Ministry for Primary Industries
Manatū Ahu Matua

Risk Management Proposal:

Fresh Bananas (*Musa* spp.) for Consumption from the People's Republic of China

MPI Discussion Paper No: 2015/03

ISBN: 978-0-477-10533-0(online)
ISSN: 2253-3907(online)

January 2015

New Zealand Government

Growing and Protecting New Zealand

Plant Imports
Plants, Food & Environment
Ministry for Primary Industries
Pastoral House
25 The Terrace
PO Box 2526
Wellington 6140
New Zealand
Tel: +64 4 894 0100
Fax: +64 4 894 0662
Email: plantimports@mpi.govt.nz

DISCLAIMER

This document does not constitute, and should not be regarded as, legal advice. While every effort has been made to ensure the information in this document is accurate, the Ministry for Primary Industries does not accept any responsibility or liability whatsoever for any error of fact, omission, interpretation or opinion that may be present, however it may have occurred.

Requests for further copies should be directed to:

Plant Imports
Plants, Food & Environment
Ministry for Primary Industries
PO Box 2526
Wellington 6140
New Zealand

Email: plantimports@mpi.govt.nz

SUBMISSIONS

The Ministry for Primary Industries (MPI) invites comment from interested parties on the proposed new import health standard (IHS) for fresh banana (*Musa* spp.) from the People's Republic of China for consumption which is supported by this document. The meaning of an IHS is defined in section 22(1) of the Biosecurity Act 1993 as 'An import health standard specifies requirements to be met for the effective management of risks associated with importing risk goods, including risks arising because importing the goods involves or might involve an incidentally imported new organism". MPI therefore seeks comment on the requirements (including measures) in the proposed new IHS. Submitters may also like to comment separately on other aspects of the IHS and MPI will respond to these in due course.

The following points may be of assistance in preparing comments:

- Wherever possible, comment should be specific to a particular section/paragraph in the IHS.
- Where possible, reasons, data and relevant 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.

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

Plant Imports
Plants, Food & Environment
Ministry for Primary Industries
PO Box 2526
Wellington 6140
New Zealand

The closing date for submissions is 5:00 pm, Friday 13 February, 2015.

Submissions received by the closure date will be considered during the development of the final draft IHS. Submissions received after the closure date may be held on file for consideration when the issued IHS 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 purpose of this document is to provide information about the proposed measures contained in the draft import health standard (IHS) for "Fresh Banana (*Musa* spp.) for Consumption from the People's Republic of China".

2. This document is not the subject of consultation but MPI will accept comments and suggestions in order to improve future consultation.

SCOPE

3. This document provides the rationale for the proposed measures contained in the draft import health standard (IHS) for Fresh Banana (*Musa* spp.) for Consumption from the People's Republic of China (PRC). It includes:

    - pests (hazards) identified that may be associated with the importation of fresh banana into New Zealand from PRC;
    - an assessment of the general requirements for managing pests associated with fresh banana;
    - identifying specific pests or pest groups requiring additional phytosanitary measures; and
    - an assessment of risk management options considered for specific pests.

4. This document is in two parts.

    - Part 1 provides the background and context used to inform the decision-making process identifying the strength of measures required to manage regulated pests identified on the pathway covered by the scope.
    - Part 2 lists the information sources and the assessment for the proposed measures to manage risks associated with banana from PRC.

PART 1: RISK MANAGEMENT DECISION-MAKING

CONTEXT

INTERNATIONAL

5. 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 (SPS Agreement) (SPS-Agreement, 1995), and section 23(4)(c) of the (Biosecurity Act, 1993).

6. The WTO and SPS Agreements set 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 in managing the risks associated with the international movement of goods.

7. "The SPS Agreement will continue to guide how New Zealand sets standards and makes decisions related to biosecurity. In particular, it will be important to maintain the standards of transparency and scientific rigour required by the SPS Agreement, and to make decisions as quickly as possible. This will encourage other countries to comply with the rules of the SPS Agreement, and also demonstrate that New Zealand's strict controls are justified to countries that challenge them" (Balance in Trade).

8. IHSs are developed in accordance with the Biosecurity Act. In keeping with New Zealand's obligations under the WTO SPS Agreement and the International Plant Protection Convention (IPPC), phytosanitary measures must:

    - be justified and can only be for regulated pests;
    - be commensurate with the risk;
    - must not discriminate unfairly between countries or between imported and domestically produced goods; and
    - are to 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.

9. Note that international standards guidelines or recommendations referred to in the WTO agreement are those of Codex, World Organisation for Animal Health (OIE) and IPPC.

10. As a member of the Asia Pacific Plant Protection Commission (APPPC) New Zealand also recognises regional phytosanitary standards developed by APPPC.

DOMESTIC

11. The New Zealand biosecurity system is regulated through the Biosecurity Act 1993. Section 22 of the Act describes the meaning of an IHS and requires all risk goods (including plants and plant products) entering New Zealand to be covered by one.

12. The Ministry for Primary Industries (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).

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

NEW ZEALAND'S BIOSECURITY SYSTEM

14. Fresh product can only be imported subject to an IHS and from a country where the National Plant Protection Organisation (NPPO) has provided evidence of national systems, programmes and standards for regulatory oversight of the export industry in accordance with International Standard for Phytosanitary Measures (ISPM) 7: *Phytosanitary certification system* (Food and Agriculture Organisation, 2011) to the satisfaction of a Chief Technical Officer (CTO). The export system is subject to audit by MPI.

15. The export system must contain (at least) the systems and procedures for the following elements based on ISPM 7 and ISPM 12: *Phytosanitary certificates* (Food and Agriculture Organisation, 2011)

    - recognition of the competent authority;
    - registration of export production sites;
    - standard commercial agronomic practice;
    - monitoring and oversight;
    - inspection for the pests and disease specified in Part 3 of the relevant IHS;
    - operational requirements for disease monitoring;
    - registration of packing stations;
    - disinfection treatment (where appropriate) at packing stations and prevention of contamination after disinfection;
    - traceability system (including labelling);
    - freedom from trash;
    - prevention of contamination in storage, transport and handling;
    - phytosanitary inspection and certification;
    - post inspection product security; and
    - audit arrangements.

16. If the commodity has associated pests that require targeted or specified measures to be applied, an export plan based on an MPI pathway assessment visit and identifying how those measures will be applied will be negotiated with MPI. The export plan is subject to audit by MPI.

17. The export plan must contain (at least) the systems and procedures for the following elements:

    - competent/trained personnel;
    - records completion and maintenance;
    - procedures for the application of measures specified in Part 3 of the relevant IHS;
    - product security following the application of measures;
    - monitoring and oversight of the measures;
    - pest security during packing and storage; and
    - NPPO inspection and phytosanitary certification.

18. Managing pest risks on imported commercial consignments of plants and plant products occurs at several layers operating as an integrated system to provide a high level of phytosanitary security.

19. The objective of the system is to reduce to an acceptable level the likelihood of entry and establishment of new pests (including pests, diseases and weeds).

20. No biosecurity system is capable of reducing risk to zero.

21. The phytosanitary system is focused on ensuring that the most significant pests, for example economically important fruit flies, are unlikely to ever establish in New Zealand. However the system aims to manage risk associated with all regulated pests.

22. New Zealand operates a biosecurity system for which the phytosanitary aspect (covering plant health) is a key part. The system has seven main components covering:

    - international standards;
    - trade agreements and bilateral arrangements;
    - risk assessment and IHS development;
    - border interventions;
    - surveillance;
    - readiness and response; and
    - pest management.

23. The components of the phytosanitary system are implemented to reduce the likelihood of pests entering and establishing, or to provide effective management should they establish.

24. The focus of the IHS for plant-based goods is to manage any phytosanitary risk associated with an import before it arrives at the New Zealand border; the expectation is that commercial consignments of plants and plant products meet New Zealand's phytosanitary import requirements on arrival. Phytosanitary measures that must be applied before risk goods can be given clearance into New Zealand are contained in IHSs.

25. MPI monitors the pathway performance related to each IHS to ensure they provide the expected level of protection. MPI monitors the pathway to ensure that hazards identified in the IHS are effectively managed by the measures, and that the measures are applied correctly. This is achieved through inspection at the border (and where possible, identification of pests detected) and audits of the export systems and critical points contained in the export plans.

26. The phytosanitary system also includes verification, inspection and monitoring activities when a commercial consignment of plants and plant products arrives at the New Zealand border.

27. The decision to inspect (or not) a sample of the consignment and the action selected on detection of live pests will depend on a number of factors including:

    - the overall risk assessed for the commodity and country;
    - previous non-compliances on the pathway;
    - risk assessment of any detected live pest;
    - changing risk profile in the country of export.

28. A sample of each consignment on a high risk pathway (for example, fruit fly host material) will in almost all cases be inspected.

29. MPI will inspect documentation and may inspect a sample of fresh produce consignments on arrival in New Zealand. A 600 unit randomly selected sample may be drawn from each lot and inspected for live regulated pests. A nil detection of live regulated pests in a 600 unit sample provides (approximately[1]) that with 95%

[1] The actual level of confidence depends on a number of factors including the efficacy of inspection in detecting the pest, and the distribution of the pest on the consignment

confidence no less than 99.5% of the units are free of regulated pests. Clearance will only be given to those lots where no detections of live regulated pests (unless irradiation was used as the treatment[2]) are found and all other requirements have been met.

30. Detection of live regulated pests associated with a commodity on arrival in New Zealand will result in one of the following actions to be taken:

- reshipment of the consignment;
- destruction of the consignment; or
- treatment of the consignment.

31. In addition, detection of certain significant pests of concern (for example, economically important fruit flies), and repeated interceptions of certain high risk pests (for example *Thrips palmi*) may result in the pathway being suspended pending a full traceback and remedial action.

RISK ANALYSIS

SUMMARY OF THE RISK ANALYSIS PROCESS

32. Before attempting to describe the New Zealand biosecurity system as it relates to the management of risks related to trade, it is important that the four terms that result in most confusion are defined: risk, risk assessment, risk management, and risk analysis.

a. *Risk:* the likelihood of the occurrence and the likely magnitude of the consequences of an adverse event.

b. *Risk assessment*: the evaluation of the likelihood, and the biological and economic consequences, of entry, establishment, or exposure of an organism or disease.

c. *Risk management*: the process of identifying, selecting and implementing measures that can be applied to reduce the level of risk.

d. *Risk analysis*: the process comprising hazard identification, risk assessment, risk management and risk communication."

