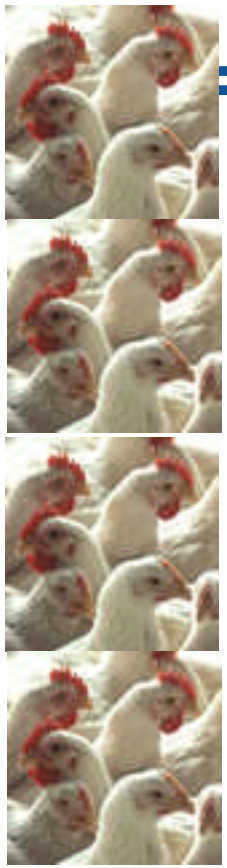
Better Training for Safer Food
BTSF

Epidemiological and statistical basis, passive and active surveillance, laboratory parameters, risk factors and early detection systems of emerging animal diseases

Dr Véronique Chevalier
UR AGIRs « Animals and Integrated Risk Management»
CIRAD – ES, Montpellier, France

Introduction



=> Diseases has causal and preventive factors

=> Diseases do not occur at random in space and time and are not randomly distributed throughout a population

Goals of epidemiological investigation

Measure of **disease frequency**

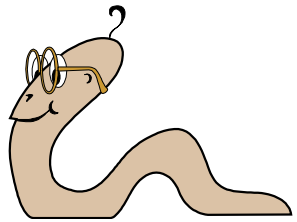
=> prevalence

=> incidence

Distribution of disease

- Which animals are getting diseased?
- Where is disease occurring?
- When is disease occurring?

=> GIS tools



Determinants (risk factors) of disease

=> Statistical models

Prevalence

Proportion of individuals in a population with disease or specific condition at a specific point of time

- Provides estimate of the probability that one will be affected at a point in time
- Provides an idea of how severe a problem may be
  (Useful for planning animal health services)

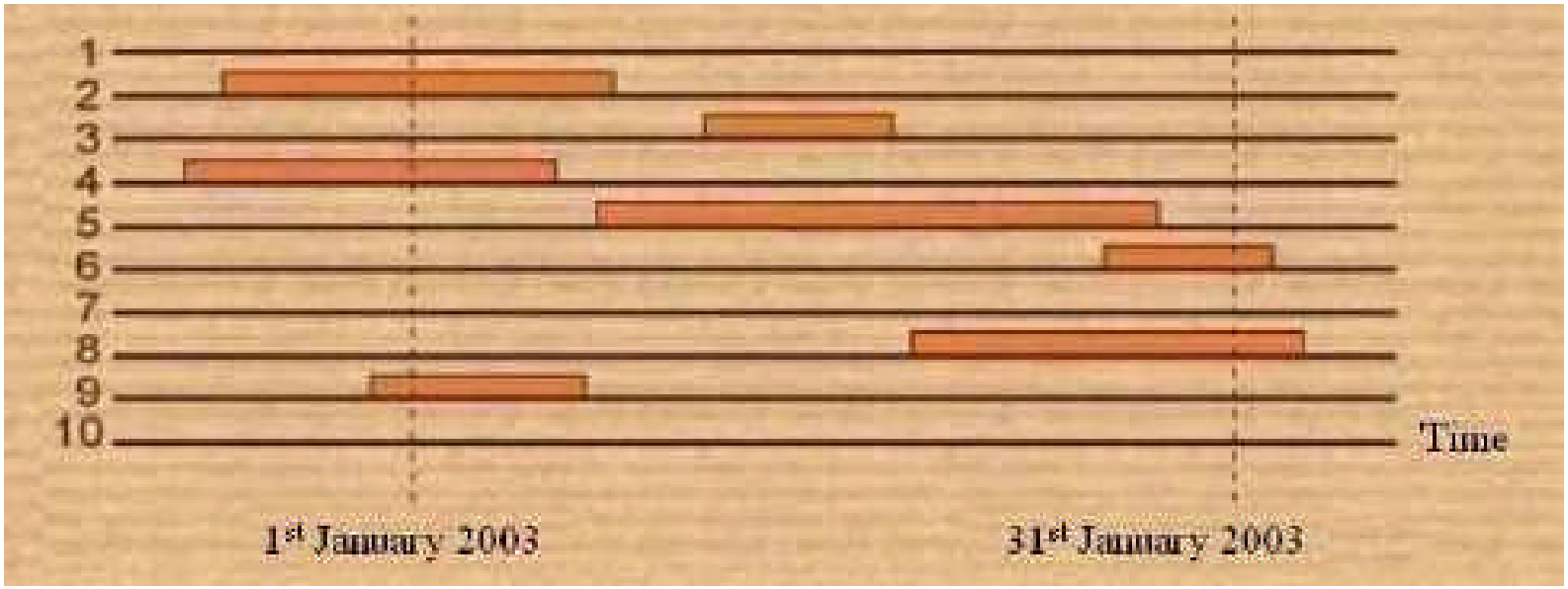
$$\text{Prevalence} = \frac{\text{\# of cases observed at time t}}{\text{total \# of individuals at time t}}$$

Incidence

Measure of new cases of disease that develop in a population during a specified period of time

- Measure of the probability that unaffected animals will develop the disease
- Used to investigate outbreaks

