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Manatū Ahu Matua

Report on the 2017 New Zealand Colony Loss Survey

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Contents

Page

Executive Summary

The 2017 NZ Colony Loss Survey seeks to quantify colony losses experienced over the winter of 2017 (winter 2017). It also seeks to augment the 2015 and 2016 NZ Colony Loss Surveys by providing additional data for monitoring bee health over time, and for investigating emerging challenges for the apiculture industry and those industries that rely on pollination services. However, trend analysis is not a specific objective of this report.

The survey questionnaire was adapted from the 2016 and 2015 questionnaires, which in turn included a core set of questions from a standardised survey that has been conducted in more than 30 countries. It was conducted online.

Invitations to participate in the survey were sent to all New Zealand beekeepers who had included email addresses when registering their apiaries with AsureQuality, and participation was widely encouraged in news and speciality media. In addition, personal phone calls were made to beekeepers with 400-plus hives registered to encourage participation. In total, 2,066 beekeepers completed the 2017 survey, representing a 30.9% response rate overall and a 33.8% response rate among beekeepers with 400 or more registered hives. Together, these beekeepers reported on 235,924 production colonies that were recorded as of 1 June 2017, representing 30.1% of all New Zealand production colonies. While these participation rates widely surpass those obtained in other countries, they are down on 2016 participation rates.

The survey is anonymous, and beekeepers are the unit of analysis in most cases. Results are aggregated separately by region and by operation size; reporting by region is restricted to beekeepers with more than 250 colonies while reporting by operation size includes the entire sample. The descriptive statistics presented here and on the Manaaki Whenua – Landcare Research (Manaaki Whenua) website are presented as bar charts, pie charts, and/or histograms, as appropriate.

To estimate hive losses at the national level, we multiply the average share of colonies lost per beekeeper within each operation size class in AsureQuality's apiary registry by the total number of colonies reported in each size class. Using this method, we estimate the hive loss rate during winter 2017 to be 9.84%, with a 95% confidence interval of [8.57%, 11.11%]. This national-level loss rate is statistically indistinguishable from losses during the winters of 2015 and 2016.

The share of hives lost over the 2017 winter ranges from an estimated 5.27% in the Upper South Island to 11.35% in the Middle South Island. Average loss rates are significantly higher for non-commercial beekeepers (compared to semi-commercial and commercial beekeepers). Nevertheless, as in previous years, the survey results indicate wide variation in individual loss rates.

Colony losses across apiary registry locations and operation sizes were most frequently attributed to queen problems, suspected varroa and related complications, suspected starvation, and wasps. Losses to natural disasters, robbing by other bees, American Foulbrood, suspected diseases such as nosema, accidents, theft/vandalism, and Argentine ants are significantly less common but also contribute to colony losses.

Questions pertaining to queen problems, varroa monitoring and treatment, brood comb replacement, pollination services, nectar flow, nutrition, and lost and compromised apiary sites were also included in the survey to facilitate further analyses of factors contributing to colony loss. These data also provide useful information on management practices.

1 Introduction

Managed bees provide cost-effective pollination services, and thus form the backbone of agriculture in temperate climates. The plight of domesticated honey bees (*Apis mellifera*) has been particularly worrying since large-scale disappearances of adult bees from hives were first noted in the USA in 2005 (Aizen & Harder 2009; Potts et al. 2010; Goulson et al. 2015). The key challenge facing honey bee populations, however, is not the decline in the total number of bee colonies but rather the elevated rates of colony losses, especially after overwintering (Neumann & Carreck 2010).

Despite losses that greatly exceed historical averages, many countries are seeing rapid increases in the number of managed bee colonies (van der Zee et al. 2012). The year-on-year increases in New Zealand – managed largely by splitting existing hives – are among the highest in the world. Indeed, while the number of beekeepers in New Zealand increased by approximately 20% between 1945 and June 2017, the number of registered colonies increased by well over 500%. Between June 2016 and June 2017 the number of colonies reported in AsureQuality's Apiary Registry increased by 17.7% (down from an increase of 20.0% between June 2015 and June 2016) to 805,902 colonies.

Several features distinguish the New Zealand apiculture industry from its European and North American counterparts. First, mānuka honey commands significant price premiums due to its medicinal properties (van Eaton 2014; Ministry for Primary Industries 2016). These price premiums have not only contributed significantly to the recent increase in colony numbers, but they have also led to the uncommon situation whereby many beekeepers' livelihoods depend on honey production rather than providing pollination services.

Second, non-commercial beekeeping operations (fewer than 251 colonies) comprise 93.3% of the beekeeping operations and manage 14.0% of the colonies, while commercial beekeeping operations (over 250 colonies) comprise 6.7% of the beekeeping operations and manage 86.0% of the colonies. Third, American Foulbrood disease (AFB) is one of only two animal diseases that are notifiable in New Zealand. As a result, New Zealand beekeepers are obliged to destroy colonies that are found to have AFB.[1] Fourth, *Varroa destructor* is a comparatively recent arrival in New Zealand, having been discovered in the North Island in 2000 and in the South Island in 2006 (Zhang 2000; Goodwin & Taylor 2007). Finally, the discovery of *Nosema ceranae* is also fairly recent relative to other countries. The short time during which New Zealand has been contending with the management of varroa and *Nosema ceranae* gives New Zealand the advantage of being able to learn from overseas experiences.

Losses associated with varroa and other pests and diseases have prompted many countries to implement annual surveys of colony losses. Such an approach was first initiated in Canada in 2002 in response to problems with emerging resistance to varroa treatments, and the surveys have continued annually since 2007 (Currie et al. 2010; Canadian Association of Professional Apiculturalists 2016). The sudden and dramatic winter colony losses in excess of 35% in 2005 and 2006 prompted the USA to initiate annual surveys of winter colony losses, and

[1] National American Foulbrood Pest Management Plan (2017). http://www.afb.org.nz.

these have also continued annually (Lee et al. 2015; Seitz et al. 2015). High levels of overwintering colony losses in Europe as well as in the Middle East, Africa, and Asia, led to the initiation of similar annual surveys (e.g. van der Zee et al. 2012, 2014, 2015; Brodschneider et al. 2016; Meixner & Le Conte 2016). By 2008 the COLOSS (Prevention of honey bee COlony LOSSes) had developed a standardised survey format to harmonise data collection on colony losses (van der Zee et al. 2014), and this approach to monitoring colony losses has been adopted across Europe, North America, and elsewhere to facilitate international comparisons and identify potential causes.

Until 2015, New Zealand did not systematically record annual wintering losses. Seeking to fill this critical knowledge gap, the Ministry for Primary Industries (MPI) and the Bee Industry Advisory Council commissioned Manaaki Whenua to conduct the first NZ Colony Loss Survey in 2015. For winter 2015 losses were estimated to be 10.73%, with a 95% confidence interval of [8.66%, 12.80%] (Brown & Newstrom-Lloyd 2016).[2] A subsequent survey was conducted in 2016, for which losses were estimated to be 9.78%, with a 95% confidence interval of [8.51%, 11.04%] (Brown & Newstrom-Lloyd 2017).[3] The current report highlights the results of the third NZ Colony Loss Survey, which was conducted over winter 2017.

[2] See https://www.mpi.govt.nz/dmsdocument/11512-report-on-the-2015-new-zealand-colony-loss-and-survival-survey.

[3] See https://www.mpi.govt.nz/dmsdocument/16711-new-zealand-colony-loss-survey-report-2016.

2 Project Milestones and Objectives

Deliverable/Milestone	Performance Standards
Milestone 1: **SURVEY DESIGN AND COMMUNICATIONS** 1a. Develop the 2017 survey questionnaire, incorporating changes based on recommendations outlined in the 2016 report. 1b. Develop consistent communication about the Bee Health Survey.	• Questions are complete and appropriate to New Zealand circumstances. • Survey questions are programmed into an online survey. • A communication package about the Bee Health Survey is available to all relevant organisations. • Survey to go live on 14 August 2017 until 3 November 2017. • Target all beekeeping operations from AsureQuality's AFB database, with particular follow-up work with operations with 400+ hives. • Monitor responses for follow-up and calculate response rates. • Make phone calls to those who have not responded 21 days after the survey invitation is sent out. • Liaise with ApicultureNZ to incentivise uptake of the survey.
Milestone 3: **SURVEY COLLATION, ANALYSIS AND REPORT** 3a. Collate and analyse information received from all survey respondents. 3b. Submit to MPI a report, an online presentation of results, and all raw data in association with the survey.	• Build on the baseline of data for future surveys and analysis. • Compare colony loss across geography, enterprise size, and management practices. • Report aggregated data on a web page, ensuring that no individual identification is possible. This summary information will remain online, and future survey results can be added to facilitate additional analysis over time. • Provide MPI and the beekeeping industry with a final report that expands on the detail provided online, offers analysis of the data, and identifies any issues or improvements for any future survey. • The analysis of the survey will be published in the popular press.

3 Methods

3.1 Survey Design

As with the 2015 and 2016 surveys, the 2017 NZ Colony Loss Survey was administered to beekeepers online. Electronic survey enumeration affords several advantages over alternative data collection methods. In particular, it enables the use of survey logic to deliver a smart, tailored questionnaire to each participant. For example, only beekeepers who indicated that they had new queens in autumn 2017 were asked about the source of those queens. Similarly, only beekeepers who gave their bees supplemental protein were asked which types of protein they gave. In addition, electronic enumeration eliminates data entry error, thereby increasing the accuracy of the results.

One criticism levelled at online surveying is lack of accessibility, particularly for rural populations. However, approximately 80% of rural New Zealanders had home access to broadband in 2015 (a figure that is rapidly expanding under the government's Rural Broadband Initiative), as do more than 90% of registered New Zealand beekeepers. To reach beekeepers without Internet access, the survey was also made available via telephone interview and mail.

The 2015 survey questionnaire (Brown 2015; Brown & Newstrom-Lloyd 2016) was based on an annual survey of beekeepers developed by the international COLOSS honey bee research association. Survey topics include the number and nature of over-winter colony losses, queen health and performance, indicators of pests and diseases such as varroa and *Nosema ceranae,* treatment of the varroa mite, supplemental feeding, and colony management. The challenges facing New Zealand beekeepers differ from those facing beekeepers in the northern hemisphere, and so the New Zealand questionnaire was adapted to the local context. For example, the 2015 NZ Colony Loss Survey added questions on competition for apiary sites, and on losses from American Foulbrood Disease (AFB), theft and vandalism, natural disasters, and wasps. It also adapted the question on nectar flow to reflect New Zealand plants.

The 2016 NZ Colony Loss Survey was a refinement of the 2015 survey. While retaining the core international COLOSS questions to facilitate international comparisons, it incorporated feedback from scientists, beekeepers, and industry representatives to increase the relevance and accuracy of the information collected. In particular, it incorporated three specific suggestions arising from feedback on the 2015 survey report:

- It included new questions on the acquisition and disposal of hives, to improve accounting of winter losses.
- It replaced AsureQuality's Apiary Registry Location with well-understood geographic regions.
- It was made available to beekeepers as a download before they began the survey.

In addition, new questions on emerging challenges to apiaries were added to quantify the threats posed by Argentine ants and giant willow aphid. Questions on methods for monitoring varroa were also included, as were several new methods for treating varroa. The 2016 questionnaire also included new questions on beekeepers' estimates of the primary reasons that apiary sites had been lost or compromised, and revised questions on the nectar flow of selected native monoflorals.

The 2017 questionnaire was kept very similar to the 2016 questionnaire in order to facilitate trend analysis. However, the 2017 questionnaire did include three important refinements.

- Feedback from the previous two surveys indicated that beekeepers found the term ‘colony death’ – which appears in international COLOSS surveys – to be poorly defined. In response we asked about specific causes of losses associated with colony death (e.g. starvation and exposure to toxins) without first asking beekeepers to identify colony death as the cause.
- We added other important explanations for colony loss, including suspected varroa, suspected nosema and other diseases, and robbing by other bees. We recognise that beekeepers may not be in a position to diagnose diseases in the field, but we feel that beekeepers have strong indications of the causes underlying losses and that these categorisations are less ambiguous than ‘colony death’.
- We allowed beekeepers whose wintering apiary locations span multiple regions to enter region-specific loss details to improve the accuracy of the results. Less significant changes are noted in the text below.

3.2 Colony Losses

Colony losses, in general, may be attributed to queen problems (including drone-laying queens or no queen), AFB, wasps, robbing by other bees, Argentine ants, suspected starvation, suspected toxic exposure, suspected varroa and related complications, suspected nosema and other diseases, natural disasters, theft and vandalism, and accidents. Losses due to varroa mite, insecticides or plant toxins, and other pathogens and pests are difficult to diagnose, hence the caveat ‘suspected’. As noted above, several of these categorisations were added to the 2017 questionnaire at the suggestion of beekeepers.

3.3 Sampling Strategy

Our sampling strategy aimed for inclusiveness while targeting New Zealand’s largest beekeeping operations. To achieve this we adopted a two-pronged approach to recruiting respondents.

Under the Biosecurity Act 1993 all New Zealand beekeepers are legally obliged to register their apiaries with AsureQuality and to complete an Annual Disease Return by 1 June. Approximately 90% of New Zealand beekeepers have registered email addresses with AsureQuality. AsureQuality provided these email addresses to Manaaki Whenua for the purpose of conducting the 2017 NZ Colony Loss Survey.

Manaaki Whenua sent personalised email invitations to participate in the survey to 6,676 New Zealand beekeepers on 17 August 2017. In total, 75 emails bounced (probably due to invalid email addresses and/or overly aggressive spam filters) and 79 beekeepers asked to be removed from the list of email contacts. Non-respondents received up to four email reminders between 30 August 2017 and 12 October 2017.

Participation was encouraged by presentations at the 2015 and 2016 ApicultureNZ conferences, interviews on television and radio news, articles in newspapers and *The New Zealand BeeKeeper Journal*, and the opportunity to win one of ten $100 vouchers for morning tea provided by Manaaki Whenua. In addition, all 379 beekeepers with 400+ hives registered with AsureQuality received personal phone calls to encourage completion of the survey; phone calls began in early September for northern New Zealand and continued through mid-October for southern New Zealand, targeting beekeepers who had not completed the survey at the time of the call.

Two important changes to incentivising participation were made in 2017: the survey advisory group was disbanded, so this group did not make personal telephone calls to targeted beekeepers as in years past; and team members no longer worked with the largest beekeepers in person to facilitate survey completion, as in 2016. Six beekeepers responded to the survey offline.

In total, 2,066 beekeepers completed the 2017 survey, indicating a gross response rate of 30.9%. After data cleaning we were left with 2,029 complete, usable responses. Among the beekeepers who completed the survey were 128 of the 379 beekeepers with 400 or more registered hives, indicating a response rate of 33.8% among these large commercial beekeepers. Both the general response rate and the target response rate were significantly below those achieved in 2016, perhaps due to less media coverage in 2017, to changes in the sampling (described above), and to the extraordinary response rates obtained in 2016. Even so, response rates in New Zealand are approximately 50% higher than for any country in the European COLOSS survey, and approximately five times the average response rate in that survey (Brodschneider et al. 2016). See Table 1 for a breakdown of region and operation size.

Table 1: Number of beekeepers responding to the NZ Colony Loss Survey, by region and operation size

<table>
<tr><th>Region</th><th>Non-commercial (1–50 colonies)</th><th>Semi-commercial (51–500 colonies)</th><th>Commercial (501–3,000 colonies)</th><th>Large commercial (more than 3,000 colonies)</th></tr>
<tr><td>Upper North Island</td><td>507</td><td>36</td><td>28</td><td rowspan="6">20</td></tr>
<tr><td>Middle North Island</td><td>347</td><td>60</td><td>28</td></tr>
<tr><td>Lower North Island</td><td>352</td><td>30</td><td>14</td></tr>
<tr><td>Upper South Island</td><td>134</td><td>10</td><td>9</td></tr>
<tr><td>Middle South Island</td><td>275</td><td>21</td><td>9</td></tr>
<tr><td>Lower South Island</td><td>163</td><td>12</td><td>13</td></tr>
<tr><td>Total</td><td>1,770</td><td>156</td><td>88</td><td>15</td></tr>
</table>

Notes: Large commercial beekeepers are not reported by region in order to preserve anonymity, and some beekeepers have hives in multiple regions. Therefore the total shown in the last row reflects the total number of beekeepers in each size class and is not a column total.

Together, these beekeepers reported on 242,924 production colonies as of 1 June 2017, representing 30.1% of all New Zealand production colonies.

Consistent with international practice, all responses are confidential. Data access is limited to the survey director (Pike Brown, Manaaki Whenua), and data are stored exclusively on password-protected computers.

4 Survey Questionnaire

The entire text of the survey questionnaire is included below. The main questions from the standardised international COLOSS survey are included to enable international comparison. Additional questions were added to reflect both the New Zealand context and feedback on the 2015 and 2016 NZ Colony Loss Surveys provided by scientists, beekeepers, and other end users. The survey was available online between 17 August and 10 November 2017.

2017 NZ Colony Loss Survey

*1) Please click YES to begin the survey.**
( ) YES, take me to the survey
( ) NO, I don't want to do the survey

*2) Did you have at least one production colony at the beginning of winter (1 June 2017)? **
Please consider colonies that are queenright and likely to be strong enough to provide a honey harvest and/or pollination services as production colonies.
( ) Yes
( ) No

3) Which of the following best describes *your role* in this beekeeping operation?*
( ) Owner/partner
( ) Site manager

*4) Do you personally manage all apiaries?**
( ) Yes
( ) No

*5) Ideally, managers will complete the survey for the apiaries that they manage. Do you wish to complete the survey yourself or to ask managers to complete the survey?**
If you will report on some apiaries and managers will report on others, please tick "Managers will complete the survey".
( ) I will complete the survey myself
( ) Managers will complete the survey

*6) **Please enter the** email address of each apiary manager in the box below. **We will send a request to complete the survey directly to the manager(s). Enter each address on a new line.***
Please do not include yourself, even if you manage apiary sites.
____
____
____
____

*7) Do you wish to report on any apiary sites yourself?**
( ) Yes
( ) No

*8) How many apiary sites **did you manage** during the first spring round of 2017?**
____

*9) In which region(s) were your apiary sites located during your first spring round (spring 2017)?**
Note that Coromandel is listed separately from Waikato and that Wairarapa is listed separately from Wellington.
Tick all that apply.
[ ] Northland
[ ] Auckland
[ ] Coromandel
[ ] Waikato (apart from Coromandel)
[ ] Bay of Plenty
[ ] Gisborne
[ ] Hawke's Bay
[ ] Taranaki
[ ] Manawatu−Wanganui
[ ] Wairarapa
[ ] Wellington (apart from Wairarapa)
[ ] Tasman / Nelson
[ ] Marlborough
[ ] Canterbury
[ ] West Coast
[ ] Otago
[ ] Southland
[ ] Chatham Islands

10) Are all of your apiary sites within 15 km *of one another?**
( ) Yes
( ) No
( ) Unsure

11) ***How many*** *production colonies* ***did you have*** *on 1 June 2017,* ***as per your Annual Disease Return?****
Again, please consider colonies that are queenright and likely to be strong enough to provide a honey harvest and/or pollination services as production colonies. If the exact number of production colonies is not known, please estimate.

____

*12) Of the ## production colonies that you had on 1 June 2017, approximately how many were in each of the following areas? **
________Option 1
________Option 2

*13) Did you acquire new production colonies after 1 June 2017 but before the first spring round of 2017?**
Examples include purchasing, receiving as a gift, creating new production colonies from nucs and splits, and hiving swarms and/or feral colonies.
( ) Yes
( ) No

14) How many production colonies did you acquire ***after 1 June 2017 but before the first spring round of 2017?****
If the exact number of production colonies is not known, please estimate.

____

*15) Did you sell or give away production colonies after 1 June 2017 but before the first spring round of 2017? **
( ) Yes
( ) No

16) How many of your ## production colonies did you sell or give *away* after 1 June 2017 but before the first spring round of 2017? *
If the exact number of production colonies is not known, please estimate.

____

17) ***How many*** *production colonies* ***did you have during your*** *first spring round* ***this year*** *(spring 2017)?**
As a reminder, please consider colonies that are queenright and likely to be strong enough to provide a honey harvest and/or pollination services as production colonies. If the exact number of production colonies is not known, please estimate.

____

*18) Of the ## production colonies that were lost during winter 2017, in your opinion, how many were lost as a result of...?**
________Queen problems (including drone-laying queens, no queen, etc.)
________American foulbrood (AFB)
________Wasps
________Robbing by other bees
________Argentine ants (ants that attack the brood and honey comb)
________Suspected starvation (dead workers in cells and no food present in the hive)
________Suspected toxic exposure (many dead bees in or in front of the hive)
________Suspected varroa and related complications
________Suspected nosema (e.g. a high level of faeces on the front of the hive) and other diseases
________Natural disasters (gale-force winds, flooding, etc.)
________Theft or vandalism
________Accidents from livestock, tractors, etc.
________Other
________Unsure

19) ***Please describe the*** *other cause of losses* ***to your production colonies****.*

____
____
____
____

*20) In which area did queen problems have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland

( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*21) In which area did AFB have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*22) In which area did wasps have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa

( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*23) In which area did robbing by other bees have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*24) In which area did Argentine ants have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) Otago
( ) Southland
( ) Chatham Islands
( ) West Coast

*25) In which area did suspected starvation have the biggest impact on your production colonies during winter 2017?**

( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) Otago
( ) Southland
( ) Chatham Islands
( ) West Coast

*26) In which area did suspected toxic exposure have the biggest impact on your production colonies during winter 2017?**

( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) Otago
( ) Southland
( ) Chatham Islands
( ) West Coast

*27) In which area did suspected varroa have the biggest impact on your production colonies during winter 2017?**

( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne

( ) Hawke’s Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) Otago
( ) Southland
( ) Chatham Islands
( ) West Coast

*28) In which area did suspected nosema and other disease have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke’s Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) Otago
( ) Southland
( ) Chatham Islands
( ) West Coast

*29) In which area did natural disasters have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke’s Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury

( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*30) In which area did theft and/or vandalism have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*31) In which area did accidents have the biggest impact on your production colonies during winter 2017?**
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

*32) **How many of the ##** production colonies **that survived winter 2017 were** weak but queenright **during the** first spring round of 2017?**
If an exact number is not known, please estimate.

____

33) In terms of *queen problems* (such as drone-laying queens, no queen, etc.) how does the 2016−2017 season compare to previous seasons? *The 2016−2017 year was...**
( ) Much worse than normal
( ) Somewhat worse than normal
( ) About normal
( ) Somewhat better than normal
( ) Much better than normal
( ) Unsure

*34) Of the ## production colonies that you had on 1 June 2017 (the time of your Annual Disease Return), did any have new queens (own queens or commercial source)?**
( ) Yes
( ) No

*35) **Of the ##** production colonies **that you had on 1 June 2017**, how many had new queens?**
If an exact number is not known, please estimate.

____

*36) **How many of these new queens** were from queen breeder stock?**
If an exact number is not known, please estimate.

____

*37) How did production colonies with young queens survive winter 2017 relative to production colonies with old queens? Young queens did...**
( ) Much worse than old queens
( ) Somewhat worse than old queens
( ) About the same as old queens
( ) Somewhat better than old queens
( ) Much better than old queens
( ) Unsure

*38) Did you notice bees with signs of deformed wing virus (crippled or deformed wings) in your production colonies during the 2016−2017 season?**
( ) Yes
( ) No

*39) Did you notice bees with signs of parasitic mite syndrome (spotty brood patterns, increased levels of brood disease, and/or white larvae that are chewed or pecked down by workers) in your production colonies during the 2016−2017 season?**
( ) Yes
( ) No

*40) Did you monitor your production colonies for varroa during the 2016−2017 season?**
( ) Yes
( ) No

*41) What methods did you use to monitor your production colonies for varroa during the 2016−2017 Season? Tick all that apply. **
[ ] Alcohol wash
[ ] Sticky board (or other collection tray below the hive)
[ ] Sugar shake / roll
[ ] Visual inspection of adult bees
[ ] Visual inspection of drone brood
[ ] Sent sample to a lab
[ ] Other − Please specify: ____

*42) Did you treat Varroa during the 2016−2017 season.**
( ) Yes
( ) No

*43) Please indicate how you treated varroa during the 2016−2017 season.**
Tick all that apply.
[ ] Flumethrin (e.g. Bayvarol)
[ ] Amitraz (in strips, e.g. Apivar)
[ ] Thymol (e.g. Apiguard, ApilifeVar, ThymoVar)
[ ] Thymol cords
[ ] Tau-fluvalinate (e.g. Apistan)
[ ] Oxalic acid − sublimation (evaporation)
[ ] Oxalic acid − dribbling / trickling
[ ] Drone brood removal
[ ] Formic acid − short term (3 days or less)
[ ] Formic acid − long term (4 days or more, e.g. Mite Away Quick Strips)
[ ] Formic acid − very long term (42-day treatment, e.g. Nassenheider evaporator)
[ ] Complete brood removal (including queen trapping)
[ ] Fogging food-grade mineral and essential oils (e.g. thymol, wintergreen)
[ ] Fogging food-grade mineral oil
[ ] Hyperthermia (heat treatment of brood/bees)
[ ] Other method (1): ____
[ ] Other method (2): ____

*Please indicate when you started treatment for varroa during the 2016−2017 season.**
Tick all that apply. For example, if you started one treatment in September and repeated it in December, please tick both September and December. Please tick Unsure if you do not remember.

	Unsure	Aug 2016	Sep 2016	Oct 2016	Nov 2016	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017

44) How many production colonies did you have at the start of your last spring round (spring 2016)?
This question will help us to track trends over time. Again, please consider colonies that are queenright and strong enough to provide a honey harvest as production colonies.

Production colonies: ____

*45) Did you replace any brood combs with comb foundation during the 2016−2017 season?**
( ) Yes
( ) No

*46) Approximately what proportion of brood combs did you replace with comb foundation (per colony) during the 2016−2017 season?**
( ) <10%
( ) 10%
( ) 20%
( ) 30%
( ) 40%
( ) 50%
( ) 60%
( ) 70%
( ) 80%
( ) 90%
( ) 100%
( ) Unsure

*47) During the 2016−2017 season, approximately what share of production colonies were used for pollination, for honey production, and for both pollination and honey production?**
Please enter numbers only. For 50%, enter "50". For 0%, enter "0". Total must sum to 100. If you did not use colonies for pollination or honey production (e.g., if they were used only to produce queens), please leave this question blank.
________% for pollination only
________% for honey production only
________% for both pollination and honey production

*48) Did you migrate any of your production colonies at least once during the 2016−2017 season?**
This question refers to moving production colonies from one apiary site to another.
( ) Yes
( ) No

*49) Approximately what proportion of production colonies were migrated during the 2016−2017 season?**
( ) <10%
( ) 10%
( ) 20%
( ) 30%
( ) 40%
( ) 50%
( ) 60%
( ) 70%
( ) 80%
( ) 90%
( ) 100%
( ) Unsure

*50) In which regions were your apiaries kept at any time during the 2016−2017 season?**
Note that Coromandel is listed separately from Waikato and that Wairarapa is listed separately from Wellington.
Tick all that apply.

[ ] Northland
[ ] Auckland
[ ] Coromandel
[ ] Waikato (apart from Coromandel)
[ ] Bay of Plenty
[ ] Gisborne
[ ] Hawke's Bay
[ ] Taranaki
[ ] Manawatu−Wanganui
[ ] Wairarapa
[ ] Wellington (apart from Wairarapa)
[ ] Tasman / Nelson
[ ] Marlborough
[ ] Canterbury
[ ] West Coast
[ ] Otago
[ ] Southland
[ ] Chatham Islands

51) Did the majority of your bee colonies have a significant flow on one or more of the following plants during the 2016−2017 season?
Tick all that apply.

[ ] Manuka
[ ] Kanuka
[ ] Mixed manuka and kanuka
[ ] Clover / pasture
[ ] Kamahi
[ ] Willow honey (spring)
[ ] Willow honeydew (summer-autumn)
[ ] Rewarewa
[ ] Citrus
[ ] Borage / Vipers bugloss
[ ] Rata
[ ] Pohutukawa
[ ] Tawari
[ ] Beech honeydew
[ ] Thyme
[ ] Nodding thistle
[ ] Ling heather
[ ] Native bush blend
[ ] Urban floral and garden
[ ] Other: ____

52) During the 2016−2017 season, approximately what share of of the manuka flow came from plantation manuka?

( ) 0%
( ) 10%
( ) 20%
( ) 30%
( ) 40%
( ) 50%
( ) 60%
( ) 70%
( ) 80%
( ) 90%
( ) 100%
( ) Unsure

53) How was the nectar flow from kamahi in 2016−2017 compared to 2015−2016? The 2016−2017 nectar flow from kamahi was...

( ) Much better
( ) Somewhat better
( ) About the same
( ) Somewhat worse
( ) Much worse
( ) Not sure

54) How was the nectar flow from rewarewa in 2016−2017 compared to 2015−2016? The 2016−2017 nectar flow from rewarewa was...

( ) Much better
( ) Somewhat better
( ) About the same
( ) Somewhat worse
( ) Much worse
( ) Not sure

55) How was the nectar flow from rata in 2016−2017 compared to 2015−2016? The 2016−2017 nectar flow from rata was...

( ) Much better
( ) Somewhat better
( ) About the same
( ) Somewhat worse
( ) Much worse
( ) Not sure

56) How was the nectar flow from pohutukawa in 2016−2017 compared to 2015−2016? The 2016−2017 nectar flow from pohutukawa was...

( ) Much better
( ) Somewhat better
( ) About the same
( ) Somewhat worse
( ) Much worse
( ) Not sure

57) How was the nectar flow from tawari in 2016−2017 compared to 2015−2016? The 2016−2017 nectar flow from tawari was...

