

The epidemiology of *Phytophthora ramorum* and *P. kernoviae* at two historic gardens in Scotland

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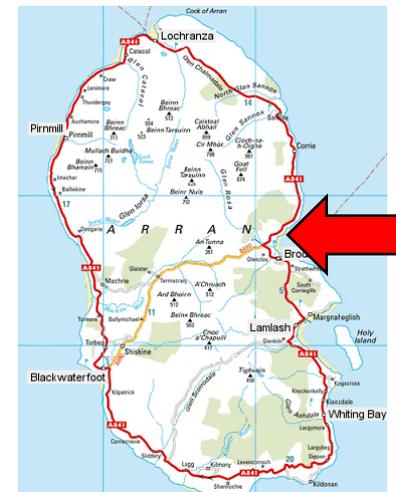


Background

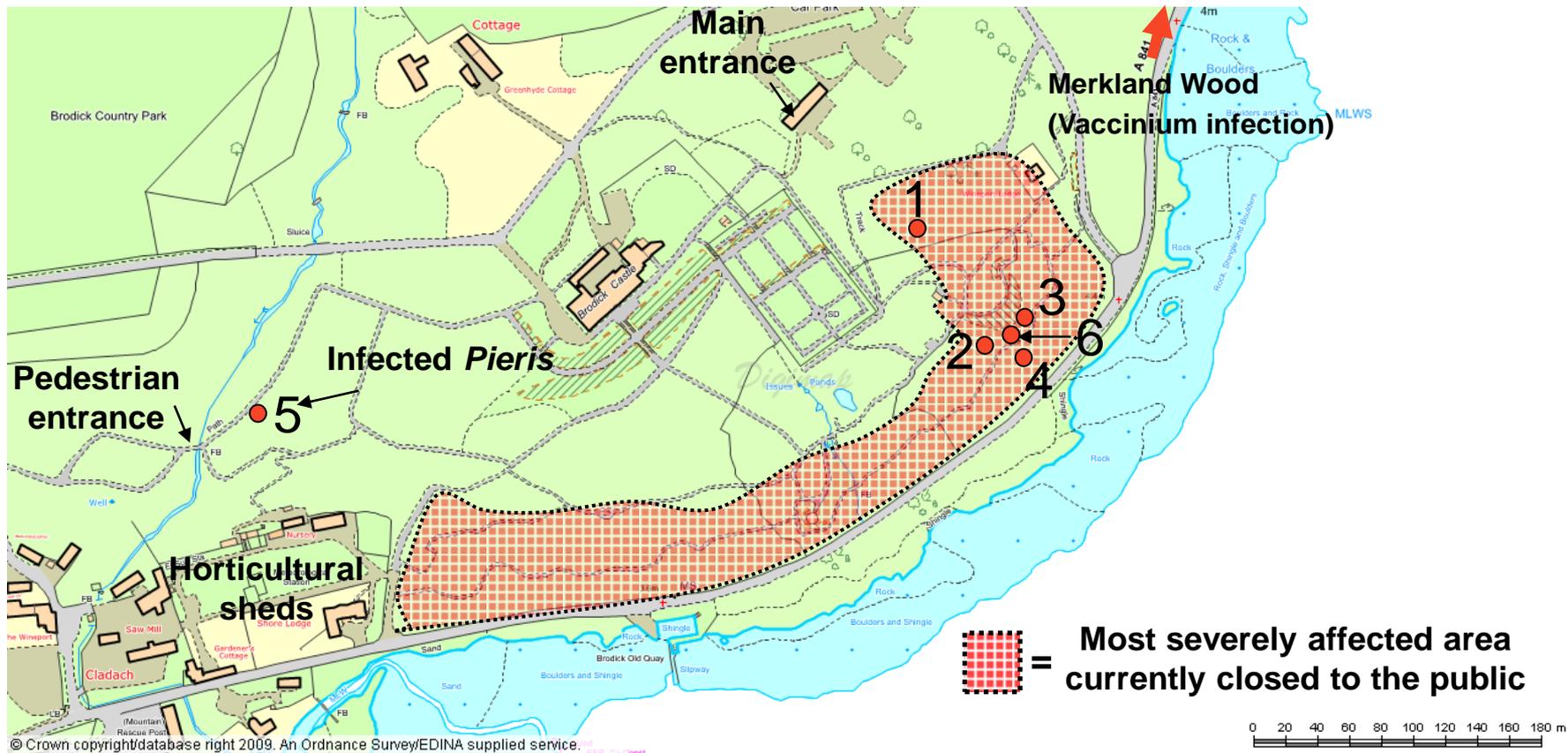
- ❖ Scottish Government project started in August 2009
- ❖ Aims:
 - Develop an understanding of the local development and spread of these pathogens in the managed garden context by:
 - Quantifying the relationship between inoculum levels and environmental conditions
 - Developing models to determine the impact of environmental and management practice on disease spread
 - Provide management advice to garden staff and managers to reduce the risk of spread
- ❖ Two study locations chosen in the west of Scotland

