Annex 1

REVISED DRAFT IMPORT RISK ANALYSIS REPORT FOR APPLES (IRA) FROM NEW ZEALAND

NSW Department of Primary Industries Response:

Technical issues concerned with pathogens

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Summary

Through iterative feedback most substantive issues relating to fireblight have been resolved. What remains are areas in which stakeholders disagreed with BA's interpretation of the scientific literature. This disagreement stems from unclear or contradictory discussion within the literature and hence definitive resolution of many issues without further scientific testing is not possible.

Stakeholders highlighted the role of extracellular polysaccharides (EPS) and their role in epiphytic survival of *Erwinia amylovora (the fireblight pathogen = Ea)*. This is a valid argument and BA's rejection of stakeholder concerns seems to be based on a misinterpretation of the literature (details below).

This revised draft IRA also deals at length with other pests and diseases and European canker (caused by the fungal pathogen *Neonectria galligena*) poses a particular threat to NSW.

This pathogen has a latent phase in both fruit and twigs which would protect it from disinfestation and allow it to escape detection at inspection. Additionally through its production of ascospores the fungus has a means of long distance dispersal independent of vectors.

It is therefore proposed that BA has significantly underestimated the probability of spread of European canker (page 128) and that this should be revised upwards.

Additional measures should also be taken in the Operational framework to cater for the serious threat posed by latent infections of European canker.

Introduction

Despite its length and complication the logic behind the IRA is quite simple. For an exotic pest (using the term generically for arthropod pests and diseases) incursion to occur as a result of trade the pest must

1. survive the production and import process
2. have a means of dispersing into a population of susceptible hosts.

The import risk assessment purports to examine all import scenarios and establishes the risk associated with each step of the import process to the point of consumption and waste disposal.

The overall risk associated with import is appraised by multiplying the individual risks associated with each step of the import pathway.

Additional consideration is given to the impact of incursions by examining their effect at national, regional and local levels.

Risk and impact scores have been generated subjectively by a panel. Their objective is to generate an index of risk which can be compared to Australia's Acceptable Level of Protection (ALOP). If the risk associated with import exceeds the ALOP remedial action to lower it to below the ALOP must be undertaken before imports are allowed.

This IRA found that the unrestricted import of whole apple fruit from New Zealand posed an unacceptably high level of risk of introducing a number of diseases (Fireblight and European Canker[1]) and insect pests (Apple leaf curling midge[2]).

Subsequently the IRA proposes a number of preventative strategies which reduce the risk associated with apple imports to below the ALOP. These are presented in the section of the IRA entitled 'Risk management and draft operational framework' (pp291-301)

Fireblight

The bacterial disease fireblight has been the focus of previous draft IRAs. Given BAs consultative approach in actively seeking and addressing stakeholder feedback almost all substantive issues surrounding this disease have been resolved. What remains are contentious issues supported by conflicting literature or literature which is subject to various interpretations. The following discussion highlights a number of those issues.

Surviving the production and import process

Endophytic populations

Populations which exist within the tissues of another organism are termed endophytic. The argument here is that populations of *Ea* can exist within whole symptomless apple fruit and are therefore impervious to normal disinfestation processes.

It is doubtful that this is a significant incursion pathway. The Japanese relied heavily on this issue in the recent WTO dispute with the USA. This dispute was resolved in favour of the USA allowing importation of apples from the USA into Japan. Japan argued that endophytic populations of *Ea* existed within symptomless mature fruit and posed a significant incursion risk. Much of Japan's argument rested on a paper by van der Zwet and colleagues (1990). The USA called the authors of this paper to appear before the WTO and they acknowledged that the experiments reported within the paper were conducted on immature fruit and the results therefore invalid. The Japanese subsequently sought to establish the existence of endophytic populations experimentally but the WTO ruled that their methodology was questionable.

[1] Apple black spot was considered a specific risk for WA

[2] A number of arthropod pests were considered further as specific risks for WA (p. 44)

Epiphytic populations

Populations which exist on a plant surface are termed epiphytic. The existence of epiphytic populations of *Ea* on the surface of mature, symptomless fruit is undisputed. However, the persistence of these populations is contentious with published durations varying between very short periods and 101 days (Ceroni et al 2004).

After reviewing the literature BA believe that epiphytic survival of the fireblight pathogen is short-term and poses little risk given the duration of the export / import process. They have also imposed pre-export conditions aimed at reducing epiphytic populations (see discussion of the draft operational framework below).

In reviewing conflicting literature BA highlight perceived short-comings of some of research supporting longer term survival. An example of this can be seen in BA's discussion of the work of Ceroni et al. 2004. This paper reports that bacteria survived epiphytically for a period of up to 101 days. BA dismisses this due to the high experimental inoculum dose and inoculation technique.

However BA's interpretation of other studies which they feel support short-term survival is questionable. Many of BA's arguments revolve around *Ea*'s perceived inability to behave as a competent epiphyte. BA would assert that this inability

- Restricts persistence on surfaces including fruit, leaves, soil and packing material
- Lowers the chance of bacterial transfer from surface to surface

To a large degree *Ea*'s ability to survive as an epiphyte is mediated through its ability to produce an exopolysaccharides (EPS) capsule.

EPS is dispersed in water and this may be relevant to its ecological role. Simply, EPS protects bacterial cells from desiccation during dry periods, but is dispersed following rainfall events allowing the bacteria to disperse and infect; failure to infect results in cell death following the resumption of dry weather. This theory is supported by Jock et al. (2005) who found that EPS deficient EA mutants survived for shorter periods than wild types capable of producing EPS under desiccating conditions. BA misinterpret the intention of this work by Jock and colleagues. BA interpret the use this work to assert that *Ea* is vulnerable to dry conditions. The authors intent was to highlight the importance of the EPS by examining the difference in survivability between an EPS-deficient mutant and wild type *Ea*.

Further evidence of the importance of EPS is supplied by Geider (2000) and Bennet and Billing (1978)

BA's interpretation of several studies relating to this phenomenon is simplistic and warrants closer scrutiny of the experimental protocols.

BA argues that because EA survived epiphytically for only short periods of time in several studies, epiphytic populations would pose insignificant risk. Many of the studies used to support this assertion used washed bacterial cells which were unlikely to have an EPS capsule; examples follow.

BA cites the study of Thomson and Gouk (1999) in which only transient populations of bacteria were present on leaves following rain storms. This is used to infer low epiphytic fitness. Further evidence for this assertion is provided by the study of Maas Geesteranus and de Vries (1984) in which washed cells of E.A. died within short periods when exposed to high relative humidity and solar radiation. Both of these studies deal with bacteria which are essentially washed.). Washing is likely to remove the EPS. The studies of Thomson and Gouk (1999) and Maas Geesteranus and de Vries (1984) were therefore likely to have been conducted with bacteria unfit to withstand desiccation and other environmental stresses.

In practice this has important implications. Harvest is biased towards dry weather. Any EA. present on plant surfaces at harvest will not be washed and therefore their epiphytic fitness will not be compromised.

