

# Introduction pathways, mechanisms of invasion, and control strategies of emergent forest pathogens



Matteo Garbelotto

University of California at Berkeley

# Course Outline

- Principles of invasion biology
- Introduction pathways for plant pathogens
- Why invasions: lack of coevolution (high susceptibility of naïve hosts) does not explain all: ecological fitness, synchronicity with host, phenotypic plasticity, genomic variations, and above all traits affecting transmission rates are key  $R_t > 1 = \text{invasion}$
- Soilborne Phytophthoras in restoration sites, *P. cinnamomi*, SOD, Cypress Canker, *Heterobasidion* root rot including most valuable disease management option for each example

# EMERGENT DISEASES

- Caused by exotic pathogens introduced from a different region of the world. Either pathogen or pathogen+vectors may be introduced
- Caused by climatic or ecological changes increasing pathogenicity of native microbes
  - Global warming, strongest effects are at the margin of ranges
  - Anthropogenic alteration of the ecosystem
  - Exotic ecosystem and native pathogens: planting of exotics or planting off site

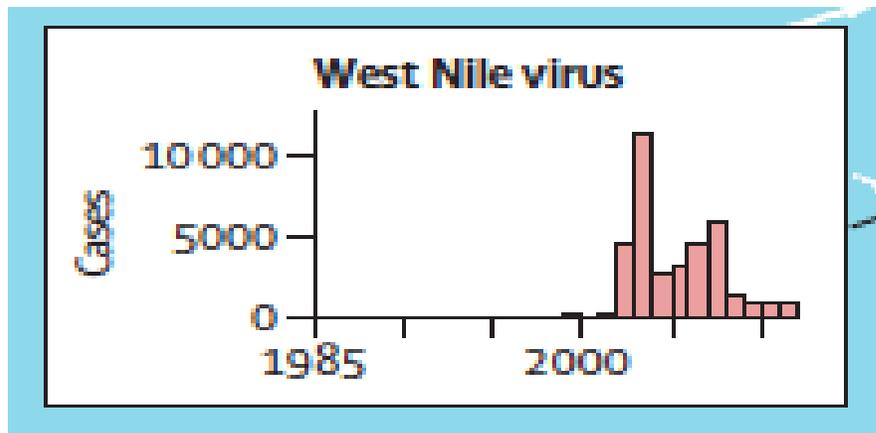
# Emergent diseases

- They are normally infectious, not to be confused with syndromes caused by a combination of abiotic and biotic factors
- They are long lasting or permanent, as opposed to secondary diseases that emerge periodically, for instance during prolonged drought

# Emergent Diseases: temporal patterns are generally different between

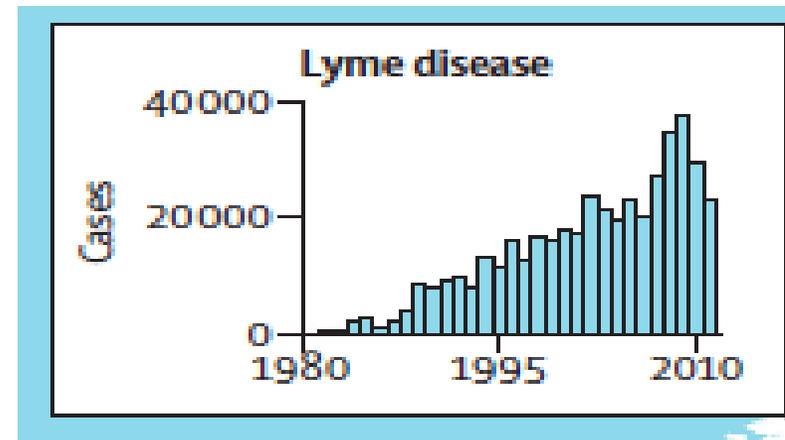
- EXOTIC AGENTS

- Rapid outbreaks
- May cycle down after outbreak



- NATIVE AGENTS

- Progressive, gradual even if dramatic increase
- Less likely to cycle down



# Human Domination of Earth's Ecosystems

Peter M. Vitousek, Harold A. Mooney, Jane Lubchenco, Jerry M. Melillo

Human alteration of Earth is substantial and growing. Between one-third and one-half of the land surface has been transformed by human action; the carbon dioxide concentration in the atmosphere has increased by nearly 30 percent since the beginning of the Industrial Revolution; more atmospheric nitrogen is fixed by humanity than by all natural terrestrial sources combined; more than half of all accessible surface fresh water is put to use by humanity; and about one-quarter of the bird species on Earth have been driven to extinction. By these and other standards, it is clear that we live on a human-dominated planet.