First study location – Brodick Castle

- ❖ Brodick Castle Garden is on the east coast of Arran in the west of Scotland
- ❖ Managed by the National Trust for Scotland and infected with Pk
- ❖ ca.2500mm rain per year
- ❖ Annual mean temperature 9.4 to 9.7 °C (ca. 50 °F)
- ❖ Mean daily max and min., 14.6 to 18.5 °C; -3.4 to -0.9 °C
- ❖ The garden contains many Pr and Pk host species including *Rhododendron*, *Magnolia*, *Pieris* and *Larix*



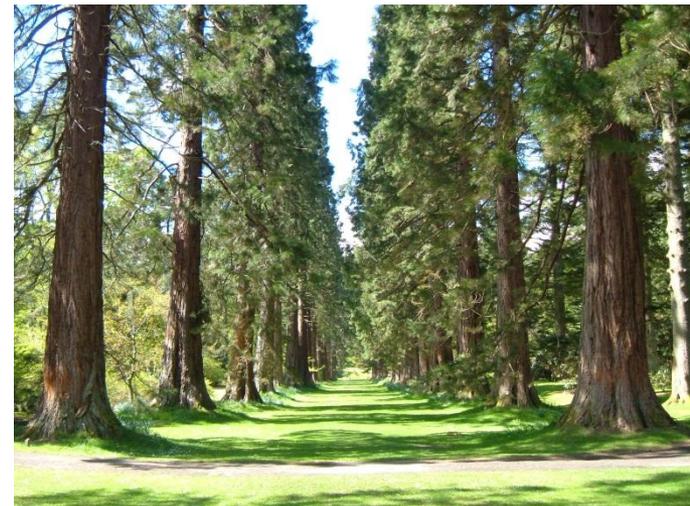
- ❖ 6 study sites set up within the garden and one in Merkland Wood



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Second study location – Benmore Botanic Garden

- ❖ Benmore Botanic Garden is further inland in Argyll & Bute
- ❖ Managed by RBGE and infected with both Pr and Pk
- ❖ ca.3000mm rain per year
- ❖ Similar temperature range to Brodick
- ❖ This garden also contains many of the Pr and Pk host species found at Brodick

