The REPHRAME Consortium

REPHRAME includes scientists from 11 organisations in 8 countries. The organisations and the Principal Investigators for each are shown in the Table below:

Bene-ficiary	Institute	Short Name	Country	Principal Investigator	Email
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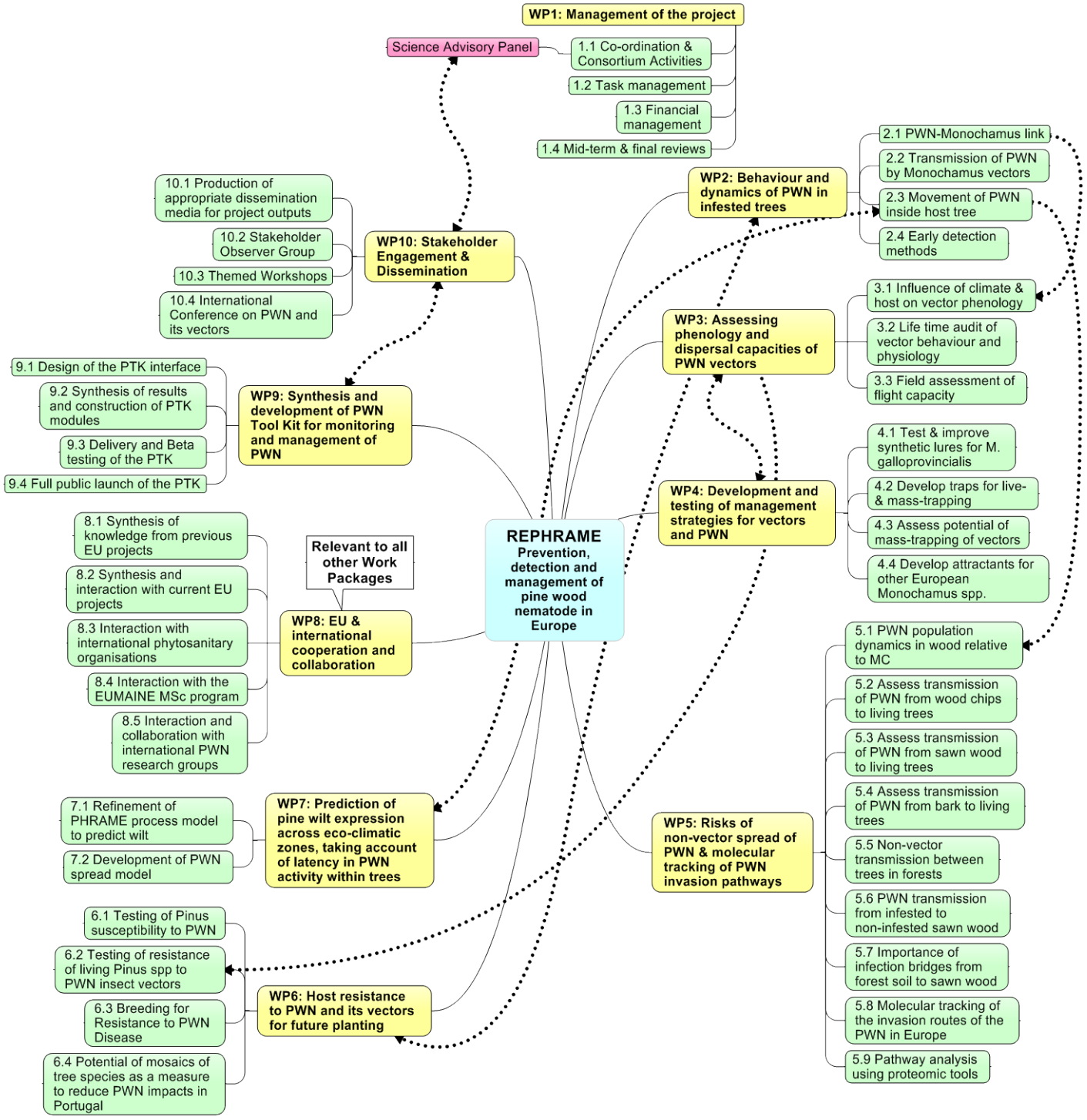
4	Institut National De La Recherche Agronomique	INRA	France	Alain Roques	Alain.Roques@orleans.inra.fr
5	Julius Kuhn Institut Bundesforschungsinstitut Fur Kulturpflanzen	JKI	Germany	Thomas Schroeder	thomas.schroeder@jki.bund.de
6	Instituto Nacional de Investigação Agrária e Veterinária, I.P.	INIAV (ex. INRB)	Portugal	Edmundo Sousa	edmundo.sousa@iniav.pt
7	Universidade De Evora	UE	Portugal	Manuel M. Mota	mmota@uevora.pt
8	Agencia Estatal Consejo Superior De Investigaciones Cientificas	CSIC	Spain	Alfonso Navas	mcnan618@mncn.csic.es
9	Universidad De Valladolid	UVA	Spain	Juan Pajares	jpajares@pvs.uva.es
10	Institute Of Zoology, Chinese Academy Of Sciences	IOZ	China	Jianghua Sun	sunjh@ioz.ac.cn
11	Norwegian Institute For Agricultural And Environmental Research - Bioforsk	Bioforsk	Norway	Christer Magnusson	christer.magnusson@bioforsk.no

