



Sudden Oak Death

caused by *Phytophthora ramorum* (Oomycetes)

Invasive plant diseases

- Chestnut blight
(*Cryphonectria parasitica*) on
American chestnut
- White pine blister rust
(*Cronartium ribicola*) on
Western white pine
- Dutch elm disease
(*Ophiostoma ulmi*) on
American elm
- Sudden oak death
(*Phytophthora ramorum*) on
tanoak, oak, larch, many
more.

These are capable of eliminating certain
host species from an ecosystem



Chestnut blight caused by the fungus
Cryphonectria parasitica

Phytophthora – the plant destroyer



P. infestans – responsible for the Irish potato famine in 1845

P. sojae - soybean stem and root rot

Several *Phytophthora* spp. cause disease on cacao

P. cinnamomi – causes damage to forest ecosystems worldwide

P. ramorum – causes Sudden Oak Death (SOD)

Phytophthora root rot

Several species including

P. cinnamomi

P. citricola

P. cactorum

P. parasitica

P. ramorum has not
generally been observed
to cause root rot
symptoms



Phytophthora lateralis

A close relative of *P. ramorum* that normally causes root disease but has been found to cause aerial infections in France and coastal Oregon.



Hosts:

Port-Orford cedar (*Chamaecyparous lawsoniana*)

C. obtusa – Taiwan and US

Pacific yew (*Taxus brevifolia*)

Thuja occidentalis - UK



Phytophthora kernoviae



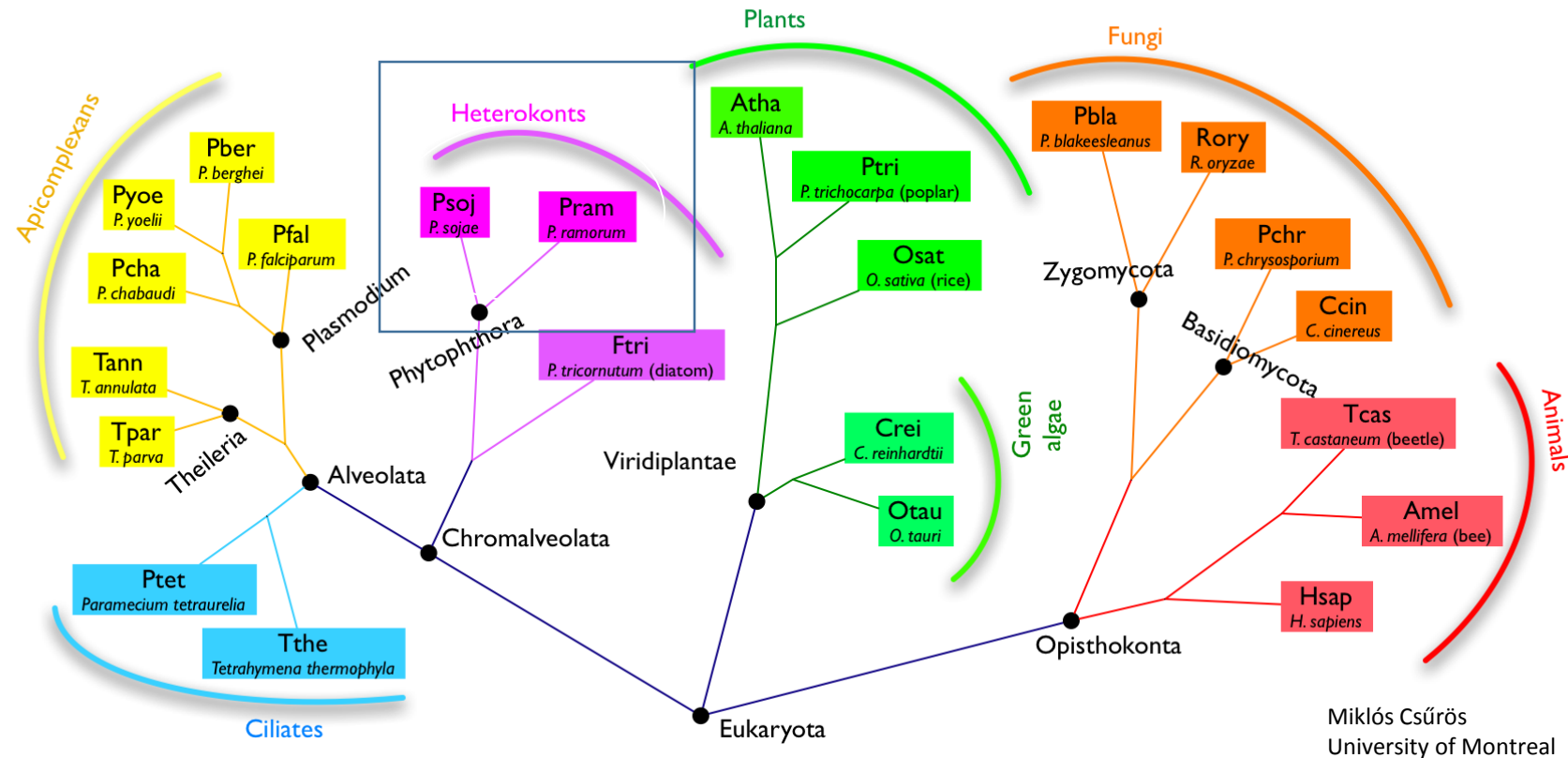
In UK – more aggressive than Pr on Rhododendron.

