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Disease Risks in Parks and Protected Areas, A One Health Perspective

IUCN World Parks Congress
Sydney 2014
Improving Health and Wellbeing: Healthy Parks Healthy People Stream

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IUCN SSC Species Survival Commission WHSG

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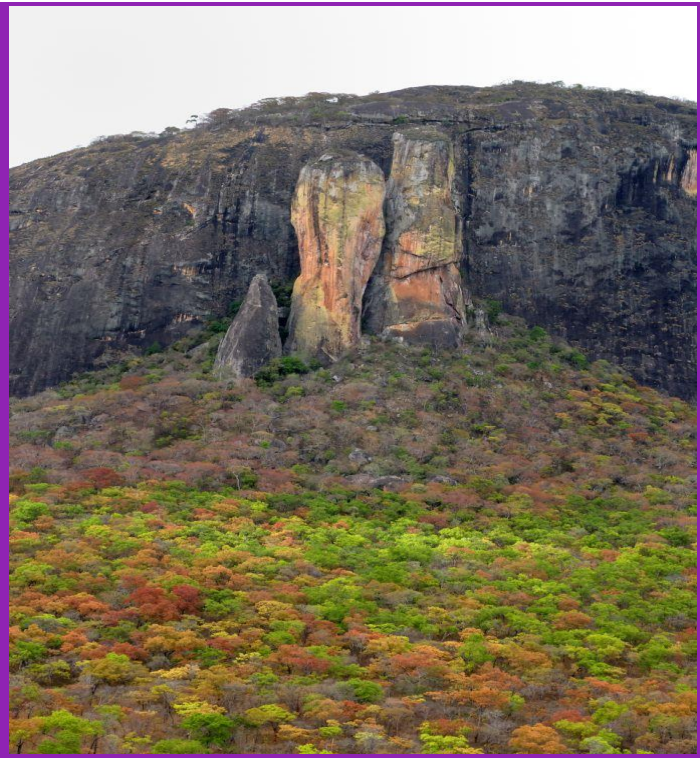
RVC Royal Veterinary College University of London

IUCN SSC Species Survival Commission

WHSG

Summary

- Disease risks - do we have the bull by the horns?
- Importance of diseases to wildlife, people & parks
- Politics, economics & disease
- Future focus?
- A One Health Approach



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- **Disease risks - do we have the bull by the horns?**

Scientific & Veterinary Tools

Ross and McKendrick

- Disease investigation is an ancient practice *(Schwabe).* but epidemiology as a science has evolved over the last 40 or so years to better define, monitor, analyse & explain disease processes *(May and Anderson).*
- Development of efficient safe wildlife capture methods in parallel has enabled studies.

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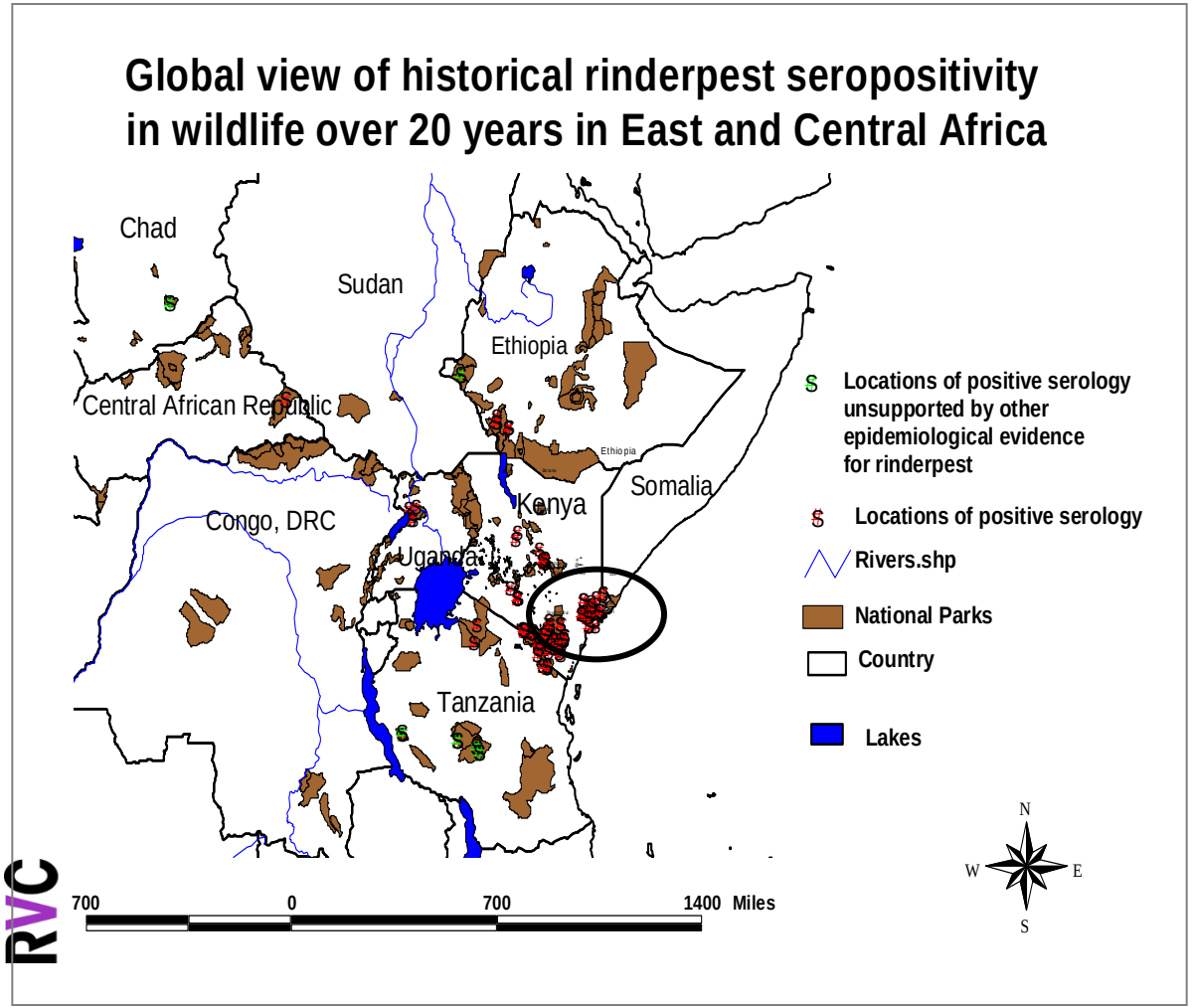
Epidemiological study amongst wildlife

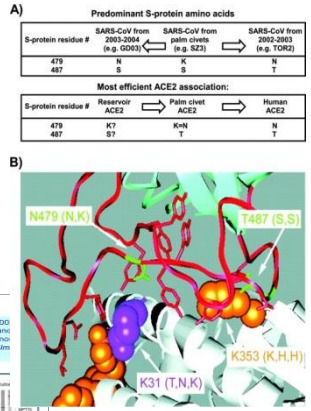


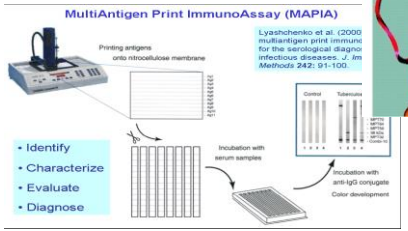
- Most studies based on pathology & serosurveys (antibody detection)

Kock et al 2006, 2008

Epidemiological study amongst wildlife

- Improved antigen detection methods (e.g. LFD, PCR) improved practicality, accuracy & efficiency of detecting pathogens
- Genomics revolutionising understanding of infection dynamics, evolution & pathways





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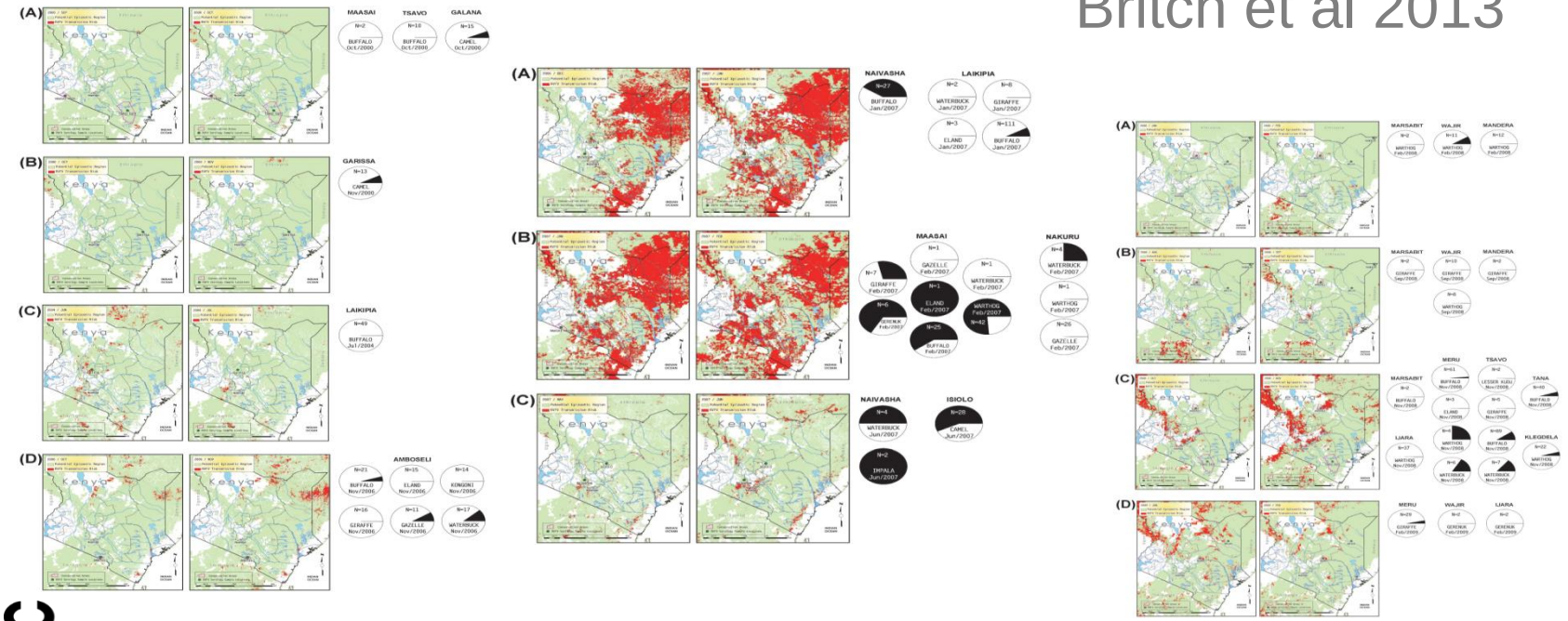
RVF risk maps showing antibody detection in wildlife over time

Britch et al 2013



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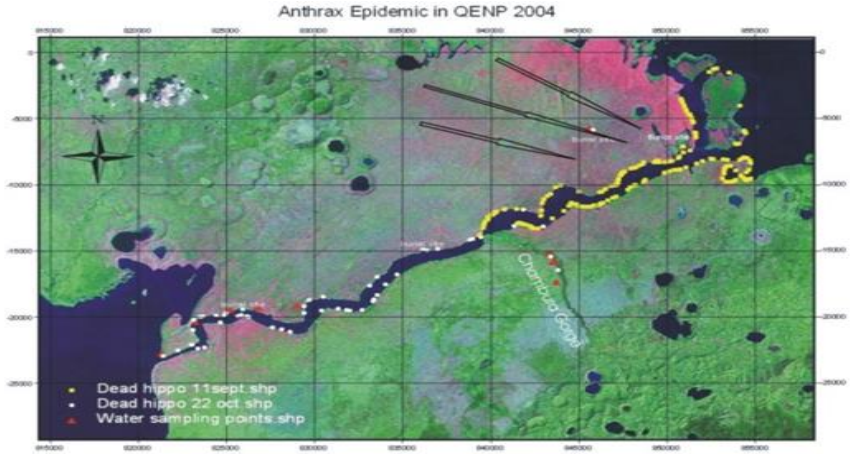
2000 → 2006 → 2009

Interface

With radiocollars & GPS we have a better idea of wildlife movements & and home range including the interface between groups & species.

