Ministry for Primary Industries
Manatū Ahu Matua

Risk Management Proposal:

Revision of the level of post entry quarantine (PEQ) for blueberry (*Vaccinium* spp. excluding *V. macrocarpon*) imported as tissue culture from non-accredited facilities under the Import Health Standard (IHS) 155.02.06: Importation of Nursery Stock

14 August 2017

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Submissions

The Ministry for Primary Industries (MPI) propose to amend the *Vaccinium* schedule of the import health standard 155.02.06: Importation of Nursery Stock (the IHS) to allow *Vaccinium* tissue cultures imported under option 3.2 of the IHS to undergo post entry quarantine (PEQ) in a lower level of physical and operational containment than is currently required. The proposed amendment is supported by this Risk Management Proposal (RMP).

The purpose of an IHS is defined as follows in section 22(1) of the Biosecurity Act 1993 (the Act): "An import health standard specifies requirements that must be met to effectively manage risks associated with importing risk goods, including risks arising because importing the goods involves or might involve an incidentally imported new organism".

MPI must consult with interested parties in accordance with section 23 of the Act and MPI's consultation policy before issuing or amending an import health standard under section 24A of the Act.

MPI therefore seeks formal comment on the proposed change to the level of PEQ required for *Vaccinium* tissue cultures.[1]

MPI has developed this RMP based on the best available technical evidence and assessment of this evidence. If you disagree with the measures proposed to manage the risks, please provide either data or published references to support your comments. Similarly, if you support the proposed measures, or consider that additional measures are required to manage the risks, please provide appropriate evidence to support your comments. This will enable MPI to consider additional evidence that may change how it is proposed risks are to be managed.

The following points may be of assistance in preparing comments:

- Wherever possible, comments should be specific to a particular section/requirement of the standard;
- Where possible, reasons, data and supporting published references to support comments are requested;
- The use of examples to illustrate particular points is encouraged.

MPI encourages respondents to forward comments electronically. Please include the following in your submission:

- The title of the consultation document in the subject line of your email;
- Your name and title (if applicable);
- Your organisation's name (if applicable); and
- Your address.

Send submissions to: plantimports@mpi.govt.nz.

If you wish to forward submissions in writing, please send them to the following address:

Plant Imports
Plants, Food & Environment
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PO Box 2526
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[1] The proposed amendment applies only to tissue cultures that are imported from non-accredited facilities under option 3.2 of the *Vaccinium* schedule of the IHS. The level of PEQ for *Vaccinium* tissue cultures imported from MPI-accredited facilities (option 3.1 of the IHS) has not been considered as part of this assessment. This is because these tissue cultures are already eligible for PEQ in a Level 2 greenhouse facility with a minimum period of six months in PEQ. There are not currently any MPI-accredited facilities that are approved for the export of *Vaccinium* nursery stock to New Zealand.

All submissions must arrive by close of business on 11 September 2017. Submissions received by the closure date will be considered during the development of the final standard. Submissions received after the closure date may be held on file for consideration when the issued standard is next revised/reviewed.

Official Information Act 1982

Please note that your submission is public information and it is MPI policy to publish submissions and the review of submissions on the MPI website. Submissions may also be the subject of requests for information under the Official Information Act 1982 (OIA). The OIA specifies that information is to be made available to requesters unless there are sufficient grounds for withholding it, as set out in the OIA. Submitters may wish to indicate grounds for withholding specific information contained in their submission, such as the information is commercially sensitive or they wish personal information to be withheld.

Any decision to withhold information requested under the OIA is reviewable by the Ombudsman.

Contents

Purpose

(1) The draft IHS schedule for *Vaccinium* is the subject of consultation under section 23(3) of the Biosecurity Act (1993). The consultation is restricted to the following changes that are proposed for the *Vaccinium* schedule:

a) the addition of a new part (part 3.3) to the IHS schedule that will identify specific post entry quarantine (PEQ) requirements for *Vaccinium* tissue cultures from non-accredited facilities;

b) a requirement to introduce testing for the fungal pathogen *Diaporthe vaccinii*. This testing will apply to all plant material imported under the *Vaccinium* schedule;

c) the addition of the fungal pathogen *Exobasidium maculosum* to the pest list in the *Vaccinium* schedule.

(2) The purpose of this RMP is to:

a) Summarise the known biosecurity risk associated with tissue cultures imported from non-accredited offshore facilities under option 3.2 of the *Vaccinium* schedule of the import health standard (IHS) 155.02.06: Importation of Nursery Stock. The summary of risk is limited to disease organisms that are currently listed in the *Vaccinium* schedule, or that have been recorded in the MPI emerging risk database;

b) Evaluate whether the biosecurity risk can be effectively managed using a lower level of physical and operational containment than is currently required;

c) Show how the measures proposed in the draft IHS schedule (provided in Part 3 of this RMP) will effectively manage known biosecurity risks and are consistent with New Zealand's domestic legislation and international obligations.

(3) The RMP assesses the risk management measures required to manage biosecurity risks associated with *Vaccinium* tissue cultures.

(4) The RMP provides information to support the consultation on the draft IHS, but is not itself the subject of consultation. However, MPI will accept comments and suggestions on the RMP in order to improve future IHS consultations.

Scope

(5) The RMP provides the rationale for a proposed reduction in the level of quarantine containment required for deflasked tissue cultures imported under part 3.2 of the *Vaccinium* schedule in the nursery stock IHS.

(6) The RMP applies to all plant species with an import specification of 'L2, L3 see 155.02.06 under *Vaccinium*" in the Ministry for Primary Industries (MPI) Plants Biosecurity Index (PBI). This includes all members of the *Vaccinium* genus that are eligible for import into New Zealand except *V. macrocarpon*, which has a separate IHS schedule and is not considered here.

(7) The RMP includes:

- A summary of disease organisms potentially associated with *Vaccinium* nursery stock from all countries (taken from the current *Vaccinium* schedule in the nursery stock IHS).

- A summary of organisms that are not included in the IHS, but that are recorded as being associated with *Vaccinium* spp. in MPI's register of emerging risks.
- An assessment of how the risks associated with these disease organisms will be managed in a Level 3A PEQ greenhouse.

(8) The RMP excludes:

- A comprehensive review of potential risk organisms that have been recorded as being associated or potentially associated with *Vaccinium* nursery stock from all countries since the current schedule was adopted (i.e. since 1999).
- Dormant cuttings (from MPI accredited and non-accredited facilities).
- Tissue cultures of *Vaccinium* imported from accredited facilities.
- Nursery stock (including tissue culture material) of *Vaccinium macrocarpon*.

Background

(9) In March 2016 MPI reissued the Transitional Facility Standard: Post Entry Quarantine for Plants. The reissued standard includes a new level of quarantine greenhouse facility, known as Level 3A. This type of greenhouse provides an intermediate level of physical and operational containment relative to Level 2 and Level 3[2] greenhouse facilities that were included in the previous version of the standard. The reason for including a new level of quarantine greenhouse was to enable plants to be held in a level of quarantine more commensurate with the level of biosecurity risk.

(10) MPI intends to assess selected genera of high value nursery stock which require Level 3B PEQ to identify whether the biosecurity risk can be effectively managed in a Level 3A PEQ greenhouse. This will reduce the volume of imports through Level 3B PEQ facilities (which often do not have sufficient capacity), and help to support the import into New Zealand of new plant germplasm.

(11) The assessments will also provide certainty about which species can be held in a Level 3A PEQ greenhouse.

(12) High value genera of nursery stock have been prioritised for assessment based on the following criteria:

a) Current frequency of imports into Level 3B PEQ.

A main aim is to reduce the pressure on existing Level 3B PEQ facilities and to support industry by reducing unnecessary costs and helping to remove barriers to import that arise from limited PEQ capacity. As such, MPI reviewed the recent history of imports to identify the genera that are using the most space in Level 3B PEQ. Genera for which there is no current demand to import will not be assessed.

b) Feasibility of importing plants in tissue culture.

[2] Under the previous version of the PEQ standard (MAF Biosecurity Authority Standard PBC-NZ-TRA-PQCON) the highest level of greenhouse quarantine facility was referred to as Level 3. The equivalent level under the revised standard is Level 3B. For the remainder of this document, the highest level of PEQ is referred to as Level 3B

MPI will only assess import requirements for plants where tissue culture is a known pathway for trade in new germplasm. This is because some groups of organism (for example insects and mites) present a very low risk on the tissue culture pathway. In addition, risks associated with other classes of disease organism (for example wood-inhabiting fungi) are lower for plants in tissue culture than for some other plant parts (such as whole plants and/or cuttings).

c) Status of current import schedule.

The only genera considered for assessment will be those where imports are allowed under the existing IHS schedule. This is because MPI consider that the current measures in the IHS will effectively manage biosecurity risk. Furthermore, any new or emerging risks that may be associated with these genera will have been identified by MPI when recent import permits were issued. As such, it is feasible to assess the most appropriate level of PEQ without undertaking a broader review of the entire schedule.

d) Review of IHS schedule not included in current Plant Imports work programme.

The assessments will only include genera that were not otherwise going to be assessed in the near future. This means that IHS schedules already under review on the current MPI work programme will not be considered. Schedules on the current work programme can be viewed on the MPI website here.

(13) Species falling under the *Vaccinium* schedule of the IHS have been assessed for the following reasons:

a) *Vaccinium* imports are permitted under the existing schedule in the nursery stock IHS; this is the most common genus of nursery stock imported into Level 3B PEQ, so imports are increasing the pressure on these facilities;

b) *Vaccinium* is the most common fruit crop currently undergoing Plant Variety Rights testing in New Zealand, with most varieties under test being of overseas origin. This highlights the interest in importing overseas bred material;

c) *Vaccinium* nursery stock is commonly imported as tissue cultures. This shows that overseas germplasm is readily available as tissue cultures, and that these are a practical way of importing *Vaccinium* germplasm into New Zealand.

Summary

(14) Quarantine in a Level 3A PEQ greenhouse, in conjunction with some specific additional risk management measures, will effectively manage the biosecurity risk for the types of risk organism that are likely to be associated with *Vaccinium* tissue cultures for the following reasons:

a) Importing plants in tissue culture effectively manages the risk associated with regulated insects, mites and nematodes given that these classes of organism are highly unlikely to be transferred into tissue culture.

b) Regulated bacteria that may be associated with *Vaccinium* tissue cultures will be effectively managed in a Level 3A PEQ greenhouse for a combination of the following reasons:

i) Waste water will be treated to ensure that soil or waterborne bacteria do not escape from the facility via the waste water stream[3];

ii) Mesh screening on Level 3A PEQ greenhouses will exclude the vectors of insect transmitted bacteria;

iii) Greenhouses will be monitored for insect vectors, and appropriate control measures will be taken in the event that vectors are present within a facility.

Based on the above, if regulated bacteria were present, they could not escape from the facility.

c) Regulated viruses that may be associated with *Vaccinium* tissue cultures will be effectively managed in a Level 3A PEQ greenhouse for the following reasons:

i) Imported plants will not be allowed to flower until they have been tested for pollen-borne viruses;

ii) Mesh screening on Level 3A PEQ greenhouses will exclude the adult stages of insect vectors of these viruses;

iii) Greenhouses will be monitored for insect vectors, and appropriate control measures will be taken in the event that vectors are present within a facility.