PEST RISK ASSESSMENT

33. A description of the pest risk assessment (PRA) process for quarantine pests can be found in the ISPM 11: *Pest risk analysis for quarantine pests* (Food and Agriculture Organisation, 2013).

34. More information on MPI's risk analysis process and procedures can be found at: http://www.biosecurity.govt.nz/regs/imports/ihs/risk.

35. The risk assessment identifies pests (termed 'hazards') associated with the commodity according to IPPC criteria.

36. MPI's risk assessment process provides qualitative information about the:

- likelihood of a pest entering as a result of its association with a commodity;
- likelihood of a pest being exposed to a suitable host in New Zealand;
- likelihood of a pest establishing; and the
- likelihood of spread of a pest within New Zealand.

[2] Note: irradiation does not cause mortality but inhibits development of pests to the next lifestage (for example, larvae to pupae). Hence live pests may be detected following irradiation but because development is arrested, the risk is managed.

37. It also includes an assessment of the likely economic, environmental, socio-cultural and human health consequences the pest may have if it were to establish and spread in New Zealand as the result of its association with a pathway.

38. The risk assessment also documents the key assumptions made when assessing likelihoods and any specific uncertainties.

PEST EVALUATION

39. New Zealand categorises organisms associated with the commodity into:

- regulated pests (quarantine pests and regulated non-quarantine pests[3], ISPM 5 (2002): *Glossary of phytosanitary terms* (Food and Agriculture Organisation)), and
- non-regulated pests.

40. Organisms are included on the regulated pest list for a commodity if they are:

- absent from New Zealand or under official control, and
- likely to be present on the pathway if risk was unmanaged, and
- known to be associated with the commodity, and
- hosted by species present in New Zealand, and
- climatically able to establish in New Zealand, and
- likely to cause unacceptable economic, environmental or human health impacts to New Zealand.

41. Targeted or specified measures are required where the likelihood of introduction of pests is unacceptable or where the impact of establishment of the pest is very significant.

42. Often, due to uncertainties with the information on which a risk assessment is based, the risk assessment cannot identify a specific level of impact or likelihood of entry and establishment. Rather a range of potential impacts or likelihoods are identified.

43. In such cases MPI takes a precautionary approach during its risk management assessment of the strength of measure required. If additional information is provided at some future date, this stringency can be reviewed.

PEST RISK MANAGEMENT

44. Pest risk management involves identifying and implementing the best option(s) for reducing or eliminating the likelihood of the risk occurring (Article 5, (SPS-Agreement, 1995)).

45. Pest risk management evaluates and selects options (measures) to reduce the likelihood of introduction (encompassing entry, exposure, establishment and spread) of a regulated pest for New Zealand to an acceptable level while recognising it is not possible to completely eliminate all risk.

46. Measures are applied to effectively manage the risks. If a significant risk cannot be effectively managed, MPI will not issue an IHS. A measure applied to a specific pest will in many circumstances effectively manage other pests for which no separate measure has been identified.

47. The selection of appropriate measures is made considering both the likelihood and impacts of introduction against the following criteria:

[3] Note: New Zealand does not use the concept of "regulated non-quarantine pest", hence regulated pest means the same as quarantine pest

- technically justified;
- effectiveness of the management option at reducing the risk to an acceptable level;
- risk management is not more stringent than necessary;
- risk management is feasible and practical;
- measures are consistent with previous decisions;
- measures are consistent with measures proposed on New Zealand exports (where appropriate); and
- cost effectiveness.

48. MPI selects measures where the strength of the measure is proportionate with the risk. The strength of the measure chosen depends on the likelihood of introduction and the likely magnitude of impacts of introduction.

49. "Strength of measures" is a concept found in the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement).

50. (Food and Agriculture Organisation, 1998) discusses “strength of measures” as follows:
    - “The strength of measures for regulated pests should be based on the risk associated with the pest as determined by PRA. Stronger measures may be justified where risk is greatest.”
    - “Pest risk assessment necessarily precedes consideration of the strength of measures.”
    - “The level of pest risk and the strength of measures used to manage the pest risk are visualized as a sliding scale where the strength of measures corresponds to the level of risk.”; and
    - “A regulated pest may not require measures (action) if the results of PRA indicate that the level of risk is acceptable, measures are not possible, feasible, or cost effective, or where particular circumstances do not warrant action which may be taken based on the risk posed by the pest under other conditions (e.g. consumption versus propagation).”

51. The concept is also reflected explicitly in the New Revised Text of the IPPC (1997) where, in Article II (Use of Terms), pest risk analysis is defined as "... the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it" (IPPC 1997).

52. Amongst other things, MPI considers previous decisions on measures to guide its selection of measures because these have been previously assessed by technical experts as being sufficient to effectively manage risks in other country/commodity combinations and the same pests, and were consulted with stakeholders.

53. The measures defined in the IHS target the risks assessed for regulated pests associated with a commodity and the strength of the measure required depends on the risk the pest poses to New Zealand. For example, high impact pests such as fruit fly require measures with higher level of stringency than pests of lesser impact. In such cases, a pre-export treatment or an equivalent measure (specified by New Zealand) may be required to manage the risk.

54. For lower impact pests the combination if commercial production with packhouse grading of export fruit, official inspection and certification, and inspection on arrival in New Zealand is often sufficient to reduce the level of infestation by regulated pests

to an acceptable level because damaged or infested/infected product would not meet commercial grade requirements.

55. New Zealand export production systems are used as a template to identify commercial practices that may be considered appropriate measures to act against regulated pests. For example, New Zealand relies on industry practices (for example, IPM) to manage pests on exported products identified as regulated but of lower concern to importing countries.

56. Acceptance of industry practice to manage pests of lower concern is an important plank in New Zealand's horticulture export system and is used to support New Zealand's market access requests. New Zealand argues strongly that these measures are sufficient to manage these pests, and that more stringent measures (treatments or Official Assurance Programmes (OAPs)) are required only for significant pests. Usually standard pest management used during commercial production, and official inspection and certification are sufficient to manage most pests.

57. To ensure New Zealand can have confidence in the commercial production and export systems in export countries, and pathway assessment visit will be conducted for new commodity/country combinations. Pathway assessments will be in addition to any systems audits.

58. Depending on the outcome of a pathway assessment, measures are identified to provide an appropriate level of protection to New Zealand. These will often be consistent with those negotiated for similar pests by New Zealand for market access to certain export markets.

59. Once trade has begun, MPI will also conduct pathway assurance visits to ensure compliance with the negotiated export plan.

DESCRIPTION OF THE STRENGTH OF MEASURES

60. In broad terms there are three options available for pest risk management based on the risk of introduction and the potential impact the pest poses to New Zealand:

    i. Phytosanitary inspection and certification by the exporting NPPO (minimum requirement for all products);

    ii. Targeted Measures (in addition to phytosanitary certification and inspection); and

    iii. Specified Measures (in addition to phytosanitary certification and inspection).

PHYTOSANITARY CERTIFICATION AND INSPECTION

Pre-export inspection and phytosanitary certification

61. Pre-export inspection and phytosanitary certification of all commercially produced fresh produce for export to New Zealand is required.

62. A minimum sample of 600 randomly selected fruit must be inspected using official procedures and at 10x magnification for cryptic or small pests. Consistent with international practice, the inspected sample must be free from regulated pests.

63. Where any live regulated pest is found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot must be rejected for export to New Zealand.

Inspection on arrival in New Zealand

64. MPI will inspect documentation and may inspect a sample of the consignment on arrival in New Zealand as described in the section on New Zealand's biosecurity system in this document.

65. When a consignment is found to be infested with live regulated pests on arrival in New Zealand, one of the following risk management activities will be applied:

- reshipment of the consignment;
- destruction of the consignment; or
- treatment of the consignment

TARGETED MEASURES

66. Where regulated pests are assessed by New Zealand as presenting a higher likelihood of establishment and spread, or a higher impact, MPI requires measures to be applied that target those pests ('Targeted Measures', TM). The pests requiring targeted measures are listed in Part 3 of the IHS.

67. Targeted measures may be proposed by the exporting country and must be negotiated with MPI. MPI will consider the proposed measures to ensure they are sufficient to manage the risk. Alternative measures may be proposed by MPI.

68. The details of any targeted measure will be incorporated into the export plan. The export plan must include (as a minimum):

- in-field monitoring by competent people;
- pest control activities effective against specified pests*;* and
- post harvest inspection conducted by appropriately trained personnel.

69. Examples of risk management options for targeted measures are listed below:

- Testing;
- Pest Free Area (country, place or production site) verified by official survey (where appropriate);
- approved systems approach;
- in-field monitoring and controls;
- preventing or reducing infestation during production (for example, fruit bagging);
- non-preferred host status;
- washing and brushing;
- enhanced inspection;
- pre-conditioning (e.g. removal of plant parts such as crown, calyx, skin, peduncle);
- restricted variety/hybrids.

70. The measures selected depend on the pest being managed, characteristics of the commodity and the systems and practices in the export country.

71. Selection of an appropriate targeted measure is based on qualitative information, expert judgement and experience, and quantitative data (where available).

72. The phytosanitary certificate must be endorsed with the details of any treatment in the 'treatments' section. Appropriate documentation or an additional declaration must be included in or accompany the phytosanitary certificate (for example, a treatment certificate).

73. The application of a targeted measure may also be effective against non-target pests.

SPECIFIED MEASURES

Measures specified by New Zealand for identified high risk or high impact pests

74. Where regulated pests are assessed by New Zealand as presenting the highest likelihood of establishment and spread, or highest impact, MPI will specify the measures that must be applied to manage those pests ('Specified Measures', SM). These pests and the specified measures will be listed in Part 3 of the IHS.

