Submission to the Quarantine and Biosecurity Review
Pat Boland
(9 May 2008)

Varroa - a neglected quarantine threat?

Summary

This submission draws attention to a few key facts:

- Because of disparity within the range of industries potentially affected by an incursion of varroa, there is no single voice drawing attention to the overall threat.
- As a consequence, there is inadequate appreciation of the magnitude of the threat nor of the range of industries affected.
- Significantly increased attention to varroa in terms of pre- and post-border quarantine activities is warranted.
- The National Sentinel Hive Program should be expanded and incorporated into quarantine activities.

Background

Varroa destructor is the most significant pest of honeybees world wide. It affects a wide range of pollination-dependant industries besides the honeybee industries. This submission therefore concentrates on this pest to the exclusion of more minor pests and diseases which are also targets for instance under the National Sentinel Hive Program. In terms of honeybee diseases, varroa is the important focus.

Australia is now the only major region in the world free of varroa. Varroa could enter Australia through survival of honeybee swarms on board ships or aircraft. There have been some 16 such detections (of bees, not varroa) since the mid 1990s. It could also enter Australia through illegal smuggling of honeybees, one case of which is on record. The risk is real - varroa has been detected by AQIS on several occasions in recent years during quarantine inspection of legally imported queens (despite having been certified as free).

Efforts to maintain Australia free of varroa are presently implemented in two ways. The first is a pre-border AQIS campaign of awareness amongst agents and shippers and procedures such as pratique requirements to ensure pre-arrival inspection of vessels for honeybees. The second, post-border, is the National Sentinel Hive Program for varroa and other honeybee pests which aims to facilitate early detection of varroa should an incursion occur. The latter program was established by AQIS Animal Quarantine Policy Branch in 2000 and maintained when that branch was incorporated into Biosecurity Australia. More recently, the program was devolved to the Office of the Chief Veterinary Officer and there is a process under way through which it may be managed by Animal Health Australia. There thus seems to have developed a certain ambiguity as to whether the program is a quarantine activity or an animal health surveillance activity, and there is no consensus on who should fund it.

The threat of a varroa incursion

If varroa gained a foothold in Australia, it would spread to the limits of its geographic range within a few years. That range might be limited for an indefinite period by significant barriers such as the Bass Strait or the deserts of central and Western Australia.

Would eradication be feasible?

Eradication following a large varroa incursion, ie one discovered long after its initial occurrence, would be impossible given current technology, because of the nature of the honeybee industry and the numerous colonies of feral honeybees. However, eradication of a small, early-discovered incursion may warrant significant effort and expenditure, depending on the chances of success. No work has yet been undertaken to determine the likelihood of successful eradication in relation to the number and distribution of detections. The absence of such information would appear to be a significant deficiency in the tools available to decision makers should an incursion be discovered.

What is the potential economic impact of varroa?

In areas infested with varroa, virtually all feral honeybees are destroyed within a few years. Feral colonies are not capable of being treated and therefore die out within perhaps a year or two of first infestation. Managed hives can be treated with acaricides to control the mites, at a cost. The economic impact of an incursion therefore impinges on crops which rely on pollination by feral honeybees and on the honeybee industries (comprising honey producers, contract pollinators, breeders and exporters of honeybees).

Recent work has improved our knowledge of the potential impact on some pollination-dependent crop industries. In total, over a 30 year period, the benefits to 25 crop industries of preventing entry of varroa are estimated to be between $22 million and $51 million per year (Cook et al 2007). The largest benefits were enjoyed by the sunflower industry, a fact probably unknown within AQIS, Biosecurity Australia, or other key stakeholder institutions, prior to that report.

Apart from lesser affected crops, there are significant pasture industries, particularly lucerne and clovers, which are pollinated largely by honeybees. There is also the cost to beekeepers of regular treatment of their hives. There are about 673,000 registered hives in Australia and the annual cost of treatment based on New Zealand experience would be about $30 per hive per year.

Overall, the honeybee industries bear only a small proportion of the cost of a varroa incursion. Economic work in New Zealand indicated that, depending on the severity level, only 5-13% of the total economic impact of varroa accrued to the honeybee industries (see table), the brunt being borne by the pastoral industries. (NZ MAF 2002).

Sector:	Horticultural	Pastoral	Arable	Beekeeping	Total
Best case Impacts % of total	17	66	3.48	13	100
Middle case Impacts % of total	12	78	2.56	6.73	100
Worst case Impacts % of total	9.71	84	2.07	4.67	100

Whilst obviously the agricultural industries in Australia differ from those in New Zealand, it is clear that much of the cost of a potential varroa incursion here would impinge upon industries other than the honeybee industry. This important fact is not reflected in the funding arrangements for prevention or emergency response to varroa (Cook et al, 2007).

The National Sentinel Hive Program

The National Sentinel Hive Program provides for targetted surveillance for varroa in the hope that early detection will increase the chances of successful eradication. It addresses the risk posed through shipping by placing sentinel hives in the vicinity of about 27 ports nationally and checking those hives regularly for varroa. It supplements the various routine honeybee health programs which are undertaken by State authorities.

As mentioned, there have been recent changes to the coordination and management responsibilities for the program. A review of the program was undertaken by Biosecurity Australia in 2004 and various recommendations made (see Attachment 1). Most of those recommendations have not been put into effect. However, options for continued management, coordination and funding of the program have been discussed.

The prime purpose of the National Sentinel Hive Program is early detection of a pest incursion, targetting the relevant border vicinity. This role is consistent with current post-border functions within AQIS, to wit, under the Northern Australia Quarantine Strategy (NAQS) "to develop and implement measures for the early detection of targeted pests and diseases". It is thus not clear why responsibility for management is moving away from AQIS. The program is a central pillar to keeping Australia free of varroa and AQIS would therefore seem the appropriate body to take responsibility for its management.

References

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3. Review of Varroa Economic Impact Assessment: Recommendations on Revision. December 2002. NZ MAF <http://www.biosecurity.govt.nz/files/pests/varroa/assessment-review.pdf>

Attachment

"A Review of the National Sentinel Hive Program" Pat Boland, Biosecurity Australia, June 2005.

A Review of the

National Sentinel Hive Program

in Queensland, New South Wales, Victoria, Western Australia

and the Northern Territory

Pat Boland

Biosecurity Australia

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Executive Summary

The National Sentinel Hive Program was established in 2000 to enhance surveillance for honeybee parasites (most notably varroa) and exotic bees in the vicinity of seaports. The purpose of the program is assist the early detection of these parasites and bees. This will provide a better chance that an incursion will be eradicated or that an eradication program is smaller and less costly.

A strong feature of the program is the close collaboration and cooperation between the honeybee industry, State departments of agriculture and Biosecurity Australia. While the program is currently part-funded by Biosecurity Australia, there are significant 'in kind' costs which are met by the respective State department of agriculture and by participating beekeepers.

The National Sentinel Hive Program operates at 27 ports and the review covered 20 ports in New South Wales (NSW), Victoria, Queensland, South Australia, Northern Territory and Western Australia.

The review makes a number of general recommendations for the program as well as specific ones for particular locations. The key recommendations are

. a comprehensive analysis of the benefits of the program to be conducted by the honeybee industry and those horticultural and seed crop and pastoral industries identified as significant beneficiaries of pollination;

. a review of the long-term funding and coordination of the program, including the costs;

. surveillance for Asian honeybee be extended to all ports on the eastern seaboard as far south as Brisbane.

