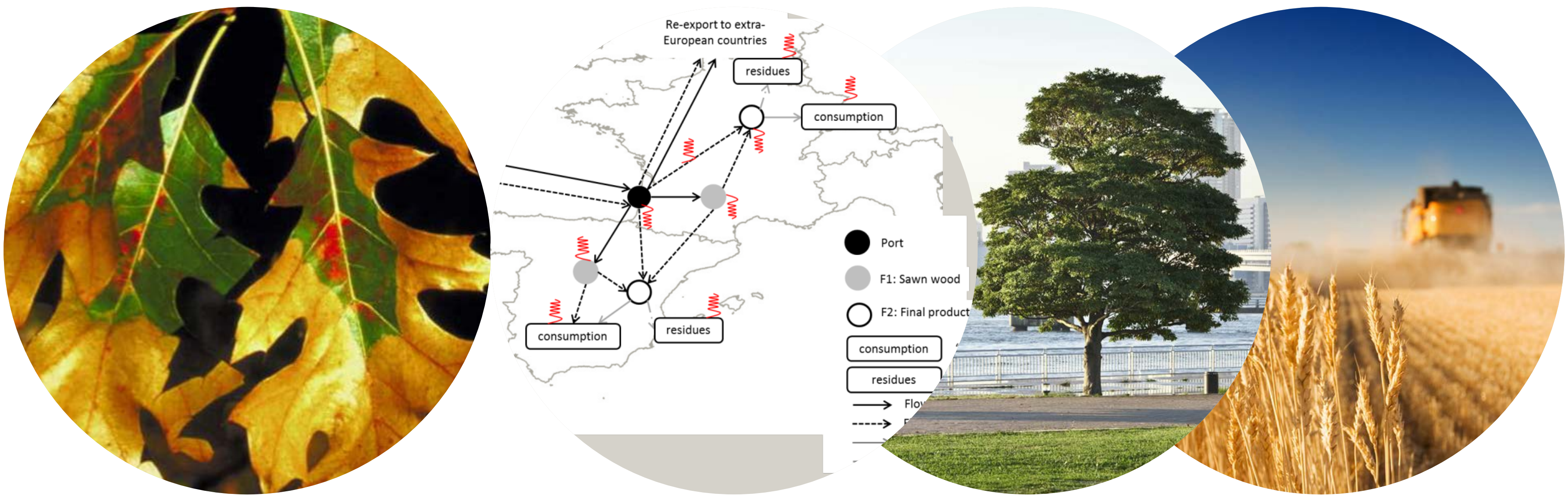
Pathway modelling to assess pest entry into Europe – a case study on oak wilt

Christelle Robinet, Bob Douma, Dominique Piou, Wopke van der Werf



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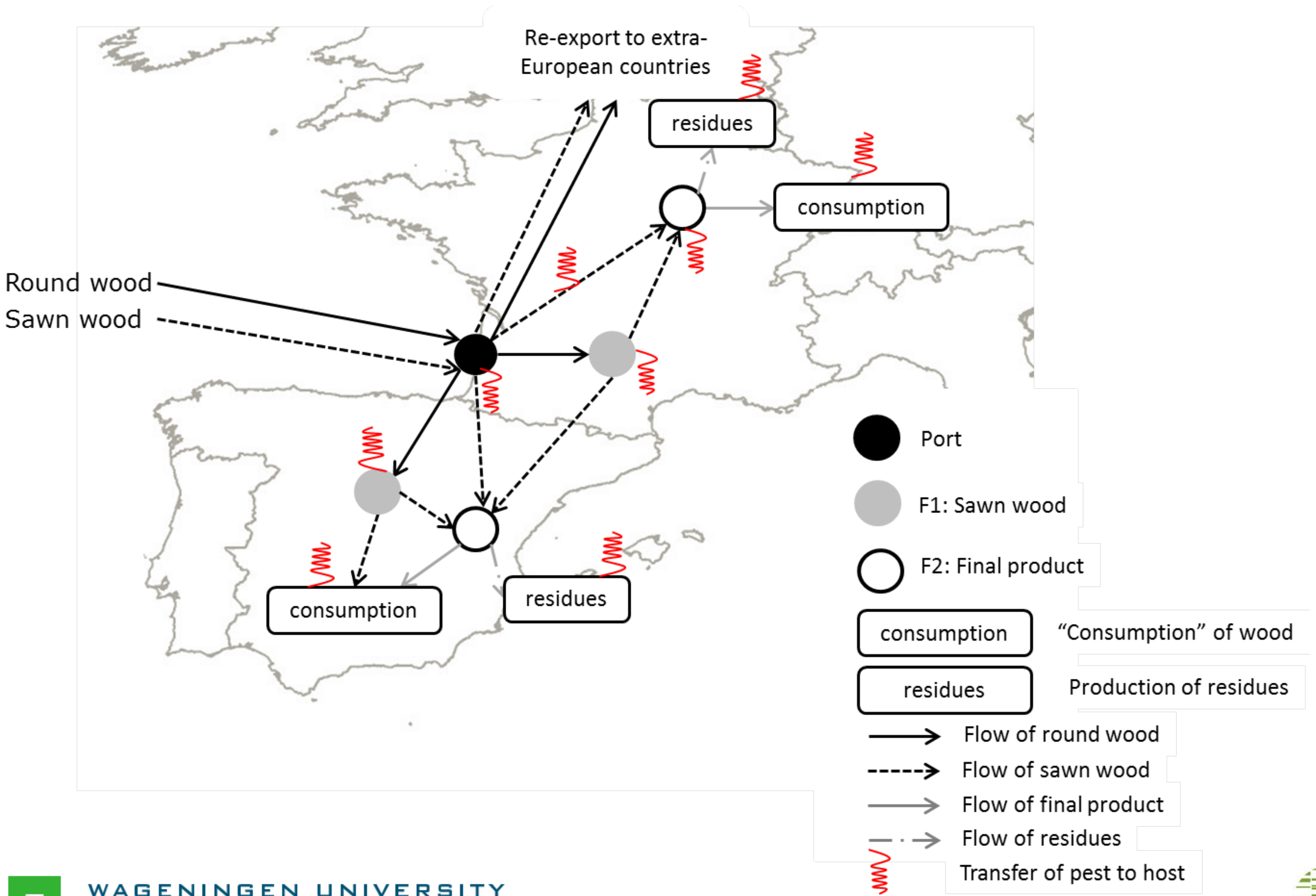
Project conducted for EFSA (2011-2015)

- Development of probabilistic models for quantitative pathway analysis of plant pests introduction for the EU territory
- Service contract CT/EFSA/PLH/2011/04: Lot 2 Non-edible plant products
- We developed pathway models for plants for planting, seeds, cut flowers, and wood products
- Development and testing of methodology; application to case studies

Pathway models

- Describe mathematically the movement of pest propagules or their vectors (carriers) from a source (area) to a geographic area of concern
- Quantify the number of pest propagules that come into contact with the host or host habitat
- Use trade statistics and pest specific parameters
- Use expert judgement to quantify parameters that are not well established from research (e.g. level of infestation in the trade)

Wood flows



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Pathway models

- Unidirectional
- A subset of epidemic network models (multi-directional)
- Agent-based or flow-based
- Probabilistic or deterministic
- Make the assessment of entry quantitative
- Enable comparison of pathways and management options
- Enable uncertainty analysis and scenario studies

Case study on oak wilt, caused by *Ceratocystis fagacearum* - questions

- Generic
  - Application of a generic pathway model for wood – what are the benefits, what are the hurdles?
- Case study-specific
  - Are current regulations against oak wilt effective?
  - Which parts of the pathway have the greatest contribution to exposure?
  - Comparative vulnerability of different EU member states?