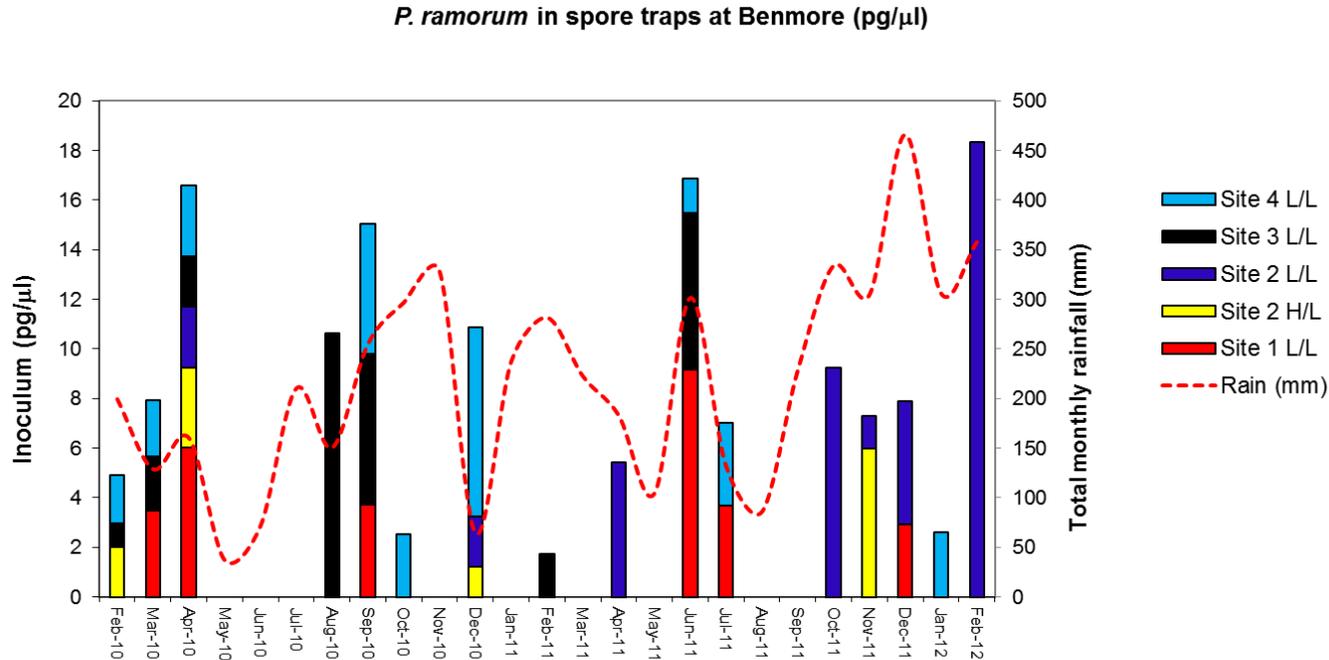


S. giganteum avenue
at Benmore

- ❖ Spore Traps:
 - High level traps are at ~1m to catch spores in the rain and splash off surrounding leaves
 - Low level are in the ground to catch rain splash off the ground
- ❖ *Rhododendron* bait plants are left at each site for one month to assess if inoculum is infectious
- ❖ *Rhododendron* leaves in muslin bags are placed in streams to bait for *Phytophthora*
- ❖ Soil samples are collected in and around the sites to determine persistence in the soil
- ❖ *Phytophthora* DNA extracted from each sample
- ❖ Real-time PCR used to quantify inoculum levels



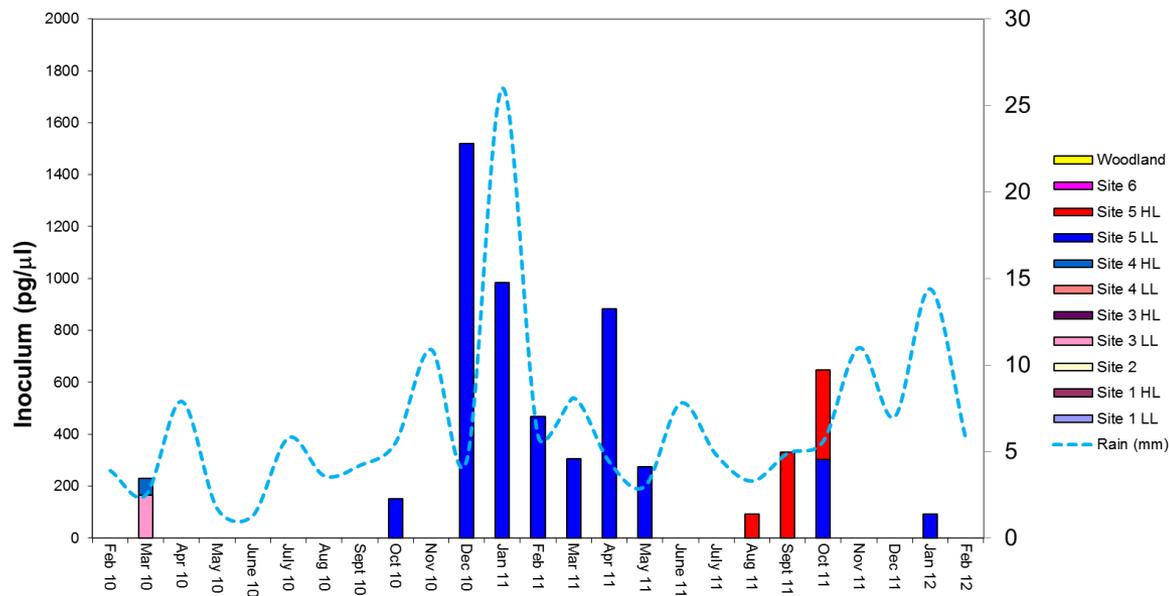
- ❖ Pr was recorded 32 times in the 5 traps over the 2 years
- ❖ Most frequently under the infected magnolia (11 times)
- ❖ Also recorded 9 times at site 4 where the host was removed before the study
- ❖ Pk was only recorded 4 times in the 2 years
- ❖ Modeling these data is ongoing



