INRA
SCIENCE & IMPACT

France’s experience in tackling transboundary plant pests

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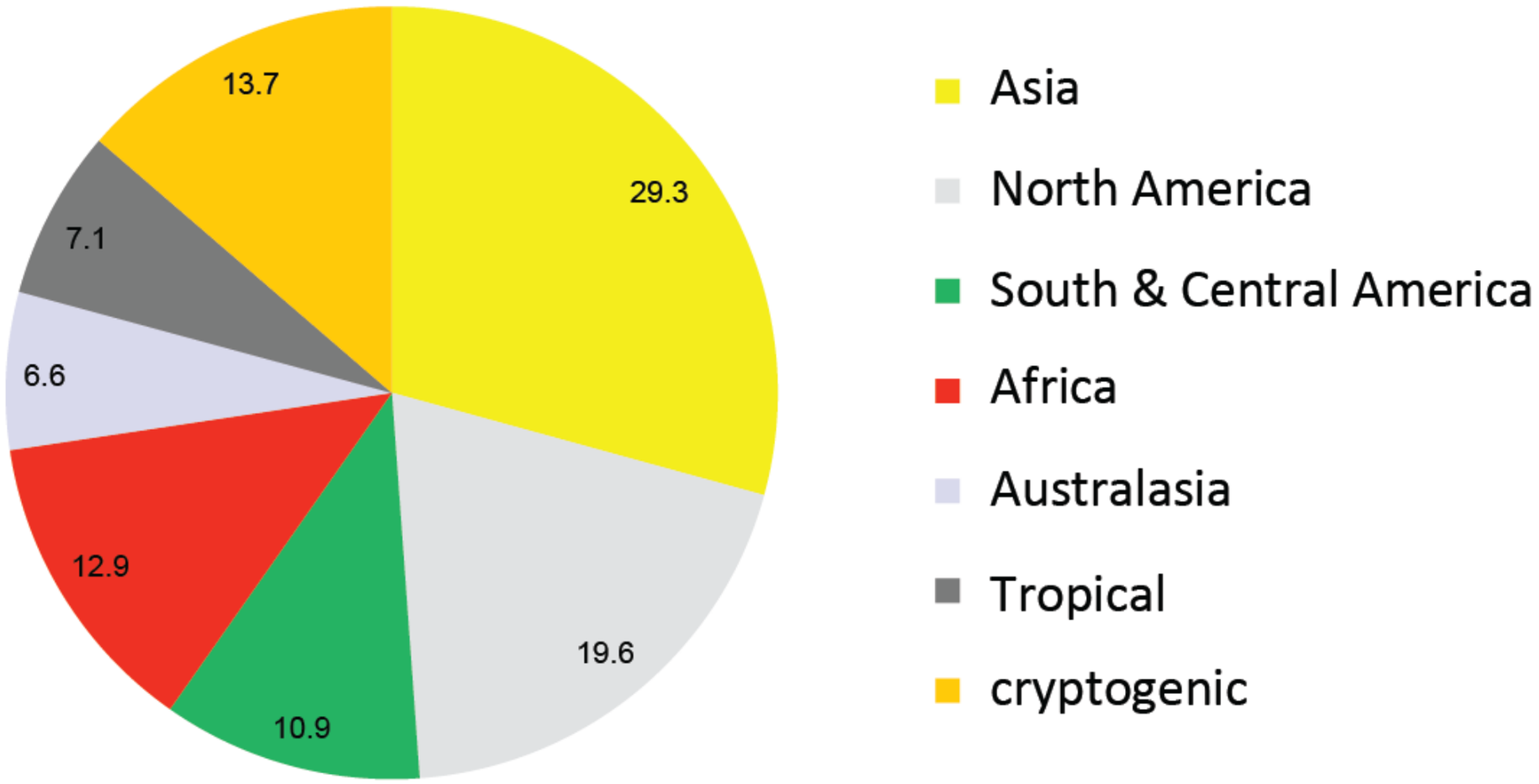
France’s experience in tackling transboundary plant pests

context

biological invasions have been much more frequent in recent years

number of insect species introduced in France per year, with agronomical consequences

origin of arthropods that are invasive in Europe



Roque et al. 2009

organization for plant protection

regional context

- EPPO : regional organization

- protocols for identification of pests
- identification of emerging threats
- recommendations and guidelines

- EFSA : European agency for food safety

- risk analysis
- categorization of pests
- methodology for risk assessment

national context

- ministry of agriculture :

- public policy
- regulations
- risks and crisis management

- Anses : agency for food safety

- Inra : research and expertise

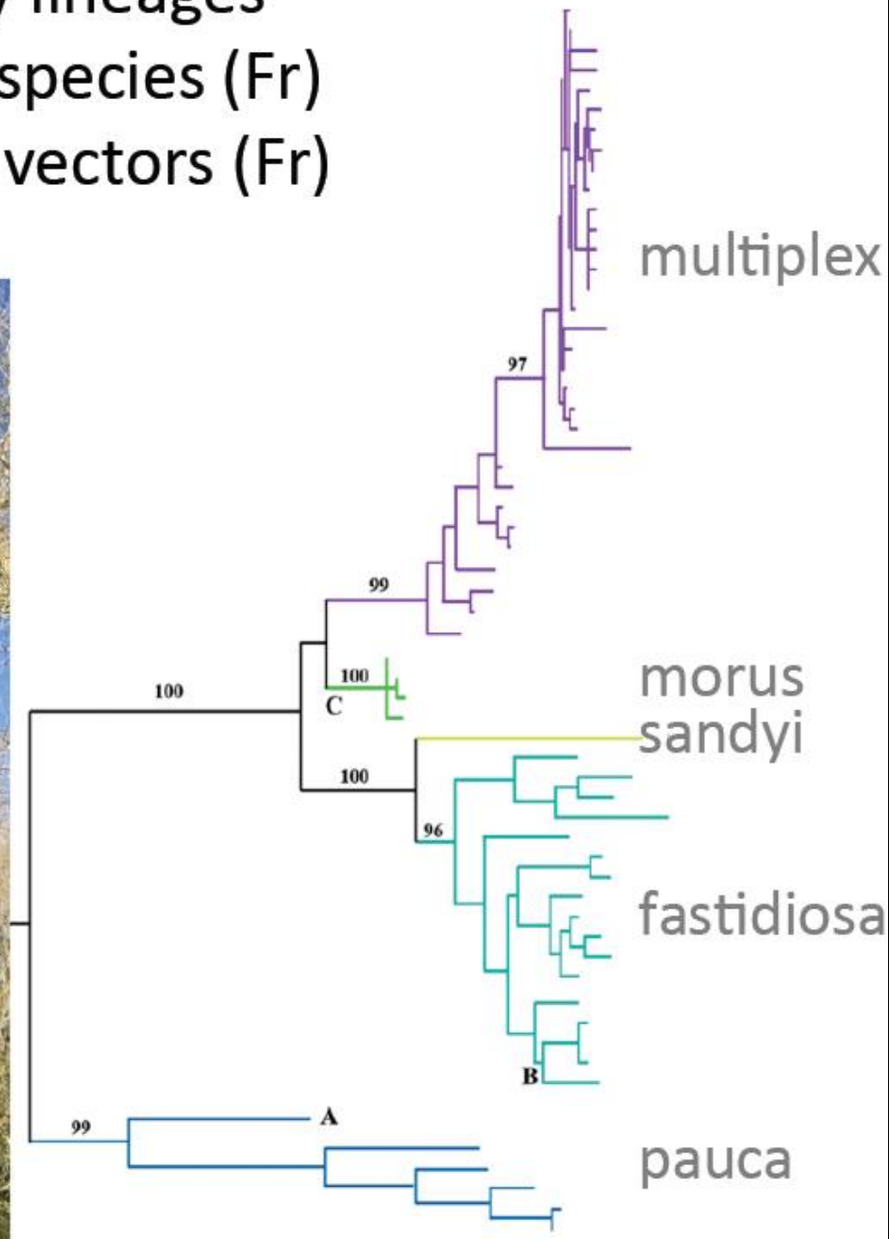
France’s experience in tackling transboundary plant pests

a return on experience

Xylella fastidiosa

a complex biological system

- 5 sub-species ; many lineages
- >200 potential host species (Fr)
- >50 potential insect vectors (Fr)