( ) Much better
( ) Somewhat better
( ) About the same
( ) Somewhat worse
( ) Much worse
( ) Not sure

58) Did you give any of your colonies a supplemental sugar feed during the 2016−2017 season?
Supplemental sugar feeds include sugar solution, invert sugar, raw sugar, white sugar, and honey.

( ) Yes
( ) No

59) What type of sugar did you use as supplementary feed during the 2016−2017 season?
Tick all that apply.

[ ] Sugar solution
[ ] Invert sugar solution
[ ] Raw sugar
[ ] White sugar
[ ] Honey
[ ] Other: ____

*60) **How many** litres of sugar solution and/or invert sugar solution **did you give to each production colony, on average?***

____

*61) **How many** kgs of dry sugar (**raw and/or white) did you give to each production colony, on average?***

____

*62) **How many** frames of honey **did you give to each production colony, on average?***

____

*63) **How much** sugar **did you give to each production colony, on average?***
Please specify units, e.g. KGs, or litres.

____

64) Did you give any of your colonies protein supplements during the 2016−2017 season?
Proteins supplements include FeedBee, MegaBee, dry pollen, and homemade supplements.

( ) Yes
( ) No

65) What type of protein supplement did you use during the 2016−2017 season?
Tick all that apply.

[ ] FeedBee
[ ] MegaBee
[ ] Dry pollen

[ ] Homemade protein supplement
[ ] Other: ____

*66) **How many** kg of supplement (dry matter) did you give to each production colony, on average?*

____

*67) **How much** protein supplement **did you give to each production colony, on average?** Please specify units, e.g. KGs, or litres.*

____

68) Between the first spring round of 2016 and the first spring round of 2017, did you lose one or more entire apiary sites?
Possible causes include being overtaken by other beekeepers, overcrowding, lost pollen and nectar sources, and effects of giant willow aphid.
( ) Yes
( ) No

69) Between the first spring round of 2016 and the first spring round of 2017, was one or more of your apiary sites compromised?
Possible causes include overcrowding, lost pollen and nectar sources, and effects of giant willow aphid.
( ) Yes
( ) No

70) Which of the following caused you to lose one or more entire apiary sites between the first spring round of 2016 and the first spring round of 2017?
Tick all that apply.
[ ] Overtaken by another beekeeper
[ ] Overcrowding (too many hives close to your apiary sites)
[ ] Pollen and nectar sources were removed without replacement
[ ] Effects of giant willow aphid
[ ] Other − Please describe: ____

71) Which of the following caused one or more of your apiary sites to be compromised between the first spring round of 2016 and the first spring round of 2017?
Tick all that apply.
[ ] Overcrowding (too many hives close to your apiary sites)
[ ] Pollen and nectar sources were removed without replacement
[ ] Effects of giant willow aphid
[ ] Other − Please describe: ____

72) Approximately what percentage of your apiary sites were entirely lost between the first spring round of 2016 and the first spring round of 2017 for each of the following reasons?

[responses piped in base don previous answers]

73) Approximately what percentage of your apiary sites were compromised between the first spring round of 2016 and the first spring round of 2017 for each of the following reasons?

[responses piped in based on previous answers]

74) In which area were problems associated with apiary sites being entirely lost or compromised between the first spring round of 2016 and the first spring round of 2017 most severe?
Please select from the list below even if only one region is shown.
( ) Northland
( ) Auckland
( ) Coromandel
( ) Waikato (apart from Coromandel)
( ) Bay of Plenty
( ) Gisborne
( ) Hawke's Bay
( ) Taranaki
( ) Manawatu−Wanganui
( ) Wairarapa
( ) Wellington (apart from Wairarapa)
( ) Tasman / Nelson
( ) Marlborough
( ) Canterbury
( ) West Coast
( ) Otago
( ) Southland
( ) Chatham Islands

75) What percent of over-winter losses do you consider to be economically sustainable?
____

76) What are the key** challenges **facing New Zealand beekeepers? Are there other problems that we should monitor in future surveys?
____
____
____
____

77) What are the key** opportunities **facing New Zealand beekeepers?
____
____
____
____

78) Were any parts of this survey difficult to answer? Please let us know so we can improve the questionnaire for the future.
____
____
____
____

*79) **Approximately how many** years of beekeeping experience **do you have?***
____

5 Highlighted Results

Results are presented as bar charts, pie charts, and histograms. The latter are useful for showing the distribution of survey responses, particularly as zeros are included separately. Averages are also noted in the histograms.

Most information from is reported according to an aggregated area (hereafter, called a 'region'). Specifically, beekeepers recorded the political regions corresponding to their AsureQuality apiary registry locations; these political regions were then aggregated and categorised into six regions: Upper North Island, Middle North Island, Lower North Island, Upper South Island, Middle South Island, or Lower South Island (Figure 1).

Most information is also reported by the total number of hives comprising each beekeeping operation as of 1 June 2017. In all figures, operation size is categorised into four size classes: 'non-commercial' for those with 1–50 hives; 'semi-commercial' for those with 51–500 hives; 'commercial' for those with 501–3,000 hives; and 'large commercial' for those with more than 3,000 hives.

Because 6.7% of New Zealand beekeepers operated 86.0% of production colonies as of 1 June 2017, figures reported by aggregated region restrict the sample to beekeepers with more than 250 hives (unless noted). Figures reported by operation size include all respondents.

5.1 National-level Estimates of Colony Losses during Winter 2017

Each respondent's colony losses for winter 2017 are defined as the number of production colonies the respondent had on 1 June 2017, less the number that were alive when he/she opened the colonies in spring, typically between August and October. To estimate colony losses for winter 2017 at the national level we multiplied the average share of colonies lost per beekeeper within each operation size class in AsureQuality's apiary registry by the total number of colonies reported in each size class. The 95% confidence interval (which may be interpreted as the true value falling within this range 95% of the time a new sample of beekeepers is drawn from the population) is calculated using the generalised linear model quasi-binomial error distributions outlined in McCullagh & Nelder 1989.

Our national-level estimate of colony losses during winter 2017, based on the NZ Colony Loss Survey, is 9.84%, with a 95% confidence interval of [8.57%, 11.11%].

In the winter 2016 NZ Colony Loss Survey, colony losses using this method were estimated to be 9.78% [8.51%, 11.04%]. In the winter 2015 NZ Colony Loss Survey, colony losses using this method were estimated to be 10.73% [8.66%, 12.80%]. **Because the confidence intervals overlap, the share of colonies lost in winter 2017 is statistically indistinguishable from the share lost in winter 2016 and winter 2015.**

For robustness, we estimated national-level colony losses for winter 2017 in two alternative ways. First, we calculated the average share of colonies lost per beekeeper in each size class in AsureQuality's apiary registry and multiplied this figure by the number of beekeepers in each size class in the registry. Using this method, our national-level estimate of colony losses during winter 2017 based on the NZ Colony Loss Survey is 10.03% [8.75%, 11.31%] (cf. 2016 estimate of 9.67% [8.41%, 10.93%] and 2015 estimate of 10.68% [8.61%, 12.75%]).

As a second alternative, we divided the total number of colonies lost during winter 2017 by the total number of colonies on 1 June 2017 as reported in the NZ Colony Loss Survey. Using this method, our national-level estimate of colony losses during winter 2017 is 9.80% [8.53%, 11.07%] (cf. 2016 estimate of 9.56% [8.31%, 10.82%] and a 2015 estimate of 8.37% [6.30%, 10.44%]).

Estimated colony loss shares over winter 2017 by region (as defined above and shown in Figure 1) are shown in Figure 2. Using the method described in the previous paragraph, we estimate total winter losses of:

- 9.90% [9.65%, 10.15%] in the Upper North Island
- 10.49% [10.28%, 10.70%] in the Middle North Island
- 9.19% [8.94%, 9.44%] in the Lower North Island
- 5.27% [4.88%, 5.66%] in the Upper South Island
- 11.35% [10.89%, 11.81%] in the Middle South Island
- 9.62% [9.20%, 10.05%] in the Lower South Island.

Analogous estimates for 2016 were:

- 8.19% [7.94%, 8.44%] in the Upper North Island
- 10.66% [10.47%, 10.86%] in the Middle North Island
- 11.94% [11.68%, 12.19%] in the Lower North Island
- 5.54% [5.18%, 5.91%] in the Upper South Island
- 7.24% [6.96%, 7.53%] in the Middle South Island
- 7.36% [7.04%, 7.69%] in the Lower South Island.[4]

Thus, over-winter colony losses were statistically higher in 2017 than in 2016 in the Upper North Island, the Middle South Island, and the Lower South Island; over-winter colony losses were statistically lower in 2017 than in 2016 in the Lower North Island; and over-winter colony losses in 2017 were statistically indistinguishable from those in 2016 in other parts of the country.

The share of total losses attributed to queen problems, AFB, wasps, robbing by bees, Argentine ants, suspected starvation, suspected toxic exposure, suspected varroa and related complications, suspected nosema and other diseases, natural disasters, theft or vandalism, accidents, and other causes is shown in Figure 3.

Overall, 34.3% of total colony losses over winter 2017 were attributed to queen problems, 16.9% to suspected varroa and related complications, 13.9% to suspected starvation, and 9.7% to wasps. Disasters accounted for 4.3% of total colony losses, while robbing by other bees accounted for 4.2%. AFB was cited as the cause of 2.82% of total colony losses, followed by disease and accidents, each at 2.6%. Some 2.0% of total colony losses were attributed to suspected exposure to toxins, and 1.9% of losses to theft. Argentine ants were responsible for 0.8% of total colony losses.

[4] Note that the confidence intervals for 2016 presented here differ from those reported in the 2016 NZ Colony Loss report due to basing estimates on beekeepers rather than colonies.

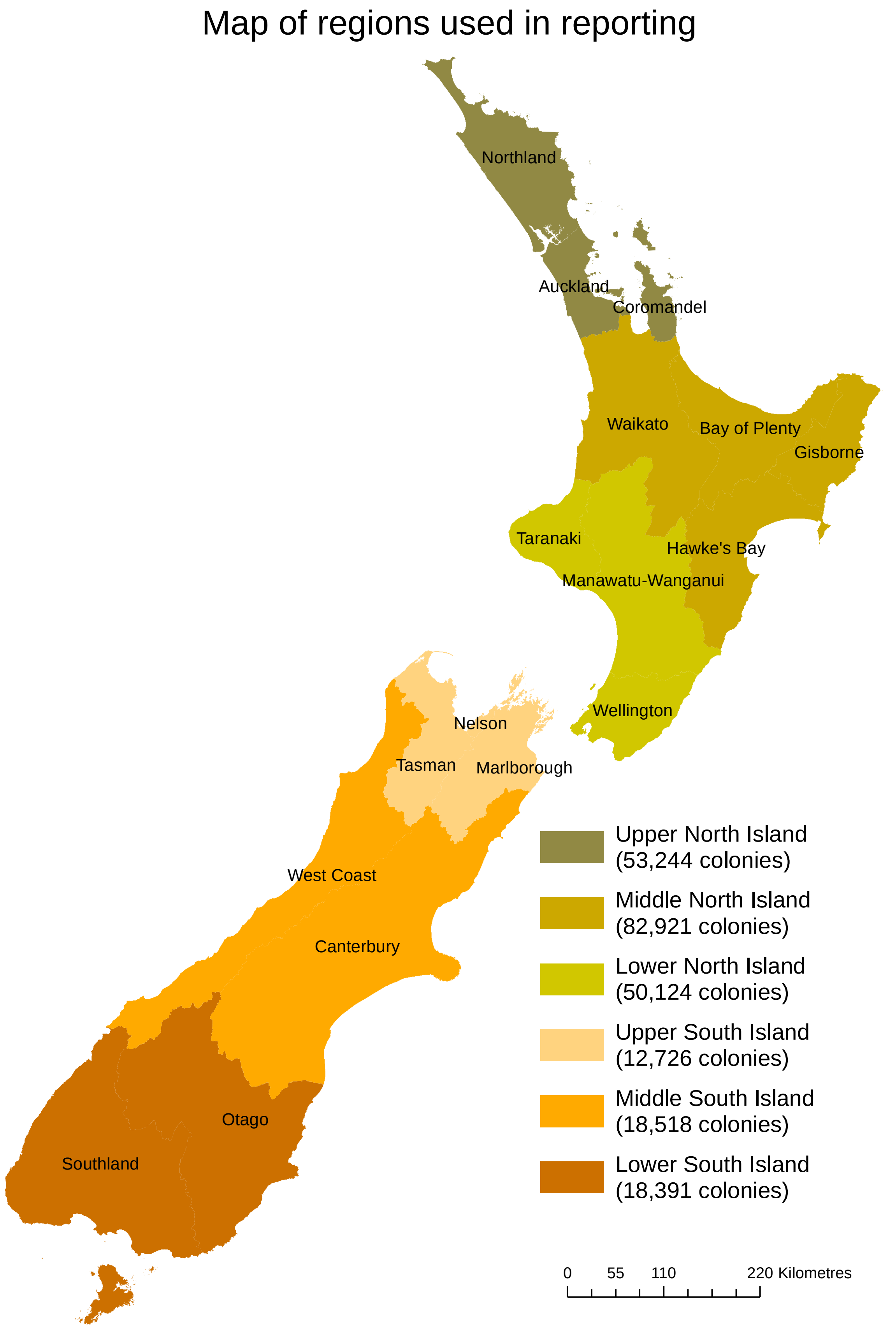

Figure 1: Reference map for reporting by region. Legend shows the number of colonies in each region. Includes all respondents in all operation size classes.

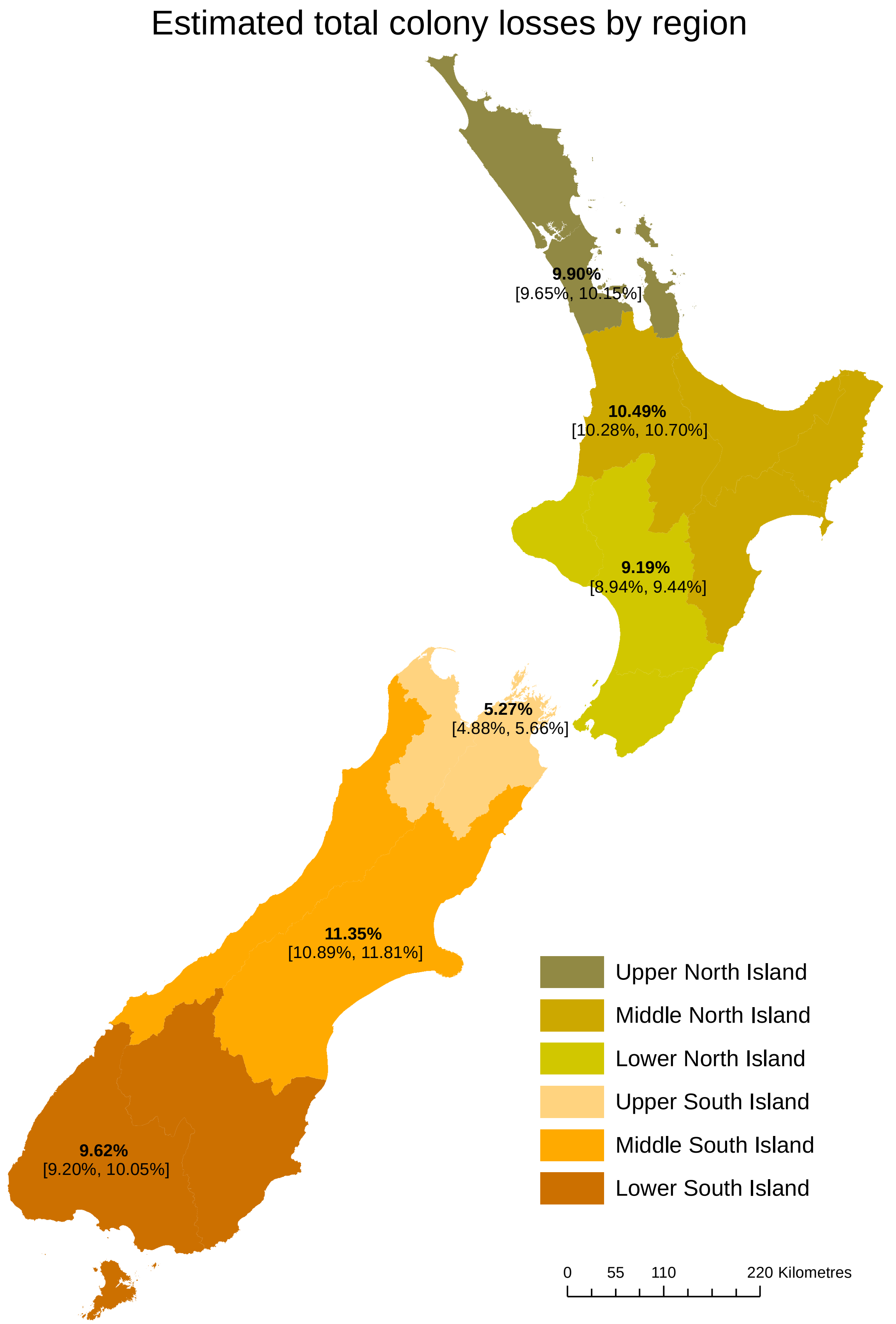

Figure 2: Estimated total colony losses by region. Includes all respondents in all operation size classes.

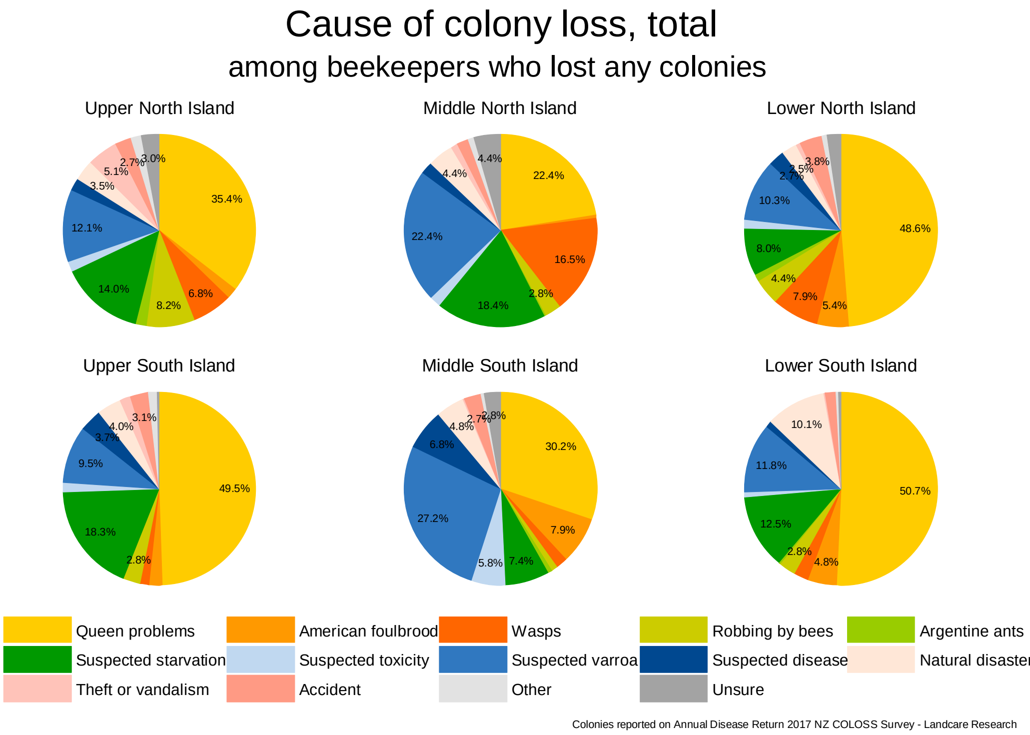

Figure 3: Share of total colony losses over winter 2017 attributed to various causes, based on reports from respondents who lost any colonies, by region.

5.2 Region and Operation Size

Figure 4 shows the region(s) in which the 2,029 beekeepers who completed the survey and who reported having hives in both autumn and spring 2017 registered their hives. Because beekeeping operations may span multiple political regions, some beekeepers are included in more than one region, and so the total share exceeds 1. Ninety-five percent confidence intervals are also depicted in the figure.

Figure 5 shows the operation size reported by each respondent, as at 1 June 2017. Non-commercial beekeepers (1–50 colonies) comprise 87.2% of the sample; semi-commercial beekeepers (51–500 colonies) comprise 7.7% of the sample; commercial beekeepers (501–3,000 colonies) comprise 4.3% of the sample; and large commercial beekeepers (3,001 + colonies) comprise 0.7% of the sample.

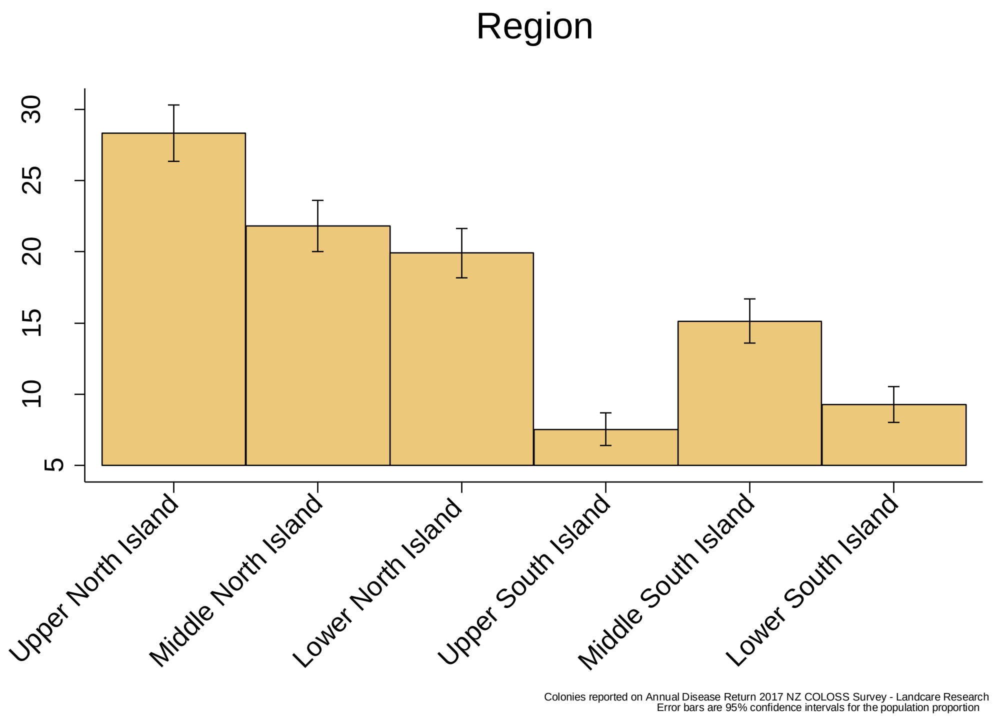

Figure 4: Share of respondents who operate in each region. Includes all respondents in all operation size classes.

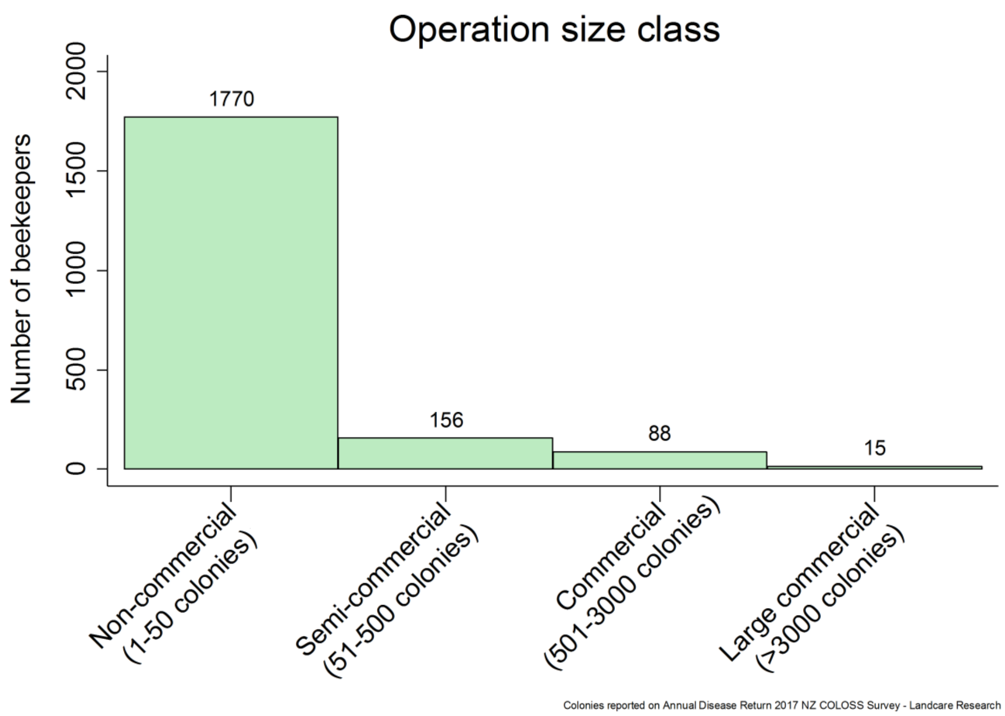

Figure 5: Operation size of respondents grouped into four size classes.

5.3 Average Share of Colonies Lost over Winter 2017

From this point on, numbers reported in figures are interpreted as averages within groups. For example, whereas Figure 2 shows losses as a share of all colonies within each region, Figure 6 reports the average losses across beekeepers within each region.[5] More precisely, Figure 6 reports the entire distribution of colony loss rates over winter 2017 across beekeepers with more than 250 colonies in each region who reported having any colony losses.

Among beekeepers with more than 250 colonies, the mean reported colony loss over winter 2017 was 9.7%, although individual beekeepers in all North Island regions reported losing 30–40% of colonies, with even higher losses reported for one beekeeper in the Middle North Island. The average shares of colonies lost among beekeepers with at least 250 colonies in the North Island and South Island were 9.5% and 8.5%, respectively, with the highest average losses in the Lower North Island at 10.1%.

Among beekeepers with more than 250 colonies in the Upper North Island, 10.3% reported not having lost any colonies. Analogous figures are 9.4% in the Middle South Island and 9.6% in the Lower North Island. Similarly, 10.5% of commercial beekeepers in the Upper South Island, 15.6% of commercial beekeepers in the Middle North Island, and 4.0% of commercial beekeepers in the Lower South Island experienced no colony losses.

Figure 7 shows the distribution of hive losses by operation size, including those with fewer than 251 colonies. Non-commercial beekeepers lost the highest share of colonies, on average, at 15.7%, although 65.7% of non-commercial beekeepers reported having no losses. Semi-commercial beekeepers lost 9.9% of their colonies, on average, with 14.1% reporting no losses. Commercial beekeepers lost 9.4%, on average, while large commercial beekeepers lost 9.6%, on average. Some 93.2% of those with between 501 and 3,000 colonies and 100% of those with more than 3,000 colonies reported colony losses over winter 2017.

[5] For example, consider a region that consists of two beeekeepers, one with 500 colonies and one with 5,000 colonies. Assume that the smaller beekeeper loses 8% of their colonies and that the larger beekeeper loses 12% of their colonies. Losses amount to 11.64% of total colonies in the region, but the average loss per beekeeper in the colony is 10.00%.

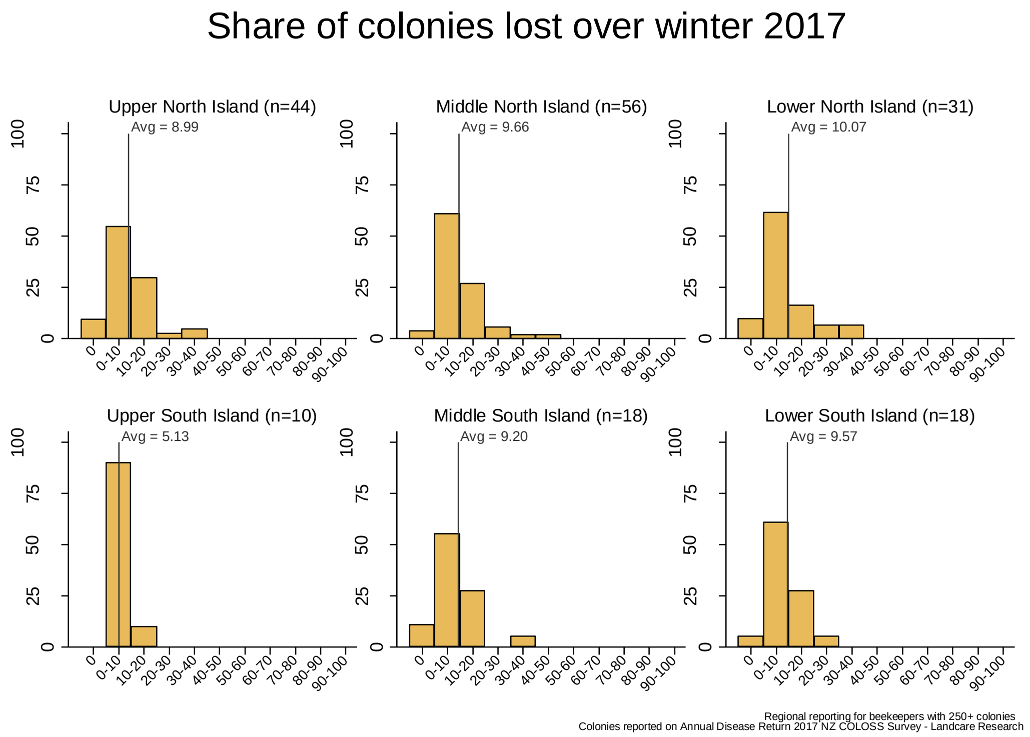

Figure 6: Winter 2017 colony losses as a share of total colonies on 1 June 2017, based on reports from respondents with more than 250 colonies, by region.

