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

Telmo Nunes
CIISA – Faculdade de Medicina Veterinária – Lisbon
tnunes@fmv.utl.pt

Introduction

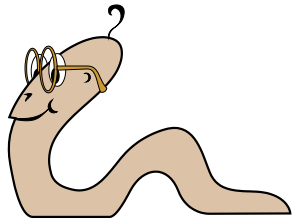
Disease has causal and preventive factors

=> Disease doesn't occur at random in space and time and is not randomly distributed throughout a population

Goals of epidemiological investigation

Measure of **disease frequency**

- Quantification of existence or occurrence of disease
  => prevalence
  => incidence



Distribution of disease

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

➔ **Formulation of hypotheses concerning causal and preventive factors**

Determinants (risk factors) of disease

- Hypothesis are tested using epidemiologic studies

Prevalence

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

- Provides estimate of the probability or risk 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)

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

Prevalence

Point prevalence: proportion of cases that exist at a given point in time

Lifetime prevalence: proportion of the population that has a history of a given disease at some point in time

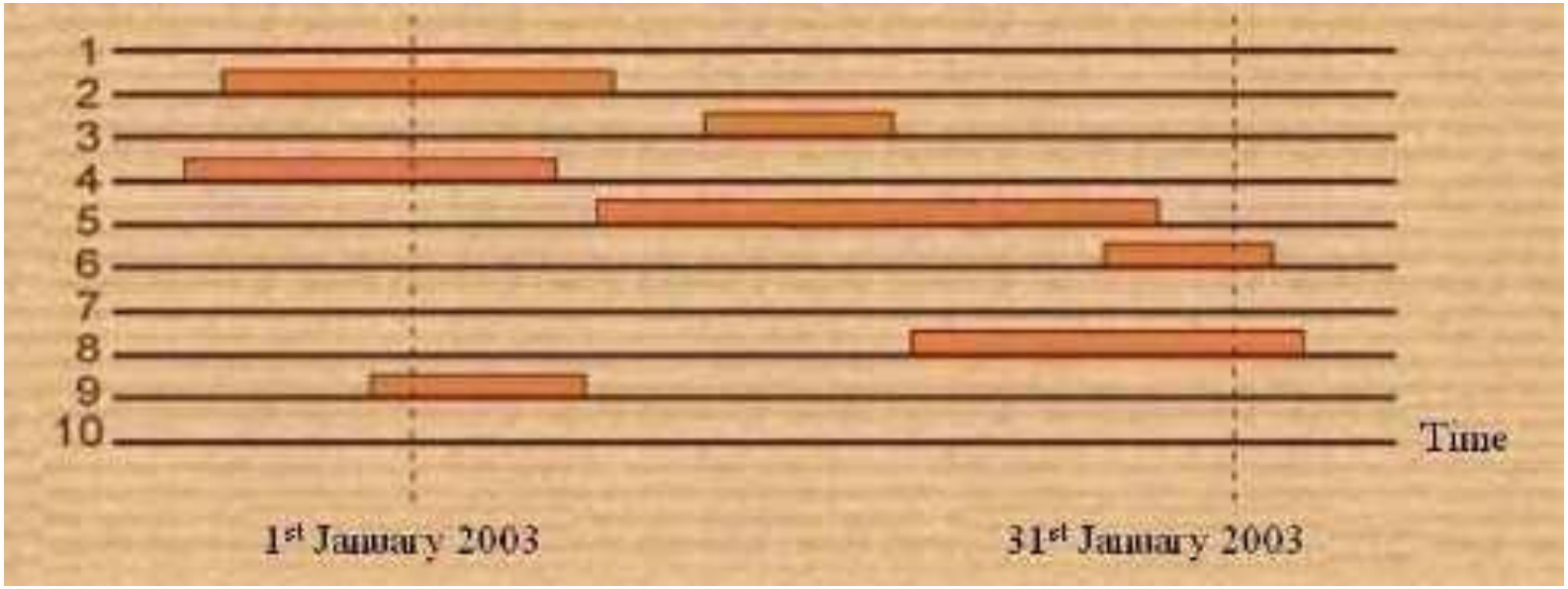
Period prevalence: proportion of cases that exist in a population during a specified period of time

