Forest Research

Evidence for natural resistance in juniper to *Phytophthora austrocedri*

Sarah Green, Carolyn Riddell, Dave Clark, Toni Clarke

Phytophthora austrocedri

- Emerging invasive pathogen
- Probably first introduced to UK in 1990s
- Now widespread in juniper populations in N. Britain

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Phytophthora austrocedri

- Also causing a forest disease epidemic in southern Argentina
- *Austrocedrus chilensis*
- ARG strain of pathogen genetically distinct from UK strain
- Geographical location of pathogen source population currently unknown

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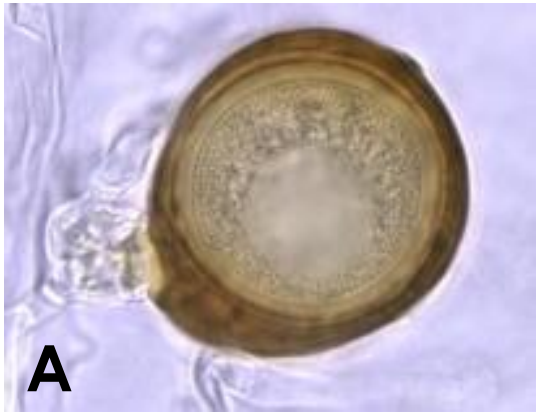
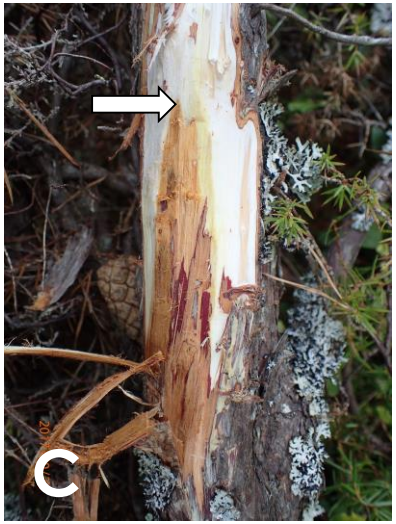
Phytophthora austrocedri

- A single genetic strain of the pathogen has spread across Britain
- Soil and water-borne
- Infects roots and stems
- Kills trees by starving them of water and nutrients





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Impact on juniper

- *P. austrocedri* can cause high levels of mortality in juniper
- But some individuals remain healthy
  - Disease escape?

  or

  - Naturally resistant?

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Hypothesis

- Survivor trees in high mortality stands have natural resistance to *P. austrocedri*

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Method

- In 2015 collected cuttings from survivor trees at two highly infected juniper populations
  - Glen Artney, Perthshire (20)
  - Haweswater, Cumbria (7)

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Method

- Dave Clark worked his magic with rooting the cuttings
- Resulted in a trial of juniper clones with putative resistance
- Grown on at NRS for 4 years

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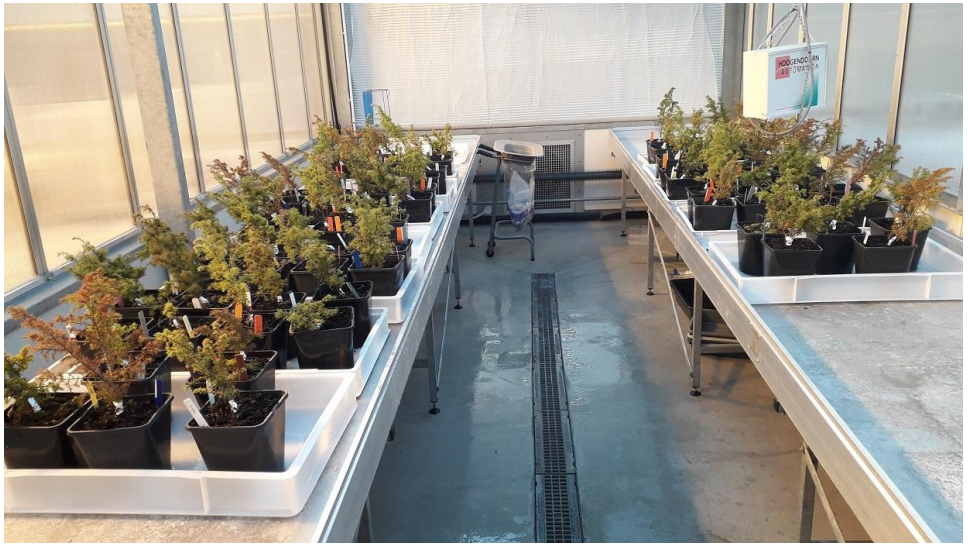
Method

- In 2019 and 2020 the clonal trial was inoculated with *P. austrocedri*
  - 17 juniper clones inoculated
  - 1 ‘known susceptible’ juniper clone (JC)
  - 4 replicate inoculated plants per clone
  - 1 plant per clone non-inoculated control
  - Entire experiment repeated once (i.e. two trials)



