Ecological risk mapping of canine leishmaniasis in France

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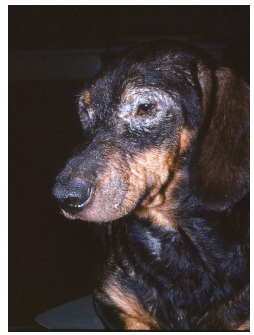
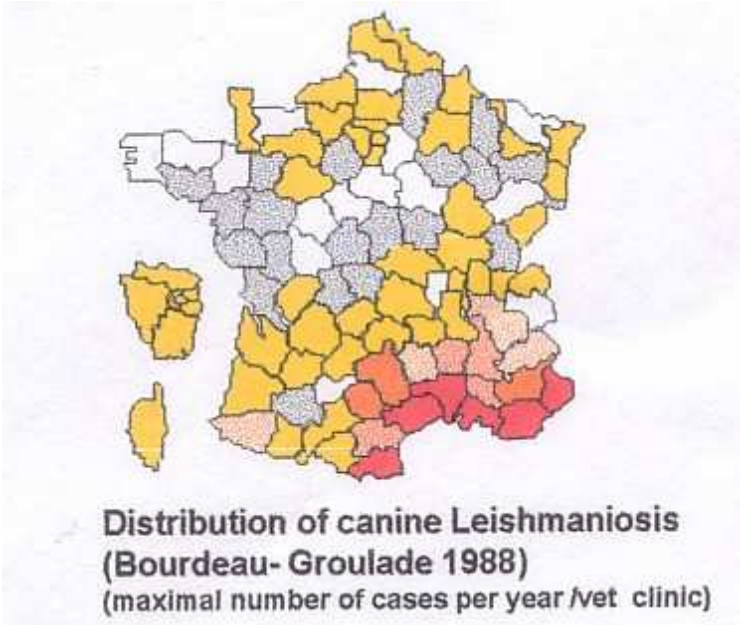
Canine leishmaniasis in southern France

- *Leishmania infantum :* a Trypanosomatid Protozoan
- Phlebotomine sandflies
- Mammalian host
  - Human (zoonotic visceral leishmaniasis)
  - Dog



- Endemic in Southern France
  - *Phlebotomus perniciosus*
  - *Phlebotomus ariasi*
- Increase of CanL prevalence over the last decade
- Influence of environmental factors?

