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Two decades of epidemiological surveillance of the pine wood nematode in France

Nicolas Mariette, Hoël Hotte, Anne-Marie Chappé, Marie Grosdidier, Géraldine Anthoine, Corinne Sarniguet, Odile Colnard, Emmanuel Kersaudy, Marie-Thérèse Paris, Emmanuel Koen and Laurent Folcher

CONNAÎTRE, ÉVALUER, PROTÉGER

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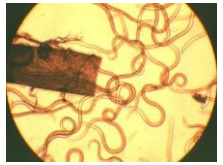
Bursaphelenchus xylophilus, the Pine Wood Nematode

Causal agent of Pine Wilt Disease (PWD)

Infection → Multiplication in the conductive vessels → Stop of the soap circulation → Wilt and death of the tree

PWN dissemination





Short distance: insect vector



Long distance: wood contaminated by infected vector

Native to North America and transported to other continents

- Became a pest in Asia (China, Korea), Europe (Portugal)

The Pine Wood Nematode, a pest under surveillance

Classified as Priority Quarantine Organism in E.U. (Council directive 2019/1702/EU 2019)

- Member States have to apply a monitoring on:

Wood-based commodities

Pine forest stands

PWN insect vector (*Monochamus spp*)

Monitoring of the PWN in France since 2000

- **1.** How the PWN monitoring is organized ?
- **2.** How many samples were collected and analysed during the 20 first years (2000-2019) ?
- **3.** Did this monitoring reveal the presence of the PWN ?

- **4.** Are the climatic conditions in France suitable for the wilt of pines in case of infection by PWN?

1. Organisation of PWN monitoring in France

Wood-based commodities

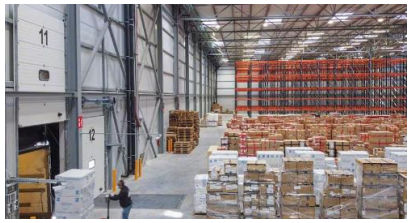
Pine forest stands

PWN insect vector

Sampling

Inspections on risk sites for introduction or spread of the nematode

Port



Logistic hub

Inspections in conifer stands and conifers located next to risk sites

→ Sampling on wilted trees

Traps placed in large and sensitive pine stands and next to risk sites

→insects collected every 10-15 days

Monochamus spp

Drill

Chips

Hole saw

Wood pieces

1. Organisation of PWN monitoring in France

Wood-based commodities

Pine forest stands

PWN insect vector

Sampling

Chips

Wood Pieces

Chips

Wood Pieces

Monochamus spp

Extraction

Oostenbrick dish method

Incubation for 14 days

Oostenbrick dish method

Grinding

Detection

Real-time PCR screening

Real-time PCR screening

Confirmation test

Identification

Morphology + conventional PCR

2. Number of analysed samples

Wood-based commodities

- 6,037 samples (2000 - 2019)

Pine forest stands

- 11,940 samples (2000 - 2019)

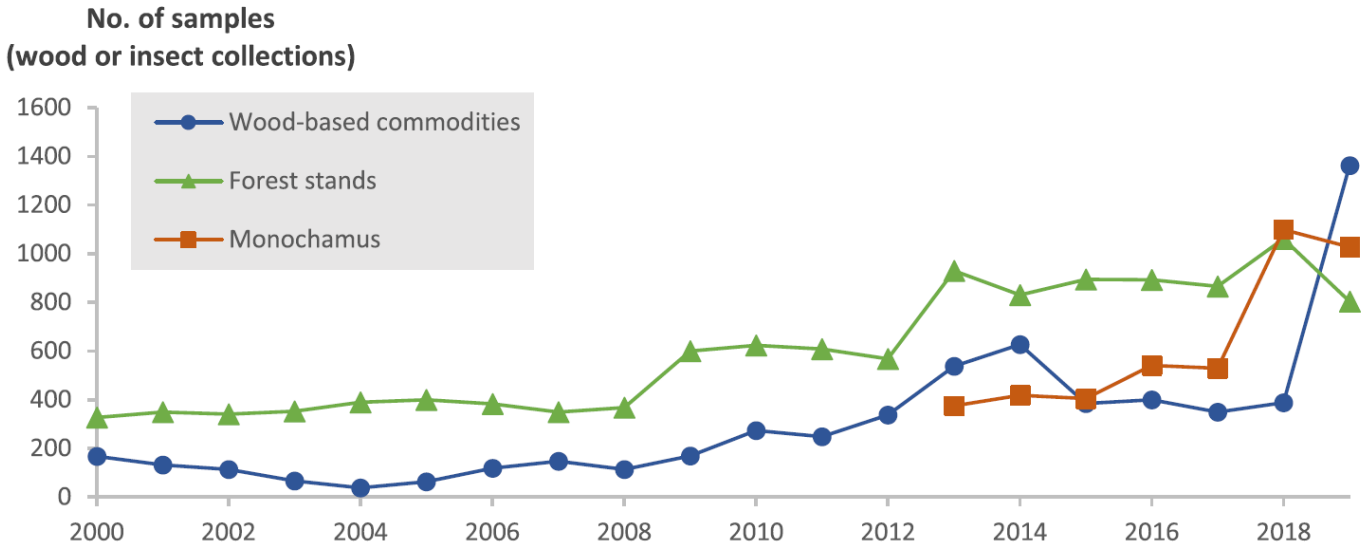
PWN insect vector

- 4,396 insect collections (2013 -2019)
  - 66,357 *Monochamus spp*

- **Reinforcement of monitoring over time**

Ex. for monitoring of forest stands:

