REPORT TO THE TWENTY-FOURTH LEGISLATURE
REGULAR SESSION OF 2008

Report on the Study, Control and Mitigation of the Bee Mite Infestation

Prepared by:

THE STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
DIVISION OF PLANT INDUSTRY
PLANT PEST CONTROL BRANCH

In response to proviso in ACT 213, SLH 2007, section 10

December 2007

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PURPOSE:

Act 213, SLH 2007, provided for a $650,000 appropriation for Plant, Pest, and Disease Control (AGR 122) to control and treat the infestation of the Varroa mite. The proviso in Section 10 of ACT 213 stated:

"Provided that of the general fund appropriation for plant, pest, and disease control (AGR 122), the sum of $650,000 or so much thereof as may be necessary for fiscal year 2007-2008 shall be expended to study, control, and mitigate bee mite infestation in the state; provided further that the department shall prepare a report that shall include but not be limited to the status of the bee mite infestation and steps to control and treat the infestation; and provided further that the department submit the report to the legislature no later than twenty days prior to the convening of the 2008 regular session."

This report is provided to meet the conditions of the proviso.

BACKGROUND:

Origin of varroa mite.

Varroa mites (*Varroa destructor*) originated in southeast Asia where they are parasites on the asian honeybee, *Apis cerana*. The mites and the asian honeybee coexist well, with the mite rarely causing death of honeybee colonies.

In 1963, the mite jumped to hives of the european honeybee, *Apis mellifera*, which were being kept in managed bee hives by beekeepers in the area. The mite then rapidly spread to the Philippines, Japan, Vietnam, and Russia through movement of bees by the beekeeping industry. As *Apis mellifera* had not evolved with this mite, it had not developed resistance as had *Apis cerana*. The result was massive die-offs of bee colonies throughout the world. The mite has continued to spread and can now be found in Asia, Europe, North and South America, Africa, New Zealand, and most recently Hawaii. Australia is currently the only area free of varroa mite.

Impact of varroa mites on bees and beekeeping.

Adult varroa mites are tiny 1-1.5 mm reddish-brown, crab-shaped, flattened mites. They are external parasites which attack adult honeybees, larvae, and pupae. They use their piercing-sucking mouthparts to feed on the haemolymph (blood) of bees. The life cycle of the varroa mite is synchronized with that of the honeybee. The female mite lays eggs in developing bee brood comb cells. After hatching, the developing mites feed on the honeybee larvae. The pregnant adult female mites emerge from the cells along with their bee host and seek another cell to repeat the cycle. The mites can only reproduce on honeybee brood (larvae and pupae) and not on other species of insects. Severe

infestations of the mite will cause malformed adult bees, decline of bee colonies, and if not treated, eventual death of the colony. The mites disperse from hive to hive by hitchiking on adult honeybees and in this way can infest mite-free hives. Although varroa mites have been seen on other insects, this occurs only after these insects have visited flowers that were recently visited by an infested honeybee. The mites can only survive for about 5 days when not in contact with honeybees.

Figure 1. Varroa mite on adult honeybee.

The mite's negative effect on honeybees comes about either by feeding on the haemolymph of the adult or by feeding on the bee brood in the cells. The direct effect from blood feeding on adults due to loss of blood appears minimal but has the potential to vector virus diseases which could be more serious. The effect of mite feeding on the brood has been shown to cause decreased body weight of bees, deformed wings, smaller royal jelly-producing glands, reduced lifespan of adult bees, and the introduction of pathogenic viruses. According to the Ministry of Agriculture and Forestry in New Zealand, their experiences, in general, show that the effects on individual bees can result in a rapid reduction in the number of adult bees in a colony, abnormal brood, and hive abandonment by the bees. The final outcome, unless a treatment is used to reduce mite populations, is usually colony death. However, when mite populations are monitored and treated properly, pollination and honey production are rarely affected.

Varroa mite populations can gradually increase in a bee colony throughout the year without causing any noticeable effects. Studies in Russia, the mainland US, and Canada have shown that honey production is not significantly different among colonies with different levels of mite densities ranging from 7-33%. However, after honey production, beekeepers that did not treat their hives for mites experienced greater losses of hives through the winter than those that did treat for mites. The greatest recent losses occurred during the 1995-1996 winter, which was exceptionally long. Beekeepers that did not treat their hives for mites lost between 30-50% more hives than those that did treat.

There has been little research on the effects of the mite on pollination. There is no doubt that feral (wild) hives have decreased in areas after the mite has become

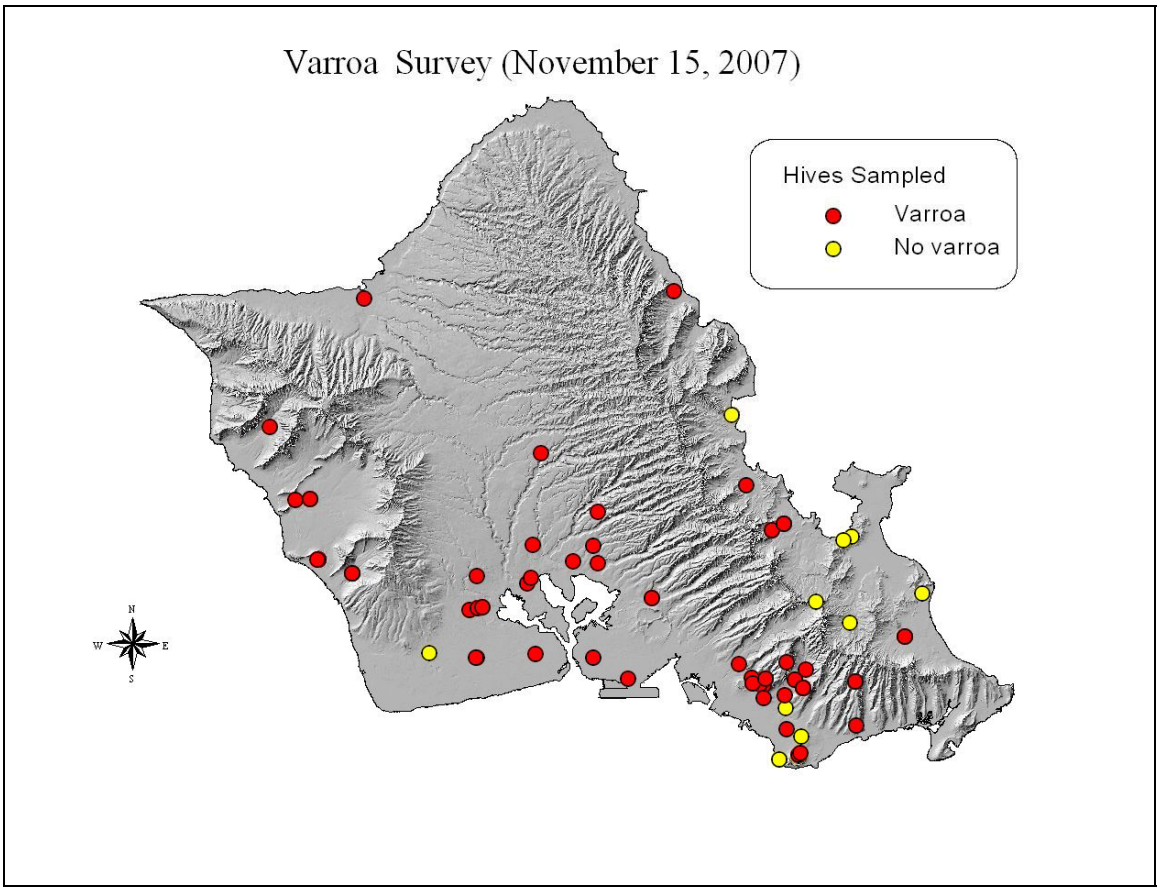
established but the numbers vary. It is estimated that up to 90% of the feral colonies died off in southern Florida and about 75% in California. However, the mite has not eliminated feral bees in areas it has invaded and the number of feral colonies has begun to increase in some areas after the initial decline. In areas that rely on managed honeybee colonies for pollination, the impact of the mite has been minimal due to the effective control of the mite by the beekeepers, although at an increased cost to the beekeepers. We don't know of any research on the impact of the loss of feral bee populations in areas that rely on feral bees for pollination but expect that the impact could be significant.

Varroa in Hawaii.

Varroa mites were first found in Hawaii in April 2007 in a beekeeper's managed hives in Makiki, Oahu. To this day, we do not know how the mites arrived into the State. The Hawaii Department of Agriculture's Plant Pest Control Branch (PPC) responded to the sighting by working with the beekeeper to destroy the infested hives. Concurrently, PPC initiated delimiting surveys (i.e., surveys designed to determine distribution of a pest) throughout Oahu which were expanded over the following weeks to the islands of Hawaii, Maui, Molokai, Lanai and Kauai. The purpose of these surveys was to determine the extent of the varroa mite infestation in the State. These surveys included the collection of data on mite distribution, rates of infestation, backtracking to determine origin of the infested hives, and forward tracing to determine where infested hives were moved to. All feral hives that were found infested with mites were destroyed. HDOA recommended to beekeepers that they destroy their infested hives. Not all did and HDOA worked with those beekeepers to control the mite infestation.