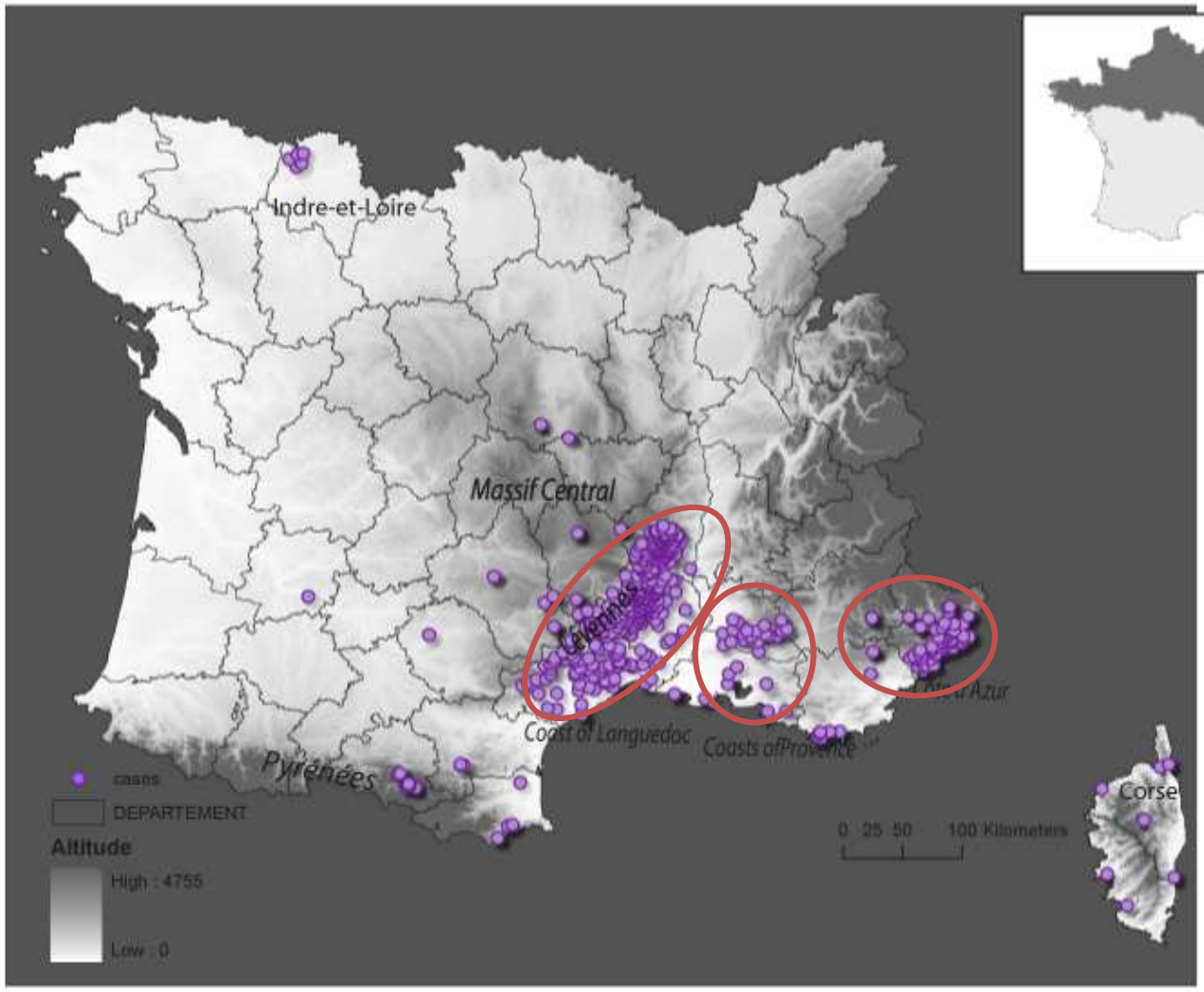


Retrospective canine leishmaniasis database

- Confirmed autochthonous cases
- Between 1965 and 2007
- Data entered :
  - Source of information
  - Type of survey or case reporting
  - Method of diagnosis
  - Information about dog
  - Location

- **Objectives:**
  - Map the reported cases in France
  - Produce an environment-based map of the areas at risk for CanL.