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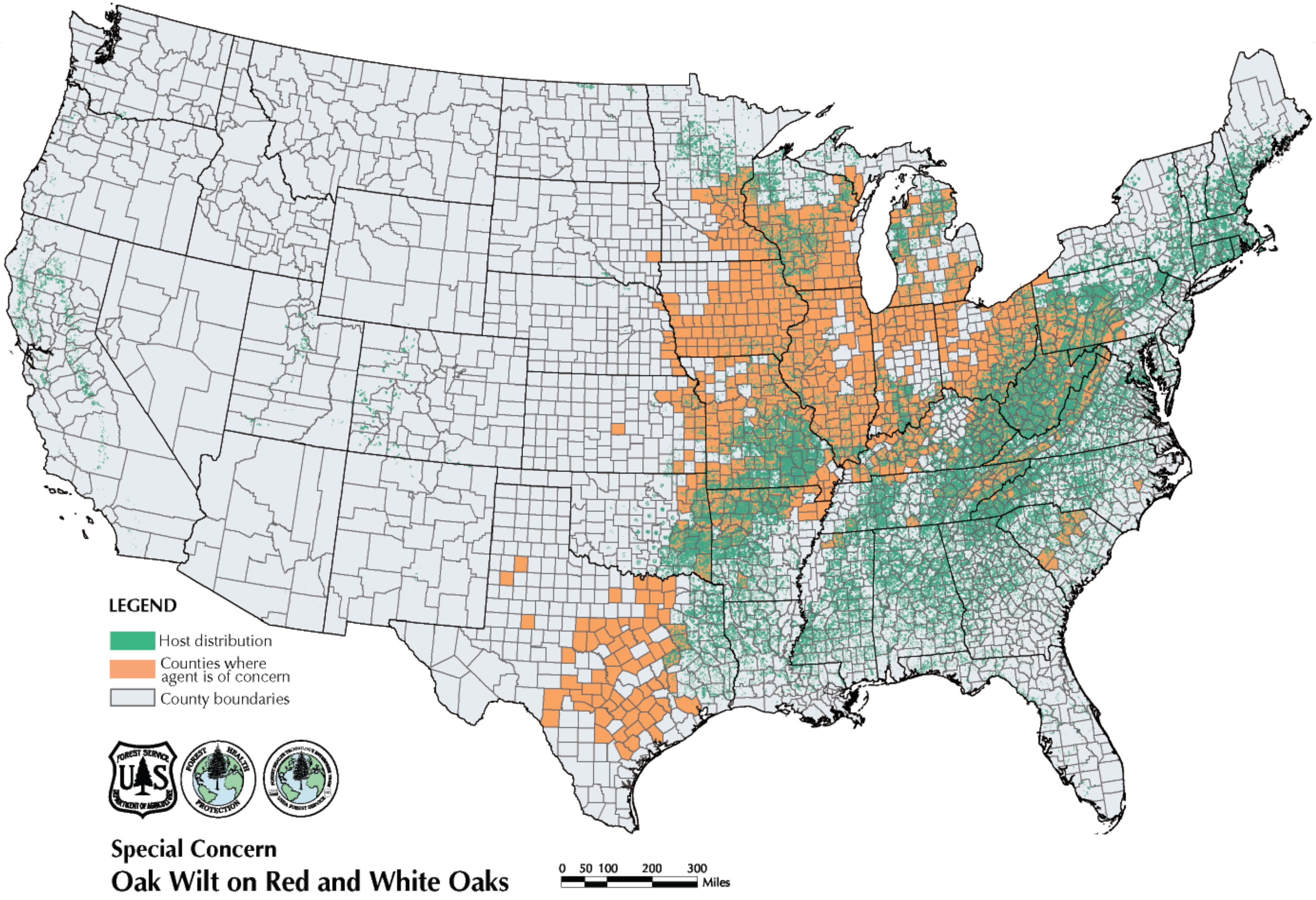
Distribution of oaks and oak wilt in the USA (2005)



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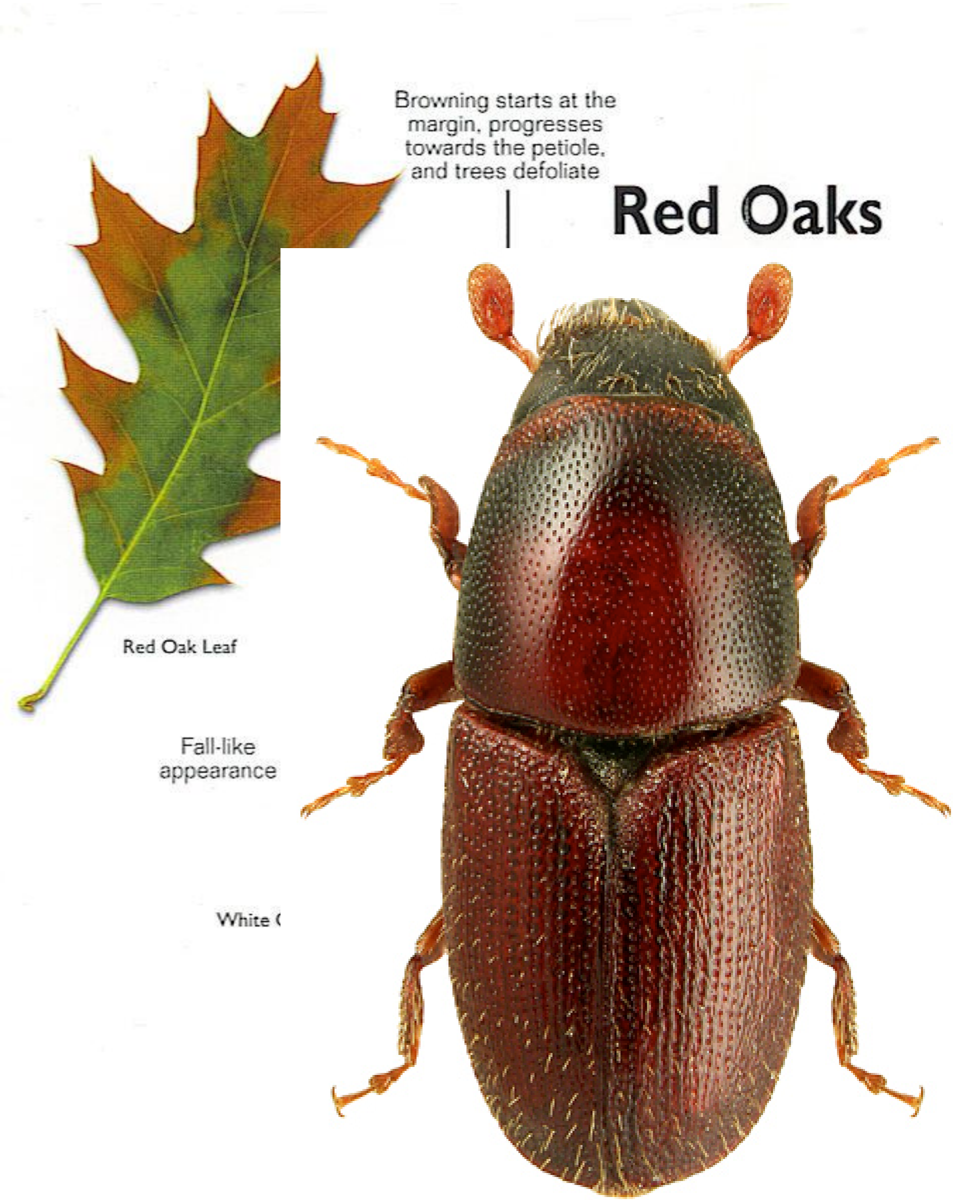