May be endemic in New Zealand

Not present in North America



Phytophthora is not a fungus

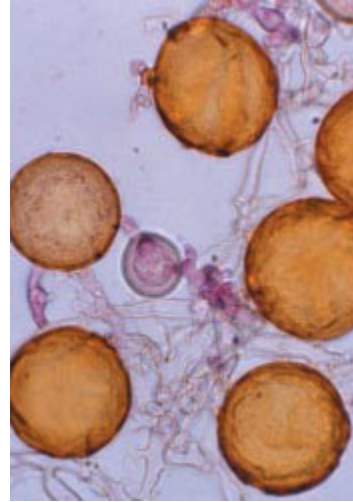


- Oomycetes were once considered to be fungi
- Fungi and Oomycetes have similar growth forms – convergent evolution
- Control agents for fungi may not work for Oomycetes and vice-versa

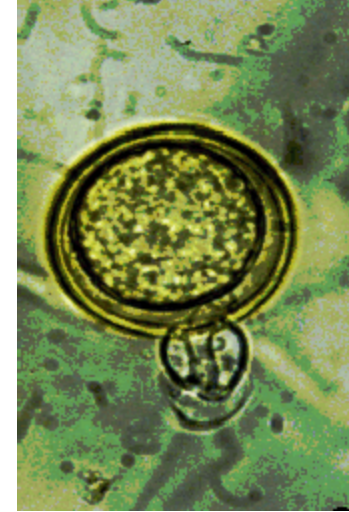
Phytophthora spore stages



Sporangia containing
swimming zoospores



Chlamydospores



Oospores (*P. infestans*)

Phytophthora is microscopic and species
can be identified by spore stages and/or
DNA sequencing

