

Communicating the potential impact of two new *Phytophthora* diseases on biodiversity objectives

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1. Introduction

- 1.1 The purpose of this paper is find out the value of JNCC producing evidence that shows the potential scale of impact of two new non-native *Phytophthora* diseases on biodiversity objectives.
- 1.2 The purpose of the evidence would be to help the agencies, administration biodiversity leads, and potentially those involved in the country biodiversity strategies understand the scale of impact and help them focus on their potential roles in aiding the bodies leading research, inspection and control.
- 1.3 Whilst there have been expert responses from agencies and JNCC to the 2008 consultations on management options for the two diseases, the potential impact does not appear to be widely recognised. Better recognition might aid the partnership between biodiversity organisations and the management bodies as they take the chance to eradicate the diseases, and avoid a large scale impact.
- 1.4 It is not JNCC's remit to advise on operational responses but it looks likely that the agency role is mainly helping the management bodies understand the potential impact at habitat and landscape scales, providing geo-spatial and other evidence to aid responses, awareness raising, in addition to the technical expertise so far engaged to understand the link between the diseases and biodiversity.

2. Background

- 2.1 The two new diseases are *Phytophthora ramorum* and *Phytophthora kernoviae*. In 2008 the Scottish, English and Welsh governments coordinated their consultations on the future management options for these diseases. The impacts on horticulture and particularly biodiversity were judged as potentially severe, and it was agreed to attempt eradication as the assessments made by the Central Science Laboratory suggested the diseases were still in the lag phase, and eradication would be feasible.
- 2.2 The management programmes have considerable resources for research, inspection and eradication *e.g.* £25 million in England and Wales over 5 years and the bodies leading are the new Food and Environment Research Agency for England and Wales, the Scottish Executive, and the Dept of Agriculture and Rural Development Northern Ireland.
- 2.3 The diseases can infect a wide range of native and horticultural plants but the current host is *Vaccinium myrtillus* and the relatively few wild infections (2-3) so far have lead to the loss of rapid loss of the entire *Vaccinium* component of vegetation at the immediate location of the infection.
- 2.4 Given the biology and epidemiology of the diseases JNCC's initial impact of the potential scale of impact on the diseases if eradication is not attempted, or does not work, is as follows, based on the role of *Vaccinium* within UK habitats. Lab tests of the diseases show that several other plants are equally vulnerable to the disease, so the impact could be far greater.
 - Severe decline and loss of most of the 116 insect species (of which 11 are BAP)

species) which use *Vaccinium* as a food plant, especially the 9 of the 116 that are restricted to it

- Severe decline or loss of other species with dependencies *e.g.* the Heath Fritillary Butterfly which feeds on a parasitic plant that uses *Vaccinium* as its host at many of the strongholds for the butterfly.
- A loss of condition and change to the structure and composition of a number of Habitats directive Annex 1 habitats where *Vaccinium* is the major often dominant component of the vegetation. *Eg.*
 - European Dry heaths, Alpine and boreal heaths, blanket bogs, Old acidophilous oak woods, Old sessile oak woods, sub-arctic salix species scrub, and Caledonian pine forest.
 - All of these are listed as unfavourable bad in the Article 17 reports
 - These impacts could be translated into the BAP priority habitat framework and to SSSI habitat features.
- There would be damage to the ecosystem services provided by these habitats, the most significant of which would be to recreation services, as the loss of characteristic vegetation (and the initial die back) would affect the attractiveness of the habitats.

2.5 Further information on the diseases and their impact is provided in appendix 1, a copy of JNCC rapid internal brief on the diseases.

3. Communicating the potential impact

3.1 The evidence of the potential impact could be elaborated a bit more clearly depending on the need, for example the location and extent of the impact could be illustrated for each habitat and species.