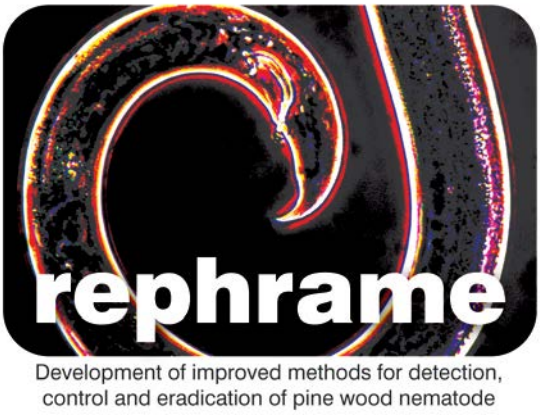
Schematic of REPHRAME Work Packages and inter-relationships



REPHRAME Website

www.rephrame.eu

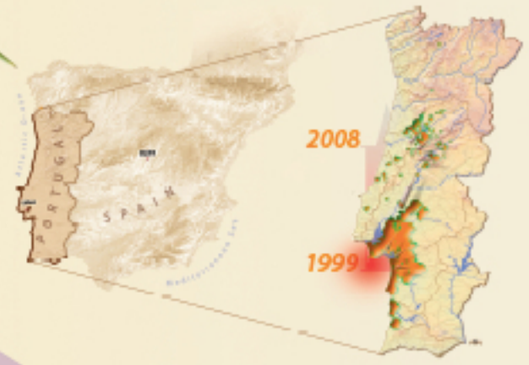
The REPHRAME logo:



The pinewood nematode

Bursaphelenchus xylophilus

(PWD) Pine wilt disease



*The pinewood nematode (PWN), **Bursaphelenchus xylophilus**, a serious threat to forest ecosystems, has become a barrier to wood trade in the affected countries, and is at present the most devastating pest and pathogen of pine forests due to the fact that it is a quarantine pest with huge economic consequences for forestry.*

*Its detection and identification in Portugal (Pegões, Península de Setúbal) in 1999, associated with maritime pine, **Pinus pinaster**, has expanded the geographical distribution of this pest to three continents in the northern hemisphere: North America (USA, Canada and Mexico), Asia (China, Japan, South Korea and Taiwan), and Europe (Portugal). Since June, 2008, the disease has spread to the central region of continental Portugal, and was recently (2010) detected on the island of Madeira and in Spain (Galicia).*