Almeida & Nunney 2015

response to the sanitary crisis

first detection in France (Corsica) : July 2015

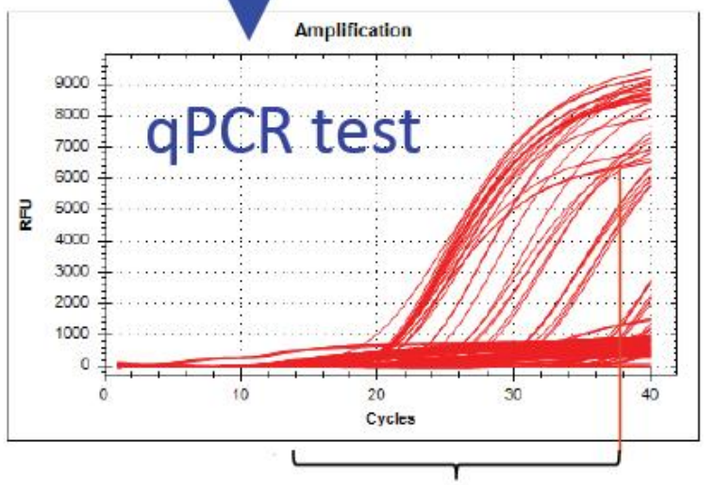
→ activation of eradication procedures (UE guidelines)

→ surveillance, sampling, identification (EPPO guidelines)

→ setting up of a research task-force for short-term response (18 months)

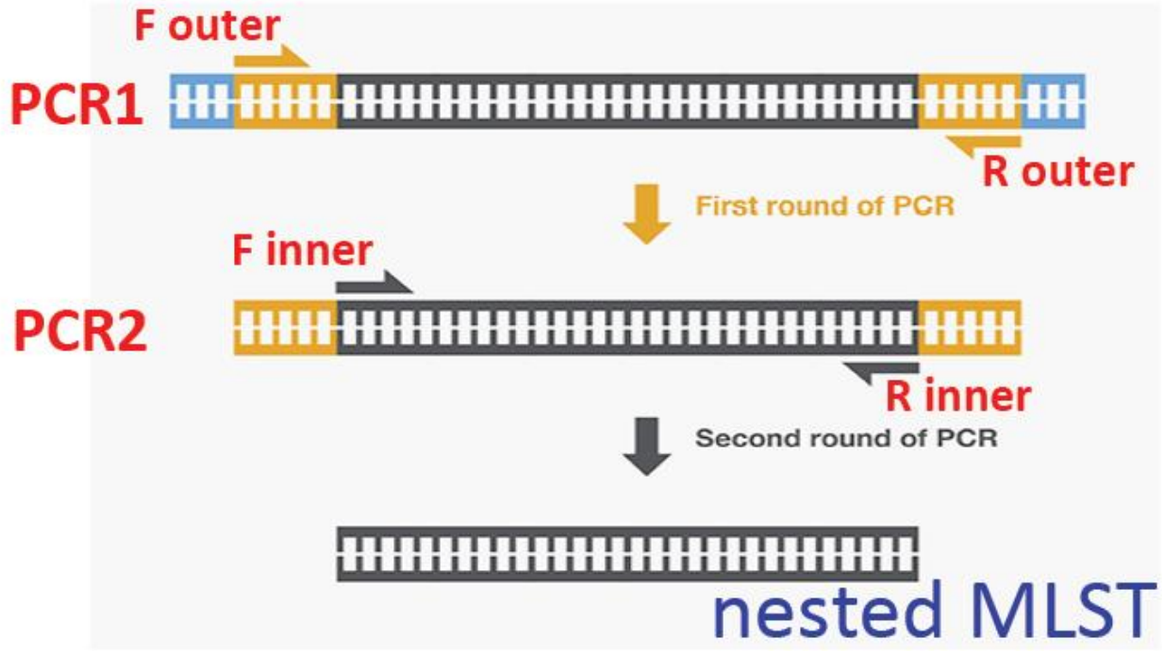
improved tools for direct typing of *Xf* from plant material

extraction



negative

positive



subspecies identification

following EPPO standards for test development
proposition of new tests and procedures to EPPO (PM 7/24, May 2018)

determination of *Xf* host range for strains present in France

Indicator species (Cv.) used as positive controls

Plants of interest for the Loire Valley


M. domestica (2 cv)


P. communis (2 cv)


Vitis vinifera (3 cv)

for the Mediterranean area


O. europaea (3 cv)


V. vinifera (3 cv)


C. clementina (2 cv)


C. x paradisi (1 cv)

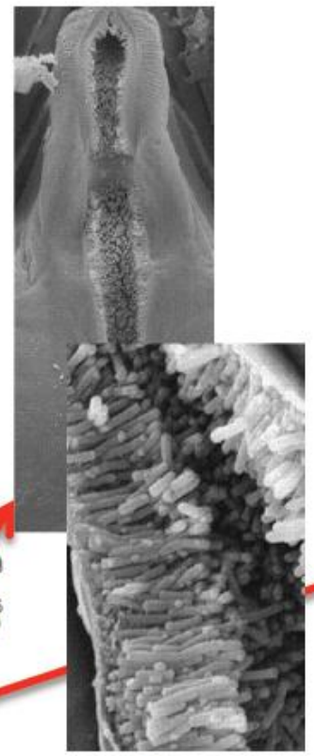
pathogenicity/susceptibility tests

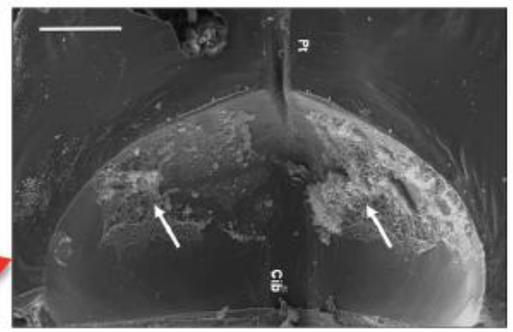
partnership with producers, associations, botanical conservatory

