

International Workshop on Feral Swine Disease and Risk Management

November 18-20, 2014, Fort Collins, Colorado, USA,

Disease issues of concern in wild suids



SABIO

Sanidad y Biotecnología
Health and Biotechnology

www.SaBio-IREC.com

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Questions to address

1. Which species/subspecies of free-ranging swine are a disease risk to livestock, wildlife, and people?
2. What is the geographical global distribution of these species? (This may require a map of the world and some evidence about the various regions with reported free ranging swine populations.)
3. What factors contribute to population growth and expansion of free-ranging swine populations?
4. Which diseases of wild swine are of most risk to livestock, wildlife, and humans if one considers the potential for exposure in susceptible populations and given the infectivity of the agent? On what basis were these diseases identified?
5. What aspects of these diseases are of greatest management concern when one considers the potential for disease spread in available host species, and interactions among animal and human populations?
6. What are the highest consequence events related to disease emergence, persistence, and re-emergence in wild swine that require policy or scientific resources to address?
7. Are there ecological or biological gaps in information that increase the risk/hazard of an event?

Questions to address

- (1-3) Wild suid ecology, distribution and trend or management
- (4-5) Main pig-related diseases
- (6-7) Risk assessment and knowledge gaps



Questions to address

- (1-3) Wild suid ecology, distribution and trend or management
- (4-5) **Main pig-related diseases**
- (6-7) Risk assessment and knowledge gaps

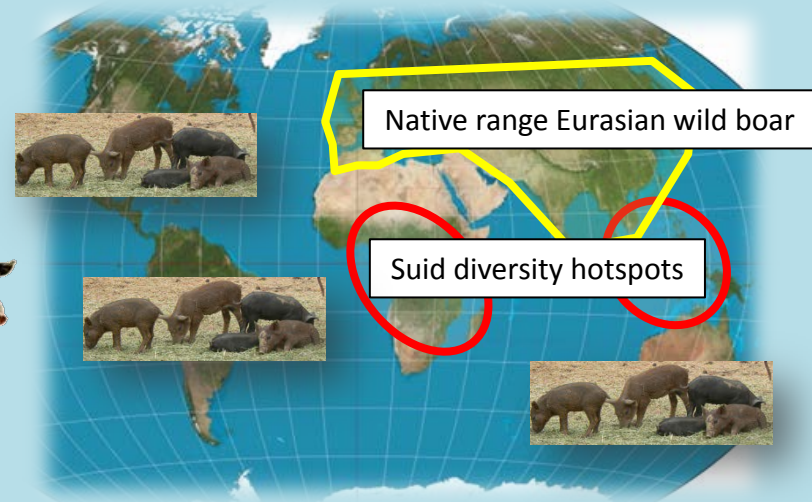
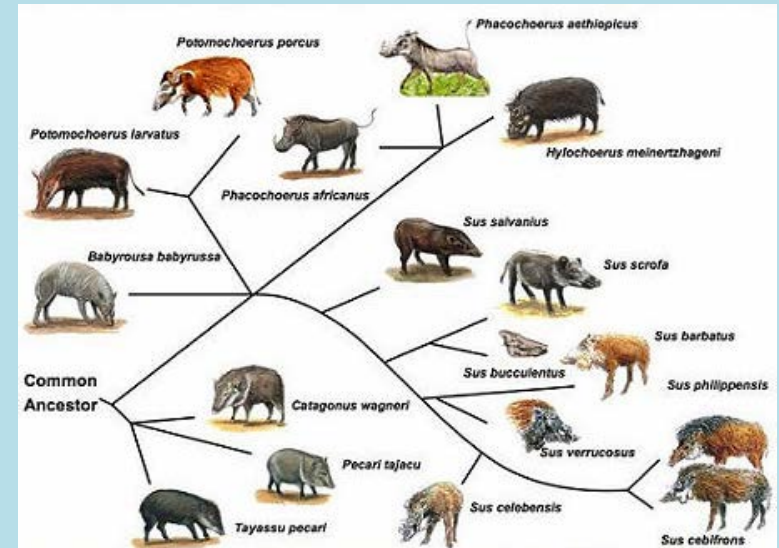
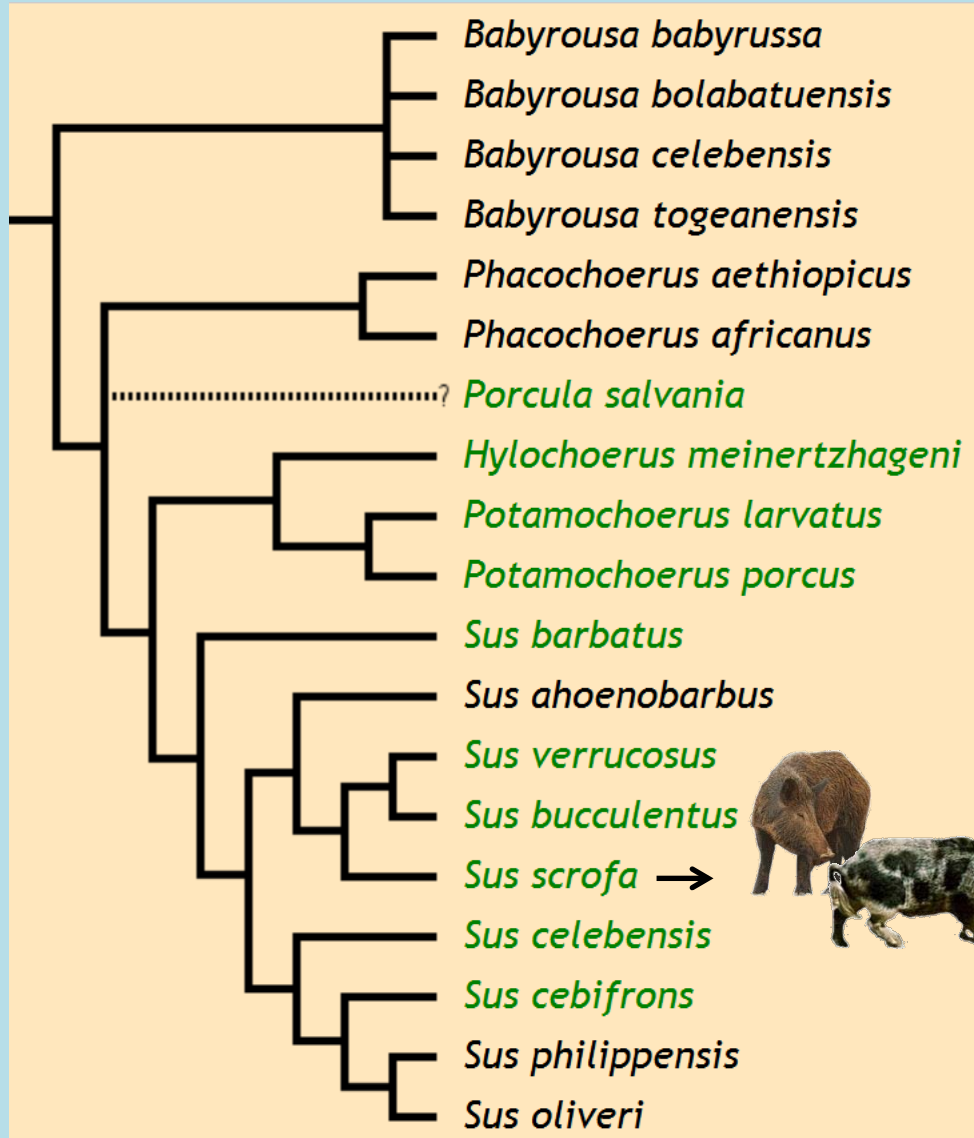


Questions to address







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Wild suid ecology, distribution ...





CATEGORY	DEFINITION	PICTURE
Wild boar	Wild ancestor of the pig, native, game species. Can eventually be managed (feeding, fencing) or farmed.	
Feral pig and pig/wild boar crossbreds	Feral invasive animals, often non-native, game species. Can eventually be managed (feeding, fencing) or farmed.	
Free-range domestic pig	Owned pig allowed to range more or less free. Biosecurity varies between seasons, countries and owners.	
Backyard domestic pig	Owned pig, not commercial, low biosecurity. Usually for family consumption and local exchange.	
Open-air domestic pig	Owned pig, commercial, relatively low biosecurity. Increasing due to animal welfare/public.	
Closed farm domestic pig	Owned pig, commercial, high biosecurity. Limited contact risk with other groups listed above.	

Wild

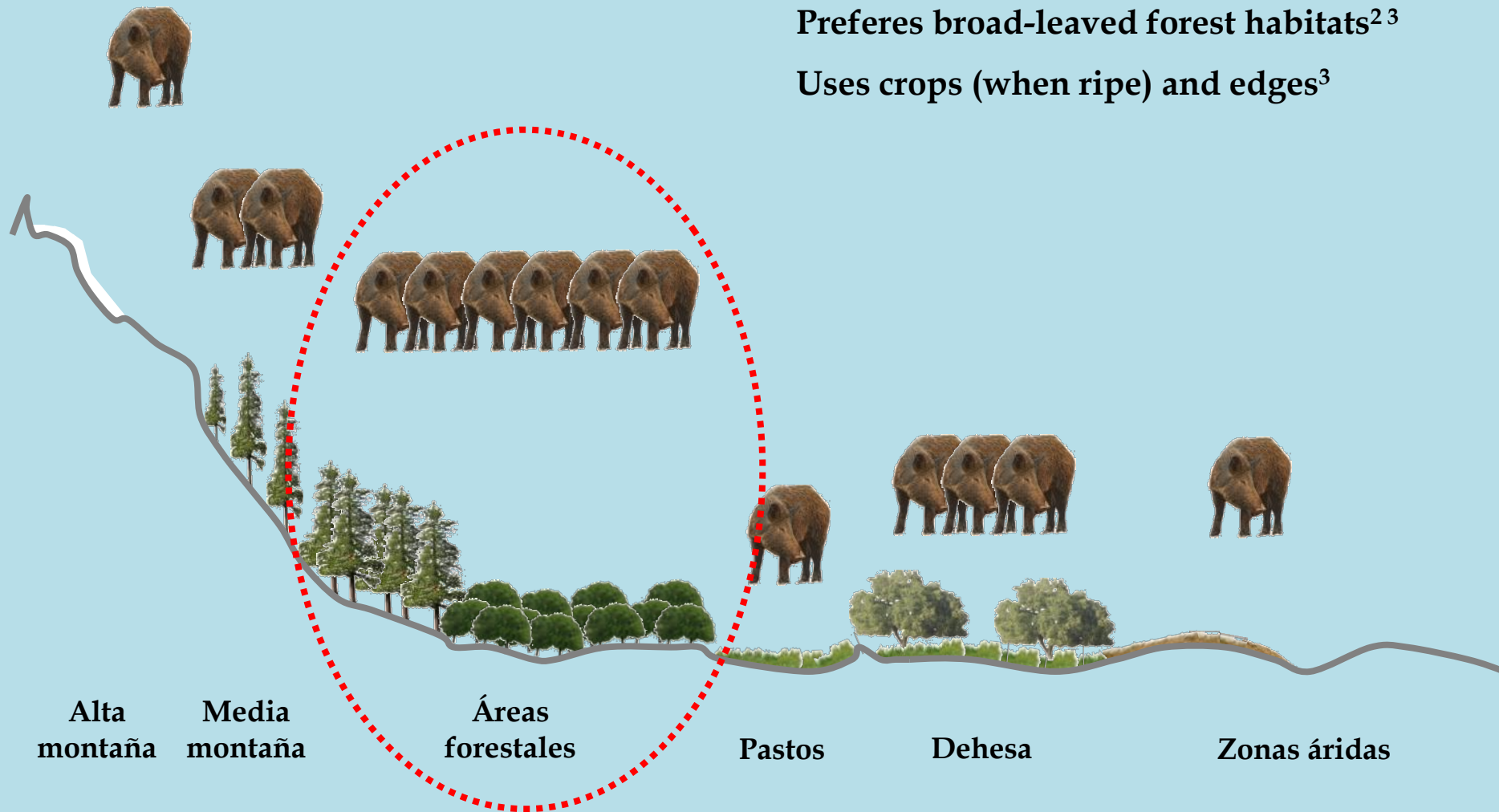
Domestic

Wild suid ecology, distribution ...

Highly adaptable to diversity of habitats¹

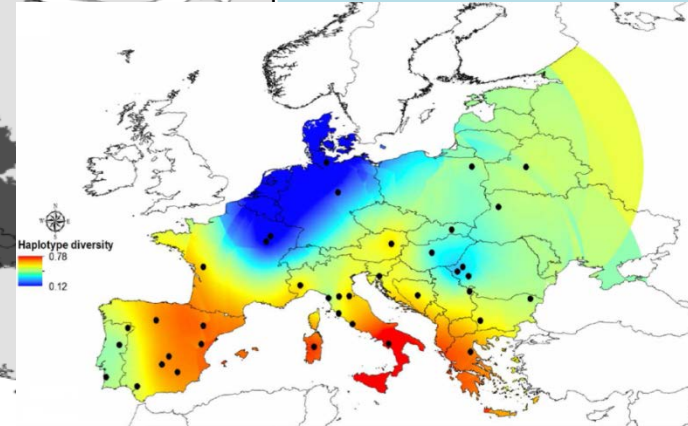
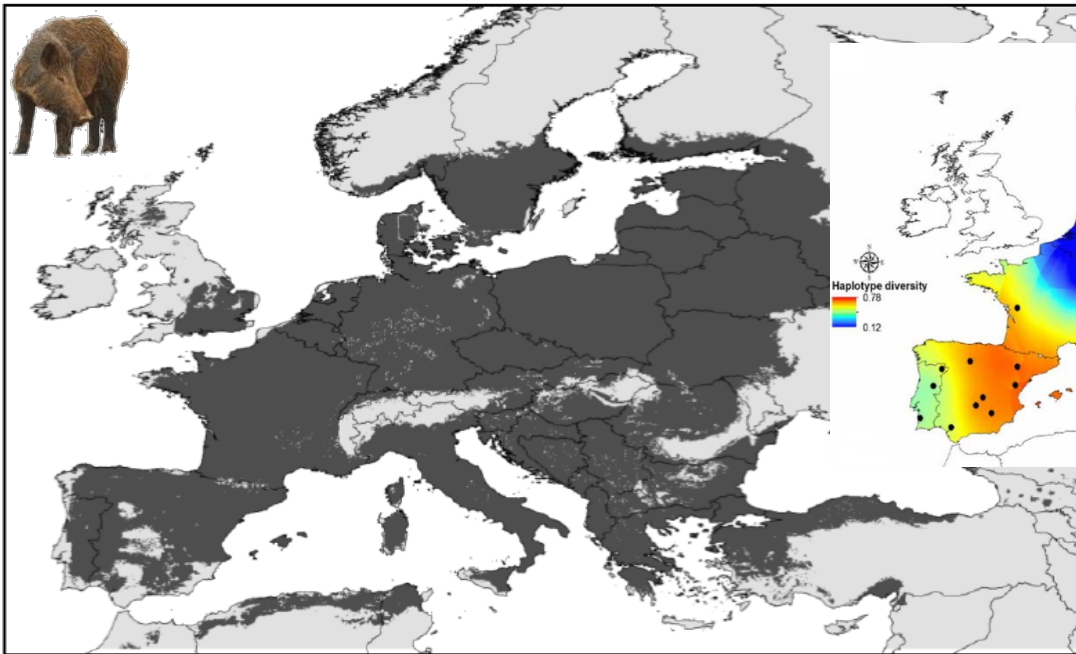
Preferes broad-leaved forest habitats^{2 3}

Uses crops (when ripe) and edges³



¹ Abaigar 1990; ² Meriggi y Sacchi 2001 ³ Thurfjell et al. 2009

Wild suid ecology, distribution ...