  - 2000 – 2008: <400 samples per year
  - From 2013: > 800 samples per year



3. Detection of PWN in the samples ?

No PWN in the samples of the monitoring of

- Pine forest stands 
- *Monochamus* spp 

41 samples from monitoring of wood-based commodities contaminated by *B. xylophilus* 

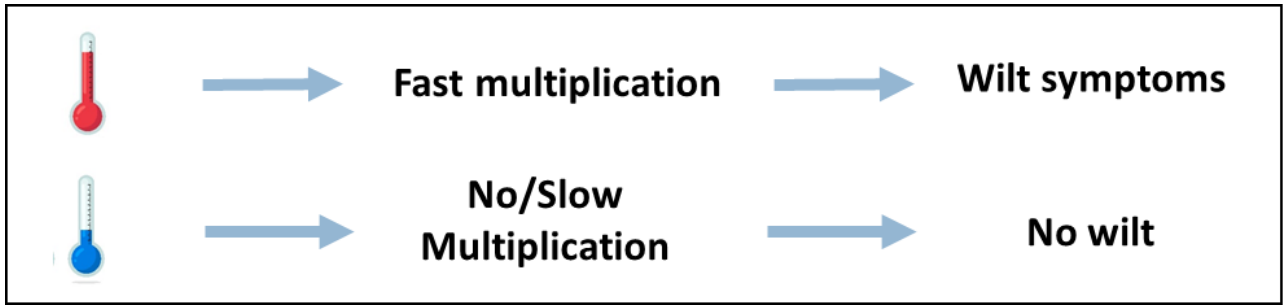
- Mainly pallets (n=35)
- 4 countries of origin (mainly Portugal, n=27)

Year	No. of samples	Type of product	Country of origin	Goods transported
2000	1	Dunnage	China	N/A
2001	1	Dunnage	Canada	N/A
2008	2	Pallet	China	Stone
2010	1	Pallet	Portugal	Stone
	4	Pallet	Portugal	N/A
	2	Pallet	Portugal	N/A
2012	1	Pallet	Canada	Wood materials
	3	Pallet	Morocco[1]	Food products
2013	1	Pallet	Morocco[1]	N/A
	1	Pallet	Portugal	N/A
2015	1	Pallet	Portugal	N/A
2018	2	Tree bark	Portugal	-
	2	Wooden crate	Portugal	Stone
	5	Pallet	No ISPM15	N/A
	1	Pallet	Portugal	Stone
	1	Pallet	Portugal	Auto parts
2019	1	Pallet	Portugal	Wood materials
	1	Pallet	Portugal	Auto parts
	1	Pallet	Portugal	Auto parts
	5	Pallet	Portugal	Auto parts
	1	Dunnage	China	Garden furniture
	1	Pallet	Portugal	N/A
	2	Pallet	Portugal	Auto parts

[1] Manufactured in Morocco

4. France: suitable climatic conditions for the Pine Wilt Disease?

Expression of Pine Wilt Disease highly dependent on the temperature



4. France: suitable climatic conditions for the Pine Wilt Disease?

Expression of Pine Wilt Disease highly dependent on the temperature

Prediction of PWD expression probability based on two meteorological parameters

(Gruffudd et al. 2016)

- mean summer temperature (MST)
- mean annual temperature (MAT)

Area with MST ≥ 19.14 °C: PWD symptoms expected
- ➢ with latency in wilt expression (>1 year) if MST < 23 °C and MAT < 14 °C

Area with MST < 19.14 °C: no PWD symptoms expected

Possible to distinguish three kinds of areas:

- Symptomatic areas: Expression of wilt expected quicly after the infection
- Latency areas: Expression of wilt expected after a latency (> 1 year)
- Asymptomatic areas: No expression of wilt expected