GIS and remote sensing has advanced the study of co-factors in wildlife disease epidemiology.



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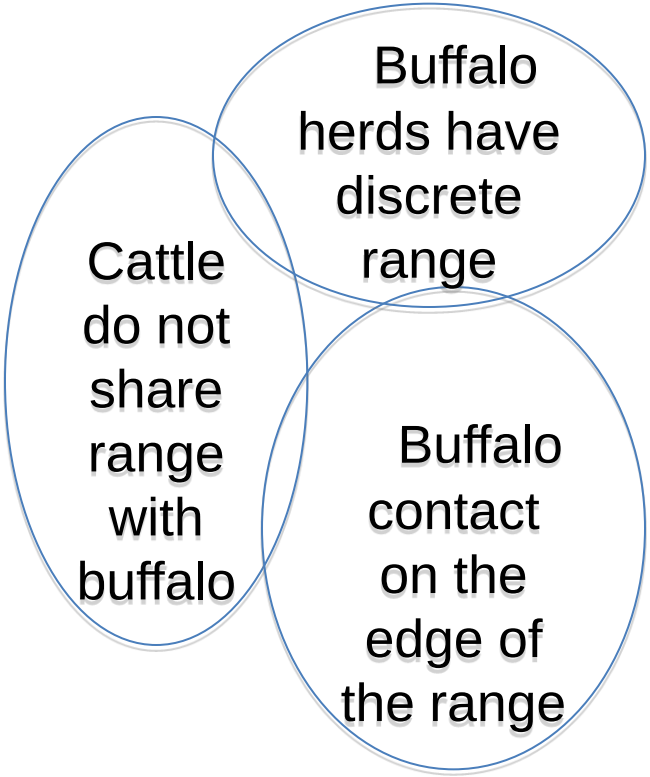
Buffalo Cattle interface



Cornelis et al (2011) Caron et al (2013)

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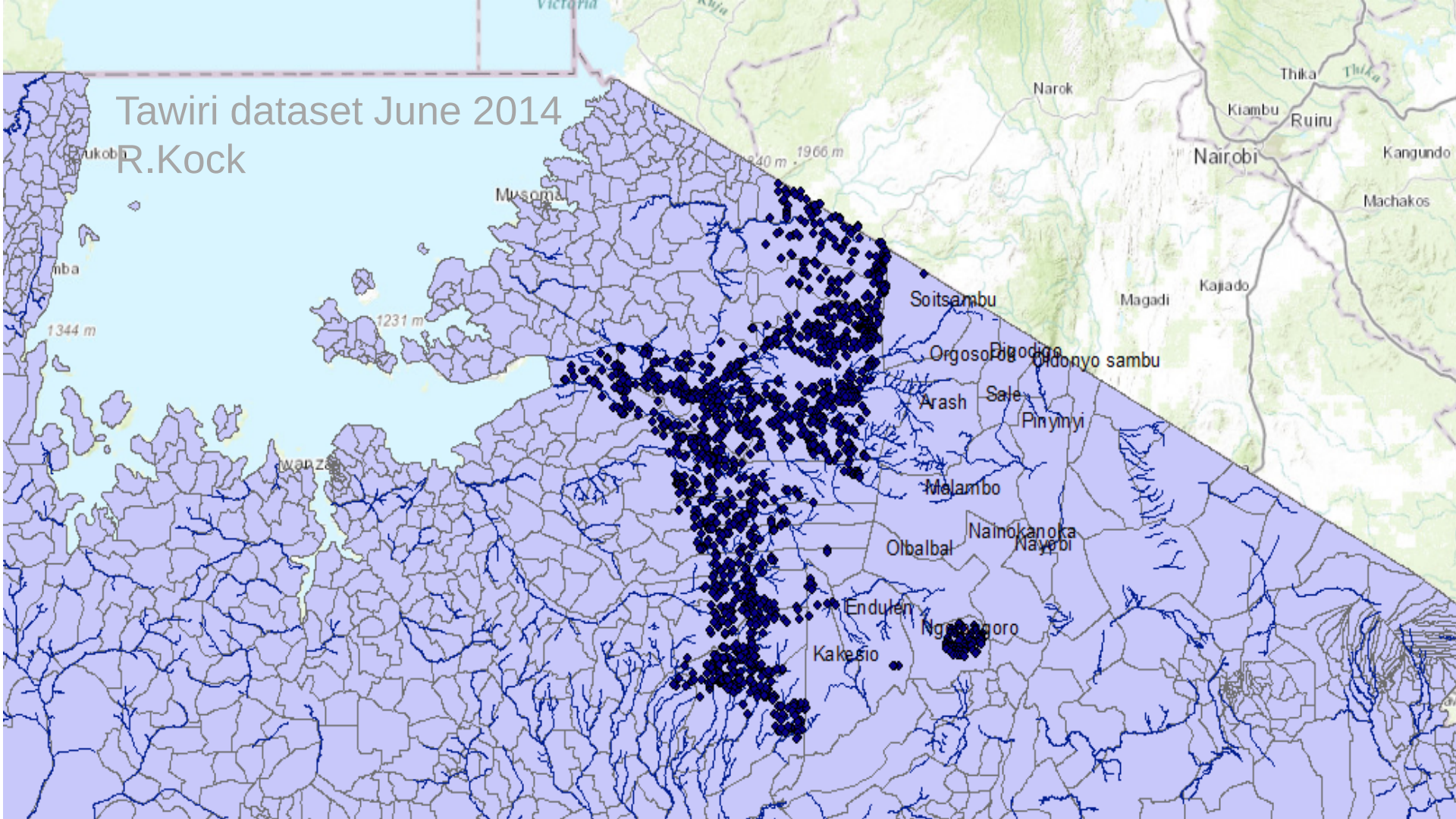
Wildlife
livestock
interface
rarely direct
contact


No Man’s land?

Wild elephant will seek out water Molo Ghana


A. Caron


Tawiri dataset June 2014
R.Kock
Victoria
Kisumu
Musoma
Narok
Thika
Kiambu
Ruiru
Nairobi
Kangundo
Machakos
Kajiado
Magadi
1966 m
1344 m
1231 m
Soitsambu
Orgosopos
Digodigo
Oldonyo sambu
Sale
Arash
Pinyinyi
Melambo
Nainokanoka
Nayobi
Olbalbal
Endulen
Kakesio

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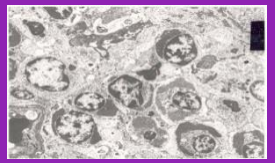
Importance of disease to wildlife, people & parks



Protected Areas Buffering Against Disease Emergence

Natural ecosystems are inherently complex & parasitised but endemism selects against pathogenicity.

Fragmentation, homogenisation of buffer zones & disturbance of PAs effectively desterilises & opens pathways for pathogen evolution & disease emergence with flows in & out (Wallace et al 2014).

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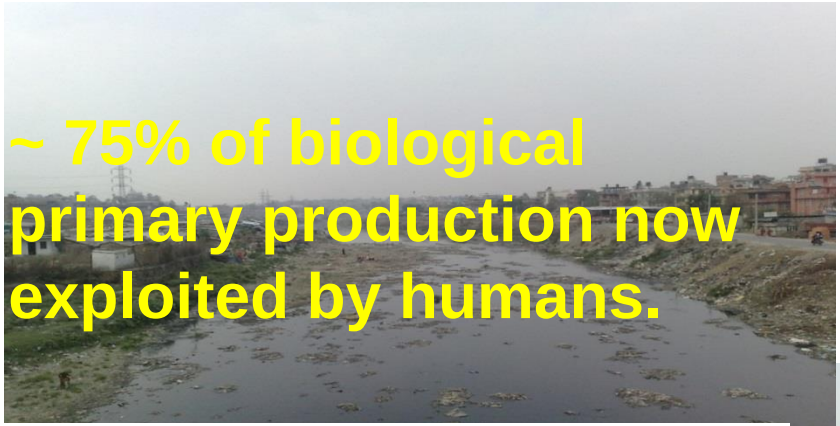
Global Drivers of Disease Emergence



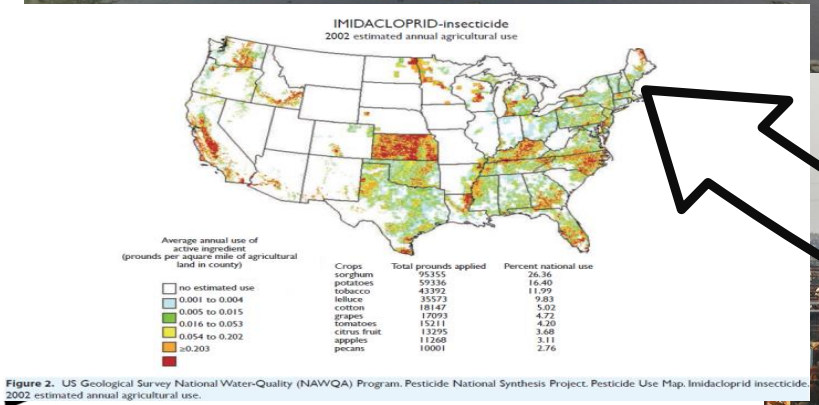
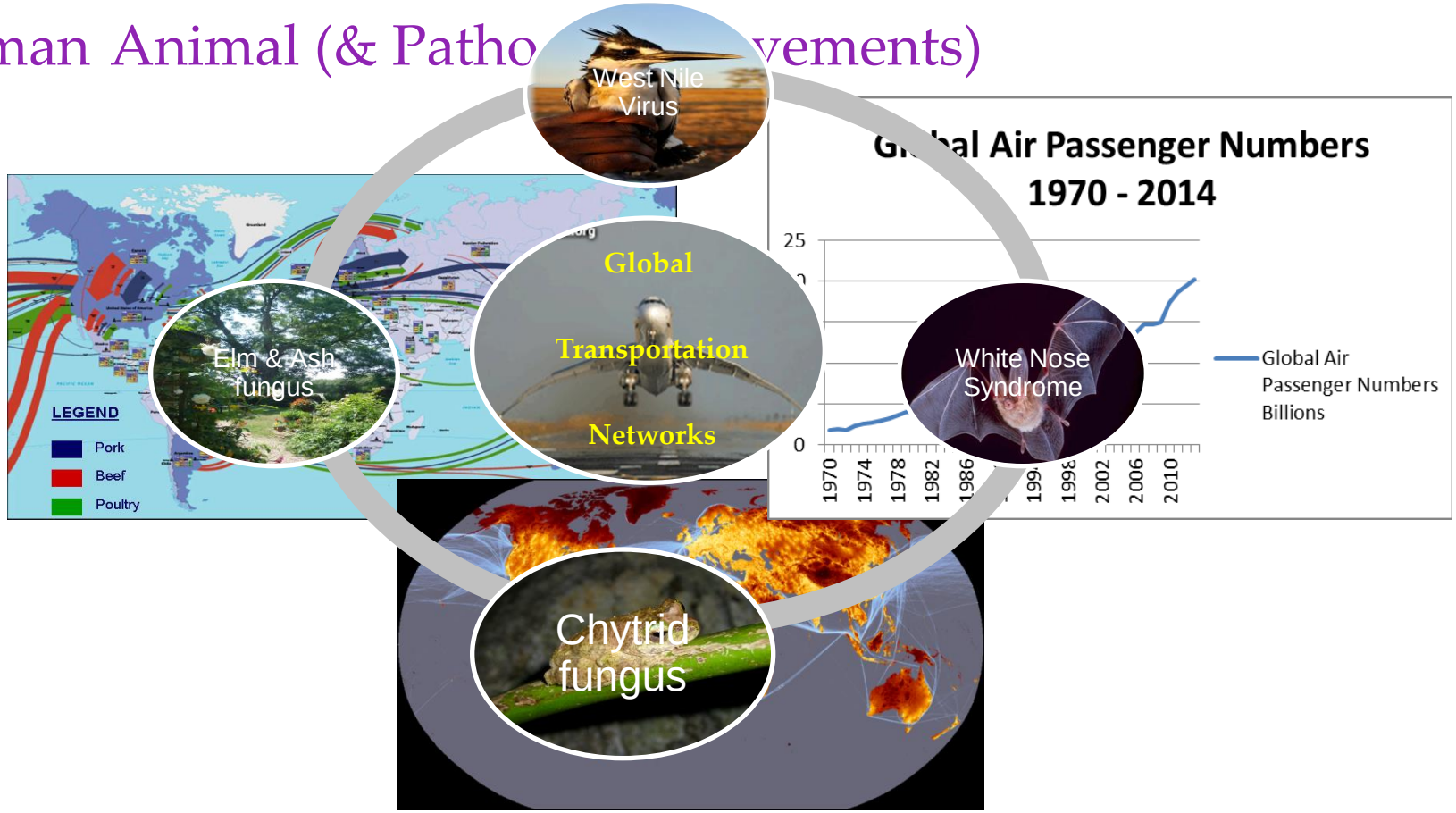