P. ramorum genetics

- Two mating types – A1 and A2
- Four clonal lineages – NA1, NA2, EU1, EU2

NA1 and NA2

All A2

EU1

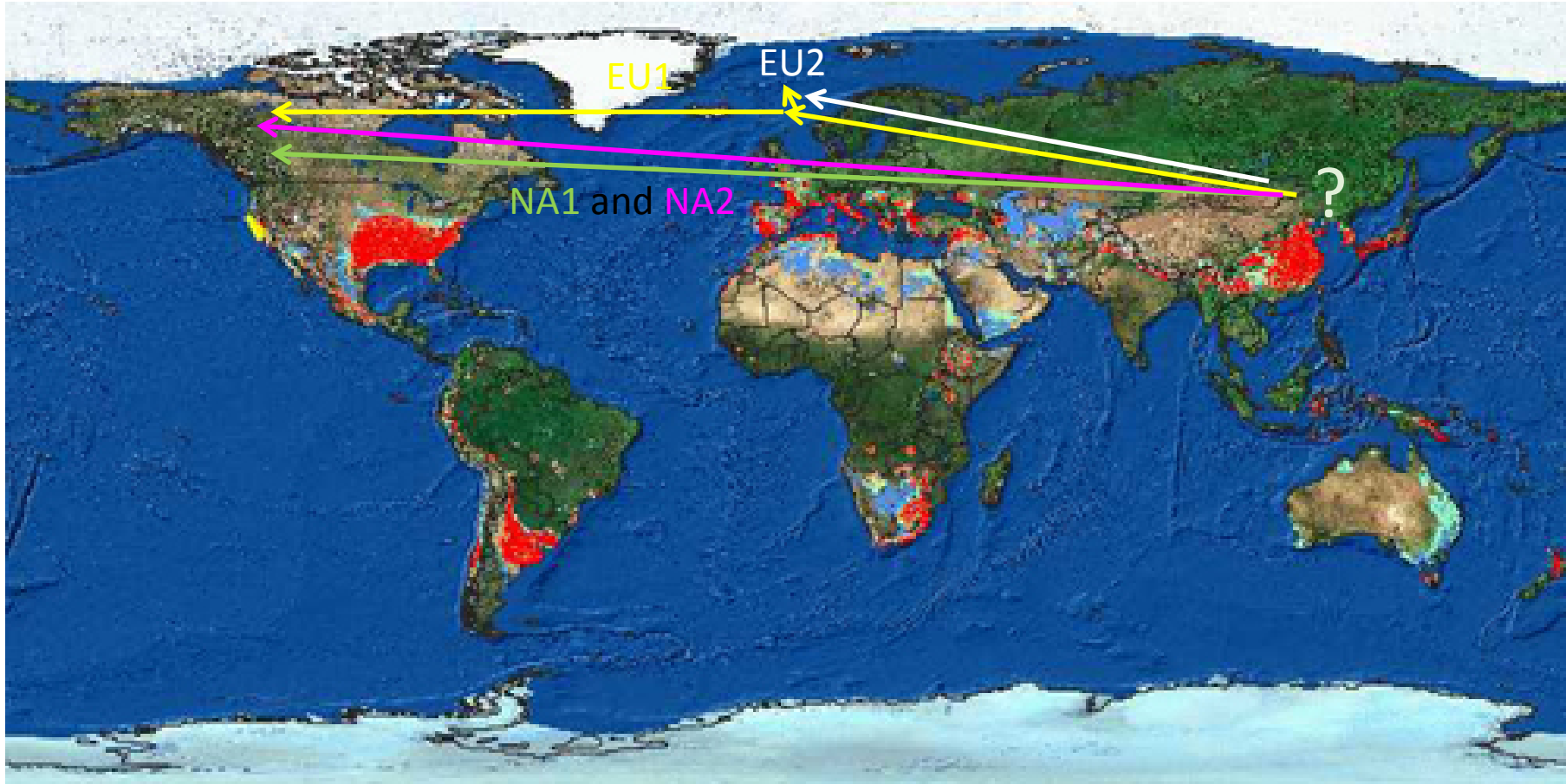
Mostly A1,
with a few A2

EU2

All A1

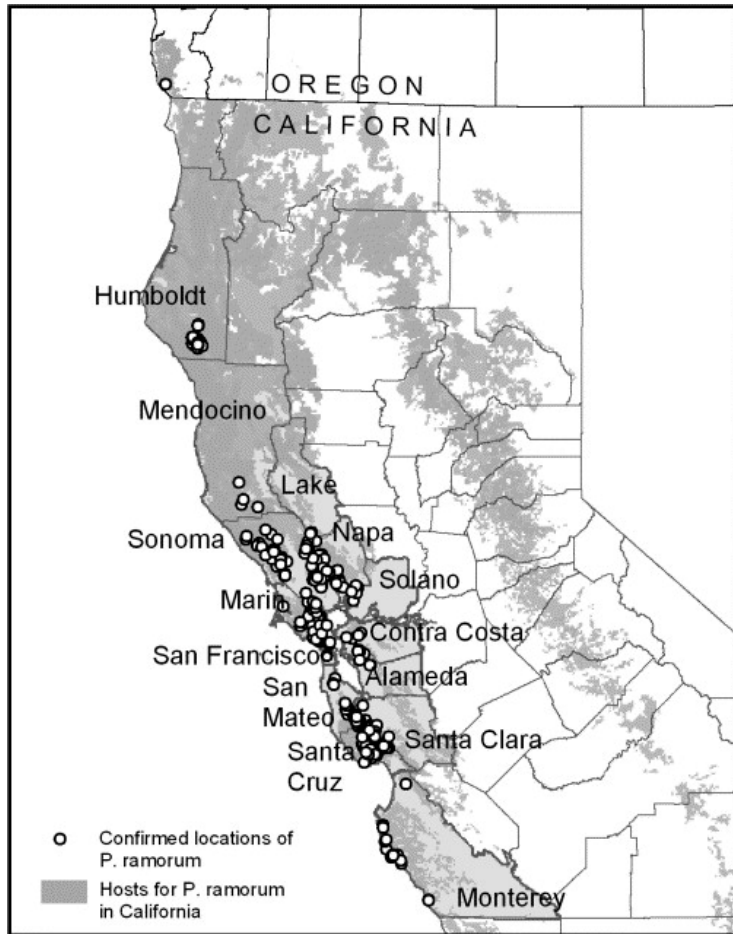
No evidence of breeding between EU and US populations has been observed, although it has been done in the lab.