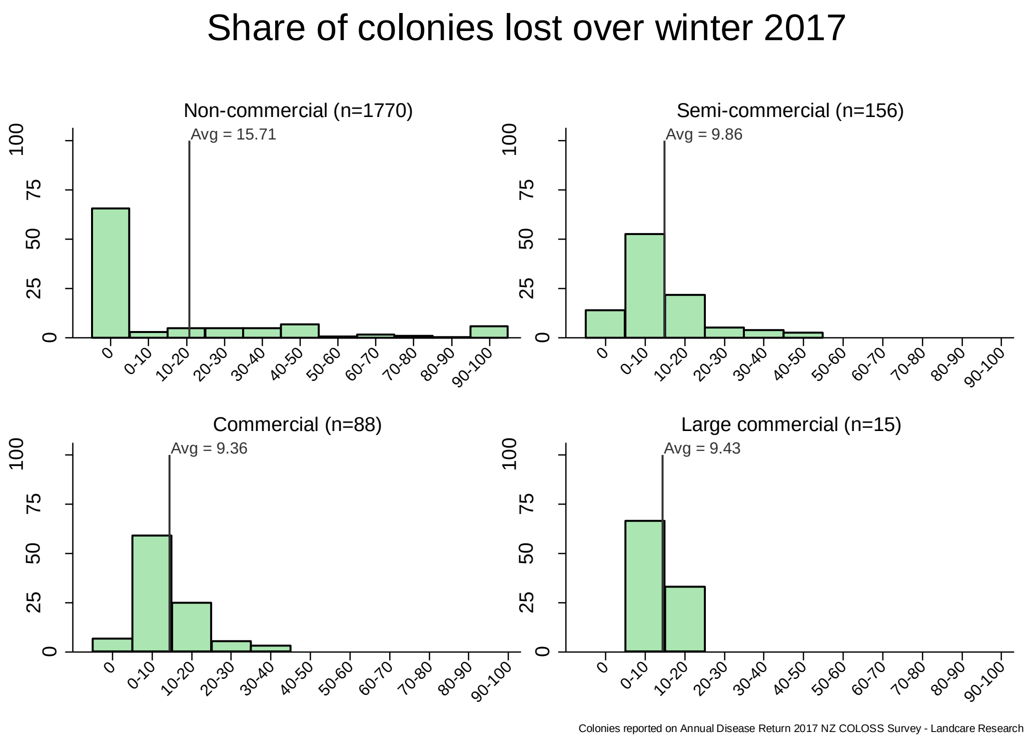

Figure 7: Winter 2017 colony losses as a share of total colonies on 1 June 2017 for all respondents, by operation size.

5.4 Colony Losses

Among beekeepers with more than 250 colonies, 92.8% reported experiencing colony losses over winter 2017. Figure 8 and Figure 9 report the total share of hives lost to queen problems, AFB, wasps, robbing by other bees, Argentine ants, suspected starvation, suspected toxic exposure, suspected varroa and related complications, suspected nosema and other diseases, natural disasters, theft or vandalism, accidents, and other causes, by region for beekeepers with more than 250 colonies and by operation size, among beekeepers who experienced any losses. For example, 23.3% of all losses among non-commercial beekeepers were attributed to queen problems, as were 41.7% of all losses among semi-commercial beekeepers.

Queen problems accounted for 43.3% of colony losses among beekeepers with more than 250 colonies; this figure ranges from 39.9% in the Upper North Island to 55.7% in the Upper South Island. Also, 14.0% of overall losses among commercial beekeepers were attributed to suspected varroa and related complications, 10.1% to suspected starvation, and 7.3% to wasps. Some 4.7% of losses among commercial beekeepers were attributed to disasters, a problem that is especially pronounced in the Lower South Island, which experienced severe flooding in winter 2017. Robber bees accounted for 4.0% of overall losses among commercial beekeepers, a more in the Middle and Lower North Island.

Losses attributed to AFB among commercial beekeepers comprised 2.8% of all losses, although AFB accounted for 8.0% of loss attributions in the Middle South Island. Similarly, losses attributed to suspected toxic exposure among commercial beekeepers comprised 2.4% of all losses, although toxic exposure accounted for 7.2% of loss attributions in the Middle South Island. Losses attributed to nosema and other diseases total 2.0%. Theft and vandalism accounted for 1.5% of losses among commercial beekeepers across the country but 3.6% of losses in the Upper North Island and 3.4% of losses in the Upper South Island. Losses attributed to accidents (typically livestock knocking over hives) are uncommon, and those attributed to Argentine ants are rare.

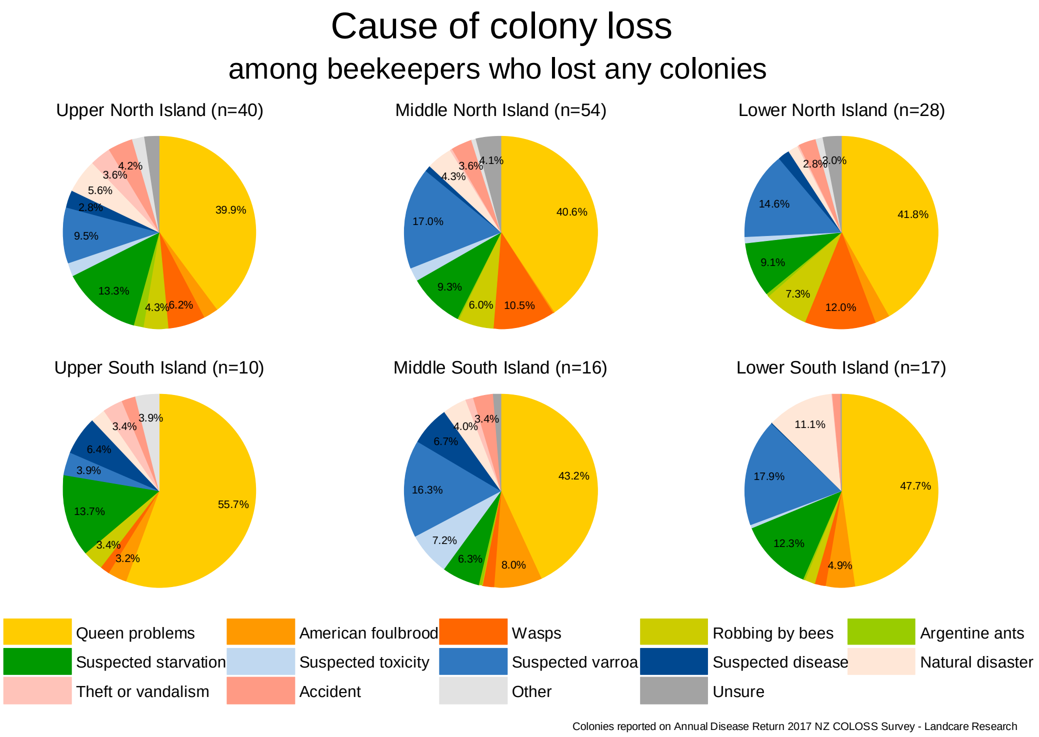

Figure 8: Share of colony losses attributed to various causes based on reports from respondents with more than 250 colonies who lost any colonies, by region.

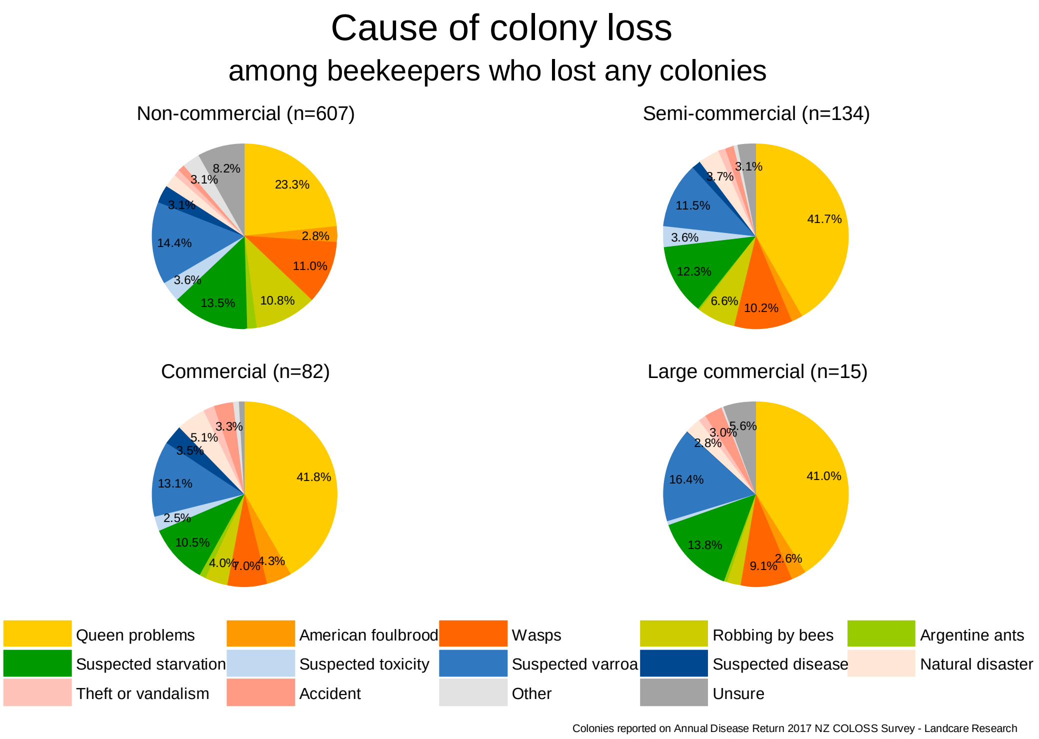

Figure 9: Share of colony losses attributed to various causes, based on reports from respondents who lost any colonies, by operation size.

5.4.1 Queen Problems

A colony functions as a 'superorganism', such that any disruption in the replenishment of each cohort, from egg to larva in the brood or from nurse to forager in the worker population, can cause a colony to fail. A well-mated, healthy queen drives the reproduction and growth of the colony, but she needs nurse bees to feed her, and nurse bees need foragers to bring pollen and nectar to make royal jelly. She, of course, needs healthy drones for mating in order to produce worker bees. As such, colonies with queen problems such as drone-laying queens, drone-laying workers in the absence of a queen, and queens that are sick or not well mated are at risk of loss.

Beekeepers with more than 250 colonies that experienced colony loss attributed a greater share of colony losses to queen problems, on average, than did smaller beekeepers (Figure 11). For example, non-commercial beekeepers who lost colonies over winter 2017 attributed 23.3% of losses to queen problems, on average, versus more than 40% of losses among commercial beekeepers. The distribution of colony losses attributed to queen problems also depends on operation size: for example, 68.4% of beekeepers with 1–50 colonies who experienced colony losses attributed none of their colony losses to queen problems, versus 7.8% of beekeepers with more than 250 colonies. Among commercial beekeepers, colony losses were attributed to queen problems more in the Lower South Island than elsewhere (Figure 10).

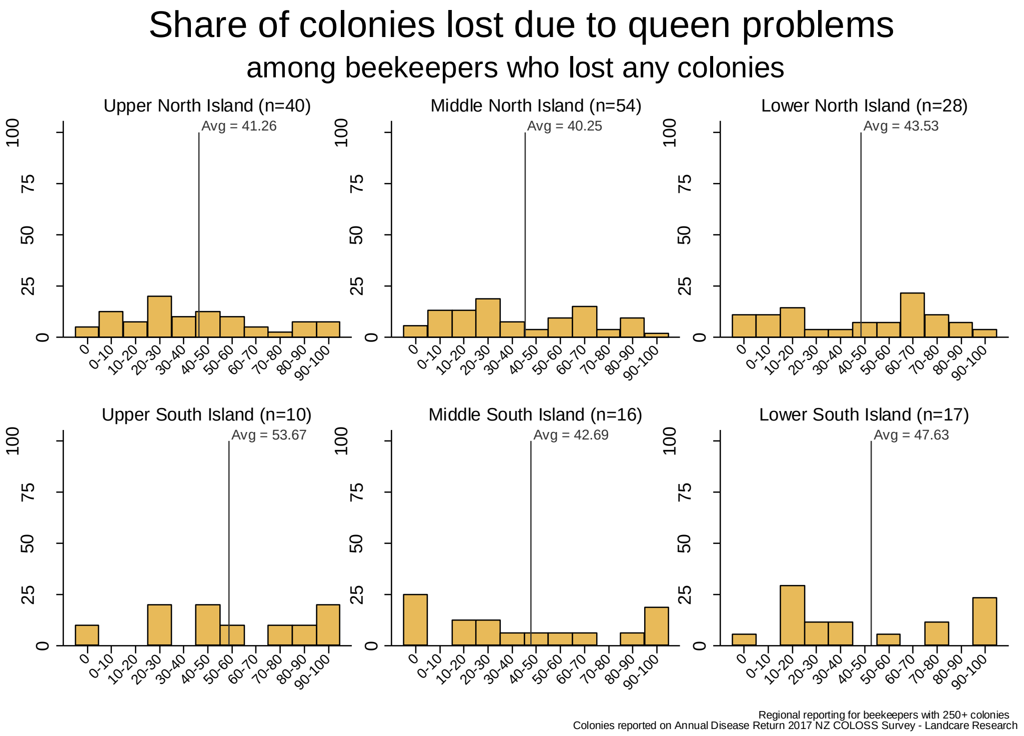

Figure 10: Winter 2017 colony losses that resulted from queen problems (including drone-laying queens and no queen), based on reports from respondents with more than 250 colonies who lost any colonies, by region.

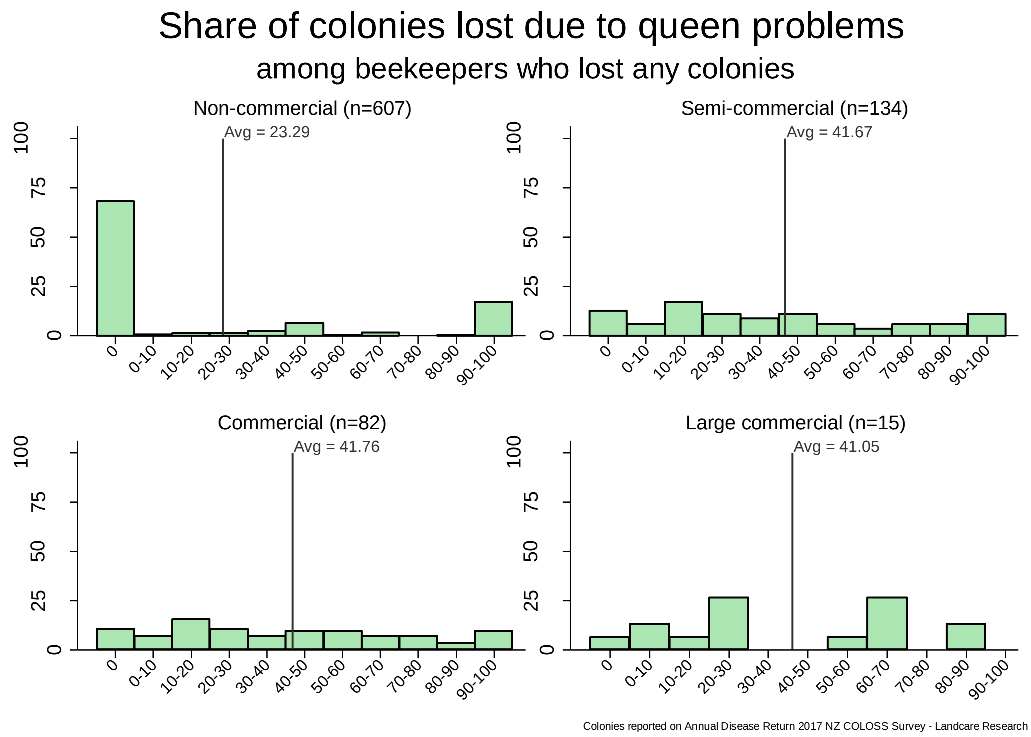

Figure 11: Winter 2017 colony losses that resulted from queen problems (including drone-laying and no queen), based on reports from all respondents who lost any colonies, by operation size.

5.4.2 Suspected Varroa and Related Complications

The international COLOSS surveys include a catch-all category of losses that generally require verification. This 'colony death' category explicitly includes suspected toxic exposure and suspected starvation, and implicitly includes varroa and related complications, and nosema and other diseases. In both 2015 and 2016, New Zealand beekeepers attributed many losses to 'colony death' and later remarked that they found the category to be poorly defined. Hence, for 2017 we asked about specific causes of losses associated with colony death (e.g. starvation and exposure to toxins) without first asking beekeepers to identify colony death as the cause.

The varroa mite is an ectoparasite that feeds off the bodily fluids of adult, pupal, and larval honey bees. Varroa can transmit deformed wing virus (which is also transmitted sexually; see Amiri et al. 2016) and many other viruses. The varroa mite arrived in the North Island in 2000 and spread to the South Island in 2006, resulting in more frequent colony losses and increased labour and control costs. Some 14.1% of overall losses among commercial beekeepers are attributed to suspected varroa and related complications. This figure ranges from 3.9% in the Upper South Island (indicating low varroa infestation levels) to nearly 18% in the Middle North Island, Middle South Island, and Lower South Island (Figure 12). Attributions of colony loss to varroa range from 11.5% for semi-commercial beekeepers to 16.5% for large commercial beekeepers (Figure 13), although the distribution of varroa-related losses among non-commercial beekeepers is bimodal, with 80.9% experiencing no varroa-related losses and 10.4% losing all colonies to varroa.

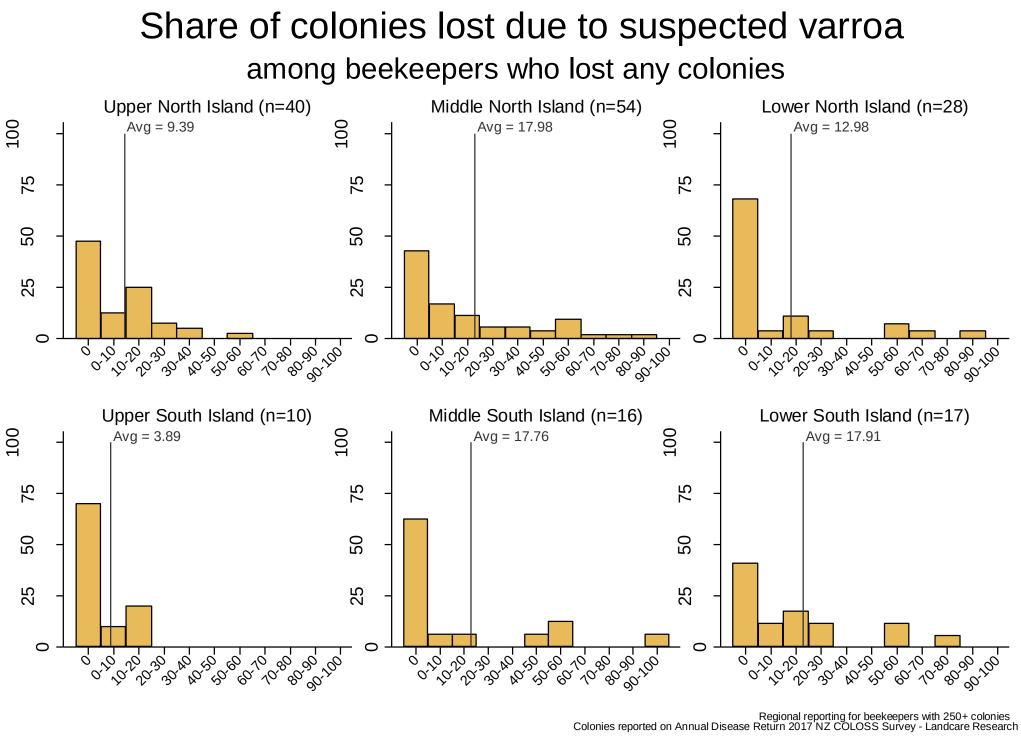

Figure 12: Winter 2017 colony losses that resulted from suspected varroa and related complications, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

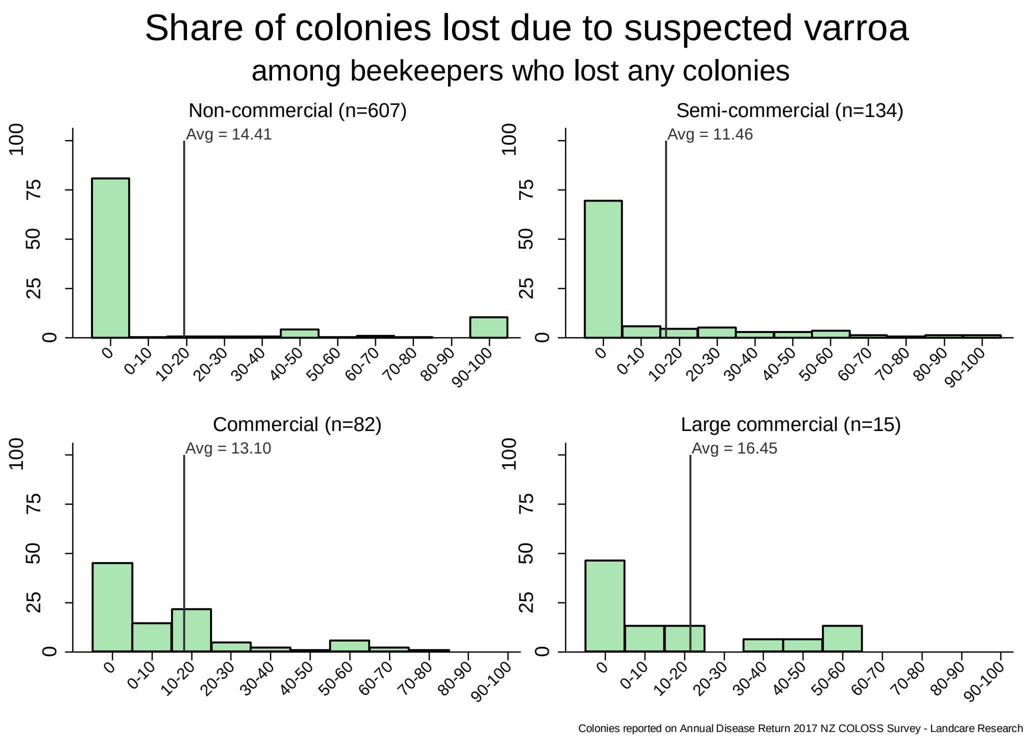

Figure 13: Winter 2017 colony losses that resulted from suspected varroa and related complications, based on reports from all respondents who lost any colonies, by operation size.

5.4.3 Suspected Starvation

Dead worker bees in cells with no food present in the colony is indicative of starvation. On average, 10.3% of losses were attributed to suspected starvation by beekeepers with more than 250 colonies (Figure 14). Loss shares attributed to starvation were similar across operation size classes (Figure 15), ranging from 10.5% for commercial beekeepers to 13.8% for large commercial beekeepers. Starvation may be a symptom of excessive competition for nectar and pollen sources and is symptomatic of the rapid increase in colony numbers associated with the mānuka honey boom. In addition, colony weakening during times of pollen and nectar dearth and during bad weather are common, although these problems may be mitigated by supplementary feeding of sugar and protein.

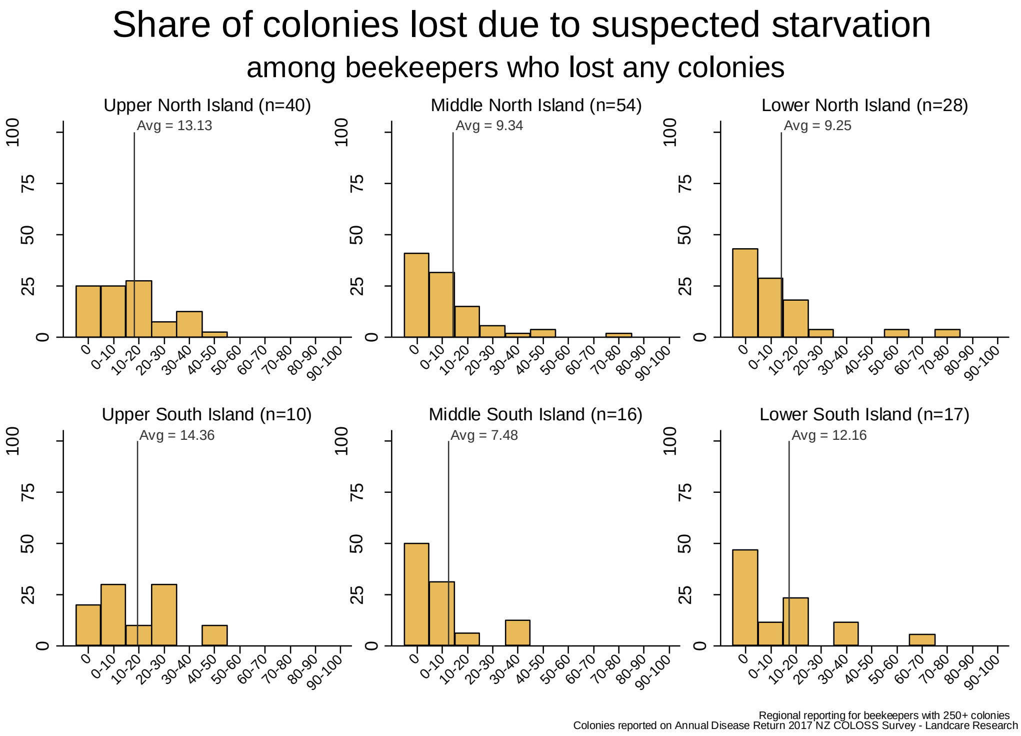

Figure 14: Winter 2017 colony losses that resulted from suspected starvation, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

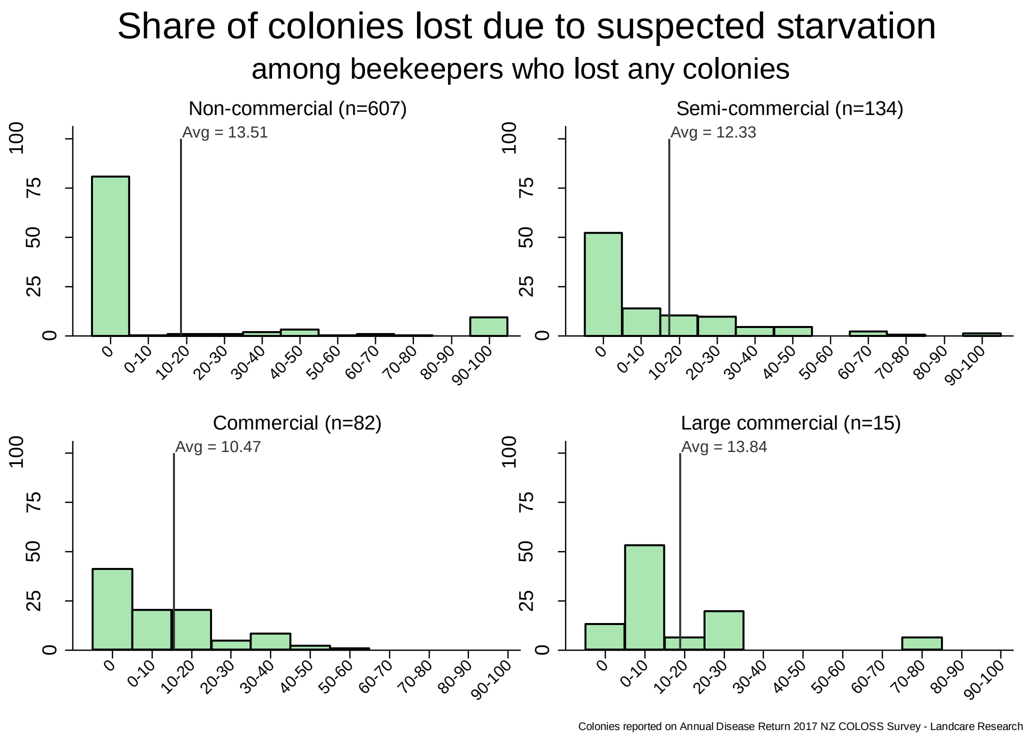

Figure 15: Winter 2017 colony losses that resulted from suspected starvation, based on reports from all respondents who lost any colonies, by operation size.

5.4.4 Wasps

Widespread infestations of the giant willow aphid have contributed to increasing populations of wasps that feed on the honeydew produced by these aphids. Wasps kill honey bee colonies in winter by robbing their honey stores and/or by seeking protein to feed their own young. As shown in Figure 17, beekeepers attributed 10.5% of colony losses to wasps. On average, the proportion was slightly higher for non-commercial beekeepers (11.0%) than for semi-commercial beekeepers (10.3%), commercial beekeepers (7.0%), and large commercial beekeepers (9.1%). Wasps contribute a much greater average share of colony losses in the North Island (9.2% among beekeepers with more than 250 colonies) than in the South Island (1.7%), with the highest average shares in the Middle and Lower North Island (Figure 16).

