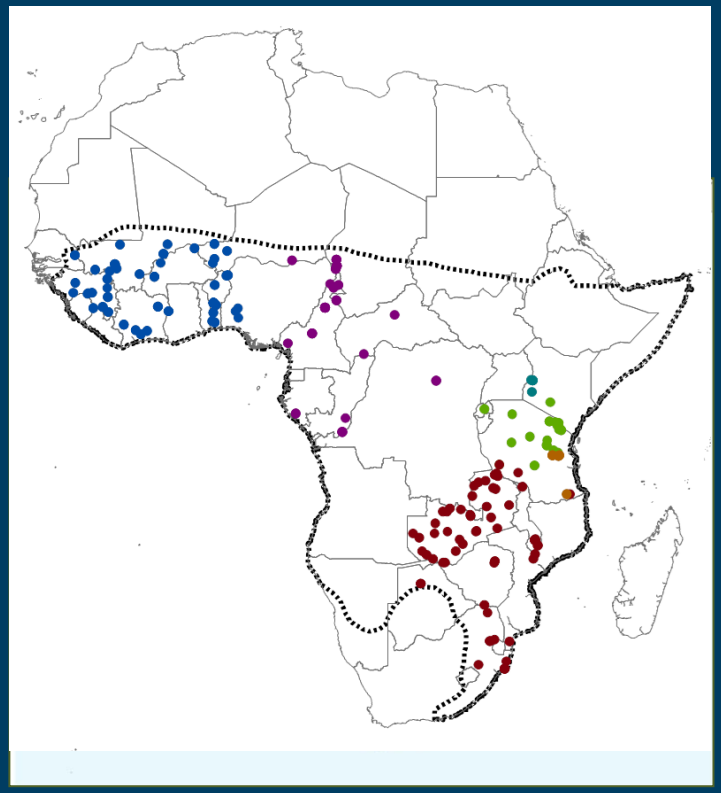


thresholds differ considerably

consequences for e.g.

- hotspot area size
- vaccination programs?

Spatial patterns:
Lassa fever has a limited distribution



several *Mastomys natalensis* clades

Diverse arenaviruses?

Sympatric Occurrence of 3 Arenaviruses, Tanzania

Joëlle Goüy de Bellocq, Benny Borremans, Abdul Katakweba, Rhodes Makundi, Stuart J.E. Baird, Beate Becker-Ziaja, Stephan Günther, and Herwig Leirs

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 16, No. 4, April 2010

High Diversity of RNA Viruses in Rodents, Ethiopia

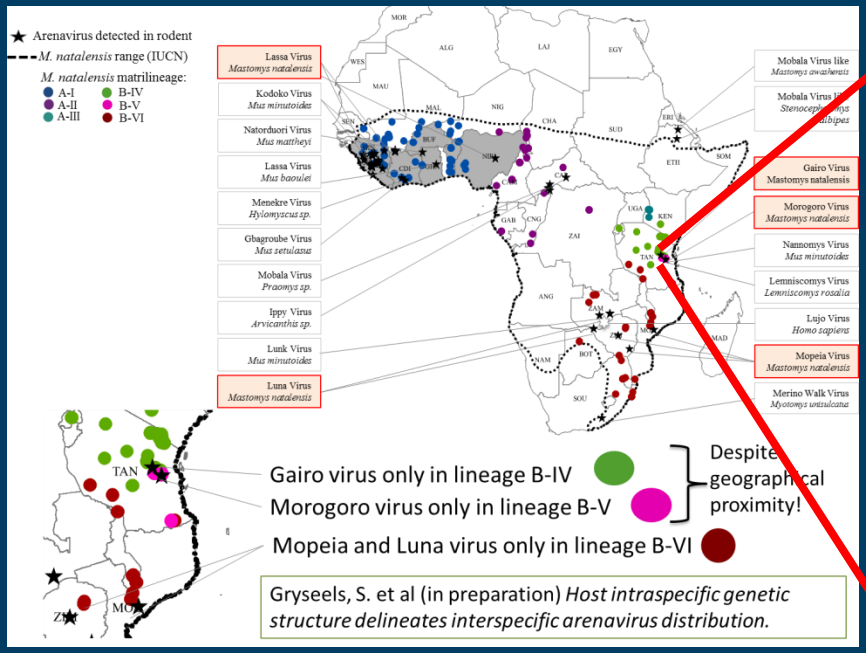
Yonas Meheretu,[1] Dagmar Čížková,[1] Jana Těšíková, Kiros Welegerima, Zewdneh Tomas, Dawit Kidane, Kokob Girmay, Jonas Schmidt-Chanasit, Josef Bryja, Stephan Günther, Anna Bryjová, Herwig Leirs, and Joëlle Goüy de Bellocq