75. The details of any specified measure must be incorporated into the export plan. The export plan must include (as a minimum):

- oversight (supervision) of the application of the measure by competent people;
- official oversight by the NPPO;
- procedures for the application of the measure*;*
- identification of records required;
- traceability;
- post treatment security; and
- post treatment inspection conducted by appropriately trained personnel.

76. The phytosanitary certificate must be endorsed with the details of the treatment in the 'treatments' section. Appropriate documentation or an additional declaration must be included in or accompany the phytosanitary certificate (for example, a treatment certificate).

77. Examples of risk management options for specified measures are listed below:

- Testing;
- end point treatments (heat, cold, chemical, irradiation);
- non-host status;
- winter window;
- Pest Free Area (country, place or production site) verified by official survey (where appropriate);
- approved systems approach.

78. The specified measure(s) selected depend on the pest being managed, commodity characteristics and the systems and practices in the export country.

79. Selection of an appropriate specified measure is based largely on quantitative data that supports a high level of phytosanitary assurance. Quantitative data may be supported by qualitative information especially with respect to approval of a systems approach. A specified measure may also be effective against non-target pests.

PART 2: PEST RISK MANAGEMENT FOR BANANA FROM PRC

COMMODITY DESCRIPTION

80. "Fresh bananas for consumption" is defined as commercially produced "hand of bananas". Each "hand" consists of two transverse rows of fruit ("fingers") without stem, leaves, roots or any other plant part. Hands of bananas are hereafter also referred to as 'bananas'.

81. "Commercially produced" is defined as the production of export grade fruit sourced from production sites that produce fruit for export under standard cultivation, pest-management, harvesting, disinfestation and packing activities. Infested, infected or damaged fruit must be discarded prior to packing.

82. Private consignments and products produced through non-commercial systems (for example, 'backyard' production) are not covered by this IHS.

83. The National Plant Protection Organisation (NPPO) must provide sufficient oversight to ensure that assurances provided on a phytosanitary certificate meet the minimum requirements indentified in ISPM 7 and additional items in the negotiated export plan. The oversight (systems and procedures) is subject to audit by MPI.

BACKGROUND

84. Bananas may be imported into New Zealand from a range of countries including Australia, Cook Islands, Ecuador, Mexico, Niue, Panama, Philippines, Samoa and Tonga.

85. The Government of PRC requested access to the New Zealand market for fresh bananas, (*Musa* spp.) for consumption and provided information on the pests associated with the fruit.

86. This pathway has the potential to introduce regulated pests into New Zealand and therefore a risk management assessment is required to determine appropriate measures to manage that risk.

87. Thirty-five pests (Appendix 1) have been identified as being associated with bananas from PRC.

PROPOSED MEASURES

88. The following is a summary of the regulated pests identified as being associated with fresh bananas for consumption from China. These pests have been evaluated to determine the appropriate measures needed to manage them based on their biological characteristics and potential impact if they established in New Zealand.

89. Proposed measures are selected based on the assessed risk and impact (from other country/commodity pathways where available), and the biology of the pest.

ARMOURED SCALES (DIASPIDIDAE)

90. The armoured scales considered in this assessment are:
    - *Aonidiella orientalis*
    - *Aspioditus destructor*
    - *Chrysomphalus aonidum*
    - *Chrysomphalus dictyospermi*
    - *Hemiberlesia palmae*
    - *Lepidosaphes gloverii*
    - *Pseudaulacaspis cockerelli*
    - *Unaspis citri*

BIOLOGY

91. The organisms in this group are small and not very conspicuous. The detection of organisms from this group can be difficult and visual inspection could need optical enhancement (MPI 2015b).

92. All lifestages (except males and crawlers) are immobile. Mixed lifestages are commonly detected on bananas imported into New Zealand (MPI Interception Database, accessed 2015a).

93. Reproduction is mainly sexual, although asexual reproduction can occur. The first instar crawlers are the dispersal stage, but become non-mobile once they settle at a feeding site. The crawlers can also move via wind, animals, other insects or movement of infested plant material. Once the crawlers settle they become sessile. Up to 600 eggs can be produced under the scales of the female adult. Many organisms in this group are polyphagous (MPI 2015b).

94. These scales do not secrete honeydew and are therefore not associated with sooty mould or honeydew feeders such as ants. The adult male scales can fly, but do not feed (MPI 2015b).

95. The major entry pathway identified for armoured scales is the presence of various life stages of the insects, including adults, nymphs and eggs that are protected in spaces between the fingers of banana fruit (MPI 2015b).

ASSESSMENT

96. The biosecurity risk from this group of organisms was assessed using *Chrysomphalus aonidum* and *Chrysomphalus dictyospermi* as representative species (MPI 2015b).

97. A review carried out in the USA (USDA APHIS 2007 2012b) examined the likelihood of introduction of diaspidids via the fresh produce pathway (that is: commercially produced fruit for consumption, shipped without leaves, stems or contaminants). The conclusion of the review was that this likelihood is low because diaspidids have a very poor ability to disperse from fruit for consumption onto hosts in the outdoor environment, consistent with the MPI (2015b) risk assessment.

98. The specialised biology of the diaspidids suggests that the likelihood of successful introduction of these insects will be limited by the exposure step given their limited mobility (MPI 2015b).

RISK MANAGEMENT

99. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and phytosanitary certification

100. Pre-export inspection (using 10x magnification) and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from armoured scales.

101. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

102. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated armoured scale species.

103. Where any regulated live armoured scale species is found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

SOFT SCALES

104. The soft scale considered in this assessment is:

- *Ceroplastes rubens*

BIOLOGY

105. *Ceroplastes rubens* is a highly polyphagous scale occurring on hundreds of plant species across more than 80 families, with bananas reported as a host (CPC 2014). Most coccids (soft scales) are legless and non-mobile apart from the crawler and adult male stages. Although *C. rubens* does possess legs, they are reduced and distorted and the only mobile lifestages are crawlers and males. Factors affecting exposure are likely to be similar to those for diaspids which are dependent on the delicate crawler leaving the host commodity and successfully finding a suitable host.

ASSESSMENT

106. The specialised biology of the soft scales suggests that the likelihood of successful introduction of these insects will be limited by the exposure step given their limited mobility (MPI 2015b).

RISK MANAGEMENT

107. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and phytosanitary certification

108. Pre-export inspection (using 10x magnification) and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from soft scales.

109. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

110. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated soft scale.

111. Where any regulated live soft scales are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

MEALYBUGS

112. The mealybugs considered in this assessment are:

- *Dysmicoccus brevipes*
- *Ferrisia virgata*
- *Maconellicoccus hirsutus*
- *Nipaecoccus nipae*
- *Pseudococcus comstocki*

BIOLOGY

113. The biosecurity risk from this group of organisms was assessed using *Maconellicoccus hirsutus* on the fresh produce pathway (MPI 2015b) and *Ferrisia virgata* on citrus from Samoa (MAF 2008).

114. *M. hirsutus* is a highly polyphagous pest predominantly occurring in tropical and subtropical areas, and infests the leaves, shoots and fruit of host plants. *M. hirsutus* like all mealybugs secretes honeydew.

115. Most life stages of *M. hirsutus* are stated to be readily detectable (MPI 2015b). *M. hirsutus* usually forms dense colonies suggesting that it would probably be detected during harvest or packaging. However, low level infestations may be missed, particularly since crawlers tend to settle in cracks and crevices of the host plants.

116. *F. virgata* is one of the most highly polyphagous mealybugs known, attacking plant species belonging to some 160 genera in over 70 families (Ben-Dov *et al*. 2010) with many of the host species belonging to the Leguminosae and Euphorbiaceae families, with bananas considered a host.

117. Both nymphs and adults of *F. virgata* attack the fruit of host plants and the likelihood of entry is considered to be moderate. Climate may be a limiting factor for *F. virgata* as this species is largely found in tropical and subtropical climates.

ASSESSMENT

118. The likelihood of entry of these mealybugs on the fresh produce pathway is considered to be negligible to moderate depending on the species.

119. The likelihood of exposure is considered to range from negligible to low depending on the species (MPI 2015b). However, the specialised biology of mealybugs means that the likelihood of successful introduction of these insects will be limited by the exposure step given their limited mobility (MPI 2015b).

RISK MANAGEMENT

120. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

121. Pre-export inspection (using 10x magnification) and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from mealy bug.

122. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

123. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated live mealybugs.

124. Where any regulated live mealybugs are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

MOTHS

125. The moths considered in this assessment are:

- *Eudocima fullonia*
- *Opogona sacchari*
- *Spodoptera exigua*
- *Tiracola plagiata*

BIOLOGY

126. *Eudocima fullonia.* Unlike most Lepidoptera, it is the adult *E. fullonia* not the larval stage that is responsible for damage to crops and the adult's size and mobility mean that it is not expected to stay on the commodity through to the point of export.

127. *E. fullonia* is an occasional vagrant in New Zealand, recorded under its synonym *Othreis fullonia* (Dugdale 1988). It is thought *E. fullonia* is occasionally blown in from Australia on the prevailing westerly winds (*pers. comm.* J. Dugdale 2007) but has never established in New Zealand.

128. *Opogona sacchari.* This moth has a wide host range but is mainly known to infest tropical and subtropical plants such as banana, pineapple and various subtropical ornamentals such as *Dracaena* and *Yucca* (van der Gaag *et al.* 2013). The pest is reported from greenhouses in Europe where host plants are grown but a few outdoor populations have been recorded (van der Gaag *et al.* 2013).

129. Van der Gaag *et al.* (2013) report that Armstrong (2001) reared *O. sacchari* from culled bananas in Hawaii. However, Armstrong (2001) considered that the culling of damaged fruit showing signs of infestation was sufficient to minimise the risk of moth larvae being exported with fruit.

130. *Spodoptera exigua.* The optimal temperature for larval development *of S. exigua* is reported to be 28°C, but is lower for both oviposition and pupation. At lower temperatures, activity and development cease, and when freezing occurs, all stages are usually killed. The species is known to overwinter in the warmer regions of the Mediterranean, North America and Africa and invade the cooler northern regions as temperatures permit (CPC 2014). If the moth was to enter New Zealand associated with bananas from China and to establish it is likely to be limited in its distribution due to temperature.