USA

- **Red oaks** (*Quercus* spp., subgenus *Erythrobalanus*) are highly sensitive to oak wilt. Infected trees rapidly die
- **White oaks (***Quercus* spp. subgenus *Lepidobalanus*) are less sensitive

Europe

- Most European oaks are white oaks (*Quercus robur*, *Q. petraea, Q. pubescens*)
- But they die rapidly when infected with *C. fagacearum*

- Native vector is present: oak bark beetle: *Scolytus intricatus*

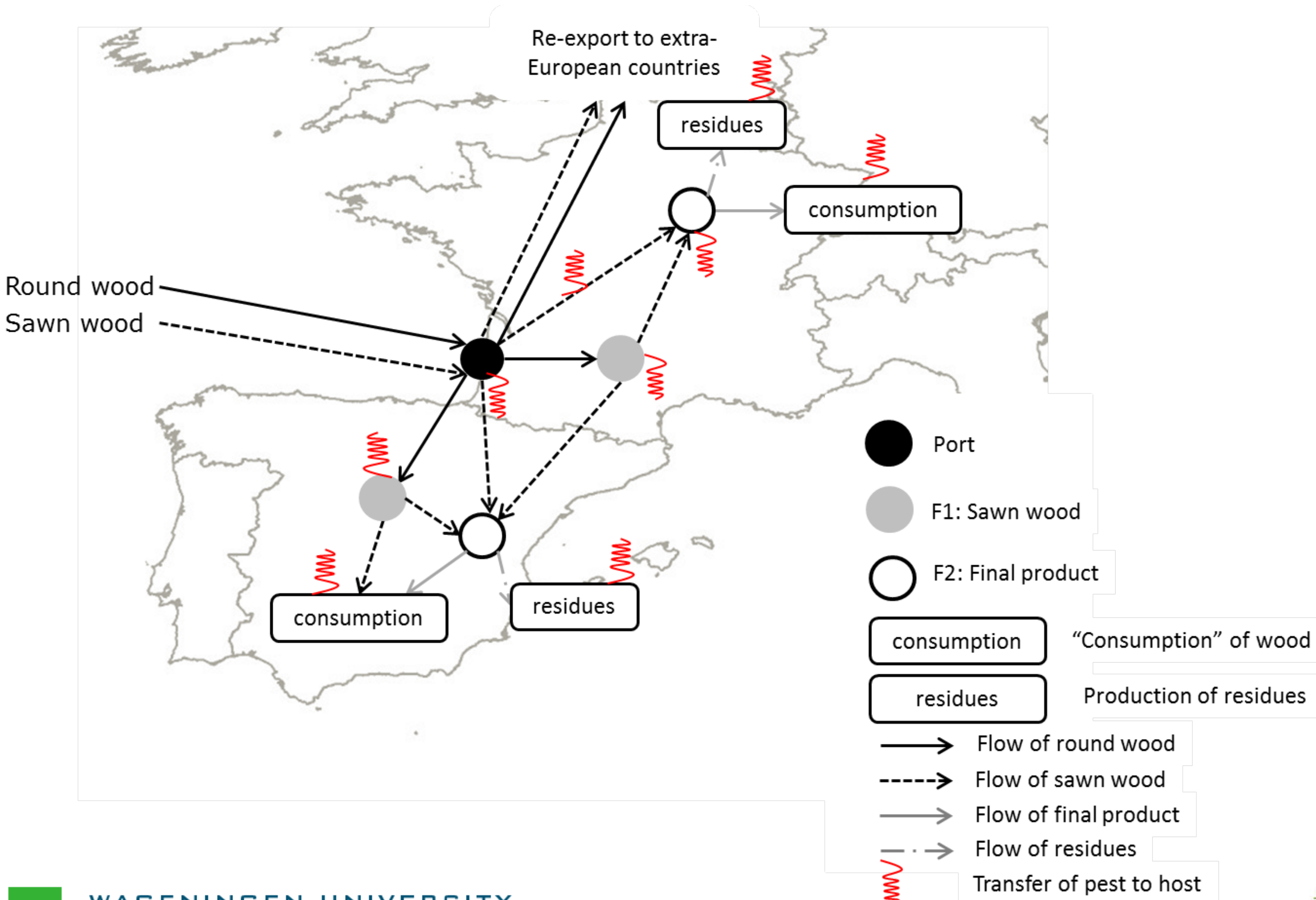
Three options for import of American oak wood under current regulation

1. Red or white oak wood, with or without bark, fumigated (BF: Bark Fumigated)
2. White oak with bark, no movement below 45° latitude (BNF: Bark, Not fumigated)
3. Red or white oak wood without bark (DB: DeBarked)