Some contend that EA entered England by surviving epiphytically on wooden packing crates (Lelliot 1959; Billing and Berrie 2002). Epiphytic survival may be a pathway and this issue should be resolved prior to the commencement of trade.

European canker

Increased emphasis has been placed on the fungal disease European canker in this IRA

New South Wales has an elevated risk of incursion primarily because of two factors

- Conducive climates
- Changes in the fungicide use spectrum in-line with Integrated Fruit Production (IFP)

Additionally this fungus has latent (symptomless) phases in both fruit and twigs which would allow it to remain undetected through inspection. It also has an effective long distance dispersal mechanism (ascospores) which does not require specific vectors.

Surviving the production and import process

Latency

Some pathogens can infect plant tissue which remains symptomless for a period of time. This phenomenon is termed latency. In the context of European canker and the proposed importation of fruit from NZ, latent infection of both fruit and twigs (trash) is relevant.

A significant proportion (6%) of infection in new orchards comes from plantings of infected but symptomless propagation material. This material can remain symptomless for up to four years and there is no cost-effective means of detection (McCracken et al 2003)

With respect to importation of whole fruit, BA (page 121) concede that:

'The cool storage and transport process would not adversely affect the viability of the fungus. Latent infections could remain, with fungal growth and fruit rot resuming when fruit is removed from the cool chain, sold to consumers and stored at room temperature. Fruit discarded into the environment could further rot, become mummified and develop viable conidia or perithecia that could initiate new infection'

They then qualify this statement by stating,

'although perithecia rarely develop on infected fruit in waste dumps (Swinburne 1964)'

BA has made an important error in misrepresenting the work of Swinburne (1964). Swinburne makes no mention of a 'waste dump' but reports that 'naturally infected fruit, partially buried in moist peat, and left exposed outside during the winter, developed perithecia with mature asci in about three months'.

BA have seriously underestimated the importance of perithecia and ascospores as a means of long distance dispersal of this pathogen (see wind blown dispersal of ascospores below).

Orchard management

Integrated Fruit Production (IFP) is now being used by all New Zealand apple orchardists (Wiltshire 2003)

The discussion of fungicide use in NZ orchards and the implications of IFP (page 109) is confusing. It also contains a number of technical errors.

European canker control in NZ orchards is largely a consequence of apple black spot control. Under IFP in NZ, BA cite references which show

1. specific recommendations for European canker control include benzimadazoles, dodine, and multi-site activity fungicides including dithiocarbamates (mancozeb, metiram, ziram)
2. Strobilurins are also highly effective.
3. Sterol Biosynthesis Inhibitors (SBIs; a synonym for Demethylation Inhibitors or DMIs) are far less effective.

Given that IPM advocates decreasing the use of dithiocarbamates (they harm beneficial mite populations) and increasing SBI/DMI (they decrease pesticide applications because they can be used with forecasting systems) European canker control is likely to be less effective.

This issue was raised by a stakeholder and dismissed by BA on page 109 and 134 "The IFP program in NZ and other countries has resulted in significant reductions in the use of pesticides for insect control, but the use of fungicides has not substantially altered" In support of this assertion BA cite Wiltshire 2003. Wiltshire states "The major objectives of the IFP disease management have been achieved. These focussed on reducing the mite-disruptive dithiocarbamate fungicides to less than four applications per season by 2000". BAs use of this reference to support their assertion is therefore incorrect.

BA also cites data gained from fruit interceptions at quarantine barriers (page 110). It is unclear which of BA's assertions this is intended to support, presumably,

- Current orchard practices in countries which have endemic European canker maintain it at a low level and/or;
- Even where European canker is present, it is rare in healthy mature fruit

No European canker was isolated from any of these interceptions. Given the estimated market annual penetration of NZ fruit into Australia would approach 200 million apples this data derived from 450 interceptions (53 from NZ) over 5 years, is insignificant.

Dispersal to susceptible hosts

Conducive climates

Given that all Australian apple production regions experience temperatures conducive to disease development the principal environmental determinant of risk is rainfall. The mean annual rainfall required for infection is approximately 1000-mm. In NZ the disease is established in the higher rainfall production regions of Waikato and Auckland.

All significant New South Wales production regions receive approximately 1000-mm annual average rainfall (Table 1) and are therefore at risk. The only other significant Australian production regions receiving similarly high rainfall are in the south-west of

Western Australia and the Adelaide Hills. Australia's only recorded European canker incursion (subsequently eradicated) occurred in Spreyton Tasmania. This was not in an apple production region which receives approximately 1000-mm of annual average rainfall.

Table 1. Mean annual average rainfall[3] of significant apple production regions in NSW.

Region	Mean annual rainfall	Years†
Batlow	1305	89
Orange	876	96
Canobolas	960	67
Bilpin	1318	81

The susceptibility of NSW orchards is also evidenced by the existence of the closely related, though less destructive disease coral spot caused by the fungal pathogen *Neonectria cinnabarina*.

Wind-blown dispersal of ascospores

In assessing the probability of spread BA draw examples from an incursion which occurred in Spreyton, Tasmania. In this case dispersal was relatively limited. As pointed out by BA, in this case the fungus may have only produced conidia and not ascospores which were better suited to long distance dispersal. They theorise that this biased spore production may be due to an unfavourable environment (Spreyton receives <900mm average annual rainfall). Production of conidia alone is atypical. Greater risk of spread is posed by ascospores and they require further consideration in assessing the probability of spread.

Ascospores are an important means of dispersal for this disease in most countries. Ascospores tend to be associated with long distance dispersal and in the case of European canker ascospores are forcibly ejected during rain and wind or water disseminated (Grove 1990). Ascospores can also be dispersed without rain, though

[3] Department of Science. Bureau of meteorology. 1977. Rainfall statistics. Australian Government Publishing Service, Canberra 510pp.

less frequently (Swinburne1971). While the maximum dispersal distance for *N. galligena* conidia appears to be 125m no information appears to be available on the maximum dispersal distance of ascospores. However, Swinburne 1971 states that 'Infections of new orchards are probably initiated by ascospores, which are better adapted to long-distance dispersal than conidia'.

Changes in the fungicide use spectrum

NSW orchardists have been encouraged to adopt Integrated Fruit Production (IFP) and many use integrated pest management (IPM). As a consequence the use of dithiocarbamate fungicides has dropped while the specific and curative demethylation inhibitors (DMIs) has increased. As pointed out by BA (page 109) the ditihiocarbamates play an important role in the control of European canker while the DMIs are much less effective.

A European Canker incursion would require reversion to the broad-spectrum dithiocarbamates and a wind-back in IPM. See also the discussion on Orchard Management

Draft operational framework

Because of a conducive climate European canker is a particular problem for NSW apple producing regions. The pathogen can establish latent infections. Infections entering orchards through nursery stocks can remain symptomless for up to four years. There are no restrictions on the movement of planting material within New Zealand and latency therefore precludes the establishment of pest free areas. It is therefore proposed that the following conditions be added to the draft operational framework.

