

Review of Joint Inter-Departmental Emergency Programme to
Contain and Eradicate *Phytophthora ramorum*
and *Phytophthora kernoviae* in Great Britain.

Isobel Tomlinson, Tom Harwood, Clive Potter, Jon Knight.

Centre for Environmental Policy, Imperial College London, South Kensington

Corresponding author: Email i.tomlinson@imperial.ac.uk

October 2009

Contents

1.	Introduction	3
1.1	Current spread of <i>Pr/Pk</i> in Great Britain	3
1.2	Methodology	4
2.	Origins, timings and points of entry into the management of the disease	6
2.1	Identification of <i>Pr</i> and pest risk analysis	6
2.2	First findings of <i>Pr</i> and response	7
2.3	The response of the plant health authorities to the risk posed by <i>Pk</i>	10
2.4	Reflections	12
3	Institutional structures and approaches to interdepartmental decision-making	14
3.1	Programme Board management structure	14
3.2	Strengths of the programme board	15
3.3	Programme board weaknesses	16
3.4	Interdepartmental working	19
4	The use of science and the development of the policy evidence base	21
4.1	Funding, knowledge base and research relevance	21
4.2	Organisation	24
4.3	Dissemination and uptake	25
4.4	Funding decisions	27
4.5	Feedback	27
4.6	Information sharing with the USA	28
4.7	Developments in diagnostic tests	28
5	Impact and effectiveness of measures taken on the ground	29
5.1	Surveys	29
5.2	Inspection of cargo in ports	31
5.3	Cornwall management zone	32
5.4	Inspection and movement restrictions in nurseries and retail premises	34
5.5	Plant passporting	38
5.6	Management of disease in woodlands	41
5.7	Management of disease in historic gardens	45
6	The involvement of stakeholders and the public	55
6.1	Stakeholder engagement	55
6.2	Public awareness and engagement	57
7	The International Context: mainland Europe and the USA	61

7.1	The role of mainland Europe	61
7.2	Management of Sudden Oak Death in the USA	62
8	Policy review and overall success of the programme	67
8.1	Public consultation	67
8.2	Overall perceptions on the success of the programme	68
9	Recommendations for future policy	69
9.1	Inspectorate	69
9.2	Garden management plans for historic gardens	70
9.3	<i>R. ponticum</i> clearance	71
9.4	<i>Vaccinium myrtillus</i> infection	71
9.5	Other research suggestions	72
9.6	Micro-propagation unit	73
9.7	Effective engagement with stakeholders and the public	73
9.8	Stakeholders for future inclusion	76
9.9	Inter departmental organisation	76
9.10	The future structure of the Programme Board	77
9.11	Factors likely to impact on <i>Pr/Pk</i> in the future	77
9.12	Plant biosecurity and future plant health risks	78
10	Summary of policy recommendations	80
	Bibliography	82
	Appendix 1: Copy of Implementers on-line questionnaire	85
	Appendix 2: Copy of Stakeholders on-line questionnaire	90

1. Introduction

This report was commissioned by Defra in order to provide a review of the inter departmental emergency programme of work to contain and eradicate *Phytophthora ramorum* (*Pr*) and *Phytophthora kernoviae* (*Pk*) that was overseen by Defra and the Forestry Commission (FC). This covers the time period from the first discovery of *Pr* in Great Britain (GB) in February 2002, to the close of this programme in April 2009. A new programme is now in place and this report seeks to identify both best practice, and the lessons that should be learnt from this experience, in order to inform future work.

Responding to the threat posed from *Pr* and *Pk* has posed an unprecedented challenge to the authorities responsible for plant and tree health in GB. Several of the characteristics of *Pr* and *Pk* have made for a unique threat to which Defra, the FC and the devolved authorities of Scotland and Wales have had to respond. This includes the diversity of habitats in which they have been found, woodland, historic gardens, heathland as well as plant nurseries; the large host range, and the initial high levels of scientific uncertainty over the nature of the pathogens and their impacts. Intervention is further complicated by infected sites having a mixture of public and private landownership, and differing levels of public access. Thus, *Pr* and *Pk* have shown the ability to jump not only habitat types and species boundaries, but also agency responsibility boundaries, exposing vulnerabilities in terms of the way in which authorities can and should react.

This report seeks to provide a balanced review of the emergency programme, incorporating the concerns, criticisms and suggestions for future policy, of those involved with designing and implementing policy for *Pr/Pk* and those involved with managing outbreaks on the ground. A review of the emergency programme response to *Pr/Pk* is not only important for improving the future management of *Pr/Pk*, but it is believed it will have wider significance in the future, in providing an important reference point for managing new plant and tree health risks.

1.1 Current spread of *Pr/Pk* in Great Britain.

In England and Wales there have been a total of 901 outbreaks of *Pr* at 766 sites between April 2002 and June 2009. 261 of the outbreaks (231 sites) have been in the wider environment. 85 of these outbreaks have been eradicated with 176 on-going. At retail and productions sites there have been 640 outbreaks (at 535 sites). 541 of these have been eradicated, with 99 on-going. (57 of these sites are plant passporting nurseries and 22 of the outbreaks are re-introductions). In the case of *Pk*, between October 2003 and June 2009 in England and Wales there have been a total of 74 outbreaks (on 73 sites). Five of these (four sites) have been on retail and production sites, with 69 in the wider environment. Of the retail and production sites, four of the outbreaks have been eradicated and one is on-going. In the wider environment, one of the outbreaks has been eradicated, with 68 on-going (personal communication Fera, September 2009).

Since 2002 in Scotland there have been 43 *Pr* outbreaks at 25 nurseries and garden centre sites and three at newly landscaped sites. There are currently no ongoing nursery or garden centre outbreaks in Scotland. At established gardens since 2007 there have been 14 outbreaks involving 21 premises of *Pr* and two outbreaks involving four premises of *Pk*. There has been one outbreak with both diseases on the same plant. One garden outbreak of *Pr* is currently being eradicated, with two premises on annual visits and two on quarterly. Four other outbreaks (one *Pk*, three *Pr*) are now on quarterly visits (personal communication John Speirs, August 2009).

1.2 Methodology

Through a series of face-to-face and telephone interviews, and an on-line survey, this report seeks to reflect and examine the diverse, and sometimes contradictory, views expressed by both those implementing the *emergency programme* and stakeholders who have been involved with *Pr/Pk* management.

This report is also informed by a review of the scientific and literature on *Pr/Pk* including Defra and FC publications, internal documents and the Programme Board minutes.

1.21 Interview programme

The authors carried out in-depth structured interviews of one to one and a half hours duration with 20 individuals; 11 of these individuals had played a key role in implementing the emergency programme as civil servants, PHSI inspectors and research scientists, and 9 were stakeholders who have been involved, in a variety of capacities, with managing *Pr/Pk* outbreaks. This report is also informed by a series of 13 interviews with stakeholders and employees of FC and Defra that were previously undertaken by the authors as part of an on-going Rural Economy and Land Use (RELU) programme funded project on *Pr/Pk*. The Section of the report on the Sudden Oak Death (SOD) in the US is informed by fieldwork carried out by the authors in California and Oregon in September 2008, including 9 interviews with managers, scientists and stakeholders.

In order to protect the anonymity of these respondents, names have been omitted from this report. Direct quotes from respondents have been labelled '*interviewee a*' etc.

1.22 On-line survey

In order to obtain the views of a wider group of people who have been involved with *Pr/Pk*, an on-line survey was implemented. Two versions of an on-line questionnaire were produced: The first was aimed at those involved with the implementing the programme in a variety of capacities. It was sent to all those named as being on the Programme Board and sub-groups for whom up-to-date email addresses could be supplied (50 people) and all plant health inspectors in England, Wales and Scotland (82 people). (Please see Appendix 1 for a copy of the questionnaire). These results are

based on 27 responses, a somewhat disappointing response rate of 20%. Whilst care has thus been taken as to the reporting of the conclusions that can be drawn from these responses, they have nevertheless raised many issues worthy of serious consideration for the future programme.

An invitation to complete a second version of the questionnaire aimed at stakeholders was sent out to Defra' stakeholder list for *Pr/Pk* (88 contacts) as well as a random selection of 200 infected sites. For reasons of confidentiality, these invitations to participate in the survey were issued through Defra. (Please see Appendix 2 for a copy of the questionnaire). These results are based on 22 responses. Again the low number of respondents was disappointing, and care has been taken with interpreting the results. However, a good range of stakeholders responded and this survey nonetheless provided some useful insights generally, and some important comments have been made.

2. Origins, timing and points of entry into the management of *Pr/Pk*

2.1 Identification of *Phytophthora ramorum* and pest risk analysis

A new *Phytophthora* was first identified infecting *Rhododendron* and *Viburnum* in Germany, and *Rhododendron* in the Netherlands, in 1993, but these observations were not formally reported at the time, nor was an identification made (Werres *et al* 2001; Sansford, 2009). Meanwhile, the death of tanoaks (*Lithocarpus densiflora*) was occurring in the San Francisco Bay area of California throughout the 1990s, an outbreak that would later be termed the 'Sudden Oak Death' epidemic (Frankel, 2008). The causal agent, a new *Phytophthora* species, was not isolated until July 2000, but a chance visit to the USA by Professor Clive Brasier of FR established a link between this pathogen and the other *Phytophthora* described to him by a Dutch scientist earlier that year. The potential similarity between the organism in European nurseries and the America pathogen giving rise to Sudden Oak Death was then communicated to Forestry Commission Headquarters (Frankel, 2008; interviewee A, scientist). Brasier was asked to prepare a pest risk assessment (Brasier 2000) and this triggered the series of management interventions that will be assessed in this report. .

Brasier's (2000) pest risk assessment noted that in the San Francisco area the disease was causing heavy mortality to three oak (*Quercus* or *Lithocarpus*) species, but that it was not yet established whether it could attack other oak species or any other tree genera. However, it was observed that this newly discovered organism posed a significant risk to UK native and exotic oaks and thus 'might have a considerable potential for damage in the PRA area (the UK)' with nursery stock, timber and wood products identified as probable pathways. The PRA notes the high level of uncertainty about the risks posed but concludes: 'Further research information is needed urgently. Obtaining this information may take some time. A decision on the *Phytophthora*'s risk status may therefore need to be taken before all the information is available' (Brasier 2000:25).

The problem was brought before the EU Standing Committee on Plant Health (SCPH) in September 2001. In April that year, a submission was made by Defra to Lord Whitty alerting him to the link being drawn between the two diseases and making the case for the FC to fund more research. The UK raised at SCPH the need for an EC wide survey. A second PRA was produced in the UK in April 2001 (Jones and Sansford 2001). This stated that in the EU, a fungal pathogen that appeared identical to the SOD pathogen in California had been detected on *Rhododendron* in Germany and the Netherlands and *Viburnum* in Germany. It stated that it was not yet known if oaks growing in the UK/EU/EPPO were susceptible to the *Phytophthora* sp. causing sudden oak death in California, but that research should be initiated into finding the oak species that are susceptible and the identity of other potential hosts. It noted that *Rhododendron* are widely distributed as ornamental and naturalised plants throughout the EU. *Rhododendron* in the UK should be checked to ensure that the pathogen is not already present. It also advised that the distribution of the pathogen within the

EU/EPPO should also be determined so that appropriate quarantine measures can be introduced to prevent further disease spread. It stated that 'in the meantime, it would be prudent to prevent further entry and spread by introducing controls on imports of known susceptible hosts and their products into and within the EU/EPPO from areas/countries where the pathogen has been found. Consideration should be given to continuation of EPPO Alert listing and to making the pathogen an EU/EPPO quarantine pest.' (Jones and Sansford 2001; 5). Both this PRA (Jones and Sansford 2001) and the datasheet (Jones and Sansford 2001a) note that *Vaccinium ovatum* is susceptible to *Pr*, and Jones and Sansford (2001a) note that the pathogen may also be carried by plants of *Vaccinium* spp. However, the risk to heathlands is not specifically acknowledged until the March 2003 PRA (Jones, Sansford and Brasier 2003:7) that states: 'Environmentally important UK/EU/EPPO *Vaccinium* heath and moorland species such as cowberry, bilberry and cranberry might also be potential hosts, if climate is not limiting' (P. Reed, CSL, 2003, personal communication).

2.2 First findings of *Pr* and response

As a result of the PRA, PHSI for England and Wales began surveys for the unnamed *Phytophthora* in the summer of 2001 (Sansford, 2009). There is a question over why there was not at this time a tree survey of oaks in the semi-natural environment given the potential threat, but it is assumed that the risk within the nursery trade was calculated as more significant. The geographical focus of the PHSI surveys for *Pr* were informed by a climate-matching model using the CLIMEX programme (carried out by Richard Baker at CSL) that was based upon identifying climatic similarities between the UK and Oregon and California in the USA. This research indicated that the South and West of the UK were at highest risk (Sansford, 2008).

The unknown *Phytophthora* was formally described as a new species in October 2001 (Werres *et al* 2001) and a third formal PRA followed in January 2002 (Jones, 2002). As a result of this on-going survey work, in February 2002 the first case of *Pr* in the UK was found on *Viburnum tinus* in a garden centre in Southern England (Lane *et al* 2003).

In April, notification of the first UK finding was made to the SCPH. On the 13th May 2002 the England emergency measures (Anon., 2002) came into force and on June 27th emergency measures were in force across GB. The UK emergency measures were first discussed in SCPH in May. Over the summer, EC measures were agreed (Anon., 2002a) and on the 1st November the EC emergency measures came into force and the UK emergency measures were aligned with these (Defra, 2005). These measures are still in place (see Anon, 2004; Anon, 2007) and the measures taken under this legislation are discussed in Section five. The research programme began in the spring of 2002 (please see Section four). The programme board first met in February 2003 (please see Section three).

In November 2003, the first confirmed case of *Pr* on an established tree in the UK was recorded on a southern red oak (*Quercus falcata*) in parkland in Sussex. This was the first record of an infected tree outside the USA. Over the following four weeks, a further four infected trees were identified at two historic gardens in Cornwall. At all three of these sites, *Pr* had earlier been confirmed as being present and causing dieback on *Rhododendrons* and several other ericaceous ornamental species (FC, 2004). Between December 2003 and April 2004 the first major FC *Pr* woodland survey was conducted, focusing on locations where *Rhododendron* is found growing in admixture with trees. This consisted of inspections at 1217 high-risk sites across England, Scotland and Wales: based on climatic factors. A total of 335 samples were collected from symptomatic plants. All samples tested were negative for *Pr*. However, the report of the survey states that this did not prove that *Pr* was not present at these locations; rather, it merely indicated that it was not found during the survey. Nevertheless, it was concluded that '*Pr*, if it is established in Britain's wider woodland environment, is at an extremely low level of incidence and that the national policy of containment and eradication at those sites where it has been found, remains fully justified' (FC, 2004). Further FC surveys were carried out (see Section five) but the first positive sample was not found until June 2006, although a significant proportion of water bait samples had been found positive in the May- August 2004 survey (FC, 2004a).

In terms of the initial response to the outbreak, our work suggests that the authorities acted as rapidly as could reasonably be expected, both in acknowledging the risk and in putting together a PRA. In the on-line questionnaire, those involved in implementing the measures were asked whether they thought that, once the risk from *Pr* had been identified, the GB authorities had acted *quickly* enough to put in place measures (Question 5). Most felt that there had been a prompt response, although observing that knowledge and information about the disease were limiting factors; the GB authorities actions were "based on the information available" [survey respondent] and "the speed was dictated by the knowledge which had to be build due to the relative newness of the situation" [survey respondent]. Broadening out the question, to cover the entire response to *Pr*, a similar theme emerges. Question 6 asked respondents to respond to the statement "Overall, the GB authorities' initial response to the *Pr* outbreak has been as rapid and effective as could be expected" (see Figure 1 below).

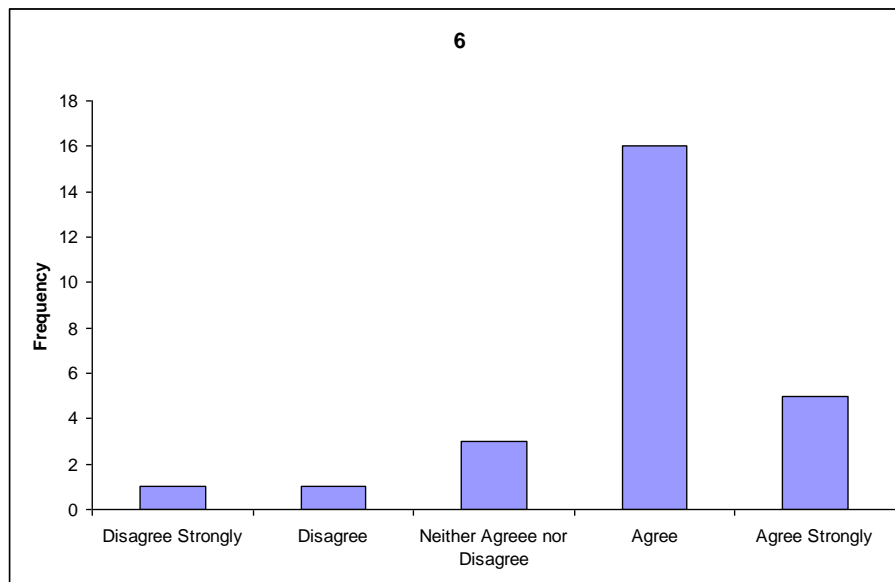


Figure 1: Bar Chart showing responses to statement "Overall, the GB authorities' initial response to the *P.ramorum* outbreak has been as rapid and effective as could be expected (Implementers survey, Question 5).

The comments made by the respondents indicated that the response, as previously described, was considered as rapid and effective as could be expected. For example:

“Contingency was in place to take appropriate action once the disease was confirmed in the UK. Type cultures had been obtained and diagnostic protocols in place prior to inspectorate surveys. A number of pest risk analyses had been carried out to ascertain risk prior to first finding.” [survey respondent]

“In response to the 2001 PRA the PHSI commenced surveys for *P. ramorum* (before it was formally-named) and the Defra R and D programme, recommended in the PRA, started in 2002.” [survey respondent]

“The GB Authorities took immediate emergency action after the first finding in May 2002 to mitigate the spread of *P. ramorum*. This included increased surveillance, emergency legislative measures and Pest Risk Analysis.” [survey respondent]

The limiting factor in terms of the speed of the response was commonly observed as the uncertainties about the impact and management of the disease in the UK, due to the low level of scientific information available (given that this was a newly identified *Phytophthora*). It was;

“Very difficult to judge the risk of this pathogen to UK flora. This is due to different conditions (both climatic and alternative hosts), different strains and different species of tree hosts compared to the USA where the pathogen is involved in wide spread tree mortality in some areas.” [survey respondent]

At the political and practical level it is considered that the response progressed in line with the developing state of knowledge at the time:

“We responded to this new disease in the best way we could until more scientific knowledge was gained”. [survey respondent]

“I think in relation to the development of a completely new organism, from our perspective, I think we responded pretty well.” [survey respondent]

“Research was ongoing and action needed to be taken in a responsible informed manner to stop knee jerk reactions.” [survey respondent]

“Always possible to do better, but hard to achieve political and resource backing against an uncertain and previously unknown risk. [survey respondent]

“This was new to all of us, we had no idea of how it was carried, and many people thought it had been indigenous for many years”. [survey respondent]

2.3 The response of the plant health authorities to the risk posed by *P. kernoviae*

Following surveys carried out for *Pr*, a new *Phytophthora* species was isolated in Cornwall in October 2003 almost simultaneously on two sites that were some 23km apart. One was made by FR scientists from a large bleeding canker on a mature beech (*Fagus sylvatica*) and from an adjacent *Rhododendron*, and the other by CSL from *R. ponticum* and *Rhododendron spp.* from an established woodland adjoining a commercial nursery (Sandsford 2008; interviewee C). By December 2003 it had been confirmed that these outbreaks were due to the same organism.

The first PRA for this new *Phytophthora* taxon C sp. nov. (as it was first called, then *kenovii* as used in the legislation) was completed in February 2004 (Sansford *et al* 2004). This reflected the first PRA on *Pr*; in terms of the high levels of uncertainty given that it was a new species of *Phytophthora*. It noted that the pathogen posed a risk to at least beech and *Rhododendron*, had a potential to spread geographically and to other unidentified hosts. An exotic introduction of unknown origin, the management of entry pathways was consequently difficult. It was recommended that destruction of infected plants be carried out, along with further surveys to determine the true distribution of the pathogen, along with host range testing to inform future inspections and surveillance work (Sansford *et al* 2004). Subsequently, *Pk* has been identified in New Zealand where it was first officially reported to be present in March 2006 (Sansford 2008) although it is now understood to have been present there since the 1950s (Ramsfield *et al* 2007).

Pk was found extensively in an area of about 12.24 square km in southern Cornwall between Redruth and Falmouth. The Plant Health (*Phytophthora kernovii* Management Zone) (England) Order 2004 (Anon 2004a) was introduced in December 2004 and gave Defra and the FC specific powers within this defined area of Cornwall where *P. kernoviae* was first identified. (This measure is discussed in Section five). Statutory action to eradicate and contain *P. kernoviae* in the UK is taken under the Plant Health (England) Order 2005 (and equivalent legislation for Scotland, Wales and Northern Ireland) and the Plant Health (Forestry) Order 2005. This new species was formally named by Brasier *et al* (2005).

Implementers of the Emergency Programme were asked (Question 7) whether they thought that once the risk of *Pk* was identified, whether the GB authorities had acted *quickly* enough. Four respondents

answered no, 23 answered yes. Again, resource levels were identified as a limiting factor. Additionally, the following comments were made by respondents:

“By this time *Pr* was taking off and large resources were being used for this, because *Pk* was unknown (not like USA/SOD) it was thought to be less significant. It took longer for the risk or its distribution, to be noted and by this time Defra appetite for another *Pr* (type campaign seemed to decrease... because we already had a major campaign”. [survey respondent]

Further, it was noted that:

“There was an earlier opportunity to address the two main areas of *Pk* foci in Cornwall - this was turned down at ministerial level because it was felt that the scientific evidence was not substantial enough at that time.” [survey respondent]

Question 8 (Figure 2) asked respondents to respond to the following statement: "Overall, the GB authorities' initial response to the *P.kernoviae* outbreak has been as rapid and effective as could be expected."

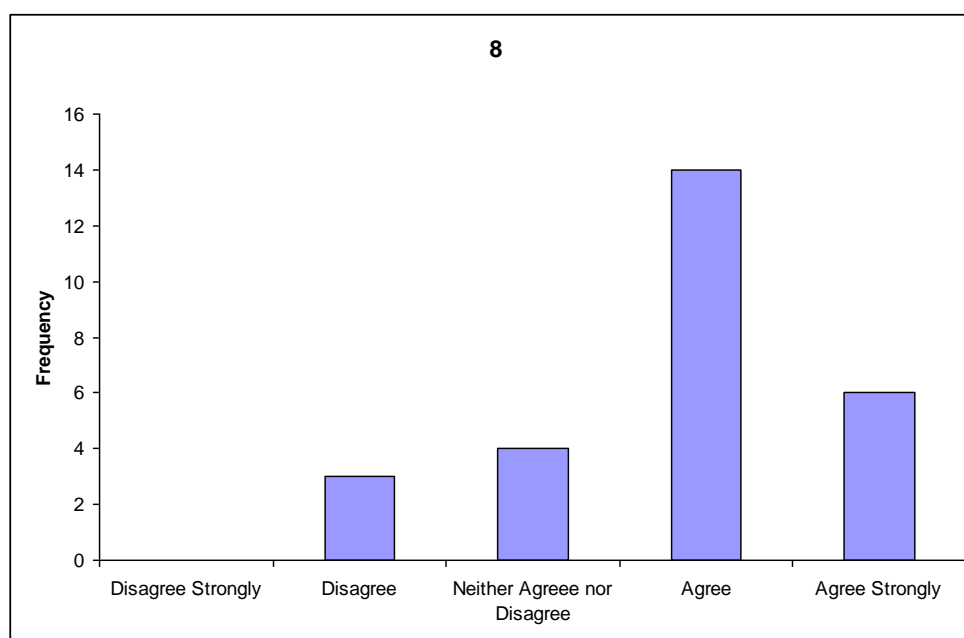


Figure 2: Bar Chart showing responses to statement "Overall, the GB authorities' initial response to the *P. kernoviae* outbreak has been as rapid and effective as could be expected (Implementers survey, Question 8).

Positive comments included the observation that lessons had been learnt in dealing with *Pr*: “Our experience with *P. ramorum* ensured an extremely rapid response to *Pk*” [survey respondent] with “the measures being applied to *Pr* were largely adopted along with wider R&D” [survey respondent]. Indeed *Pk* got absorbed into the existing programme board structure, which arguably allowed a rapid response, but it has meant that “it’s been more difficult for people outside that programme board and outside the researchers is to be clear that these are two quite separate organisms” (interviewee C, scientist). It was argued that:

“Again, this is difficult to judge the risk. In this case as the pathogen was new to science, so I think the response was appropriate.” [survey respondent]

However, others have been more critical:

“Resources were initially devoted to *P. ramorum*. Once *P. kernoviae* was found (October 2003) resources were stretched and although the PHSI included the pathogen in their surveys, there was no will/money to develop an R and D programme for this new threat.” [survey respondent]

“Equal and similar action should have been taken as for *Pr*, whereas there was less interest by Policy/PHSI as they were becoming overwhelmed with *Pr*.” [survey respondent]

“Acted quickly enough but needed to put like any other outbreak more resource and therefore effort into initial survey to establish extent of problem and then likewise if required into eradication.” [survey respondent]

2.4 Reflections

The rapid initial response of the UK authorities once the risk from *Pr* had been assessed, appears to be a good example of caution being exercised in the context of uncertainty and thus a successful application of the precautionary principle by Government. The initial actions by authorities have been described as “a holding action while we understood the nature of the problem we were dealing with” (interviewee D, policy maker). There is no evidence to suggest that, given the level of available knowledge about the risk from *Pr*, action could not have been taken any earlier. A series of thorough PRAs was produced and acted on. Meanwhile, this episode does illustrate the importance of international scientific connections, and the capacity to share information about future threats in good time. This response was made possible by ‘the collaborations and the connections [...] with the USDA Forest Service and university researchers in California and Oregon’ (interviewee C, scientist). Whilst the Dutch and German observations of a new *Phytophthora* had been made in 1993, even if they had been shared earlier with the international community, it seems unlikely that this would have made any difference to when the risk from *Pr* to the semi-natural environment was first known, as the *Phytophthora* causing ‘Sudden Oak Death’ was not isolated until 2000 (interviewee A, scientist). Nevertheless, it is possible to speculate that this would have enabled the USA scientists to make the link for themselves. A related consequence of the delay in widely reporting the new *Phytophthora* finding, was that it meant that there was almost 10 years for *Pr* to circulate in the nursery trade. In addition to potentially allowing the wider spread of *Pr*, this is likely to have increased the risk to the trade itself, within which the threat had been established on the continent.

