Utilizing genetic information to address *Phytophthora ramorum*/Sudden Oak Death

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Alt. title 1

Will SOD lead to species extinction?

A genetics answer

Alternative title 2

SOD

Can Genetics Save Us?

Why compile genetic information?

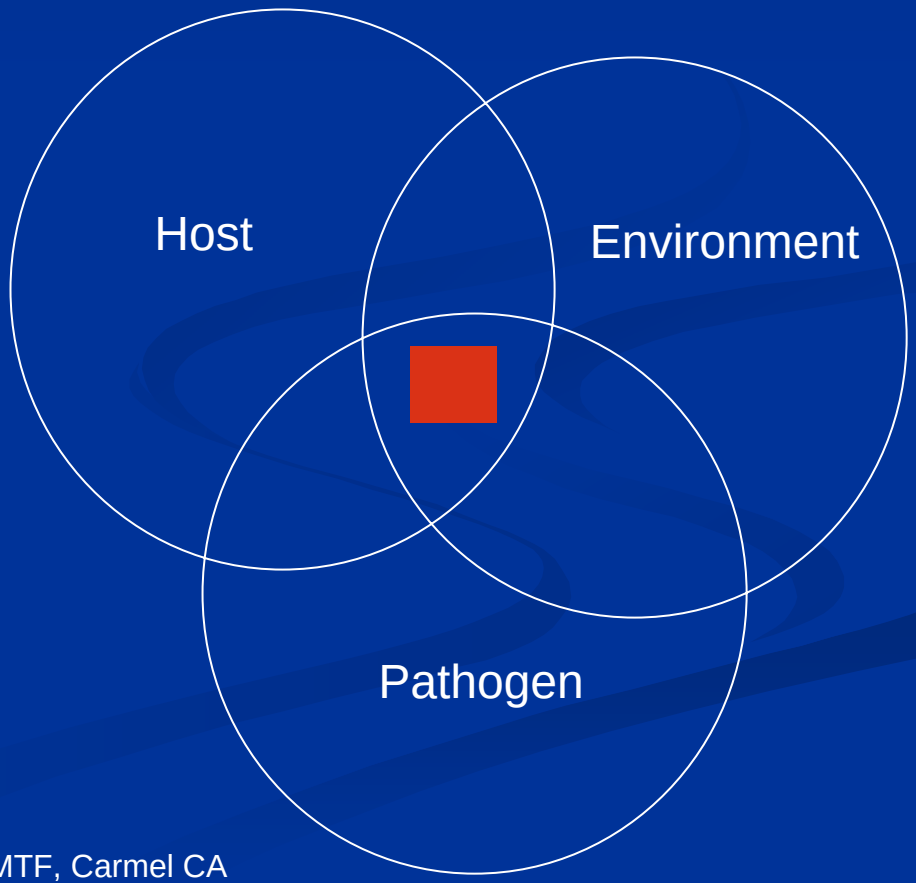
- **Understand Future Impacts of SOD**:
  - Establish info on baseline resistance levels in native host populations to predict impacts to each tree species and associated ecosystems

- **Understand capacity of pathogen to evolve towards greater virulence/aggressiveness**

- **Plan management activities to enhance frequency/level of resistance**

Impacts of SOD, depend upon

- Environment
- Pathogen (genetics)
- Host (genetics)
- Interactions (GxE…)
- Timeframe



Is there host resistance to SOD?

- **Yes (…most likely) – more importantly:**
  - What is frequency?
  - How many resistance mechanisms?
  - Is it complete or partial resistance?
  - **Is it durable?**
  - Is it useful now or requires breeding?
  - Let nature take its course and species will be okay? …examples from other non-native pathogens

Is Resistance Futile?

- Pathogen Genetics
  - A1 & A2 mating types
  - Evolutionary potential (population size, migration, sexual/asexual reproduction
- Long lived nature of trees
- Examples – other Forest Trees/pathogens

Research Needs

- Artificial inoculation system
- Field Site
- Host genetics & conservation
- Pathogen genetics
- Durable resistance
- OTHER…
  - See DRAFT ‘white paper’

Testing for Phytophthora lateralis resistance in Port-Orford-cedar

Is a breeding program needed?

- **More info needed on projected impacts**
- What other management tools are there?
- Is it possible? Yes*, but …
- Examples from other forest tree species (to nonnative pathogens)
- Expertise needed…
- When could it start?
- Public support needed