- Export fruit shall not be sourced from orchards <4 years old
- If an export block is found to contain European canker, it shall be excluded from the export scheme for 3 years from the time that re-inspection fails to find symptoms.
- Fruit shall be held in store for a period of two months following importation. Lots developing European canker shall not be released and will be destroyed or re-exported

Rejection of consignments which contain trash has now been included and this is to be commended given the risks associated with latent infections of both fireblight and European canker. Should importation be allowed it is vital that this regulation is strictly enforced and transgressing consignments be rejected.

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Annex 2

REVISED DRAFT IMPORT RISK ANALYSIS REPORT FOR APPLES (IRA) FROM NEW ZEALAND

NSW Department of Primary Industries Response:

Part C Appendix 2 – Arthropod Categorisation

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Summary

The comments focus on the entomological component of the PRA Part C to determine whether the assessment of the species not considered as posing risk to Australia is adequate. In most cases, the chance of insect or mite species becoming established in Australia through importation of New Zealand apples is appropriately rated as most unlikely. However, there are some decisions that raise concerns.

It is assumed for a number of species considered in Part C of the PRA that their ecological role in New Zealand will be simply transferred to the Australian environment. However, Australia has a more complex environment and a far greater diversity of native species than does New Zealand. Importation of biological control agents is subject to certain testing protocols governed by International Standard Phytosanitary Measure #3 and these protocols needs to be followed rather than simply assuming that the ecology of parasites or predators in New Zealand will be mirrored if the species are transferred to Australia.

Details

The following species are listed as having potential for being on mature fruit and for which establishment in Australia is feasible. However, no further consideration is made in the PRA because they are regarded either as biological control agents of pest species in New Zealand or as benign detritus feeders and their transfer to Australia is expected to have no negative effects, an assumption for which there is no evidence.

a. ***Aphytis mytilaspidis*** (Le Baron). A parasite of armoured scale insects (Diaspididae) in New Zealand. Australia not only has pest armoured scale insects but a wide range of native species are also at risk of parasitism from this wasp. There are 240 described species of Australian Diaspididae with up to 750 undescribed (Naumann 1991). It will also be necessary to test the potential impact of this parasite against related forms such as Dactylopiidae, which are biocontrol agents in Australia of pest cacti (*Opuntia* spp).

b. ***Hemisarcoptes coccophagus*** Meyer. This is a predatory mite of diaspidid scale insects. Comments given above for *A. mytilaspidis* apply even more to this predator. The statement that "it is expected that the mite would not have a negative impact in Australia" cannot be accepted without appropriate host specificity testing in accordance with international protocols.

c. ***Stathmopoda plumbiflua*** Meyrick. Larvae feed on dead and dying plant parts in New Zealand. The potential impact of this species in the Australian environment is unknown, particularly whether it will present competition to native Oecophoridae, a family of moths which has reached a remarkable degree of diversity in Australia (Nielsen and Common 1991).

d. ***Ectopsocus*** spp. and "Psocoptera". Without species identifications, it is unknown whether these species are present in Australia and some estimate of the competition they may pose to Australian native Psocoptera needs to be provided. It is unlikely that psocids would have a negative effect but more taxonomic work needs to be done on the NZ fauna to determine relationships with the Australian fauna before species can be allowed in.

e. ***Eotetranychus sexmaculatus*** (Riley) is known to be a pest of avocadoes and its occurrence in Australia has not been clearly defined. It is assumed to feed only on the leaves of apple because it only feeds in this site on citrus, an assumption that needs to be tested.

f. ***Diptacus gigantorhynchus*** (Nalepa). The Australian record is presumably based on specimens identified by D.K. Knihinicki of OAI for Ag Victoria. These have been included in the Victorian data provided to APPD but the distribution of this species in Australia has not been defined. Jim Amrine (unpublished data) has suggested that "*D. gigantorhynchus*" is a complex of several species requiring further taxonomic research to resolve. One of the species in this complex is known to cause rusting and browning of leaves.

g. ***Eriophyes mali*** Nalepa. A comprehensive survey is required to determine the distribution of this species both geographically in New Zealand and on individual plant parts. The report that it may occur on fruit may be true or false and until this is determined, the potential for this species to reach Australia on apples cannot be estimated.

h. **Mite families**

Oribatid mites. The statement that there are "no reports of oribatids as pests" is wrong. Colloff and Halliday (1998) state that they are minor pests of agriculture and some species were found to feed on foliage. These mites are considered to be of quarantine significance to Australia. It is oversimplification to treat the entire family as a single entity. Our understanding of the biology of these mites is dependent on an understanding of the taxonomic identities and interrelationships of the Australian and New Zealand fauna.

The same comment applies to the mite families Tuckerellidae (tuckerellid mites) and Acaridae (tyroglyphid mites). Information on the biology and taxonomy of both the Australian and New Zealand faunas of these families is too sparse to allow any assessment of the likelihood of various species being on the pathway to Australia via imported apple fruit. The potential impact of an introduction is also impossible to assess since we don't even know what species occur where nor how wide their host ranges may be.

i. ***Orthotydeus* spp.** This group may include predatory or herbivorous species as well as detritus-feeding forms. The Australian Tydeidae generally are poorly known and further study is required before any assessment of importations from New Zealand could be considered. Host specificity testing could be undertaken to provide some evidence of the potential host range in Australia of the species occurring on New Zealand apples but prior to this, the identities of those species in New Zealand will need to be determined by new taxonomic research.

j. ***Tenuipalpus aberrans*** Collyer. The limited host range provided in the PRA includes *Pyrus malus*. This indicates that a comprehensive survey of the occurrence of this species in New Zealand, particularly to determine its host range limits, is required before an assessment of its potential impact and likely establishment in Australia can be made.

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Annex 3

REVISED DRAFT IMPORT RISK ANALYSIS REPORT FOR APPLES (IRA) FROM NEW ZEALAND

NSW Department of Primary Industries Response:

Biometry

Dr Remy van de Ven. Senior Biometrician

Summary

Primary attention in this review focuses on fire blight and European canker.

For fire blight we argue that the importation parameter Imp 2 understates the associated risk and we query the determination of Imp 3. With European canker our specific concerns are that we get different results when determining the probability of importation and we have a problem with the averaging approach used to assess risk. This latter point arises from the mention in the BA report Part B that European canker is more prevalent in wet seasons.

We also present some limited sensitivity analyses and in view of our results consider that the BA report Part B might benefit from doing likewise, particularly so as assignment of distributions to model components are in many cases subjective.

On more general matters raised we query the use of the median rather than the mean as the summary statistic when quantifying overall risk and we query the formulation of the model used for determining the probability that an individual piece of imported infested / infected fruit results in an outbreak of disease. For the former we consider the median downplays the associated risk given the skewness of the resultant distribution. As for the model formulation, we consider that as formulated it is conceptually difficult to assign distributions to the model components.

A number of other matters are also raised, for example querying the time interval (one year) used.