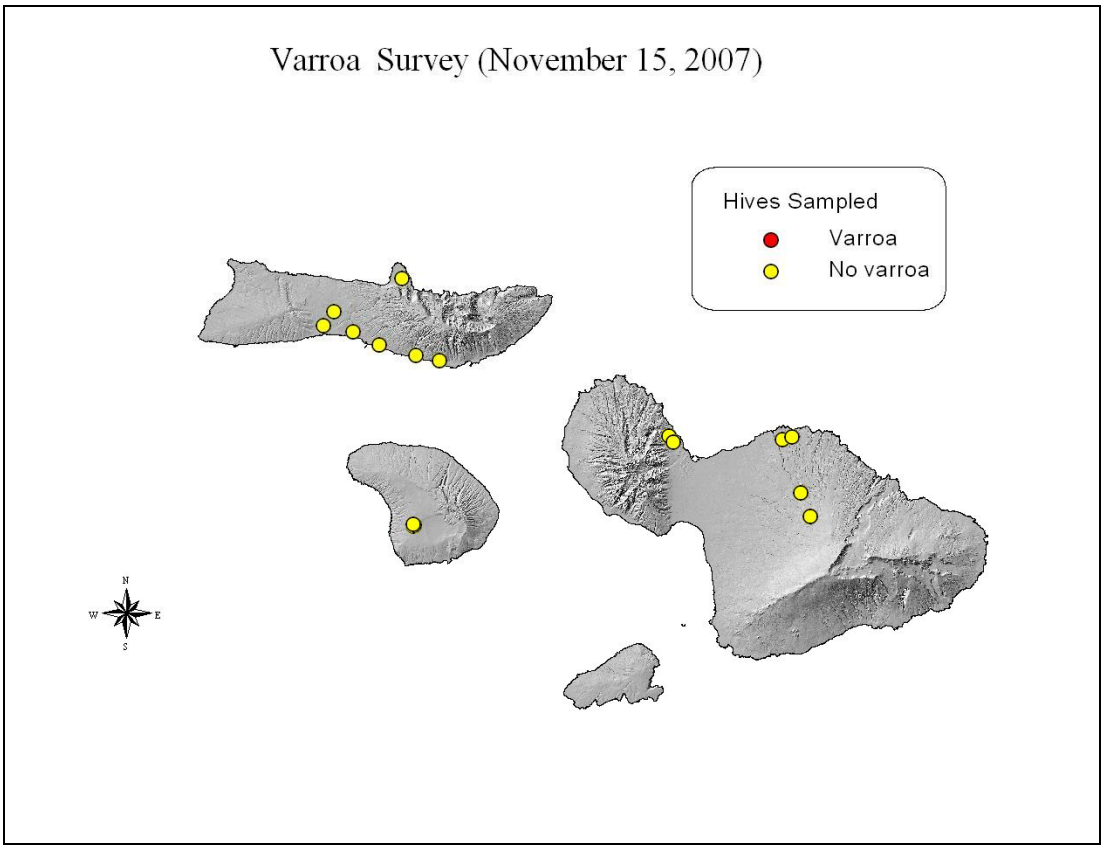
Figure 2. HDOA surveys managed hives.

Figure 3. Surveys of feral hives



These surveys continued over the following months and demonstrated that the mite was restricted to the island of Oahu. No varroa mites have been found on any other islands.

The surveys also showed that at the time of the first find in April 2007, the mite was already widely distributed throughout Oahu including in feral bee hives. These survey results demonstrated that the mite had already been on Oahu for at least a year and likely longer. Due to its wide distribution throughout the island and its prevalence in the majority of sampled feral hives, it was apparent that eradication was not a viable option. Eradication of the mite would require the destruction of every managed and feral honeybee hive on Oahu. The survival of one feral hive, inadvertently missed in an eradication program, would allow for the survival and eventual spread of mites throughout the island as that missed colony split off and spread to form new colonies. There are no tools or techniques available for the removal of the thousands of feral bee hives in the Koolau and Waianae mountains that would not also have a catastrophic effect on native insects and other biota. An effective tool such as poison baiting would kill honeybee hives as the foraging bees bring the poisoned bait back to the hive, however, other native insects would also be attracted to the bait as well as to the tainted honey and dead bees in the killed colonies.


Varroa Survey (November 15, 2007)
Hives Sampled
Varroa
No varroa
N
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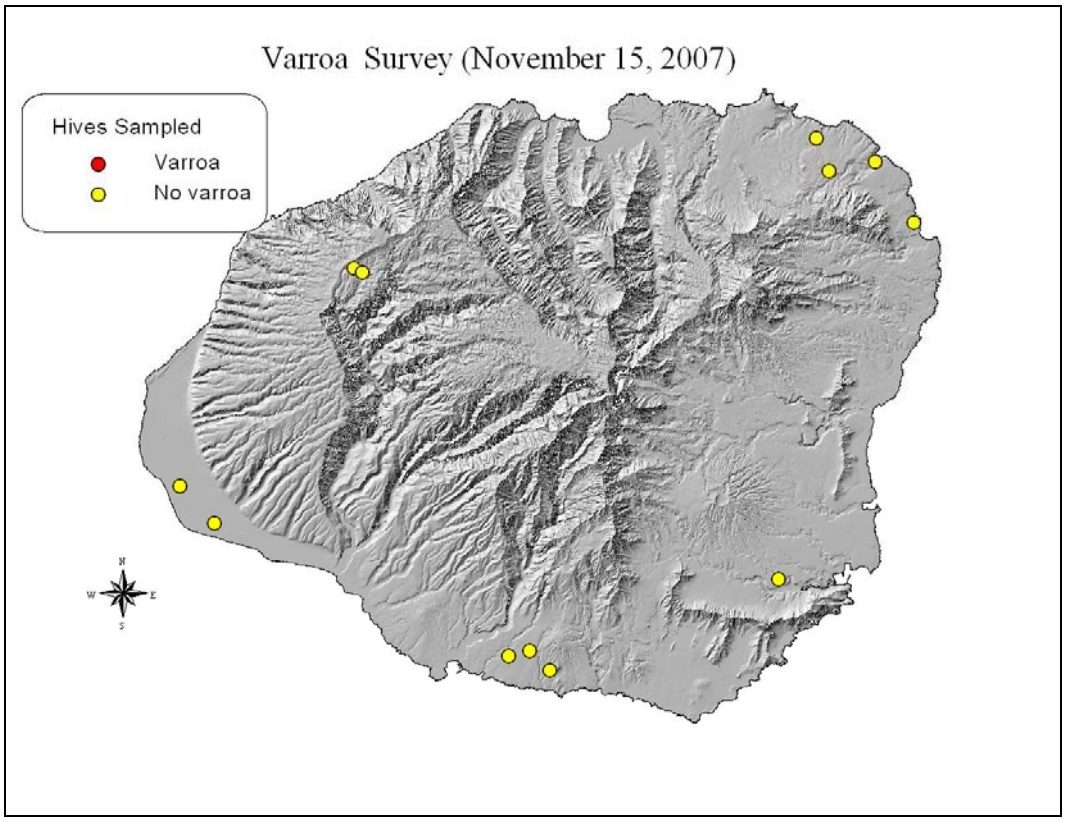
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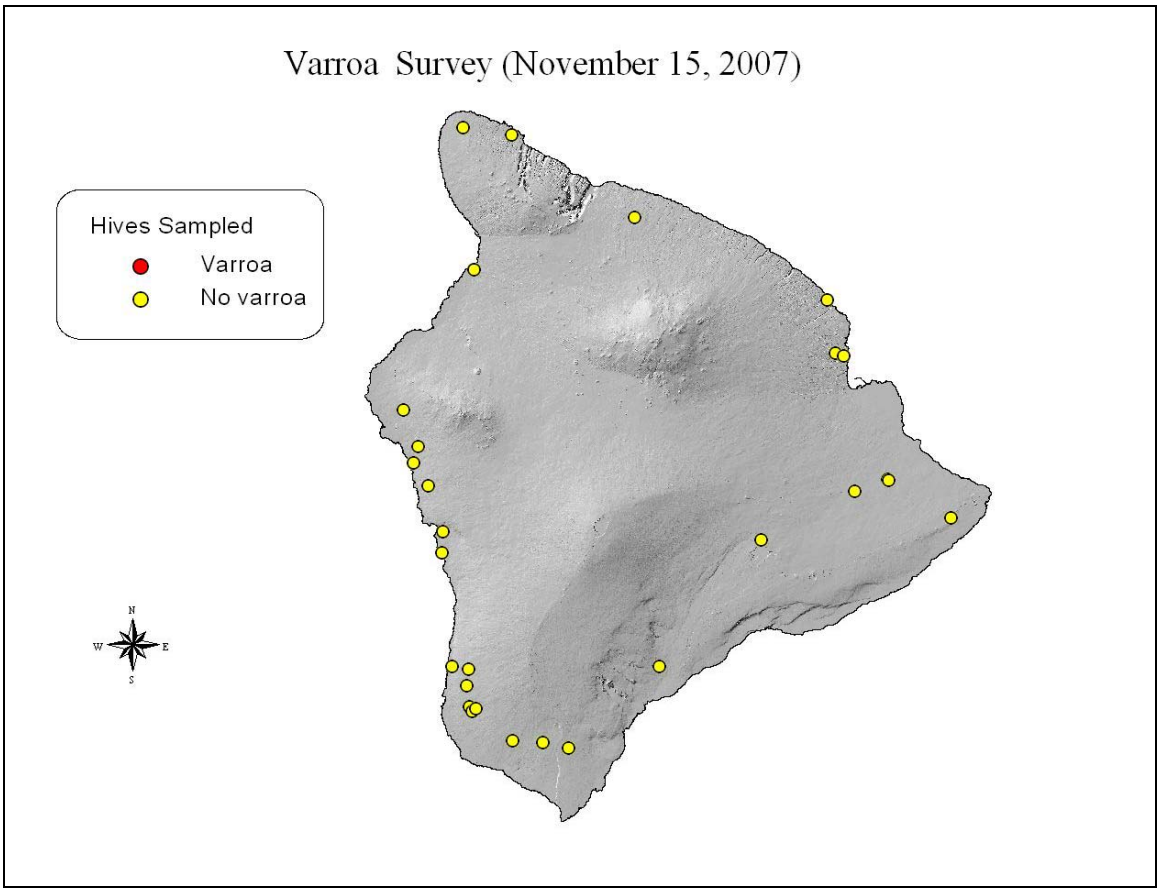

The impacts that varroa mites will have in Hawaii are unknown. The Hawaii Department of Agriculture (HDOA) conducted a preliminary assessment on the potential impacts of the mite on agriculture production (**Attachment 1**). The results were that crops known to depend on bee pollination had a farm gate value of $30.6 million and that the total loss of bee pollination could reduce this to $15-20 million. Statewide, the farm gate value of $126.3 million for bee dependent crops could be reduced to $64-84 million. Again, this is if all pollination by bees were eliminated, which is an unlikely scenario since bees have not been eradicated by mites anywhere in the world. The reality is that the farm gate value would be reduced for those farmers that rely on feral bees for pollination but not for farmers that manage bees or pay for pollination services. Mite infestations in these managed bees could be controlled to allow for pollination of the crops. This economic assessment was very preliminary and HDOA is currently developing a more in-depth economic analysis.