In the absence of reports of *Pk* from elsewhere, the pathogen was found by chance during the *Pr* survey. For the UK, *Pk* is considered to be a recent exotic introduction. This raises a number of questions about the ability of the UK to identify ‘new’, ‘unknown’ or ‘un-listed’ pathogens (see Section 9.12). It does indicate the potential value of pro-active surveying to identify the presence of new pathogens as early as possible and raises the question of whether more routine surveillance should be done (interviewee D, policy maker). Whilst there is clearly a question of how limited resources are best spent, there seems to be value in a more systematic, long-running routine sampling and monitoring to find out what is present. Clearly the earlier a new pathogen is identified, the better

chance for effective action against it. Indeed, despite efficient responses as described here by the responsible authorities, by the time *Pr* was identified as a problem, and found in the UK, it was already too late in that it had moved out of the nursery trade, where it is easier to contain, to the wider environment.

3. Institutional structures and approaches to interdepartmental decision making.

3.1 Programme Board Management Structure

The initial response by the authorities to the *Pr* risk was the setting up of an operations group. However, as the seriousness of the outbreak grew, an interdepartmental programme board was set up. The '*Phytophthora ramorum* Programme Board' first met on 26th February 2003. It met 20 times with the 20th meeting being held on 13th February 2009. The creation of this structure wasn't a unique response to such circumstances, but it was unusual, and the running of such a programme was perceived as 'quite an innovation' (interviewee D, policy maker) and 'culturally' new for many in plant health. There is an international standard phyto-sanitary measure (ISPM) on this type of management structure. The remit of the Board is given below in Figure 3:

Figure 3: Remit of the *Phytophthora* Programme Board

[Source: Second meeting 12th June 2003 *Phytophthora ramorum* programme board minutes]

Remit

1. The Programme Board has been formed to have an overview of the administration and science of *Phytophthora ramorum*, to underpin decisions made and the policy adopted by government on all aspects of the disease, in particular -
 - Detection and eradication of the disease
 - Development and implementation of EC and UK legislation related to the disease
 - Co-ordination and harmonisation of measures taken by the territories and Forestry Commission
 - Research programmes and ad-hoc projects on aspects of the detection and identification, biology, control and eradication of the disease
2. Among its functions will be
 - discussion of developments
 - reports to Ministers and senior management
 - providing feedback to other interested divisions and departments
 - ensuring inspectors have the necessary tools
 - commissioning of studies, if necessary
 - determining research priorities
 - consideration of progress of research projects
 - consideration of reports from the eradication and containment group
 - formulating and overseeing and outbreaks contingency plan
 - consideration of publicity initiatives
3. The group will meet every three to four months, or more frequently if events so determine
4. Members are: Dr Stephen Hunter, chief plant health officer and head of plant health division, Defra; Professor Stephen Hill, head of the plant health group at Defra's Central Science Laboratory; Roddie Burgess, head of plant health branch, Forestry Commission; Dr David Slawson, Principal Plant Health and Seeds Inspector, Defra; Charlie Greenslade, head of plant health branch, SEERAD. Dr Hunter chairs the group and the secretary is Steve Ashby, plant health division, Defra.
5. The group may call on experts in particular fields to attend to discuss subjects in their area of competence.

Question 11 of the implementer's questionnaire asked for a response to the following statement: "The *Phytophthora* Programme Board was an effective mechanism for overseeing the *Pr* and *Pk* outbreak". The results are displayed in Figure 4 below:

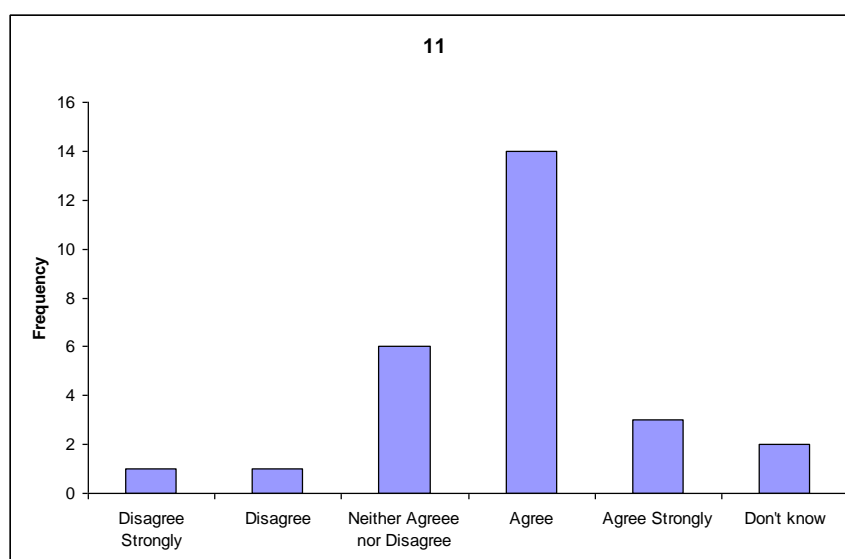


Figure 4: Bar Chart showing responses to statement
"The *Phytophthora* Programme Board was an effective mechanism for overseeing the *Pr* and *Pk* outbreak".
(Implementers survey, Question 11).

It is apparent from the responses to the questionnaire and interviews that there are quite differing views on the effectiveness of the Programme Board. These differing and somewhat contradictory views are reflected in the discussion that follows.

3.2 Strengths of the Programme Board

Question 12 asked "What, in your opinion, were the main strengths of the *Phytophthora* Programme Board and Sub-groups?" and this question was asked of all the interview respondents. It was commonly stated that the main strength of the Board was that the key departmental players were involved from the early stages. Representatives from PHD, PPHSI, CSL, FC and SEERAD attended throughout. This allowed for the effective co-ordination between responsible parties. The creation of 'sub-groups' allowed for the effective involvement of stakeholders. Initially, five were set up; resources, science, press and publicity, Cornwall disease management zone and field implementation (Industry liaison group Board minutes fourth meeting 28/1/04).

"The main strengths were ensuring a consistent and focussed approach to the management of these diseases by GB Plant Health Authorities. It provided good legal, operational and strategic delivery." [survey respondent]

"It was inter-departmental and designed to deal with all the key issues (science, main outbreak areas, nursery infections etc.) ... It involved a wide range of stakeholders." [survey respondent]

“Programme Board had all the appropriate members and ensured a joined up approach. Sub-groups were appropriate and gave good liaison between individuals working at the operations end, plus Industry liaison group have a good link and communication with industry stakeholders.” [survey respondent]

It is argued that the small size of the Board, allowed rapid feedback from the sub-groups (particularly the industry liaison group) about what was and wasn't working to the main Board. It was also commonly perceived that the inter departmental Board brought together:

“Considerable scientific and technical expertise; substantial policy experience.”
[survey respondent]

“A wide group of 'experts' from most regions of the country who had a will to do something.” [survey respondent]

The location of the meeting was rotated, and this was an aspect that was praised.

3.3 Programme Board weaknesses

Question 13 asked ‘What, in your opinion, were its main weaknesses?’. Five main areas of concern were identified:

3.31 Programme Budget

The Programme Board did not have its own programme budget, but co-ordinated activities/funds across all the government bodies and devolved authorities. Several respondents, didn't see this lack of a central budget as causing particular problems with the Programme Board giving a steer on what was funded out of the separate authority's provisions. However, others perceived that the lack of a budget dedicated to, and managed by, the Programme caused some difficulties. Whilst good communication and interaction to mitigate some of these difficulties was noted, there were differing views between the different bodies about what was necessary, and how urgent it was, and this tended to mediate what money got spent where. It was also observed that “The original plan included a resources subgroup, but this rarely met, and prioritisation of resources across the Programme was difficult” [survey respondent]. The new Programme has its own budget, and it is hoped that this will resolve some of the problems identified above.

3.32 Speed of process and decision-making

There was criticism that the decision-making process was slow and too protracted due to the high number of people involved. There was concern voiced that the meetings were not regular enough. One respondent commented that “At times there is the potential for events on the ground to have altered and there could be a delay before this is discussed at the next PB meeting” [survey respondent]. The Programme Board was considered “a bit cumbersome for the day to day stuff” (interviewee B, disease manager) and so decisions were made below the programme on a day-to-day level in order to get the flexibility needed, in cases for example when decisions were needed very quickly.

It was observed that some of the sub-groups should have been reviewed more regularly. For example, with the field implementation group the formal structure of the sub-group with meetings and minutes was too cumbersome, whilst the publicity group on reflection was deemed unnecessary as their tasks were carried out anyway. The suggestion was made that the structures should be reviewed at least once a year, if not more often, to ascertain whether each working group was fulfilling its purpose, and if it wasn't take actions to change it.

There was concern that the link up between all the sub-groups and the Programme Board was not always that strong.

3.33 Membership

Conversely, others thought that the membership of the Programme Board was not inclusive enough. For example, one respondent to the implementation survey argued "I was not confident the membership was wide enough to give an objective view of what should be done, or not done". Whilst groups such as the National Trust and the RHS were asked to join, there is a question of whether they should have been more strongly encouraged as they were not immediately forthcoming.

Criticisms have been made that several key scientists working on *Pr /Pk* in FR and CSL were not included as full members of the Board from the beginning and did not attend on a regular basis. Initial involvement was deemed good, but this engagement was perceived to reduce over time. Whilst there was a science sub-committee, and research reports were presented to Defra, some scientists reported feeling removed from the decision-making process as they were represented, rather than directly engaged and the process suffered from a lack of feedback. Direct consultation of scientists by management has been identified as being needed, and an annual meeting suggested. The science group was also criticised for having too many researchers on it and was more a forum for information exchange than functioning at the higher level of identifying and prioritising research needs.

3.34 Devolved authorities

The programme was GB only and Northern Ireland (NI) weren't represented on the inter-departmental programme board, although they were sent copies of the minutes.¹ It is acknowledged that communications with NI were not good at the beginning (as they didn't have *Pr/Pk* at this point in time) but improved later on. In August 2007, the first finding in NI of *Pr* on an established plant was confirmed in a domestic garden. It was believed that it made sense in plant health terms for NI to work more closely with the Irish Republic in managing the disease situation across Ireland as a whole. However, better communication and exchange of information with NI authorities could be beneficial.

¹ Northern Ireland forest policy is a devolved matter within the UK. See http://www.forestserviceni.gov.uk/index/about-us/what-we-do/about_us-policy.htm.

Plant health is also a devolved matter in Wales. There was a Swansea sub-group providing some links, but Wales were not represented on the main board. It is strongly suggested that Wales do have a place on the new Board. Connections with Scotland were considered good with representatives of SEERAD on the Board from the beginning.

3.35 Failure to engage with conservation organisations

The habitats where *Pr /Pk* has been found in the UK have evolved and increased over time from initially nurseries, to woodland and then to heathland, partly due to a broadening of surveying. Early research indicated that *Vaccinium myrtillus* was susceptible (see Jones and Sansford [2001a] and Jones, Sansford and Brasier 2003 for concern with *Vaccinium* spp.) and this generated concern amongst some on the Board because heathland in the UK is a key habitat, and the UK has a large proportion of the world's lowland and upland heathland. The potential for *Pr/Pk* to cause a major conservation issue for the UK was recognised. However, it is acknowledged that “we struggled to get the conservation organisations, both the governmental and non-governmental ones, really engaged” (interviewee D, policy maker). Once, *Pk* had been found on *Vaccinium* in heathland, Natural England were engaged very quickly, but it is wished that they had been engaged earlier:

“The other weakness was that the Programme Board was not able to get real engagement with the conservation interests during the early years as the problem was seen as a nursery/invasive *Rhododendron* issue. This only changed (and then very rapidly) once we found infection in *Vaccinium* in heathland and the potentially severe damaging nature of it became apparent” [survey respondent]

It is understood that before *Pk* had been found on *Vaccinnium*, the theoretical risk identified through scientific research was not given priority over more pressing, current issues. This raises issues for the communication of risk and broader risk management issues. Action is required in response to potential threats (as in the initial surveys) rather than realised threats in order to avoid reactive rather than proactive policy.

It is understood that the finding of *Pk* on heathland contributed to the decision to fund the new programme. The Board composition needs to reflect this, and it has been stated that the new Board will deal with this by including, for example, Natural England and the Countryside Council for Wales. However, the lack of engagement with other non-governmental conservation, environmental and rural interest organisations is of concern and it is recommended that more work is done to involve them with *Pr/Pk* (and plant biosecurity issues more broadly).

The success or otherwise of the management board has been down to some extent by the individuals involved and the level of commitment and ability to work together they have demonstrated. This is something that should be kept in mind for the future.

3.4 Interdepartmental working

Implementer survey respondents were asked whether they thought there had been good coordination between Government agencies under the emergency *Pr/Pk* programme (see Figure 5).

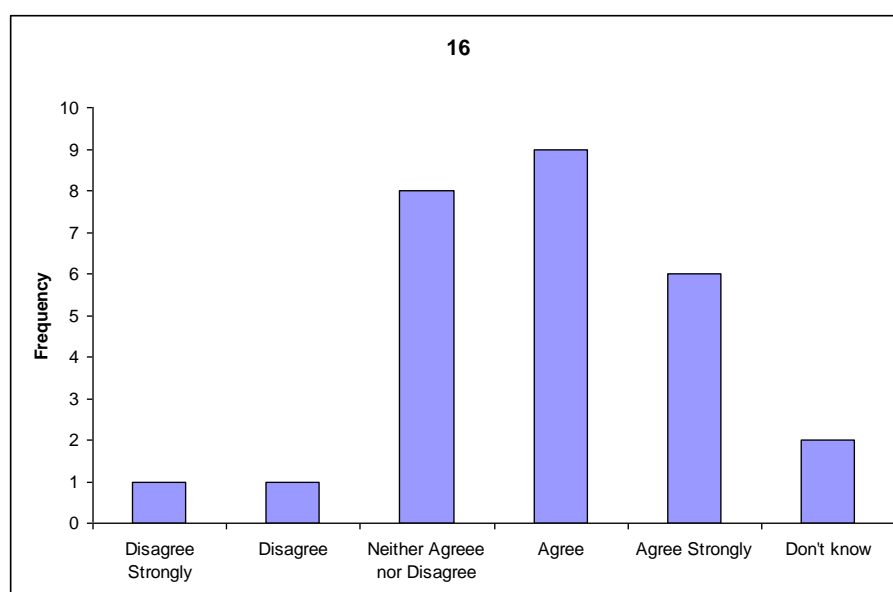


Figure 5: Bar Chart showing responses to statement
" There has been good coordination between Government agencies under the emergency *P.ramorum* and *P.kernoviae* programme" (Implementers survey, Question 16).

Views on how well the different Government agencies worked together varied quite considerably. However, it is argued that on the ground, specifically in Cornwall, that FC and PHSI worked together well. A specialist *Pr/Pk* unit was set up in Polwhele, Cornwall. This was considered by many to be an extremely good element of the programme. Particularly, it meant that there was a FC person attached to this PHSI programme:

"It brought complementary skills and there was knowledge and competence there that we didn't have... so some of the ... clearance work... there needed to be funding mechanisms, so actually having Forestry Commission, a Forestry Commission officer permanently attached to that unit was, you know, he had those skills and competencies, negotiating contracts, using grant mechanisms to fund it where necessary. We didn't have those skills and it was marvellous to bring them onboard, and that worked really, in fact one thing that worked brilliantly was that."
(interviewee B, disease manager)

The research findings point to the importance that the existing well-praised working relationships, between PHSI and FC staff in Cornwall, and between owners / staff at infected sites and PHSI/FC, can continue. Continuity of staff should be ensured.

However, others were more critical: One respondent noted that 'The involvement between FC and Defra can be confused for stakeholders when dealing with on the ground issues'. Indeed, this is illustrated by the remarks of one stakeholder:

‘I’m met various others who have been going around the place examining the plants. I’m not quite sure which areas they’ve all come from. I’ve been to various conferences when various people from all sorts of places have attended and spoken, but I couldn’t sort of tell you, really, what are the organisations they come from.’
(interviewee F, stakeholder)

From the stakeholder point of view, dealing with separate agencies has caused some confusion. There has been criticism of the way in which responsibilities were divided up between the FC/ FR and Defra / CSL. (See Section four in the particular case of research).

“... there has been a lack of joined-up thinking between the FC/FR and Defra/CSL. Some of this is historic based upon responsibilities for trees versus non-trees but for pathogens that affect both types of plant information sharing and actions have been separated because of the respective politics and power 'struggles' involved.”[survey respondent]

“...there are always territorial issues. And I think maybe this one is quite a difficult one because clearly the FC would see itself taking the lead on trees and, particularly, as the name implies, forest trees, and Defra would see it taking itself, ...the lead on the environment but also with that responsibility for plant health at a nursery level as well. So there are going to be overlaps and there are going to be conflicts of interest.” (interviewee C, scientist)

Different solutions to these difficulties have been suggested, and this is discussed further in Section 9.9. Suggestions made by respondents for the future structure of the programme board that this report recommends should be given serious consideration are also discussed in Section 9.10.

4. The use of science and the development of the policy evidence base

4.1 Funding, knowledge base and research relevance

The response has been appropriate and timely. As described in Section one, in the judgement of most stakeholders, the initial PRA was conducted rapidly, framing the problem accurately and has subsequently been developed as new information arises. Both at CSL and FR (and at Imperial/Reading and Cambridge universities), high quality research has been carried out on the main issues pertinent to immediate risk assessment, characterisation, laboratory and field identification, host range and sporulation, dispersal, management and inspection modelling. Following the discovery of *Pk* the research programme was immediately extended to quantify the new threat.

Whilst a number of issues, particularly relating to the specifics of management, and general disease ecology in different systems remain to be investigated, the issues researched to date are the basic building blocks of research and represent a suitable range of topics if funding is limited. Given more funding (perhaps from the research councils, and without using infected material), research into potential management approaches in heathlands could have been undertaken *before* the infection was realised, perhaps reducing the current state of uncertainty. The threat was flagged up early in the PRA process (Jones, Sansford and Brasier 2003), and the difficulties of potential management in a protected semi-natural habitat where the majority of dominant and sub-dominant species are potentially susceptible were immediately apparent.

Question 21 of the implementers questionnaire asked "In your opinion, how adequate is the scientific knowledge base concerning *P. ramorum* and *P. kernoviae* in this country? " Respondents were asked to specify for five areas: Identification, Dispersal / Transmission, Effects of management; Host range and spore production and future risks. The frequency of responses is shown in Figures 6 to 10 below.

a. Identification

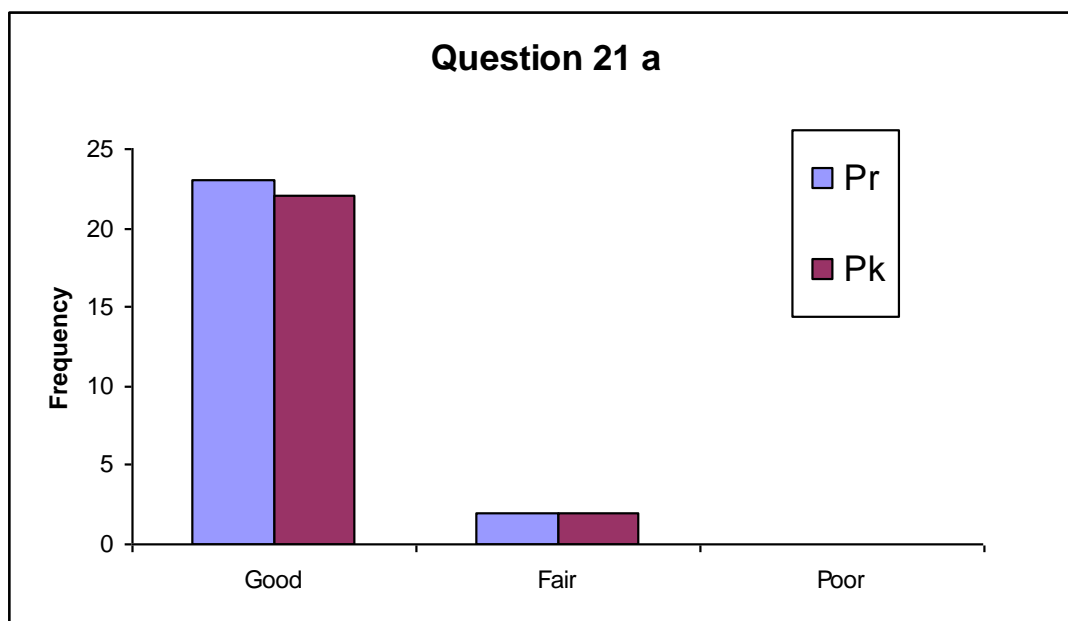


Figure 6: Bar Chart showing responses to question "In your opinion, how adequate is the scientific knowledge base concerning *P.ramorum* and *P.kernoviae* in this country in relation to "Identification"? (Implementers survey, Question 21a).

B. Dispersal / Transmission

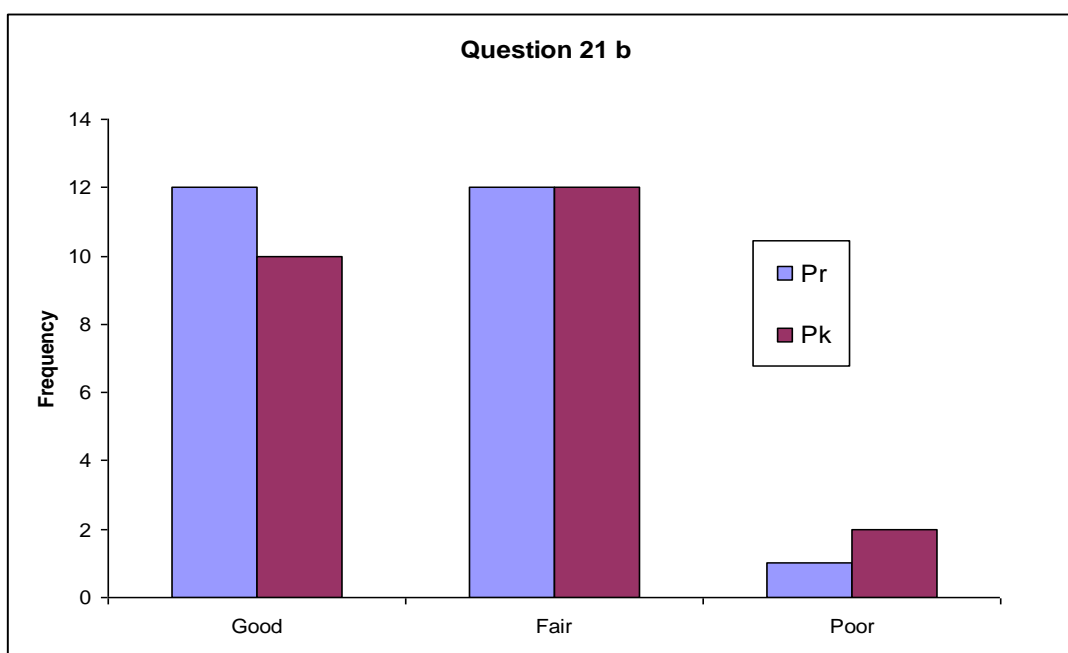


Figure 7: Bar Chart showing responses to question "In your opinion, how adequate is the scientific knowledge base concerning *P.ramorum* and *P.kernoviae* in this country in relation to "Dispersal / transmission"? (Implementers survey, Question 21b).