Journal of Biogeography (J. Biogeogr.) (2014)

ORIGINAL ARTICLE

Vilaça et al. (2014)
Mitochondrial phylogeography of the European wild boar: the effect of climate on genetic diversity and spatial lineage sorting across Europe

© British Wild Boar Organisation

Eur J Wildl Res (2013) 59:761–764
DOI 10.1007/s10344-013-0721-z

SHORT COMMUNICATION

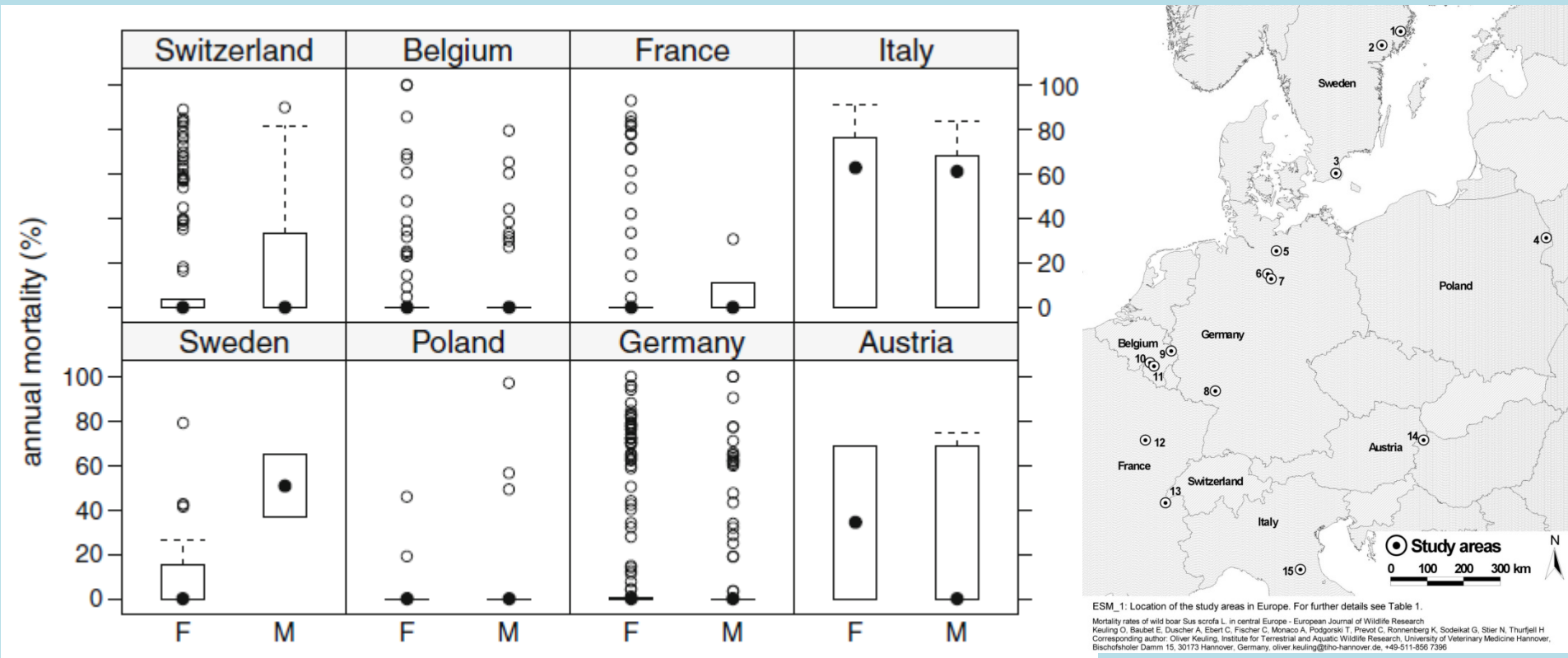
Are wild boars roaming Ireland once more?

Allan D. McDevitt • Ruth F. Carden • Ilaria Coscia • Alain C. Frantz



Pig production in Europe (Eurostats)

Wild suid ecology, distribution ...



Shooting is the main cause of death – diseases, roadkills & predation are negligible

Mortality is always lower than the reproduction rate



Oliver Keuling

Eur J Wildl Res
 DOI 10.1007/s10344-013-0733-8

ORIGINAL PAPER

Mortality rates of wild boar *Sus scrofa* L. in central Europe

Oliver Keuling · Eric Baubet · Andreas Duscher · Cornelia Ebert ·
 Claude Fischer · Andrea Monaco · Tomasz Podgórski · Céline Prevot ·
 Katrin Ronnenberg · Gunter Sodeikat · Norman Stier · Henrik Thurfjell

Wild suid ecology, distribution ...



TB causes between 25-40% of mortality in subadult wild boar in Spain
(J. Vicente, unpublished)

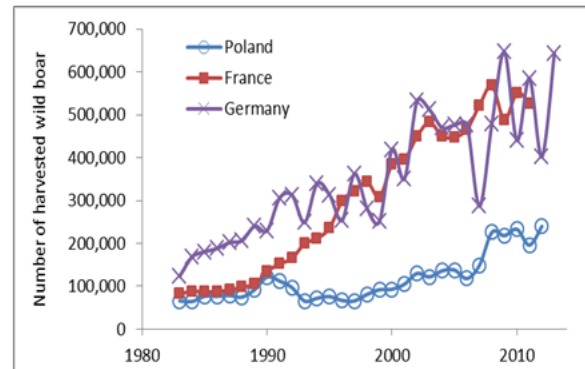
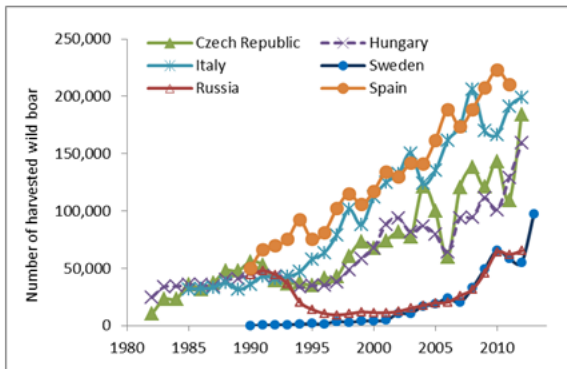
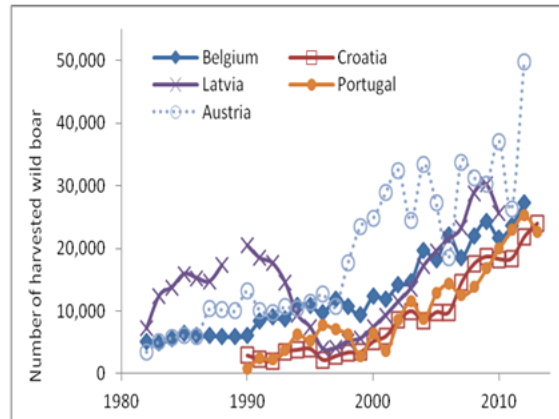
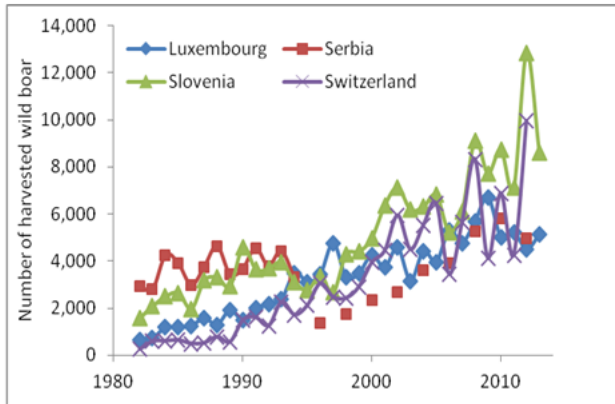
PCV2+*M. hyo*+others can cause up to 70% piglet mortality during summer in Spain
(C. Gortazar, unpublished)



Emaciation in PCV2-infected piglet

Wild suid ecology, distribution ...

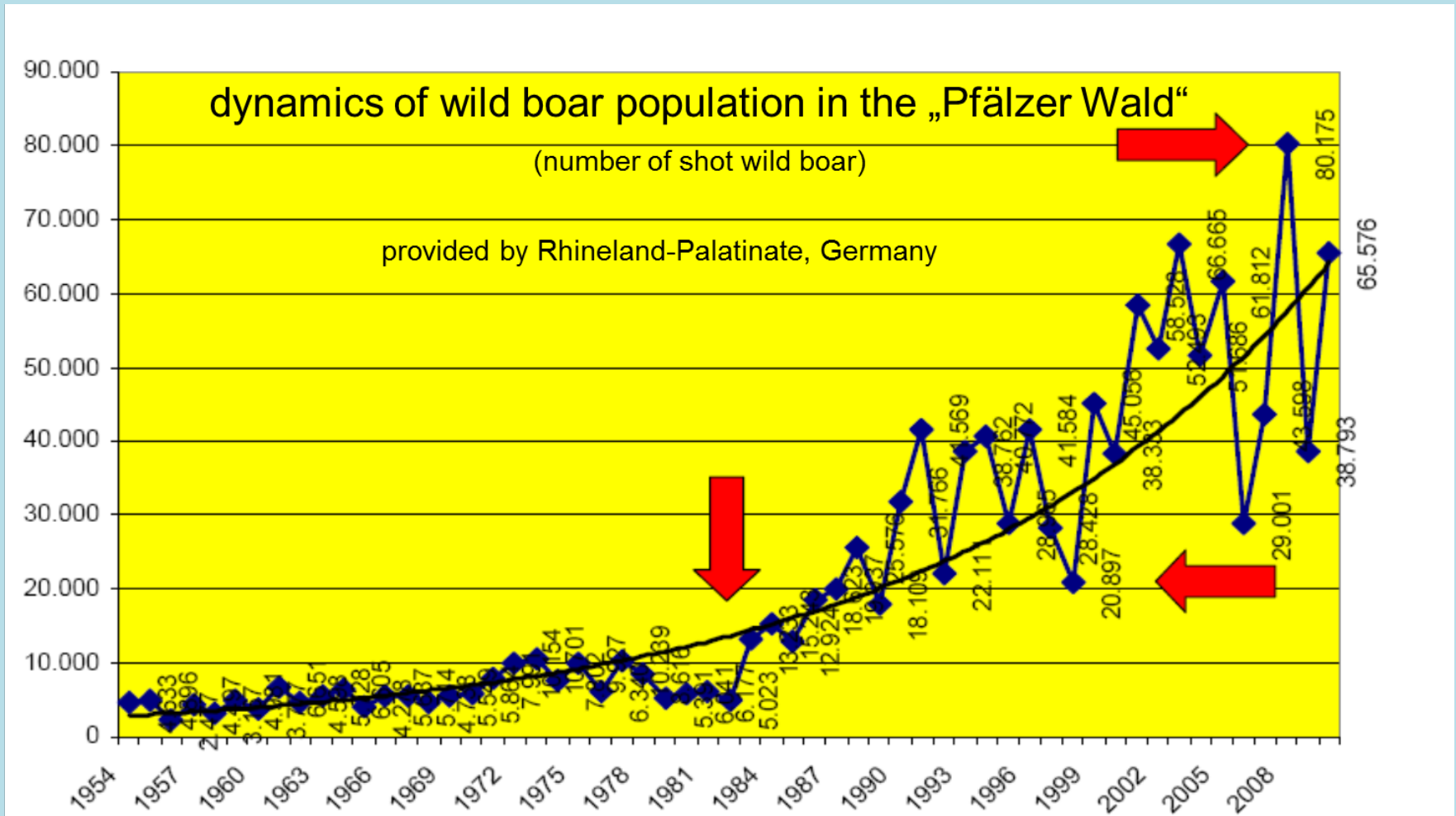
Wild boar population trends in Europe



>2 million wild boar harvest/year
Wild boar population >10 million
Growth and expansion will continue

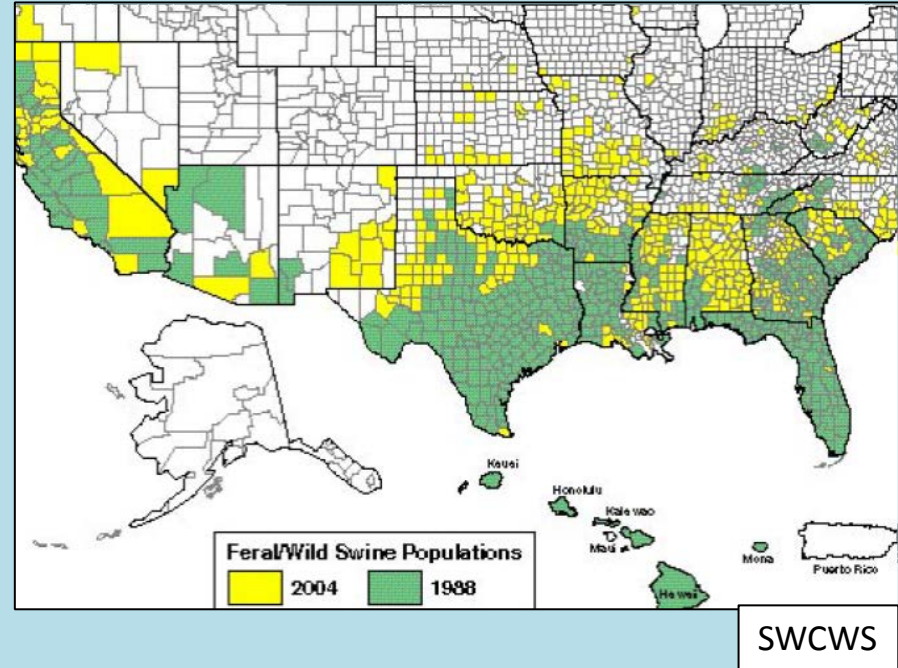
Massei et al. submitted *Pest Management Science*

Wild suid ecology, distribution ...



Figures for 2013 are already 100,000
hunter-harvested wild boar
(C. Staubach)

Wild suid ecology, distribution ...



