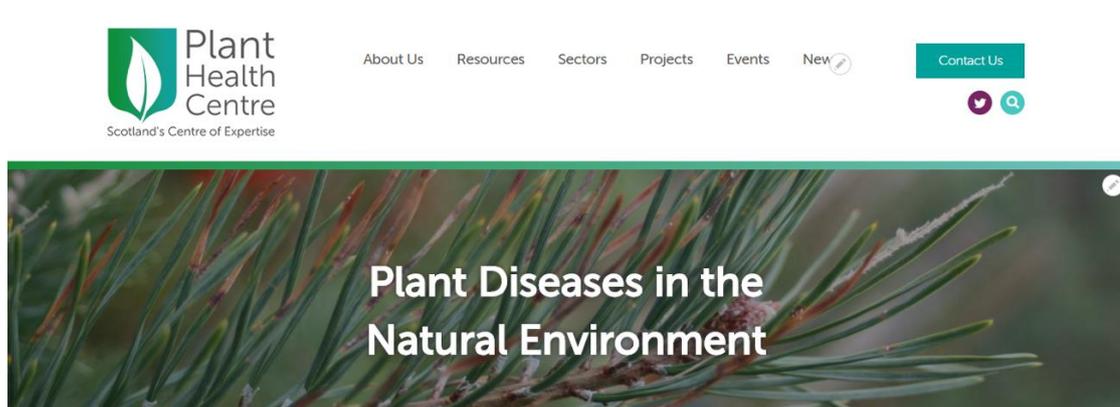# PHC2018/11. DEVELOPMENT OF AN ONLINE, USER FRIENDLY PLANT HEALTH RESOURCE BANK FOR THE SCOTTISH NATURAL ENVIRONMENT

Joanne Taylor and Katherine Hayden
Royal Botanic Garden Edinburgh,
20A Inverleith Row, Edinburgh EH3 5LR,
United Kingdom.
Email: khayden@rbge.org.uk

CONTENTS

INTRODUCTION

The natural environment of Scotland has an intrinsic ecological value and the diversity of habitats, while diminished in area in modern times, are an important source of natural capital. The protection of these natural resources is vital for their continued sustainable use. Plant health issues can seriously affect the natural environment, however compared to sectors such as agriculture and forestry, there are few practical resources for managers. At present, guidance is offered for plant health threats in managed forestlands (e.g. by Scottish Forestry), and for horticultural environments (e.g. by The Royal Horticultural Society), but equivalent sources of information for the natural environment are lacking or obscure to non-specialists. Furthermore, opportunities for knowledge exchange are limited. The frustration at a perceived lack of resources to identify and mitigate plant health issues relevant to the Scottish natural environment has been communicated by relevant stakeholders and a desire has been expressed that an online resource centre be established.

The aim of the project PHC2018/11 was to compile such a resource to be embedded within the Plant Health Centre website, with the following three main purposes: 1) To direct users to existing plant health information and resources considered comprehensive and reliable (e.g., the Forestry Commission webpages, and SASA and Fera diagnostic laboratories); 2) To provide summaries of plant health threats to the natural environment and their mitigation where this information is lacking (e.g. *Phytophthora* diseases in heathland); and 3) To direct users to appropriate government agencies and resources and advise users on steps to take should a suspected statutory pest or disease be encountered.

The information provided will be mainly relevant to native and long-term naturalised trees and shrubs in Scotland and users will be guided on the first steps in identification and signposted to relevant resources for disease diagnosis, with the aim of evaluating if the disease is common and subject to prevention and control measures, or is notifiable. Clear advice will be given on which diseases are notifiable and what to do when these threat organisms are encountered. The webpages are found on the Scottish plant Health Centre website (https://www.planthealthcentre.scot/plant-diseases).

The following activities were undertaken:

1. Review stakeholder statements to identify primary needs and refine approach;
2. Following on the above analysis:

a. Identify the first most pressing current and potential future threats to plants in the natural environment in Scotland,

b. Source existing relevant online resources,

c. Ascertain areas where information is lacking, and draft summaries to fill this gap;

3. Contract to develop a web template compatible with the current PHC site, and populate it with the information we accumulated;

4. Present this back to stakeholders for feedback and refinements.

Outputs are 1) a listing of the first most pressing plant health threats to the natural environment in Scotland and 2) a user-friendly web template, populated with links and summaries as described above.

ACTIVITIES

1. REVIEW STAKEHOLDER NEEDS

Stakeholder statements of need were gathered from two sources: 1) Stakeholder priorities communicated at a workshop held at the Royal Botanic Garden Edinburgh on 22 March 2017, and 2) interviews conducted with key stakeholders working in the environmental sector prior to the formation of the Plant Health Centre.

At the May workshop, stakeholders were asked to each provide 3 statements of priority for Scotland's Plant Health Centre. These priorities were collected anonymously and compiled into a text document (Appendix A), and then parsed using the tidytext package (Silge and Robinson 2017) in R (R Core Team 2018). Plant health in the natural environment was evident as a clear theme in these priorities. 'Environment' was one of the most frequently used words, appearing only after pest, disease, species, threat, risk, and impact (Figure 1). When word associations (that is, words that appeared together more than once in the same priority statement) were analysed, 'wider…environment' and 'native…species' were among the most frequent pairs of words encountered, alongside 'pest…pathogen', and 'control…impact', and surpassed only by 'pest…disease' and 'assess…risk'. 'Natural…environment', 'pest…threat', 'and 'improve…biosecurity' also appeared frequently together, highlighting these as stakeholders' concerns.
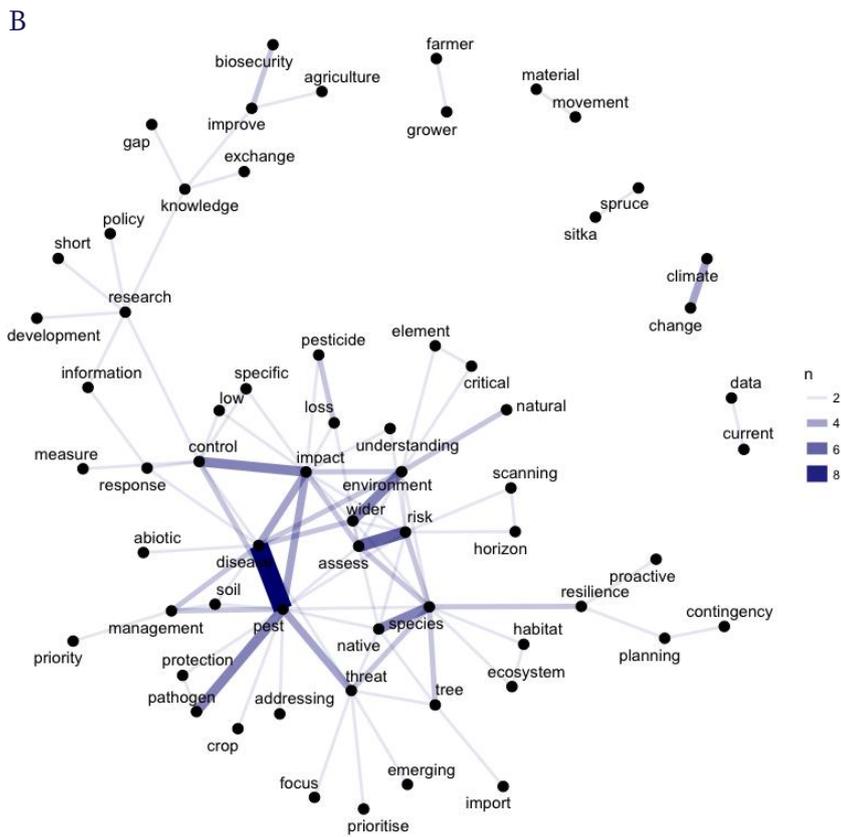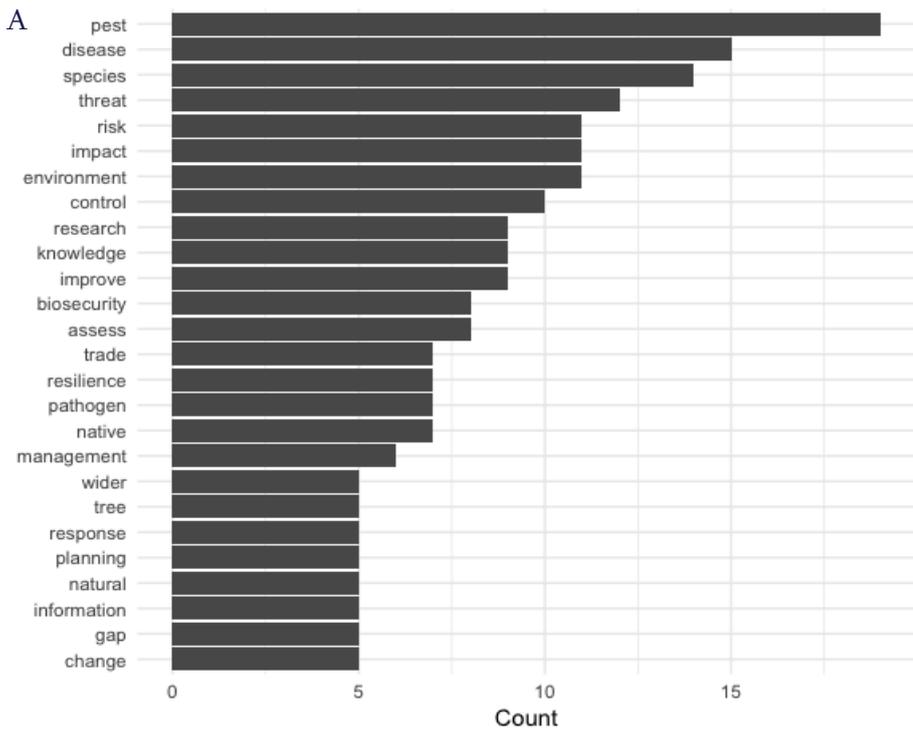
Figure 1. Text analysis of stakeholder statements of priority for the Plant Health Centre. 1A, the words appearing most frequently in stakeholders' statements. 1B, pairs of words which appeared in the same priority 2 or more times are linked by lines weighted by the number of times the words occurred together.