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interact with the atmosphere, with aquatic systems, and with surrounding land. Moreover, land transformation interacts strongly with most other components of global environmental change.

The measurement of land transformation on a global scale is challenging; changes can be measured more or less straightforwardly at a given site, but it is difficult to

- Climate Change, Urbanization and Biological Invasions are the top three causes of loss of biodiversity on earth in the Anthropocene

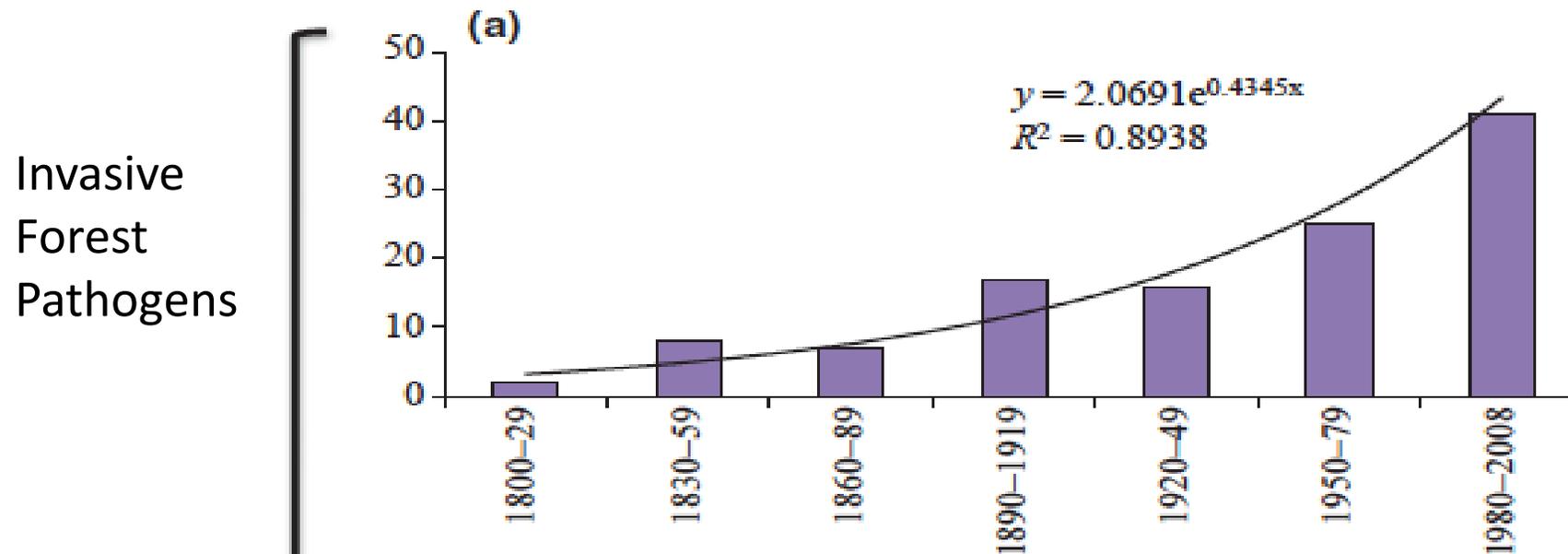
# Bases of Invasion Biology of Pathogens

- **Source:** it can be either a pathogen in its native area, possibly with a cryptic phase, or not (weak pathogen or endophyte). In general, the larger the populations of the pathogen, the easier they will become a source
- **Transport, survival:** related to resting structures, distance, season, substrate (wood, soil, live plants, animal vector)