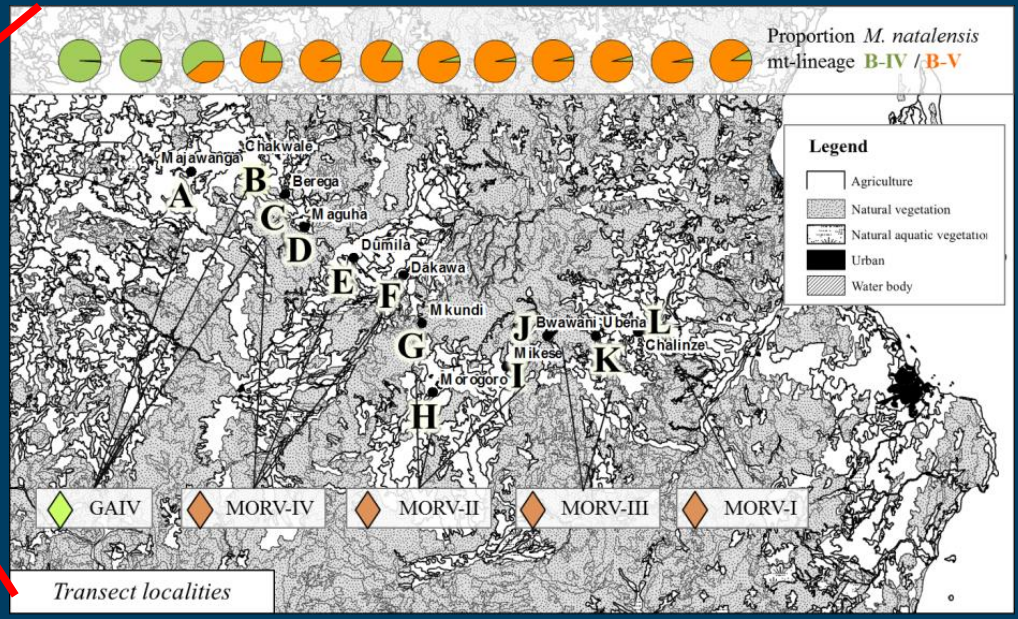
Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 18, No. 12, December 2012

Gairo virus, a novel arenavirus of the widespread *Mastomys natalensis*: Genetically divergent, but ecologically similar to Lassa and Morogoro viruses

Sophie Gryseels [a,*], Toni Rieger [b], Lisa Oestereich [b], Bart Cuypers [c,d], Benny Borremans [a], Rhodes Makundi [e], Herwig Leirs [a], Stephan Günther [b,1], Joëlle Goüy de Bellocq [a,f,1]

Virology 476 (2015) 249–256





Gryseels et al. (in review)

How do viruses remain in their own host/jump host in natural conditions?

Team work

BNITM
Bernhard-Nocht-Institut für Tropenmedizin

VAXINFECTIO
Vaccine & Infectious Disease Institute
University of Antwerp

UNIVERSITY OF HELSINKI

universiteit hasselt | I-BioStat | KU LEUVEN
Interuniversity Institute for Biostatistics and statistical Bioinformatics