Spore trap results - Brodick

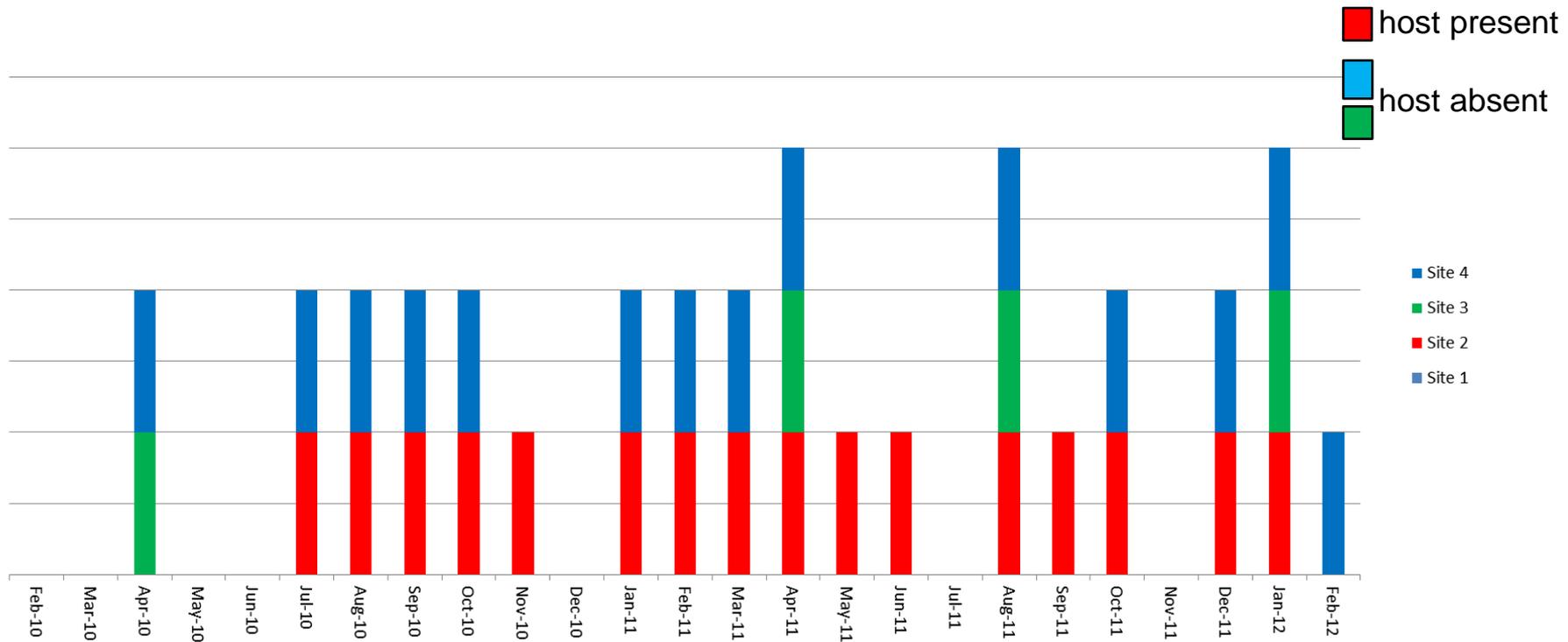
- ❖ Pk only recorded 15 times in 2 years (11 spore trap locations)
- ❖ 13 of these were at one site
- ❖ This one site contains a group of mature *Pieris* infected with Pk
- ❖ No inoculum was recorded in spore trap at Merkland Wood