131. *Tiracola plagiata* adults moths are large (50mm) and nocturnal and mature larvae are also large (60mm) and feed externally on fruit. These lifestages are considered easily detectable at post-harvest and packing. Pupae are not associated with fruit as pupation occurs in the ground (MAF 2008).

ASSESSMENT

132. *Eudocima fullonia.* This moth has previously been assessed by MPI as not a hazard on the import pathway for fresh *Citrus* fruit for consumption from Samoa (MAF 2008).

133. *Opogona sacchari.* Van der Gaag *et al.* (2013) Pest Risk Analysis for *O. sacchari* concluded that there was a low likelihood that the pest could be present in imported banana fruits, but there was a very low likelihood that infested fresh bananas could lead to establishment of the moth in greenhouses or outdoors in the EU.

134. *Spodoptera exigua*. This moth is a tropical/sub-tropical polyphagous pest which attacks most kinds of field crops. It has previously been assessed by MPI as not a hazard on the import pathway for fresh onion bulbs for consumption from China (MAF 2009a).

135. *Tiracola plagiata*. This moth has previously been assessed by MPI as not a hazard on the import pathway for fresh *Citrus* fruit for consumption from Samoa (MAF 2008). This is because eggs and young larvae are associated with small, young non-harvestable fruit.

136. While there are some differences in biology, the overall risk of entry and establishment for these pests is similar. The potential economic impact from these pests is considered from negligible to moderate depending on species. The likelihood of establishment is considered very low to low depending on species.

RISK MANAGEMENT

137. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

138. Pre-export inspection and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from regulated moths.

139. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

140. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated live moths (all life stages).

141. Where any regulated live moths (all life stages) are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

WHITEFLY

142. The whitefly considered in this assessment is:

- *Aleurodicus eminate*

BIOLOGY

143. *A. eminate* is recorded from Portugal, Spain, Africa India, Taiwan, Southeast Asia, Central and South America, Florida, Hawaii, Australia and some Pacific Islands (CPC 2014).

144. *A. eminate* is known to lay eggs on fruit. Mated females produce offspring of both sexes and unmated females produce only males (CPC 2014). Population growth can be rapid (MAF 2008).

145. The species is highly polyphagous and hosts include *Citrus* spp., *Prunus* spp., coconut, avocado, guava, *Capsicum* spp., melons, tomatoes lettuce, sweet potato and ornamentals (CPC 2014). There are sufficient hosts for *A. eminate* in urban and rural areas of New Zealand.

146. Most whiteflies actively disperse as crawlers and flying adults. Crawlers usually move a few millimetres from their hatch site (Gerling 1990), but can be caught by air currents and then carried some distance. Adult whiteflies can disperse over distances of several kilometres by air currents (Costa 1975 quoted in Gerling 1990).

147. The estimated temperature thresholds for development of *A. eminate* vary from 4.6°C for eggs to 9.8°C for 3rd and 4th instars. Adult survival is reduced at temperatures below 5°C (Wen *et al.* 1994). The adults are active at 12-32°C and the mean fecundity (28 eggs/female) is highest at 25°C (Cherry 1979). Below 10°C there is extreme mortality of *A. eminate* in Florida which limits its northward spread (Cherry 1979).

ASSESSMENT

148. *A. eminate* has previously been assessed on citrus from Samoa by MAF (2008). The likelihood of entry was determined to be low, establishment and spread moderate and consequences low to high (MAF 2008).

RISK MANAGEMENT

149. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

150. Pre-export inspection (using 10x magnification) and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from whitefly.

151. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

152. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated live whitefly (all life stages).

153. Where any regulated live whitefly (all life stages) is found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

MUSCID FLIES

154. The muscid fly considered in this assessment is:

- *Atherigona orientalis*

BIOLOGY

155. *A. orientalis* is primarily a saprophagous insect that mostly feeds on damaged or rotting material. Recent evidence suggests that *A. orientalis* is sometimes effectively phytophagous. Fruit should be examined for signs of rot and exit holes (CPC 2014).

156. *A. orientalis* has a pantropical distribution and is considered unlikely to become established in temperate areas (Cahill 1992).

ASSESSMENT

157. Based on the characteristics of the pest and pathway *A. orientalis* was assessed as an organism with a low likelihood of establishment and spread in New Zealand due to it being associated with damaged or rotten fruit. The potential economic impact of *A. orientalis* has been assessed as low because it is associated with damaged fruit.

RISK MANAGEMENT

158. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

159. Pre-export inspection (using 10x magnification) and phytosanitary certification of commercially produced banana is considered appropriate to manage the risk from muscid flies.

160. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

161. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated live muscid flies (all life stages).

162. Where any regulated live muscid flies (all life stages) are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

BEETLES

163. The beetle considered in this assessment is:

- *Basilepta fulvipes*

BIOLOGY

164. *B. fulvipes* is widespread in most regions of China including those where bananas are grown (AQSIQ 2011; GBIF 2012). The beetle has been recorded as being a pest of banana flowers, leaves and fruit most serious during the budding stage seriously affecting the appearance and commodity value of banana fruit. *B. fulvipes* adults prefer dark and concealed places, for example, in the heart leaves and bud bracts (AQSIQ 2011).

165. *B. fulvipes* is highly polyphagous, being recorded as a pest of fruit trees (leaves) and also injures soybean, foxtail millet, maize, broomcorn and other crops (AQSIQ 2011). There are sufficient hosts for *B. fulvipes* in urban and rural areas of New Zealand if it were to enter via the fresh banana pathway.

166. Temperature threshold information for *B. fulvipes* is not available, but this species is known to survive in the colder climates of northern China. The beetle overwinters (dormant) in the upper soil layer (to 15cm depth) (AQSIQ 2011).

ASSESSMENT

167. A full assessment has not been undertaken by MPI on *B. fulvipes*, however based on the characteristics of the pest and pathway the potential economic impact from *B. fulvipes* is assessed as potentially low to medium. The likelihood of establishment is considered low.

RISK MANAGEMENT

168. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

169. Pre-export inspection and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from regulated beetles.

170. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

171. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated live beetles (all life stages).

172. Where any regulated live beetles (all life stages) are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

WEEVILS

173. The weevils considered in this assessment are:
    - *Philicoptus demissus*
    - *Philicoptus iliganus*

BIOLOGY

174. The biology of *P. demissus* is very similar to that of *P. iliganus,* which is considered a more severe pest (Biosecurity Australia 2008).

175. Both species feed on leaves, flower bract and fruit peel. Feeding mostly occurs on young fruit, leaving scars on the peel, and move out of the bunch when fruit gets older. Hosts include avocado, citrus, and tropical fruit species (Biosecurity Australia 2008).

176. Adults of *Philicoptus* spp. have no effective means of long distance dispersal. When disturbed they fall to the ground and feign death. In bananas the adults hide between touching leaves and are concealed among fruit (Biosecurity Australia 2008).

177. *Philicoptus* spp. adults are conspicuous, being 5-8mm long, flightless, and brightly coloured. Eggs are white and approximately 1mm by 0.3mm. Only the adult stages of *Philicoptus* spp. are associated with the banana fruit (Biosecurity Australia 2008).

ASSESSMENT

178. *P. demissus* and *P. iliganus* have previously been assessed by Biosecurity Australia (2008) on bananas from the Philippines. Although the descriptors used in their pest risk assessments cannot be directly matched to the descriptors used by MPI, they can be used to inform the potential risk in New Zealand. They assessed the likelihood of entry and exposure as extremely low and the likelihood of establishment and spread as moderate. Economic, environmental and socio-cultural consequences were assessed as minor (Biosecurity Australia 2008).

RISK MANAGEMENT

179. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

180. Pre-export inspection and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from regulated weevils.

181. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

182. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated live weevils (all life stages).

183. Where any regulated live weevils (all life stages) are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

MITES

184. The mites considered in this assessment are:

- *Eutetranychus orientalis*
- *Tetranychus piercei*

BIOLOGY

185. *Eutetranychus orientalis.* The primary host for this mite is *Citrus* species and it also feeds upon almonds, avocado, bananas, figs, grapes, maize, olives, peaches, pears, plums, quinces, squash, sweet potato, watermelon and over 50 other plant spp. (including *Salix* spp. and the weeds *Solanum nigrum* and *Chenopodium album*) (CPC 2014).

186. Damage by *E. orientalis* occurs from feeding, which in heavy infestations weakens plants, reduces fruit yields and affects appearance (EFSA 2013).

187. EFSA (2013) state that the active stages of larva, protonymph, deutonymph and the adults are mobile and can infest all green parts of the host, including the fruit. Mites are small and cryptic in behaviour and are frequently intercepted alive in bunches of banana fruit coming from overseas (MPI Interception database 2015a). It is expected that *E. orientalis* would be sufficiently protected within bunches of bananas for some to survive transit.

188. *E. orientalis* could potentially establish in warmer parts of the North Island.

189. Reproduction in *E. orientalis* is both sexual and asexual; the latter produces only male offspring. Females begin laying eggs at 1-2 days old, along the midvein of leaves. Various research on the biology of *E. orientalis* show that favourable developmental conditions are between 18-30°C and 35-72%RH (Klein 1936; Bodenheimer 1951 cited in EFSA 2013). Zhou *et al.* 2006 estimated the lower developmental threshold as between 6.4 and 8.9°C respectively for males and females in laboratory experiments conducted at 25-35°C.

190. *Tetranychus piercei* is polyphagous (Bolland *et al.* 1998; Ohno *et al.* 2009, Migeon & Dorkeld 2013) and host plants include banana, beans, cassava, eggplant, mulberry, papaya, passion fruit, peach, sweet potato, and a range of ornamentals (CPC 2014).

191. *T. piercei* is described as an occasional pest (Jeppson *et al.* 1975), mainly found on leaves, but also on fruit of banana and papaya when populations are high (DAFF 2002, Fu *et al*. 2002).

192. *T. piercei* is at present limited in its distribution to tropical and warm sub-tropical parts of Southeast Asia and Indonesia, Japan, Papua New Guinea, French Guiana and Florida (CPC 2014, Ohno *et al*. 2009).