3.2 A provisional list of ways in which the impact could be evaluated is provided below.

- A fuller assessment of the number and distribution of species that are dependent on *Vaccinium*, and the likelihood that they would be affected
- Likely impacts on BAP species and habitats
- Likely impacts on Annex I habitats
- Likely impacts on the protected site series
- A consideration of other potential host species in the UK, and a brief assessment of the additional impact
- Possible further impacts in mainland Europe

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Appendix 1 JNCC internal rapid assessment paper: *Phytophthora ramorum* and *Phytophthora kernoviae*: impacts on conservation and information needs

Basic biology

Phytophthora ramorum (*Pr*) and *P. kernoviae* (*Pk*) are two recently identified pathogens of a wide range of native and garden plants in the UK. The biology of the two species is sufficiently similar that they can be described together in terms of impacts and informational needs; particular differences will be noted.

Both pathogens are opportunistic: they do not have obligate relationships with particular host species. This makes the pathogens especially dangerous, since they can kill their host plants without impacting their own survival. A wide range of species have been shown to be susceptible to infection, either in laboratory tests or through findings ‘in the wild’ (including nursery findings). In particular, species in the Ericaceae, Fagaceae and Magnoliaceae are susceptible. Unlike many *Phytophthora* species, *Pr* and *Pk* are not root pathogens, and instead cause three main disease forms: bleeding cankers on tree trunks, leaf blights, and diebacks of shoots and buds.

Bleeding cankers do not form spores and cannot cause further infections, whilst leaf blights and diebacks both produce sporangia, and plant species that suffer leaf blights and diebacks are referred to as ‘sporulating hosts’. Tree species such as beech only produce bleeding cankers, and hence it is not a problem to leave infected trees in the environment, since they cannot infect further plant species. Bleeding cankers can eventually cause tree death through cambial ringing. Sporulating hosts can produce very large numbers of zoospores, each of which are capable of causing a new infection. Some infected hosts can produce over 500 sporangia per square centimetre, with 10-30 zoospores per sporangium. Necrosis of sporulating hosts can be very extensive, particularly with *Pk* infection; however, roots appear to remain unaffected and hence plants may survive.

Pr and *Pk* spread *via* spores, in particular zoospores, with chlamydospores or oospores providing the potential for longer-term survival in soil or water courses. Zoospores are short-lived motile spores that are released from specialised sporangia, and which require moisture for their survival and spread. It is likely that they are capable of chemotaxis, since they seem to be attracted by plant stomata, through which they can enter plant tissue and cause infection. They are not particularly capable of long-distance dispersal, although they can be transported in water courses, on the footwear of humans and on vehicle tyres. Chlamydospores are only produced by *Pr*, and are large spores that can persist in soil for long periods of time. Oospores can be produced by *Pk*, and these may act as a similar form of resting structure that can persist in soil. Neither chlamydospores nor oospores are capable of long-distance transport except through the transport of infected soil.

Distribution in United Kingdom and rest of Europe

Initial findings of *Pr* and *Pk* in semi-natural habitat were restricted to *Rhododendron ponticum* as a sporulating host, along with a number of tree species which were in close physical contact with infected *Rhododendron ponticum* and that then suffered bleeding cankers. However, since 2007 both *Phytophthora* species have been found infecting *Vaccinium myrtillus*. This host plant suffers extensive necrosis from both stem and leaf blights, and is an extremely effective sporulating host, capable of causing rapid disease spread. Wild findings are still in the minority, with the majority of infections either occurring in nurseries or in parks and gardens (particularly affecting a number of ornamental tree and shrub species).

Both species are adapted to a temperate climate, with optimum growth at 18-20°C, and a requirement for moisture for sporulation. The western parts of Great Britain may be particularly well-adapted for pathogen spread, although infection cannot be ruled out in any part of the country, and microclimate may play an important role in maintaining the higher humidities favoured by *Pr* and *Pk* (for instance, dense bracken canopy can provide a sufficiently humid microclimate for sporulation even on dry sites). Hot dry summers can provide a check to pathogen spread, but do not kill the pathogens.