Possible *P. ramorum* origins

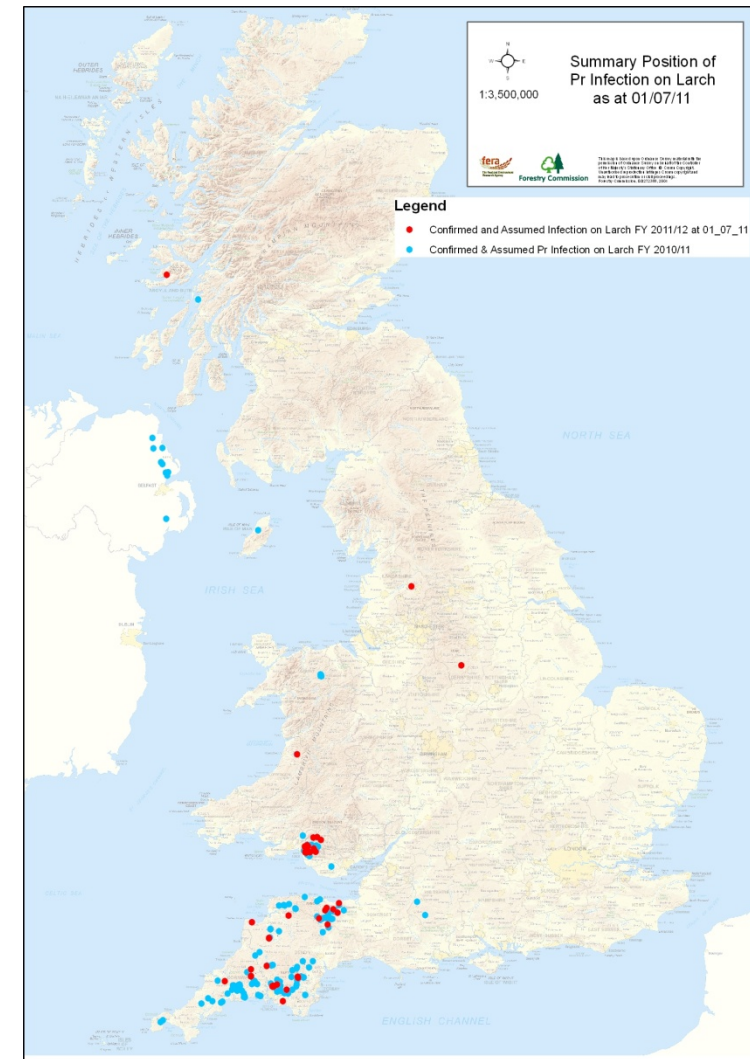


We don't know where it originally came from. High risk areas for Sudden Oak Death with suitable climate and native plants are shown in bright red.

SOD distribution in forests



Western US – 15 quarantined counties in CA and part of Curry County in OR



UK – for more recent info go here:
<http://www.forestry.gov.uk/forestry/infd-86ajqa>

Symptoms on trees

- Bleeding cankers that can girdle the tree and kill it
- Host species in Fagaceae: oaks, beech, tanoak
- Other *Phytophthora* spp can cause the same symptoms

P. cambivora on Beech



P. ramorum on Oak

Phytophthora leaf and shoot blight

P. citricola

P. cactorum

P. syringae

P. ramorum

P. kernoviae

All symptoms look the same.



Foliar hosts carry the disease

- California bay laurel (*Umbellularia californica*)
- *Rhododendron ponticum*
- Larch