Introduction

Summary of points raised and addressed in this review.

1. The distribution of Imp2 (the likelihood that picked fruit is infested / infected) for *Erwinia amylovora* is considered to under state the incidence. We draw this conclusion based on two points
    a. The BA report Part B draws heavily on results in the paper by Roberts *et al.* (1998) which we argue under estimates the incidence.
    b. The use of the model to determine the decline in infestation from the immature fruitlet stage to the mature fruit stage is questioned

2. We have some queries as to the determination of the distribution for Imp3 (likelihood clean fruit is contaminated by *E. amylovora* during picking and transport to packing house).

3. A small sensitivity analysis is undertaken to see how small changes in the component distributions Imp2, ..., Imp7 alter the distribution for the proportion of fruit imported into Australia that will be infested / infected with *E. amylovora*. This section illustrates the sensitivity of the conclusion to distributional assumptions for these parameters. This is important in light of Points 2 and 3 above.

4. The model used to determine the probability of entry, establishment and spread of the fire blight disease is outlined more succinctly than in the BA report Part B. Simulations are then performed to confirm the results given in the BA report Part B. Further simulations under alternate scenarios are performed from which we conclude that the risk of fire blight establishment and spread may not be as low as claimed in the BA report Part B. Also, after examining the distribution of the probability of entry, establishment and spread of the fire blight disease, we query the use of the median to summarise risk. We consider the mean a more appropriate summary statistic given the distribution's skewness and the consequence of fire blight entry.

5. We do not get the same results for Probability of Importation, and hence for PEES, for European canker as given in the BA report Part B. Our simulations result in lower estimates for the reported quantiles of the distributions.

6. For determining the risk associated with European canker we have a concern with the averaging approach used, in particular averaging over years. Such averaging down weights the risk for occasional bad years, eg wet years.

7. The model used in the report to quantify risk sets the probability that an individual piece of imported infested / infected fruit results in an outbreak of disease equal to $1 - (1 - Exposure \times PPES)^{Proximity}$ (omitting subscripts for convenience). We wonder why the model has been formulated so as it conceptually complicates the assignment of "prior" distributions to the parameters *Exposure*, *PPES* and *Proximity*. We suggest an alternative formulation, approximately equivalent, which is easier to conceptualise.

8. Two general remarks (re further contamination post importation and the time unit used) and one minor point are mentioned in conclusion.

Details

Point 1. Determination of Imp2 for Fire blight

Point 1a. Paper by Roberts *et al.* (1998)

The main point we wish to raise here is the emphasis the BA report Part B places on the results in Roberts *et al.* (1998) in determining the distribution of Imp2. Our concern follows as we have some serious misgiving about the estimates used in Roberts *et al.* (1998). For example, the BA report Part B includes an estimate of 4.9% infestation for apples from orchards with active fire blight based on this Roberts *et al.* (1998) paper. This estimate in turn is based on results from seven orchards[1]. From these seven orchards 1455, 80, 80, 400, 60, 40 and 72 were assayed and of these 0, 5, 27, 3, 0, 0 and 72 of the fruit respectively tested positive. Roberts *et al.* (1998) then base the estimate of the proportion testing positive from orchards as the sum of the positives divided by the total assayed (i.e. 107 / 2187). This is a very poor estimate, particularly so in this case as it is extremely influenced by the one orchard having 1455 assayed and for which none tested positive. Also note the small number assayed (72) from the orchard where all tested positive. Had instead 72 been assayed from the "clean" orchard and 1455 assayed from the "dirty" orchard the estimate for proportion testing positive using the Roberts *et al.* (1998) approach would be 1490 / 2187, that is 68%.

A better approach is to estimate the average probability of a piece of fruit from a randomly sampled orchard testing positive. A naive estimate of this value is the simple average of the proportions testing positive across the seven orchards, i.e. 20%. An alternative approach is to model the observed data using logistic regression and include in the model a random orchard effect. Using this approach (estimating the parameters in the model using penalized likelihood) gives an estimate for the probability that a piece of fruit from a randomly selected orchard with active fire blight tests positive equal to 26%. There is a large uncertainty associated with this estimate as its standard error is estimated to be 36%. This uncertainty is due to the large variation across orchards and the small number of orchards sampled. Hence the 4.9% given in Roberts *et al.* (1998) appears a gross underestimate.

Similarly, the estimated probability in the BA report Part B of 0.35% infestation for apples drawn from orchards where there was no consideration of fire blight status, based on the results in Roberts *et al.* (1998), is a severe under estimate. It is weighted very heavily by the estimated rate in the Roberts *et al.* (1998) paper of 0.1112% for fruit testing positive from lightly infected orchards. That estimate is based on the results from five orchards from which 105, 40, 80, 1400 and 173 fruit were assayed and for which 0, 0, 2, 0 and 0 fruit respectively tested positive. Here the simple average of the proportions testing positive across the five orchards equals 0.5%. Using the logistic approach in the previous paragraph we obtain an estimate for the probability that a piece of fruit, from a randomly selected lightly infected orchard, tests positive equals 1.6% with an upper 95% confidence limit equal 13%.

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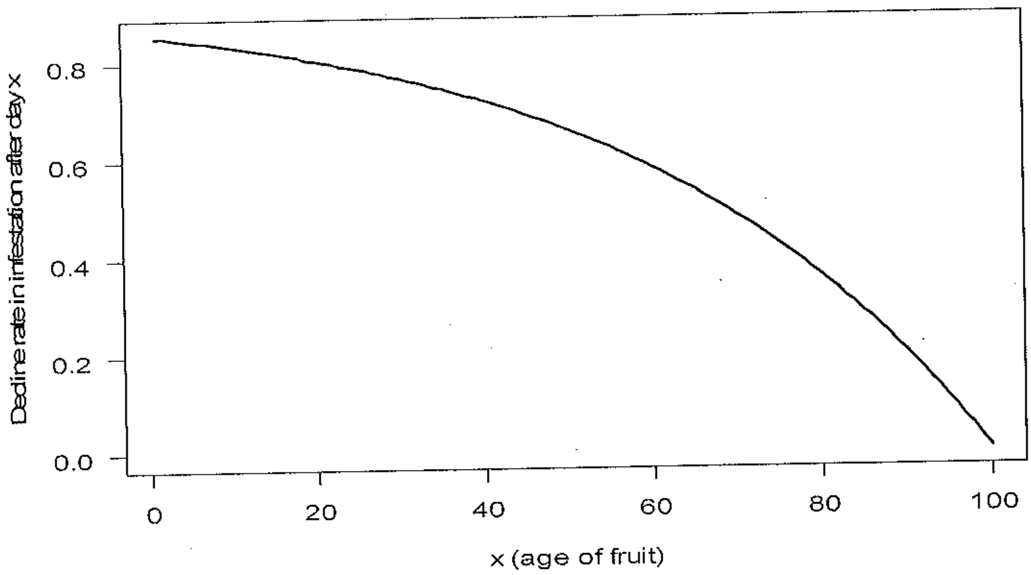
[1] We assume that the result for the NZ orchard having 1400 fruit assayed is incorrectly reported in Table 1 of Roberts *et al.* (1998) as an S3 orchard. In the text it is given as an S2, S3 orchard.)