Incidence

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

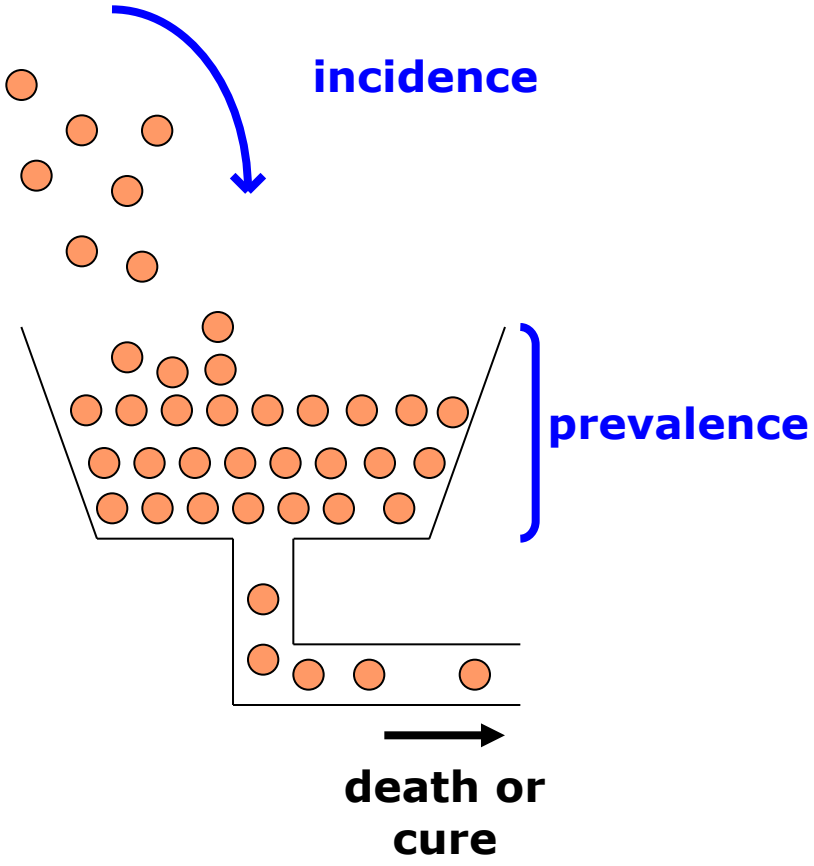
- **Measure of the probability that unaffected animals will develop the disease**
- **Used when examining an outbreak of a animal health problem (more useful to get risk factors)**

Prevalence *vs* incidence



- **Point prevalence on Jan 1st?** 3/10 = 0.3 = 30%
- **Point prevalence on Jan 31st?** 2/10 = 0.2 = 20%
- **Prevalence in January?** 7/10 = 0.7 = 70%
- **Incidence in January?** 4/10 = 0.4 = 40%