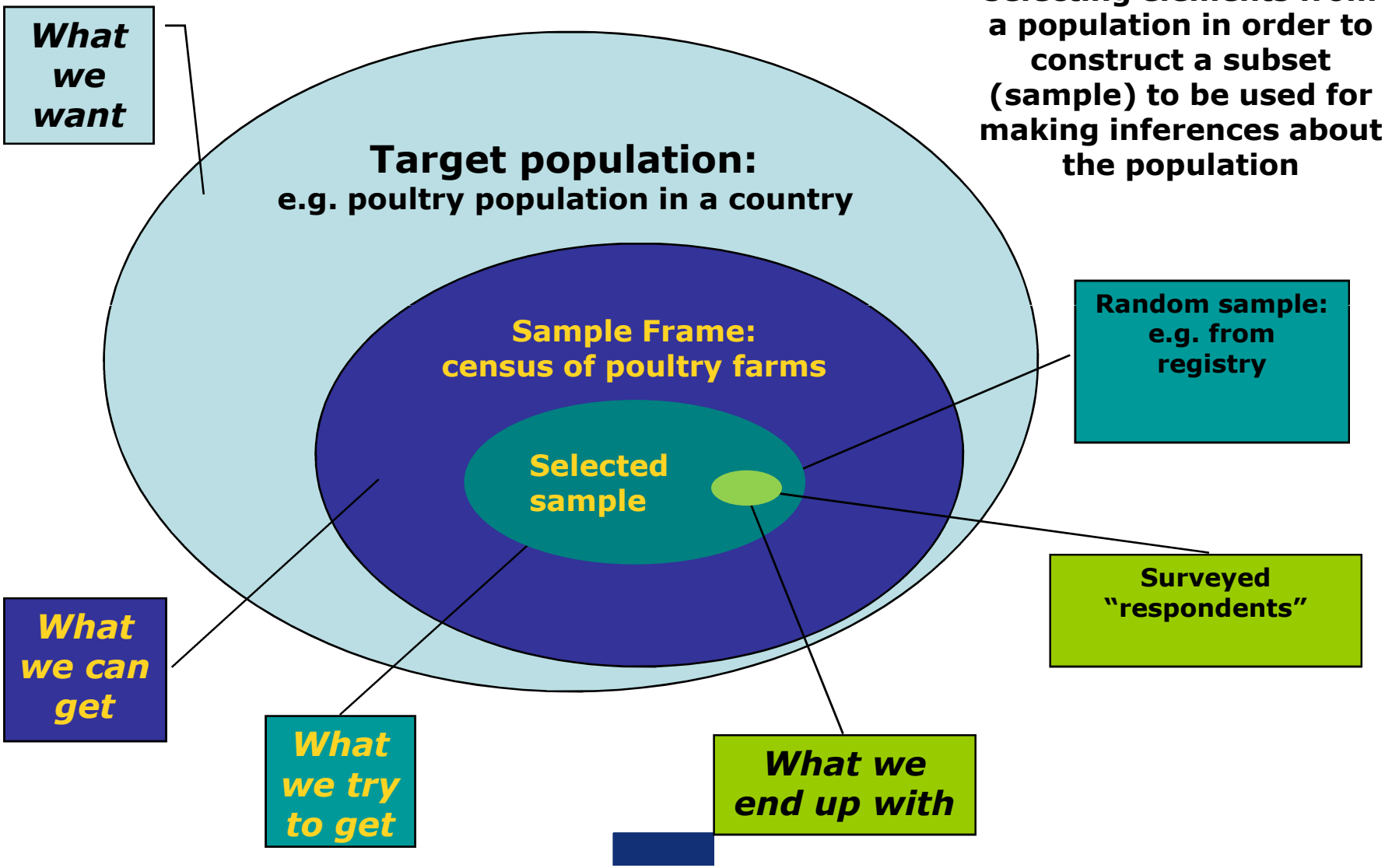
Prevalence *vs* incidence



- **Point prevalence on Jan 1st?** 3/10 = 0.3 = 30%
- **Point prevalence on Jan 31st?** 2/10 = 0.2 = 20%
- **Incidence in January?** 4/10 = 0.4 = 40%

Sampling

Sampling: process of selecting elements from a population in order to construct a subset (sample) to be used for making inferences about the population



Sampling

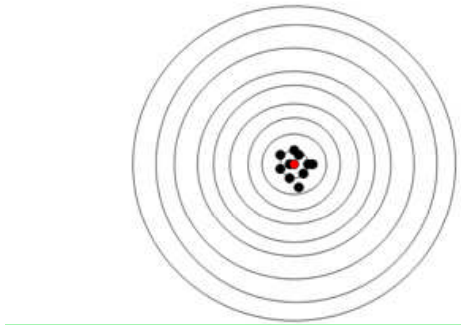
Advantages of sampling

- **Information obtained more rapidly, more easily and for a lesser cost than when working with whole population**

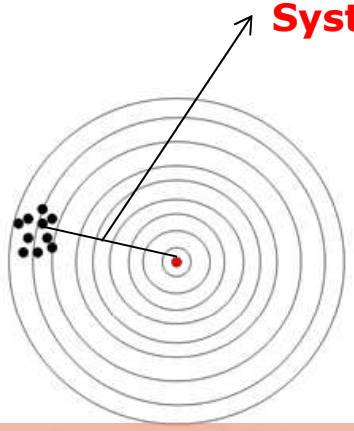
But keep in mind!!!