Results (1): Map of presence of CanL in France



- 718 entries
- 45 publications
- 425 locations

➡ **Spatial heterogeneity**

Foothills of the Cévennes mountains

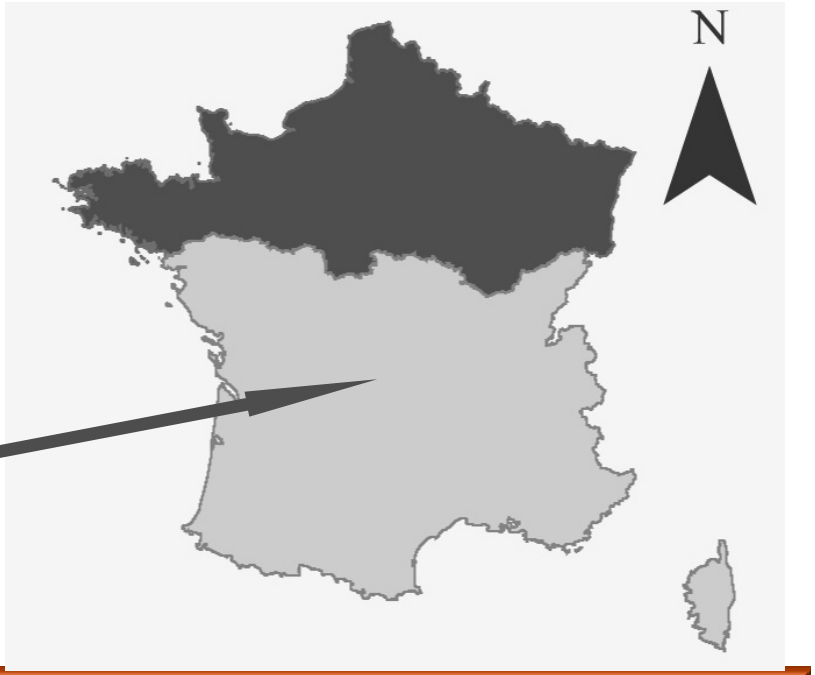
SW foothills of the Maritime Alps

Hilly Côte d'Azur

Environmental variables

- Explanatory variables for CanL distribution:
  - Summer and winter precipitations
  - Summer and winter temperatures
  - Land use (type of forest)
  - Altitude levels
  - Human densities
  - Dog densities (source: EDEN)

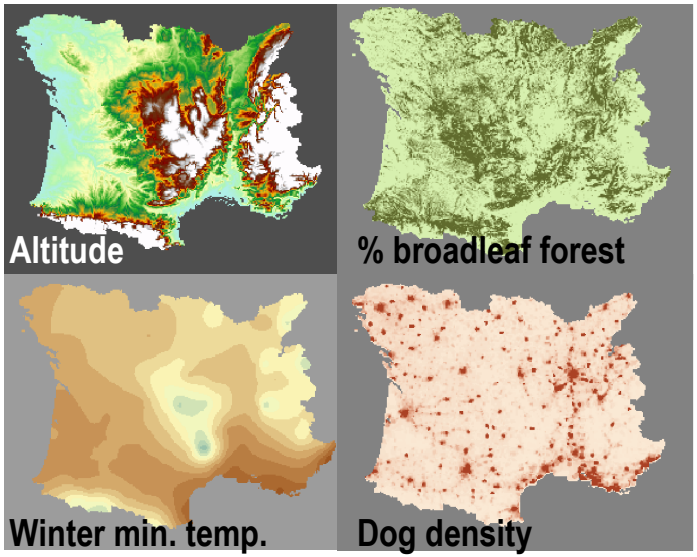
- All variables integrated in a GIS:
  - same projection (Lambert conformal conic projection)
  - same geographical area (mask)



Spatial analysis: description of the environmental characteristics of the CanL locations

- Spatial units: regular grid with 5 x 5 km cells

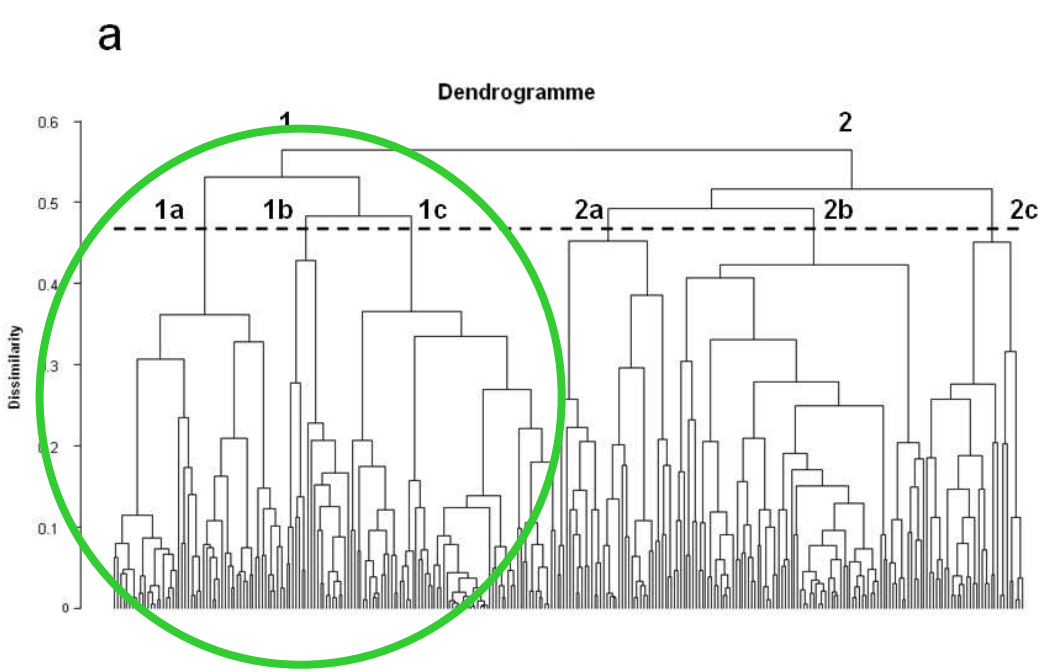
- Principal Component Analysis (13)
  - Altitude
  - Temperatures (3)
  - Rainfall (3)
  - Forests (4)
  - Humans and dogs densities