Using the weighting in Roberts *et al.* (1998), the estimate for infestation rate for apples drawn from orchards where there was no consideration of fire blight status, should be at least 2.8%[2]. This is almost 10 times the estimate of 0.35% given in the BA report Part B based on the results in Roberts *et al.* (1998).

Point 1b. Use of the Model to Determine Infestation Decline

The point we note here is that early in this section much of the determination of infestation rates of mature fruit is based on the estimate, from a single study, of the decline in infestation from the immature fruitlet stage to the mature fruit stage (a period of 100 days). The conservative estimate for decline rate used is 85%, based on the lower 95% confidence limit of the fruit infested at day 1 (i.e. 40.8%) and the upper 95% confidence limit of fruit infested at day 100 (i.e. 6%).

There are some problems with using this 85% figure to determine the infestation rate of mature fruit based on independent studies of infestation rates for fruit sampled at varying stages of development. First, reliance on an estimate derived from a single study in such a critical report leaves one open to challenge. This matter has been already raised by a stakeholder. Of more concern is the use of the 85% value as the decline rate to maturity independent of the stage of development. If one were to assume that the proportion of infested fruit declines linearly on the logit scale over the period 1 to 100 days, then the decline rate from day x to day 100 is as given in the plot below. So, for example, an estimate for the decline in infestation of fruit from day 50 to day 100 would be approximately 66%.



[2] This estimate assumes zero infestation for apples sampled under scenario S1 of Roberts *et al.* (1998). The estimate given for this probability (i.e. P(1) under S1) in that paper is 0.1%. On the other hand we have an estimate of 1% using a similar median approach but allowing orchard variability. All three estimates (0%, 0.1% and 1%) of this parameter result in basically the same overall estimate 2.8%.

For example, in the BA report Part B the 85% decline is applied to the 21.8% and 14.7% infestation rates in immature fruit reported in Clark et al. (1993). This then gives estimates of infestation rates in the mature fruit as 3.3% and 2.2% respectively. But what stage of development were the fruit in the Clark et al. (1993) study? If immature fruit corresponds to fruit at day x = 50 on the plot above the infestation rates at maturity should be estimated as 7.3% and 4.9% respectively. That is more than double the estimated proportions given in BA report Part B.

In concluding the review of this section we note that in the summary of the section of the BA report Part B under review, the determination for the distribution of Imp2 appears to be heavily based on the results in the paper by Roberts *et al.* (1998). Therefore, in view of the comments above, instead of assuming a T(0.001, 0.03, 0.05) distribution for Imp2 (i.e. a triangular distribution on (0.001, 0.05) with mode at 0.03), a more realistic distribution assumption might be T(0.01, 0.03, 0.26). Here we have left the mode at 0.03 but increased the maximum. Maybe the mode and max here should actually be increased to accommodate the uncertainty in the estimates.

Point 2. Determination of Imp3 for Fire blight

One concern we have here is with the sentence on page 62 of the report "*However, even if we consider the figures of 1.3 and 6.9 days risk days for bins and trays kept outdoors (more realistic than bins and trays continuously kept in cold storage), in terms of number of risk days per year these equate to probabilities of 0.003 and 1.9 x 10^{-2}*".

It is not immediately obvious to what 0.003 and 1.9 x 10^{-2} refer and how they are determined? Does, for example, the 1.9 x 10^{-2} imply that 19 in every 1000 fruit placed in wooden poplar trays are expected to be cross contaminated? If so, how is this conclusion drawn? We see that 1.9 x 10^{-2} corresponds to 6.9 / 365. So is the logic based on the assumption that all trays will be contaminated at random times during the year and that all fruit placed in a randomly selected tray will be contaminated if and only if the tray has a viable bacterial concentration at the time of packing? Would it not be more likely that tray contamination occurs around the time of harvest, and hence packing? The divisor 365 above would then be much smaller giving a larger probability.

Further, the paper by Ceroni *et al.* (2004) arrives at the estimate of 6.9 days for the time it takes for *E. amylovora* concentrations on trays (poplar wood) to fall below a so called ID_{50} value (11.5 cfu / cm^2) after immersion in a bacteria suspension with a target concentration of 1.0 x 10^8 cfu/mL. So this estimated time is appropriate to this particular initial concentration. What if the original contamination were more or less? This value 6.9 would then change.

Point 3. Sensitivity analysis.

To see how sensitive the model used to determine the probability of entry is to different distributional assumptions we ran the model but with the parameters for the distributions for Imp2, Imp3, ..., Imp7 changed, where we change one set of parameters at a time. In each case we moved the triangle distribution to the right setting the new values for the min, mode and max to the square root of the values used in the report. This changed the estimates for the probability of entry to the values given in the following table.

				Prob(entry) parameters		
	Min	*Mode*	*Max*	*0.05%*	*Mean*	*0.95%*
Imp distributions as given in BA report, Part B				0.0221	0.0385	0.0563
Imp changed						
2	0.0316	0.1732	0.2236	0.0511	0.0882	0.1281
3	0.0316	0.1000	0.1732	0.0473	0.0752	0.1085
4	0.5477	0.8062	0.8367	0.0267	0.0446	0.0637
5	0.0316	0.1581	0.2236	0.0704	0.1306	0.1818
6	0.8367	0.8944	1.0000	0.0243	0.0422	0.0606
7	0.0000	0.0007	0.0010	0.0226	0.0390	0.0568

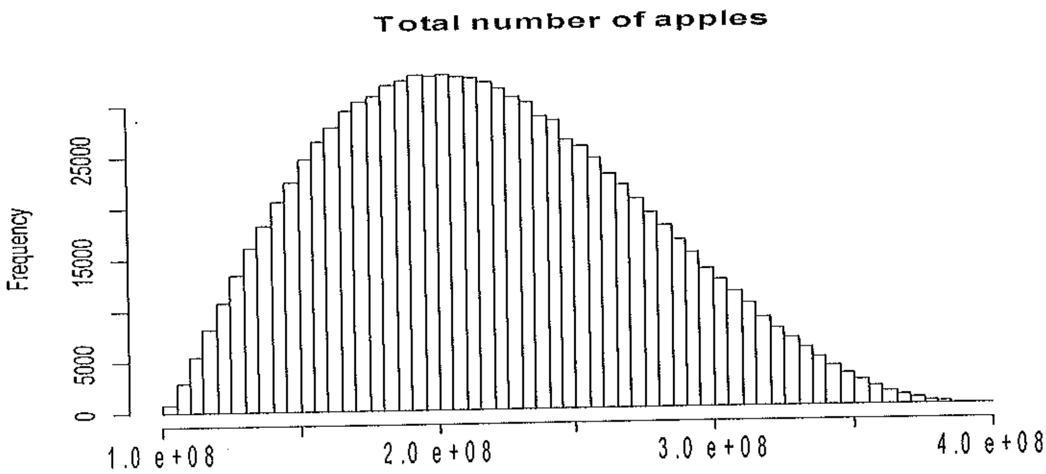
Here we see that changing the distribution for Imp5 from T(0.001, 0.025, 0.05) to T(0.0316, 0.1581, 0.2236) has the largest effect. This would indicate that extreme care must be taken with the assignment of a distribution to Imp5.

