Australian Government
Department of Agriculture, Fisheries and Forestry

A honey bee industry and pollination continuity strategy should Varroa become established in Australia

May 2011

ISBN 978-1-921575-21-1

ACKNOWLEDGEMENTS

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The steering group is grateful to the following individuals and organisations for their contributions to the continuity strategy:

Agresults Pty Ltd

Agri–Science Queensland

Alpha Group Consulting

ARC Centre for Excellence in Plant Biology

Australian Crop Pollination Association

Australian Honey Bee Industry Council

Australian Nashi Growers Association

Australian Rubus Growers Association Inc.

Better Bees WA

Capilano Honey Limited

Cherry Growers of Australia Inc.

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Collaborative Initiative for Bee Research–University of Western Australia

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Department of Environment and Conservation, WA

Department of Primary Industries, Parks, Water & Environment, Tasmania

Department of Resources–Primary Industry, NT

Department of Primary Industries, Victoria

Department of Primary Industries and Resources, SA

Fruit West

Grains Research and Development Corporation

Growcom

Heritage Seeds

Horticulture Australia Limited

Industry and Investment NSW

Monsons Honey & Apiary Products

Meat & Livestock Australia

NSW Apiarists' Association Inc.

Mr Paul Martin

Pollination Association of Western Australia

Pestat Pty Ltd

Queensland Beekeepers' Association Inc.

Rural Industries Research and Development Corporation

Mr Simon Goodhand

Strategen, Dr Rob Keogh

South Australian Research and Development Institute

Summerfruit Australia

Tasmanian Beekeepers Association Inc.

Tasmanian Crop Pollination Association Inc.

Australian Macadamia Society

The Tasmanian Farmers and Graziers Association

The Wheen Foundation Australia

The University of Adelaide

University of Western Sydney

Victoria Apiarists Association Inc.

WA Apiarists Society Inc.

WA Beekeepers Association Inc.

WA Farmers Federation-Beekeepers section

This acknowledgement does not imply endorsement of the continuity strategy by these individuals or organisations.

EXECUTIVE SUMMARY

Varroa mite is a deadly parasite of the European honey bee which has spread to all inhabited continents except Australia. In the US and Europe, Varroa kills 95–100 per cent of unmanaged hives within three to four years of infestation. Australia's honey bee researchers acknowledge that, despite best efforts, Australia is unlikely to remain free of Varroa. Once established, eradication may not be possible—it has not been possible elsewhere.

Beekeepers in other countries successfully control Varroa by using natural and synthetic chemicals, husbandry practices and bees that are partially tolerant to Varroa. However, managing and monitoring hives for Varroa increases beekeepers' costs, especially for labour.

It is likely that many Australian beekeepers affected by Varroa, possibly 50–60 per cent (mostly hobbyists and part-time commercial operators), will stop beekeeping. Larger commercial operations are likely to be less affected resulting in a small decrease in the total number of hives (less than 5 per cent). It is unclear what the effect on honey production will be.

It is expected Varroa will progressively kill Australia's feral European honey bee populations, greatly reducing the pollination service they provide. As the number of feral honey bees falls, the horticulture industry sector will be most affected, with average losses estimated at $50 million a year (out of a total of $70 million a year for all plant industries). Market forces should increase the supply of pollination hive rentals to meet the growth in demand from horticulture industries. However, there are some threats to the ability of the pollination services market to meet this demand, including uncertainty about Varroa's effect on Australia's honey bee industry, continued ageing of the beekeeping community and biosecurity zones that may be put in place to limit the parasite's spread.

The losses to oilseed and grain legume industries are expected to be small. Oilseed and grain legume producers are less likely to be major purchasers of commercial pollination services compared to horticultural producers, as the financial benefits are lower. Wild insects (alternative pollinators) will be relied upon to fill the pollination role now played by feral honey bees in these crops. Producers may also choose to replace insect-pollinated crops or varieties with self-pollinating alternatives.

This strategy proposes an objective and outlines the key actions governments and industry should collaboratively undertake to prepare for the possible establishment of Varroa in Australia. It is based on the premise that the negative effects can be reduced and industries can continue to be productive if preparations are made, there is adequate investment in research, and governments and industry respond quickly and appropriately.

This strategy is part of the Australian Government's response to the report of the House of Representatives Standing Committee on Primary Industries and Resources Inquiry into the Future Development of the Australian Honey Bee Industry, *More Than Honey: the future of the Australian honey bee and pollination industries*.

OBJECTIVE

The objective of the Continuity Strategy is:

To have arrangements in place that allow the honey bee industry, crop industries responsive to honey bee pollination and governments to prepare for, and respond quickly and efficiently to, the establishment of Varroa in Australia so effects on the honey bee industry and pollination of responsive crops are minimised.

Actions

To achieve this objective, 10 actions are proposed:

Ensure implementation

Action 1. Those parties with an interest in implementing the strategy, including industry bodies, government biosecurity, and industry development staff and scientists, should decide on an arrangement to ensure the strategy is implemented in a timely and efficient manner.

Action 2. A communication plan should be developed and implemented to ensure consistent information on Varroa is available through all Australian government agencies and industry bodies regarding the steps that can be taken to prepare for, and respond to, the pest. The target audience should include beekeepers, farmers and the public. This plan would be separate from the communication plan put in place during the emergency response phase.

Strengthen the capacity of the honey bee industry

Action 3. Industry, state and territory government agencies and other educational organisations should continue to conduct training workshops for beekeepers on business management; integrated pest management practices, including husbandry practices; chemical handling, including correct use and withholding periods (e.g. Chemcert training); and other management practices to control Varroa.

Action 4. Industry and government agencies should maintain and progress the provisional registration of chemicals, including complementary chemicals (organic acids and essential oils) and biological controls, to treat Varroa, and regularly review their status as new treatments become available overseas.

Strengthen the capacity of crop industries

Action 5. Crop and honey bee industry agencies, with the assistance of government agencies, should develop suitable pollination management training materials and quality assurance standards.

Action 6. Farmers producing crops that respond to honey bee pollination, and industry groups representing these farmers, should work with their pollination providers to develop enterprise and industry-level continuity arrangements should farmers become wholly reliant on managed honey bees for pollination. These arrangements should be designed to lessen the impact of potential border and regional control measures that may limit the movement of hives.

Action 7. Farmers producing crops that are insect-pollinated should investigate using or increasing their use of paid pollination services that may lead to improved yields and returns, and encourage the crop pollination industry to provide additional services.

Strengthen post-border biosecurity preparedness

Action 8. At-risk industries and state and territory governments should build on the outcomes of the Plant Health Australia Varroa incursion scenario workshops of 2009 (Turner, 2010). They should cooperate on developing in-principle regulatory arrangements and guidelines to delineate control and management zones, before an incursion, to optimise the twin objectives of controlling the spread of Varroa and minimising the disruption to the honey bee and honey bee pollination-responsive crop industries.

Action 9. Before Varroa becomes established, governments should develop a detailed transition-into-management plan, with the participation and support of industry and other stakeholder groups.

Coordinate research, development and extension

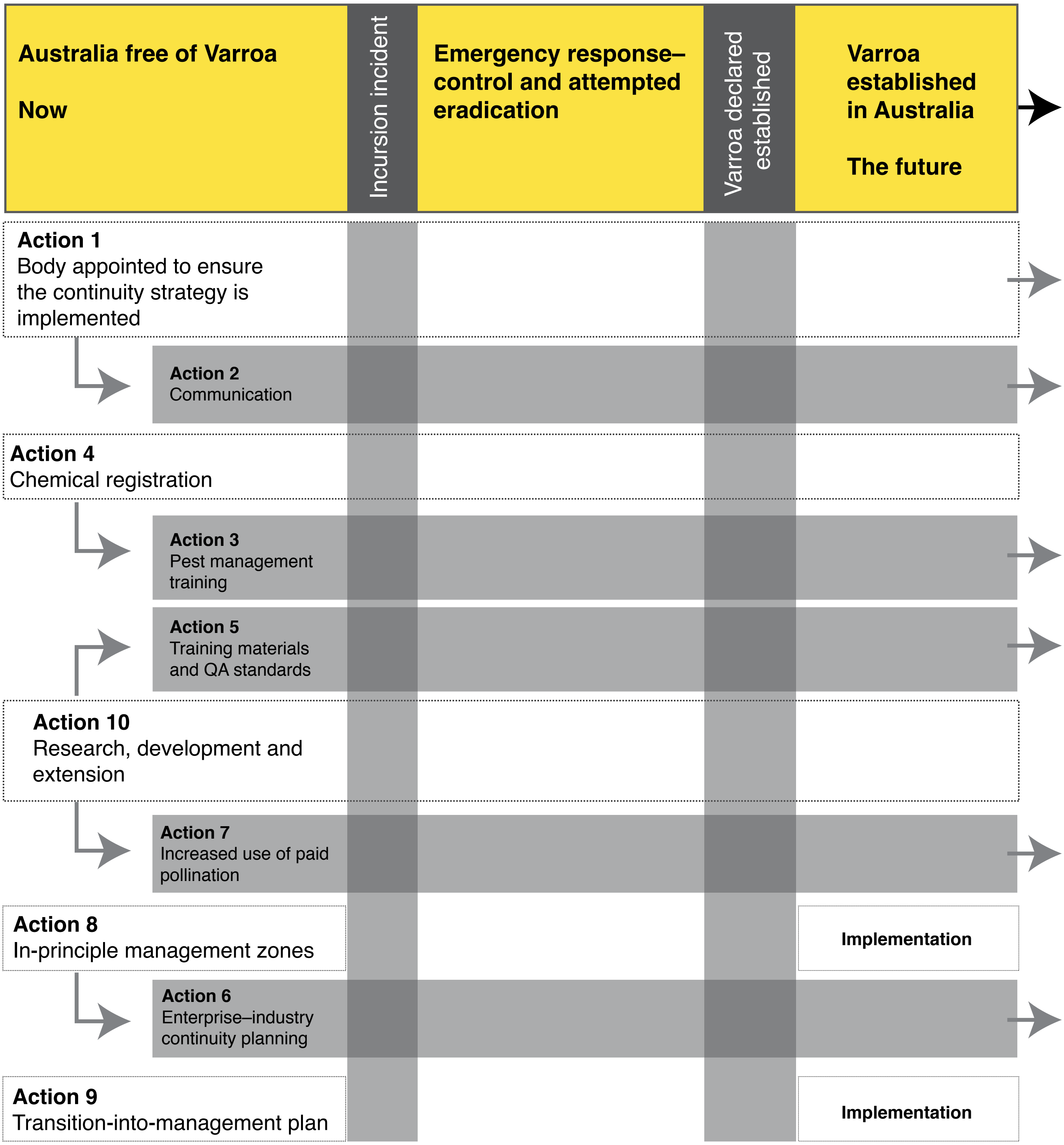
Action 10. Relevant industry and government organisations should coordinate their research, development and extension efforts to focus on gaps in understanding the economic benefits of crop pollination, determining and supporting the uptake of best management crop pollination practices, understanding the role of native (alternative) pollinators in providing pollination services and ways to enhance this contribution, bee breeding, and honey bee pest and disease management. This should be directed towards:

- improving the efficiency of crop pollination by managed honey bees (more pollination by fewer bees)
- maintaining or increasing the level of free pollination from wild insects when feral honey bees are lost
- quantifying the current role of feral honey bees and other insect pollinators in the pollination of Australian crops under Australian field conditions and the benefit of using commercial pollination services
- better understanding the biology and pathology of the Varroa-honey bee interaction at a genetic and physiological level
- better understanding the role of secondary pathogens (e.g. viruses) in bee mortality, and the scope for directly reducing the impact of secondary infection.

Image courtesy of Almond Board of Australia.