4. France: suitable climatic conditions for the Pine Wilt Disease?

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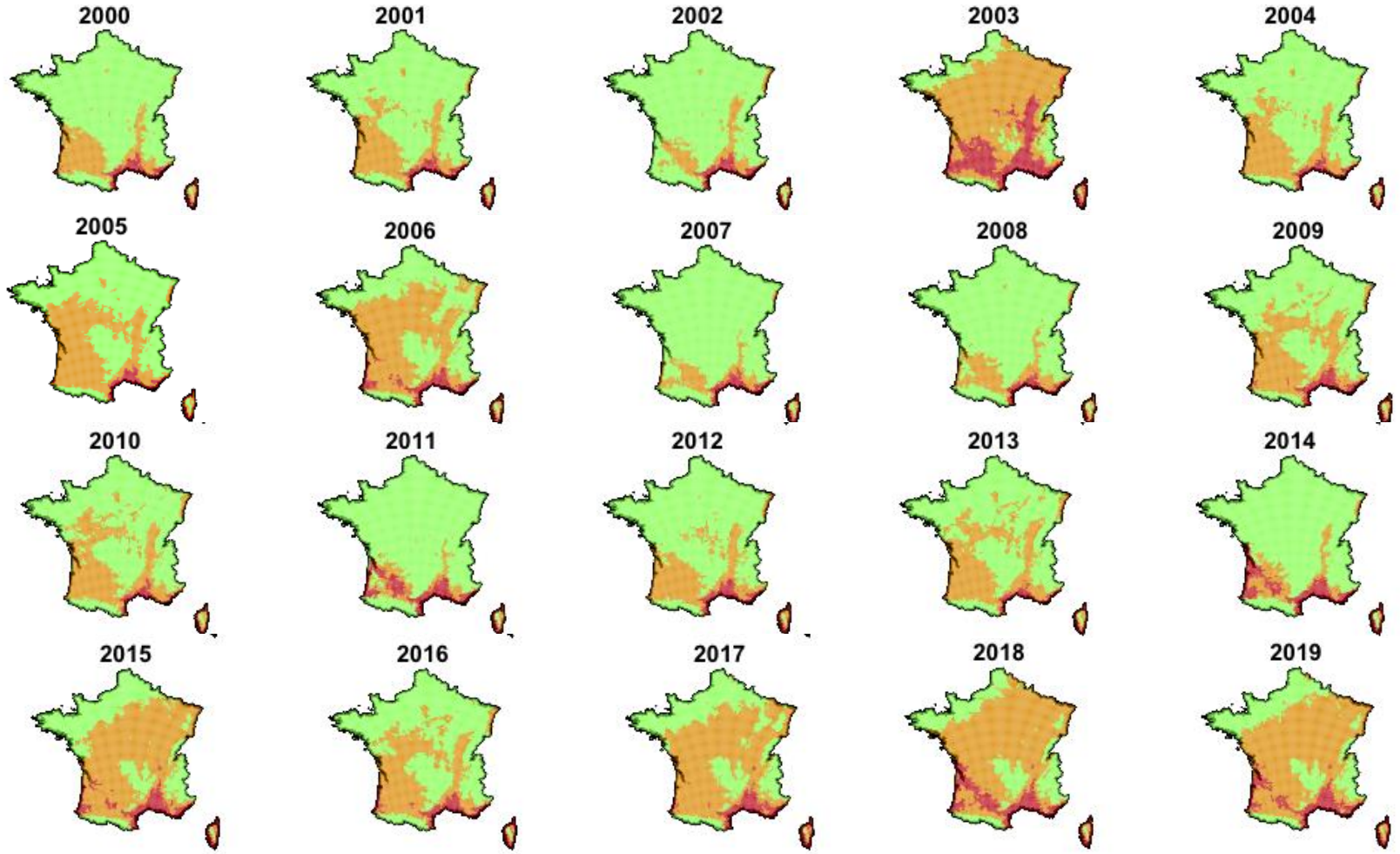
Area with MST < 19.14 °C: no PWD symptoms expected

Possible to distinguish three kinds of areas:

→ Application of this model to French climate from 2000 to 2019

- distribution of the three kinds of areas regarding PWD expression ?