Based on the above, if regulated viruses were present they would not be able to escape from the facility. This rationale is also considered to apply to blueberry fruit drop disease (currently listed in the IHS as a disease of unknown aetiology), on the basis of recent research showing that the causal agent is likely to be an aphid-transmitted virus.

d) Regulated phytoplasmas that may be associated with *Vaccinium* tissue cultures will be effectively managed in a Level 3A PEQ greenhouse because insect vectors will be excluded from the facility (as noted in clauses c)ii) and c)iii) of the preceding paragraph). As such, if regulated phytoplasmas were present they could not escape from the facility.

e) Regulated fungi and oomycetes will be effectively managed in a Level 3A PEQ greenhouse for some or all of the following reasons:

[3] Note: MPI is currently re-evaluating requirements for disposal of waste water from Level 3A PEQ greenhouse facilities to ensure that all biosecurity risk will be effectively managed. MPI will undertake public consultation before making any changes to the requirements for disposal of waste water from this type of facility.

i) To prevent signs or symptoms of fungal contamination from being masked in the tissue culture vessels, the addition of antibiotics, fungicides or charcoal to tissue culture medium will be prohibited;

ii) The particular organism is unlikely to be transferred into tissue culture (for example inhabits roots or woody tissue only), meaning that the likelihood of entry is very low;

iii) Fungal spores are unlikely to be produced whilst in quarantine (based on specific epidemiological characteristics of a particular fungal organism);

iv) Operational restrictions will be applied to minimise the likelihood of spores being dispersed outside the PEQ facility. In particular, overhead irrigation will be prohibited; this will minimise the chances of fungi which are aerially dispersed (e.g. by rain splash) from escaping from the facility;

v) All plants in PEQ will be regularly inspected for disease symptoms (at least twice per week), with contingency plans in place to contain fungal/oomycete disease organisms if these are detected;

vi) Specific risk management measures will be applied to manage risk associated with two disease organisms (*Monilinia vaccinii-corymbosi* and *Phytophthora ramorum*) before plants are transferred to the PEQ greenhouse as follows:

1) Imported tissue culture plants will be tested for *M. vaccinii-corymbosi* before plants are transferred to a Level 3A greenhouse. This is because conidia of this organism are wind dispersed and would not readily be contained within a Level 3A greenhouse;

2) Tissue cultures will be incubated for four weeks at 17-25°C before plants are transferred to a Level 3A greenhouse. If present, mycelium of *P. ramorum* is expected to become visible during this time, meaning that infected plants would not be transferred to the greenhouse.

(15) The additional risk management measures to help manage certain disease organisms (for example prohibition of overhead irrigation and contingency planning) will be evaluated by MPI at the time of facility approval (and before imports commence). Ongoing compliance will be verified through regular audits by MPI as described in the Facility Standard: Post Entry Quarantine for Plants.

(16) The current testing and inspection requirements for *Vaccinium* (as listed in the IHS) are considered appropriate to detect all regulated organisms before plants are given a biosecurity clearance (aside from the exceptions listed in the following paragraph).

(17) When preparing this risk management proposal MPI noted some additional changes that should be made to the *Vaccinium* schedule to ensure ongoing effective management of biosecurity risk on this pathway. These changes, which are summarised below, will apply to all types of *Vaccinium* nursery stock and are described in full in Part 2 of this document.

a) The IHS should be updated to require specific testing for the fungus *Diaporthe vaccinii* on all *Vaccinium* nursery stock imported into New Zealand;

b) The IHS should be amended to include the fungus *Exobasidium maculosum* as a regulated pest, with a requirement for all imported *Vaccinium* nursery stock to undergo growing season inspection for this organism.

Part 1: Context

DOMESTIC

(18) New Zealand operates a biosecurity system for which the phytosanitary aspect (covering plant health) is a key component.

(19) The biosecurity system is regulated through the Biosecurity Act 1993. Section 22 of the Act describes an import health standard (IHS) and outlines the types of matters that should be considered in an IHS.

(20) MPI is the government authority responsible for maintaining biosecurity standards for the effective management of risks associated with the importation of risk goods into New Zealand (Part 3, Biosecurity Act 1993).

(21) The biosecurity system in New Zealand operates a series of components or layers (pre-border, border and post border) that together provide a high level of assurance that pests are unlikely to establish in New Zealand. No one part of the system is able to achieve the necessary assurance on its own.

(22) No biosecurity system is capable of reducing risk to zero. The objective of New Zealand's biosecurity system is to reduce to an acceptable level the likelihood of unwanted impacts occurring. Within this system, the objective of IHSs is to reduce to an acceptable level the likelihood of entry and establishment of regulated organisms (including pests, diseases and weeds).

(23) An organism is 'regulated' by MPI if it could cause unacceptable consequences (i.e. likely to cause unacceptable economic, environmental, socio-cultural or human health impacts in New Zealand) if it were to enter and establish in New Zealand, provided the organism is:

a) not present in New Zealand; or

b) if present in New Zealand is under official control;

For organisms that represent a phytosanitary risk, entry and establishment is defined as 'introduction' by the International Plant Protection Convention (IPPC).

(24) The New Zealand phytosanitary system focuses on ensuring that the most significant pests, for example *Xylella fastidiosa*, are unlikely to ever establish in New Zealand. The system also manages risk associated with all other regulated pests.

(25) The focus of an IHS for plant-based goods is to manage unacceptable phytosanitary risks before the goods arrive at the New Zealand border. The expectation is that, to the greatest extent possible, commercial consignments of plants and plant products meet New Zealand's phytosanitary import requirements on arrival (risk is managed off-shore).

(26) In the case of plant material imported for propagation, disease organisms can survive in living plant material that does not show any signs of infection. Therefore, if specified in an IHS, material for propagation must be held in PEQ for growing season inspection and/or testing to verify freedom from regulated organisms before receiving a biosecurity clearance.

(27) MPI monitors the pathway performance related to each IHS to ensure it provides the expected level of protection. This is achieved through verification and inspection activities at the border and, where necessary, audits of offshore production systems.

(28) MPI is committed to the principles of transparency and evidence-based technical justification for all phytosanitary measures, new and amended, imposed on importing pathways.

INTERNATIONAL

(29) Where possible, phytosanitary import requirements are aligned with international standards, guidelines, and recommendations as per New Zealand's obligations under Article 3.1 of the World Trade Organisation (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures; WTO, 1995 (SPS Agreement).

(30) The SPS Agreement sets in place rules that protect each country's sovereign right to take the measures necessary to protect the life or health of its people, animals, and plants while at the same time facilitating trade. It embodies and promotes the use of science-based risk assessments to manage the risks associated with the international movement of goods.

(31) In keeping with New Zealand's obligations under the SPS Agreement and the IPPC, phytosanitary measures must:

a) be justified and can only be for regulated pests. The strength of any phytosanitary measure will depend on the assessment of risk, with an emphasis on the consequences of the pest establishing in New Zealand;

b) not discriminate unfairly between countries or between imported and domestically produced goods;

c) be based on international standards wherever possible, but WTO members can adopt a measure that is more stringent than an international standard, provided the measure is scientifically justified.

(32) Note that international standards, guidelines or recommendations referred to in the WTO agreement are those of Codex, OIE (World Organisation for Animal Health) and the IPPC, including regional standards developed by Asia Pacific Plant Protection Commission.

STRENGTH OF MEASURES

(33) Measures are required for regulated pests where the 'probability of introduction and spread' on a pathway is unacceptable (i.e. if a regulated organism is able to enter through the pathway, find a suitable host, and establish and spread in New Zealand).

(34) The greater the risk or consequence a pest can cause, the greater the level of assurance MPI requires that the pest is not present in a consignment.

(35) The required strength of a measure depends on the risk posed by a particular regulated organism on the pathway. This risk is determined by a combination of the consequences the pest may cause if it was introduced into New Zealand and the likelihood that the pest will enter and establish from a pathway.

(36) Plants imported for propagation are one of the most high risk pathways for the inadvertent introduction of pests and diseases to new areas. Part of the reason for this is that plant pests can survive in living plant material that does not show any signs of infection, and this living material is the entity that allows the pests to establish. In addition, because plants imported for propagation may be further multiplied and/or widely distributed throughout the country, the likelihood of pests surviving and being transferred to suitable hosts in the wider environment is higher than for many other import pathways. This is why, if required in an IHS, plants for propagation must be held in PEQ before receiving a biosecurity clearance.

(37) The physical design, safeguards and operating procedures for a PEQ facility are based on pest biology. However, when identifying the most appropriate level of PEQ, the following factors should also be taken into account:

- disease organism biology:
  - mode of transmission;
  - whether vectors are present (or likely to be present) in New Zealand;
  - whether vectors are likely to be present in close proximity to the PEQ facility;
  - whether the same (or related) species as the imported plants are likely to be present in close proximity to the PEQ facility.
- likelihood of entry of a quarantine pest *via* an import pathway:
  - whether a particular quarantine pest is likely to be associated with the plant parts being imported (for example seeds vs. tissue cultures vs. bulbs vs. whole plants);
  - presence or absence of the quarantine pest in the exporting country;
  - assurances provided by the exporting country in regards to freedom from quarantine pests;
  - whether material is from an MPI-accredited offshore facility, and if so the history of the facility and what testing has been done;
  - available treatment methods (for example fungicide, insecticide or other treatment before plants enter PEQ).
- likelihood of establishment of a quarantine pest via an import pathway;
- potential environmental and/or economic consequences of establishment;
- available testing methods (for example growing season inspection, biological indexing, PCR).

(38) A combination of the above factors have been considered when reviewing the level of PEQ for *Vaccinium* tissue cultures.

Part 2: Risk management of regulated organisms on the *Vaccinium* tissue culture pathway

(39) The purpose of this section is to:

a) Assess the likelihood of each disease organism (or each class of disease organism) listed in the *Vaccinium* schedule in the IHS being present on the tissue culture pathway;

b) Based on the above assessment, evaluate whether the biosecurity risk associated with *Vaccinium* nursery stock imported as tissue cultures from a non-accredited offshore facility can be managed in a Level 3A PEQ greenhouse;

c) Identify whether any risk management measures additional to those already specified in the IHS are required to manage risk.

(40) The following information sources were used in developing this risk management proposal:

a) Import health standard (IHS) 155.02.06: Importation of Nursery Stock;

b) Relevant literature (scientific journals, webpages, books, databases etc.);

c) The MPI emerging risk database.

(41) If a regulated organism was considered to present a risk on this pathway, an assessment was made of the level of PEQ facility which could safely contain the organism. Factors outlined in the Strength of measures section of this document were considered when making the assessment.

(42) As noted in the scope of this document, the *Vaccinium* schedule was developed around 1999 and has not been significantly amended since then. A comprehensive hazard identification was not done as part of this risk management proposal, but the MPI emerging risk register (which has been active since 2012) was searched for diseases of *Vaccinium*. Aside from the proposed additions to the IHS that are described in this document, MPI is not aware of any additional risk organisms that should be added to the *Vaccinium* schedule of the IHS.

Insects and Mites

(43) The IHS records numerous regulated insect pests as potentially being associated with *Vaccinium* nursery stock. One species of mite (*Acalitus vaccinii*, blueberry bud mite) is also recorded as a regulated pest.

(44) Transfer of plants into tissue culture, and the subsequent multiplication of these plants *in vitro*, will reduce to an acceptable level the likelihood of insects or mites being present on plants in tissue culture for the following reasons:

a) Selection and subsequent processing of mother plant material (for example surface sterilisation) will minimise the likelihood of insects or mites being transferred into tissue culture;

b) If any insects or mites were present they would be likely to move from the plant onto the tissue culture medium. This would result in the growing medium becoming contaminated with bacteria or fungi that are associated with the insects or mites;

c) Cultures that are contaminated with microorganisms would be discarded as a normal part of *in vitro* plant management;

d) Discarding contaminated cultures would act to remove any insect or mite populations that were present.

(45) Plants must be inspected by the National Plant Protection Organisation (NPPO) of the exporting country prior to export to verify freedom from any visually detectable regulated pests. Plants must also be inspected on arrival in New Zealand. Insects or mites would be detected either directly or indirectly because of contaminating fungi or bacteria, during these inspections.

(46) Based on the above, insects or mites will not be present in tissue cultures, so biosecurity risk will be managed prior to export. As such no additional measures are considered necessary to manage the risk associated with these classes of organism.

Fungi (including Oomycota)

(47) The *Vaccinium* schedule in the IHS records 33 fungi and one Oomycete as regulated pests. Some of these organisms may be present in tissue cultures because:

a) Some of the regulated fungal pathogens of *Vaccinium* are known to have latent or endophytic phases. This means that they could be present in symptomless mother plants from which tissue cultures are derived, and hence could be transferred into tissue cultures;

b) There is evidence that some disease organisms, including fungi, remain latent and may not induce symptoms on plants *in vitro* (for example Ganley et al., 2015; Leifert and Cassels, 2001; Purmale et al., 2012). It is known that some pathogens which remain latent *in vitro* may become virulent once plants are removed from tissue culture (Liefert and Cassells, 2001 and references therein).

