

# The outbreak of *Varroa destructor* in New Zealand bees: delimiting survey results and management options

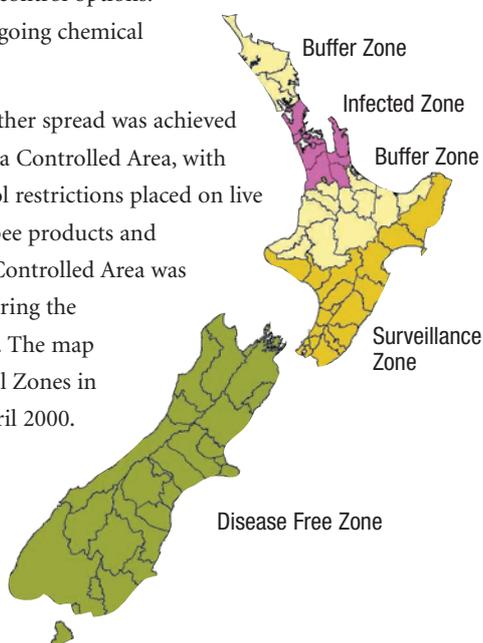
*Varroa destructor* is an external parasite of honey bees (*Apis mellifera*) and feeds on haemolymph of both adults and brood (larvae). An adult female mite lays between two and five eggs shortly before the brood cell is capped. Development from egg to adult takes eight to 10 days. Mating takes place in the brood cell, and emerging female mites lay eggs in other cells after two weeks. Their lifespan is about two months in the presence of live bees, but without bees to feed on it is only about three days. Infestation of a European honey bee colony results in deformed bees, reduced lifespan and eventual death of the colony. The mite shifted from its natural host, the Eastern honey bee (*A. cerana*), to *A. mellifera*<sup>(1)</sup> and since then has been carried into most beekeeping regions of the world. Until recently, New Zealand and Australia were the only major beekeeping countries free of the mite.

*Varroa* spreads between colonies and apiaries through drifting or robbing bees (natural spread). Beekeeper assisted spread occurs through normal management practices such as interchanging hive components containing infested brood, movement of bee products attractive to bees, shifting hives for pollination of crops or honey collection, and international trade of live bees. New Zealand has prohibited the import of live bees since about 1960 to protect its disease-free status.

## Delimiting survey

A delimiting survey for *Varroa* was conducted from 12 April to early June 2000. Its aim was to determine the geographical distribution of the infestation and to obtain information on the timing and means of introduction of *Varroa* to New Zealand. It also formed a basis for deciding the likely success of eradication and for assessing control options: eradication or ongoing chemical control.

Prevention of further spread was achieved by declaration of a Controlled Area, with movement control restrictions placed on live bees and brood, bee products and equipment. The Controlled Area was extended once during the delimiting survey. The map shows the Control Zones in place from 28 April 2000.



The presence in New Zealand of *Varroa destructor*, a notifiable organism, was confirmed in Auckland on 11 April 2000. MAF undertook a delimiting survey, which defined the limits of spread of the mite and provided the basis for decisions on whether to undertake eradication or control.

## Survey design

The survey focused on testing managed colonies (apiaries as opposed to feral colonies), and on tracing the movements of live bees and equipment from infested or potentially infested apiaries. A comprehensive database, available because of existing compulsory registration of apiary sites, proved invaluable. Data quality was not perfect and, although most major beekeepers were registered, some omissions of apiary sites became apparent.

Diagnostic testing of hives used Apistan® strips (polymer strips impregnated with tau-fluvalinate, a synthetic pyrethroid miticide) inserted between the brood frames for a 24-hour period, with a sticky board placed on the bottom of the hive to catch fallen or dead mites. Only phoretic mites (ie those feeding on adult bees) are detected by this method. The sticky board was withdrawn and inspected for mites, and the number of mites recorded was used as a measure of the infestation level. The sensitivity of the test in this survey was estimated to be 84% at the hive level, 73% at the apiary level and 100% at the cluster level. These levels were achieved because there were relatively high infestation levels at the hive level, a relatively low sample of hives on apiaries, and highly clustered infested apiaries because of natural spread in the Infested Zone. Only a percentage of hives in an apiary (20 to 100%, depending on the risk of infestation) were tested. In the Infested Zone, 20% of hives on site were tested and 50% in the Buffer Zone. Testing all hives on site provides a high apiary level sensitivity, and in the lower North Island and South Island all hives on each sampled site were tested at least once. Low level infestations (five or fewer mites) in a hive, implying an infestation of up to six month's duration, have a lower chance of being detected.