MATURATION FEEDING

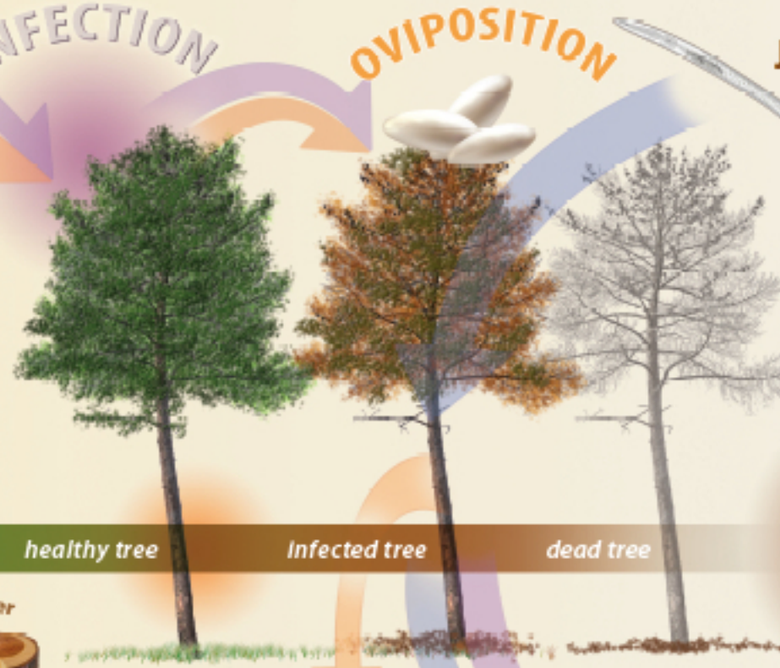
TRANSMISSION

Transmission of the PWN through its insect vector may occur by primary transmission (during feeding, at the crown – maturation feeding), or by **secondary transmission** *(through female oviposition along the trunk and branches of maritime pine).*

Once inside a healthy tree, the PWN reproduces and spreads very rapidly, from crown to root system, colonizing and ultimately occluding the entire vascular region and resin canals, thus condemning the tree to death in a few months.

INFECTION

OVIPOSITION



healthy tree — infected tree — dead tree

anthropogenic

cut, storage transport, timber industry ...

dissemination

J_2

J_1

- "reproductive" development
- "dispersive" development
- life cycle of the insect-vector

Eggs

J_3

J_4

adults

25 µm

J_{III}

J_{IV} ***DAUER** juvenile — resistance phase (dormancy)*

Dauer migration to the pupal chamber (chemical attraction?) **and pupae tracheae.**

pupal chamber

pupa (colonized by J_{IV} of PWN)

larval chamber

larva

adults (colonized)

1 cm

This species of longhorn beetle, belonging to the family Cerambycidae, is the only known vector of the PWN in Portugal.