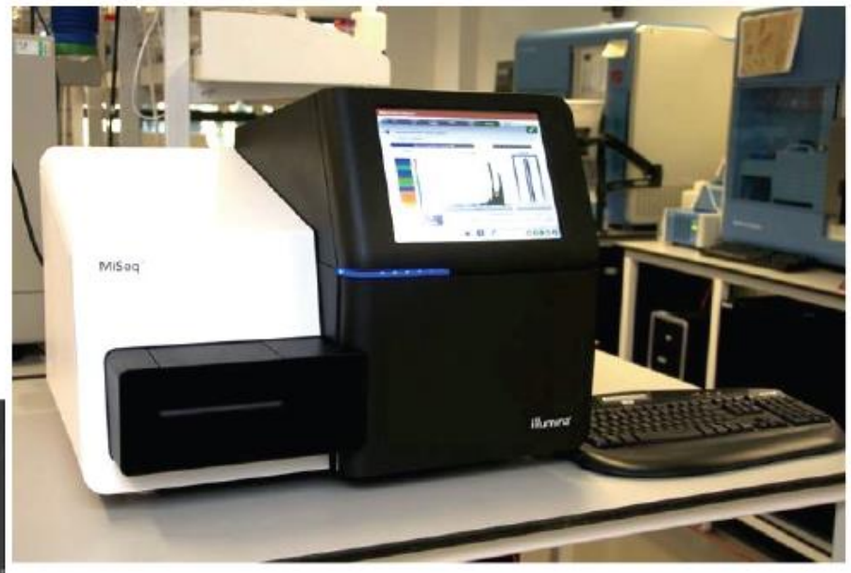
- S3 chambers
- 8 - 18 months

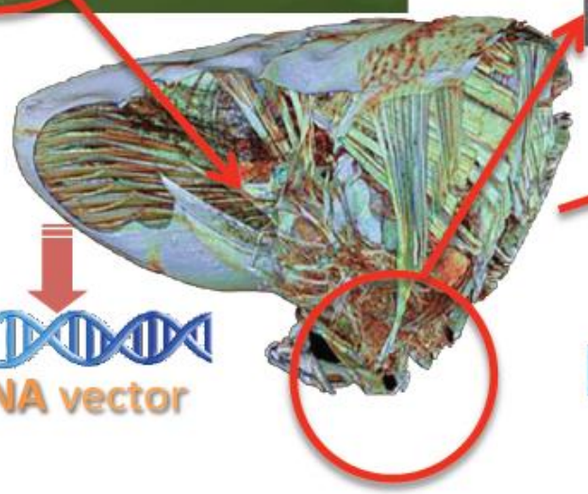
new detection tools for insect vectors

high performance molecular tools for identification of vectors + Xf strains + ... plants they fed on









DNA vector

DNA *Xylella*

DNA ingested sap

→ screening hundreds of vectors without dissection for presence of Xf (10 €/unit)
→ preliminary identification of strains carried (25€/unit for 7 loci)
→ will be used on sample insect bulks to quickly assess the local presence of Xf strains

building reference databases for identification

DNA sequences of vectors and host plants

European vectors

40 species
BLAST tool

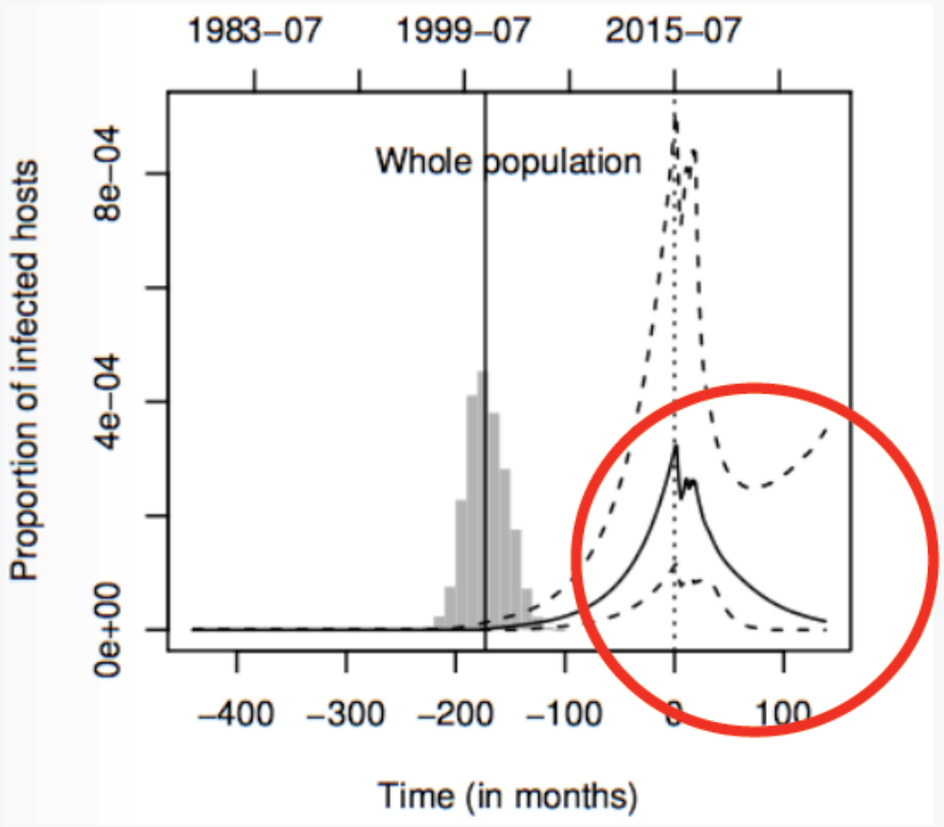
Corsican plant database

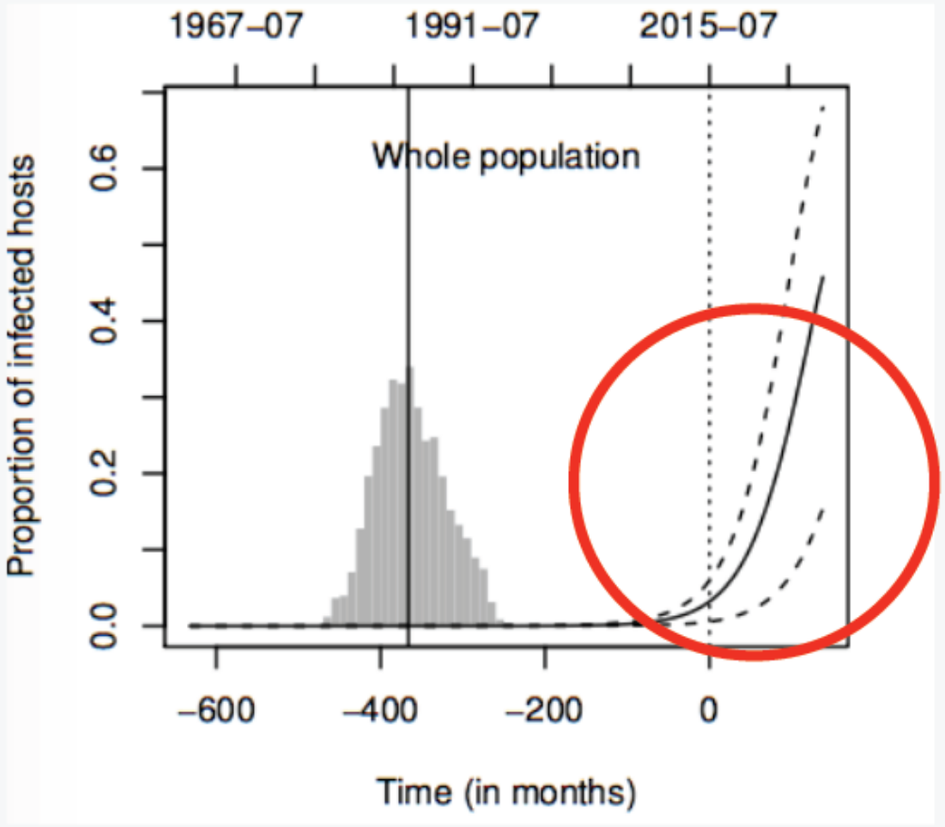
collaborative local network (sampling)

- olive producers (AFIDOL)
- National Botanical Conservatory Corsica

adaptation of standard epidemic models

- postulation of introduction date in 80's (modeling + phylogeny)
- postulation of hidden reservoir of disease in Corsica





results : short-term response (18 months)