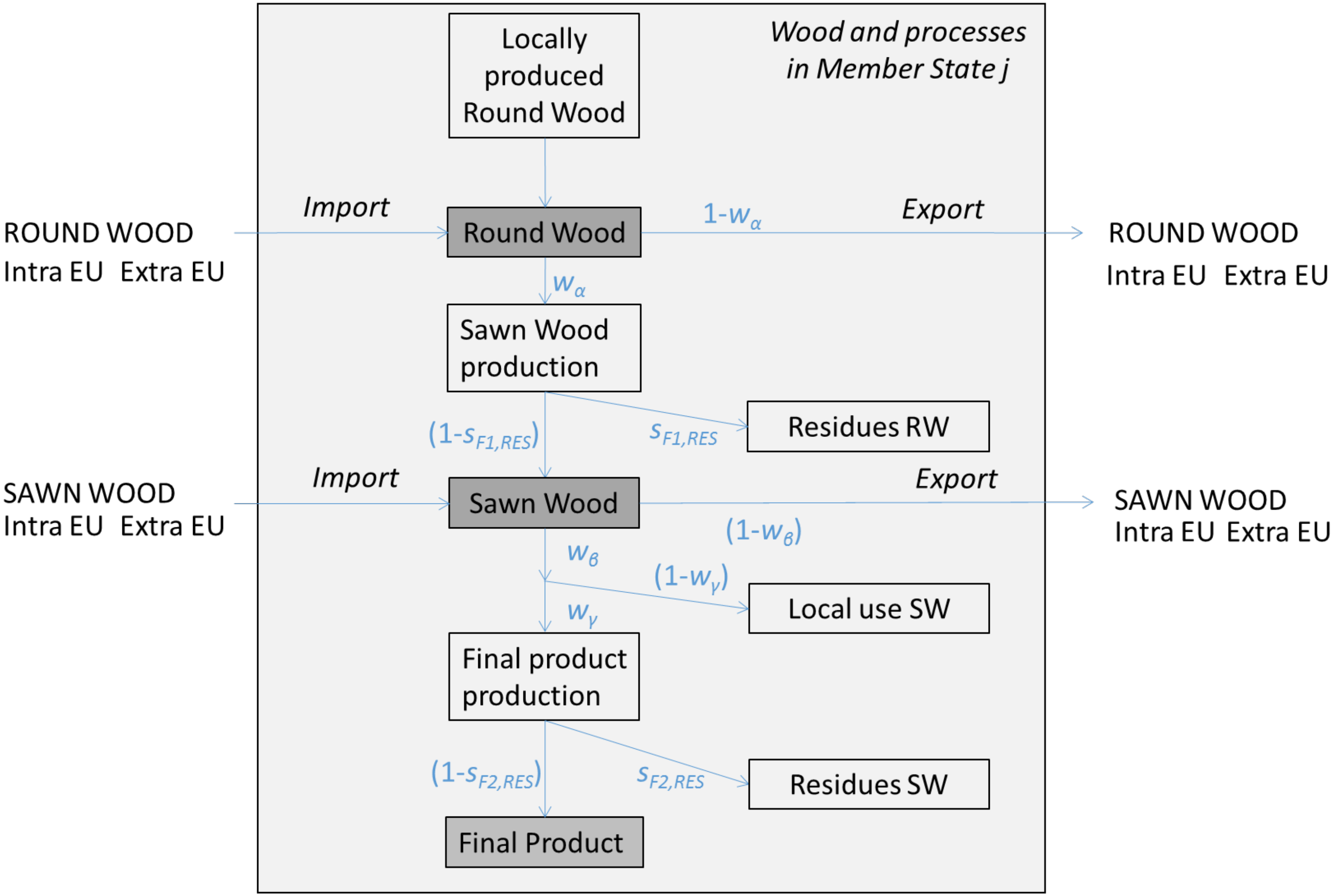
Model features

- Total flow of wood, distinguishing all ports and trade between member states, as well as local production per member state
- Partitioning of product flows to processing plants doing wood transformation according to number of plants per NUTS2 region (sub country level)
- Parameters expressing pest density in wood, pest survival during processing, dispersal rate from wood
- Encounter probability with hosts based on host cover maps, climate

Wood flows



Re-export to extra-European countries
residues
consumption
Round wood
Sawn wood
consumption
residues
Port
F1: Sawn wood
F2: Final product
consumption
"Consumption" of wood
residues
Production of residues
Flow of round wood
Flow of sawn wood
Flow of final product
Flow of residues
Transfer of pest to host