. investigating the feasibility of establishing or re-establishing hives at various locations.

. increasing the intensity of surveillance by more regular sampling of hives at certain locations.

Background to the National Sentinel Hive Program

The National Sentinel Hive Program was established in 2000 to enhance surveillance for honeybee parasites (most notably varroa) and exotic bees in the vicinity of seaports. The program was the result of consultation between Biosecurity Australia, State departments of agriculture and the honeybee industry. The purpose of the program was to institute a mechanism for early detection of any incursions of:

- Varroa mite, *Varroa destructor*
- Tropilaelaps mite, *Tropilaelaps clareae*
- Tracheal mite, *Acarapis woodi*
- Asian honeybee, *Apis cerana*.

Early detection of these pests gives rise to a better chance that the incursion will be eradicable, or possibly that the eradication program is smaller and less costly.

Seagoing vessels are considered to present a significant opportunity for the transportation to Australia of exotic bees (and associated parasites) either in superstructure, containers or equipment, or in vessel holds. *Apis cerana, Apis dorsata, and Apis scutellata* have all been detected on ships destined for Australia or in port areas in recent years (see Annex A). These incidents confirm the potential for incursions by exotic honeybee pests via ocean-going cargo vessels that enter Australian ports.

Alongside the National Sentinel Hive Program, there is a program of awareness for vessel masters and port personnel of honeybees on incoming vessels. There is also a program of pratique and inspection of vessels on arrival. These programs have an important function in preventing incursions but they are not the subject of this paper.

The National Sentinel Hive Program operates at 27 ports that receive a significant volume of cargo (see Annex B). In most cases, the sentinel hives are cared for, and provided by, cooperating beekeepers under the auspices of the Australian Honey Bee Industry Council. In some cases, the hives are provided by the respective State department of agriculture. The sentinel hives are located within reasonable proximity of port areas.

For detection of

. varroa and tropilaelaps mites, acaricides in controlled release plastic strips are placed in hives for one to two days in conjunction with adhesive entomological strips (sticky boards) that are subsequently submitted to diagnostic laboratories and examined for the presence of exotic bee parasites.

. tracheal mites, whole adult bees are also submitted for dissection and examination by CSIRO Black Mountain.

. the Asian honeybee in selected sites in the north of Australia, log traps are used in conjunction with pheromone baits. The pheromone is a five component synthetic mixture in a slow release formulation developed by CSIRO. The lure has been tested in PNG and Indonesia and has been found efficacious in attracting *Apis cerana* and yet not being especially attractive to the European honeybee (*Apis mellifera)*.

Under the supervision of apiary officers, surveillance is conducted quarterly in each State or Territory. In some instances, sampling is done twice each quarter. The results are summarised and published as part of the National Animal Health Information System (NAHIS).

Annex C gives a summary of the results of the program to date.

In addition to providing an enhanced early detection capacity, a spin-off benefit of the National Sentinel Hive Program is the collection of data which demonstrates Australia's continued freedom from honeybee parasites and supports official health certification for live honeybee exports.

The program is currently funded and coordinated by Biosecurity Australia. There are significant 'in kind' costs which are met by the respective State department of agriculture and participating beekeepers. A Biosecurity Australia staff member works part-time coordinating, monitoring and reporting on the program. The costs of materials met by Biosecurity Australia are about $6,000 per year.

The National Sentinel Hive Program is not the only surveillance undertaken in Australia for honeybee parasites. Several States promote the use of the "sugar shake" method which can be done

by beekeepers without special chemicals or equipment, for the detection of varroa. State governments also undertake routine surveys for honeybee diseases and pests. Results of these tests are not recorded in the NAHIS.

Background to the Review

In the light of experience to date of the National Sentinel Hive Program, Biosecurity Australia proposed that a review be undertaken with the following terms of reference:

- Assess factors affecting the efficacy of the program at each location by examining:
  - the number and siting of the sentinel hives/traps in relation to the port area;
  - the potential incursion risks associated with all ports, both those in the program and those not;
  - any local issues or impediments to the program at each port;
  - suggestions for improvements;
  - alternative or additional techniques which might be practicable for surveillance.
- Prepare a report on the findings and circulate for comment to the honey bee industry, State authorities, CSIRO and AQIS.

The Australian Honey Bee Industry Council (AHBIC) supported the proposed review.

The review was undertaken between late 2003 and late 2004 through a series of visits to most of the ports involved in the program together with a study of statistical data and other information pertinent to the terms of reference. Not all States were covered in the review. Visits to ports in South Australia and Tasmania have not yet been undertaken.

As mentioned above, the purpose of the surveillance program is to enhance early detection of pests. Its effectiveness in achieving this is a direct measure of its usefulness. Varroa is without question the most significant pest of honeybees world-wide. The value of the program would be strongly reflected by its effectiveness in improving the chances that a varroa incursion is eradicable.

The notion of eradicating a varroa incursion should not be taken lightly. If Australia succeeded in eradicating a varroa incursion, it would be the first country to do so. Many countries have tried and failed, some incurring difficult and costly eradication attempts (De Jong D, 1997). Eradicating an incursion would depend on the geographic distribution of the mite. By way of example, an incursion of small hive beetle, *Aethina tumida*, around Sydney in late 2002 was already widespread by the time it was found. Eradication was not considered a feasible objective.

On the other hand, one should not presume the worst. Eradication of a varroa incursion might be feasible if detected early. A possibly relevant example was the detection of *Apis cerana* in Darwin in 1998 which was detected early and successfully eradicated.

Risks of entry of honeybee pests

The two main pathways by which honeybee parasites and exotic bees might enter Australia are smuggling of bees and the inadvertent conveyance on cargo or vessels. The National Sentinel Hive Program is specifically targeted towards the latter by concentrating surveillance in the vicinity of ports. Neither the program nor this report attempt to assess the relative risk of entry via smuggling.

To assess the effectiveness of the program at any given port, it is necessary to assess the risk of entry of honeybees from overseas through that port. Contributing factors risk include:

- The number and size of vessels arriving at that port from overseas;
- The quantity of cargo discharged;
- The nature of the cargo discharged, particularly whether it is bulk cargo (eg minerals, liquids or grain) or containers or break bulk;
- The country from which the vessel has come.

Statistics on these parameters and other relevant information are available through the relevant port authorities. Whilst it is difficult to make a quantitative estimate of risk, the statistics can be used to estimate the relative risks for entry of exotic bees for the various ports throughout Australia. Thus we can identify those ports which are more likely to be associated with an incursion of honeybee pests.

An estimate of the relative risks of the main commercial ports throughout Australia is presented at based on the first three factors above. In this table, the contributing factors to the risk of entry and the weighting given to each were assumed to be as follows:

The tonnage of containers or break bulk cargo entering the port 66%
The number of vessels visiting the port 30%
The tonnage of bulk cargo entering the port 4%

There was no attempt to include the influence of the source country in these calculations. There were two reasons for this. First, it was considered that the widespread world-wide distribution of varroa would give rise to an approximately equivalent weighting in most cases, no matter which source country was in question. Second, the major Australian ports receive vessels from a dispersed range of countries.