C. Effects of management

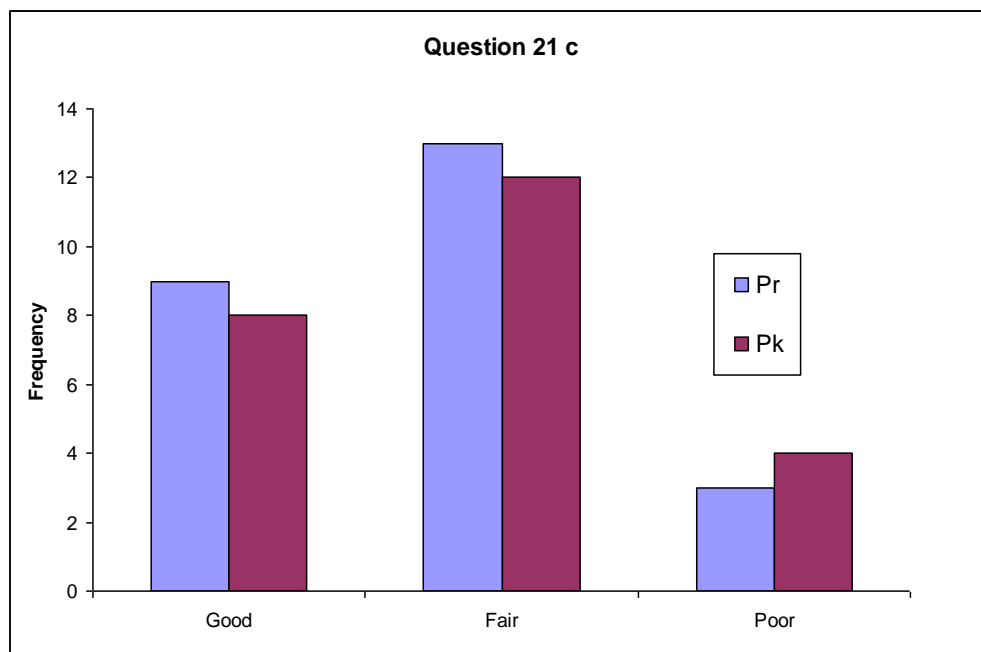


Figure 8: Bar Chart showing responses to question "In your opinion, how adequate is the scientific knowledge base concerning *P.ramorum* and *P.kernoviae* in this country in relation to effects of management?" (Implementers survey, Question 21c).

d. Host range and spore production

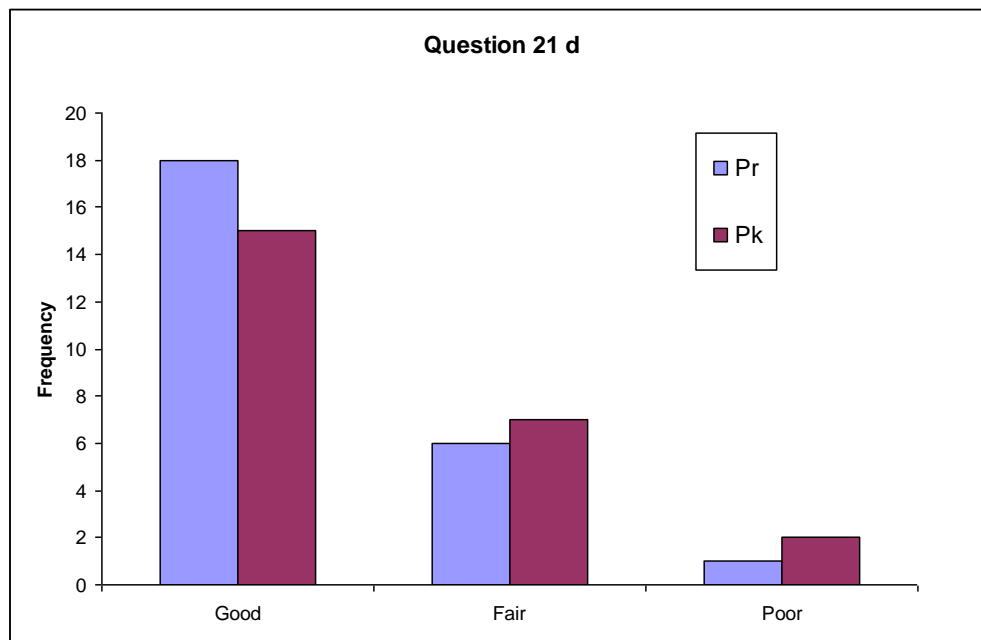


Figure 9: Bar Chart showing responses to question "In your opinion, how adequate is the scientific knowledge base concerning *P.ramorum* and *P.kernoviae* in this country in relation to host range and spore production?" (Implementers survey, Question 21d).

e. Future risks

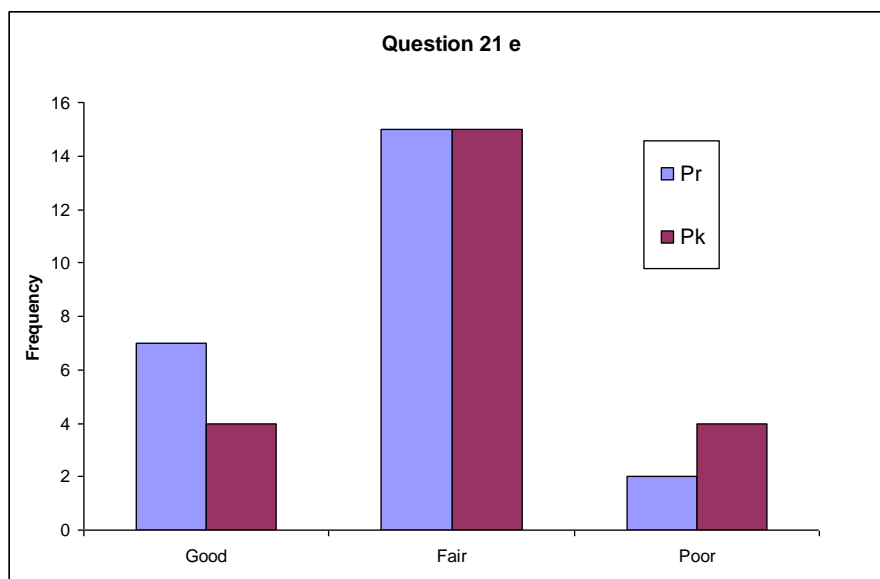


Figure10: Bar Chart showing responses to question “In your opinion, how adequate is the scientific knowledge base concerning *P.ramorum* and *P.kernoviae* in this country in relation to future risks?” (Implementers survey, Question 21e).

As the Figures above show, in the majority of cases the relative adequacy of the knowledge base was deemed to be better for *Pr* than for *Pk* where there is a general feeling that more of the research has been dedicated to *Pr*. The knowledge base in the cases of ‘Identification’ was thought to be good in the majority of cases, whilst for the other four areas respondents were mostly of the opinion that knowledge was mostly good or fair with some indicating it was poor.

4.2 Organisation

Both *Pr* and *Pk* represent a new cross habitat challenge for both management and research. As such the pathogens did not fall exclusively into either of the traditional domains of CSL or FR. At an early point, the decision was made that since *Rhododendrons* are large ornamental shrubs, they should be dealt with entirely by CSL, and that FR should not conduct research into woodland *Rhododendron*. This decision was apparently made with the intention of clarifying funding, but failed to take into account the areas of expertise of each organisation, and the complex nature of the problem. From an objective viewpoint this decision seems both artificial and inappropriate. As reported by those interviewed for this research, it has caused continual difficulties, where CSL have been required to conduct research which would for another disease have been conducted by FR.

There is a high degree of mutual respect between FR and CSL at the research level. This has resulted in the development of a satisfactory working relationship to meet the new challenge. However, there is evidence from our survey of stakeholders that the results of the separate research

studies were not always fully shared with the other organisation. The possibility of joint research projects was never followed through by funding bodies. The artificial boundary of responsibility between CSR and FR on this issue has had a particular impact on research into ecosystem level science. In the woodland system, trees become infected via an unknown pathway due to complex 3D (above and/or below ground) spore movement from *R. ponticum*. An understanding of the infection of trees can only be gained by direct ecological study of this system, and while there is some understanding of the role of *rhododendron* the overall epidemiology of the disease, important epidemiological questions remain unanswered. Since *R. ponticum* acts as the vector for the pathogens in woodlands, this is akin to excluding the mosquito from malarial research. Further to this, many of the microclimatic and dispersal conditions in managed gardens are similar to those of woodlands, and FR expertise would have been useful in this context. Similarly we have been advised that CSR expertise could have been better deployed concerning tree-related issues. Hence, whilst CSL appear to have adapted well to new research challenges, some of our respondents have argued that it is appropriate to allocate research to those *best qualified to address specific questions*, rather than according to an arbitrary species specific delineation. Indeed good management practice is to use each individual as efficiently as possible. It seems unlikely that a more flexible approach to the allocation of research would have been problematic.

As the outbreak spreads to heathlands, the problem widens. Neither CSL nor FR has existing habitat specific expertise to address the problem. Some respondents argued that a full reappraisal of the organisation of research into cross-habitat threats is required. It is possible for scientists from different research organisations to both compete for funding and subsequently work co-operatively. In a complex ecological context, with variable degrees of symptomatic, asymptomatic, foliar, stem and root infection the occasional replication of research in different contexts is not unfortunate but rather essential.

4.3 Dissemination and uptake

There has been praise for CSL and FR research scientists for their role in personally sharing their research through presentations, for example to the Cornwall working group. This was viewed as valuable in building relationships and demonstrating to stakeholders the seriousness of the problem. Nevertheless, there is a perception from some of the ground managers/ inspectors that the flow of information from research was not as rapid as it could have been. This may, however be due to a poor understanding of the development of knowledge on these pathogens. However, on occasions information was not being communicated until a final report was written and published. Whilst there was an appreciation that there are potential problems with sharing information before research findings are confirmed, it would be valuable for those working on the ground if information was passed on before the end of a research project.

Both Defra and FR websites have maintained up to date information on the epidemics and some aspects of the research. Project reports are often uploaded, and a key findings document has been maintained and improved over time. Nevertheless, the nature of web information means that the full extent of available information is not always obvious. Critically, web and other published material is a passive form of dissemination. In this case, rapid dissemination of research findings to PHSI and FC inspectors is essential so that they can be passed on to managers on the ground. An alert mechanism to tell individuals about updates to web content via an email bulletin would be helpful here.

There is an additional and critical factor in the uptake of information, particularly where there is a high degree of uncertainty as in this case. People are selective in what they choose to believe and the way they interpret information. Long distance aerial transport of spores, whilst theoretically postulated was widely dismissed in favour of a more optimistic short splash dispersal distance until proof from the US, and this view persists. Many gardeners perceive the threat to be largely *R. ponticum* specific, in that they can manage the disease by removing *R. ponticum* alone, choosing to ignore evidence of high sporulation from other *Rhododendron* cultivars and other species in their gardens. The threat from persistence in the soil, causing infection of susceptible replanting is also debated, despite clear evidence from both research and from in situ replanting. In combination these selective interpretations of the evidence result in inappropriate management.

To some extent this is true within the development of policy in response to research. Research results are filtered through an intermediate representative who is likely to be qualified to comment only on a specific part of the system. This is not a problem specific to this issue; indeed geneticists making unfounded public statements on ecological ramifications was the main contributor to the breakdown and polarisation of the GM debate. Taking random examples: can an expert in systematics or entomology be expected to critically filter theories of dispersal, or an expert in commercial forest economics comment on oomycete chlamydospore viability? In order to ensure an unbiased and objective flow of information, the fewer intermediaries the better. As suggested below regarding information flow in the other direction, meetings between actual research scientists and field managers/policy makers are to be encouraged.

The perception of the threat to heathlands is an interesting case. This was flagged up as a major concern early in the PRA, subsequent inoculation studies at CSL and modelling studies at Reading confirming the threat posed by both pathogens. Prior to the actual discovery of infected *Vaccinium myrtillus* in Dec 2007, there was little concern beyond the scientists and policy makers in the plant health area though Defra's decision to begin funding PHD research at this point suggests that the risk was beginning to be recognised). Indeed despite further confirmation of the sporulation capacity of *V. myrtillus*, the wider level of concern has reflected the development of the epidemic rather than the indications of the research. Indeed press comments in 2009 on the infection in the New Forest make

reference to *R. ponticum* and the potential threat to the New Forest's trees, but makes no mention of the vast areas of heathland in the New Forest National Park which are threatened. As previously argued, the conservation organisations were not proactive in the face of the threat to the majority of semi-natural habitat in Great Britain until the extent of epidemic development was confirmed. This lack of awareness is likely to affect management. A nurseryman who may be content to accept a degree of loss due to infected plants, and who perceives the threat to many woodlands to be low or at least manageable is likely to be more complacent than one who understands that they may have a devastating impact on our wilderness areas.

From the stakeholder point of view, dealing with separate agencies has caused some confusion and several respondents suggest that a single agency or shop-front approach would be more straightforward. (Please see Section 9.9).

4.4 Funding decisions

It has been suggested that an early request for more funding for *Pk* to enable pro-active clearance was turned down at the Ministerial level because it was believed that there was not enough of a science base to justify such action, and that more information was needed before such a funding decision could be made. It seems that in this particular case, the precautionary principle was not used when it would have been advantageous. Whilst this did not lead to a lag in terms of ground response, it meant pro-active clearance did not take place where it might otherwise have done. This was considered unfortunate and may have contributed to the scale of the problem in Cornwall.

The issue in this *Pk* case is that the scientific understanding was 'playing catch-up' with the disease on the ground because this was a newly discovered pathogen and the knowledge base had to be created. There is always the danger of a 'lag phase', so that by the time the science has been done the disease has moved on again. It has been flagged up that it is often harder for funding to be obtained when scientists are still in a process of learning about the disease. The case of *Pk* compares unfavourably with *Pr*, as because of the situation in the USA, there was some knowledge already.

Funding decisions must of course be based on full information and scientific evidence, but situations like *Pr/Pk*, where a precautionary policy stance has been taken, pose a new set of questions over the nature of information that is needed to implement positive funding decisions.

4.5 Feedback

Research into pathogen management is a two way process. Scientists require feedback from practical managers to both reflect on the adequacy of their recommendations and to flag up new aspects of the pathosystem. As previously stated, in the early stages of the epidemics, scientists and

managers/ policy makers met formally. However, once the Science Sub-Group had been formed, key scientists working in the field felt that there was a degree of disconnection of the research, and a reduction in the interaction of scientists and managers. As already suggested, ideally a greater degree of contact should be maintained.

4.6 Information sharing with the USA

There is evidence of good collaborative working and information sharing with the US, who have had very well funded research programme, and the UK has gained from this. There have been good synergies between USA and UK research and the USA have contributed to UK funding. For example, UK representatives have attended and given presentations at the Sudden Oak Science Symposiums.² It is hoped that the UK can make use of the plans in the USA for an experimental research nursery.

4.7 Developments in diagnostic tests

Developments in diagnostic tests have been important for the efficient carrying out of inspectors duties, proved cost-effective and speeded up the diagnosis process considerably. The development of LFDs (lateral flow devices) on-site test kits at £7 has been a cost-effective way of ruling possibilities in and out, and has cut the costs of sending samples to CSL. It has also given inspectors confidence in what they are seeing and have been used by FR field staff and garden and nursery owners.

The initial time delay for garden and nursery owners to hear whether a sample was positive of about a month did not help inspectors communicate the urgency of the problem and the need to take action, and had cost implications for these businesses. The development of a real-time PCR 'smart cyclor' that can be used on site to identify *Pr* and *Pk*, where there is a power source, has speeded up the process in certain garden situations, but also improved relations with landowners;

"it's had an improvement in relations...some people now will actually ring up the inspectors who cover their area and will ... say, 'Can you come out and have a look at something?' So actually having something like the smart cyclor enables you to engage with the client more." (interviewee G, disease manager)

Recommendations for the priorities for future research are outlined in Sections 9.4 and 9.5.

² See <http://nature.berkeley.edu/comtf/sodsymposium/schedule.htm>.

5. Impact and effectiveness of measures taken on the ground

This chapter examines separately in turn the actions that were taken as part of the Programme in the management of *Pr* and *Pk*.

5.1 Surveys

a) PHSI

As already noted in Section one both PHSI and the FC carried out surveys. PHSI surveys began in 2001. As a result of this on-going survey work, in February 2002 the first case of *Pr* in the UK was found on *Viburnum tinus* in a garden centre in Southern England (Lane *et al* 2003).

b) Forestry Commission

The first major FC *Pr* woodland survey was carried out between December 2003 and April 2004. This consisted of inspections at 1217 high-risk sites in Scotland, England and Wales, identified by climatic factors. A total of 335 samples were collected from symptomatic plants. All samples tested were negative for *Pr* (FC, 2004). A second survey, on a reduced scale in England and Wales, was undertaken between May and August 2004 but it also did not find any cases of *Pr*. By this point in time *Vaccinium myrtillus* had been identified by CSL to be a potential high-risk host and subsequently *Vaccinium* in woodlands was included within the sampling protocol. During August, 19 water bait samples were taken and 3 of these did prove positive for *Pr* (FC, 2004a).

In 2005, the *Phytophthora* Programme Board decided that, in the light of the continuing outbreaks, it was necessary to revisit all those high-risk sites, which were surveyed in 2004, over a 5 year period, with 20% of the total being surveyed annually. Between August and September 2005, the FC undertook the resurvey of 149 woodlands in England and Wales. None of the 11 samples proved positive (FC, 2005). During 2005 further outbreaks of both *Pr* and *Pk* were discovered in Cornwall following intensive surveys by PHSI. The FC supplemented the PHSI surveys by undertaking further surveys in Cornwall of woodlands in admixture with *Rhododendrons* and/or *Vaccinium* which had not previously been surveyed. This survey was carried in August 2005. No new positives were found (FC, 2005a).

Between June and September 2006, the FC undertook its annual Forest Condition Survey of woodlands in England, Scotland and Wales to ascertain the health of five species. While engaged in this survey, surveyors were asked to identify whether *R. ponticum* was present in or around the plots and if so inspect for signs of *Pr/Pk*. 338 plots were visually inspected and samples were analysed from seven sites with symptomatic plants, but no positives were found (FC, 2006). Between June and August 2006, the FC undertook a re-survey of 126 woodlands in England and Wales. 25 samples

were sent to the CSL for testing, of which only one, from a wood in Hampshire, tested positive for *Pr* (FC, 2006a)..

Additionally, between July and September 2006, the FC undertook a survey in Devon of 71 woodlands and woodlands associated with heritage gardens, which were in admixture with *Rhododendron* and/or *Vaccinium*, and which had not previously been inspected either by the FC or PHSI. No positives were found (FC, 2006b). In October and November 2006, the FC undertook a second survey, on a much reduced scale, in Devon. It targeted a number of woodlands which were associated with plant movement, heritage gardens and regular recreational activity, and where movement through these woods had the potential to transmit *Pr* and/or *Pk*. No positives were found. At five of the sites, water baits were used but they also proved to be negative (FC, 2006c).

Following the initial discovery of *Pk*, in Cornwall in 2003, the FC surveyed woodlands known to have *Pk* infected *Rhododendrons* to find out if any trees were showing symptoms of the disease. This continued over the next three years, with previously surveyed woodlands and new outbreak sites being examined. The FC reports that since they first looked at trees with bleeding cankers in 2003, the Tree Health Division have examined around 500 trees with bleeding cankers (439 of these in Cornwall) with a further 250 trees checked out for possible *Pk/Pr* foliar infections. Out of this total, 185 have been found to be positive for either *Pr* or *Pk*. By October 2007 22 trees were found to have bleeding lesions and 69 trees have foliar infections as a result of *Pr* while 22 trees have bleeding lesions and 44 trees have foliar infections as a result of *Pk*. Infected *Rhododendrons* were present on all of these sites, usually in close proximity to the infected trees (FC, 2007).

Between June and October 2007, the FC undertook a re-survey of 186 woodlands in England and Wales (originally surveyed 2004). In 18 of the woods, symptomatic material was tested using LFDs and these showed up positive for *Phytophthora*. 33 samples were sent to CSL for testing. Nine samples were positive for *Pr* one from a wood in West Sussex, and eight from two sites in Cornwall. (FC, 2007a)

There was concern that the two surveillance programmes were not fully co-ordinated between the two agencies. There were problems on the ground where both FC and PHSI surveyors would turn up at the same site on the same day. This was perceived poorly from the landowners perspective. Further, there is evidence that FC had turned up at sites to survey, not knowing in advance that these were outbreak sites. Additionally, there was no single database where the two surveys could be combined, which would obviously be a much more effective way of recording the data. It is thus recommended that there is better co-ordination between the two agencies in terms of surveying and that a single database is set up for the new programme.

5.2 Inspection of cargo in ports

a) Timber imports

It is considered that the risk of disease introduction from timber imports is extremely low; there is no evidence to suggest that the pathogen sporulates on timber and further most of the timber imports is from the east coast, not the west coast, of the USA where extensive surveys indicate that *Pr* is not present.

b) Plants for planting imports

It was recognised very quickly that there was a problem with infected material coming into the UK from the continent. Inspections at the dockside were carried out, focusing on east and south coast ports that receive ships from continental Europe. Relatively draconian measures were taken with material that was not supported with the correct plant passport paperwork being sent back. This was contentious with other member states, for example France. However, no infected material was actually found during the port inspections of material entering from other Member States.

Views on the effectiveness of these inspections varied as the response to the Question 27a of the stakeholder questionnaire indicated (Figure 11):

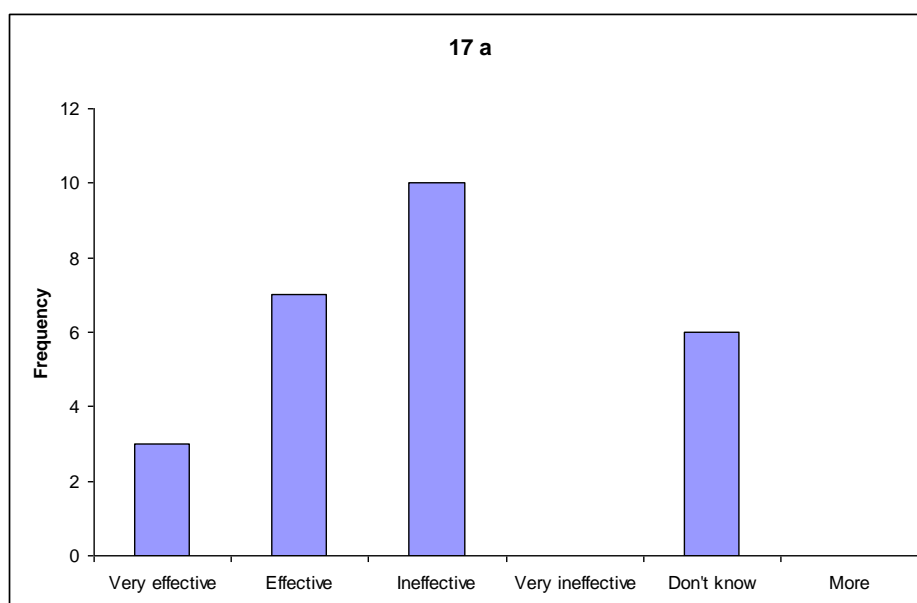


Figure 11: Bar Chart showing responses to question
In your opinion, how effective was the inspection of cargo at ports in limiting the spread of *P.ramorum* /*P.kernoviae*?' (Implementers survey, Question 17a).

However, it is still believed by many that infected material continues to enter the UK from the continent (see Section 7.1). Concerns are raised about how effective these port inspections really are given the huge quantities of material involved, and the use of fungicides which can suppress

symptoms. Import controls, are therefore inadequate in themselves, making the inspection programme after unloading essential.

Nevertheless, the positive impact of these measures has been a message being sent to the rest of Europe that this was an issue that the UK was taking very seriously. The European suppliers became more careful with the material being exported, as well as UK growers being more careful with their sourcing. It is seen to be a valuable deterrent, and an effective way of raising awareness. It addressed the concerns of the UK horticultural trade about a level playing field. In 2008/09, the annual target is to make 25 visits to inspect material arriving from other Member States. It is understood that the new programme is considering a period of heightened checks and for the above reasons, it would seem to be an effective action to be taken.

All plants for planting from non-European countries need a phytosanitary certificate and so in effect require an inspection prior to entry into the country. In addition, the phytosanitary certificate for consignments of *Pr* susceptible plants from the USA requires additional declarations confirming freedom from *Pr* (area based or place of production) plus inspection to confirm. There are no specific requirements for *Pk* from anywhere in the world except that all plants for planting need a phytosanitary certificate. *Pr/Pk* has never been found on imports from non-EU countries including the US.

5.3 Cornwall Management Zone

Pk was found extensively in an area of 12.24 square km in southern Cornwall between Redruth and Falmouth. The Plant Health (*Phytophthora kernovii* Management Zone) (England) Order 2004 (Anon, 2004a) was introduced in December 2004 and it gave Defra and FC specific powers within this defined area of Cornwall where *Pk* was first identified.

The purpose of the Order was to supplement the powers available under general plant health legislation and enable inspectors to close footpaths for the purpose of carrying out eradictory action. The Order also prohibits the removal of all host plants out of the Zone without permission. The implementers survey (Question 17h) asked how effective respondents thought the establishment of the *Pk* management zone in Cornwall was in limiting the spread of *Pr/Pk* (see Figure 12).

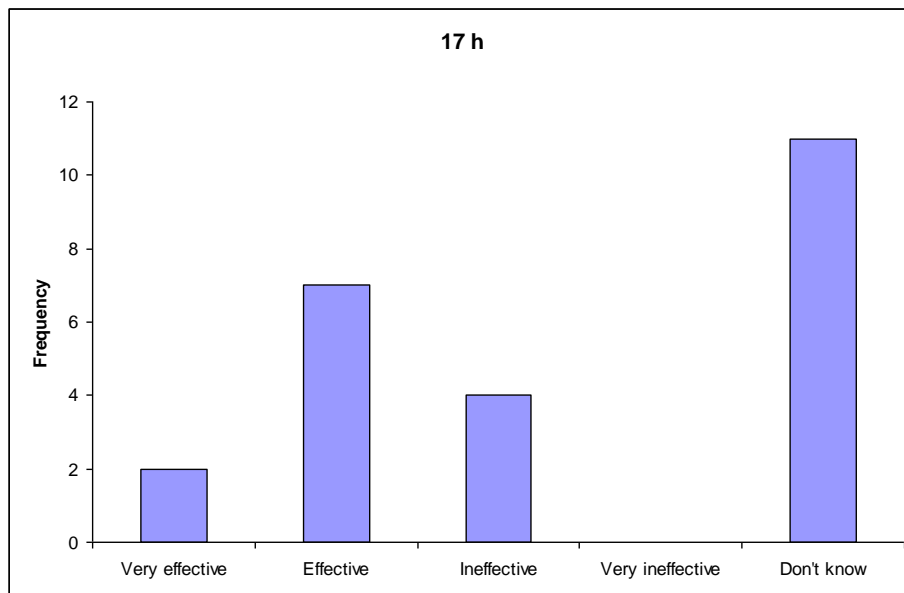


Figure 12: Bar Chart showing responses to question
'In your opinion, how effective was the establishment of the *P.kernoviae* management zone in Cornwall in
limiting the spread of *P.ramorum* /*P.kernoviae*?'
(Implementers survey, Question 17h).

The Zone was set up to deal with the particular nature of the incidence of the disease in this particular area. It was not found on nurseries or large scale landowner plots, but on a relatively large number of houses [c1600 landowners/occupiers] and it would have been extremely difficult logistically, laborious and expensive, to issue individual notices to each of these properties separately. Thus, the Zone was introduced whereby all the controls were standard for everyone. In these terms it was an effective method. The Zone also gave powers to close footpaths temporarily and this was considered very important in that area, facilitating the rapid removal of high risk infection close to footpaths. It was considered difficult to police effectively, though, and was resource intensive and perceived to be in need of more resources.

Residents were informed through leaflets and letters. Respondents differed in their assessment of the effectiveness of the Zone in communicating to local people the risk posed by *Pk* to plant health. Some believed that it maintained awareness amongst the landowners affected. However, it was also felt that first points of contact were often not followed up through further discussion with the local community. It seems that the intention to keep local stakeholders informed of developments with a regular newsletter was not fully realised here. It is reported that the establishment caused considerable concern from the main landowners affected by its creation due to the lack of communication and timing, partly because letters were received by the landowners on the day before Christmas Eve (interviewee I, disease manager).