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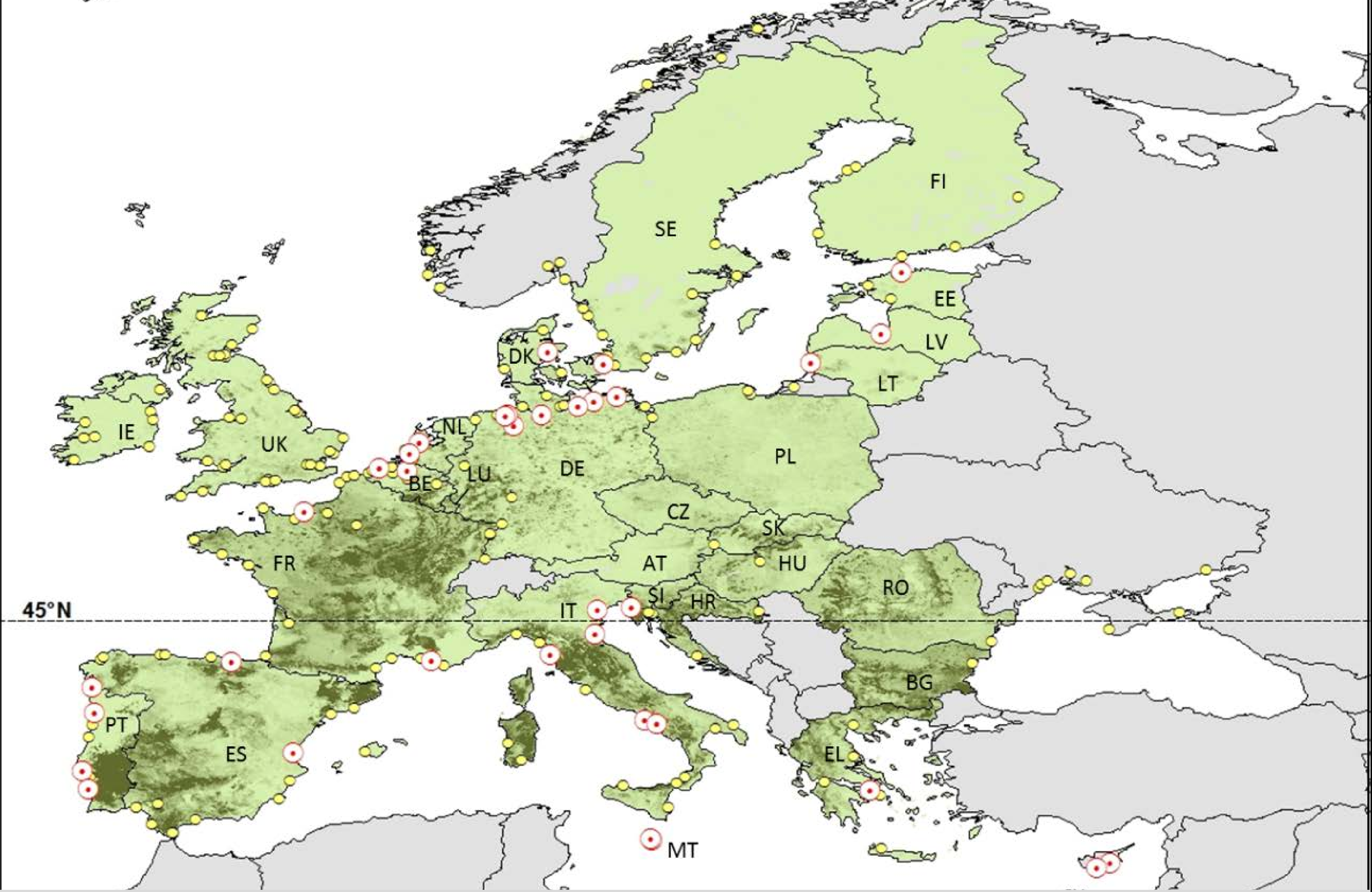
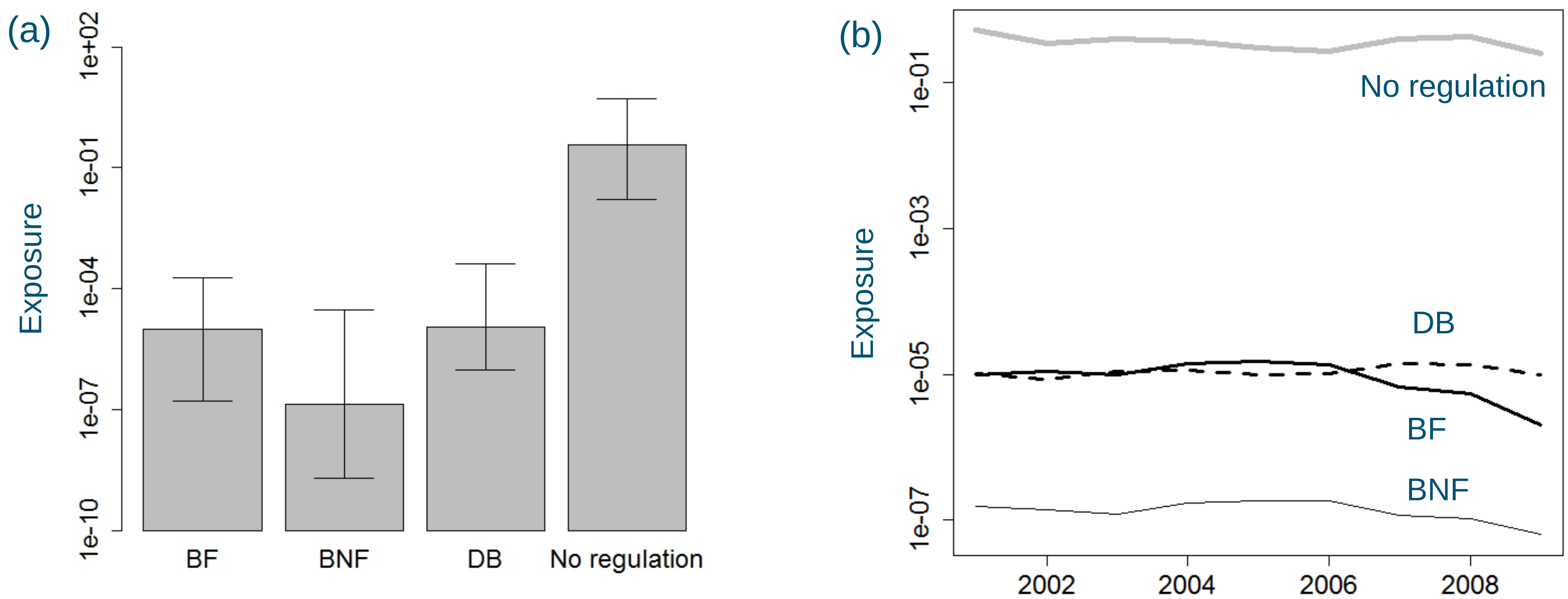
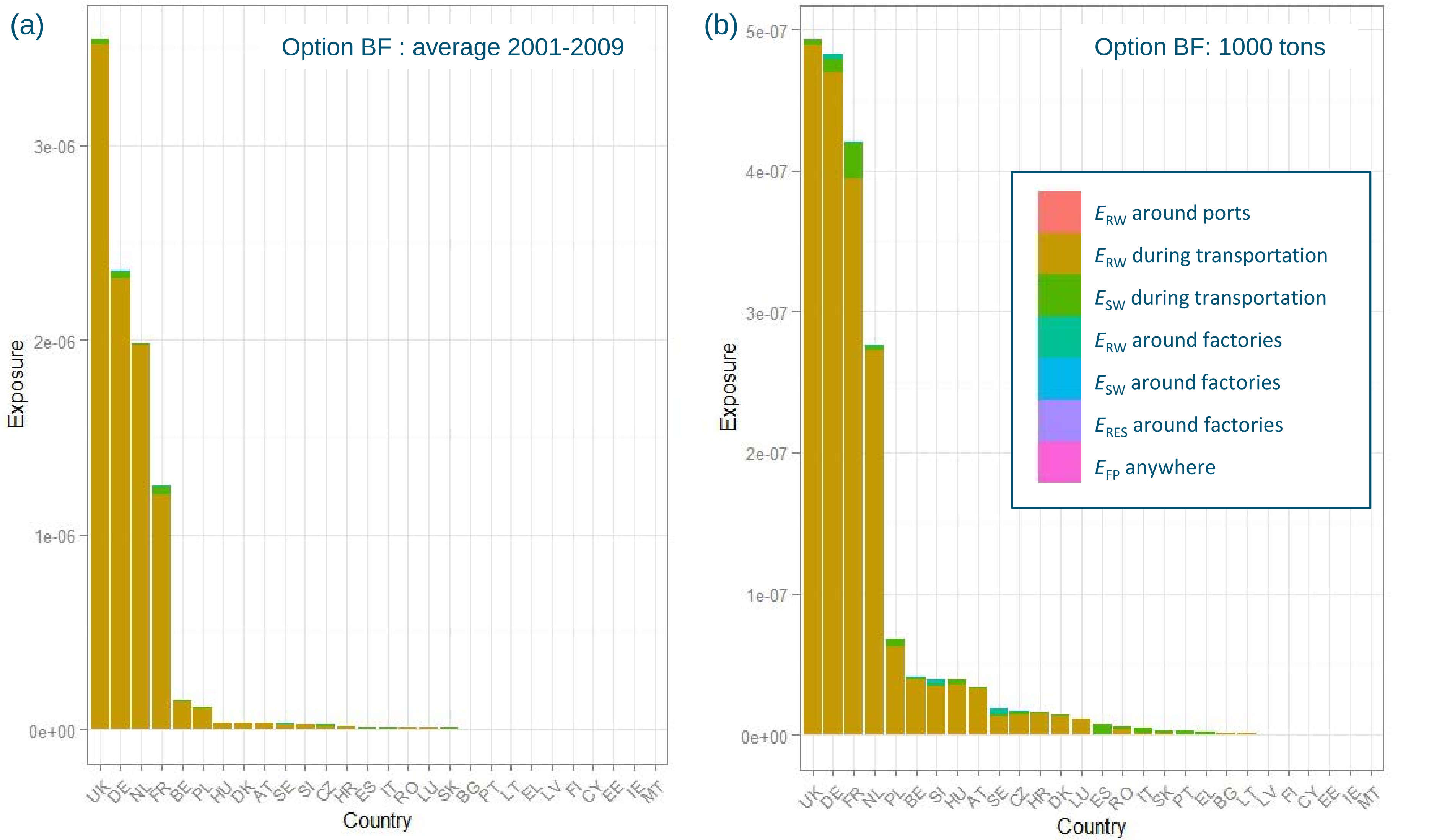