The majority of Oahu beekeepers are hobbyists, a few produce honey for sale, and a couple provide pollination services to farmers. It is estimated that there are anywhere from 600 to 1,000 managed hives on Oahu. The exact number is not known because beekeepers are not regulated in Hawaii and there is no organization that formally represents every active beekeeper in the state. Managed hives on Oahu are spread throughout the island and are managed by many different beekeepers. Most are

hobbyists and do not associate with other beekeepers or beekeeping associations. There are fewer hives on the other islands compared to Oahu, the exception being the Big Island. The heart of Hawaii's beekeeping industry is in Kona where some beekeepers have up to 3,800 hives for honey production. Four other Big Island beekeepers have thousands of hives each and are major suppliers of queen bees for the rest of the state, the mainland, and internationally. The establishment of the mite on the Big Island would cause economic hardship for most of the beekeepers, in particular for the queen producers and organic honey producers. The exact figure for the value of the Kona queen bee industry is not known but it is estimated to be a multimillion dollar business which has created many jobs in the region. The impact of the mite on the queen bee industry could be devastating causing some queen producers to go out of business.

OBJECTIVES:

HDOA has developed a strategy to address the mite infestation in the State with the goal of preventing the mite from moving off of Oahu and from becoming established on other islands. A draft of this strategy was presented to the 2007 Legislature as part of a budget breakdown (**Attachment 2**). This was revised and presented as a draft plan to beekeepers in June 2007 (**Attachment 3**). The objectives of this plan are to:

1. Contain the mite on Oahu
2. Reduce mite populations on Oahu
3. Detect and respond to infestations on mite-free islands.

Containment on Oahu

Containment of the mite on Oahu is being accomplished through quarantine action, port buffer zones, and monitoring and detection surveys.

Quarantine:

At the time of the discovery of varroa mites on Oahu in April 2007, it was illegal to bring into the State any live or dead honeybees or used bee equipment that was not certified by the department to be free of pests. However, there were no laws in place to prevent the movement of bees or bee equipment from one island to another or throughout an island. It was apparent that such a law was needed to help prevent the movement of mites from Oahu to uninfested areas in the State. On August 28, 2007, HDOA established an interim rule, valid for one year, which prohibits the intrastate movement of any live or dead honeybees and used bee equipment from Oahu or any island or island area infested with varroa mite (**Attachment 4**). Violation of the rule will result in a misdemeanor with a fine of $100 to $10,000 per violation. A second violation will result in a fine between $500 and $25,000. The interim rule is valid for one year which will allow time for HDOA to establish a permanent rule. The rule is enforced by the Plant Quarantine Branch (PQ) within HDOA through inspections at ports. In addition, PPC has informed all known beekeepers in the State of the rule.

Bee-free Buffer Zones at Ports

HDOA has established bee-free buffer zones around all air and sea ports on Oahu. USDA Plant Protection and Quarantine personnel are assisting us in setting up and maintaining these buffer zones. The purpose of the buffer zones is to reduce the risk that individual honeybees or bee swarms will enter aircraft or ships and be transported to other islands. We are currently creating a one-mile buffer by eliminating all honeybees in the buffer zone and intend to expand this to a three-mile buffer. This is being accomplished through the removal or destruction of all feral bee hives, relocation of all managed hives, and outreach and education of port authorities and workers.

Removal or destruction of feral hives first requires finding the hives. They can occur in buildings, under eaves, in hollows of trees, and many other hidden locations. The hives are currently being found through visual surveys in the area, placement of swarm traps, and by reports of hives and swarms from port authorities, port workers, and the public through the pest hotline. Upon identification of a feral hive location, staff will collect samples for laboratory testing and, if possible, remove the hive. The colonies are tested for the presence of varroa mite, tracheal mite, tropilaelaps mite, Nosema disease, africanization (aka killer bees), and any other bee pests. Hives that are free of these pests are kept by PPC for research purposes or made available to beekeepers. All hives with any of these pests are destroyed. The goal is to have no honeybees present in the buffer zone.

Figure 4. Removal of feral colony in hollow tree

As it is extremely difficult and inefficient to find all feral hives by visual surveys, PPC has been experimenting with toxic baits which can be placed in an area to kill all hives. Using this method, we would not need to know the location of the hives as the bees will bring the poison back to the colony. These baits are composed of an attractant and a toxin which are consumed by foraging bees and brought back to the colony and fed to the other worker bees, larvae, and queen. An effective toxicant cannot have any repellant effects to the foraging bees and needs to be fairly slow acting so that it will not kill the honeybee before the bee has had time to pass the toxin on to other bees. We are currently researching the best delivery methods and toxicants to use to get the most

effective results. We will also be monitoring any secondary effects that the baits may have on non-target insects which may be attracted to the bait or to the dead bees or honey in the dead hive. This may not be as important around port areas but will be critical in areas where native insects and arthropods are present.

In addition to the above methods, swarm traps are also being placed in these buffer zones to catch any swarms that move into the area or colonies in the area that are moving or splitting. The swarm traps are composed of a bucket or box with an attractant inside. We are using synthetic Nasonov gland pheromone as an attractant. Worker bees produce Nasonov pheromone as an assembly pheromone. We check these traps on a periodic basis to see if any honeybee swarms have taken up residence in the trap. All captured colonies are removed from the buffer zone, brought back to the lab, frozen, and tested for varroa and other pests.

Figure 5. Placement of swarm trap.

Data from all honeybee colonies removed from the buffer zones is entered into the PPC survey database.

Oahu Surveys

Surveys are being conducted on Oahu to determine the distribution and density of varroa mites throughout the island and to detect any new pests that are not known to occur on Oahu or in Hawaii. These surveys are being carried out by PPC staff and by beekeepers. Anyone who calls PPC or the Pest Hotline is given a list of beekeepers that are working with PPC on this survey. The caller can then call the beekeeper of

their choice to remove the bees from their property. The beekeepers on the list have agreed to collect samples of bees and brood comb, following PPC's protocol, and to submit the sample to PPC where they will be analyzed in the laboratory. The data are also entered in the survey database. PPC responds to calls on public property or if no beekeepers are available to respond.

There are a number of other honeybee pests that are not known to be in Hawaii that these surveys are also testing for, besides varroa mites. Some of these pests are just as damaging or more serious pests to honeybee colonies than the varroa mite. These include tropilaelaps mites (*Tropilaelaps clareae)*, tracheal mites (*Acarapis woodi*), small hive beetle (*Aethina tumida*), and africanized honeybees. The trapping and survey methods are the same for all of these but differences occur in the laboratory procedures to process the survey samples. The tropilaelaps mite is an external feeder on honeybees. Tracheal mites are internal feeder and occur in the trachael tubes (ie. lungs) of the honeybee. These require the dissection of each bee to find the mites within the tracheal tissue. The small hive beetle is an external feeder within the hive of the bee. Determination of whether a hive is africanized bees (ie. Killer bees) is determined by taking very precise measurements of various body parts for 100 bees and comparing this with the average measurements for european honeybees.

Figure 2. Tracheal mites

Figure 3. Varroa and Tropilaelaps mites

Figure 4. Small hive beetle

The results to date for these surveys and laboratory testing are that none of these other pests have been detected in Hawaii and the varroa mite is restricted to Oahu.

We have also found that 76% of honeybee hives we sampled are infested with varroa mites. There was no difference between feral hive and managed hive infestation rates. We could also find no difference in the density of mites in feral hives vs. managed hives indicating that we need to work more with the beekeepers so they can more effectively suppress mites in their hives.

Surveyed hives on Oahu (Number of hives)		
	Varroa present	no Varroa
Feral colony	40	14
Managed hive	53	15

These surveys will continue throughout the project period.

Suppression of Oahu Mite Population

The second objective of the project is to suppress or reduce the population of mites on Oahu. The rational is that lower mite densities on Oahu will reduce the risk of mites moving off island to other uninfested islands. HDOA has determined that eradication is not feasible on Oahu due to the wide-spread nature of the infestation and the fact that the mite is prevalent in the feral bee population throughout Oahu. The suppression strategy differs between managed hives and feral hives.

Managed Hives

HDOA has stressed that beekeepers need to be diligent in their efforts to suppress mites in their managed hives. HDOA's role has been and will continue to be supportive of these efforts through the registration of pesticides, distribution of pesticides, bottom boards, and other mite suppression materials. HDOA will provide a list of pest control operators that can exterminate bee colonies and will train beekeepers to use these tools, as well as provide compensation for destroyed colonies, colony replacement, and education.

When varroa mites arrived in Hawaii in April 2007 only one pesticide was registered and licensed for use in Hawaii. In order to be legally used in Hawaii, all pesticides must be registered by the Environmental Protection Agency and licensed in Hawaii by the HDOA Pesticides Branch. Apistan (fluvalinate) was the only product that met these requirements at that time. HDOA has since been working with the various pesticide manufacturers to secure additional legal pesticides to increase the options for the Hawaii beekeepers (**Attachment 5**). Varroa mites on the mainland have already shown some resistance to Apistan. The varroa in Hawaii may already be resistant but if not, will rapidly develop resistance if only one pesticide is being used. Since April 2007, HDOA has been able to secure the registration and licensing of three additional pesticides. These are Mite Away II (formic acid), ApiLife VAR (thymol), and ApiGuard (thymol). HDOA is working on two other compounds, Sucrocide (sucrose octanoate esters), and Check Mite (coumaphos).