Changing the distribution of Imp2 also has a marked effect and in view of the concern raised above with the estimation of the parameters associated with this distribution it may warrant revisiting the model's parameters.

Point 4. Model for probabilities of entry, establishment and spread of Fire blight.

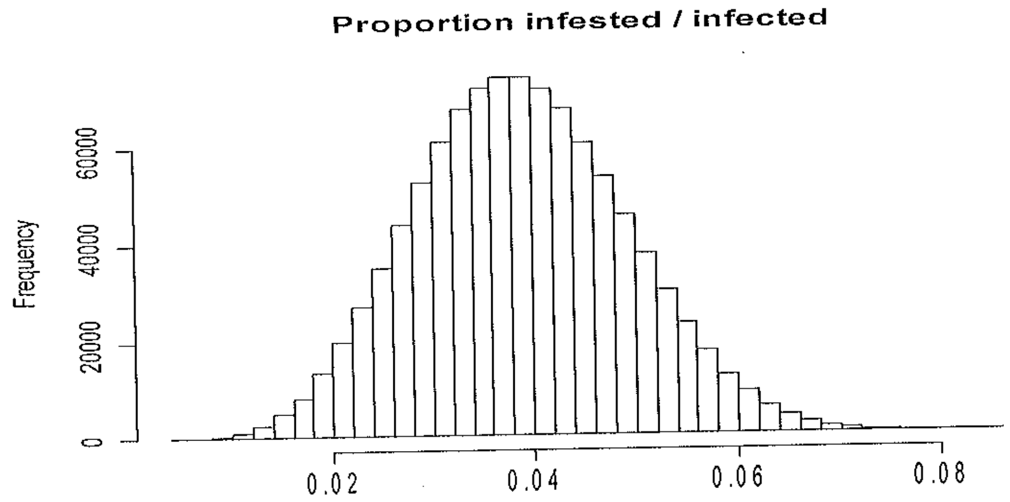
Here we present the model used by BA in a way that is hopefully easier to follow.

First, it is assumed that a total number of apples (*T* say) will be imported into Australia from NZ in a given year, where $T \sim Pert(10^8, 2 \times 10^8, 4 \times 10^8)$. Simulating one million realisations from this population gives a histogram as follows.



Next, of the *T* apples imported into Australia, a portion will be infested / infected with the pest. The determination of this proportion is covered in the BA report Part B (pp

18 – 23 for general issues and Part B pp 50-72 for issues particular to fire blight). Simulating one million realisations for the proportion infested / infected using the assumptions in the BA report, Part B we get the following histogram. Here the mean 0.039 and the 5th and 95th percentiles are 0.022 and 0.056. These values are in agreement with the values in the BA report, Part B (using the parameter "prior" distributions given in that report but for which we have already raised some queries).



We denote the proportion infested / infected for a given year by P0. This value is a random sample from the above distribution.

We now consider the probability of establishment and spread once fruit has entered Australia. In the BA report Part B this depends on five utility sites (abbreviated here as Orchard Wholesalers, Urban Wholesalers, Retailers, Food services and Consumers) and four exposure groups (Orchard, Nursery, Garden and Wild Plants). The BA model assumes that, according to a probabilistic model, N_i apples pass through the ith utility group (i = 1, 2, 3, 4, 5) in a given year and of which W_i will be discarded as waste. These numbers are given in the following table, where P1, P3, P6, P7, P9, P10 an P12 are independent uniform random variables with distributions as given in BA report Part B, page 25

Utility	*Total fruit handled (N_i)*	*Total fruit wasted (W_i)*
Orchard Wholesalers	T × P1	N_1 × P3
Urban Wholesalers	T × (1 – P1)	N_2 × P3
Retailers	T × (1 – P3 – P6)	N_3 × P7
Food services	T × (P6 + (1 – P3 –P6) × P9)	N_4 × P10
Consumers	T × (1 – P3 – P6) × (1 – P7 – P9)	N_5 × P12

The numbers of fruit handled or wasted that are infested / infected are taken as the values in the above table multiplied by P0.

Next we consider the probability that **at least one** infested / infected apple at the ith utility will result in the establishment and spread of fire blight within the jth exposure group. Here each fruit is assumed to independently contribute to the likelihood. The probability is then determined, first by conditioning on the number of infested / infected fruit that are wasted at the i^{th} utility. This conditional probability is given by

$$1-\left(1-PPES_j \times Exposure_{ij}\right)^{w_i \times P0 \times \Pr oximity_{ij}}$$

The random quantities in the above expression not already mentioned are $PPES_j$, $Exposure_{ij}$ and $Proximity_{ij}$. Their distributions are covered in BA report Part B on pages 88 (noting that $PPES_j = PPE_j \times PPS_j$), 81 and 77 respectively.

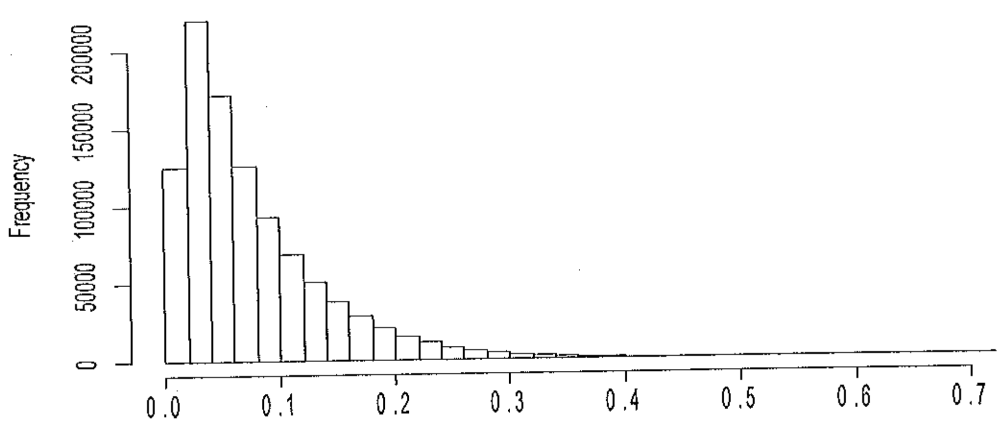
To finally determine the probability that **at least one** outbreak occurs during the year within **at least one** utility / exposure group combination independence is again assumed. Conditional on the numbers of infested / infected fruit wasted, this is calculated as

$$1-\prod_{i,j}\left(1-PPES_j \times Exposure_{ij}\right)^{w_i \times P0 \times \Pr oximity_{ij}}$$

This is then averaged over the distribution of the number of infested / infected fruit wasted and the total imported.