4. France: suitable climatic conditions for the Pine Wilt Disease?



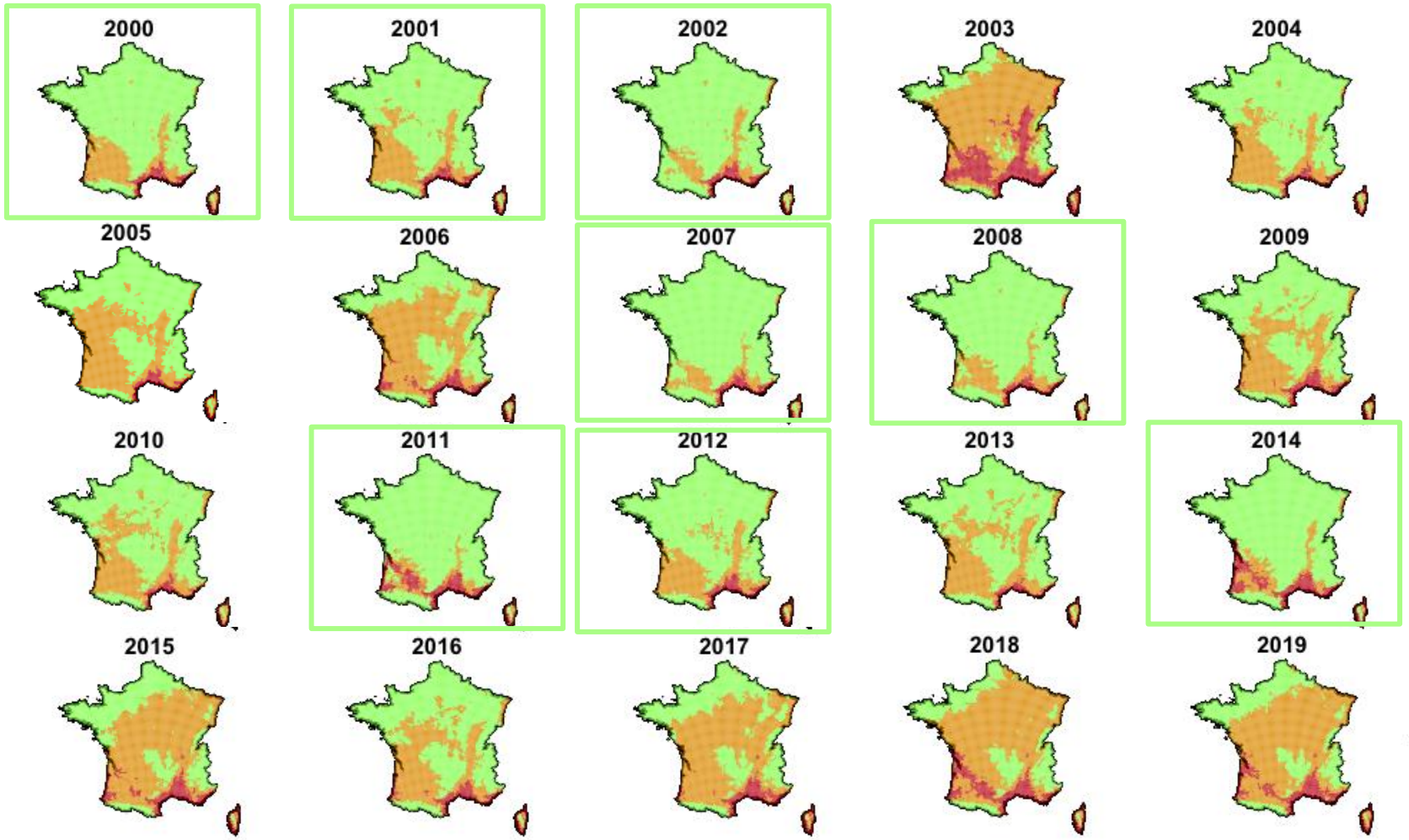
PWD expression without latency
PWD expression with latency
Absence of PWD expression

MST ≥ 19.14 °C
MST < 23 °C and MAT < 14 °C
MST < 19.14 °C

4. France: suitable climatic conditions for the Pine Wilt Disease?

Disparities among the years :