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Method

- Two isolates of *P. austrocedri* tested on the juniper clones
  - GA7 – Glen Artney, Perthshire, Scotland, 2018
  - TDJ3 – Teesdale, Co. Durham, England, 2011

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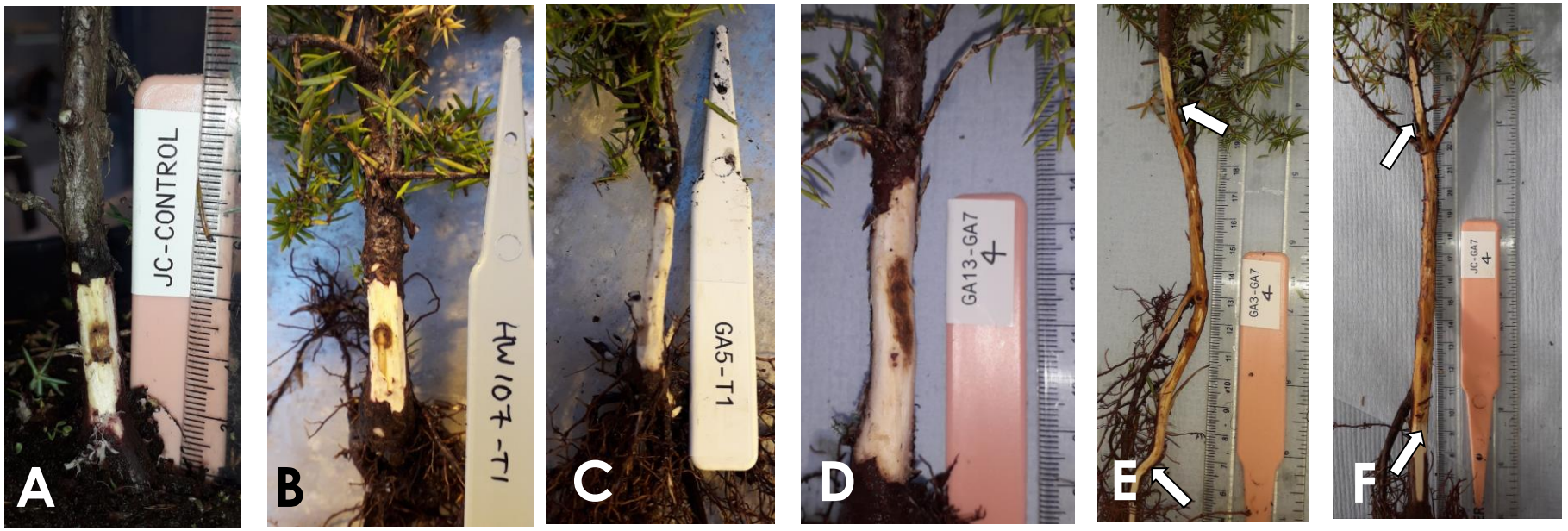
Results