However, individual moderating factors were applied to the calculations, to reflect local idiosyncrasies. At certain locations for instance, there were obvious local circumstances (eg distance from shore) which mitigated against the possibility of an incursion of honeybee pests. Where such circumstances were considered to exist, appropriate weightings were made to the data.

On the basis of this approach to measuring risk, it is apparent that six ports dominate the national situation. Collectively, Melbourne, Sydney, Port Botany, Brisbane, Fremantle and Kwinana account for 72% of the overall risk of entry of honeybee pests. There is a reasonable argument that the intensity of surveillance at these locations should reflect their high proportion of the overall national risk. The intensity of surveillance can be increased by increasing the number of sentinel hives and the frequency of testing. The value of these two parameters is discussed below.

Asian honeybee *Apis cerana*

Apis cerana has been the most frequently detected pest species in Australia over the years (see Annex A). The means used to detect this species is by log traps. Presently this is only done at Darwin and Brisbane.

Given the fact that Asian honeybee has been relatively frequently intercepted, and the fact that it would probably thrive in most warm temperate and tropical locations in Australia, it is recommended that surveillance for this pest be broadened. In particular, the main ports on the eastern seaboard as far south as Brisbane are all considered as potential sites where surveillance specifically for *Apis cerana* could be instituted.

Several types of trap have been suggested as suitable for *Apis cerana* surveillance. In a study comparing five different designs in Irian Jaya (Indonesia), it was found that a hollow palm log design was significantly better at attracting *Apis cerana* than were the other designs. It is recommended that this design be used in conjunction with the pheromone lures developed by CSIRO. Other trap designs which have been put forward should be adopted only if they can be shown to be of similar acceptability to *Apis cerana* as a nesting site.

In 1998-99, CSIRO gained support from the Honeybee Research and Development Program, AQIS and other agencies, to develop and test a synthetic five component mixture which mimics queen pheromone. The final blend, was judged to have significant potential for the development of a specific long range attractant.

Funding principles

Under current arrangements, the costs of the National Sentinel Hive Program are borne by Biosecurity Australia, State governments and participating beekeepers. The relative contribution by each of these parties and the overall costs of the program are not clear because 'in-kind' costs have not been measured. It probably varies from place to place. The long-term continuation of the program might well depend on funding sources. Biosecurity Australia has paid for the cost of materials, averaging around $6,000 per year.

In principle, the program should be supported by those sectors which stand to gain by what it brings. The program provides the advantages of early detection of honeybee pests, most notably varroa. That advantage of early detection can be measured by the increase in the likelihood that an incursion can be eradicated or, less likely, by the reduction in cost of eradication.

The sectors which stand to gain from the program include horticultural and seed crop and pastoral industries which benefit from pollination, and the honeybee industry. It is beyond the scope of this review to undertake an analysis of the benefits. Such an analysis would need to cover:

- The costs by sector, of each honeybee pest targeted under the program
- The costs of a permanent incursion versus a temporary one, or of a protracted versus a shorter eradication effort
- The likelihood that detection of the pest via the program will make the difference between eradication and failure to eradicate, or the difference between a short or protracted eradication effort.

An overall analysis of the benefits of the program would appear to be feasible using accessible data. Such an analysis should be done in close consultation with not only the honeybee industries but also those horticultural and seed crop and pastoral industries identified as significant beneficiaries of pollination. In that way, those 'secondary' industries, which stand to lose much in the event of an incursion, might give added impetus to the continuation or enhancement of the program.

Research needs

One area of uncertainty in such an analysis is the complexity of factors which would bear upon the decision whether to eradicate an incursion or whether to adopt a management program to manage the spread. (Given the mobility of honeybees and previous experiences both here and overseas, containing a major incursion could be impossible, the exception being significant geographical barriers such as Bass Strait or the Nullarbor Plain). Since the aim of the program is to increase the likelihood of eradication, this gap in our knowledge should be explored further.

Taking a hypothetical varroa detection as an example, in the vicinity of most ports, feral honeybee colonies would be common. Together with domestic hives, we could expect anything up to possibly 100 or more colonies per km^2. This estimate is based on the demography of the feral bee population in woodland in north-west Victoria . Even if the colony density is markedly lower, we could expect there would be a number of different colonies near the port area.

At the time of detection of varroa in a sentinel hive therefore, we would presume that the mite may already be present in a number of other colonies - the questions would be how many are infested and how widespread are they? An immediate survey to determine the hive prevalence in the vicinity of the incursion would be in order, targeting both domestic hives and feral colonies. There would also be trace forward investigations and surveillance on a broader geographical scale in an attempt to give a meaningful estimate of how far the incursion might have spread. It is likely that no commitment would be made to an eradication attempt until such information was available. The decision makers would be well aware that eradication would entail not only the destruction of domestic hives within a declared zone but also the (much more difficult) attempted destruction of all feral colonies. The feasibility of such a strategy would weigh heavily on the decision to eradicate.

Supposing that the index case, by which is meant the first infested domestic or feral hive, is within 'easy' flying distance of a group of 10 other hives which include the sentinel hive. Assuming there is approximately equal likelihood any of these 10 hives being infested from the index case. Also supposing that by the end of 12 months, 50% of these 10 hives are infested. By this time, when we have a 50% chance that the incursion has been detected, there would be six hives already infested plus any 'secondary' infestations possibly outside the limits of our initial study area.

The scenario above may be very approximate and speculative but some of the issues it covers are clearly important. In order to provide useful technical advice to decision makers, there needs to be advance knowledge of the likely spatial distribution of an incursion by the time it is detected in a sentinel hive. There also needs to be knowledge of the likely temporal pattern of new infestations. This could be aided by studies modelling the frequency of contacts and the rate of spread of varroa between hives in various environments. In New Zealand, some work has already been done on modelling the spread of varroa. The New Zealand work might usefully be adapted to the Australian environment, presumably taking account of different environmental scenarios here.

Intensity of surveillance

How can we intensify surveillance to obtain a more sensitive level of detection? Two options are to institute more sentinel hives and inspect hives more frequently.

In the course of the field work associated with this review, the question has arisen whether inspection of sentinel hives at quarterly intervals is sufficiently sensitive. Should sentinel hives be inspected at intervals of six weeks as already happens in some cases?

The benefit of inspection at six weekly intervals rather than quarterly, would appear to be that an incursion could be detected in that hive up to six weeks earlier than it might otherwise have been. This would happen on average half of the time, half of the inspections being those which would not have been carried out on a quarterly regime. The benefit can thus roughly be equated to a detection in that hive from zero to six weeks, or an average of three weeks, earlier than if inspection had been on a quarterly basis.

The benefit of more sentinel hives in proximity to the port is a little more difficult to quantify. Quantification would be facilitated by the application of the model mentioned above if one existed for Australia. For most locations in Australia, and all of the major ports, the sentinel hives might be viewed as just one colony amongst a local population of both domestic hives and feral colonies. As such, the sentinel hive may well not be the index case in the event of an incursion.

Anecdotal reports from New Zealand indicate that significant inter-apiary spread of varroa could be expected some 12 months after initial infestation. (Although inter-apiary spread is obviously *possible* immediately after infestation, it is more likely to take place only after there has been time for a build up of mite numbers within the infested hive.)