PROGRAM SCHEDULE

figure 1 **Program schedule of Actions proposed in the Honey Bee Industry and Pollination Continuity Strategy should Varroa become established in Australia compared with the phases of a typical biosecurity response.**



GLOSSARY

Apiary – colonies, hives, and other equipment assembled in one location for beekeeping operations.

Apiculture – is the maintenance of honey bee colonies, commonly in hives, by humans. A beekeeper keeps bees in order to collect honey and other products of the hive to pollinate crops, or to produce bees.

Apis cerana – scientific name of the Asian honey bee not naturalised in Australia.

Apis mellifera – scientific name of the European honey bee, which is naturalised in Australia.

Beehive – a box or receptacle with movable frames, used for housing a colony of bees.

Beekeeper – one who keeps bees, an apiarist.

Brood – bees not yet emerged from their cells: eggs, larvae and pupae.

Brood chamber – the part of the hive in which the brood is reared; it may include one or more hive bodies and the combs within.

Capped brood – pupae whose cells have been sealed with a porous cover by mature bees to isolate them during their non-feeding pupal period; also called sealed brood.

Colony – the aggregate of worker bees, drones, queen and developing brood living together as a family unit in a hive or other dwelling.

Drone – the male honey bee.

Emergency Plant Pest Response Deed (EPPRD) – an agreement between the Australian Government , state and territory governments and plant industry groups to facilitate making rapid responses to, and the control and eradication or containment of, certain plant diseases.

Establishment (of a pest)– perpetuation, for the foreseeable future, of a pest within an area after entry.

Genotype – the genetic makeup of a cell, organism, or individual.

Honey flow – a time when nectar is plentiful and bees produce and store surplus honey.

Larva (plural, larvae) – immature honey bee life-stage before pupation: white, legless, soft and grub-like.

Migratory beekeeping – the moving of colonies of bees from one locality to another during a single season to take advantage of two or more honey flows.

PaDIL – Pest and Disease Image Library (www.padil.gov.au)

PlantPlan – the agreed technical response plan used by jurisdictions and industry in responding to an emergency plant pest incident.

Pollination – the transfer of pollen from the anthers to the stigma of flowers.

Pollinator – the agent that transfers pollen from an anther to a stigma: bees, flies, beetles, birds, etc.

Queen bee – a fertile female bee, larger and longer than a worker bee; able to lay fertilised eggs.

Self-pollination – the transfer of pollen from an anther to a stigma of the same plant.

Varroa – a parasitic mite of the Asian Honey Bee (*Apis cerana*). In the 20th century three lineages of *V. destructor* and *V. jacobsoni* made a host shift to the European Honey Bee (*Apis mellifera). V. destructor* is larger than and genetically distinct from *V. jacobsoni*.

Veterinary chemical – a substance or mixture of substances that is administered, applied or consumed by an animal to prevent, diagnose, cure or alleviate a disease or condition in the animal or an infestation of the animal by a pest; this includes synthetic, natural or organic substances.

Worker bee – sterile female bee that builds, provisions and cleans the hive and feeds the larvae.

TABLE OF CONTENTS

Appendixes

INTRODUCTION

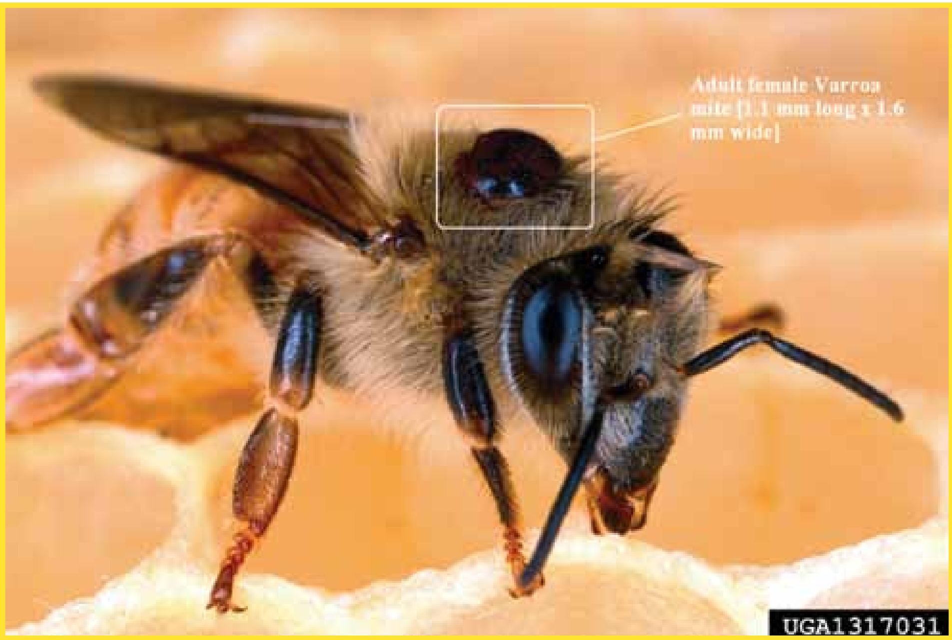
The European honey bee (*Apis mellifera*) makes an important contribution to agricultural production in Australia. The industry produced $90 million of honey and bees wax in 2009–10 (ABARE-BRS, 2010) and provided pollination services to Australian crop industries. Honey bees contribute directly to between $100 million and $1.7 billion of agricultural production a year (Gordon and Davis, 2003). This estimate refers to the pollination benefit to 35 of the most responsive crops to honeybee pollination.[1] If all agriculture is included the estimates may run as high as $4-$6 billion (Thomson, 2007). The broad range of estimates reflects differences in how much crop yield the reports apportion to honey bee pollination (versus pollination by other insects) and how much crop yield is apportioned to other inputs (irrigation, nutrient and pest management) to crop production.

Thanks in part to its geographic isolation, an effective biosecurity system and good fortune, Australia is free of many serious honey bee pests, such as Varroa mite (*Varroa destructor:* Photograph 1).

The parasitic mite, Varroa destructor*, is the most detrimental honey bee parasite in the world today. It can safely be assumed that all honey bee colonies within the mite's range harbour Varroa mites. As a consequence of mite infestation, dramatic colony losses have repeatedly occurred in affected countries (vanEnglesdorp and Meixner, 2010).*

Varroa spread worldwide during the 20th century and is regarded as the major threat to beekeeping internationally. In Europe and the US most hives die within three to four years without regular treatments. The need to control the pest has increased the costs of beekeeping and has contributed to a fall in the number of beekeepers, creating problems with crop pollination (Rosenkranz et al., 2010).

A Varroa mite on a honey bee



1 Crops can be pollinated by the wind, insects or other animals. This document pertains to those crop industries that are responsive to pollination by European honey bees and other insects.

Australia remains the only inhabited continent free of Varroa.

….it is unlikely that Australia will remain free of the mite (Oldroyd, 1999).

Oldroyd's 1999 assessment still stands. It is widely acknowledged among Australia's honey bee researchers that Australia, despite best efforts, is unlikely to remain free of Varroa mite. The most likely entry scenario is for *V. destructor* to arrive with the European honey bee *(A. mellifera)* on a sea vessel of international origin (Barry et al., 2010; Appendix 2). As a guide to the likelihood of an incursion, there have been at least 17 border detections of *Apis* species [bees] since 1995 and there may have been additional undetected arrivals (Barry et al., 2010).

Once in Australia, the Varroa mite is likely to spread.

The unusual nature of the honey bee industry, in which bees travel widely around their home colony and managed colonies may be moved over long distances and even interstate, combined with the widespread distribution of feral colonies of European honey bee, which interact with managed hives, provides ample scope for rapid dissemination of honey bee diseases and pests. The ability of bees to move in cargo containers and ship fittings compounds the risks. The eradication of bee diseases or pests is highly dependent on early detection and immediate action. Where surveys indicate that an infestation is widespread, it is unlikely that eradication will be successful (Animal Health Australia, 2010).

If Varroa cannot be eradicated, beekeepers and farmers will have to change their management practices to ensure healthy bee stocks and the effective pollination of some crops.

Government agencies and industry organisations are strengthening biosecurity arrangements to exclude or eradicate Varroa and are making preparations should Varroa establish in Australia. They include industry representative bodies (The Almond Board of Australia and the Australian Honey Bee Industry Council), rural research and development organisations (RIRDC and HAL), the CSIRO, DAFF, state and territory government agriculture agencies and Plant Health Australia. Development of a continuity strategy was recommended at a meeting of representatives of these organisations in August 2008.[2,3] The recommendation is based on the premise that Varroa's negative effects on the honey bee and crop industries can be reduced, and that the industries can continue to be productive if preparations are made, governments and industry respond quickly and appropriately, and there is adequate investment in research.

2 The broad responsibilities of the Commonwealth, state and territory governments and industry for honey bee biosecurity are outlined in Appendix 3.
3 Further details on the origin of this continuity strategy and how it aligns with existing government–industry emergency response agreements can be found in Appendix 4.

WHAT WE WANT TO ACHIEVE

OBJECTIVE

A widespread incursion of Varroa in Australia is unlikely to be eradicated; judging from the experience of other countries and the nomadic nature of the Australian honey bee industry. However, the honey bee and crop industries can continue to operate, as they do in all other countries in the world that have Varroa.

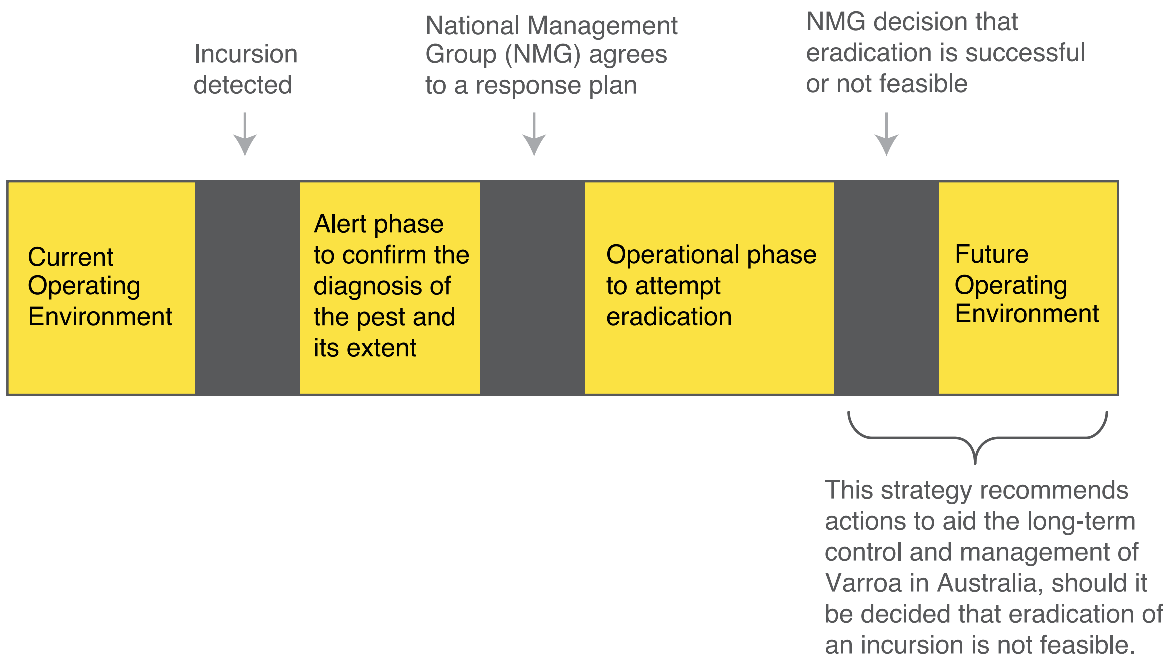
Therefore, the objective of this strategy is:

To have arrangements in place that allow the honey bee industry, crop industries responsive to honey bee pollination and governments to prepare for, and respond quickly and efficiently to the establishment of Varroa in Australia so effects on the honey bee industry and pollination of responsive crops are minimised.