HDOA has been working with Oahu beekeepers to suppress varroa by supplying them with licensed pesticides and sticky bottom boards. The bottom boards are a passive control technique. They work by capturing mites that happen to fall onto the glue after passing through a screen, thus removing many mites from the hive. The boards will not remove all mites from a hive but are an additional tool for the beekeepers to reduce the mite populations in their hives. The boards consist of a sticky cardboard insert covered with a screen mesh. The screen mesh prevents honeybees from getting stuck in the glue but allows the mites to pass through. HDOA trains the beekeepers in their use when we distribute them. We have also requested that used sticky sheets from the bottom boards be returned to HDOA so that we can inspect them to assess changes in varroa population levels and to assess whether any other pests may be present in the hives. This assessment of pests on the bottom boards supplements the other survey programs we have on Oahu.

Figure 5. Screened bottom board.

At times these suppression techniques may not work and HDOA has been working with beekeepers to encourage them to destroy heavily infested bee hives. We are in discussions with beekeepers to develop a compensation and colony replacement program. The colony replacement program was proposed by Oahu beekeepers. It is envisioned to be an endeavor by a private entity with HDOA acting as a facilitator and advocate of the project. The premise behind the program is that there needs to exist in the state the capacity to restock existing colonies that decline or die out due to mite infestations. This capacity does not currently exist. The project would establish a honeybee production facility in a mite free island or zone that can meet this need. This idea is currently in the discussion and planning stage. A project proposal developed by Hawaii beekeepers was shared with HDOA (**Attachment 6**).

HDOA is currently in discussions with USDA for their support in developing an area-wide strategy for varroa mite suppression in the State. These discussions are preliminary at this point but we anticipate federal support in the near future.

Feral Hives

HDOA has been working in a search and destroy mode with respect to feral hives in and around port areas on Oahu. This was discussed in more detail above under “Bee-free Buffer Zones at Ports”. Our goal with respect to feral hives is to remove all feral hives from port areas and to reduce the number of feral hives throughout the rest of the island. The absence of bees in the port areas will reduce the pressure and risk for the mites to move on honeybees to mite-free islands.

Calls to our Pest Hotline (643-PEST) by the public have been very helpful in finding these feral hives. We have been participating in television and radio interviews to get the message out. We have additionally distributed informational material (**Appendix 7**) and set up a page on our department website that is dedicated to the varroa mite (http://www.hawaii.gov/hdoa/pi/ppc/varroa-bee-mite-page).

Detection and Response on Mite-free Islands

Varroa mites have only been found on Oahu. All other islands are apparently free of the mite. There will always be some risk for the movement of mites from Oahu or from the mainland to a mite-free island despite the best quarantine systems and strategies. HDOA's objective is to prevent the establishment of mites on the mite-free islands through an early detection and rapid response strategy should they arrive there despite our best efforts. This involves the early detection of mites in these areas through collaboration with beekeepers. A second component is to respond immediately to all detected infestations before they have had a chance to spread and become well-established and widely distributed.

Detection in Commercial Hives

HDOA is working with all beekeepers to ensure that their hives are being adequately surveyed for the presence of varroa mite and other honeybee pests. There are three techniques being currently used. These are the 500-bee alcohol shake method, brood comb scrape method, and bottom board capture method.

The 500-bee alcohol shake method involves collecting approximately 500 adult worker bees and placing them into a liter jar with ethanol. The bees are then vigorously shaken for one minute to dislodge any mites that might be present. The contents of the jar are then passed through a series of filter meshes of different sizes to sort out the bees from the mites. The number of mites found is then counted. In addition to determining the presence or absence of mites, the technique also gives estimates on the density of mites in the hives. This data can be used to assess the density of mites in areas and the effectiveness of treatments to determine if mite suppression is successful.

At the time that the 500-bee sample is taken, we also sample the drone (male) brood comb for varroa mite by removing the caps on 100 drone brood cells and visually search for the brown mites on the white drone pupae. Varroa mites prefer to feed and develop on the drone brood and will reach the highest densities in the hive in these cells, making it an effective tool for discovering mites in hives, even when the mites are at relatively low densities.

A third technique for the detection of mites is through the use of bottom boards. Bottom boards are white cardboard sheets that are covered with glue to capture mites. There is a screen mesh above the glue that allows mites to pass through but is too small for the larger honeybee. These boards are placed on the bottom of the hive and capture any mites that fall. This method is a useful detection tool but has limited effectiveness for controlling mites. HDOA has begun distributing these to all beekeepers on mite-free islands. Our goal is to place these in all hives for bee yards with 10 or fewer hives and in 10% of the hives for bee yards with more than 10 hives. The boards are left in the hives for 48 hours, removed, and returned to HDOA for analysis. Each beekeeper is expected to repeat this procedure 4X per year.

Bee-free Buffer Zones at Ports

Bee-free buffer zones at the ports on mite-free islands decrease the risk of establishment of mites from other areas. Any infested bees that arrive at the port will not have an accessible honeybee colony to infest with mites. The goal is to create these buffers on other islands as is being done on Oahu. USDA/APHIS/PPQ officers and technicians are working with us to place swarm traps and survey for feral colonies at ports on Kauai, Maui, and the Big Island.

Response Preparation

In the event that the varroa mite does appear on a mite-free island, HDOA needs to have a rapid, coordinated effort with the beekeepers to eradicate the infestation before it can become established and spread. To this end we have been collaborating with the beekeepers, ensuring that supplies and equipment are available, have developed a Varroa Mite Response Plan (**Appendix 8**), and contacted Pest Control Operators (PCO) to secure a list of PCO's that have the capability to exterminate honeybee hives.

Expenditures

The budget for the $650,000 allocated by the Legislature was sent to the Legislature in May 2007. The funding was separated into five project areas (Appendix 2). These were:

1. Detection and Monitoring Survey Program ($350,000)
2. Pest Management Program ($140,000)
3. Colony Recovery Program ($125,000)
4. Inter-island Quarantine Program ($5,000)
5. Public Awareness Program ($30,000)

Expenditures to date have totaled $85,580 and have been for the first two program areas, detection and pest management. The money has been spent for the purchase of monitoring and survey equipment, supplies, and safety gear to conduct the surveys needed to determine distribution and spread of the mite. Expenditures for the pest management program have been for the purchase of chemicals and equipment that HDOA is supplying to beekeepers to manage infestations of mites in their colonies as well as using ourselves in our operations. We have not spent money on the colony recovery program. An inter-island quarantine has been established without the expenditure of the estimated $5,000. Public outreach to date has included the addition of a varroa mite page to the HDOA website that updates the viewer on current status. We have also been conducting media outreach through television and radio to inform the public about the problem and to educate them to call the pest hotline to report bee swarms.

Although it has not yet been encumbered, HDOA will be spending approximately $52,000 on an economic assessment of the impact of the varroa mite on the agriculture industry. This assessment will be conducted by the Agricultural Development Division.

One of the difficulties in the implementation of these programs has been the small staff available in the Plant Pest Control Branch to conduct the work. We are in discussions with Research Corporation of the University of Hawaii (RCUH) to use these funds to hire postdoctoral researchers, graduate students, and field laborers to research better control methods, conduct additional surveys, remove feral colonies, and set and monitor swarm traps throughout the state.

ATTACHMENTS

Attachment 1. HDOA preliminary economic assessment.

Acreage of Pollinator-Dependent Crops for Oahu: Preliminary (June 22, 2007)
Estimated Based on Statistics of Hawaii Agriculture 2005

		Vegetables	Herbs	Fruits		Coffee	Macnuts	F&F	Seed	
Snap Beans		75		Avocados	50					
Chinese Cabbage	Seed			Guava	171					
Head Cabbage	Seed			Papaya	130					
Cucumbers		230		Tropical Specialty	221					
Eggplant		70								
Lettuces	Seed									
Green Onions	Seed									
Green Peppers		128								
Romaine	Seed									
Italian Squash		73								
Sweetpotatoes	Seed									
Tomatoes		367								
Watermelons (2004)*		384								
Bittermelons		17								
Broccoli	Seed									
Burdock	Seed									
Cabbage, Mustard	Seed									
Pumpkins		19								
Radish	Seed									
Squash, Oriental		22								
Output Pollinator Dependent		**1,384**	**-**	**-**	**573**	**-**	**-**	**-**	**-**	**1,958**

Notes:
- F&F: Flowers & Folliage
- Seed: Certain vegetable crops may be propagated using in-farm seed production, which would benefit from bee pollination
- *: 2004 data.

HDOA, ADD, MANB

Preliminary Estimates of the Added Value to Crop Production by Bee Pollination
Based on 2005 Output Value
DRAFT (June 22, 2007)

		State	Oahu
		$million	*$million*
1	**Total production (farm gate) value of fruits, vegetables and melons, herbs, macadamia, and coffee**	**183.8**	**44.57**
2	**Total production (farm gate) value of crops known to depend on bee pollination**	**126.3**	**30.63**
4	**Upper Limit Added Value by Bee Pollination:**	**62.40**	**15.13**
5	**Lower Limit Added Value by Bee Pollination:**	**41.86**	**10.15**

NOTES:
a. These upper and lower limit estimates are based on crops reported in the *Statistics of Hawaii Agriculture* only.
b. Parameters used for the upper and lower limits are the estimated variations based on pollination studies by various authors with varying conclusions.
c. Different rates of bee pollination contribution to yield for individual crops are considered.
d. Crops that are known to attract bee for pollination, but unknown for how much bee pollination contributed to yield take the average of the crops with bee pollination contribution rates.
e. The cattle industry is also benefitting from bee pollination of its feed crop, *kiawe*. Kiawe beans are highly nutritious and have been used for cattle feed widely in the first half of the 20th century. Actually, bees were first imported into Hawaii to support the cattle industry. Today, only some cattle ranches with Kiawe trees still use kiawe beans for feed.
f. Flowers and folliage are not included in the estimate because it is unkown how much of them rely on seeds produced in Hawaii, which would benefit from bee pollination.
g. Still, numerous vegetable and fruit crops grown in Hawaii that are not reported in the *Statistics of Hawaii Agriculture,* either to avoid disclosure of individual operations or they are still not widely commercialized, that depend on bee pollination are not included in the estimates.
h. Many varieties of backyard fruits and vegetables, with unknown market values, would also be affected by the varroa mite infestation.
i. Many wild plant species would also be affected if bee population is reduced substantially by the varroa mites, which would in turn affect the natural flora and fauna, and possibly the water supply.