One million simulations under the above scenario result in the following histogram, for which the mean is 0.077 and the 5%, 50% and 95% quantiles are 0.013, 0.057 and 0.207 respectively. These quantile values agree with the values in the BA report Part B, page 88, Table 21. We also have agreement when we modify the distribution of P1 to U(0.001, 0.05).

Prob(At least one case of entry, establishment & spread)



An interesting point to note with respect the above distribution is that it is skewed to the right. Hence, the mean value is greater than the median. In cases such as this where the outcome is unfavourable it could be argued that the mean is a more useful summary statistic than the median.

In determining the above distribution we have averaged over the likelihood of all random variables. It is of interest to see how the distribution of the Prob(At least one case of entry, establishment & spread), denoted by PEES, changes when conditioned on some variables, eg Total number of apples, Proportion infested / infected. This we have done and the results are presented in the following table.

Total number of apples	Proportion infested / infected	mean	5%	95%
100 million	0.02	0.019	0.004	0.049
100 million	0.04	0.038	0.008	0.096
100 million	0.06	0.057	0.011	0.141
100 million	0.08	0.075	0.015	0.184
100 million	0.10	0.092	0.019	0.224
200 million	0.02	0.038	0.008	0.096
200 million	0.04	0.075	0.015	0.184
200 million	0.06	0.108	0.023	0.262
200 million	0.08	0.140	0.030	0.334
200 million	0.10	0.170	0.038	0.398
400 million	0.02	0.074	0.015	0.184
400 million	0.04	0.140	0.030	0.333
400 million	0.06	0.199	0.045	0.456
400 million	0.08	0.252	0.059	0.555
400 million	0.10	0.299	0.074	0.638
600 million	0.02	0.108	0.023	0.262
600 million	0.04	0.199	0.045	0.456
600 million	0.06	0.276	0.067	0.598
600 million	0.08	0.342	0.088	0.705
600 million	0.10	0.398	0.108	0.781

It is interesting to see how quickly the mean PEES changes with increasing apples imports. For example, with 400,000,000 apples imported there is a 14% chance on average of getting at least one outbreak per year when the proportion of infested / infected apples is 4%. This chance increases to 30% if the number of infested / infected apples equals 10% , a not improbable event given earlier comments .

Actually, if we set the distribution of Imp2 (i.e. likelihood that picked fruit is infested / infected) to (T(0.01, 0.03, 0.26). and leave all the other distributions as given in the BA report Part B, then PEES has mean 0.131 and the 5%, 50% and 95% quantiles are 0.021, 0.098 0.356 respectively.

Of more concern are if some of the other distributions are incorrect. For example, consider the distribution for Exposure. If instead of assuming a U(0, 0.000001) we assume a U(0, 0.00001) distribution and leave all other distributions as in the BA report Part B, we have PEES then with mean 0.474 and the 5%, 50% and 95% quantiles are 0.121, 0.449 and 0.902 respectively.

Point 5. Probabilities of importation and PEES for European Canker

Running the model with the parameter "priors" for importation as given in the BA report Part B (pp 106-115) we get a mean probability of importation equal 1.703 ×

10^{-5} and the 5% and 95% quantiles equal 3.674×10^{-6} and 3.624×10^{-5} respectively. These values differ to the values given in the report.

Subsequently we get different values for PEES, the values being

	PEES quantiles		
	5%	*50%*	*95%*
P1 ~ U(0.7, 1.0)	0.0023	0.0197	0.1065
P1 ~ U(0.001, 0.05)	0.0022	0.0194	0.1060

These values are lower than the values given in the BA report Part B.

As for the corresponding values with fire blight, here it might be more meaningful to report the mean rather than the median because of the skewness.

Point 6. Determination of risk associated with European canker based on the averaging approach employed in the model.

Mention is made in the summary section for determination of Imp1 for European canker, following the raising of the issue by a stakeholder, that "*the disease occurs only sporadically in very wet seasons*" (BA report Part B, page 108). This highlights a problem with the averaging approach used in modelling risk. By averaging the Imp1 value over all possible seasons one downplays the risk when one has knowledge that the year is particularly wet. If one conditioned on a particular wet year the risk might end up unacceptable. What should the strategy be in such cases? Should extra precautions be put in place during very wet years? This problem applies equally to the other parameters in the model.

Point 7. Modelling establishment and spread post importation.

The model used in the report to quantify risk sets the probability that an individual piece of imported infested / infected fruit results in an outbreak of disease is equal to (omitting subscripts for convenience)

$$1 - (1 - Exposure \times PPES)^{Proximity}$$

Conceptually it is hard to see from this expression what the range and most likely values one should assign to the "prior" distribution for each of the parameters *Exposure, PPES* and *Proximity.*

Fortunately, to a first order approximation this equals

$$Proximity \times Exposure \times PPES.$$

This latter expression can be thought out as a three stage process. First the discarded fruit must fall within proximity of a host, then the agent must be exposed (transferred) to a host and finally the agent must establish and spread. Each of these can be treated as independent events and then a probability assigned to each (depending on the utility site and the exposure group).

It might thus be argued that a more appropriate model would have that the probability that an individual piece of infested / infected fruit results in an outbreak of disease is equal to *Proximity* × *Exposure* × *PPES* as it would make the assigning of "prior" distribution more transparent. But, as the two expressions are approximately equal it should not affect the results.

General remarks

1. Is it reasonable to assume that the proportion infested / infected will remain constant once apples have entered Australia? Would it be possible after importation for "clean" fruit to become contaminated through coming in contact with "unclean" fruit?

2. The unit of time when determining risk in the report has been set as a year. Does this distort one's impression of the risks involved? For example, in Table 21 the *Qualitative description* for the chance of an out break of fire blight is given as *Low*. Is this a reasonable call? Assuming the assumptions remain the same for the coming years and years are independent, we estimate (based on bootstrap samples from the simulated PEES values), that the median probability of at least one outbreak during the next five years equals 0.32 (the 5% and 95% quantiles equal 0.17 and 0,.52 respectively). For a ten year period these increase to 0.55 (median), 0.38 (5% quantile) and 0.72 (95% quantile).

Minor matter

1. BA report Part B, Figure 2 page 24. Arrow from *Urban packing house* to *Fruit processor* should be labelled P4 (not P5)

References.

See the BA report Part B.

Annex 4

REVISED DRAFT IMPORT RISK ANALYSIS REPORT FOR APPLES (IRA) FROM NEW ZEALAND

NSW Department of Primary Industries Response:

Risk Management and Draft Operational Framework

Dr Kathy Gott Policy Officer Plant Biosecurity and Risk Management

Summary

Operational arrangements to address specific risk management measures for New Zealand apples entering Australia generally align with Interstate Certification Assurance arrangements that operate within Australia and with accepted norms for international trade.