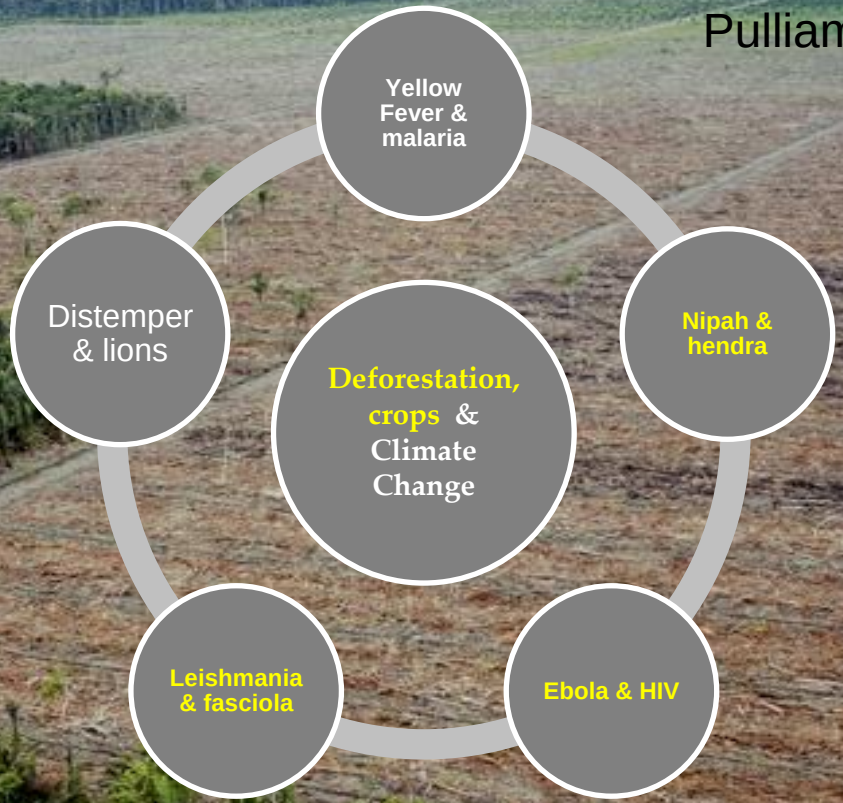
Figure 2. US Geological Survey National Water-Quality (NAWQA) Program. Pesticide National Synthesis Project. Pesticide Use Map. Imidacloprid insecticide 2002 estimated annual agricultural use.

World is now One – major threat for EIDs

Human Animal (& Patho vements)



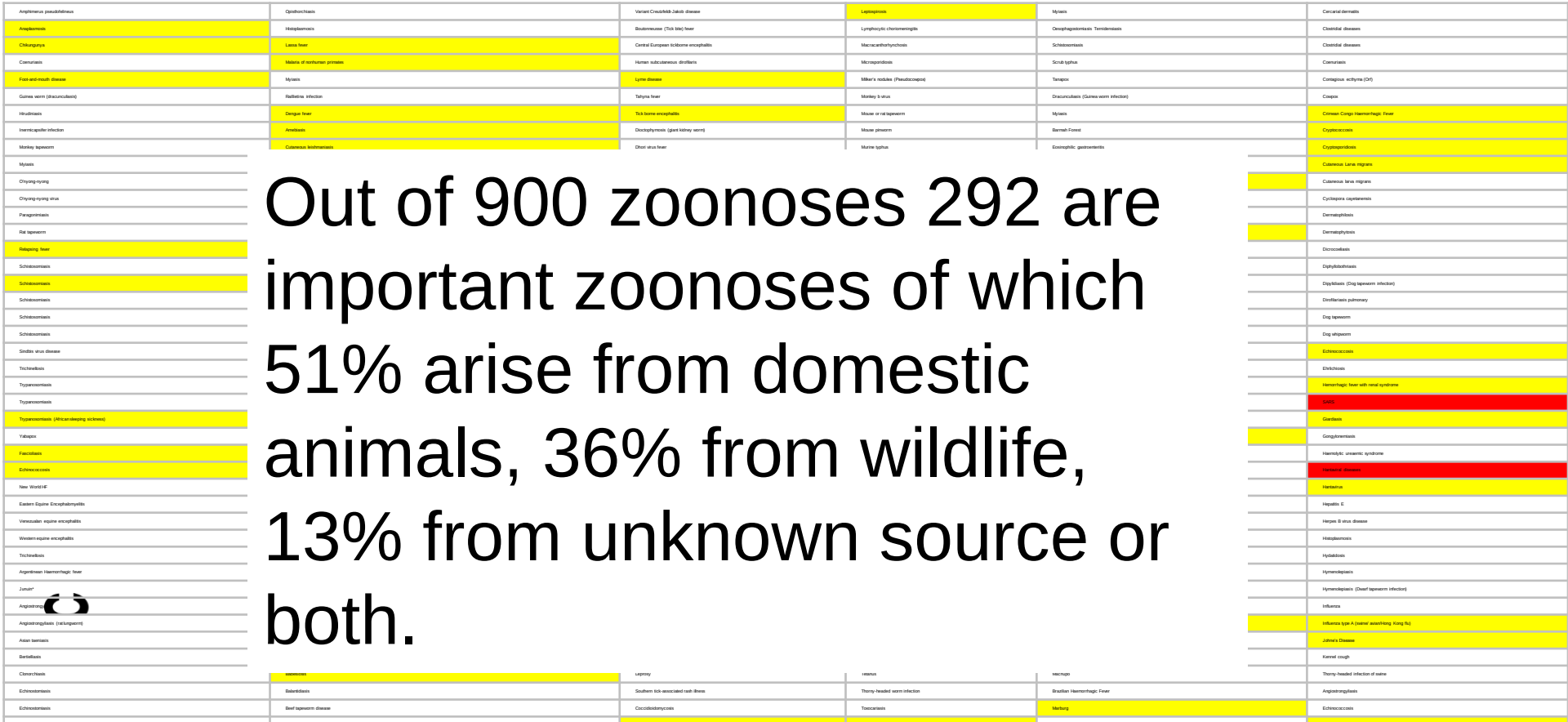
(Munson et al 2008; Pulliam et al 2010)



(Holmes, 2007;Gimeno, 2008; Lee et al., 2012).


Lyme's
HIV
?
EBLV
TEV
Ebola
Human Behavior

We are only beginning to explore zoonoses



Why bats & zoonoses?

- Epidemiological significance for infectious diseases?

Only flying mammal,variable body temperature, virus adaptation ~ tolerant to temperature change? Bat tolerant of viruses? Bats host more zoonotic viruses per species than rodents and other mammals;

O'shea et al 2014; Banyard et al 2011; Luis et al 2013

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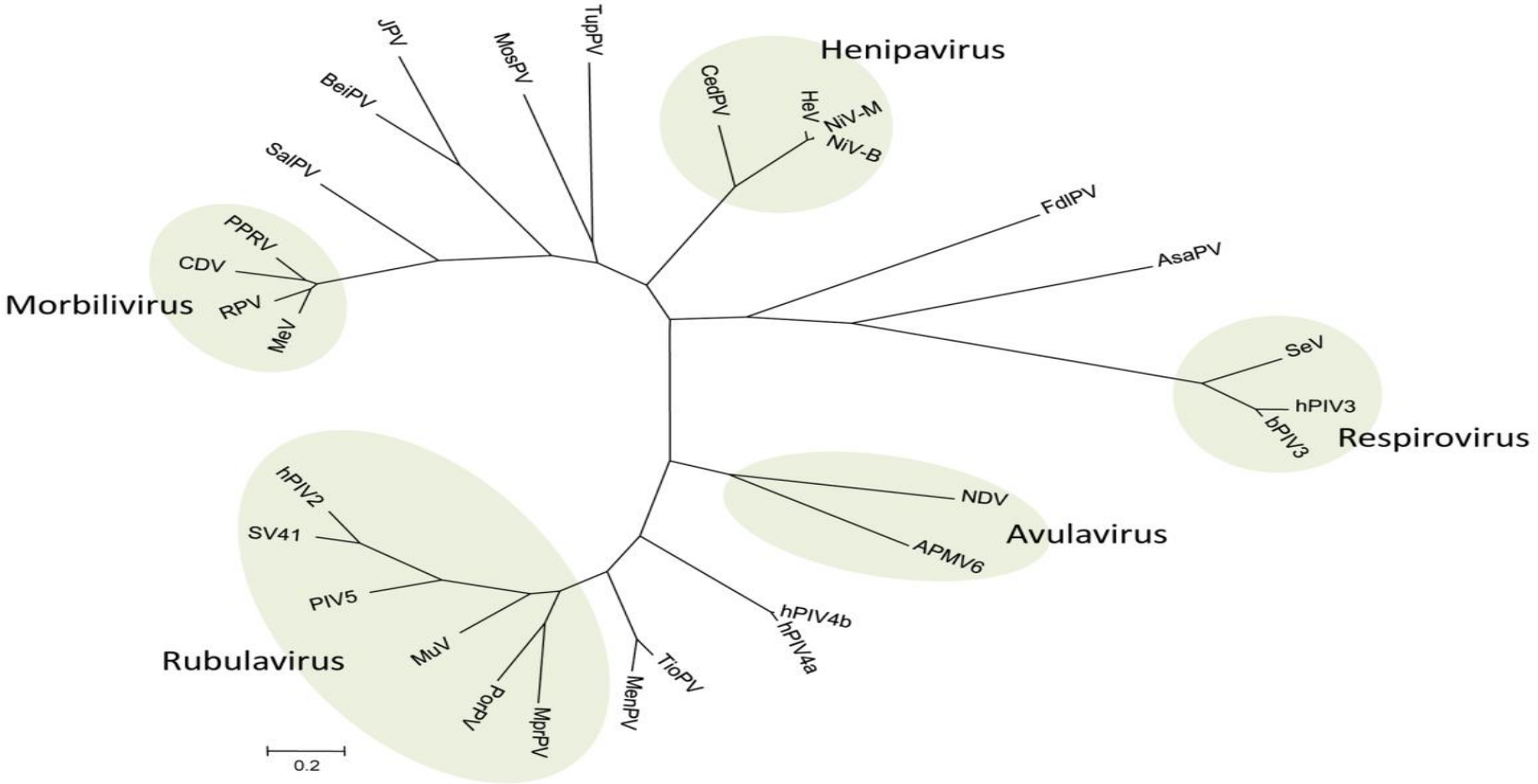
Morbilliviruses..