- Years with no suitable climate for wilt in most of the territory



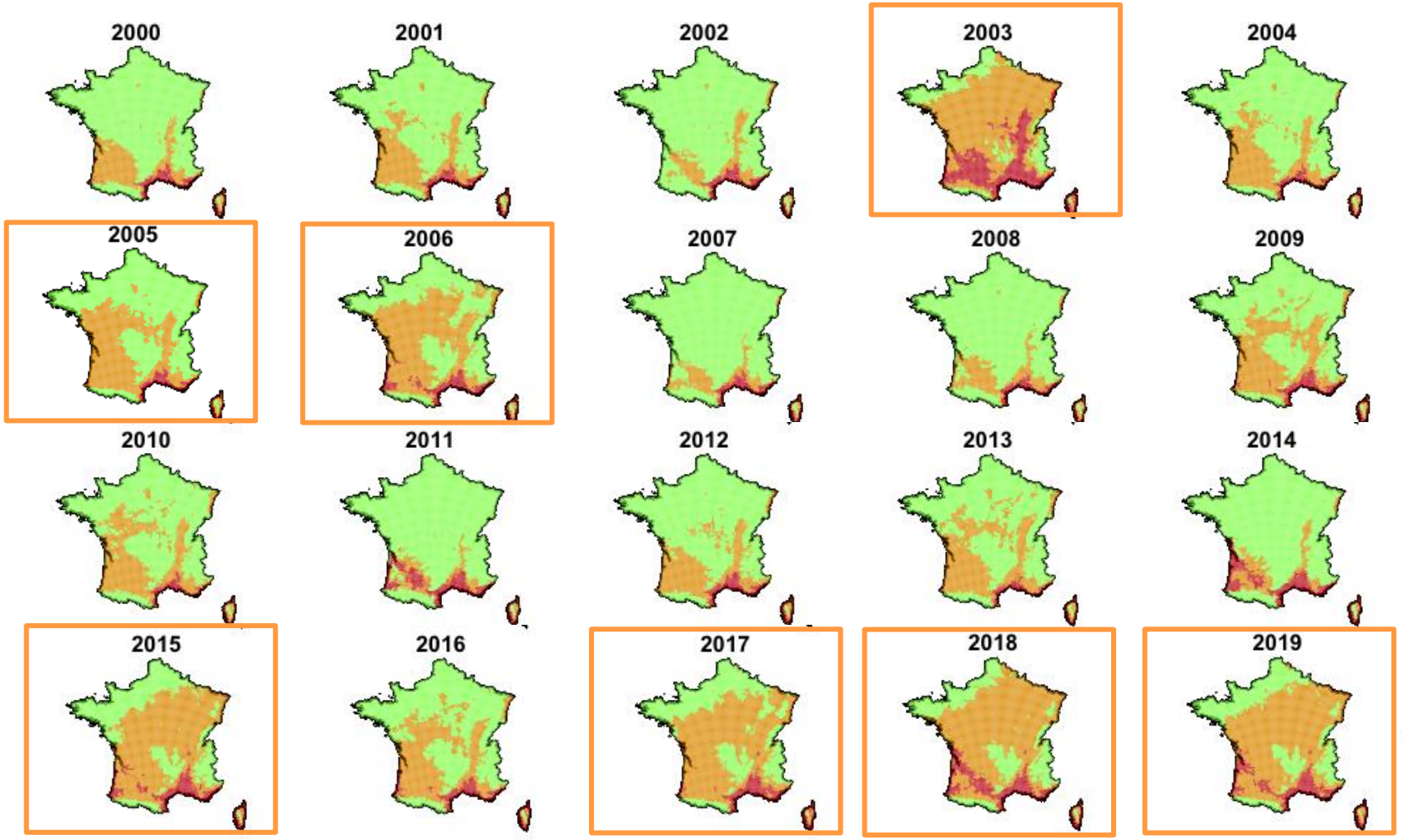
PWD expression without latency
PWD expression with latency
Absence of PWD expression

MST ≥ 19.14 °C
MST < 23 °C and MAT < 14 °C
MST < 19.14 °C

4. France: suitable climatic conditions for the Pine Wilt Disease?

Disparities among the years :

- Years with no suitable climate for wilt in most of the territory
- Years with suitable climate for wilt for most of the territory
  - **Frequent in the most recent years**



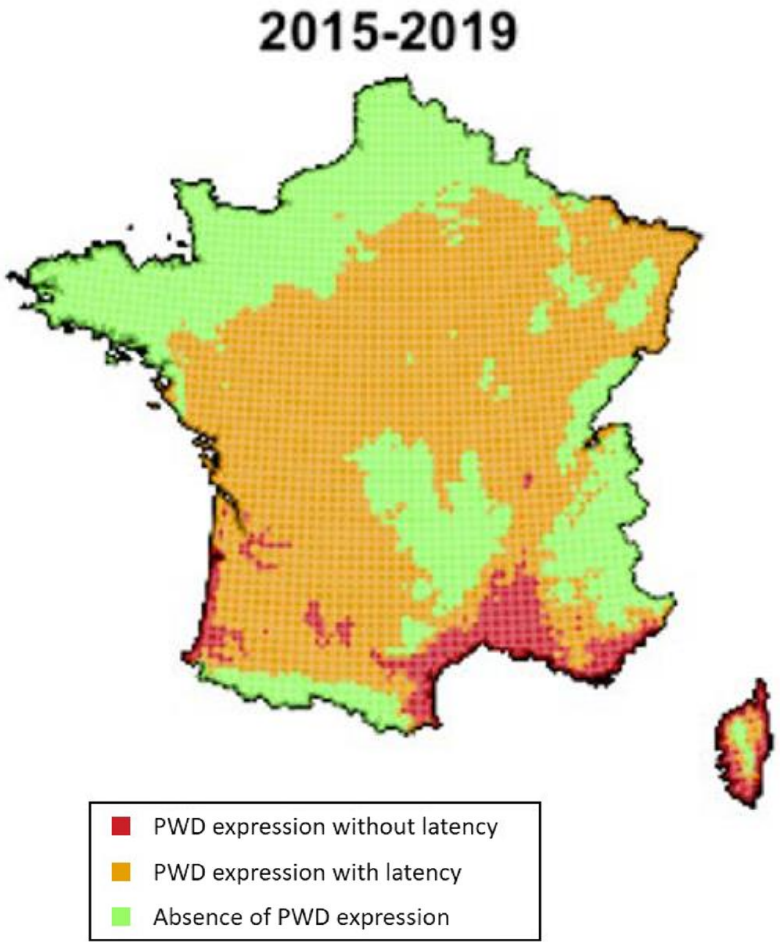
PWD expression without latency
PWD expression with latency
Absence of PWD expression