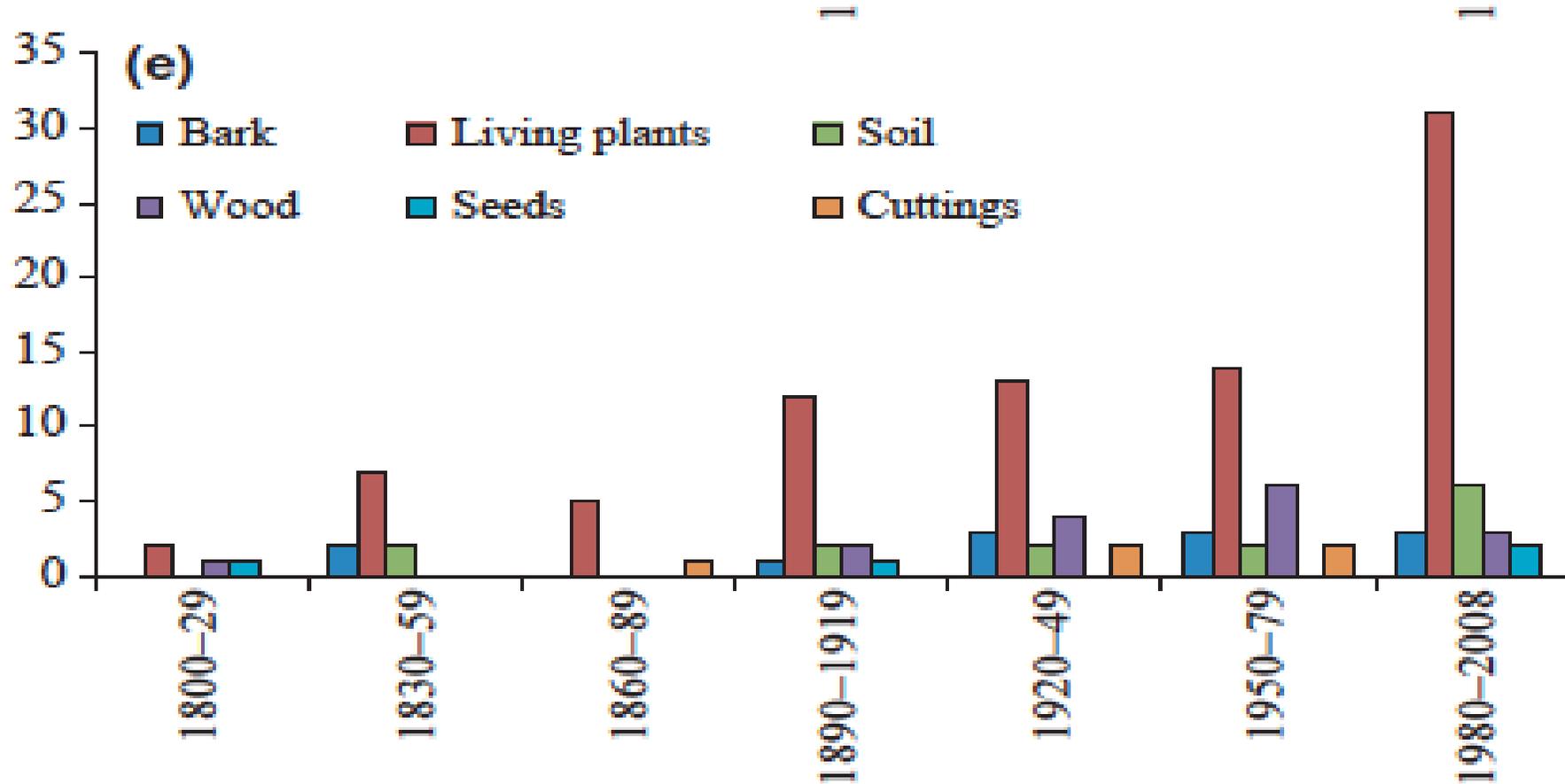
# Biogeographical patterns and determinants of invasion by forest pathogens in Europe

2013

A. Santini<sup>1</sup>, L. Ghelardini<sup>1</sup>, C. De Pace<sup>2</sup>, M. L. Desprez-Loustau<sup>3</sup>, P. Capretti<sup>4</sup>, A. Chandelier<sup>5</sup>, T. Cech<sup>6</sup>, D. Chira<sup>7</sup>, S. Diamandis<sup>8</sup>, T. Gaitniekis<sup>9</sup>, J. Hantula<sup>10</sup>, O. Holdenrieder<sup>11</sup>, L. Jankovsky<sup>12</sup>, T. Jung<sup>13</sup>, D. Jurc<sup>14</sup>, T. Kirisits<sup>15</sup>, A. Kunca<sup>16</sup>, V. Lygis<sup>17</sup>, M. Malecka<sup>18</sup>, B. Marcais<sup>19</sup>, S. Schmitz<sup>5</sup>, J. Schumacher<sup>20</sup>, H. Solheim<sup>21</sup>, A. Solla<sup>22</sup>, I. Szabó<sup>23</sup>, P. Tsopelas<sup>24</sup>, A. Vannini<sup>25</sup>, A. M. Vettraino<sup>25</sup>, J. Webber<sup>26</sup>, S. Woodward<sup>27</sup> and J. Stenlid<sup>28</sup>