P. kernoviae in spore traps at Brodick (pg/ μ l)



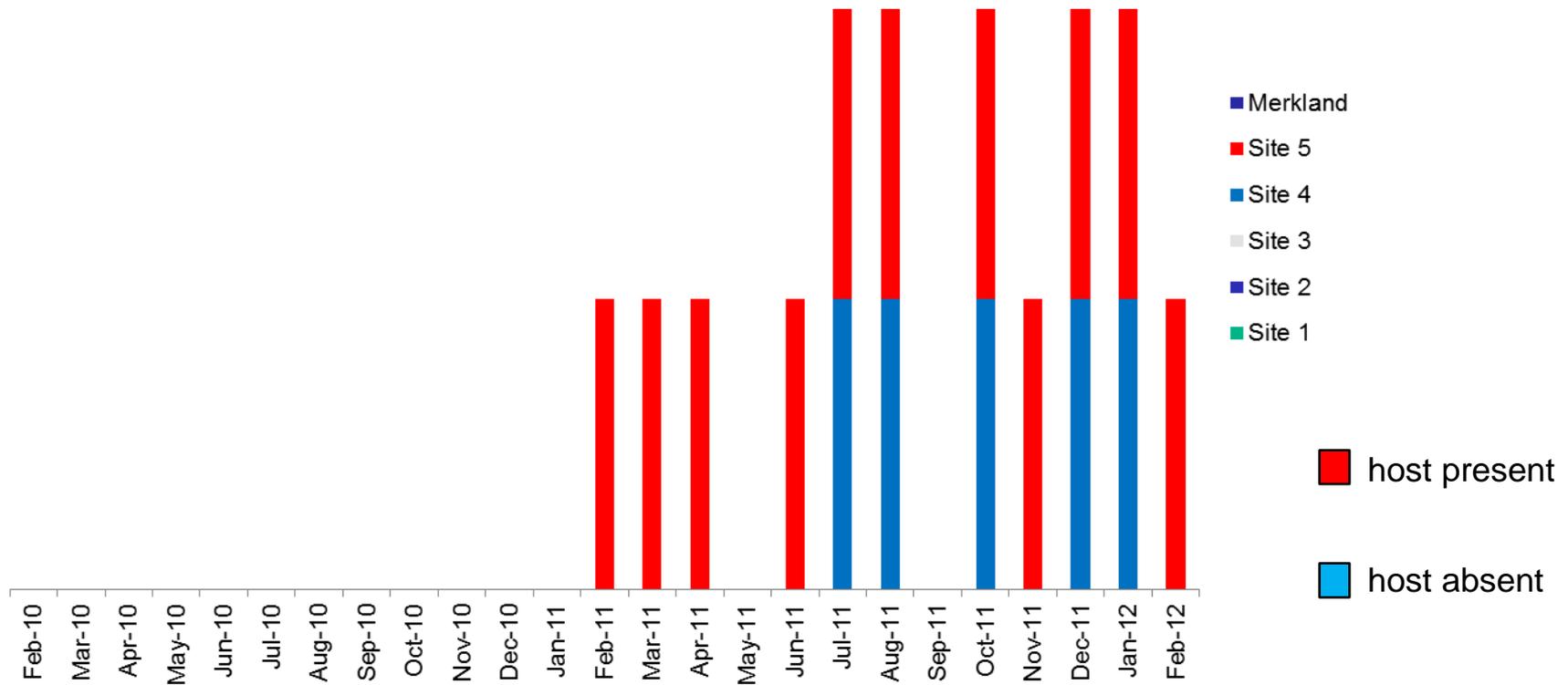
Bait plant results

- ❖ Benmore (Pr) – most infection under magnolia but almost as much at site 4 where host was removed
- ❖ Therefore baits are infected via soil splash