- **Poor sampling method → unreliable, or wrong results**

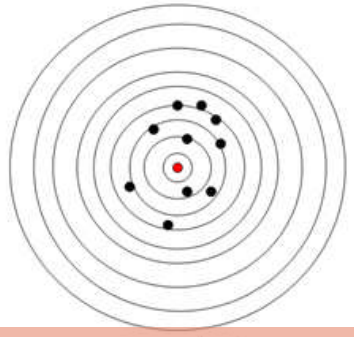
Accuracy and precision



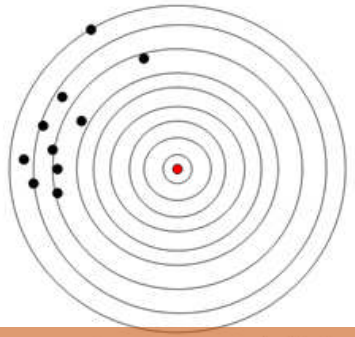
Accurate and precise



Precise and biased



Accurate and imprecise



Imprecise and biased

Sampling

Accurate (no systematic error)

➔ use random sampling method: sampling set will have the same characteristics than the whole population : age, sexe, geographical distribution, ...

Precise (repeatability)

➔use an adequately large sample size

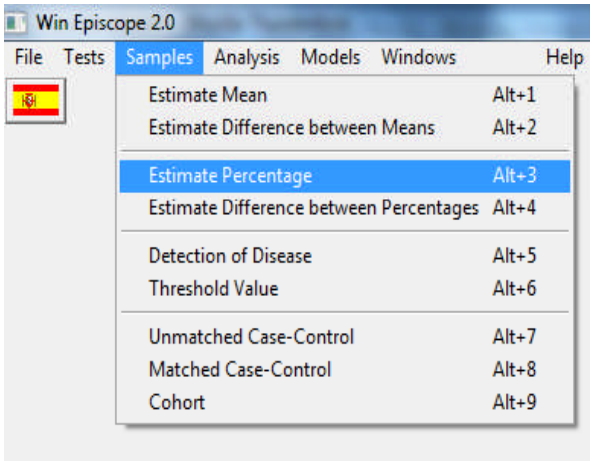
➔Statistical tools exist to calculate the appropriate sample size, depending on the objective

- ➔determine the frequency of the disease = estimate the prevalence with a predetermined confidence interval
- ➔estimate the presence or absence with respect to a confidence threshold

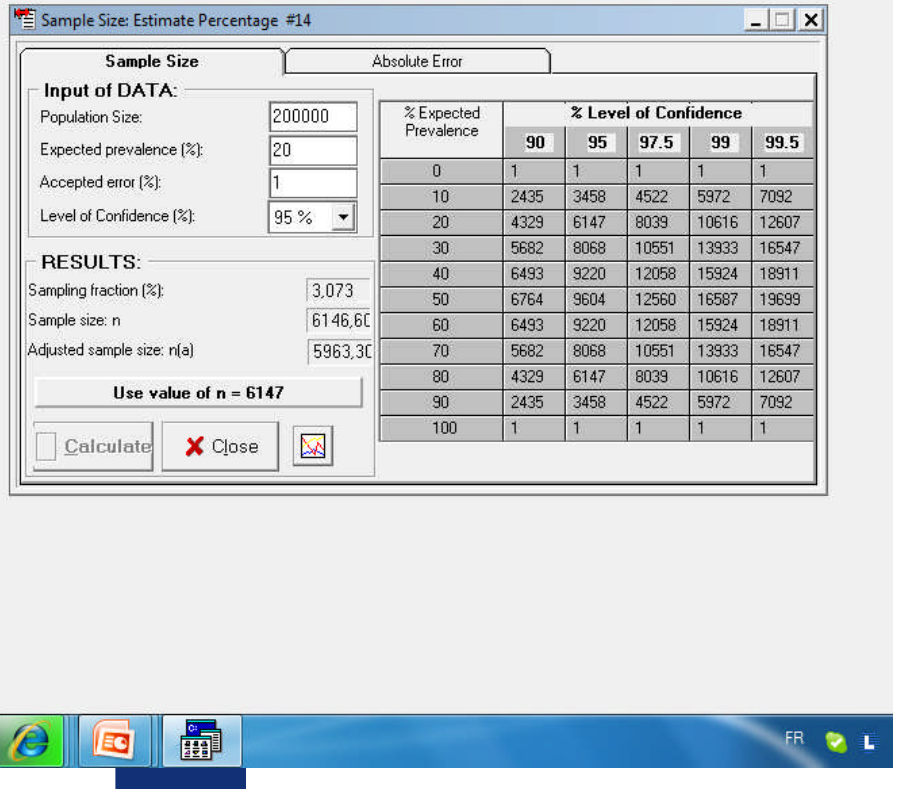
Remember

➔Increasing sample size does not compensate for systematic error due to a non random sample!!!

Sampling



http://www.clive.ed.ac.uk/winepiscope/



Sensitivity and Specificity

Real situation

Test results	Infected	Non infected
+	RP	FP
-	FN	RN

$$Se = \frac{RP}{RP + FN}$$

$$Sp = \frac{RN}{RN + FP}$$

$$Se = \frac{10}{10 + 10}$$

⇒Se = 50%
⇒ underestimation !!!