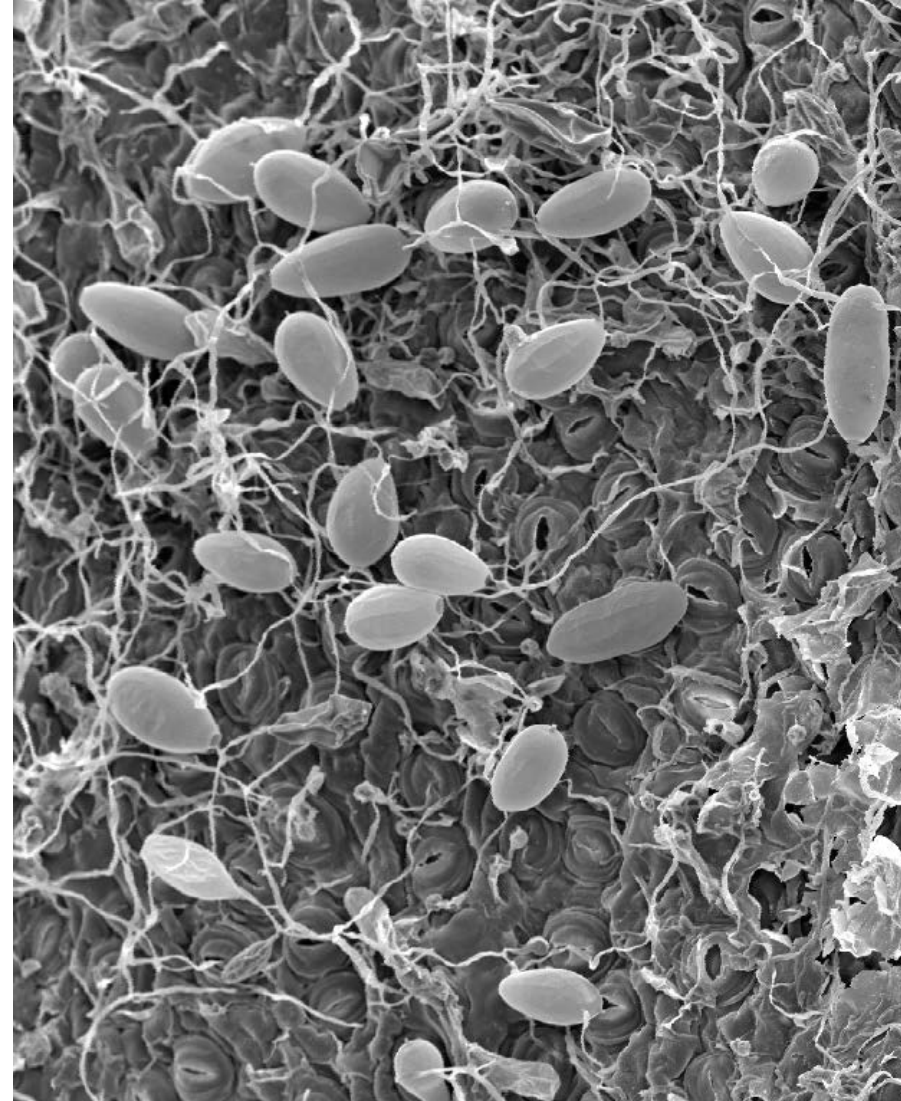


Foliar hosts

Epidemiologically important
hosts produce large numbers of
sporangia



Rhododendron 'Purple Splendour'



SEM Photo by K. McKeever, WSU

Chlamydospores in infected foliage are another source of Pr inoculum



P. ramorum in nurseries

Ornamental nurseries are a means of long-distance spread.



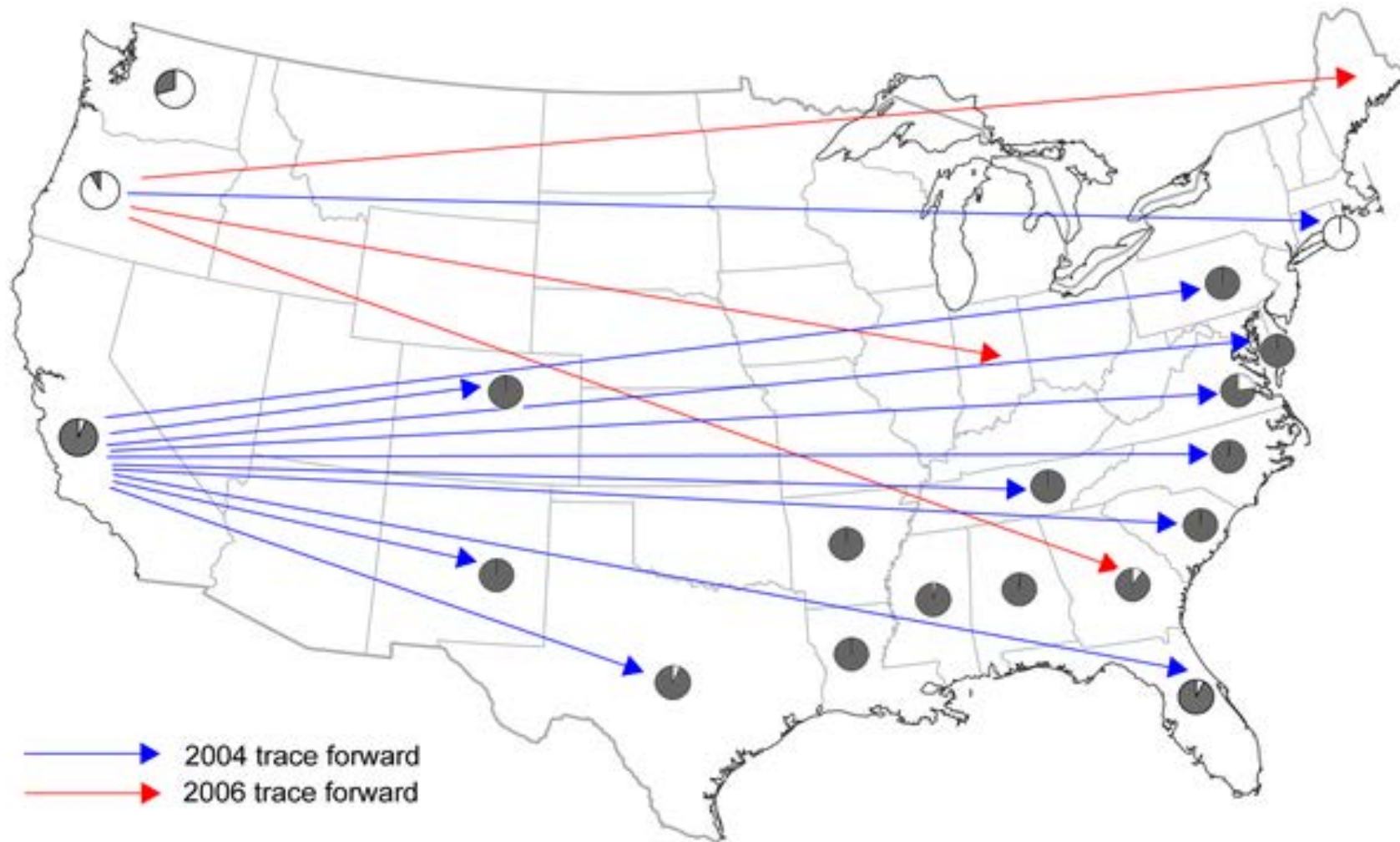
Interstate shipping from west coast nurseries