- Length of lesions caused by *P. austocedri* was measured after 6 wks



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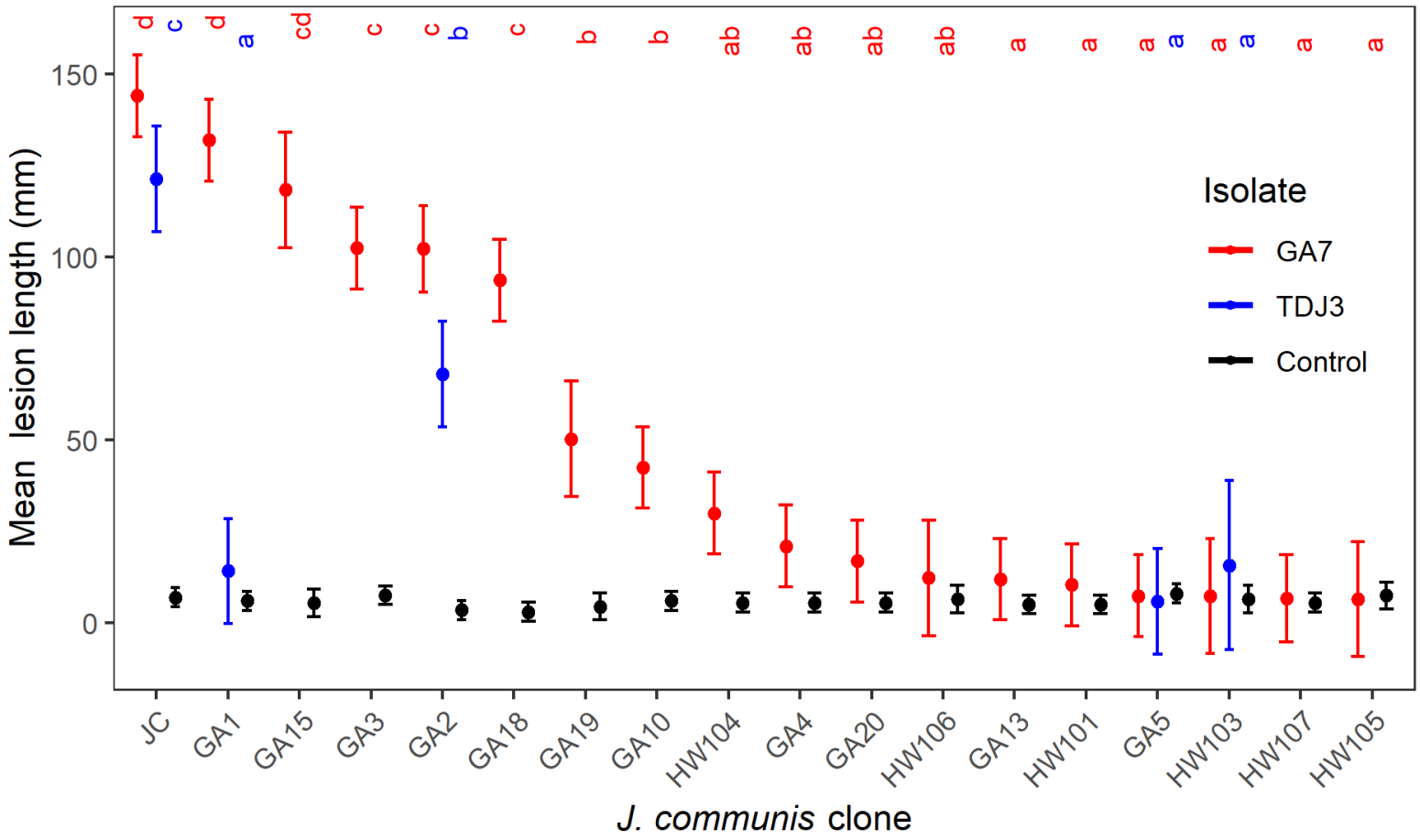

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Results

- Replicate plants of each clone presented highly consistent disease responses (as expected)
- Juniper clones exhibited varying degrees of susceptibility to *P. austrocedri*
- 9 clones appeared to be largely resistant to *P. austrocedri*
- 3 clones only moderately susceptible
- 4 clones as susceptible as the 'known susceptible control'
- 1 clone differed in its disease response to the two isolates (?)

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Conclusions and next steps

- Trial provided strong evidence that some genotypes of juniper have natural resistance to this invasive pathogen
- Resistance may allow population recovery <u>if heritable</u>
- Existing juniper provenance/progeny trial will be used to analyse whether resistance is heritable

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Management considerations

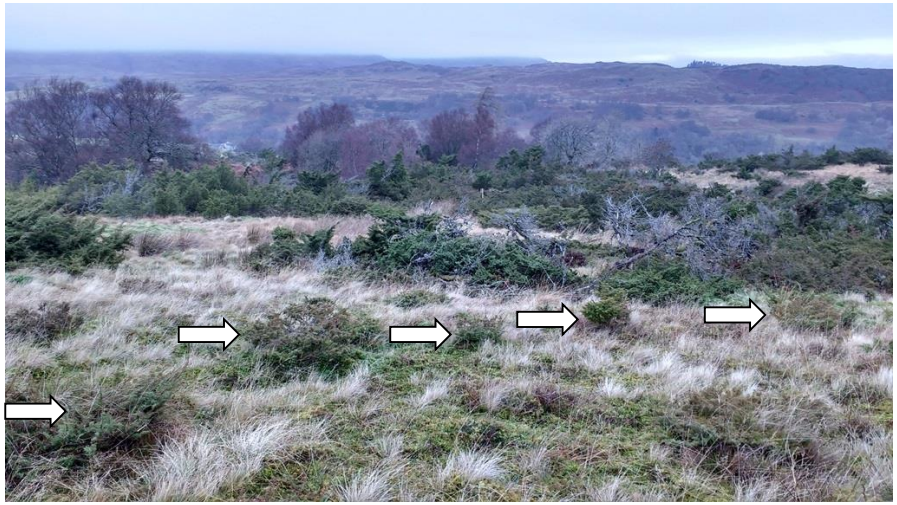
- Meanwhile manage juniper populations to maximise natural regeneration

- Avoid planting existing juniper populations

  - Pathogen is present in nursery trade and in some plant nurseries

  - Strong evidence for link between planting at sites and pathogen introduction/onset of disease

  - Introduction of more pathogen genotypes due to new plantings could put juniper populations at greater risk



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Phytophthora in nurseries

- *Phytophthora* introduction and spread linked to plant trade
- Phyto-threats project

https://www.forestresearch.gov.uk/research/global-threats-from-phytophthora-spp/

- Analysed *Phytophthora* diversity in British plant nurseries

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Phytophthora diversity in UK nurseries