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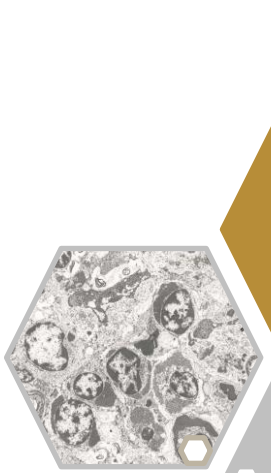
Rinderpest & Pestes des Petits Ruminants Viruses

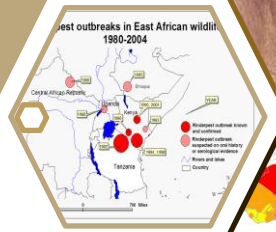


Buffalo susceptible to RPv vectored disease but not long term reservoir

RPv was a significant cause of mortality in buffalo (60% recorded in naïve epidemic)

Buffalo can be infected with PPRv (antibody evidence) but vectoring not proven

PPRv antibody in buffalo in Chad, Ethiopia, Uganda &Tanzania



PPRv antibody in buffalo associated with interface suggesting spiil over infection

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Ecological driver – rinderpest virus

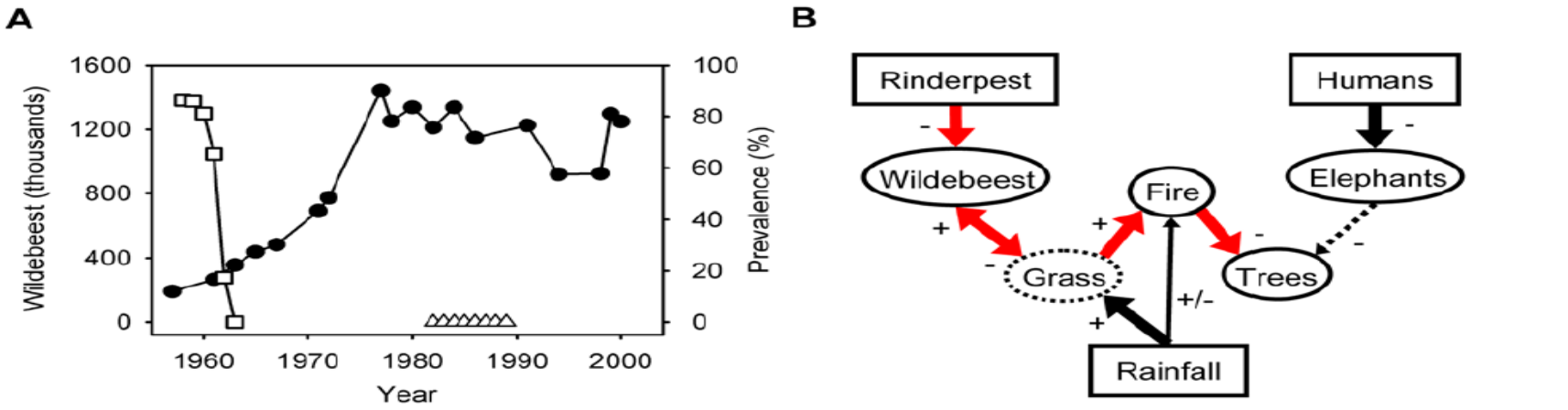

Figure 4. Rinderpest-mediated regulation of ecosystem dynamics. (A) Serengeti wildebeest population (filled circle) and rinderpest seroprevalence reported for the periods 1958–1963. (B) Inferred causal relationships driving tree population dynamics in the Serengeti. The dominant effects are shown with thick arrows. Highlighted in red is a four-step pathway of causality linking rinderpest with tree population dynamics. The grass compartment, as an unobserved variable, is shown in dotted outline.
doi:10.1371/journal.pbio.1000210.g004

Haldo et al 2010

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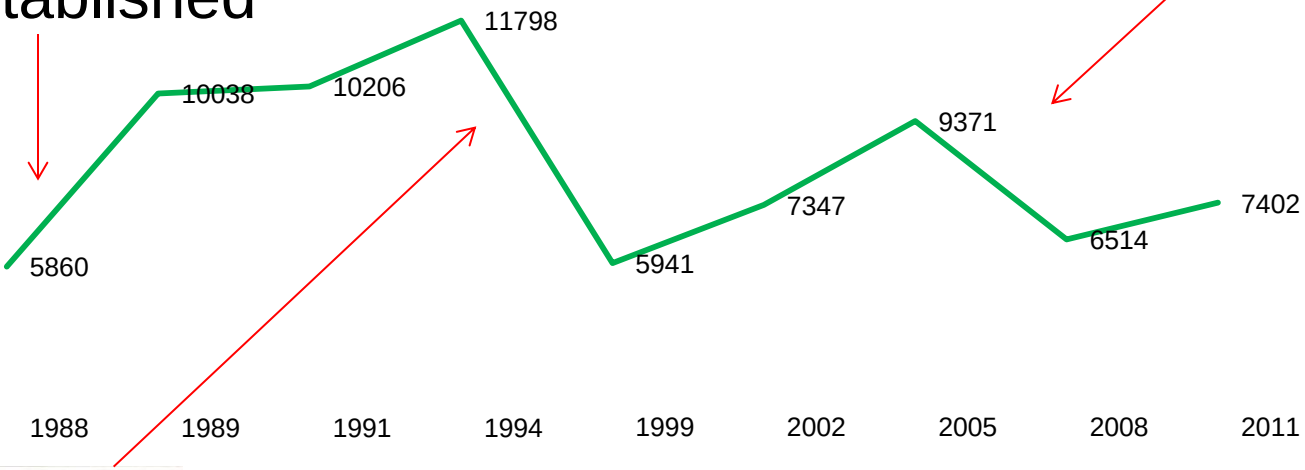
Tsavo Ecosystem Kenya

Total Aerial Count

KWS established

Drought



Rinderpest epidemic

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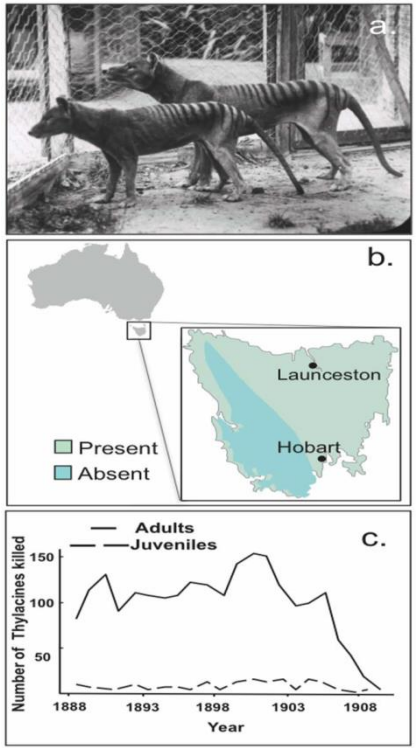
Distemper – complex syndemics

Should we be concerned about morbilliviruses of free-ranging large carnivores in Africa & Asia?

- Serengeti – Mara epidemic (Carpenter et al 1998; Roelke-Parker et al 1996; Munson et al 2008; Kock et al 1998)
- Extinction of Tazmanian Wolf? Menzies 2012
- Current debate about CDV & tigers across the range. Evidence of mortalities in Russian Far East (Quigley et al 2010)



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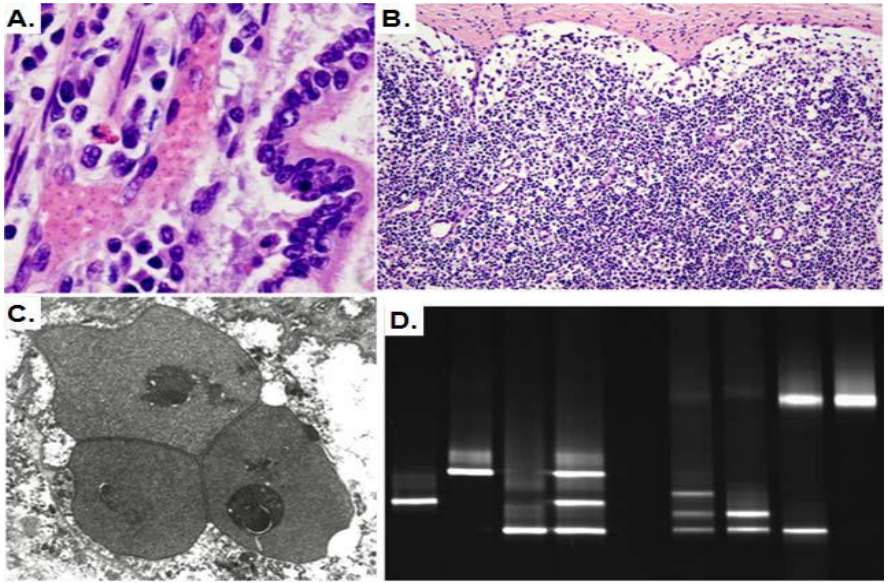
Distemper

Co-infection with protozoa

Lion - fulminating haemoprotozoanaemia + viraemia e.g. *babesia CDV* co-infection. Serengeti Mara ecosystem (Munson et al 2008)



Tiger – *Toxoplasma gondii & Bartonella* (Goodrich et al 2102)