(48) At present, *Vaccinium* tissue cultures imported from a non-accredited offshore facility must be deflasked into a Level 3B PEQ greenhouse and undergo regular growing season inspections for a minimum period of 9 months active growth. All outgoing air from a Level 3B PEQ greenhouse must be HEPA (high efficiency particulate air) filtered. This will contain the spores of any fungal disease organisms that may be present. A Level 3A PEQ greenhouse does not require filtration of outgoing air. This means that airborne fungi would not necessarily be contained within a Level 3A greenhouse. However, as noted in paragraphs (33) to (38), in addition to basic pest biology various other factors can also be considered when assigning the level of PEQ, and it may be possible to apply other measures which will effectively manage the risk.

(49) Based on the above, an assessment was made of each fungus listed as a regulated pest of *Vaccinium* to evaluate the following:

a) Likelihood of transfer into tissue culture (for example root inhabiting fungi versus stem- or leaf- inhabiting);

b) Likelihood of detection in tissue culture (for example superficial leaf-inhabiting fungi versus fungi with a known endophytic stage);

c) Significance of the disease organism (for example lower phytosanitary risk versus a significant disease of *Vaccinium* or other plant genera);

d) Host range of the disease organism (for example restricted to the *Vaccinium* genus versus wide host range);

e) Suitability of a Level 3A PEQ greenhouse to contain the disease organism based on the physical and operational requirements for this level of facility;

f) Whether any additional measures can be applied to effectively manage the risk.

(50) The assessment (summarised in Appendix 1) showed for 27 of these fungi, passage into tissue culture combined with regular growing season inspections of deflasked plants in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk for the following reasons:

a) They are restricted to the *Vaccinium* genus; and/or

b) They are considered unlikely to have an adverse impact on other plant species important to the New Zealand environment and/or economy; and/or

c) Transfer into tissue culture will reduce the likelihood of these 27 species of fungi being present because:

i. the particular fungal species are considered very unlikely to be transferred to tissue culture (for example in the case of root-inhabiting fungi); and/or

ii. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

iii. plants are surface sterilised before initiation of tissue cultures, which will help to remove any superficial fungal contamination;

iv. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

d) Visible infection of plants, or fungal contamination of growing medium, would be detected before plants are transferred to a PEQ greenhouse:

i. plants must be inspected by the NPPO of the exporting country prior to export to verify freedom from any visually detectable regulated pests;

ii. plants must be inspected by an MPI inspector on arrival in New Zealand.

e) Plants will be deflasked and grown in a Level 3A PEQ greenhouse for a minimum of 9 months before a biosecurity clearance is given:

i. plants will be regularly inspected for any signs or symptoms of disease organisms by the MPI inspector (a minimum of five growing season inspections) throughout the PEQ period;

ii. the PEQ facility operator (or a suitably qualified delegate) will inspect plants for signs of pests and disease at least twice per week throughout the entire PEQ period;

iii. if symptoms did become evident during PEQ, these would be identified at a very early stage, and appropriate measures would be taken to contain any disease organism(s) within the PEQ facility.

(51) A summary of the evaluation of each of the 27 species of fungi that fell into the above category is included in *Appendix 1* of this document. In some cases, there is very limited information about fungal disease organisms listed in Appendix 1, and these appear to be

of low impact. This is partly why basic measures (such as transfer into tissue culture) were considered sufficient to manage the risk. However, these fungi will remain regulated until MPI does a full assessment of the risk associated with each disease organism. This assessment is beyond the scope of this risk management proposal.

(52) The assessment showed that additional risk management measures may be needed for the seven remaining regulated fungi if plants are to be eligible for quarantine in a Level 3A PEQ greenhouse. These seven species needed further assessment for a combination of the following reasons:

a) Higher likelihood of being present on the tissue culture pathway; and/or

b) A particularly high impact in countries where they are known to occur; and/or

c) Additional measures may be required to manage the risk if held in a Level 3A PEQ greenhouse; and/or

d) Potential significant impact on the environment and/or economy.

(53) The species identified as requiring further assessment were:

a) *Botryosphaeria corticis*;

b) *Diaporthe vaccinii*;

c) *Gloeosporium minus*;

d) *Godronia cassandrae* (including *G. cassandrae* f.sp. *vaccinii*);

e) *Monilinia vaccinii-corymbosi*;

f) *Phytophthora ramorum;*

g) *Septoria albopunctata*.

Botryosphaeria corticis

(54) *B. corticis* causes cane blight of *Vaccinium* in some parts of the USA, which is the only country from which this disease organism is known to occur. *B. corticis* has only been reported from members of the *Vaccinium* genus (Philips et al. (2013). It can be a serious disease, and may cause the destruction of new plantations (Moore, 2015).

(55) Symptoms of *B. corticis* become evident as small stem lesions in the early stages of infection, about a week after infection (Moore, 2015; Caruso and Ramsdell, 1995), and in susceptible cultivars lesions develop over the next several months into large swollen cankers which may kill infected stems. Fruiting bodies do not become evident until several years after infection. This means that even if symptoms were expressed in a Level 3A PEQ greenhouse, the disease organism is unlikely to escape from the facility due to the delay in fruiting body production.

(56) Various members of the *Botryosphaeriaceae* family cause latent infections in *Vaccinium*, but no records were found of latent infections of *B. corticis*. For example, *Botryosphaeria vaccinii* is recorded as causing latent infections of cranberry (Jeffers, 1991). No records were found in the Crop Protection Compendium (CPC; CABI, 2016), or in a literature search, of any members of the *Botryosphaeria* genus being transmitted in tissue cultures. Ganley et al., (2015) identified PCR products with a high sequence identity to certain species of *Botryosphaeria* in tissue cultures of *Pinus radiata*, although viable fungi were not isolated from these samples.

(57) Spores of many members of the *Botryosphaeriaceae* can be induced by incubation in a humid incubation chamber. As such, if present in tissue culture, the disease organism may be visually detectable, given the humid conditions under which tissue cultures are maintained.

(58) Passage into tissue culture followed by quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *B. corticis* because:

a) The known host range is restricted to members of the *Vaccinium* genus;

b) It is unclear whether *B. corticis* would successfully establish and/or have an impact in New Zealand given that optimal growth temperatures are between 25°C – 28°C. At a lower temperature (16°C) symptoms were restricted to small red flecks (Millholland, 1972);

c) The likelihood of *B. corticis* being present in tissue cultures is low because:

i. no records were found of *B. corticis* causing latent infections in *Vaccinium*;

ii. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures given that infected plants are recorded as showing symptoms around one week after infection occurs. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

iii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

d) The pathogen is not expected to develop fruiting bodies during the PEQ period, so would be very unlikely to escape from a Level 3A PEQ greenhouse even if diseased plants were present;

e) All plants in PEQ must be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible, and before the disease organism could spread beyond the PEQ facility.

Diaporthe vaccinii

(59) *D. vaccinii* causes Phomopsis canker and dieback, twig blight and fruit rot of various species of blueberry and cranberry. The organism is recorded as being restricted to members of the *Vaccinium* genus.

(60) The fungus is present in the USA, Canada, Chile, and China, and as having a restricted distribution in Latvia. *D. vaccinii* is included on the EPPO A2 pest list (as of September 2015). Although introduced via the nursery stock pathway to Romania and Scotland, the disease organism did not establish in either of these countries (EFSA, 2014).

(61) In the USA, *D. vaccinii* is recorded as being a serious pathogen that can kill infected plants under favourable conditions (EFSA, 2014). There is little recent information about the impacts of the disease, although Cline (2002) recorded yield losses of up to 70%. It is not clear what impacts this organism would have in New Zealand.

(62) Nursery stock is a known means of spread of *D. vaccinii*. The fungus can have a latent phase and has been detected in up to 90% of isolations from stems of healthy plants

(CABI, 2016). Plants *in vitro* are recorded as liable to transmit *D. vaccinii* in trade (CABI, 2016), although no evidence was provided to support this statement.

(63) When symptoms become evident, infected shoots are recorded as wilting and becoming covered in minute lesions. Pycnidia appear within two weeks of infection (Anon, 2009).

(64) Infections are initiated when conidia are released from pycnidia on plant debris from previous infections. Secondary infections may occur throughout the growing season from conidia produced at the site of new infections (EFSA, 2014). Conidia are dispersed by water splash via rain or overhead irrigation.

(65) Based on the above, passage into tissue culture followed by quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *D. vaccinii* because:

a) The known host range is restricted to members of the *Vaccinium* genus;

b) Transfer into tissue culture will reduce (but not eliminate) the likelihood of *D. vaccinii* being present because:

i. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

ii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

c) Operational measures can be implemented in PEQ to decrease the likelihood of the disease organism from spreading beyond the facility if it is present:

i. all plants must be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period[4]. This will ensure that if disease symptoms do become evident they will be detected as soon as possible, and before conidia are produced. Level 3A PEQ greenhouse facilities will be required to develop contingency plans to contain infections (for example by segregating plants in a manner which will prevent spore dispersal) as part of the facility approval process;

ii. overhead irrigation will not be permitted whilst plants are in PEQ. This will ensure that even if for some reason conidia were not detected during visual inspection they would be very unlikely to disperse beyond the facility.

(66) The current requirement of the *Vaccinium* schedule in the IHS is for imported plants to undergo growing season inspection to verify freedom from *D. vaccinii*. However, as noted above the disease organism is known to have a latent phase, and diagnosis based on symptom expression is not always considered reliable (EFSA, 2014).

(67) Based on the above MPI recognise that relying on growing season inspection to detect this disease organism is not the most appropriate diagnostic technique because:

a) There is a widespread occurrence of latent infections;

[4] Note that the Facility Standard for Post Entry Quarantine for Plants identifies actions that must be taken if signs or symptoms of disease organisms are observed in a PEQ facility.

b) Nursery stock is a known pathway for transmission of the disease organism;

c) *D. vaccinii* can cause significant crop losses under favourable conditions (up to 70%) in the USA.

(68) It is proposed to amend the IHS to require pre-determined testing as a mandatory requirement for *D. vaccinii*. This will be required for all types of *Vaccinium* nursery stock (i.e. tissue cultures and cuttings). It should be noted that the EPPO has developed a testing protocol for *D. vaccinii* (Anon, 2009).

Gloeosporium minus

(69) Recorded as a serious disease of blueberries in the south eastern USA (Moore, 2016) that is restricted to members of the *Vaccinium* genus. The organism is also recorded from blueberry fruit in Latvia (Vilka et al., 2009). No quantitative information was found about yield loss caused by the fungus.

(70) Infection causes leaf flecks, stem dieback and stem canker (Caruso and Ramsdell, 1996). Caruso and Ramsdell (1996) note that *G. minus* is recorded as the most severe foliar disease of blueberry in the south eastern United States.

(71) Optimum temperatures for disease development are recorded as being between 25 – 30°C (Milholland, 1974). Artificial inoculation of stems showed that symptoms developed within 14 days at these temperatures (Milholland, 1973). In artificial culture, growth occurs at temperatures between 12 – 36°C. (Milholland, 1970).

(72) Spores are believed to be dispersed during windy rainy periods (Frost, 2008), although little further information was found about spore dispersal of this species.

(73) Passage into tissue culture followed by quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *G minus* because:

a) The likelihood of *G. minus* being present in tissue cultures is low:

i. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

ii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) All plants in PEQ must be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible, and before the disease organism is likely to spread beyond the PEQ facility. Level 3A PEQ greenhouse facilities will be required to develop contingency plans to contain infections (for example by segregating plants in a manner which will prevent spore dispersal) as part of the facility approval process;

c) Overhead irrigation will not be permitted whilst plants are in PEQ. This will ensure that even if for some reason spores were not detected during visual inspection they would be unlikely to disperse beyond the facility.

Godronia cassandrae

(74) Both G. *cassandrae* and the *formae speciales G. cassandrae* f.sp. *vaccinii* are listed as regulated pests in the *Vaccinium* schedule of the IHS. Stromeng and Stensvand (2011) note that members of the *Godronia* genus are generally host specific, and that *G. cassandrae* f.sp. *vaccinii* is responsible for disease of blueberry known as 'Godronia canker'. Although *G. cassandrae* is listed separately in the *Vaccinium* IHS schedule, it is not clear whether forms of *G. cassandrae* other than f.sp. *vaccinii* can cause disease on *Vaccinium*.