193. Results of a study by Fu *et al.* (2002) suggest that *T. piercei* could develop and reproduce within a wide range of temperatures but temperatures between 25.8-32°C are the most suitable for the development, survival and reproduction of this species. Female mites can overwinter in protected cavities of host plants (Fu *et al.* 2002).

194. New colonies of *T. piercei* can be established by mated as well as unmated females but unmated females produce male progeny only (DAFF 2002).

195. These mites may not be easily detected with the naked eye as adults are less than 0.5 mm. Magnification may be needed for their detection.

ASSESSMENT

196. A full assessment has not been undertaken by MPI on *E. orientalis*, however based on EFSA (2013) conclusions, the pest's characteristics and the pathway, the likelihoods of entry, exposure, establishment, spread are estimated to be moderate with potentially low consequences.

197. The likelihood of entry and establishment for *T.piercei* was assessed by DAFF (2007) as high and the impact low.

198. This combination of high and moderate likelihoods for entry, establishment and spread and uncertainty of the impact of these species to New Zealand justifies targeted measures.

RISK MANAGEMENT

199. The following risk management measures are proposed to manage the assessed risk from these pests.

Pest management activities detailed in the negotiated export plan

200. The details of the production system with reference to the management of *T. piercei* and *E. orientalis* must be negotiated with MPI and incorporated into the export plan. The export plan must include (as a minimum) procedures for the following activities;

- in-field monitoring for *T. piercei* and *E. orientalis* by competent people;
- targeted measures effective against *T. piercei* and *E. orientalis* (if detected);
- post harvest inspection conducted by competent people;
- pest control activities effective against *T. piercei* and *E. orientalis;* and
- training and evaluation for competence as above.

Pre-export inspection and phytosanitary certification

201. In addition to pest management activities, pre-export inspection and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from mites.

202. Banana fruit for export to New Zealand must be sampled and inspected using official procedures at 10x magnification.

203. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated mites.

204. Where any regulated live mite is found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

THRIPS

205. The thrips included in this assessment are:

- *Thrips hawaiiensis*

BIOLOGY

206. *T. hawaiiensis* is a polyphagous and variable flower thrips, about 1.2mm long. It can reproduce sexually and asexually with population numbers peaking when suitable host plants such as *Citrus* are flowering (MAF 2008).

207. *T. hawaiiensis* has a preference for plants in the Fabaceae and Convolvulaceae families (Mau & Martin 1993). At least 25 different crops have been recorded as being attacked by *T. hawaiiensis* including avocado *Capsicum annuum* (bell pepper), *Malus* sp. (apple) and *Vitis vinifera* (grapevine) (MAF 2008).

208. *T. hawaiiensis* is found throughout Asia, parts of Africa, southern and western and southern North America, Mexico, Jamaica and Southern France. In the Pacific it is in Australia, Fiji, Guam, Norfolk Island, Papua New Guinea, Samoa, Midway Island (CPC 2014, Reynaud *et al.* 2008). The current range is mostly tropical to subtropical climates. Although it has been found in North America it is not considered to be common (CPC 2014, Mound & Masumoto 2005).

209. *T. hawaiiensis* is not known to vector viruses and has not been shown to be a pest outside of its native range (Reynaud *et al.* 2008). In its native range *T. hawaiiensis* damages flowers and fruits resulting in lesions, scarring, necrosis or malformations (Reynaud *et al.* 2008). In bananas it causes corky scabs on the fruit (Nelson & Taniguchi 2012). *T. hawaiiensis* is also recognised as a beneficial pollinator of some crops (Free 1993).

210. There are no records of *T. hawaiiensis* being intercepted at the New Zealand border associated with bananas from countries where the pest is present (MPI Interception Database 2015a). However, *T. hawaiiensis* is reported as being frequently intercepted by quarantine inspectors in the United States of America associated with cut flowers from Asia and the Pacific (Nakahara 1985).

ASSESSMENT

211. *T. hawaiiensis* was assessed previously on *Citrus* spp. from Samoa (MAF 2008) as having a high likelihood of entry and exposure, establishment, spread and economic and environmental consequences. This combination of high likelihoods and impact justifies targeted measures.

RISK MANAGEMENT

212. The following risk management measures are proposed to manage the assessed risk from this pest.

Pest management activities detailed in the negotiated export plan

213. Pest risk management activities targeted at the control of *T. hawaiiensis* must be used during the production of banana for export to New Zealand.

214. The details of the system must be negotiated with MPI and incorporated into the export plan and must include:

- in-field monitoring for *T. hawaiiensis* by competent people;
- targeted measures effective against *T. hawaiiensis* (if detected);
- post harvest inspection conducted by competent people;

- pest control activities effective against *T. hawaiiensis;* and
- training and evaluation for competence as above.

Pre-export inspection and phytosanitary certification

215. In addition to pest management activities, pre-export inspection and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from thrips.

216. Banana fruit for export to New Zealand must be sampled and inspected using official procedures at 10x magnification.

217. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated thrips.

218. Where any regulated live thrips are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

APHIDS

219. The aphids considered in this assessment are:

- *Pentalonia nigronervosa*
- *Toxoptera odinae*

BIOLOGY

220. *Pentalonia nigronervosa.* The primary host of *P. nigronervosa* is banana but they will also attack plants from other families. Tomatoes are also reported as a host (Mau *et al.* 1994). They are generally found on leaves but have also been observed on fruit (Robson *et al.* 2006, unpublished data)

221. *P. nigronervosa* does not lay eggs but instead give birth to juvenile females (ovoviviparous parthenogenesis).

222. *P. nigronervosa* is known to vector banana bunchy top virus (BBTV) and cucumber mosaic virus (CMV) BBTV has not been conclusively reported to affect anything other than *Musa* species, and CMV is known to be present in NZ.

223. *P. nigronervosa* has a subtropical-tropical distribution, including Queensland and New South Wales in Australia and is considered potentially able to establish in the northern North Island.

224. *Toxoptera odinae* feeds on the undersides of young leaves, petioles, young branches and fruit of a range of hosts. Banana is not a usual host (Martin 2009).

225. *T. odinae* is very polyphagous (Blackman *et al*. 2011).

226. Infested parts of a plant are covered with aphids, honeydew, sooty mould, and ants. Infestation would therefore be conspicuous during visual inspection.

227. Aphids cause damage through feeding on plants causing blemishes on fruit that reduce saleability. Aphids excrete honeydew which provides a substrate for sooty mould growth thus inhibiting photosynthesis and weakening plants. Honeydew excretion also attracts ant species which tend and protect the aphids and may interfere with biocontrol agents (Cheraghian 2013).

ASSESSMENT

228. A full assessment has not been undertaken by MPI on *P. nigronervosa*, however based on the pest's characteristics and the pathway, the likelihood of entry, exposure, establishment, spread are estimated to be low.

229. Likelihood of entry (importation x distribution) for *T. odinae* has been assessed by Biosecurity Australia (2005) for fresh mangoes from Taiwan as very low. The potential consequences were assessed as low (Biosecurity Australia, 2005). Although the descriptors used in the Biosecurity Australia pest risk assessments cannot be directly matched to the descriptors used by MPI, they can be used to inform the potential risk to New Zealand.

RISK MANAGEMENT

230. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

231. Pre-export inspection and phytosanitary certification of commercially produced banana fruit is considered appropriate to manage the risk from aphids.

232. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

233. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from regulated aphids (all life stages).

234. Where any regulated live aphids (all life stages) are found in the inspected lot, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

PATHOGENS

235. The pathogens considered in this assessment are:

- *Ceratocystis paradoxa (Thielavipsis paradoxa)*
- *Guignardia musae*

BIOLOGY

236. *Ceratocystis paradoxaxa* affects mainly monocots (Mbenoum *et al.* 2014) (including various palm species) and maize carrot and Eucalyptus (CPC 2014). Therefore *C. paradoxa* has potential to affect New Zealand pasture and crops, along with iconic native species such as cabbage trees and nikau palm.

237. *C. paradoxa* seems to have a tropical sub-tropical distribution and therefore has the potential to establish in the warmer northern regions of the North Island of New Zealand. It is likely to have a temperature restricted distribution if it were to establish here.

238. It is not clear whether *C. paradoxa* is present in New Zealand (NZ Fungi 2015).

239. *Guignardia musae.* Cultivars of banana are the primary hosts of *G.musae*. It causes disease on banana leaves and fruit although symptoms are rarely seen on fruit unless the leaves are also infected (DAFF 2007). The disease has little impact on other host plants (DAFF 2007).

240. The long distance spread of *G.musae* is by the movement of diseased leaves, small pieces of leaf tissue and occasionally on fruit (CPC 2014).

ASSESSMENT

241. It is not clear whether *C. paradoxa* is present in New Zealand. Although this name has been used in New Zealand, NZ Fungi (2015) currently states that its presence is uncertain and that records need reconsidering based on the genetically more restricted concept of *C. paradoxa* presented in a recent paper by Mbenoum *et al.* (2014). The potential entry, exposure, establishment and spread cannot be estimated for this species.

242. Based on the DAFF (2007) assessment, characteristics of the pest and pathway, the likelihood of entry, exposure, establishment and spread of *G. musae* is assessed as very low. The economic consequences are assessed as very low.

RISK MANAGEMENT

243. The following risk management measures are proposed to manage the assessed risk from this pest.

Pre-export inspection and certification

244. Banana fruit for export to New Zealand must be sampled and inspected using official procedures. Fruit showing signs or symptoms of disease must be excluded from lots for export to New Zealand.

245. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from pathogens.

246. Where any diseased fruit are found in the inspected lot the lot must be rejected for export to New Zealand.

HITCHHIKER PESTS

247. The pests considered in this assessment are not pests of the fruit but can be found associated with the commodity:

- *Achatina fulica* (snail)
- *Latrodectus elegans* (spider)
- *Solenopsis eminate* (ant)
- *Solenopsis invicta* (ant)

BIOLOGY

248. *Achatina fulica* (giant African snail, GAS) are polyphagous, with up to 500 known hosts recorded (Smith 2005).