- Washington – 282
- Oregon – 1800
- California - 1562



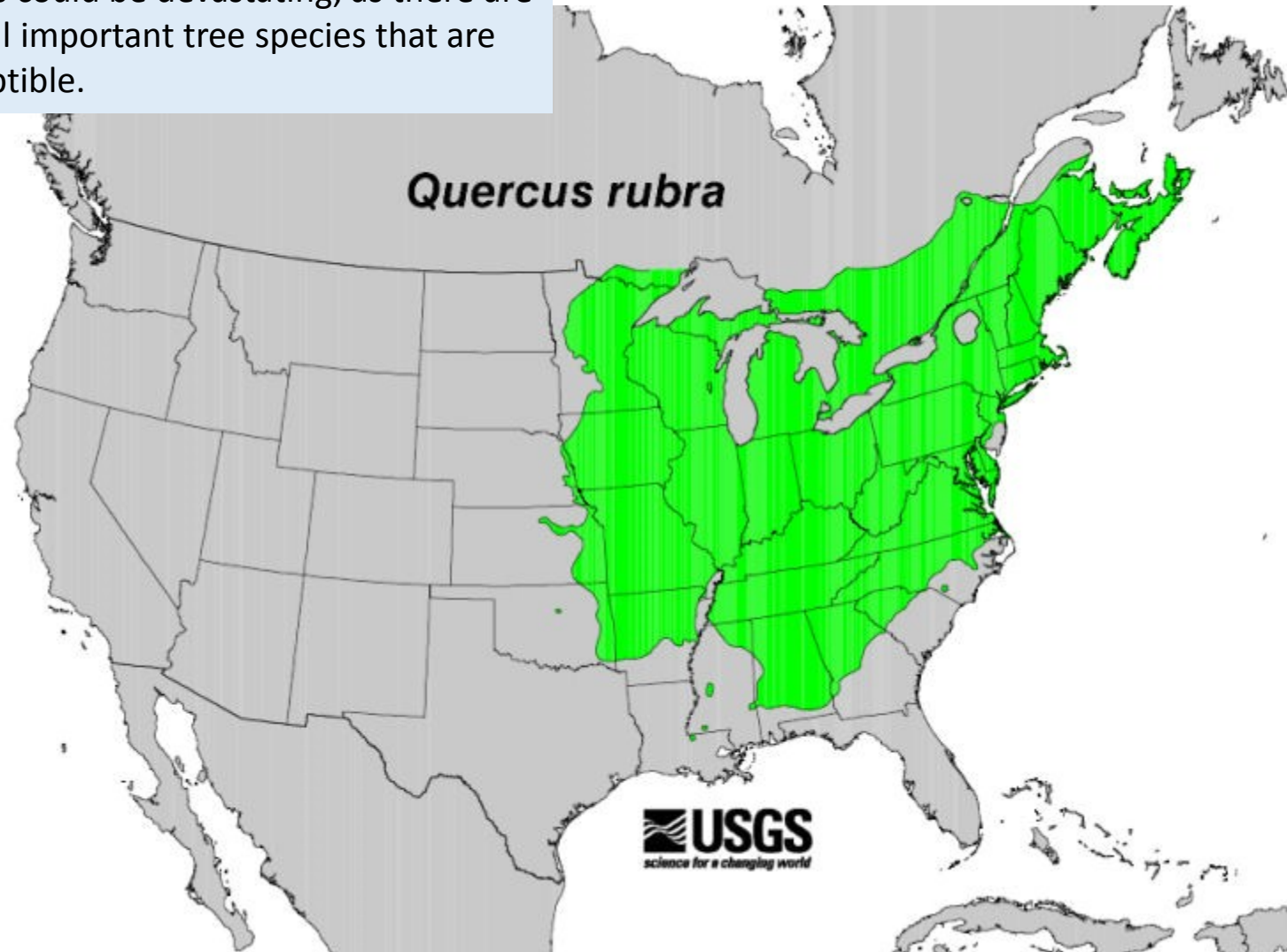
2009 data from WSDA

Figure 6. NA1 migration pathways.