(75) *G. cassandrae* f.sp. *vaccinii* can cause severe stem dieback of highbush blueberry and may be particularly severe in young plantings. Plant mortality of up to 40% has been reported, along with severe yield loss in plants that are not killed (Stromeng and Stensvand, 2011 and references therein).

(76) The disease has been reported from the USA, Canada and various countries in Europe. There are varying reports of disease significance. For example in Canada it is reported as the most serious disease of highbush blueberry in British Columbia (Sabaratnum, 2016). In the USA it is recorded as being a limiting factor of production in Michigan (Caruso and Ramsdell, 1995), but is not considered a significant pest in New Jersey, where it is also present.

(77) Stromeng and Stensvand (2011) state that in artificial culture optimal growth of mycelium occurs at 20°C, and note that the pathogen seems to be well adapted to growth at low temperatures.

(78) Infections generally occur on young non-lignified stems around ground level. Infections are initiated when conidia are released from pycnidia on infected stems following rainfall or as a result of overhead irrigation. Conidia are recorded as infecting leaf scars, petioles, buds, wounds or stomata (Moore, 2015). Stromeng and Stensvand (2011) noted that pycnidia generally appeared after lesions were at least one month old.

(79) Leaf infections have been reported (Lockhart, 1970), but there are few subsequent reports of this being a problem. On cranberry (*V. macrocarpon*), there is evidence that *G. cassandrae* can cause latent infections of leaves (Jeffers, 1991). In contrast, experimental evidence suggests that leaves of highbush blueberry develop symptoms within two weeks of inoculation (Stromberg and Stensvand, 2011 and references therein). Given that plants with obviously diseased leaves are unlikely to be used to initiate tissue cultures, the likelihood of the organism being present in tissue cultures imported under the *Vaccinium* schedule seems low. Some evidence for this is provided by Stromeng (1999; cited in Stromberg and Stensvand, 2011), who reported that in Norway 'micropropagated disease free planting material developed far less Godronia canker a few years after planting than planting material propagated by cuttings' (although this statement does not exclude the possibility of the disease organism being present in tissue cultures).

(80) Passage into tissue culture followed by quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *G. cassandrae* because:

a) The likelihood of *G. cassandrae* being present in tissue cultures is low:

i. plantations derived from micropropagated plants are much less likely to develop Godronia canker;

ii. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures given that infected plants are likely to show symptoms around two weeks after infection occurs. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

iii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) All plants in PEQ must be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible, and before the disease organism could spread beyond the PEQ facility. Level 3A PEQ greenhouse facilities will be required to develop contingency plans to contain infections (for example by segregating plants in a manner which will prevent spore dispersal) as part of the facility approval process;

c) Pycnidia (fruiting bodies which contain spores) do not develop until lesions are at least 1 month old, which means that spores are highly unlikely to produced. However, to manage residual risk, overhead irrigation will not be permitted whilst plants are in PEQ. This will help to ensure that even if for some reason conidia are not detected during visual inspection they would be very unlikely to disperse beyond the facility.

Monilinia vaccinii-corymbosi

(81) *M. vaccinii-corymbosi* causes a disease known as 'mummy berry' and is the most economically important *Monilinia* species which infects blueberry. Mummy berry is one of the most prevalent and important diseases of blueberry in North America (Ngugi et al., 2002) and can cause 70-80% crop loss in organic blueberry production (Florence, 2014). The pathogen was detected in Austria in 2003 and Slovenia in 2004 (Munda, 2011), where it is recorded as causing losses of up to 50%.

(82) *M. vaccinii-corymbosi* infects common commercially grown species of *Vaccinium* (for example *V. corymbosum* and hybrids, *Vaccinium angustifolium* and *Vaccinium ashei*), as well as other members of the *Vaccinium* genus and the related genera, *Gaylussacia* and *Rhododendron* (Batra, 1983). *Rhododendron* spp. are commonly grown as ornamental plants in New Zealand, and New Zealand has native genera (for example *Gaultheria* and *Pernettya* spp.) in the same subfamily (Vaccinioideae) as *Vaccinium*. It is not known whether *M. vaccinii-corymbosi* would affect these genera.

(83) Foliar symptoms are initiated by ascospores which overwinter on mummified berries on the ground. Leaf blight becomes evident around 10-17 days after initial infection (Shinners and Olsen, 1996). Infected leaves and shoots, which become covered with conidia, eventually dry up and fall off infected plants. Conidia initiate infections on open flowers, which cause the subsequent mummification of fruit (Ngugi et al., 2002).

(84) The dry conidia are transmitted by insects, wind and rain, so may not be contained in a Level 3A PEQ greenhouse.

(85) The likelihood of *M. vaccinii-corymbosi* being present on the tissue culture pathway is unclear. No evidence was found as to whether the pathogen remains as a latent infection within seemingly healthy leaf and shoot tissue (from which tissue cultures could be selected). However, there is a latent period before symptoms are expressed on mature

berries. In addition, Vilanova *et al.* (2016) note that other members of the *Monilinia* genus may cause latent infections which do not develop until conditions favour disease development. There is no evidence as to whether symptoms of infection would become evident if the disease organism was transferred into tissue culture.

(86) The CPC notes that the related species, *Monilinia fructigena*, is not known to be transmitted in micropropagated plants, but no specific evidence was provided to support this statement (CABI, 2016). Stems and leaves are recorded as being capable of transmitting *M. fructigena* in trade. Some studies have isolated members of the *Monilinia* genus, including *M. fructigena*, living as endophytes within leaf tissue (for example Gherbawy and Gashgari, 2014; Shebany et al., 2014; Hema et al., 2015).

(87) It is unclear from the literature exactly how long the delay is between disease symptoms becoming evident and conidia being produced. However, artificial inoculations (Batra, 1983) showed that after infection with ascospores, visible symptoms of infection first appeared 5 days after inoculation, blight was evident on the 6th day, and conidia became evident on the 11th day after inoculation. No other evidence was found in regards to the timing of conidia production.

(88) Mummy berry is a significant disease of blueberry that could have large impacts on the industry in New Zealand. As noted above, the disease organism is not restricted to members of the *Vaccinium* genus, and native genera that belong to the same subfamily as *Vaccinium* are present in New Zealand.

(89) An additional risk management measure is proposed if tissue cultures of *Vaccinium* spp. are to be held within a Level 3A PEQ greenhouse because:

a) The disease organism is not restricted to the *Vaccinium* genus and can infect other members of the same plant family (*Ericaceae)*, which has some native genera in New Zealand;

b) There is evidence that members of the *Monilinia* genus may survive as endophytes in leaf tissue. *M. vaccinii-corymbosi* is known to have a latent period in infected berries;

c) Conidia of *M. vaccinii-corymbosi* are wind-dispersed and may not be contained within a Level 3A PEQ greenhouse;

d) *M. vaccinii-corymbosi* is a serious disease of blueberry which causes yield losses of up to 70%.

(90) As such it is proposed that on arrival in New Zealand, all tissue culture plantlets must be tested for the presence of *M. vaccinii-corymbosi* before transfer to a Level 3A greenhouse as follows:

a) Representative leaf samples should be taken from each plantlet (or clump of plantlets and plated on agar medium suitable for the isolation of *M. vaccinii-corymbosi*;

b) Samples must be taken when plants arrive in New Zealand, and testing must be completed before plants are deflasked into a Level 3A greenhouse;

c) If sufficient leaf material is not available on imported tissue cultures, these must be bulked up so that representative samples can be taken for testing before plants are deflasked into the Level 3A greenhouse.

(91) Passage into tissue culture followed by testing for the presence of *M. vaccinii-corymbosi* and quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *M. vaccinii-corymbosi* because:

a) The likelihood of *M. vaccinii-corymbosi* being present in tissue cultures is low:

i. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

ii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) The disease organism would be expected to be detected by plating leaves onto isolation medium before plants are transferred to the Level 3A greenhouse;

c) All plants in PEQ will be required to be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible, and before conidia are produced. Level 3A PEQ greenhouse facilities will be required to develop contingency plans to contain infections (for example by segregating plants in a manner which will prevent spore dispersal) as part of the facility approval process.

Phytophthora ramorum

(92) Three members of the *Vaccinium* genus (*V. vitis-idaea*, *V. myrtillus* and *V. ovatum*) are known hosts of the oomycete, *P. ramorum*. Given the wide host range of *P. ramorum*, it seems likely that other members of the *Vaccinium* genus are potential hosts.

(93) *P. ramorum*, along with other members of the *Phytophthora* genus, is considered by MPI to be very high risk pest. MPI are currently assessing the risk associated with various members of the *Phytophthora* genus on imported nursery stock and will undertake public consultation on these measures in due course. The outcomes of that work will be incorporated as necessary into the import requirements for *Vaccinium* nursery stock.

(94) At present, MPI does not require any specific measures to be taken to manage the biosecurity risk associated with *P. ramorum* on plants in tissue culture, although there is a requirement for all tissue culture medium to be free from fungicides and antibiotics. All other classes of nursery stock are considered a potential pathway for *P. ramorum*, and all known host genera (including *Vaccinium*) must meet the requirements set out in part 2.2.1.11 of the IHS for importation of nursery stock.

(95) If the disease organism is present in tissue cultures, disease symptoms are considered likely to become evident either directly in tissue cultured plantlets, or indirectly by colony growth on the tissue culture medium, when cultures are incubated between 17 – 25°C (for example see Linderman and Davis; 2007).

(96) Based on the above, passage into tissue culture is considered justified and sufficient to manage biosecurity risk associated with *P. ramorum* because:

a) The likelihood of *P. ramorum* being present in tissue cultures is low:

i. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

ii. plants are surface sterilised before initiation of tissue cultures, which will help to remove any superficial fungal contamination;

iii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) Antibiotics, fungicides and/or charcoal will not be permitted in the tissue culture medium;

c) Before plants are transferred to the greenhouse, all tissue cultures will be incubated at temperatures between 17 – 25°C for four weeks. If *P. ramorum* was present, mycelium would be expected to become visible during the incubation period.

Septoria albopunctata

(97) *S. albopunctata* is recorded as being a serious problem in south eastern USA and parts of Canada (Caruso and Ramsdell, 1995; Moore, 2015). It has also been recorded from South Korea (CABI, 2016). As well as infecting various members of the *Vaccinium* genus, *Rhododendron minus* is also recorded as a host (Andrianova and Minter, 2005).

(98) Infection can cause leaf spotting, severe defoliation and poor growth, and is most serious in rooting beds (Caruso and Ramsdell, 1995). No quantitative information was found in regards to yield loss caused by the fungus.

(99) Symptoms develop throughout the year (Ojiambo, 2004), and become visible as leaf spots and stem cankers.

(100) Pycnidiospores are recorded as only being released following rain (Ojiambo, 2004).

(101) Passage into tissue culture followed by quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *S albopunctata* because:

a) The likelihood of *S. albopunctata* being present in tissue cultures is low:

i. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

ii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) All plants in PEQ will be required to be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible, and before the disease organism could spread beyond the PEQ facility. Level 3A PEQ greenhouse facilities will be required to develop contingency plans to contain infections (for example by segregating plants in a manner which will prevent spore dispersal) as part of the facility approval process;

c) Overhead irrigation will not be permitted whilst plants are in PEQ. This will ensure that even if for some reason pycnidia were not detected during visual inspection spores would be very unlikely to disperse beyond the facility.

Bacteria

Agrobacterium rubi

(102) *Agrobacterium* spp. inhabit the roots or bases of canes of *Vaccinium* spp. and may cause galls on these plant parts.

(103) *A. rubi* can cause plants to be stunted or weak. Symptoms are recorded as becoming evident within two to four weeks after infection when temperatures are above 20°C, although it is noted that temperatures below 15°C can delay the development of symptoms.

(104) No information was found about the distribution of *A. rubi* within infected *Vaccinium* plants, although recent research (Johnson et al., 2016) showed that in infected *Vitis* plants the organism was widely distributed including in shoot tips and meristems.

(105) There are reports that the related species, *A. vitis* and *A. tumefasciens* can remain latent in micropropagated plants (for example Poppenberger et al., 2002).

(106) Based on the above information it is considered that *A. rubi* has the potential to be transferred into tissue culture, although the likelihood of this seems low if tissue cultures are initiated from plants with no visible symptoms.