In the first step, the delimiting survey moved outwards from the first detected infestation to determine the boundaries to the north and south of the infestation. Once boundaries of sufficient width (approximately 20 km) were established, the survey was directed back towards the centre of the outbreak area to increase the test effort within 'Infested Areas', defined as the area within a 5 km radius of any known infested apiary. At the same time targeted surveillance was conducted to check whether spread had occurred through movement of colonies to high-density pollination areas in the Bay of Plenty.

Purposive sampling was used to establish the status of Buffer, Surveillance and Disease Free Zones. This targeted large commercial beekeeping operations that had apiaries in the Infested Zone as well as in the Buffer Zone or Surveillance Zone.

Two beekeeper operations in the South Island that may have received infested bees from the North Island were tested and placed under movement restrictions. Sites of origin of bees transported to the South Island over the previous two years were also tested.

Tracing movements from the Infected Zone and from all infested apiaries over the previous two- to five-year period gave additional information for the targeted surveillance. All other apiaries owned by beekeepers with an infested apiary also received special attention to check for spread within the beekeeper's operation.

## Survey results

It took 3,106 apiary visits (representing 60,479 hives) and 15,962 sticky board tests, of which 3,705 were diagnosed *Varroa* positive, to complete the survey. The survey detected 309 infested apiaries with 4,282 hives on sites owned by 148 beekeepers. The percentage of apiaries tested and the resulting prevalence within the different components of the delimiting survey and Control Zones are shown in the table.

Percentage of apiaries tested and prevalence listed per delimiting survey component and per control zone		
	% tested	% prevalence
<b>Delimiting survey components</b>		
Infected Area	50	22
Northern Boundary	63	2
Southern Boundary	67	1
Bay of Plenty	28	3
Infested Areas in Buffer Zone (5-15 km radius)	100	10-30
Common ownership with infested place	100	21
<b>Control zones</b>		
Infected Zone	53	14
Buffer Zone	11	2
Surveillance Zone	3	0
Disease Free Zone	0	0

Infested apiaries were found to be highly clustered. Clusters in the Infected Zone had developed around Auckland, Hauraki Plains, Pukekohe and Helensville as a result of natural spread. The Auckland cluster was the oldest, most heavily infested, cluster and could possibly have spread from an introduction of *Varroa* three to four years ago.

In November 1998, the Hauraki Plains cluster became infested, most likely through beekeeper movement. In late 1998 or early 1999 the Pukekohe cluster became infested, probably through beekeeper movement or natural spread. The smallest of the four most prominent clusters was the Helensville cluster, which most likely became infested in November 1999.

Beekeeping activity spread *Varroa* mite to several Buffer Zone sites, including Te Puke and Hokianga (where some further natural spread occurred), and to single sites at Te Awamutu, Otorohanga and National Park. The small Te Puke cluster seemed to be the result of bee movements from the Hauraki Plains in November 1999. Hokianga, Te Awamutu and Otorohanga apparently became infested as a result of movements of bees used for pollination in Pukekohe around the same time. Although few feral colonies were

tested, they were assumed to be infested wherever natural spread from managed colonies occurred. Thus the Mamaku area is considered to be infested although no infested apiaries are currently present. Because spread occurred in early 1999, resident feral bees are considered to be infested.

The lower North Island and South Island were considered to be free of *Varroa* based on the purposive sampling strategy.

Tracing of 2,327 beekeepers in the North Island revealed 394 movements from infested areas, which were followed up by testing. An attempt was made to contact all registered South Island beekeepers to determine whether they had received bees directly or indirectly from the North Island. There were 44 movements from the North Island, representing 5,521 queen bees and one hive, for which the apiaries of origin were subsequently tested.

Many other activities took place during the delimiting survey: phone enquiries from members of the public (3,728), movement permit issues (1,347) and investigations of alleged movement control violations (16).

## Technical and epidemiological projects

A number of associated projects were undertaken at the same time as the delimiting survey.

A trial was undertaken to assess whether the introduced *Varroa* mites showed resistance to tau-fluvalinate, as resistant populations exist in many countries. No evidence of resistance was found.

The simultaneous introduction of other exotic infestations or diseases with *Varroa* was investigated in a survey of the primary cluster. Apiaries with a known map reference in a 6.2 km radius of the primary cluster point location were tested and found negative for European foulbrood, *Tropilaelaps*, tracheal mite, small hive beetle and Africanised honey bees. Most apiaries were heavily infested with *Varroa*.

Studies of the effectiveness of Apistan® strips at killing *Varroa* mites were undertaken at different times. The transmission of American foulbrood spores through repeated use of Apistan® strips was also examined.