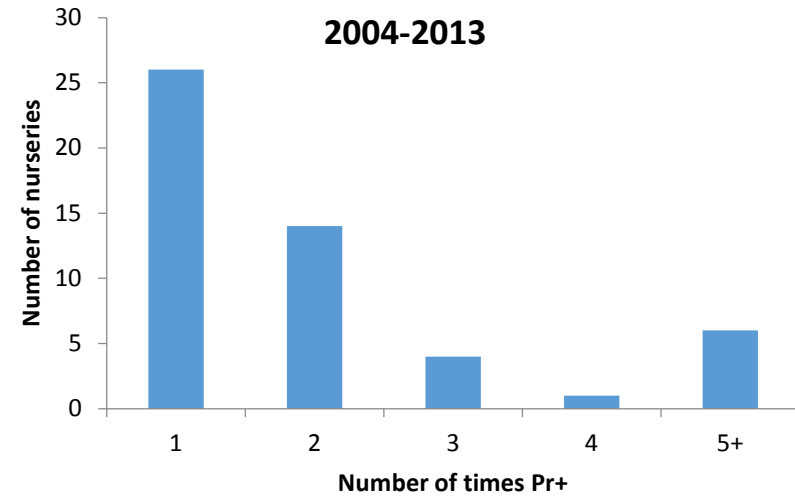
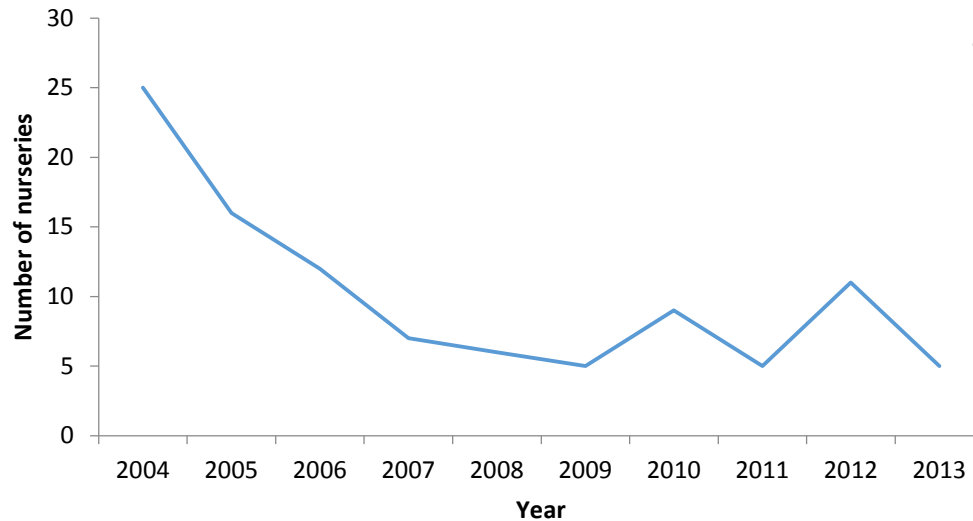


Goss EM, Larsen M, Chastagner GA, Givens DR, et al. (2009) Population Genetic Analysis Infers Migration Pathways of *Phytophthora ramorum* in US Nurseries. PLoS Pathog 5(9): e1000583. doi:10.1371/journal.ppat.1000583
<http://www.plospathogens.org/article/info:doi/10.1371/journal.ppat.1000583>

P. ramorum establishment in eastern US forests could be devastating, as there are several important tree species that are susceptible.

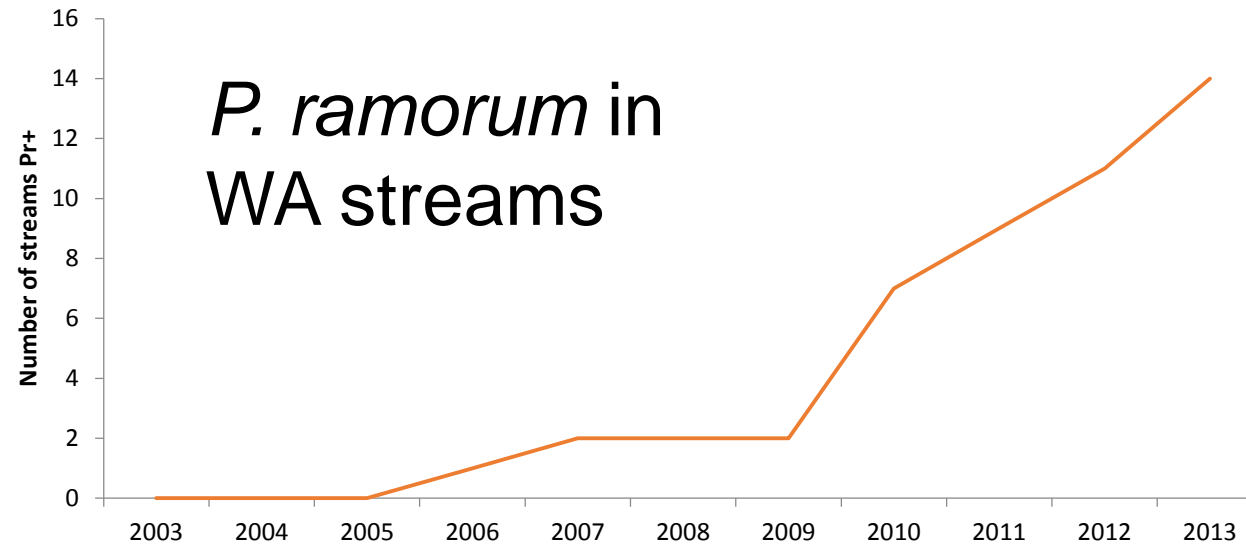


P. ramorum in WA nurseries



WSDA annually inspects nurseries who ship interstate.

As of 3/2014 only growers who have been Pr+ since 3/2011, want to continue shipping, and are in a regulated area will be inspected.