1. Fine scale survey

- 15 partner nurseries across Britain with a range of practices

2. Broad scale survey

- 118 nurseries across Britain (roots sampled only)

3. Sampling method biased to finding *Phytophthora* (not random)

- Water and root samples collected from each nursery in triplicate plus associated metadata (i.e. sample origin and nursery practice)
- Range of plant hosts tested – depends on individual nursery + symptoms
- Samples analysed for *Phytophthora* **DNA** using a metabarcoding approach
- Feed results back to nursery managers and to guide accreditation

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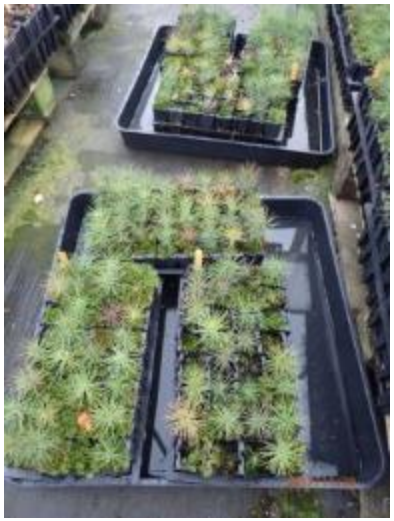
Nursery water sampling

- Water sampled at source
- Also from drainage ditches, ponds and puddles
- Rainwater collection butts
- Streams running alongside nurseries
- Batches of plants watered and water flow-through sampled



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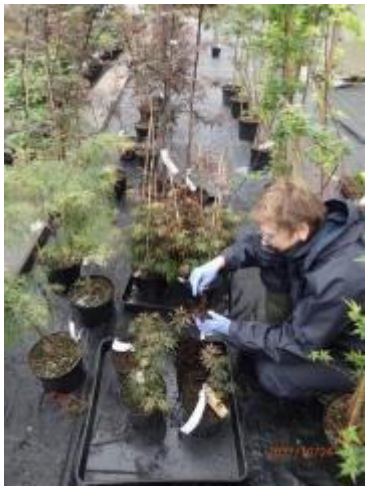
Nursery root sampling

- Roots sampled from water flow-through batches
- And from other batches of plants
- Mix of symptomatic and asymptomatic hosts
- Also sampled roots from dumped plants



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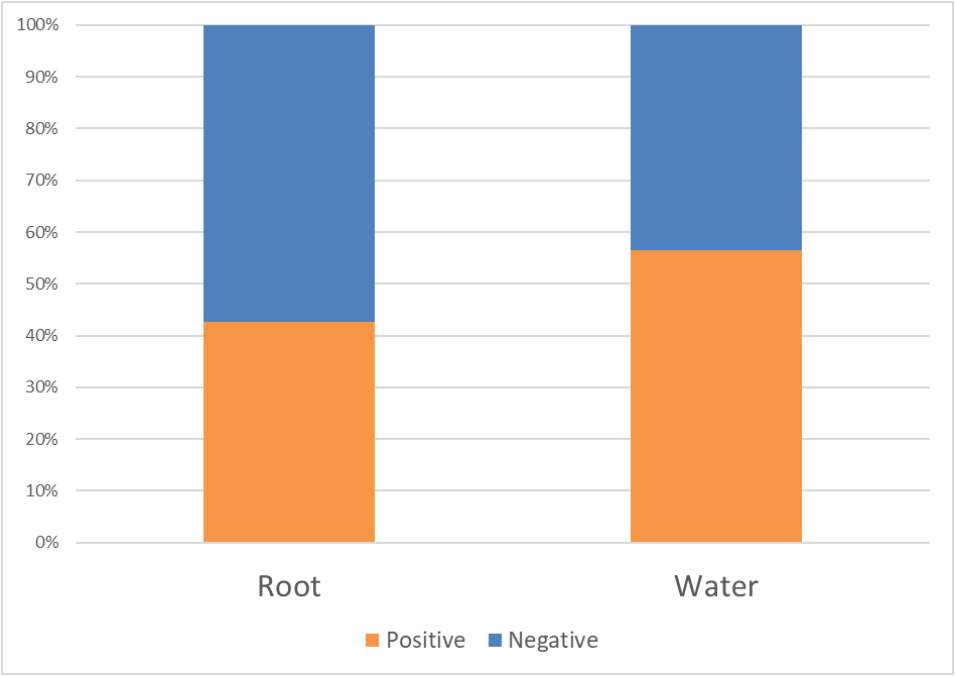
Nursery sampling PCR results

Fine scale sampling

- 4-5 visits per nursery over 3 yrs
- ~3000 samples collected from ~150 host plant species
- ~50% +ve for *Phytophthora* in PCR test