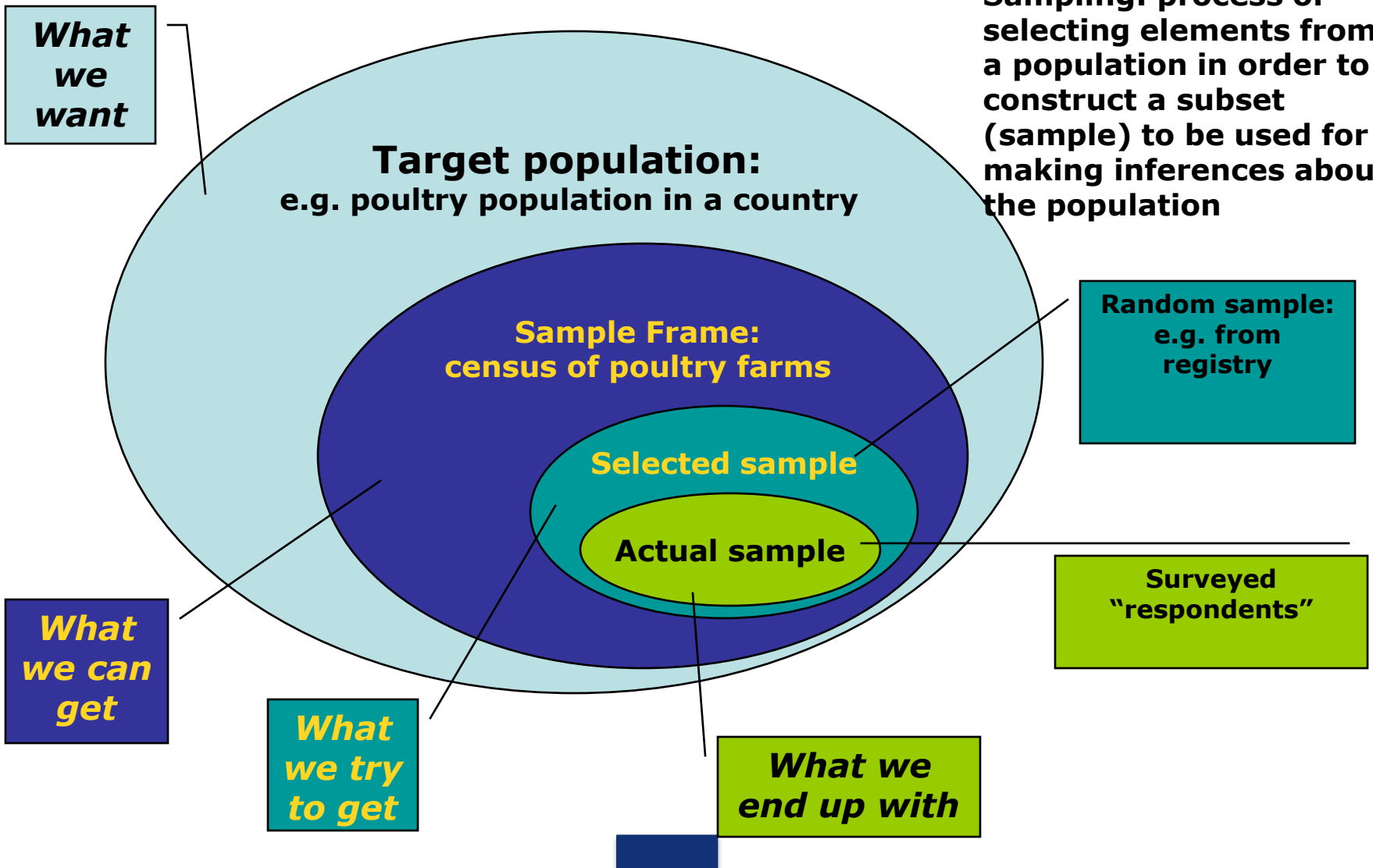
Prevalence *vs* incidence



- **Prevalence ~ Incidence x Duration**
- **Incidence generally a more relevant measure of disease occurrence**
- **However in chronic diseases, where flow of new disease is slow, prevalence is more employed**

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

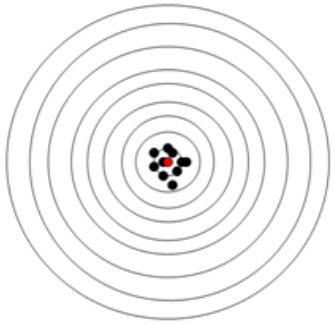
Advantages of sampling

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

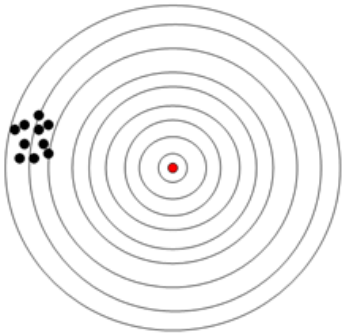
But keep in mind!!!

- **Poor sampling method ➔ unreliable results**

Accuracy and precision

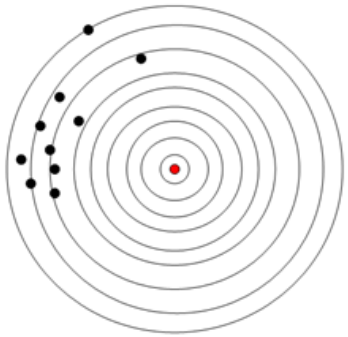


Accurate and precise



Precise and biased

Accurate and imprecise



Imprecise and biased

Sampling

***Representative** of the population*

➔ use random sampling method

Precise

➔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 bias due to a non random sample!!!

Diagnostic tests
Sensitivity and Specificity

Test results (T)	Real situation (D) Infected	Free
+	TP	FP
-	FN	TN

Test results (T)	Real situation (D) Infected	Free
+	TP	FP
-	FN	TN

$$Se = P(T+|D+)$$

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

$$Sp = P(T-|D-)$$

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

True prevalence

Prevalence values based on imperfect tests should be adjusted considering the test characteristics:

$$TP = \frac{AP + Sp - 1}{Se + Sp - 1}$$

Useful tools:

- **EPITOOLS** - **http://epitools.ausvet.com.au –** Web application
- **EpiR - http://epicentre.massey.ac.nz/Default.aspx?tabid=195** R library

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 and uses of surveillance

=>Detect the occurrence of disease

=> Determine trends over time

=> **Early detection and control of animal diseases of importance to national economy, food security and trade**

=> 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 surveillance

= basically relying on breeder's and vets reports and visual observations

=> waiting

=> case reporting

=> cheap

but dependent on motivation and awarness 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 sensibility