MST ≥ 19.14 °C
MST < 23 °C and MAT < 14 °C
MST < 19.14 °C

4. France: suitable climatic conditions for the Pine Wilt Disease?

- **Period 2015–2019 (means)**
  - **Latency areas** covered most of the country (i.e. 58%)
  - **Symptomatic areas** covered 7% of the territory
    - Mediterranean coastline and some areas in the southwest
  - **Asymptomatic areas** accounted for 35.4% of the territory
    - along the English Channel and mountains

Under climate change, years with hot summers, suitable for PWD expression, could be more and more frequent in the future



Conclusion & Perspectives

PWN monitoring in France: major sampling effort, reinforced over time

No outbreak but contaminated wood based commodities

High risk in France for the introduction and establishment of PWN:

- Wood trade with other countries
- Large susceptible forest areas
- Presence of *Monochamus spp* in all the regions

Suitable climatic conditions in France for pines to succumb to Pine Wilt Disease

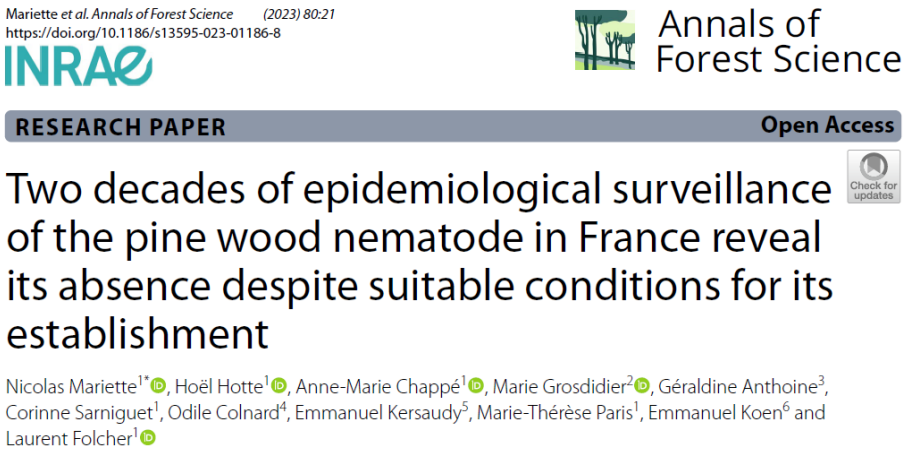
- In most of the country in the recent years
  - This could increase in the future with more frequent hot years (like 2003)
  - Modelling future climate scenarios could help the Pest Risk analysis

Thanks to all the people implied in the PWN monitoring (coordination, sampling, analysis…)

and to the people directly involved in this work:

H. Hotte , A.M. Chappé , M. Grosdidier , G. Anthoine, C. Sarniguet, O. Colnard, E. Kersaudy, M.T. Paris, E. Koen, L. Folcher

For more information:



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Two decades of epidemiological surveillance of the pine wood nematode in France reveal its absence despite suitable conditions for its establishment

Nicolas Mariette[1*], Hoël Hotte[1], Anne-Marie Chappé[1], Marie Grosdidier[2], Géraldine Anthoine[3], Corinne Sarniguet[1], Odile Colnard[4], Emmanuel Kersaudy[5], Marie-Thérèse Paris[1], Emmanuel Koen[6] and Laurent Folcher[1]