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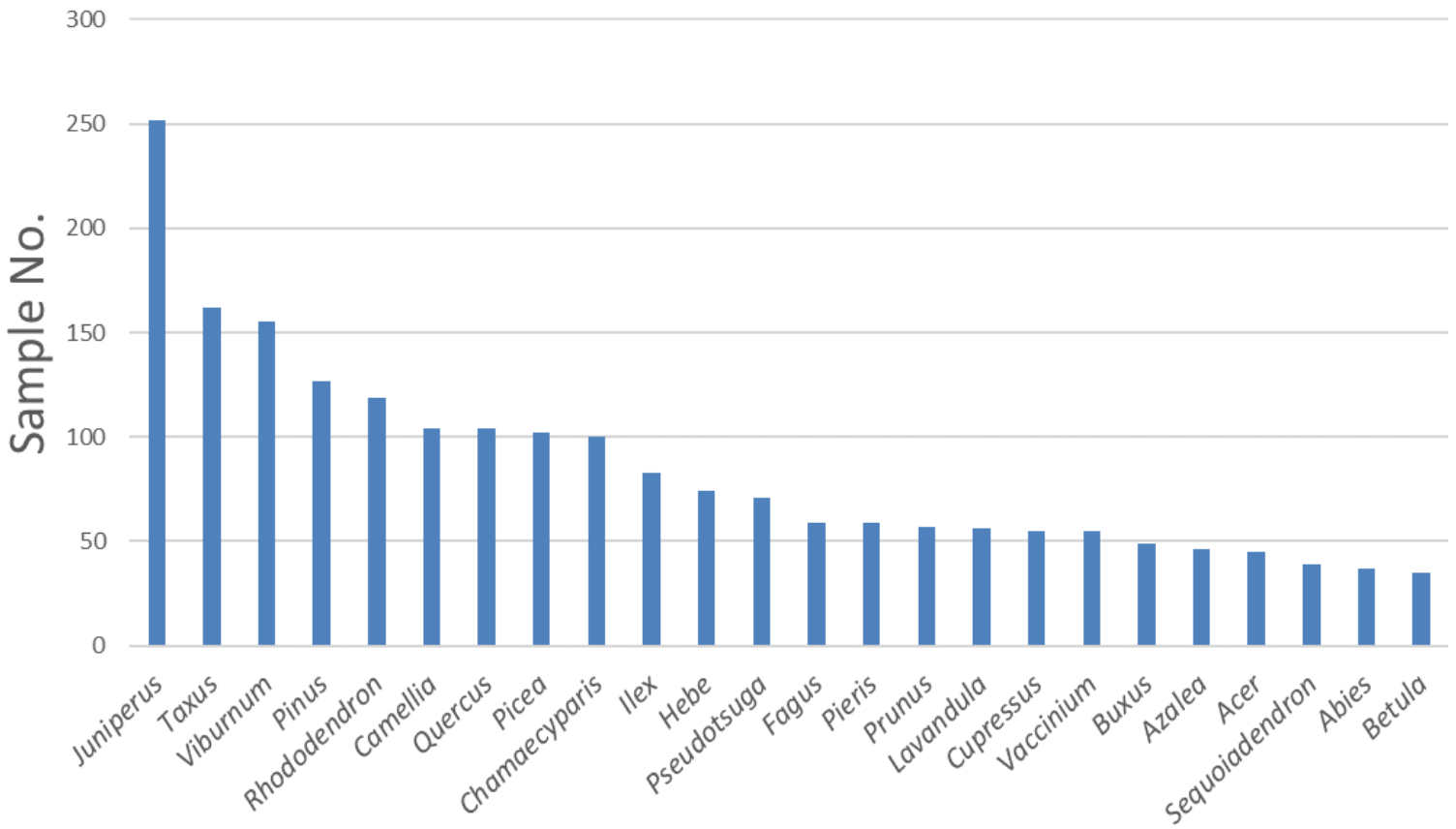
Nursery sampling

Top 24 host genera sampled (out of ~150 host plant species sampled)