Surveillance

*Disease surveillance in animal health is the ongoing systematic **collection**, **analysis** and **interpretation** of data and the **dissemination** of information to those who need to know in order to take action.*

Objectives of surveillance

=> Early detection and control of animal diseases

=> Determine trends over time

=> Set goals and targets based on information regarding prevalence and trends in order to design control measures

=> Assess whether animal health goals and targets are being reached

Passive *vs* Active

= relies on breeder's and vets reports and visual observations

=> waiting

=> case reporting

=> cheap

but dependent on motivation and awareness of actors

= frequent and regular effort to determine the animal health status in a given sub-population

=> searching

=> survey

=>rather expensive

=> need a dense network for a good sensitivity

Passive *vs* Active surveillance : West Nile in southern France

Passive surveillance=

detection and reporting of WN signs in horses and human

mortality in wild birds

S. Lecollinet, ANSES

J. Hars ONCSF

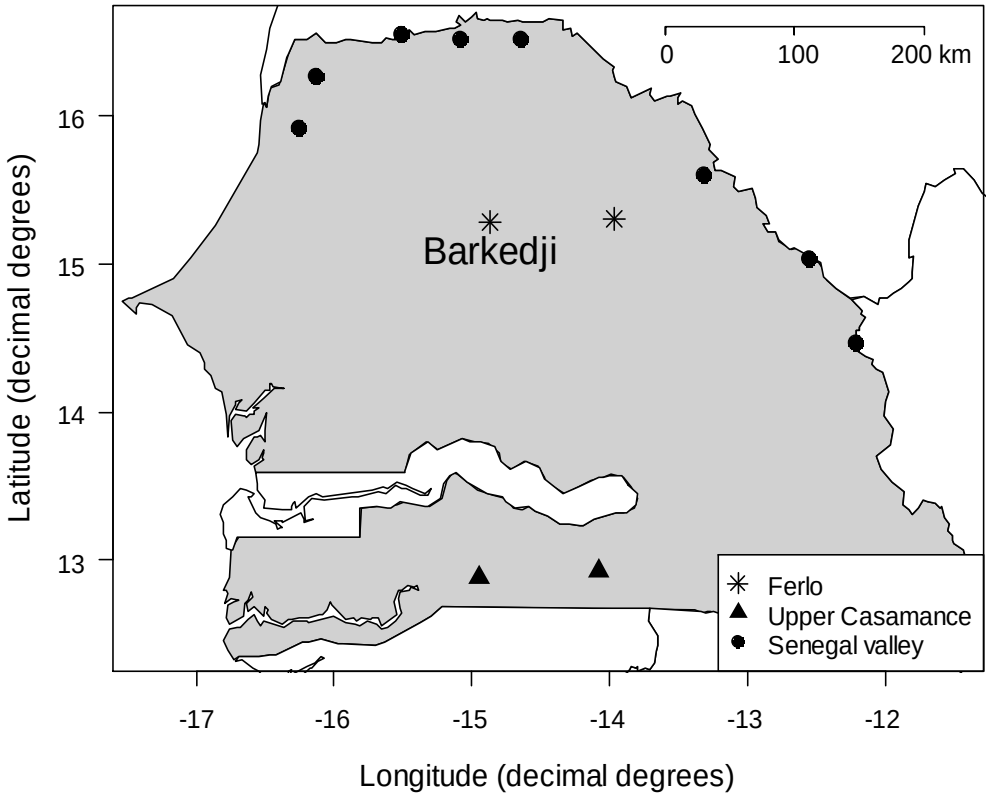
Active surveillance =

sentinel horses and chicken mosquito trapping for WNV genome detection by PCR

J. Hars ONCSF

J. Hars

Active (targeted) surveillance RVF in Senegal



Since 1987

12 herds

2 or 3 sampling during the rainy season

Seroneutralization

+ abortion reporting

Chevalier et al, EID, 2005

Active (targeted) surveillance RVF in Senegal

Chevalier et al, EID, 2005

5 outbreaks were recorded in 2003 in Senegal,

Nothing was notified in the Ferlo where an outbreak occurred!

=> network not sensitive enough

Disease warning issued at the end pf the rainy season when nomadic farmers had already left the area

=>high risk of dissemination because of the time lag between disease occurrence and reporting/ health authorities reactions