Spatial distribution of oak trees in Europe (background scale indicates the proportion of land covered by *Quercus* spp.), location of ports (small points) and location of the 35 ports where entry of wood with bark is allowed under the import options “bark fumigated (BF) and “bark non-fumigated” (BNF) (big points with small dot inside). The dotted line indicates the latitude of 45°N which is the southern limit of the area allowed for wood transport under import option BNF.

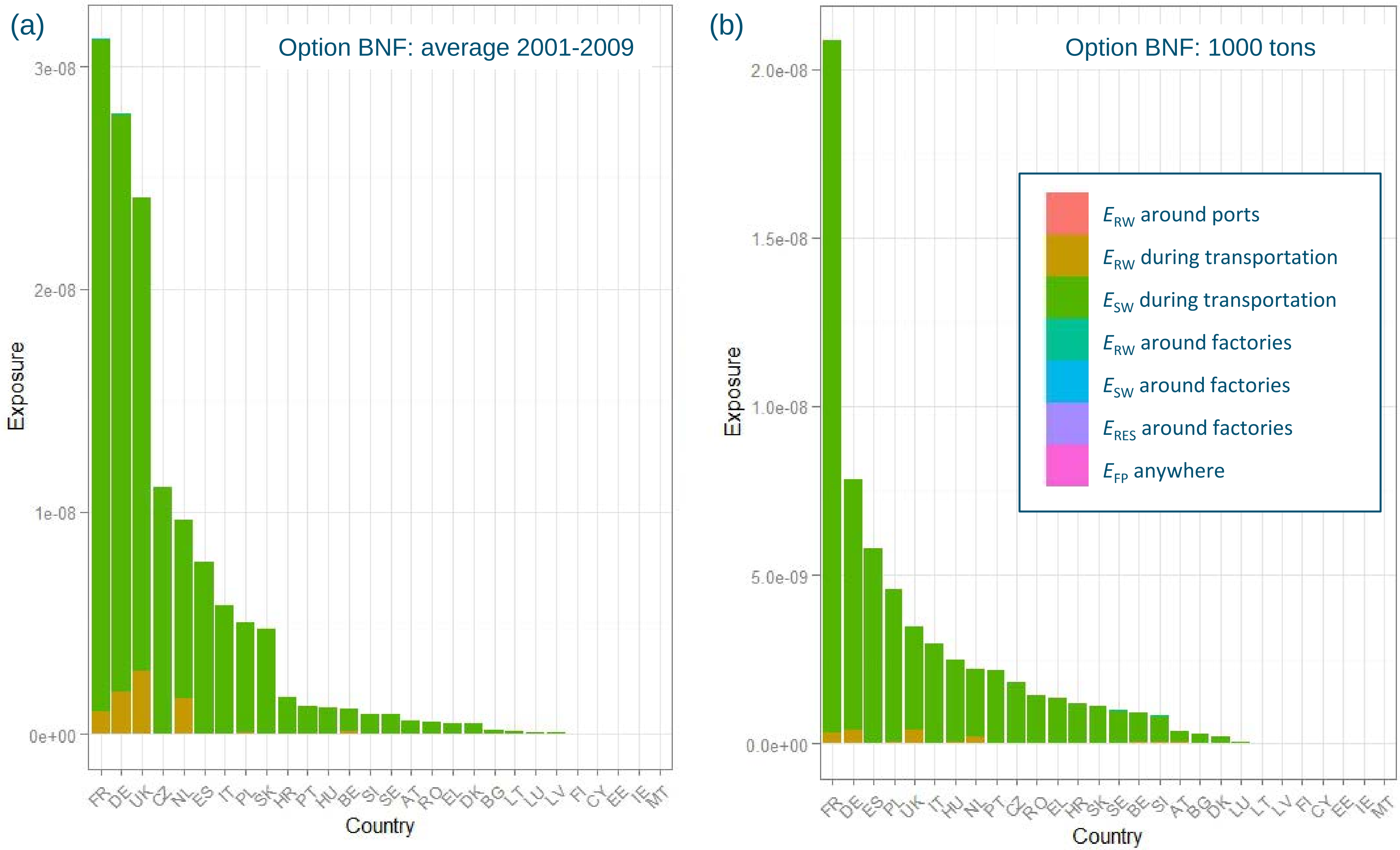
Comparison of import regulation options



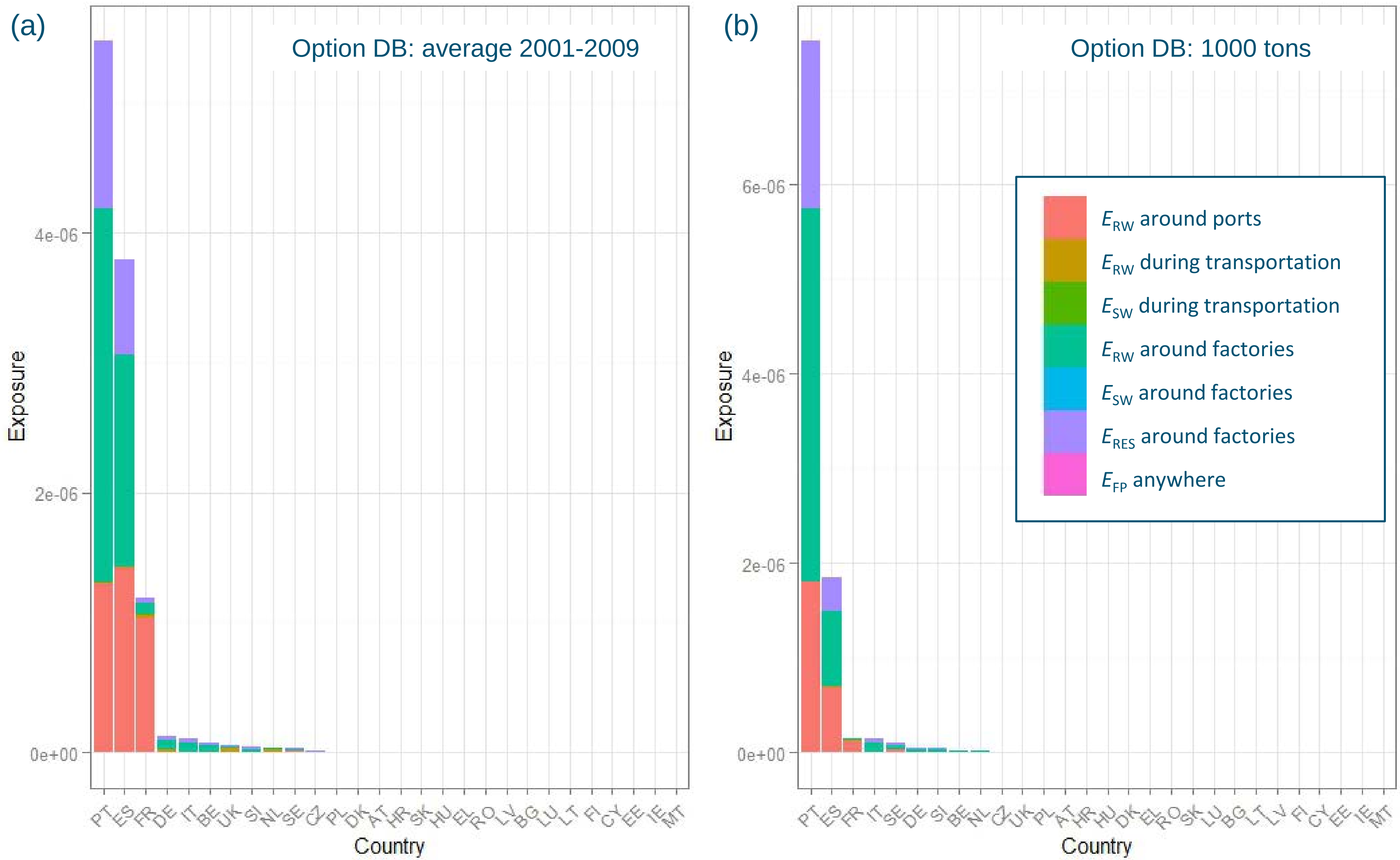
Exposure when considering three import options (BF: import of fumigated wood of red and white oaks, BNF: import of non-fumigated wood of white oaks, and DB: import of debarked wood of red and white oaks) and a scenario without regulation. Panel