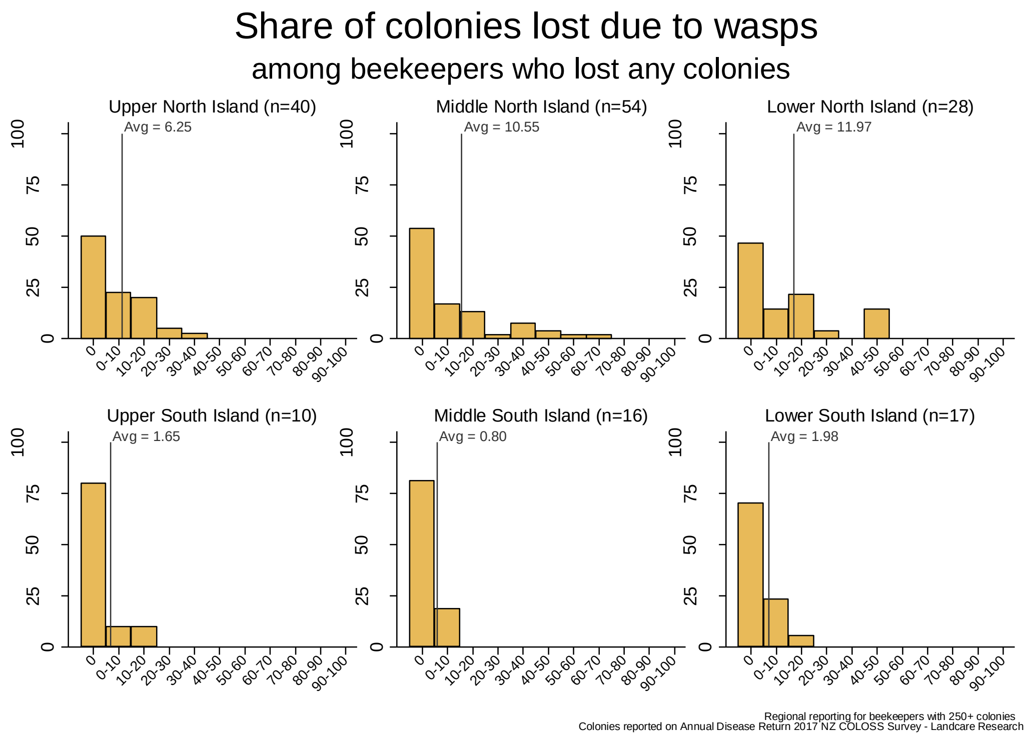

Figure 16: Winter 2017 colony losses that resulted from wasp problems, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

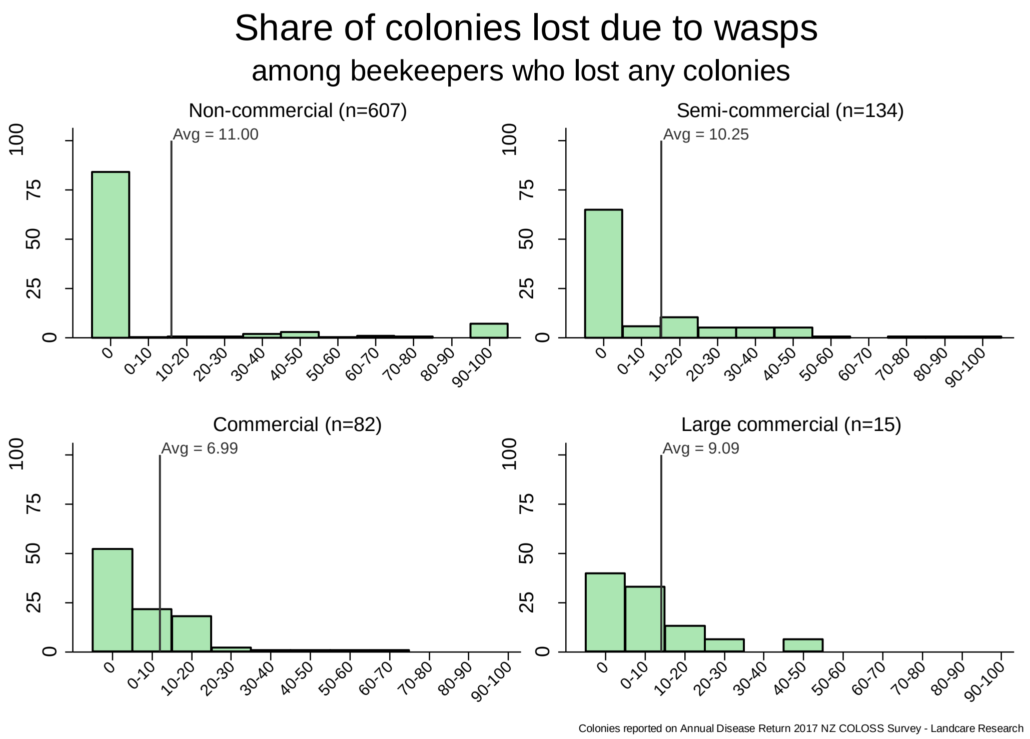

Figure 17: Winter 2017 colony losses that resulted from wasp problems, based on reports from all respondents who lost any colonies, by operation size.

5.4.5 Natural Disasters

Severe flooding in Otago during winter 2017 probably contributed to losses due to natural disasters in the Lower South Island, where 11.1% of losses among commercial beekeepers were attributed to disasters, on average (Figure 18). Individual beekeepers in both the Middle South Island and Lower South Island lost 30% or more of their colonies to natural disasters (Figure 19).

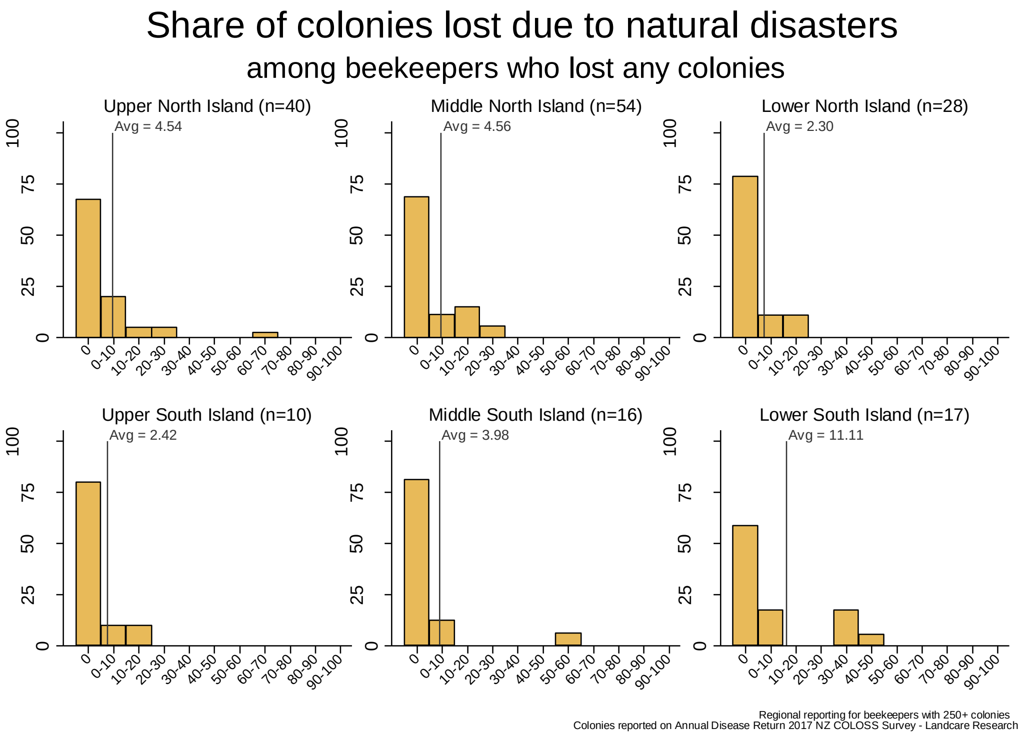

Figure 18: Winter 2017colony losses that resulted from natural disasters, based on reports from respondents with more than 250 colonies who lost any colonies, by region. Natural disasters include gale force winds, flooding, etc.

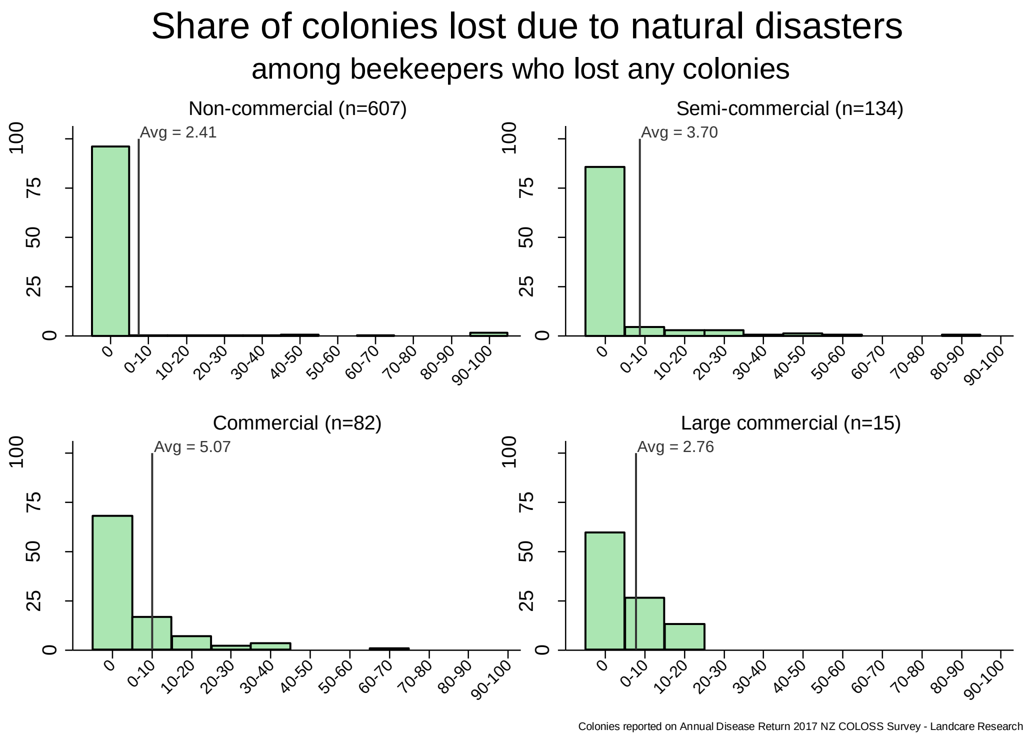

Figure 19: Winter 2017colony losses that resulted from natural disasters, based on reports from all respondents who lost any colonies, by operation size. Natural disasters include gale force winds, flooding, etc.

5.4.6 Robbing by Other Bees

Robber bees rob weaker hives, particularly when there is a dearth of nectar sources. Robbing is significantly more common among non-commercial beekeepers than among commercial beekeepers (Figure 21). Among beekeepers with at least 251 colonies, robbing is more common in the North Island, where mānuka-honey production is prominent (Figure 20).

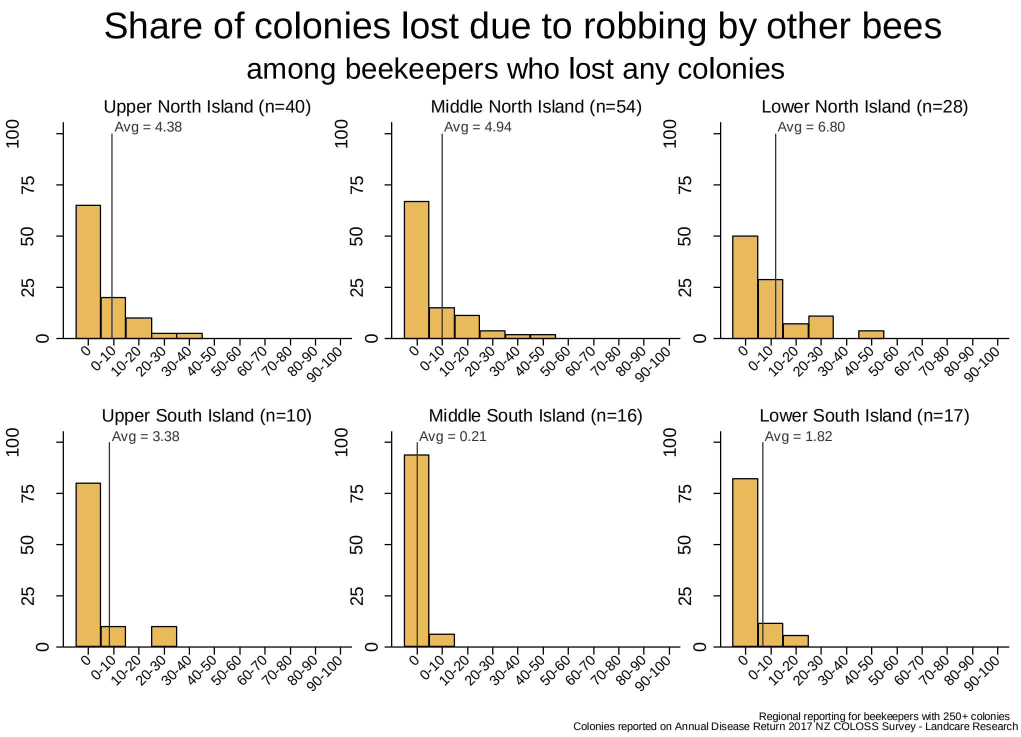

Figure 20: Winter 2017 colony losses that resulted from robbing by other bees, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

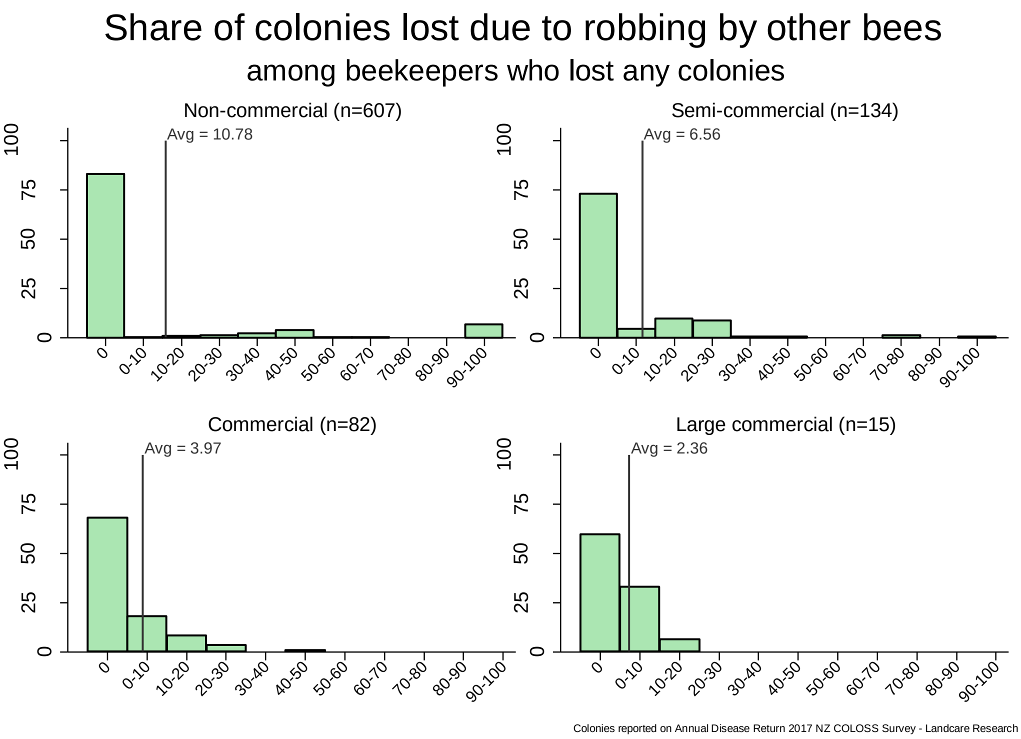

Figure 21: Winter 2017 colony losses that resulted from robbing by other bees, based on reports from all respondents who lost any colonies, by operation size.

5.4.7 American Foulbrood Disease

Among the 242,924 colonies reported on by all beekeepers, 651 cases of AFB were reported. Among beekeepers with more than 250 colonies who reported losing any colonies in winter 2017, 2.8% of losses were attributed to AFB (Figure 22). However, large losses were reported among individual commercial beekeepers in the Upper North Island and the Lower South Island. AFB accounted for 8.0% of loss attributions in the Middle South Island.

New Zealand has a Pest Management Plan (PMP) under the Biosecurity Act 1993 that aims to eradicate AFB from this country. Controls on spread of AFB under them PMP include beekeeper training, annual inspections, and a requirement to burn colonies with any signs of AFB infestation. Beekeepers reported that AFB affected 0.06% of the colonies included in the 2015 NZ Colony Loss Survey, 0.21% of the colonies included in the 2016 NZ Colony Loss Survey, and 0.27% of the colonies included in the 2017 NZ Colony Loss Survey.

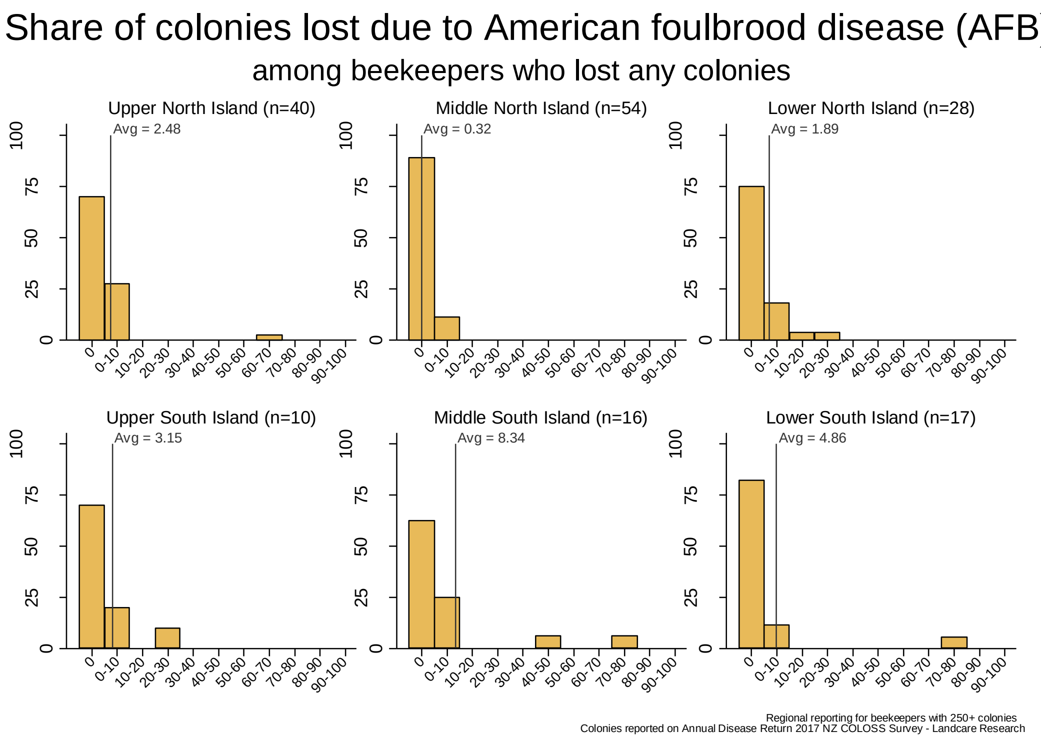

Figure 22: Winter 2017 colony losses that resulted from AFB, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

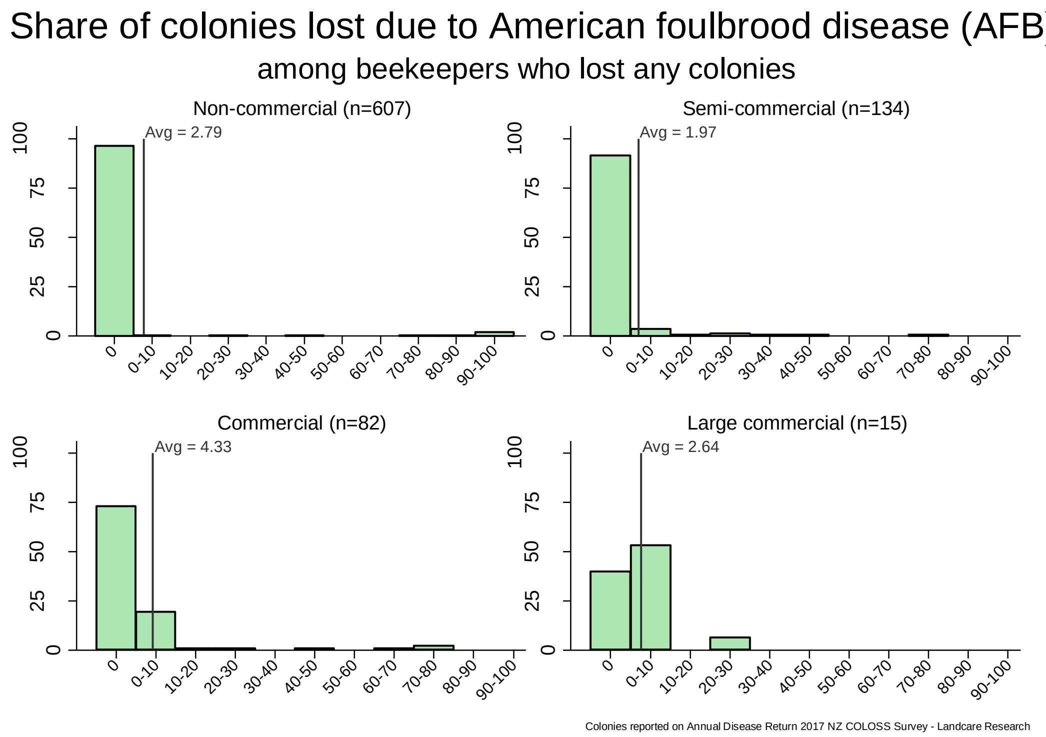

Figure 23: Winter 2017 colony losses that resulted from AFB, based on reports from all respondents who lost any colonies, by operation size.

5.4.8 Suspected Toxic Exposure

Having many dead bees in or in front of the colony is indicative of exposure to environmental toxins such as plant toxins and chemicals such as insecticides, fungicides, and surfactants. Some 2.4% of winter 2017 losses among commercial beekeepers were attributed to toxicity (Figure 24), indicating that toxic exposure is a concern, particularly in the Middle South Island, where 7.2% of losses were attributed to suspected toxic exposure. However, the survey does not distinguish between insecticides/agrochemicals and naturally occurring karaka poisoning (Palmer-Jones & Line 1962). Exposure to toxicity is qualitatively lower among large commercial beekeepers than among smaller beekeepers (Figure 25).

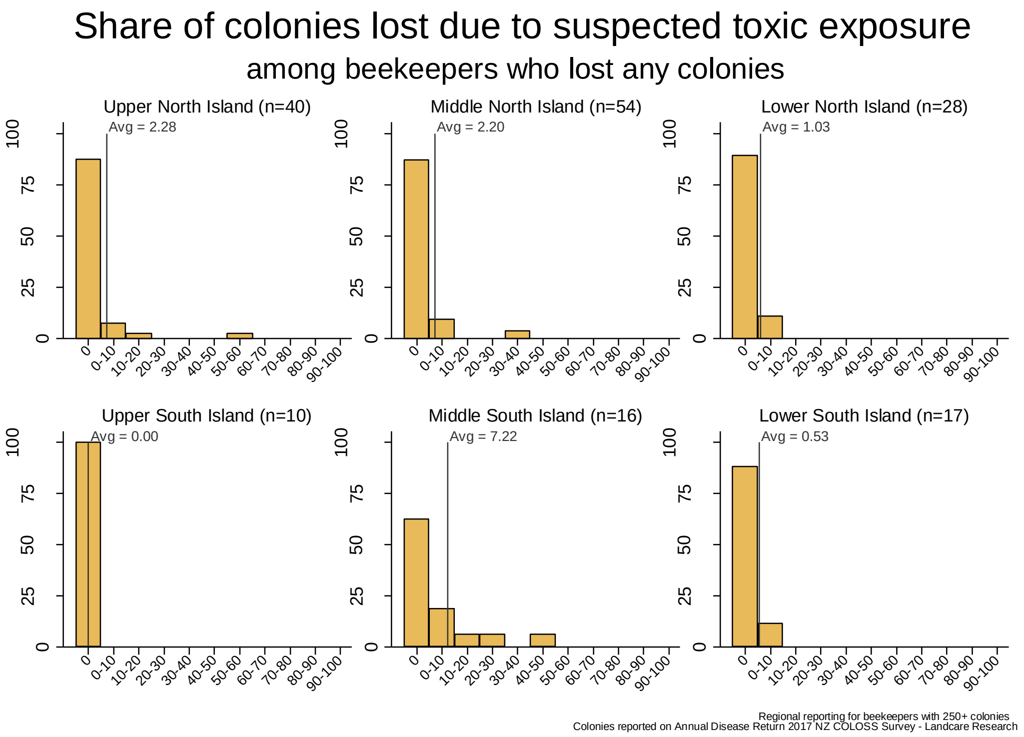

Figure 24: Winter 2017 colony losses that resulted from suspected toxic exposure, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

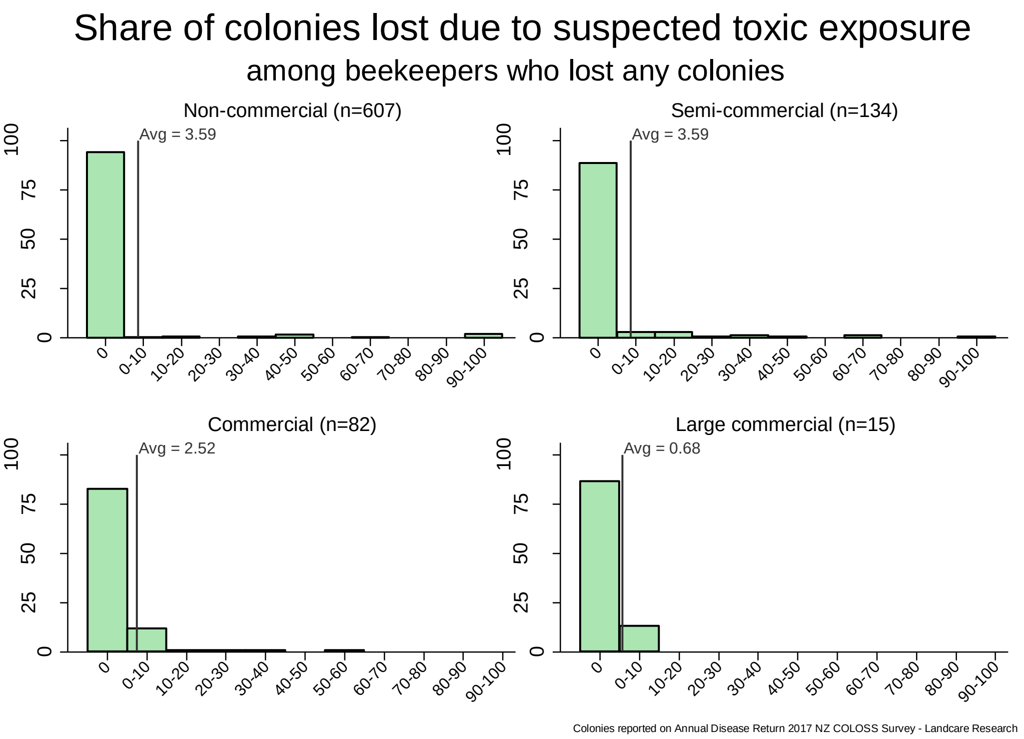

Figure 25: Winter 2017 colony losses that resulted from suspected toxic exposure, based on reports from all respondents who lost any colonies, by operation size.

5.4.9 Suspected Nosema and Other Diseases

Nosema apis is a microsporidian parasite that invades the intestinal tracts of adult bees, causing nosemosis. It is most problematic when bees cannot leave their colonies to eliminate waste (e.g. during cold winters or when bees are stored indoors). Unable to take cleansing flights, bees can develop dysentery, the tell-tale signs of which include high levels of faeces on the front of the hive. Commercial beekeepers attributed 2.0% of winter 2017 colony losses to suspected nosema and other diseases, with significantly higher shares in the Upper South Island (7.8%) and Middle South Island (6.7%) (Figure 26). Suspected disease is less problematic among large commercial beekeepers, on average (Figure 27).