While textual analysis of the stakeholders' priorities provides insights to their overall concerns, interviews with those working in the environmental sector provided more detailed guidance on their needs. They indicated that stakeholders were unclear about where to go to for advice about plant diseases, and what sources were reliable. For instance, invasive non-native invasive species (INNS) were felt to be a real threat and knowledge of possible plant health impacts was vital with stakeholders indicating that advice on biosecurity was necessary. Control options and advice on disease management for non-specialists (that is those practitioners who have little or no training in plant diseases but who are now having to face the impacts in the environments in which they work) was highlighted as being necessary but lacking.

One outstanding theme in interviews was the need for assistance with identification and diagnostics. Workshops and conferences are very useful and are sometimes offered but it is acknowledged that they are expensive and time consuming to implement. In addition, submitting samples for laboratory based diagnostic analysis is costly. However, there is a wealth of information online which is accessible, and when reliable sources are used, can be very helpful. Finding this information and understanding what is reliable can be problematic however.

Other issues highlighted were around planting and restoration of habitats and efforts to minimise diseases introductions and the constraints of planting moratoriums in certain habitats. Keystone species (those species for which loss from a system would have wider ecological impacts, also known as system critical elements) were seen as being particularly important and plant health advice on these should be prioritised. Furthermore, 'unknowns' (that is, for instance, disease threats that have not yet been introduced but may cause an impact if they were) should also be brought to attention. Stakeholders indicated that it was unclear when and how to notify authorities about diseases.

2. DEVELOP CONTENT

2A. IDENTIFY PLANT HEALTH THREATS IN THE SCOTTISH NATURAL ENVIRONMENT

It was first necessary to determine the host plants on which to focus, and system critical elements or keystone species were identified as broadly considered to be the dominant plants in Scottish habitats, or other notable plants. These consisted of mainly trees and shrubs and include some non-native species that have become naturalised e.g. Sycamore

and Horse Chestnut. Plant communities outlined in the Joint Nature Conservation Committee 'National Vegetation Classification' (JNCC NVC) as occurring in Scotland were ascertained and plants were identified (mainly trees and shrubs) which occurred in these habitats. Plants were listed at genus level only and subsequent searches were also made at genus level. The NVC plant community codes were binned into the BAP Broad Habitats (http://jncc.defra.gov.uk/page-4266 accessed December 2018). For non-woody plants, the criteria were less prescriptive and the selection of plants were made partly based on the list of notable herbaceous plants in Scotland (Boa & Woodward 2018).

Threats were determined by comparing the 33 selected genera (Appendix B) against the latest PRR (Pest Risk Register, Supplementary File 1, https://secure.fera.defra.gov.uk/phiw/riskRegister/ accessed 01/02/2019) using the following selection parameters: Pests including pathogens known to be present in the UK, with selections made by removing associated pests with a UK relative risk rating (unmitigated) of *<20* (Appendix C). Further discretionary decisions were made to include certain pests that are currently absent in the UK, but which have been identified as of high likelihood for introduction by the Observatree project (https://www.observatree.org.uk/), or have high relative risk rating should they be introduced (e.g. *Xyella fastidiosa*), and to exclude those where no statutory action is necessary and which are considered to cause minimum damage in the natural environment (e.g. *Drosophila suzukii*).

Relevant reference material regarding the selected diseases was then sourced from online and print sources of mainly UK origin. For each disease-causing agent a selection of reliable reference material suitable for non-specialists is suggested. Furthermore, as many diseases encountered will be caused by common native and long term introduced disease agents, several excellent sources are recommended for consultation (e.g. online resources such as http://www.greenmanconservation.co.uk/Tree_Decay_Fungi.htm or https://www.first-nature.com/fungi/index.php, and books such as Gregory & Redfern 1998; Watson & Green 2011; Watson 2013; Roques *et al.* 2017). These sources highlight the most common diseases likely to be encountered and enable familiarisation with them. Many of these diseases, although causing damage, do not reach the epidemic proportions that the INNS often do.

Stakeholders reported a lack of clarity as to when or to whom findings of plant diseases should be reported. The following advice is thus given in the Threats, Recommended Sources, and Control pages with underlined words are hyperlinked to the relevant page or contact:

Most pests encountered will not be notifiable, but if after checking <u>diagnostic</u> and <u>specific</u> <u>resources</u> you think you may have encountered a notifiable pest it is important that you report it quickly. In forest trees in Scotland notify Scottish Forestry via <u>TreeAlert</u> or by <u>email</u>, or if in any other plants notify <u>the Horticulture and Marketing Unit</u> at <u>SASA</u>. Outwith Scotland consult the <u>Plant Health Information Portal</u> for other UK reporting contacts.