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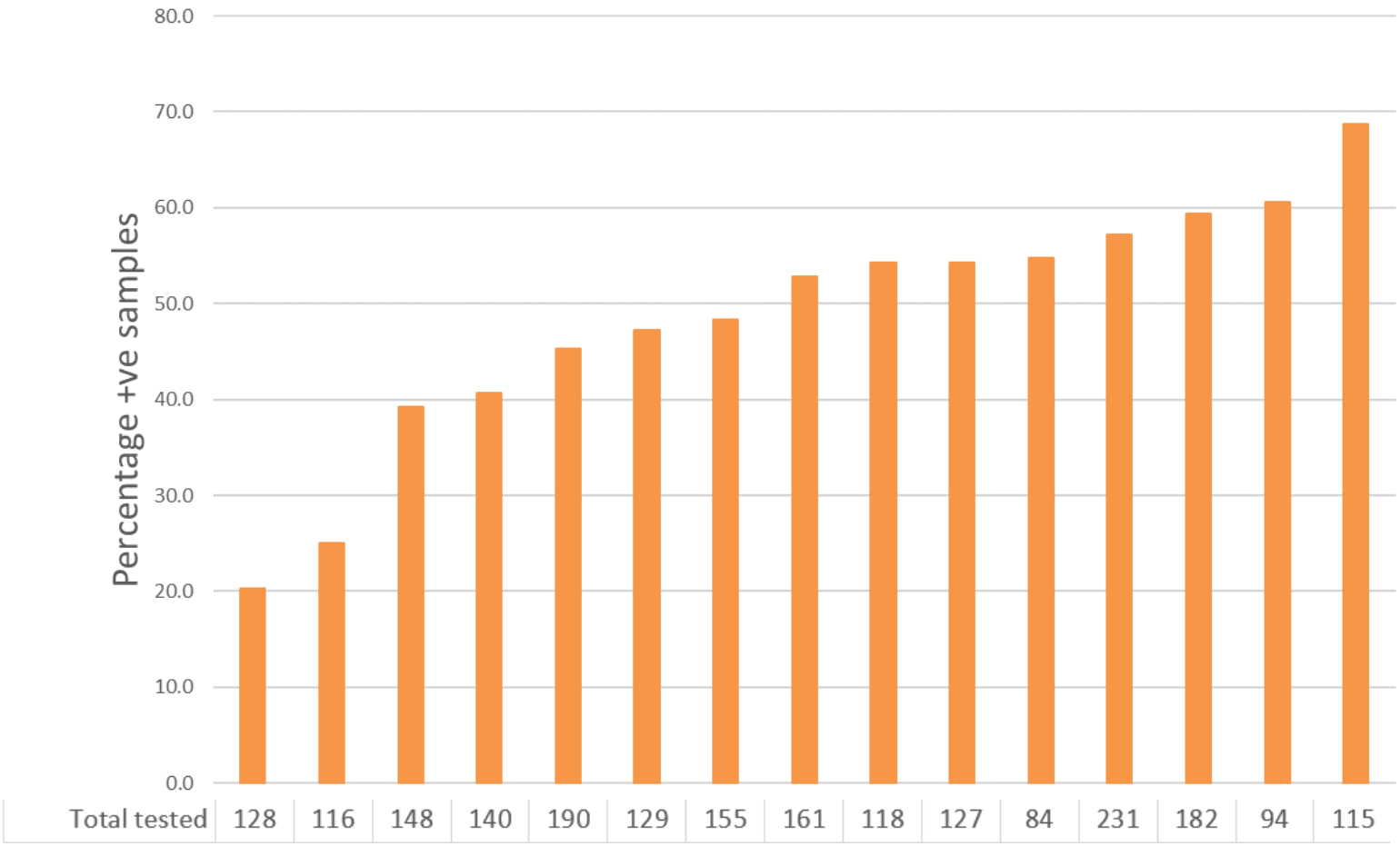
Nursery sampling results

Fine scale survey: an overview of PCR results by nursery



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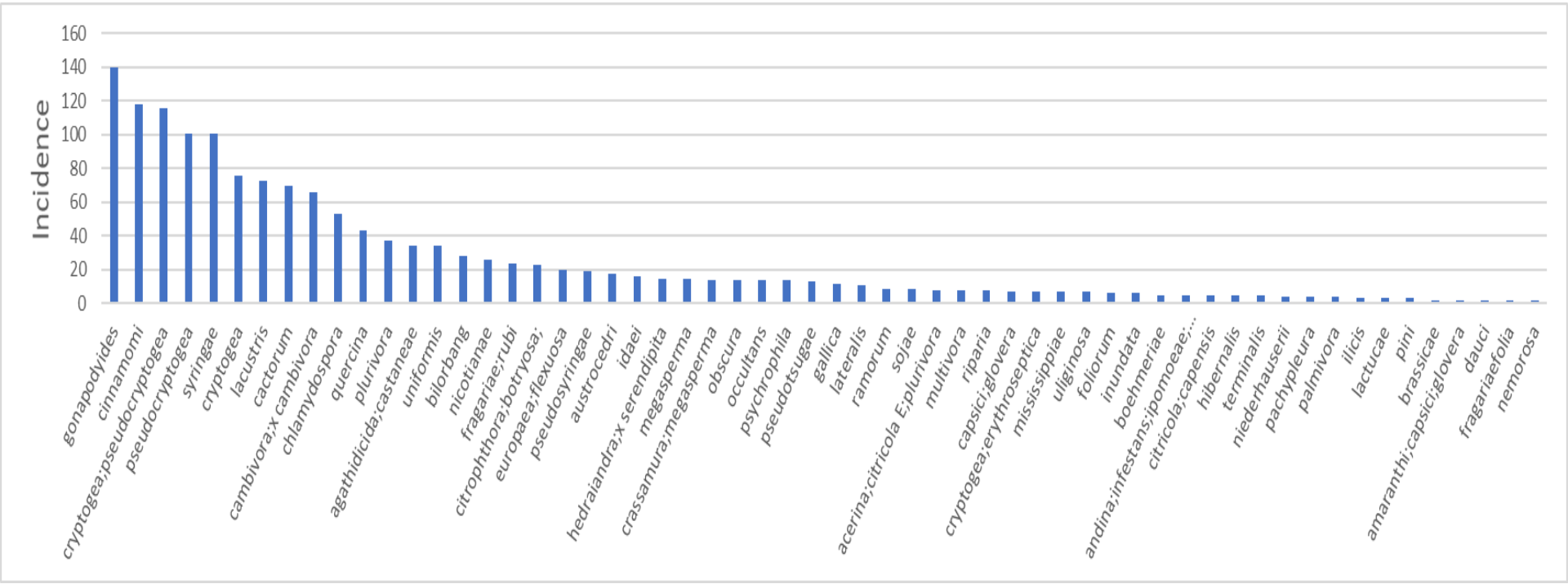
51 *Phytophthora* species found so far