However, the Risk Management and Draft Operational Framework section comprises a mere eleven pages in a 587 page report. Presumably, as this section will guide the procedures to be adopted if apples from New Zealand are granted access to Australian markets, its brevity is of concern. Comment on the management measures for apple leafcurling midge and leafrollers and other pests could have been clearer if the IRA team had recommended a preferred position for consideration.

Details

Requirement for pre-clearance

The loop-hole allowed by the phrase *'at least for the initial trade'* (page 292) raises uncertainties about on-going export conditions that may or may not be required of apples from New Zealand. Also uncertain in this section is the use of undefined terms, especially *'pre-clearance'*, *'experience'* and *'significant'* in the sentence *'The need for pre-clearance would be reassessed after experience has been gained following significant trade'*. Definitions of benchmarks for pre-clearance, experience and significance should be presented as well as how the achievement of the benchmarks is to be measured.

Inspection

a. Fire Blight

On page 291 the 'Risk Management and Draft Operational Framework' section is introduced by an 'invitation' from BA for '*technical comments on the economic and practical feasibility* *of the measures'*. It is a matter of concern that the presumably evidence-based assessment of the IRA team is compromised and dismissed by a comment about trade. It is stated that the IRA team concluded that handling bulk fruit presents a 'significant' risk of fire blight (page 103) but this has been overturned by the technically unsubstantiated opinion that requiring fruit to be packed in boxes as a risk management measure *'could be overly trade restrictive'*.

Whether disinfection treatment with chlorine to prevent contamination of apples with fire blight bacteria is a mandatory condition or a recommended condition is unclear.
The Summary statement (Part A page 1) implies that the use of chlorine as a disinfection treatment may be an optional condition for the importation of apples to Australia from New Zealand. Chlorine use specifications are detailed for concentration levels, immersion period and auditing (page 295) and the conclusion of the fire blight discussion notes that Australia's ALOP would be achieved by the *'combination of orchards being free of symptoms and disinfection by chlorine'* (page 103). In contrast, the fire blight report (page 64) noted that *'in New Zealand 37% of packing houses in the export program use chlorine ...'* but that *'chlorine or alternatives were not used by 47% of the packing house operators'*. Concentration levels of effective chlorine might also be open to dispute as the report notes that chlorine concentrations in New Zealand packing house dump tanks vary *'between 5 and 50ppm'* (page 64) whereas the Australian requirement to reduce the risk of contamination from fire blight is specified at 100ppm (page 295).

Behaviour and survival of *E. amylovora* on waxed fruit exported to and entering Australia is an acknowledged unknown (page 66). The comment is made that bacteria will survive low-temperature waxing and so it is possible that waxing may protect the pathogen in a manner similar to the naturally produced exopolysaccharide capsule. Waxing is standard practice in commercial scale packing houses but there is no mention of whether waxed fruit is excluded from the export stream to Australia. Both bacterial survival and waxing practices should be resolved before apples from New Zealand are permitted entry into Australia.

b. European Canker

On page 294 BA takes the position that *'Risk management for European canker is based on establishing that export orchards or blocks are pest-free places of production'* by visual inspection of trees. Management conditions addressing concerns about European canker have been presented by pathologist Dr Shane Hetherington (Annex 1). These concerns arise because European canker can persist as symptomless infections in plant material for up to four years and that the unrestricted movement of planting material in New Zealand precludes the establishment of pest free areas. For these reasons, time-framed export conditions have been proposed in the report by Dr Hetherington. Similarly, variety and date of picking (month and year) would be useful additions to fruit labelling requirements (*Adequate labelling of lots* page 296). It is likely that apple varieties vary in susceptibility to disease, while picking dates provide an indication of latent potential for disease development.

European canker is considered to be a disease of high risk to NSW because climates conducive to the establishment and spread of the disease occur in apple production areas in NSW and the long-term latency potential of the pathogen would favour its inadvertent dispersal. Additional threats are that the fungus is an ascomycete with effective long-range dispersal spore mechanisms, has a wide host range and that control will necessitate an industry-wide reversal of progress in the adoption of Integrated Fruit Production systems through renewed reliance upon broad-spectrum dithiocarbamates.

Packing Houses

a. Adequate labelling of lots

See notes above regarding mitigation of the risk of European canker.

b. Freedom from trash

Importation is predicated on the fruit being *'free from trash'* (page 296). The assumption is made that this standard is achievable. Achievement of the standard *'free from trash'* should be validated by packing shed data obtained in New Zealand before entry is countenanced, not just inspection after arrival in Australia. The IRA does not adequately address the procedure to be followed if trash is detected in a consignment. Should importation be approved, this regulation should be strictly enforced and non-compliant consignments rejected.

c. Prevention of contamination in storage, transport and handling

The range of choices presented in the first two sentences of this section (page 296) negates the force of the destination instruction that '*After inspection, packed fruit will be immediately ...*' and again highlights that the term *'immediately'* has not been defined. There is no indication given about how segregation of apples designated for Australia is to be achieved and enforced and by what parameters segregation is to be assessed. Also questioned is the increased level of risk of introducing unassessed pests and diseases into Australia that would be incurred if it is accepted practice that consignments to Australia from New Zealand be allowed transit via *'another country en route to Australia'* (page 296). This potential risk factor should be excluded and direct transit to Australia be required if the importation of apples from New Zealand is approved.

Management of apple leafcurling midge

Two principal management options have been presented in order to reduce the assessed risk for apple leafcurling midge to below Australia's acceptable level of protection. Stakeholder comments could be more targeted if the IRA team had presented a preferred option for consideration and the format of the processes had been clearer. Will stakeholders be consulted before decisions are made on which management conditions will be required prior to any approval for the importation of apples from New Zealand to Australia?

The proviso that *'the IRA team acknowledges that it may be possible to develop other risk management measures (for example, perhaps based on low pest prevalence in orchards or pest free places of production)* (page 296) is dangerously vague given that information presented in the Apple Leafcurling Midge Risk Assessment excludes the likelihood of either low pest prevalence or pest free places of production (page 143). The note that Gala types and cultivars with Gala parentage are '*particularly prone to infestation*' (page 143) is of concern because the Gala group is estimated to currently comprise 30-35 % market share in Australia and this proportion is likely to increase as older varieties are removed and replaced.

The Risk Assessment raised a number of technical question marks with regard to survival of cocoons of apple leafcurling midge through packing house operations (pages 145-146) and the flight capabilities of adults (page 153). Research should be undertaken to clarify survival and viability characteristics of the pest under various treatment regimes and environmental circumstances (page 158) as well as adult flight distances. Research should also be directed to assessing the points raised by stakeholders but dismissed by BA with the clause that the stakeholder *'provides no further evidence to support this claim'*. Demarcation of responsibilities in the provision of evidence is at issue.

'*Feral and roadside apple trees*' were identified as potential breeding grounds for apple leafcurling midge (page 157) were this pest to enter and establish in Australia. Such trees are most likely to be more prevalent in apple production areas and pose a consistent risk to commercial orchard management. Destruction and removal of feral and roadside trees could be a cost impediment that might exceed the resources and legal capacities of local (and state) governments.