Clearly, there will be a period when a larger proportion of the hives around the index case will be becoming infested. How long that period is and the actual likely proportion of hives infested at any given stage is less clear. We will have a better chance of detecting the infestation if we test two sentinel hives rather than one. In simplified statistical terms, if half of a sample of ten hives are infested, we have a 50% chance of detecting the infestation by testing one of those hives whereas we have a 78% chance if we test two. By comparison, six weekly testing will not increase that likelihood at all, it will simply make the first detection zero to six weeks earlier.

In conclusion, it is not possible to be prescriptive about the relative benefits of more sentinel hives vs more frequent sampling of existing hives. Accurate modelling might demonstrate that the answer depended on factors such as the density of honeybee colonies in the locality.

It should be noted that finding a suitable location for a sentinel hive entails liaison between the respective State agriculture department, local beekeepers, local government authorities, land owners, port management, and/or other community organisations. The task is daunting and it is not always possible to establish sentinel hives in locations which are ideal from a purely scientific point of view. The details of recommendations in this report for establishment of new sentinel hives should therefore not be regarded as prescriptive.

Acaracidal products used in the program

Currently, two products are permitted for use in Australia for diagnostic surveillance for varroa and tropilaelaps mites. These are flumethrin (Bayvarol) and thymol (Apiguard). These products are

also permitted for emergency use in the event of an outbreak. In earlier times, fluvalenate (Apistan) was also permitted for use

In certain overseas countries, where synthetic pyrethroids are widely used to control varroa, resistance to flumethrin has become common. There has been some question therefore whether the use of this product in Australia would be effective in detecting varroa if the mite was present in a sentinel hive.

The National Sentinel Hive Program has continued to use flumethrin as a diagnostic tool. There have been two reasons for this. First, for an incursion to be detected, there has to be a positive identification of one mite. Should the population of mites infesting a hive be resistant to flumethrin, there should still be a proportion of that population which will succumb to the chemical and be detected on inspection of the sticky board. Given the number of mites likely to be present within a short time after initial infestation of a hive and the necessity to identify only one, there may be little loss of sensitivity with this approach compared to a normal mite population. One arguable exception to this rationale might be the case of varroa from Italy where an unusually high level of resistance to fluvalenate (which shares cross-resistance with flumethrin) has been reported (Milani N, 1995).

Second, there is no previous diagnostic experience with the use of the alternative available chemical, thymol. It would be appropriate to confirm whether this chemical will kill a significant number of mites when used for diagnostic purposes.

In Europe, formic acid has been widely used for varroa control. There has been a suggestion that this might be another alternative for use in the National Sentinel Hive Program. If such a product was permitted by Australian Pesticides and Veterinary Medicines Authority in Australia, the same comments as for thymol above would apply.

Ever since the program commenced, there has been a practice of reusing flumethrin strips on consecutive hive inspections. For the three months between inspections, the strips are kept inside the aluminium foil packet which they come in. This is contrary to the recommended manner of use of the product and if the active ingredient evaporates during the interval, there might be significant loss of lethal effect. It is proposed that new strips be used at each hive inspection.

It was reported that some beekeepers feel uneasy about the use of chemicals such as flumethrin in their hives for fear of adverse consequences. In contrast with the situation in countries where varroa exists, these chemical strips are rarely used in hives in Australia. It is understandable that some Australian beekeepers would be averse to the use of such chemicals but their widespread use overseas without major side effects suggests that occasional use for surveillance here is unlikely to produce adverse side effects.

Payment of beekeeper's costs

The National Sentinel Hive Program undoubtedly depends for its success on the goodwill of a large number of conscientious and enthusiastic beekeepers. During the course of this review, a number of people questioned whether there should be some reward for, or at least recognition of, the efforts and financial input from these beekeepers. It was suggested that such a reward would improve the incentive for participating beekeepers to continue with the program. It was recognised that the more important issue was to have a beekeeper in place with an aptitude for the surveillance program rather than one who was motivated more by financial reward. For this reason, the level of reward

should be such as to offset costs and not constitute a financial incentive of itself. A certificate of appreciation was regarded as an appropriate way of recognising cooperating beekeepers in NSW.

Although most of the beekeepers participating in the program are already well motivated, the establishment of a certificate of appreciation or a payment towards the costs might assist in maintaining their level of motivation. It would also provide a better recognition of the beekeepers in the import role of early detection of target pests. The issue of who would provide funding would need to be examined as described above in 'Funding principles'.

Other issues

During the course of this review, several related matters have been raised.

One location which has not yet been considered in the National Sentinel Hive Program is Norfolk Island. Because there is significant trade between Norfolk Island and New Zealand, and there is a regular shipping route between New Zealand, Norfolk Island and Yamba, NSW, concern has been expressed over the risks associated with varroa. There is a sentinel hive at Iluka near Yamba which is intended to monitor the Goodwood Island wharf area at Yamba. This hive was not visited as part of this review. Whilst it would be appropriate to examine this location, there is value in contacting the one vessel regularly travelling the above route to ensure awareness about the risks of honeybees on board. This would hopefully improve the chances of detection of honeybees before they had the chance to enter Australia.

The situation in the Torres Strait is unique. *Apis cerana* and *Varroa jacobsoni* both exist on the islands of Saibai, Dauan and Boigu, which are very close to Papua New Guinea. These are not regarded as a significant threat per se because there is a 35 km wide stretch of open water to be traversed between these islands and islands close to the Australian mainland. There are feral *Apis mellifera* on Thursday Island and Hammond Island and probably Prince of Wales Island. There are also reported to be two boxed hives on Prince of Wales Island but they cannot be moved - a by-law was introduced by the Torres Shire Council to prevent the keeping of honeybees of the genus *Apis* in the area. The intention of this by-law was to prevent the movement of *Apis mellifera* hives to islands in the Torres Strait. Given this situation, it has been suggested that there should be no boxed sentinel hive on Thursday Island or any other island in the Torres Strait.

Alternative methods of surveillance have been suggested. Examples include designs for specific attraction of *Apis cerana* in association with sticky boards, the use of empty used hive boxes to attract *Apis mellifera* in the vicinity of ports, and the examination of dung pellets from honey-eater species for wings of *Apis cerana*. It has not been possible to assess such novel methods in the context of this review but there is a need to assess their cost and efficacy compared with the established methods of surveillance.

The giant honeybee *Apis dorsata* is a potentially important pest for Australia and it has been highlighted as worthy of consideration in this review. It has been found on vessels and landed cargo/containers (see Annex A). It is the natural host for the mite *Tropilaelaps clareae* which would be of importance to Australian beekeeping. There are reports that it is attracted to blue light, a fact which might be of use if specific surveillance were considered. Again it has not been possible to assess this pest species in the context of this review but the importance of *Apis dorsata* could be considered further by technical experts with a view to determining whether it can and should be the subject of specific surveillance.