a describes the average exposure (propagules transferred to hosts per year) between 2001 and 2009, while panel b shows the variability of exposure over the years. The bar chart in panel (a) represent exposure for the most likely parameter values and error bars represent a 95% enclosure interval when considering parameter uncertainty. Y-axes are logarithmic.



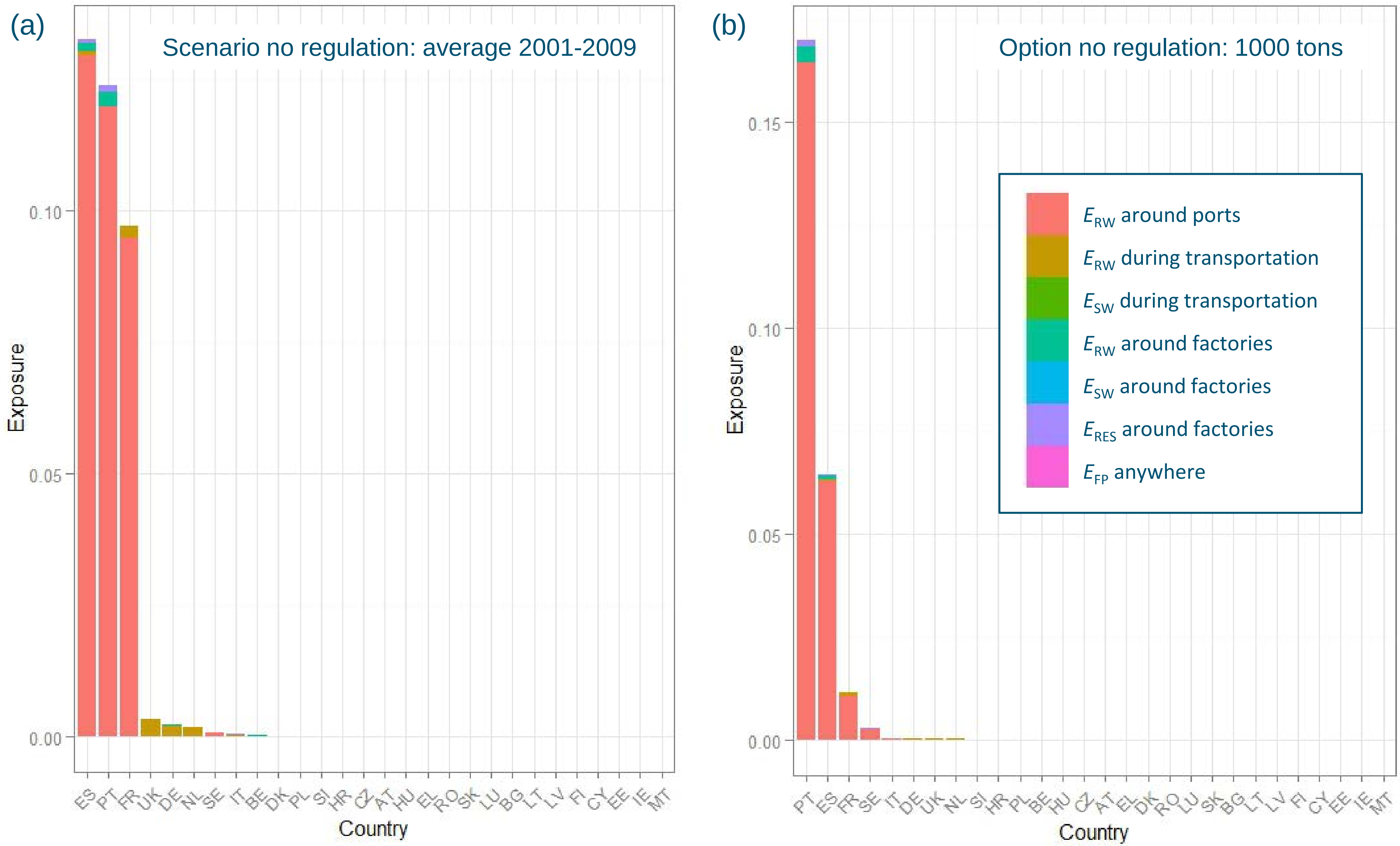
Exposure (*E*) at different points along the pathway and for each European country under import option BF (wood fumigated). Panel (a) shows the average exposure between 2001 and 2009 while panel (b) shows exposure resulting from importing 1000 tons of oak logs into every European country. Abbreviations for points of escape of the vector resulting in exposure: RW =round wood, SW = sawn wood, RES = wood residues, and FP = final products.