Thank you for your attention

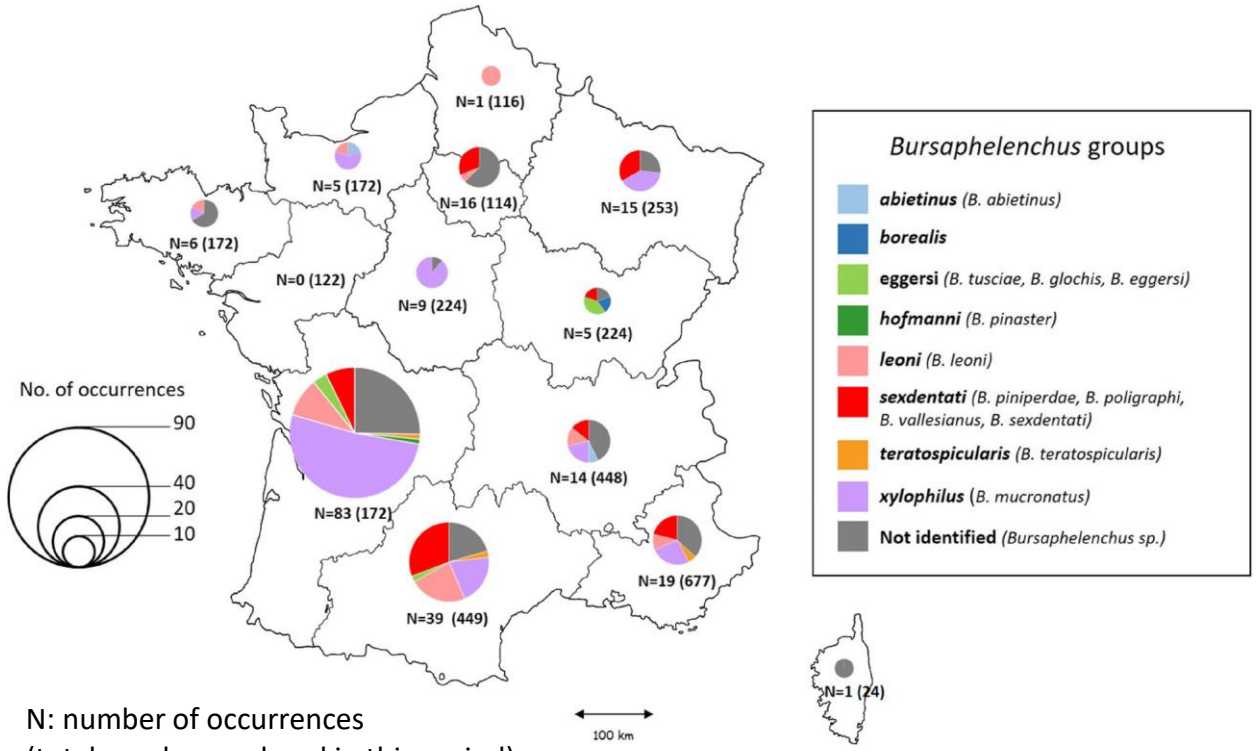
From 2000 to 2011, the morphological identification carried out for PWN detection allowed the detection of other *Bursaphelenchus spp.*
For some species (e.g. *B. leoni* or *B. poligraphi*) this identification was further confirmed by a PCR–RFLP (Burgermeister et al. 2005, 2009) :

Host distribution of the *Bursaphelenchus* spp. detected from 2000 to 2011 in the framework of PWN monitoring in metropolitan France

Bursaphelenchus groups	*Bursphelechus* species	*Pinus sylvestris*	*Pinus nigra*	*Pinus halepensis*	*Pinus pinaster*	*Abies grandi*	*Pinus sp.*	Total
Abietinus	*B. abietinus*[a]	1	0	0	1	0	0	2
Borealis	*Bursaphelenchus sp.*	0	1	0	0	0	0	1
Eggersi	*B. tusciae*[a]	1	1	0	1	0	0	3
	B. glochis[a]	0	0	0	0	0	1	1
	B. eggersi[a]	1	0	0	0	0	0	1
	Bursaphelenchus sp.	0	0	0	1	0	0	1
Hofmanni	*B. pinasteri*	0	0	0	0	0	1	1
Leoni	*B. leoni*	5	5	2	7	0	4	23
	Bursaphelenchus sp.	0	1	0	1	0	0	2
Sexdentati	*B. piniperdae*[a]	2	0	0	0	0	0	2
	B. poligraphi[a]	1	3	1	3	0	3	11
	B. vallesianus[a]	1	1	0	0	0	0	2
	B. sexdentati[a]	0	1	0	1	0	0	2
	Bursaphelenchus sp.	3	1	1	4	1	8	18
Teratospicularis	*B. teratospicularis*[a]	0	1	1	0	0	1	3
Xylophilus	*B. mucronatus*	11	12	1	13	0	40	77
Not identified	*Bursaphelenchus sp.*	14	8	7	13	0	21	63
	Total	40	35	13	45	1	79	213

[a] Species detected for the first time in France

Geographical distribution of *Bursaphelenchus* groups in metropolitan France, with the assignment of species/group when available, detected from 2000 to 2011 during PWN monitoring of host trees



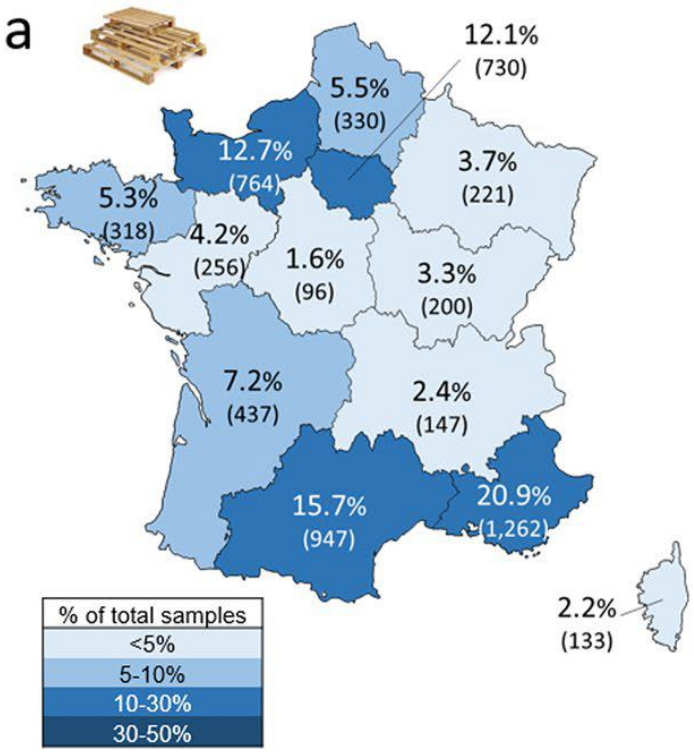
N: number of occurrences
(total number analysed in this period)