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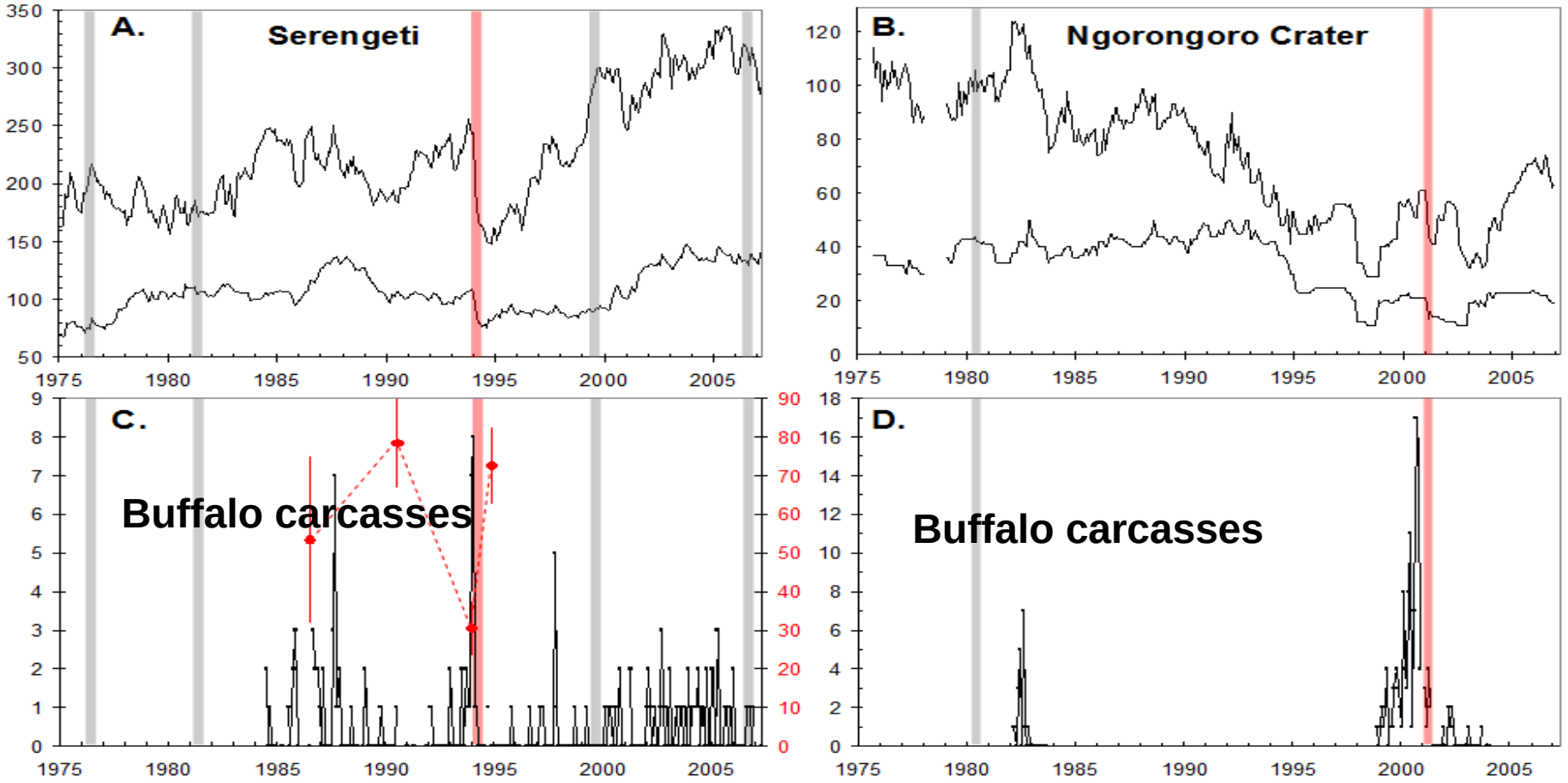
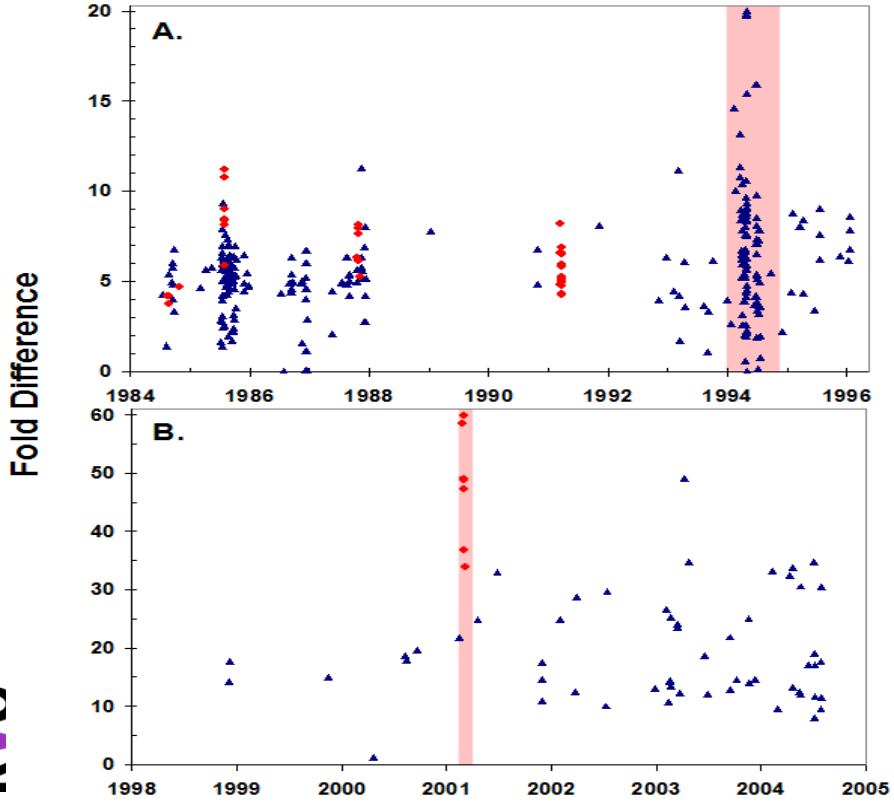
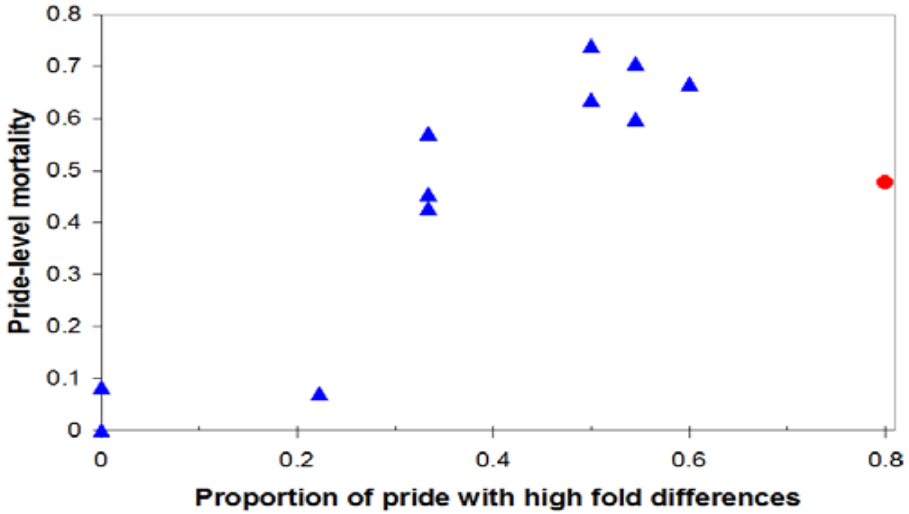
Distemper in lions



Relative quantity of Babesia in lions sampled Blue Serengeti Red Ngorongoro rt PCR





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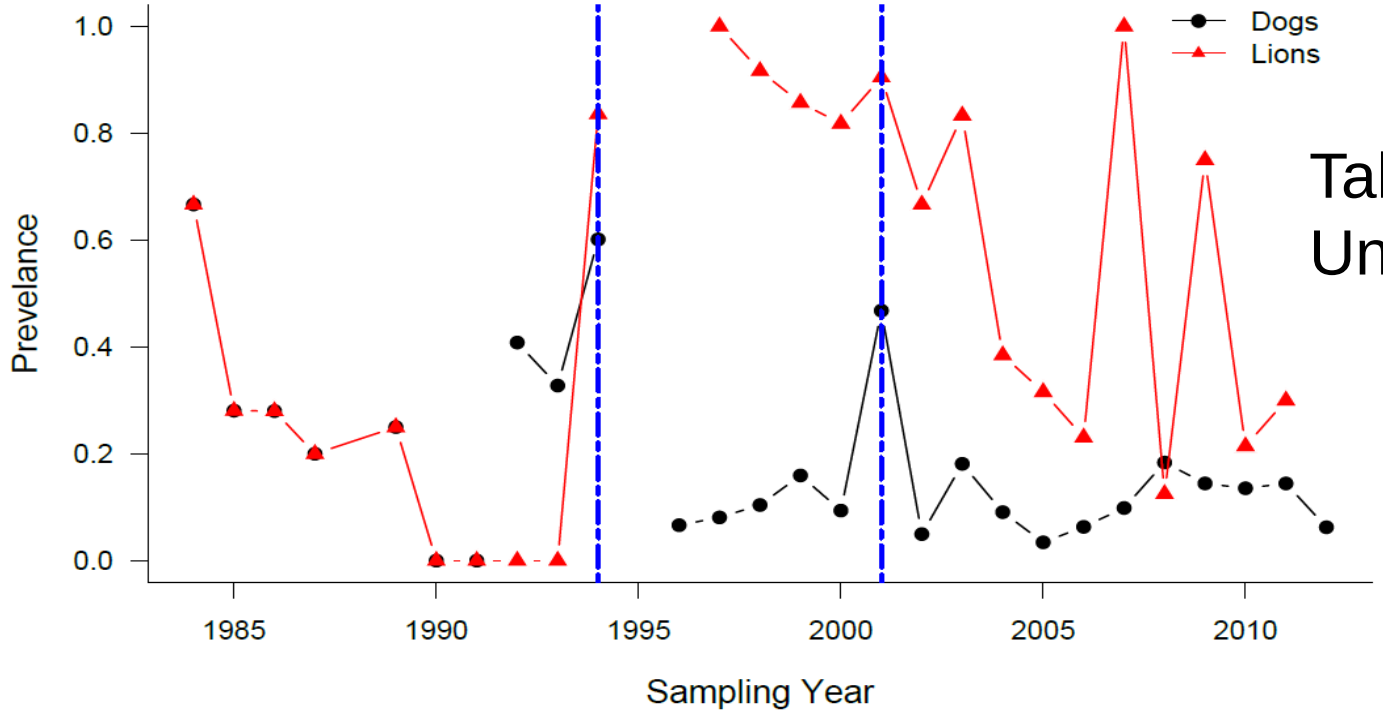
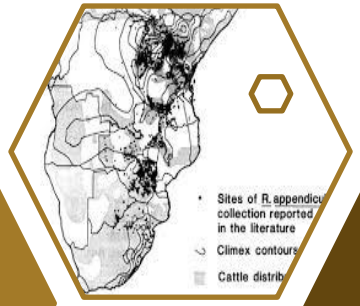


Takahashi et al
Unpublished

Figure 6. Plot illustrating dog (black dots, n=7,407) and lion (red triangles, n=558) CDV seroprevalence over time from 1984 to 2012. The dashed vertical blue lines demark reported CD outbreak years (1994 and 2001). The 1994 outbreak is preceded by infection in dogs, however the direction of the disease is not as clear for 2001.

East Coast Fever (& Corridor Disease)

$168,000,000 annual loss across 30% Africa (FAO)



50 years of T parva vaccine development still not having big impact

Recent evidence showing T mutans infection immunises cattle against T parva

Woolhouse 2014

Buffalo infection problem where disease controlled or absent in cattle

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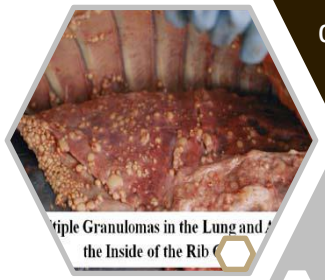
Bovine Tuberculosis

De Garine-Wichatitsky et al 2013

Kruger National Park
10-55% South to North
In buffalo & other spp.



High prevalence with high density buffalo

Low prevalence with low density buffalo

Lack of evidence for transmission between cattle and buffalo

Amboseli - Low prevalence in cattle TT 6%
mod prevalence in buffalo bovigam 14%

QEPA evidence
Low prevalence in cattle TT 5% individual 18% herd
high prevalence in buffalo? ~ 30%

Zoonotic TB rare <3% Mtb complex
No evidence for infection from buffalo
Spill back wildlife to livestock unproven?