The **INSECT VECTOR**

Monochamus galloprovincialis

HOST

Maritime pine

Pinus pinaster

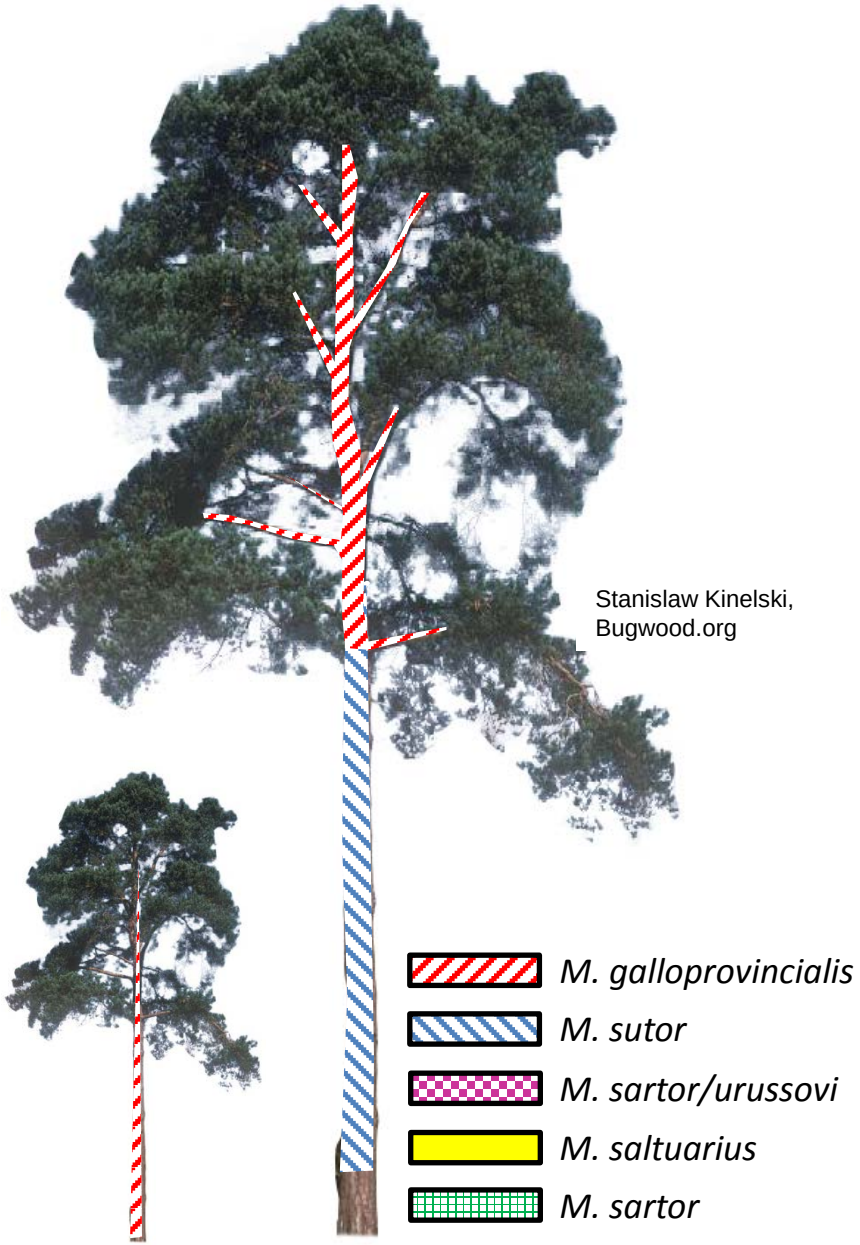
The PWN, slightly less than 1 mm long, reproduces at such a rate that a 10g wood piece may contain approximately 40 000 individuals.