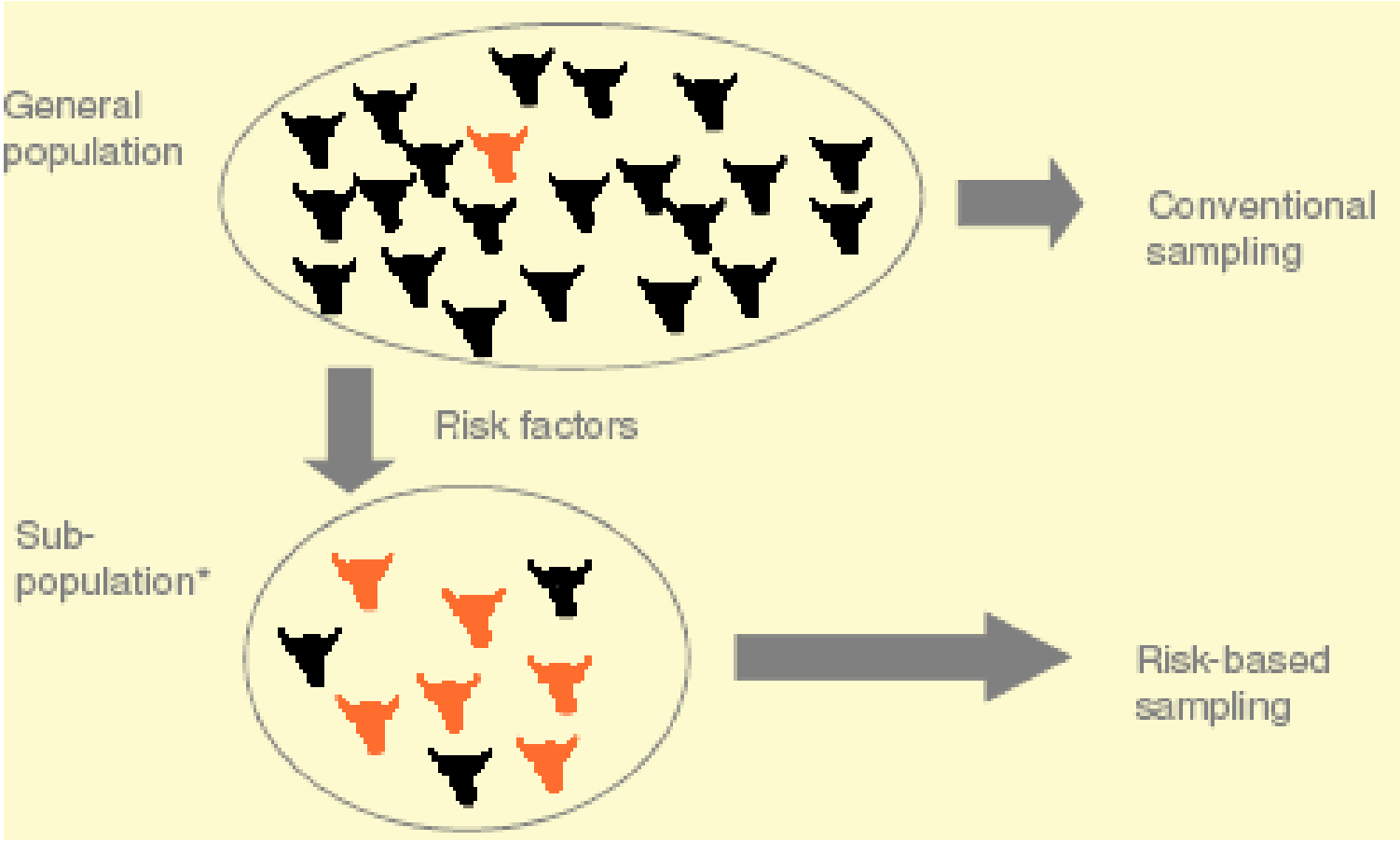
Risk-based surveillance

„A surveillance programme in the design of which risk assessment methods have been applied together with traditional design approaches in order to assure appropriate and cost-effective data collection„

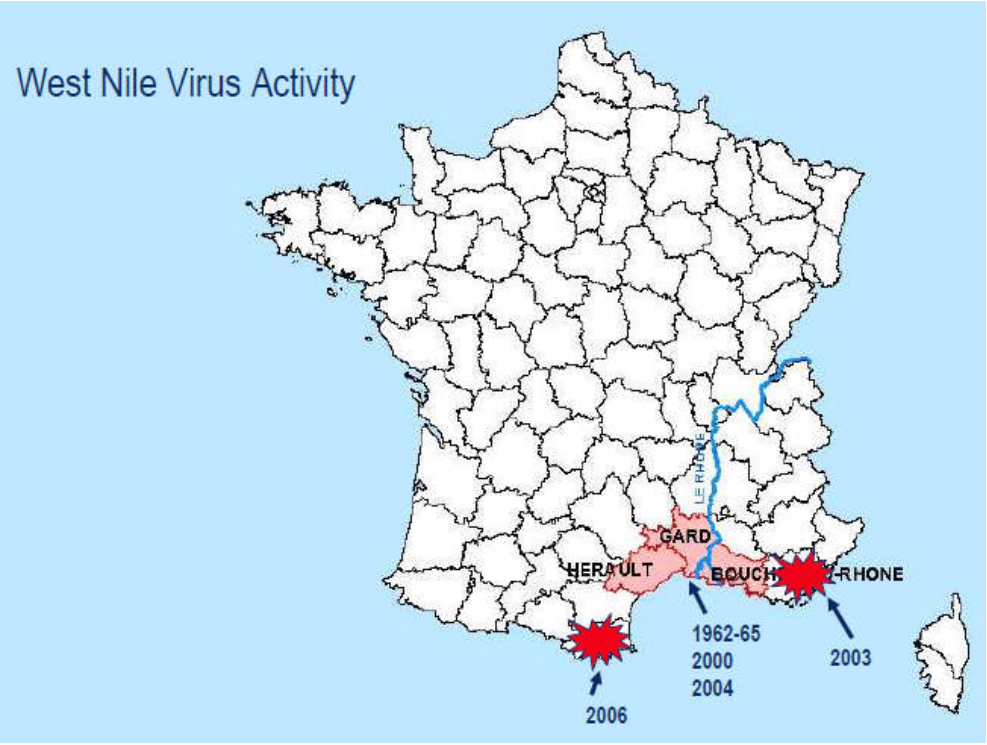
=> *these systems intentionally use selective sampling of high-risk sub-populations to increase the probability of detecting affected individuals within the general population*