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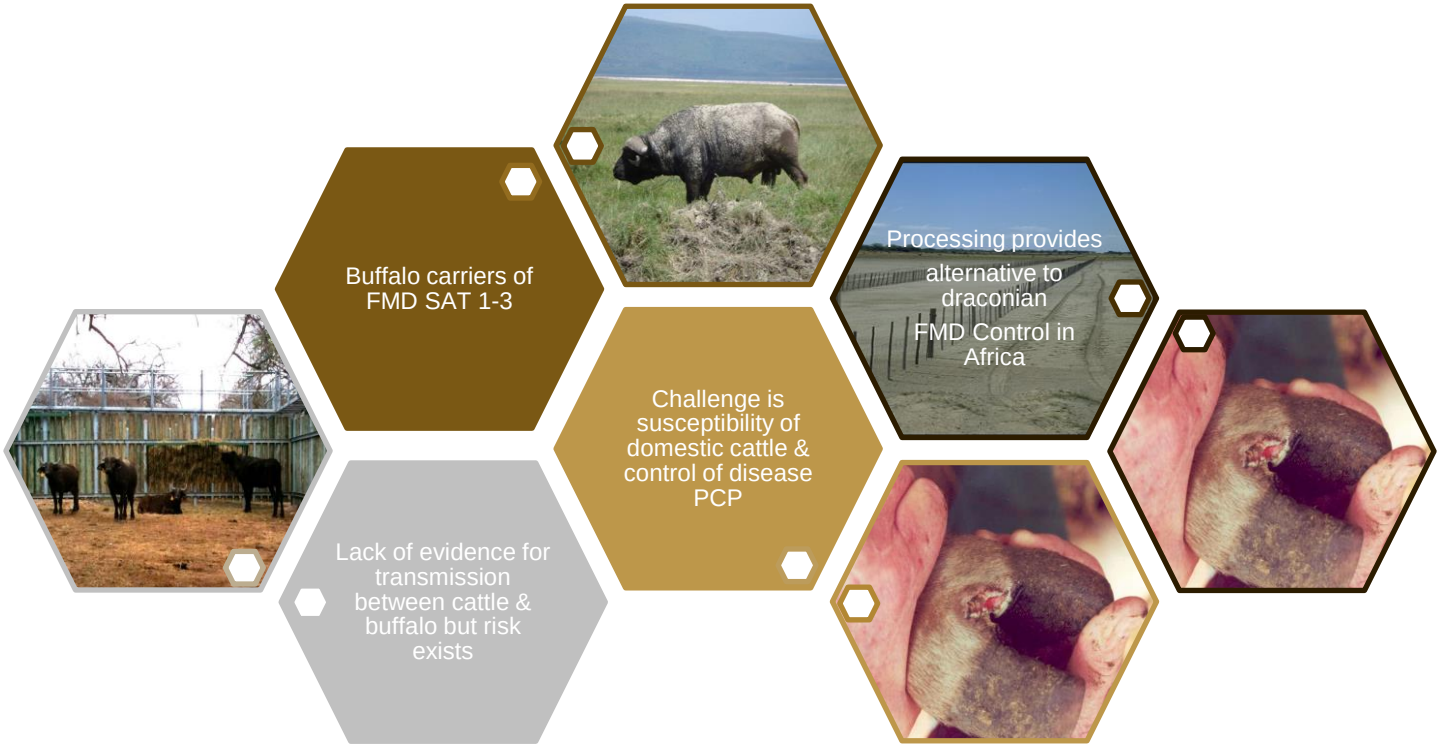
Foot & Mouth Disease



Thomson et al 2003; Weaver et al 2013; Ferguson et al 2013

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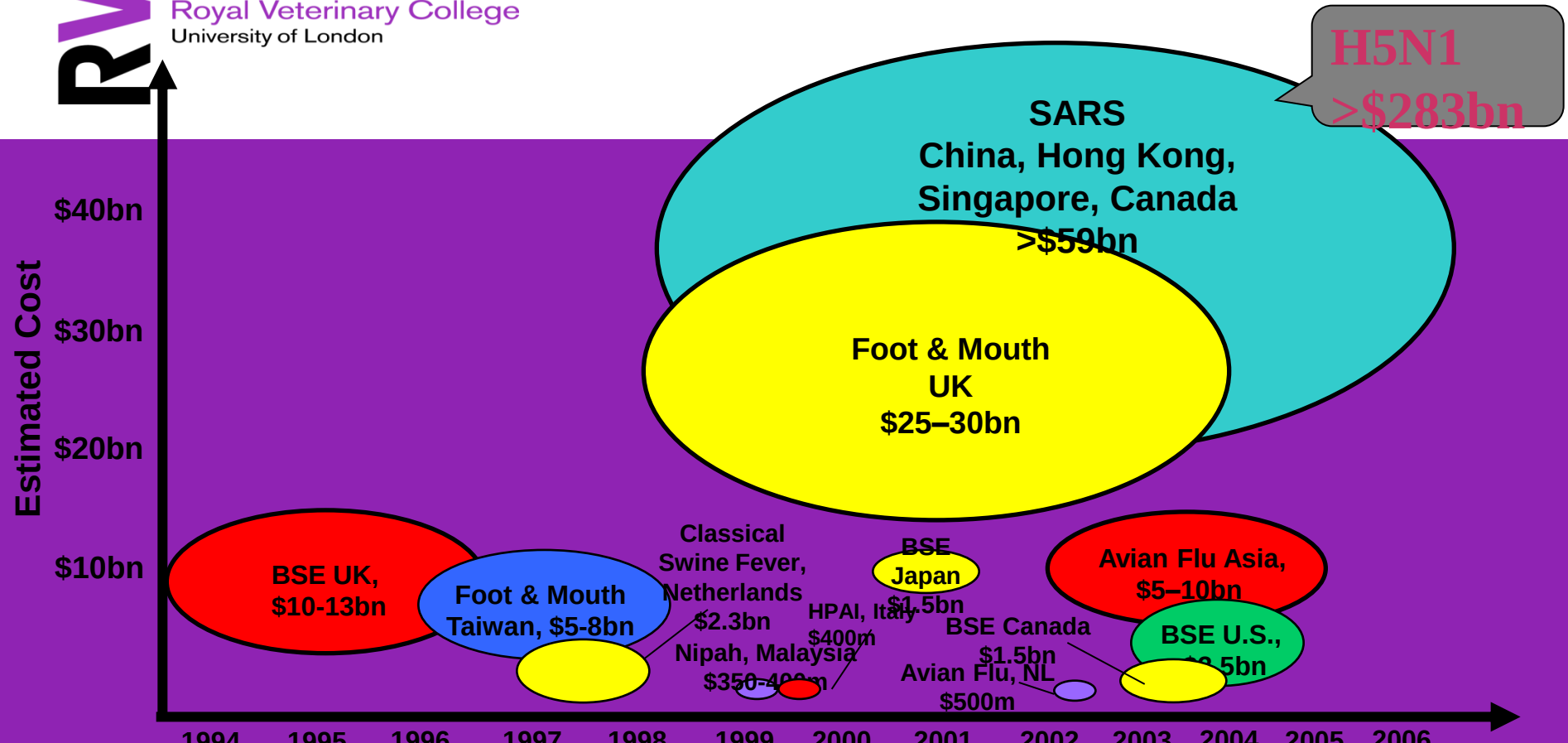
- **Politics, economics & disease**



Politics of disease and wildlife

Ranchers voiced concern about plans to relocate some Yellowstone Park bison to Indian reservations in Montana and Wyoming. The ranchers are worried about the animals' history of carrying brucellosis, a disease that causes domestic cows to miscarry.

"There isn't anyone up here who wants it. It's a cockamamie idea, and it's an experimental deal," said John Brenden, a Scobey, Mont., rancher and legislator. "I don't like anybody experimenting on us."

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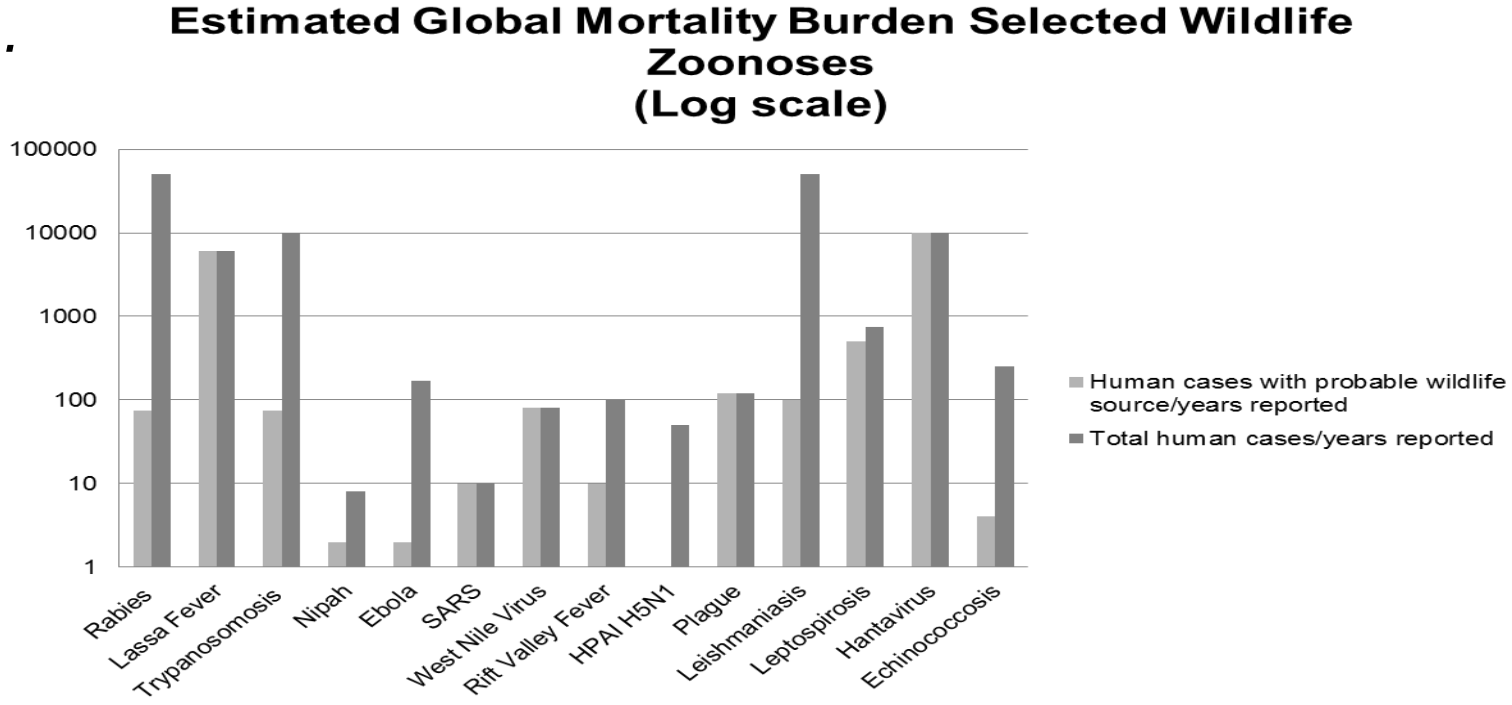
Perceptions Flawed? – role of wildlife in disease



Wildlife host contribution to **Total burden**

Kock R. (2014)

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Politics of the interface

Wildlife role in disease overstated in livestock and human outbreaks – blame game

- Little actual evidence of transmission of FMD from wildlife to livestock (Thomson et al 2003).
- No apparent reservoir host for HPAI H5N1 transmission cycles – poultry to poultry (Scientific Task Force 2011 http://www.aiweb.info/Default.aspx)
- Rare transmission of rabies from wildlife to livestock or people – e.g. bats (Swanepoel 2004).
- Trypanosomes, RVF transmitted efficiently in absence of wildlife (Fevre et al 2006)
- Low prevalence TB in extensive "natural" integrated wildlife livestock systems (Tschopp et al 2010)
- Only about 30 cases of human Ebola directly contracted from wildlife over 40 years (CDC) but one spill can lead to epidemic.

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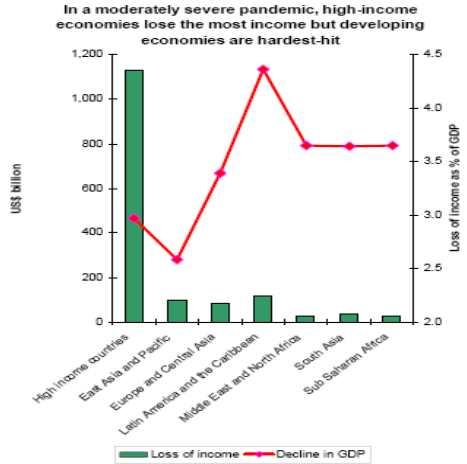
Socio – economics, Parks governance & disease

- Parks, Biodiversity and natural ecosystems (resources) have weak governance structures compared to health, industry, & other human development sectors.
- When disease emerges with a link to wildlife it is a significant threat to management & even biodiversity conservation itself & sometimes to socioeconomics.