The **PATHOGENIC AGENT**

Bursaphelenchus xylophilus

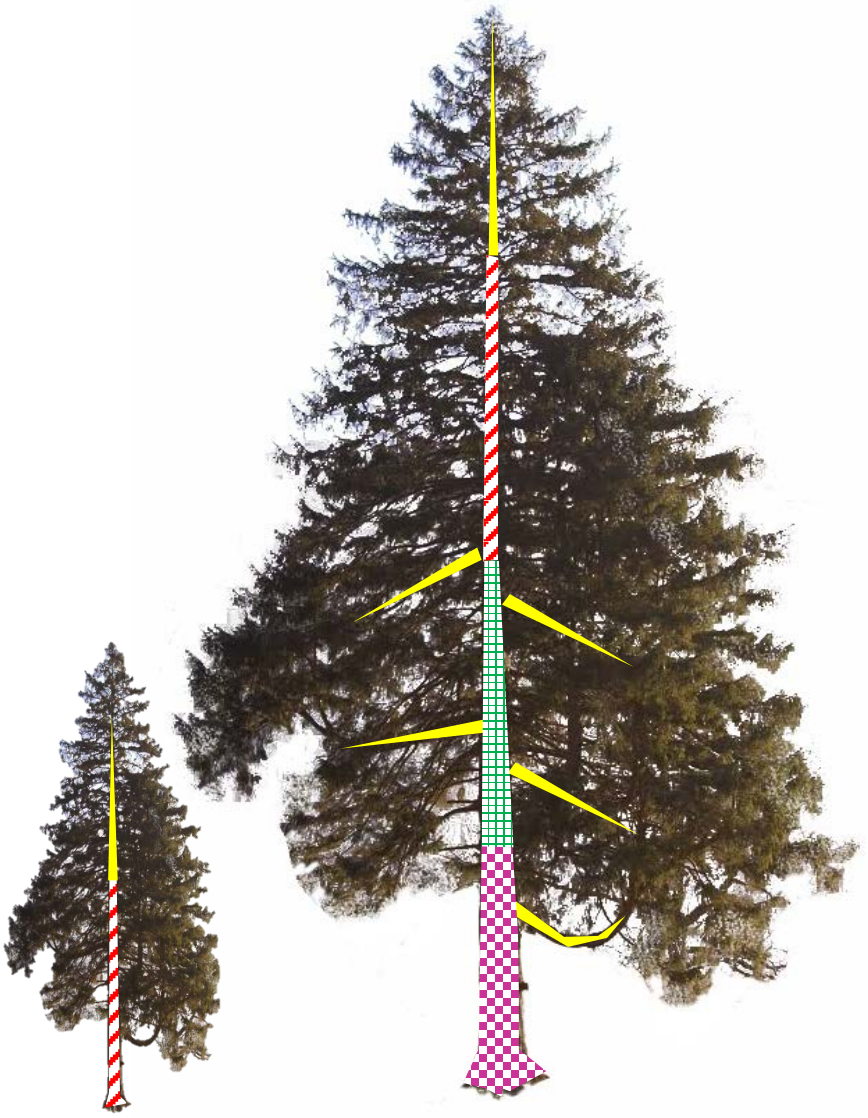
Project coordination, Texts and Editing: **Manuel Mota & Paulo Vieira** (Dep. de Biologia, Universidade de Évora)