Stärk et al. 2006

Risk-based surveillance



WN surveillance in France



Breeding sites for migrating birds ➞ **Risky area : southern France**

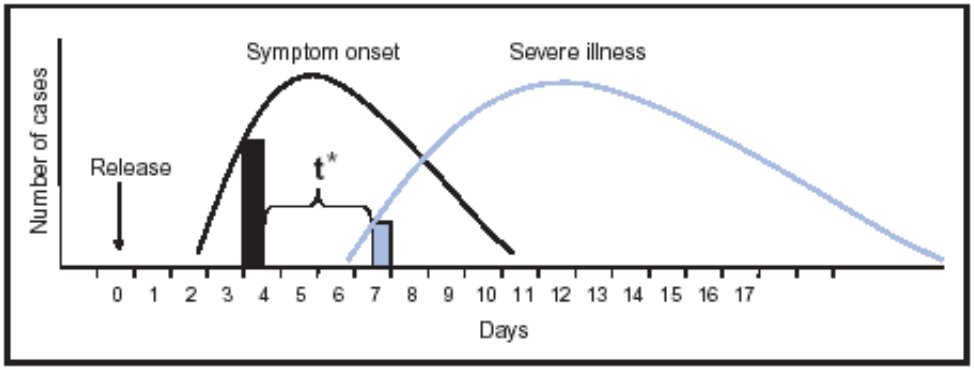
Wild bird density +++
Mosquito density +++ ➞ **Risky period : July to November**

Syndromic surveillance:

Theorically minimize the main limitations of the passive surveillance

- **late stage of reporting**
- **under-reporting**
- **lack of sensitivity**

FIGURE. Syndromic surveillance — rationale for early detection



* t = time between detection by syndromic (prediagnostic) surveillance and detection by traditional (diagnosis-based) surveillance.

=>**earlier stage of detection**: instead of monitoring a disease, we monitor syndroms or indicators

- febril syndrom
- trade intensity
- school or work absenteism data
- paracetamol consumption
-

Syndromic surveillance

=>**under-reporting** is minimized by the systematic and continuous screening of information at earlier stage of the disease process

Algorithms able to analyse data in real-time and identify abnormal clustering in time and /or in space of the occurrence of these syndroms

- Need to be followed by an epidemiological investigation and diagnosis

=> **increased sensitivity**: case definition is deliberately non-specific

Syndromic surveillance : examples

. Neurological signs in horses

⇒ **West Nile fever, Equine Herpes virus, rabies…**

. Hemorragic in ruminants

=> **Rift Valley fever, Salmonellosis**

. Respiratory Syndrom in pigs

- **=> Porcine reproductive and respiratory syndrome virus (PRRSV), Nipah, H1N1**

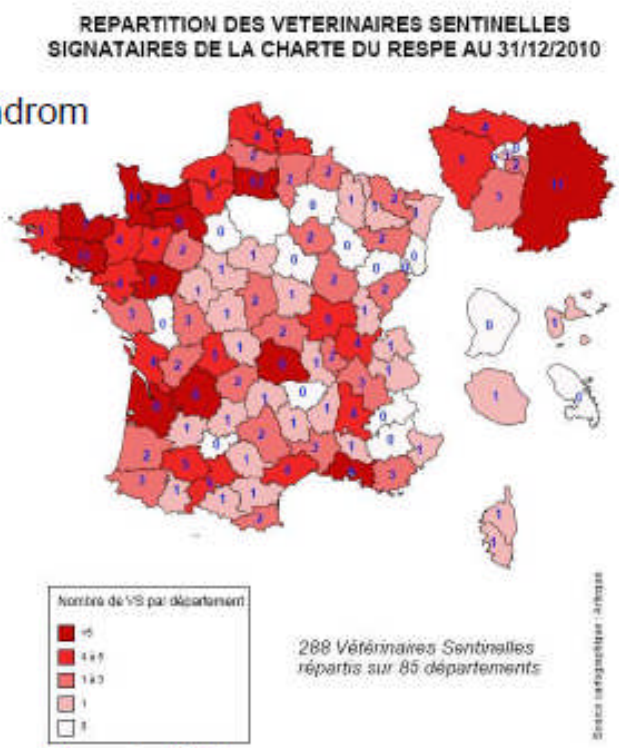
Acute flu syndrom in humans

- **=>Flu, but also …Leptospirosis, RVF, Chikungunya, dengue, malaria..**

Syndromic surveillance on horses in France

RESPE

Surveillance of
- acute respiratory syndrom
- atypical myopathia
- nervous syndrom
- abortion



330 sentinel veterinarians (voluntary practioners), 85 departments.

http://www.respe.net/node/24

Application of Se and Sp to surveillance

Surveillance generally uses methods distinguished by their practicality, uniformity and rapidity rather than by accuracy or completeness

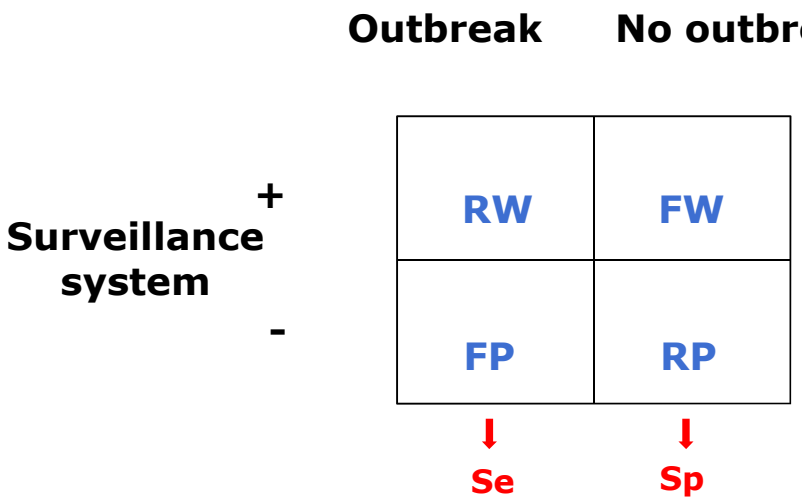
In a perfect surveillance system…

- **all cases in the population would be detected**
- **and all those that the surveillance system identified as having the disease would indeed have the disease.**