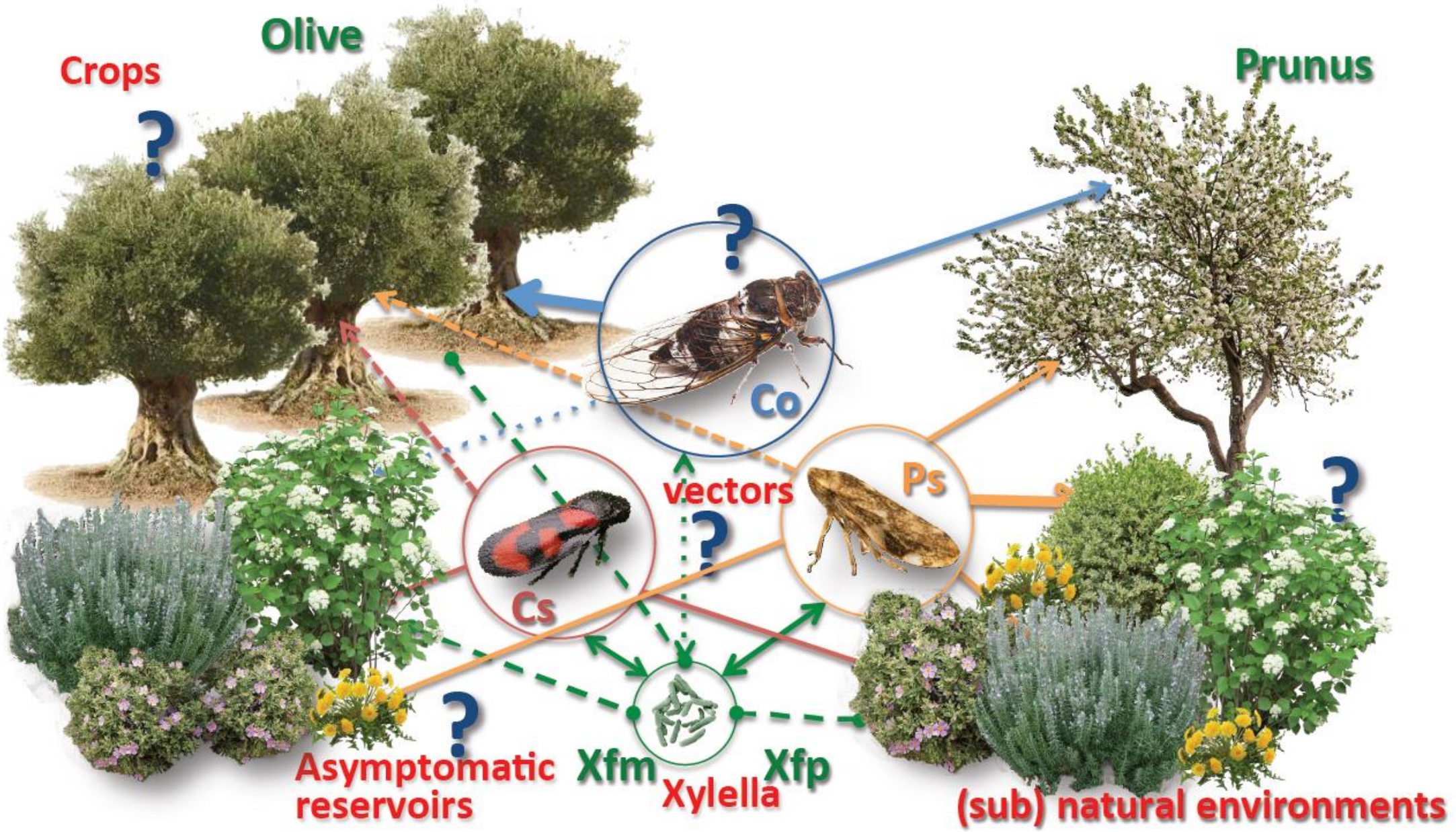
- improved tools for detection : bacteria in plants
  bacteria in insects

→ transfer to state agency (Anses) and EPPO

- postulation of introduction date (phylogeny + modeling)
- postulation of hidden reservoir of disease in Corsica

→ from eradication to containment strategy
→ first recommendations for prophylaxis

long term : deciphering ecological network



network of interaction between plants, vectors and bacteria using high-throughput molecular tools → developing **prophylactic strategies** for disease management

general context

- available data
- basic knowledge
- *ex-ante* risk analysis

EPPO / EFSA
general guidelines

introduction

sanitary
crisis

local context

- local host plants
- local vectors
- local conditions
- strain introduced

specific ecology

need of

local
data

local
expertise

efficient tools
for detection

→ identification of competences
→ funding for short-term project

France’s experience in tackling transboundary plant pests

anticipating the next crisis

improving risk assessment

a case-study on the pinewood nematode, a vector-borne pathogen causing pine wilt disease

Bursaphelenchus xylophilus

present in Europe but not in France

introduction is feared ; surveillance is intense

a study by Marie Grosdidier, Marine Marjou & Lucie Michel (PF ESV)

improving risk assessment

from random sampling to risk-based approach :
targeting high-risk areas for improving the surveillance strategy

$W_i = R_{0i} * P_i$

W_i = estimated risk at site *i*
R_{0i} = expected epidemic severity at site *i*
P_i = introduction probability at site *I*

based on Parnell et al., 2014

estimating potential epidemic size

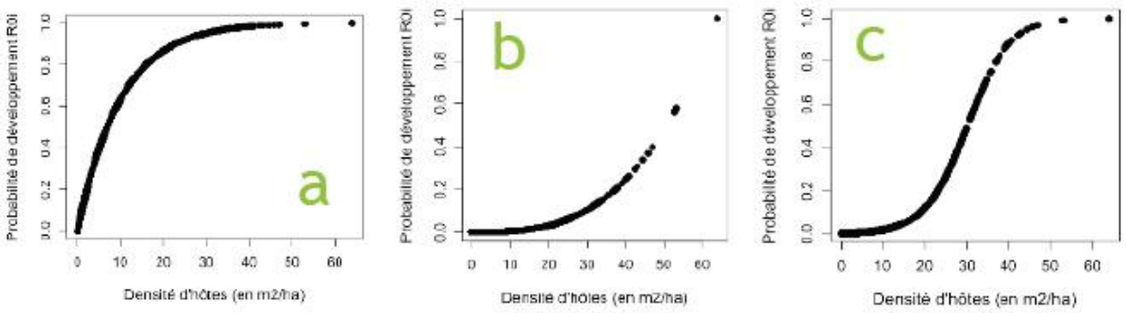
R_{0i} = expected epidemic severity in quadrat *i* , based on host density

3 models tested :

a) R_{0i} = 1-exp(a*host density)

b) R_{0i} = prob((host density)^3)

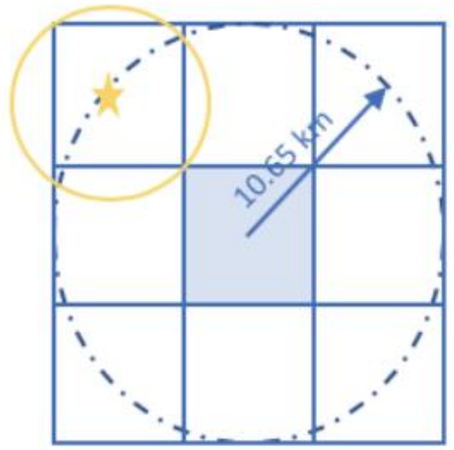
c) R_{0i} = 1/(1+exp(a*host density+b))