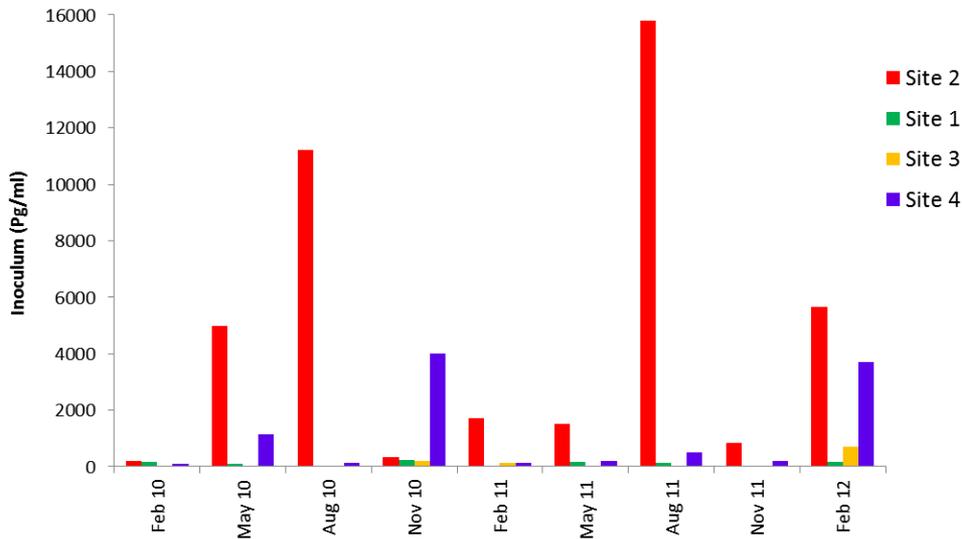
Bait plant results

- ❖ Bait plants at Brodick only became infected with Pk when using *V. myrtillus* baits
- ❖ The baits under the infected *Pieris* trees were most often infected

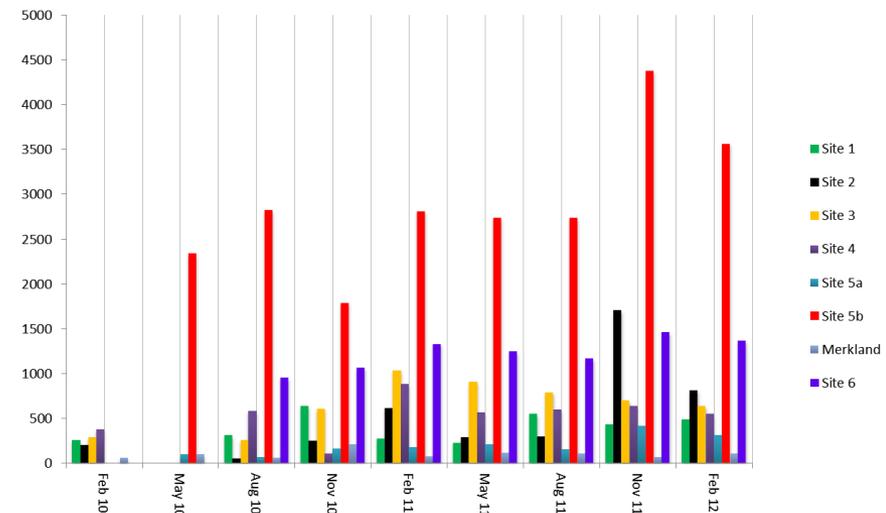


- ❖ Pr & Pk inoculum in the soil did not deplete over the 2 year period including at sites where the hosts had been removed