(107) The bacterium is soil-borne, so would be contained within a Level 3A PEQ greenhouse if present in infected plants.

(108) Growing season inspection in PEQ, which is the current phytosanitary measure, is considered justified and sufficient to manage the risk associated with this disease organism.

Xylella fastidiosa

(109) *X. fastidiosa* is a very high-risk pest, and MPI policy is to regulate the bacterium at the genus level (i.e. when a single plant species within a genus is known to be a host, the disease organism will be regulated on all members of that genus).

(110) *X. fastidiosa* subspp. *multiplex* and *fastidiosa* can infect southern highbush blueberry (Oliver et al., 2015).

(111) Tissue culture is a potential pathway by which *X. fastidiosa* could enter New Zealand given that the bacterium primarily resides in the xylem tissue of infected plants, and tissue cultures may include xylem tissue.

(112) The IHS currently requires that all deflasked tissue cultures of *Vaccinium* are tested for *X. fastidiosa* by PCR.

(113) Quarantine in a Level 3A PEQ greenhouse, combined with growing season inspection and PCR testing is considered justified and sufficient to manage the risk associated with *X. fastidiosa* because:

a) The likelihood of *X. fastidiosa* being present in tissue cultures is low:

i. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

ii. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) All openings in Level 3A PEQ greenhouses must be covered by insect proof mesh with a maximum aperture of 0.2 mm. This is an appropriate mesh size to manage risk associated with *X. fastidiosa* given that:

i. the adult stages of all known vectors of the disease organism will be excluded by mesh that meets the above specification;

ii. the smallest (nymph) life stages of insect vectors are also likely to be excluded from a Level 3A PEQ greenhouse, especially given that nymphs are usually closely physically associated with host vegetation and no vegetation will come into contact with the exterior of the PEQ facility.

c) If present, *X. fastidiosa* would detected by PCR testing before plants are released from PEQ.

d) All plants in PEQ will be required to be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible.

Viruses

(114) Eight viruses are regulated pests in the *Vaccinium* schedule of the nursery stock IHS, as listed in Appendix 2.

(115) Viruses of *Vaccinium* are known to be present on the tissue culture pathway in international trade. For example, *Blueberry mosaic associated virus* was detected in imported *Vaccinium* tissue cultures that had been deflasked into a PEQ greenhouse in New Zealand.

(116) Pre-determined testing is required for all virus species listed as regulated in the IHS.

(117) Level 3A PEQ is considered justified and sufficient to contain all regulated viruses, or vectors of regulated viruses listed in the *Vaccinium* schedule. This is based on the following known methods of transmission of regulated viruses of *Vaccinium*:

a) Pollen borne or spread by honey bees.

This type of virus can be contained in a Level 3A PEQ greenhouse if flowering is not allowed in PEQ, or if flowering is only allowed after testing has been done for all pollen borne viruses (as is required under the PEQ facility standard for Level 3A greenhouse facilities).

b) Aphid transmitted.

All openings and vents in Level 3A PEQ greenhouses must be screened using stainless steel mesh with a maximum aperture of 0.2 mm. A mesh size of 0.35 x 0.35 mm will exclude the adult stages of aphids.

All Level 3A PEQ greenhouses must use insect traps to monitor for the presence of any flying insects. These traps must be inspected at least once per week, and the MPI Inspector notified if any insects, apart from Sciarid flies, are detected. This provides an additional risk management measure in case any insect vectors do enter a PEQ facility.

c) Nematode transmitted.

Nematodes are unlikely to be present in tissue cultures. The requirement for all plants in Level 3A PEQ greenhouses to be grown on pasteurised or inert growing medium will manage any risk associated with nematode vectors being inadvertently introduced into a facility. As such, any nematode-vectored viruses of *Vaccinium* will be sufficiently managed within a Level 3A PEQ greenhouse.

(118) A summary of virus species that are regulated on *Vaccinium*, including the known modes of transmission, is given in *Appendix 2*.

Diseases of unknown aetiology

Blueberry fruit drop disease

(119) Blueberry fruit drop disease is listed in the IHS as a disease of unknown aetiology with a requirement for growing season inspection to detect this disease in PEQ. This is because at the time the IHS was issued the causal agent of the disease had not been identified.

(120) Recent research (Diaz-Lara et al., 2016) shows that the disease is likely to be caused by a newly identified virus named *Blueberry fruit drop associated virus* (BFDaV). Staff at the MPI Plant Health and Environment Laboratory are currently evaluating PCR primers for the detection of this virus and it is likely that the *Vaccinium* schedule of the IHS will shortly be updated to list BFDaV as a regulated virus which is the causal agent of blueberry fruit drop disease.

(121) Diaz-Lara et al. (2016) proposed that BFDaV should be classified as a new genus within the Caulimoviridae family. Other viruses within this family are known to be insect transmitted (for example by aphids; Whitfield et al., 2015).

(122) Until the IHS is updated to record BFDaV as the causal agent of blueberry fruit drop disease, the requirement for growing season inspection will remain in place. MPI consider that this disease can be adequately contained within a Level 3A PEQ greenhouse, given that it is likely that this virus will be transmitted by aphid vectors.

Phytoplasmas

(123) Three species of phytoplasma are regulated in the *Vaccinium* schedule of the IHS.

(124) Pre-determined testing is required for all three species, using phytoplasma-specific PCR primers.

(125) Phytoplasma vectors all fall within the Hemiptera order of insects, and are either leafhoppers, planthoppers or psyllids. Psyllids are the smallest phytoplasma vectors, and are generally around 1-2 mm long. Adult leafhoppers are generally regarded as being a minimum of around 2 mm in length, whereas planthoppers are generally a minimum of around 1 cm in length. Known vectors of phytoplasmas of *Vaccinium*, namely leafhoppers which belong to the *Scaphytopius* or *Scleroracus* genera, are generally

around 3-4 mm long and 1-2 mm wide (Nielson, 1968). The vector(s) of *Vaccinium* witches broom phytoplasma have not been identified.

(126) None of the above vectors are recorded as being present in New Zealand. If present, they would be excluded by the 0.2 mm insect mesh used in Level 3A PEQ greenhouses.

(127) All Level 3A PEQ greenhouse facilities must use insect traps to monitor for the presence of any flying insects. These traps must be inspected at least once per week, and the MPI Inspector notified if any insects, apart from Sciarid flies, are detected. This will provide an additional risk management measure in case any insect vectors do enter a PEQ facility.

(128) Based on the above, quarantine in a Level 3A PEQ greenhouse combined with pre-determined testing and visual inspection of plants for disease symptoms is considered justified and sufficient to manage the risk associated with regulated phytoplasmas of *Vaccinium*.

Organisms on the MPI emerging risk register

(129) The emerging risk register was checked for all organisms recorded as being as being associated with *Vaccinium*.

(130) Of the organisms in the emerging risk register, one fungal pathogen, *Exobasidium maculosum*, was identified as needing further assessment. The remaining organisms were either managed by existing measures, or were classes of organism that were not considered likely to be associated with nursery stock (for example insects), or were already present in New Zealand and non-regulated. A summary of these organisms is given in *Appendix 3*.

Exobasidium maculosum

(131) *E. maculosum* has been identified as the causal agent of a leaf and fruit spot disease that was first reported in the USA (North Carolina) in 1997. The disease can also cause lesions and blighting of young expanding shoots (Ingram et al., 2016).

(132) The disease has increased in prevalence over recent years, and is to be an emerging disease in the south eastern USA (Brewer et al, 2014). It causes yield losses of up to 70% in certain locations (Brannen, 2013).

(133) Rabbit eye blueberry (*Vaccinium virgatum*) is most susceptible, although *V. corymbosum* and hybrids are also affected.

(134) The disease cycle is not yet fully understood, but it seems that the fungus may not be systemic within plant tissue, and may instead survive through the winter as blastospores on the plant surface or in shallow lesions. Blastospores are thought to initiate new infections in spring (Scherm, 2014; Brannen, 2013). Airborne basidiospores are produced on current season infections.

(135) Stewart et al (2015) commented that *E. maculosum* may have the potential to persist as an endophyte before becoming pathogenic, but did not provide any evidence for this. Similarly, based on field studies, Ingram et al (2016) suggested that the disease organism may be capable of overwintering epiphytically on blueberry tissue, but went on to note that primary infection does not seem to be the result of infection from the previous season.

(136) Based on the above, there is no specific evidence that *E. maculosum* has an endophytic stage. Epiphytic infections should be managed when plants are surface sterilised before passage into tissue culture. As such, based on the current information, the disease organism seems unlikely to be present on the tissue culture pathway.

(137) Passage into tissue culture followed by quarantine in a Level 3A PEQ greenhouse is considered justified and sufficient to manage biosecurity risk associated with *E. maculosum* because:

a) The likelihood of *E. maculosum* being present in tissue cultures is low:

i. no evidence has been found that the fungus is capable of causing latent infections;

ii. material from obviously diseased mother plants is unlikely to be used to initiate tissue cultures. Material needs to be healthy and actively growing to maximise the chances of successful plant growth and/or rooting in tissue culture;

iii. plants are surface sterilised before initiation of tissue cultures, which will help to remove any superficial fungal contamination (for example if the disease organism does overwinter epiphytically);

iv. plants in tissue culture with obvious signs of contamination (either on the plants or in the tissue culture medium) will be discarded as part of routine culture maintenance.

b) All plants in PEQ must be actively inspected for signs or symptoms of the disease organism at least twice per week throughout the PEQ period. This will ensure that if disease symptoms do become evident they will be detected as soon as possible. Level 3A PEQ greenhouse facilities will be required to develop contingency plans to contain infections (for example by segregating plants in a manner which will prevent spore dispersal) as part of the facility approval process.

(138) *E. maculosum* is not listed as regulated in the *Vaccinium* schedule of the IHS. As noted above, the disease organism is unlikely to be present on the tissue culture pathway. For plants imported as cuttings, current generic measures for fungi (growing season inspection in Level 3B PEQ) are considered sufficient to manage the risk associated with the organism. MPI is actively monitoring information about this organism, and will reassess current measures if any new information becomes available. In the meantime, as part of this review of the *Vaccinium* schedule of the IHS, and based on the above information, MPI will amend the pest list to include *E. maculosum* as a regulated fungus of *Vaccinium*.

FEASIBILITY AND PRACTICALITY OF MEASURES

(139) Many measures proposed in the revised IHS are the same as those already required. MPI do not anticipate any difficulties complying with these measures. Likewise, it is not anticipated that the proposed new risk management measures will present a barrier to imports for the following reasons:

a) The four week incubation required for *P. ramorum* is within the temperature range under which tissue cultures of *Vaccinium* are generally grown. As such, this requirement should not have a negative effect on plant health. It is not anticipated that there will be any difficulty in securing space in a Level 3 tissue culture facility to hold imported tissue cultures for this period of time. This is because imported

Vaccinium tissue cultures are usually held in a tissue culture facility and further propagated throughout the PEQ period.

b) The prohibition of overhead irrigation is a practical way to help manage residual risk associated with rain-dispersed organisms. This is seen as unlikely to have an adverse impact on the operations of a PEQ facility.

c) Imported tissue culture plantlets will be tested for *M. vaccinii-corymbosi* before plants are transferred to the greenhouse. The test will consist of plating leaf samples on agar isolation medium. This will cost $75 for the first sample and $25 for each subsequent sample. If morphological examination reveals fungal colonies that require identifying, this would be an additional cost of $255 for the first fungal isolate and an additional $145 for subsequent isolates (all prices excluding GST). If insufficient leaf material is available on the originally imported tissue culture plants, these may need to be multiplied before transfer to the PEQ greenhouse so that representative samples can be taken for testing.

d) All imported *Vaccinium* nursery stock will be tested for *D. vaccinii* during the PEQ period. The costs will be similar to those described for *M. vaccinii-corymbosi*.