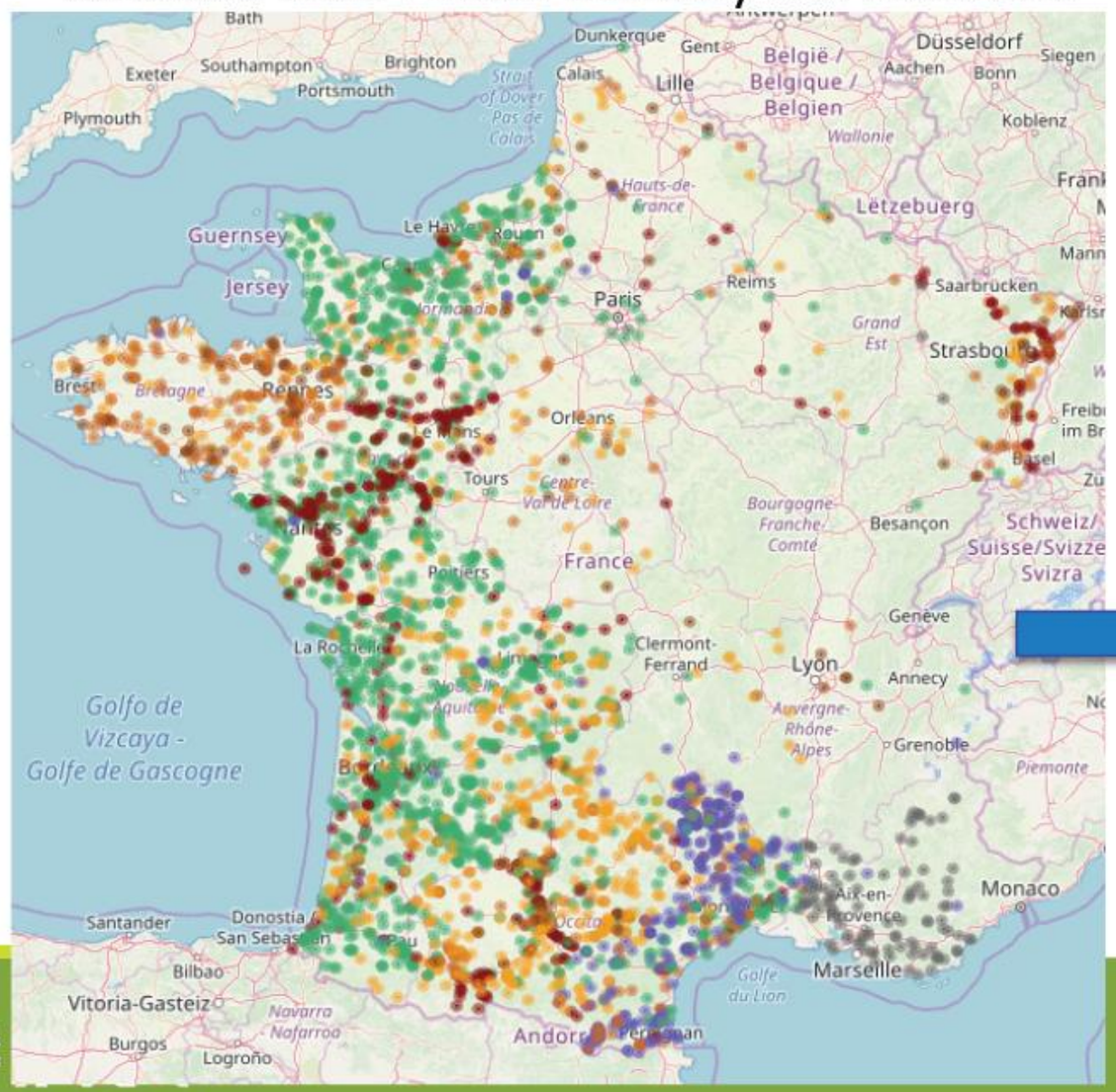
estimating introduction probability

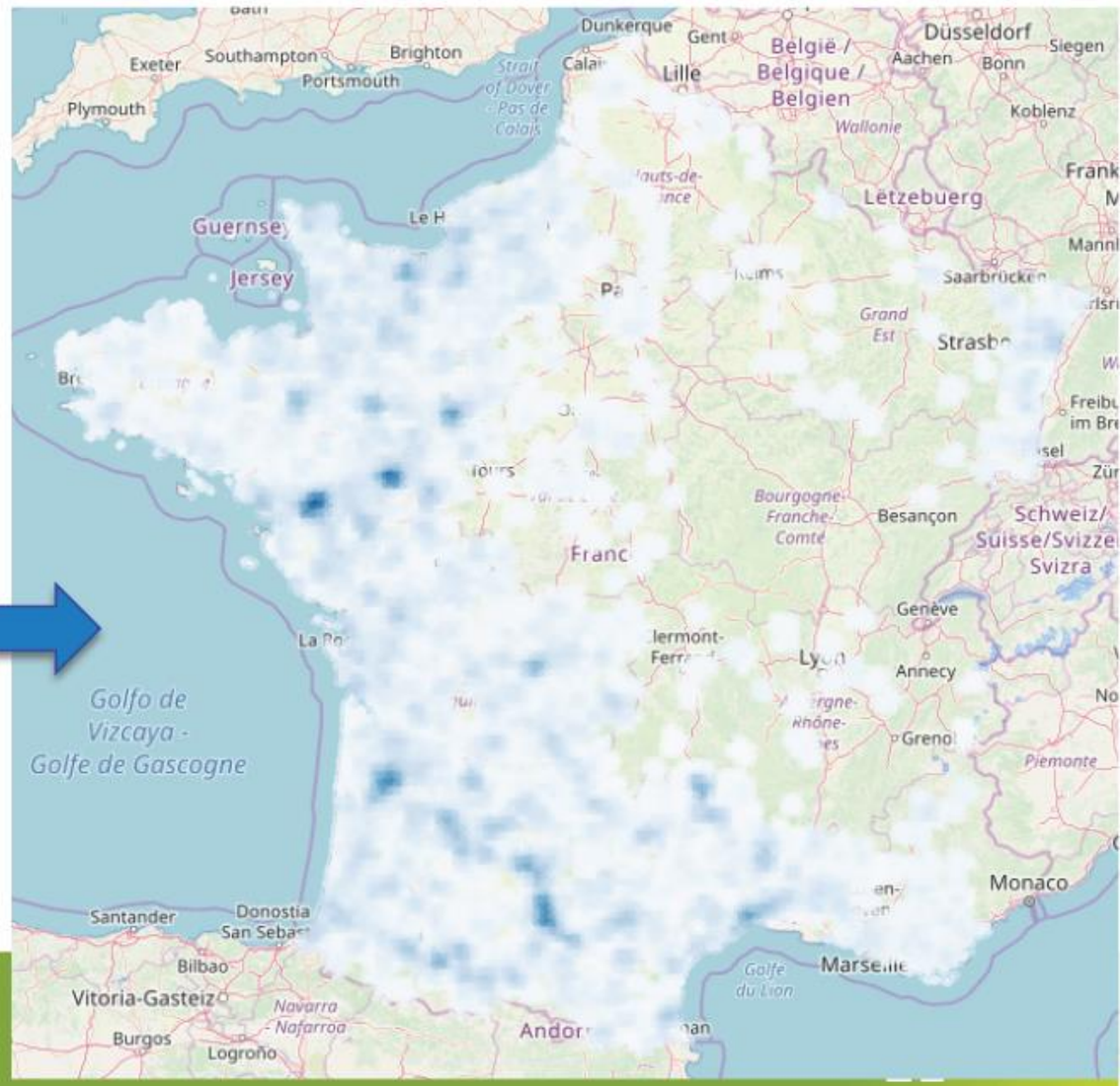
P_i = introduction probability at site *i* ,
based on the number of sensitive neighbor sites