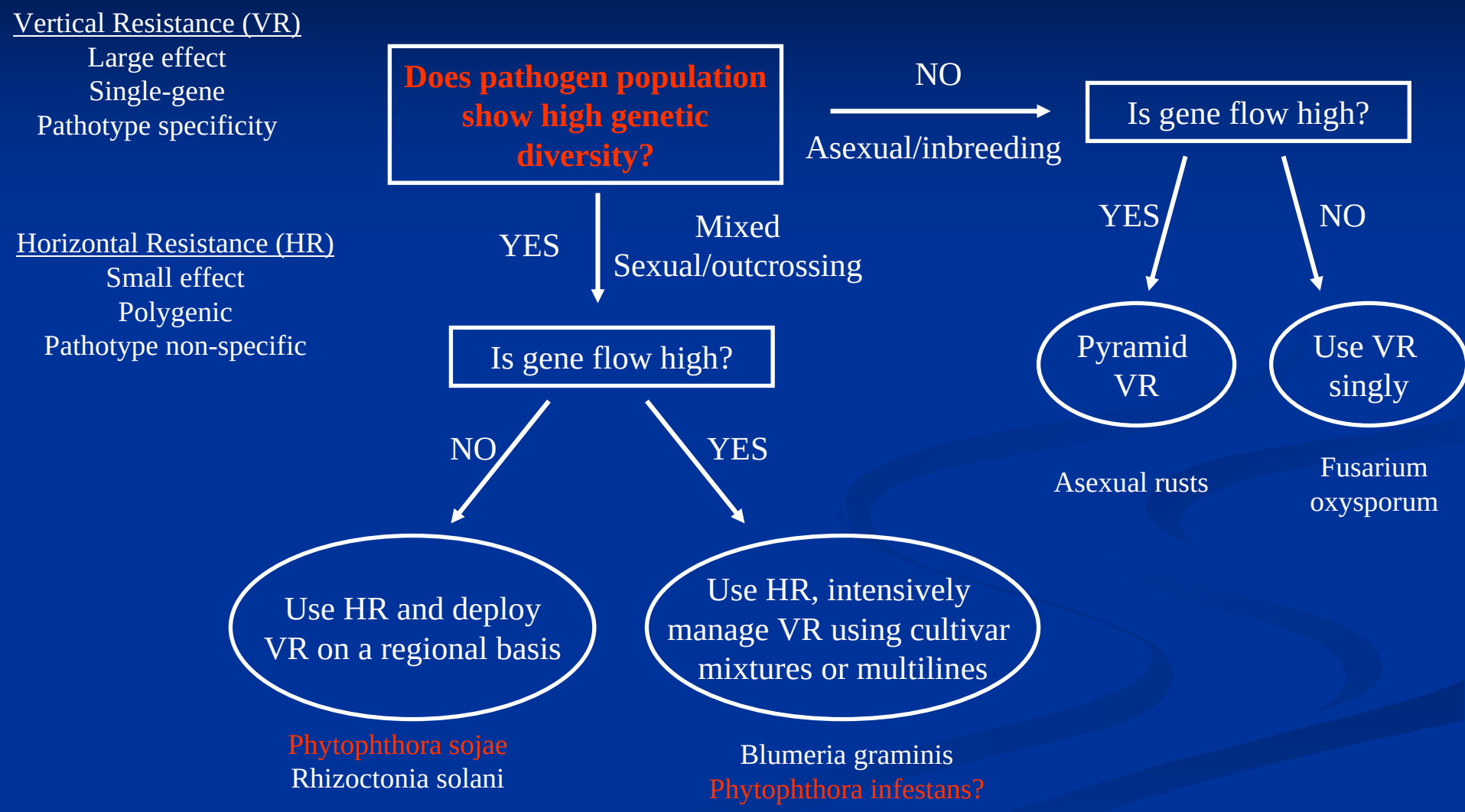
Developing Resistant POPULATIONS

- Long term
- Expensive
- Different from crop breeding
  - Genetic diversity, long lived, partial resistance
- Cooperative effort
- Specialists needed: Tree breeders, pathologists, geneticists, etc.
- Doable: POC example….

Partial Resistance

- ‘While race-nonspecific resistance (to P. infestans) may contribute to durability of disease control, its polygenic inheritance makes breeding difficult and cumbersome’ (Pilet et al 2005)

A Flow-chart to Guide Deployment of R-genes Based on Knowledge of Pathogen Genetic Structure



Bruce McDonald, ETH Zurich

Restoration Obstacles

- Even if resistant seedlings (or seed) is available, how to return to forest?

Recommendations

- Formation of Genetics/Resistance Steering Committee
- Increased research efforts for genetics/resistance related work
- ‘White paper’ on genetic information needed (draft handout at this mtg)

WWP – Canker Types

Risk Assessment for Evolution Based on Genetic Structure

48 pathosystems considered thus far by Celeste Linde

Mixed "epidemic" genetic structure	High (3)	*Phytophthora sojae* *Rhizoctonia solani*	*Leptosphaeria maculans* *Rhynchosporium secalis* *Mycosphaerella fijiensis* *Mycosphaerella graminicola* *Venturia inaequalis*	*Blumeria graminis* *Bremia lactucae* *Phytophthora infestans* *Puccinia graminis tritici* *pre- 1930s*
outcrossing Sexual high genotype diversity inbreeding	Medium (2)	*Armillaria mellea*	*Tilletia and other smuts*	
Asexual low genotype diversity	Low (1)	*Fusarium oxysporum melonis, lycopersici, cubense* *Pseudomonas solanacearum* *Xanthomonas malvacearum* *X. campestris vesicatoria* *X. oryzea oryzae*	*Erwinia amylovora*	*Magnaporthe grisea* *Colletotrichum graminicola* *Cladosporium fulvum* *Puccinia graminis tritici* *Puccinia striiformis*
Reproduction /mating system		Low (1)	Medium (2)	High (3)
Gene flow		soilborne, difficult to disperse ~ 5 meter total dispersal	propagules waterborne, moderate dispersal ~100 m – within field	propagules airborne, easily dispersed ~10 – 1000 km