Pk outbreaks were then found outside the Zone and there was discussion of whether to extend the zone or not. Other outbreaks outside the Zone were dealt with by issuing separate notices. The Defra consultation suggests that further management zones in other places might be a possible

solution. One civil servant considered it not to be ‘a widespread management tool’, but if there were to be other outbreaks in a limited area where there were a high number of individual properties, it might be worth introducing. It would not be practical on larger areas because of practical enforcement limitations.

5.4 Inspection and eradication measures in nurseries and retail premises

Both *Pr* and *Pk* are notifiable plant pathogens and so there is a legal requirement to notify PHSI if an outbreak is known or suspected on host species. A policy of disease eradication is in place for nurseries and retail premises. If the presence of *Pr* /*Pk* is confirmed by a plant health inspector at a nursery or garden centre the following actions (Figure 13) must be taken under a Statutory Notice (Defra, 2005a):

- Destruction by burning or deep burial (infected plants, susceptible plants within a 2m radius of infected plants and associated plant debris).
- Disinfection of surfaces.
- Disinfection of pots.
- Prohibition on movement of susceptible plants within a 10 m radius of infected plants and remaining plants in infected lot for at least 3 months.
- Prohibition on use of *Phytophthora* fungicides during the holding period.
- Advise the cessation of overhead irrigation.
- Trace-back and trace-forward of related plant material.
- An intensive inspection regime involving fortnightly visual inspections, quarterly random sampling of susceptible hosts and quarterly water baiting.

Figure 13: Eradication measures for *Pr/Pk* infected nursery and retail premises [Source: <http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/eradicationMeasures.cfm>]

Following this, if the disease is found again, the date of sale of plants within this area will be deferred for a further three months after infected plants are destroyed and the area may increase in size if the plant are close to the edge of the previous 10m quarantine area. Follow up PHSI inspections will take place every three months for 9 months after eradication (Defra, 2005a).

The number of inspections carried out by PHSI staff in England and Wales is shown in Figure 14. The number of these that were positive for *Pr* is shown in Figure 15:

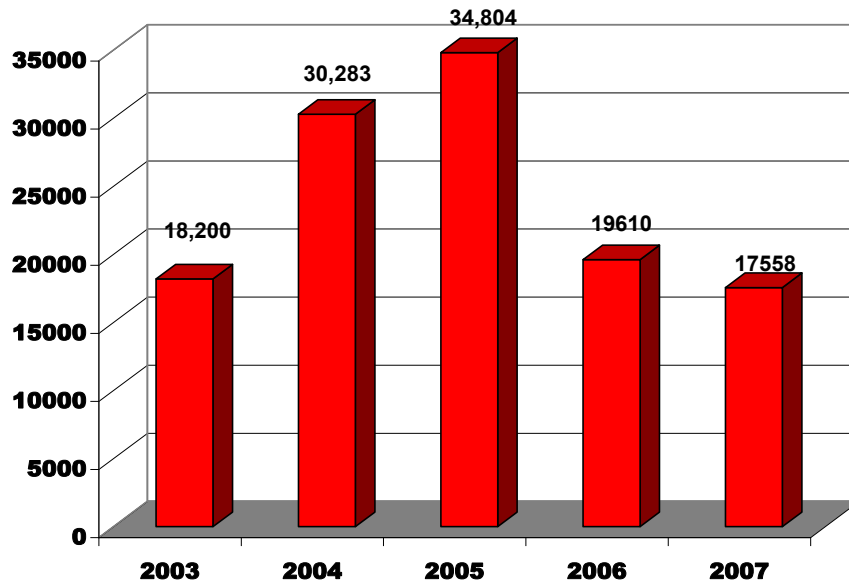


Figure 14: *Phytophthora ramorum* - number of inspections in England and Wales. (Source: Defra personal communication September 2009).

Note that since inspection frequency increases for 9 months following a positive inspection, there is a positive correlation with Figure 15 below.

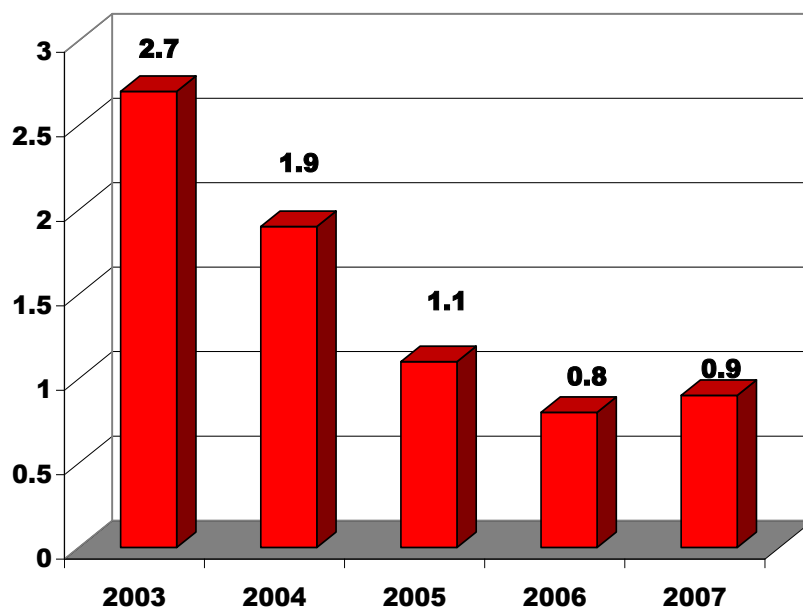


Figure15. *Phytophthora ramorum* -% positive inspections in England and Wales. (Source: Defra personal communication September 2009).

The nursery and retail premises inspection and eradication regime is commonly seen as one of the most effective aspects of the Programme measures. As the current figures for outbreaks show (see Section 1.1), at retail sites 85% of the *Pr* infections have been eradicated, and 80% for *Pk* (where the scale of the problem is much smaller) Question 17e of the implementers questionnaire, asked respondents how effective they thought the inspections of nurseries and garden centres was in limiting the spread of *Pr/Pk* (Figure 16) whilst Question 17f asked the same question the destruction of diseased plants and restrictions on plant movements (see Figure 17 below). In both cases, the majority of respondents thought that inspections, and destruction/ restrictions on plant movements were very effective or effective.

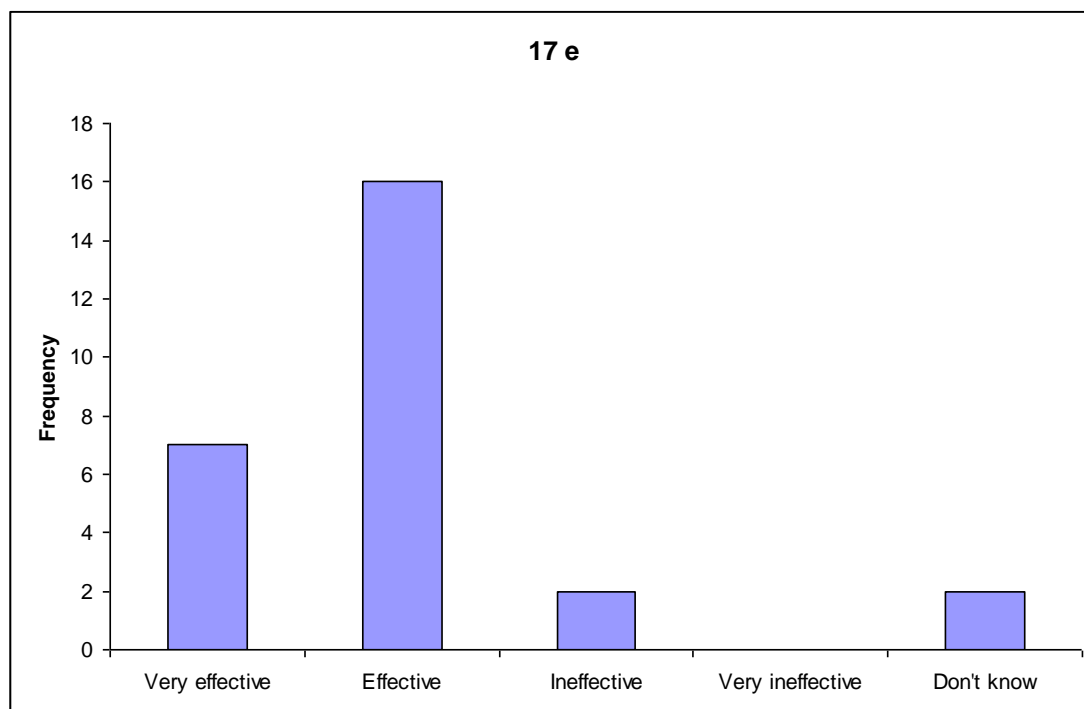


Figure 16: Bar Chart showing responses to question
'In your opinion, how effective was the inspections of nurseries and garden centres in limiting the spread of
P.ramorum /*P.kernoviae*?' (Implementers survey, Question 17e).

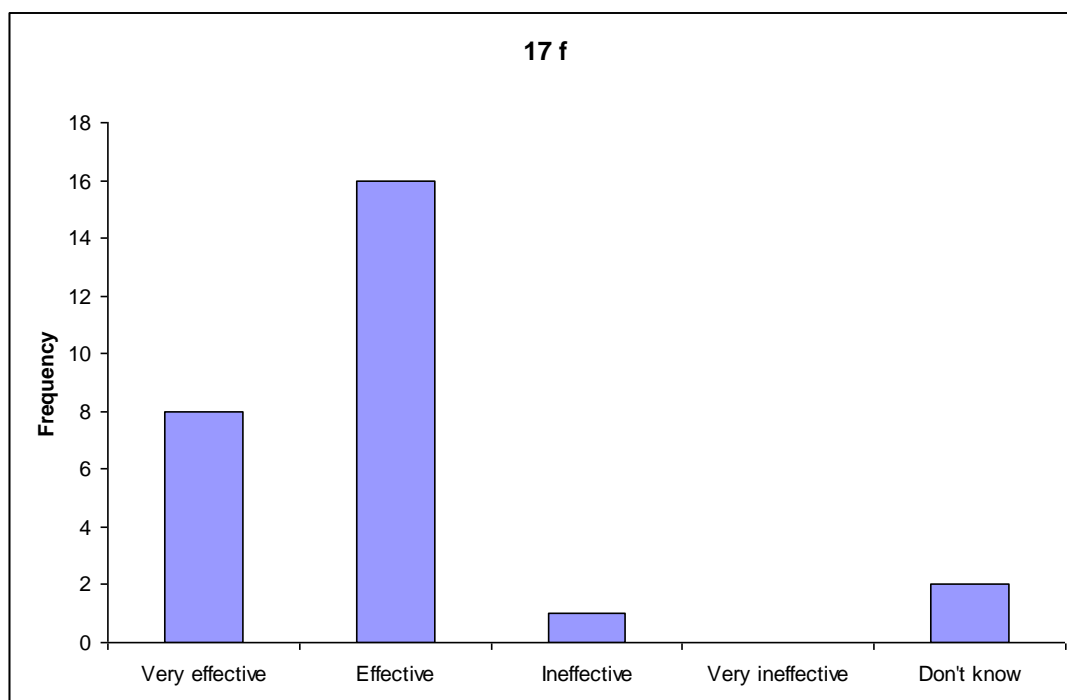


Figure 17: Bar Chart showing responses to question
'In your opinion, how effective was the destruction of diseased plants and restrictions on plant movements in nurseries in limiting the spread of *P.ramorum* /*P.kernoviae*?' (Implementers survey, Question 17f).

Taking infected plants out of circulation before they can be planted out in the wider environment is a critical step in preventing further spread. It was observed that ‘the inspection regime has been effective not only in locating infection but in getting many nurseries to start taking biosecurity issues into account’ (interviewee J, stakeholder). Not only did this regime result in the removal of many diseased plants, it also helped to raise awareness back up the distribution chain. The effectiveness of these measures is reliant on co-operation of the industry, which generally, with notable exceptions, has been good. Inspectors have experienced accusations of alarmism or denial over the scale of the problem from nursery owners. However, as discussed later in this Section, there is a long-standing history of interaction between nurseries and Defra/PHSI and a long-term awareness and experience of pest and disease issues that has contributed to easier management. This compares favourably with other environments in which *Pr/Pk* has been found.

However, infections are still being identified. It is reported that regular interceptions are still being made on imported plants. The level of nearly one percent findings is still a worry, and so there is consideration of whether these measures ought to be strengthened to reduce below one per cent. There are also questions over the frequency of inspections. It is understood that the actions at nurseries for removing and destroying plants will be reviewed by the Commission.

It is understood that the quarantine distances (2m and 10m) were based on common sense as the science to inform such a decision was not available at the time. It was intended that the RAPRA project would examine whether these were the correct, most effective distances. The RAPRA project

did not do this, partly because there was conflicting evidence that it worked in some cases, but not in others. There was not always the co-operation of the nursery owners to carry out the necessary experimentation. Indeed, there has been limited scope for research within the nursery settings in the UK more generally because of lack of co-operation with nursery owners, whose aim (understandably) is to get rid of the infection very quickly, rather than allowing the scope to study it. In the USA, researchers are in the process of purchasing an experimental nursery. Clearly, it would be extremely beneficial for the UK to engage with this research.

There have been problems with re-infection or persistent infection on some nurseries, sometimes because the disease wasn't properly cleared in the first instance. It has been observed that sometimes the distances did not work because the disease had been present in the nursery for a lot longer than had been observed and the measures were not being imposed on the first infection. It is argued that when it was the first infection, the measures were effective. Concern was also raised that the detection was too late, following asymptomatic infection.

A concern was raised that the focus of the inspections in the nurseries, in the case of *Pk*, might be too much on *Rhododendron* and not enough on other species, for example magnolia about which there is also thought to be a risk.

Clearly, the eradication measures have an economic cost for nurseries and retail centres with an infection. The policies on holding stock for a particular length of time and destruction of some plants raise particular economic decisions for nurseries. For example, one manager of a series of nurseries decided that they couldn't afford to build a standing area nearby to all their retail sales areas to put stock for three months to hold and meet the associated staff costs. Instead they have been destroying all susceptible plants in the plant sales area, without anything on hold. There was a concern that plants on hold might miss their sales window, when flowering and consequently most marketable.

5.5 Plant passporting

Species/hybrids of *Camellia*, *Rhododendron* (other than *R. simsii* which has been shown to be resistant to *P. ramorum* in tests) and *Viburnum* are now subject to plant passporting requirements to the point of final retail sale. The conditions of the passport are that material originates in areas where *Pr* is known not to occur or where there have been no signs of the pathogen at the place of production. In cases where signs of the pathogen have been found, appropriate procedures for eradication must have been implemented (Defra, 2005b).

As Figure 18 shows, the total number of *Pr* passporting infringements has fallen substantially from 117 in 2003 to 19 in 2007. Figure 19 shows the number of these *Pr* findings that were on passported material is small, compared to those found on non-passported material:

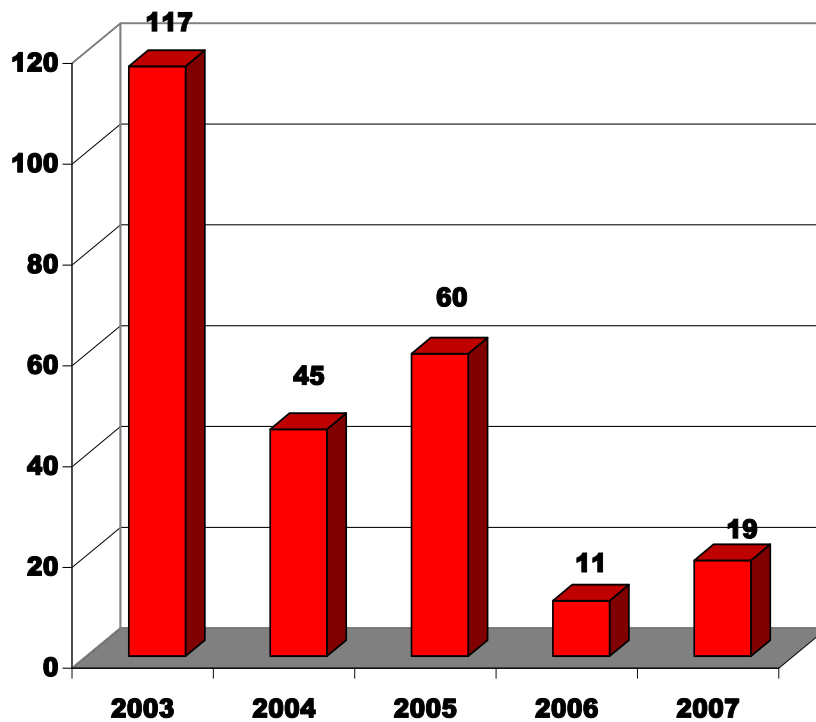


Figure 18. Annual total of passport infringements for *Pr* in England and Wales.
(Source: Defra, personal communication September 2009).

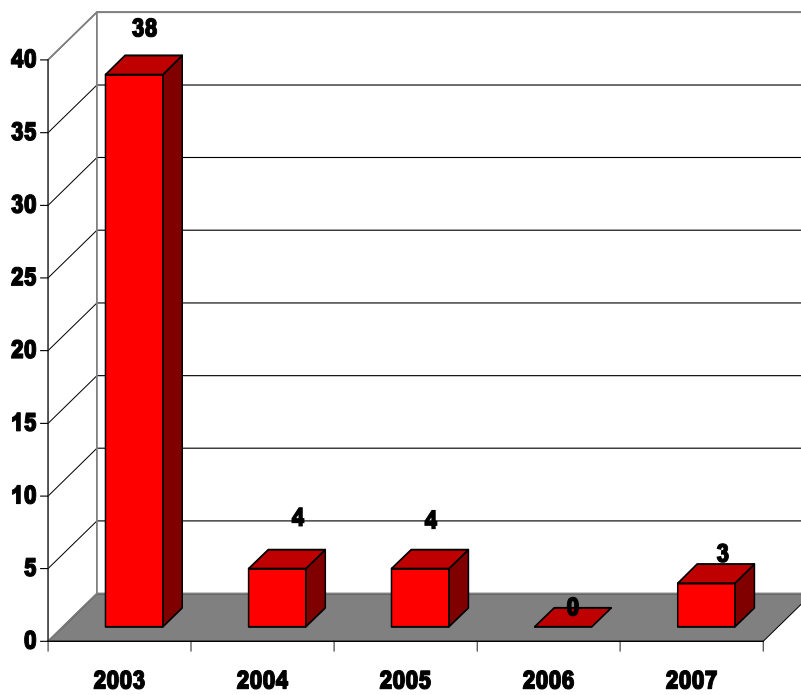


Figure 19. Annual total of number of *Pr* findings on passported material in England and Wales.
(Source: Defra, personal communication September 2009).

Respondents were asked how effective they thought plant passporting was in limiting the spread of *Pr/Pk*. As shown in Figure 20, the majority of respondents thought that they were effective or very effective. Whilst the data above show it is not fully effective in eliminating all disease, the majority of *Pr* findings are on plants where the plant passport is missing. It is seen by many as the only realistic prospect for bringing down levels of disease in traded nursery stock. It benefits from being an established mechanism with substantial delegation of responsibility to industry. It has raised awareness of the issue and resulted in nurseries checking plants more thoroughly. The traceability the system gives has been useful in tracking down and destroying infected/suspect plants. Plants are now traceable to source.

Several concerns were highlighted by respondents. There is a view that within the UK plant passporting has helped, as the UK authorities have given it a high priority. However, there is some question as to whether in the wider EU, the effectiveness is more variable depending on the priority given to it by the inspection services. There is a question over whether more genera, other than the current three that are passported, should be given that the host lists for both pathogens is extensive.

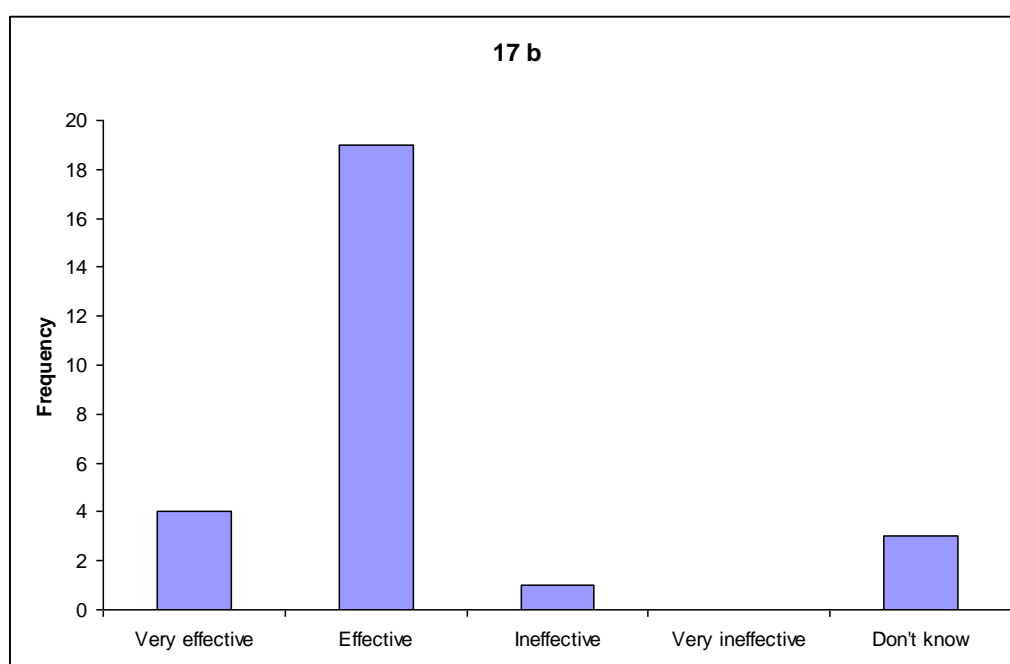


Figure 20: Bar Chart showing responses to question
'In your opinion, how effective was plant passporting in limiting the spread of *P.ramorum* /*P.kernoviae*?'
(Implementers survey, Question 17b).

Questions remain over the use of fungicides; The use of anti-*Phytophthora* fungicides on plants held under Statutory Notice is prohibited. It is also *recommended* that trading arrangements with suppliers stipulate a 6 week prohibition on the use of anti-*Phytophthora* fungicides on known host plants prior to despatch, other than where such fungicides are required to suppress other *Phytophthora* species

(Defra, 2005b). Nevertheless, fears have been articulated in this survey, that fungicide use is masking symptoms and allowing infected plants to evade visual detection during import inspections or during monitoring. According to Sansford and Woodhall (2007), two studies (Shishkoff, 2005; Turner *et al*, 2006) indicate this may not be a major factor, but confirmatory evidence is still not available.

5.6 Management of disease in woodlands

It is considered that the management of the diseases in the natural and semi-natural environment (woodland and historic gardens) has been much more difficult in comparison to the nurseries, in terms of pinpointing where the disease is, knowing what the susceptible plants are and taking correct action. In addition to knowing much less about what the hosts were, it was often the case that those responsible were coming to the infections in the natural environment much later when they were already quite intense infections, particularly in Cornwall. Thus a move to the idea of eradication rather than containment seemed to be the only way forward there.

Clearance of *R. ponticum* has been the main management mechanism on infected woodland sites. Early research work indicated that small scale clearance of *Rhododendron* from woodlands reduced the inoculum levels and reduced the likelihood of trees becoming infected and the wider spread of the disease. In England, about 140 hectares of *Rhododendron* has been cleared out of approximately 800-850 hectares of woodland on sites with *Pr/Pk* infection. The vast majority of this clearance, about 130 hectares, has been in Cornwall. Disposal of material has generally been by burning or in some cases by chipping and disposal in landfill (Tracy, 2009) (or mulching, see below).

This clearance work in England was funded both from FC and Defra Plant Health. In the first year there was £100,000 from each department, and then in subsequent years two £150,000 from FC and £100,000 from Defra plant health. The average cost of clearing *R. ponticum* has been around £8000 per hectare. However, the cost is determined by the amount of *R. ponticum* on the ground and the most expensive site that the FC have undertaken the clearance cost approximately £13000 per hectare (personal communication, Ben Jones).

The delivery mechanism for both FC and Defra money was the Woodland Improvement Grants scheme (WIGS), as it was a suitable pre-existing mechanism. The only exceptions were occasional clearance under research projects; for example the two woods that amounted to one point one hectares of clearance.

In South Wales, from December 2005, *Pk* infected *R.ponticum* was cleared from 37.5 hectares of native broadleaved woodland containing *Rhododendron* in Clyne Country Park, by the owners, Swansea City Council. These infected bushes were removed by cutting and burning. A decision was then taken to clear the woodland of all *R. ponticum* for woodland improvement but by removing the *R. ponticum*, it also eradicated the sporulating pathogen infecting the host plants (Tracy, 2009). This

was 75% funded through the FC Wales' Woodland Improvement Grant Scheme, and later under the new Better Woodlands for Wales Grant Scheme.³

The clearance of infected *R. ponticum* is commonly seen as key to the management of the disease:

"I think that programme demonstrated to us, at least in terms of protecting trees, removing infected *Rhododendron* is your best management tool." (interviewee D, policy maker)

"...that's the key to the, to controlling this disease. We've got evidence that it is highly effective... we've got woods where we've taken all the *Rhododendron ponticum* out and we have seen no new tree infections ...We've got gardens where we've been monitoring and where we've taken out *Rhododendron* and where we've had, again, no new plant infections. So I think it's a brilliant way of reducing the inoculum so you don't get new spread or new infection." (interviewee B, scientist)

Clearance of *R. ponticum* seen to have other positive consequences, not related to the management of disease. It is commonly viewed an invasive (non-native) species;

"Actually getting rid of the *Rhododendron [ponticum]* itself, even if the disease is not eradicated, the landscape will be improved...*Rhododendron [ponticum]* is not much use in landscape terms, for biodiversity or wildlife or anything like that, so not having it is going to be better." (interviewee F, stakeholder)

The clearance of *R. ponticum* improves access to land for the public. In Swansea, for example clearance work in Clyne Country Park has created a new 'amenity woodland', improving access for horse-riding and mountain biking. It has also opened up the landscape with new views down the valley. It was found to be much more cost-effective to get Till Hill specialist contractors to do the clearance work, rather than local authority teams.