Recommendations

A. General recommendations for the program

1. The program's operation in South Australia and Tasmania should be reviewed along similar lines to that which has already been done in other States.
2. A detailed analysis of the benefits of the National Sentinel Hive Program should be undertaken by the honeybee industries and invlove those horticultural and seed crop and pastoral industries that are significant beneficiaries of pollination.
3. Options for the long-term funding and coordination of the program should be reviewed. This should involve both government and industry and it should take into account the above analysis.
4. The review of funding should consider what costs should be covered, including whether these should include a payment towards the costs of participating beekeepers. In any case, it is recommended that an expression of appreciation to participating beekeepers be given.
5. A study should be made of the likely inter-colony spread of varroa in Australian environments. This information would assist in making reasonable predictions and decisions on responses if varroa were detected in one sentinel hive or a small number of colonies. The potential use of a model to assist in decision making in the face of an incursion should be explored.
6. Technical experts should consider the potential advantages of alternative chemicals for surveillance for external mites and make appropriate recommendations for future surveillance.
7. Bayvarol strips should not be reused.
8. Surveillance for *Apis cerana* using traps should be extended to all ports on the eastern seaboard as far south as Brisbane.
9. Traps used specifically for *Apis cerana* should use the palm log design in conjunction with the CSIRO synthetic lure unless alternatives are shown to be superior.

B. Recommendations for particular locations

1. Investigate the feasibility of establishing sentinel hives at the following new locations where the port statistics indicate that the risk of honeybee pests is relatively high, eg:
   - Port Kembla, NSW
   - Hay Point, Queensland
   - Western Port, Victoria
   - Weipa, Queensland (re-establishment)
   - Klein Point, South Australia
   - Port Walcott, Western Australia
   - Mackay, Queensland

2. Sydney: Consider establishing one additional sentinel hive close to Sydney Harbour and another close to Port Botany.

3. Melbourne: The second sentinel hive should be re-established in the vicinity of Port Melbourne. Although sampling at six weekly intervals could be undertaken for the sentinel hives in Melbourne, a preferable option would be to establish a third sentinel hive in the vicinity of Port Melbourne in a location generally to the east of Coode Island.
4. Portland: Re-establishing a sentinel hive at a location close to the port area.
5. Fremantle: Consider establishing an additional sentinel hive in reasonable proximity to the port area.
6. Kwinana: Explore possible locations for at least one and preferably two more sentinel hives, close to the northern and southern ends of the Kwinana port area.
7. Broome: Continue work to identify a site for a sentinel hive and include sticky boards in surveillance as well as whole bees.
8. Wyndham: Discontinue attempts at maintaining a sentinel hive at Wyndham.
9. Port Hedland: The new nucleus hive at Pretty Pool should be nurtured until it is strong enough to be relocated to the Customs House site.
10. Dampier: Replace the sentinel hive and reinstitute regular surveillance as soon as practicable.
11. Port Walcott: Explore the feasibility of establishing a new sentinel hive in the vicinity of Port Walcott.
12. Brisbane: Continue sampling of the two sentinel hive locations at regular quarterly intervals. Seek a suitable location for a third sentinel hive further upstream near the port area. Maintain at least two permanent traps of the palm log design with pheromone lures, which are inspected at least quarterly for *Apis cerana*. "Lucitraps" should be discontinued in favour of palm log traps unless they are intended as a trap for other insect species or they are shown to be of similar efficiency as the palm log design. All trap monitoring should be reported for inclusion in the National Animal Health Information System.
13. Townsville: Locate a new sentinel hive closer to the port area if a suitable location can be found. A palm log trap with pheromone bait should also be established close to the port area at Townsville and inspected at least quarterly for *Apis cerana*.
14. Cairns: A palm log trap with pheromone bait should be established at this location and inspected at least quarterly for *Apis cerana*.
15. Darwin: Explore the feasibility of establishing a new sentinel hive near East Arm wharf.
16. Gove: Explore the feasibility of using lures in the Gove trap. Include the inspection results in the report for the National Animal Health Information System.

Annex A

List of incursions and potential incursions involving honeybee pests

Date	Agent	Place	Comments
Early 1970s	*Apis dorsata*	Fremantle	From Java, Indonesia. No further details.
February 1994	*Apis scutellata*	Fremantle	A nest of live bees was found on a container. Destroyed.
April 1995	*Apis cerana*	Near Brisbane	No further details.
June 1996	*Apis cerana*	South Australia	No further details.
February 1997	*Apis scutellata*	Fremantle	Abandoned nest only. Originated from Durban in South Africa.
December 1997	Bumble bee (*Bombus vosnesenskii*). Not the same as that in Tasmania.	Buderim, Qld	Not diagnosed till May 1999. Mites were found *Kunzenia* sp. Which are basically scavengers in bumble bee nests - not significant for *Apis cerana*.
June 1998	*Apis cerana*	Darwin	Nest discovered by a local beekeeper. Eradication program instituted and intensive surveillance.
July 1999	*Apis dorsata*	Sydney	Air freight from Penang Malaysia - computer motherboards. Examination showed no mites.
September 1999	*Apis cerana*	Brisbane	Asian honeybees were detected on a ship (ex Singapore, Lae and Port Moresby) berthed in Brisbane. Swarm of approximately 50-100 absconded but follow up monitoring revealed nothing.
December 1999	*Apis cerana*	Brisbane	Introduced with heavy earth moving equipment from Lae, PNG. Hive of 5,000 bees destroyed. DNA test showed the bees were Java Flores type. *Varroa jacobsoni* found.
March 2000	*Apis dorsata*	Brisbane	A swarm was found under a container at the Brisbane wharves. Destroyed.
January 2002	*Apis cerana*	Melbourne	Swarm on a container ship from Lae, New Guinea. Destroyed. Inspection revealed *Varroa jacobsoni*.
January 2002 (or earlier)	*Aethina tumida*	Richmond, NSW	Discovered October 2002 but probably already present for at least a year. Means of arrival unknown.
December 2002	*Apis cerana*	Brisbane	One bee found on ship from PNG. Follow up surveillance in Hamilton area revealed nothing.
February 2003	*Apis dorsata*	Vessel off north Australia	Oil tanker from Singapore. A "quite large swarm" found by crew and (inexpertly) destroyed before arrival. Only dead bees found. No mites seen on inspection.
February 2003	*Apis dorsata*	Vessel off north Australia	Vessel from Indonesia. Seven dead and one dying bee found. No evidence of swarm found despite repeated checks. No mites found on inspection.
May 2003	*Bombus terrestris*	Fisherman Island Brisbane	A single bee was found by AQIS.

Date	Agent	Place	Comments
May 2004	*Apis cerana*	Cairns	Vessel from PNG. Swarm of *Apis cerana* found in hold on arrival in port. Bees destroyed. Spread considered unlikely. No mites found on inspection.
Nov 2004	*Apis cerana*	Brisbane	Vessel from PNG. Nest of *Apis cerana* found under a container in port. Bees destroyed. Spread considered unlikely. *Varroa jacobsoni* found on inspection. Surveillance for *Apis cerana* put in place within 6 km radius for 12 months.

Annex B

List of originally established ports subject to surveillance under NSHP

New South Wales
- Iluka
- Newcastle
- Richmond
- Sydney

Victoria
- Geelong
- Melbourne
- Portland

Queensland
- Brisbane
- Cairns
- Gladstone
- Townsville
- Weipa

South Australia
- Adelaide

Northern Territory
- Darwin
- Gove

Western Australia
- Albany
- Broome
- Bunbury
- Dampier
- Esperance
- Fremantle
- Geraldton
- Kwinana
- Port Hedland
- Wyndham

Tasmania
- Bell Bay
- Burnie
- Devonport
- Hobart

Annex C

National Sentinel Hive Program - Number of samples

Period	Tracheal mites	Varroa/Tropilaelaps	Apis cerana
2000 - 3rd quarter	27	27	
2000 - 4th quarter	29	29	
2001 - 1st quarter	17	20	
2001 - 2nd quarter	23	26	
2001 - 3rd quarter	22	35	
2001 - 4th quarter	17	25	5
2002 - 1st quarter	29	35	5
2002 - 2nd quarter	16	16	10
2002 - 3rd quarter	16	15	0
2002 - 4th quarter	26	26	12
2003 - 1st quarter	26	31	16
2003 - 2nd quarter	26	30	12
2003 - 3rd quarter	18	20	5
2003 - 4th quarter	26	24	20
2004 - 1st quarter	20	16	12
2004 - 2nd quarter	28	25	15
2004 - 3rd quarter	26	24	18

Note: All results were negative for the respective pest.