June 22, 2007
HDOA, ADD, Market Analysis and News

Attachment 2. Budget plan presented to legislature in May 2007.

Background:

The mite, *Varroa destructor*, was previously not known to occur in Hawaii until it was first found in the State on Oahu on April 5, 2007. The Department of Agriculture (DOA) responded immediately to this discovery by sending staff to sample the hive to verify the find. After the presence of the mite was confirmed, the next objective was to discover the extent of the infestation in the State. If the infestation was limited, it may have been possible to eradicate the mite from Hawaii. After destroying the infested hive, DOA staff conducted extensive surveys of commercial, backyard, and feral hives throughout Oahu. These island-wide surveys indicated that the mite was already widely distributed throughout Oahu. The wide distribution in feral colonies eliminated the possibility for eradication of the mite from the island of Oahu. DOA is continuing to sample hives throughout the State to determine the density of mite infestations and possibly the origin of the initial infestation. The sampling by DOA is not limited to *Varroa* mite but also includes sampling for two other mites not known to occur in the State.

Surveys for the mites have also been conducted on Kauai, Maui, Molokai, and Hawaii. The surveys on the other islands are not completed but to date have all been negative for the mites. All four of Hawaii's queen bee exporters, which are in the Kona area, are free of the mites. Based on the preliminary results, it is assumed that the *Varroa* mite is currently restricted to Oahu.

Short Term Plan:

1) Contain the *Varroa* mite on Oahu by preventing its spread to other islands. Based on data we have to date, DOA is in the process of implementing an interim rule that will establish an inter-island quarantine to prevent the movement of honeybees and bee equipment off of Oahu. This quarantine should contain the mite infestation to Oahu as it is unlikely that infested bees could fly to another island. The interim rule will be effective for one year and will be followed with a permanent rule as detailed in the long-term plan;
2) Complete surveys on all islands. The purpose of these surveys is to:
    a) ensure that the other islands are free of *Varroa* destructor and if not assess the potential for eradication for the island;
    b) ensure that all islands, including Oahu, are free of other mites and other honeybee pests that are not known to occur in the State;
    c) determine infestation rates and distribution of *Varroa* destructor on Oahu.
3) Determine which pesticides are legally available in the State and to secure licenses for their use in Hawaii to control mite infestations.
4) Work with University of Hawaii extension and honeybee keepers in the State to educate them on current tools available to manage mite infestations.

Long Term Plan:

Based on DOA's experience with honeybees and conversations with researchers in Canada, US, and New Zealand who have worked with honeybees and *Varroa* mite, it is believed that the mite cannot be eradicated from Oahu at this point but can be contained on the island. Beekeepers on Oahu will need to manage their hives to keep the mites at low densities so that they can economically produce honey and pollinate crops.

DOA's long term plan is to quarantine Oahu by implementing and enforcing an inter-island quarantine that would prevent the movement of honeybees and used bee equipment from Oahu to other islands. We also plan to develop a honeybee pest and disease survey and monitoring program, a bee pest management program, a colony recovery program, and a public awareness program. We plan to create an Advisory Panel composed of HDOA personnel and commercial beekeepers to discuss and collaborate on the refinement and implementation of this plan.

These programs will be funded by this appropriation from the Legislature and supplemental federal funding. To date, all survey and control efforts have been funded with federal grant money that was received specifically for this purpose.

The $650,000 appropriated by the Legislature will be used by the Department of Agriculture for:

1) Detection and monitoring survey program - $350,000
2) Pest Management Program - $140,000
3) Colony Recovery Program - $125,000
4) Inter-island Quarantine Program - $5,000
5) Public Awareness Campaign - $30,000

These can be broken down as follows:

1) Detection and Monitoring Survey Program - $350,000
   This program will involve the continuation of the ongoing efforts at detection and monitoring for the mite pests of honeybees on all islands. We would like to expand this to include the detection and monitoring for other pests and diseases of honeybees which could have as devastating or an even greater effect on the bee industry as the *Varroa* mite does. This program will require money for inter-island travel for surveys, mainland travel for training of Department of Agriculture staff and University of Hawaii extension agents at the United States Department of Agriculture (USDA) bee research lab in Maryland, to learn to identify different pests and diseases and hive management and pest control techniques which can be passed on to local beekeepers by HDOA staff and extension agents. The training will also include a program that will certify HDOA as apiary inspectors. We currently certify Kona beekeepers which export queens but do not have any staff that is officially certified by USDA for apiary inspections. The training will be a week-long course conducted by USDA bee lab trainers on the mainland and is estimated to cost $6,000 for 12 individuals, including airfare, per diem, and other training expenses. Equipment and supplies for lab and field work will be required to carry out the detection and monitoring.

Costs:	Interisland travel:	38,000
	Equipment:	90,000
	Supplies:	150,000
	Training:	72,000

2) Pest Management Program - $140,000
   This program will be based on discoveries from the survey activities. Infested hives will need to be either treated, pests managed or hives destroyed. This money will be used for the purchase of chemicals, supplies, equipment used to help the beekeepers, and registration/licensing of new chemicals. Currently only one product is licensed for use in Hawaii.

3) Colony Recovery Program - $125,000
   This program will be set up to aid the beekeeper in the recovery of destroyed hives. Replacement of a queen and workers costs about $50. Replacement of 2,500 hives will cost approximately $125,000.

4) Inter-island Quarantine Program - $5,000
   The establishment of an inter-island quarantine will be accomplished by establishing a permanent rule. This will need to go through a public hearing process which typically costs $5,000-$8,000. Costs over $5,000 will be covered by other funding sources within the Plant Quarantine Branch.

5) Public & Industry Awareness Campaign - $30,000
   The effectiveness of quarantine will be dependent on the awareness of the public and the beekeepers about the requirements of the quarantine and the knowledge that bees should not be moved from one island to another. DOA and the HBA will work closely on this campaign as its success will directly affect the success of the other programs.

Attachment 3. Draft plan presented to beekeepers on June 20, 2007.

Varroa Mite Plan (draft)
6/20/07

I. Oahu Infestation

Extent of Infestation:

Surveys on Oahu have demonstrated that the mite is widespread throughout the island. Infestations have been found in managed colonies as well as feral colonies. Based on its wide distribution and infestation levels in hives, it is estimated that the varroa mite has been present on Oahu for at least one to two years. The Australia bee pest plan for eradication and control determined that an incursion undetected for more that 2 weeks is most probably no longer eradicable. The strategy for Oahu should be focused on control and not eradication for these established populations.

Goal:

The goal is to decrease mite populations to very low levels to decrease the risk that they will move to other islands.

Objective:

1. suppress mite population to levels as low as possible
2. prevent movement of mites off of Oahu

Strategy:

1. Suppress mite population to levels as low as possible
   - Beekeepers should monitor their hives for varroa infestation.
   - HDOA will provide training and materials (Apistan and sticky boards) to beekeepers so they can monitor for varroa.
   - HDOA currently recommends that beekeepers destroy all infested hives and treat all hive boxes and equipment associated with that hive. HDOA will establish a contract with a Pest Control Company for the destruction of the infested hives. (HDOA has recommended in the past that beekeepers should destroy hives that are heavily infested with mites but treat lightly infested hives. However this strategy will still allow for mite populations to remain at low levels in hives thus increasing the risk for their movement off island.)
   - HDOA is in the process of developing a program to compensate beekeepers that have destroyed infested hives. The money for this program will be available to the HDOA after July 1, 2007.
     - The compensation program will require an HDOA employee to witness the destruction and to confirm that the destroyed hive was infested with mites.
     - Compensation will include the replacement of bees and funds for associated losses.
     - Replacement bees will be provided from a source off of Oahu (to be arranged).

2. Prevent movement of mites off of Oahu.
   - HDOA will create a bee-free buffer around airports and harbors on Oahu. This will be accomplished with swarm traps and poison baits.
   - HDOA will establish an interisland quarantine that will restrict the movement of bees and bee equipment off of Oahu.

II. Uninfested Islands:

Extent of Infestation:

Surveys on Kauai, Molokai, Maui, and Hawaii have not found any varroa on those islands. These survey results are in support that varroa has not yet made it to these islands despite being present on Oahu for at least a year. These surveys have covered wide areas on the other islands but the number of surveyed hives needs to be increased in order to detect a recent infestation before it can spread.

Goal:

Ensure that varroa does not become established on uninfested islands and detect an infestation early.

Objective:

1. Establish a quarantine to prevent mite movement off of Oahu
2. Detect new varroa incursions as early as possible before they have spread
3. Eradicate new infestations

Strategy:

1. Establish a quarantine to prevent mite movement off of Oahu.
   - HDOA will establish an interisland quarantine that will restrict the movement of bees and bee equipment off of Oahu.

2. Detect new varroa mite incursions as early as possible before they have spread.
   - It is essential that extensive periodic surveys are conducted to detect new infestations of varroa as early as possible before they have a chance to spread.
   - Beekeepers should sample their hives using the “whole-of-colony acaricidal knockdown” technique as described in the Australian Veterinary Emergency Plan. This involves placing a mesh covered sticky board on the hive floor and two Apistan strips in the brood nest. The Apistan should be removed after 48 hours. The sticky board can also be removed and checked for mites. The honey can still be sold but will not be marketable as organic.
   - HDOA will provide the training, Apistan and sticky boards and monitor the results.