$P_i = SS_i$ / max (SS), with SS = number (or weight) of sensitive sites



sensitive sites : wood industry and activities

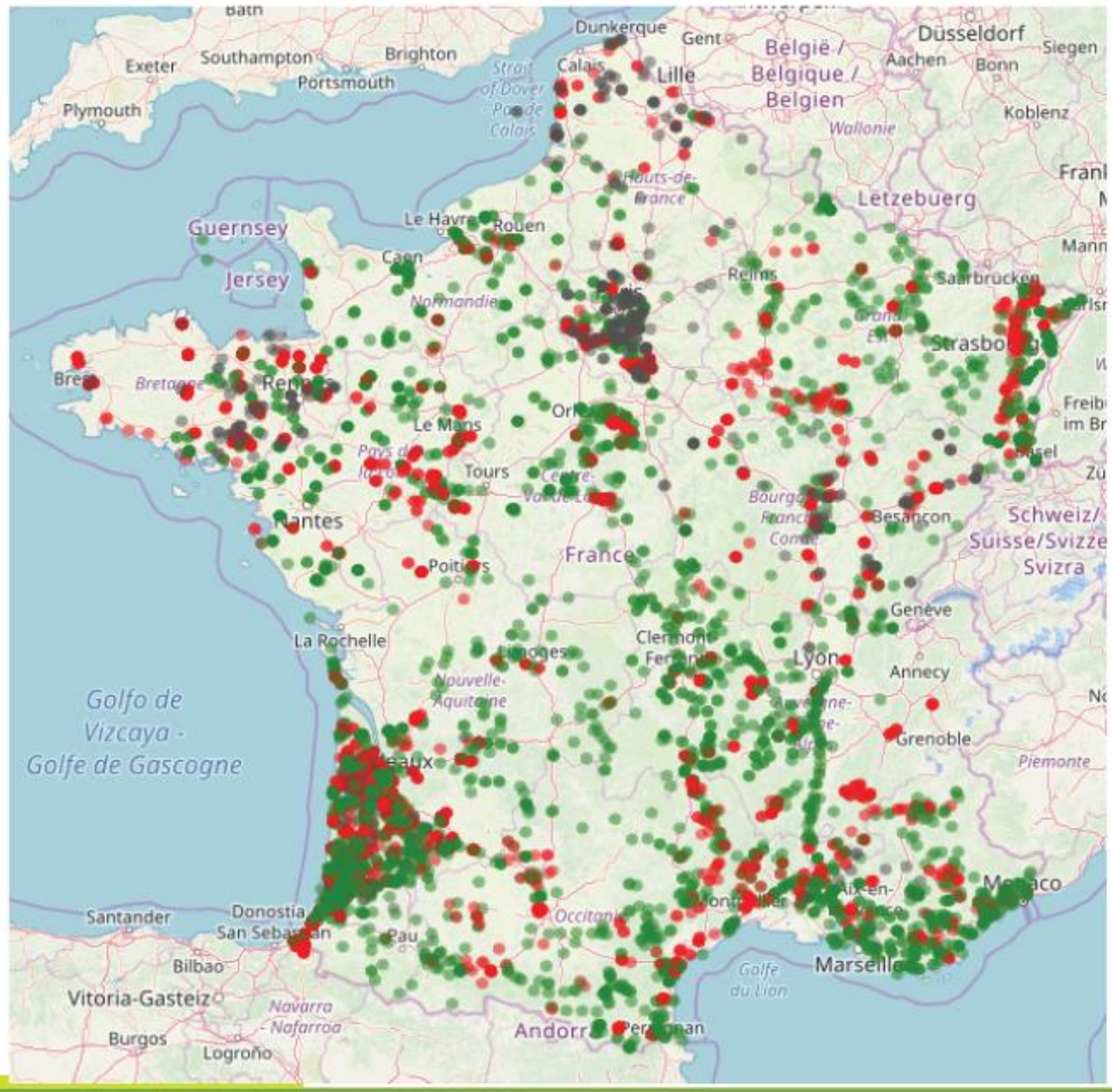




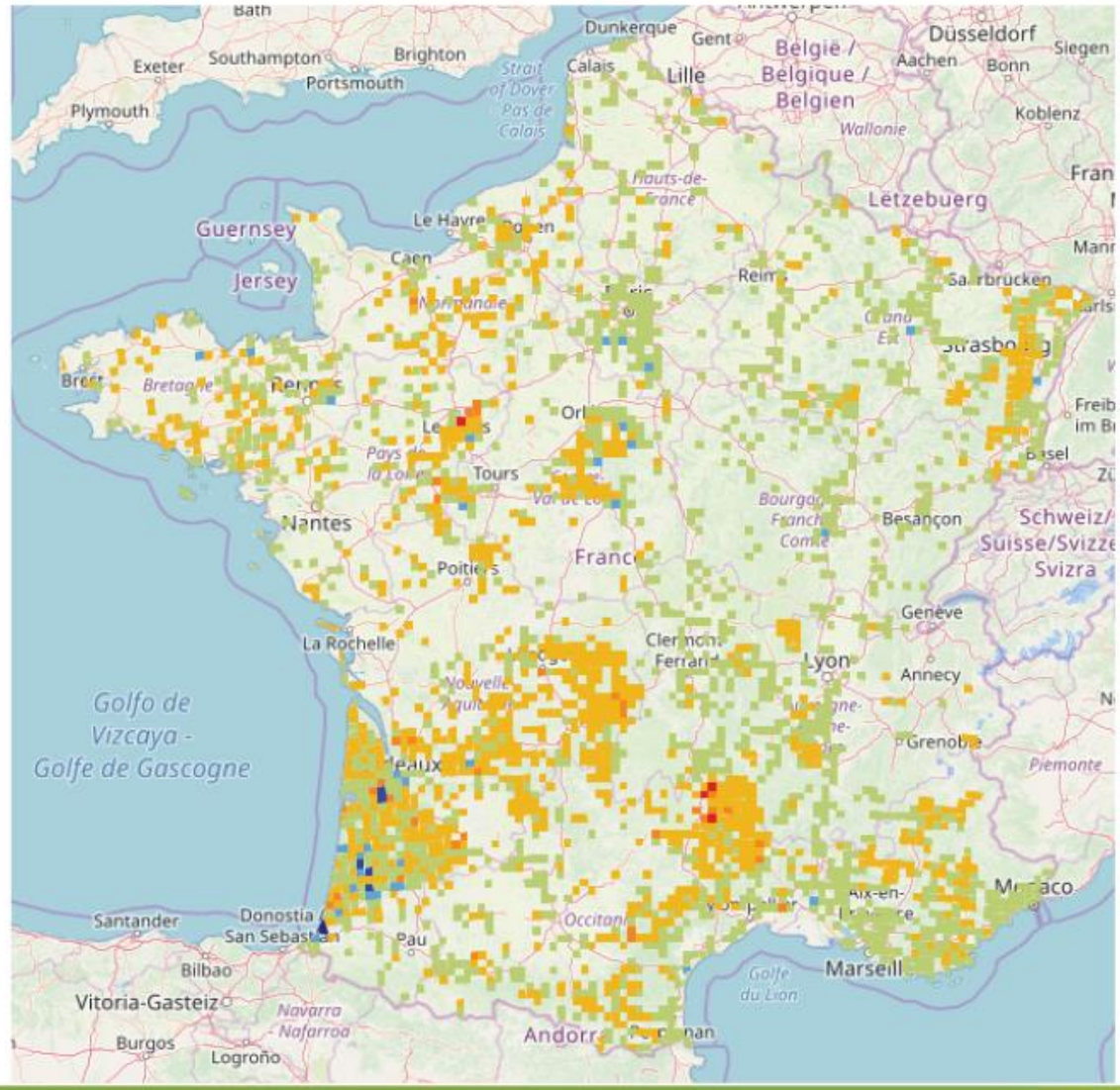
is sampling effort optimal with regards to risk ?