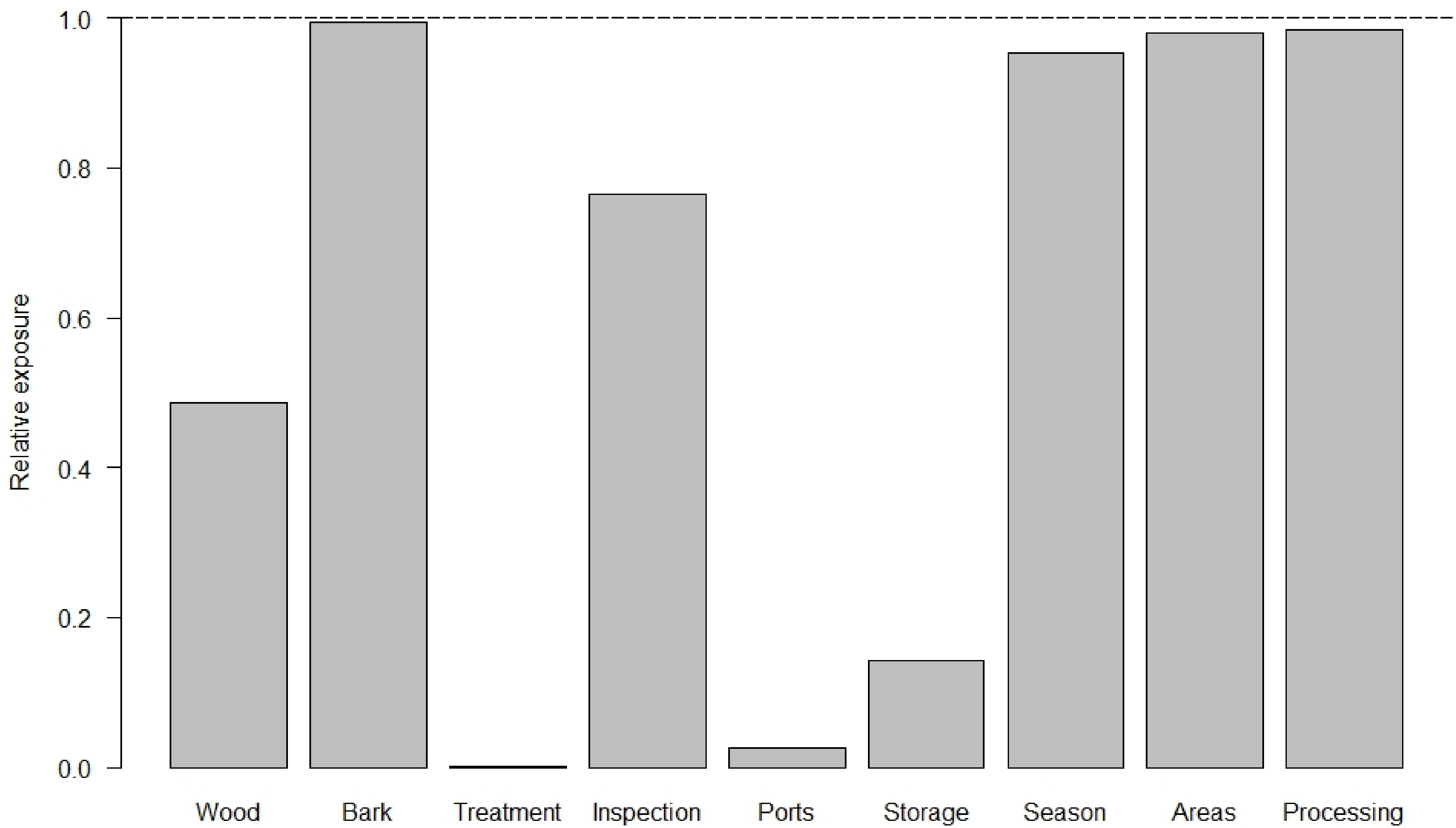
Exposure (*E*) at different points along the pathway and for each European country under import option BNF (wood of white oaks not fumigated). Panel (a) shows the average exposure between 2001 and 2009 while panel (b) shows exposure resulting from importing 1000 tons of oak logs into every European country. Abbreviations for points of escape of the vector resulting in exposure: RW =round wood, SW = sawn wood, RES = wood residues, and FP = final products.



Exposure (E) at different points along the pathway and for each European country under import option DB (wood without bark). Panel (a) shows the average exposure between 2001 and 2009 while panel (b) shows exposure resulting from importing 1000 tons of oak logs into every European country. Abbreviations for points of escape of the vector resulting in exposure: RW =round wood, SW = sawn wood, RES = wood residues, and FP = final products.



Exposure (*E*) at different points along the pathway and for each European country under the no regulation scenario. Panel (a) shows the average exposure between 2001 and 2009 while panel (b) shows exposure resulting from importing 1000 tons of oak logs into every European country. Abbreviations for points of escape of the vector resulting in exposure: RW =round wood, SW = sawn wood, RES = wood residues, and FP = final products.



Relative exposure calculated for individual measures when implemented in the scenario without regulation: effects of restricting imports to only white oaks (“wood”), allowing imports of only debarked wood (“bark”), allowing imports of only fumigated wood (“treatment”), increasing the detection efficiency (“inspection”), restricting imports to only a set of ports (“ports”), adopting particular storage conditions at the port (“storage”), restricting transportation to the cold season (“season”), restricting areas where wood can be transported to above 45° latitude (“areas”) and restricting wood processing to certified locations with destruction of wood residues (“processing”).

Outcomes

- Current regulations are effective
- Highest exposure around ports – greatest risk if high import and forest cover around port + suitable conditions for transfer
- Intra-EU trade relevant for exposure
- Sufficient information on trade; though intra-EU a bit challenging
- Considerable difficulty to estimate pest specific parameters
- Reviewers appreciate transparency on these difficulties

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Application of a wood pathway model to assess the effectiveness of options for reducing risk of entry of oak wilt into Europe†

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