Phytophthora species metabarcode incidence (n=800 samples)



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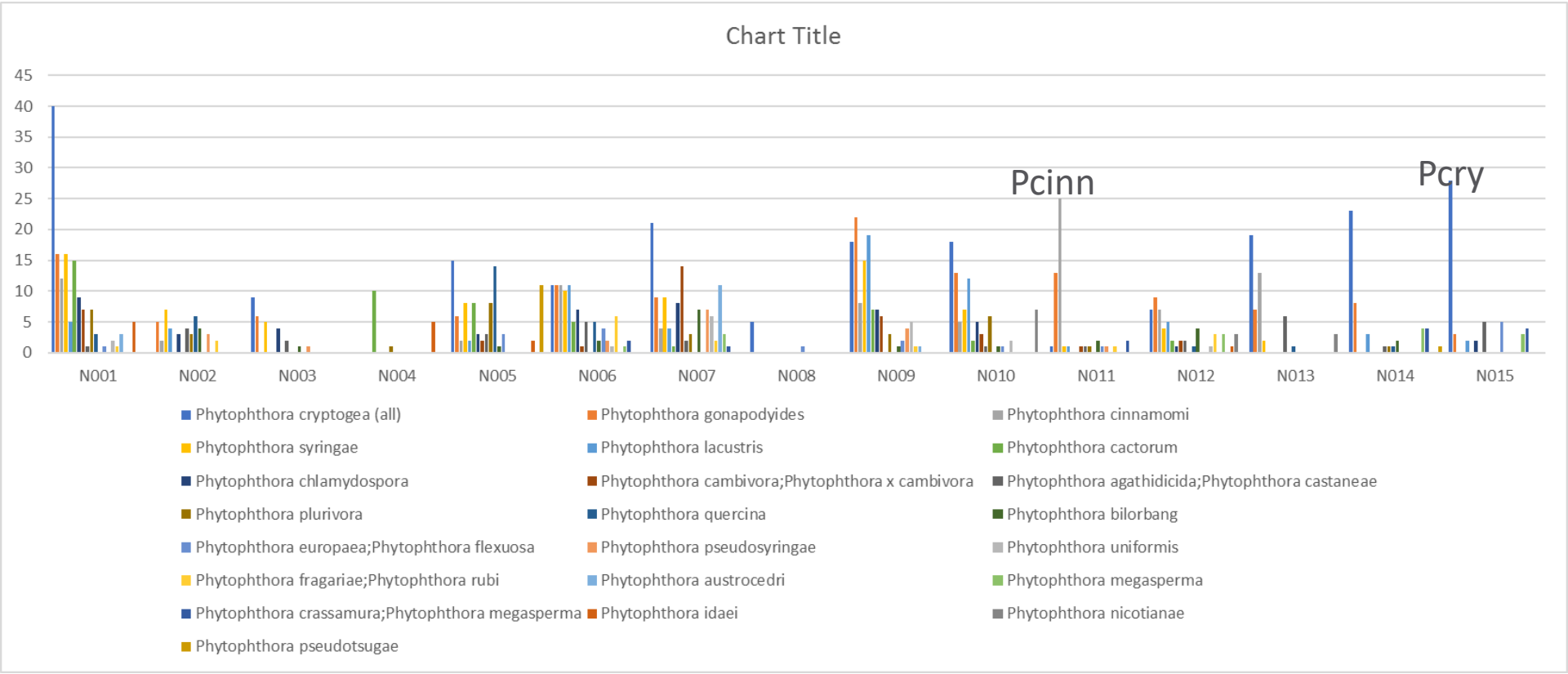
Nursery by Species (top 22 species)



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Juniper results so far

- 95 juniper samples tested +ve for *Phytophthora*
- 15 *Phytophthora* species associated with juniper in nurseries
- *P. austrocedri* DNA detected at five nurseries
- Hosts predominantly juniper but also Lawson cypress and one finding in roots of cherry laurel