2B. COMPILE RECOMMENDED SOURCES

The aim of this activity was to bring together available resources regarding plant diseases in the UK that are useful to those who work in the natural environment. A 'Getting Started' paragraph was prepared to pinpoint resources that we recommend as good places to start in the identification process, or which we considered was lacking or not obvious in the resources available online or in print. Resources are then listed alphabetically or can be searched by keyword or by category (Activity 3, Figure 2), and are separated into 8 sections as follows:

1. Biosecurity. Key resources are listed with information ranging from land managers advice for members of the public to guidance for nursery owners and arboriculturists. The advice is from across horticultural and forestry sectors, and e-learning modules, which can be undertaken, are highlighted.

2. Diagnostic services. Government and other institutions that offer diagnostic services are listed, although it is acknowledged here that there are private companies that also offer such services.

3. Field Guides & Self Diagnosis. We have highlighted guides that we think are particularly useful for disease diagnosis and pest identification. Some of these guides offer simple keys or other methods for determining if the disease is caused by an insect, fungus, bacterium etc. and these will assist in the 'First Steps in Identification' which is outlined on the 'Threats' page. More specific information can then be searched once a basic diagnosis is made, or as mentioned there are institutions and organisations that can carry out diagnostic services. In addition, we have listed key resources for identification of notifiable organisms, many of which are also referred to by threat organism on the 'Threats' page.

4. Further Information. Useful information that does not directly fall into the other categories such as government plant health strategies or links to relevant organisations listed here.

5. Newsletters. In order to remain informed about tree diseases in particular, there are several organisations where you can sign up to receive regular news letters by email or which produce blogs or downloadable news updates.

6. Outreach & Education. Resources that are considered suitable for highlighting plant health issues directly to the public are listed here.

7. Reporting & Regulatory Information. The information given here supplements the advice given on each main page about reporting notifiable diseases.

8. Treatment & Management. Advice on how to manage some of the important plant diseases in the natural environment are listed here. Information is listed from across the horticulture and forestry sectors on biological control, pesticide advice, planting guidance and managing resilient forests.

2C. IDENTIFY RESOURCE GAPS

Activities 1 (review stakeholder feedback) and 2b (compiling recommended sources) highlighted a clear gap: generalised advice for responding to plant diseases in the natural environment. We therefore created two linked pages of original content under the heading of Prevention and Control.

Prevention and Control consists of a simple introductory page followed by subpages titled Control and Prevention – Biosecurity. These pages were highlighted as high priorities by the stakeholders, who noted an absence of online plant health advice relevant to the natural environment. We compiled advice from the sources listed in the Recommended Sources page into an easy to read format, and highlighted a few highly recommended sources of biosecurity advice. The primary sources reviewed in advice for biosecurity were the UK Government "Guidance to prevent the introduction and spread of tree pests and diseases" (https://www.gov.uk/guidance/prevent-the-introduction-and-spread-of-tree-pests-and-diseases), Fera Biosecurity Best Practice Protocols for Nurseries, Retailers, and Landscapers (NR&L) (Scrace et al. 2012a) and Parks & Gardens (P&G) (Scrace et al. 2012b), and the Working Group for Phytophthoras in Native Habitats guidelines for restoration nurseries (WGPNH 2016).

A Control page is provided to compile readily accessible, generalised advice suitable for the natural environment. The precise diagnosis of the cause of plant diseases can sometimes be difficult even for specialists, so we opted to organise the control advice into broad categories of plant diseases: Notifiable Diseases (in which users are advised to observe good biosecurity practices and report to authorities only); Problems of Leaves, Twigs, and Branches; Root and Wood Decay; Viruses; and Wilts and Vascular Diseases. Users are advised to consult specific sources of information when the causal agent can be identified, but in the alternative, are provided resources to determine the kind of damage and possible responses. The control options presented are aimed to reduce pathogen loads in the natural environment and, if possible, slow disease transmission, and are compiled from across sources cited in the Recommended Sources page, as well as from the text Infectious Forest Diseases (Gonthier and Nicolotti, eds., 2013).

3. DEVELOP AND POPULATE A WEB TEMPLATE

The website developer Allstar Solutions (https://allstar-solutions.com/) which provided a web template and training in order that the template could be populated, and provided additional support to enact changes following stakeholder feedback. The template (Figure 2) was designed to fit within the style and framework of the Plant Health Centre pages, and to be extendable, such that a similar resource could eventually be prepared for sectors other than the natural environment.
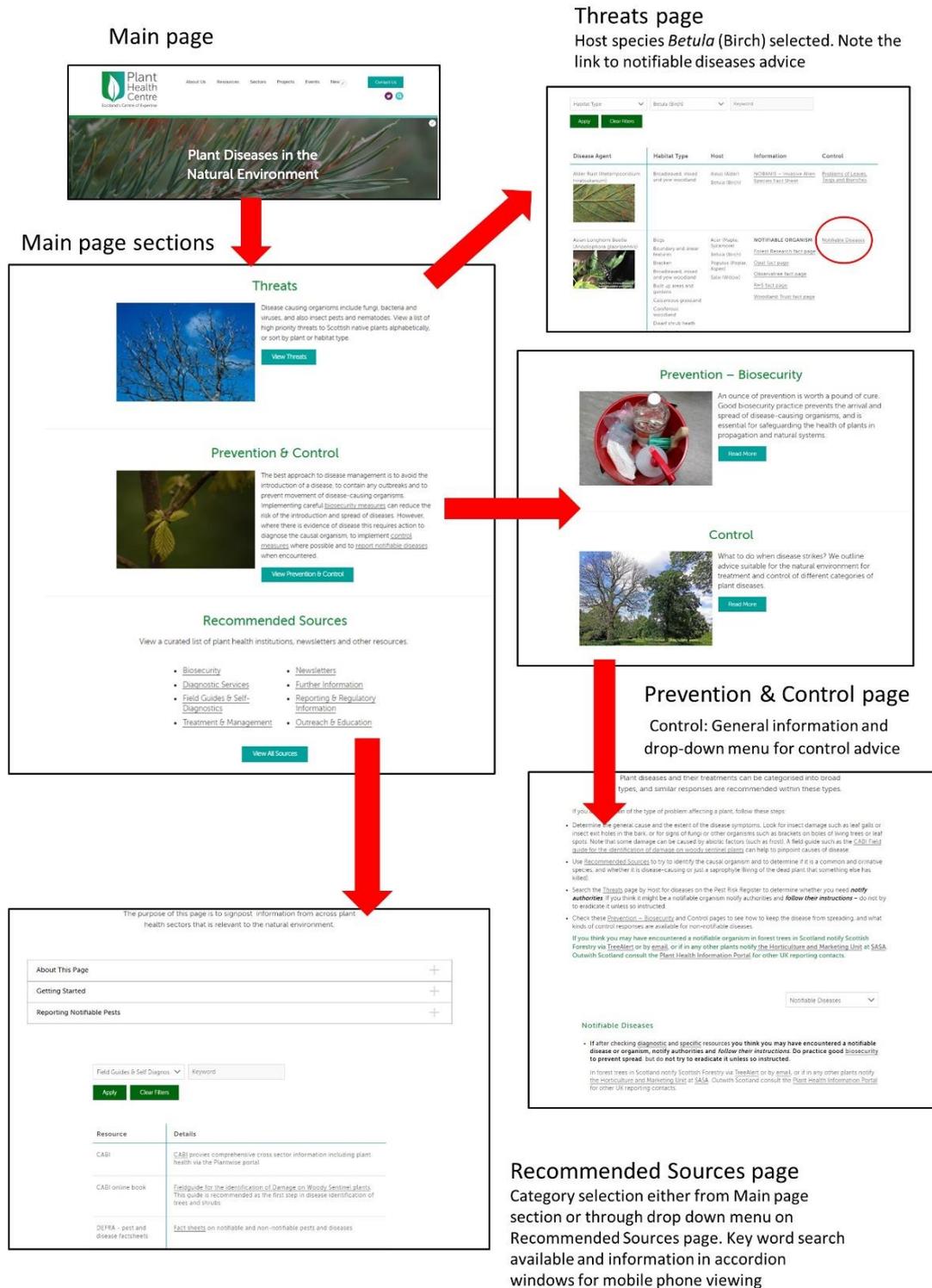
Figure 2. Layout and flow of the web resource (https://www.planthealthcentre.scot/plant-diseases)