SCOPE

As shown in figure 2, this strategy will assist beekeepers and farmers transition to a future operating environment that will follow Varroa's establishment in Australia after eradication is deemed not to be possible. Figure 2 illustrates where this strategy fits within the biosecurity response framework. Varroa is the priority because it is the exotic honey bee pest most likely to arrive and establish here. However, the actions being developed for Varroa mite will provide the basis for national action on other exotic pests and diseases. A summary of exotic and established bee pests and diseases is at Appendix 2.

figure 2 **The phases of a biosecurity response illustrating where the actions recommended in this continuity strategy fit with the response**



In addition to the actions recommended in the strategy, the National Management Group that is formed to oversee the response and eradication (if cost-shared eradication is entered into) may develop a 'transition–into-management plan'. This strategy provides a foundation to these future decisions but does not seek to pre-empt what they might be.

PRINCIPLES

This strategy is underpinned by five principles:

- **Build on the most recent experience of other countries and work in Australia:** Substantial work has already been done in other countries on Varroa and its management and crop pollination, and work is underway in Australia. The continuity strategy aims to draw on and to integrate these efforts.
- **Take a coordinated and collaborative approach:** The Australian honey bee industry is nomadic and cannot readily be defined by jurisdictional boundaries. In addition, Australia has a diverse range of agricultural and horticultural industries that rely on honey bee pollination. Furthermore, research, development and extension are not carried out or funded by a single agency but by a range of Australian Government and state and territory government agencies.
- **Create a supportive regulatory and management environment:** The regulatory and management environment within which the industries operate must be sensitive to the issues and risks, and support the actions taken to address them.
- **Be prepared:** Economic analysis (Monck et al., 2008; Barry et al., 2010) demonstrates the economic benefits for the honey bee and crop industries from investing in appropriate preparedness activities in anticipation of the establishment of Varroa in Australia.
- **Build awareness:** A precursor to changing behaviour is to generate interest in the subject. Ensuring an orderly response by key honey bee and crop industry groups and the community as a whole to the future establishment of Varroa requires building awareness of the issue and of appropriate preparatory actions that can be taken.

TIMEFRAME

The continuity strategy proposes that all the actions necessary to ensure continuity should be in place before Varroa is established. This strategy should be reviewed periodically—as actions are completed, new information on the responsiveness of crops generated and new control techniques developed—to ensure actions remain appropriate.

THE CONSEQUENCES OF VARROA BECOMING ESTABLISHED IN AUSTRALIA

The establishment of Varroa will cause a progressive decline in Australia's feral honey bee population and require significant changes to management practices and commercial arrangements in the honey bee and crop industries.

THE EFFECT OF VARROA ON EUROPEAN HONEY BEES

Varroa mites live in honey bee colonies, except for brief periods of dispersal on foraging or swarming bees. Varroa feeds on developing larvae, pupae and adult bees, reducing the body weight and lifespan of bees (Rosenkranz et al., 2010). Its effect on European honey bees depends on several factors, including:

- **Varroa genotype.** Two genotypes of *V. destructor* can breed on the European honey bee—the Japanese (J) and Korean (K) (Anderson and Trueman, 2000). The hyper-virulent K genotype spread worldwide during the 20th century.
- **Honey bee sub-species; some are more susceptible than others.** The sub-species of *A. mellifera* can be classified into four branches: Near East—O branch; Tropical Africa—A branch; or Mediterranean–Europe—M and C branches (De la Rue et al., 2009). Sub-species from the M and C branches experience 95 to 100 per cent hive losses within three to four years of Varroa infestation in the United States and Europe (Page, 1998; Fries et al., 2006; Le Conte et al., 2007). Some sub-species of the A branch, such as Africanised and Cape honey bees, are tolerant to Varroa (Allsop, 2006; Calderón et al., 2010) but aggressive. The European honey bees in Australia are M and C branch sub-species (Oldroyd et al., 1995).
- **The presence of bee viruses.** Secondary viral infections are the likely cause of death of individual bees and hives associated with Varroa. Bee viruses are generally considered harmless. However, Varroa is a mechanical and biological vector of viruses, activates virus multiplication and depresses bee immune systems, leading otherwise non-lethal viral infections to become extremely virulent (Genersch and Aubert, 2010). Most of the viruses that cause high mortality in association with Varroa are already present in Australia (Anderson and Gibbs, 1988; Appendix 2).
- **Climatic zones.** Reports about the effect of climate on Varroa vary; some suggest that Varroa has less effect in tropical or subtropical climates than temperate or Mediterranean climates, possibly owing to maintained brood levels under warmer winter temperatures or reduced Varroa reproduction under high temperatures (Rosenkranz et al., 2010; Harris et al., 2003). However, significant negative effects have been reported in sub-tropical and tropical states of the United States (Harris et al., 2003) and Costa Rica (Calderón and van Veen, 2008). The effect of climate on Varroa virulence may be overstated because of the confounding effects of less virulent Varroa genotypes and tolerant honey bee sub-species in some tropical regions.
- **The health of the hives.** If the hive is already stressed, the effects of Varroa are likely to be greater. Sources of stress include poor nutrition, other pathogens and some bee-keeping practices (Rosenkranz et al., 2010).

Given the establishment of the most widespread *V. destructor* genotype (K), and that Australian bees are *A. mellifera* M and C branch sub-species, we can expect about 95 to 100 per cent of unmanaged and feral colonies to be killed within three to four years of infestation by Varroa in temperate and Mediterranean areas of Australia. Varroa may be less damaging in tropical and subtropical areas but evidence from scientific literature is conflicting.

THE LIKELY EFFECT OF VARROA ON THE HONEY BEE INDUSTRY

In 2006–07 the Australian honey bee industry comprised about 10 000 registered beekeepers operating 572 000 hives (Crooks, 2008). Around 1700 beekeepers, each operating 50 or more hives, accounted for more than 90 per cent of Australia's honey bee products. The physical and financial characteristics of the commercial Australian honey bee industry (those 1700 beekeepers with 50 or more hives each) are presented in Tables 1 and 2.

Varroa can be effectively controlled by natural and synthetic chemical treatments, husbandry practices and maintaining tolerant bees. However, managing and monitoring hives increases beekeepers' costs, especially labour. New Zealand beekeepers have experienced increased costs of $40 to $50 per colony per year (Monck et al., 2008). Based on this, total cash costs for an average-size Australian beekeeping operation could increase by around 30 per cent, more than halving the cash operating surplus for the average operation, with some small operations operating at a cash loss.

table 1 **Physical characteristics of Australian honey bee businesses during 2006–07 (Crooks, 2008)**

Size of operation	Number of beekeepers	Proportion of beekeepers	Average number of hives	Proportion of total hives
hives		**%**		**%**
50–250	1 023	60	121	24
250–500	340	20	320	21
500–1000	264	16	632	32
More than 1000	74	4	1 592	23
Total	1 701	100	304	100

table 2 **Financial performance of Australian honey bee businesses during 2006–07 (Crooks, 2008)**

Size of operation	Total cash receipts	Total cash costs	Cash operating surplus	Profit at full equity	Rate of return
hives	**$**	**$**	**$**	**$**	**%**
50–250	24 343	19 757	4 587	-24 440	–4.7
250–500	77 375	46 224	31 151	-27 297	–4.4
500–1000	144 199	87 933	56 266	-778	–0.1
More than 1000	412 328	242 654	169 673	49 887	4.8
Average					
304	71 386	45 860	25 526	-17 971	-3.0

As well as increased costs, there are likely to be increased financial returns to the honey bee sector from the establishment of Varroa because of:

- **Increased honey yields.** Feral honey bees currently compete with managed honey bees for nectar. Varroa will significantly reduce the number of feral bees and this may lead to increased nectar and honey yields from the managed bees. Yield increases of 25 per cent were reported in New Zealand (Somerville, 2008). This effect may be moderated by competition from *A.cerana*.
- **Increased pollination receipts.** The fall in pollination from feral honey bees will lead more farmers to procure paid pollination services from beekeepers. However, not all honey bee operations in Australia offer pollination services, so not all operations will benefit from increased pollination receipts.

Many hobby and some part-time commercial beekeepers affected by Varroa are likely to stop beekeeping. Varroa led to a 50 per cent reduction in New Zealand beekeepers (MAF, 2007; Somerville, 2008) and a 60 per cent reduction in the United States (Daberkow et al., 2009). On this basis, for the whole of Australia the number of beekeepers to exit the sector may be in the order of 5000 to 6000.[4] Affected beekeepers will be deprived of the pleasure or additional income that hobby or part-time commercial beekeeping gives them.

Larger commercial operations are likely to be less affected by Varroa. The decrease in the number of commercial hives is likely to be small (2 per cent in New Zealand; little change in the United States[5] or Europe; MAF, 2007; Daberkow et al., 2009; Moritz et al., 2010). The number of managed hives in New Zealand and the United States has grown in recent years (although both countries have Varroa), because of the expanding Manuka honey industry in New Zealand (MAF, 2010) and the expanding pollination services industry in the United States (Champetier, 2010).

Other challenges that may indirectly affect the Australian honey bee industry's ability to adjust and manage Varroa include:

- reduced flowering of native vegetation because of drought
- reduced access to floral resources because of government regulation and competing land uses
- other pests and diseases
  - nosema
  - small hive beetle
  - foul brood
  - viruses
- the increasing average age of industry members with fewer trained replacements
- a lack of skills and finance act as barriers to new entrants to the industry.

It is not within the scope of this strategy to address these challenges.

4 Cheaper, more effective and easier-to-apply Varroa management options may reduce this figure.

5 Economic forces were already causing a decline in beekeepers and hive numbers in the United States before the establishment of Varroa. The rate of decline in hive numbers was not increased by Varroa (vanEngelsdorp and Meixner, 2010).

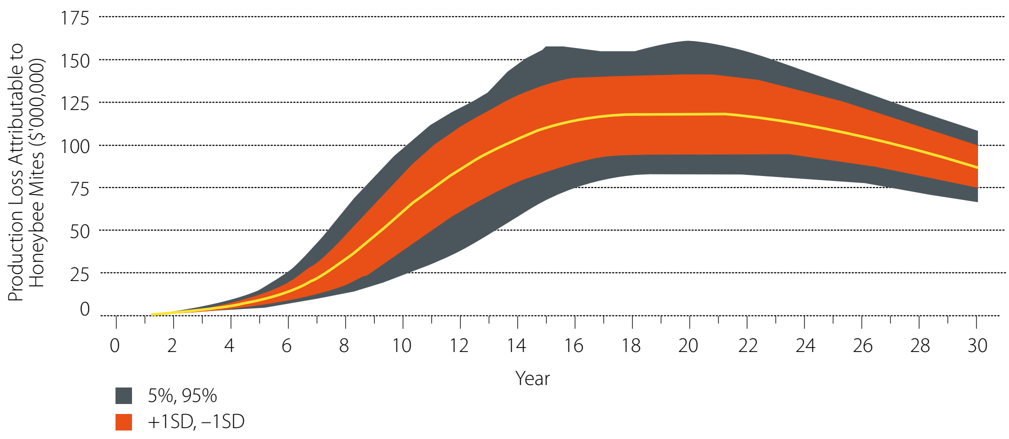
The likely effect of Varroa on crop industries

The impact that Varroa destructor *naturalisation would have on the delivery of pollination services in Australia is expected to be particularly severe (Cook et al., 2007).*

Varroa's likely effect on Australia's crop industries cannot be directly inferred from overseas experience: there are few reports from other countries on falls in crop pollination or yield caused by Varroa. Instead of direct observations, economic models are used to estimate the range or magnitude of possible effects on crop industries. These models include assumptions about the proportion of crop yield attributable to feral honey bees, the efficacy and cost of replacing feral honey bees with commercial pollination services and the rate of Varroa spread.