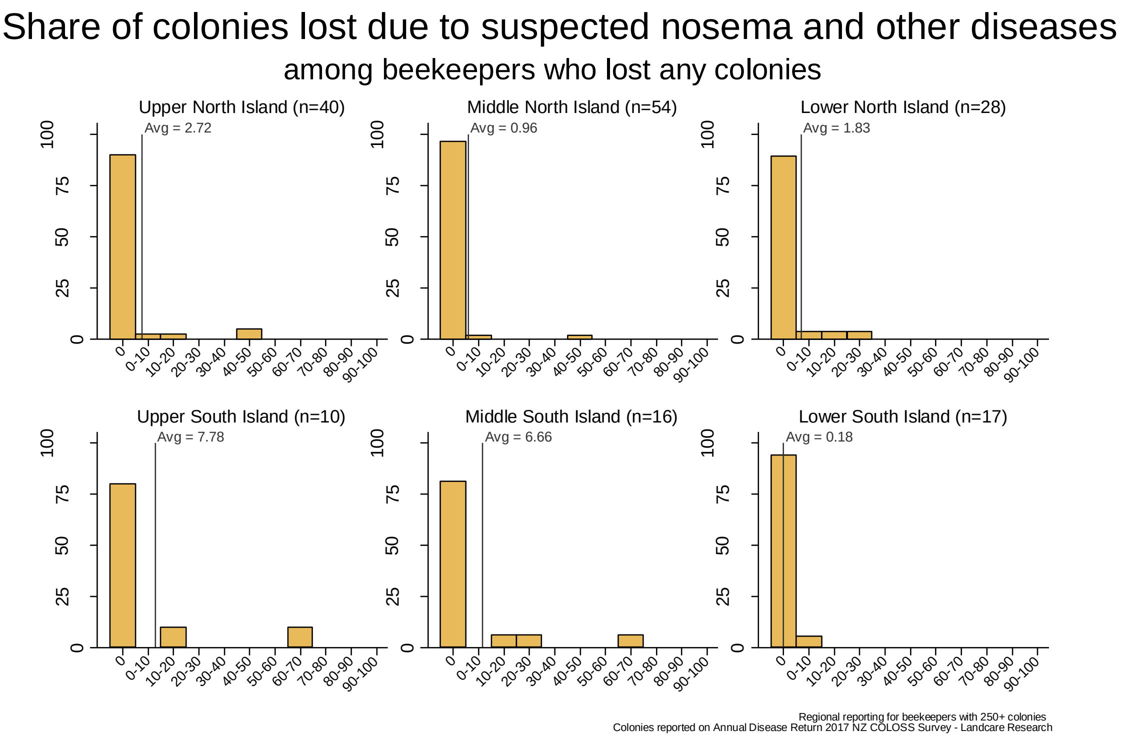

Figure 26: Winter 2017 colony losses that resulted from suspected nosema and other diseases, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

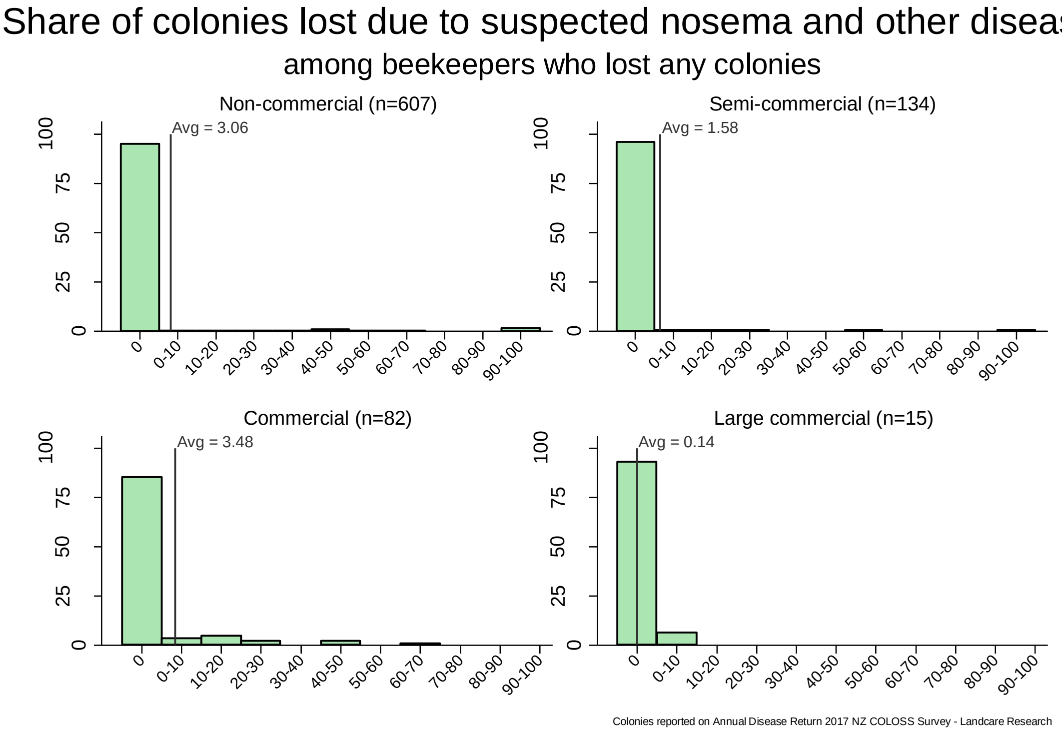

Figure 27: Winter 2017 colony losses that resulted from suspected nosema and other diseases, based on reports from all respondents who lost any colonies, by operation size.

5.4.10 Theft or Vandalism

Theft and vandalism are rare overall but more common in mānuka-producing areas than elsewhere. Nevertheless, 1.5% of winter 2017 colony losses among commercial beekeepers were attributed to theft or vandalism (Figure 28), with 3.4% of losses attributed to theft or vandalism in the Upper North Island and the Upper South Island.

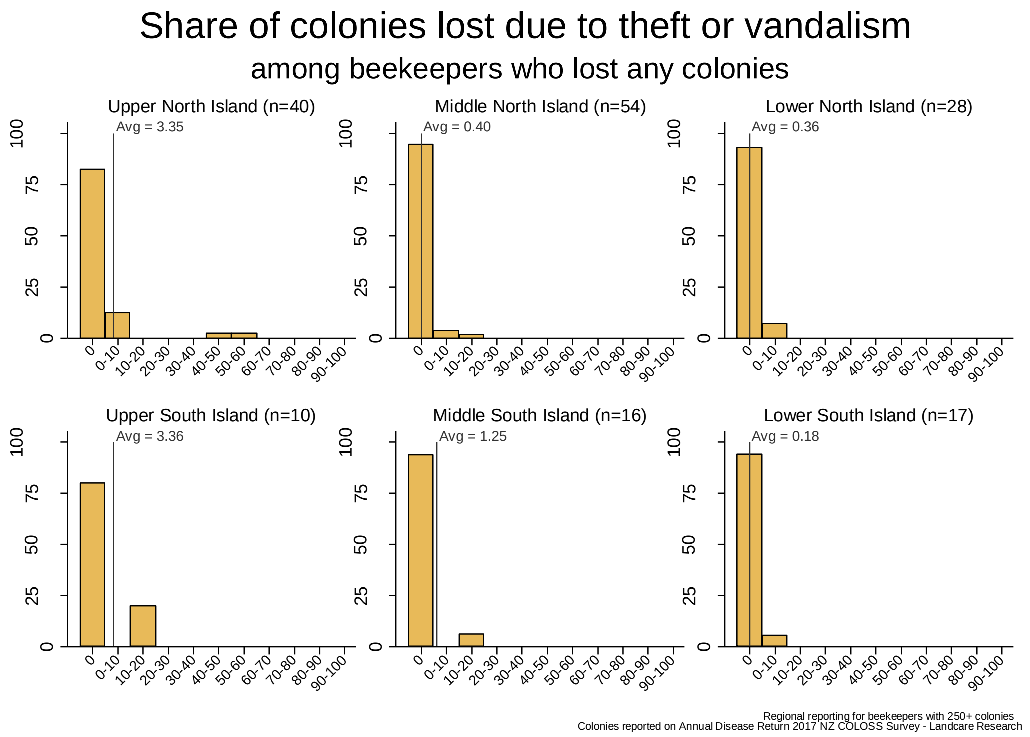

Figure 28: Winter 2017 colony losses that resulted from theft or vandalism, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

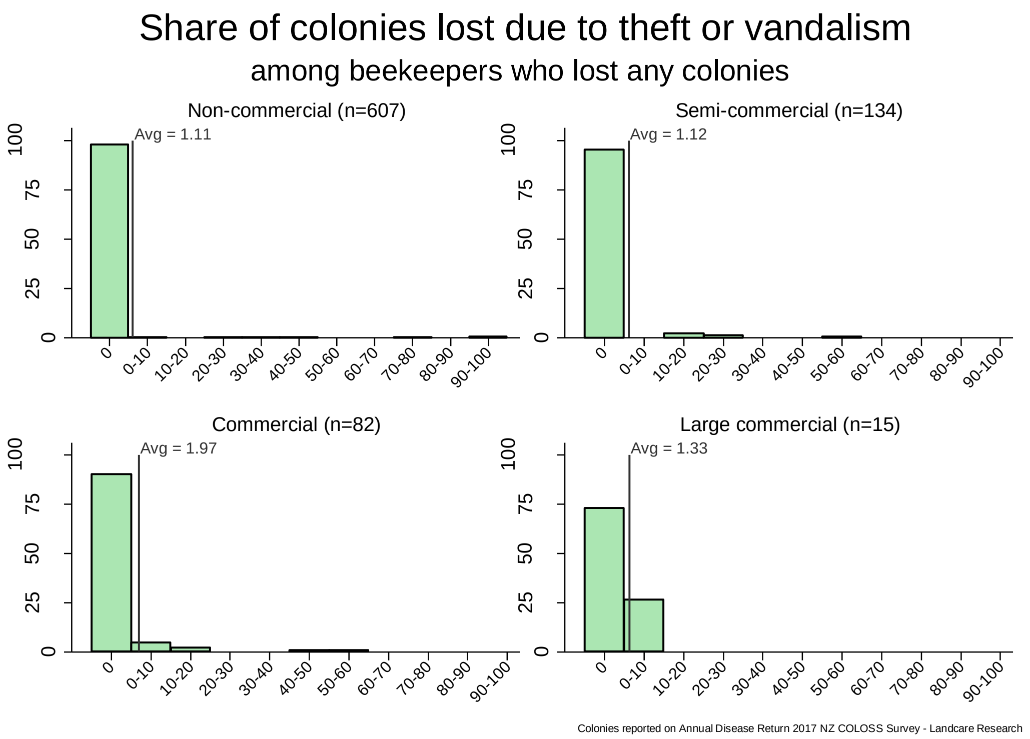

Figure 29: Winter 2017 colony losses that resulted from theft or vandalism, based on reports from all respondents who lost any colonies, by operation size.

5.4.11 Other Attributions of Colony Losses Over Winter 2017

Losses attributed to accidents, Argentine ants, and other causes are reported in Figures 30–31, Figures 32–33, and Figures 34–35, respectively.

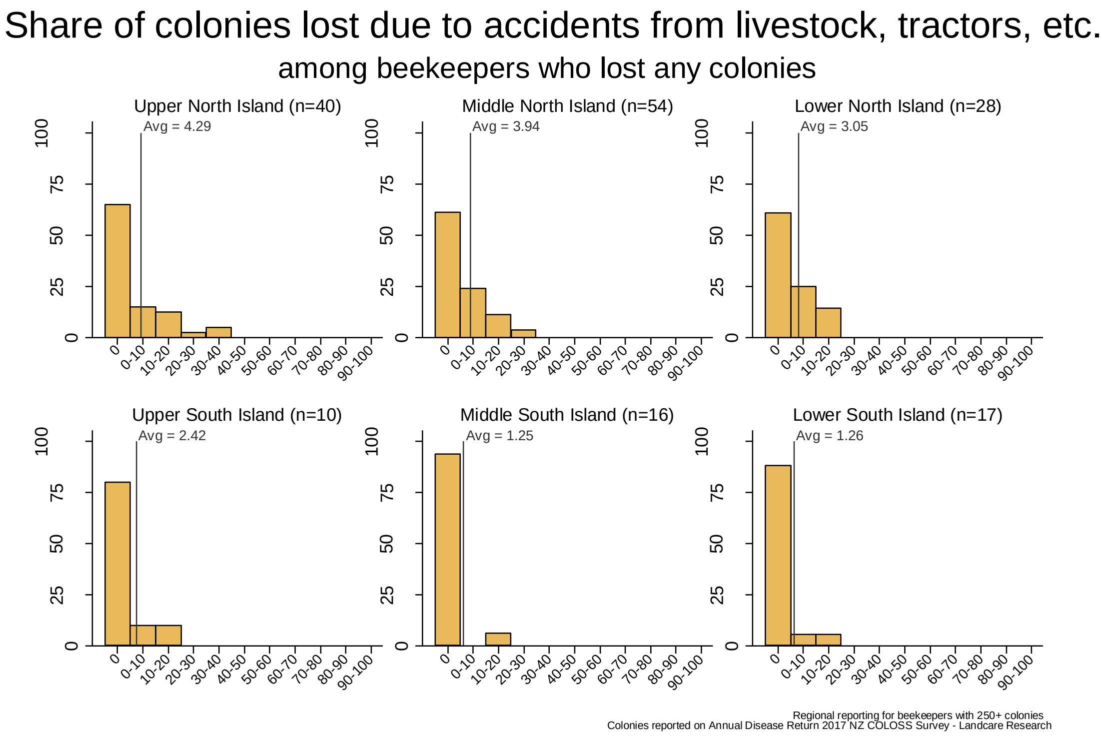

Figure 30: Winter 2017 colony losses that resulted from accidents such as livestock, tractors, etc., based on reports from respondents with more than 250 colonies who lost any colonies, by region.

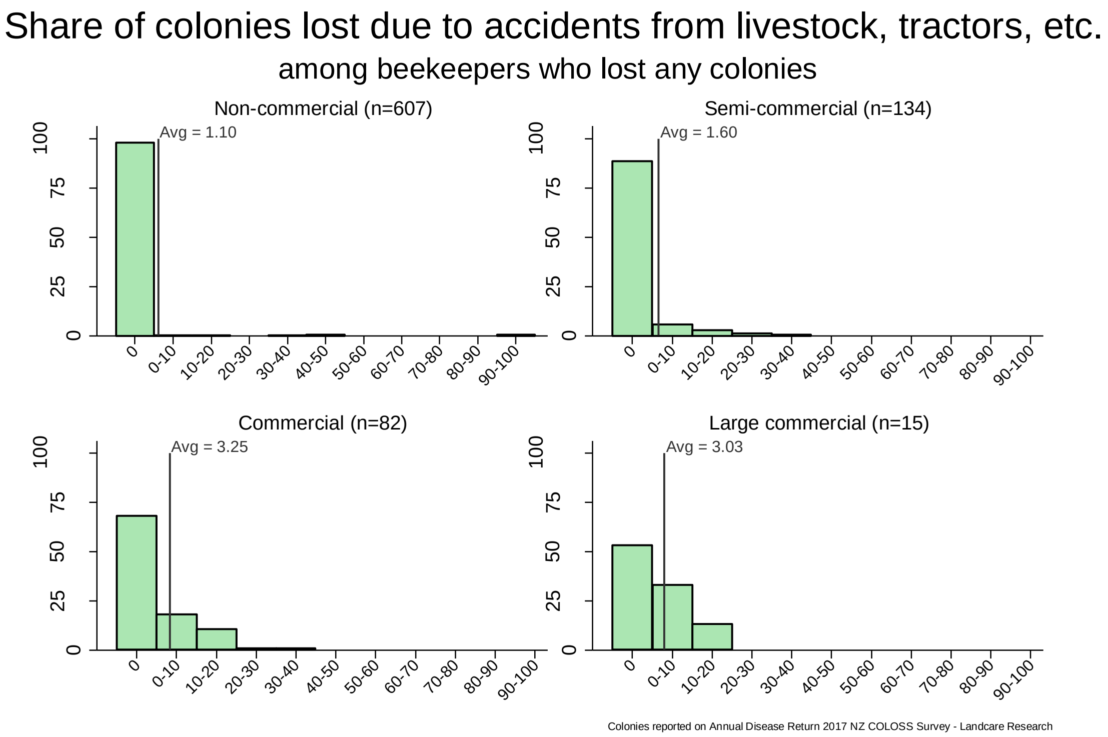

Figure 31: Winter 2017 colony losses that resulted from accidents such as livestock, tractors, etc., based on reports from all respondents who lost any colonies, by operation size.

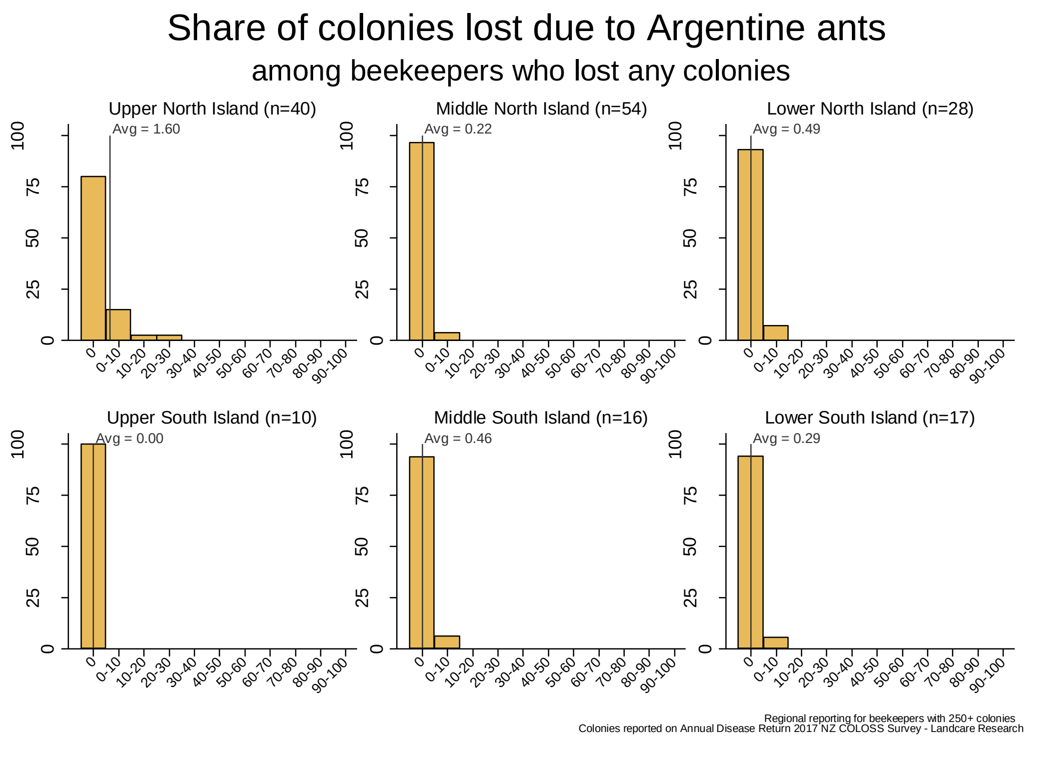

Figure 32: Winter 2017 colony losses that resulted from Argentine ant problems, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

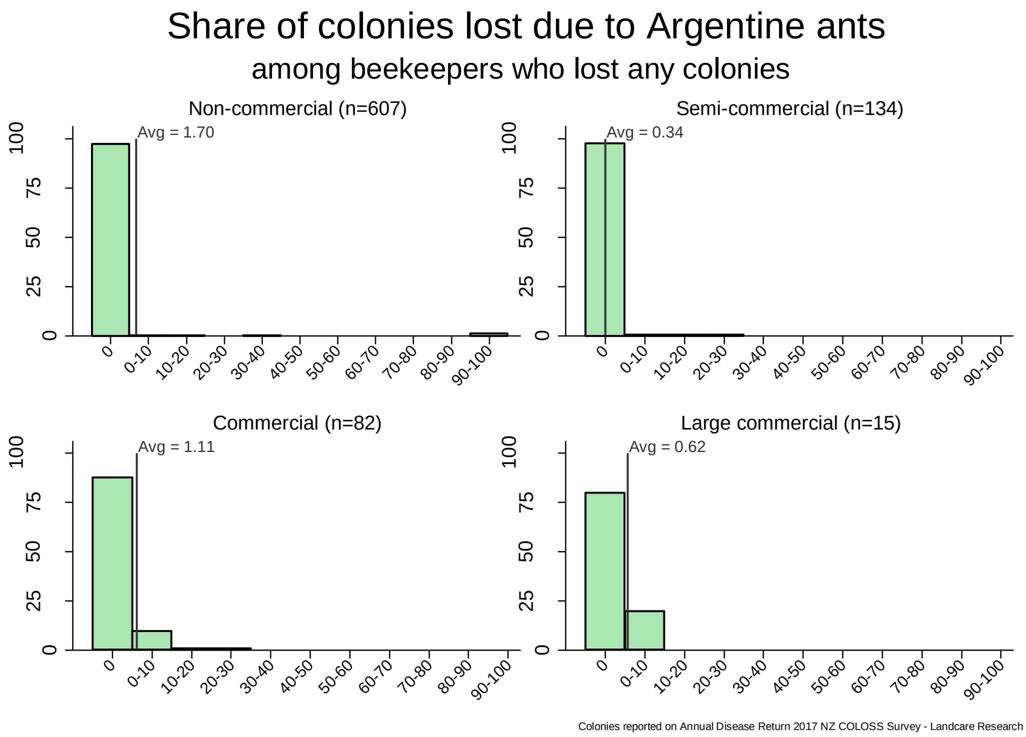

Figure 33: Winter 2017 colony losses that resulted from Argentine ant problems, based on reports from all respondents who lost any colonies, by operation size.

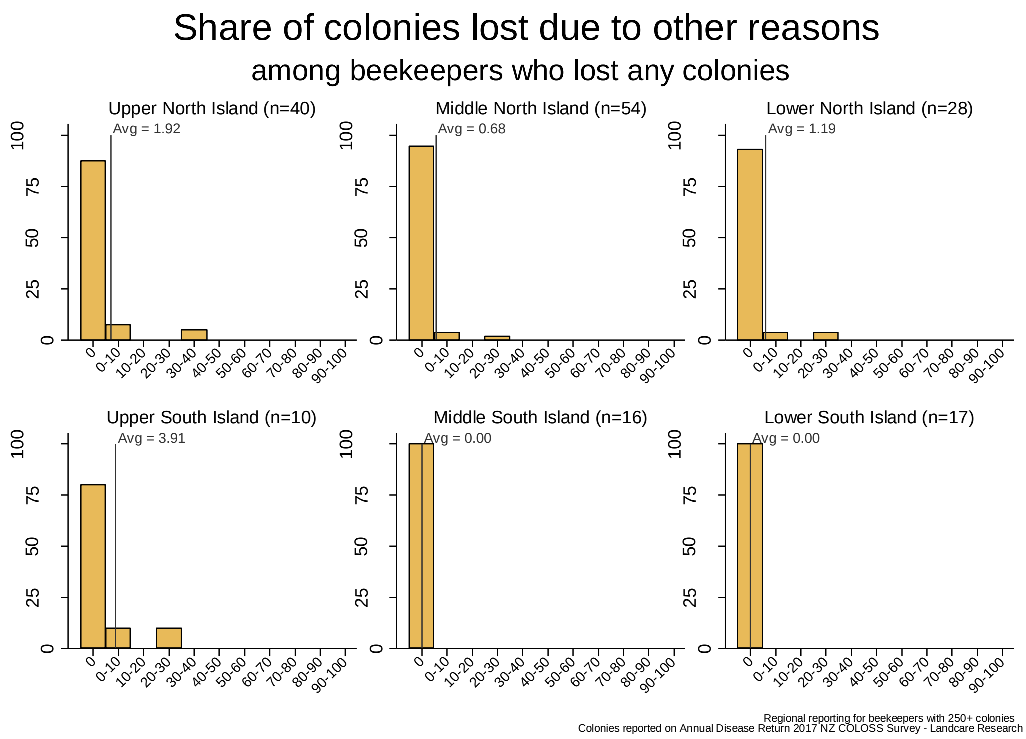

Figure 34: Winter 2017 colony losses that resulted from other problems, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

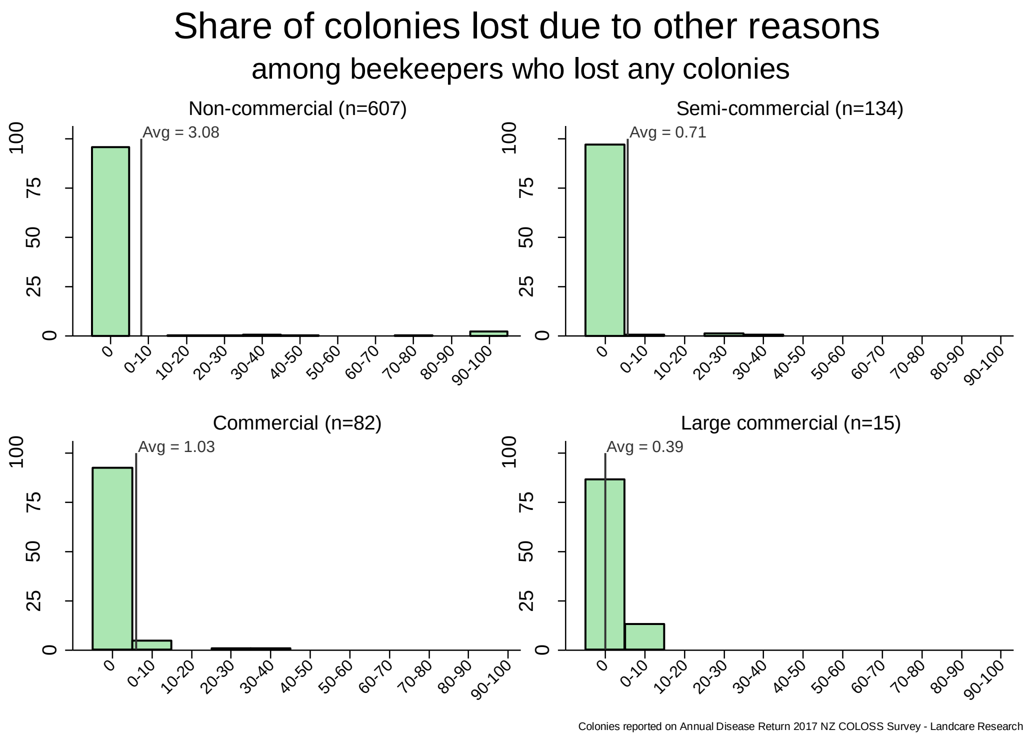

Figure 35: Winter 2017 colony losses that resulted from other problems, based on reports from all respondents who lost any colonies, by operation size.

5.5 State of Surviving Colonies

Production colonies may survive winter but enter spring in a weakened state. Beekeepers with more than 250 colonies reported that 17.0% of their colonies were weak but queenright in spring 2017 (Figure 36), with higher shares reported in the Middle South Island and Lower South Island. Weak colonies were a pronounced challenge for non-commercial beekeepers, who reported that 31.4% of their surviving colonies were weak but queenright, on average (Figure 37).

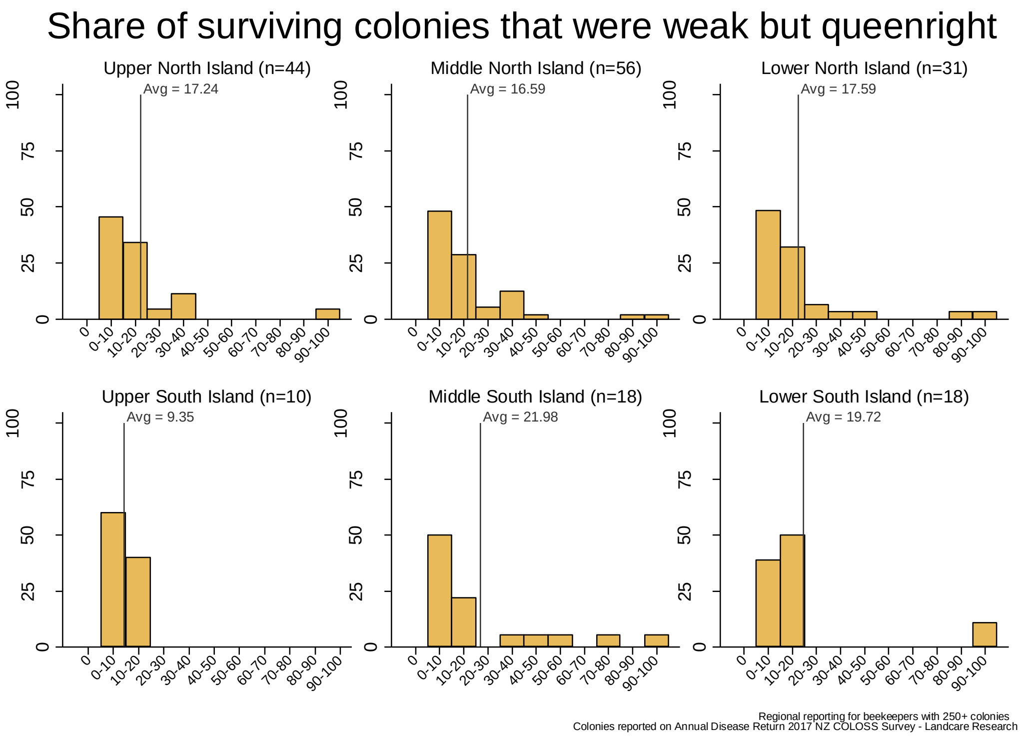

Figure 36: Colonies that survived winter 2017 and that were weak but queenright, based on reports from respondents with more than 250 colonies, by region.

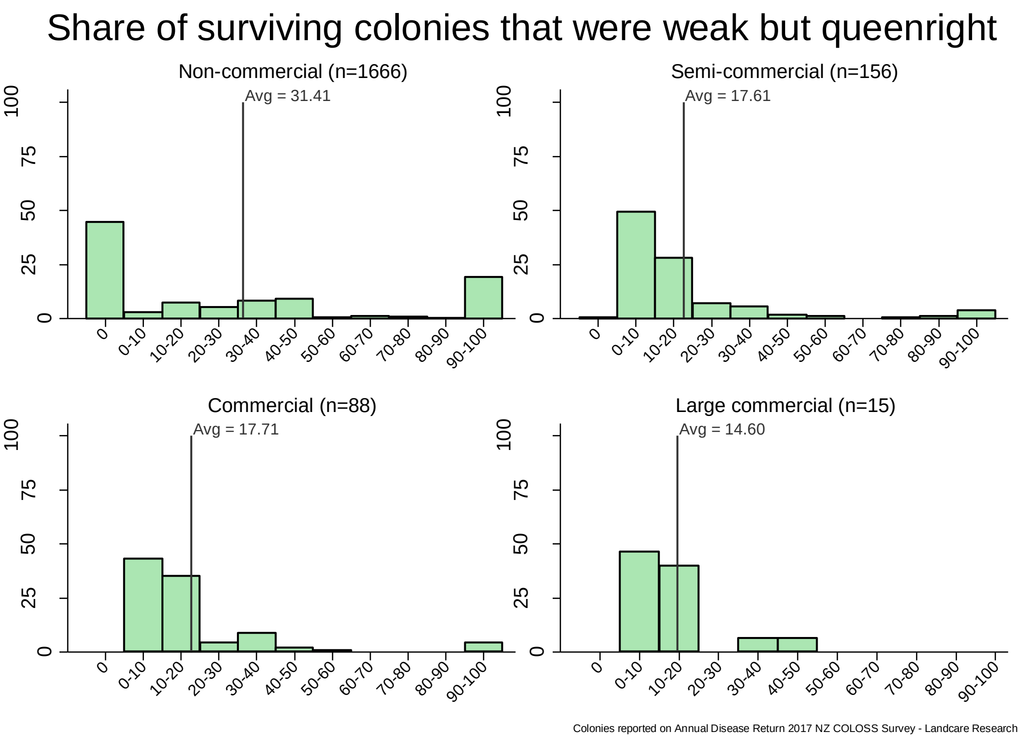

Figure 37: Colonies that survived winter 2017 and that were weak but queenright, based on reports from all respondents, by operation size.