risk = expected epidemic size x introduction probability

Samplings : wood material + insect vector
2013-2018

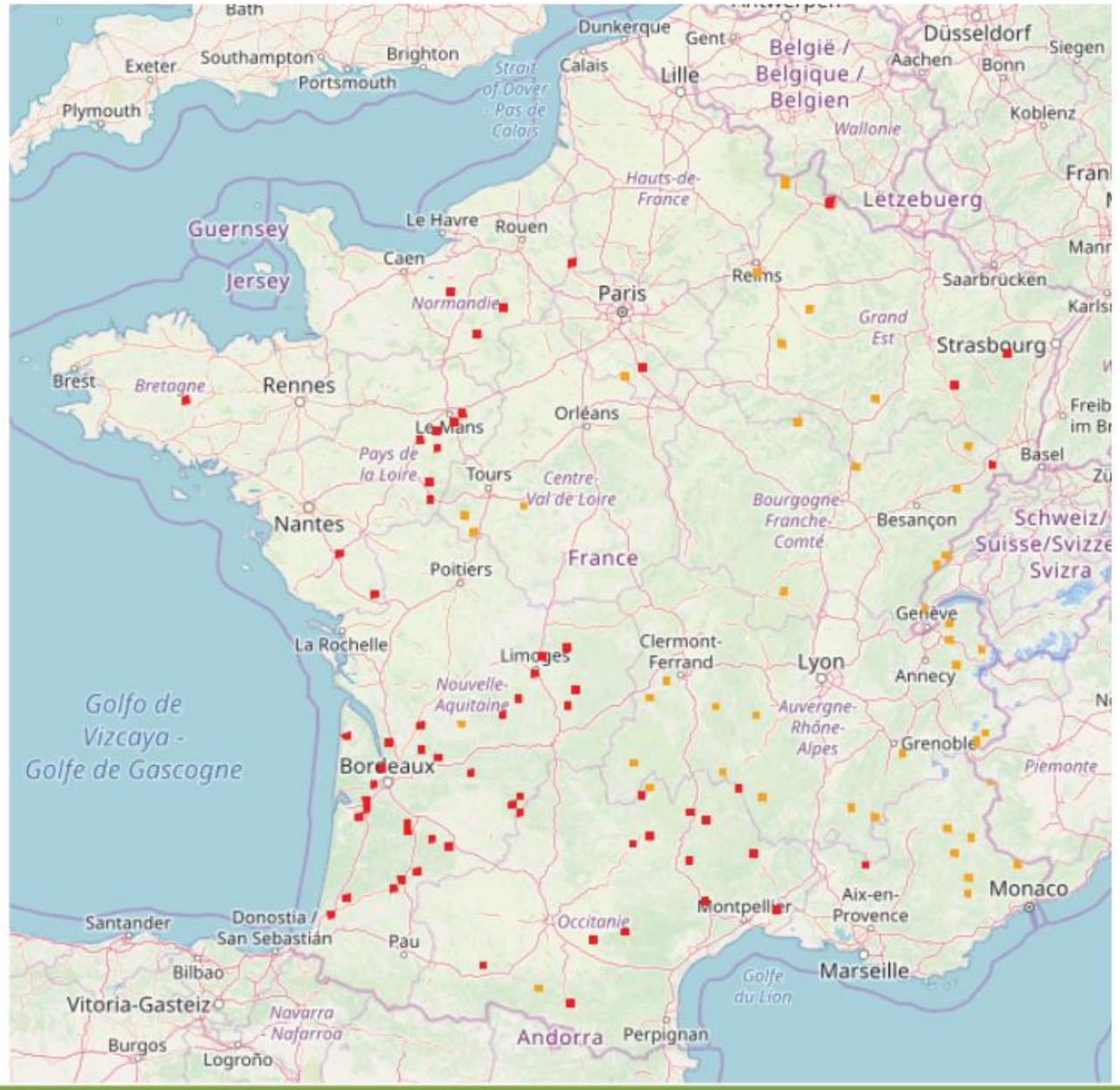


- red : insufficient sampling
- blue : excessive sampling



proposition of optimal sampling design

- targeting both sensitive and low-risk areas
- for 300 insect traps
- based on estimated risk



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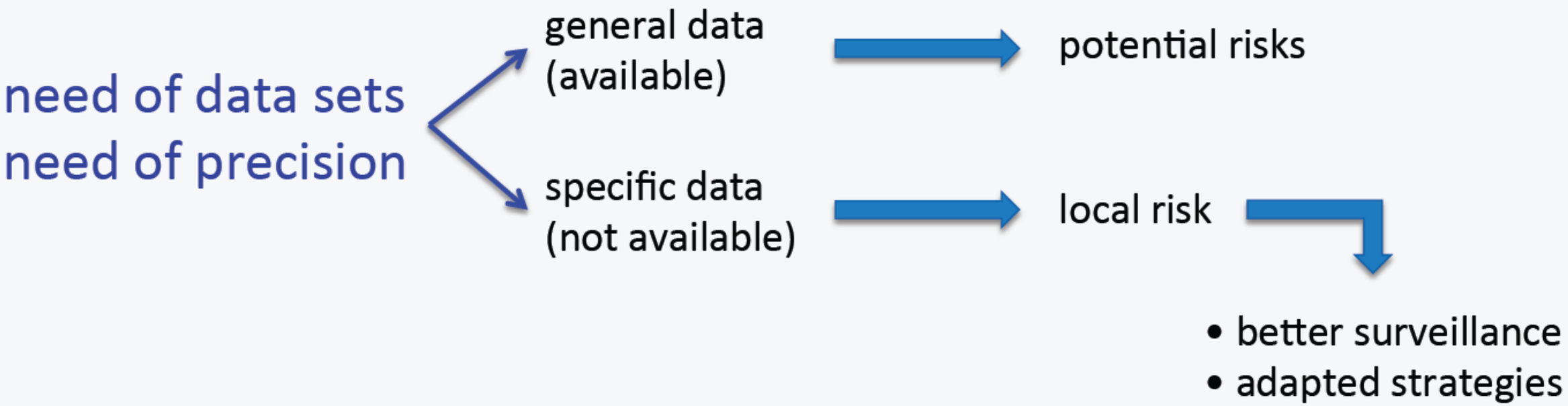
conclusions