The 'filthy five'

In nurseries, *P. ramorum* is most commonly found on these 5 hosts:



Rhododendron



Viburnum



Pieris

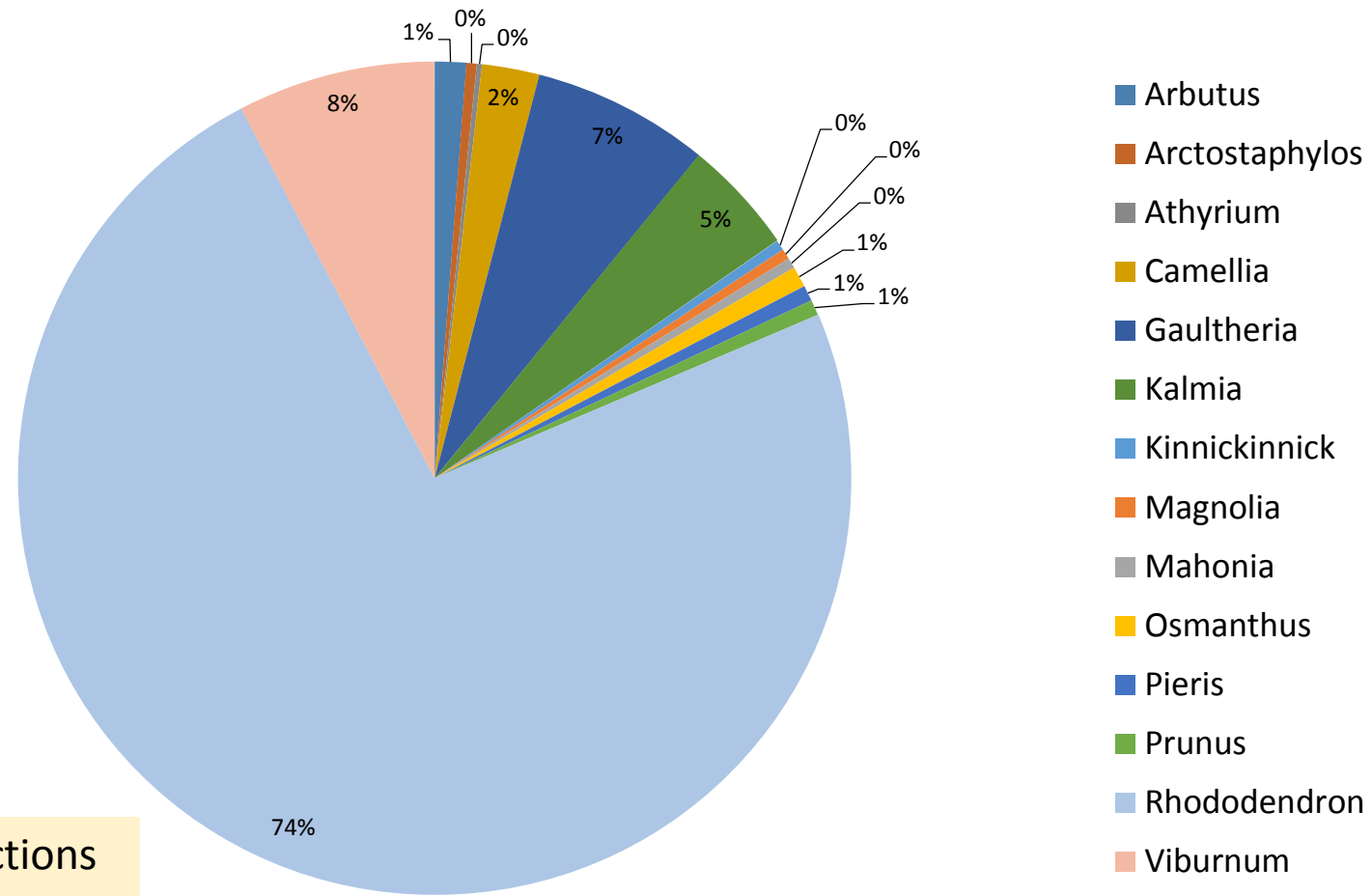


Camellia



Kalmia

P. ramorum from WA nursery hosts 2004-2013



Most Pr detections
in WA nurseries are
on Rhododendrons

How does SOD impact WA's economy?

Ornamental nurseries who ship interstate

Forest products: Douglas fir and western hemlock logs (more than 12 bn \$US in 2010)

Non-timber forest products: greenery, transplants, floral products

Christmas trees

All these commodities represent a large proportion of WA trade



Will it infect humans or animals? What about food safety?

No. Although there are oomycetes that cause disease in animals.



P. ramorum does not attack food crops such as corn and soybeans. Its main hosts are woody plants and some herbaceous plants.

How do you get rid of SOD on plants?

- There are no known fungicides that will kill the organism once infection has occurred
- Destroy infested plants - bury in a landfill or burning to ash

Prevention is the best means of controlling SOD (or any other plant disease)