249. At hatch *A. fulica* are 4-5mm long and by 133 days old are approximately 42 to 45mm (Thakur 1998). They are hermaphrodites, and attain sexual maturity at around 5-8 months after egg hatch or later. Newly hatched snails stay with the eggs for up to seven days, and then begin travelling to nearby food plants. Juveniles disperse widely, and have been recorded travelling as far as 500m in six months (Raut and Barker 2002).

250. *A. fulica* are described as nocturnal (Raut and Barker 2002) but have been recorded as active in the daytime after rain (Tomiyama and Nakane 1993). *A. fulica* feeds on leaves during the night, and it is likely that sometimes juveniles will shelter during the day under leaves or in bunches of shoots and fruit. Juveniles can easily be missed when hidden between fruit in a bunch of bananas.

251. *A. fulica* aestivate in dry weather, with aestivation lasting 2 to 10 months depending on the climatic zone (Raut and Barker 2002). They can survive periods of cold by hibernating (Cooling 2005).

252. *A fulica* is highly adaptable and tolerant of a wide range of conditions. It can survive in a range of habitat types and appears to be adapting to temperate climates expanding from its original niche as a tropical snail. *A. fulica* is likely to be able to establish in parts of the North Island.

253. Plant diseases such as black pod disease caused by *Phytophthora palmivora* are spread in the faeces of *A. fulica* (Raut and Barker 2002). Also, *A. Fulica* is a vector of the rat lungworm, *Angiostrongylus cantonensis*, which causes eosinophylic meningoencephalitis in humans, which can be fatal (Thiengo *et al*. 2007). *A. Cantonensis* does not seem to be recorded from New Zealand (*e.g.* Alicata and McCarthy 1964).

254. A related species, *Angiostrongylus costaricensis* may also be carried by *A. fulica* (Cooling 2005). This nematode causes abdominal symptoms rather than neurological ones (Cooling 2005).

255. New Zealand's endemic flax and kauri snails may be negatively impacted by the arrival of the giant African snail (MAF 2011). In addition, Cooling (2005) suggests *A. Fulica* is more likely to increase its diet of fresh plants and other material when introduced to new environments.

256. GAS has been detected at the border on bananas (MPI Interception database 2015a, leafy crops entering New Zealand from the Pacific Islands).

257. *Latrodectus elegans.* The redback spider (*L. elegans*) is closely related to the black widow spider (*L. mactans*) has previously been described as a subspecies of

L. mactans (VAPAGuide 2015). *L. mactans* has been assessed previously on the table grapes from China pathway (MAF 2009b).

258. The Genus *Lactrodectus* is cosmopolitan and the genus has been intercepted many times entering New Zealand associated with table grapes in particular (MPI Interception Database 2015a, MAF 2009b).

259. These spiders are unlikely to have a biological host relationship with bananas. Its related species, *L. mactans* is carnivorous and eats a variety of pest and beneficial insects. The species has the potential to out-complete native spiders if it were to establish in New Zealand (MAF 2009b).

260. The spider or signs such as webbing are likely to be detected during harvest and packing of bananas (MAF 2009b).

261. *Solenopsis eminate* (tropical fire ant) is a 'hitchhiking', polymorphic, reddish-brown ant, 3-8mm long, with a square brown head. It tends honeydew excreting homopterans and has a severe sting. The ant does not have a direct association with banana fruit but individuals or small groups of ants could be incidentally exported with bunches of bananas (MAF 2011).

262. It is likely to establish in parts of New Zealand which are ecoclimatically suitable and has the potential to establish in buildings (MAF 2011).

263. Potential impacts are broad including damage to crops from chewing and girdling plant stems (*e.g. Citrus*, tomatoes, avocados, potato and cucumber), disease spread, seed predation, and chewing of polyethylene irrigation tubing should *S. eminate* establish in large numbers (MAF 2011). Large incursions would mean movement controls on a range of freight including produce, flowers and nursery stock until eradication was successful. Increased measures or restrictions on exports to countries free of *S. eminate* are also likely (Harris 2005). Surveillance and response programmes are very costly.

264. Endemic species potentially at risk from *S. eminate* establishment in New Zealand would be hatchlings of herpetofauna, and eggs and nestlings of some birds, especially surface and burrow nesters (Harris 2005).

265. *S. eminate* does not necessarily have to establish in New Zealand to have an impact. It only needs to come into contact with people as *S. eminate* delivers a painful bite and multiple, venomous stings when disturbed.

266. *S. eminate* queens have been intercepted on fresh leaves from the Pacific (MAF Interception database 2011). This ant species has been intercepted at the New Zealand border at least 55 discrete times from 1964 to 2002 and frequently on fresh produce including banana, from the Pacific (Harris 2005).

267. *Solenopsis invicta* (red imported fire ant, RIFA) are highly invasive insects because of their high reproductive capacity, large colony size, ability to exploit human disturbances, wide food range, aggressiveness, and ability to sting. Where they establish, they can affect agricultural and horticultural systems, wildlife, natural ecosystems, and people's quality of life; incur medical and pest control costs; and cause damage to roads and electrical equipment (MAF 2002).

268. RIFA are aggressive and readily defend their nests, injecting venom, which consists primarily of alkaloids, into any animal that disturbs the colony. Workers are stimulated to attack by vibrations or in response to a chemical released by other

workers when using their stings. Worker ants are able to sting multiple times (MAF 2002).

269. RIFA are omnivorous, opportunistic feeders and will feed on almost any type of animal or plant material and will cannibalise one another if food is short. However, their primary diet has been shown to consist of insects, other small invertebrates, and plant saps (phloem). RIFA have been reported to feed on a variety of crops, including citrus trees, corn (germinating seeds and seedlings), potatoes (young plants and tubers), eggplant, cabbage and watermelon (MAF 2002).

270. Incursions of *S. invicta* have been eradicated from New Zealand on more than one occasion (Dhami & Booth 2008).

ASSESSMENT

271. The likelihood of entry of *A. fulica* is estimated to be low, and the likelihood of exposure is moderate (MAF 2011). In the North Island, the likelihood of establishment is low and likelihood of spread high (MAF 2011). In the north of the North Island, the potential economic consequences are low, and potential environmental, human health and socio-cultural consequences are moderate (MAF 2011).

272. A full assessment has not been undertaken by MPI on *L. elegans*, however based on the MAF's assessment of *L. mactans* (MAF 2009b) the pest's characteristics and similarities with *L. mactans* the likelihood of entry is considered to be low to moderate. The likelihood of establishment is considered to be moderate to high. The potential economic consequences are considered to be low, while the potential environmental consequences are considered to be moderate. The potential human health consequences of establishment are considered to be high.

273. The likelihood of entry of *S. eminate* is considered to be moderate, exposure is high, establishment low-moderate and the economic, environmental, health and socio-cultural consequences are considered to be moderate (MAF 2011).

274. The likelihoods estimations for *S. invicta* are considered to be similar to *S. eminate* based on its biological characteristics.

RISK MANAGEMENT

275. The following risk management measures are proposed to manage the assessed risk from hitchhiker pests.

Pre-export inspection and certification

276. Pre-export inspection and phytosanitary certification of commercially produced banana combined with inspection on arrival in New Zealand is considered appropriate to manage the risk from hitchhiker pests.

277. Banana fruit for export to New Zealand must be sampled and inspected using official procedures.

278. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample and packaging must be free from regulated pests.

279. Where any regulated live hitchhiker pests (all life stages) are found in the inspected lot or packaging, an appropriate measure must be applied (for example fumigation with an efficacious chemical) or the lot rejected for export to New Zealand.

FRUIT FLIES

280. The fruit flies considered in this assessment are:

- *Bactrocera dorsalis*

BIOLOGY

281. Fruit fly larvae are internal feeders on banana (Brown 1998). Detection of pests directly is limited, but often frass, external damage or secondary infections are more obvious signs of infestation. The larvae inside the fruit need to develop into adults for dispersal. The eggs are less than one millimetre long; hatched larvae develop inside the fruit (Brown 1998).

282. Almost any soft fruit with thin or soft enough skin to permit oviposit penetration is a potential host. The larvae feed between 6 and 35 days, however this is dependent on various factors including ambient air temperature, as fruit flies are temperature sensitive, especially to low temperatures. Pupation occurs mainly in soil and dispersal is achieved by flying adults or the transportation of infected fruit.

283. Tephritidae fruit flies are of economic importance due to their threat to fruit and vegetable production and trade worldwide.

284. Banana is a host fruit for fruit fly and some species of the *B. dorsalis* complex are capable of laying eggs in sound or damaged, ripening or ripe banana fruit in the field (Armstrong 1983, 2001). However bananas harvested at the mature hard green stage are not preferred hosts to fruit flies except for *Bactrocera musae* (banana fruit fly, not present in PRC) (Brown 1998).

285. Fruit fly larvae do not develop in hard green fruit under natural conditions. Three fruit fly species; *B. dorsalis, B. cucurbitae* (melon fly) and *Ceratitis capitata* (Mediterranean fruit fly) can readily lay eggs into mature green bananas but the eggs or the first instar larvae do not survive (Brown 1998). Unripe bananas form dark, hard tissue around egg-laying sites, encapsulating the eggs (Armstrong 1983). Latex is also produced at the site surrounding the eggs and forming a sticky surface onto which eggs and first instar larvae would adhere and die. The latex hardens forming an adhesive cap over the site, suffocating the eggs and any first instar larvae (Armstrong 1983). Banana is therefore not a host for *B. dorsalis, B. cucurbitae* and *C. capitata* when the bananas are hard green, undamaged and attached to the banana plant, or for up to 3–4 days post-harvest (Brown 1998).

286. Brown (1998) stated that eggs of most fruit fly species, with the exception of *B. musae*, will not hatch if laid in hard green bananas. Female fruit flies are less likely to deposit eggs in hard, immature fruit than softer, ripe fruit although immature fruit may become infested if the skin is split or broken. Host-specific information underpins this general observation. For example, researchers note that fruit flies are not known to infest mature hard green bananas (Biosecurity Australia 2008).

287. Based on this information, many countries permit the importation of bananas in their mature hard green stage, as 'mature hard green' is considered to be an effective quarantine measure for fruit flies (USDA APHIS 2014), including:

- New Zealand permits the importation of green bananas from Ecuador, Mexico, Niue, the Philippines, Samoa and Tonga (MPI 2014).
- New Zealand's import health standard for bananas from Australia also accepts that green bananas are not preferred hosts to economically important Australian fruit flies (including *B. musae*) (MAF 2006).