Figure 3 presents the outcome of one approach to modelling the impact of Varroa on Australia's crop industries (Cook et al., 2007; Barry et al., 2010). Losses to 25 pollination-dependent plant industries over the next 30 years are presented, including potential yield losses and cost increases because of the need to purchase commercial pollination services. These are expected losses in the sense that they reflect that Australia is currently (i.e. year 0) free of honeybee mites, including Varroa.[6] It assumes a likelihood of entry and establishment of 20–70 per cent per annum. Losses are expected to peak at around $115 million per year, but may exceed $135 million. On average, annual losses over the 30-year period simulated by the model were around $70 million (Barry et al., 2010).

figure 3 Estimated loss of plant industry production (decrease yields and higher input costs) over time attributable to honey bee mite incursion, establishment and spread (Barry et al., 2010[7])



Although it is difficult to accurately predict incursion scenarios, the model anticipates a gradual spread of the honey bee mites through feral honey bee colonies over the first two to five years, before accelerating rapidly and spreading throughout Australia[8] within about 10 to 15 years of their introduction. Owing to the nature of the Varroa mite it is likely to be some time (10 to 24 months) after it enters Australia before it is detected (Barry et al., 2010), decreasing the amount of time for industry to adapt after the initial discovery.

6 Cook (et al., 2007) modelled the economic impact of a *V. destructor* incursion. Barry (et al.,2010) modelled the economic impact of a honey bee mite (*V. destructor; V. jacobsoni* and *Tropilaelaps*) incursion; but the model is largely unchanged from Cook et al., 2007.

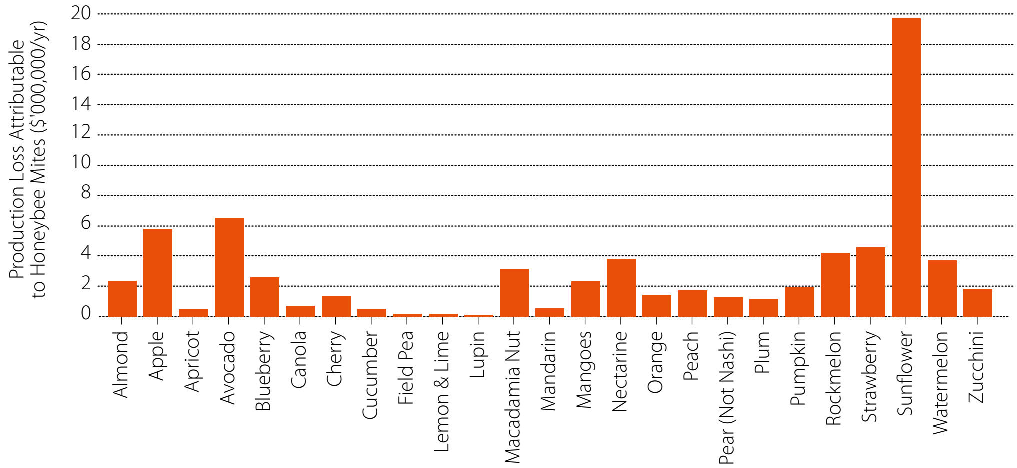
7 Refer also to Cook et al., 2007 for additional details about the modelling methodology.

8 The spatial spread model does not take into account natural barriers to spread in Australia, such as Bass Strait or the Simpson Desert.

A number of horticultural industries will incur losses from Varroa (figure 4). Following a fall in feral honey bee numbers, horticulturalists who do not already use commercial pollination services are likely to start using them (Monck et al., 2008). Hive rental fees range from $60 to $120 a hive and stocking rates between three and five hives per hectare; total crop pollination costs are in the range of $180–$600 a hectare. Increased demand may drive pollination hive rental costs higher shortly after the establishment of Varroa (Monck et al., 2008). Nevertheless, in most high-value horticultural crop industries these costs are a relatively small proportion of the total costs (fixed + overhead) per hectare. These extra costs may be offset through benefits from using pollination services including increased product yield and quality, or lengthening the economic life of tree crops (Monck et al., 2008).

The losses to broadacre oilseed and grain legume crops from Varroa are likely to be small (figure 4). Estimated average losses to lupins and field peas from Varroa are negligible, and amount to around $600 000 a year for the canola industry (Barry et al., 2010). Modern hybrid sunflower varieties grown in Australia are largely self-pollinating (Serafin et al., 2010) and as a result of this, costs to the sunflower industry are likely to be much smaller than suggested by the analysis of Barry et al., 2010 (figure 4). Producers of these crops are unlikely to be major purchasers of commercial pollination services as the benefit of paid pollination services will be much lower than for horticultural crops—in most cases this will be too low to warrant paid pollination services (Monck et al., 2008).

figure 4 **Estimated annual costs to selected crop industries from the establishment of Varroa in Australia averaged over the 30-year period presented in Figure 3[9,10] (Barry et al., 2010)**



In considering the costs of Varroa to New Zealand agriculture, the NZ Ministry of Agriculture and Forestry (MAF) suggested that the pastoral industry would face significant costs. These costs would arise from the need to apply more nitrogen fertiliser and clover seed to mitigate the falling clover content in pastures in the absence of feral honey bee pollination (MAF, 2000). It will take a decade for any affects of Varroa on clover productivity to appear because of clover's ability to vegetatively reproduce and its large seed bank in the soil. Effects are not yet apparent in New Zealand. Pastures were not included in the model used by Barry (et al., 2010).

9 The estimated annual costs are based in part on 2004 Australian Bureau of Statistics crop area data. Crops areas are likely to be different now. In particular, the almond industry, a large user of paid pollination services, has grown substantially since 2004.

10 Modern sunflower hybrids are largely self-pollinating and, as a result, the costs to the sunflower industry are likely to be much less than reported by Barry et al., 2010.

ACTIONS TO DATE

Biosecurity arrangements

Australian Government, state and territory governments and industry have already strengthened biosecurity arrangements to deal with Varroa. Table 3 summarises six biosecurity phases (column 1) ranging from prevention through to management of a disease or pest if it becomes established. The actions completed or underway are described in column 2.

table 3 **Summary of actions already taken to strengthen elements of Australia's biosecurity system to prevent an incursion, improve detection and prepare to respond to, and recover from, a major bee pest or disease**

Biosecurity phases	Actions completed or underway
Prevention: The regulatory and physical measures to ensure that biosecurity incidents are prevented or their effects mitigated.	Review of import conditions for honey bees into Australia to assess the threat posed by Colony Collapse Disorder and bee parasites. This resulted in a cessation of honey bee imports to Australia [2008–10][11]. Review and enhancement of Australian Quarantine and Inspection Service (AQIS) activities at the border to address the threat posed by the new strain of V. jacobsoni in Papua New Guinea (PNG) [2009].
Surveillance: The examination and testing of an animal or plant population or area to determine the presence or absence of pests, diseases or contaminants.	CSIRO research on Varroa species in PNG South-East Asia and the South Pacific. Northern Australian Quarantine System (NAQS) survey for bee pests and diseases in PNG and Papua province of Indonesia [2008].
Preparedness: The arrangements to ensure that, should a biosecurity incident occur, all resources and services needed to manage the response can be efficiently mobilised and deployed.	DAFF has APVMA minor use permits for Bayvarol and Apistan for surveillance during a Varroa incursion. DAFF also has permits for unleaded petrol to destroy hives and permethrin dust to destroy feral nests. Simulation exercises conducted by Animal Health Australia [2000] and Plant Health Australia and the Victorian Department of Primary Industries [2009]. DAFF training of state–territory officers on the diagnostics of honey bee pests and diseases and the diagnostics of Apoidea. Department of Environment and Conservation WA – Feral bee bait station development. State quarantine response teams.
Response: Actions taken in anticipation of, during and immediately after a biosecurity incident to ensure that its effects are minimised.	AUSVETPLAN Disease Strategy Manual for bee diseases and pests updated [2009–10]. Honey bee industry moving under the Emergency Plant Pest Response Deed [2010].
Recovery: The reconstruction of physical infrastructure and restoration of emotional, social, economic and physical wellbeing after a biosecurity incident has been managed.	The HAL-RIRDC 'Pollination Aware' project has identified the potential demand for commercial pollination services in the event of a loss of feral bee-associated pollination because of a Varroa incursion.
Management: The management of established pests and diseases or existing contaminants of significant risk.	Steering Group to oversee the development of the honey bee and pollination continuity strategy convened [2009–10]. HAL–RIRDC investment in the registration of chemicals to control Varroa [2010–]. HAL–RIRDC investment is genotyping/phenotyping Australian bee breeding populations for Varroa resistance [2010–]. HAL–RIRDC non-chemical control of Varroa workshops [2010]. Industry and Investment NSW bee management training workshops. The advisory role played by state agency apiary industry development officers.

11 Biosecurity Australia is reviewing quarantine conditions for the importation of live queen honey bees with a view to resuming importation. A formal review is required before imports of bees can resume, ensuring that all disease risks can be adequately managed to protect the Australian honey bee industry and the environment.

Scientists in Australia are already studying Varroa to ensure healthy honey bees and gain a better understanding of crop pollination in this country. Further work is also taking place on training and awareness-raising on Varroa and crop pollination. Some of the actions suggested in this continuity strategy are already underway.

RESEARCH AND DEVELOPMENT

Projects completed, or underway, include:

- D Anderson, CSIRO, Australian Centre for International Agricultural Research (ACIAR) numerous projects: *Parasitic mites of honey bees and Asian honey bees.*
- BP Oldroyd, University of Sydney, RIRDC project, D*evelopment of two genetic markers for hygienic behaviour of honey bees.*
- BP Oldroyd, University of Sydney, Australian Research Council (ARC) project, *Marker assisted selection of honey bees.*
- B Baer, University of Western Australia and Better Bees of Western Australia, ARC linkage project, *Better bees for tomorrow: A proteomic and physiological characterisation of male fertility in managed versus feral honey bees in Western Australia.*
- GW Luck and PG Spooner, Charles Sturt University, ARC project, *Designing landscapes to deliver ecosystem services to agriculture.*
- CSIRO – Pollinators in the landscape and biosecurity and invasive species research themes.
- T Bates, B Long and D Martin, Churchill Fellowships to study the impact of Varroa on honey bee and crop industries, and management options in the US and Europe.
- R Spooner-Hart, University of Western Sydney, RIRDC project, *Evaluation of anti-Varroa boards for increase in honey production.*
- D Le Feuvre (Australian Bee Services) and S Cunningham (CSIRO), GRDC project, *Managed pollination of Vicia faba beans.*

GOVERNMENT TRAINING COURSES

- Industry and Investment NSW – Pests and diseases of honey bees course 2010.
- DEEDI QLD – Apiary information sessions.
- Department of Agriculture, Fisheries and Forestry – Establishment of the PaDIL website as an aid in identifying insects and insect pests.

INDUSTRY AWARENESS RAISING

Industry groups have invited presentations on Varroa and crop pollination at several recent conferences including:

- Annual Almond Industry Conference 2008 and 2009.
- Lucerne Australia, Pollination Symposium, 2009.
- National Cherry Growers Conference and National Apple & Pear Growers Conference, 2009.
- The Wheen Foundation-Honey bee genetics and breeding seminar, 2009.
- State and national beekeepers association conferences, 2009.
- RIRDC Honey bee industry study tour, *Lessons for the Australian beekeeping industry – The New Zealand experience with pests and diseases.*
- HAL–RIRDC Pollination Aware project.

POTENTIAL CONTROL AND MANAGEMENT ACTIONS

Early reporting will be crucial to any effort to eradicate or aggressively control the spread of Varroa. If Varroa is declared as established following an incursion, there are a range of actions that governments and industry could implement to control its spread and to minimise its effects on honey production and crop pollination activities.