4. STAKEHOLDER FEEDBACK AND REFINEMENTS

The website was reviewed by target stakeholders and plant health professionals (14 in total responses received) to ensure that the information given was correct and relevant, and the format user friendly. Feedback was evaluated and incorporated, and many excellent suggestions were synthesised which improved the pages greatly and for which reviewers are thanked for their time and efforts. These included improvements to formatting, clarification of advice in the case of suspicion of a notifiable disease, improvements to filtering and presentation of hosts and habitats, and redirection of links from the Forestry Commission Scotland to Scottish Forestry, or other sites as appropriate.

OUTCOMES

The aim of the project was to respond to needs voiced by stakeholders working in the natural environment in Scotland for user-friendly plant health advice, which is provided in the form of a website which is accessible to non-specialists. The project has delivered several of the key Goals of the PHC. Engagement with the stakeholders at the beginning and end of this process demonstrates commitment to this site being stakeholder-led, giving ownership and promoting uptake (Goal 6). As a result of increased accessibility to relevant information, it is anticipated there will be improved surveillance and detection (Goal 1) as stakeholders will be more equipped to diagnose plant health issues and take the necessary steps to implement management advice (Goal 2). This cohort of land managers can be utilised as a resource to flag emerging plant health issues and provide feedback which can inform horizon scanning efforts (Goal 3). Finally, information provided to the Plant Health Centre by stakeholders will add to a body of accumulated scientific evidence to improve efforts to respond and mitigate threats from pests and diseases (Goal 4).

A further outcome aimed to promote the webpages is the publication of a guidance paper in a special issue on global challenges in plant health of the journal *Sibbaldia*, subscribers of which include many of our stakeholders. This will be published late in 2019 or early 2020.

REFERENCES

Boa, E., Woodward, S. (2018) *Analysis of disease threats facing notable plant species found in Scottish habitats.* Economic, environmental and social values of Scottish plant sectors. Report for Brookdale Consulting on behalf of Scottish Government, University of Aberdeen, UK: 1-14.

Gregory, S., Redfern, D. (1998) *Diseases and Disorders of Forest Trees: A Guide to Identifying Causes of Ill-health in Woods and Plantations.* HMSO Publications Centre, UK.

Gonthier, P., Nicolotti, G., eds. (2013). *Infectious Forest Diseases.* CAB International, Oxfordshire, UK.

R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Roques, A., Cleary, M., Matsiakh, I., Eschen, R. (2017) *Field Guide for the Identification of Damage on Woody Sentinel Plants.* CABI, Wallingford, UK.

Scrace, J., Slawson, D., Beales, P (2012a) Nurseries, Retailers and Landscapers (NR&L) -- Biosecurity Best Practice Protocols. The Food and Environment Research Agency https://webarchive.nationalarchives.gov.uk/20130903103928/http://www.fera.defra.gov.uk/plants/plantHealth/documents/nrlProtocol.pdf, accessed 01 February 2019

Scrace, J., Slawson, D., Beales, P (2012b) Parks & Gardens (P&G) -- Biosecurity Best Practice Protocols. The Food and Environment Research Agency https://webarchive.nationalarchives.gov.uk/20121105225826/http://www.fera.defra.gov.uk/plants/plantHealth/documents/pgProtocol.pdf, accessed 01 February 2019

Silge, J., Robinson, D. (2016) "tidytext: Text Mining and Analysis Using Tidy Data Principles in R." _JOSS_, *1*(3). doi: 10.21105/joss.00037.

Watson, G. (2013) *Tree Pests and Diseases: An Arborists' Field Guide.* Arboricultural Association, UK.

Watson, G., Green, T. (2011) *Fungi on Trees: An Arborists' Field Guide.* Arboricultural Association, UK.

Working Group for Phytophthoras in Native Habitats (2016) Guidelines to minimize *Phytophthora* pathogens in Restoration Nurseries. California Oak Mortality Task Force http://www.suddenoakdeath.org/wp-content/uploads/2016/04/Restoration.Nsy_.Guidelines.final_.092216.pdf, accessed 01 February 2019

APPENDIX A. STAKEHOLDER PRIORITIES FOR THE PLANT HEALTH CENTRE

Priorities listed by stakeholders during workshops at the launch of the PHC on 22 May 2018, and used in the formation of Figure 1.

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
3	Effective plant health protection legislation that is established through effective communication of evidence	Research applications and synthesis	Capacity	Data gaps	Regulations	Public perception
3	Baseline biological data	Capacity	Data gaps			
3	Sentinel networks for oubreak monitoring	Capacity	Data gaps	Horizon scanning	Smarter surveillance	
3	Plant health and natural hazards - risk mapping spatially and temporally	Capacity	Horizon scanning	Surveillance	Surveillance gaps	Data gaps
3	Specific technological expertise e.g. natural pheromones vs artificial	Capacity	Data gaps	Surveillance	Surveillance gaps	
3	Surveillance technology e.g. remote sensing; sniffer; spore traps	Capacity	Horizon scanning	Surveillance	Smarter surveillance	Data gaps
3	Widen control measures (specific and low collatoral impacts) suited to our damp environment	Control measures	Toolkits			
3	Better delivery mechanisms for control measures	Control measures	Toolkits			
3	Encourage recording of what species (eg fungi; lichens; insects) use which plants for better understanding of ecological relationships for better risk assessments of	Resilience	Systems interactions	Risk		

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	wider environmental impacts					
3	How to build resilience to plant disease into wider environment to maintain associated species and function	Resilience	Systems interactions			
3	Soil-borne pests and diseases and the influence of soil management	Soil health	Control measures			
3	Loss of pesticides from market	Control measures	Toolkits			
3	Impact assessments of loss of pesticides due to resistance and regulation	Control measures	Toolkits	Regulations		
3	Knowledge transfer - use research to provide practical solutions for farmers and growers	Knowledge exchange	Toolkits			
3	Communication to a wider environment forum eg Moorland Forum	Knowledge exchange				
3	Improved short; sharp research and development	Capacity	Research applications and synthesis			
3	Knowledge gap activity	Capacity	Data gaps			
3	Cross-cutting knowledge exchange and research and development opportunities for pathogen diagnosis	Capacity	Knowledge exchange	Diagnostics and decision support		
3	Complete plant health capability & capacity project (resource and resilience)	Resilience	Capacity			
3	Consumer education about plant health issues	Knowledge exchange	Public perception	Trade	Biosecurity	Regulations