- The United States of America permits imports of green bananas from Africa, the Caribbean, the Pacific and South America (USDA APHIS 2014).

288. Fruit fly is a very significant pest of concern for New Zealand.

ASSESSMENT

289. *B. dorsalis* was assessed previously on table grapes from China (MAF 2009b) risk analysis as having a moderate likelihood of entry, exposure and establishment and high likelihood for economic consequences and therefore specified measures are justified.

RISK MANAGEMENT

290. A range of specified measures was considered to determine the appropriate measures as listed in Table 1.

Table 1: Measures considered for Fruit Flies

Measures considered	Comment
Endpoint treatments	
a. Methyl bromide fumigation	Currently limited data available to support efficacy of methyl bromide fumigation against fruit flies associated with banana
b. Irradiation	A 400 Gy dosage is likely to be sufficient to manage fruit flies and other regulated pests of concern. This option has not been requested and therefore not considered further.
c. Vapour heat treatment	Banana fruit does not withstand the treatment without fruit quality being affected. This option has not been requested and therefore not considered further.
d. High Temperature Forced Air	Banana fruit does not withstand the treatment without fruit quality being affected. This option has not been requested and therefore not considered further.
e. Cold treatment	Limited efficacy data available. This option has not been requested and therefore not considered further.
f. Chemical dips (e.g. dimethoate)	This option has not been requested and therefore not considered further.
Non-host status	Banana harvested and packed in the hard green stage is accepted as a non-host for fruit flies with the exception of *Bactrocera musae.*
Winter window	Information available for *Bactrocera cucumis* only. This option has not been requested and therefore not considered further.
In-field pest control	Used as part of the routine pest management during commercial production.
Pest free area (PFA)	Must meet ISPM 4 for recognition by MPI. Country/area specific. This option has not been requested and therefore not considered further.
Pest free place of	Must meet ISPM 10 for recognition by MPI. Country/area specific. This option has not been requested and therefore not considered further.

production (PFPP)	
Systems Approach	This option has not been requested and therefore not considered further.

291. MPI accepts the use of irradiation, vapour heat treatment, high temperature forced air, cold treatment, non-host status, and chemical dips as being effective against fruit flies for certain commodities.

292. The use of these measures for banana from PRC has not been requested, and were not assessed further.

293. MPI accepts 'non-host status' as a suitable measure for managing fruit flies on banana from a number of countries, and this measure is extensively used around the world (e.g. USA, Australia) for imports of banana from third countries. New Zealand has been successfully importing banana using 'hard green' as the measure for fruit flies for many years.

294. Banana harvested in the 'hard green' state are not a host for fruit flies present in PRC.

295. The following risk management measures are proposed to manage the assessed risk from this pest.

Pest management activities detailed in the negotiated export plan

296. Pest risk management activities specified by New Zealand for the control of *B. dorsalis* must be used during the production of banana for export to New Zealand.

297. The pest management activities must be detailed in the export plan.

298. Banana fruit must be harvested in the hard green state.

Pre-export inspection and phytosanitary certification

299. Banana fruit for export to New Zealand must be sampled and inspected using official procedures. Fruit showing signs or symptoms of pests or disease must be excluded from lots for export to New Zealand.

300. A minimum of randomly selected 600 units from each lot must be inspected by appropriately trained personnel. The inspected sample must be free from pest or disease.

Packing

301. Banana fruit selected for export to New Zealand must be in the hard green state of maturity and packed in clean insect-proof packaging.

Inspection on-arrival

302. MPI will inspect documentation and may inspect a sample of the consignment on arrival in New Zealand as described in the section on New Zealand's biosecurity system in this document.

303. If a fruit fly of significant concern is detected the pathway will be immediately suspended and a full review conducted before exports can resume.

SUMMARY

304. Thirty-five pests were identified as being present in PRC and associated with banana.

305. One pest (*Bactrocera dorsalis*) requires measures specified by MPI to be applied during production, harvesting and post harvest before consignments are exported to New Zealand.

306. MPI requires that banana for export to New Zealand is commercially grown and are harvested in the mature hard green stage.

307. The measures for *B. dorsalis* must be detailed in the negotiated export plan.

308. A phytosanitary certificate produced by the NPPO for PRC must be endorsed with a declaration that these measures have been applied as identified in the negotiated export plan for banana from PRC.

309. Three pests (*Thrips hawaiiensis, Tetranychus piercei* and *Eutetranychus orientalis*) require measures to be applied that target them during production and post harvest activities.

310. The measures must be agreed by MPI and detailed in the negotiated export plan for banana from PRC.

311. A phytosanitary certificate produced by the NPPO for PRC must be endorsed with a declaration that these measures have been applied as detailed in the negotiated export plan for banana from PRC.

312. The remaining pests are effectively managed to an acceptable level through standard commercial production methods, pre-export inspection and certification, and inspection and actions (if any) on arrival in New Zealand.

REFERENCES

Alicata, J.E., McCarthy, D.D. 1964. On the incidence and distribution of the rat lungworm *Angiostrongylus cantonensis* in the Cook Islands, with observations made in New Zealand and Western Samoa. *Canadian Journal of Zoology*. 42: 605-611.

Armstrong, J.W. 2001. Quarantine Security of Bananas at Harvest Maturity Against Mediterranean and Oriental Fruit Flies (Diptera: Tephritidae) in Hawaii. *Journal of Economic Entomology*, 94(1):302-314.

AQSIQ 2011. Commodity, pest lists and pathway information provided by the Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China.

Balance in Trade [http://www.biosecurity.govt.nz/files/biosec/policy-laws/intl/sps/resources/new-zealand/balance-in-trade.pdf]

Ben-Dov, Y., Miller, D.R. and Gibson, G.A.P. 2010. *ScaleNet*.

Blackman, R.L., Sorin, M., Miyazaki, M. 2011. Sexual morphs and colour variants of *Aphis* (formerly *Toxoptera*) *odinae* (Hemiptera, Aphididae) in Japan. *Zootaxa* 3110:53-60.

Biosecurity Act 1993. http://www.legislation.govt.nz/default.aspx

Biosecurity Australia 2005. Draft Extension of Policy for the Importation of Fresh Mangoes (*Mangifera indica* L.) from Taiwan.

Biosecurity Australia 2008. Final Import Risk Analysis Report for the Importation of Cavendish Bananas from the Philippines into Australia.

Bolland, H.R., Gutierrez, J. & Flechtmann, C.H.W. (1998) A world catalogue of the spider mite family (Acari: Tetranychidae). Brill, Netherlands. 392 pp.

Brown, A.G.P. 1998. Pest risk analysis of *Musa* species for the Northern Australian Quarantine Strategy. A report prepared for the Australian Quarantine and Inspection Service, Australian Department of Agriculture Fisheries and Forestry.

Cahill, M. 1992. Eco-climatic assessment of *Atherigona orientalis*

(Diptera): pest potential in New Zealand. Information Paper – Bureau of Rural Resources (Canberra), No. IP/1/92: iv +65 pp

Chalkley, D. 2014. Systematic Mycology and Microbiology Laboratory, ARS, USDA. . Invasive Fungi. *Alternaria* leaf blight of wheat –*Alternaria triticina*. Retrieved December 21, 2014, from /sbmlweb/fungi/index.cfm

Cheraghian, A. 2013. A guide for diagnosis and detection of quarantine pests. Banana aphid Pentalonia nigronervosa Coquerel, 1859 Hemiptera: Aphididae. Bureau of Plant Pest Surveillance and Pest Risk Analysis. Ministry of Jihad-e-Agriculture. Iran.

Cherry, R.H. 1979. Temperature tolerance of three whitefly species found in Florida. Environmental Entomology 8(6): 1150-1152.

Cooling, V. 2005. Risk assessment of the Giant African Snail *Achatina fulica* Bowdich in New Zealand. Unpublished thesis.

Costa, A. S. 1975. Increase in the population density of *Bemisia tabaci*, a threat of widespread virus infection of legume crops in Brazil. In: Bied, J; Mamarmorosch, K (Eds.) *Tropical diseases of legumes* pp 27-49. Academic Press, New York.

CPC 2014. Crop pest compendium http://www.cabicompendium.org/

Crop Genebank 2014. *Alternaria* leaf blight. http://cropgenebank.sgrp.cgiar.org/index.php/management-mainmenu-433/stogs-mainmenu-238/wheat/guidelines/fungi.

DAFF 2002. Importation of Fresh Bananas from the Philippines. Technical Information Paper, Part 5 of 5. http://www.ibrarian.net/navon/paper/Importation_of_Fresh_Bananas_from_the_Philippines.pdf?paperid=3953841

DAFF 2007. Revised Draft Import Risk Analysis Report for the Importation of Cavendish Bananas from the Philippines, Part B. http://s3.amazonaws.com/zanran_storage/www.daff.gov.au/ContentPages/5662461.pdf

Dhami, M.K. and Booth, K. 2008. Review of dispersal distances and landing site behaviour of *Solenopsis invicta* Buren, Red Imported Fire Ant (RIFA). http://www.biosecurity.govt.nz/files/pests/invasive-ants/red-imported-fire-ants/rifa-dispersal-distances-landing-site-behaviour.pdf

Dugdale, J.S. 1988. Lepidoptera – annotated catalogue and keys of family-group taxa. Fauna of New Zealand 14: 1–262.

EFSA PLH Panel (EFSA Panel on Plant Health), 2013. Scientific Opinion on the risk to plant health posed by *Eutetranychus orientalis* Klein in the EU territory, with the identification and evaluation of risk reduction options. EFSA Journal 2013;11(7):3317, 81 pp. Doi:10.2903/j.efsa.2013.3317

Food and Agriculture Organisation. 1998. Expert consultation on the strength of measures for regulated pests which have a minor biological impact. Rome: International Plant Protection Convention.

Free, J. B. 1993. Insect Pollination of Crops. Academic Press, London, UK.