Landowners have been positive about being paid to clear *R. ponticum*, which otherwise they wouldn't be able to afford to do, and enabling them to manage the land better. In the future, widespread clearance of *R. ponticum* will necessitate more decisions to be made about how the cleared land will be managed and will inevitably lead to changes in land use. (See Section 7).

Nevertheless, it has been stated that flowering *Rhododendron* species are popular with the public in open woodland areas and therefore clearance leads to the loss of this public amenity. It has also been suggested that *R. ponticum* understorey is an important habitat for game.

This funding was for the clearance of *R. ponticum* on land that was *infected*. The rationale was to remove the infected *R. ponticum* and any other *R. ponticum* on that site to create, in effect, a host free buffer zone around that site. The areas that need to be cleared, given limited resources, were

³ This is now the funding mechanism for clearance in South Wales and the Conwy Valley in North West Wales. Please see [http://www.forestry.gov.uk/pdf/Phytophthora_BWW_Grant20090512.pdf/\\$FILE/Phytophthora_BWW_Grant20090512.pdf](http://www.forestry.gov.uk/pdf/Phytophthora_BWW_Grant20090512.pdf/$FILE/Phytophthora_BWW_Grant20090512.pdf))

prioritised using a risk matrix. This weighed up certain risk factors. These parameters included (Tracy, 2009:164):

- Does the woodland have *Pr* or *Pk* present?
- Is it part of a heritage garden?
- Does the woodland have specific value? I.e. is it classified as an ancient semi-natural woodland?
- Is the woodland near to a nursery where susceptible plants are being produced for sale?
- Is there water present where dissemination spores via the waterway is possible?

Thus assessment was made of the sites that were the highest priority and should be dealt with first; this was based on focusing on minimising the potential for distance spread. However this has meant that larger woodland and non-woodland sites that were infected were being left and were, in effect, acting as reservoirs of inoculum. Whilst it was believed that it was correct to use this rationale to focus on the highest priority sites, it is believed that there would've been a strong rationale to continue an active programme of clearance on the larger sites that were infected but that posed a lower risk of distance spread. This would involve working on two different fronts. Obviously this would require considerably more financial resources.

Problems emerged about the type of land that can be cleared using the existing WIGS funding mechanisms. It can only be used on woodland, and not open land without tree cover. (Gardens can be cleared under that scheme if the percentage tree cover is high enough). This has contributed to the criticism made that clearance has been in a rather 'patchwork' manner. There is a need for a more joined-up, co-ordinated approach to *R. ponticum* clearance, as indicated by this quote from a landowner:

'... money to clear *Rhododendron* from in the woodland, which is fine, but this *Rhododendron* is not within woodland and yet is next door to woodland, next door to the garden...There's not much point clearing the woodland if you've got huge amounts just next door to the woodland which remain there'.
[interviewee H, disease manager]

It is understood that for the future programme, there are discussions on-going with Natural England the competent authority for that area, (and for the Countryside Council for Wales) on a mechanism to get the funding to those infected areas where clearance is needed that are not woodland. For example, it is understood that Natural England are currently funding the clearance of the outbreak on land owned by the local authority on Cannock Chase in Staffordshire through the already existing Higher Level Stewardship scheme. To deal with *Pr* a "works only" agreement has been added to clear the *Rhododendron*.

Clearly, the amount of clearance that occurred is restrained by the budget. It is recognised that the clearance of *R. ponticum* has not been as extensive as was hoped. The resources necessary for

clearance became very large and the funding wasn't available on this scale. It is reported that some of the sites were so large that neither the landowner nor government could fund the clearance. It is considered that this has been a failure;

'in that those areas have continued to pump out inoculum and, possibly, the heathland infection in Cornwall has come from [these] areas... So I'd say a major success in one way, it's a shame we couldn't have cleared everything when we found it'
(interviewee B, scientist).

However, it was also felt that it was not just the overall level of funding, but that the biggest constraint on further work being done was that they were annualised (because they were being contributed to by a variety of agencies, not a central programme). This led to a short-term view of the funding of clearance, with a medium-term view not being possible.

"not just the actual funds, but ... the knowledge that there wasn't a programme and that funds were year on year, which means you can only look at the disease within that one year snapshot rather than taking a perhaps more holistic view."
(interviewee I, disease manager)

The other criticism identified of the clearance programme is that no pro-active clearance of *R. ponticum* (i.e. on uninfected sites) was carried out. It is understood that this will occur in the new programme.

5.61 The waste disposal /management issue

There have been concerns around waste disposal and management of cleared *R. ponticum*. The most appropriate way of dealing with this from a waste management perspective (so that infected material is not moved around) is through burning. This has to comply with the Environment Agency (EA) waste management regulations that state that only 10 tons of material can be burnt within a 24 hour period. A forthcoming change will provide an exemption for the burning of plant tissue, including wood and bark, either on a dockside (in the case of imported material that presents a plant health risk) and also trees, shrubs and other plants, including wood and bark, where destruction is required as part of a disease management policy. Initially the EA were concerned about burning as there was no evidence base to show that it was the best approach (a concern perceived to originate from the Foot and Mouth outbreak where there was a worry that disease was spread as a result of the burning pyres). However, working relationships developed between the EA and FC/PHSI and the EA now seem to be reassured that burning will destroy the pathogen. It is stated that there are now no major concerns with the EA over the waste issue.

In Swansea, South Wales, large burners 'burn boxes' were used on-site to dispose of cleared *R. ponticum*. However difficulties were experienced here with getting enough accelerant for the burning of the green wood material around the burn cycle. As they did not have a waste transfer licence, waste wood could not be used and so 'white wood' had to be used, a rather wasteful practice as it was intended for other purposes. It has therefore been suggested that attention is paid to ensuring that waste legislation is not in conflict with *Pr/Pk* management.

It has been suggested that on non-infected material from large-scale clearance (but from infected sites) could be more usefully used, for example in biofuel burners. Research is clearly needed to see whether this is practical and what the risk of disease spread is, as there is always a risk that the material is infected. It has been suggested that the use of water bait traps in the area could assist with this.

For local authorities, the risk of disease spread posed by mobile forestry gangs (and their equipment) moving between sites was identified. In Swansea this was changed as a matter of urgency. It is also necessary for authorities to consider any potential negative impact on woodland wildlife, for example badgers, from clearance. Surveying in advance of clearance of a site with 3 or 4 metre high walls of *R. ponticum* can be difficult, but licences must be sought in advance

In Swansea, funding limitations meant that in Clyne Country Park areas of non-infected *R. ponticum* were cleared, chipped and then put as a thick mulch (three to four inches in places) on the ground. Whilst this decision was made because it was perceived, that given funding limitations it was better to clear the *R. ponticum* than leave it, it has caused new problems. Apart from aesthetic concerns, this mulch can cause de-nitrification of the soil and causes difficulties of regeneration of under-storey plants. Whilst it is perceived that these areas need to be ideally re-planted with a mixture of relatively large plants/samplings to re-create a multi-stage woodland, it hasn't been possible to get funding for multi-sized material for planting.

5.7 Management of disease in historic gardens

The third type of habitat where *Pr/Pk* has had significant impacts is in public and private 'historic' gardens. The majority of these are in Cornwall, and a sizeable proportion belong to the National Trust. These traditional Cornish Spring gardens, whose main attractions are the early spring flowers of *Rhododendron*, *Magnolias*, and *Azaleas*, have been badly affected. This is posing a risk to the Cornish tourist economy. There is general consensus that the management of the disease in historic gardens has been much more of a challenge than in the nurseries or in woodland, due to a combination of physical, environmental and social /cultural factors.

In nurseries the plants are commonly standing on beds or concrete that can be changed or sterilised. This compares favourably in terms of effectiveness of eradication actions, with the natural environment where it is now known that with sites where there has been heavily infected *Rhododendron* over a number of years, the pathogens can persist in the soil for a long period even with the removal of infected plants and infected litter. In nurseries, the case is that the fate of an (infected) plant is to be sold and moved on out of the nursery. This should be compared with the circumstances of a historic garden where infected plants and trees might be unique, a hundred years old, very large specimens and of horticultural significance.

It is argued that nurseries, to a degree, can accept the robustness of plant health measures (excepting that in certain cases the outbreak has had critical financial implications) and have a longer association with plant health issues and measures;

“undoubtedly...industry where they’re used to dealing with, or more used to dealing with pests and diseases, it’s easier to take onboard. “ (Interviewee I, disease manager)

Historic gardens on the other hand have not been involved in this sphere of regulation until the *Pr/Pk* outbreak, and Defra had no experience of dealing with this sector in this context. It is acknowledged that Defra started with a very low level of engagement and understanding of the particular issues facing the gardens in relation to *Pr/Pk*.

There is diversity in the nature and ownership of infected historic gardens; from major national organisations like the National Trust, to individual privately-owned gardens that might only open for a few weekends a year or on a regular basis, to gardens owned and run by local authorities. Each of these stakeholders can potentially have different concerns about the *Pr/ Pk* outbreak and respond in a different way.

5.71 Shift in garden policy

The socio-economic impacts, specifically the fact that these gardens are major tourist attractions, and especially in Cornwall a critical part of the local economy, had to be acknowledged by Defra. The initial policy of eradication created difficulties and was not found to be practicable in the end. Indeed, inspectors found resistance to plants and trees being taken out of the gardens, because in many cases, especially in Cornwall, the main susceptible hosts of *Pr/Pk* are the main reason for the gardens being there. From the gardeners perspective, it was perceived that such an ‘eradication’ strategy would mean, as one garden owner described;

“the only logical thing to do in the garden would be to remove every member of every susceptible species, and that would entirely destroy the garden” (interviewee F, stakeholder)

An inspector described the increase in disease identification overtime which meant that;

“You then start hitting rare plants, plants in the guidebook, plants that were brought back from such and such plant hunter or that the owner’s father was involved with planting, introducing.” (interviewee G, disease manager).

Inspectors involved on the ground describe the initial problems they encountered when work started five years ago when the levels of infection were much less visible, particularly at certain times of the year, and it was difficult to convince gardeners and garden owners of the seriousness of the problem and that plants needed to be removed.

“the problem was in the early days we didn’t have any trees dying, we didn’t have any infected trees. So what does it matter if trees are dying in California, they’re obviously not dying here.” (interviewee D, policy maker).

Additionally, at the time the inspectors ‘didn’t have as many tools in the toolbox’ (interviewee G, disease manager) as now. As the LFDs were not put out to trial for the inspectorate until later on, the smart cyclor didn’t exist.

PHSI have reported that it has been easier to work with infected sites that are in local authority control because livelihoods are not put under direct threat by the disease, and the absence of historical, personal ties to the place.

A shift to containment through the issuing of statutory containment notices ensued. This acknowledged that any action taken might impact on a local tourist income stream and that a balance had to be struck between that concern and the effective management of the *Pr/Pk* risk. This evolution in policy was driven from the ground up through the Programme Board mechanism. It went from policy of removal and strict rules about eradication and a no re-planting policy, to a process of issuing a containment notice on the site. The intention was to minimise the risk of spread of disease from the site. Rather than an insistence that all infected plants be removed at one, the issue was dealt with on a case by case basis at different gardens.

An examination of the policy (Defra, 2008) shows a significant degree of freedom and flexibility in what actions the owners of historic gardens might be asked to take. Figure 21 below outlines the actions that *may be required* under official Notice against all findings of *Pr/Pk* in parks, gardens and uncultivated land situations;

- Prohibition on the movement of infected plants and parts of plants (e.g. must not be used for propagation purposes or foliage purposes).
- Destruction by burning or deep burial (at an approved landfill site – see section 10.4 for important information on dealing with waste) of infected plants, susceptible plants within an appropriate cordon sanitaire, and associated plant debris.
- Prevention of re-growth.
- Felling or pruning of infected trees depending on the part of the tree infected and the extent of the infection.
- Implementation of measures to prevent re-infection at the site. These may, for example, include a prohibition on planting susceptible plants in contaminated soil, removal or sterilisation of contaminated soil.

Figure 21. Actions that *may be required* under official Notice against all findings of *P.ramorum* / *P.kernoviae* in parks, gardens and uncultivated land situations.
(Source: Defra, 2008a:32).

Here, immediate eradication may not be deemed appropriate in cases of a lower risk or 'where comprehensive eradication would completely destroy the character of a historic garden' (Defra, 2008a:33); rather the emphasis is on containment measures that may include a 'biosecurity protocol' (see Figure 22) but again it is stated that there will be 'a degree of flexibility to take account of site differences' (Defra, 2008a:33). Similarly 'some eradication work may be required under Notice to ensure containment, to protect the public (from falling trees and/or from taking the problem home with them) or to protect important or valuable specimens.' (Defra, 2008a:33) The measures that this may include are listed in Figure 23.

- A regular programme of cleaning to remove plant debris from the surface of paths and standing areas.
- Safe disposal of all waste susceptible plants and plant material by burning or deep burial.
- Repair and maintenance to the physical structure of the footpaths e.g. where possible gravelling of mud paths.
- Restrictions on access to contaminated areas e.g. cordoning-off or re-routing of footpaths to avoid contaminated areas.
- Hygiene measures for employees and contractors including cleaning and disinfection of footwear and machinery before leaving the site.
- Some restraint on the movement of dogs or domestic stock e.g. for parks and gardens open to the public, all dogs to be kept on short leads.
- Erection of information signs to alert the public of the presence of the disease and include advice relevant to the site.

Figure 22: Biosecurity protocol measures that may be requested for a site under Notice for *Pr/Pk*
(Source: Defra, 2008a:33)

- Removal and destruction of infected plants adjacent to the footpath(s).
- Removal and destruction of infected plants, especially large shrubs and trees that are deemed to be unsafe.
- Removal and destruction of infected plants (e.g. large shrubs or trees that have leaf infection) which pose a risk to neighbouring plants (e.g. those directly in the drip line).
- Fungicide treatment to reduce either inoculum or to protect valuable specimens.

Figure 23. Control measures that may be requested for a site under Notice for *Pr/Pk*
(Source: Defra, 2008a:33)

This more flexible approach was made possible in part by an evolution in scientific understanding that some of the ornamental plants were sporulators, and some were not, so some infected plants would not pose a risk as far as spreading the disease was concerned, whilst others would. There was a developing understanding of the relative susceptibility of hosts. It has been found that trees with

bleeding cankers do not pose a risk to other plants. When there were trees with infected foliage, they were considered to be less of a risk, especially as they were usually much more sporadic in gardens, than compared to a mass of understorey *Rhododendron*. (On the local scale there are exceptions to this: for example *Drimys* in gardens are very high sporulators). It was also observed that there was stratification within the tree; often the upper part of the trees remained unaffected. Therefore different protocols were developed for gardens, to try and keep some of the trees and plants, deemed to be less of a risk in terms of spreading the disease, particularly ‘champion trees’.

Question 17g of the implementers questionnaire asked “In your opinion, how effective was the destruction of diseased plants and restrictions on plant movements in historic gardens in limiting the spread of *Pr/Pk*?” (see Figure 24). The majority thought it had been very effective / effective but there was some variation in views.

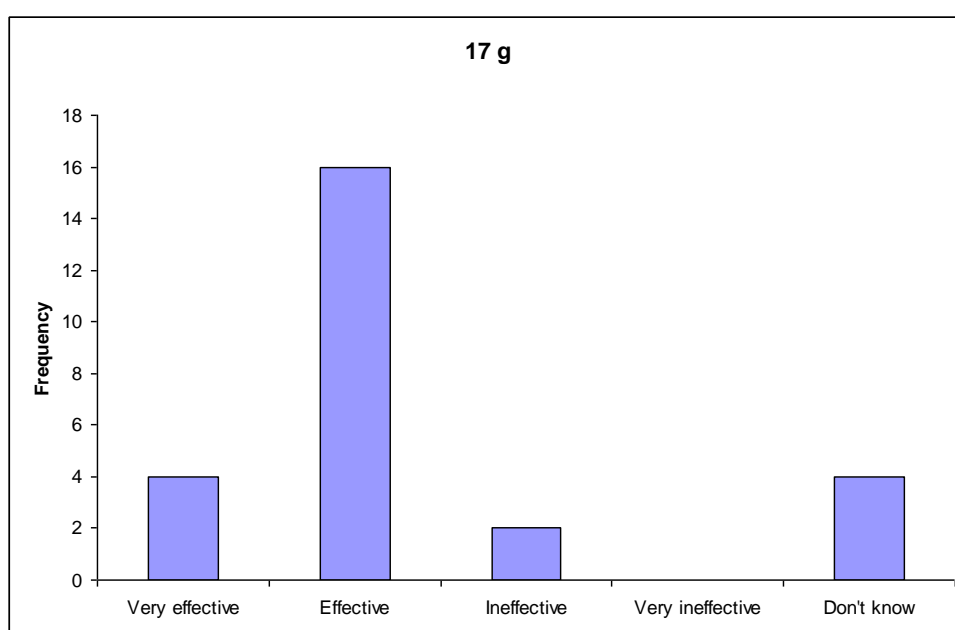


Figure 24 : Bar Chart showing responses to question
‘In your opinion, how effective was the destruction of diseased plants and restrictions on plant movements in
historic gardens in limiting the spread of *P.ramorum* /*P.kernoviae*?’
(Implementers survey, Question 17g).

It was observed that the success of such measures depended on how quickly the action was taken, and the scale of the outbreak. They were less effective at sites linked to, or nearby to, unmanaged woodlands with *R. ponticum*. It was also noted that management of the diseases in ornamental collections of different susceptible species is extremely difficult and complex. Therefore effectiveness will only be relative to the circumstances of the individual sites.

There have been benefits of this more flexible approach including improved relations between garden owners and PHSI/FC. It has been observed by inspectors that infected sites have responded better when they have felt that their engagement with PHSI has been a two-way process:

“that they’re listened to, that you respect their business situation, their needs, their requirements, so in effect both sides make it clear what their aims and objectives are, but actually within that you do a level of negotiation, and that’s where the containment notices were useful.” (interviewee G, disease manager)

Whilst there were complaints of a heavy-handed approach at the beginning, this changed to working in co-operation with the land owners/managers. The responsible authorities had to build up contacts with new organisations such as the National Trust, who owned a number of these properties.

PHSI have been involved with improving communication and interaction with stakeholders in Cornwall through activities such as awareness workshops with staff. It is observed that building these relationship helps when difficult negotiations are necessary and decisions need to be made. When both parties have knowledge and work experience of each other, there is respect and integrity. This leads to a more positive engagement than if a new person with authority comes in cold. There is a desire by inspectors not to use their legal powers;

“We have powers but we would rather advise, support, and manage the disease with you as best as all the circumstance allow, because I think that’s where you get a more productive end product.” (interviewee G, disease manager)

Within Cornwall there are specific *Pr/Pk* risks with plant movement given the number of gardens open to the public in Cornwall and the number of visitors who come and take a plant home. A fortnightly inspection programme was instigated for infected nurseries, gardens under containment notices, or if there was a nursery within the boundaries of a garden that was under a containment notice. Infected gardens that have a retail sales area on site received a fortnightly visit even if they weren’t actually producing any of the plants, but were buying them in, as there still exists a risk of infection.

In several gardens research scientists have been given permission by garden owners to carry out research work and this has been seen as beneficial to both parties, with garden owners appreciating the extra information about the disease in their gardens.

Gardens have begun to adapt daily practices in relation to *Pr/Pk*. For example in some retail sales areas, managers are getting more creative about how they display their plants and considered their benching material; for example a bench with gravel on it can be a reservoir for infection. In considering the need for disinfection, rather than putting plants on the ground, some have come up with better practical solutions and have displayed them on raised supports. For local authorities in Wales, it has been necessary to stop working groups moving from site to site using the same machinery, for example for emptying bins, and to have dedicated machinery for each park or garden.

5.72 Problems with containment approach

However, importantly, this approach had been contentious with accusations that not enough has been done to ensure that the gardens don’t act as a source of inoculum for the wider environment.

Some gardens are not removing infected plants. There is a concern with the risk posed by large numbers of visitors to these public gardens, many of whom will visit more than one garden on their trip or visit the wider countryside. Coach parties are common, often on a tour of several gardens in a region, if not further afield.

The research for this report suggests that a variety of approaches have been taken by gardens under these containment notices. Decisions have been made within each garden about which plants to prioritise to protect and which to remove. An 'aesthetic' approach might involve leaving in an infected plant that did not show many visible signs of disease, unless, for example, it was next to a more valuable plant. Protection measures have included the lifting of canopies of larger specimens. Clearance of *R. ponticum* has been an important strategy, but creates its own problems as the wind-break that these were originally planted as are removed. Additionally, the danger has been articulated that focusing on *R. ponticum* has been to the detriment of taking proper account of other heavily sporulating hosts, such as other species or cultivars of *Rhododendron*, *Drimys* or *Magnolia*;

"You've got to have an approach in the round to deal with these things, it's no good just saying, 'Well, we'll make sure that we take out all our *ponticum*.' (Interviewee C, scientist).

There is evidence that many gardens have attempted to change their everyday gardening hygiene practices, such as washing tools between use on different plants, raking up infected foliage, and keeping visitors away from infected areas. It is clearly critical that good biosecurity practices to become part of the daily routine at all gardens, not just infected ones.

Further, it has been observed that the approach PHSI have taken has varied between gardens and areas of the country. The destruction of infected plants in gardens was variable according to historic value. There has not been a common approach to management and it is argued that the whole process needs to review. It has been suggested that perhaps a tougher approach is required.

Whilst clearly there are many benefits to having a flexible approach that can take into account the nature of the risk at specific gardens, it might be valuable to have a system in place to verify that the process is fair and to clarify the criteria in which decisions are being made. It has been suggested that garden management plans should be developed and this is discussed further in Section 7.

With hindsight it is now thought that, if some gardens had been prepared to be more robust with eradication measures at the beginning, they may well have much lower levels of inoculum on their sites than they do have;

"I think gardens where they have been prepared to bite the bullet they are managing the disease rather than the disease managing them." (interviewee G, disease manager).

However, there are differences in opinion on how the disease should be managed between the head gardener and the owners of the garden, leading to difficulties in implementing a more effective management regime.

There is clearly a tension between the desire for garden owners to not have their visitor numbers reduced by providing too much 'alarmist' information about *Pr/Pk*, and on the other hand being able to reap the benefits from providing more information to the public so that they modify their behaviour and reduce the risk of spreading *Pr/Pk*. In National Trust gardens, notices have been placed on notice boards and retail sales areas informing the public about the presence of *Pr/Pk* but these are rather low key. At the Lost Gardens of Heligan, a more visible attempt has been made to communicate with the public, although some of the signage has been made necessary through management practices, such as the raising of the canopy of *Rhododendron* sp. and the need to stop the public wandering underneath. A similar tension arises for the suggestion that physical biosecurity measures such as installing foot dips or pads of fungicide at known infected gardens.

Recent research by the authors of this report (forthcoming) at Imperial College of 500 garden visitors to NT gardens in Devon and Cornwall asked about the public's willingness to change behaviour to manage *Pr*. They were asked how far they disagreed or agreed with several statements on a scale of 1 (strongly disagree) to 5 (strongly agree). The first was 'I would be happy to keep to footpaths when visiting historic gardens in order to reduce the spread of Ramorum disease.' 46% ticked (5) (strongly agreed), 47% ticked (4) with 3% ticking (3), 1% ticking (2) and 2% ticking (1) strongly disagree. The second statement was 'I would be happy not to wear open toe shoes and to disinfect my shoes when visiting historic gardens to reduce the spread of Ramorum disease.' Here 35% strongly agreed (5), 50% ticked (4), with 8% ticking (3) and 4% ticking (2) and 3% ticking 1 (strongly disagree). This research thus indicates that the concerns of the gardens in terms of impact on garden visitors may be unfounded as it shows potential adaptability of garden visitors to new biosecurity measures.

Questions have arisen about the future of these gardens, and what the long-term impact of the disease will be. Many garden owners are hoping to manage the disease through actions that include changing the local environment of the garden (see Section 9.2). It has been suggested that a radical re-design of the garden might be necessary. However, any shift away from the traditional Cornish Spring garden is likely to have major impacts on the Cornish economy and many garden owners are resisting suggestions made to consider the longer-term. In the research by the Imperial team respondents were also asked to respond to a third statement: 'I would still be interested in visiting historic gardens such as this one if they had new designs and different types of plants, to make them more resistant to tree pests and diseases'. 27% stated that they strongly agreed (5), 55% ticked (4), 14% ticked (3), 3% ticked (2) and 1 % ticked (1) (strongly disagree). This indicates a willingness to contemplate how gardens might have to change in the future.

5.73 Case Study: The National Trust

The approach of the NT has evolved overtime from a very reactive response to a more proactive view of the whole issue looking at how barriers and systems can be put in place to help each of the gardens protect themselves from *Pr/Pk* with the realisation that the problem was not just going to go away. This shift was triggered as increasing numbers of the more valuable, larger specimens such as magnolias became infected and had to be cleared. As containment became a possibility, the Trust worked with Defra. There was a risk that a strategy of leaving certain plants in would potentially create infection pools that could spread to other plants, so it was a balancing act. A risk assessment was created for NT properties to use and then an action plan implemented when sites did get infected.

The NT also started considering the role of *R. ponticum* clearance. They received some funding from the Forestry Commission about £60,000, costed at £10,000 a hectare in a garden setting. The whole *Pr/Pk* issue is estimated to have cost the trust around £600,000. *Pr/Pk* made it necessary for the NT to work in conjunction with its neighbours as the disease doesn't respect property boundaries; sometimes this produced some tricky issues for example when a donor family owned non-NT land next door that had *R. ponticum* that was impacting on what was happening in the gardens.

There is now more awareness of *Pr/Pk* within the NT due, at least in part, to the awareness training and symptom recognition training that has been delivered in conjunction with Defra to staff in the high risk areas. David Slawson (Defra) was seconded to the NT, and was responsible for the production of bio-security guidance notes and the production of a poster for gardens (see Section 6.15). The NT work to date has focused purely on staff to date, rather than visitors where there is, as in other garden in similar circumstances, a concern about not creating 'panic' that might affect garden visitor numbers. The NT has produced a question and answer sheet for reception staff. The issue is now being taken seriously by senior management. The *Pr/Pk* issue has meant that the NT is now taking wider biosecurity issues more seriously.

Pr/Pk has also highlighted to the NT that they didn't have a comprehensive picture of what was in their gardens; only 5% had been recorded. Now 70 of the gardens are being surveyed and one of the outputs will be a priority propagation list. The question then arises about what to do with successfully propagated plants in the context of a continuing risk of pathogens and climate change (see Section 4.84).