Annex D

Estimate of relative risks for entry of exotic bees

Port	RISK INDEX	Cumulative risk	BTRE: Imports bulk (T)	BTRE: Imports cont'rs (T)	AAPMA: Imports bulk (T) (1)	AAPMA: Imports cargo (T) (2)	AAPMA: Vessels (3)
Melbourne Port Corp	**28.26**	28.26	3,174,213	6,327,664	6,096,031	8,455,743	3,195
Sydney/Port Botany (4)	**22.43**	50.70	7,611,537	5,809,521	12,879,086	5,553,640	2,331
Brisbane	**12.08**	62.77	7,223,805	2,478,710	10,989,596	2,818,076	2,331
Fremantle/Kwinana (5)	**9.22**	71.99	6,584,162	1,673,666	8,495,272	2,527,183	1,621
Port Adelaide (Flinders)	**3.29**	75.28	733,456	563,734	2,645,689	667,786	999
Dampier Port Auth	**2.77**	78.05	523,369	19,126	206,287	41,591	2,298
Devonport Corp	**2.24**	80.29	50,604	7,474	437,730	811,123	893
Newcastle Port Corp	**2.14**	82.43	1,028,685	112,146	2,893,384	145,391	1,390
Burnie Port Corp	**1.84**	84.27	113,300	51,717	146,670	751,578	557
Gladstone Port Authority	**1.52**	85.79	1,074,600	6,402	10,852,479	23,154	998
Townsville Port Authority	**1.42**	87.21	4,079,060	46,635	5,388,620	111,350	739
Geelong Port	**1.36**	88.58	5,062,362	97,549	5,996,493	145,515	515
Darwin Port Corp	**1.22**	89.79	391,596	45,054	723,167	117,794	803
Launceston	**1.15**	90.94	241,130	84,340	1,263,915	254,856	499
Cairns Port Authority	**1.09**	92.03	352,314	27	574,217	34,200	876
Port Kembla Port Corp	**0.93**	92.96	1,997,092	33,363	1,900,000	29,302	599
Port Hedland Port Authority	**0.85**	93.81	185,586	347	342,820	23,359	691
Thursday Island (PCQ)	**0.57**	94.38	182	0	0	14,482	474
Hay Point (PCQ)	**0.47**	94.85			0	0	410
Bunbury Port Authority	**0.47**	95.32	1,051,889	0	1,147,445	1,503	339
Portland	**0.40**	95.72	325,376	32,137	1,234,793	9,330	246
Hobart Ports Corp	**0.39**	96.11	158,662	4,016	1,012,621	29,038	268
Western Port (6)	**0.36**	96.47	441,249	0	1,314,656	0	268
Weipa (PCQ)	**0.31**	96.78	54,396	0	0	7,701	259
Klein Point (Flinders)	**0.31**	97.09			0	0	270
Port Walcott	**0.30**	97.40	53,725	0			260
Mackay Port Authority	**0.26**	97.66	234,793	19,000	121,086	19,000	160
Geraldton Port Authority	**0.26**	97.92	157,129	4,222	325,431	9,267	192
Broome Port Authority	**0.19**	98.11	8,030	1,679	105,010	13,973	145
Esperance Port Authority	**0.19**	98.29	222,173	0	431,247	0	143
Gove	**0.18**	98.47	1,024,451	2,510			110
Karumba (PCQ)	**0.16**	98.64	770	0	0	10,232	130
Port Stanvac	**0.16**	98.79	911,988	0			100
Port Lincoln (Flinders)	**0.15**	98.94	88,359	0	213,968	4,703	117
Abbot Point (PCQ)	**0.15**	99.09			0	0	128
Albany Port Authority	**0.14**	99.23	160,499	0	140,694	7,084	107
Thevenard (Flinders)	**0.13**	99.36	87	0	0	0	112
Port Pirie (Flinders)	**0.12**	99.48	3,607	3,895	452,672	5,849	81
Rockhampton Port Authority	**0.11**	99.59	20	0	0	28,733	55
Wyndham	**0.06**	99.65	37,720	0			50
Mourilyan (PCQ)	**0.05**	99.70			0	0	43
Quintell Beach (PCQ)	**0.04**	99.74			0	1,366	37
Cape Flattery (PCQ)	**0.04**	99.78			0	0	37
Wallaroo (Flinders)	**0.04**	99.83	29,270	0	77,346	0	34
Yamba	**0.04**	99.87			0	674	35
Bundaberg Port Authority	**0.04**	99.91	10,996	0	71,923	0	31
Port Giles (Flinders)	**0.03**	99.94			0	0	26
Eden	**0.03**	99.96			18,183	0	22
Lucinda (PCQ)	**0.02**	99.98			0	0	17
Whyalla	**0.02**	100.00	126,145	0			12
Total	**100.00**		**45,528,387**	**17,424,935**	**78,498,531**	**22,674,576**	**26,053**

Notes:
1. Homogenous unpacked cargo eg includes coal, iron ore and grain.
2. Containers and break bulk. Does not include homogeneous bulk products.
3. Includes visits by naval vessels.
4. Sydney and Port Botany are combined because some data are not broken down between the two.
5. Fremantle and Kwinana likewise.
6. 963,214 t AAPMA gen cargo is steel from Pt Kembla ie bulk

Adjustments made for local circumstances at Klein Port.

BTRE – Bureau of Transport and Regional Economics
AAPMA – The Association of Australian Ports and Marine Authorities Incorp

Annex E

Notes on individual ports visited

Sydney

Port areas in Sydney can be divided into three areas, Sydney Harbour, Port Botany and Kurnell. The latter two are only about four km apart on opposite sides of Botany Bay. The ports handle a large amount of cargo of widely differing nature.

Sentinel hives are located at three corresponding sites. One is in Balmain about one to two km from the port areas of Mort Bay, Darling St Wharf and Blackwattle Bay. Another is at Pagewood about three to four km from the Port Botany area. The third is near the Towra Point Nature Reserve about two km from the Kurnell port area. The latter is very fortuitously situated in being on the neck of the Kurnell Peninsula. Any mite incursion is expected to 'saturate' the Peninsula area (and be detected) before moving further afield.

Given the large amount of cargo brought into Sydney ports, it would appear appropriate to increase the intensity of surveillance. The Kurnell area is already in a relatively strong position as explained above. However the other two port areas, Sydney Harbour and Port Botany would be well served by one other sentinel hive in reasonable proximity. It is recognised that finding suitable locations and/or beekeepers may present significant logistical problems.

The Richmond air base is located about 45 km north west of Sydney. Since it handles a quantity of cargo, a sentinel hive has been established about one to two km from the air base. No estimate has been made of the relative risk of this location. However, the sentinel hive here appears to be suitable for the purposes of surveillance.

