Forest pathology in the age of the anthropocene

Richard C. Hamelin
Biotic disturbances are part of natural forest ecosystems

- In natural forest ecosystems there is an equilibrium between trees, insects and pathogens
- Pathogens play an important positive role in healthy forest ecosystems: forest openings, decomposition of biomass, nutrient cycling
In the anthropocene age the equilibrium is disturbed.

Domestication

Forest invasive alien species

Climate change
Globalization is making the planet smaller and invasive species are loving it!
Forest invasive alien diseases cause irreversible ecosystem changes

Chestnut Blight  
Sudden Oak Death
White pine blister rust was introduced from Asia and Europe
White pine blister rust and other invasives cause impact on wildlife

Invasive pathogen threatens bird–pine mutualism: implications for sustaining a high-elevation ecosystem

Shawn T. McKinney,1,3 Carl E. Fiedler,1 and Diana F. Tomback2
Prevention is the best protection against invasive species.

High import volumes increase exposure to threats.

Fibre supply threatened.

Cost of inaction $2B.

Prevention, Preparedness, Response, Recovery.

Prevention is the best protection against invasive species.
Biosurveillance is important to prevent invasion of forest invasive alien species

- Canada is a signatory to the International Plant Protection Convention
- Establishes standards for phytosanitary measures
- Canadian Food Inspection Agency is our National Pest Protection Organization
- Guidelines for surveillance, list of regulated pests, etc
Insects and fungi can be propagated on wood packing material.
Pathogens can be transmitted asymptomatically on seedlings

- Infected symptomatic seedlings are easy to spot
- Infected seedlings that do not show symptoms appear healthy, but they are still infected!
The challenge: rapid and accurate identification of these threats

Asian gypsy moth

Sudden oak death
The remarkable advances in genomics is part of the solution
Innovations in genomics are driven by human health.
Genomes can be used to develop rapid and accurate detection tools

Identification of genome targets

Pathogen detection and monitoring assays
Phytophthora: the plant destroyer!
What is the impact of human activities on Phytophthora?

- Very little data on species present in Canada outside agricultural crops.
- Hypothesis: anthropogenic impact increases abundance and diversity.
DNA barcoding Phytophthora in natural and urban environments

Meta DNA barcoding ITS1

Soil samples

Barcoding with ITS1 and 2

Baiting & culturing
Human-impacted sites have more Phytophthoras and greater diversity

Chi-square = 7.2, p=0.027
The highest proportion of unknown Phytophthoras is in urban sites.
Phytophthora ramorum causal agent of sudden oak and larch death
Genomes of >100 *P. ramorum* from a global collection

Causes sudden oak death: four distinct lineages with different virulence profiles

EU1

EU2

NA1

NA2
Dynamics of *P. ramorum* outbreak in BC
Dynamics of *P. ramorum* outbreak in BC
Dynamics of *P. ramorum* outbreak in BC

- **NA2**
- **NA1**
- **EU1**

Genotype 1, Genotype 2, Genotype 3
Phytophthora ramorum assays used with over 100k samples

- Helped prevent spread of pathogen outside nurseries
Over 50 DNA tests for the detection and identification of pathogens and insects

- Top 50 most unwanted pathogens and insects on pines, oaks, poplars, larch, ash, etc
- Application of these DNA tests at FLNRO, CFIA, AESRD, QMNR, OMNR, City of Victoria, Butchart Gardens
BioSurveillance of Alien Forest Enemies: BioSAFE
Bringing genomics to the field: it’s happening!
Merci!!!