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	to drive safer trade practices					
3	Bringing together experiences and information about response and outcomes of plant health campaigns; from research to control and results. Publish short accounts for wide audience	Knowledge exchange	Public perception	Research applications and synthesis		
3	Contingency outbreak planning	Horizon scanning	Research applications and synthesis	Capacity	Contingency planning	
3	Xylella: knowledge gaps and capacity	Capacity	Data gaps	Targeted species		
3	E-commerce - assess risk; stakeholder awareness	Trade	Knowledge exchange	Public perception	Risk	
3	Assessment on blight 37A2 strain fungicide program	Capacity	Research applications and synthesis	Control measures	Targeted species	Horizon scanning
3	Do we have any risk assessment or work for the Tecia solanivora pest?	Risk	Research applications and synthesis	Control measures	Targeted species	Horizon scanning
3	Potential pathogens in waiting in the natural environment	Horizon scanning	Risk			
3	Impact of abiotic stress on plant health - not all about pests and disease	Climate change				
3	Strategic prioritisation of Scottish plant health issues	Capacity	Prioritisation			
3	Addressing pest control gaps which are starting to arise in response to loss of pesticide authorisations and impact on crop production and	Control measures	Toolkits	Regulations		

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	agricultural economy					
3	Identify wider environment plant health priorities (system-critical elements; likelihood of disease management)	Prioritisation	Systems interactions			
3	Priority should be on prevention of introduction	Biosecurity	Regulations			
3	Contingency planning in natural environment	Horizon scanning	Contingency planning			
3	Horizon scanning (Pest Risk Assessments) for threats to native plants species	Horizon scanning				
3	A means to prioritise threats to critical elements in the environment	Prioritisation	Knowledge exchange			
3	Management actions for priority threats	Control measures	Research applications and synthesis	Knowledge exchange		
3	Assessing wider environment impacts of plant disease - inclusion in risk assessments	Risk	Systems interactions			
3	Having access to a range of expertise - science and social science	Capacity				
3	Surveillance of quarantine pests & disease	Surveillance				
3	Data gaps - better survey design. Where; when; what to inspect. Is current survey strategy best?	Capacity	Data gaps	Surveillance	Smarter surveillance	
3	Epidemiology - lack of data analysis on past	Capacity	Data gaps			

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	and current surveillance					
3	Skills gaps - lack of trained inspectors	Capacity				
3	Understanding impact and measuring costs; changes; and implications of plant health problems	Data gaps				
3	Help with our planning assumptions and future plant health risks; eg resilience and protected areas planning	Horizon scanning	Data gaps			
2	Bronze birch borer; EAB; Anaplophora species.	Targeted species				
2	Sitka spruce	Targeted species				
2	Prevention of any serious threat to Sitka spruce	Targeted species				
2	Threats to native tree species	Targeted species				
2	Hylobius control in forestry	Targeted species	Control measures			
2	What do we specify as a replacement tree species where ash dieback is an issue?	Targeted species				
2	Uptake of integrated pest management	Biocontrol and IPM				
2	Sustainable pesticide use	Control measures				
2	Decreasing toolkit of controls	Control measures	Toolkits			
2	Impact of alternative controls	Control measures	Research applications and synthesis	Data gaps		
2	Registration of non-native species as biocontrol agents	Control measures	Toolkits	Biocontrol and IPM	Regulations	

17

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	in the UK - after appropriate risk assessment - come non-natives could be very effective in a situation of loss of other measures					
2	What about soils management and use of growing media and conditioners - are they tested? If not; how can we be sure no contamination?	Biosecurity	Soil health	Regulations	Risk	Surveillance gaps
2	Regulate the plant trade	Biosecurity	Regulations	Trade		
2	Stop the import and use of more extotic tree species; especially related to native species	Biosecurity	Regulations	Trade		
2	Develop proactive; sustainable protection against pests and pathogens by using ecological and evolutionary principles to produce resilient crop populations	Resilience				
2	What and where are the primary; current biosecurity threats to trees and garden plants in Scotland?	Risk	Horizon scanning			
2	How to be more proactive - Planning for unknowns - resilient landscapes?	Resilience				
2	Interaction between policies on climate change; pests and pathogens;	Systems interactions	Climate change			

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	biodiveristy conservation					
2	Intensifying global trade; climate change; and Brexit	Trade	Risk	Regulations	Climate change	
2	Managing trade restrictions in a free-trade economy	Trade	Risk	Regulations	Biosecurity	
2	Need to establish value for plants with high biosecurity status	Trade	Knowledge exchange	Biosecurity	Public perception	
2	Need to establish the role and recognition of the Plant Health Professional across the market	Knowledge exchange	Trade	Public perception		
2	Need to engage all sectors within the market in matters of biosecurity	Knowledge exchange	Biosecurity	Public perception		
2	Procurement and use of plants with local provenance	Regulations	Trade	Risk		
2	Improved national; international; and island biosecurity	Regulations	Trade	Biosecurity		
2	Lack of capability to intercept plants	Regulations	Trade	Biosecurity	Surveillance gaps	Surveillance
2	Nursery imports of forest trees	Regulations	Trade	Biosecurity	Surveillance gaps	Surveillance
2	Protecting trade and the environment	Regulations	Trade	Biosecurity		
2	Surveillance and early warning on novel threats	Capacity	Surveillance	Smarter surveillance	Horizon scanning	
2	Early detection - does the molecular approach work in trade?	Capacity	Data gaps	Surveillance	Smarter surveillance	Surveillance
2	Improved coordination of invasive and non-native species and plant health	Capacity	Systems interactions	Knowledge exchange		

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
1	Pest and disease management solutions	Control measures	Toolkits	Research applications and synthesis		
1	Lessons learnt between sectors	Knowledge exchange				
1	A smaller toolkit for pests and diseases due to registration changes - with a very slow transition time to new tech	Control measures	Toolkits	Research applications and synthesis	Regulations	
1	Emerging and future threats	Horizon scanning				
1	Improve collaboration and knowledge exchange across 4 sectors - agriculture; horticulture; forestry; natural environment	Knowledge exchange				
1	Prioritise protection and designation of habitats and species and ecosystems under threat from pests; pathogens and INNs	Prioritisation	Resilience	Systems interactions		
1	Increase resilience and adaptive ability of habitats and species to climate change in ecosystem restoration	Resilience	Climate change			
1	Addressing one pest or disease threat might increase susceptibility to others	Resilience	Data gaps			
1	How plant responses to other; abiotic signals affect disease response; and how will this	Climate change	Data gaps			

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	change with climate change?					
1	Access to knowledge eg pest and disease identification; existing controls; impact of soil or compost sterilisation	Knowledge exchange	Diagnostics and decision support	Biosecurity	Control measures	
1	Exchanging ideas and information across institutions in the UK that perhaps dont talk	Knowledge exchange				
1	Interpreation of research and policy as reader-friendly information	Knowledge exchange	Research applications and synthesis	Regulations		
1	Plant agronomy - improvement and increased knowledge for overall better health	Resilience	Knowledge exchange			
1	Decision support - providing growers and farmers with validated information to help them make step changes to production with confidence	Knowledge exchange	Diagnostics and decision support			
1	Improve understanding of plant health risk in general public - online sales - foreign travel	Knowledge exchange	Public perception	Biosecurity	Risk	
1	Efficacy and legality of organic controls for gardeners	Knowledge exchange	Diagnostics and decision support	Control measures	Biocontrol and IPM	
1	Knowledge of food production and perception of public	Knowledge exchange	Public perception			
1	More biological solutions	Capacity	Research applications and synthesis	Control measures	Biocontrol and IPM	
1	Improve biosecurity in	Biosecurity				