Recommendations for this location: Consider establishing one additional sentinel hive close to Sydney Harbour and another close to Port Botany.

Newcastle

Newcastle is a large port which has two main port areas, a coal handling facility to the north and the container depot and main port area near Mayfield.

A sentinel hive is located about three km west of the main port area and about six km from the coal terminal. NSW Department of Primary Industries (Primary Industries Agriculture and Fisheries Division) has recently established a second sentinel hive about two km north of the main port area. This is justified by the large size of the port (see Annex E, page 21) and the distance of the coal terminal from the existing sentinel hive.

Recommendations for this location: The additional sentinel hive is now established and no further changes are recommended.

Melbourne

Melbourne is Australia's largest port in terms of tonnage handled. Port Melbourne covers an area roughly six km across.

Vessels waiting for a berth often anchor in Port Phillip Bay about six to eight km off shore near Williamstown.

The only operating sentinel hive is located at the Spotswood Quarantine Station. Another was previously located at Coode Island. The Victorian Department of Primary Industries proposes to re-establish this hive and has been negotiating with the Port of Melbourne Authority for reinstatement of the second original hive at Coode Island. An alternative location suggested was near the AQIS office at Port Melbourne. It is also considering the option of more frequent sampling in an effort to increase the intensity of surveillance.

Recommendations for this location: The second sentinel hive should be re-established in the vicinity of Port Melbourne. Although sampling at six weekly intervals could be undertaken for the sentinel hives in Melbourne, a preferable option would be the establishment of a third sentinel hive in the vicinity of Port Melbourne in a location generally to the east of Coode Island - this would appear to be a more appropriate manner of managing the risk occasioned by the high port traffic at this location.

Western Port

There has also been a suggestion from the Victorian beekeeping industry that other locations seen as being at risk should be subjected to sentinel surveillance including Western Port, which is the western head to Port Phillip Bay near Point Lonsdale.

Port statistics (Annex D) showed that a significant number of vessels (268 in 2002-3) pass through this port. This places Western Port in much the same risk rating as other ports where the surveillance program is operating. However, its risk is difficult to assess, as anchored vessels are some kilometres off shore. As a result, it is considered that the risk in this location is not of a sufficient priority to warrant a sentinel hive - there are higher priorities at ports elsewhere where ships are in closer proximity to shore.

Recommendation for this location: Monitor developments with a view to re-considering the establishment of a new sentinel hive in the vicinity of Western Port.

Geelong

The port at Geelong consists of jetties servicing the oil refinery to the north of Corio Bay and other jetties some four km to the south for the grain terminal and other purposes.

The sentinel hive is located close to the oil refinery.

The Victorian beekeeping industry suggested at a meeting in April 2004 that a second sentinel hive should be located at Geelong. Whilst such a suggestion has merit, there are a number of other ports throughout Australia which should be regarded as of equally high risk and therefore deserving of two sentinel hives (see Annex E, page 22).

Recommendations for this location: The Geelong sentinel site is operating well and no changes are recommended.

Portland

The port at Portland serves principally as an outlet for timber, woodchips, live animals and other bulk products. There are no container handling facilities.

There has been no sentinel hive here following the death of the previous participating beekeeper. The Victorian Department of Primary Industries proposes to re-establish a sentinel hive at Portland and this is in keeping with a proposal by the Victorian beekeeping industry at a meeting in April 2004. It is also in keeping with the relative risk estimated for this port as a result of this review.

Recommendations for this location: Re-establishing a sentinel hive at a location close to the port area.

Fremantle

Fremantle Port is at the mouth of the Swan River. The port is very large, handling over 1.6m tonnes of container or break bulk imports. However, it is fairly discrete in that it does not stretch over a long distance of shoreline.

The sentinel hive is on the eastern side of the river about three km north-east from the port area. The hive is sampled every six weeks.

Given the size of this port, a high intensity of surveillance would seem appropriate. The six weekly inspection of the existing sentinel hive is one way to increase the intensity of surveillance but as explained above this has the sole effect of detecting an incursion up to six weeks earlier than it would otherwise have been detected. Hence, an additional sentinel hive is the prefered option.

Recommendations for this location: Consider establishing an additional sentinel hive in reasonable proximity to the port area.

Kwinana

Kwinana is a large port about 15 km south of Fremantle. Kwinana handles relatively more bulk imports than Fremantle. The distance separating the two ports dictates that they should be considered separately for the purposes of surveillance.

The port stretches over about eight km of fairly straight north-south coastline which is protected by nearby Garden Island. The sentinel hive is about two km inland at the Western Australian Department's Medina Research Station. The bushland east of the port area is well suited to the sustained presence of feral colonies which could support any pest incursion. The prevailing winds during afternoons are westerly to south-westerly.

Given the long stretch of coastline at Kwinana, there is some doubt about the effectiveness of one sentinel hive to monitor possible incursions. While the sentinel hive is well placed, it seems reasonable to suppose that an incursion entering at either end of the port area could easily be blown well past the sentinel hive and propagate well inland before the sentinel hive became infested. The

high volume of the port traffic and the geographic peculiarities of this port would suggest that preferably two more sentinel hives should be placed towards the extremities of the port area.

Recommendations for this location: Explore possible locations for at least one and preferably two more sentinel hives, close to the northern and southern ends of the Kwinana port area.

Bunbury

This port handles mostly exports, the principal commodities being wood chips and mineral sands. There are two distinct port areas, Inner Harbour and Outer Harbour, about three km apart. Outer Harbour handles significantly less traffic. No container facilities exist and only a small amount of break bulk cargo is imported. AAPMA reported 339 vessel calls for the year 2002-3.

One sentinel hive is present, being one of a group of five hives in a suburban backyard located about two km south of Inner Harbour.

Recommendations for this location: The Bunbury sentinel site is operating well and no changes are warranted.

Broome

Broome is a small port with over 100 pratique visits per year. The terminal is at the end of a peninsula. The main commodity handled is live cattle to a number of destinations mostly in SE Asia.

There are only a small number of managed hives in the surrounding district, often for the purpose of pollination. The terrain appears quite suitable for survival of feral bees.

In recent time, samples of whole bees and honey have been supplied by a local beekeeper. No sticky boards have been done. The origin of samples has been close to Broome but the precise location is obscure.

Work is in hand to identify a suitable sentinel hive site on the peninsula. Anywhere along this strip would be acceptable. A local beekeeper is willing to provide a hive and assist in surveillance.

Recommendations for this location: Continue work to identify a site for a sentinel hive. Include sticky boards in surveillance as well as whole bees.

Wyndham

Wyndham is a small port handling mainly livestock exports and some sugar. Pratique visits are about 35 per year but could increase to about 50 in the future. Wyndham is well inside the Cambridge Gulf. It is located about 70 km in a straight line west from Kununurra and the horticultural areas of the Ord River.

Kununurra relies quite heavily on honeybees for pollination of crops but the environment is not suitable for their survival in the hot season. At least 750 hives are brought up from the southern areas of Western Australia about March each year and taken out in about October.

Wyndham's surrounds are a difficult environment for honeybees. Mangroves around Wyndham continue for many miles on both sides of the Gulf. In a suitable season, these mangroves would seem capable of supporting honeybees. However an experienced local beekeeper contends that there are no sustained feral colonies in this area.