- (An alternative non-toxic sampling technique would be to use bottom sticky boards but this technique will be less effective in detecting low populations of mites. We need to find effective non-toxic sampling techniques for organic honey producers)

3. Eradicate new infestations
    - All infested hives should be immediately destroyed (HDOA will contract with a Pest Control Company for the destruction of infested hives)
    - HDOA will work with beekeepers to sample all apiaries within 5 miles of the infested hive for varroa mites twice a year for one year using the “whole-of-colony acaricidal knockdown”. The number of hives in an apiary that need to be sampled will vary with the size of the apiary and should be based on the Australian sampling requirements.

Attachment 4. Interim rule 07-1.

LINDA LINGLE
Governor

SANDRA LEE KUNIMOTO
Chairperson, Board of Agriculture

DUANE K. OKAMOTO
Deputy to the Chairperson

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STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
Plant Quarantine Branch
1849 Auiki Street
Honolulu, Hawaii 96819

PLANT QUARANTINE INTERIM RULE 07-1

Restrictions on the Intrastate Movement
of Any Live or Dead Honey Bees, or Used Bee Equipment,
Except by Permit Issued by the Hawaii Department of Agriculture

Under authorization granted in Section 150A-9.5, Hawaii Revised Statutes (HRS), the Hawaii Department of Agriculture ("Department") hereby establishes this interim rule to impose a quarantine on the intrastate movement of any live or dead honey bees, or used bee equipment. This quarantine is necessary to prevent the spread of the recently-discovered Varroa mite, a serious pest of honey bees, to uninfested islands within the State of Hawaii ("State").

The island of Oahu has been determined to be infested by the Varroa mite. Intrastate movement of any live or dead honey bees, or used bee equipment from or within Oahu, or from any island or island area subsequently determined by the Department to be infested with Varroa mite, is prohibited. Intrastate movement of any live or dead honey bees, or used bee equipment is allowed only by permit upon the determination of the Department Plant Quarantine Branch Manager that the proposed movement is from or within an uninfested island or island area to another uninfested island/area or to an infested island, and subject to permit conditions established by the Plant Quarantine Branch to maintain an effective quarantine. The decision whether to issue a permit allowing intrastate movement will be made case-by-case, based on the known facts and risks of Varroa mite spread at the time of permit application.

The ban on movement does not apply to and no permit is required for the movement or transport of the following articles by duly authorized Department employees or agents: (1) dead honey bees from a sampling point to any area within the State for purposes of analysis if the specimens are preserved in a chemical solution that exterminates the Varroa mite; or (2) used bee equipment if the equipment is treated by an approved method that exterminates the Varroa mite.

Pursuant to Section 150A-14, HRS, violation of this interim rule is a misdemeanor subject to a fine not less than $100 and not more than $10,000 per violation. For a second offense committed within five years of a prior offense, the fine shall not be less than $500 and not more than $25,000.

This interim rule is valid for no longer than one year from the date of issuance.

Dated at Honolulu, Hawaii this 28th day of August, 2007

SANDRA LEE KUNIMOTO
Chairperson, Board of Agriculture

Effective August 28, 2007

Attachment 5. Effective Pesticides for Varroa Mite.

Product (active ingredient)	**Efficacy for Varroa**	**Mechanism Of Action**	**Temperature dependent?**	**Effective on other pests?**	**Remove Supers while treating?**	**Dosage**	**Notes**
Apistan (Tau-Fluvalinate)	97% or greater Varroa mites can develop a resistance to this product. Results may vary.	CONTACT – bees come in contact with product which then kills mites	no For best results, apply Apistan when daytime temps are at least 50° F	no	Remove supers during treatment Allow 14 days after treatment is completed and removed before adding honey supers.	1 strip for every 5 frames of bees/brood. Leave strip(s) in the hive for 42 to 56 days. **READ LABEL FOR PROPER USE AND APPLICATION** NOTES: 1) Wear latex gloves when handling strips	1) Be sure to remove treatment at the recommended date (42 to 56 days after start date) 2) Do not use any hardware that was in the hive during the treatment when producing comb honey.
Check Mite (Coumaphos)	97% or greater Varroa mites can develop a resistance to this product. Results may vary.	CONTACT – bees come in contact with product which then kills mites	no	Small Hive Beetle – staple strips to the underside of delaminated piece of corrugated cardboard and place on bottom board inside the hive. Beetles seek shelter near strips and die.	Remove supers during treatment Allow 14 days after treatment is completed and removed before adding honey supers.	1 strip for every 5 frames of bees/brood. Leave strip(s) in the hive for 42 to 45 days. **READ LABEL FOR PROPER USE AND APPLICATION** NOTES: 1) Wear chemical resistant gloves when handling strips (nitrile gloves – NOT LATEX!)	1) Be sure to remove treatment at the recommended date (42 to 45 days after start date) 2) Do not use any hardware that was in the hive during the treatment when producing comb honey.
Mite Away II (Formic Acid)	93.3% (± 5.5%)	FUMIGANT – vapors from the product kills mites	50° F to 79° F *Remove the pads if temp exceed 82° F at any point in first 7 days*	Tracheal Mites	Remove supers during treatment Honey supers can be placed back on hive immediately after the treatment is removed (no withdrawal). However, if treatment is conducted before honeyflow, allow at least two weeks between end of treatment and HARVEST of honey.	Apply 1 soaked pad for 21 days (21 day total treatment) **READ LABEL FOR PROPER USE AND APPLICATION** NOTES: 1) Reduce hive so it consists of only 2 brood chambers 2) A 1.5" spacer rim and two small spacer sticks are required to elevate the pad above the top frame. 3) Apply pad so that the holes are facing DOWN.	1) For the first 7 days, brood may be killed during treatment but this will have no lasting effects. 2) Safety equipment must be worn during application. Read label for more information.

NOTE: READ AND FOLLOW ALL INSTRUCTIONS PROVIDED BY THE MANUFACTURER. Information in this grid may have changed. Use at your own risk.

Product (active ingredient)	Efficacy for Varroa	Mechanism of Action	Temp dependent?	Effective on other pests?	Remove Supers while treating?	Dosage	Notes
ApiLife VAR (Thymol)	75%	FUMIGANT – vapors from the product kills mites	59° F to 69° F DO NOT APPLY IF TEMPERATURE EXEEDS 90°F	Tracheal Mites	Remove supers during treatment **Do not add supers back to hive until 1 month after treatment has been removed.**	Reduce the hive so it has only 1 or 2 brood chambers (no honey supers either). Take 1 tablet and break it into 4 pieces. Put the pieces in a screen container and then place them in the 4 corners of the top chamber of the hive (the screen prevents bees from removing the product). In 7 - 10 days, take another tablet and repeat. In another 7 – 10 days, take another tablet and repeat. In another 12 days, remove any remaining pieces of product from hive. **READ LABEL FOR PROPER USE AND APPLICATION**	1) Remove supers during treatment and for **30** days after treatment. 2) Wear protective gloves while handling this product. Use disposable gloves -- the product will leave an oily residue on the gloves. 3) The vapors from this product are very strong. Be sure to store any unused tablets in an airtight container where vapors will not accumulate.
ApiGuard (Thymol)	85% to 95% (Mark Winston from Canada found only 77% efficacy for varroa mites and highly variable for Tracheal Mite control)	CONTACT + FUMIGANT – bees come in contact with product, spread it around the hive, releasing vapors which then kill the mites	60° F to 105° F	Tracheal Mites	Remove supers during treatment	Apply (2) 50g trays on top of the brood nest. Apply another (2) trays in 14 days. (28 day total treatment) **READ LABEL FOR PROPER USE AND APPLICATION**	1) Treatment is a gel that encourages hygienic behavior. As bees clean the gel out of the hive, the treatment is spread throughout the hive.
Sucrocide (Sucrose Octanoate Esters)	97% or greater Results vary depending on how product was applied.	CONTACT – mites (and bees) are sprayed with the product. Product kills mites but not bees.	Because bees will be wet during application, do not apply if temp drops below 70° F while bees are still wet.	no	No need to remove supers during treatment	Mix 3 tablespoons of Sucrocide with 2 gallons of water. Spray onto both sides of every frame in the hive, being sure to get all the bees wet with the mixture. Apply 3 treatments 7 to 10 days apart. **READ LABEL FOR PROPER USE AND APPLICATION**	1) Because bees will be wet during application, do not apply if temp drops below 70° F while bees are still wet. 2) Be careful not to spray open brood or queen. 3) It is recommended to wear goggles and gloves while applying treatment.

NOTE: READ AND FOLLOW ALL INSTRUCTIONS PROVIDED BY THE MANUFACTURER. Information in this grid may have changed. Use at your own risk.

Attachment 6. Apis mellifera Restocking Program (AMRP)

APIS MELLIFERA RESTOCKING PROGRAM (AMRP)

A Program of Support in Pollination-Enhancing Sustainability of Hawaii Agriculture

October 31, 2007

EXECUTIVE SUMMARY

The importation of Insecta Hymenoptera Apidae or Apis mellifera alive or dead into the State of Hawaii is prohibited.[1] In order to sustain production, apiculture in Hawaii is currently dependent upon hive splitting, feral colonies or swarms to expand or restock existing apis mellifera apiaries in Hawaii. In April 2007, Arachnida Acari Paasitidae V. destructor infestation was confirmed by the HDOA around Oahu in managed and feral hives.[2] At this time it is believed that the spread of V. destructor is limited to Oahu.

Current thoughts of mitigation by stakeholders in Hawaii call for strategies based on control or eradication for these established populations in order to protect its spread to the rest of the state. The spread of V. destructor and parasitic mite syndrome (PMS) is inevitable based upon current outside observation of mite population explosions and the realization of no known viable solution. Exacerbating the current mitigation efforts is the evolution of pesticide resistance by V. destructor. Further, over 12 viruses have already been identified and associated with V. destructor and suggested to be a major contributing factor in colony collapse. [3]

In Asian honeybees mite numbers are restricted by the amount of drone brood present in the colonies, but in Apis mellifera mites are able to reproduce in all available brood leading to the explosion in the parasite population.[4] Variability in the number of mites necessary to cause colony collapse[5] is substantial and national US surveys provide further evidence of colony collapse and document heavy loses.[6] It has also been observed that there is no clear correlation between mite number and mortality within the colony[7]

According to the USDA over 300 million people in the US alone depend upon Apis mellifera pollinating over 120 agriculturally important crops. One apparent correlation according to the industry is as Apis mellifera decline demand for pollination will increase. In relation to pollination, Apis mellifera, is and will continue to be the main emphasis in crop production in order to feed an ever growing population that includes Hawaii. A by-product of pollination is honey. Without continued strong pollination efforts the State of Hawaii will face loss of products, markets and goodwill.