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	arable agriculture. Pig farmers do it; why dont veg and potato farmers?					
1	Continued freedom from all notifiable potato diseases	Biosecurity	Targeted species			
1	Maintain the high health status of Scottish seed potatoes (bacterial and viral health)	Biosecurity	Targeted species			
1	Improved clarity of biosecurity issues	Biosecurity	Knowledge exchange			
1	Biosecurity	Biosecurity				
1	Prevent the introduction of non-indigenous pests or pathogens	Biosecurity				
1	Encourage stakeholders to use clean material to begin with	Biosecurity	Knowledge exchange	Public perception		
1	Make sure people are aware of all plants that may be affected by pests and pathogens	Biosecurity	Knowledge exchange	Public perception		
1	Phytophthora species	Targeted species				
1	How to bridge motivation for university researchers (REF) with a national focus	Capacity	Research capacity			
1	How to assemble and communicate research to policy?	Capacity	Research applications and synthesis	Knowledge exchange	Research capacity	
1	How much potential is there for collaboration between plant and animal health re: common skills and capability; eg modelling; social research; etc	Capacity	Research capacity	Knowledge exchange		
1	Research into specific pest and	Capacity	Data gaps	Targeted species		

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	disease issues for which no known controls exist; with low volume but high sector impact eg golden root mealybug; boxblight; cushion scale					
1	Restrict the movement of plant material from regions where new pests are present	Regulations	Biosecurity			
1	Scientifically robust regulatory systems that respect sound research	Regulations	Knowledge exchange	Research applications and synthesis		
1	Reduce risk by reducing movement of plant material	Regulations	Biosecurity			
1	Improved pre-border detection	Regulations	Biosecurity	Surveillance	Surveillance gaps	
1	Regulation of imports - biosecurity	Regulations	Biosecurity			
1	Accreditation and reliability of nursery planting stock encompassing provenance and traceability	Regulations	Biosecurity			
1	Resilience - alternative species and provenances and implications	Resilience	Biosecurity			
1	Knowledge and training	Knowledge exchange				
1	How do we get Ministers to focus on longer term emerging plant threats and issues?	Knowledge exchange	Regulations	Impact	Prioritisation	
1	Evidence of impacts of issues in Scotland to justify our actions	Research applications and synthesis	Impact	Knowledge exchange	Data gaps	
1	How to pick potential losers - deciding which of	Prioritisation	Data gaps			

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5
	the many pests and disease threats to focus on					
1	Linking genome information to mechanisms - both disease and response	Data gaps	Research capacity			
1	Sharing data - what social or technological barriers can we overcome; and can we do well because of Scotland small scale?	Data gaps	Knowledge exchange	Research capacity		
1	Horizon scanning and producing risk registers	Horizon scanning	Data gaps	Impact		

Group	Priority	Tag_1	Tag_2	Tag_3	Tag_4	Tag_5

Common name	Genus
Alder	Alnus
Apple	Malus
Ash	Fraxinus
Blaeberry	Vaccinium
Bearberry	Acrtostaphylos
Birch	Betula
Buckthorn	Rhamnus
Crowberry	Empetrum
Elderflower	Sambucus
Elm	Ulmus
Hawthorn	Crataegus
Hazel	Corylus
Heath	Erica
Heather	Calluna
Holly	Ilex
Hornbeam	Carpinus
Horsechestnut	Aesculus
Juniper	Juniperus
Lime	Tilia
Oak	Quercus
Pine	Pinus
Poplar	Populus
Primula	Primula
Rose	Rosa
Rowan	Sorbus
Sloe/Cherry	Prunus
Sweetchestnut	Castanea
Sycamore/maple	Acer
Willow	Salix
Yew	Taxus
Bramble	Rubus
Gorse	Ulex
Broom	Cytisus

APPENDIX C: PEST RISK REGISTER PESTS ON MAJOR SCOTTISH GENERA

This report includes code and output used to produce a list of the threats listed in the Pest Risk Analysis that may affect plants important to the Scottish Natural Environment. The code was run in R v3.5.0; session information follows output. Additional judgements were made to exclude some pests because of little expected damage in the natural environment (e.g. where damage was primarily cosmetic) or to include pests not yet present in the UK but considered to be of high risk (e.g. those followed by Observatree).

1. Load the Pest Risk Register

The UK Pest Risk Register was downloaded from
https://secure.fera.defra.gov.uk/phiw/riskRegister/downloadEntireRiskRegister.cfm
on 29/01/2019 in csv format. It includes 1039 observations (rows) and 57 columns. We load the entire risk register, and then create a new object including only those listed as Present in the UK, whether widespread or limited.

```
pra <- read.csv(file="~/Data/Risk Register 29_01_2019 10_22_55.csv", st
ringsAsFactors = FALSE, header=TRUE)
#make a new object with subset present in UK
pra_UK <- pra[grep("Present",pra$UK),]
```

2. Load the genera of interest

The genera of interest were selected from the Joint Nature Conservation Committe National Vegetation Classification habitat types marked as present in Scotland. These major vegetation types were compiled, and the lists of genera present were compiled.

```
genera <- read.csv(file="~/data/genera.csv", header=TRUE, stringsAsFact
ors = FALSE) #file name
#convert this to a vector with the genus names only
genera <- genera$genus
```

3. Print a list of pests including pathogens that are listed as affecting the important Scottish genera and are already present in the UK.

First, generate a dataframe including only the hosts of interest, and write this intermediate object to a csv to be used for other analyses.

```
natuk <- NULL #creates a dummy object, to be populated with the for loo
p
for(i in 1:length(genera)){
  genus <- genera[i]
  pests <- pra_UK[grep(genus, pra_UK$Major.Hosts),] #searches the major
 hosts for the genera of interest
  natuk <- rbind(natuk, pests) #adds the lines it finds to the dummy ob
ject
}
natuk_dedup <- unique(natuk) #removes duplicate rows
#write.csv(natuk_dedup, file="~/data/RiskReg_20190129_natenv_UKpresent.
csv") #remove hash to write csv
```

Now, filter out the pests with UK relative risk rating of less than 20, and report a table of the pests and pathogens by genus

```
hi <- natuk_dedup[natuk_dedup$UK.Relative.Risk.Rating..unmitigated.>19,
]

library(knitr)
for(i in 1:length(genera)){
  genus <- genera[i]
  pests <- hi[grep(genus, hi$Major.Hosts),]#cycles through each genus,
searching for associated records
  if(nrow(pests)>0){
    print(kable(pests[, c(3:4,29)], row.names=FALSE, caption=genus))
    }#where there are pest records for the genus prints a table with pe
st name, presence in uk
}
```

Alnus

Pest.Name	Common.name.or.abbreviation	UK
Melampsoridium hiratsukanum		Present (Limited)
Phytophthora alni	Alder bleeding canker; Alder Phytophthora root disease	Present (Widespread)
Phytophthora pseudosyringae		Present (Limited)
Phytophthora siskiyouensis		Present (Unknown Distribution)
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)

Malus

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora pseudosyringae		Present (Limited)
Drosophila suzukii	Spotted wing drosophila	Present (Unknown Distribution)
Erwinia amylovora	Blossom blight; Fire blight; Fireblight; Twig blight of apple	Present (Widespread)
Lymantria dispar	Gypsy moth	Present (Limited)
Neofusicoccum australe	Drupe rot of olive	Present (Unknown Distribution)
Neofusicoccum parvum		Present (Unknown Distribution)
Nysius huttoni	Wheat bug	Present (Limited)
Phacidiopycnis washingtonensis		Present (Unknown Distribution)
Xiphinema pachtaicum	Dagger nematode	Present (Unknown Distribution)