CONTROLLING THE SPREAD OF VARROA

Movement controls and increased surveillance

In the event of a Varroa incursion, Australian Government authorities will follow the predetermined response plans in PlantPlan.[12] The nature of the control measures is briefly described below.

In the event of an incursion of Varroa mite, the officer with legislative powers in the state/territory in which the incursion occurs will institute a restricted area and a control area around the identified infected premises. Within the restricted area all managed apiaries will be quarantined and inspected and this will be extended to include all other apiaries owned or managed by beekeepers with infested apiaries. Movement of all life stages of bees and honey bee colonies, all beeswax or comb out of the restricted area will be prohibited.

The control area will be a larger declared area around the restricted area(s) and, initially, possibly as large as a state or territory. The declaration of a control area helps to control the spread of the infestation from within the restricted area. Movement control restrictions are to be placed on all managed apiaries within the control area until inspections within the restricted area are completed. Movement of potentially contaminated apiaries and materials within the control may be allowed, but movement out of the control area is prohibited without approval of the officer with legislative powers and after surveillance has determined the extent of the incursion.

Interstate quarantine measures

Interstate movement of honey bees currently requires a health certificate (for the interstate movement of apiary products, bee colonies, used appliances, queen bees, escorts, queen cells and package bees) issued by the Department of Primary Industries (or equivalent) in the state or territory of origin. Applications for this certificate require the owner to declare 'the bee colonies are not in quarantine and are not from a declared quarantine area or declared prohibited zone.' Given this requirement, establishing a control area in response to an incursion of Varroa will prevent the interstate movement of any bees from the declared control area. The initial control area that is declared may be as big as the entire affected state or territory.

Unaffected states or territories could impose movement bans to prevent entry of any bee hives from the affected states and territories.

12 Until 2010 honey bees were covered by the Emergency Animal Disease Response Agreement, but they are now covered by the Emergency Plant Pest Response Deed, managed by Plant Health Australia. As a consequence, AUSVETPLAN: Bee diseases and pests will require updating and reformatting into a PlantPlan manual format.

Potential impacts of interstate quarantine measures and movement controls

Measures to limit the rate of spread of Varroa may have positive and negative effects. If successful, they will provide more time for industries to adjust to Varroa and limit Varroa to certain areas of Australia. In particular, effective interstate quarantine controls, combined with the natural barriers provided by Bass Strait and the Simpson Desert, are likely to prevent the movement of Varroa into or out of Tasmania and Western Australia. However, Australia's honey bee industry is nomadic, with beekeepers transporting their hives over large distances, including between states, in pursuit of honey flows or to provide pollination services. Figure 5 provides an example of the extent of hive movement in a year for an beekeeper with a home base in Wagga Wagga, New South Wales. Quarantine zones that seek to limit the movement of bee hives into or out of certain areas will interrupt the movements of some beekeepers, making it difficult for them to operate as normal or to meet the needs of pollination-requiring crop industries. The costs and benefits of inter or intrastate quarantine zones need to be taken into account when deciding to implement them.

figure 5 **The distribution of hives by a beekeeper based in Wagga Wagga, New South Wales, during 2008 (Bresolin and Peterson, 2010)**

CHANGES TO HIVE MANAGEMENT

Beekeepers in other countries manage Varroa using a combination of natural and synthetic chemical treatment, altered husbandry practices and maintaining partially tolerant bees. However, such management practices may not be applicable under Australian conditions. In particular:

- Labour-intensive cultural practices developed in Europe (where the average bee keeping operation is relatively small) are unlikely to be commercially viable in larger operations in Australia.
- Chemical or cultural practices that rely on a 'winter brood break' are unlikely to be useful under natural conditions as Australian winters are not cold enough (except possibly in alpine regions)
- Uncertainty about the performance of current organic acid products under the relatively high ambient temperatures in Australia
- Year-round honey flows in Australia leading to the need to consider timing of treatments to avoid honey taint or contamination issues.

As a consequence more research will be needed to test and adapt overseas knowledge and practices to Australian conditions.

Integrated pest management

Varroa cannot be controlled in the long term by a single management practice. Synthetic chemicals, although effective, are costly and Varroa will eventually develop resistance to them. Other treatments are not effective enough by themselves to provide commercial levels of control. As a result integrated pest management (IPM), in which beekeepers assemble a number of practices into a control program, offers the best long-term strategy to control Varroa. Rosenkranz (et al., 2010) recommend that IPM programs should:

- If possible, use acaricides of natural compounds, tolerant bees and cultural-husbandry methods, in preference to synthetic chemicals
- Include several different management actions to avoid treatment failure or chemical resistance, and to increase overall efficacy
- Include the use of a suitable diagnostic tool to define when management actions are required, control the efficacy of treatments and recognise an unexpected reinfestation of mites
- Only apply management actions based on mite population growth and the risk of 'reinfestation' from other non-treated beehives (treatment at economic threshold levels)
- Not involve chemical treatment during nectar flow
- Perform management actions before producing overwintering bees. Only healthy winter bees that were not parasitised during their ontogenetic development can survive until the next spring.

Chemical controls

Table 4 lists chemicals (acaricides) used for Varroa control in other countries. Initially, Australian beekeepers are likely to rely on synthetic chemicals to control Varroa. Over time, with increased familiarity of Varroa under Australian conditions, beekeepers may move to more integrated management practices and use synthetic chemicals less.

In the long-term chemical resistance and the accumulation of residues in the wax and/or the honey will limit the effectiveness of synthetic chemicals. It is essential to rotate the chemical mode of action groups to delay the onset of resistance and to adhere to minimum withholding periods to ensure maximum residue levels in honey are not exceeded.

It is possible that the population of Varroa that establishes in Australia may already have resistance to some of the common chemicals used to control it, because of previous exposure to these chemicals in the source country.

Varroa can be controlled by organic acids and essential oils, lessening the risk of product residues or pesticide resistance associated with synthetic chemical use. However, the Varroa control they offer varies (Rosenkranz et al., 2010). The level of control depends on how the treatment is applied, the condition of the hive and environmental conditions (table 4). New formulations and application methods are being developed that improve the control offered by natural chemicals (Bayer CropScience, 2010; see also the section on Biological Controls).

Effective and appropriate use of all control measures, and the use of chemicals in particular, requires training and awareness of the particular method or chemical on the part of the person applying the treatment. In some states, beekeepers will be required to undertake training, and hold a chemical handling and application licence, for them to use agvet chemicals (e.g. Chemcert training).

table 4 **A compilation of chemical treatments in use, or part of research activities for Varroa control in other countries (Rosenkranz et al., 2010)**

Synthetic chemical acaracides	Active ingredient	Chemical class	Valuation
Apistan	Fluvalinate	Pyrethroid	Substances mostly lipophilic (except cymiazole) and persistent with high risk to create residues in bee products, thus boosting the likelihood of resistant mites developing.
Apitol	Cymiazole	Iminophenyl thiazolidine derivative	
Apivar	Amitraz	Amadine	
Bayvarol	Flumethrin	Pyrethroid	
Check-mite +, perizin	Coumaphos	Organophosphate	
Folbex	Bromopropylate	Benzilate	
Essential oils and organic acids			
Apiguard, thymovar, apilife var and generic forms	Thymol	Essential oil	Effective, but with varying results. Wax residue issues, but not stable.
Generic	Oxalic acid	Organic acid	Efficacy 90% + in broodless colonies; less than 60% with brood; potential negative effects on brood and bees.
Apicure, mite away, mitegone and generic forms	Formic acid	Organic acid	Highly effective, minimum risk of residues or resistance (if appropriately applied). Efficacy dependant on a number of factors.
Generic	Lactic acid	Organic acid	Efficacy 80% + in broodless colonies, 20–40% with brood; labour intensive.
Generic	Food grade mineral oil and other oils	Mineral and essential oils	Scarce effect-further development required.

Cultural/husbandry practices

The effectiveness of chemical control is likely to be increased and the negative side effects of their use reduced with the adoption of complementary practices, including:

- annual requeening
- queen isolation cages
- hive splitting
- brood removal
- manipulating production of drone brood to reduce Varroa numbers
- screen bottom boards
- monitoring of Varroa numbers
- minimising reinfestation from untreated or feral colonies (i.e. preventing swarming; area-wide management)
- heat treatment.

These practices work by maintaining strong bee populations, physically removing Varroa from the hive, protecting the apiary from reinfestation and using heat to kill or drive Varroa out of cells.

Breeding Varroa tolerant bees

Bees can be bred to have useful tolerance to Varroa. The United States Department of Agriculture (USDA) has a Suppression of Mite Reproduction/Varroa Sensitive Hygiene (VSH) breeding program and a Russian honey bee (RHB) breeding program. The former program is based on tolerance already present in United States bee stocks, the latter on imported Russian stocks. Both programs are delivering commercially useful results (reviewed by Rinderer et al., 2010). Breeding from untreated survivor colonies (i.e. untreated feral colonies or commercial hives that survive Varroa) has also delivered commercially useful levels of tolerance in a number of European countries (reviewed by Büchler et al., 2010) and in New Zealand (HortResearch, 2007).

Maintaining tolerant bee lines is an active process for the beekeeping industry. In the United States the USDA sells VSH breeder queens to queen producers who produce and sell a variety of out-crossed VSH queens to beekeepers. A group of queen breeders has formed the Russian Honeybee Breeders Association to maintain the RHB lines and make them available to the industry (Rinderer et al., 2010). Similar arrangements exist between bee-breeding associations and government institutions in Europe (Büchler et al., 2010).

Beekeepers have to adjust their management techniques to maintain tolerant stocks, including to:

- Identify and select tolerant colonies/queens and cull or requeen sensitive colonies/queens to maintain tolerance in their stocks (to counter the effects of sexual out-crossing that tends to diminish tolerance in the colonies over time)
- Monitor Varroa numbers and quarantine hives with high numbers from the rest of the stock and manage them to get numbers down
- Reduce the use of other management practices so that selection pressure for Varroa tolerance is kept high within the stock (Büchler et al., 2010).

Biological controls

Research is underway overseas on the use of organisms, such as the fungi, *Metarhizium* spp., that are pathogenic or parasitic of Varroa. Although in its infancy, this research is already delivering commercially useful results of up to 90 per cent control (Williams, 2010). A product based on research done on *Metarhizium* in New Zealand is being commercialised.

OPTIONS FOR HONEY BEE POLLINATION RESPONSIVE CROP INDUSTRIES

Use of managed honey bee pollination services

Market forces should ensure that the supply of pollination hive rentals increases to meet plant industry demand in Australia. A pollination market already exists in Australia, with 481 honey bee businesses supplying an estimated 220 000 pollination rentals in 2006–07 (Crooks, 2008; Monck et al., 2008). The market has not reached its full potential, partly because Australia does not have Varroa. Varroa has increased the demand for commercial pollination services in other countries by decreasing the quality of pollination services offered by feral bees (Rucker et al., 2003).

Shifts in the prices of honey and pollination services lead beekeepers to change how they use their hives. Because of this, the quantity of pollination services from a given number of hives is not fixed (Champetier, 2010; Burgett et al., 2010) but it does have a maximum limit. Australia's commercial honey bee sector is focused on honey production, with its 506 000[13] hives delivering only 220 000 pollination rentals a year (Crooks, 2008; Monck et al., 2008). However, hives can perform up to four pollination rentals a year, meaning that the commercial honey bee sector could potentially increase its capacity 10-fold and deliver around 2 million pollination rentals a year. The potential annual demand for commercial pollination services in Australia, assuming feral bees do not exist, is about 500 000 rentals (Appendix 1).

In reality, the sector could not deliver 2 million pollination rentals. Providing pollination services is more physically demanding on beekeepers than harvesting honey. Physical constraints (26 per cent of businesses) and the difficulty in providing the service (34 per cent) were key factors limiting the ability of honey bee businesses to expand or introduce pollination services (surveyed in 2006–07; Crooks, 2008). These factors are possibly linked to the demographic profile of the industry. The average age of owner-operators was 58 in 2006–07 (Crooks, 2008).