Another change that the NT has made with regard to day-to-day practices is to do with changes in plant husbandry. There has been a concern that the environmental conditions that some of the *Rhododendron* are existing in do not mimic the ideal conditions for growth with organic matter two or

three feet deep around the roots. There is a hope that improving the conditions that the plants live in will help the management of *Pr/Pk* and disease/pests more broadly.

There is recognition now within the NT that the garden conservation plans that are created with an understanding of the evolution of the garden will have to be modified to account for outside influences like climate change and pathogens. One scenario may be that it might not be possible to grow *Rhododendrons* in this way again. The aim has to be not to hold the garden in a static, status-quo position, rather that a 'sense of place' should be maintained whilst the garden should 'move forward' (interviewee J, stakeholder).

6. The Involvement of stakeholders and the public

It is widely accepted that the engagement of stakeholders and the wider public is critical in the management of *Pr/Pk* in GB.

6.1 Stakeholder engagement

Stakeholders have been formally involved in the *Pr/Pk* programme through stakeholder meetings (open public meetings, invited stakeholder meetings, individual meetings with landowners and seminars) and through involvement in the industry liaison group. Several of our respondents commented that there has been more stakeholder engagement on *Pr/Pk* than any previous plant health issue. Whilst communications were perceived as generally good, some respondents felt that there had been too much emphasis on nurseries and garden centres. Information for woodland and garden owners came later (Defra, 2008). Whilst this was understandable given the nature of the disease, woodland owners in particular have stated that they could have been better provided for. It is observed that the general level of awareness by landowners (gardens and woodlands) is very low. Typically interest is triggered only once there has been an outbreak and there is a specific threat to their site.

6.11 Stakeholder involvement on the Board / sub-groups and workshop attendance

The Cornwall group of working stakeholders was set up because it was perceived that the stakeholders on the ground, particularly in gardens, were not being well represented. Although the majority of the industry membership is gardeners who have been most affected (rather than nursery owners where infection is reducing in the trade), it seems to have worked well and fed into the Cornwall sub-group and Programme board.

8 of the 22 respondents had attended at least one stakeholder meeting (stakeholder survey Question 37) and the majority thought that they were useful. However, it was commented that the meetings focused on what Defra were doing or decisions that had already been made, rather than asking for stakeholder views. It was observed that often there was little time left for full discussion or questioning at the end of the presentations. Indeed the point has been made by one civil servant that whilst they have liaised closely with stakeholders through, for example the industry liaison group and local groups and have sought their views in advance of EU discussions, their involvement in actually planning the campaign, has been more limited. Criticism had been made of some of these meetings in that the science presented was not comprehensible to some in attendance.

Greater participation at horticultural shows has been suggested as has local, regional and national workshop-type events. The workshop in Reading focusing on the new programme, was seen as very useful by many stakeholders, and it was stated that whilst it is a shame that these type of meetings hadn't occurred before, there would be value in these occurring more in the future

6.12 Text based information (printed and website)

Disease information was available on the Defra, CSL and FR websites. Defra produced several publications aimed at stakeholders including a practical guide for established parks, gardens and amenity landscapes (Defra, 2008) and another for the nursery and garden centre industry (Defra, 2005a) available on the Defra website. The stakeholder survey (Question 38) indicated that use had been made of printed information (80% of respondents), the Defra website (60%), the FC website (40%), posters (30%), email bulletins (18%), personal communication with officials (80%). Other sources of information mentioned included the internet searches, national press articles, colleagues, and NT information. The gardens practical guide (Defra, 2008) was seen as a good introduction, simple and easy to use, but it was advised that there was a need for it to be produced in both an electronic on-line format but that a hard copy was useful. The CSL website recognised as an important site for getting more detailed information. It was noted that lots of information was available and accessible, but it was not always digestible. Further it was observed that a lot of relevant research and information was not broadcast to stakeholders.

6.13 Publicity and use of media outlets

Of the 10 respondents who indicated that they were aware of the *Pr/Pk* risk before the outbreak on their land (stakeholder questionnaire Question 10), the source for this information included the gardening/horticultural press, mainstream national newspaper and radio. It was observed that the horticultural trade papers had covered the issue reasonably well, but that in many cases people don't use trade papers, and that the mainstream media needs to be involved with communication. However, the media were criticised for some of their coverage; it was observed that the media still have the false idea that the UK's oak trees are going to die.

6.14 Importance of positive stakeholder relationships

It is observed that one of the positive impacts of the *Pr/Pk* programme is that relationships have developed between Defra and external stakeholders and partners who are all now communicating better with each other. The programme has also contributed to a developing awareness that there are responsibilities beyond the government, and that solutions must involve more than just financial resources. It is important to continue creating a momentum with stakeholder and public organisations in developing the skills and knowledge that are needed to keep inoculum levels manageable. Permanent biosecurity practices need to be encouraged that will continue even in the absence of government intervention.

Positive stakeholder engagement contributed to improved negotiations on the ground with the inspectors, and facilitated research permission for scientists in some gardens. Continuity in staff to maintain established working relationships is essential, not least because officials who have built up such relationships understand the landowners concerns and are able to reach adequate compromise.

It has been suggested that it would be very useful to stakeholders if an 'update' email bulletin or newsletter was sent out at regular intervals, perhaps once a quarter. It could contain, for example, updates or changes to particular policies, new developments in scientific understanding, and preliminary findings of research or management techniques. With regard to the *Pk* Zone it seems that the intention to inform local stakeholders of developments with a regular newsletter was not followed through.

Training and contact / networking events between organisations with confirmed cases to share best practice were requested. More practical workshops were requested for horticultural and arboriculture specialists, with positive suggestions for pro-active management and how to identify *Pr* / *Pk*.

A National Trust colourful poster produced for gardeners and to be placed in garden staff rooms is a very good example of innovative ways to engage particular stakeholder groups about changing everyday practices around *Pr/Pk* risk. It is a format that would clearly have wider applicability.

6.2 Public awareness and engagement

6.21 Public awareness of Pr/Pk

Both stakeholders and implementers commented on the low level of public awareness of *Pr/Pk*:

"the lack of clear information about the risks of bringing back plant material without due care and attention means members of the public in particular are quite prepared to move seeds, cuttings and even small plants and transfer them straight to their gardens". (stakeholder respondent)

The previously mentioned survey, by the authors of this report (forthcoming), focused on National Trust garden visitors, a specific demographic of the public that one can hypothesise would have a higher level of awareness and interest than amongst the general public. Of the 479 visitors to National Trust gardens in Devon and Cornwall surveyed in June 2009, only 48 respondents (10%) had heard of *Phytophthora ramorum* whilst only 228 (45%) had heard of 'Sudden Oak Death'. Aside from anything else, this supports the comment by one stakeholder that the name(s) of the disease contribute to a low level of awareness and confusion:

"It's got this long Latin name that no one can really understand. And there's no point calling it Sudden Oak Death 'cause it's completely irrelevant in this country to call it that" (interviewee F, stakeholder)

Asked how much knowledge they had of *Ramorum disease* / Sudden Oak Death on a scale of (1) to (5), 306 (67%) said they had no knowledge at all (1), whilst only 2 (0.5%) said that they had a lot of knowledge (5). Additionally, 28% chose (2), 4% chose (3) and 0.5% (4). Asked the sources of this knowledge, newspapers /magazines were the most popular (82 respondents), followed by television (78 respondents), then information posted in gardens (46), radio (37), word of mouth (34), other (11) and the internet (6).

6.22 *The role of the media*

The results above show that the important role that the general media seems to have played in increasing awareness of *Pr/Pk*, and stakeholders too reported that awareness was gradually improving with media coverage. However, the media were criticised for some of their reporting; for focusing on the 'death and destructions side of it' rather than more positive messages about the action was being taken. It was observed that the public had the false idea that the UK's oaks are going to die and perceived that this was likely to be have been created by messages in the media. In many reports, pictures of oaks feature prominently providing a strong visual miscue.

6.23 *Balanced communication*

As discussed in Section 5.7, in the context of gardens, there are difficulties about how to best engage with the general public over *Pr/Pk* risks. It is always a difficult balance to raise awareness whilst not causing panic and over-reaction. It is perceived that there is a real risk of unnecessary scare-mongering in trying to involve the general public, and that such action must be taken with extreme caution. When dealing with an outbreak situation there is a need to be informative rather than alarmist. There is a need to balance disease management against a panic response by the public which in the long-term is likely to have less effect than a programme which is informative, and provides people with knowledge and understanding.

In addition to historic gardens, these concerns may also be true for nursery businesses, and to an extent the wider countryside. In the case of local authority woodland in South Wales, at Clyne Country Park, press releases were issued to communicate to the public about why the large-scale clearance works were taking place, to avoid confusion and to protect against the concern that visitor numbers would decrease. Tension arises over the suggestion of installing 'physical' biosecurity measures such as foot dips or pads of fungicide at known infected gardens, nurseries or sites in the semi-natural environment. These are seen as problematic in that they are not necessarily effective: This is particularly true when there are numerous exits to a site, when it would be impossible to have adequate staff; where there are concerns about vandalism and leaving disinfectant chemicals unattended and where people might be wearing inappropriate footwear such as sandals. Whilst the research reported in Section 5.72 indicated that garden visitors would adapt to such biosecurity

measures, there are genuine worries over the impact such measures might have for visitor numbers not just at gardens but in publicly-owned parks and woodlands.

The low level of public awareness can possibly be partly explained by the compromised nature that many of the stakeholders are in when they are considering commercial interests, and thus the low profile is deliberate.

6.24 Public engagement with the Emergency programme

The majority of respondents to the implementer's questionnaire (Question 27) disagreed that the general public have played a central role in the implementation of the Emergency Programme (see Figure 25 below).

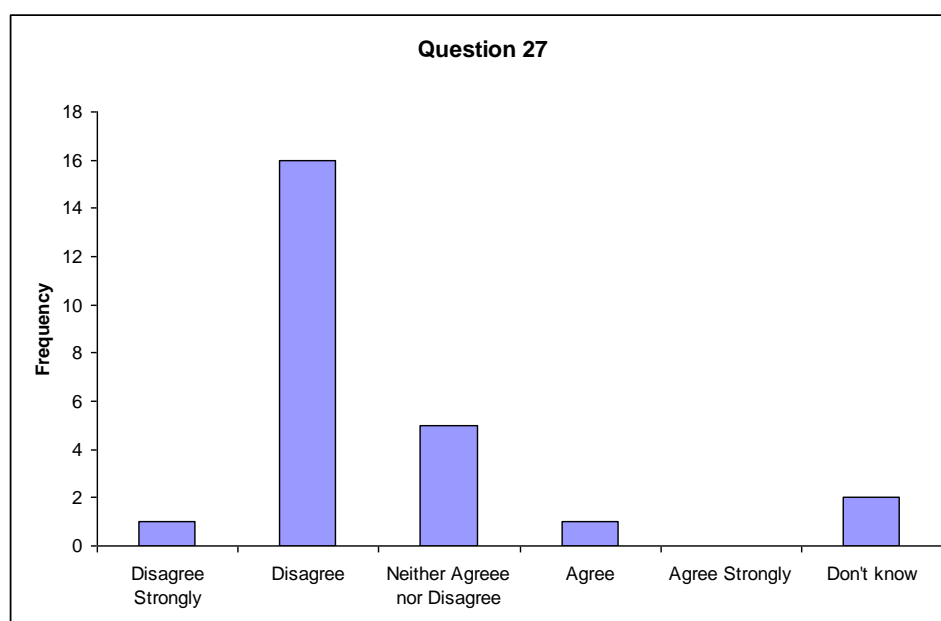


Figure 25: Bar Chart showing responses to statement "The general public have played a central role in the implementation of the Emergency Programme" (Implementers survey, Question 127).

54% of respondents believed that there should be a greater role for the public in managing future action, on *Pr/Pk*, whilst 46% said no (Question 28). The disparate views on this topic are reflected in the comments made. It is important to consider what the role for the public could and should be:

6.25 Disease identification and surveillance

It was argued that the most of the general public would not have sufficient knowledge/interest, dedication or experience to be of assistance. There was resistance to the idea of further engaging the public in identifying *Pr/Pk* infections as diagnosis of the disease is not possible based on symptoms alone as other diseases can result in similar symptoms. Training would be prohibitively expensive.

The concern that the public sending in sample of possible infections would lead to a huge workload has been articulated. Greater resources would be essential to handle their input.

However, others called for enhanced vigilance by the public and were supportive of more use of the public in disease surveillance, increasing the likelihood of early detection than could be managed officially. In the long term, catching new epidemic foci before they spread beyond the threshold of practical control may be worth the additional effort of critically filtering misreports from the public. If involved in this way, the public might also be more supportive of management measures such as closing footpaths or land clearance at a future date. It is reported that on rare occasions, informed visitors to gardens have been aware and witnessed infected plants on sites and have reported them to gardeners or the inspectorate. It was suggested that greater use could be made of the "informed" public (for example wildlife groups) for reporting suspect cases of plant diseases. Again this would need careful management to avoid potential resource overload. The appointment of a dedicated official to separate the wheat from the chaff with regards actual sample testing, and to record the spatial distribution of reports in order to identify areas of concern would have the additional benefit of potentially flagging up the establishment of new disease threats. At State and Shire level in Australia, for example, contact is initially made through a non-specialist receptionist or helpline.

6.26 Biosecurity practice

The suggestion was made that volunteers could be of help in certain parks or gardens to assist with managing or limiting the spread of disease. There was general agreement for a need for government to promote a greater understanding and foster awareness of general good biosecurity practice, ensuring that advice and guidance is followed to help limit the potential spread not only of *Pr/Pk*, but future biosecurity risks as well.

6.27 Policy-making

The suggestion was made that the public could have a more direct role in policy-making within the Programme through the creation of a group of representatives of the general public that will feed directly into the program.

Please see Section 9.7 for discussion of recommendations for the effective engagement with stakeholders and the public

7. The International Context: The role of mainland Europe and the experience of managing SOD in the USA.

7.1 The role of mainland Europe

*[Since *P. kernoviae* is not present in mainland Europe, this Section necessarily comments exclusively on *P. ramorum*]*

From the outset the UK has led action on *Pr* (and *Pk*) and been strongly influential in determining the nature of the EU regime and having European-wide measures has been a major benefit. There has been autonomy in the UK to define its own management regime, with Article 16(2) emergency action to use within the UK. Whilst Great Britain and the USA have been active in tackling the threat from *Pr*, both in terms of research and practical management, the role of infected mainland European states has been less enthusiastic. Question 30 of the implementer's questionnaire asked "To what extent was the ability of Great Britain to effectively deal with *P.ramorum* / *P.kernoviae* affected by the actions in other European member states? There was generally doubt expressed as to whether other member States were effectively surveying for *Pr*. Similarly, there are still concerns that some Member States could be more effective in ensuring outbreaks are identified and effectively dealt with. It is argued that the controls are not applied equally rigorously across all Member States and that other member states did not see it as a problem on such a scale and were not as concerned about the consequences as the UK. This may be partly due to the difficulties of Member States managing their epidemics unilaterally, but is also due to the protection of commercial interests. An optimistic stance towards the disease in the face of evidence to the contrary is likely to be strongly correlated with protection of vested interest, witness the US position on global warming.

However, the effects all this had on the level of diseased plants reaching the UK were disputed. The extent to which infected material from the continent was continuing to enter the UK is something on a contention. For some, the EU continues to be a source of infected material into the UK, despite the effective UK controls. One respondent commented that "Some other Member States may take a more lax approach the diseases and continue to supply infected material to garden centres" [respondent to implementer's questionnaire]. For others, however, this did not seem to be having any impact on the effectiveness of the controls: For example, one respondent commented "Import inspections of material from other member States failed to show that infected plants were being sent here, contrary to the belief of many in the industry" [respondent to implementer's questionnaire]. Another respondent claimed that "our import inspection work demonstrates that most of the UK infection is self-generated and that probably only a limited amount of new infection is coming in" [respondent to implementers questionnaire]. This position is reflected in the comments of a third respondent: 'Blaming other Member States is something of a reflex action, and is not always borne out by the figures. I am not convinced that the level of introductions from other Member States since

2003 has made the situation substantially worse than it would have been if there had been no trade' [respondent to implementers questionnaire].

The effectiveness of port inspections has been previously discussed (Section 5); specifically whether the fact that no *Pr/Pk* was found at port inspections indicates that there is hardly any infection coming into the UK, or whether it reflects the difficulty for inspectors in finding infections that are present. In this case, questions arise as to whether inspections of potentially susceptible material at the point of entry have not been effective in keeping out infected plants. Indeed it is questionable whether this is a good use of inspectors' time, since detection will be more likely further down the line.

The use of fungicides has been previously discussed (Section 5) and is relevant in this context. Used to keep plants in good condition prior to sale, it is feared that they can mask infections resulting in a delay of onset of symptoms. This has two key effects. Firstly it makes tracing the actual source of infections very difficult, because a plant with a realised infection may have picked up its infection at any point post import but prior to its detection. Secondly, it can mean that plants are widely distributed and planted before any suspicions arise.

Collaborations with other Member States on research and information sharing for *Pr/Pk* are obviously essential. However, whilst there has been some good collaboration with some European laboratories, sharing of type cultures and information, there are indications that the flow of information between mainland Europe and Great Britain has been somewhat asymmetrical, partly due to the higher commitment of the UK authorities to research into *P. ramorum*, but also due to commercial interests.

7.2 Management of Sudden Oak Death in the USA

P. ramorum is responsible for the current outbreak of Sudden Oak Death (SOD), as major tree disease epidemic affecting large parts of California and Oregon. The different political contexts, temporal and spatial incidence of the disease, susceptibility of ecosystems and land ownership between California and Oregon contribute to two contrasting approaches and institutional structures for managing SOD in the two States. Whilst the species of plants and trees affected, the environments affected and the social and cultural impacts are different to the UK, there is much of the US experience and management approach that is valuable to controlling *Pr/Pk* in the UK.

By contrast to the UK, *P. ramorum* was first found in the US in the wider environment, and not in a nursery setting. In 1995, observations of large numbers of dying tan oaks were made in Marin and Santa Cruz Counties in California, but it was not until July 2000 that researchers at the University of California identified the cause of SOD to be a previously unknown *Phytophthora* species. As previously stated it was officially named *Phytophthora ramorum* in April 2001. In 1998 and 1999 (following the El Nino Event), high mortality of the prized Coast Live Oak caused a big visual impact

in Marin County, California, largely in the gardens of a very wealthy and politically well-connected population who were able to mobilise local public support and to get the issue taken up at County, State and Federal government levels. This triggered a release of funds for research, monitoring and management.

COMTF was founded in August 2000 as a unifying body of public agencies, non-profit organisations and private interests, and conceived as a 'non-governmental' voice with which to speak to the public about SOD. It 'brings together public agencies, other non-profit organizations and private interests to address the issue of elevated levels of oak mortality. The Task Force will implement a comprehensive and unified approach for research, management, education and public policy.'⁴ The approach of those who are part of COMTF has been very much of informing and engaging the wider public about the disease and what should be done to manage it. COMTF have sponsored SOD science symposiums where UK researchers and policy-makers have participated. Research in the USA is perceived to be well funded by those in the UK who have benefited from the research outputs.

In the USA, State level and Federal regulations are in place to prevent the spread of the pathogen from quarantine areas in California and Oregon to uninfected areas.⁵ A system based on quarantine, it restricts the movement of *Pr* host material within or from counties infested with SOD without authorisation.

7.21 Public and stakeholder engagement strategy

Whilst the model for stakeholder engagement in the USA on SOD is different from the UK and is based on an 'extension service' with outreach co-ordinators and public information officers, many aspects of the COMTF model and experience are very valuable for the UK.

The COMTF website acts as a 'one-stop shop' central information hub for information on SOD. It provides an impressive range of resources, specifically written for a range of stakeholder groups including homeowners, professionals and native tribes.⁶ Resources are also provided in Spanish. A calendar of events, including, for example, free monthly SOD preventative treatment training sessions, is published. COMTF publishes a monthly newsletter that address new or recent developments relating to SOD includes recently published research, monitoring and management activity, legislative decisions, announcements of COMTF training sessions or Sudden Oak Death related meetings and presentations, publication of new diagnostic guides, best management practices, or other documents, and any other recent activity in the field.. Interested parties can

⁴ See <http://www.suddenoakdeath.org/>

⁵ See <http://www.suddenoakdeath.org/html/regulations.html>;
http://www.oregon.gov/ODA/PLANT/NURSERY/reg_sod.shtml ;
http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/regulations.shtml;
<http://www.cdfa.ca.gov/cdfa/pendingregs>.

⁶ See http://www.suddenoakdeath.org/html/treatment_management.html.

subscribe to receive this newsletter by email. This approach would be valuable in the UK context, with resources specifically tailored to different stakeholder groups.

At Federal level, the USDA has developed a '*Phytophthora ramorum* Educate to Detect (PRED) Program Nationwide training to 'help Master Gardeners, Extension personnel, and homeowners identify, report and prepare samples of plants possibly infected with *Phytophthora ramorum*'.⁷

7.22 Californian Case studies

SOD occurs in a variety of habitats posing unique management challenges in each one. Three case studies are given illustrating the complexity of decision-making, particularly in relation to public access and stakeholder communication. Thus, it provides valuable insights relevant to generic management dilemmas in the UK, particularly if the Pr/Pk outbreak continues to spread in the semi-natural environment.

7.22 a Los Trancos, Public Open Space District, California

Los Trancos, Public Open Space District where the high visitor numbers for hiking and cycling creates particular problems for the management of SOD. For example, 'hot spots' of the disease are concentrated along the stopping points of the educational 'earthquake trail' popular with groups of local school children. The increased level of tree mortality has led to new discussions and decision-making about safety and aesthetics in Los Trancos, especially when dead and dying trees are close to the highly used footpaths. Information to the public about the disease is provided on notice boards at the start of the Los Trancos trail, as is a foot brush (although its primary value is seen as an educational tool) and equipment for the cleaning of mountain bikes. As the area is a mixed forest, there isn't a major visual impact on landscape scale. However, whilst public visiting the Open Space once, generally don't notice the disease, local returning visitors do. A number of management options are currently being considered; the complete removal of trees as they die; the closure of trails, or their relocation; proactively cutting down susceptible trees; or treating plants along the trail. In the future a combination of such methods seems likely. Whatever decisions are made in this high risk area, will serve as a precedent for managing SOD in a further 60,000 acres in the Public Space Open District.

7.22 b Muir Woods, California

The first wave of SOD hit Muir Woods in 1997, with a second wave in 2000. Whilst the California coast redwoods are unaffected, the disease has killed the tan oaks, and this has significantly changed the feel of the woods, creating much more open space and light around the redwoods. With the death of the tan oaks, the disease is currently not so obvious, but management continues. Located only 12 miles from the Golden Gate Bridge, the Woods get about one million visitors a year. Here, however, the visiting public are considered a low risk for spreading the disease as they

⁷ See <http://www.ncipmc.org/sod/pred.cfm>.

generally keep to the designated paths. There is more concern with the volunteers who come to the Woods on public work days who in their duties often stray from the walkways. On these occasions SOD cleaning stations are provided at the entrance to the park. Such facilities are also provided for contractors who must follow regulations on cleaning tools and the disposal of waste materials. The increased oak mortality caused by the disease has implications for fire risk that has led to restrictions on smoking and the parking of cars on dry grass. The disease creates new challenge for the National Parks in their task of striking a balance between preserving and protecting this national monument for future generations of both people and wildlife.

7.22 c Humboldt County, California

In Humboldt County, California, the diverse mixture of land ownership and social fabric of the social community, provides a different context for the management of SOD, than in Marin County further south where it was individual property owners who were affected by the disease. In Humboldt County the patchwork of private landowners, many of whom were part of the 'back-to-the-land' movement of the 1960s and now live on small land holdings but without proper land management plans, combined with commercial timber land, state parks, US forestry land and tribal lands, makes the management of 90,000 acres a challenging task. For example, on private homesteads where the disease is known to exist, regulators are having to contend with different attitudes about intervention where the disease is seen as part of the 'natural' balance and should be allowed to take its course. The overall aim of management in this County is to limit the disease to particular geographical area and protect others, such as specific watersheds and tribal lands. It is suggested that the SOD message was most successful when it fitted with the existing motivations and priorities of the individuals concerned. Here, as in the rest of California the risk posed by forest fire is a serious concern for the public, and the connections between fire and increased fuel load because of SOD induced tree mortality is a contentious and ongoing issue. In Humboldt County, however, the association has been a positive driver for the management of SOD with the fire crews, respected members of the local community, taking forward the message of managing vegetation for fire risk and complying with SOD management as well.

7.23 Oregon State

Oregon State provides an interesting comparison with California, both in terms of disease incidence and management aims and practice. Already aware of what was happening in California, plant pathologists in Oregon had put quarantine regulation in place before SOD was found in 2000. There is an official policy of eradication in place, and today the quarantine area is 162 square miles. Tan Oak is seen as the driver of the disease here, and as this tree is seen as a weed by the logging industry, the disease did not initially cause much concern. Today, SOD management practices vary with the landowner, although generally involve removing the Tan Oak host by cutting it back and then burning on site. The aim is to get the infected material out of the canopy layer as quickly as possible and onto the forest floor where it is more difficult for the disease to spread. Often, the remaining

stumps are treated with herbicides to stop re-growth. Federal funds cover the costs of these management practices. Much of the land is owned by logging companies who have been generally co-operative as the management practices for SOD, namely the removal of tan oak, fit with their own concerns of controlling this 'weed' species. However, management on Federal lands has had to contend with the concerns of environmental organisations, specifically the implementation of threatened and endangered species legislation that has created a more complicated regulatory and political context for SOD eradication.

The resulting management regime in Oregon is thus very different to California. There is no comparative organisation in Oregon of COMTF. Stakeholder and public information on SOD is provided by several bodies including the Oregon State University Extension Service⁸ and the Oregon Department of Agriculture⁹. The disease in Oregon is only in one County, there is more regulation, and, as an aim of eradication has been declared, the priority is the enforcement of this. There has been no major engagement with the public or an education programme as is the case in California. Here, the Government (State and Federal) are playing a more significant role where there exists a history of involvement of these actors with forest health problems.