AUSTRALIA: approx. 13 million feral swine distributed across 40% of the continent. Abundance varies from low densities (e.g. 0.5-1 pig/square kilometer) up to very high densities (e.g. 10-20 pigs/square kilometer). Source: Brendan Cowled.

Wild suid ecology, distribution ...



Wild suid ecology, distribution ...

Feeding has spectacular effects:

- Increased reproduction
- Better survival during limiting seasons
- More predictable presence of game
- Along with fencing, prevents crop damage
- (...)

But:

- Causes high densities
- Main driver of northward expansion in EU
- Facilitates intra- and inter species contacts
- Creates high spacial aggregation → transmission
- (...)



Questions to address

1. Which species/subspecies of free-ranging swine are a disease risk to livestock, wildlife, and people?
 1. Probably all. However, *Sus scrofa* is the best known, has the widest distribution and is the key species in most regions.
2. What is the geographical global distribution of these species?
 1. Worldwide except for extremely dry or extremely cold regions... and **expanding!**
3. What factors contribute to population growth and expansion of free-ranging swine populations?
 1. General habitat suitability, and extreme adaptability
 2. Low mortality due to hunting, diseases, road kills, predators
 3. Man-driven expansion and population growth: **feeding** & translocations

Questions to address

- (1-3) Wild suid ecology, distribution and trend or management
- (4-5) **Main pig-related diseases**
- (6-7) Risk assessment and knowledge gaps



Main pig-related diseases

Viral

- African swine fever
- Classical swine fever
- Aujeszky's disease
- Porcine circovirus type 2
- Porcine parvovirus
- Swine influenza
- PRRS
- Coronavirus
- FMD
- Other vesicular diseases
- Hepatitis E
- (...)

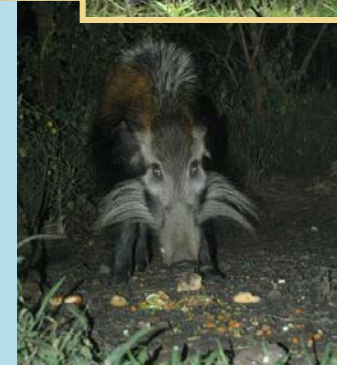
Bacterial

- Tuberculosis
- Swine brucellosis
- *Erysipelothrix* infection
- Streptococcosis
- Salmonellosis
- Colibacillosis
- Enzootic pneumonia
- Q fever
- Leptospirosis
- *Lawsonia intracellularis*
- *Actinobacillus pleuropneumoniae*
- (...)



African swine fever

- OIE listed viral disease
- Acute, highly contagious disease of domestic pigs
- High mortality, reaching 100%
- No vaccines
- Emerging trans-boundary disease
- Endemic in large parts of SSA including Uganda
- Considered a main constraint for the development of the pig industry

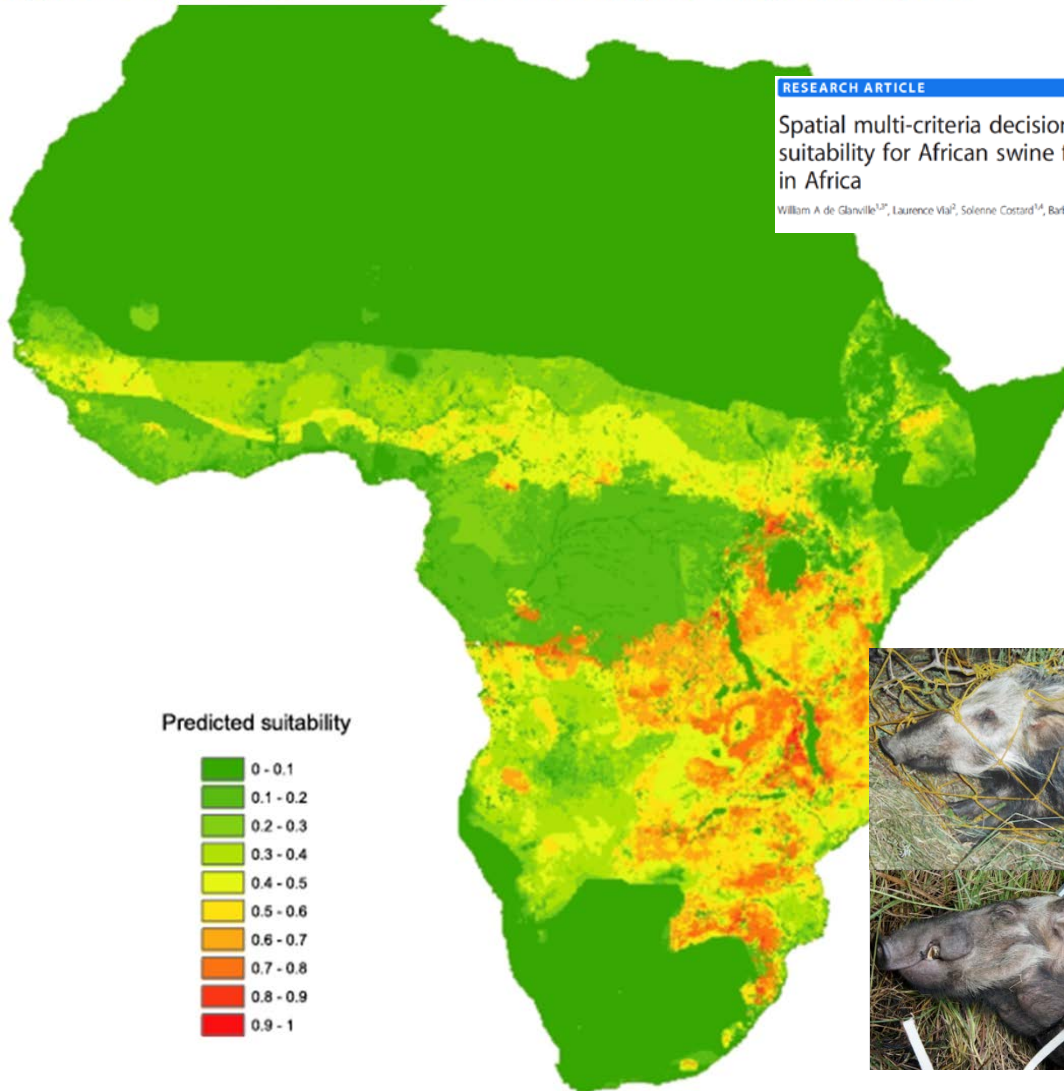


African swine fever

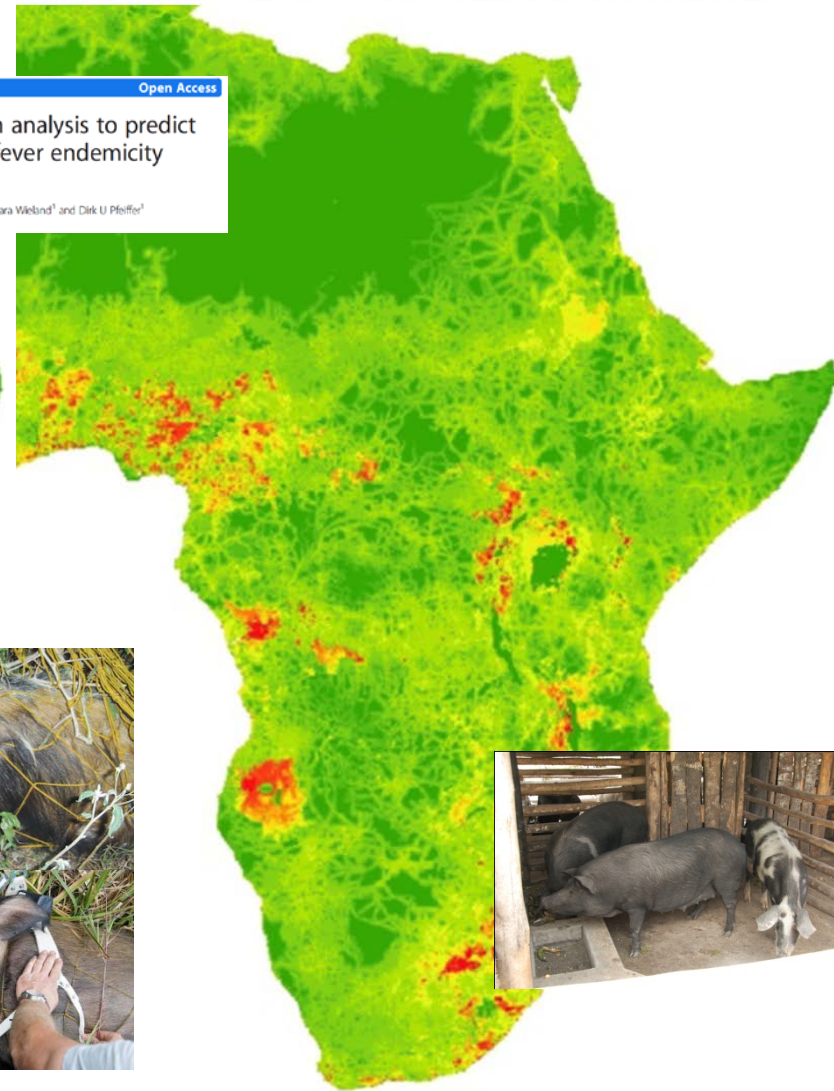


African swine fever

Figure 2 Suitability for ASF persistence as part of sylvatic cycles



Suitability for ASF persistence as part of domestic cycles



RESEARCH ARTICLE [Open Access](#)

Spatial multi-criteria decision analysis to predict suitability for African swine fever endemicity in Africa

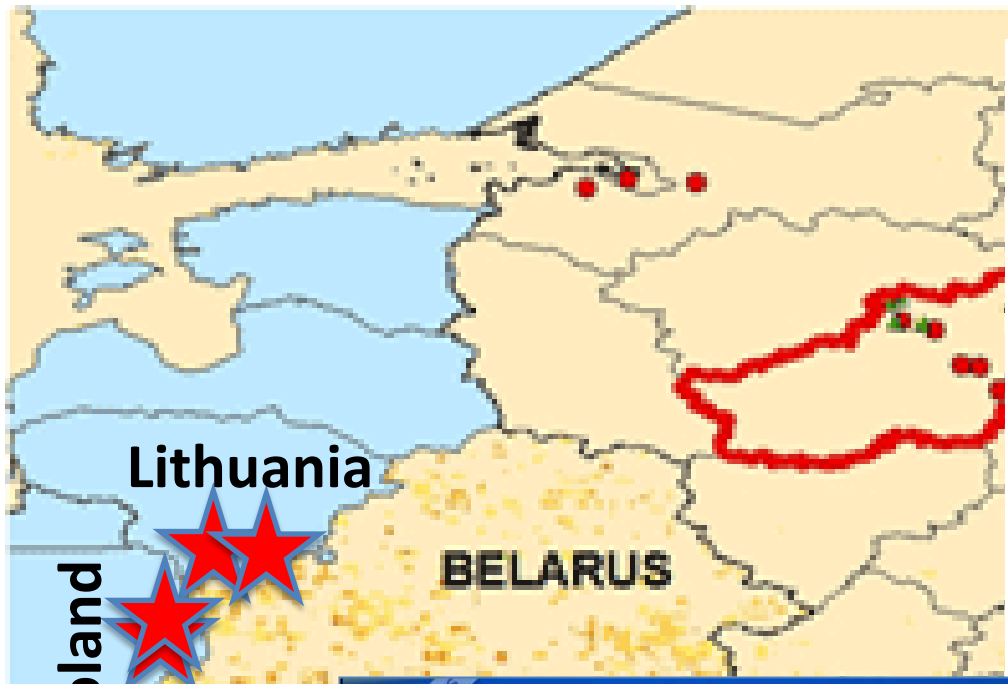
William A de Glanville^{1,2*}, Laurence Via², Solenne Costard^{1,4}, Barbara Wieland¹ and Dirk U Pfeiffer³



African swine fever



ASFORCE (Collab. JM Sánchez-Vizcaino):
Wild boar life-trapping in Sardinia, 2014



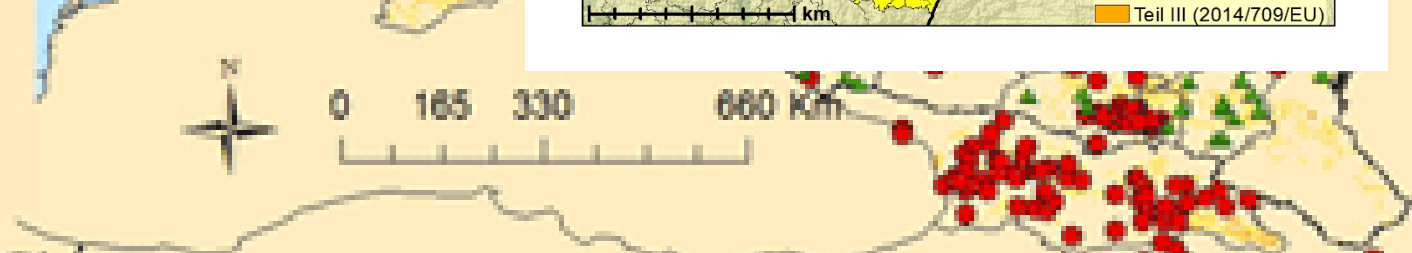
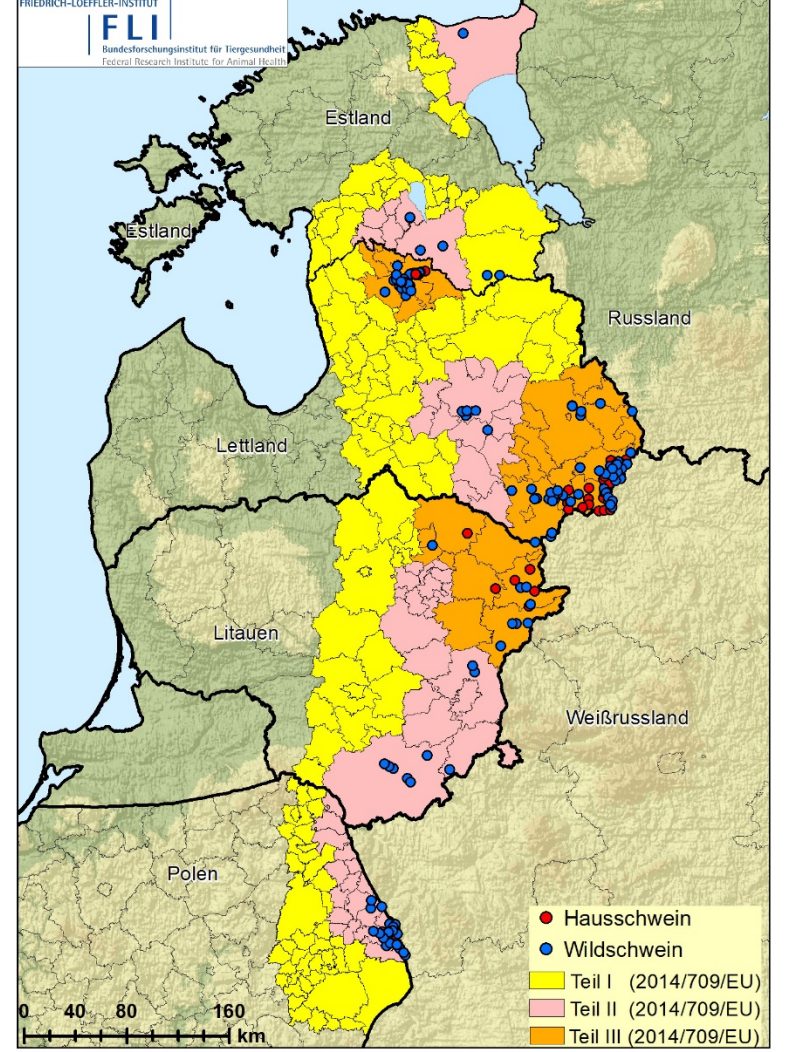
ASF OUTBREAKS