However, 40 per cent of businesses indicated that low prices paid for pollination were a factor in their decision not to expand or introduce pollination services (Crooks, 2008). There is likely to be an increased willingness by some farmers to pay for hive rental and higher hive rental prices following the establishment of Varroa. We anticipate that increased hive rental prices will draw those businesses for which price was the limiting factor to provide paid pollination services following the establishment of Varroa.[14]

The Australian pollination services industry has grown vigorously in recent years to meet crop industry demand. The expansion of the almond industry—from 3648 bearing hectares in 2000 to 18 668 bearing hectares in 2010 (Almond Board of Australia, 2010)—led the almond sector to grow its demand for pollination services from about 15 000 to 100 000 hives a year. As an additional 10 000 ha of almond plantings mature, demand for pollination services will increase further. This growth in demand may be reflected in the future aspirations of honey bee businesses, with an estimated 36 per cent of businesses expecting to start or expand the provision of pollination services over the next five years (Crooks, 2008).

Although it is suggested that the current pollination services market can ensure that the future demands of crop industries will be met in the absence of feral honey bees, there are a number of threats to the ability of the pollination services market to meet the growth in demand, including;

- Uncertainty about Varroa's effect on the Australian honey bee industry; Varroa may prove harder to manage in Australia than in other countries, leading more beekeepers to exit the sector than anticipated.
- Continued ageing of the beekeeper population, which may limit the industry's ability to provide more pollination services as beekeepers retire and are not replaced.
- Biosecurity zones put in place to limit the spread of Varroa, which may restrict the movement of hives to provide pollination services for those crops that require them.

Use of domesticated alternative (i.e. other than the European honey bee) pollinators

Some Australian native bees can be domesticated and are useful crop pollinators. Growth in demand from crop industries after the establishment and spread of Varroa is likely to stimulate the growth of this sector. There is already a small, but established, managed stingless bee industry in New South Wales and Queensland that provides commercial crop pollination services (Halcroft, unpublished). The industry is based on the management of the Australian native bees *Trigonia carbonaria, T. hockingsi* and *Austroplebeia australis*. It mainly services the macadamia, lychee, watermelon, blueberry, mango and avocado industries (Halcroft, unpublished). However, they may be useful in other crops. Blue-banded bees (*Amegilla spp.*) are Australian native buzz pollinators that are being developed to pollinate glasshouse tomatoes (Bell et al., 2006; Hogendoorn et al., 2006). They may also be useful in other field-grown crops, such as melons, pumpkins and capsicums.

13 The 506 000 hive figure excludes another 65 000 hives held by operators with 50 hives or less. These operators are considered to be 'non-commercial' for the purposes of this analysis.

14 Pollination fees are determined by a number of factors, chiefly: beekeeping costs, crop industry demand, and honey yields and prices (Burgett et al., 2010).

Although they hold promise, the amount of commercial crop pollination by domesticated alternative pollinators is likely to remain much less than the European honey bees for the foreseeable future.

Use of undomesticated alternative pollinators

Producers of broadacre oilseed and grain legume crops[15] and pastures containing legumes are less likely to be major purchasers of commercial pollination services because, in most cases, the financial benefits are low (Monck et al., 2008; Appendix 1).[16] Nevertheless, modest decreases in yield may lead to significant decreases in profitability for these sectors. In crop sectors that benefit from feral honey bee pollination, but for which payment for pollination services is not economically viable, undomesticated alternative pollinators will be relied on to fill the pollination role now played by feral honey bees.

The Australian insect fauna includes many species that are known to pollinate commercial crops (Batley and Hogendoorn, 2009). The current and potential contribution to pollination from these insects is not well understood. It could be significant where such insects are known to be present and the crop to be pollinated is in close proximity to habitat supporting large populations of these insects. In Australia and overseas there are farmers that support commercial crops based on unmanaged pollinators. It may be that they could get a higher yield and be more profitable with managed honey bees, but they opt for a lower input strategy that may still be profitable.

Klein (et al., 2007) suggests incorporating four general practices into farm or landscape management plans to enhance the contribution from alternative pollinators:

- Increasing insect nesting opportunities, for example by modifying cultivation practices or retaining native vegetation adjacent to cropping areas.
- Increasing forage by ensuring floral diversity at a landscape scale, for example by modifying crop rotations, retaining or establishing native vegetation.
- Enhancing opportunities for colonisation by ensuring a degree of connectedness between floral resources surrounding cropping areas.
- Reducing risks to existing populations by avoiding the use of broad spectrum insecticides during, or in the lead up to, crop bloom.

Reduce exposure to insect pollination

Farmers may choose to replace cultivars or species that are responsive to honey bee pollination with ones that are more strongly self-pollinating if they are available.

RAISING AWARENESS AND IMPROVED COORDINATION

Beekeepers and farmers can be made aware of the risks that they face from Varroa and the likely arrangements should Varroa establish in Australia. The focus needs to be on being alert, rather than alarmed. An alarmed response by New Zealand beekeepers led some to abandon the industry when Varroa arrived there, only to return to it later when it became clear there was 'life after Varroa' (Somerville, 2008).

An active scientific community is already carrying out fundamental research on honey bees, crop pollination and Varroa. In addition, industry research bodies and state agencies are funding applied research and extension activities on honey bees, crop pollination, and pest and disease management. A greater level of coordination among all the parties with an interest in these issues could be achieved.

15 Grain legumes that are responsive to insect pollination include faba bean, soy bean and mung bean; the yields of chickpea, field pea and lentils are not affected by insect pollination (Klein et al., 2007).

16 Grain and grazing legume (medic, lucerne) and oilseed crops (sunflower, canola) grown to generate planting seed are likely to continue or expand their use of managed pollination services.

RECOMMENDED ACTIONS

The threat to Australia's honey bee industry and crop pollination posed by an incursion of Varroa is real and significant. While possible, eradication would .

If Varroa becomes established, honey production and pollination services can continue to be provided. However, changes will be required and there will be higher costs to maintain managed hives, and for the producers of pollination-dependent crops.

ACTIONS

If the following proposed actions are implemented, they will minimise these costs, giving industries and governments the capacity and confidence to respond quickly and effectively. The sooner they are implemented, the better the response.[17]

Ensure implementation

Action 1. Those parties with an interest in implementing the strategy, including industry bodies, government biosecurity, and industry development staff and scientists, should decide on an arrangement to ensure the strategy is implemented in a timely and efficient manner.

Outcome. This strategy is implemented and its objective is achieved.

Action 2. A communication plan should be developed and implemented to ensure consistent information on Varroa is available through all Australian government agencies and industry bodies regarding the steps that can be taken to prepare for, and respond to, the pest. The target audience should include beekeepers, farmers and the public. This plan would be separate from the communication plan put in place during the emergency response phase.

Outcome. Beekeepers, farmers of honey bee pollination responsive crops and government agencies are informed and ready to respond quickly and calmly to an outbreak of Varroa and its possible establishment.

Strengthen the capacity of the honey bee industry

Action 3. Industry, state and territory government agencies and other educational organisations should continue to conduct training workshops for beekeepers on business management; integrated pest management practices, including husbandry practices; chemical handling, including correct use and withholding periods (e.g. Chemcert training); and other management practices to control Varroa.

Outcome. Beekeepers will understand the drivers of profitability in their business, and be informed and ready to use the correct chemical and husbandry treatments as part of an integrated pest management package.

17 Although developed in preparation for a Varroa mite incursion, the actions provide the basis for national action on other exotic honey bee pests.

Action 4. Industry and government agencies should continue maintain and progress the provisional registration of chemicals, including complementary chemicals (organic acids and essential oils) and biological controls, to treat Varroa, and regularly review their status as new treatments become available overseas.

Outcome. Beekeepers will have access to a number of chemicals to treat hives affected by Varroa.

Strengthen the capacity of crop industries

Action 5. Crop and honey bee industry agencies, with the assistance of government agencies, should develop suitable pollination management training materials and quality assurance standards.

Outcome. Beekeepers providing crop pollination services are able to supply consistently high-quality services to farmers. Farmers will know their responsibilities regarding the appropriate use of insecticides and how to make the best use of managed pollination services.

Action 6. Farmers producing crops that respond to honey bee pollination, and industry groups representing these farmers, should work with their pollination providers to develop enterprise and industry-level continuity arrangements should farmers become wholly reliant on managed honey bees for pollination. These arrangements should be designed to lessen the impact of potential border and regional control measures that may limit the movement of hives.

Outcome. Individual enterprises are able to maintain pollination at existing, or close to existing, levels, even if movement controls between states/territories are implemented.

Action 7. Farmers producing crops that are insect pollinated should investigate using or increasing their use of paid pollination services that may lead to improved yields and returns, and encourage the crop pollination industry to provide additional services.

Outcome. The dependence of honey bee pollination responsive crop industries on feral honey bee pollination is reduced before Varroa is established. Pollination-dependent crop enterprises are better equipped to maintain or improve crop pollination and, therefore, financial returns. Farmers achieve increased yields from improved crop pollination. Beekeepers experience increased demand for crop pollination services.

Strengthen post-border biosecurity preparedness

Action 8. At-risk industries and state and territory governments should build on the outcomes of the Plant Health Australia Varroa incursion scenario workshops of 2009 (Turner, 2010). They should cooperate on developing in-principle regulatory arrangements and guidelines to delineate control and management zones, before an incursion, to optimise the twin objectives of controlling the spread of Varroa and minimising the disruption to the honey bee and honey bee pollination-responsive crop industries.

Outcome. The likelihood of negative affects to the honey bee industry and honey bee pollination responsive crop industries from management and control zones implemented to control the spread of Varroa is reduced.

Action 9. Before Varroa becomes established, governments should develop a detailed transition-into-management plan, with the participation and support of industry and other stakeholder groups.

Outcome. The implementation of control, management and recovery actions following the establishment of Varroa is rapid.

Coordinate research, development and extension

Action 10. Relevant industry and government organisations should coordinate their research, development and extension efforts to focus on gaps in understanding the economic benefits of crop pollination, determining and supporting the uptake of best management crop pollination practices, understanding the role of native (alternative) pollinators in providing pollination services and ways to enhance this contribution, bee breeding, and honey bee pest and disease management. This should be directed towards:

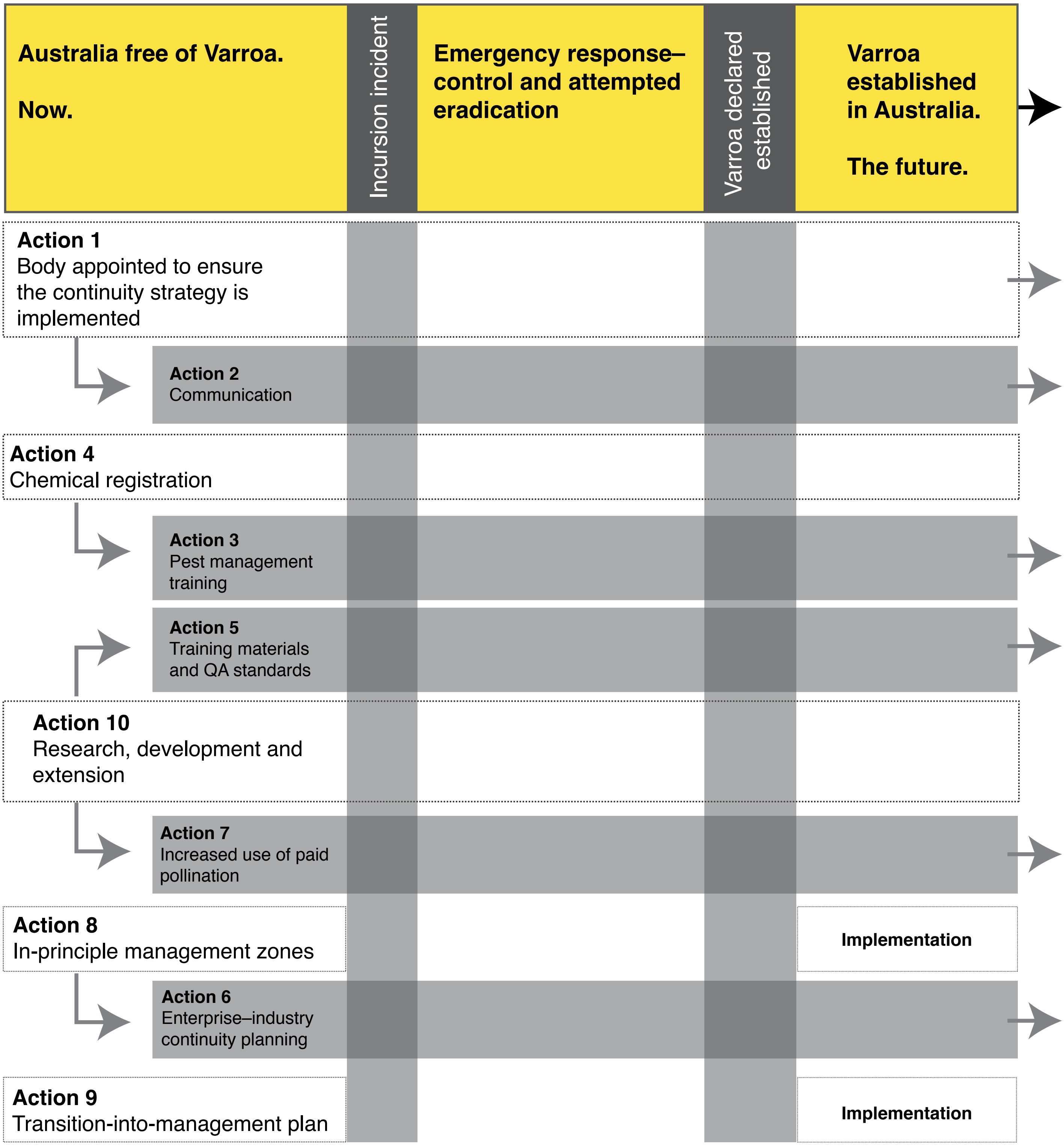
- improving the efficiency of crop pollination by managed honey bees (more pollination by fewer bees)
- maintaining or increasing the level of free pollination from wild insects when feral honey bees are lost
- quantifying the current role of feral honey bees and other insect pollinators in the pollination of Australian crops under Australian field conditions and the benefit of using commercial pollination services
- better understanding the biology and pathology of the Varroa-honey bee interaction at a genetic and physiological level
- better understanding the role of secondary pathogens (e.g. viruses) in bee mortality, and the scope for directly reducing the impact of secondary infection.

Outcome: Better methods to maintain bee health are developed and crop pollination practices and outcomes are analysed, improved crop pollination practices are developed and the economic result of different approaches to crop pollination is understood.

PROPOSED PROGRAM SCHEDULE

Figure 6 outlines a program schedule that illustrates the timing and dependency of the suggested actions, compared with the phases of a typical biosecurity response. The exact circumstances surrounding an incursion of Varroa, such as its location, initial distribution and rate of spread, are unknown. The time between making the transition from the report of an incursion incident and deciding that the incursion can not be eradicated could be short. Consequently, the continuity strategy proposes that all actions necessary to ensure continuity are in place before an incursion occurs.

figure 6 **Program schedule of Actions proposed in the Honey Bee Industry and Pollination Continuity Strategy should Varroa become established in Australia compared with the phases of a typical biosecurity response.**



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APPENDIX 1

ESTIMATING THE DEMAND FOR COMMERCIAL HONEY BEE POLLINATION SERVICES IN AUSTRALIA

Two recent reports have estimated the need for commercial pollination services by crop industries in Australia following the eradication of feral honey bees by Varroa as being between 2 million and 5 million pollination rentals per annum (Monck et al., 2008; Keogh et al., 2010; table 5).

table 5 **Estimates on the likely scale of demand for commercial honey bee pollination services in Australia in the absence of feral honey bees**

		Monck et al., 2008 – *Analysis of the market for pollination services in Australia*			Keogh et al., 2010 *Pollination Aware*	
			Hives required per hectare			
Crop	**Pollination done by insects [a] %**	**Area ha**	**Lower limit**	**Upper limit**	**Area ha**	**Average hive density**
Almond	100	18 500	3	5	27 314	6
Apple	90	17 000	4	12.5	12 258	3
Apricot	70	3 100	2	5	1 408	3
Avocado	100	2 400	5	8	6 392	3
Blueberry	100	n/a	2.5	10	669	3
Canola	15	Considered not economically viable			971 400	0.5
Capsicum	n/a	Not included			2 078	3
Cherry	90	1 900	2.5	5	3 670	3
Citrus	20-30	20 250	1	2	12 076	1
Cotton	n/a	Not included			327 194	0.6
Cucumber	100	1 000	2.5	7.5	8 661	4
Faba beans	n/a	Considered not economically viable			130 000	2
Field pea	50	Considered not economically viable			Not included	
Lucerne seed	n/a	25	3	5	19 000	3
Lupin	10	500 000	5	8	Considered not economically viable	
Lychee and longan	n/a	Not included			1 930	2.5
Macadamia	90	17 770	5	7.5	14 864	7
Mango	50	5 000	8	15	7 613	12
Melons	100	4 000[b]	3.5	3.5	8 471	4
Nectarine	60	n/a	3	3	2 938	2
Other fruit[c]	n/a	230	3	8	1 402	2.5-6
Peach	60	6 600	2	4	2 879	2
Pear	50	3 500	2.5	5	827	3.5
Plum and prune	70	3 500	2	3	3 176	4

Continued...

table 5 **Estimates on the likely scale of demand for commercial honey bee pollination services in Australia in the absence of feral honey bees** Continued

		Monck et al., 2008 – Analysis of the market for *pollination services in Australia*			Keogh et al., 2010 *Pollination Aware*	
			Hives required per hectare			
Crop	**Pollination done by insects a %**	**Area ha**	**Lower limit**	**Upper limit**	**Area ha**	**Average hive density**
Pumpkin	90	5 800	2.5	7.5	Incl. in cucumber estimate	
Rubus	n/a	Not included			613	4.5
Soybean	n/a	Considered not economically viable			23 819	4
Strawberry	40	1 300	1.25	1.25	1 460	18
Sunflower	100	Considered not economically viable			77 515	4
Tomatoes	n/a	Not included			6 795	4
Vegetable seed	n/a	14 073	2.5	37.5	1 949	11
Zucchini	100	Not included			Incl. in cucumber estimate	
Total potential demand			2 961 725 436 054 **d**	4 972 010 837 004 **d**	2 056 690 709 338 **e**	
Equilibrium demand– supply**f**			266 712	486 933	Not considered	

a Barry et al., 2010; **b** refers only to watermelons; **c** Other fruit = kiwifruit, nashi, passionfruit, persimmon and pomegranate. Monck (et al., 2008) included only kiwifruit in their analysis; **d** hive rental estimates corrected for the erroneous inclusion of lupins and the incorrect area of vegetables and lucerne grown for seed in the analysis by the original authors; **e** hive rental estimate excluding the crops canola, cotton, soybean, faba bean and sunflower. **f** equilibrium supply-demand from a linked commodity market and bee market general equilibrium economic model.

Within a crop species the response to honey bee pollination is likely to vary depending on crop variety and location, among other things. Table 5 presents the best available figures on total potential demand[18] (or the agronomic need for commercial pollination services).

Monck (et al., 2008; pp 3) states:

From the information in table 2.2 [presented in table 5 in this report] the total potential demand for pollination services in Australia can be estimated. Over the course of the year over five million hives [hive rentals] would be used based on the upper limit of the optimal stocking rates. Without detailed information on the timing of pollination needs and geographical location of demand, and hence how many crops one hive could service in a year, the estimates are largely indicative. They do demonstrate that the current level of pollination services used, at around 220,000 hives [hive rentals] a year (includes paid pollination services and incidental pollination from beekeepers putting voluntarily hives on farmers land), is well short of potential demand.

The 5 million hive rentals a year figure given in the passage above is an overestimate of total potential demand:

- 4 million hive rentals are estimated for the pollination of lupins. However, in the body of the text, Monck (et al., 2008; pp. 5) argue 'it is difficult to make an economic case these industries [grain legumes and oilseeds] would be major consumers in the pollination services industry'
- 200 000 hive rentals are estimated for the pollination of vegetable seed-a figure based on the total crop area, not just the crop area used for seed production, of relevant vegetable crops.

18 Total potential demand is the number of hive rentals likely to be needed by crop industries; it is based on the responsiveness of a crop to honey bee pollination and the gross margin or value of the crop. It is an agronomic term and not an economic term. It does not consider the ability of the market to supply these needs.

- Monck (et al., 2008) underestimated the area of the Australian lucerne seed industry (25 ha). Keogh (et al. 2010) estimated 19 000 ha and Carter and Heywood (2008) estimated from 15 593 to 28 194 ha, with areas varying substantially from year to year, between 2005-2008.

Correcting these points produces a range for total potential demand from 436 054 to 837 004 pollination rentals (table 5).

Keogh (et al., 2010) included cotton, canola, faba bean, soybean and sunflower in their estimate of pollination hive rental demand in the absence of feral bees. Multiplying crop area and hive stocking density for all the crops included in the 'Pollination Aware' case studies (Keogh et al., 2010) produces an estimate of demand of around 2 million hive rentals (table 5). In estimating total potential demand Monck (et al., 2008) exclude oilseeds, pastures and grain legumes from their analysis:

It is unclear that they [producers of these crops] would purchase services given that the small increase in yield (10 to 15 per cent) provides an additional return, which is less than the current price of pollination services. Thus it is difficult to make the economic case that these industries would be major consumers in the pollination service industry

In support of Monck's (et al., 2008) argument, oil-seed and grain legume producers are not significant purchasers of pollination services in the United States (Burgett et al., 2010). Barry (et al., 2010) estimate that no additional hives would be required to pollinate canola, field pea or lupins in the absence of feral honey bees. Subtracting fibre, oilseed and grain legume crops from the 2 million hive rental a year figure produces a figure of around 700 000 pollination hive rentals a year (table 5).

Comments on an earlier draft of this document suggest that some of the industries included as potential sources of demand for pollination by Monck (et al., 2008) and Keogh (et al., 2010) will not enter the pollination services market because:

- current crop varieties grown in Australia are not as responsive to insect pollination as suggested (e.g. nectarines and peaches)
- alternative insect pollinators play a much larger role in crop pollination than currently suggested (e.g. mangoes, macadamia)
- increased seed yields are not desirable (e.g. citrus).

Monck (et al., 2008) performed a linked commodity market and bee market general equilibrium model to estimate equilibrium hive rental demand[19] and supply, and hive rental prices[20]. Two scenarios are modelled based on a Varroa incursion that 'wipes out feral bees overnight' in 2010—one assumes no crop industry preparation and the second assumes an increased level of crop industry preparedness. Estimated equilibrium demand-supply for hives in 2015 is 266 712 for the first scenario and 486 933 for the second one (table 5). The overnight eradication of feral bees from Australia is unrealistic and, because of this, the 266 712 estimate of equilibrium demand-supply is lower than what is likely to occur. Given it will take 10–15 years for Varroa to spread throughout Australia (Barry et al., 2010), the 486 933 estimate of equilibrium demand-supply appears more realistic.