(140) The revised IHS will include additional risk management measures to help manage residual risk associated with certain disease organisms (for example this includes specific contingency planning and prohibition of overhead irrigation). Each PEQ facility operator will be required to demonstrate to MPI how they will meet any such requirements before imports can occur. This will be assessed by MPI when the operating manual is approved for each PEQ facility; each operating manual will be expected to show how specific requirements of the IHS will be implemented and how ongoing compliance will be measured. PEQ facility operators will also be required to demonstrate their understanding of import requirements as part of the PEQ operator training programme. Ongoing compliance will be monitored by MPI during regular inspections of each PEQ facility, and by the operator through the internal audit process (as described in the Facility Standard: Post Entry Quarantine for Plants).

Part 3 Draft IHS schedule for *Vaccinium*

Vaccinium

Note: The entry conditions in this schedule only apply to species in the Plants Biosecurity Index listed under Import Specifications for Nursery Stock as "see 155.02.06 under *Vaccinium*", and are additional to those specified in sections 1, 2 and 3 of the import health standard.
These conditions do not apply to *Vaccinium macrocarpon*.

1. **Type of *Vaccinium* [excluding *Vaccinium macrocarpon*] nursery stock approved for entry into New Zealand**

Cuttings (dormant); Plants in tissue culture

2. **Pests of *Vaccinium***

Refer to the pest list.

3. **Entry conditions for:**

3.1 *Vaccinium* cuttings and tissue culture from offshore MPI-accredited facilities in any country

An offshore accredited facility is a facility that has been accredited to the Standard PIT.OS.TRA.ACPQF to undertake phytosanitary activities. The operator of the accredited facility must also have an agreement with MPI on the phytosanitary measures to be undertaken for *Vaccinium*. Refer to the "*Vaccinium* Inspection, Testing and Treatment Requirements".

(i) *Documentation*

Phytosanitary certificate: a completed phytosanitary certificate issued by the NPPO of the exporting country must accompany all *Vaccinium* nursery stock exported to New Zealand.
Import permit: an import permit is required.

(ii) *Phytosanitary requirements*

Before a phytosanitary certificate is issued, the NPPO of the exporting country must be satisfied that the following activities required by MPI have been undertaken.

The *Vaccinium* cuttings / plants in tissue culture [choose ONE option] have been:

- inspected in accordance with appropriate official procedures and found to be free of any visually detectable regulated pests.

AND

- treated for regulated insects and mites as described in in section 2.2.1.6 of the basic conditions within 7 days prior to shipment [cuttings only].

AND

- held and tested for/classified free from specified regulated pests as required in the agreement between MPI and the [name of the MPI-accredited facility].

AND

- held in a manner to ensure that infestation/reinfestation does not occur following inspection and testing at the accredited facility, and certification.

(iii) *Additional declarations to the phytosanitary certificate*
If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by recording the treatments applied in the "Disinfestation and/or Disinfection Treatment" section and by providing the following additional declarations to the phytosanitary certificate:

"The *Vaccinium* cuttings have been:
- held and tested for/classified free from specified regulated pests as required in the agreement between MPI and the [name of the MPI-accredited facility].

AND
- held in a manner to ensure infestation/reinfestation does not occur following inspection and testing at the accredited facility, and certification."

(iv) *Special tissue culture media requirements*
The tissue culture media must not contain charcoal.

(v) *Post-entry quarantine*
PEQ: All *Vaccinium* nursery stock must be imported under permit into post-entry quarantine in a level 2 quarantine facility accredited to standard MPI.STD.PEQ: Facilities for Post Entry Quarantine for Plants.
Quarantine Period and Inspection, Testing and Treatment Requirements: The nursery stock will be grown for a minimum period of 6 months in post-entry quarantine and will be inspected, treated and/or audit-tested for regulated pests, at the expense of the importer. Six months is an indicative minimum quarantine period and this period may be extended if material is slow growing, pests are detected, or treatments/testing are required.

3.2 *Vaccinium* cuttings from non-accredited facilities in any country

(i) *Documentation*
Phytosanitary certificate: a completed phytosanitary certificate issued by the NPPO of the exporting country must accompany all *Vaccinium* nursery stock exported to New Zealand.
Import permit: an import permit is required.

(ii) *Phytosanitary requirements*
Before a phytosanitary certificate is issued, the NPPO of the exporting country must be satisfied that the following activities required by MPI have been undertaken.

The *Vaccinium* cuttings have been:
- inspected in accordance with appropriate official procedures and found to be free of any visually detectable regulated pests.

AND
- treated for regulated insects and mites as described in in section 2.2.1.6 of the basic conditions within 7 days prior to shipment.

AND
- held in a manner to ensure that infestation/reinfestation does not occur following certification.

(iii) *Additional declarations to the phytosanitary certificate*
If satisfied that the preshipment activities have been undertaken, the exporting country NPPO must confirm this by recording the treatments applied in the "Disinfestation and/or Disinfection Treatment" section. No additional declarations are required.

(iv) *Post-entry quarantine*
PEQ: All *Vaccinium* cuttings must be imported under permit into post-entry quarantine in a level 3B quarantine facility accredited to standard MPI.STD.PEQ: Facilities for Post Entry Quarantine for Plants.
Quarantine Period and Inspection, Testing and Treatment Requirements: The nursery stock will be grown for a minimum period of 16 months in post-entry quarantine. During this time it will be inspected, treated and/or tested for regulated pests as specified in the "Inspection, Testing and Treatment Requirements for *Vaccinium*", at the expense of the importer. These times are indicative minimum quarantine periods and may be extended if material is slow growing, pests are detected, or treatments/testing are required.

3.3 *Vaccinium* tissue cultures from non-accredited facilities in any country

(i) *Documentation*
Phytosanitary certificate: a completed phytosanitary certificate issued by the NPPO of the exporting country must accompany all *Vaccinium* nursery stock exported to New Zealand.
Import permit: an import permit is required.

(ii) *Phytosanitary requirements*
Before a phytosanitary certificate is issued, the NPPO of the exporting country must be satisfied that the following activities required by MPI have been undertaken.

The *Vaccinium* plants in tissue culture have been:
- inspected in accordance with appropriate official procedures and found to be free of any visually detectable regulated pests.

AND
- held in a manner to ensure that infestation/reinfestation does not occur following certification.

(iii) *Additional declarations to the phytosanitary certificate*
No additional declarations are required.

(iv) *Special tissue culture medium requirements*
The tissue culture medium must not contain charcoal.

(v) *Post-entry quarantine*
PEQ: All *Vaccinium* tissue cultures must be imported into post entry quarantine in a level 3A or level 3B quarantine facility accredited to standard MPI.STD.PEQ: Facilities for Post Entry Quarantine for Plants..
Special requirements for plants imported into a level 3A quarantine facility:
- Before plants are deflasked into a level 3A quarantine facility the tissue cultures must be held at a level 3 tissue culture laboratory until the following activities have been completed:
    - Tissue cultures must be held between 17°C and 25°C for a minimum period of four weeks and all plants must be inspected by the MPI inspector for signs or

symptoms of *Phytophthora ramorum* prior to deflasking. This inspection will be in addition to growing season inspections which are required in the greenhouse. Sub culturing must not occur during this period.
    - The tissue cultures must be held at the level 3A tissue culture laboratory until they have been tested for, and found free from *Monilinia vaccinii-corymbosi*.
- Requirements at the level 3A quarantine facility:
    - All plants must be inspected for signs and symptoms of pests and disease at least twice per week throughout the entire quarantine period (including during dormancy).
    - Plants must be irrigated using a method which prevents water coming into contact with plant foliage (such as drip irrigation). Overhead irrigation must not be used.
    - Contingency plans must be developed to identify actions that will be taken to contain the propagules of any fungal or oomycete disease organisms in the event of disease symptoms becoming evident during the quarantine period. These plans must be recorded in the facility operating manual.

Quarantine Period and Inspection, Testing and Treatment Requirements:
The imported tissue culture plants must be deflasked and grown for a minimum period of 9 months in post-entry quarantine. During this time plants will be inspected, treated and/or tested for regulated pests as specified in the "Inspection, Testing and Treatment Requirements for *Vaccinium*", at the expense of the importer. This time is the indicative minimum quarantine period and may be extended if material is slow growing, pests are detected, or treatments/testing are required.

Pest List for *Vaccinium*

REGULATED PESTS (actionable)

Insect	
Insecta	
Coleoptera	
Cerambycidae	
Oberea myops	azalea stem borer
Chrysomelidae	
Altica sylvia	blueberry flea beetle
Rhabdopterus picipes	cranberry rootworm
Curculionidae	
Anthonomus musculus	cranberry weevil
Conotrachelus nenuphar	plum curculio
Pseudanthonomus validus	currant fruit weevil
Scarabaeidae	
Popillia japonica	Japanese beetle
Diptera	
Cecidomyiidae	
Contarinia vaccinii	blueberry tip midge
Tephritidae	
Rhagoletis mendax	blueberry maggot
Hemiptera	
Coreidae	
Veneza phyllopus	leaf-footed bug
Homoptera	
Aphididae	
Illinoia borealis	aphid
Illinoia pepperi	blueberry aphid
Cicadellidae	
Euscelis striatulus	Blunt-nosed leafhopper
Scaphytopius magdalensis	sharpnosed leafhopper
Hymenoptera	
Tenthredinidae	
Caliroa annulipes	sawfly
Neopareophora litura	gooseberry sawfly
Pristiphora idiota	willow redgall sawfly
Pristiphora mollis	-
Lepidoptera	
Arctiidae	
Hyphantria cunea	fall webworm
Geometridae	
Itame ribearia	currant spanworm
Noctuidae	
Acronicta tritona	acronicta caterpillar
Actebia fennica	black army cutworm
Notodontidae	
Datana major	azalea caterpillar
Pyralidae	
Acrobasis vaccinii	cranberry fruitworm
Sphingidae	
Paonias astylus	huckleberry sphinx
Tortricidae	
Archips rosanus	rose leafroller
Argyrotaenia velutinana	red-banded leafroller
Aroga trialbamaculella	leaftier
Cheimophila salicella	European carnation tortrix
Choristoneura hebenstreitella	tortricid
Choristoneura rosaceana	oblique-banded leafroller

Cydia packardi	cherry fruitworm
Dichomeris vacciniella	leaftier
Hendecaneura shawiana	blueberry tip borer
Spilonota ocellana	eyespotted bud moth
Thysanoptera	
Thripidae	
Catinathrips similis	thrips
Catinathrips vaccinicola	thrips
Frankliniella bispinosa	flower thrips
Frankliniella tritici	eastern flower thrips
Frankliniella vaccinii	blueberry thrips
Scirtothrips ruthveni	-
Taeniothrips vaccinophilus	thrips
Mite	
Arachnida	
Acarina	
Eriophyidae	
Acalitus vaccinii	blueberry bud mite
Fungus	
Ascomycota	
Diaporthales	
Valsaceae	
Diaporthe vaccinii (anamorph *Phomopsis vaccinii*)	twig blight
Dothideales	
Botryosphaeriaceae	
Botryosphaeria corticis	cane blight
Botryosphaeria vaccinii (anamorph *Phyllosticta elongata*)	--
Polystomellaceae	
Dothidella vacciniicola	twig canker
Erysiphales	
Erysiphaceae	
Microsphaera vaccinii	powdery mildew
Hypocreales	
Hypocreaceae	
Calonectria ilicicola (anamorph *Cylindrocladium crotalariae*)	root and stem rot
Leotiales	
Leotiaceae	
Godronia cassandrae (anamorph *Fusicoccum putrefaciens*)	foliage spot
Godronia cassandrae f. sp. *vaccinii*	cane canker
Sclerotiniaceae	
Monilinia baccarum	mummy berry
Monilinia fructigena (anamorph *Monilia fructigena*)	European brown rot
Monilinia ledi	twig blight
Monilinia megalospora	-
Monilinia oxycocci	-
Monilinia urnula	brown rot
Monilinia vaccinii-corymbosi	brown rot
Phyllachorales	
Phyllachoraceae	
Ophiodothella vaccinii	fly speck leaf spot
Meliolales	
Meliolaceae	
Asteridiella exilis	black mildew
Rhytismatales	
Rhytismataceae	
Lophodermium hypophyllum	-
Lophodermium maculare	leaf spot