Fraxinus

Pest.Name	Common.name.or.abbreviation	UK
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Hymenoscyphus fraxineus	Ash dieback	Present (Limited)
Tropidosteptes pacificus	Ash mirid plant bug	Present (Unknown Distribution)

Vaccinium

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora pseudosyringae		Present (Limited)
Drosophila suzukii	Spotted wing drosophila	Present (Unknown Distribution)
Neofusicoccum australe	Drupe rot of olive	Present (Unknown Distribution)
Neofusicoccum parvum		Present (Unknown Distribution)
Phytophthora kernoviae		Present (Limited)
Phytophthora ramorum	Ramorum leaf blight; Ramorum shoot dieback; Rhododendron twig blight; Sudden oak death	Present (Limited)

Betula

Pest.Name	Common.name.or.abbreviation	UK
Melampsoridium hiratsukanum		Present (Limited)
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Lymantria dispar	Gypsy moth	Present (Limited)

Ulmus

Pest.Name	Common.name.or.abbreviation	UK
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Lymantria dispar	Gypsy moth	Present (Limited)
Xiphinema pachtaicum	Dagger nematode	Present (Unknown Distribution)
Aproceros leucopoda		Present (Unknown Distribution)
Duponchelia fovealis		Present (Limited)

Pest.Name	Common.name.or.abbreviation	UK
Ophiostoma novo-ulmi	Dutch elm disease (aggressive form)	Present (Widespread)
Tinocallis nevskyi		Present (Widespread)
Tinocallis takachihoensis		Present (Limited)
Xylotoles griseus	New Zealand fig longhorn	Present (Limited)

Crataegus

Pest.Name	Common.name.or.abbreviation	UK
Erwinia amylovora	Blossom blight; Fire blight; Fireblight; Twig blight of apple	Present (Widespread)

Erica

Pest.Name	Common.name.or.abbreviation	UK
Chryseococcus arecae	Golden root mealybug	Present (Limited)

Carpinus

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora pseudosyringae		Present (Limited)
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)

Aesculus

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora ramorum	Ramorum leaf blight; Ramorum shoot dieback; Rhododendron twig blight; Sudden oak death	Present (Limited)
Cameraria ohridella	Horse-chestnut leaf miner; Horse-chestnut miner	Present (Widespread)
Pseudomonas syringae pv. aesculi		Present (Widespread)

Juniperus

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora austrocedri		Present (Limited)

Tilia

Pest.Name	Common.name.or.abbreviation	UK
Candidatus Phytoplasma asteris in Carrot	Aster yellows; AY; yellow disease phytoplasmas	Present

Quercus

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora pseudosyringae		Present (Limited)
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)

Lymantria dispar	Gypsy moth	Present (Limited)
Neofusicoccum australe	Drupe rot of olive	Present (Unknown Distribution)
Neofusicoccum parvum		Present (Unknown Distribution)
Phytophthora kernoviae		Present (Limited)
Phytophthora ramorum	Ramorum leaf blight; Ramorum shoot dieback; Rhododendron twig blight; Sudden oak death	Present (Limited)
Acute Oak Decline		Present (Limited)
Agrilus biguttatus	Oak jewel beetle; Oak splendour beetle; Two -spot woodborer	Present (Limited)
Platypus cylindrus	Oak pinhole borer; Pinhole borer	Present (Limited)
Thaumetopoea processionea	Oak processionary caterpillar; Oak processionary moth	Present (Limited)

Pinus

Pest.Name	Common.name.or.abbreviation	UK
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Phacidiopycnis washingtonensis		Present (Unknown Distribution)
Dendroctonus micans	European spruce beetle; Large spruce beetle	Present (Limited)
Dendrolimus pini	PIne lappet; Pine lappet moth; Pine moth	Present (Limited)
Dothistroma septosporum	Dothistroma needle blight; Red band needle blight	Present (Limited)
Essigella californica	Monterey Pine Aphid	Present (Limited)
Gremmeniella abietina	Canker of conifers; Dieback of pine; Scleroderris canker of conifers; Scleroderris of canker; Shoot blight of pine	Present (Limited)
Hylobius abietis	large brown pine weevil; large pine weevil; pine weevil	Present (Widespread)
Ips sexdentatus		Present (Limited)
Neonectria fuckeliana	Stem canker: spruce; Wound decay: spruce	Present (Limited)

Populus

Pest.Name	Common.name.or.abbreviation	UK

Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Neofusicoccum parvum		Present (Unknown Distribution)
Candidatus Phytoplasma asteris in Carrot	Aster yellows; AY; yellow disease phytoplasmas	Present
Entoleuca mammata	Canker of aspen; Canker of poplar; Hypoxylon canker of poplar; Poplar canker	Present (Limited)

Primula

Pest.Name	Common.name.or.abbreviation	UK
Chryseococcus arecae	Golden root mealybug	Present (Limited)
Candidatus Phytoplasma asteris in Carrot	Aster yellows; AY; yellow disease phytoplasmas	Present
Impatiens necrotic spot virus	Necrotic spot	Present (Widespread)
Simo hirticornis		Present (Unknown Distribution)

Rosa

Pest.Name	Common.name.or.abbreviation	UK
Duponchelia fovealis		Present (Limited)
Candidatus Phytoplasma asteris in Carrot	Aster yellows; AY; yellow disease phytoplasmas	Present
Arabis mosaic virus	Arabis mosaic; Forsythia yellow net; Hop bare bine; Hop nettlehead; Hop split leaf blotch; Raspberry yellow dwarf; Rhubarb mosaic; Strawberry mosaic	Present (Limited)
Frankliniella occidentalis	alfalfa thrips; western flower thrips	Present (Widespread)
Prunus necrotic ringspot virus	Almond bud failure; Almond calico; Almond line pattern; Almond necrotic ringspot; Apricot line pattern; Apricot necrotic ringspot; Cherry lace leaf; Cherry line pattern; Cherry necrotic ringspot; Cherry ringspot; Cherry rugose mosaic; Cherry stecklenberger disease; Cherry tatter leaf; Necrotic ringspot of prunus; Peach line pattern; Peach mule's ear; Peach necrotic leafspot; Peach necrotic ringspot; Peach ringspot; Peach willow leaf; Plum decline; Plum European line pattern; Plum oak leaf; Prunus necrotic ringspot; Prunus ringspot; Rose mosaic; Rose yellow mosaic; Sour cherry fruit necrosis; Sour cherry line mosaic; Sour cherry necrotic ringspot	Present (Widespread)

| Strawberry latent ringspot virus | Latent ringspot of strawberry | Present (Limited) |

Sorbus

Pest.Name	Common.name.or.abbreviation	UK
Erwinia amylovora	Blossom blight; Fire blight; Fireblight; Twig blight of apple	Present (Widespread)
European mountain ash ringspot associated virus	European mountain ash ringspot associated virus	Present (Unknown Distribution)