Number of analysed samples

Monitoring of wood-based commodities

- 6,037 samples of wood-based commodities collected and analysed from 2000 to 2019
- sampling effort particularly high in four regions (Normandie, Occitanie, Île-de-France and Provence-Alpes-Côte d'Azur)

    → regions with the main national airports and seaports

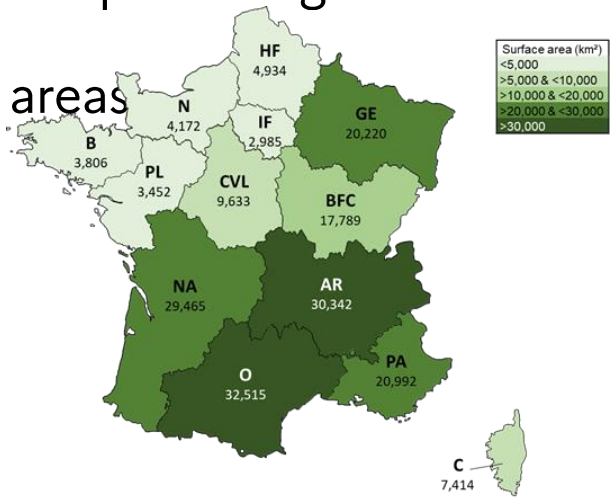


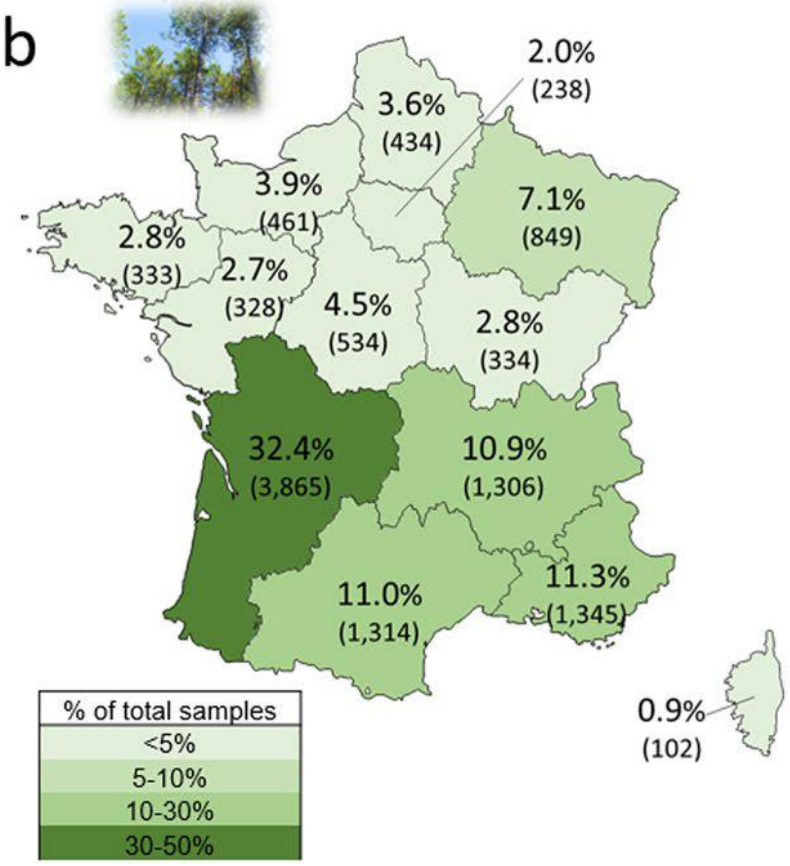
Number of analysed samples

Monitoring of pine forest stands

- Higher sampling effort in the south regions (around 70% of samples)
- Less samples in the north (except the region Grand-Est)

→ Linked to the pine areas





Number of analysed samples

Monitoring of the PWN insect vector

- From 2013 to 2019, 4,396 insect collections (emptying of traps)
  - collection of a total of 66,357 *Monochamus spp*

- High disparities in the number of insect collections according to the geographical area:

  - Nouvelle-Aquitaine accounts for more than 40% of all sampling
  - N-A also accounts for 60% of *Monochamus* insects trapped

  - A lower sampling effort in each of the other regions (<300 collections)
    - except Bretagne and Nouvelle-Aquitaine (>600 collections).