5.6 Queen Performance

Over half of all reporting beekeepers (and nearly half of all commercial beekeepers) reported that queen performance in 2016/17 was similar to that in 2015/16 (Figures 38 and 39). Remaining beekeepers were split approximately evenly between reporting better performance and worse performance in 2016/17. Not surprisingly, non-commercial beekeepers are the most likely to report being unsure about comparative queen performance (non-commercial beekeepers have significantly less experience than semi-commercial and commercial beekeepers, on average, and 16.9% of reporting non-commercial beekeepers report having 1 year of experience or less). Queen performance in 2016/17 was qualitatively worse in the South Island, on average, and large commercial beekeepers reported the largest decline in queen performance.

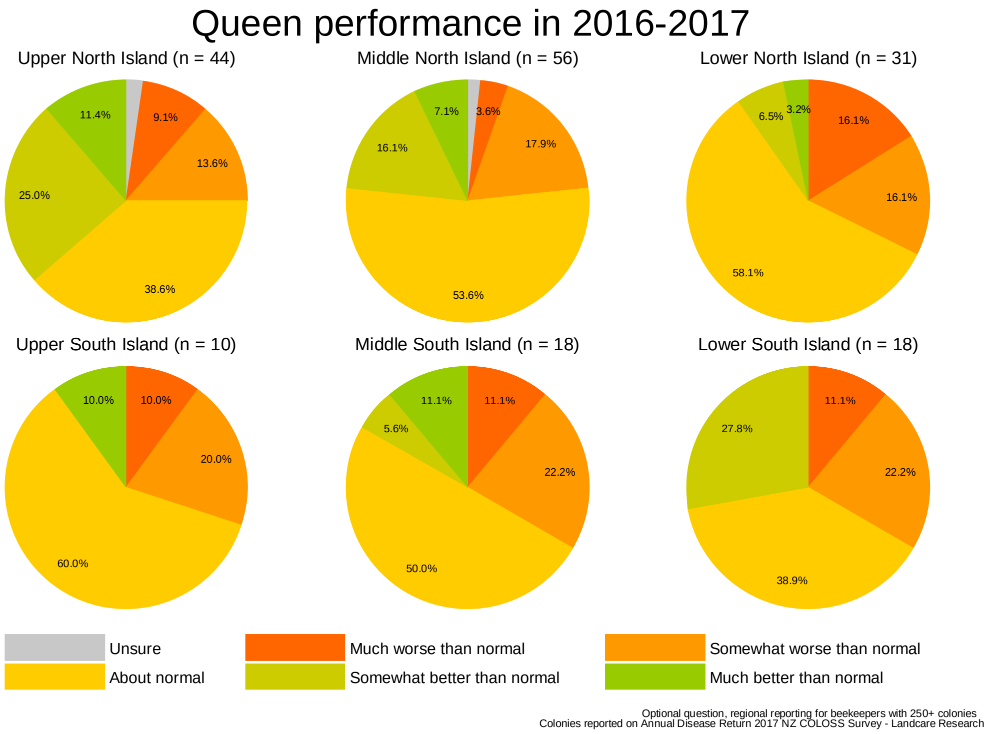

Figure 38: Queen performance during 2016/17 compared with previous years for respondents with more than 250 colonies, by region.

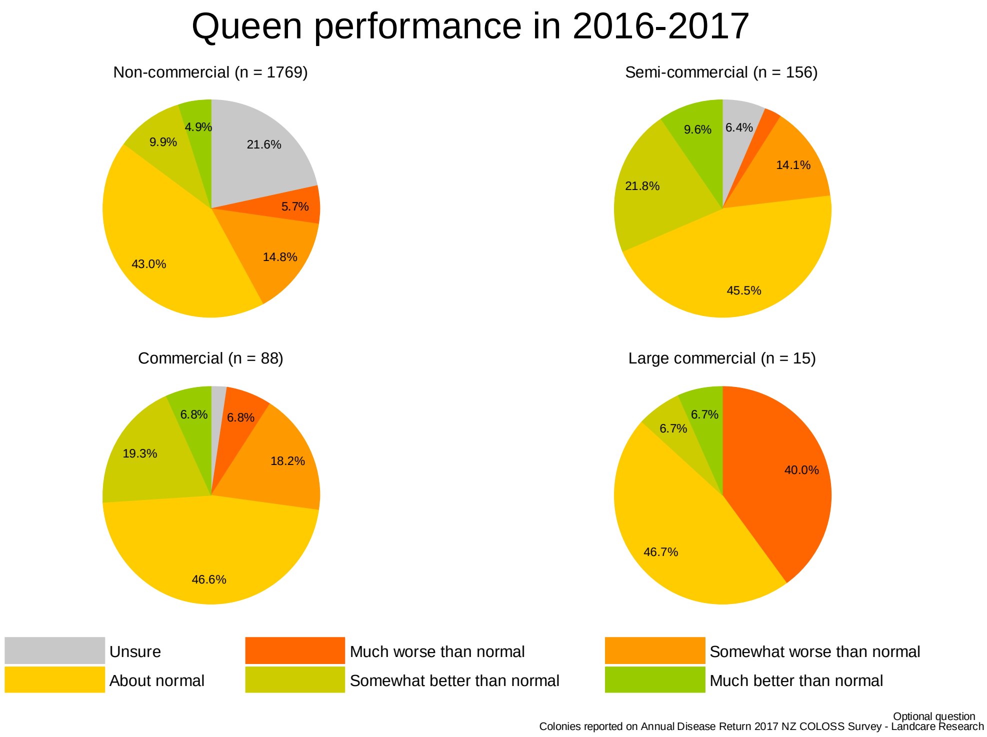

Figure 39: Queen performance during 2016/17 compared with previous years for all respondents, by operation size.

5.7 Varroa

Deformed wing virus (DWV) causes deformities on adult honey bees. Symptoms include stubby wings, deformed abdomens, and discolouration, as well as paralysis. Infected bees are typically ejected from the colony. Although DWV exists in bee populations that have not been affected by varroa, the level of infection strongly coincides with varroa. Parasitic mite syndrome (PMS) presents with spotty brood patterns and sunken, dark, and/or perforated cell cappings, although only larvae and prepupae are affected (unlike AFB). PMS is associated with increased aggressiveness and DWV, and only occurs with infestations of varroa mites.

Overall, 43.5% of beekeepers reported having noticed bees with crippled or deformed wings during the 2016/17 season (Figure 41), a figure that increases to 72.4% among commercial beekeepers. Nine out of ten commercial beekeepers with apiaries in the Upper South Island reported seeing such symptoms of DWV (Figure 40). Similarly, 20.3% of surveyed non-commercial beekeepers and 63.2% of commercial beekeepers reported noticing symptoms of PMS (Figure 43), most commonly in the Upper South Island (Figure 42).

Whereas commercial beekeepers have higher levels of DWV and PMS (or are perhaps better at identifying symptoms), non-commercial beekeepers formally monitor for varroa at higher rates than commercial beekeepers (Figure 45). However, all but large commercial operations disproportionately rely on visual inspection for varroa monitoring: only 48.0% of non-commercial beekeepers, 34.2% of semi-commercial beekeepers, and 35.1% of commercial beekeepers used alcohol washes, sticky boards, sugar shakes/rolls, or lab sampling to monitor varroa, whereas 60.0% of large commercial beekeepers relied on these methods. Among commercial beekeepers, strong regional trends are evident (Figure 44), with 61.1% of beekeepers undertaking no varroa monitoring in the Lower South Island.

Beekeepers across all regions and across all operation sizes reported using flumethrin and amitraz to treat varroa much more commonly than any other method (Figure 46 and Figure 47).

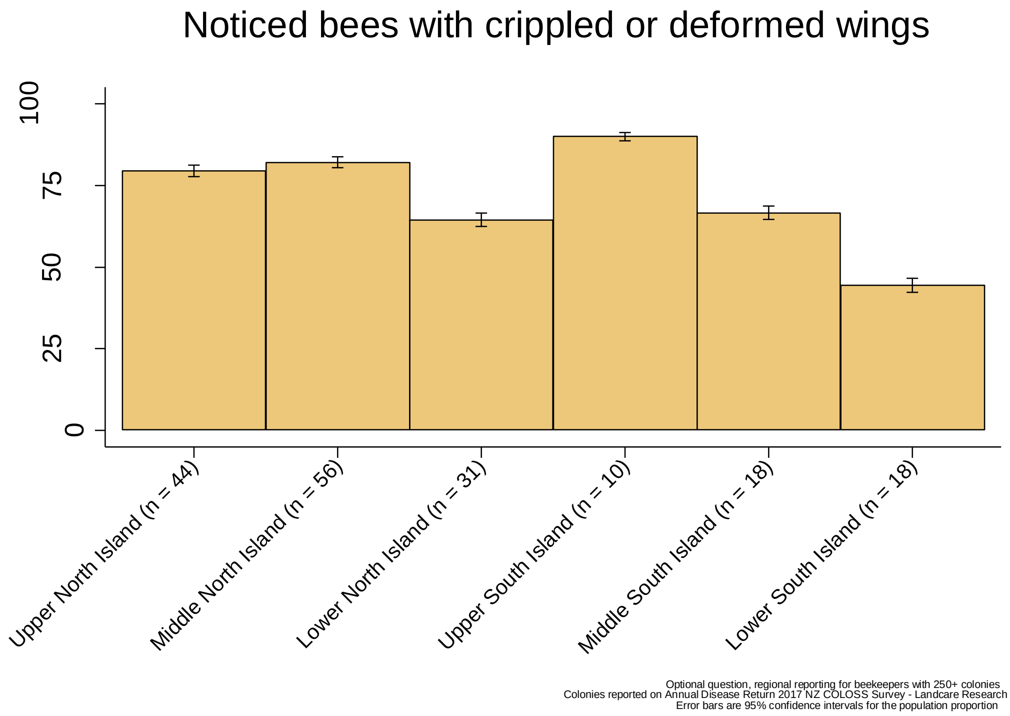

Figure 40: Share of respondents who observed crippled or deformed wings during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

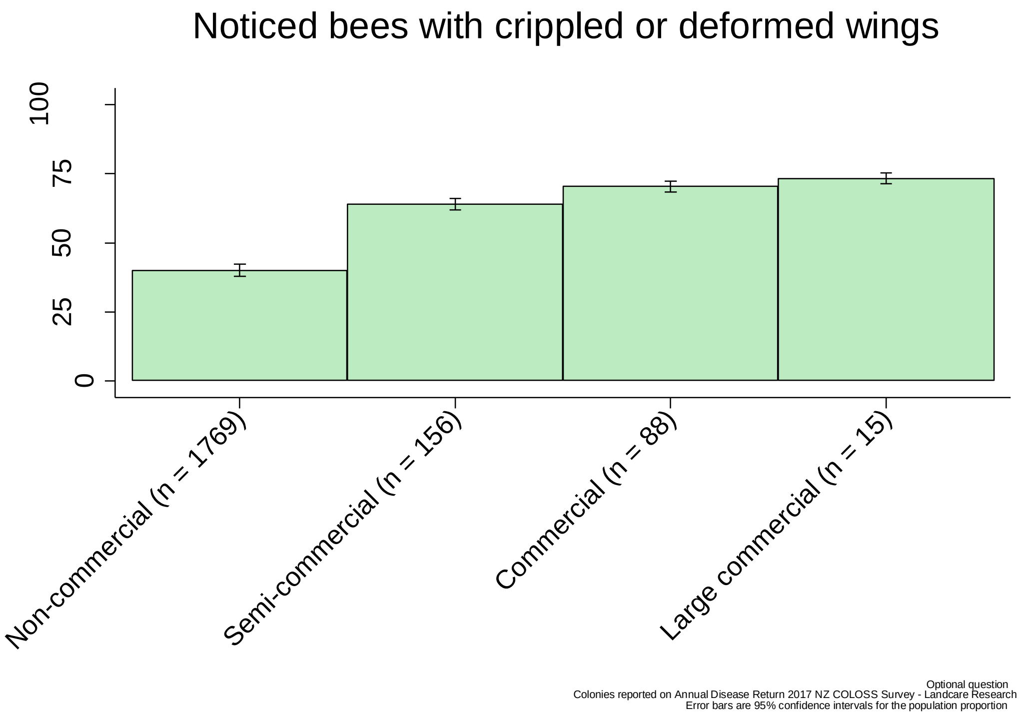

Figure 41: Share of respondents who observed crippled or deformed wings during the 2016/17 season, based on reports from all respondents, by operation size.

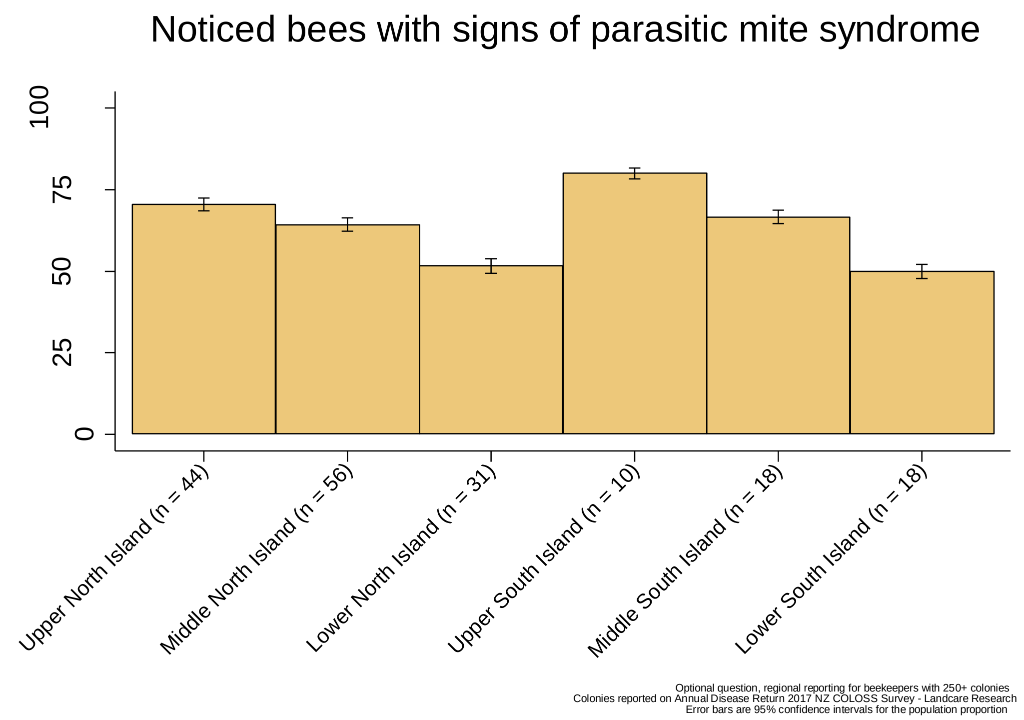

Figure 42: Share of respondents who noticed symptoms of parasitic mite syndrome during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

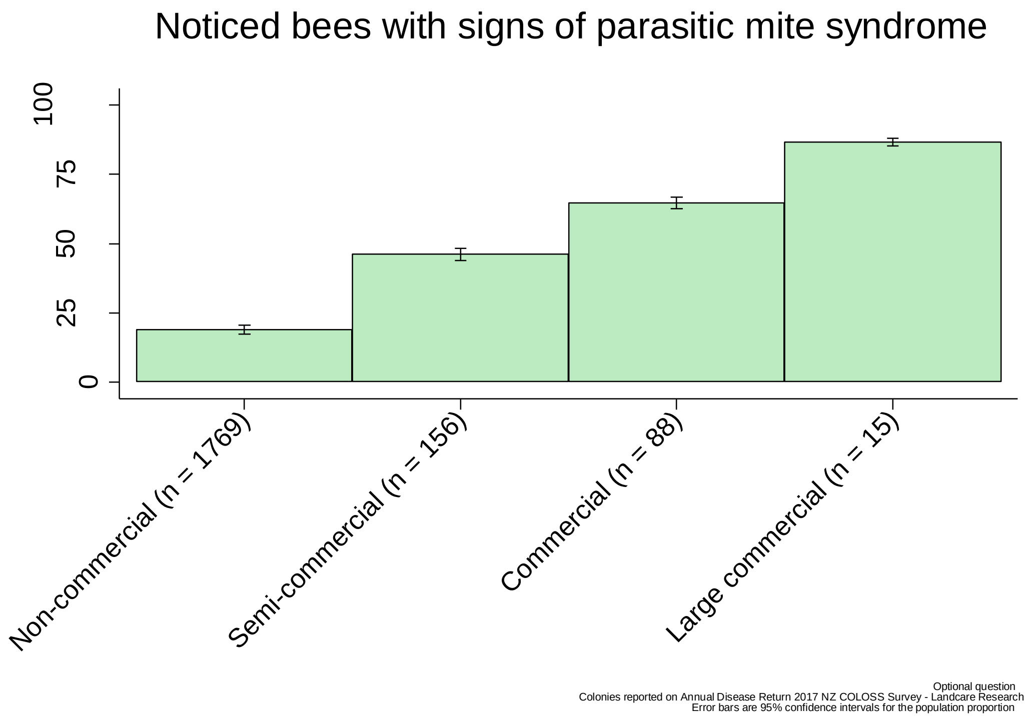

Figure 43: Share of respondents who noticed symptoms of parasitic mite syndrome during the 2016/17 season, based on reports from all respondents, by operation size.

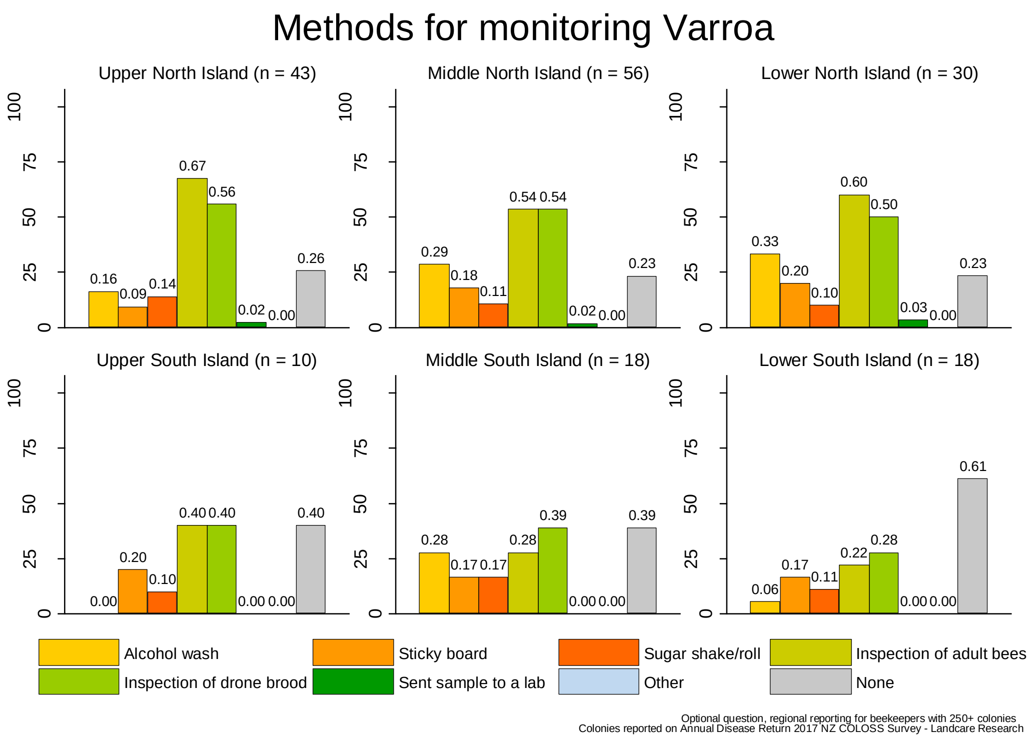

Figure 44: Methods for monitoring varroa during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

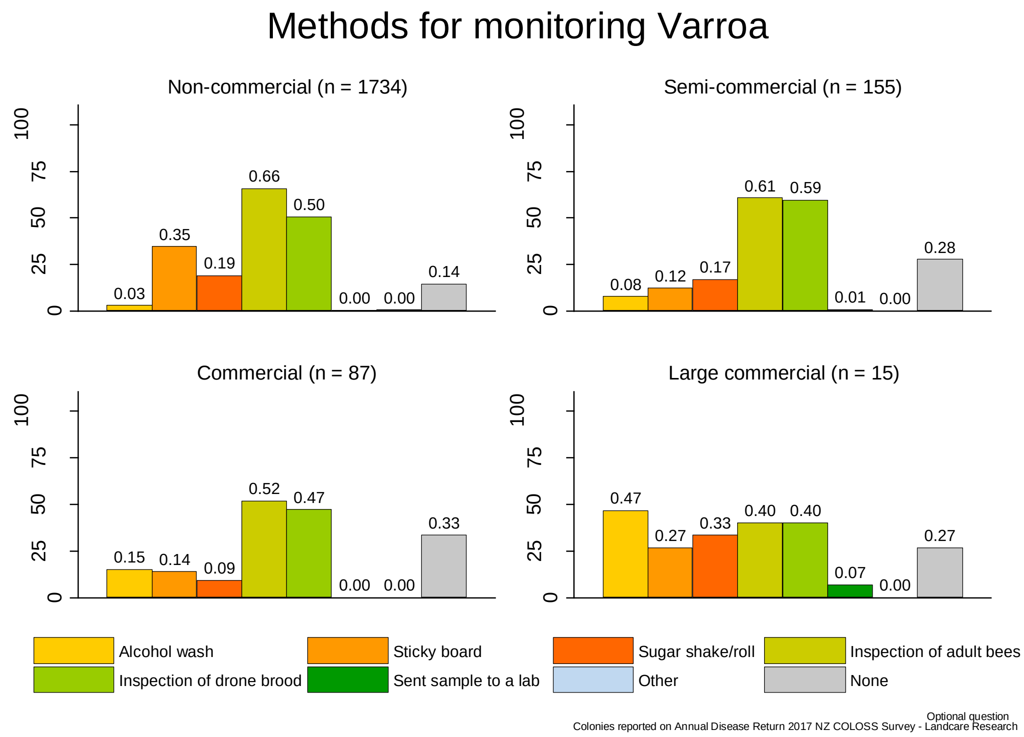

Figure 45: Methods for monitoring varroa during the 2016/17 season, based on reports from all respondents, by operation size.

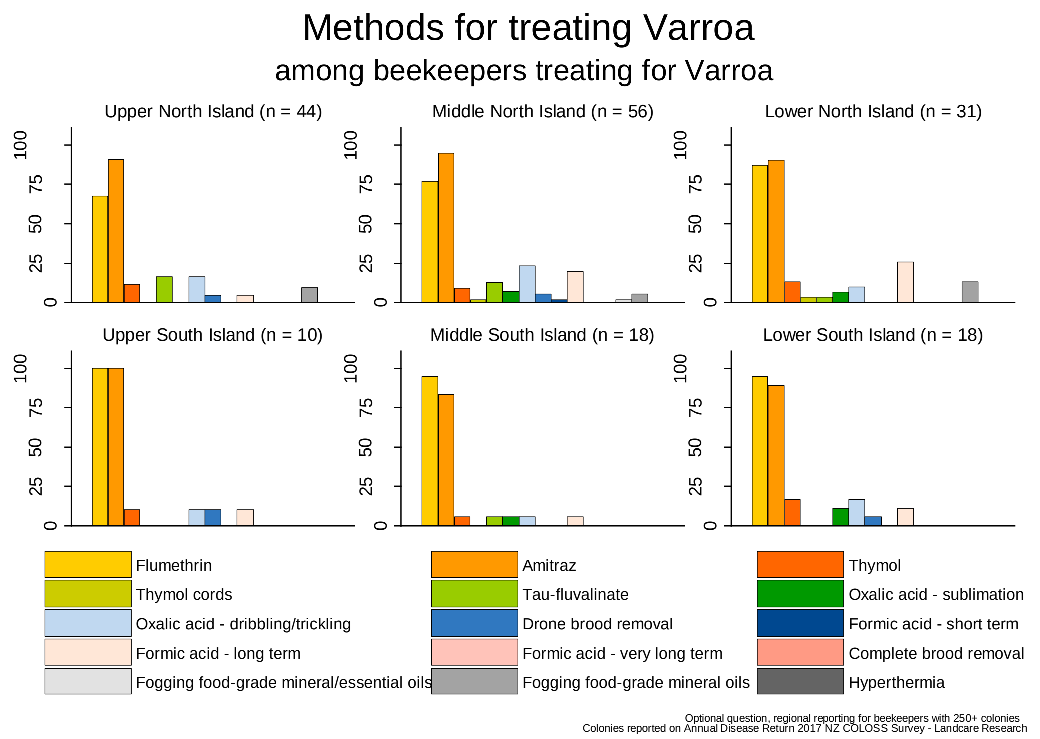

Figure 46: Varroa treatment methods during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

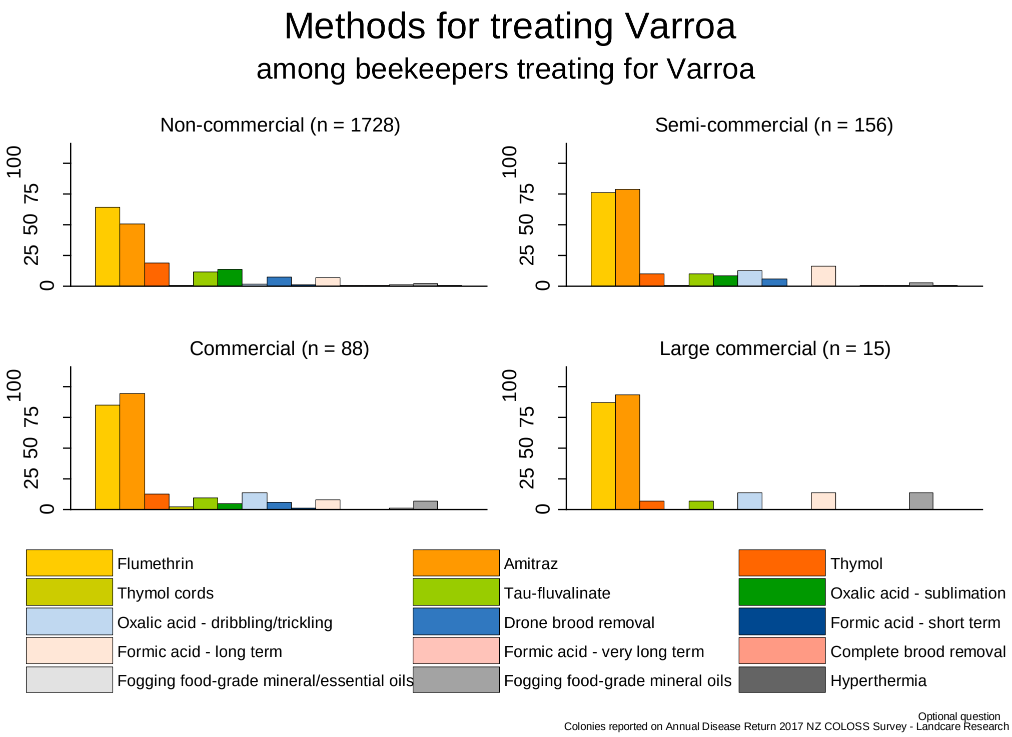

Figure 47: Varroa treatment methods during the 2016/17 season, based on reports from all respondents, by operation size.

5.8 Toxicity

One method to mitigate toxin loads embedded inside colonies is replacing wax brood combs with new foundation. Beekeepers with more than 250 colonies replaced 16.7% of brood combs during the 2016/17 season, on average. The highest average replacement levels occurred in the Middle South Island and the Lower South Island (Figure 48). Non-commercial beekeepers reported replacing just 7.7% of brood combs, on average, which is significantly lower than other beekeepers (Figure 49). Overall, 66.5% of the non-commercial beekeepers reported that they did not replace any brood combs with foundation, compared with 26.4% of semi-commercial beekeepers, 27.7% of commercial beekeepers, and 26.7% of large commercial beekeepers.