- Human pandemic Flu
- US$2 trillion disease cost

WNS - bat losses impact on agriculture $22.9 billion/year

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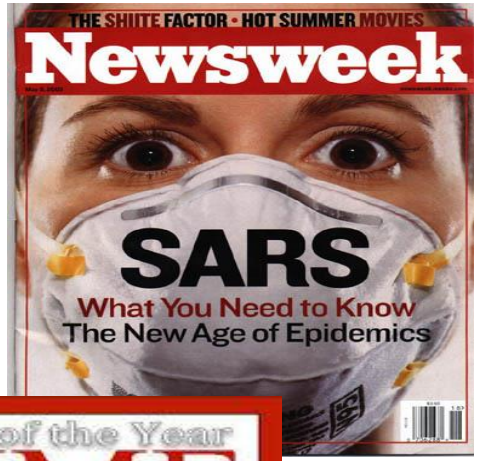
Parks, wildlife, disease & fear factor



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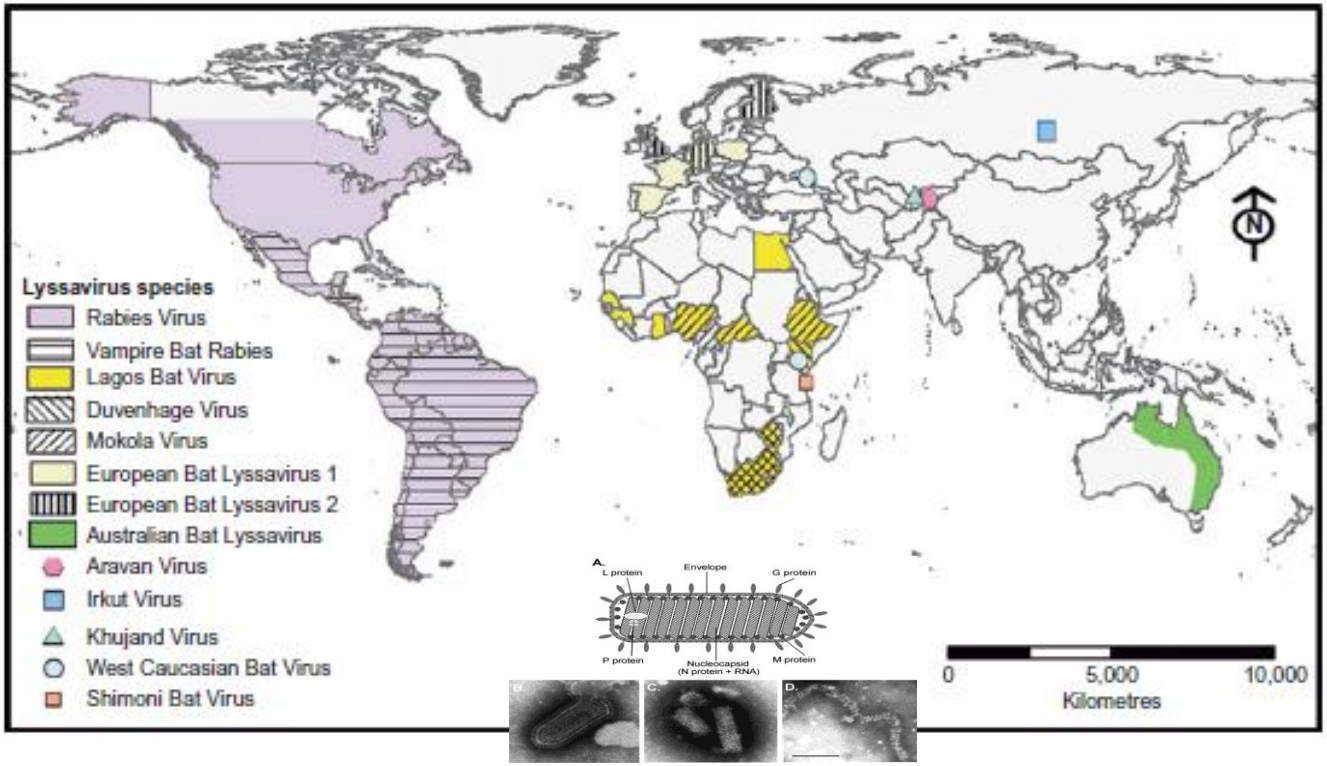
Bat lyssavirus distribution



Banyard et al 2011

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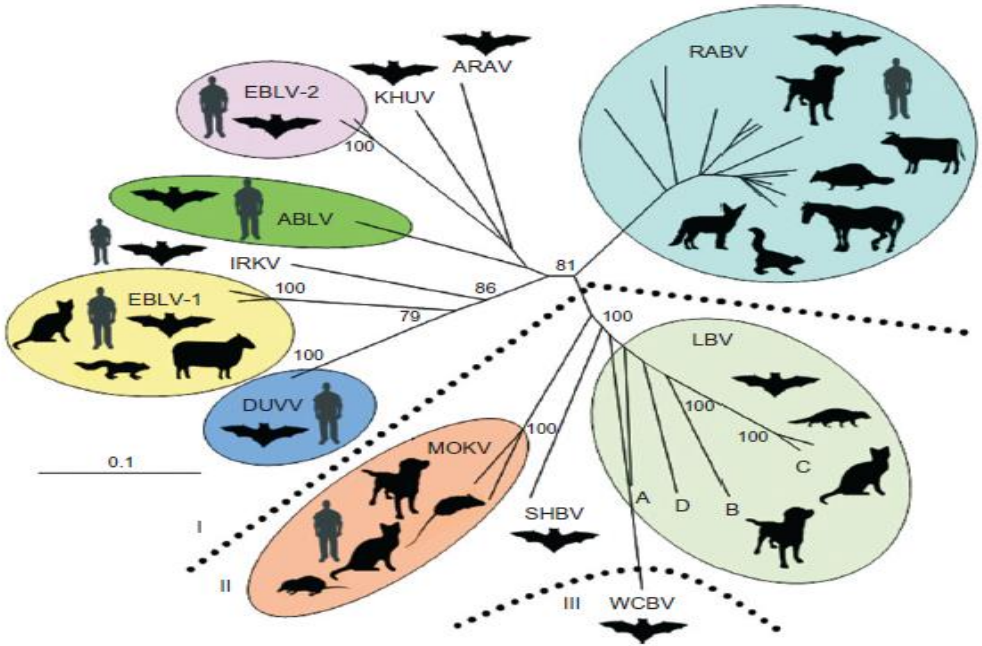
Species association ..



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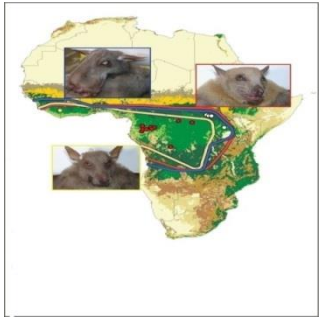
Filoviridae
Ebola



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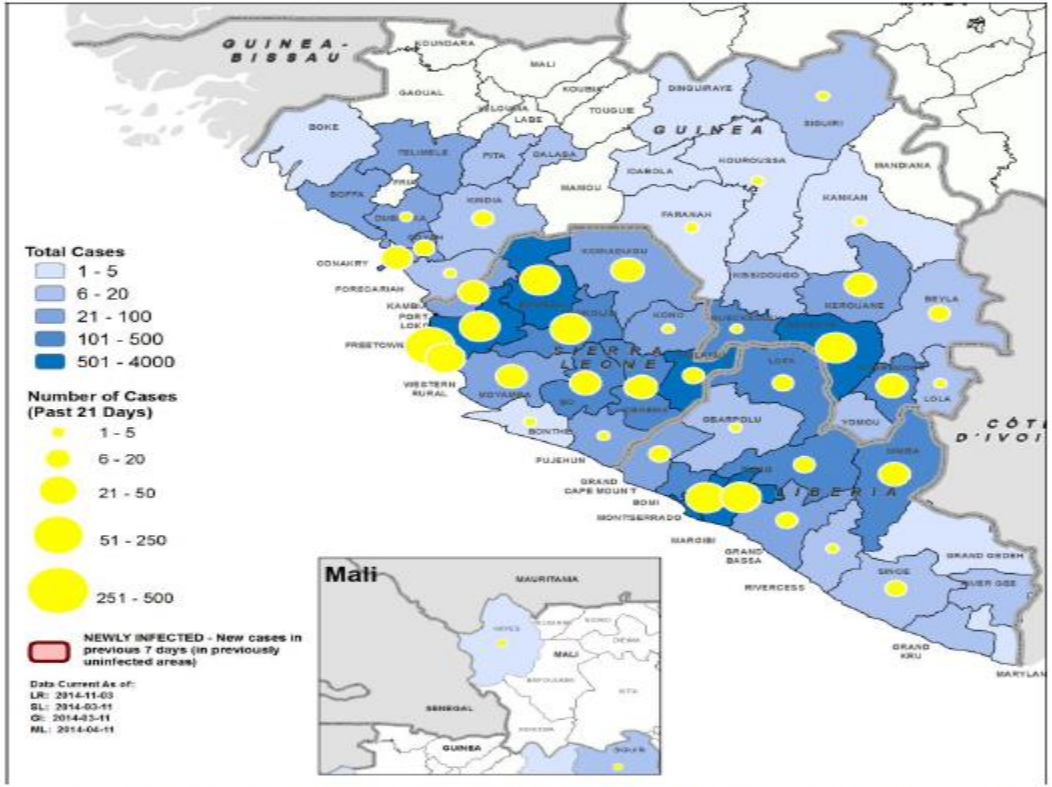
Reported Ebola Cases - CDC

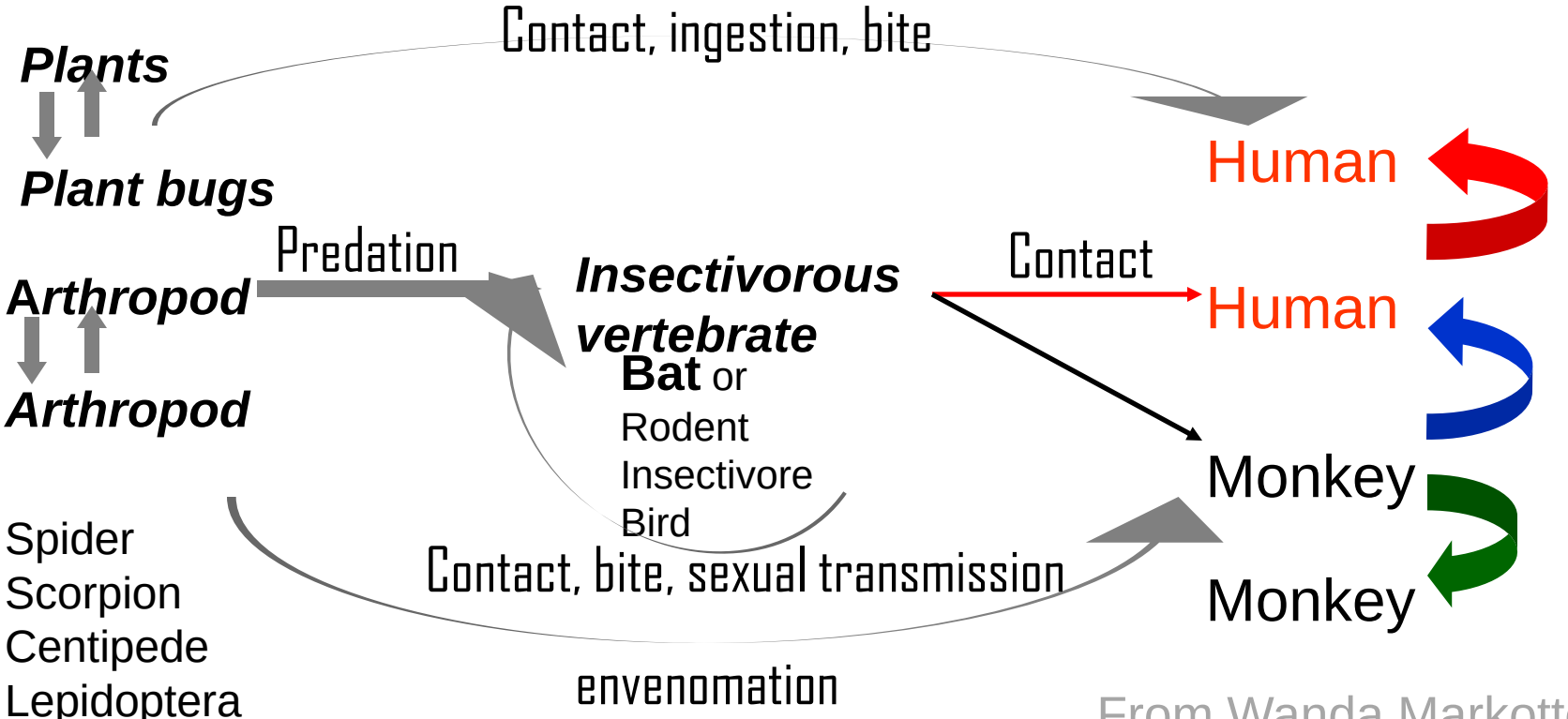
Year	Country
1994	Ivory C
1990	USA
1989	USA
1992	Italy
1996	USA
1996	Philipp
2001–2002 Oct–Mar	Gabon
2001–2002 Oct–Mar	Repub
2004	Sudan
2008–2009 Dec–Feb	Democ
2012 Jul–Aug	Ugand
2002–2003 Dec–Apr	Repub
2003 Nov–Dec	Repub
2007	Democ
2007–2008 Dec–Jan	Ugand
2014 (Presently Ongoing)	Guinea, Liberia, Sierra
2008 Nov	Philipp
1976	Zaire (Congo
1979	Sudan
1976	Sudan
1994	Gabon
1996 Jan–Apr	Gabon
1995	Democ (forme
2000–2001	Ugand
1996–1997 Jul–Jan	Gabon
1977	Zaire
1989–1990	Philipp
1996	South