Wyndham has not been sampled for some time due to the lack of any expert in the vicinity, who could regularly send samples. The sentinel hive was destroyed because of American Foul Brood in October 2004. Reestablishment of a sentinel hive would be hampered by the lack of either a beekeeper or government officer to maintain it and take samples.

Given the low risk of an incursion via this port, it is questionable whether surveillance is warranted.

Recommendations for this location: Discontinue attempts at maintaining a sentinel hive at Wyndham.

Port Hedland

Port Hedland is a major outlet for minerals from the Pilbara region. No significant facilities exist for the handling of containers or break bulk cargo.

The sentinel hive present is a newly supplied nucleus colony. This hive is still quite small and when it gains strength will replace the previous sentinel hive which was removed when its owner left the district.

At present, the sentinel hive is located at Pretty Pool about eight km from the port area under the care of an AQIS officer. When it gains strength it will be located at Customs House immediately outside the port area.

There are no local beekeepers in the district. The last one left in 2002.

At first sight, the terrain around Port Hedland appears such that feral bees would not thrive or even survive. However, at least further inland in the former gold mining areas of the Pilbara, feral bees do survive in the absence of significant vegetation cover and in the absence of significant bodies of permanent water. The conclusion is that the propensity for spread of varroa or other honeybee pests following any incursion here should not be underestimated.

Recommendations for this location: The new nucleus hive at Pretty Pool should be nurtured until it is strong enough to be relocated to the Customs House site.

Dampier

Dampier is a major export port for Pilbara ore. A quantity of equipment as well as bulk materials are imported. There are five terminals stretched over about 15 km on islands or on the mainland. Those more distant from the sentinel hive are toward the distant end of a peninsula.

The sentinel hive is normally situated near the town centre near the base of the peninsula which is about five km wide. This hive had to be destroyed because of American Foul Brood and chalkbrood. Plans are in train to replace the hive.

There are no managed hives in the vicinity of Dampier. Some hives are kept at a mesquite plantation about 50 km south of Dampier.

The terrain around Dampier appears fairly unsuitable for the survival of feral bees (and therefore for the dispersal of a potential incursion). On the other hand, it was reported that feral colonies do exist in the inland mining areas of the Pilbara, despite an apparent dearth of nesting sites or permanent water sources. It would seem best therefore to assume that dispersal of honeybee pests may occur in any area of the Pilbara.

Recommendations for this location: Replace the sentinel hive and reinstitute regular surveillance as soon as practicable.

Port Walcott

Port Walcott is a significant port about 40 km east of Karratha and 220 km west from Port Hedland. At present it handles about 260 vessel visits per year and this is increasing.

Whilst no visit was made to this port, the quantity of shipping indicates that it should be regarded as a candidate for surveillance if the volume of port traffic increases significantly in the future.

There may be significant logistical problems in locating a sentinel hive in this area because of the harsh environment.

Recommendations for this location: Explore the feasibility of establishing a new sentinel hive in the vicinity of Port Walcott.

Geraldton

Geraldton Port serves the surrounding agricultural areas. The terminal area is quite discrete.

The sentinel hive is situated in a suburban area about one km south of the wharf area. One other hive which was in reserve had died out but had been functioning well.

The terrain around Geraldton would be conducive to the sustenance of feral bees and the dispersal of any incursion of honeybee pests.

There are no specific recommendations for this location.

Brisbane

The port facilities at Brisbane stretch almost 10 km along the river from Fisherman Island to Hamilton.

Sentinel hives are located at Pinkenba and Whyte Island and a feral hive at Lytton has occasionally been sampled. Before 2004, not all of these locations were sampled at regular quarterly intervals.

One palm log trap and several "Lucitraps" intended for detection of *Apis cerana* are located in the Lytton-Fisherman Island area. In November 2004, a nest of *Apis cerana* was detected underneath a container from Papua New Guinea. Following this detection, the Queensland Department of Primary Industries (DPI) planned to place a number of other traps in the Hamilton area for a period of 12 months.

Recommendations for this location: Continue sampling of the two sentinel hive locations at regular quarterly intervals. A third sentinel hive further upstream would be desirable and a suitable location should be sought. Maintain at least two permanent traps of the palm log design with pheromone lures, which are inspected at least quarterly for *Apis cerana*. "Lucitraps" should be discontinued in favour of palm log traps unless they are intended as a trap for other insect species or they are shown to be of similar efficiency as the palm log design. All trap monitoring should be reported for inclusion in the National Animal Health Information System.

Townsville

Townsville handles a considerable quantity of imports both bulk and general cargo. The size of this port places it quite high on the risk ranking table (see Annex E, page 27).

The sentinel hive is located at the Queensland DPI property at Oonoonba, about four km south west of the port area. There have been difficulties in organising monitoring, despite a suitable location being found close to the port area.

The existing sentinel hive is rather distant from the port area. Unfortunately, any incursion of pests might well move in a westerly or north westerly direction through the Townsville suburbs where the environment and vegetation would be generally quite suited to exotic bees. Thus, there could be some significant delay in detection of an incursion at the Oonoonba location. It would seem best to attempt to locate a new sentinel hive closer to the port area if possible. This hive could be in addition to the existing hive at Oonoonba. It might be owned by a cooperating local beekeeper or the Queensland DPI, depending on local circumstances.

Recommendations for this location: Locate a new sentinel hive closer to the port area if a suitable location can be found. A palm log trap with pheromone bait should also be established close to the port area at Townsville and inspected at least quarterly for *Apis cerana*.

Cairns

Most cargo shipping into Cairns originates from PNG and the Gulf of Carpentaria. There is no container port.

A single sentinel hive is located on the Queensland DPI property about 1.5 km east of the cargo port area.

Recommendations for this location: A palm log trap with pheromone bait should be established at this location and inspected at least quarterly for *Apis cerana*.

Darwin

Darwin is a large port handling a range of products. It is important as a port for live cattle exports. The parts of the port are rather widely separated with East Arm wharf being about six km in a direct line from Fort Hill wharf and about 10 km from Cullen Bay, a wharf used by smaller vessels.

Two sentinel hives are established, one at Dinah Beach about two km from Fort Hill wharf and on the other side of the Darwin peninsula near Cullen Bay. Rainbow bee-eater birds *Merops ornatus* make the maintenance of sentinel hives difficult.

Log traps with lures are placed at five locations, near the airport, at Cullen Bay, Fort Hill wharf, and two at East Arm wharf.

With the development of East Arm facilities and the consequent growth in traffic at this site, and taking into account its location and distance from the existing sentinel hives, it would be appropriate to establish a new sentinel hive south of Berrimah close to East Arm if possible.

Recommendations for this location: Explore the feasibility of establishing a new sentinel hive near East Arm wharf.

Gove

Gove was not visited during this review but it has a significant place on the risk ranking table (see Annex E, page 28) on account of the number of vessels visiting for the mining industry. There is no sentinel hive at this location as no feral populations of *Apis mellifera* exist and it was feared that they would be introduced. However a log trap is located there. The quarantine officer station in Gove, monitors the log trap monthly. No lures are used.

In view of the significance of this port, it would seem appropriate to include the use of lures in the trap.

Recommendations for this location: Explore the feasibility of using lures in the Gove trap. Include the inspection results in the report for the National Animal Health Information System.

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