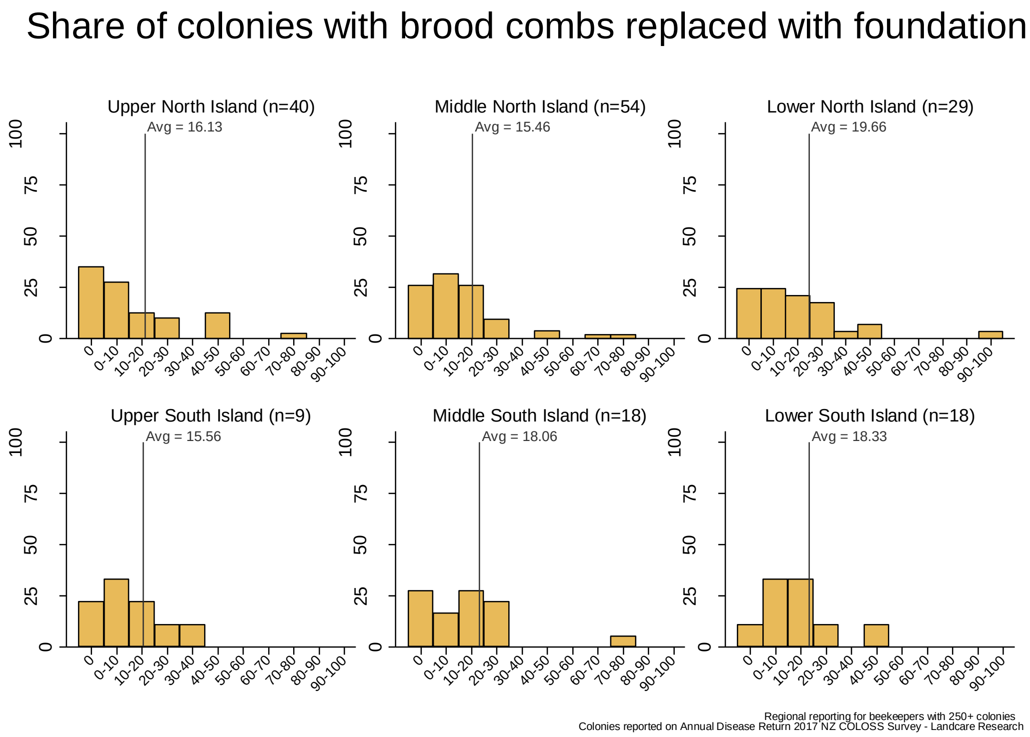

Figure 48: Share of brood combs replaced by comb foundation (per colony) during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

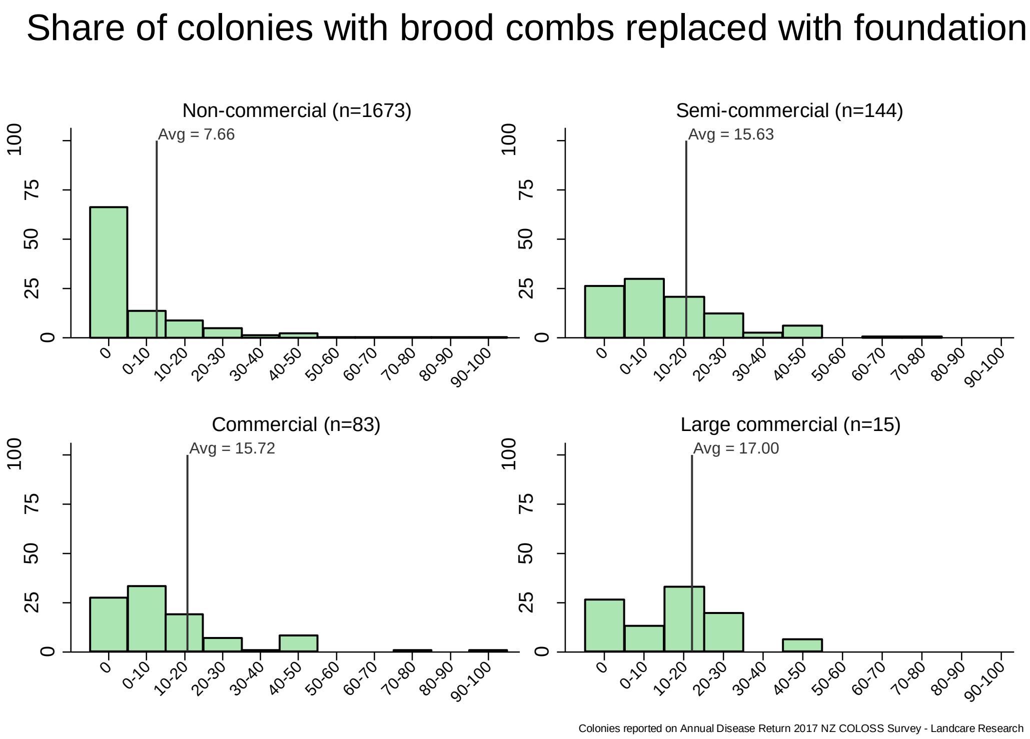

Figure 49: Share of brood combs replaced by comb foundation (per colony) during the 2016/17 season, based on reports from all respondents, by operation size.

5.9 Pollination and Honey Harvesting

High-value honey from mānuka presents an opportunity to many beekeepers to pursue honey and to abandon pollination services that were formerly provided for pastoral, arable, and horticultural plantations. Beekeepers across all size groups reported that 62.7% of production colonies were used exclusively for honey production (Figure 51), on average, and that a further 31.9% of production colonies were used for both honey production and pollination. Honey production dominates across all regions for beekeepers with more than 250 hives (Figure 50), although pollination services are provided by at least one-quarter of beekeepers in the Upper North Island and the Middle North Island (both of which are centres of kiwifruit production), and in the Middle South Island (which includes extensive cereal production and pasture for livestock).

Nectar flows across regions are reported in Figure 52. Among beekeepers with more than 250 colonies in the Upper North Island, mānuka, kānuka, and native bush blend are very common, together with clover/pasture. Rewarewa is more significant in the Middle North Island and Lower North Island. Beech honeydew is a common source of flow in the Upper South Island and Middle South Island, while clover/pasture and willow honey (spring) are the most significant sources of flow in the Lower South Island. Large commercial beekeepers focus more on mānuka than smaller beekeepers, while semi-commercial and commercial beekeepers' bees have a comparatively high flow on clover pasture (Figure 53). Only non-commercial and semi-commercial beekeepers' bees have a significant flow from urban floral and garden sources. Semi-commercial and commercial beekeepers report migrating hives to take advantage of different nectar flows in much higher numbers than non-commercial beekeepers (Figure 55), and migration is particularly common for colonies that are wintered in the Middle North Island and Lower North Island.

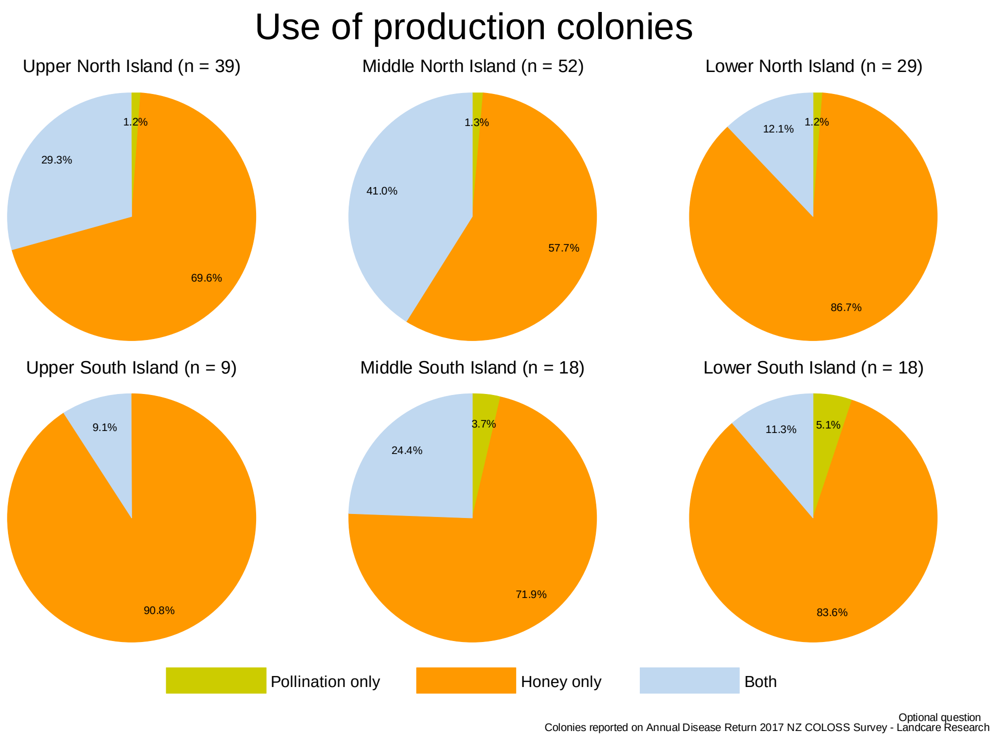

Figure 50: Use of production colonies during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

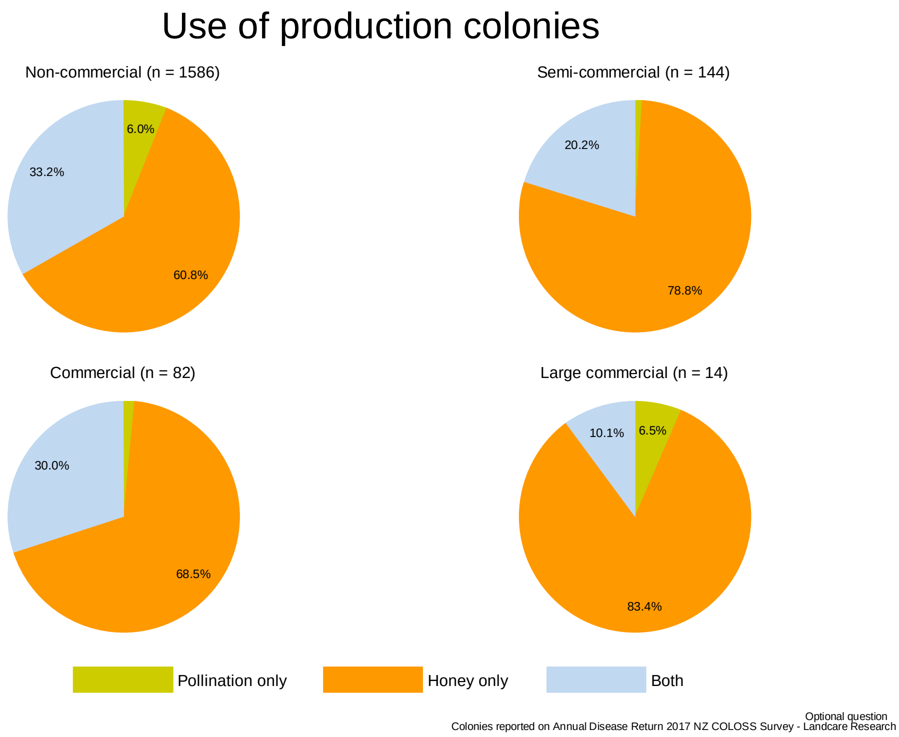

Figure 51: Use of production colonies during the 2016/17 season, based on reports from all respondents, by operation size.

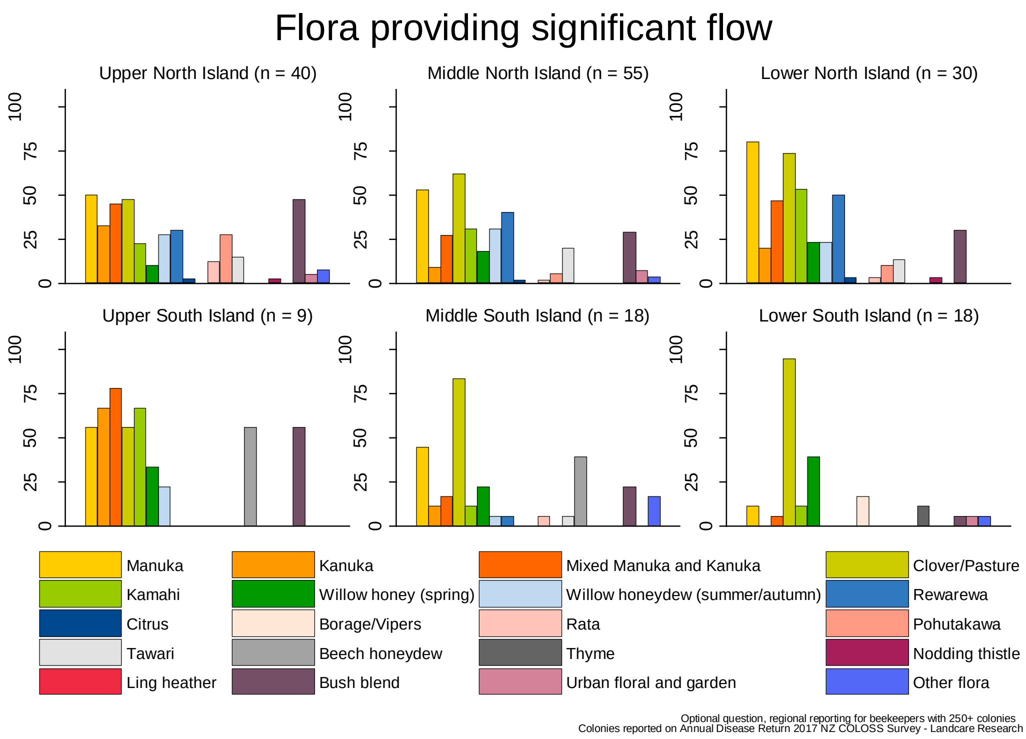

Figure 52: Sources of significant flow during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

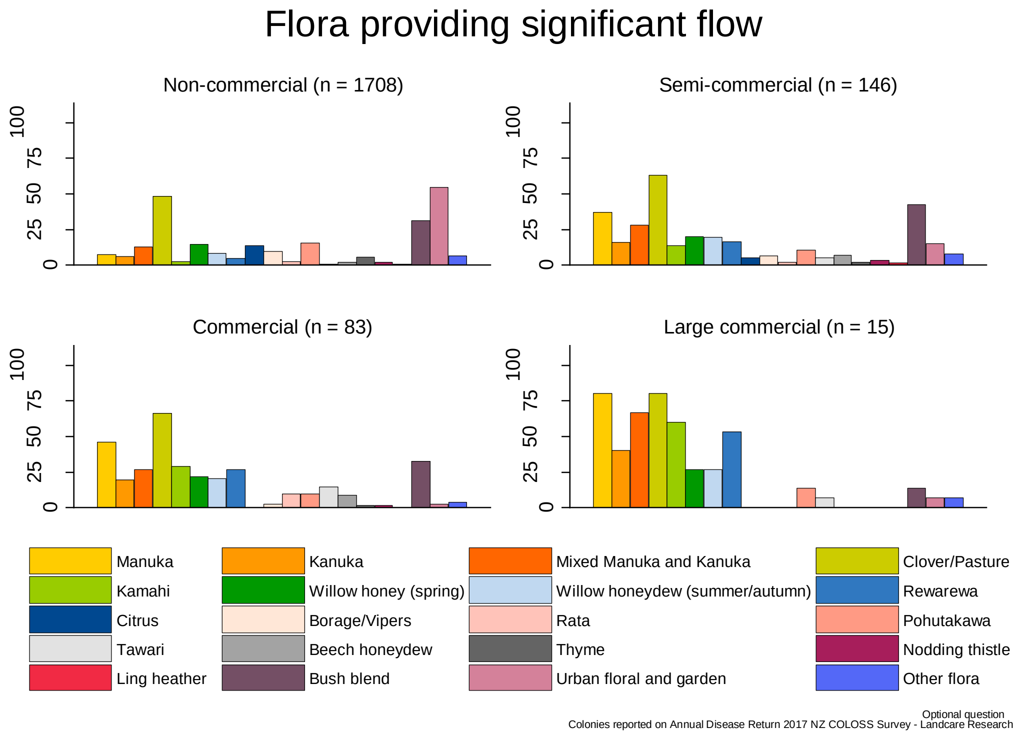

Figure 53: Sources of significant flow during the 2016/17 season, based on reports from all respondents, by operation size.

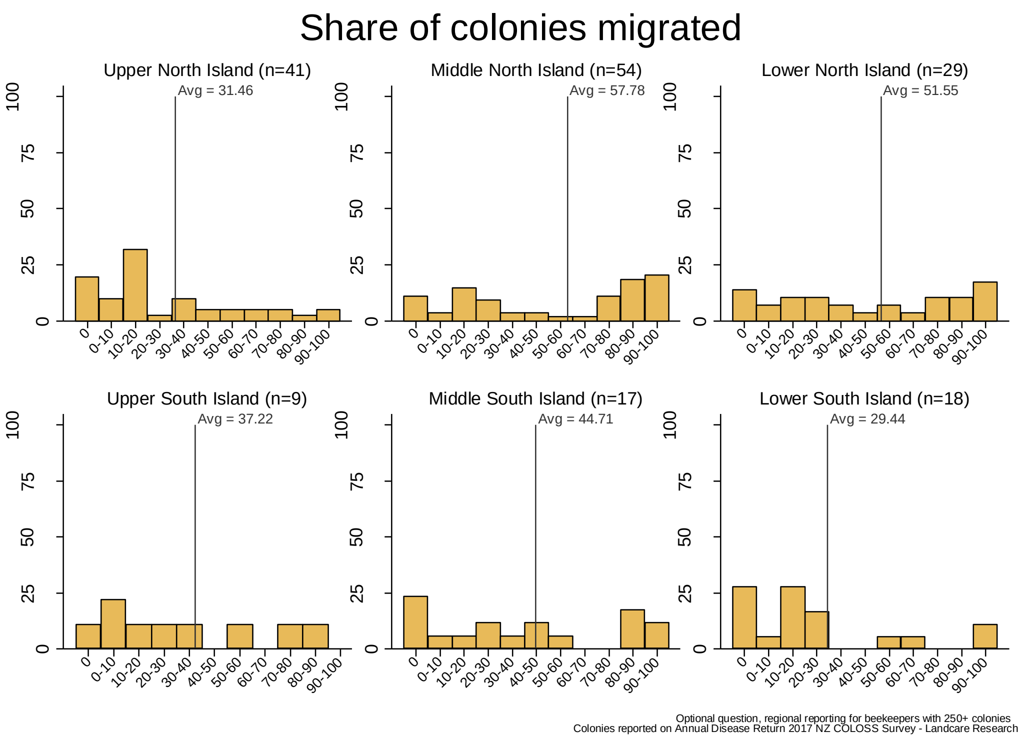

Figure 54: Share of colonies that were migrated at least once during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

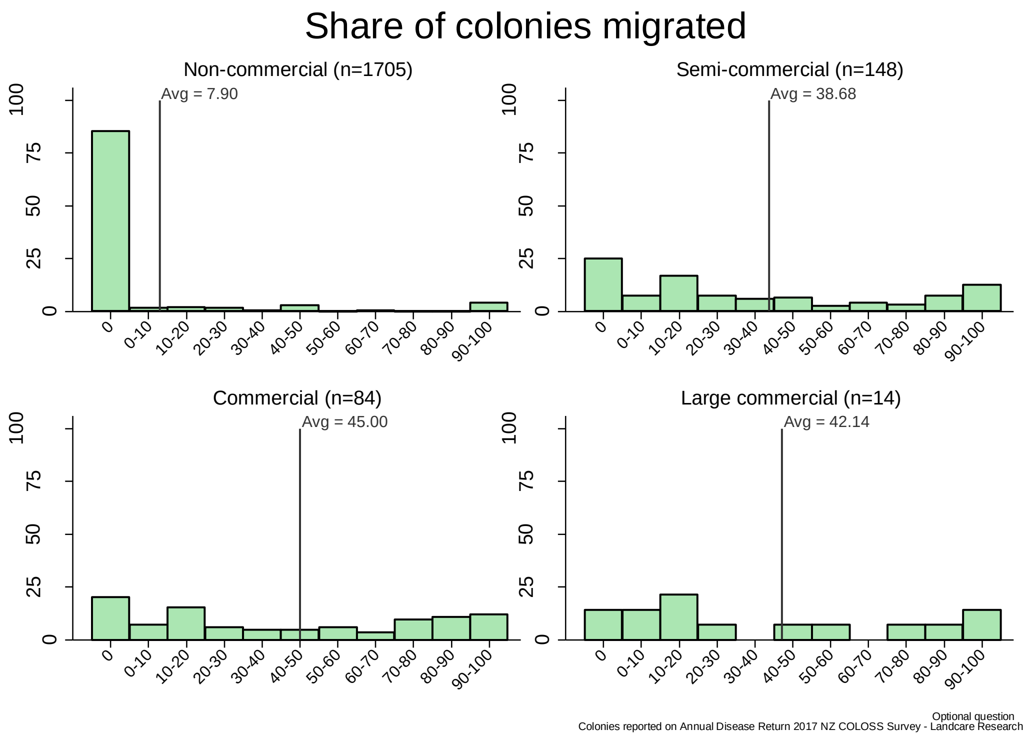

Figure 55: Share of colonies that were migrated at least once during the 2016/17 season, based on reports from all respondents, by operation size.

5.10 Supplementary Feeding

If pollen and nectar sources within foraging range are insufficient, bees consume their stores. If the weather is too severe for bees to forage and if they do not have sufficient stores of pollen and nectar in their colonies, then bees will starve. Bees also use nectar for carbohydrates for wax production. Hence, many beekeepers actively plant forage resources for their bees to improve nutrition and overwintering success (DeGrandi-Hoffman et al. 2016).

In addition, beekeepers may provide supplemental nutrition. Nectar supplies fuel for adult bees and can be supplemented by supplying sugar, a source of carbohydrates. Pollen, which is needed for the brood, provides protein, lipids, vitamins, and minerals. A variety of protein supplements are commercially available.

Nearly all beekeepers (97.9%) with more than 250 colonies used supplemental sugar during the 2016/17 season (Figure 56). Sugar feeding among these large beekeepers is common across the entire country. In contrast to commercial beekeepers, only 61% of non-commercial beekeepers provided supplementary feed in the form of sugar (Figure 57). Sugar solution is most commonly used across all regions and size classes, although invert sugar is also widely used in the North Island and raw sugar is also widely used in the South Island.

Nearly two-thirds (66.2%) of beekeepers with more than 250 colonies provide supplemental protein to their bees (Figure 58). MegaBee is the most commonly used protein supplement, used by 43.7% of commercial beekeepers (FeedBee is used by 23.2%). Supplemental protein feeding is especially common among the beekeepers with the most colonies, who substitute or augment commercial products with homemade products (Figure 59). Only 14.0% of non-commercial beekeepers reported providing supplemental protein in 2016/17.

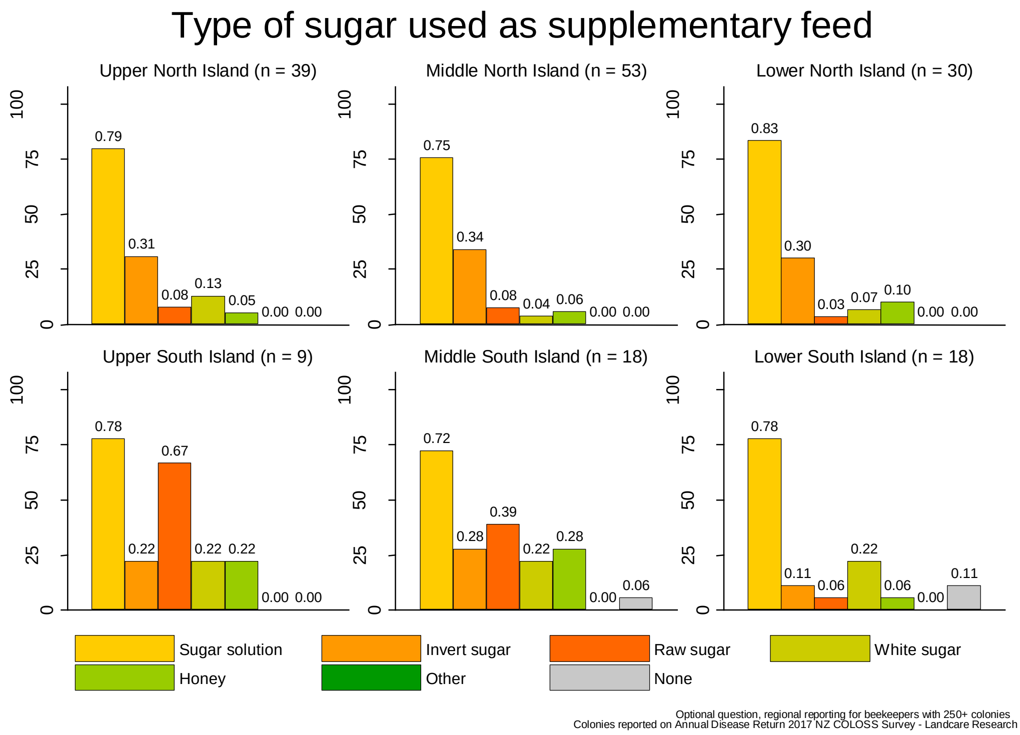

Figure 56: Types of supplemental sugar feed provided to production colonies during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

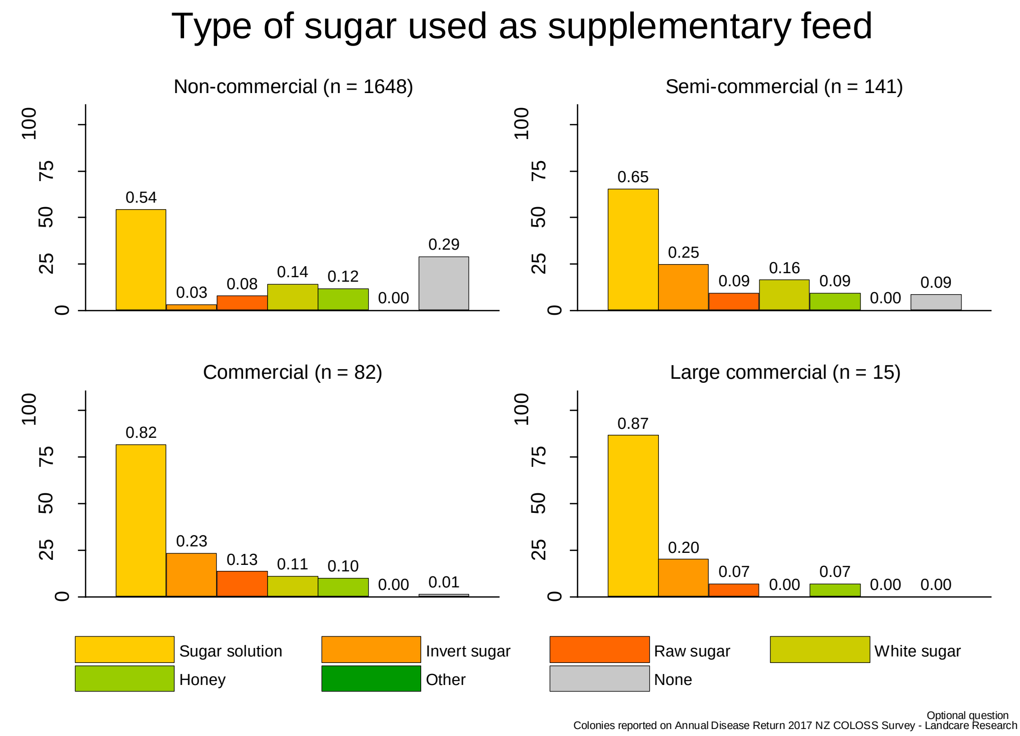

Figure 57: Types of supplemental sugar feed provided to production colonies during the 2016/17 season, based on reports from all respondents, by operation size.

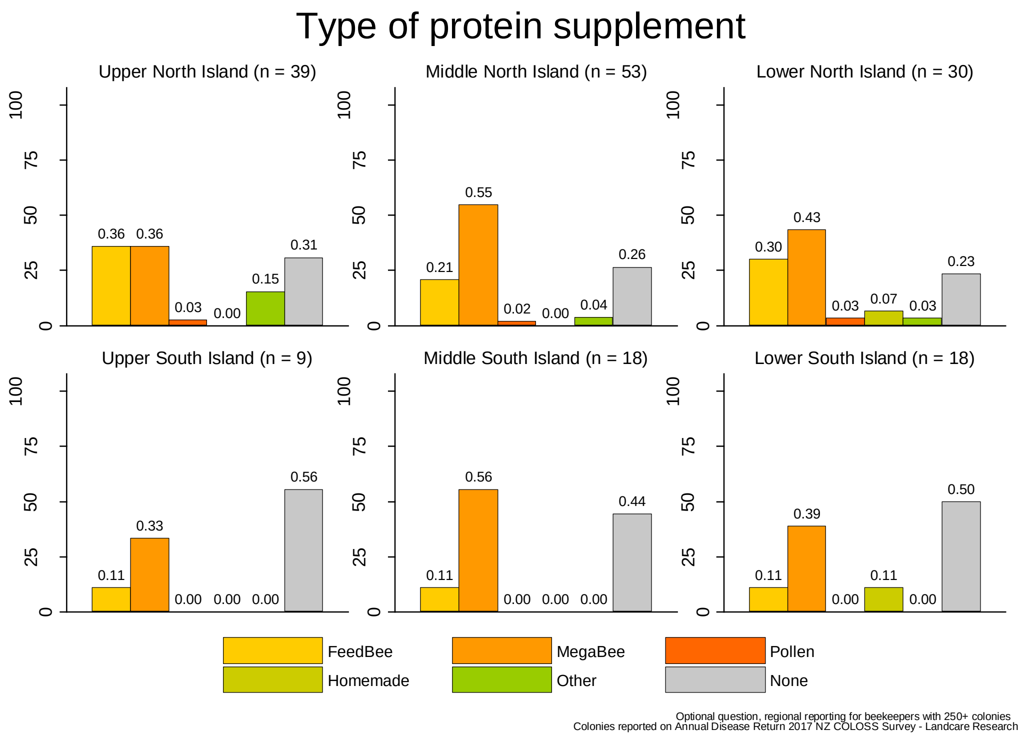

Figure 58: Types of supplemental protein feed provided to production colonies during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

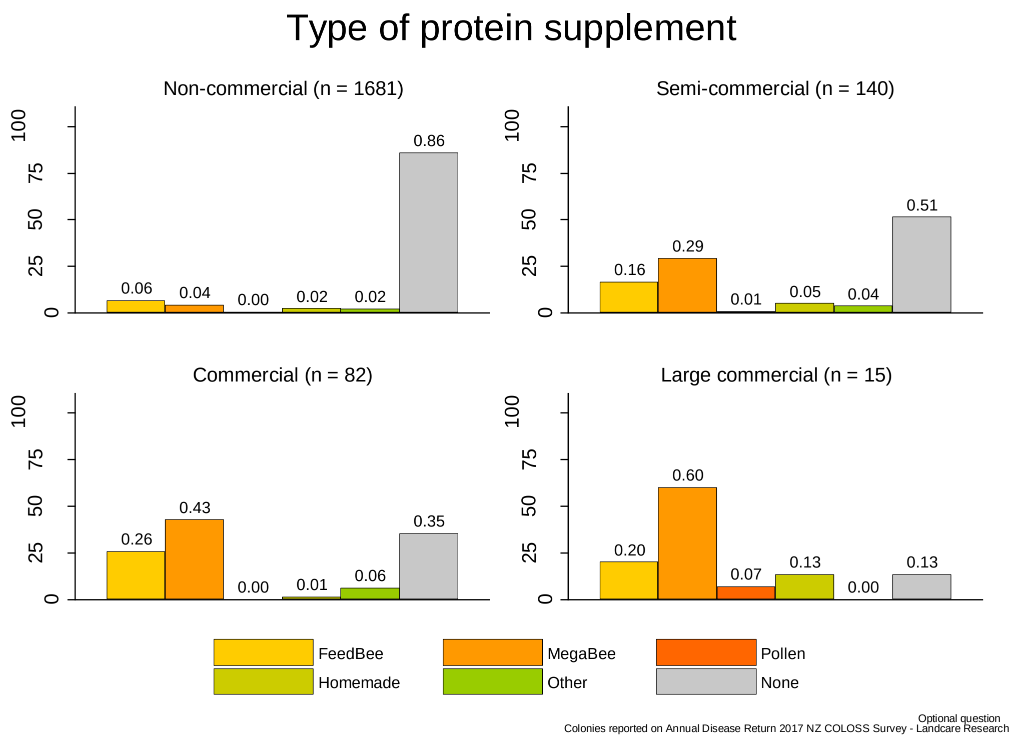

Figure 59: Types of supplemental protein feed provided to production colonies during the 2016/17 season, based on reports from all respondents, by operation size.