Figure 1: Geographical distribution of cases in the past 21 days and total cases in Guinea, Liberia, Mali and Sierra Leone



Data are based on situation reports provided by countries. The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Hypothetical transmission cycle of filoviruses



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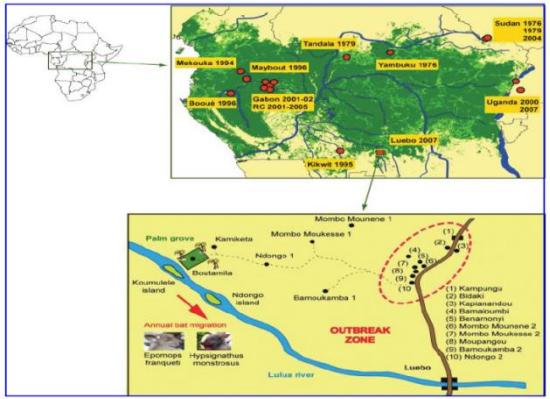
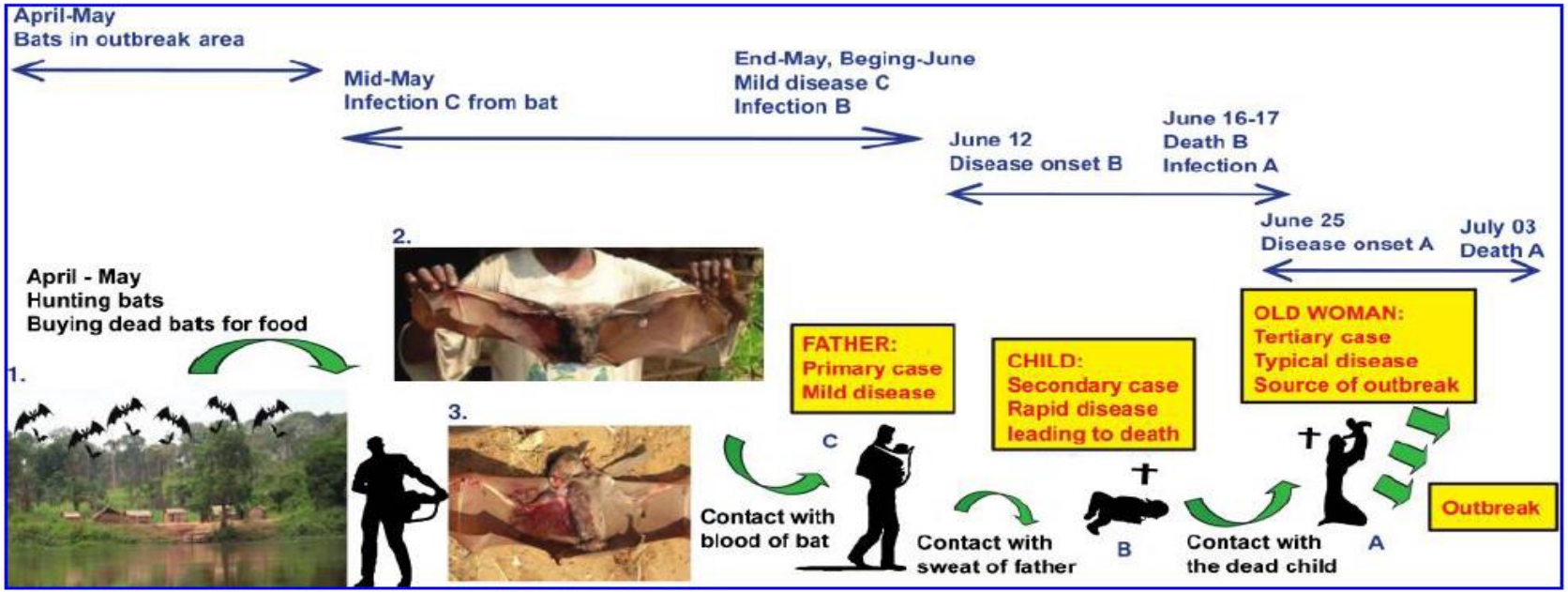
From Wanda Markotter



Human Ebola outbreak resulting from direct Exposure to fruit bats in Luebo, DRC, 2007

Leroy et al., 2009, Vector-borne & Zoonotic Disease



Ebola disease ecology & agroeconomics

Disease emergence is complex requiring a One Health approach.

Wallace et al 2014
https//:theconversation.com

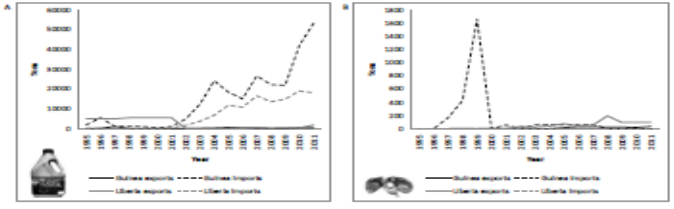
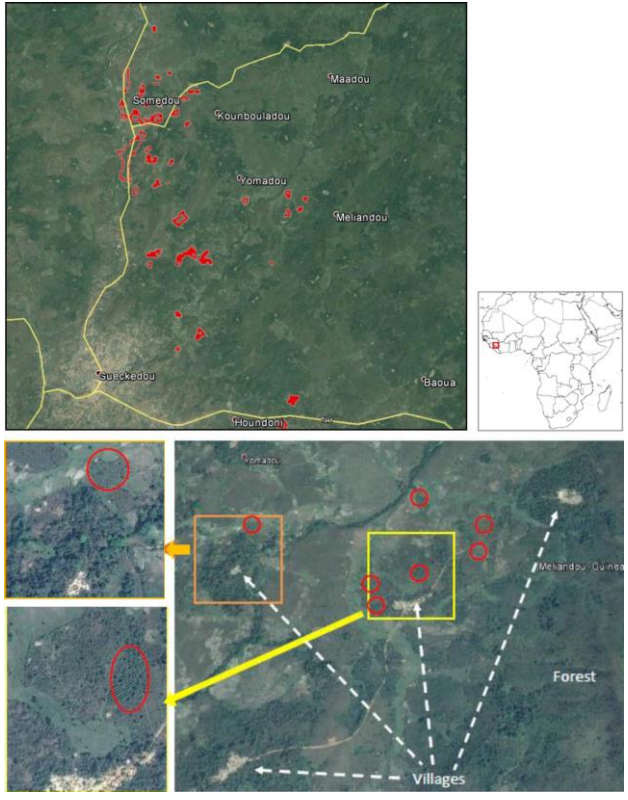


Figure 1: Figure 1. Exports-imports of a) palm oil and b) palm oil kernels for Guinea and Liberia, 1995-2011. Data from FAOStat.



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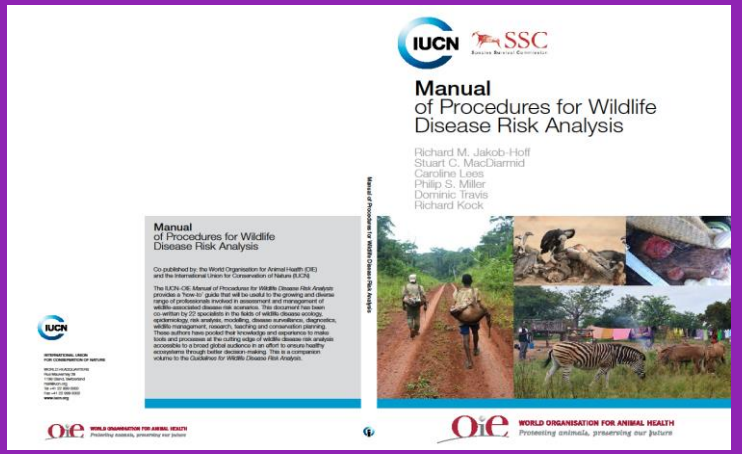
- **Future Focus**



WHSG members…..

Chytrid – is there sufficient evidence to link disease and amphibian decline? Only 14% of threatened amphibians confirmed with the disease. Heard et al 2013

Batrachochytrium salamandrivorans Asian commensal causing die-off of salamanders in Europe Martel et al 2013

Diclofenac licensing in Europe for veterinary use threatens Mediterranean vultures (*Gyps*)

Brucella ceti in marine mammals as a cause of disease & stranding

Mtb from humans to elephants (*Loxodonta africana* & *Elaphas maximus*)

Rabies & wildlife especially kudu *Tragelaphus strepsiceros*

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Precautionary principle

Use a Disease Risk Analysis Approach

Reframe the current risk messages in Parks :

Caution on:

- recreational activity in e.g. bat & insect/tick vector habitats
- food habits & traditions involving bats & bush meat
- fragmentation & development in contiguous habitats with Parks especially agriculture & livestock systems
- Excessive interventions

Encourage:

- Protection of habitat & wild populations
- reduced human contact, disturbance, minimise road systems, paths in high risk areas, minimise management systems, water points etc.
- buffer zones without crop or livestock agriculture, settlement

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Conservation Medicine - Ecohealth - One Health

Emerging disciplines, which study the links between animal, human, and ecosystem health

The need evolved from the recognition of a crisis: increasing levels of disease driven by human-induced environmental degradation, human behaviour and wide ranging ecological impacts

Transdisciplinary, bringing together veterinarians, epidemiologists, public health & social scientists, economists resource managers & more…

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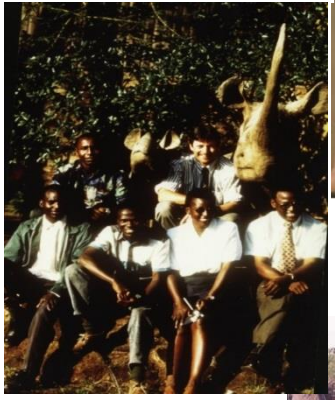
learning to live with change & uncertainty;
self-organization towards social-ecological sustainability.
New Way
nurturing diversity for resilience
combining different types of knowledge for learning;

Acknowledgements





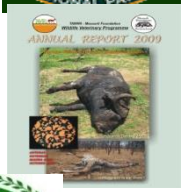












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TANZANIA
NATIONAL PARKS

ANNUAL REPORT 2009

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