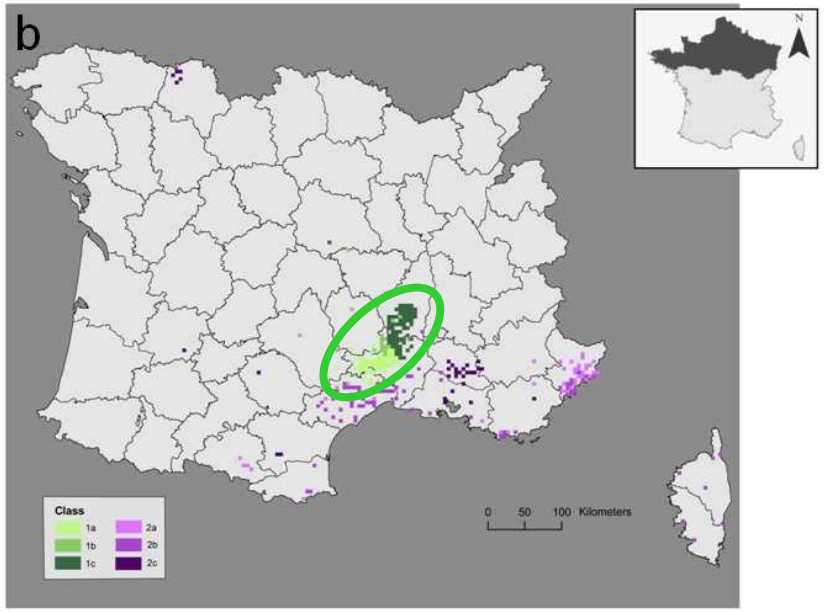


  - PCA Result : synthetic variables (PC) = Linear combination of the initial variables

- Hierarchical Ascendant classification :
  - Performed on the PCs
  - Grouping the cells with similar environmental characteristics
  - Obtaining the most homogeneous and the most distinctive classes