⁸ See http://extension.oregonstate.edu/emergency/oak_death.php.

⁹ See http://egov.oregon.gov/ODA/CID/PLANT_HEALTH/sod_index.shtml.

8. Policy review and overall success of the Programme

8.1 Public consultation

The initial emergency programme was set up with the aim of gathering further information and thus building-up an evidence base for future decision-making for policy. The policy evolved as the disease did, in particular with the finding of *Pk*. The public consultation occurred once it was felt that there was enough information on the nature of *Pr* (and *Pk*) and the threat posed, to enable a policy decision to be made.

A public consultation was launched in July 2008 (Defra 2008). A comprehensive document was produced with background information on *Pr/Pk*, extent of spread, current management regime, and science summaries of both diseases. It set out two options for consideration; Option 1 (the baseline option) cease any additional disease controls other than EU minimum statutory requirements necessary to prevent disease spread to other Members states and Option 2 of increased activity with a view to reducing disease levels to epidemiologically insignificant level. These were detailed in full in the Impact assessment documents, and included cost-benefits analyses of the options.

An invitation to respond to the consultation was sent out to 170 stakeholder organisations (Defra, 2008a). Two public consultation meetings were held in July 2008 and the consultation closed in October 2008. Defra received 41 responses. It is worth noting that only two responses were from private individuals, the rest were from stakeholder organisations. This would seem to be indicative of the level of unawareness amongst the general public about *Pr/Pk* (and biosecurity issues more widely). Of the 38 respondents who stated which option they preferred, 28 favoured option 2, 6 favoured Option 1, one favoured Option 1 for commercial business and historic parks and gardens and Option 2 for the wider environment, whilst a further three respondents found neither option satisfactory. One respondent favoured the discounted third option (Defra 2009).

There were only limited criticisms from respondents of the way in which the consultation was carried out: There was considered to be too much information for it all to be read thoroughly. Whilst the two options were highlighted clearly, there was too much background information. There was concern about the poor wording of Option 2 by garden owners and managers who thought that it implied that there would be enforced removal of all sporulating hosts or all plants that were susceptible from their gardens. It is understood that this misunderstanding has now been resolved.

Following the results of this consultation, and a policy and science review, a business case for further management of *Pr/Pk* was produced with a proposed programme of work focused on three areas of disease control, behavioural change and research. Subsequently, a new Defra-funded *Pr* and *Pk* Disease Management Programme was approved to begin April 2009. This will focus on three work

streams: Disease management, Awareness and Behavioural Change and a Research work stream (Defra, 2009a).

8.2 Overall perceptions on the success of the programme to date

In the absence of any baseline, against which to compare the impact of the programme, conclusions on the overall success of the programme are hard to judge. There is a general consensus that the extent to which the programme has been effective has varied between different habitats and sites. Disease management has been much more straightforward in the controlled context of nursery and retail centres, than in the wider environment, whilst the complex cultural and botanical features and the economic realities of the historic gardens, have made action there fraught with difficulties. The data given in Section 1.1 shows clearly that the eradication of both *Pr* and *Pk* has been possible more frequently in retail and production sites, than in the wider-environment where 67% of *Pr* infections are still on-going, rising to 98% for *Pk*. These figures are clearly of concern. There is now not considered to be a major threat to trees from *Pr/Pk*, but the heathland *Vaccinium* is now of serious concern. Instigators of the Emergency Programme would see that their aim was not necessarily to eradicate the disease, but to find out about the nature of the threat so that proportionate action could be taken. This building of an evidence-base seems to have largely occurred.

Respondents were asked (Question 18 of the implementers questionnaire) whether they felt that the progressive spatial spread of these pathogens in Great Britain could have been avoided. 10% thought it could have been, 30% didn't know, and the remaining 60% thought it couldn't have been. For those who feel the spread could not have been avoided, the difficulties facing those attempting to manage this disease include many of the factors discussed in this report; the diseases have been present for a number of years prior to detection; the origin of the diseases is unknown; outbreaks are usually found only once some establishment has taken place; once off a nursery site and into the wider environment they are very difficult to control; not all the infected areas have been discovered yet; the difficulties in controlling pathways such as animals and birds; and two wet summers making control particularly difficult.

There was considerable uncertainty about what more could have been done, and thus much is speculation about the impact that increased resources for more immediate action at outbreak sites and more widespread clearance might have had. Instead, it is much more useful to consider actions that should be taken in the future programme and other factors that may impact on the disease in the future (as follows in Section 9).

9. Recommendations for future policy

The following recommendations are made by the authors based on an objective analysis of a collation of the information provided by the respondents to this research, and as presented in the previous sections of this report. These are discussed in some detail in the following sections. A summary of the recommendations can be found in Section 10.

9.1 Inspectorate

It is worth noting that of the stakeholders asked about how they would assess the way in which the management of *Pr/Pk* was carried out by authorities on their property, (Question 26 of stakeholders questionnaire) 70% were very satisfied or satisfied, whilst 30% were neutral. There was lots of praise for individual inspectors;

“From our own point of view, our local inspector has been a joy to work with, very thorough, diligent and just doing his job extremely well. Without inspectors of his experience and calibre, effective control will be very difficult and we imagine that, across the country, the disease will not always be as well managed as in our area.”
(Stakeholder response)

However, it was recognised that the PHSI inspectorate were understaffed. Indeed, it is clear that many PHSI inspectors have heavy workloads, covering a large geographical area and where *Pr/Pk* is only one of many diseases they are concerned with. The only team of people working solely on the disease were based in Cornwall and it is suggested that more could have been made of this resource as a portable team, or that there should be an increase in the number of inspectors who work solely on *Pr/Pk* and receive specialist training in the identification and management of these diseases.

One consequence of the heavy workloads that individual PHSI inspectors are carrying is that they cannot always manage to do the strategic surveying for *Pr/Pk* that they would wish to. Due to level of resources and timing they have to focus on the ‘known’ infected sites rather than understanding where the future risks might lie. Thus it has been suggested that other relevant land-based agencies, with staff already working on the ground in susceptible habitats, should become involved with surveying, monitoring and testing. There is potential for the creation of new roles and responsibilities in existing organisations, through training programmes for existing staff. Additionally, there could be new roles at regional or national levels, or both, for co-ordination of these different agencies in different locations on the ground so to increase the scope and area covered for inspection, monitoring and identification of disease. This could include a wider range of organisations such as the Countryside Commission for Wales, Natural England, wildlife and conservation charities, as well as private bodies, such as woodland management companies.

A good existing example of where such responsibility has already been introduced to people on the ground, is within Natural England who are doing an extensive condition assessment of SSSIs

(running until September 2010). They have asked their surveyors to keep a look out for signs of *Pr/Pk*. In addition, Natural England seems committed to training for their staff as outlined in their *Pr/Pk* project, although there are some concerns over time and resources. Natural England also has staff going out to meet landowners for assessment and setting up of land grant schemes, and some of them have already noticed plant health problems. This is another potential mechanism for existing staff to be involved in disease monitoring. Further, it may be worth considering whether generic biosecurity issues are part of the details of existing Natural England administered land schemes.

9.2 Garden management plans for historic gardens

The idea of garden management plans has been articulated by the authorities as a way of engaging gardens in the on-going management process. These would ensure that the gardens do not feel overwhelmed, or that disease progressively gets out of control. They would also be a means of giving back responsibility of disease management to the gardens. These would be developed through co-operation between the garden managers and PHSI. They should also be an opportunity for garden owners/managers to give serious consideration to how each garden will evolve in the future. A strict regime of biosecurity should be compulsory and include advice to the visiting public and the introduction of rigorous hygiene practices into the daily routine of the garden.

Garden management plans should include re-planting and be informed by research on the effectiveness of measures to change the local environment of the gardens. Re-planting decisions, following plant removal are posing difficulties for historic gardens as the susceptible species list is very extensive, and advice is sought on what can be re-planted and when re-planting (time-gap) can safely take place. Further research to inform disease management in the gardens would be helpful. This could include the relative level of susceptibility and resistance of different species and cultivars, and if there is a difference for *Pr* and *Pk* within the garden environment. Consideration of whether this affected by local climatic conditions, as well as the relative levels of sporulation for different species and cultivars would also be useful. Additionally, this would be beneficial to inspectors in being able to provide a scientific reason to the client for the removal of a certain specimen : for example in cases where specific plants positive for *Pr/Pk*, but that do not show host symptoms for a large part of the year.

As previously stated, there are many benefits to having a flexible approach to intervention that can take into account the nature of the risk at specific gardens. However, it might be valuable to have a system in place to verify that the process is transparent and fair, and to clarify the criteria in which decisions are being made at each garden. A common policy (notice) and a good practice agreement should be considered. A review of whether gardens are doing enough to protect the wider environment is needed with particular attention paid to the rate and extent of the removal of sporulating hosts, and to the management of public visitors. However, previous experience shows the importance of maintaining a two-way dialogue in such management. It is also desirable that there is

further development of awareness training for garden owners, head gardeners and all those working within the historic gardens.

9.3 *R. ponticum* clearance

Prioritisation of sites for the clearance of infected *R. ponticum*, was made on the basis of a risk matrix designed to minimise the risk of spread. However, this meant that some larger sites were being left as reservoirs of inoculum. There has been criticism made that clearance has been in a rather 'patchwork' manner due to the risk matrix, but also because of the funding mechanism (WIGS) that made clearance of infection from some land types impossible because they do not fit the tree cover criteria. Annualised budgets also contributed to a short-term view of the clearance programme. These issues should be explored in the future programme of work. It is understood that for the future programme, there are negotiations and discussions on-going with Natural England (and the Countryside Council for Wales) to make funding possible in those infected areas where clearance is needed that are not woodland.

The Emergency programme did not have resources for pro-active clearance of uninfected *R. ponticum*. However, there is now a strong rationale to operate on two fronts; reactive clearance, but also the pro-active clearance of uninfected sites where there is a potential for the disease to take hold. Given limited resources, there needs to be a focus on sites which are particularly valuable, for example, for biodiversity or in cultural terms. In particular there needs to be a focus in areas where there is *R. ponticum* in conjunction with high levels of *Vaccinium*. These sites should be prioritised for protection into the future.

It is understood that currently discussions are under way between Natural England and Fera as to how pro-active clearance in Cornwall will be funded. A scheme is being developed whereby sites for clearance will be chosen by overlaying two maps to show the locations of land under Natural England agreements (HLS, ELS or CCS) that are within 10km of *Pr/Pk* infected sites. These will be eligible for Fera funding for five years for clearance of *Rhododendron*.

One of the consequences of widespread clearance of *R. ponticum* is that new habitats will need to be established in the cleared areas. This, if managed properly, could provide new opportunities for the creation of valuable semi-natural environments, for biodiversity or recreation.

9.4 *Vaccinium myrtillus* infection

It is clear that the foremost concern for those involved with the future management of *Pr/Pk* is in relation to the impact of *Vaccinium myrtillus* infection on heathland. In terms of management, it is problematic because whilst *Rhododendron spp.* is generally seen as invasive, and widespread clearance is largely unopposed, *Vaccinium* is valued for conservation and biodiversity and thus destruction faces difficulties. The high sporulation potential of *V. myrtillus* for *P. ramorum* and *P.*

kernoviae puts it in the same order of magnitude per unit ground area as a vector as *R. ponticum* (Harwood *et al*, 2009), increasing the threat to the dominant *Calluna vulgaris* and other susceptible ericaceous species, and consequently the heathland ecosystem as a whole and as a source of infection to other habitats. Furthermore, persistence of viable spores within the deep acid litter layer and topsoil of heathlands renders eradication very difficult. The problem is made more complex by the parallel discovery of *P. pseudosyringae* epidemics on *Vaccinium* (Beales *et al*, 2009), the implications of which will be explored in a PRA this year. At a national level, these threats are of more significance and a much greater scale than the loss of a proportion of woodland beech or the replanting of traditional gardens and parks. Furthermore, the UK has an international responsibility to maintain these semi-natural systems in good condition. A clear national policy is required urgently to address these threats.

Many of our respondents felt that there should be a prioritisation of work on *Vaccinium* and other heathland species to enable appropriate management decisions to be made. Various research questions have been identified. It is recommended that these are given consideration and action taken when deemed appropriate:

- The source of infection; the prognosis for infected plants; how widespread the infection is, rate of spread.
- The effective methods of control and eradication (to include physical removal, burning, identification of a fungicide)
- Level of prophylactic removal necessary in the area surrounding known infected *Vaccinium*.
- Whether infection can cross onto *Calluna vulgaris* or other heathland plants in the field.
- The threat that infected *Vaccinium* in woodlands pose to trees.
- Assessment of other potential *Phytophthora* threats to UK heathland.
- Management approaches and associated epidemiology on heathland.

9.5 Other research suggestions

In addition to the above research, respondents made the following suggestions for further research. It is recommended that these are given serious consideration and action taken when deemed necessary:

- Socio-economic research on communication of risks and responses to a wider (public) audience and best practice in nurseries.
- Investigating persistence of disease on some nurseries.
- Better use of non-infected materials than burning, for example as a biofuel.
- Further research into spore loads and distance dispersal via air movement; levels of susceptibility within a genus; survival rates of infected species and whether some susceptible species have any resistant varieties.
- Further research on the host range for *Pk* to mirror level of research already carried out for *Pr*.

- A better understanding of the methods of spread of both *Phytophthora* species
- Genetic variation of the pathogens.
- Decline/eradication of the pathogen in soil.
- Continue to improve on site diagnostic methods.
- Potential environmental / bio-diversity impact
- Plant breeding for resistant varieties.
- Development of fungicides that kill rather than suppress the disease
- The potential for climate change to exacerbate the whole *Phytophthora* problem.
- Translating research findings into practical management advice.

9.6 Micro-propagation unit

The micro-propagation unit at Duchy College is significant in being the only place in the country licensed to handle infected material for propagation purposes. Researchers there have been successful in propagating non-infected historically significant *Rhododendron* species from infected plants. There seems to be a demand from the historic gardens for this, and they have service level agreements with a number of gardens who supply material for propagation, and then buy back the infected material. The unit requires further funding from Defra to research techniques for micro-propagating magnolia and camellia species to see if they can propagate from infected specimens as they can now do for *Rhododendron*. The micro-propagation path offers potential for the conservation of rare species, cultivars and varieties of *Rhododendron*, and potentially other host plants such as *Magnolia* and *Camellia* species.

However, there is uncertainty concerning what is to be done with this new, disease-free plant material. Questions remain as to what will happen if they are returned to the gardens, and whether they can be sited in disease-free areas. The argument is made that the susceptible list is so extensive that the solution has to be to change the environmental conditions (as above). Connected to this is the suggestion that 'cultural practices' such as mulching and feeding may produce more vigorous plants that will be less susceptible to disease. It is recommended that the further funding is made available for the micro-propagation unit at Duchy College to continue its work, but that a clear plan of where the new disease-free plant material will be placed in both the short and long-term, be developed

9.7 Effective engagement with stakeholders and the public

There is a very low level of awareness amongst stakeholders and the general public about plant biosecurity. In the case of *Pr/Pk*, specific causes of this have been identified, i.e. information has not been shared due to concerns of infected sites of an adverse affect on business. However, in relation to generic plant biosecurity risks reasons for the low level of awareness are not immediately clear. Whilst the issue of invasive species of plants has received some attention, environmental and

conservation NGOs have not been actively engaged with the risk of invasive plant pathogens and it has suffered from a lack of publicity. Whilst campaigning on such issues clearly suffers from lacking the benefits of more 'charismatic species', it may be that this is a newly identified problem in an arena dominated with concern about climate change.

Nevertheless, focus group research with the general public carried out by the authors of this report for the previously mentioned RELU project, as well as the responses to the NT survey, strongly indicated that once individuals were informed of the risks they were genuinely concerned and wanted details about what they could do. Thus, a widespread but targeted education programme would be the first step in engaging with the public and stakeholders;

An education programme about generic plant and tree biosecurity risks targeted at specific sections of the general public and at particular stakeholder groups would be advantageous. (Clearly a broader based campaign, as well as tackling a variety of pest/disease threats, also overcomes some of the difficulties felt by gardening and nursery commercial interests with regard to *Pr/Pk* specifically). This could include specific practical information for particular sections of the general public including gardeners, frequent garden visitors, conservation volunteers, hikers, dog walkers and golfers, so that they can take responsibility for their own behaviour. For example, it could aim to get walkers to clean their boots thoroughly in between visiting different areas of countryside, and the same for golfers between visiting different clubs. For the gardener, this could cover a range of issues including plant purchasing, responsible planting and general garden hygiene. In the case of the latter, even if gardeners are aware of good garden hygiene for management of diseases in their own gardens, it appears that there is very low awareness of the importance of this in protecting the wider environment. The National Trust for Scotland has issued advice for gardeners (see Figure 26).

1. Keep up to date with current notifications via the DEFRA or SGRPID websites:
2. Check woody plants of susceptible genera, e.g. *Viburnum*, *Rhododendron*, *Erica*, and *Pieris* etc., for signs of unusual leaf death.
3. In areas where outbreaks have occurred, ensure gardens are kept clean - remove leaf debris and burn.
4. Keep tools clean and disinfected to prevent disease spread.
5. Remove soil from shoes and boots with soap and water.
6. Beware of bringing infected plants or soil into your garden. Buy your plants from a trusted source and ensure they are covered by the plant passport scheme, signifying that they have been grown in safe, clean and hygienic conditions.
7. Contact your local Scottish Government Rural Payments and Inspection Division office if you have any concerns with plants.
8. If visiting areas where outbreaks have occurred, make sure you take no leaves or cuttings from the garden and keep dogs under control on short leads.

Figure26. National Trust for Scotland Guidelines for Gardeners
(Source: <http://www.nts.org.uk/Property/13/News/171/>).

Resources aimed both at individuals and for delivery through existing civil society groups would be beneficial. This needs to be presented in an accessible, fun and informative way. For example, the development of a 'Biosecurity Code' modelled on the existing 'Countryside Code' has been suggested (interviewee g) as an effective way of engaging individuals. Versions for both adults and children could be produced. Existing local ramblers groups, horticultural societies and allotment organisations, for example, who hold regular meetings are very well placed to be sources of practical information for members. Resources such as leaflets, posters and even DVD presentations could be produced and distributed through these networks. The authors of this review have found that amongst the older population, the memory of Dutch Elm Disease is often vivid and can be an effective tool for engaging people with current plant biosecurity risks.

These suggestions are equally valid for engaging with the professional stakeholders, many of whom could play a dual role in modifying their own behaviour but also be pro-active in informing the public; for example this would be particularly relevant for garden and landscape designers.

Nevertheless, there is a danger of falling into the trap of the 'information-deficit' model of participation here, and awareness is needed of the 'value-action gap' whereby individuals articulate (environmental) concerns but still do not change their behaviour. In overcoming this, sensitivity to local diversity and consideration of a more equitable distribution of responsibility between different (environmental) stakeholders is needed (Blake, 1999). In the case of plant biosecurity, this might mean for example, that the public and stakeholders are aware of the action being taken by others, and see their responsibility as part of wider collective action. One respondent to this research likened the societal response that was needed to the social 'stigma' that now exists around the use of mobile phones whilst driving (interviewee J). A governance approach with a framework based around the notion of 'environmental citizenship' seems very relevant in this context. Environmental citizenship is

'about the active participation of citizens in moving towards sustainability. It challenges conventional notions of citizenship to reflect the nature of environmental problems...[it] challenges the model of the 'self-interested rational actor' which pervades policy, government thinking and economic modelling – by acknowledging that the rational citizen has wider social and environmental interests and concerns; counters the often individualistic accounts of environmental responsibility by emphasising the role of government, and participatory governance in achieving sustainability' (MacGregor and Pardoe, 2005:1)

Environmental citizenship includes both *rights* 'to a clean and liveable environment and to information about environmentally-relevant policy decisions' and *responsibilities* 'for environmentally sustainable actions by reducing environmental impact and participating in collective actions aimed at achieving greater sustainability' (MacGregor and Pardoe 2005:3). Environmental citizenship addresses the value-action gap through a focus on social and institutional learning, access and infrastructure, participation and thus, inspiration and leadership (see MacGregor and Pardoe, 2005).

In addition to the awareness raising actions by government, knowledge and technology transfer by industry needs to play a key role in *Pr/Pk* and broader biosecurity management. In particular, the RHS and the National Trust, as well as the HTA, seem very well placed to playing a key role in communication with the gardening, walking and general public. Government could play a training and advisory role in such programmes. It is understood that an 'Awareness and behavioural change' work stream has been outlined for the new approach (Defra 2009a).

9.8 Stakeholders for future inclusion

The nature of *Pr/Pk* in terms of the range of sites it impacts on (both horticultural production and the semi-natural environment) means that there is a large and diverse group of stakeholders, many of whom may not have even been aware of plant biosecurity issues before, now need to be enrolled for effective management. Suggestions of new stakeholders (Question 26 of implementer's questionnaire) that need to be brought on board under the new programme of work are listed below, and it is recommended that these are given serious consideration and action taken when deemed necessary:

- Statutory and non-governmental conservation bodies and heath land stakeholders (E.g. Natural England, CCW).
- Garden designers and architects.
- Professional plant-hunters.
- Garden societies/marketing groups.
- Ramblers Association.
- Royal Horticultural Society (RHS).
- Heathland landowners.
- Local government.
- Floristry.
- Garden History.
- Landscape Institute and other landscape interests.
- Tree officers and tree wardens
- Others with responsibility in the countryside who could help with early detection.

9.9 Interdepartmental organisation

It has been previously noted that *Pr/Pk* represents a new cross habitat challenge for both research, as the pathogens did not fall exclusively into either of the traditional domains of CSL or FR,, and for management responsibilities between Defra (as it was) and the FC. Specific difficulties have arisen with the co-ordination of surveys and monitoring that need to be addressed, and it is recommended that a single database is set up for the new programme. These problems are of particular concern with regards the heathland threat, for which responsibility remains unclear. Additionally, there was confusion amongst stakeholders as to the responsibilities of the different agencies. This had led to

questions being raised as to whether the historical distinction between FC and Defra is still appropriate for today's situation, and given the likely nature of future biosecurity risks that too will be multi-habitat:

"We believe , given the resources available for plant health and the complications which arise from having two independently operating services (DEFRA and Forestry), that the country would be better served by having a single service, with better resourced scientific back-up that provides practical advice on control and eradication.
(stakeholder survey respondent)

The details of what a 'single service' might entail have not been articulated. This might be a more cosmetic 'shop-front' approach to simplify interactions with stakeholders. Other respondents have suggested that this needs to involve more fundamental re-organisation into one institution. Alternatively, it has been suggested that a cross-departmental unit focusing on new pest and pathogen threats to multi-habitats would be beneficial.

9.10 The Future Structure of the Programme Board

It is recommended that the suggestions made below on the future structure of the programme board be considered and changes made where deemed necessary.

- The new Programme structure should address the issues of funding control and conservation involvement;
- It would be helpful to bring in a wider range of stakeholders to make sure each sector has a voice. This will need to be carefully managed so as not to make the board too large but at the same time representative;
- Scientists that know the subject and the history of both diseases should be on the Programme Board and able to express their views;
- Where necessary, there should be flexible sub-groups of a small number of key individuals to drive the work;
- For the science group there should be a core group of GB science advisers and research funders (governmental and non-governmental) and at least one independent expert, with a remit to consider research needs and priorities. (I.e. not any direct involvement from researchers themselves, though still feeding in their thoughts/ideas);
- There should be early establishment of a more formal meeting and attendance structure with regular planned meetings;
- There should be clearer accountability for resources, and prioritisation between different activities; research, surveillance, diagnostics, clearance.

9.11 Factors that may impact on the disease in the future: Climatic and the Evolution of Pr/Pk

The future disease situation will be significantly impacted by climatic conditions with hot, dry summers reducing spread and warm moist conditions, encouraging disease. Increased instability as projected by most GCMs for the coming decades are therefore likely to result in highly variable annual cycles.

Of particular concern would be gradual low level (and consequently hard to detect) spread of infections during unsuitable seasons, followed by a series of optimal seasons, resulting in a widespread epidemic.

There is a longer term risk *Pr/Pk* will evolve and find new hosts. There is a risk of horizontal gene transfer between *Pr/Pk* and other *Phytophthoras* (such as occurred, for example with the alder *Phytophthora* that is a new hybrid), as well as mutation. This needs to be taken seriously in terms of management for the future.

9.12 Plant biosecurity and future plant health risks

Many of the criticisms and suggestion made in this report have a wider relevance to generic plant biosecurity issues. There is a need for further work with the nursery industry, and stakeholders in terms of technology transfer and education to raise the standards of biosecurity across the whole sector. There is a need to increase awareness levels and engage the general public with generic biosecurity issues (as previously discussed in Section 9.7).

The fear that *Pr/Pk* could be a forerunner to other similar infections was articulated by several participants in this research. Since the 1990s there has been a stream of invasive pathogens that are potentially damaging to trees, natural ecosystems and horticulture, entering the UK (Brasier, 2008). An RHS Working Group on the disease and pest risk to the UK associated with international plant trade, came to the general agreement (RHS, 2008:1) that ‘the scientific arguments for this threat were real and incontrovertible.’ The pathway of highest risk is now seen to be the ‘...commercial movement of living plants, together with unlicensed specialist or amateur plant collecting’ (Brasier, 2008:4). Several features of the modern international plant trade have enhanced the risk; the increasing volume and the demand for more variety, especially for ‘exotic’ plants and for larger ‘instant’ plants not available in the UK, and in particular the desirability for instant ‘woody’ landscapes that involves the importation of large finished tree specimens (RHS, 2008; Moran, 2008; Brasier 2008). As well as fashions in garden design, this trend has also been driven by abolition of trade barriers within the EU that has facilitated plant movement. In addition, the UK horticultural trade has ‘reacted to competition from cheaper overseas production by sourcing more of its plant stock from these sources, with a concomitant decline in home production but with the benefit of survival in a difficult commercial environment’ (RHS, 2008:1). This leads to difficult decisions then for those charged with managing plant health issues in the UK:

‘There is therefore a tension, in terms of risk to the cultural and natural environment, between the conservation and environmental responsibilities of horticulturalists, foresters, garden designers and landscape architects and their desire for novel material or (these days) cheaper plants and instant trees’ (Brasier, 2008:1).