Application of Se and Sp to surveillance

In practice, depending on the case definition used

- **Some of those who have the disease will not be included as cases (lack of sensitivity) : No Warning = FP (False Peace)**
- **and some of those that are included will not have the disease (low specificity) : “False” Warning (FW)**



Using a broad case definition to improve sensitivity, will increase the rate of false warning and decrease specificity

Similarly, improve the criteria required to make a diagnosis will increase specificity, but sensitivity will decline

Additionally, not all of those who meet the case-definition will actually have the disease

Warning system	Outbreak	No outbreak
+	RW	FW
-	FP	RP

Positive Predictive Value

$$PPVs = \frac{RW}{RW + FW}$$

=> if the positive predictive value is low, you will lose money triggering investigation for nothing

Factors affecting the surveillance system performances

Geographic coverage

Awareness of field veterinarians and farmers

- What to report? To whom? What happens if I do?
- Poor feedback to health workers and communities

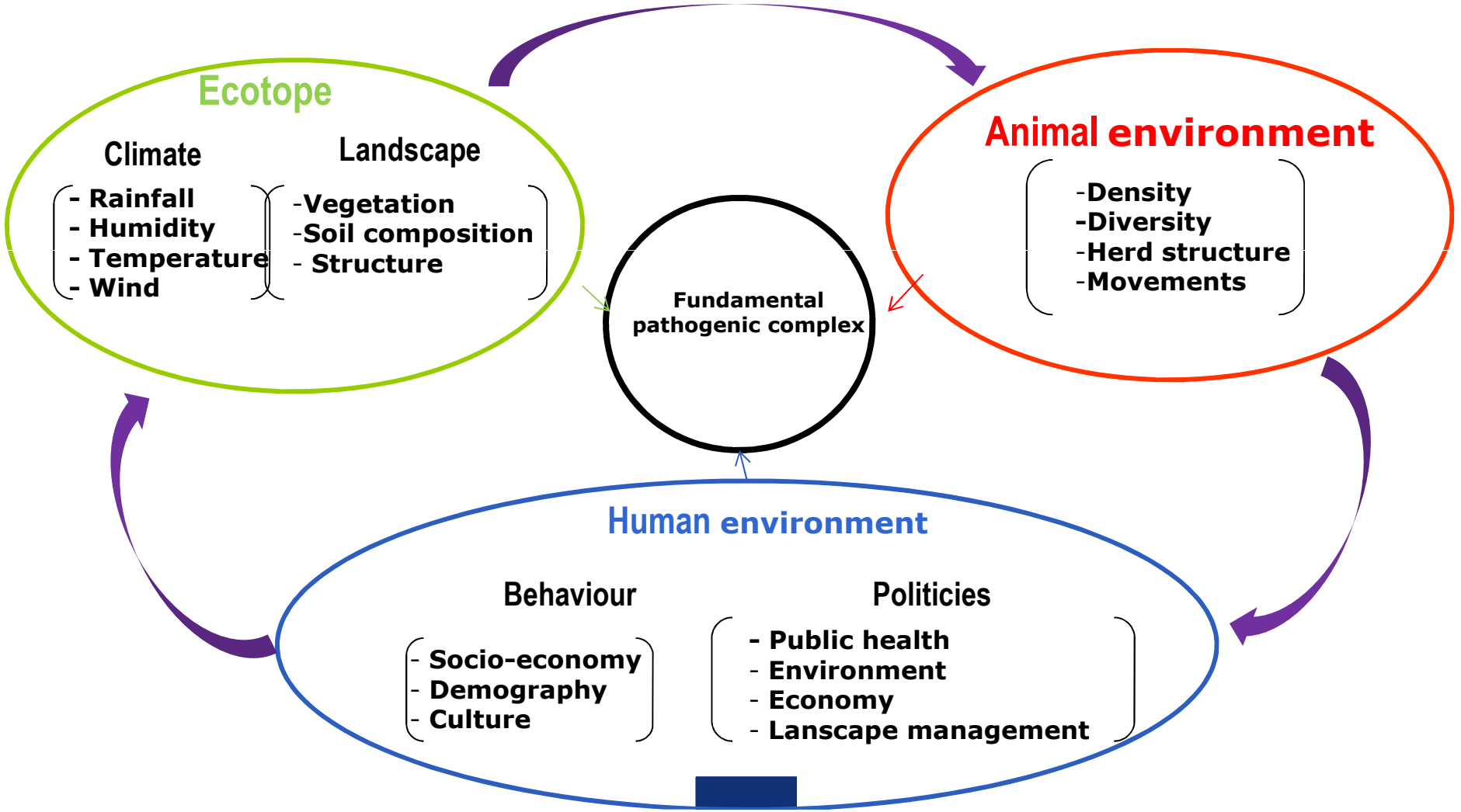
Economic incentives

- Possible consequences of disease reporting
- Conflicts of interest

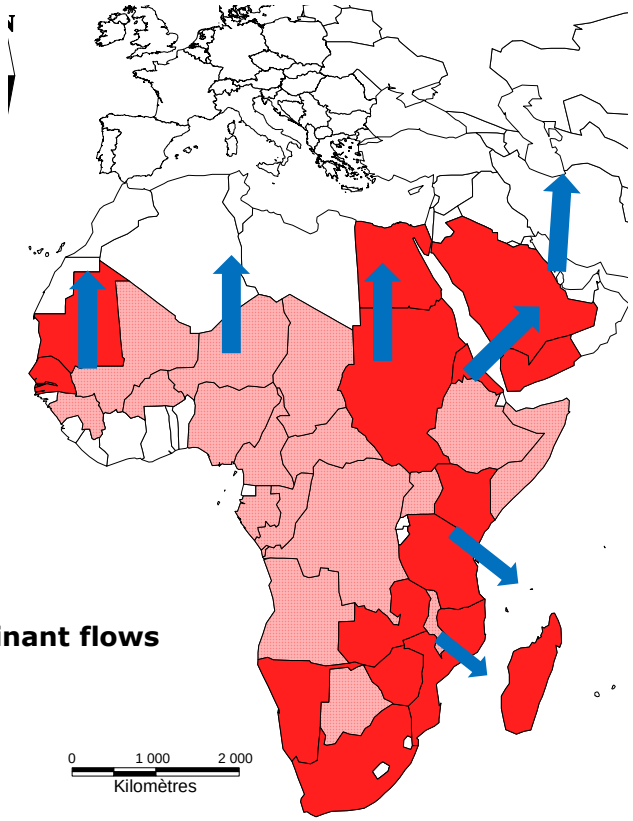
Factors affecting the effectiveness of surveillance systems

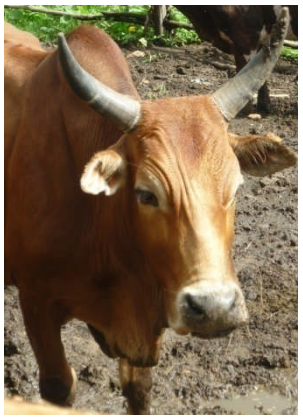
- **Time-lag**
  - Incomplete and late reporting
- **Data analysis**
  - Inadequate data analysis
  - Failure to use available information to check trends
  - Under utilization of surveillance information in decision making

Emergence risk factors



Rift Valley fever spread and animal movements





1970 : Sudan => Egypt

2000 : Horn of Africa => Arabic Peninsula

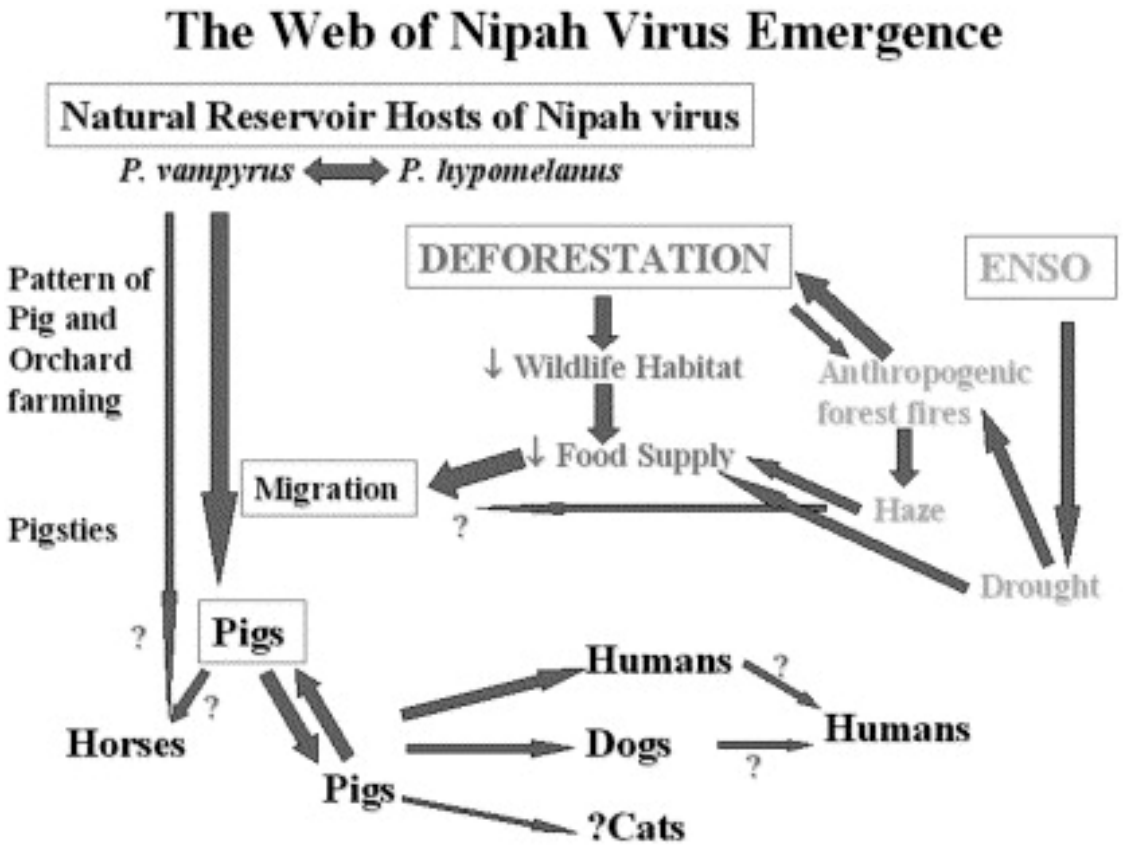
2007 : East Africa => Comoro islands

2010 : Senegal river basin =>Northern Mauritania ?

Next ?

Chevalier et al, Eurosurveillance 2010

Nipah virus emergence factors Malaysia 1998-1999



Thank you for your attention!