Prunus

Pest.Name	Common.name.or.abbreviation	UK
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Drosophila suzukii	Spotted wing drosophila	Present (Unknown Distribution)
Lymantria dispar	Gypsy moth	Present (Limited)
Neofusicoccum australe	Drupe rot of olive	Present (Unknown Distribution)
Neofusicoccum parvum		Present (Unknown Distribution)
Xiphinema pachtaicum	Dagger nematode	Present (Unknown Distribution)
Candidatus Phytoplasma asteris in Carrot	Aster yellows; AY; yellow disease phytoplasmas	Present
Simo hirticornis		Present (Unknown Distribution)
Arabis mosaic virus	Arabis mosaic; Forsythia yellow net; Hop bare bine; Hop nettlehead; Hop split leaf blotch; Raspberry yellow dwarf; Rhubarb mosaic; Strawberry mosaic	Present (Limited)
Frankliniella occidentalis	alfalfa thrips; western flower thrips	Present (Widespread)
Prunus necrotic ringspot virus	Almond bud failure; Almond calico; Almond line pattern; Almond necrotic ringspot; Apricot line pattern; Apricot necrotic ringspot; Cherry lace leaf; Cherry line pattern; Cherry necrotic ringspot; Cherry ringspot; Cherry rugose mosaic; Cherry stecklenberger disease; Cherry tatter leaf; Necrotic ringspot of prunus; Peach line pattern; Peach mule's ear; Peach necrotic leafspot; Peach necrotic ringspot;	Present (Widespread)

	Peach ringspot; Peach willow leaf; Plum decline; Plum European line pattern; Plum oak leaf; Prunus necrotic ringspot; Prunus ringspot; Rose mosaic; Rose yellow mosaic; Sour cherry fruit necrosis; Sour cherry line mosaic; Sour cherry necrotic ringspot	
Strawberry latent ringspot virus	Latent ringspot of strawberry	Present (Limited)
Candidatus Phytoplasma pyri on perry pears	Decline of pear; Leaf curl of pear; Moria disease of pear; Pear leaf curl	Present (Limited)
Plum pox virus	Plum pox; Pox disease of plum; Sharka; Sharka disease of plum	Present (Limited)
Raspberry ringspot virus	Cherry rasp leaf (in part) (European); Gooseberry leaf distortion; Lloyd George raspberry yellow blotch disease; Pfeffinger disease of cherry; Redcurrant ringspot; Ringspot diseases of raspberry; strawberry and flowering currant; RRSV; Spoon leaf of redcurrant (Netherlands)	Present (Limited)
Scirtothrips inermis		Present (Limited)
Tomato black ring virus	Black ring of tomato; Bouquet of potato; Pseudo-aucuba of potato; Ringspot of bean; Ringspot of beet; Ringspot of lettuce; Yellow vein of celery	Present (Limited)
Tomato ringspot virus	Chlorosis mosaic of raspberry; Chlorosis of pelargonium; Crumbly fruit of raspberry; Decline of raspberry; Eola rasp leaf of cherry; Peach yellow bud mosaic; Ringspot of tomato; Stem pitting of prunus; Stub head of gladiolus; Stunt of gladiolus; Union necrosis of apple; Yellow blotch curl of raspberry; Yellow bud mosaic of peach; Yellow vein of grapevine	Present (Unknown Distribution)
Verticillium dahliae	Verticillium wilt; Verticillium wilt of cotton	Present (Widespread)

Castanea

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora pseudosyringae		Present (Limited)
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Phytophthora ramorum	Ramorum leaf blight; Ramorum shoot dieback; Rhododendron twig blight; Sudden oak death	Present (Limited)
Dryocosmus kuriphilus	oriental chestnut gall wasp	Present (Limited)

		Present (Unknown Distribution)
Gnomoniopsis smithogilvyi		

Acer

Pest.Name	Common.name.or.abbreviation	UK
Phytophthora pseudosyringae		Present (Limited)
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Lymantria dispar	Gypsy moth	Present (Limited)
Phytophthora ramorum	Ramorum leaf blight; Ramorum shoot dieback; Rhododendron twig blight; Sudden oak death	Present (Limited)
Verticillium dahliae	Verticillium wilt; Verticillium wilt of cotton	Present (Widespread)

Salix

Pest.Name	Common.name.or.abbreviation	UK
Xylosandrus germanus	Black timber bark beetle; Smaller alnus bark beetle; tea root borer	Present (Limited)
Lymantria dispar	Gypsy moth	Present (Limited)
Scirtothrips inermis		Present (Limited)

Rubus

Pest.Name	Common.name.or.abbreviation	UK
Drosophila suzukii	Spotted wing drosophila	Present (Unknown Distribution)
Nysius huttoni	Wheat bug	Present (Limited)
Xiphinema pachtaicum	Dagger nematode	Present (Unknown Distribution)
Arabis mosaic virus	Arabis mosaic; Forsythia yellow net; Hop bare bine; Hop nettlehead; Hop split leaf blotch; Raspberry yellow dwarf; Rhubarb mosaic; Strawberry mosaic	Present (Limited)
Prunus necrotic ringspot virus	Almond bud failure; Almond calico; Almond line pattern; Almond necrotic ringspot; Apricot line pattern; Apricot necrotic ringspot; Cherry lace leaf; Cherry line pattern; Cherry necrotic ringspot; Cherry ringspot; Cherry rugose mosaic; Cherry stecklenberger disease; Cherry tatter leaf; Necrotic ringspot of prunus; Peach line pattern; Peach mule's ear; Peach necrotic leafspot; Peach necrotic ringspot; Peach ringspot; Peach willow leaf; Plum decline; Plum European line	Present (Widespread)

	pattern; Plum oak leaf; Prunus necrotic ringspot; Prunus ringspot; Rose mosaic; Rose yellow mosaic; Sour cherry fruit necrosis; Sour cherry line mosaic; Sour cherry necrotic ringspot	
Strawberry latent ringspot virus	Latent ringspot of strawberry	Present (Limited)
Raspberry ringspot virus	Cherry rasp leaf (in part) (European); Gooseberry leaf distortion; Lloyd George raspberry yellow blotch disease; Pfeffinger disease of cherry; Redcurrant ringspot; Ringspot diseases of raspberry; strawberry and flowering currant; RRSV; Spoon leaf of redcurrant (Netherlands)	Present (Limited)
Tomato black ring virus	Black ring of tomato; Bouquet of potato; Pseudo-aucuba of potato; Ringspot of bean; Ringspot of beet; Ringspot of lettuce; Yellow vein of celery	Present (Limited)
Tomato ringspot virus	Chlorosis mosaic of raspberry; Chlorosis of pelargonium; Crumbly fruit of raspberry; Decline of raspberry; Eola rasp leaf of cherry; Peach yellow bud mosaic; Ringspot of tomato; Stem pitting of prunus; Stub head of gladiolus; Stunt of gladiolus; Union necrosis of apple; Yellow blotch curl of raspberry; Yellow bud mosaic of peach; Yellow vein of grapevine	Present (Unknown Distribution)
Otiorhynchus lavandus		Present (Unknown Distribution)
Phytophthora rubi	Raspberry root rot	Present (Widespread)

```
sessionInfo()
```

```
## R version 3.5.0 (2018-04-23)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS  10.14.3
##
## Matrix products: default
## BLAS: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/lib
Rblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/l
ibRlapack.dylib
##
## locale:
## [1] en_GB.UTF-8/en_GB.UTF-8/en_GB.UTF-8/C/en_GB.UTF-8/en_GB.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base


##
## other attached packages:
## [1] knitr_1.20
##
## loaded via a namespace (and not attached):
##  [1] compiler_3.5.0  backports_1.1.2 magrittr_1.5    rprojroot_1.3-2
```

```
##  [5] tools_3.5.0      htmltools_0.3.6 yaml_2.2.0     Rcpp_0.12.18
##  [9] stringi_1.2.4   rmarkdown_1.10  highr_0.7      stringr_1.3.1
## [13] digest_0.6.16   evaluate_0.11
```