# SUBSTRATE/PATHWAY of introduction



# Globalization

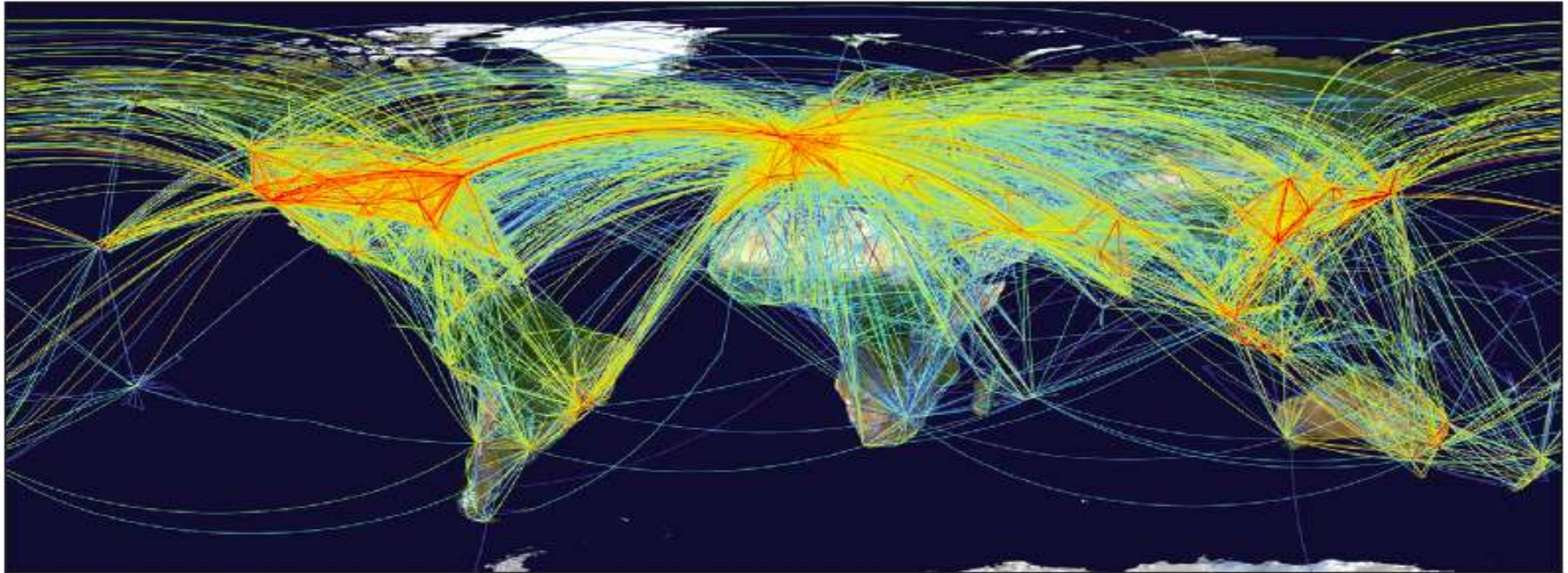


Figure 2: The global aviation network

# Bases of Invasion Biology of Pathogens

- Establishment success is related to
  - presence of host (if host specific) or of similar host
  - survival as saprobe
  - similarity in climate between home and new region
  - lack of competitors/predators.
- If transmission  $>$  mortality then organism becomes invasive ( $R_t > 1$ )

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# Presence of host

- How large and how far are the hosts
  - SYSTEMATIC INTRODUCTION
    - Worse case scenario: we introduce exotics in natural ecosystems (soilborne Phytophthoras in restoration sites)
    - Second worse: introduction in parks and large scale landscape (Cypress canker)
    - Third worse: introduced through ornamental plants (escape from gardens and nurseries: Sudden oak Death)
    - Fourth worse: Introduced in agricultural settings: *Phytophthora cinnamomi*
  - ACCIDENTAL INTRODUCTIONS: *Heterobasidion* and *Ceratocystis* in Italy