Unless a solution of abolishment is found coexistence with V. destructor will be inevitable for the State of Hawaii and much focus, talent and expense will be directed and allocated towards pollination of Hawaii crops. An ongoing state controlled Apis mellifera restocking program is a proactive long-term and viable mitigation effort for what will come our way in the future. It is a program in support of sustainability in Hawaii agriculture. A hedge of protection for industry now generating in excess of $2.9 billion to the state's annual economy and directly and indirectly impacting thousands of jobs.

PROPOSAL FOR SAUSTAINABILITY

In order to sustain an Apis mellifera population at a reasonable level on the island of Oahu and predictably in the state, it will be necessary to restore or restock existing colonies on an ongoing basis. Since importation is problematic and highly unlikely given the current understanding of Colony Collapse Disorder (CCD)[8] – in order to meet the impending demand it will be necessary to have a system in place for local acquisition of colonies.

The thought of asking the established Hawaii apiculture community in clean locals to tap into their existing production assets in order to assist or subsidize replenishment of Oahu or the state on an ongoing basis is not sustainable. These entities are currently on established routine schedules and understandably need these assets for their own production.

It will be necessary to certify that both seed stocks as well as program facilities are free from infection and disease to the greatest extent possible given Hawaii's current natural environment. It is planned that this apiary will be located in a clean zone such as an island free from V. destructor and transportation corridors for example Niihau, (by potential agreement with the Robinson estate), Kauai (DLNR) or Big Island (DLNR), preferably in a remote restricted area within one of these locals, but access to forging areas and fresh water resources.

The Hawaii Department of Agriculture will need to act as a facilitator and advocate in order to carryout and accomplish this objective.

Start-up Costs[i]

Associated with the acquisition of this system and implementation of the program costs will include, but not be limited to: the purchase price of the acquisition, site preparation costs, freight charges and staff costs.

Capital

1500 colonies (5lbs and queen)	$105,000
1500 queens (after splits)	$25,500
Woodenware	$630,000
Feed	20,000
Infrastructure – Buildings	500,000
Infrastructure Support	$200,000
Truck and forklift	$80,000
	1,560,500

Personnel $

[1] State of Hawaii -Hawaii Administrative Rules, Chapter 71: S-4-71-6:
[2] http://www.hawaii.gov/hdoa/pi/ppc/varroa-bee-mite-page
[3] A Summary of the Varroa-Virus Disease Complex in Honey Bees, Peter G. Kevan, American Bee Journal, August 2006, Vol. 146, No. 8, p. 694-697
[4] Peng YS, Fang Y, Xu S & Ge L (1987). The resistance mechanism of the Asian honey bee, Apis cerana Fabr., to an ectoparasitic mite, Varroa jacobsoni Oudemans. Jouranl of Invertebrate Pathology 49, 54-60.
[5] Martin SJ (2001). The role of Varroa and viral pathogens in the collapse of honey bee colonies: a modeling approach. Journal of Applied Ecology 38, 1082-1093.
[6] National Honey Bee Loss Survey: June 19, 2007: Correlation of Common Pathogens with CCD, American Bee Journal Vol 147. No. 8, August 2007, p. 661
[7] Martin SJ (1998). A population dynamic model of the mite Varroa jacobsoni. Ecological Modelling 109, 267-281.
[8] Black, Richard. Virus implicated in bee decline. BBC News website, 6 September 2007.

APIS MELLIFERA RESTCOKING PROGRAM

Start up List

Project Manger				125,000
Land	2.5 to 3 acres			unknown
Site Preparation				unknown
Professional Fees				150,000
Fencing	1500 lf		@$/lf	18,000
Buildings	wood/paintshop office/lab storage packing	4500 sf 20x225	@200/sf	900,000
Equipment	truck/forklift feeding equip harvest equip			80,000 15,000 15,000
Elec./water		allowance		15,000
Communications	telephone/cable			2,500
Office Equipment	computer fax/printer desks/chairs files/misc			3,000 400 800 1,600
Office Supplies				1,000
Small Tools				2,500
Woodenware	3000 hive w/supper/stand		@$150/hive	450,000
Woodenware labor	3000 mh		@$60/mh	180,000
Paint	100gl		@25$/gl	2,500
Bee Colonies	1500		@$100/5lb	150,000
Queens	3000		@$15/qn	45,000
Feed				20,000
Shipping and Freight				150,000
			Total	2,327,300

APIS MELLIFERA RESTOCKING PROGRAM

Operations List - monthly expenses (no taxes included)

Plant				
	electric		1,000	
	water		400	
	maintenance		400	
	equipment repair		300	
	small tools		150	
	communications		300	
	insurance		300	
	office supplies		150	
	office equipment		100	
	shipping and postage		unknown	
	travel		400	
	supplies		1,000	
	labor	6 persons @ $50/hr	48,000	
	lease rent		unknown	
	professional services		150	
	feed sugar/protein		4,000	
	woodenware replacement @1%		4,500	
	packing material/nucs@1250*$25		31,250	
	shipping @$25/nuc		31,250	
		Total Monthly Total	123,650	
		Total Annual		1,483,800

Operational Income - annual

Bee Packages - 15,000 per @ $100		1,500,000	
Honey	30lbs/hive @$100/ib	90,000	
	Total Annual		1,590,000

Attachment 7. HDOA Varroa Pest Advisory

State of Hawaii
DEPARTMENT OF AGRICULTURE

New Pest Advisory
No. 07-01 June 2007

Figure 1. Enlarged photo of an adult varroa mite. Length is about 1 mm with a width near 1.5 mm (1/16").

Varroa Mite

Varroa destructor Anderson and Trueman

(Acari: Varroidae)

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Introduction. In April 2007, a beekeeper in Manoa on the island of Oahu observed tiny red mites in several abandoned honey bee hives which he obtained several miles away in Makiki. After reporting it to the Hawaii Department of Agriculture (HDOA), specimens were collected and identified as the varroa mite, *Varroa destructor* Anderson and Trueman. The identification was confirmed by the USDA Systematic Entomology Laboratory in Beltsville, Maryland. Prior to this detection, Hawaii was one of the few places in the world free of this very destructive honey bee pest.

Adult varroa mites are tiny 1–1.5 mm reddish-brown, crab-shaped, flattened mites (Figure 1). They are external parasites which attack honey bee adults, larvae (Figure 2), and pupae (Figure 3) and use their piercing-sucking mouthparts to feed on the hemolymph (blood) of bees. In varroa mite-infested honey bee colonies, newly emerging bees are malformed. Severe infestations of the mite will result in an eventual decline of bee colonies and a reduced honey bee population.

Commercial beekeeping in Hawaii, which includes queen bee and honey production, has been estimated at over $4 million. However, the most important value of bees is their ability to pollinate fruit trees, vegetables, and seed crops. With the presence of the varroa mite in Hawaii, there is a great potential for the honey bee population to decline. This will significantly reduce pollination of many commercial and residential fruit trees and vegetable crops, resulting in poor yields and low quality produce.

Figure 2. Enlarged photo of a honey bee larva with varroa mites attached to the body.

Hosts and life cycle. The varroa mite has been found in Florida on several other insects that visit flowers. The mite cannot reproduce on these other insects, but can use them as a means to disperse (Sanford et al, 2007). Elsewhere in the world, the varroa mite can use other species of bees in the genus *Apis* to multiply. In Hawaii, the only known host is the European honey bee, *Apis mellifera*. According to Sanford (2007), the life cycle of the varroa mite is synchronized with that of the honey bee. The female mite lays eggs in developing bee brood cells. After hatching, the developing mites feed on the honey bee larvae. After copulation, the pregnant adult female mites emerge from the cell along with their bee host and seek another cell to repeat the cycle.

Distribution. Varroa mites are now found world-wide. In the State of Hawaii, surveys conducted soon after its detection revealed a wide distribution on Oahu, with infestations being found in the leeward area (Makaha, Waianae, Nanakuli, Ewa, Kunia), central area (Wahiawa, Mililani), Honolulu (Makiki, Tantalus, Manoa) and east Oahu (Waimanalo). The mite has been found on both managed and feral bees. Based on its wide distribution and relatively heavy infestation levels, it is estimated that the mite has been present on Oahu for at least one to two years. HDOA surveys conducted on the neighboring islands of Hawaii, Maui, Molokai, and Kauai have not revealed any varroa mite infestations.

Current objectives. In order to minimize the impact of the varroa mite in Hawaii, a management plan is being implemented to suppress mite infestations on Oahu and prevent the movement of mites to the neighboring islands. For the neighboring islands, the plan provides for the detection and elimination of any new mite incursions at an early stage before they get a chance to spread. The plan involves intensive monitoring, training of staff and beekeepers on management techniques, compensation of beekeepers with infested hives, and public outreach.

Figure 3. Enlarged photo of a bee pupa with a varroa mite attached to its body.

Reporting suspect varroa mite infestations. Beekeepers who suspect that bees in their hives are infested with varroa mites should call the HDOA's toll-free Pest Hotline at 643-PEST (7378).