The above analysis suggests that, following the eradication of feral bees by Varroa, the pollination services market is likely to be able to meet the total potential demand (or agronomic need) for pollination rentals from crop industries. The total potential demand for commercial pollination services in the absence of feral European honey bees is in the range of 436 054 to 837 004 hive rentals per annum (table 5); the equilibrium demand-supply of hive rentals from the pollination services market is about 500 000 hive rentals (Monck et al., 2008).

19 This refers to the market solution, that price point at which the demand and supply for hives intersect (i.e. demand and supply are equal).
20 Given the errors made in estimating crop areas, it is unclear how reliable the outputs from the model are.

APPENDIX 2

SIGNIFICANT PESTS AND DISEASES OF HONEY BEES

PESTS AND DISEASES EXOTIC TO AUSTRALIA

Varroa

Varroa mites (*V. destructor)* are foremost among pest threats to the beekeeping and crop pollination industries in Australia. There are six species of the genera Varroa and EuVarroa, all of which parasitise one or more of the member species of the bee genus Apis. The assisted entry of *V. destructor* on *Apis mellifera* is the most likely entry pathway for Varroa into Australia (table 6).

Tropilaelaps mite

Tropilaelaps mite (*Tropilaelaps* clareae) is a parasite of brood only, and causes brood mortality or reduced longevity of adult bees that survive the parasitised brood stage. This mite will breed and survive in bee colonies as long as brood is present. Its establishment in Australia is of very low probability (table 6), but would result in widespread losses of honey bee colonies causing serious economic hardship to beekeepers and growers of those crops that require honey bee pollination to achieve viable production.

table 6 **Overall probability of entry[a], establishment and spread of Varroa spp. and *Tropilaelaps* spp. for the pathways under consideration (Barry et al. 2010)**

Pathway	Probability of entry	Probability of establishment and spread	Overall probability of entry establishment and spread
Pathway 1 – *A. mellifera* with *V. jacobsoni*	Low	High	Low
Pathway 2 – *A. mellifera* with *V. destructor*	High	High	High
Pathway 3 – *A. cerana* with *V. destructor*	Low	High	Low
Pathway 4 – *A. cerana* with *V. jacobsoni*	High	High	High
Pathway 5 – *A. mellifera* or *A. dorsata* with *Tropilaelaps spp.*	Very low	High	Very low

a Refers to assisted entry only. The likelihood of entry of A. mellifera or A. cerana as unassisted swarms is considered Extremely Low.

Tracheal mite

Tracheal mite (*Acarapis woodi*) is an internal parasite that infests the respiratory system of adult honey bees. This mite is responsible for causing acarine disease or acariasis. The European honey bee (*Apis mellifera*), including the subspecies *A. mellifera scutellata* (Africanised honey bee), and the Asian honey bee (*A. cerana*) are the only known hosts of this pest. Drones, workers and queens may be infected.

Bee viruses

Viral diseases of honey bees that occur in European honey bees include acute bee paralysis virus (ABPV) and deformed wing virus (DWV). These viruses are among the diseases that could be introduced by Varroa or one of the other mite pests, should they become established in Australia.

ABPV and DWV have been observed existing in apparently healthy colonies elsewhere in the world, and are most damaging when present in conjunction with *V. destructor*.

Asian bees

There are a number of species of honey bees native to various parts of Asia, including the Asian honey bee (*A. cerana*)[21], giant honey bee (*A. dorsata*), and dwarf honey bee *(A. florea)*. There are also four lesser known species, *A. andreniformis*, *A. koschevnikovi*, *A. nigrocinta* and *A. nuluensis*. While all these bees and *A. cerana*, in particular, have the potential to pollinate some of the plants serviced by the European honey bee their introduction into Australia is considered undesirable because of their potential to introduce diseases and compete with or raid commercial hives and because they are less manageable than *A. mellifera*.

Africanised bees and Cape honey bees

Africanised bees (*A. mellifera scutellata*) and Cape honey bees (*A. mellifera capensis*) are sub-species of *A. mellifera*. They have the potential to be the means of introduction and spread of exotic pests and diseases. They can also interbreed with the European honey bee with the potential to introduce undesirable behaviours and characteristics to the honey bee population, such as aggressive behaviour. The Cape honey bee is a social parasite that takes over and eventually kills host hives.

PESTS AND DISEASES ALREADY PRESENT IN AUSTRALIA

Nosema

Nosema apis and *N. ceranae* are host-specific microsporidian parasites of the adult European honey bee. *N. apis* is an established pest of honey bees throughout the world—it invades the midgut of adult bees, shortening the lives of infected individuals and reducing the ability of nurse bees to feed larvae. *N. cerenae*, a newly recognised species, operates in a similar manner.

Chalkbrood

Chalkbrood is caused by the fungus *Ascosphaera apis* and affects sealed and unsealed brood, causing death and mummification of brood with consequent weakness of bee colonies. Chalkbrood can weaken a colony, leading it vulnerable to other diseases.

Braula fly

Braula fly (*Braula coeca*), which is present in Tasmania but not mainland Australia, is not considered a significant pest or threat to the welfare of honey bees as it does not damage or parasitise any stage of the honey bee life cycles. This tiny wingless fly lives inside the colonies and on the bodies of bees, and feeds on nectar and pollen. The larvae of *B. coeca* can damage the appearance of comb honey by burrowing under the cappings.

Small hive beetle

Small hive beetle, *Aethina tumida,* has the potential to cause beekeepers significant economic losses by damaging wax comb, spoiling stored honey, pollen and brood, and causing bees to abandon hives.

21 In 2007, Asian honeybees were detected in Cairns, Queensland, with a national eradication program being undertaken. In 2011, a decision was made that it was no longer technically feasible to achieve eradication of the bees. On 20 May 2011 the Minister for Agriculture, Fisheries and Forestry, Senator the Hon Joe Ludwig, announced funding of $2 million to support a national pilot program aimed at transitioning to containment and management of Asian honeybees.

American foulbrood

American foulbrood (AFB) is a destructive brood disease caused by a spore-forming bacterium, *Paenibacillus* larvae. Spores are ingested by the bee larvae with their food; once ingested, the spores quickly multiply and the bee larvae die. Spores of AFB can remain viable for more than 30 years and are extremely resistant to desiccation.

European foulbrood

European foulbrood (EFB) is caused by the bacterium, *Melissococcus plutonius*, which infests the midgut of infected bee larvae, leading to their death. EFB is considered less deadly to a colony than American foulbrood and is often considered to be a stress disease.

Bee viruses

Israel acute paralysis virus, Kashmir bee virus and black queen cell virus (BQCV) are all caused by the *Dicistroviridae* family of insect-infecting viruses. Although sometimes found in apparently healthy colonies, these viruses are thought to play a role in the sudden collapse of honey bee colonies affected with Varroa. BQCV is also thought to be associated with nosema.

Chronic paralysis virus causes abnormal trembling of wings and body, with some bees also becoming almost hairless and dark in appearance. Affected bees become flightless and show dysentery-type symptoms.

Cloudy wing virus is a little-studied virus commonly found in honey bees, especially in collapsing colonies infested by Varroa.

Sacbrood virus is an infectious disease that affects the honey bee brood. It mostly occurs as a mild infection, which only kills a few larvae, but it can be more severe. Few hives die out as a direct result of sacbrood, but many are weakened to the extent that they succumb to other threats.

Image courtesy of Almond Board of Australia.

APPENDIX 3

ROLES AND RESPONSIBILITIES OF THE COMMONWEALTH, STATE AND TERRITORY GOVERNMENTS AND HONEY BEE AND CROP INDUSTRIES FOR BIOSECURITY

AUSTRALIAN GOVERNMENT

- Negotiating international agreements and trading obligations.
- Informing trading partners of a change in pest status (*Tropilaelaps*, tracheal and Varroa mites are included on the World Organisation for Animal Health list of notifiable diseases as diseases of bees).
- The Office of the Chief Plant Protection Officer provides coordination and leadership for Australia's plant health in primary industries. It underpins quarantine and facilitates domestic and international market access.
- Establishing border quarantine measures to prevent pest and diseases entering Australia (Australian Quarantine and Inspection Service).
- Cost sharing of eligible emergency response and eradication programs.
- Coordination of national approaches and strategies.

STATE AND TERRITORY

Empowering state and territory legislation to do with the regulation and control of beekeeping, the control, prevention and restriction of diseases and pests affecting bees is summarised below:

- New South Wales *Stock Diseases Act 1923*, New South Wales *Apiary Act 1985*, Apiaries Regulation 2005
- South Australian *Livestock Act 1997* and Livestock Regulations 1998
- Queensland *Apiaries Act 1982* and Apiaries Regulation 1998
- Victoria *Livestock Disease Control Act 1994* and Apiary Code of Practice 1997
- Western Australian *Beekeepers Act 1963*
- Tasmanian *Animal Health Act 1995* and Animal Health (Apiaries) Regulations 2001
- Northern Territory *Livestock Act 2009* and Livestock Regulations, 2009.

Under the Australian Constitution, state and territory governments are responsible for plant and animal health services within their borders. This includes:

- risk mitigation to identify potential pest threats and minimise their impacts should they arrive
- policy and strategy development

- maintenance of domestic quarantine, including certification, treatment and inspection services
- targeted and passive surveillance for high-priority pests (established and exotic)
- ongoing pest control and management of regionalised pests
- maintenance of diagnostic services
- activities to increase awareness among private and public stakeholders.

HONEY BEE AND CROP INDUSTRIES

- Plant Health Australia (PHA) industry members develop industry biosecurity plans.
- Research and development corporations invest in projects to improve industry biosecurity.
- PHA industry members take part in national responses to emergency plant pest (EPP) incursions and cost sharing of eligible eradication programs.
- Individual beekeepers and farmers contribute by:
  - treating produce to ensure compliance with necessary quarantine regulations (e.g. interstate certification assurance and export protocols)
  - suppressing pest prevalence and damage to produce
  - pest surveillance, which contributes to the early detection of exotic pests and significantly increases the likelihood of eradication.

APPENDIX 4

BACKGROUND INFORMATION ON THE DEVELOPMENT OF THE CONTINUITY STRATEGY

THE AUSTRALIAN GOVERNMENT RESPONSE TO THE MORE THAN HONEY REPORT

On 16 June 2008 the House Standing Committee on Primary Industries and Resources tabled its report on the Inquiry into the Future Development of the Australian Honey Bee Industry, *More Than Honey: the future of the Australian honey bee and pollination industries*.

The Australian Government convened a workshop on 29 August 2008 to consider how to give effect to several of the recommendations in the report and to address key biosecurity risks affecting pollination-dependent industries. Attendees included participants from the honey bee industry, pollination-dependent industries, research organisations and governments from around Australia. At the workshop the Department of Agriculture, Fisheries and Forestry agreed to develop a strategy to support the development of viable business continuity options for honey producers and pollination-service providers, and the industries they support in the event of Varroa becoming established in Australia.

HOW THIS STRATEGY INTEGRATES WITH EXISTING GOVERNMENT–INDUSTRY EMERGENCY PLANT PEST RESPONSE AGREEMENTS

PLANTPLAN is the agreed technical response plan used by jurisdictions and industry in responding to an emergency plant pest (EPP) incident. It provides nationally consistent guidelines for response procedures under the Emergency Plant Pest Response Deed, outlining the phases of an incursion (investigation, alert, operational and stand down), as well as the key roles and responsibilities of industry and government during each phase.

Responding to an incursion to contain and, if possible, eradicate it is the responsibility of state and territory governments, and the Office of the Chief Plant Protection Officer, Department of Agriculture, Fisheries and Forestry.

During the stand-down phase of an incursion—if eradication of a confirmed EPP is not considered cost beneficial—efforts will shift to controlling the spread of the disease, investigating long-term control methods and movement restrictions. The relevant states/territories will determine the appropriate strategy.

This continuity strategy suggests actions that should be taken now to prepare for the possible future decision that it will not be possible to eradicate Varroa from Australia.