In the context of the existing international regulation of plant pathogens, Brasier (2008) acknowledges that in the UK, EU regulations are usually regulated and operated to a high standard, but that in the

light of recent developments in the plant trade itself and of regular breaches of UK plant biosecurity, 'some tenets underlying the protocols must now be viewed as outdated and seriously flawed (Brasier, 2008:4). These protocols, broadly following the Sanitary and Phytosanitary Agreement (SPS) of the WTO, aim to minimise any disruption to trade that plant health regulation might impose. The plant biosecurity legislation is based on lists of organisms *already known to be pathogens* and the inclusion of each organism must be based on scientific evidence. These will be organisms that have already 'broken out' of their native ecosystems and caused disease in another parts of the globe. The RHS (2008:1) report states that this system 'can take no account of those that are as yet unrecognised because they have not become invasive but some estimates suggest as many as 90% of fungi are as yet undescribed. Thus the majority of potential invasive pathogens are not covered by international legislation.' *Pr* is one example of several 'newly escaped' organisms that were previously unknown to science and were therefore not on any international list before they escaped (Brasier, 2008).

In this context, it is essential that *Pr/Pk* is seen as a key experience from which lessons can be learnt, and strategies put in place, for the management of not just new pathogens that are 'spotted on the horizon', but critically, future yet 'unknown' plant health threats. Given these weaknesses in international regulation, the potential for pathogen evolution and the impacts of climate change, it is key that at local and national levels, stakeholders and the public alike are encouraged and facilitated through the provision of information, and financial support where appropriate, to take on responsibility for biosecurity, and to manage their land in a way that increases their ability to deal with future threats.

10. Summary of recommendations:

- It is recommended that there is an increase in the number of staff tasked with pro-active surveying, monitoring and testing for new *Pr/Pk* outbreaks. The possibility for staff from other land-based organisations, who are already working in susceptible habitats, taking on these roles, should be explored. It is also suggested that a new co-ordinating role (s) at national and/or regional levels would be useful in this context.
- It is recommended that garden management plans for infected gardens, and gardens considered at high risk from *Pr/Pk* in the future, are developed in a co-operative manner between garden owners and/or head gardeners, and the plant health authorities. These should ensure support for the gardens in the effective management of the disease, but also play a strategic role in setting out a plan for the future evolution of the garden. They should include a compulsory regime of rigorous hygiene practices within the garden and, where relevant, a management plan for the visiting public.
- It is recommended that research to inform disease management in the gardens is carried out. It would be useful if this included the relative level of susceptibility and resistance of different species and cultivars, and if there is a difference for *Pr* and *Pk* within the garden environment. Consideration of whether this is affected by local climatic conditions, as well as the relative levels of sporulation for different species and cultivars would also be useful.
- It is recommended that clearance of *R. ponticum* continues to occur at infected sites, but that the Programme ensures that clearance occurs on all land-types where it is necessary, and that the pattern of clearance does not leave reservoirs of inoculum to build up. It is also recommended that there is pro-active clearance of *R. ponticum*. Given limited resources, this should be focused on sites which are particularly valuable for biodiversity, or in cultural terms, and in particular in areas where there is *R. ponticum* in conjunction with high levels of *Vaccinium*.
- It is recommended that resources are focused on research into *Vaccinium myrtillus* infection, as outlined in Section 9.4, as a matter of urgency. In this context, a national policy on protecting heathland ecosystems and disease management should be developed.
- It is recommended that the other research suggestions listed in Section 9.5 are given serious consideration and action taken when deemed necessary.

- It is recommended that the further funding is made available for the micro-propagation unit at Duchy College to continue its work, but that a clear plan of where the new, disease-free plant material will be placed in both the short, and long-term, is decided.
- It is recommended that an education programme focused on generic plant and tree biosecurity risks, and targeted at specific sections of the general public (e.g. garden visitors, ramblers, dog walkers) and at particular stakeholder groups (e.g. professional gardeners, landscape architects) be developed and implemented. Resources aimed both at individuals and for delivery through existing civil society groups would be beneficial. This needs to be presented in an accessible, fun and informative way. For example, the development of a 'Biosecurity Code' modelled on the existing 'Countryside Code' may be an effective way of engaging the general public.
- It is recommended that the suggestions for new stakeholders to be brought on board under the new programme of work (as listed in Section 9.8) are given consideration and action taken when deemed necessary.
- It is recommended that consideration is given to how responsibility for *Pr/Pk* management between Fera (Defra) and PHSI can be more effectively distributed and co-ordinated, particularly in relation to scientific research and survey work. It is suggested that a single survey database is created. It is also suggested that the responsibilities of the different agencies are always clearly explained to stakeholders and the public to avoid confusion.
- It is recommended that the suggestions listed in Section 9.10 on the future structure of the programme board be considered and changes made where deemed necessary.

Bibliography

Anon (2002) The Plant Health (*Phytophthora ramorum*) (England) Order 2002, Statutory Instrument 2573, HMO.

Anon (2002a) Commission Decision of 19th September 2002 on provisional emergency phytosanitary measures to prevent the introduction and the spread within the Community of *P. ramorum* Werres, De Cock and man in't Veld sp. Nov. (2002/757/EC). Official Journal of the European Communities 20.9.2002; L252/37.

Anon (2004) The Plant Health (*Phytophthora ramorum*) (England) Order 2004, Statutory Instrument 2590, HMO.

Anon (2004a) The Plant Health (*Phytophthora kernovii* [sic] Management Zone) (England) Order 2004. Statutory Instrument 2004. No.3367.

Anon (2007) Plant Health (*Phytophthora ramorum*) (England) (Amendment) Order 2007, Statutory Instrument 2155, HMO.

Beales, P.A., Giltrap, P.M., Webb, K.M. and Ozolina, A. (2009 in press) A further threat to UK heathland bilberry (*Vaccinium myrtillus*) by *Phytophthora pseudosyringae*. *Plant Pathology, New Disease Reports*. <http://www.bspp.org.uk/publications/new-disease-reports/ndr.php?id=019056>

Blake, J. (1999) Overcoming the 'Value-Action Gap' in Environmental Policy: tensions between national policy and local experience, *Local Environment*, Vol.4, No.3, pp.257-258.

Brasier, C.M. (2000) (unpublished). *Summary Pest Risk Analysis*. Forest Research, Alice Holt Lodge, Farnham, Surrey, UK, 26pp.

Brasier, C.M., Beales, P.A., Kirk, S.A., Denman, S. and Rose, J., (2005) *Phytophthora kernoviae* sp.nov, an invasive pathogen causing bleeding stem lesions on forest trees and foliar necrosis on ornamentals in the UK., *Mycological Research*, 109, 853-859.

Brasier, C.M. (2008) The biosecurity threat to the UK and global environment from international trade in plants, *Plant Pathology*, 57 (5), 792-808.

Defra (2005) *Stocktake and Look Forward report*, Appendix to 11th meeting of the *Phytophthora* Board, 4th October 2005.

Defra (2005a) *P. ramorum - A Practical Guide for the Nursery and Garden Centre Industry* [available at <http://www.fera.defra.gov.uk/plants/publications/plantHealth/documents/pramnurs.pdf>]

Defra (2008) *Phytophthora ramorum: A Practical Guide for Established Parks & Gardens, Amenity Landscape and Woodland Areas* [available at <http://www.fera.defra.gov.uk/plants/publications/plantHealth/documents/pramparks.pdf>]

Defra (2008) Consultation on future management of risks from *Phytophthora ramorum* and *Phytophthora kernoviae*, Defra, London and FC, Edinburgh.

Defra, (2008a) List of consultees for Consultation on future management of risks from *Phytophthora ramorum* and *Phytophthora kernoviae* [accessed from defra.gov.uk on 16/4/09].

Defra (2009) Summary of responses to the consultation on future management of risks from *Pr* and *Pk* – 15th July to 10th October 2008, March 2009, Defra, London and FC, Edinburgh.

Defra (2009a) SID 1ROAME statement, Draft, *Pr* and *Pk*, Version 04/2009.

Frankel, S, (2008) Sudden oak death and *Phytophthora ramorum* in the USA: a management challenge, *Australasian Plant Pathology*, 37, 19-25

FC, (2004) Report on the Forestry Commission Woodland Surveys 2004 to Assess the Level of Incidence of *Phytophthora ramorum* in British Woodlands

FC, (2004a) Report of the Second Forestry Commission Woodland Surveys 2004 to Assess the Level of Incidence of *Phytophthora ramorum* in British Woodlands

FC (2005) First Forestry Re-survey of Woodlands 2005 to Assess the level of Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* in Woodlands in England and Wales.

FC (2005a) Report on the Forestry Commission Woodland Survey 2005 to Assess the Level of Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* in Cornwall.

FC (2006) Report on the 2006 Forestry Commission Forest Condition *Phytophthora* Survey to Assess the Level of *Phytophthora ramorum* and *Phytophthora kernoviae* in Great Britain.

FC (2006a) Report on the Forestry Commission Re-Survey of Woodlands 2006 to Assess the Level of Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* in Woodlands in England and Wales.

FC (2006b) Report on the 1st Forestry Commission Woodland Survey 2006 to Assess the Level of Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* in Devon.

FC (2006c) Report on the 2nd Forestry Commission Woodland Survey 2006 to Assess the Level of Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* in Targeted Woodlands in Devon.

FC (2007) Report On The Forestry Commission Intensive Tree Surveys 2004 - 2007 To Assess The Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* In Woodland Trees in Cornwall.

FC (2007a) Report on the Forestry Commission Re-Survey of Woodlands 2007 to Assess the Level of Incidence of *Phytophthora ramorum* and *Phytophthora kernoviae* in Woodlands in England and Wales.

Harwood, T.D., Xu, X., Pautasso, M. Jeger, M.J. and Shaw. M.W. (2009 in press) Epidemiological risk assessment using linked network and grid based modelling: *Phytophthora ramorum* and *Phytophthora kernoviae* in the UK. *Ecological Modelling*. Online Early view: <http://dx.doi.org/10.1016/j.ecolmodel.2009.08.014>

Jones, D.R. and Sansford, C. (2001) Revised Pest Risk Assessment of the *Phytophthora* sp. causing sudden oak death, CSL, York, UK.

Jones, D. R., and Sansford, C. (2001a) Revised Datasheet for the *Phytophthora* sp. causing sudden oak death, 7 June 2001 CSL, York, UK.

Jones, D. R., (2002) Revised Pest Risk Assessment of *Phytophthora ramorum* -, 11 January 2002, CSL, York, UK.

Jones, D.R., Sansford, C., and Brasier, C (2003) Summary Pest Risk Analysis, Revision number 3, 20th March 2003, CSL, York and FC, Surrey UK.

Moran, H. (2008) *Invertebrate Plant Pests Associated with Large and Exotic Trees Imported in the UK*, CSL, September 2008.

MacGregor, D., and Pardoe, S, (2005) *Environmental Citizenship: the Goodenough Primer*, Summary report of an Interdisciplinary seminar series, May 2005 [available at www.environmentalcitizenship.net].

Ramsfield, T.D., Dick M.A., Beever R.E., and Horner I.J, (2007) *Phytophthora kernoviae* – of southern hemisphere origin? Abstracts of the fourth meeting of the IUFRO working party 7.02.09. *Phytophthoras in Forest & Natural Ecosystem*, Monterey, California, USA 26-31st August 2007.

Royal Horticultural Society (2008) *Non-native diseases and the future of UK gardens*: A report by an RHS Working Group on the disease and pest risk to the UK associated with the international plant trade, RHS.

Sansford, C., Brasier, C, Inman, A, (2004) Summary PRA for a new *Phytophthora* species affecting European beech (*Fagus sylvatica*) and *Rhododendron* in south-west England, CSL and FR.

Sansford, C. (2008) Revised Pest Risk Analysis for *Phytophthora kernoviae*, Version 6, February 25th 2008, CSL, York and Forest Research, Surrey.

Sansford, C. (2009) Development of UK/EU/EPPO Pest Risk Analyses for *Phytophthora kernoviae*, and *P.lateralis*, *Proceedings of the Fourth Meeting of IUFRO Working Party*, 07.02.09

Sansford, C.E, and Woodhall J. (2007). Datasheet for *P.ramorum*. CSL, York

Shishkoff, N, (2005) The effect of systematic fungicides on detection by culturing of *P.ramorum*, *Phytopathology*, 95, S96.

Tracy, D.R., (2009) *P.ramorum* and *P.kernoviae* : the woodland perspective, *Bulletin OEPP/EPPO* Bulletin 39, 161-167.

Turner, J.A, Jennings, P., and McDonough, S. (2006) Chemical control of *P.ramorum* causing foliar disease in outdoor hardy nursery stock. Final Project Report HNS 123A. 35pp.

Werres *et al* (2001) *Phytophthora ramorum* sp.nov, a new pathogen on *Rhododendron* and *Viburnum*, *Mycology Research*, 105 (10): 1155-1165

Appendix 1: Copy of Implementers on-line questionnaire

A: Introductory questions

1. Name
2. Organisation
3. Please give brief details of your role at this organisation
4. Please give a description of the capacity in which you have been involved with *P.ramorum* and/ or *P.kernoviae*

Please give details of locations, dates of involvement and specific duties.

B: Initial response to *P.ramorum* and *P.kernoviae* risks

P. ramorum

5. Once the risk from *P.ramorum* was identified, do you think the GB authorities acted *quickly* enough?
If No, why not?

6. Please read the following statement and tick the option which best describes your view:

"Overall, the GB authorities' initial response to the *P.ramorum* outbreak has been as rapid and effective as could be expected"

Disagree Strongly

Disagree

Neither agree nor disagree

Agree

Agree Strongly

Please explain your answer

P. kernoviae

7. In your opinion, once the risk of *P.kernoviae* was identified, do you think the GB authorities acted *quickly* enough?
If No, why not?

8. Please read the following statement and tick the option which best describes your view:

"Overall, the GB authorities' initial response to the *P.kernoviae* outbreak has been as rapid and effective as could be expected"

Disagree Strongly

Disagree

Neither agree nor disagree

Agree

Agree Strongly

Please explain your answer

C. *Phytophthora* Programme Board and Sub-groups

9. Were you a member of the main *Phytophthora* Programme Board?

Yes

No

If Yes please give dates of involvement

10. Please list any Sub-groups you belonged to

11. Please respond to the following statement:

"The *Phytophthora* Programme Board was an effective mechanism for overseeing the *P.ramorum* and *P.kernoviae* outbreak"

Disagree Strongly
Disagree
Neither agree nor disagree
Agree
Agree Strongly

12. What, in your opinion, were the main strengths of the *Phytophthora* Programme Board and Sub-groups?

13. What, in your opinion, were its main weaknesses?

14. Would you recommend a similar set up to oversee the new programme of work?

15. If you answered Yes to Q14, can you suggest improvements to the current mode of working? If you answered No to Q14, what alternative structure would you like to see put in place?

16. Please respond to the following statement:

"There has been good coordination between Government agencies under the emergency *P.ramorum* and *P.kernoviae* programme"

Comments

D: Implementation of policy

17. In your opinion, how effective were the following actions in limiting the spread of *P.ramorum* /*P.kernoviae*

- a. Inspection of cargo at ports
- b. Plant passporting
- c. Clearance of uninfected *Rhododendron ponticum* from woodland areas
- d. Clearance of uninfected *Rhododendron ponticum* from boundaries of gardens
- e. Inspections of nurseries and garden centres
- f. Destruction of diseased plants and restrictions on plant movements in nurseries
- g. Destruction of diseased plants and restrictions on plant movements in historic gardens
- h. Establishment of the *P.kernoviae* management zone in Cornwall

Very effective
Effective
Ineffective
Very ineffective
Don't know

Comments

18. Do you feel that the progressive spatial spread of these pathogens in Great Britain could have been avoided?

Yes
No
Don't know

If Yes, how could it have been avoided?

19. Please describe any difficulties you have faced in performing your role within the Emergency Control Programme that were administrative, logistical or practical.

E: Legal aspects

20. Do you feel that the legal framework for the management of *P. ramorum* /*P. kernoviae* was adequate?

Yes

No

Please give details of how you think it served the necessary actions of the authorities well, and where you think it was limiting.

F: Research

21. In your opinion, how adequate is the scientific knowledge base concerning *P. ramorum* and *P. kernoviae* in this country?

Please specify in terms of:

a. Identification

P. ramorum

Good/Fair/Poor

P. kernoviae

Good/Fair/Poor

b. Dispersal/transmission

Good/Fair/Poor

Good/Fair/Poor

c. Effects of management

Good/Fair/Poor

Good/Fair/Poor

d. Host range and spore production

Good/Fair/Poor

Good/Fair/Poor

e. Future risks

Good/Fair/Poor

Good/Fair/Poor

Comments

22. What do you think should be the priorities for future research?

G: Stakeholder engagement

23. Which of the following stakeholder engagement activities have you used? Please tick those that apply

Printed leaflet/ Information sheet

Poster

Meeting

Online information

24. Please respond to the following statement:

"Overall, stakeholders been closely involved in the planning and execution of the Emergency Control Programme"

Disagree Strongly

Disagree

Neither agree nor disagree

Agree

Agree Strongly

Don't know

Comments

25. What could have been done better to communicate with and involve stakeholders?

26. Please list any new stakeholders that need to be brought on board under the new programme of work?

H: The role of the general public

27. Please read the following statement and tick the option which best describes your view:

"The general public have played a central role in the implementation of the Emergency Programme"

Disagree Strongly

Disagree

Neither agree nor disagree

Agree

Agree Strongly
Don't know

28. In future action, do you think there should be a greater role for the public in managing the *P. ramorum* / *P. kernoviae* problem?

Yes

No

Please explain your answer

I: Resources

29. Were sufficient resources allocated to the following programme components?

- | | | |
|-------------------------------------|-----|----|
| a. Plant health inspections | Yes | No |
| b. Laboratory identification | Yes | No |
| c. Research and Development | Yes | No |
| d. Stakeholder engagement | Yes | No |

Comments

J. Europe

30. To what extent was the ability of Great Britain to effectively deal with *P. ramorum* / *P. kernoviae* affected by the actions in other European member states? Please give details

K. Future strategy

31. *Prior* to the new commitment to £25million for managing *Pr/Pk*, how did you feel about the future impacts of *Pr/Pk* in the following habitats?

- a.** In historic gardens
- b.** In nurseries and garden centres
- c.** In woodland
- d.** In heathland

Very optimistic

Optimistic

Undecided

Pessimistic

Very pessimistic

Comments

32. After the new commitment to £25million for managing *Pr/Pk*, how do you feel about the future impacts of *Pr/Pk* in the following habitats?

- e.** In historic gardens
- f.** In nurseries and garden centres
- g.** In woodland
- h.** In heathland

Very optimistic

Optimistic

Undecided

Pessimistic

Very pessimistic

33. In order of priority, what in your opinion does government and its agencies now need to do in order to improve or build upon the Emergency Programme? Please consider existing measures and suggest new policies where appropriate

a. In historic gardens

b. In nurseries and garden centres

c. In woodland

d. In heathland

L. Any other comments

34. Would you like to make any other comments?

Appendix 2: Copy of Stakeholders on-line questionnaire

A : Introductory questions

1. Name
2. Organisation
3. Please give brief details of your role at this organisation
4. Please give a description of the capacity in which you have been involved with *P.ramorum* and/ or *P.kernoviae*.

Please give details of locations, dates of involvement and specific duties.

5. Is your organisation based within the Cornwall *P.kernoviae* management zone?

Yes
No

6. Please give your overall assessment of the importance of the *P.ramorum* /*P.kernoviae*. issue in Great Britain by responding to the following statement:

"*P.ramorum* and *P.kernoviae*. are a serious threat to the biodiversity, landscape and horticultural heritage of Great Britain"

Disagree Strongly

Disagree

Neither agree nor disagree

Agree

Agree Strongly

Please explain your answer

Why do you say that?

B: Involvement with *P.ramorum* and *P.kernoviae*

7. Please choose one of the options to indicate the nature of your involvement with *P.ramorum* /*P.kernoviae*:

A: You have direct experience of *Pr* and *Pk* because of an infection on land or a nursery that you own or have responsibility for

B: You do not have direct experience of the management of *Pr* and *Pk*, but it is an issue that the organisation you work for/represent is concerned about

C: Both of the above

If you answered **A** or **C**, to Q7 please continue to Q8

If you answered **B**, to Q7 please skip to Q26

8. Please give details of the land that you own or manage where there has been outbreak of *P.ramorum* /*P.kernoviae*. Please include the size of the area, location, and land use (public or private garden, woodland or heathland)

9. Have you had an outbreak of:

P.ramorum only

P.kernoviae only

Both

10. Were you aware of *P.ramorum* /*P.kernoviae* as a risk before the outbreak on your land?

If you answered Yes, what was your source of information on this?

11. Had you taken any actions to minimise the risk from *P.ramorum* /*P.kernoviae* before the outbreak?

Yes

No

If yes, what were these?

12. When was *P.ramorum* / *P.kernoviae* first identified on your land or in your nursery?

13. How was this identification made?

As a result of an official inspection

As a result of your own observation

As a result of an observation by another. (Please specify below)

14. How many and what species of plants and trees were initially found to be infected?

Species name

Number of plants

C: Action taken by you

15. What action did you take in response to the disease outbreak? (Please tick all that apply)

Destruction of infected plants

Destruction of non-infected susceptible species

Stopping movement of plants

Clearance of non-infected *Rhododendron ponticum*

Other measures (Please give details)

16. If you cleared *R.ponticum* did you receive any financial assistance?

17. Have you permanently changed any of your working practices following the disease outbreak?

If Yes, please give details

18. Has the outbreak of *P.ramorum* / *P.kernoviae* changed your attitudes to the risk from plant/tree diseases generally?

If No, why not?

19. What has been the impact of the disease on your business?

D: Action taken by official authorities

20. Please indicate which of the following actions were undertaken by authorities following the discovery of *P.ramorum* / *P.kernoviae* on your property (Please tick all that apply).

Destruction of infected plants

Quarantine of plants

Restrictions on movements of plants

Clearance of non-infected *Rhododendron ponticum*

Other measures (Please give details)

21. How would you assess your working relationship with the Plant Health Inspectors?

Very satisfactory

Satisfactory

Neutral

Unsatisfactory

Very unsatisfactory

If applicable, what improvements would you like to see in the way inspectors work?

22. With which inspectors did you have contact?

PHSI
FC
Both

23. Were you provided with enough information by the inspectors to make informed choices about managing the disease?

If No, please give details.

24. Were the legal requirements that you needed to take action on clearly explained to you?

If No, please give details.

25. Do you think that the official response was well co-ordinated between the different government agencies of Defra and the Forestry Commission?

Comments

26. Overall, how would you assess the way in which the management of *P. ramorum* / *P. kernoviae* was carried out by authorities on your property?

Very satisfactory
Satisfactory
Neutral
Unsatisfactory
Very unsatisfactory

Comments

E. Details of other involvement with the *P. ramorum* / *P. kernoviae* issue

27. Please explain how your organisation is involved in the *P. ramorum* / *P. kernoviae* issue

28. Is your organisation's main concern related to the impact on

Woodland
Heathland
Gardens
Nurseries

(Please tick all that apply)

F. Influence on decision-making and policy

29. Please list any of the sub-groups of the management board that you or your organisation have been involved with

30. Did this opportunity allow you to influence decision-making?

Yes No Not applicable

31. Did you respond to the policy review and public consultation?

Yes No

32. Did you think that the policy review set out the right options for consultation?

Yes No

33. Could the process have been improved?

Yes No

If Yes, in what ways?

34. Have you had the opportunity to be part of decision-making or the policy process in any other ways?

Yes No

If Yes, in what ways?

35. Do you have any suggestions on how your views could be better incorporated into decision-making and the policy process in the future?

G. Communication Activities

36. Please read the following statement and tick the option which best describes your view:

""The Government and its agencies is doing an effective job communicating the risks from *P. ramorum* and *P. kernoviae* and the need for action"

Disagree Strongly

Disagree

Neither agree nor disagree

Agree

Agree Strongly

Please explain your answer

37. Please list any of the public or stakeholder meetings organised by Defra or the FC that you or your organisation attended.

Please state date and location and whether you found it useful

38. Please indicate the source of any other information you have received about *P. ramorum* and *P. kernoviae*

Please select all that apply

Printed leaflet or information sheet

Defra website

Forestry Commission website

Poster

Email bulletin

Personal communication with officials

Other (please specify)

39. What further communication activities with *Pr/Pk* stakeholders would you like to see be undertaken by government agencies?

H. Effectiveness of management carried out

40 . In your opinion, how effective were the following actions in limiting the spread of *P.ramorum* /*P.kernoviae*

i. Inspection of cargo at ports

j. Plant passporting

k. Clearance of uninfected *Rhododendron ponticum* from woodland areas

l. Clearance of uninfected *Rhododendron ponticum* from boundaries of gardens

m. Inspections of nurseries and garden centres

n. Destruction of diseased plants and restrictions on plant movements in nurseries

o. Destruction of diseased plants and restrictions on plant movements in historic gardens

p. Establishment of the *P.kernoviae* management zone in Cornwall

Very effective
Effective
Ineffective
Very ineffective
Don't know

Comments

41. How would you assess the effectiveness of the emergency programme in managing the overall threat from *Pr* and *Pk* in this country?

Very effective
Effective
Ineffective
Very ineffective
Don't know

Comments

M. Future strategy

31. *Prior* to the new commitment to £25million for managing *Pr/Pk*, how did you feel about the future impacts of *Pr/Pk* in the following habitats

- i.** In historic gardens
- j.** In nurseries and garden centres
- k.** In woodland
- l.** In heathland

Very optimistic
Optimistic
Undecided
Pessimistic
Very pessimistic

Comments

32. *After* the new commitment to £25million for managing *Pr/Pk*, how do you feel about the future impacts of *Pr/Pk* in the following habitats?

- m.** In historic gardens
- n.** In nurseries and garden centres
- o.** In woodland
- p.** In heathland

Very optimistic
Optimistic
Undecided
Pessimistic
Very pessimistic

Comments

44. In order of priority, what in your opinion does government and its agencies now need to do in order to improve or build upon the Emergency Programme? Please consider existing measures and suggest new policies where appropriate.

- a.** In historic gardens
- b.** In nurseries and garden centres
- c.** In woodland
- d.** In heathland

N. Any other comments

45. Would you like to make any other comments?