- Species
- Wild Boar
 - Domestic

SWINE DENSITY



Afrikanische Schweinepest in Estland, Lettland, Litauen und Polen in 2014
 Quelle: ADNS (Stand: 13.11.2014 - 17:45 Uhr)
 nach Anhang des Durchführungsbeschlusses 2014/709/EU



African swine fever

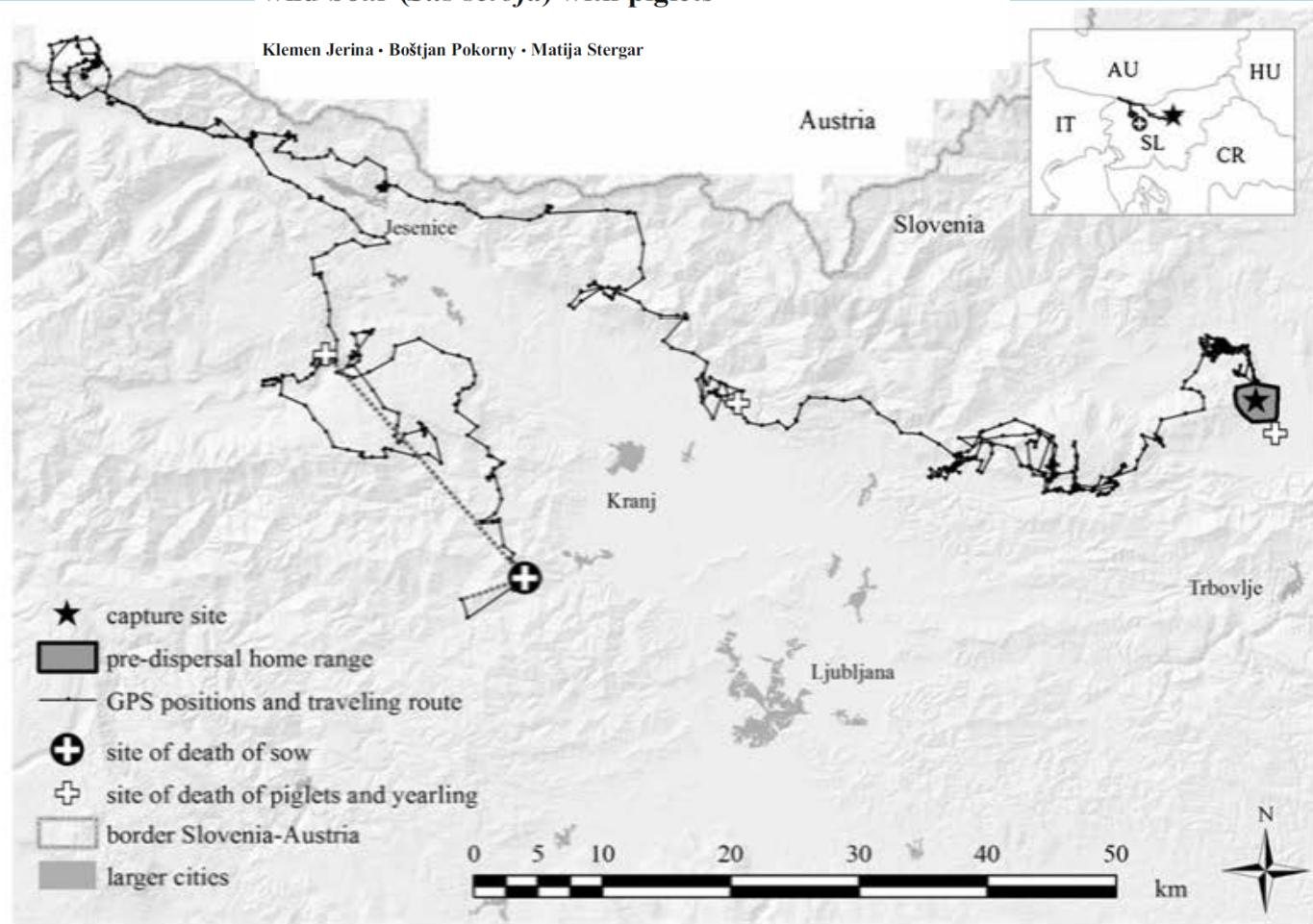
Eur J Wildl Res
DOI 10.1007/s10344-014-0796-1

ORIGINAL PAPER

First evidence of long-distance dispersal of adult female wild boar (*Sus scrofa*) with piglets

Klemen Jerina · Boštjan Pokorny · Matija Stergar

Fig. 2 Travelling route of the wild boar sow, its eight piglets and a yearling after they left their home range. The sow's 2-month dispersal ended with a culling 60 km from capture site. In between, it maximally moved 100 km away from its pre-dispersal home range



African swine fever

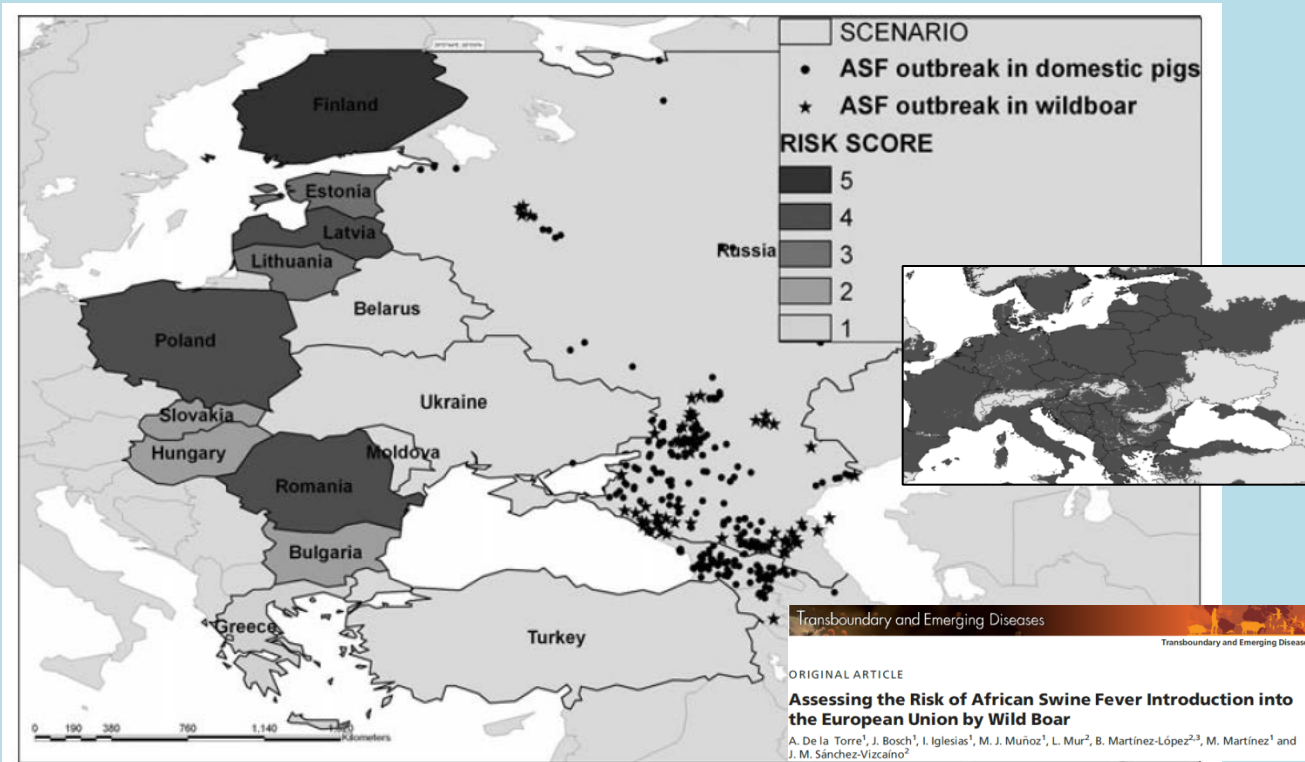
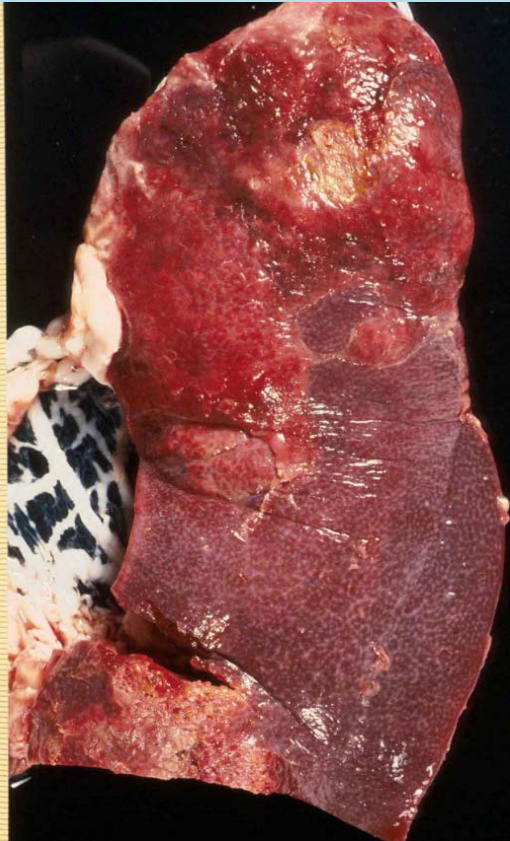
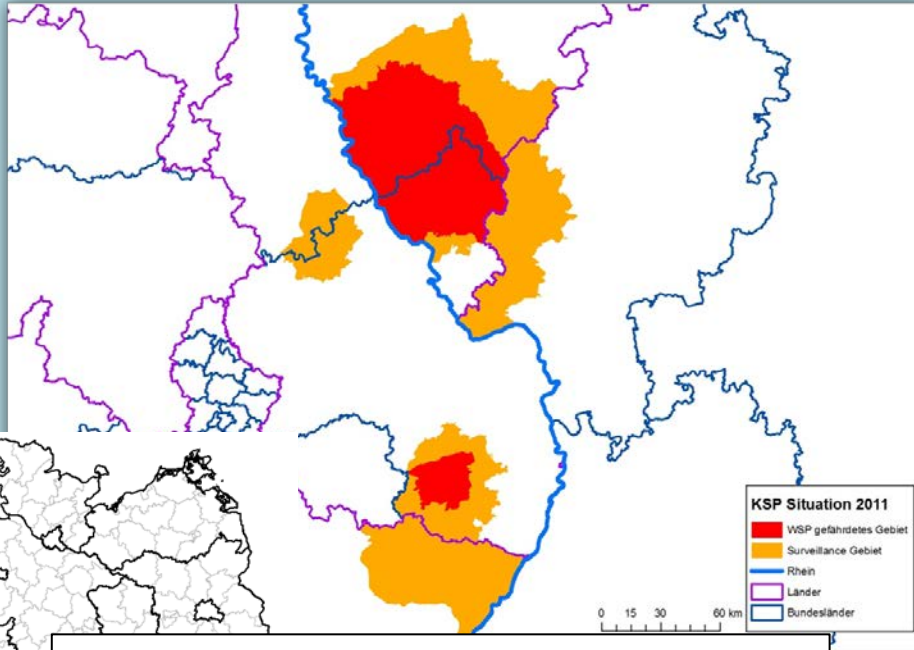


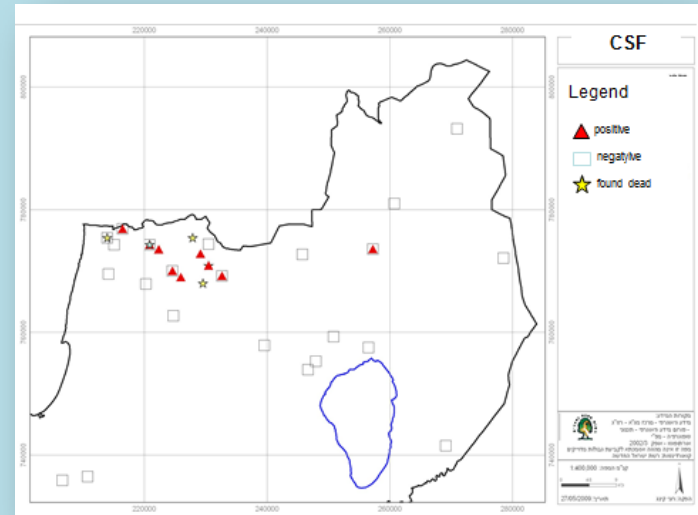
Fig. 1. Probability of ASFV introduction into EU by wild boar. Risk value of 0 should be expected for other EU countries not included in the scenario of study.

- Wild boar long time regarded as irrelevant
- Recent observations show that not all infected animals die after short time (e.g. Kurinov et al. 2012)
- Wild boar can move long distances, do contact pigs and pig products, ...