Fu, Y., F. Zhang, Z. Peng, K. Liu, and Q. Jin. 2002. The effects of temperature on the development and reproduction of *Tetranychus piercei* McGregor (Acari: Tetranychidae) in banana. *Syst. Appl. Acarol.* 7: 69–76.

GBIF 2012. *Aspergillus avenzceus*. http://taiwanmicrobe.bcrc.firdi.org.tw/detail.jsp?id=14375164

Gerling, D (Ed.) 1990. *Whiteflies: their bionomics, pest status and management*. Intercept Ltd. Andover, Hants., UK.

Harris, R. 2005. Invasive Ant Risk Assessment: *Solenopsis geminata*. Landcare Research contract to Biosecurity New Zealand. BAH/35/2004-1 https://mpi.govt.nz/document-vault/2911

IPPC 1997. New revised text of the interantional p[lant protection convention, Article II Use of terms. https://www.ippc.int/sites/default/files/documents/20130603/13742.new_revised_text_of_the_international_plant_protectio_201304232117en_2013060311%3A04_65.4%20KB.pdf

ISPM 4: 1995. Requirements for the establishment for pest free areass. International Plant Protection Convention. Food and Agriculture Organisation.

ISPM 5: 2002. Glossary of phytosanitary terms. International Plant Protection Convention. Food and Agriculture Organisation.

ISPM 7: 2011. Phytosanitary certification system. International Plant Protection Convention. Food and Agriculture Organisation.

ISPM 10: 1999. ISPM 10: Requirements for the establishment of pest free places of production and pest free production sites. International Plant Protection Convention. Food and Agriculture Organisation.

ISPM 11: 2013. Pest risk analysis for quarantine pests. International Plant Protection Convention. Food and Agriculture Organisation.

ISPM 12: 2011. Phytosanitary certificates. International Plant Protection Convention. Food and Agriculture Organisation.

Jeppson, L.R., Keifer, H.H., Baker, E. W. 1975. *Mites injurious to economic plants*. University of California Press; Berkeley.

Jones, D.R. 1991. Chemical control of crown rot in Queensland bananas. Australian Journal of Experimental Agriculture, 31:693-698.

MAF 2002. Hazard identification and import release assessment: The introduction of red imported fire ants into New Zealand via the importation of goods and arrival of craft from Australia, the Caribbean, South America, and the USA.

MAF 2006. Import Health Standard Commodity Sub-class: Fresh Fruit/Vegetables Bananas, (*Musa spp*) from Australia. http://www.mpi.govt.nz/document-vault/1169

MAF 2008. Import Risk Analysis: Fresh Citrus Fruit (7 species) from Samoa. https://mpi.govt.nz/document-vault/2877

MAF 2009a. Import Risk Analysis: Onion *(Allium cepa* Liliaceae) Fresh Bulbs for Consumption from China. https://mpi.govt.nz/document-vault/2879

MAF 2009b. Import Risk Analysis: Table grapes (*Vitis vinifera*) from China. https://mpi.govt.nz/document-vault/2885

MAF 2011. Import Risk Analysis: Fresh Island cabbage leaves (*Abelmoschus manihot*) from Cook Is., Fiji, Samoa, Tonga, Vanuatu. https://mpi.govt.nz/document-vault/2886

Martin, J.H. 2009. Identification, occurrence and pest status of *Toxoptera odinae* (van der Goot) (Hemiptera: Aphididae) in Africa. *Bulletin of Entomological Research*, 79(4): 607-611.

Mau, R.F.L, Martin Kessing, J.L., Tenbrick, V.L., Hara, A.H. 1994. *Pentalonia nigronervosa* fact sheet. Crop Knowledge Master. University of Hawaii.

Mau, R. F.; Martin, J. L. 1993. *Thrips hawaiiensis* (Morgan): Crop Knowledge Master Fact Sheet. http://www.extento.hawaii.edu/kbase/CropType/t_hawai.htm updated 2007.

Mbenoum, M.; de Beer, Z.W., Wingfield, M.J., Wingfield, B.D., Roux, J. 2014. Reconsidering species boundaries in the *Ceratocystis paradoxa* complex, including a new species from oil palm and cacao in Cameroon. *Mycologia* 106(4): 757-784.

Migeon, A., Dorkeld, F. 2013. Spider Mites Web: a comprehensive database for the Tetranychidae. http://www.montpellier.inra.fr/CBGP/spmweb.

Mound, L.A., Masumoto, M. 2005. The genus Thrips (Thysanoptera, Thripidae) in Australia, New Caledonia and New Zealand. *Zootaxa* 1020: 1-64. http://www.mapress.com/zootaxa/2005f/zt01020p064.pdf

MPI 2014. MPI Standard 152.02: Importation and Clearance of Fresh Fruit and Vegetables into New Zealand. http://www.mpi.govt.nz/document-vault/1147

MPI 2015a. Interception database, Quantum (January accessed 2015).

MPI 2015b. *Generic Pest Risk Assessment: Armoured scale insects (Hemiptera: Coccoidea: Diaspididae) on the fresh produce pathway.* Wellington: Ministry for Primary Industries. https://mpi.govt.nz/document-vault/5224

Nakahara, S. 1985. Review of *Thrips hawaiiensis* and Revalidation of *T. Florum* (Thysanoptera: Tripidae). *Proceedings of the Entomological Society of Washington* 87:864-870.

Nelson, S., Taniguchi, G. 2012. Ant Damage to Banana Fruits by Abdominal Secretions. UH–CTAHR IP 29, http://www.ctahr.hawaii.edu/oc/freepubs/pdf/IP-29.pdf

NZ Fungi 2015. http://nzfungi.landcareresearch.co.nz/html/mycology.asp (accessed January 2015).

Ohno, S., Miyagi, A., Ganaha-Kikumura, T., Gotoh, T., Kitashima, Y., Ooishi, T., Ando, T., Kijima, K., Futagami, K., Uesato, T., Yasuda, K. (2009) Species composition of spider mites (Acari: Tetranychidae) on vegetables in Okinawa, southwestern Japan. *Appl Entomol Zool* 44:628–633.

Raut, S.K., Barker, G.M. 2002. *Achatina fulica* Bowdich and other Achatinidae as pests in tropical agriculture Pg 55-114 in Barker, G M (ed) *Molluscs as crop pests* CABI Publishing, Wallingford.

Reynaud, P., Balmès, V., Pizzol, J. 2008. *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae), an Asian pest thrips now established in Europe. *Bulletin OEPP/EPPO Bulletin 38, 155–160.*

SPS-Agreement. 1995. *Agreement on Sanitary and Phytosanitary Measures.* Geneva: World Trade Organisation.

Smith, J.W. 2005. Recently recognised risk of importing the giant African snail, *Achatina fulica* Bowdich, 1822, and its relatives into the United States and the efforts of the U.S. Department of Agriculture to mitigate the risk. *Amer. Malac. Bull.* 20: 133-141.

Thakur, S. 1998. Studies on food preference and biology of giant African snail, *Achatina fulica* in Bihar. *Journal of Ecobiology* 10(2): 103-109.

Thiengo, S.C., Faraco, F.A., Salgado, N.C., Cowie, R.H., Fernandez, M.A. 2007. Rapid spread of an invasive snail in South America: the giant African snail, *Achatina fulica*, in Brasil. *Biological Invasions* 9: 693-702.

Tomiyama, K., Nakane, M. 1993. Dispersal patterns of the giant African snail, Achatina fulica (Férussac) (Stylommatophora: Achatinidae), equipped with a radio-transmitter. *J. Moll. Stud.* 59: 315-322.

USDA APHIS 2007. Scale insects: Identification tools for species of quarantine significance: Scale Insects. Systematic Entomology Laboratory, ARS, USDA.

USDA APHIS 2012a. Guidelines for Plant Pest Risk Assessment of Imported Fruit & Vegetable Commodities.

USDA APHIS 2012b. Quantitative risk analysis for the establishment of armoured scales via avocado from Mexico. USDA APHIS, Raleigh, NC.

USDA APHIS 2014. Fruits and Vegetables Import Requirements (FAVIR). https://epermits.aphis.usda.gov/manual/index.cfm?CFID=2043460&CFTOKEN=5a1607f4df42a3f4-70554460-F869-202E-96359C9954485555&ACTION=pubHome

van der Gaag, D.J., van der Straten, M., Ramel, J-M., Baufeld, P., Schrader, G. 2013. Pest Risk Analysis for *Opogona sacchari.* Netherlands Food and Consumer Product Safety Authority, Utrecht, the Netherlands.

VAPAGuide (2015) *Latrodectus* spp. https://www.vapaguide.info/catalogue/NORAM-SPI-117 (accessed January 2015).

Wen, H.C., Hsu, T.C., Chen, C.N. 1994. Effects of temperature on the development, adult longevity, activity and oviposition of the spiralling whitefly, *Aleurodicus dispersus* Russell (Homoptera: Aleyrodidae). *Chinese Journal of Entomology* 14(2): 163-172.

Zhou, C., Zhang, W., Qiao, L., Sun, X., Wang, Z. 2006. The biological characteristics, effective 374 accumulate temperature and occurrence regulation of *Eutetranychus orientalis*. *Scientia* 375 *Silvae Sinicae* 42:89-93.

APPENDIX 1

Achatina fulica
Aleurodicus dispersus
Aonidiella orientalis
Aspioditus destructor
Atherigona orientalis
Bactrocera dorsalis
Basilepta fulvipes
Ceratocystis paradoxa (Thielavipsis paradoxa)
Ceroplastes rubens
Chrysomphalus aonidum
Chrysomphalus dictyospermi
Dysmicoccus brevipes
Eudocima fullonia
Eutetranychus orientalis
Ferrisia virgata
Guignardia musae
Hemiberlesia palmae
Latrodectus elegans
Lepidosaphes gloverii
Maconellicoccus hirsutus
Nipaecoccus nipae
Opogona sacchari
Pentalonia nigronervosa
Philicoptus demissus
Philicoptus iliganus
Pseudaulacaspis cockerelli
Pseudococcus comstocki
Solenopsis geminata
Solenopsis invicta
Spodoptera exigua
Tetranychus piercei
Thrips hawaiiensis
Tiracola plagiata
Toxoptera odinae
Unaspis citri