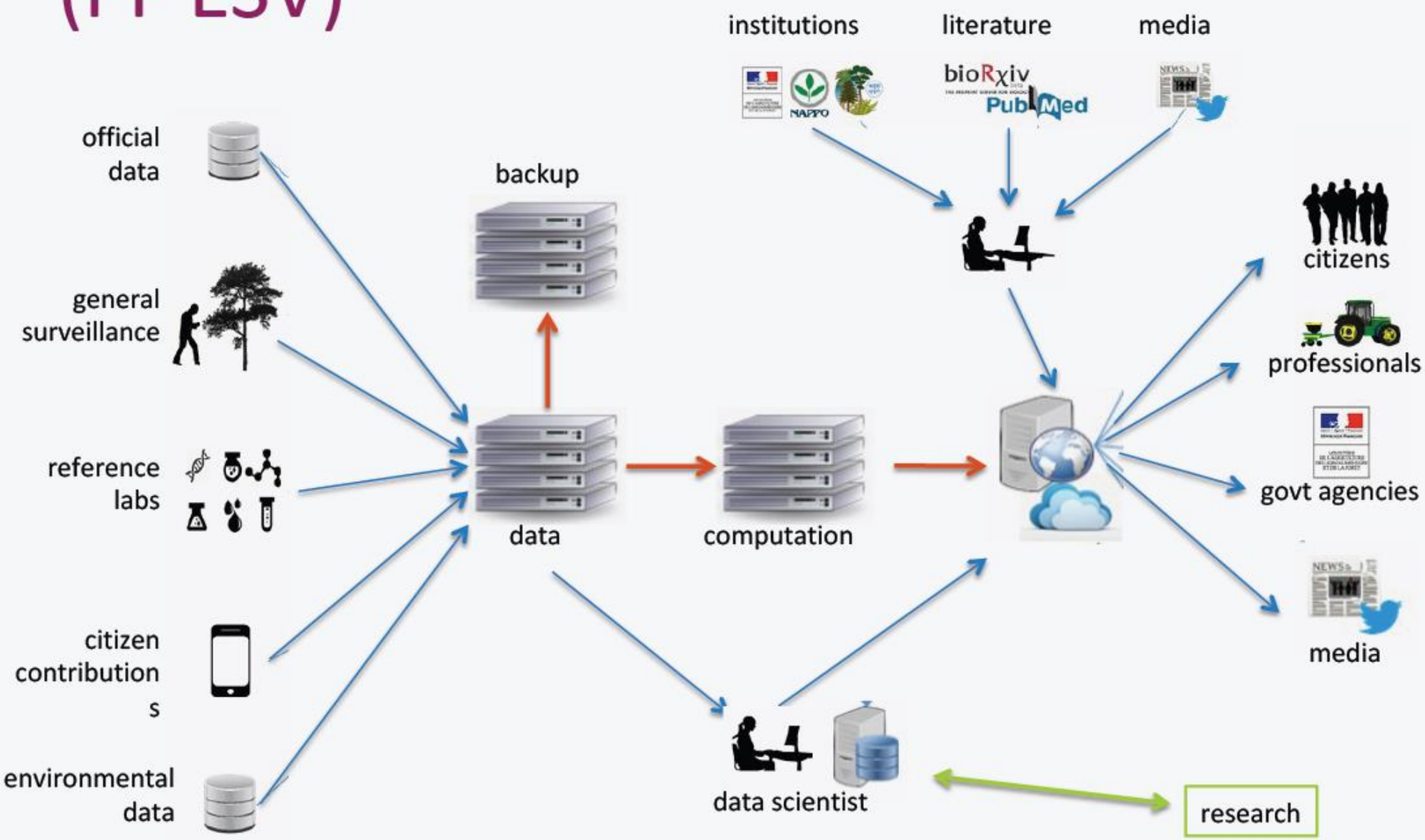
anticipation is crucial (eradication is difficult)

- identification of competences → task force
- fast data processing and analysis → risk analysis, containment strategies
- funding for short-term projects

long term : new tools can be used for research on prophylaxis, breeding, ecology, …

Plateform for Plant Health Surveillance (PF ESV)

Epidémiosurveillance Santé Végétale

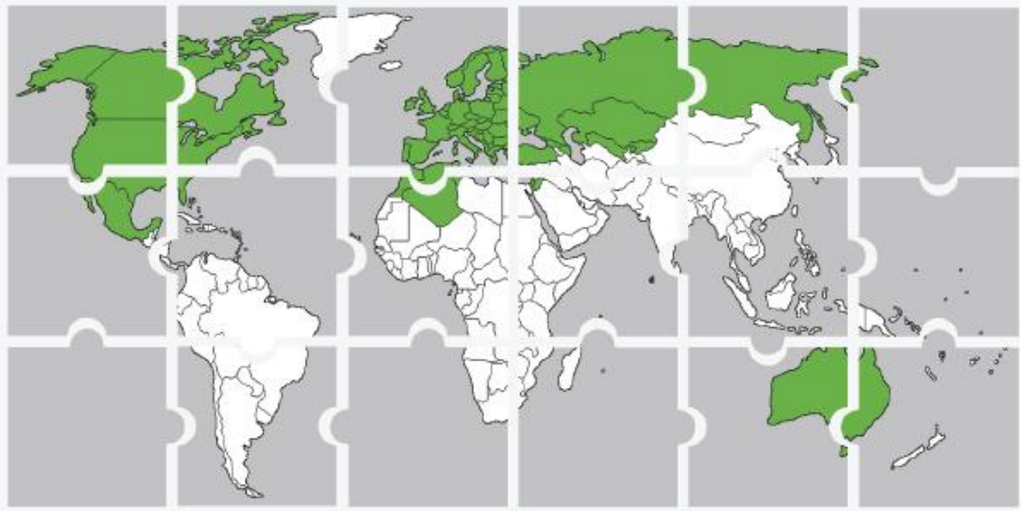


French cooperation at international level

efficient action against transboundary pests requires international cooperation

Euphresco : a network of organisations funding coordinated research projects

initiated as an EU funded ERA-NET in 2006
→ now 70 organizations (>50 countries)



bilateral cooperation

- **joint linkage calls** : e.g Inra - CSIRO call

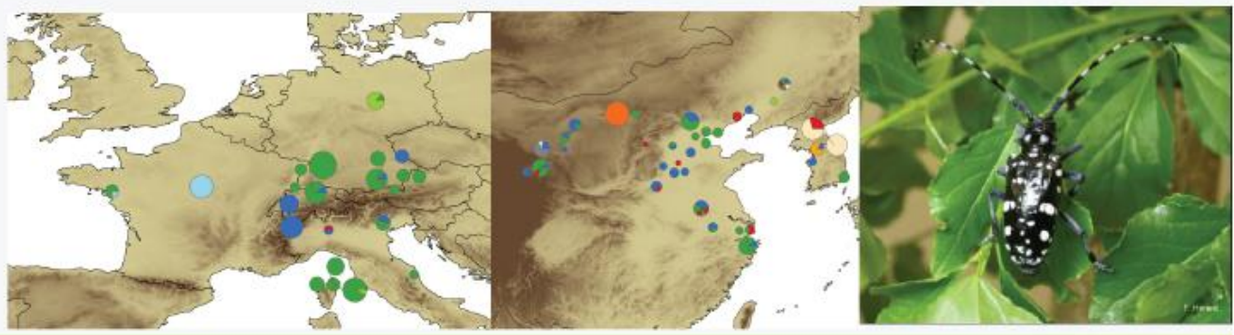
  → genomic tools for risk assessment of invasive fall armyworm *Spodoptera frugiperda*

- **joint labs** : e.g. Inra-BFU Joint laboratory on Invasive Forest Pests in Eurasia

RESEARCH ARTICLE

Planting Sentinel European Trees in Eastern Asia as a Novel Method to Identify Potential Insect Pest Invaders

Alain Roques[1]*, Jian-ting Fan[2], Béatrice Courtial[1], Yan-zhuo Zhang[3], Annie Yart[1], Marie-Anne Auger-Rozenberg[1], Olivier Denux[1], Marc Kenis[4], Richard Baker[5], Jiang-hua Sun[3]



thank you
for
your attention