P. ramorum inoculum in soil at Benmore (Pg/ml)



P. kernoviae inoculum in soil at Brodick (pg/ml)



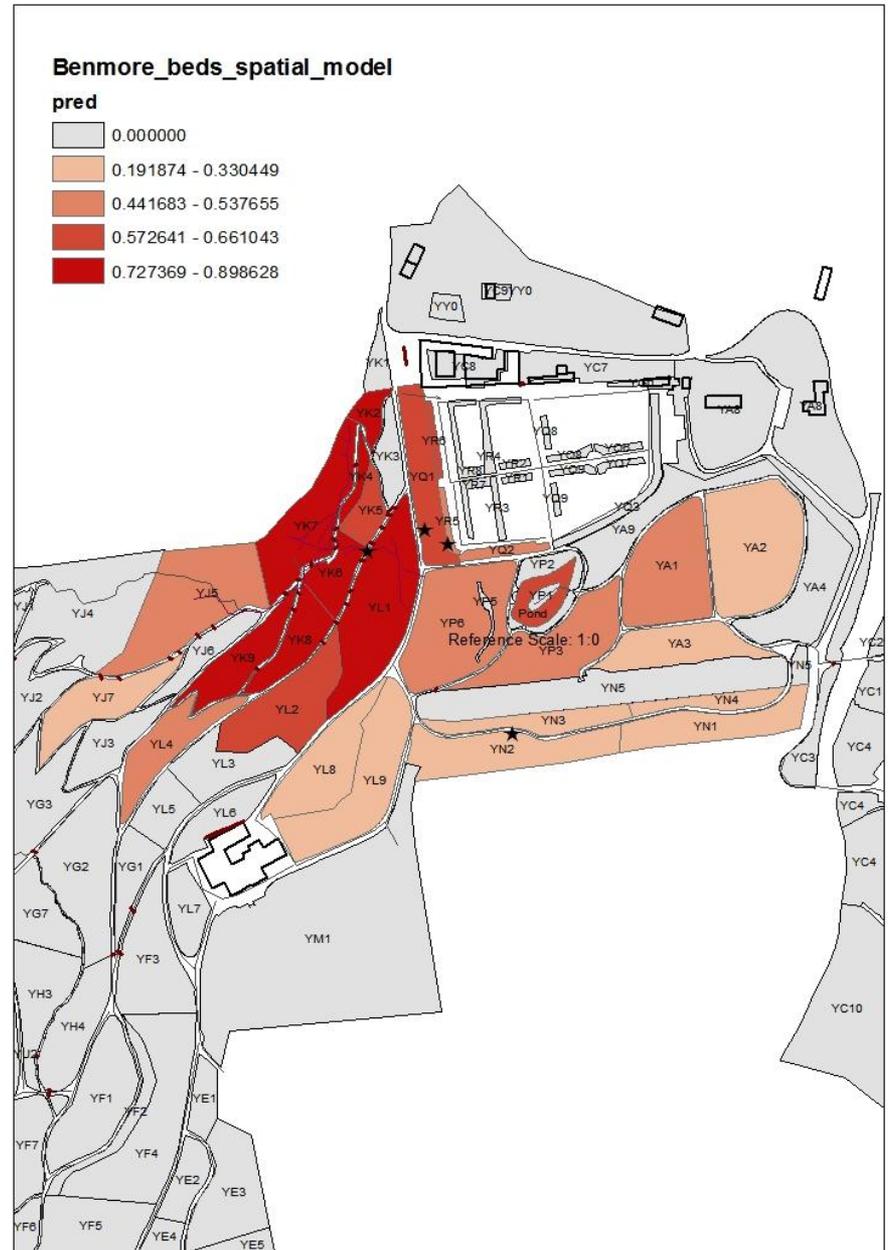
- Higher inoculum levels under the infected trees (red bars) at both gardens
- Possible seasonal effect at Benmore site 2

Other interesting soil findings

- ❖ We found that Pr infested compost has been inadvertently spread around Benmore during horticultural activities
- ❖ Pk infested patches of ground were also found in unexpected areas around Brodick garden
- ❖ Soil at the down hill sides of wooden water channels across the paths at Benmore contains higher levels of Pr inoculum than surrounding soil



- ❖ Large detailed plant database (BGbase) held at Benmore allowing garden level risk mapping
- ❖ R statistical package used to model risk factors
- ❖ Soil infection risk map created using ArcGIS 10
- ❖ Enables garden managers and plant health inspectors target their surveillance



Conclusions

- ❖ The west of Scotland provides ideal environmental conditions and an abundance of hosts
- ❖ Soil remains infested with both Pr and Pk in these gardens for at least 2 years
- ❖ Infested soil and compost can be inadvertently moved around sites
- ❖ Bait plants become infected by Pr from soil splash
- ❖ Pr was found in streams at Benmore throughout the study period
- ❖ The spore traps were not particularly sensitive (51 out of 400 emptied contained inoculum), especially poor at detecting Pk
- ❖ Further statistical analysis to be carried out to establish if a link exists between findings and environmental conditions

Thank you

Acknowledgements:

- RBGE and NTS for permission to study in the gardens
- My supervisors Alexandra Schlenzig at SASA and Catriona Harris and Tom Meagher at St. Andrews
- FERA and JHI for the initial DNA extraction protocols
- CEH for modelling and mapping help
- Met Office for providing rain data
- This project is funded by the Scottish Government.