Rhytisma vaccinii	tar leaf spot
Basidiomycota: Basidiomycetes	
Agaricales	
Tricholomataceae	
Armillaria mellea (anamorph *Rhizomorpha subcorticalis*)	armillaria root rot
Armillaria ostoyae	armillaria root rot
Exobasidiales	
Exobasidiaceae	
Exobasidium maculosum	
Basidiomycota: Teliomycetes	
Uredinales	
Pucciniastraceae	
Pucciniastrum goeppertianum	rust
Oomycota	
Pythiales	
Pythiaceae	
Phytophthora ramorum	sudden oak death disease
mitosporic fungi (Coelomycetes)	
Sphaeropsidales	
Sphaerioidaceae	
Dothichiza caroliniana	double leaf spot
Coniothyrium vaccinicola	brand canker
Phoma vaccinii	stem blight
Piggotia vaccinii	leaf spot
Septoria albopunctata	septoria spot
Septoria vaccinii	septoria spot
unknown Coelomycetes	
unknown Coelomycetes	
Gloeosporium minus	leaf spot and stem canker
Leptothyrium conspicuum	fly speck
mitosporic fungi (Hyphomycetes)	
Hyphomycetales	
Moniliaceae	
Gloeocercospora inconspicua	leaf spot
Ramularia vaccinii	leaf spot
unknown Hyphomycetes	
unknown Hyphomycetes	
Aureobasidium vaccinii	twig and leaf blight
Bacterium	
Pseudomonadaceae	
Xylella fastidiosa	Pierce's disease
Rhizobiaceae	
Agrobacterium rubi	cane gall
Virus	
Blueberry leaf mottle virus	-
Bluberry red ringspot virus (syn. *Cranberry ringspot virus*)	-
Blueberry scorch virus	-
Blueberry shock virus	-
Blueberry shoestring virus	-
Peach rosette mosaic virus	-
Tobacco streak virus [strains not in New Zealand]	-
Tomato ringspot virus	-
Phytoplasma	
Blueberry stunt phytoplasma	-
Cranberry false blossom phytoplasma	-
Vaccinium witches' broom phytoplasma	-
Disease of unknown aetiology	
Blueberry fruit drop disease	-

Inspection, Testing and Treatment Requirements for *Vaccinium*

ORGANISM TYPES	**MPI-ACCEPTED METHODS** (See notes below)
Insects	Visual inspection AND approved insecticide treatments (Refer to section 2.2.1.6 of the basic conditions)
Mite	Visual inspection AND approved miticide treatments (Refer to section 2.2.1.6 of the basic conditions)
Fungi	Growing season inspection in PEQ for disease symptom expression
Diaporthe vaccinii	Plating of twig or leaf material onto suitable isolation medium
Monilinia vaccinii-corymbosi	Growing season inspection in PEQ for disease symptom expression **Note**: Tissue cultures to be imported into a level 3A quarantine facility under option 3.3 of the Vaccinium schedule must be tested by plating onto suitable isolation medium before transfer to the greenhouse
Oomycota	
Phytophthora ramorum	Growing season inspection in PEQ for disease symptom expression **Note:** Tissue cultures to be imported into a level 3A quarantine facility under option 3.3 of the Vaccinium schedule must be actively grown for at least four weeks on arrival in New Zealand at a temperature between 17-25°C and inspected for signs or symptoms of *P. ramorum* by the MPI inspector before transfer to the greenhouse
Bacterium	
Agrobacterium rubi	Growing season inspection in PEQ for disease symptom expression
Xylella fastidiosa	Growing season inspection in PEQ for disease symptom expression AND PCR
Virus	
Blueberry leaf mottle virus	Herbaceous indicators Cq and Nc AND ELISA or PCR
Bluberry red ringspot virus (syn. *Cranberry ringspot virus*)	ELISA or PCR
Blueberry scorch virus	Herbaceous indicator Cq AND ELISA or PCR
Blueberry shock virus	Herbaceous indicators Nc and Nt AND ELISA or PCR
Blueberry shoestring virus	ELISA or PCR
Peach rosette mosaic virus	Herbaceous indicators Cq and Nt AND ELISA or PCR
Tobacco streak virus [strains not in New Zealand]	Herbaceous indicators Cq and Nt AND ELISA or PCR
Tomato ringspot virus	Herbaceous indicators Cq and Nt AND ELISA or PCR
Phytoplasmas	
Blueberry stunt phytoplasma	Nested PCR or real time PCR using universal phytoplasma primers
Cranberry false blossom phytoplasma	Nested PCR or real time PCR using universal phytoplasma primers
Vaccinium witches' broom phytoplasma	Nested PCR or real time PCR using universal phytoplasma primers
Disease of unknown aetiology	
Blue berry fruit drop disease	Growing season inspection in PEQ for disease symptom expression

Notes:

1. The unit for testing is defined in section 2.3.2.1.
2. Herbaceous indicator hosts: *Chenopodium quinoa* (Cq), *Nicotiana clevelandii* (Nc) and *Nicotiana tabacum* (Nt). At least two plants of each herbaceous indicator species must be used in each test. Tests are to be carried out using the new season's growth in the spring. Plants shall be sampled from at least two positions on every stem including a young, fully expanded leaf at the top of each stem and an older leaf from a midway position. Herbaceous indicator plants must be grown under appropriate temperatures and must be shaded for 24 hrs prior to inoculation. Maintain post-inoculated indicator species under appropriate glasshouse conditions for at least 4 weeks. Inspect inoculated indicator plants at least twice per week for symptoms of virus infection.

3. Virus testing (herbaceous indexing, ELISA and PCR) must be carried out in the spring or under spring-like conditions using the new flush of growth. Bacteria and phytoplasma testing (PCR) must be carried out at the end of the summer or under summer-like conditions.
4. Vaccinium plants must be sampled from at least two positions on every stem including a young, fully expanded leaf at the top of each stem and an older leaf from a midway position.
5. All PCR and ELISA tests must be validated using positive controls prior to use in quarantine testing. Positive and negative controls (including a blank water control for PCR) must be used in all tests. Ideally positive internal controls and a negative plant control should also be used in PCR tests.
6. Inspect *Vaccinium* plants for signs of pest and disease at least twice per week during periods of active growth and once per week during dormancy. Note: plants held in a level 3A quarantine facility under option 3.3 of the IHS must be inspected at least twice per week for the entire quarantine period (including during any periods of dormancy).
7. With prior notification, MPI will accept other internationally recognised testing methods.

Part 4: References

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APPENDIX 1

Summary of an assessment of the fungi that are regulated in the Vaccinium schedule of the nursery stock IHS, but where passage into tissue culture combined with pre-export, on-arrival and growing season inspections is considered sufficient to manage any phytosanitary risk. Further information about the risk management decision is provided in paragraphs (49) to (50).

Disease organism	Notes
Botryosphaeria vaccinii (anamorph *Phyllosticta elongata*)	- Recorded as mainly infecting cranberry. Caruso and Ramsdell (1995) noted that *Phyllosticta elongata* and *P. vaccinii* are both responsible for causing leaf spot, fruit spot and berry speckle of blueberry, but almost no other references to this were found in the literature. - No records found about impacts on any species of *Vaccinium* other than *V. macrocarpon*. - No records have been found of any members of the *Botryosphaeria* genus being transmitted in tissue cultures, although it should be noted that *B. vaccinii* causes symptomless leaf infections on cranberry (Weidemann and Boone, 1983). - Little is known about the disease cycle and epidemiology, but Caruso and Ramsdell (1995) stated that fruiting bodies do not develop until leaves and fruit senesce and drop from plants. - Spores of many members of the *Botryosphaeriaceae* can be induced by incubation in a humid incubation chamber. As such, if present in tissue culture, the disease organism may be visually detectable, given the humid conditions under which tissue cultures are maintained.
Dothidella vacciniicola twig canker	- Very few records of this disease organism were found in an literature search (September 2016; CAB Abstracts and Google Scholar). - No description was found of symptoms on *Vaccinium* following infection by *D. vacciniicola*. - An entry in the CPC for the related species, *D. ulei*, (causal agent of South American leaf blight of rubber) notes that symptoms are likely to be visible in traded tissue culture plants.
Microsphaera vaccinii powdery mildew	- *M. vaccinii* is generally a minor disease, although Caruso and Ramsdell (1995) note that isolated incidences can be serious. - Symptoms are evident as mycelium on upper and/or lower leaf surfaces. Mycelium is recorded as being entirely superficial (Caruso and Ramsdell, 1995). Therefore, the disease organism is considered unlikely to be transferred to tissue cultures. If present, mycelium is expected to be visible in tissue culture.
Calonectria ilicicola (syn *Cylindrocladium crotalariae*) root and stem rot	- *Calonectria ilicicola* is a polyphagous species with a wide geographical distribution. There are few reports of *Vaccinium* being a host, although members of the *Cylindrocladium* genus (not identified to the species level) are recorded as causing root and stem rots of *Vaccinium* spp. (Haralson et al., 2007). - This species appears to be a minor pathogen of *Vaccinium*, based on the lack of information in the literature. - The likelihood of *C. ilicicola* being present in tissue cultures of *Vaccinium* is low, given that *Cylindrocladium* species are reported as causing stem girdling and lesions and attacking developing root systems in *Vaccinium* (Haralson et al., 2007).
Monilinia baccarum	- *M. baccarum* is recorded as being restricted to *Vaccinium myrtillus* (Batra, 1983), and has only been reported from Europe. The disease causes mummification of berries and blight of newly emerging shoots, which turn brown and droop (Munda, 2011). - There was little information on the impacts of this disease on *V. myrtillus*, and it is not expected to have an effect on other species of *Vaccinium*.
Monilinia fructigena	- Although listed in the *Vaccinium* schedule of the IHS, *Vaccinium* spp. do not appear to be a main host of *M. fructigena* and there are few records of this organism having an impact on blueberry. - *M. fructigena* is recorded as having a similar biology to *M. vaccinii-corymbosi* (see paragraphs (81) to (91)).

	- Micropropagated plants are not known to carry the disease organism in trade (CABI, 2016).
Monilinia ledi	- Although included in the *Vaccinium* schedule of the IHS, almost no references were found about this species in a literature search. Batra (1983) noted that the anamorph of *M. ledi* is found on *Vaccinium uliginosum*, whereas the teleomorph is found on *Rhododendron tomentosum* (syn *Ledum palustre*). - No information was found about this organism having any potential adverse effects on the economy or environment.
Monilinia megalospora	- Although included in the *Vaccinium* schedule of the IHS, almost no references were found about this species in a literature search. Based on genetic analysis, *M. megalospora* is considered likely to be most closely related to *M. baccarum, M. oxycocci* and *M. vaccinii-corymbosi* (Holst-Jensen et al., 1997). Batra (1983) noted that *M. megalospora* is found only on *Vaccinium uliginosum.* - No information was found about this organism having any potential adverse effects on the economy or environment.
Monilinia oxycocci	- *M. oxycocci* is recorded as an important disease of *V. macrocarpon* and also infects *V. oxycoccus* (wild small cranberry; Batra, 1983; Caruso and Ramsdell, 1996; Diekmann et al., 1994). No records were found of it infecting other members of the *Vaccinium* genus. - Symptomatic shoots of infected plants would not be expected to be transferred into tissue culture. - *V. macrocarpon* is not included within the scope of this assessment, and there are no records in MPI databases of *V. oxycoccus* having been imported as nursery stock.
Monilinia urnula	- *M. urnula* is recorded as being restricted to *Vaccinium vitis-idaea* (Batra, 1983; Munda, 2011) and causes blight of newly emerging shoots, which turn brown and droop, and mummification of berries (Munda, 2011). The disease has been reported from Europe and Japan (Munda, 2011). - There was little information on the impacts of this disease, which is not expected to have an effect on other species of *Vaccinium*.
Ophiodothella vaccinii fly speck leaf spot	- Causes a foliar disease of *Vaccinium arboretum* in the USA, resulting in large lesions on leaves, few reports of this disease organism in the literature. - *V. arboretum* is not an economically important species of *Vaccinium*, and is not listed on the PBI (so is not eligible for import under the *Vaccinium* schedule in the IHS).
Asteridiella exilis black mildew	- A single record was found of this species infecting *Vaccinium* sp. in Hawaii (Raabe et al., 1981), so this is not considered to be an important pathogen. - Members of the *Asteridiella* genus appear to be mildews which affect leaves and are mostly tropical in distribution.
Lophodermium hypophyllum (syn Lophodermium oxycocci).	- Recorded as causing serious disease of cranberry in Washington and Oregon. - Although recorded in the *Vaccinium* schedule of the IHS, the host range appears to be limited to *V. macrocarpon* (not considered in this assessment). *L. hypophyllum* has also been recorded on a dead leaf of *V. oxycoccus* (Minter, 2005) and *V. vitis-idaea* is recorded as a potential host (Diekmann et al., 1994). - No records were found of this disease organism affecting production of species of *Vaccinium* other than *V. macrocarpon*. - There is a latent period before infections become visible in cranberry, and although infection generally occurs in summer, symptoms are usually not observed until winter or the following spring Bristow (Carruso and Ramsdell, 1995). - Species of *Vaccinium* other than *V. macrocarpon* are considered unlikely to be hosts. If disease symptoms were expressed on material imported into PEQ these would be expected to become evident before ascospores were produced, so the disease organism would not be expected to disperse beyond the PEQ facility.
Lopohdermium maculare	- Recorded in the IHS as causing leaf spot. - Does not appear to be a major disease organism, with no specific records found of this causing disease symptoms in *Vaccinium.*
Rhytisma vaccinii	- This species is recorded as causing ‘tar spot’ of *Vaccinium* in Florida, Oklahoma and Texas (Horst, 2013; Field Manual of Diseases on Trees