Nursery findings of *Pr* have occurred throughout the UK, and there are also considerable numbers of nursery findings in mainland Europe (*Pr* is believed to have reached the UK through nursery trade with mainland Europe). Wild findings of *Pr* are more restricted, and with a particular prevalence on the west of the country, where climatic conditions may be especially favourable. However, *Pr* has been found in all four UK countries. There are many fewer findings of *Pk* in the UK, although again findings are widely distributed. Currently, *Pk* is only known in Europe from the UK and from the Republic of Ireland. Findings of either disease on *Vaccinium myrtillus* have occurred in both England and Scotland; these findings have been more in the west of Great Britain. The 'wild' situation of *Pr* in Europe is not clear, but potentially impacts could be severe, particularly if it started to spread through wild *Quercus ilex*.

Impacts of disease spread

The conservation impacts of *Pr* and *Pk* are most likely to be related to the impacts on *Vaccinium myrtillus* and associated habitats and species. There may also be impacts to tree species and woodlands, although these are not the main focus since trees are not normally sporulating hosts and are only infected if they are in close contact with sporulating hosts. Tree symptoms are not severe at early stages of the disease.

The Database of Insects and their Food Plants lists 116 insect species that have been recorded using *Vaccinium myrtillus* as a food plant. Nine of these insects appear to be completely restricted to *Vaccinium myrtillus*, with a further 18 that are somewhat restricted to *Vaccinium myrtillus*. There are 11 UK Priority species that are listed as using *Vaccinium myrtillus* as a food plant. There are also known to be a number of fungi (particularly rusts and mildews) that are specific to *Vaccinium myrtillus*. Other species will have indirect but important relationships with *Vaccinium myrtillus*, for instance the UK Priority heath fritillary butterfly (*Melitaea athalia*) feeds on the hemiparasite *Melampyrum pratense*, which has a range of host plants, but apparently is parasitic on *Vaccinium myrtillus* on a number of important heath fritillary sites.

A number of habitat types listed on Annex I of the Habitats Directive contain *Vaccinium myrtillus* as a major, often dominant, component. These include: European dry heaths, Alpine and boreal heaths, Blanket bogs, and the ground flora of Old acidophilous oak woods, Old sessile oak woods, Sub-arctic *Salix* species scrub, and Caledonian forest. All of these habitat types are currently listed as Unfavourable – Bad in the Article 17 reporting. Widespread loss of *Vaccinium* from these habitats would lead to further habitat deterioration. Additionally, there are a considerable number of SSSIs with lowland and upland heath types as interest features. Heathland has among the highest proportion of unfavourable habitat features. Loss of *Vaccinium* would lead to these features being in an unfavourable condition, not least because they would almost certainly fail in the dwarf shrub cover and composition attributes.

Heathland also provides a number of ecosystem services which would be impacted by the loss of a dominant habitat component. It is likely that a number of services would be affected

(primary production, nutrient cycling, food provision), but the most obviously impacted service would be recreational. Heathlands are widely visited for tourism and recreation, and the visual amenity would be significantly affected by large quantities of necrotic *Vaccinium*.

Future management of *Pr* and *Pk* and informational needs

In 2008, Scottish, English and Welsh governments consulted on the future management options for *Pr* and *Pk*, and it was agreed to attempt eradication through a more active management programme. Assessments made by the Central Science Laboratory suggested that the diseases were still in the lag phase and hence it could be possible to reduce them to epidemiologically insignificant levels. This is still considered to be the case, despite individual sites (particularly those with *Pk* infections) entering into an exponential phase of infection spread. However, the relatively recent findings on *Vaccinium myrtillus* might suggest that there could be an undiscovered level of infection already present in wild sites. (It is only once the pathogens are actively looked for on a particular host type that findings are made in any quantity.) If it turns out that *Pr* and *Pk* are already extensively established in *Vaccinium myrtillus* in Great Britain then the management plans will need to be reconsidered.