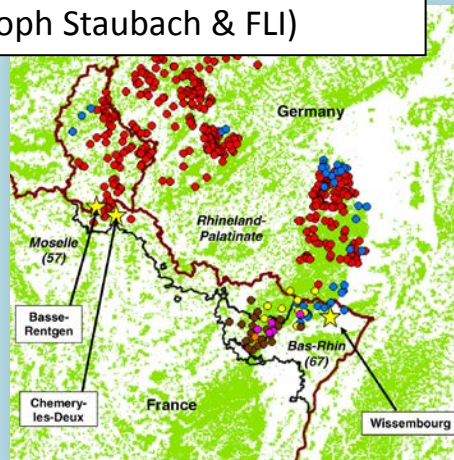
Classical swine fever



Germany officially CSF-free since 31 March 2012
(Source: Christoph Staubach & FLI)



CSF spillover to wild boar in Israel, 2009
Chinese strain. Map: Roni King



Veterinary Microbiology 166 (2013) 631–638

Contents lists available at SciVerse ScienceDirect



Veterinary Microbiology

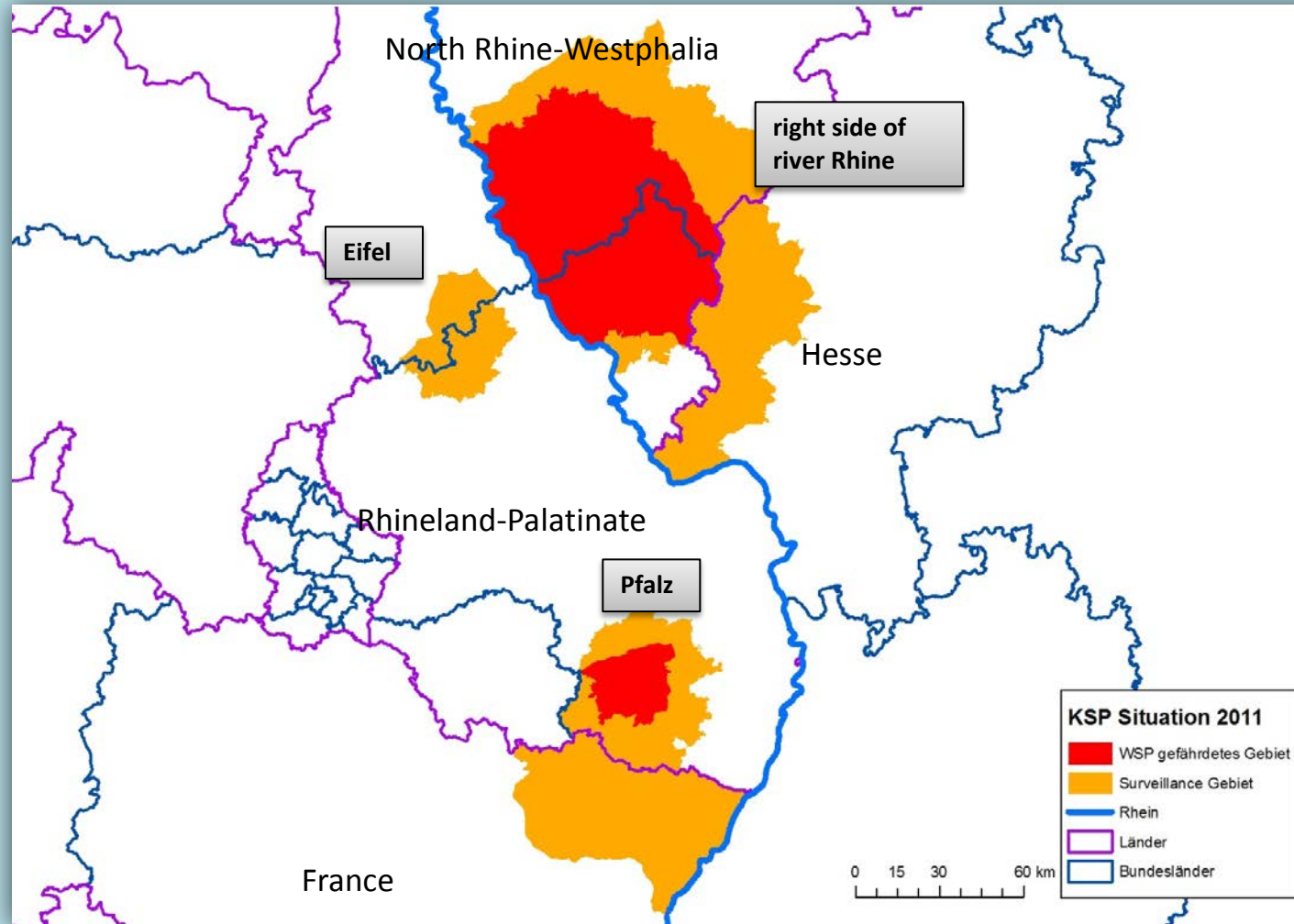
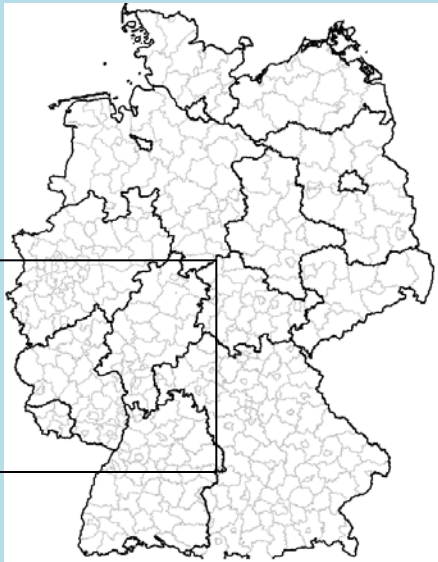
journal homepage: www.elsevier.com/locate/vetmic

Short communication

Molecular tracing of classical swine fever viruses isolated from wild boars and pigs in France from 2002 to 2011

Gaëlle Simon^{a,b,*}, Mireille Le Dimna^{a,b}, Marie-Frédérique Le Potier^{a,b}, Françoise Pol^{a,b}

overview about the current CSF - areas



CSF: Critical Community Size

- Size/density threshold required to maintain circulation of a pathogen.

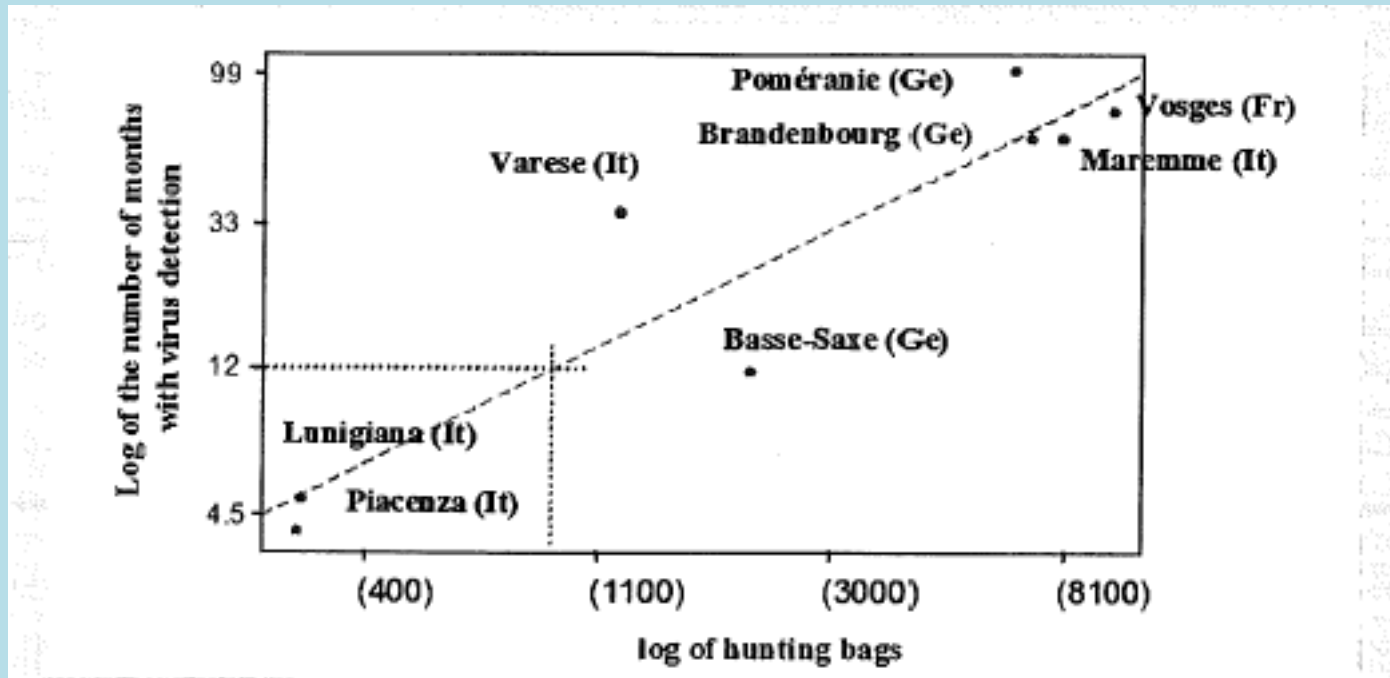


Fig. 8.2 In the 1990s and 2000s many CSF outbreaks were monitored in Germany (Ge), Italy (It) and France (Fr) (Laddomada 2000; Rossi et al. 2005a). The persistence of infection during these epizootics was highly correlated with the size of the wild boar population (as estimated from hunting bags)

Classical swine fever

Germany

SCHWEINEPEST BEI
WILDSCHWEINEN
-
BEOBACHTUNGSZONE

Geregelter
Schweinetransport
und -handel

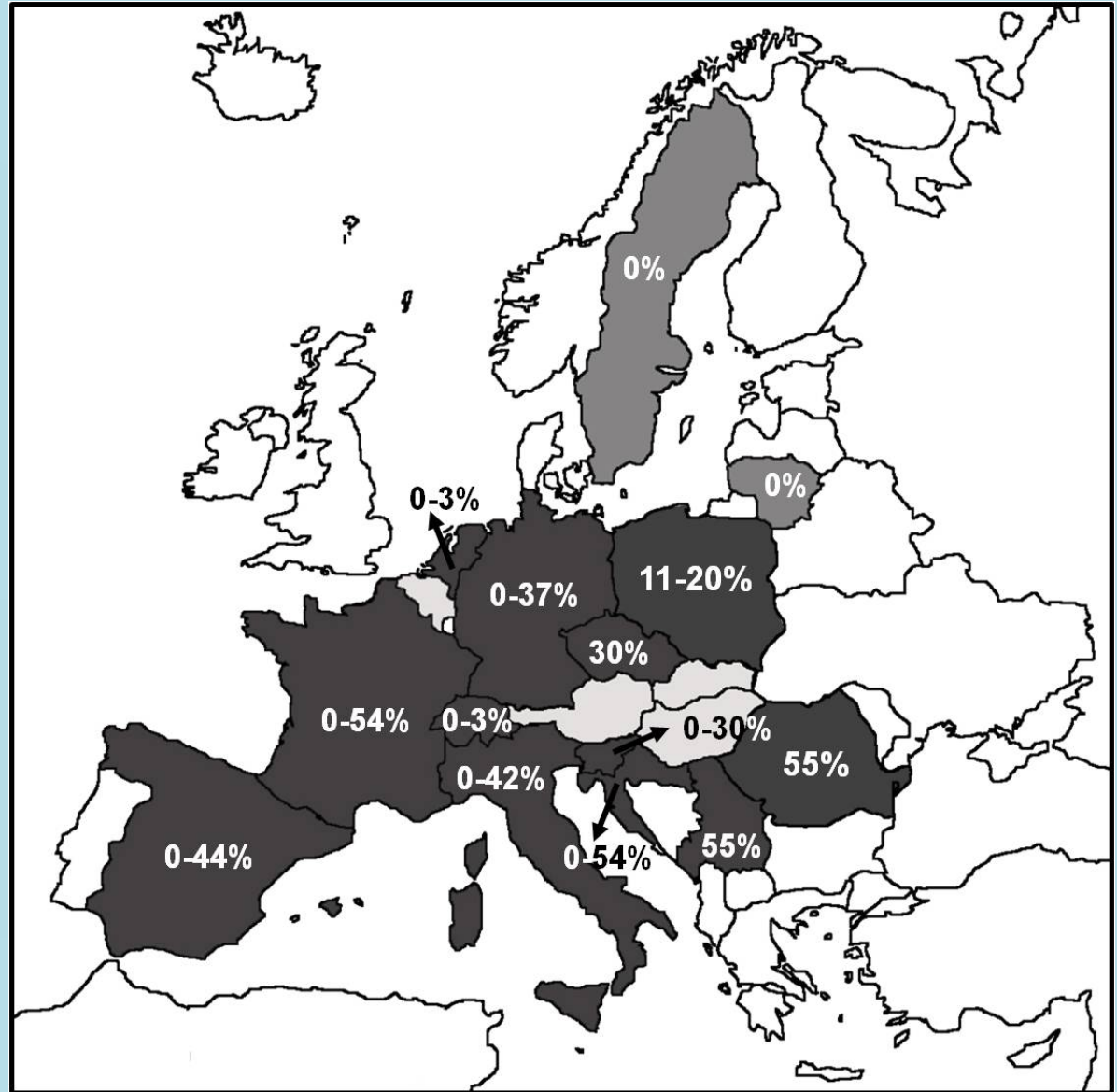
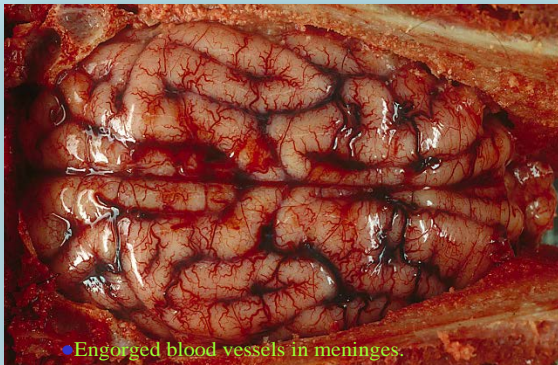
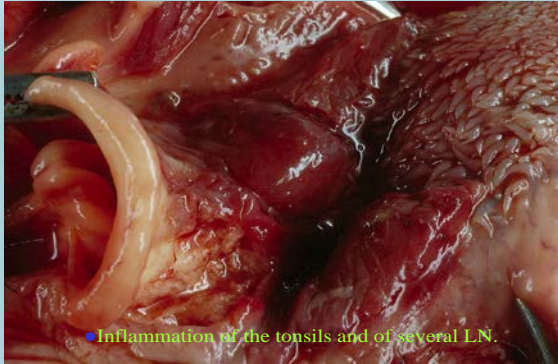
PESTE PORCINE
CHEZ LES SANGLIERS
-
ZONE D'OBSERVATION