Results (2): Classification

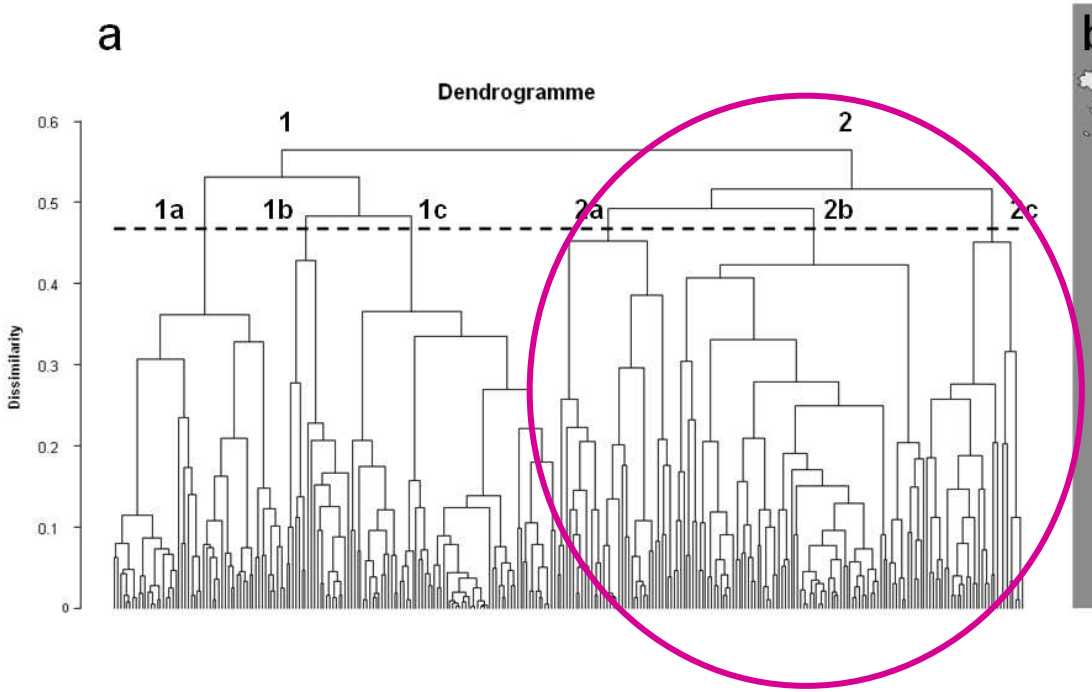


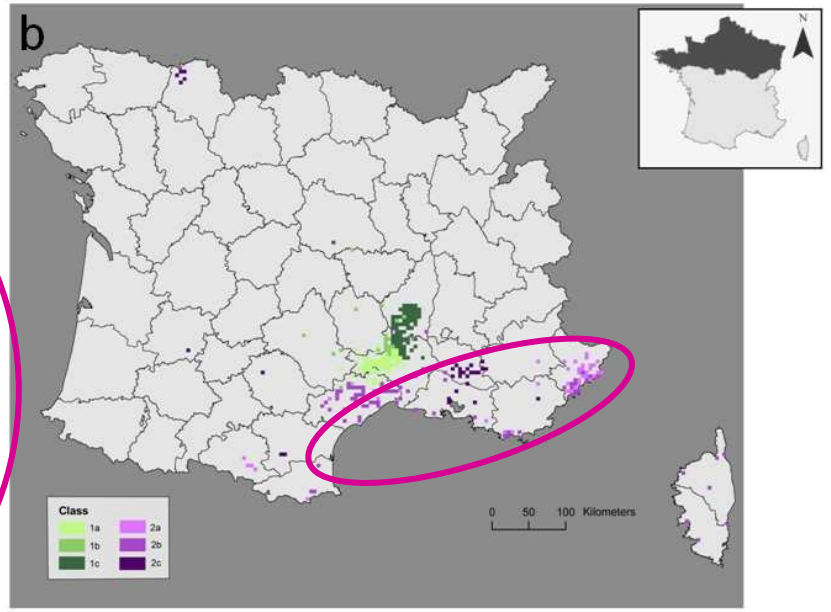


- Class 1
  - Positively associated with PC 1
  - Locations 200 – 1000 m altitude
  - Coldest winter temperatures and Highest precipitation
  - Important % broadleaf forest

Class 1 ~ *P. ariasi*

Results (2): Classification





Profile 2 ~ *P. perniciosus*

- Class 2
  - Close to mainland coast and Corsica
  - Warmer summers (average 26.1° C) and winters (average 3.4° C)
  - less precipitation (average 860 mm)

Ecological niche modelling: Mapping the areas more suitable for the presence of CanL

For each group identified by the HAC:

- Univariate screening analysis
- Ecological niche modelling
  - Maxent model (a general-purpose machine learning method)
  - Maximal entropy principle
  - The model estimates the probability distribution respecting a set of constraints based on the values of the environmental variables