The new management programme will run over the next 5 years, costing £25m in England and Wales. There are three main workstreams: Disease Management, Awareness and Behavioural Change, and Research. Both Disease Management and Research will be heavily reliant on information provision from a range of sectors. In particular, information will be required to 'support survey, monitoring and other research activities for the pathogens in the wider environment as well as on nurseries' and to 'further develop evidence-based management practices and control methods for use in woodlands, heathlands, nurseries, parks and gardens'. Components of the new management programme that have relevant informational needs are the following:

1) Randomised survey of *Vaccinium myrtillus* to ensure that there is not a pre-existing disease problem in the wild.

Planned in Scotland for 2009-10, there are also plans in England and Wales. Surveys are most likely to take place in the winter months when the bracken canopy has died back, allowing easier findings of stem blights. If extensive disease findings are made then all of the disease management plans will need to be reconsidered. The survey is intended to be randomised and based on a statistically valid sample of *Vaccinium myrtillus*. Survey planners are hoping for tetrad-scale *Vaccinium* records; exact sites are not necessary (unless the *Vaccinium* is at very low density within the tetrad, and an exact site would be required in order to locate it). Available BSBI records are mostly at the hectad scale, with very patchy availability of tetrad records. It is not easy to improve the scale of record availability for such a common plant, which is not subject to any special attention during surveys. Remote sensing sources might be able to provide tetrad information, but the surveys need to take place very soon, and hence there is not time to develop major new interpretations of data.

2) Eradication of infected sporulating hosts, in particular *Rhododendron ponticum*.

This part of the work programme will be driven by findings of infection. The inspection regime is going to be increased in intensity, and will have greater focus on wild sites, in addition to nurseries, parks and gardens. Improving the inspection regime will require improved mapping of *Rhododendron ponticum* in wild sites, in particular mapping at the site level, such that inspectors are not having to inspect large areas of countryside in order to find likely hosts. This level of mapping is not available from distribution maps of *Rhododendron ponticum*, and is difficult to provide through standard recording due to the prevalent nature of this non-native species. Inspections are not randomised, and can be driven by the risks involved, and hence it would be possible to focus inspections on areas with both

Rhododendron ponticum and *Vaccinium myrtillus*. This would require a more sophisticated mapping product that was able to show co-occurrence of *Rhododendron* and *Vaccinium* in woodlands, heathlands and wetlands. The only possibility for providing this within the short-medium term would appear to be through development of a remote sensing data source. The requirement for this mapping is not as urgent as for the randomised sampling of *Vaccinium*, but would be used as soon as it became available.

3) Proactive clearance of *Rhododendron ponticum* to protect vulnerable sites.

It is hoped that there will be sufficient funds available to undertake some proactive clearance, although the bulk of funding will be dedicated to clearance of known infections, since the large infected sites are expensive and difficult to clear. This will require the most information from the conservation sector: site-based mapping of *Rhododendron*, co-occurrence with *Vaccinium* or other vulnerable native species, possibly some climatic mapping to help prioritise the clearance, and further co-mapping with 'vulnerable' sites (possibly high biodiversity value sites). Proactive clearance is unlikely to be undertaken in the early years of the management programme, and hence there should be time to develop new mapping products.

Remote sensing has the potential for providing a range of useful information sources to assist in these problems, but this potential has yet to be realised, and further investigations will be required before information can be delivered to disease leads. For instance, *Rhododendron* was one of the identified end-points during the production of the Land Cover Map, and this could possibly provide much more detailed site mapping of *Rhododendron*. There may even be potential for remote sensing to be used to monitor large areas of countryside for suspicious necroses of *Vaccinium*, thereby providing a cost-effective mechanism for very broad-scale monitoring, however further studies of whether this would provide too many false positives will be required.