Passive vs Active surveillance
BSE surveillance in Europe

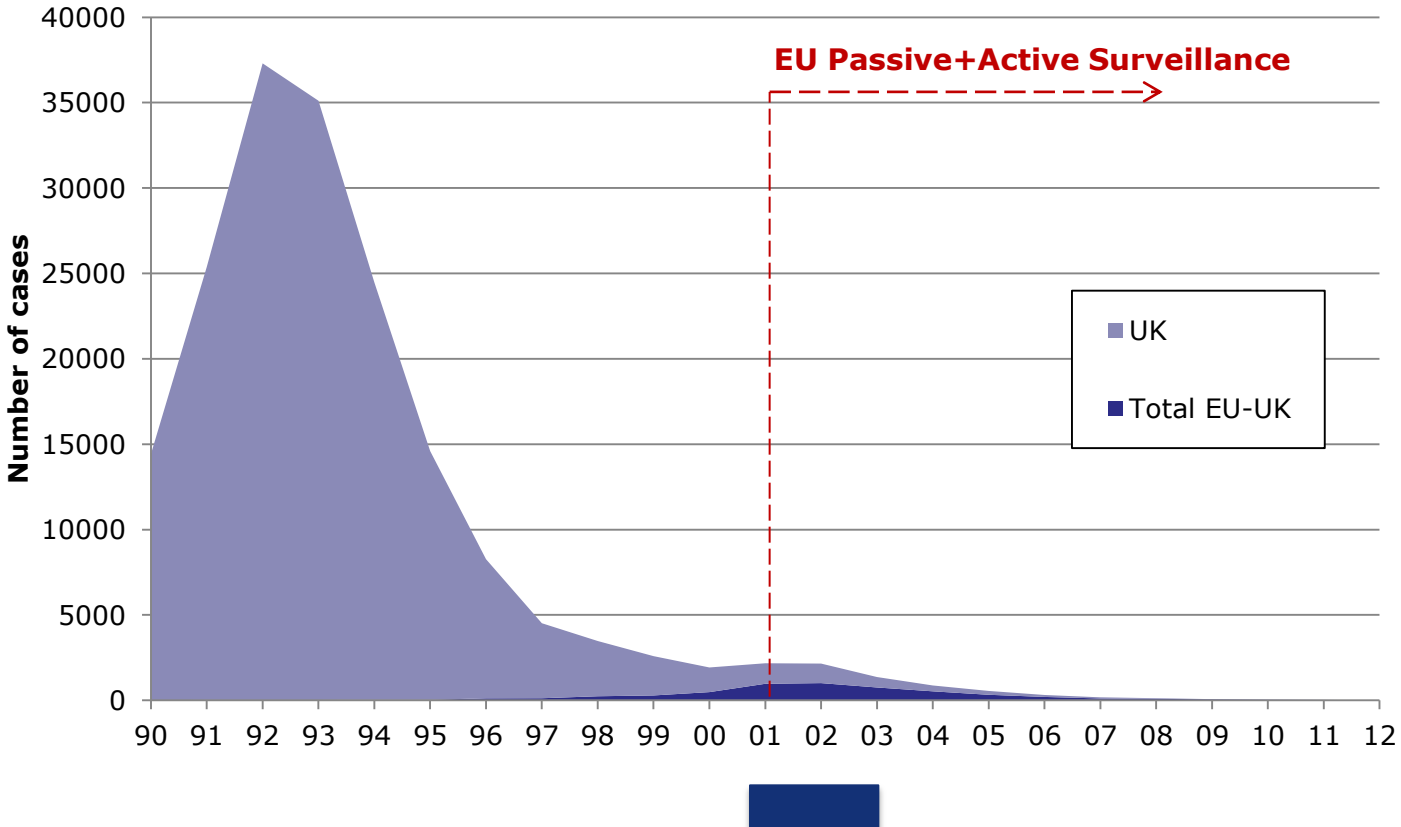
Passive Surveillance

- **Animals clinically suspected of being infected by BSE**

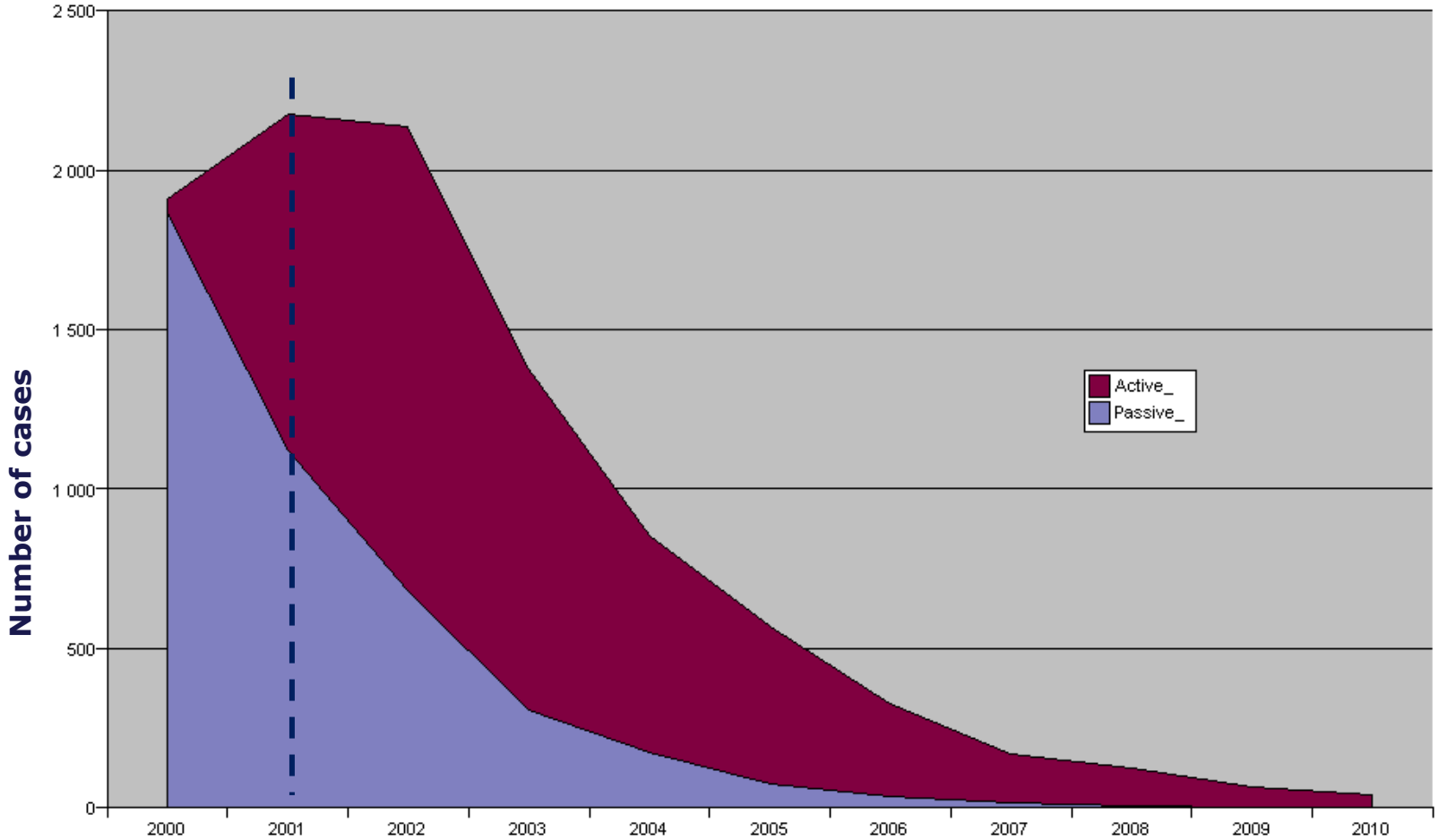
Active Surveillance

- **Fallen stock**
- **Emergency slaughtered animals**
- **Animals with clinical signs at AM**
- **Healthy slaughtered animals**
- **Animals culled under BSE eradication**

Number of BSE cases



Evolution of BSE cases detected by passive surveillance and active monitoring in the EU-27, from 2000 to 2010



DGSANCO,2010

BSE Surveillance results 2006-2010

	2006 (EU25)			2010 (EU27)		
Testing group	Tested	Positive	Ratio*	Tested	Positive	Ratio*
Clinical Signs at AM	65 988	10	1.52	20 440	0	0.00
Emergency Slaughter	93 854	31	3.30	50 885	0	0.00
Erradication Measures	4 918	1	2.03	378	0	0.00
Fallen Stock	1 305 248	166	1.27	1 101 744	29	0.26
Healthy Slaughter	8 574 888	79	0.09	6 330 680	16	0.03
Suspects	2 344	33	140.78	660	0	0.00
Total	10 047 240	320	0.32	7 504 787	45	0.06