tar leaf spot	and Shrubs). No further information was provided. - Other members of the genus appear to infect leaves of susceptible hosts.
Armillaria mellea (anamorph *Rhizomorpha subcorticalis*) and *Armillaria ostoyae* armillaria root rot	- Members of the *Armillaria* genus infect roots and woody tissues. - Infections are caused by root contact with mycelium of the disease organism. Basidiospores are not considered to be a common source of infection (Caruso and Ramsdell, 1995). - Infections are localised within the trunk, or below the soil line.
Pucciniastrum goeppertianum	- Recorded as a relatively minor disease (Caruso and Ramsdell, 1995) that is present in North America, Europe and Japan. - Causes witches broom symptoms and may cause total yield loss in infected plants. Because disease incidence is usually very low, crop losses are not considered significant. - Infections are initiated when aeciospores germinate on leaves or stems of *Vaccinium* plants. Aeciospores are produced on the alternative host (*Abies* spp.), but are not known to be produced on infected *Vaccinium* plants. Disease incidence is highest in plantations located near *Abies* trees. - Symptoms do not usually become apparent for approximately one year after infection, so recently infected symptomless plants could potentially be selected for passage into tissue culture. - It is not clear whether symptoms would be expressed *in vitro*. No evidence was found of either *P. goeppertianum* or other members of the *Pucciniastrum* genus being present in tissue culture. - In infected *Vaccinium* plants, symptoms become evident before basidiospores are produced, so the disease organism would not be expected to disperse beyond the PEQ facility.
Dothichiza caroliniana double leaf spot	- An uncommon disease, reported from North Carolina (Caruso and Ramsdell, 1995) and more recently Argentina (Baino et al., 2007). - Causes leaf spotting, recorded as having an optimal temperature for growth of 20 – 27°C. - Can result in severe defoliation of highbush cultivars (Caruso and Ramsdell, 1995), but generally regarded as a disease of minor concern. - Baino et al. demonstrated expression of symptoms five weeks after plants were inoculated with conidial suspension when plants were incubated under humid conditions between 25-29°C. - Infected plants are considered likely to display disease symptoms, so the disease organism is considered unlikely to be transferred into tissue culture.
Coniothyrium vaccinicola (syn *Sphaeria vacciniicola*) brand canker	- There are very few records of this disease organism in the literature, and no records of it having an impact on blueberry production. - A related species, *Coniothyrium sporulosum* has recently been implicated as potentially being pathogenic towards *Vaccinium*, but pathogenicity has not been determined (Sabaratnam et al., 2009). *C. sporulosum* is already recorded as being present in New Zealand). - The CPC records the related organism *Leptosphaeria coniothyrium* (present in New Zealand, syn. *Coniothyrium fuckelii*) as being a wound pathogen of *Vaccinium* and notes that tissue culture is not a known pathway for transmission of this disease organism.
Phoma vaccinii stem blight	- A description of symptoms associated with *P. vaccinii* could not be found. - Some other members of the *Phoma* genus have been recorded in association with *Vaccinium*, although none are recorded as significant pathogens.
Piggotia vaccinii leaf spot	- A description of symptoms associated with *P. vaccinii* could not be found, although there was one record of *Piggotia* sp. being isolated from fruit of *V. macrocarpon* in Oregon in 2004. - Because of the limited information, this organism was not considered further here.
Septoria vaccinii septoria spot	- There are few records of this disease organism in the literature, although Caruso and Ramsdell (1995) record *Septoria* sp. as causing 'brown leaf spot' of lowbush blueberry and *S. albopunctata* as causing leaf spot and stem canker.

	- Symptoms are visible on leaves and stems early in the growing season.
Leptothyrium conspicuum fly speck	- Few records of this disease organism in the literature, no records of symptoms. - Passage into tissue culture, combined with pre-export and on-arrival inspections are considered sufficient to manage any risk associated with this organism.
Gloeocercospora inconspicua leaf spot	- Recorded from wild blueberry and some commercial cultivars in North Carolina. - Little information about this disease organism, which does not seem to cause significant impacts.
Ramularia vaccinii leaf spot	- Few records of this disease organism in the literature, with no description of symptoms found during a literature search. - The teleomorph (*Mycosphaerella*) is a commonly known genus of plant pathogens that generally causes foliar symptoms, but can also cause stem cankers or fruit symptoms. - Micropropagated plants are considered capable of dispersing members of this genus, although symptoms are considered likely to be visible in culture (CABI, 2016).
Aureobasidium vaccinii twig and leaf blight	- Few records of this disease organism in the literature. - Some members of the genus are recorded as causing stem dieback of *Vaccinium* (Caruso and Mika, 1991).

APPENDIX 2

Summary of virus species that are regulated in the *Vaccinium* schedule of the IHS for importation of nursery stock.

Virus	Notes
Blueberry leaf mottle virus (BLMoV)	- Pollen borne/spread by honeybees, seed transmissible and sap transmissible to a limited host range (Caruso and Ramsdell, 1995; Martin et al., 2012). - Martin et al. (2012) note that nematode and aphid transmission studies were unsuccessful, although other members of the genus (Nepovirus) are transmitted by these vectors. - Can be contained within Level 3A PEQ provided that flowering is not permitted in PEQ, or is only allowed after testing for BLMoV has been completed.
Blueberry red ringspot virus (syn. *Cranberry ringspot virus*)	- Graft transmissible and spread through propagation of infected plants (Martin et al., 2012). - No reports of transmission by insect vectors. Gillet and Ramsdell (1988) noted that aphid and/or mealybug transmission is suspected, although experimental transmission by these organisms was not successful (Caruso and Ramsdell, 1995). - Level 3A PEQ would be sufficient to contain the putative insect vectors.
Blueberry scorch virus	- Aphid transmitted (*Aphis pomi*. *A. spiraecola*, *Ericaphis fimbriata*, *Myzus ornatus*, *M. persicae*, *Illinoia pepperi*, *Rhopalosiphum padi* (Jan van der Gaag et al., 2012); some of these vectors are present in New Zealand. - 0.2 mm mesh size of Level 3A greenhouses is considered sufficient to contain and exclude all aphid vectors.
Blueberry shock virus	- Pollen borne/spread by honeybees (Martin et al., 2012; Bristow and Martin, 1999). - Appropriately contained within Level 3A PEQ provided that flowering is not permitted, or is only allowed after testing has been completed.
Blueberry shoestring virus	- Known to be aphid transmitted, unclear if there are any other vectors (Martin et al,. 2012). - Level 3A PEQ would be sufficient to contain and exclude potential aphid vectors.
Peach rosette mosaic virus	- Spreads in soil via nematode vector (Martin et al., 2012). - Level 3A suitable as nematode vectors will not be present, or would be contained within the facility.
Tobacco streak virus [strains not in New Zealand]	- Pollen-transmitted via thrips carriers, seed transmitted in other hosts. - Level 3A PEQ does not necessarily exclude all thrips species. - Appropriately contained within Level 3A PEQ provided that flowering is not permitted, or is only allowed after testing has been completed.
Tomato ringspot virus	- Spreads in soil via nematode vector. - Level 3A suitable as nematode vectors will not be present, or would be contained within the facility.
Blueberry fruit drop associated virus	- Not currently listed in the IHS, but now considered likely to cause Blueberry fruit drop disease (recorded as a disease of unknown aetiology, for which there is a requirement for growing season inspection). - MPI anticipate that the IHS will be updated in the near future to include this virus as a regulated organism with a requirement for specific testing in PEQ. - Vectors not yet identified, but other members of this family of viruses are aphid transmitted. - 0.2 mm mesh size of Level 3A facilities is sufficient to contain and exclude potential aphid vectors.

APPENDIX 3

Summary of organisms recorded in the MPI emerging risk register as potentially being present on *Vaccinium* nursery stock

Disease organism	Summary	Conclusion
Blueberry mosaic disease or blueberry mosaic associated virus (BlMaV).	This was included in the emerging risk register as a result of an expansion of distribution within the USA. This disease is already regulated.	Already included on the regulated pest list, IHS schedule up to date for this organism.
Blueberry necrotic ring blotch virus (BNRBV)	BNRBV is a relatively recently described virus of blueberry, first recorded in 2006. The virus causes defoliation of plants, but is not known to be systemic. Recent evidence suggests that the virus is not transmitted through vegetative propagation (Robinson et al., 2016). If present, experimental evidence shows that symptoms would be expected to become evident within two to three weeks. Mites have been identified as a possible vector in the field (Burkle et al., 2012)	Given the evidence that the disease is not transmitted through vegetative propagation, this virus is considered highly unlikely to be present on the tissue culture pathway. Although the disease may be transmitted by mites, inspection for symptoms is considered sufficient to manage the risk in a Level 3A PEQ facility given the extremely low likelihood of BNRBV being present. MPI will assess whether this organism should be included on the regulated pest list when the IHS schedule is next reviewed.
Blueberry scorch virus (BlScV)	This organism was included in the emerging risk register as a result of it being detected in a new part of the USA.	Already included on the regulated pest list, IHS schedule up to date for this organism.
Blueberry shock virus (BlShV)	This organism was included in the emerging risk register as a result of it being detected in a new part of the USA.	Already included on the regulated pest list, IHS schedule up to date for this organism.
Candidatus Phytoplasma solani	Symptoms identified on diseased blueberry plants in Serbia in 2009 were identified as being caused by a phytoplasma belonging to the 16SrXII-A (stolbur) subgroup (Starović et al., 2013).	Generic measures for phytoplasmas described earlier in paragraphs (123) to (128) of this RMP are considered sufficient to manage the risk. MPI will assess whether this organism should be included on the regulated pest list when the IHS schedule is next reviewed.
Diaporthe vaccinii	This organism was included in the emerging risk register as a result of a change in distribution.	Already included in the IHS, see paragraphs (59) to (68) of this RMP.

Exobasidium maculosum	This is an emerging fungal disease of *Vaccinium* that may cause yield losses of up to70%. The disease is increasing in significance in the USA.	Because of the potential significance of this disease organism, a more detailed assessment is provided in paragraphs (131) to (138) of this RMP.
Thekopsora minima (blueberry leaf rust)	There are two entries for this rust fungus in the emerging risk register, both relating to changes in the worldwide distribution of this organism.	*T. minima* is already present in New Zealand, so is non-regulated. No measures required in the IHS.
Totricid moths (four species)	Four totricid moth species (*Clarkeulia deceptiva, C. bourquini*, *Platynota meridionalis* and *Argyrotaenia sphaleropa*) are now known to be present on *Vaccinium*, and are not currently listed on the *Vaccinium* pest list.	As with other insect pests of *Vaccinium*, risk is considered appropriately managed by passage into tissue culture
Xylella fastidiosa subsp. *multiplex* and *fastidiosa*	This was included in the emerging risk register when *X. fastidiosa* subsp. *fastidiosa* was identified as infecting *Vaccinium*. This disease organism is already regulated in the *Vaccinium* schedule of the IHS.	Already included in the IHS, see paragraphs (109) to (113) of this RMP.