Conception, Composition, Illustrations & Design: **Fernando Correia** (Dep. de Biologia, Universidade de Aveiro)



Young (thin bark) Mature (range of bark thicknesses)

Pinus spp. (pines)



Young (thin bark) Mature (range of bark thicknesses)

Picea spp. (spruces)

M. galloprovincialis

M. saltuarius

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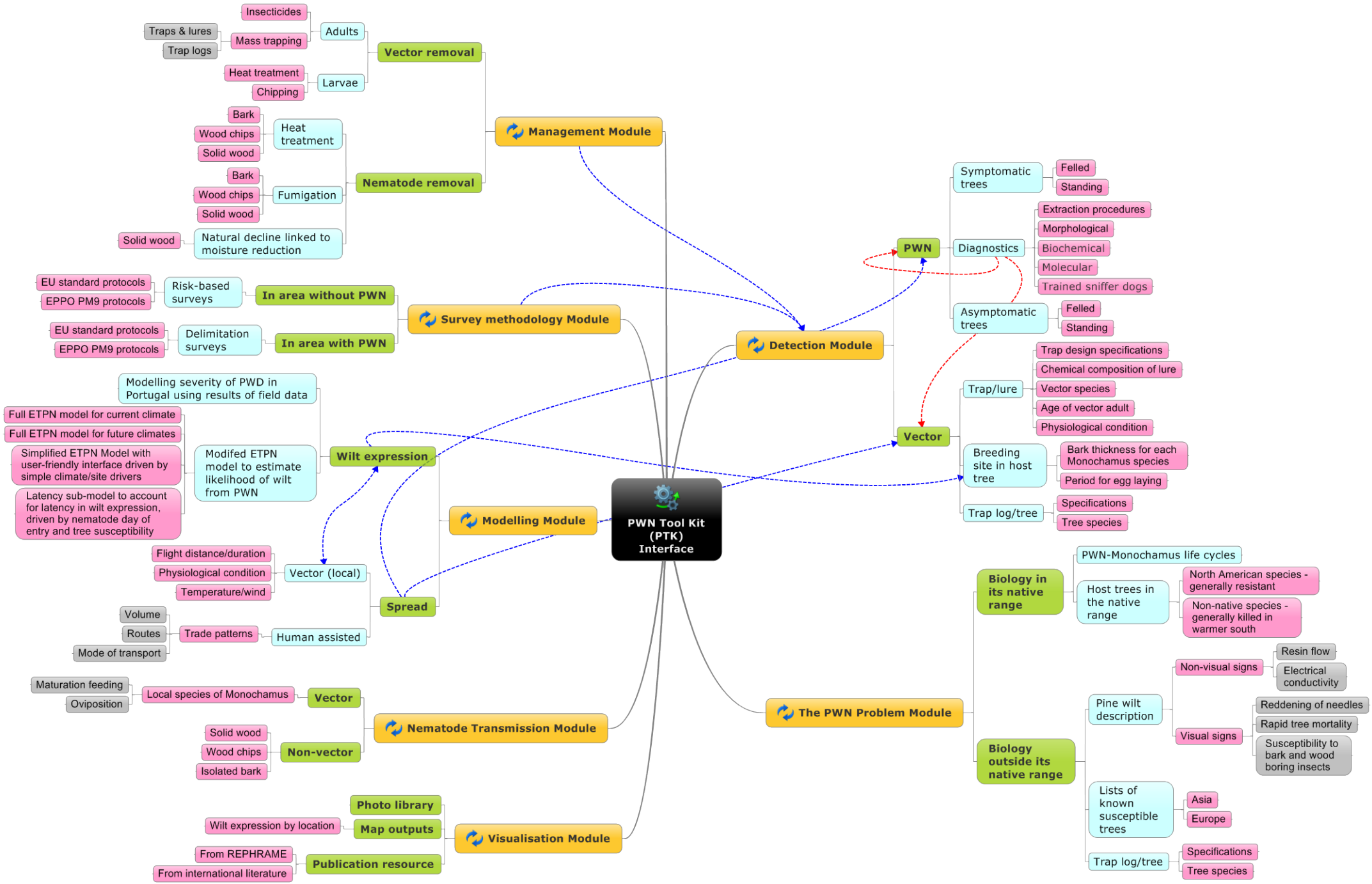
PWN Tool Kit (PTK) Interface
Management Module
Vector removal
Adults
Insecticides
Mass trapping
Traps & lures
Trap logs
Larvae
Heat treatment
Chipping
Nematode removal
Heat treatment
Bark
Wood chips
Solid wood
Fumigation
Bark
Wood chips
Solid wood
Natural decline linked to moisture reduction
Solid wood
Survey methodology Module
In area without PWN
Risk-based surveys
EU standard protocols
EPPO PM9 protocols
In area with PWN
Delimitation surveys
EU standard protocols
EPPO PM9 protocols
Detection Module
PWN
Diagnostics
Extraction procedures
Morphological
Biochemical
Molecular
Trained sniffer dogs
Symptomatic trees
Felled
Standing
Asymptomatic trees
Felled
Standing
Vector
Trap/lure
Trap design specifications
Chemical composition of lure
Vector species
Age of vector adult
Physiological condition
Breeding site in host tree
Bark thickness for each Monochamus species
Period for egg laying
Trap log/tree
Specifications
Tree species
Modelling Module
Wilt expression
Modelling severity of PWD in Portugal using results of field data
Modifed ETPN model to estimate likelihood of wilt from PWN
Full ETPN model for current climate
Full ETPN model for future climates
Simplified ETPN Model with user-friendly interface driven by simple climate/site drivers
Latency sub-model to account for latency in wilt expression, driven by nematode day of entry and tree susceptibility
Spread
Vector (local)
Flight distance/duration
Physiological condition
Temperature/wind
Human assisted
Trade patterns
Volume
Routes
Mode of transport
Nematode Transmission Module
Vector
Local species of Monochamus
Maturation feeding
Oviposition
Non-vector
Solid wood
Wood chips
Isolated bark
Visualisation Module
Photo library
Map outputs
Wilt expression by location
Publication resource
From REPHRAME
From international literature
The PWN Problem Module
Biology in its native range
PWN-Monochamus life cycles
Host trees in the native range
North American species - generally resistant
Non-native species - generally killed in warmer south
Biology outside its native range
Pine wilt description
Non-visual signs
Resin flow
Electrical conductivity
Visual signs
Reddening of needles
Rapid tree mortality
Susceptibility to bark and wood boring insects
Lists of known susceptible trees
Asia
Europe
Trap log/tree
Specifications
Tree species