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Reference

Sanford, M.T., H.A. Denmark, H.L. Cromroy, and L. Cutts. 2007. Varroa mite. In: Featured Creatures. University of Florida and Florida Dept. Agric. & Cons. Services. http://creatures.ifas.ufl.edu/misc/bees/varroa_mite.htm

Attachment 8. Varroa response Plan

VARROA MITE RESPONSE PLAN

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DEPARTMENT OF AGRICULTURE
DIVISION OF PLANT INDUSTRY

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I. Purpose:

The purpose of this document is to establish a plan for HDOA and its collaborators when responding to the presence of varroa mites in managed and feral honeybee colonies when the varroa mites are found outside the Island of Oahu or in other previously uninfested areas of the State. The goal is to have a rapid response, with effective containment, eradication, or control of varroa mites. When a positive confirmation is made outside of Oahu or other previously infested area, the HDOA shall use this plan to guide its actions, partner's actions, and to recommend a pest control program to the owner or person in charge of the property. These procedures and control methods are subject to change due to changing circumstances and as new methods become available. They will be modified when appropriate.

II. Detection:

It is critical that any new incursion into previously uninfested areas is detected early before the mites have a chance to become established and disperse. HDOA and beekeepers on each island need to monitor for the presence of varroa mites in all established hives.

The following methods can be used to detect varroa mites in hives. No single method is 100% effective in discovering mites especially when the mites are at low densities. It is recommended that a combination of these methods be used to increase the probability for mite detection.

A. Visual Inspection:

Field inspections of hives should be carried out to detect any signs of varroa mite infestations. Newly emerged adult bees at the hive entrance with deformed wings, legs, and abdomens are an indication of a possible mite infestation. Patchy brood patterns may be evident in heavy infestations. The dark brown adult female mites may also be seen on adult bees and within brood cells in heavy infestations.

B. Brood cell cap removal:

Varroa mites spend most of their life cycle within the sealed brood cells. They prefer the drone brood cells. This is the most likely place to find mites during a hive inspection.

Pupae can be removed from their cells with a forceps and examined for the presence of mites. The brown mites will be easily observed on the white pupae. A comb rake can also be used to rupture the caps and expose many worker and preferable drone pupae for inspection. It is recommended that at least 100 pupae be examined in each hive.

C. Sticky Bottom Boards:

Mites move freely throughout the hive and drop to the bottom of the hive. An effective tool for detection of mite presence is to place cardboard sheets coated with an adhesive material on the bottom of the hive. The sticky bottom board is covered with an 8-12 mesh screen which allows mites to pass through but not honeybees. The boards should be placed in the hives for 48 hours and then removed. The number of mites on the board should be counted and recorded. Boards should be placed in a minimum of 10% of the hives in a bee yard at least 4 times per year.

The use of acaricide strips such as Apistan in combination with the sticky bottom boards is a much more effective detection tool than the use of the boards alone. This acaricide-knockdown technique involves the use of two strips of Apistan which should be suspended in the brood nest, one on either side of the center of the brood rearing area. It is essential that the strips be hung centrally in the bee space between the frames so the bees can walk on the sides of the strips. Apistan will kill the mites on the bees. The dead mites will drop to the bottom of the hive and adhere to the sticky bottom boards. The Apistan should be left in the hive for a minimum of 24 hours and preferably for 48 hours before removal for more effective results. The acaricide-knowdown method should be used once per year.

D. Alcohol Shake:

The alcohol shake method for sampling of honeybees for varroa mites consists of retrieving a 500 bee sample from designated hives. The bees can be collected by shaking a frame over a tray or large cardboard funnel and placing the bees in a one quart jar. Care should be taken that the queen is not collected. The jar should then be filled half way with 70% ethanol. The contents of the jar are then shaken for 5 minutes to dislodge the mites from the adult bees. After shaking, the bees and alcohol should be passed through an 8-12 mesh screen to remove the bees. The solution should then be passed through a 30 mest screen or a white cotton cloth which is then examined for mites. The number of mites and number of bees needs to be recorded to determine infestation level.

III. Response and Containment:

When an incursion of varroa mite is detected in a previously uninfested area, the following steps should be taken:

A. Quarantine:

The movement of all live or dead bees and used bee equipment will be prohibited from the infested area and all managed hives within the area will be inspected. The infested area will extend for a 15 mile radius surrounding the infested hives or a distance determined by the Board of Agriculture.

B. Delimiting Survey:

It is critical that the extent of an infestation is determined when an incursion is detected. These delimiting surveys should initially focus on managed colonies, because their

movement results in a greater potential for rapid spread of mites. Managed hives are also more readily accessible for sampling than feral colonies. All managed hives within the quarantine zone should be samples. All feral hives within 5 miles of the incursion should be identified and sampled. A smaller radius is applied to feral colonies as these are not capable of being moved.

The quarantined area will expand to a 15 mile radius surrounding each new find of varroa mite in the delimiting surveys.

A simple randomized sampling technique should be applied to each apiary. The number of hives to be sampled per apiary will vary according to the sensitivity of the field test being used.

To determine the boundaries of an infested area, a rate of sampling that will provide a 95% confidence of detection of prevalence of infestation in 2% or more hives within an apiary is recommended. Such rigorous accuracy required intensive sampling (see Table 1) but provides good confidence of accurately identifying both infested and non-infested apiaries. Application of acaricides for a 48-hour period is recommended when sampling apiaries in which infestation, if present, is likely to be at a very low prevalence (eg. when exposure to mites is likely to have only occurred in the previous six months). Repeat sampling of apiaries at intervals of 6 to 1 months should be conducted to confirm freedom from infestation.

Table 1 Sampling requirements for detection of intra-apiary prevalence of 2, 5, 10, 20 and 40% (at the 95% confidence interval), using intra-hive application of Bayvarol strips (flumethrin) for 24 hours (test sensitivity = 80% approx.)

	Number of hives to be sampled (based on hypergeometric probability distribution)				
No. of hives in apiary	**2%**	**5%**	**10%**	**20%**	**40%**
10	10[a]	10*	10*	10	6
20	20[a]	20*	20	13	7
30	30[a]	30	24	14	8
40	40[a]	39	26	15	8
50	50[a]	47	28	16	8
60	60[a]	49	29	16	8
80	78	53	31	16	8
100	97	56	32	17	8
120	111	59	32	17	8
140	117	60	33	17	8
160	118	62	33	17	8
180	126	63	34	17	8
200	132	64	34	17	8
250	141	66	34	17	8
300	147	67	35	17	8
350	152	68	35	17	8

400	156	69	35	17	8
450	159	70	35	17	8
500	161	71	35	17	8

a Required confidence level cannot be achieved for this sized apiary even when every hive is tested. Repeat testing should be applied in 6 to 12 months to confirm freedom from infestation.
Source: Data derived using Survey Toolbox software — Angus Cameron, Ausvet Animal Health Services.

Depending on the prevalence of infestation, the sampling needed to detect an infestation in an apiary may be less intensive that that required to demonstrate freedom from infestation.

C. Trace Forward and Trace Backward:

Trace-forward investigations should be conducted to all apiaries and beekeepers that have received risk materials from the infested apiary or beekeeper, using the estimated date of the initial mite introduction. Also, trace-back investigations should be conducted identify potential sources for the infestation.

IV. Control and Eradication:

The decision by HDOA to initiate a control versus an eradication program will depend on the results from the delimiting surveys. If it is determined that the varroa mite infestation is widespread throughout managed and feral colonies then the decision for a mite management and control program would be more appropriate. An eradication program should be attempted if it is determined that the mites are present in a localized area or restricted to managed colonies.

A. Eradication:

When the decision to eradicate the mites from an infested area has been made, the following procedures should be implemented:

- When an infested colony is identified in an apiary, bees, combs, and all hive components in that apiary are to be destroyed. However, isolation of some beekeeping equipment and honeybee products in bee-proof facilities for a specified period to prevent reinfestation may result in their being cleared of the infestation. HDOA-approved treatments of bee equipment to kill mites may also be used to avoid destruction of equipment.

- All feral nests within 5 miles of each detection site should be destroyed.

HDOA will perform, supervise and/or contract out the task of destruction of varroa-infested honeybee hives. The property owner will be apprised of treatment options and HDOA will coordinate the initial treatment and verify the varroa infestation has been eliminated. HDOA will use or provide advice on products to use that are licensed for use by the HDOA Pesticides Branch to destroy varroa mite-infested honeybee hives. HDOA maintains a list of licensed pest control operators in Hawaii who have stated an interest in doing bee control work on a hired basis.

B. Control:

When the decision for control rather than eradication is made then the role of HDOA will be to assist beekeepers in the management of varroa mites in their hives. This will be accomplished through training, education, and treatment recommendations.

V. Approved treatments:

A. Chemical treatment for varroa mites in bee hives:

1. Mite-Away II (formic acid) EPA #75710-1
2. Apiguard (thymol 25%) EPA #79671-1
3. Zoecon Apistan Anti-varroa mite strips (tau-fluvalinate) EPA #2724-406

B. Mechanical treatment for varroa mites in bee hives:

1. sticky boards
2. HappyKeeper bottom boards

VI. Authority:

The Hawaii Department of Agriculture (HDOA) has the authority to conduct control and eradication programs of designated pests under Chapter 141, Hawaii Revised Statutes, and Chapter 4-69A, Hawaii Administrative Rules. HDOA also has the authority under Chapter 150A to regulate the movement of commodities that harbor or are at high risk of spreading pests.

Chapter 141-3.6, HRS, provides the authority for the HDOA to enter private property to control or eradicate designated pests. This section establishes the criteria and procedures required for HDOA personnel to enter private property. Under this section, the department of agriculture shall give at least five days notice to the landowner and occupier of any private property of its intention to enter the property for the control or eradication of a pest. The notice shall set forth all pertinent information on the pest control program and the procedures and methods to be used for control or eradication. Under Chapter 4-69A, HAR, the varroa mite and honeybee are listed in the HDOA "List of Insects, Mites, Other Pests, and Plant Diseases Designated as Pests for Control or Eradication Purposes by the Hawaii Department of Agriculture."

VII. Acknowledgements:

This plan is based on and adapted from the Australian Veterinary Emergency Plan, (AUSVETPLAN, Version 3.0, 2006) a technical response plan for Honeybee diseases and pests produced by the Primary Industries Ministerial Council, Canberra, ACT. (www.animalhealthaustralia.com.au).