* Positives per 10 000 bovine animals tested

DGSANCO, 2006-2010

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„

Stärk et al. 2006

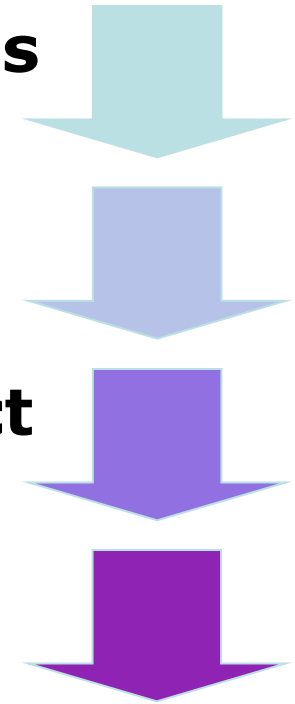
Risk-based surveillance: Design steps

Risk assessment to select hazards to be surveyed

Risk assessment to select strata to be surveyed

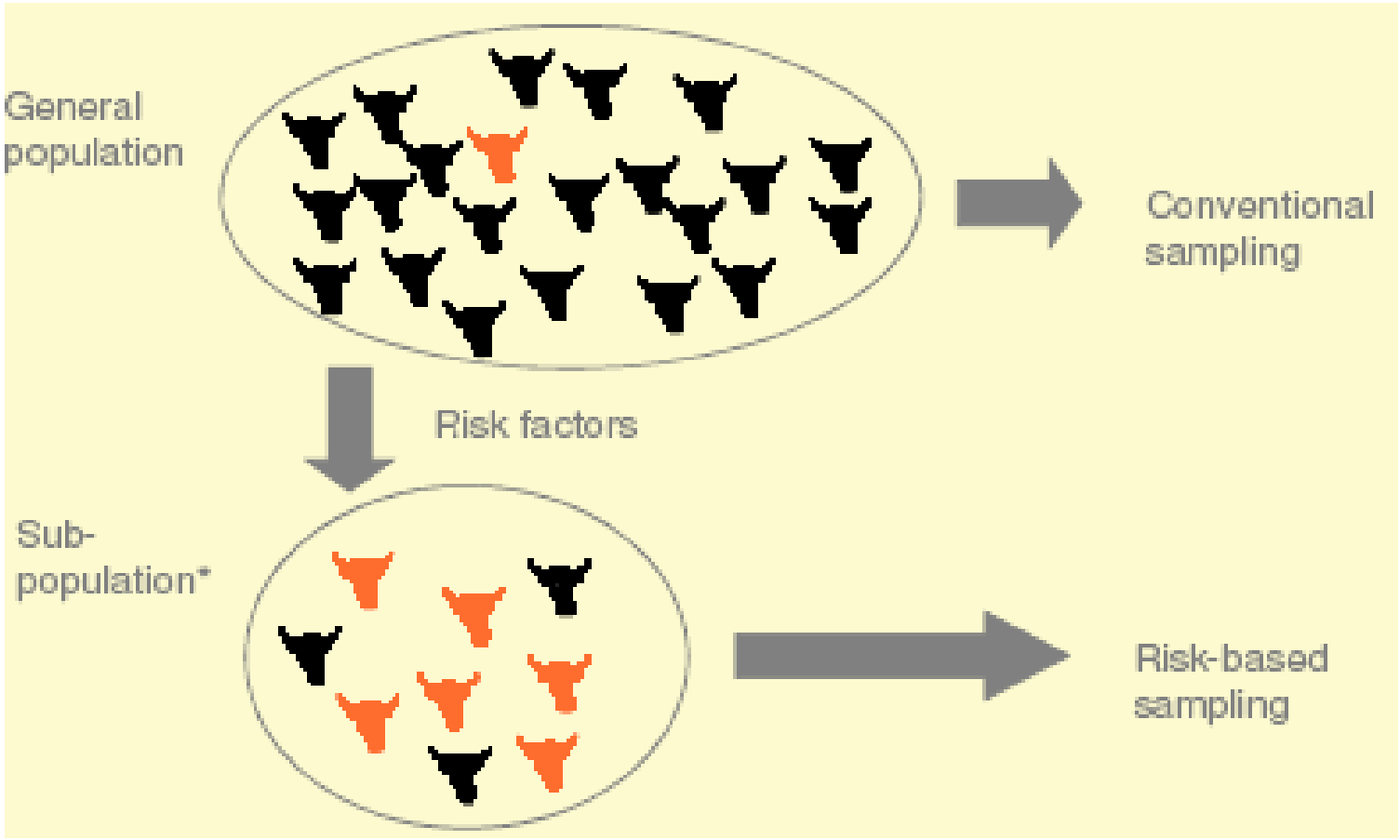
Risk assessment to select product to be surveyed

Random sampling



http://epitools.ausvet.com.au

Risk-based surveillance



Syndromic surveillance

Objective

- **Methods aimed at early detection of emerging diseases**
- **Often, syndromes that are typical of early stages of disease are monitored**

Case definition is deliberately non-specific to increase sensitivity

Algorithm able to identify abnormal clustering in time and /or in space of the occurrence of these syndroms => early warning

Syndromic surveillance : examples

. Neurological in horses

=> West Nile fever, Equine Herpes virus

. Hemorragic in ruminants

=> Rift Valley fever, **Salmonellosis**

. Severe Acute Respiratory Syndrom in pigs

- **=>Nipah**

. Stomatitis in ruminants

- **=> FMD**

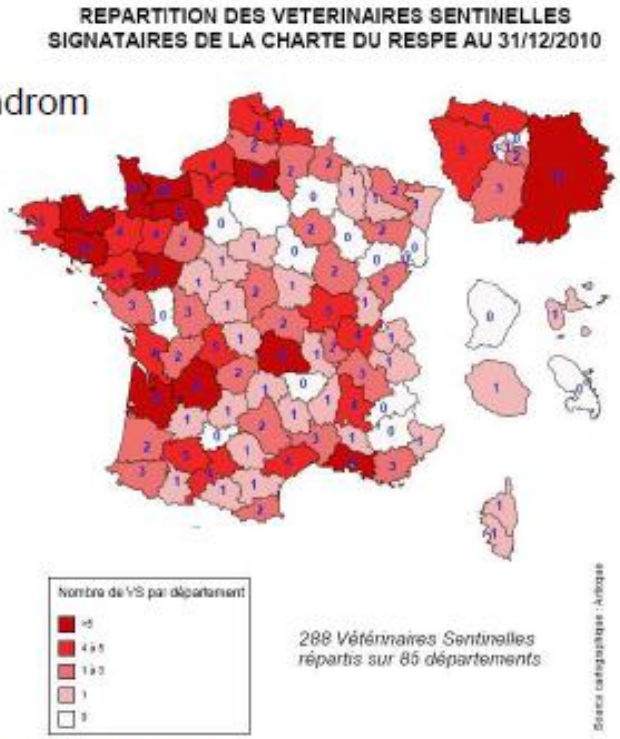
Acute flu syndrom in humans in Mayotte

- **=>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 sensitivity and specificity to surveillance

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

In an ideal 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)**
- **and some of those that are tested as positive will not have the disease (low specificity).**

Additionally, not all of those who meet the case-definition will actually have the disease => **positive predictive value**

		Infected	Free
Test results	+	TP	FP
	-	FN	TN

$$PPV = P(D+|T+)$$

$$PPV = \frac{TP}{TP + FP}$$

Application of Se and Sp to surveillance

Positive predictive value *is important if the surveillance system may trigger the further investigation of individual cases or of outbreaks*

- **if the positive predictive value is low, resources will be wasted chasing problems that do not exist**

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

- **Similarly, increasing the criteria required to make a diagnosis will increase specificity, but sensitivity will decline**