Insufficient information was available to determine the likelihood of successful depopulation of feral bee colonies, a key component of an eradication programme. A feral bee depopulation trial was started in June 2000 to establish feasibility. Although *Varroa* eradication was not attempted in the North Island, this option is still open for the South Island if or when infestation with *Varroa* is detected.

Case studies were helpful in estimating the risk of various mechanisms of spread of *Varroa*.

A spatial simulation model, predicting the spread of *Varroa* within the North Island under different control strategies, was used to evaluate the feasibility of eradication of *Varroa* from the North Island.

Published literature, although scarce, was consulted to estimate the sensitivity of the diagnostic test and these estimations were revised as field data became available. The need for good data on the diagnostic test sensitivity triggered a study on Apistan® test sensitivity.

## Management options

The northern and southern boundaries of the Infested Area were defined on the basis of ability to detect a lower than 2% prevalence of infested apiaries. We are confident the infested areas were accurately defined and all clusters identified in the Infected Zone. The survey clearly indicated the extent of natural spread in the Infected Zone and supported a conclusion that beekeeper transmission was a major mechanism for geographical spread. The Buffer Zone prevalence was not greater than 2%. This was confirmed by the Bay of Plenty survey, which was designed to detect a maximum prevalence of 2% (200 sites, assuming sensitivity of detection was 71% at the apiary level).

At this stage it is unknown how the mite arrived in New Zealand. The most likely methods of introduction are on an illegally imported queen bee, or in a swarm attached to a ship or shipping container.

MAF advised Cabinet that there was a low probability that an eradication programme would be successful, although it was theoretically technically feasible. The expected impacts of the *Varroa* incursion for horticultural, pastoral, arable and apicultural sectors were estimated to range from \$400 million to \$900 million over the next 35 years (MAF Policy, unpublished paper). The direct cost of eradication was estimated at \$55 million.

Eradication was considered to be worthwhile from an economic perspective if it were deemed to be technically feasible with a high probability of success. **The main risks to successful eradication were considered to be accurate definition of test sensitivity, the ability to detect infested apiaries before further spread occurred and achieving eradication of feral bees.** It was considered that a failed eradication attempt would negatively influence successful managed control of *Varroa*, because of the impact on agriculture of depopulating bees over a wide area. Amongst the technical experts and industry representatives consulted during the process of formulating this advice there was a range of views. This created a challenge for communicating the advice to Cabinet as the decision-maker.

On 12 July 2000, Cabinet agreed to a three-phase *Varroa* management programme involving immediate assisted treatment of high-risk hives, a two-year government supported interim management programme, and the development of a long-term *Varroa* pest management strategy proposal using the process set out in Part V of the Biosecurity Act 1993.

The immediate assisted treatment programme of high-risk hives (Phase I) involved government assisted treatment with Apistan®, the only product approved for treatment, of apiaries identified during the delimiting survey as infested or potentially infested with *Varroa*.

Optional testing was made available to beekeepers if sites were located within 5 km of an infested apiary, a high-risk trace had occurred, or upon suspicion of *Varroa*. The treatment programme started in July 2000 and ran for 10 weeks during which 11,155 hives received treatment and 5,197 hives were tested.

The two-year government supported interim management programme (Phase II) is intended to facilitate transition to long-term control. The objectives are to ensure the South Island remains *Varroa*-free for as long as possible, and that the impact of infestation in the North Island is minimised. In November 2000, Cabinet approved the transitional management programme, which was finalised by MAF after extensive consultation with beekeepers and other interested industries.

The programme components are movement controls, surveillance, treatments, extension services, research and administration. Movement controls were implemented in such a way as to minimise the economic impact of *Varroa* and associated regulatory controls for beekeepers in the North Island, and to minimise the risk of transfer of *Varroa* to the South Island and ensure its freedom for as long as realistically possible. The surveillance objective in the North Island is to monitor spread of *Varroa* in order to provide beekeepers with information upon which management decisions can be based, and in the South Island to verify freedom from *Varroa* and provide early detection. The combined costs of the two-year programme are \$7.7 million.

To ensure a smooth transition from government assisted to industry only management, the development of a long-term management programme based upon integrated pest management has commenced. MAF Biosecurity Programme Co-ordinator – *Varroa* facilitates the pest management strategy development process, as established by the Biosecurity Act Part V, with appropriate consultation with the National Beekeepers Association, other industries and government departments. This may or may not result in a decision to proceed with a national pest management strategy.

## Reference

- (1) Anderson DL. Variation in the parasitic bee mite *Varroa jacobsoni* Oud, *Apidologie* 31, 281-92, 2000.

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