Transport et commerce
de porcs réglementés

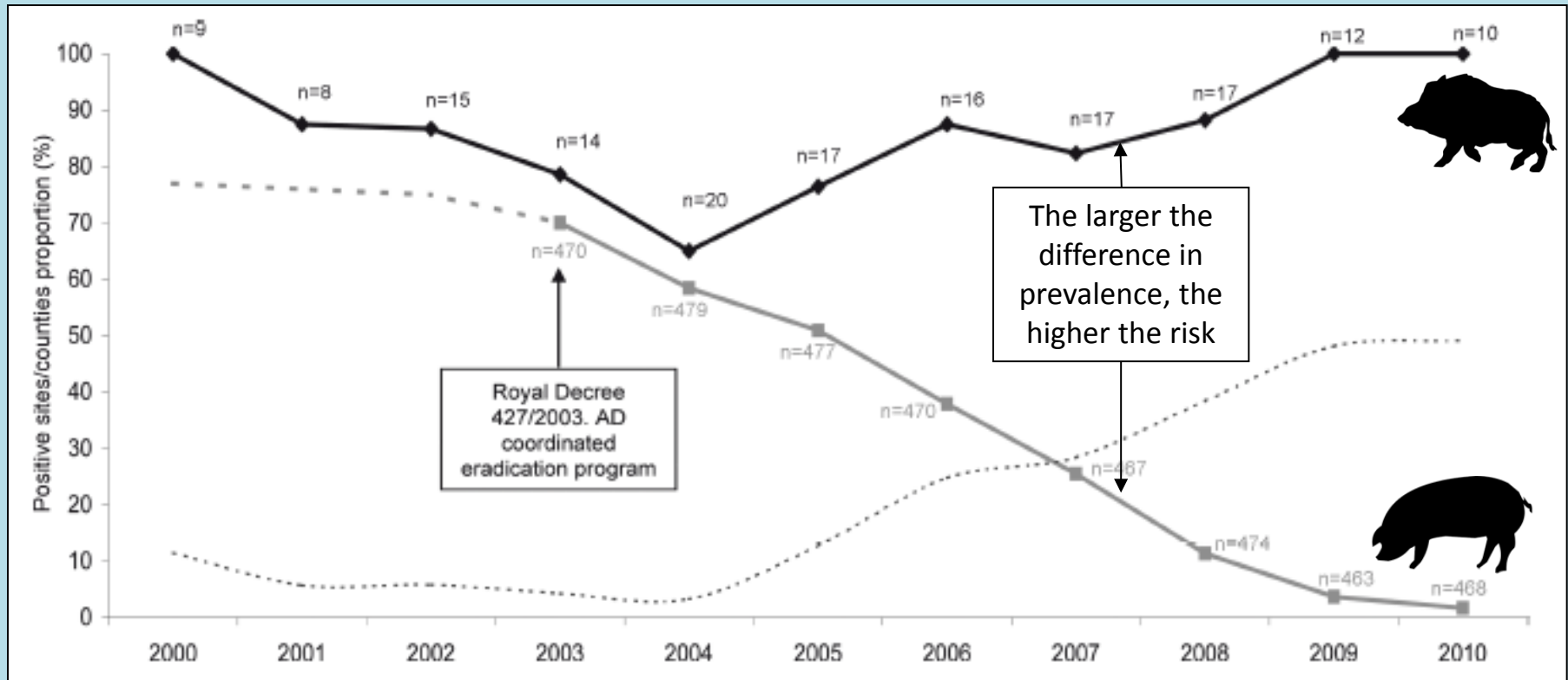


Fotos: Wild & Hund

Aujeszky's disease (Pseudorabies)



Aujeszky's disease



Boadella et al. BMC Veterinary Research 2012, 8:7
<http://www.biomedcentral.com/1746-6148/8/7>

BMC
Veterinary Research

RESEARCH ARTICLE

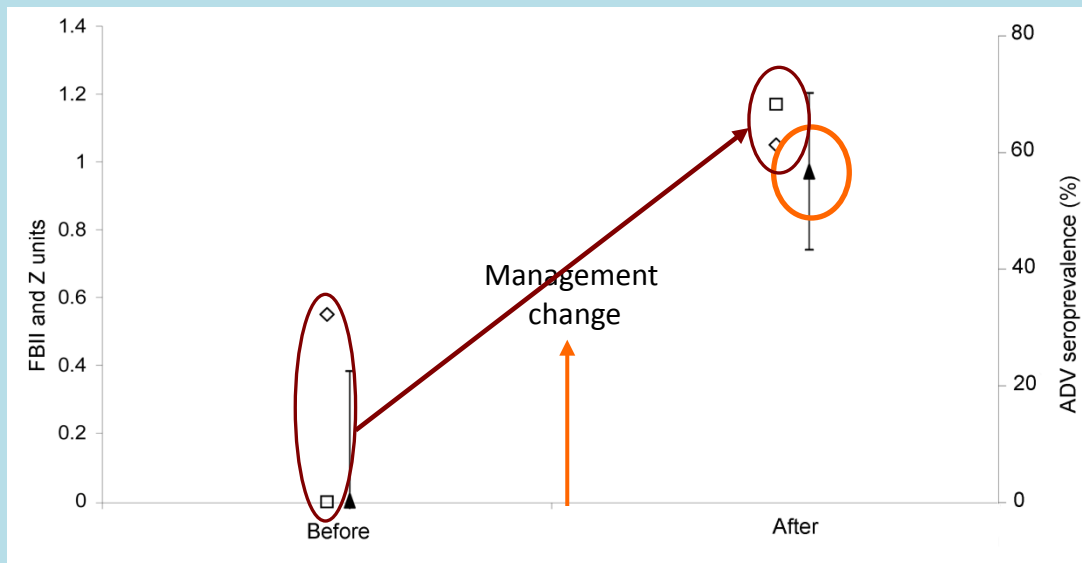
Open Access

Wild boar: an increasing concern for Aujeszky's disease control in pigs?

Mariana Boadella*, Christian Gortázar, Joaquín Vicente and Francisco Ruiz-Fons

Aujeszky's disease

- A special case:
 - Hunting estate outside the AVD “core-area”
 - Negative until 2008
 - Significant change in management → fencing / feeding
 - Increase in abundance (FBII) and spatial aggregation (Z)
 - After 2008: 56% ADV seroprevalence



“Unlike love, HERPES is forever”
(Vittorio Guberti)

Foot and mouth disease

T. Alexandrov et al. / Veterinary Microbiology 166 (2013) 84–90

85

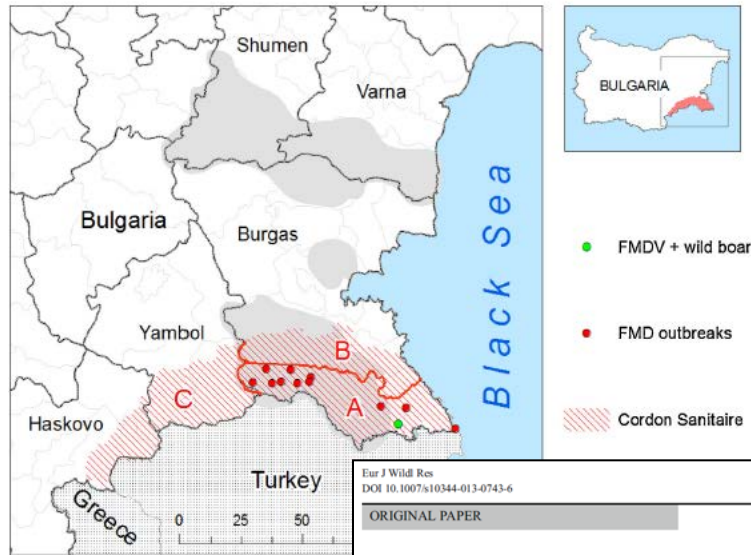


Fig. 1. Locations of the shot FMDV positive wild boar and the 11 outbreaks and C and the East-Balkan pig herds.

Eur J Wildl Res
DOI 10.1007/s10344-013-0743-6

ORIGINAL PAPER

A serological survey of selected pathogens in wild boar (*Sus scrofa*) in northern Turkey

Harun Albayrak · Emre Ozan · Abdullah Cavunt

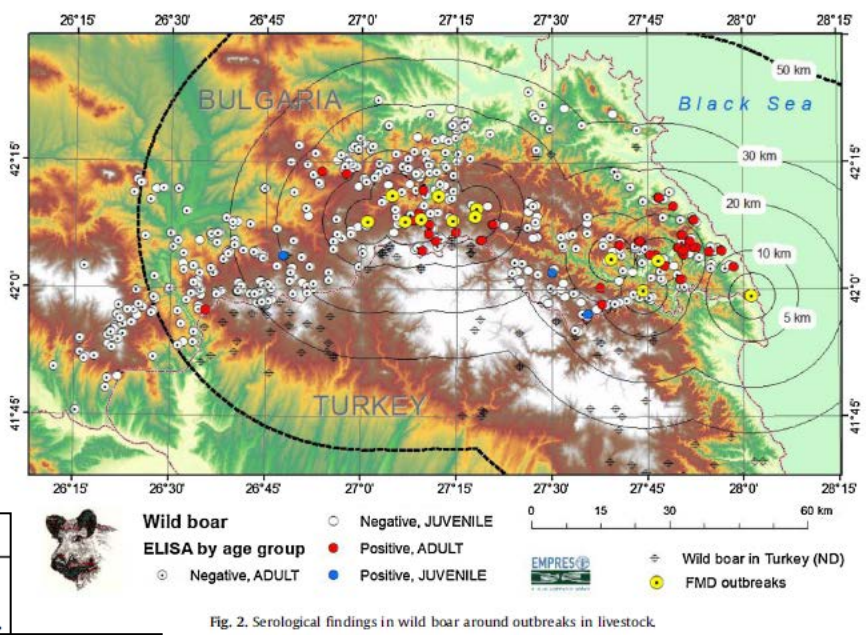


Fig. 2. Serological findings in wild boar around outbreaks in livestock

BULGARIA: low seroprevalence and clustered distribution of seropositive wild boar and roe deer suggest that FMD infection in wildlife was a short living event, which failed to develop into a large scale epidemic.

ISRAEL: After a major outbreak of FMD in gazelles, a survey detected $108/840 = 15\%$ boar seropositive and $2/72 = 3\%$ that had the virus. Results show the exposure of the boars, but not necessarily a role in maintenance (R. King).

Veterinary Microbiology 166 (2013) 84–90

Contents lists available at SciVerse ScienceDirect

Veterinary Microbiology

journal homepage: www.elsevier.com/locate/vetmic

Surveillance of foot-and-mouth disease (FMD) in susceptible wildlife and domestic ungulates in Southeast of Bulgaria following a FMD case in wild boar

Tsviatko Alexandrov^a, Dimitar Stefanov^b, Pencho Kamenov^a, Alexandra Miteva^a, Sergei Khomenko^c, Keith Sumption^d, Hinrich Meyer-Gerbautlet^e, Klaus Depner^{f,*}

Main pig-related diseases

Viral

- African swine fever
- Classical swine fever
- Aujeszky's disease
- Porcine circovirus type 2
- Porcine parvovirus
- Swine influenza
- PRRS
- Coronavirus
- FMD
- Other vesicular diseases
- Hepatitis E
- (...)

Bacterial

- Tuberculosis
- Swine brucellosis
- *Erysipelothrix* infection
- Streptococcosis
- Salmonellosis
- Colibacillosis
- Enzootic pneumonia
- Q fever
- Leptospirosis
- *Lawsonia intracellularis*
- *Actinobacillus pleuropneumoniae*
- (...)



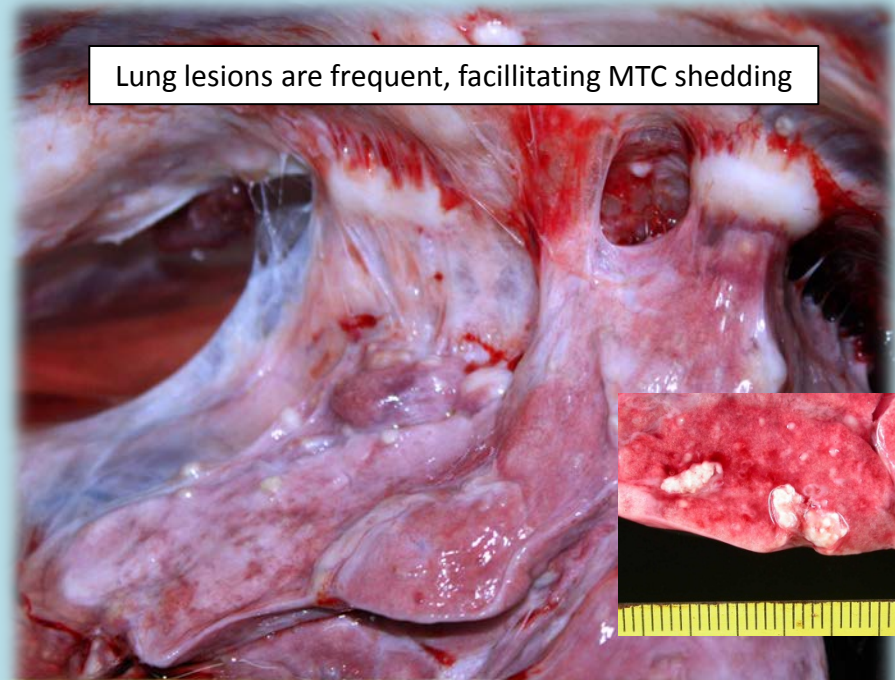
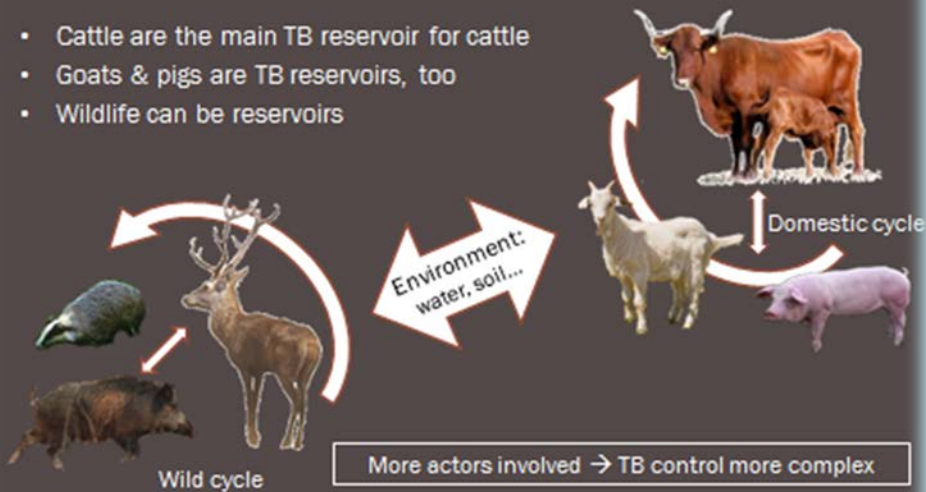
Tuberculosis

- M. tuberculosis* complex: a multi-host pathogen
- each situation can be different
 - Only **spillover host** in New Zealand & Australia
 - Key wild **maintenance host** in Iberian Peninsula, Sicily (Italy, pigs), Molokai (Hawaii, feral pigs)...
 - Increasingly reported as MTC host in >14 EU countries, N Africa, S America... status unknown in many regions