Application of Se and Sp to surveillance

In surveillance, the two most important values are sensitivity and positive predictive value. **Sensitivity** is affected by:

- **Whether farmers are in contact with vets and paravets**
- **Whether the disease is diagnosed**
- **Whether the disease is reported**

To evaluate sensitivity, you need external evaluation through a mechanism such as a survey

Recall that sensitivity does not have to be high in order to monitor trends, as long as sensitivity remains relatively constant

Factors affecting the effectiveness of surveillance systems

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

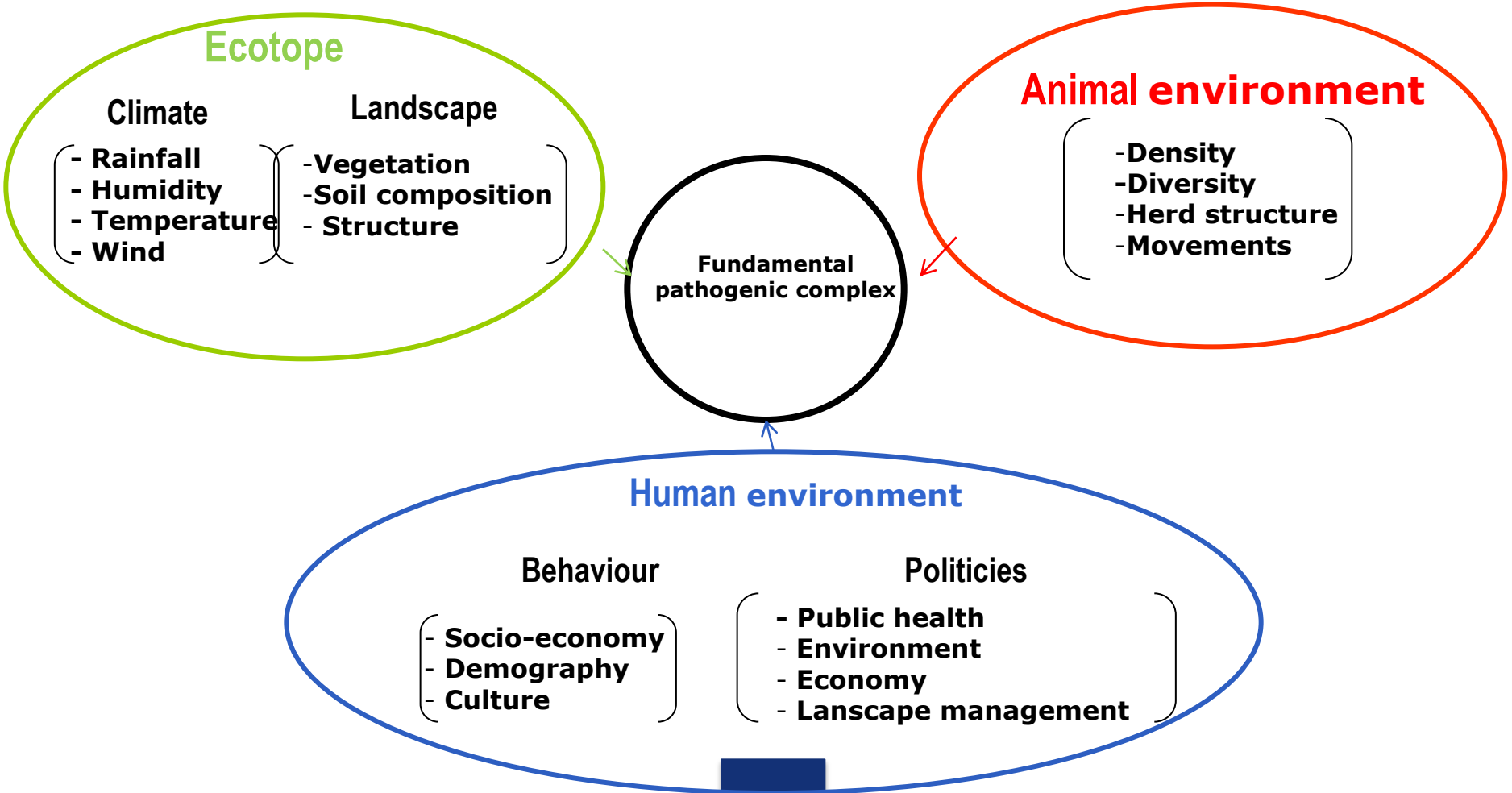
Time-lag

- Failure to report on time
- Incomplete and late reporting

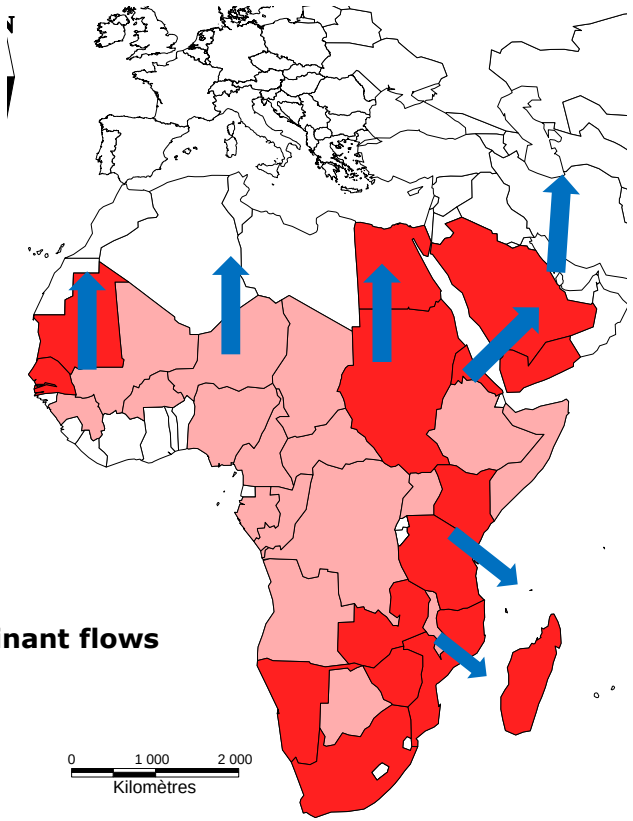
Data analysis

- 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



Main ruminant flows

1970 : Sudan => Egypt

2000 : Horn of Africa => Arabic Peninsula

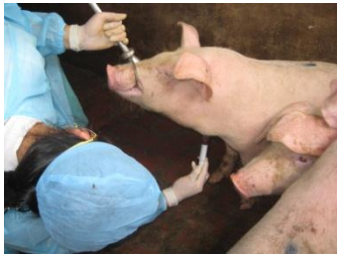
2007 : East Africa => Comoros

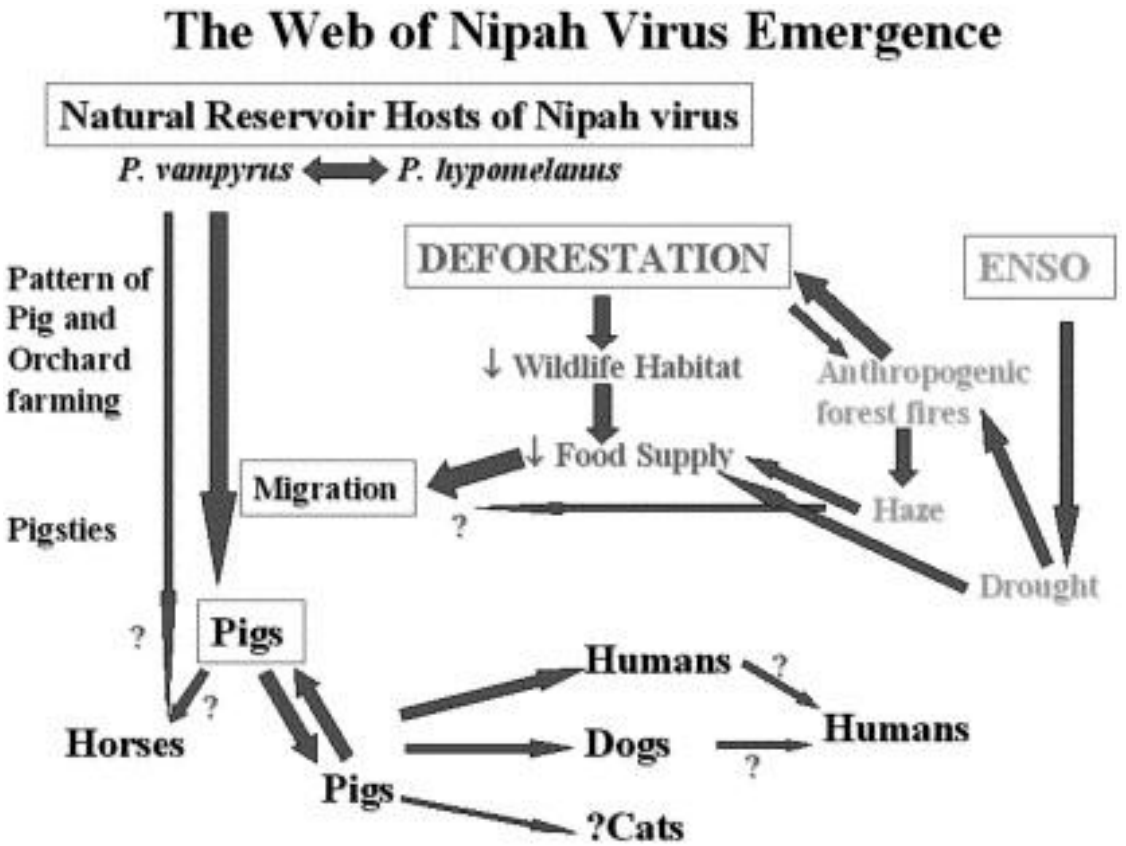
2010 : Senegal river basin =>Northern Mauritania ?

Next ?

Chevalier et al, Eurosurveillance 2010

Nipah virus emergence factors





European Commission

Thank you for your attention!