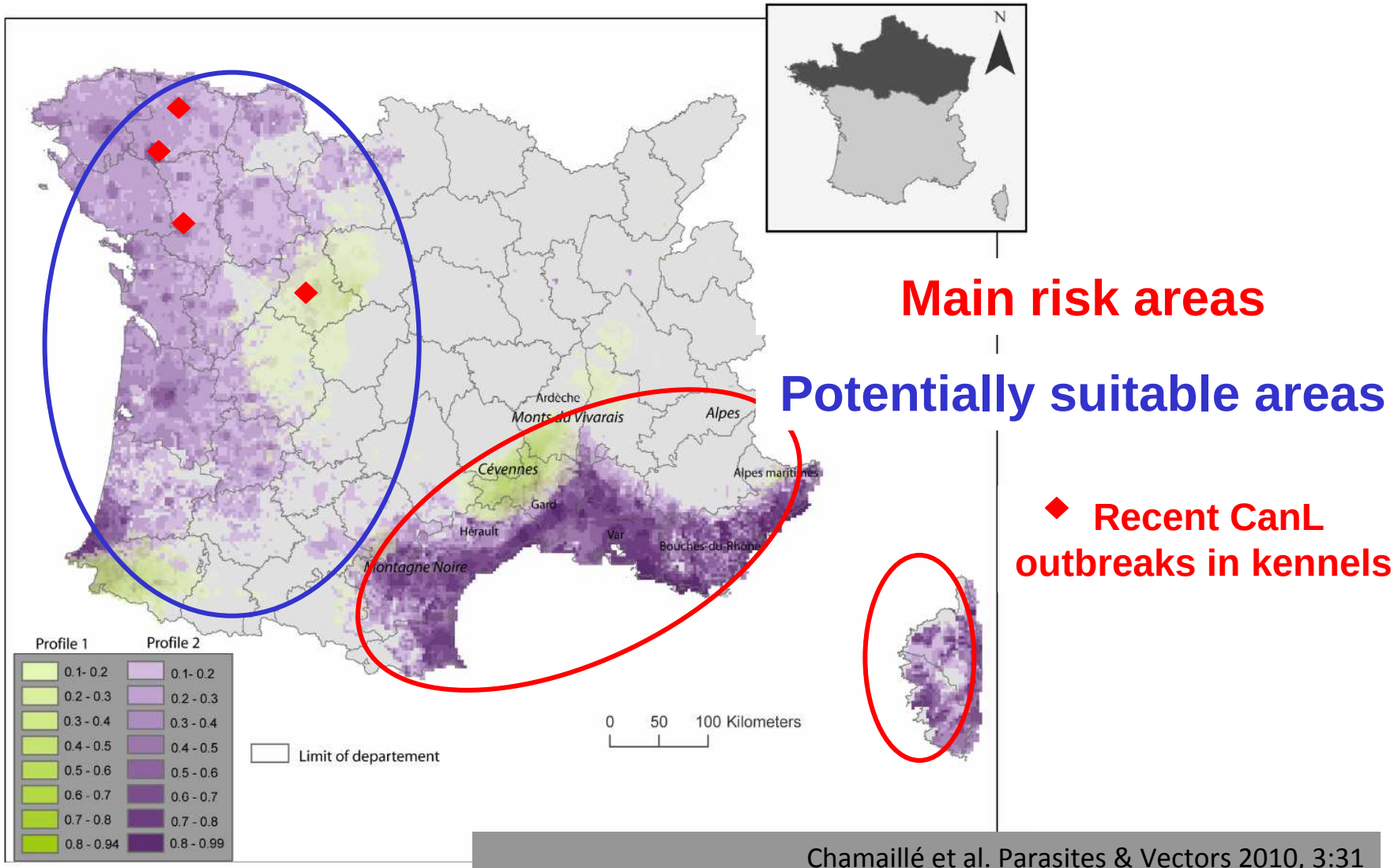
The entropy of a probability distribution π is defined as

$$H(\hat{\pi}) = -\sum_{x \in X} \hat{\pi}(x) \ln \hat{\pi}(x)$$

X: finite set of pixels

Phillips et al. Ecological Modelling 2006, 190:231-259

Results (4): Risk map of CanL in Southern France



Chamaillé et al. Parasites & Vectors 2010, 3:31

Discussion and perspectives

- First retrospective study of CanL in France
- Some biases could not be avoided
  - Presence only
  - Sampling effort
  - Location
- Two classes probably reflecting the niches of the two vectors
  - Entomological surveys are needed!
- Environmental risk map:
  - *Formulating hypotheses about CanL*
  - *Tool for surveillance / studies*

Thank you for your attention!

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