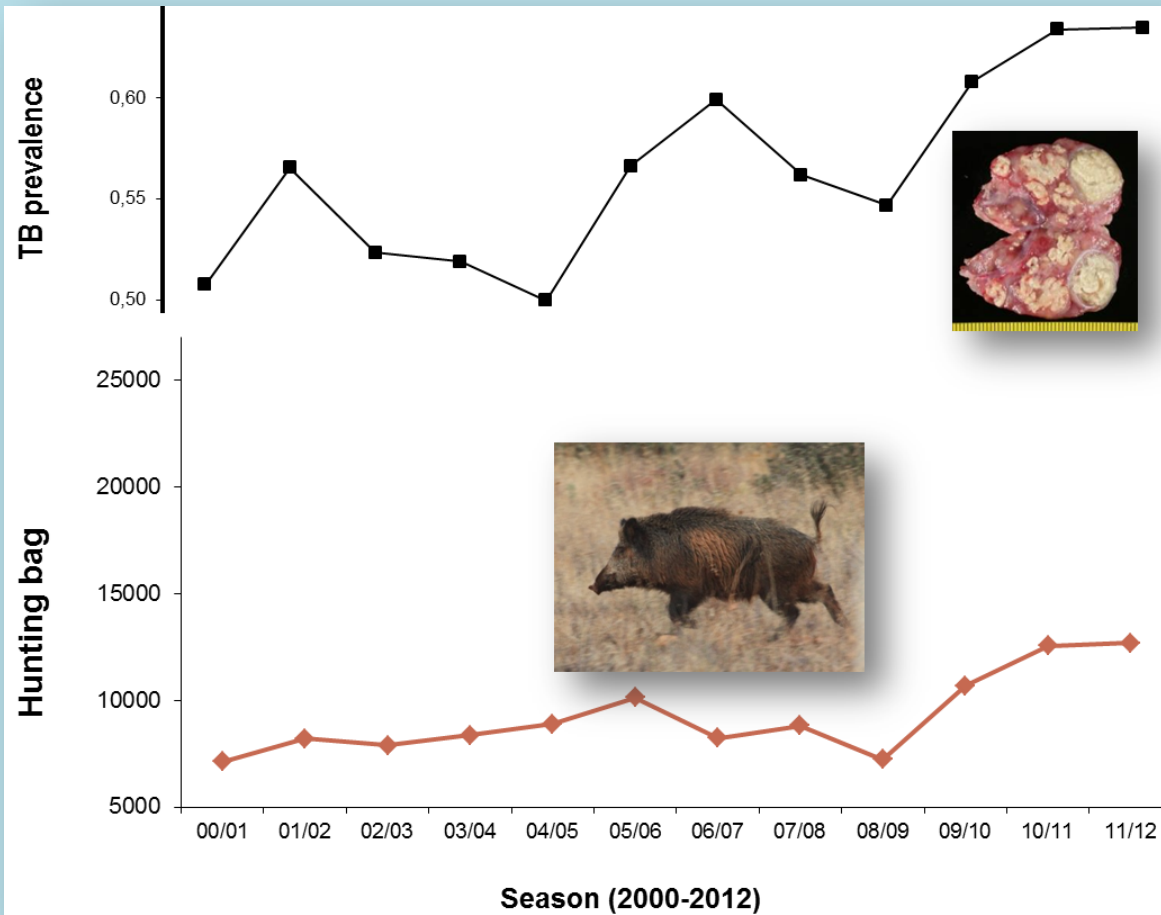


The MTC reservoir

- Cattle are the main TB reservoir for cattle
- Goats & pigs are TB reservoirs, too
- Wildlife can be reservoirs



Tuberculosis



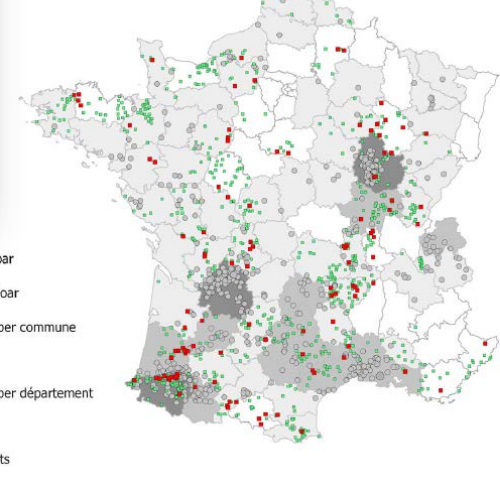
- Well-established link between wild boar and cattle TB (e.g. Richomme et al. 2013)
- Prevalence trend in wild boar contrasts with decreasing cattle TB (Boadella et al. 2011)
- Culling wild boar reduced cattle TB incidence and red deer TB prevalence (Boadella et al. 2012)

OPEN ACCESS [freely available online](#) PLOS ONE

Exposure of Wild Boar to *Mycobacterium tuberculosis* Complex in France since 2000 Is Consistent with the Distribution of Bovine Tuberculosis Outbreaks in Cattle

Céline Richomme¹, Mariana Boadella², Aurélie Courcou¹, Benoit Durand¹, Antoine Drapeau¹, Yannick Corde¹, Jean Hars¹, Ariane Payne^{1*}, Alexandre Fediaevsky¹, Maria Laura Boschiroli^{1*}

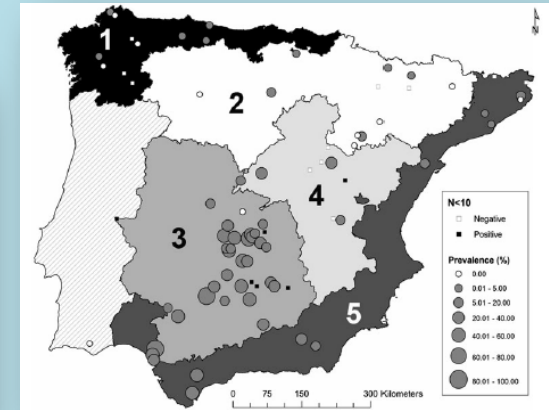
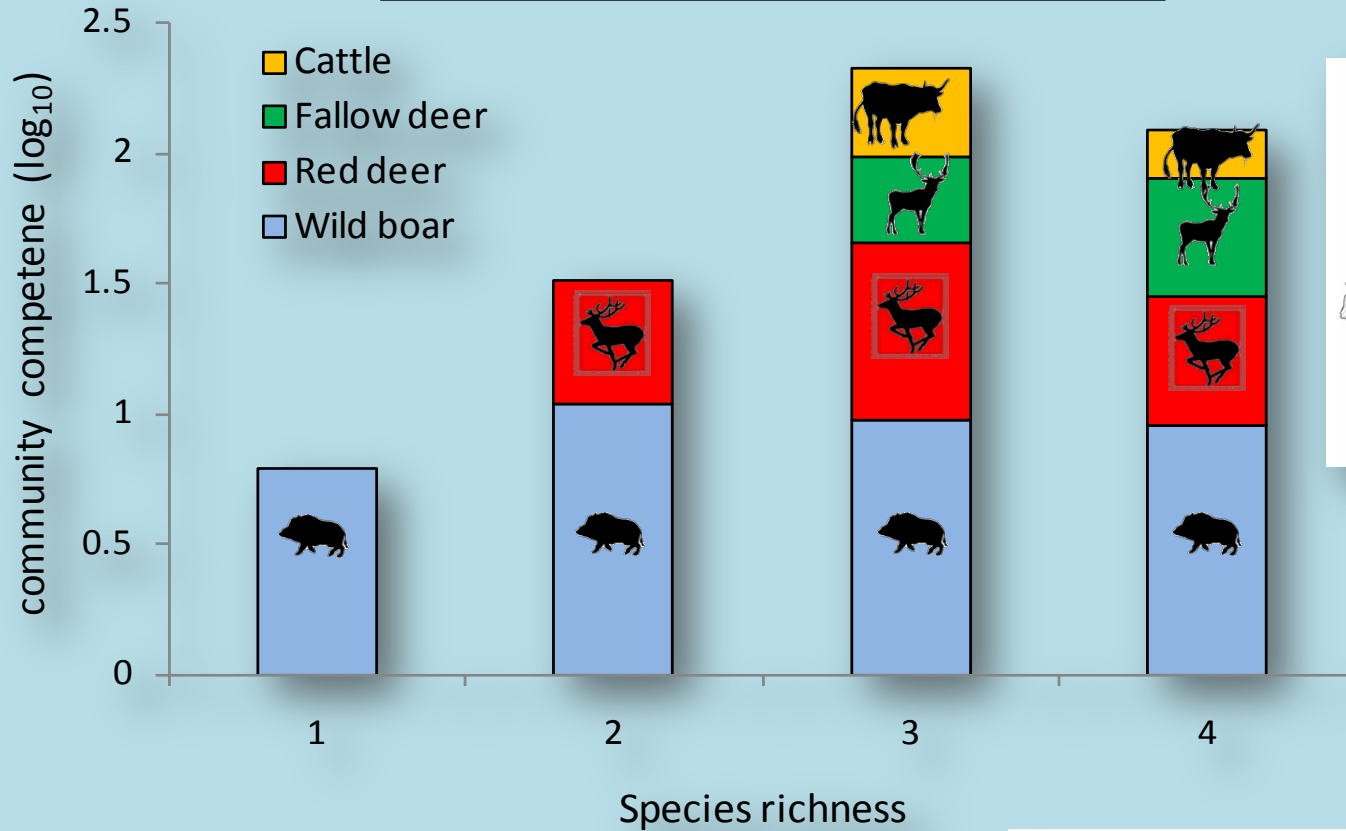
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Transboundary and Emerging Diseases
 ORIGINAL ARTICLE
Temporal Trend of Tuberculosis in Wild Ungulates from Mediterranean Spain
 J. Vicente¹, J. A. Barasona¹, P. Acevedo^{2*}, J. F. Ruiz-Fons¹, M. Boadella¹, I. Diez-Delgado¹, B. Beltran-Beck¹, D. González-Barrio¹, J. Queirós¹, V. Montoro¹, J. de la Fuente¹ and C. Gortazar¹

Tuberculosis

$$\sum \text{Prevalence} \times \text{Shedding} \times \text{Abundance}$$



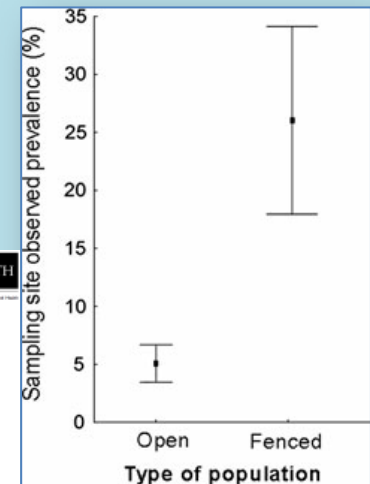
Vicente et al. (in prep.)

Methods
DOI: 10.1093/ehp/ehp111/111/111

Original Contribution

Spatio-Temporal Trends of Iberian Wild Boar Contact with *Mycobacterium tuberculosis* Complex Detected by ELISA

Martina Beakli,¹ Felice Acevedo,² Inés Vicente,³ Gregorio Montalvo,³ Ana Balboa,⁴ María Cruz Arnao,⁵ David Martínez,⁶ Ignacio García-Bezares,⁶ Carmen Casó,⁷ Julio Álvarez,⁸ Álvaro Ortega,⁹ Santiago Lavín,⁹ María Muñoz,⁹ José L. Siso-Llucena,⁹ José de la Fuente,¹⁰ and Christian Gottwein¹



Tuberculosis

- Individual risk factors
 - Increasing age
 - Infected social group
 - Genetic background
 - Co-infections



- Population risk factors
 - Contact to other host species
 - High density
 - Spatial aggregation
 - Indirect contacts at feeders, waterholes
 - Fencing



Swine brucellosis

- *Brucella suis* biovars 1 & 3 in Asia & America (zoonotic); biovar 2 in Europe
- Widespread in Europe; prevalences range from 0-40%, locally higher; sporadic spillover to cattle (Fretin et al. 2013)
- Present in Australia: recent human and canine cases related to pig hunting (Ridoutt et al. in press)
- Widespread in USA - increasing threat to agriculture and hunters (Leiser et al. 2013)

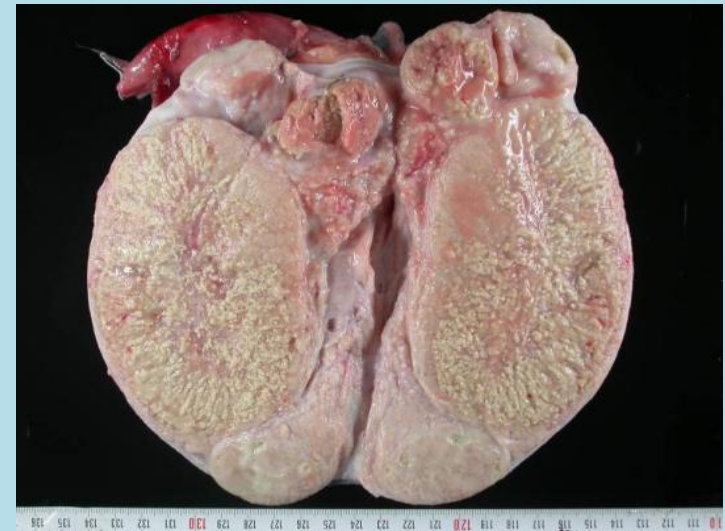
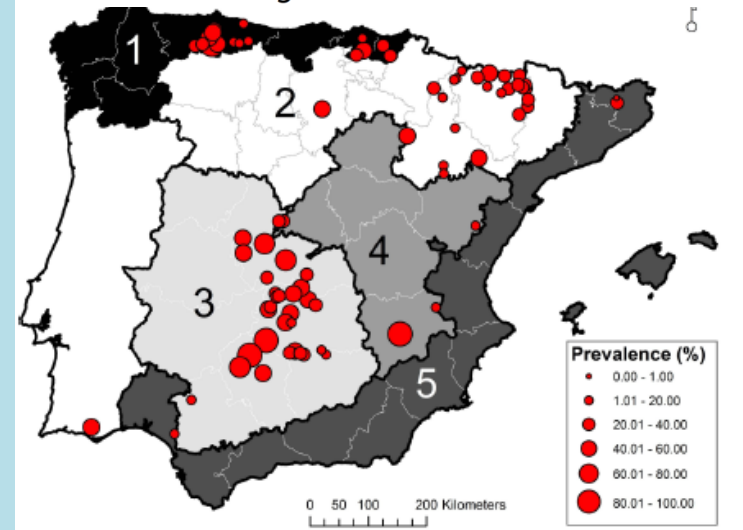
Muñoz et al. *BMC Infectious Diseases* 2010, 10:46
<http://www.biomedcentral.com/1471-2334/10/46>