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River example

- River sample has 8 known species;

Phytophthora sp. (unknown)
Phytophthora chlamydospora
Phytophthora gallica
Phytophthora gonapodyides
Phytophthora lacustris
Phytophthora pseudosyringae
Phytophthora riparia
Phytophthora rubi
Phytophthora syringae

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Puddle example

- Single puddle sample has 12 known species;

Phytophthora sp. (unknown)
Phytophthora austrocedri
Phytophthora bilorbang
Phytophthora chlamydospora
Phytophthora cryptogea
Phytophthora gallica
Phytophthora gonapodyides
Phytophthora hibernalis
Phytophthora inundata
Phytophthora megasperma
Phytophthora plurivora
Phytophthora pseudosyringae
Phytophthora syringae

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Risks in planting schemes

- *P. quercina* in sessile oak intended for restoration scheme
- Survey has highlighted risk of disease introduction and spread through supplementary planting existing woodland
- Put biosecurity into the heart of woodland management
- Do you really need to plant? And if so……

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Key biosecurity considerations

- Where does/will the stock come from?
- Visit your grower, ask about;
  - Water source
  - Growing media
  - Quarantine holding area
  - Drainage
  - Plant disposal
  - Nursery surroundings
  - General nursery hygiene
  - Plant health knowledge

Forest Research Biosecurity

Plant health considerations for planting schemes

A recent increase in invasive tree diseases has highlighted the growing risks to UK forest and woodland ecosystems from the dissemination and establishment of pests and pathogens in diseased planting material through trade pathways. These risks can be mitigated by ensuring good biosecurity practice throughout the supply chain.

The following guidance aims to help those responsible for planting schemes to identify and select plant providers who follow good biosecurity practice.

Key biosecurity considerations when sourcing plants

Plant origin

Understand where the stock will/has come from. Stock grown in the UK for its entire life (i.e. from UK-sourced seed) has a lower risk of introducing diseases not yet present in the country. However, if it is raised alongside imported stock, it is still at risk from infection.

Bare root versus containerised stock

Some pathogens can survive for long periods in soil or contaminated growing media, so bare root stock has a lower risk of carrying soil-borne diseases than containerised stock.

Get to know your grower

Visit prospective suppliers to look around before deciding where to obtain your plants. Look out for the following issues.

Covered borehole water storage tank.

- **Water source:** Water is an effective carrier of many pathogens. Mains or borehole water supplies carry the least risk. Sourcing water from open reservoirs, ponds, rainfall butts or extracting from rivers carries a high risk, unless the water is treated using a method proven to kill damaging microorganisms.
- **Growing media:** Is the growing media sterile? This may be particularly important when using peat-free mixes that may contain local authority green waste, bark and coir (the latter being imported from the tropics).
- **Quarantine holding area:** Importing plants from overseas carries a risk of introducing diseases new to the UK. If your supplier imports plants, do they have a 'quarantine area' where imports are well separated from main stock and observed regularly over several

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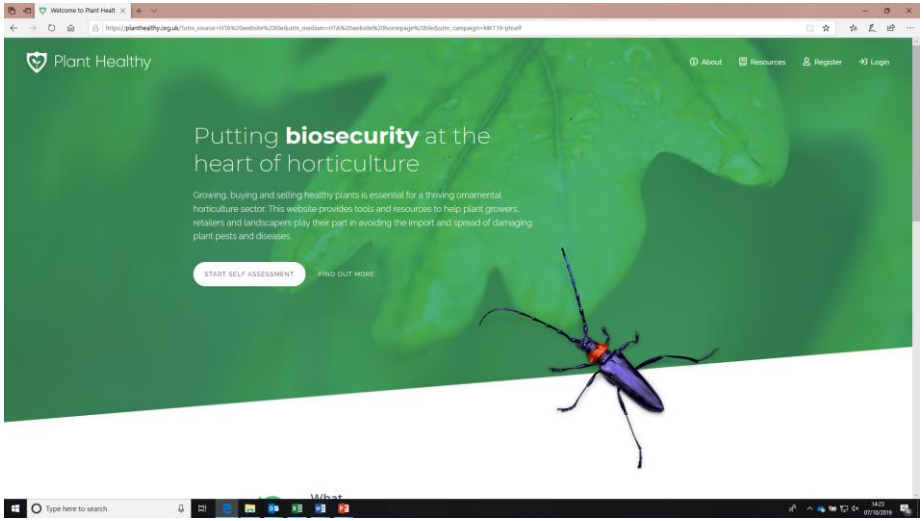
Supporting accreditation

- Nursery sampling data are highlighting the riskiest management practices
- HTA/UK government/industry are developing and trialling a 'Plant Healthy' Certification Scheme https://hta.org.uk/assurance-compliance/plant-healthy.html
- Strongly consider supporting growers who are part of this scheme or intending to join
- Natural regeneration of existing woodland preferable to planting



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