RESEARCH ARTICLE

Open Access

Spatial distribution and risk factors of Brucellosis in Iberian wild ungulates



Escherichia coli

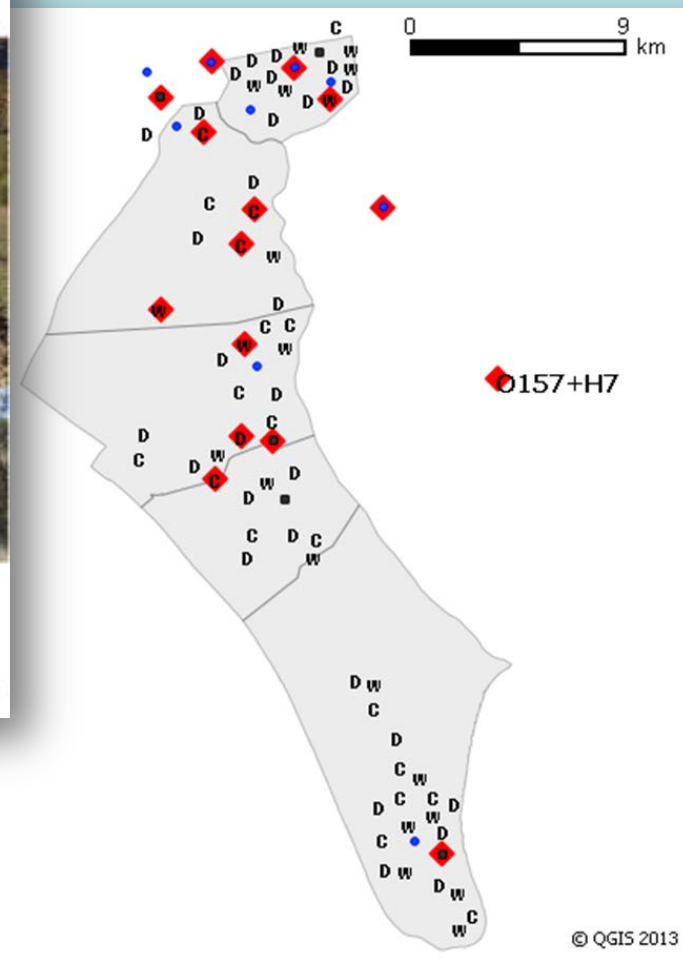
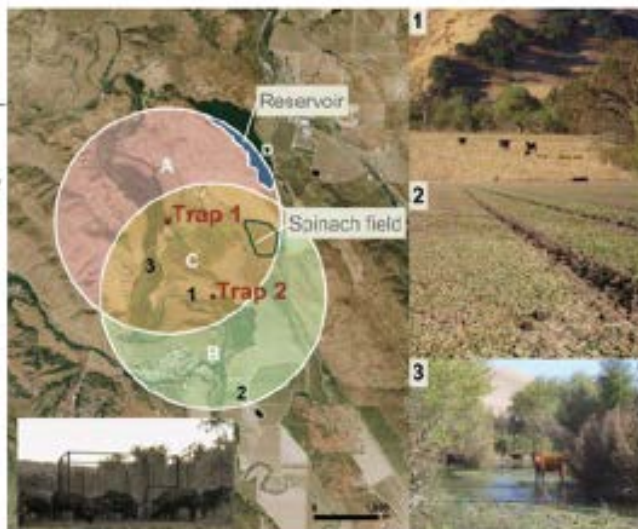
Spinach, feral pigs & *E. coli*

DISPATCHES

***Escherichia coli* O157:H7 in Feral Swine near Spinach Fields and Cattle, Central California Coast¹**

Michele T. Jay,[†] Michael Cooley,[‡] Diana Carychao,[‡] Gerald W. Wiscomb,[§] Richard A. Sweitzer,[¶] Leta Crawford-Miksza,^{*} Jeff A. Farrar,[#] David K. Lau,^{**} Janice O'Connell,^{*} Anne Millington,[#] Roderick V. Asmundson,^{**} Edward R. Atwill,[†] and Robert E. Mandrell[‡]

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 13, No. 12, December 2007



Questions to address

1. Which diseases of wild swine are of most risk to livestock, wildlife, and humans if one considers the potential for exposure in susceptible populations and given the infectivity of the agent? On what basis were these diseases identified?
 1. **ASF, CSF, TB**: diseases with a high economic impact and a confirmed suid maintenance host
 2. AVD, swine brucellosis...: diseases with a medium economic impact or zoonotic relevance and a confirmed suid maintenance host
 3. FMD, ...: diseases with a high economic impact but suid maintenance host not confirmed
 4. Other diseases of zoonotic (HEV, *E. coli*, ...), economic (*Mycoplasma hyo*) or conservation relevance
2. What aspects of these diseases are of greatest management concern when one considers the potential for disease spread in available host species, and interactions among animal and human populations?
 1. Direct and **indirect contacts** between farmed pigs and suids, or between other livestock and suids, or between human beings and suids → contact mitigation research needed
 2. Population size and metapopulation dynamics are likely drivers of pathogen maintenance for e.g. CSF; spatial aggregation is a risk factor for e.g. AVD, PCV2, TB

Questions to address

- (1-3) Wild suid ecology, distribution and trend or management
- (4-5) **Main pig-related diseases**
- (6-7) **Risk assessment and knowledge gaps**



Risks & gaps

- Risks:
 - Emergence or re-emergence of diseases (e.g. wild boar and ASF in Poland and the Baltic countries)
 - Establishment of endemicity, for instance MTC in new regions with expanding and increasing suid populations
 - These risks are largely driven by:
 - Fencing/feeding/translocating (hunters)
 - Natural expansion and population growth
 - Frequent intra- and inter-species contacts

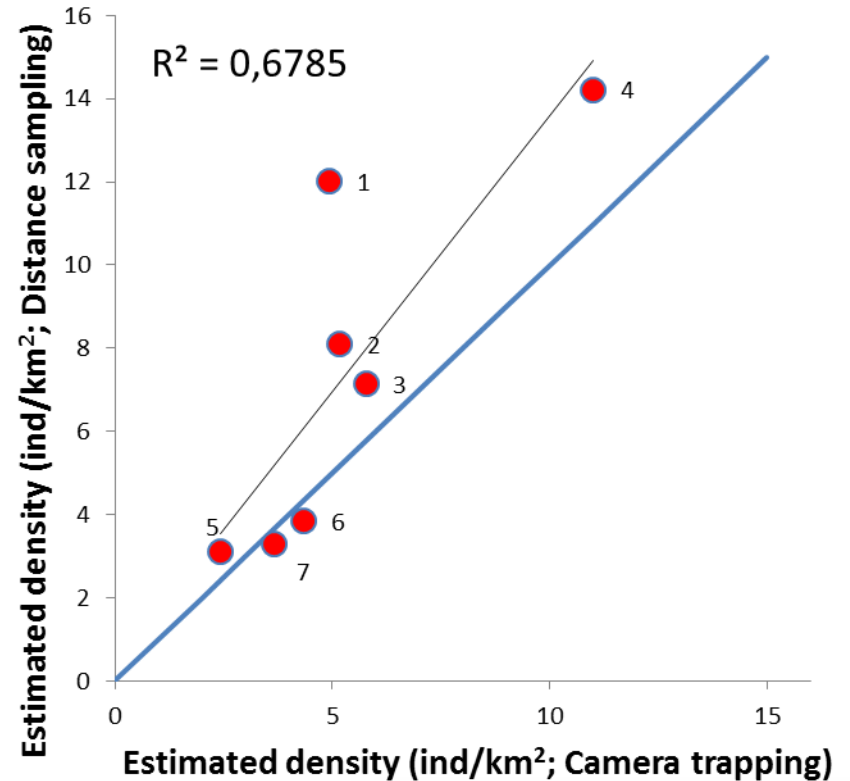
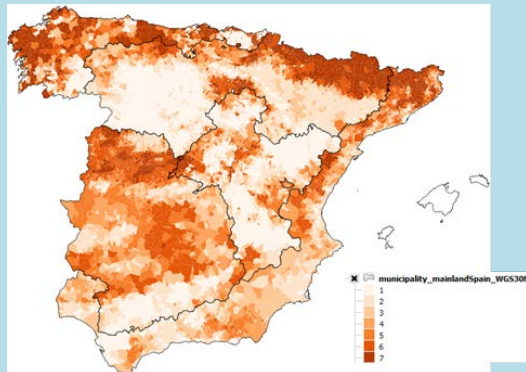
Risks & gaps

- Knowledge gaps:
 - Abundance and monitoring
 - Behavior at the interface
 - Epidemiology of less-known pathogens
 - Pathogenesis (e.g. ASF)
 - Intervention (how to exclude, cull, vaccinate, etc.)
 - (...)

Risks & gaps

Gap: abundance monitoring

- Often only hunting bags available (large scale; not easy to compare between regions)
- New, more accurate and comparable, techniques needed
- Recent developments:
 - Dropping frequency (relative abundance & aggregation; Acevedo et al. 2007)
 - Density estimates from camera-trapping (ongoing)
 - Spatial models (large scale; Acevedo et al. 2014)



Risks & gaps

Gap: behavior & epid

- How, where, when... do contacts take place?
- How to avoid them?
- Quantify indirect transmission



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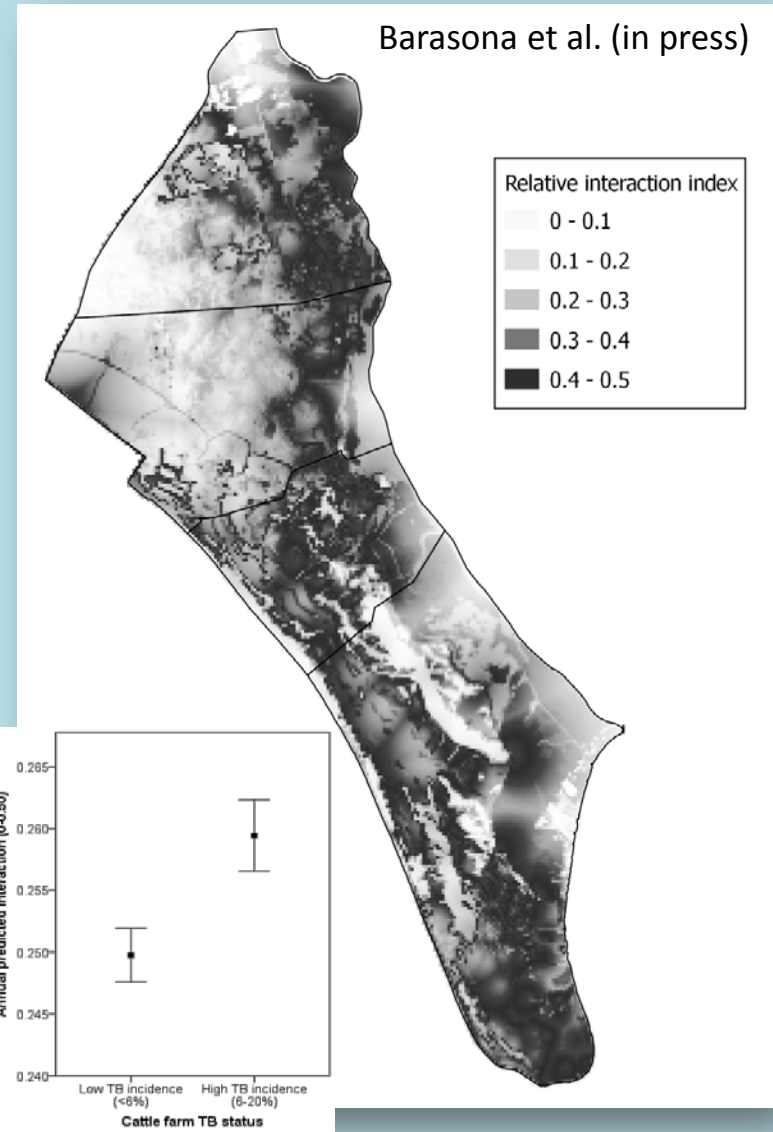
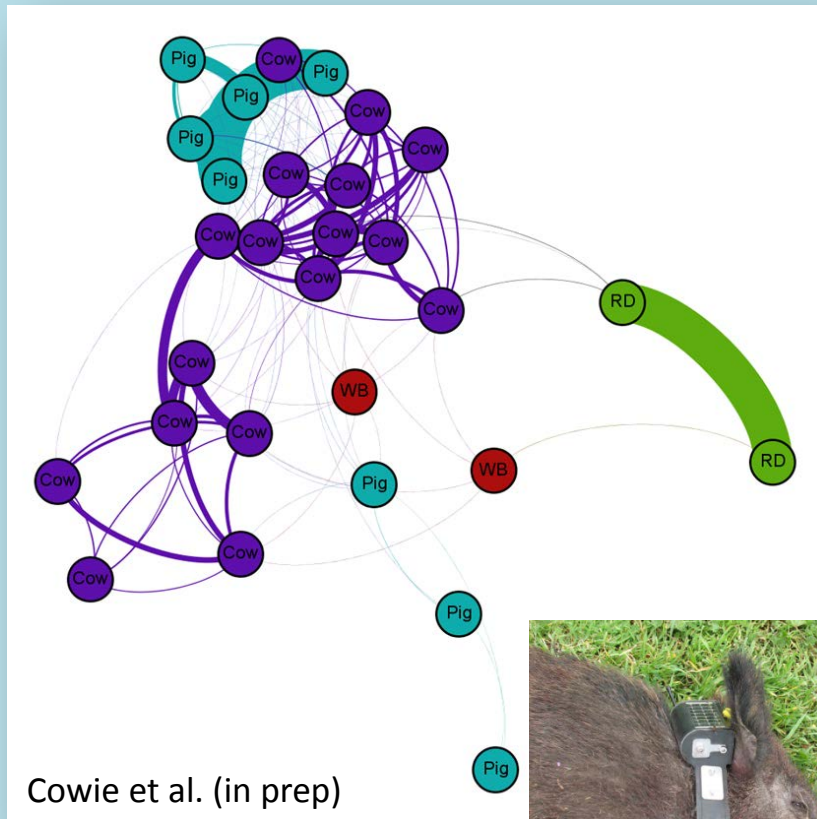
Spatial and temporal interactions between livestock and wildlife in South Central Spain assessed by camera traps

E. Kukielka^{a,b,*}, J.A. Barasona^c, C.E. Cowie^{c,d}, J.A. Drewe^e, C. Gortazar^c, I. Cotarelo^c, J. Vicente^c



Risks & gaps

Gap: behavior & epid



Risks & gaps

Gap: intervention



Questions to address

1. What are the highest consequence events related to disease emergence, persistence, and re-emergence in wild swine that require policy or scientific resources to address?
 1. From a (current) EU perspective: re-emergence of a high impact disease such as ASF via wild suids (Poland, Baltic Countries)
 2. From a US perspective: risk of MTC endemicity in growing/expanding feral pig populations, particularly in risk regions (Texas, Michigan)
 3. (...)
2. Are there ecological or biological gaps in information that increase the risk/hazard of an event?
 1. Pathogenesis and epidemiology still have significant knowledge gaps, e.g. for ASF
 2. Suid population (abundance) monitoring is often limited to hunting bags, this is insufficient and needs to be complemented with new, more accurate and harmonized methods
 3. A cross-disciplinary approach to feeding is needed: how does it affect wild suid demographics, and disease maintenance and spread?; how can feeding bans be implemented?
 4. Tools for intervention should be developed for all relevant diseases (e.g. CSF & TB vaccines, barriers, population control tools...)



Thank you!

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