5.11 Apiary Losses

Beekeepers typically keep bees based on agreements with landowners. Any rearrangements in permissions by landowners, encroachment into the foraging range of an apiary, or removal of major pollen or nectar sources can significantly affect beekeeping operations financially and/or via bee health, as can the arrival of pests or diseases via relocation of new hives to the area.

Apiary sites being overtaken by other beekeepers has coincided with the rapid expansion of the mānuka honey industry. Some 32.6% of beekeepers with more than 250 colonies reported losing one or more apiary sites to other beekeepers during the 2016/17 season. This problem is pronounced outside the Lower South Island (Figure 60), particularly among large commercial beekeepers, who reported that 8.9% of all apiaries were lost to being overtaken during the 2016/17 season (Figure 61); in contrast, only 1.1% of non-commercial beekeepers reported having had sites overtaken by other beekeepers, accounting for just 0.3% of their apiaries.

Losing apiaries and seeing apiaries compromised due to overcrowding (as opposed to be overtaken by other beekeepers) has also coincided with growth in the mānuka honey industry, a challenge that is exacerbated by new beekeepers being less cognisant of stocking rates. Overcrowding is particularly problematic in the Upper North Island, where commercial beekeepers report having lost 4.3% of hives due to overcrowding in the 2016/17 season (Figure 62). Overcrowding is a more significant problem for commercial beekeepers than for non-commercial beekeepers (Figure 63).

While losing entire apiary sites due to overcrowding is not common, apiaries being compromised by overcrowding is common, particularly in the North Island, where 86.3% of beekeepers with more than 250 colonies reported that overcrowding had compromised their apiaries (Figure 64). Commercial and large commercial beekeepers noted that 10.7% and 16.7% of their apiaries had been compromised due to overcrowding, respectively, compared with 3.1% of non-commercial beekeepers (Figure 65).

Apiary sites lost to the sudden removal of pollen and nectar sources was less commonly reported, but may nevertheless be problematic in some areas. For example, 8.0% of beekeepers with more than 250 colonies in the North Island reported having lost apiary sites due to pollen and nectar sources being removed (Figure 66). In addition, 11.0% of North Island beekeepers with more than 250 hives reported that apiary sites had been compromised due to lost pollen and nectar sources (Figure 68); again, apiaries in the Middle North Island were most compromised due to pollen and nectar sources being removed. The overall share of apiary sites lost or compromised due to lost pollen and nectar sources is low (Figure 67 and Figure 69).

Giant willow aphids were first reported in Auckland in late December 2013 and have since spread throughout the country. These pests tap the sugar flow in willow stems, causing willow honeydew to flow, thereby attracting wasps to areas that provide important sources of flow for honey bees. In addition, giant willow aphids transform some of the willow sucrose to glucose and fructose. In this process, enzymes attach glucose to sucrose to form the less osmotically active melezitose, which is then present in the honeydew. Bees take this honeydew back to their colonies, where the melezitose crystallises in the comb during the honey-conditioning phase. The crystals are not suitable as food for the bees and they also clog filters during honey extraction. Thus, giant willow aphid may also cause apiaries to be lost and/or compromised.

Beekeepers with more than 250 colonies in the Middle North Island reported having lost 0.4% of their apiary sites as a result of infestation by giant willow aphid (Figure 70). A further 3.9% of their apiaries were compromised due to giant willow aphid (Figure 72). No South Island beekeepers with more than 250 colonies reported having lost apiaries to giant willow aphid, although one South Island respondent did note that their apiaries had been compromised by giant willow aphid. Figures 71 and 73 indicate that small and large beekeepers are similarly at risk of being affected by giant willow aphids.

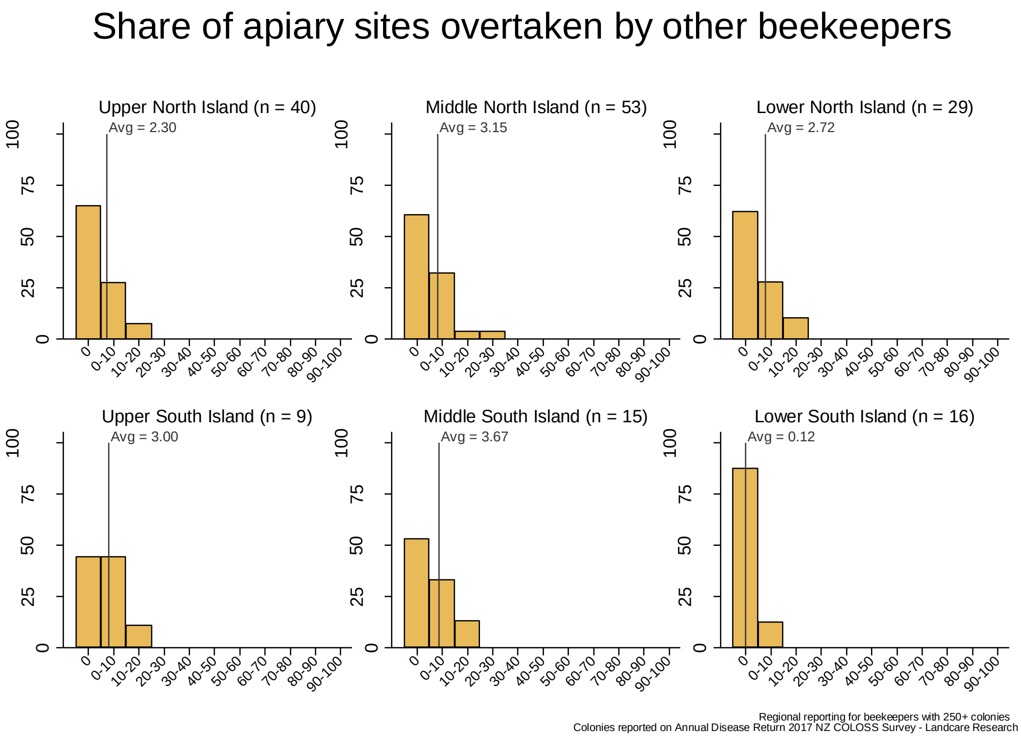

Figure 60: Share of apiary sites lost due to being taken over by other beekeepers during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

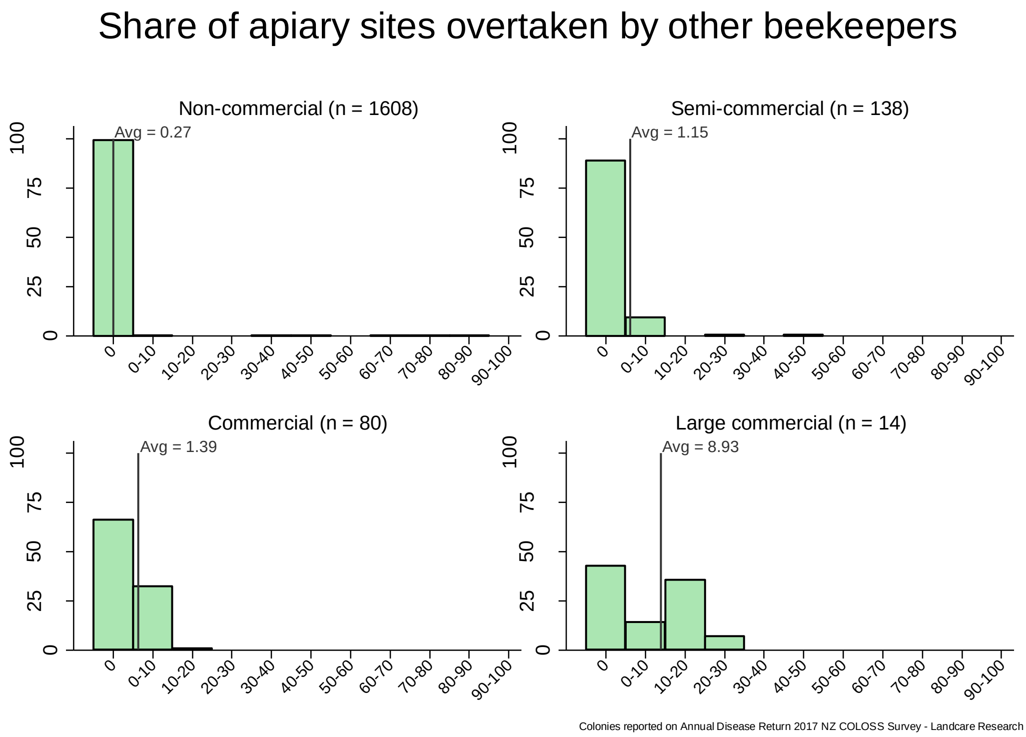

Figure 61: Share of apiary sites lost due to being taken over by other beekeepers during the 2016/17 season, based on reports from all respondents, by operation size.

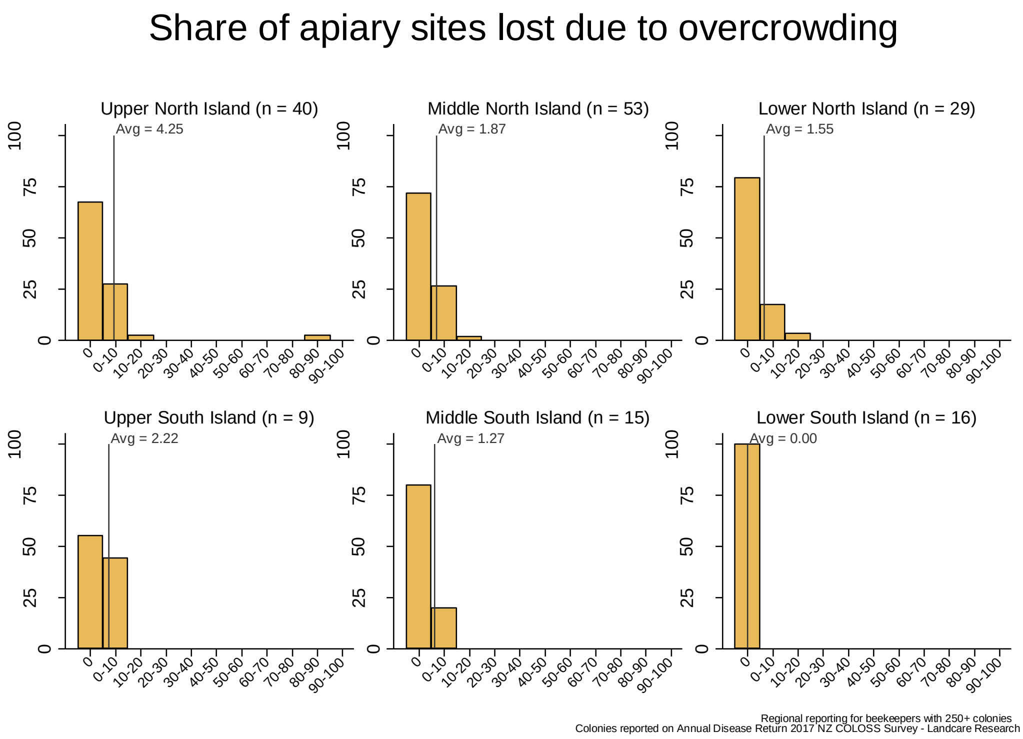

Figure 62: Share of apiary sites lost due to overcrowding during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

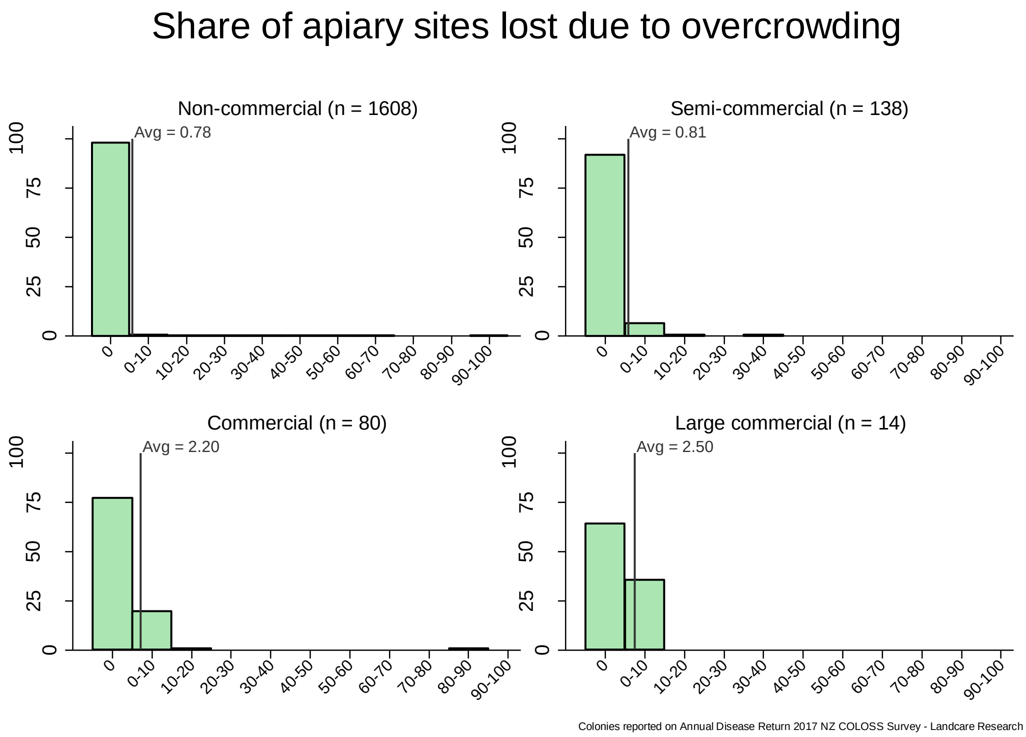

Figure 63: Share of apiary sites lost due to overcrowding during the 2016/17 season, based on reports from all respondents, by operation size.

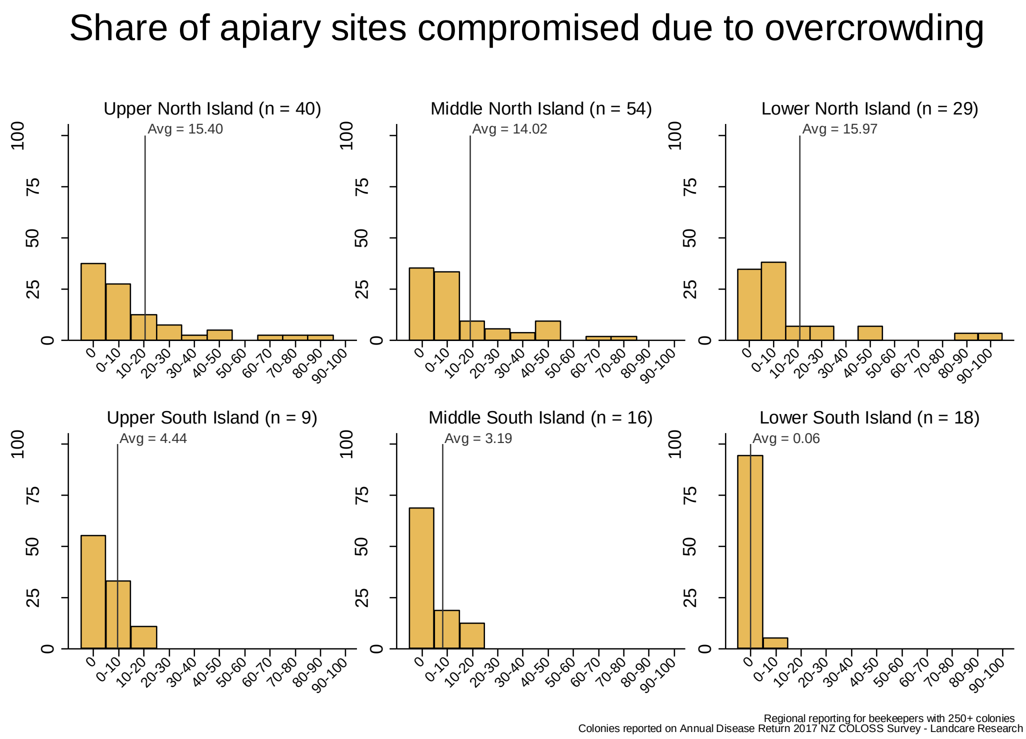

Figure 64: Share of apiary sites compromised due to overcrowding during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

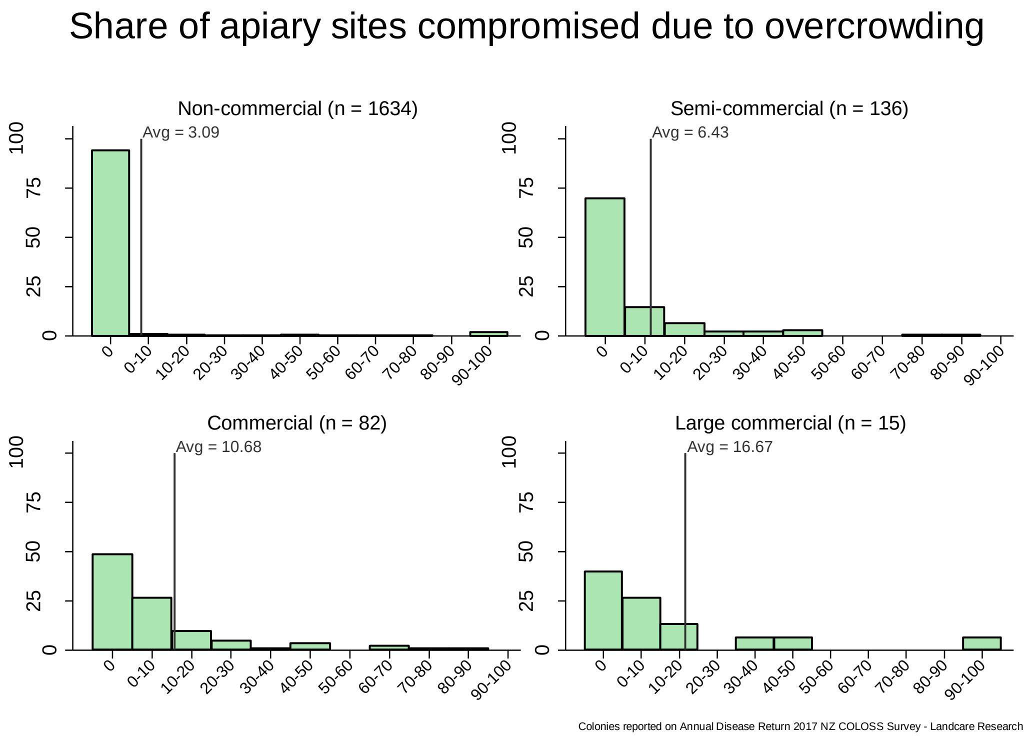

Figure 65: Share of apiary sites compromised due to overcrowding during the 2016/17 season, based on reports from all respondents, by operation size.

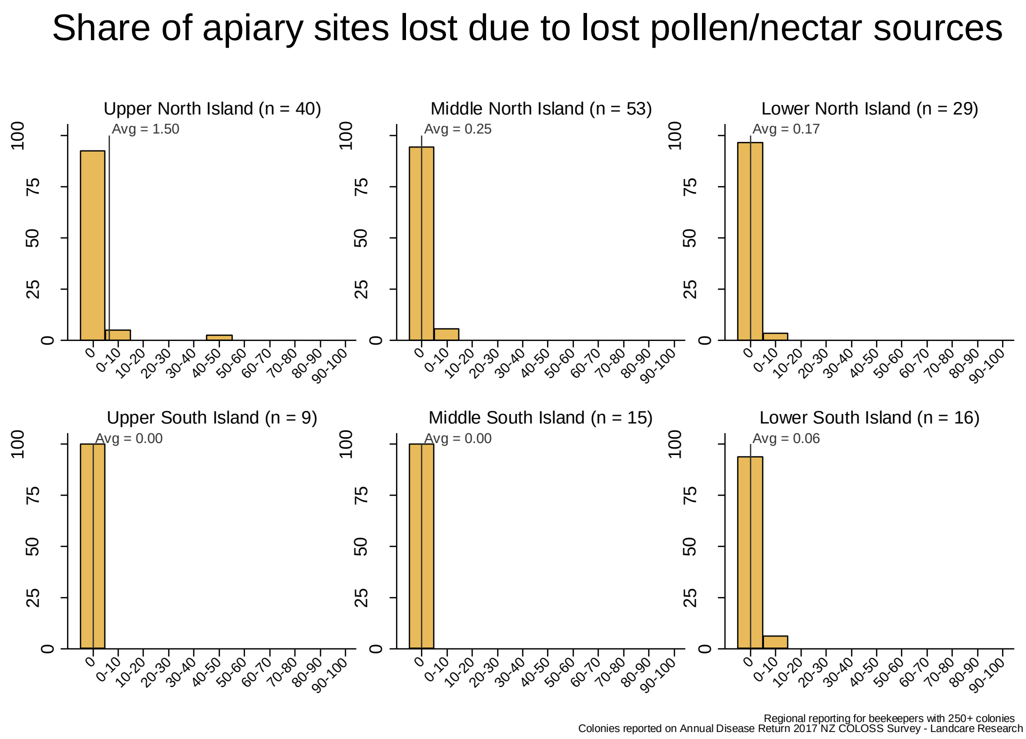

Figure 66: Share of apiary sites lost due to sources of pollen and nectar being removed during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

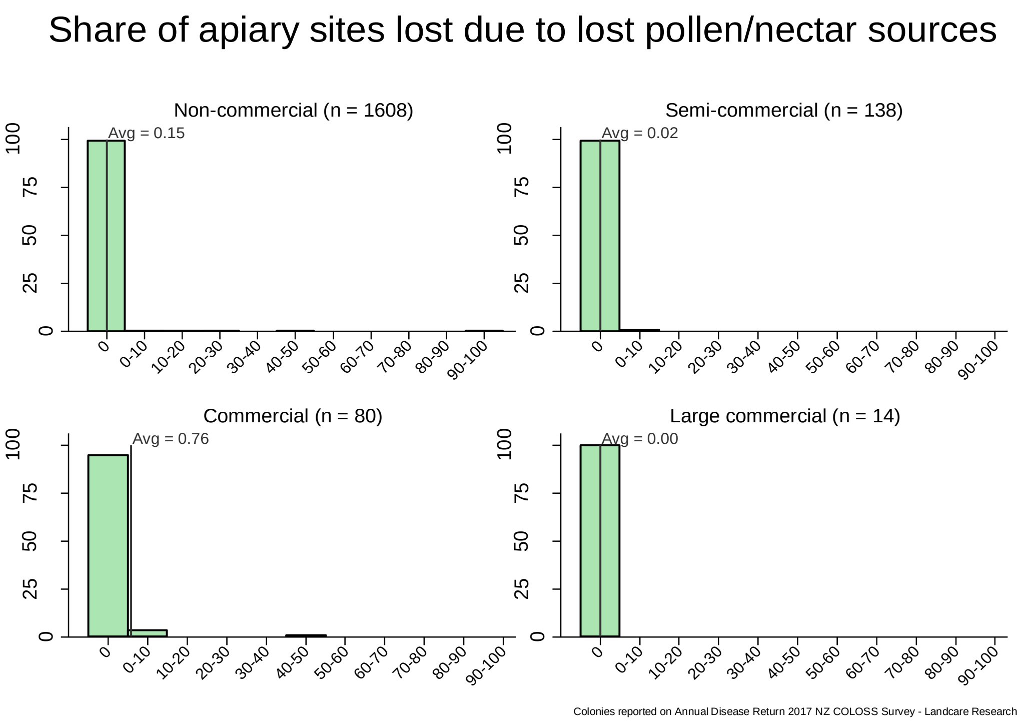

Figure 67: Share of apiary sites lost due to pollen and nectar sources being removed during the 2016/17 season, based on reports from all respondents, by operation size.

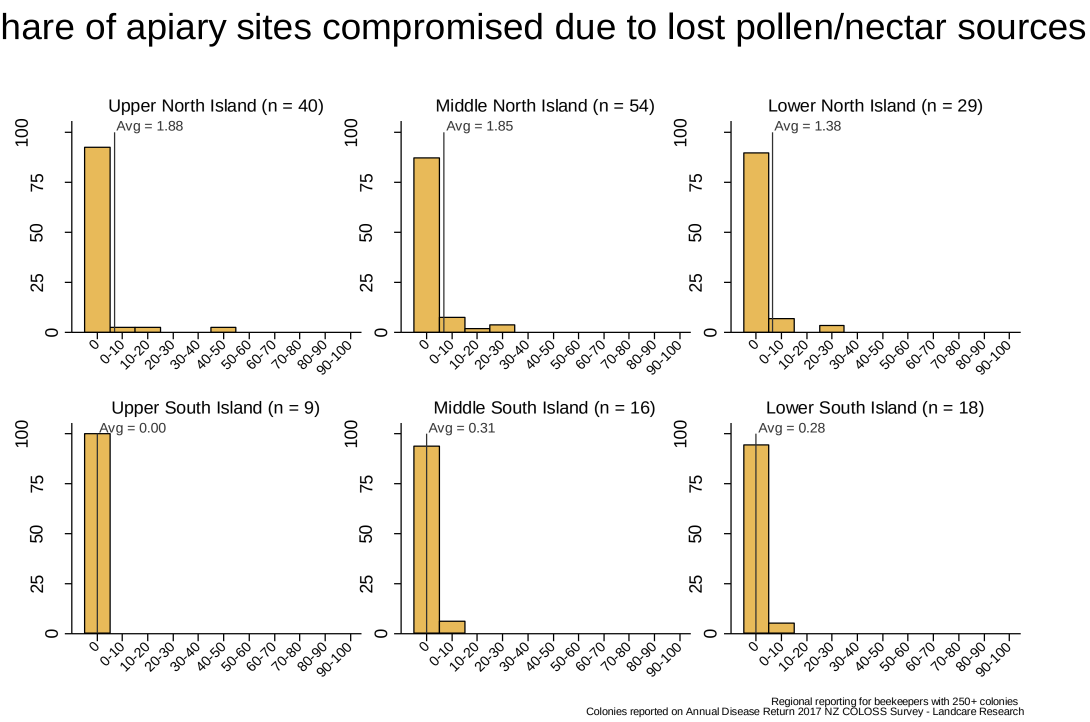

Figure 68: Share of apiary sites compromised due to pollen and nectar sources being removed during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

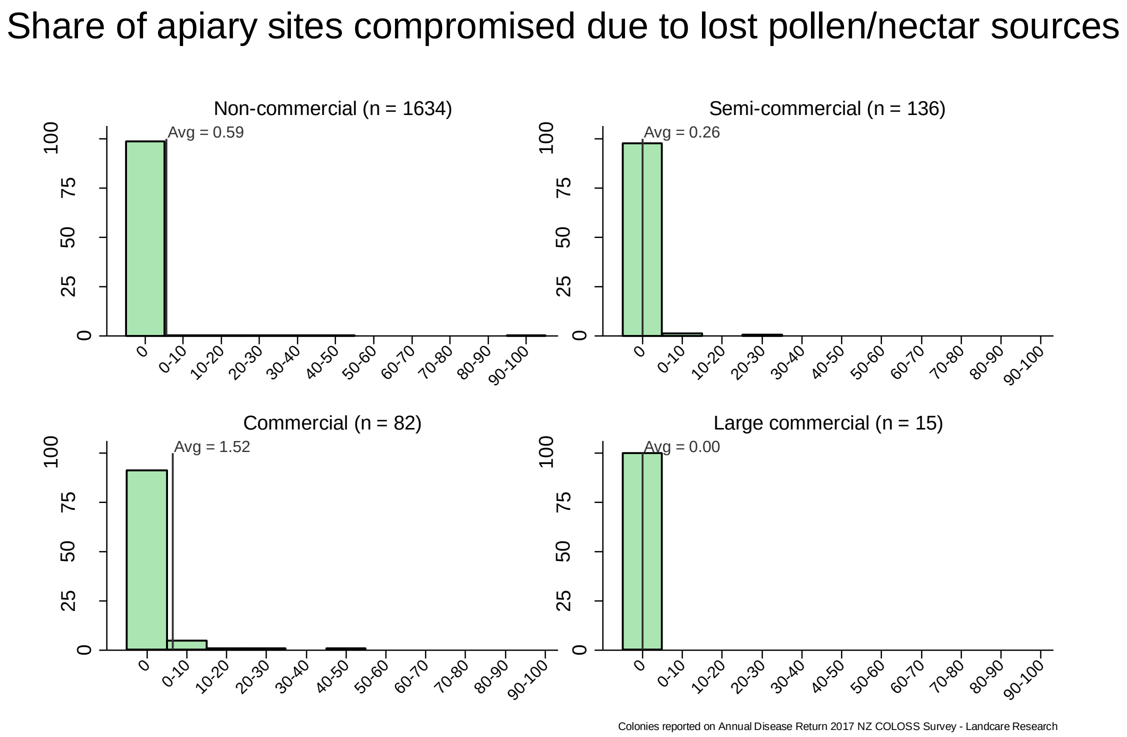

Figure 69: Share of apiary sites compromised due to pollen and nectar sources being removed during the 2016/17 season, based on reports from all respondents, by operation size.

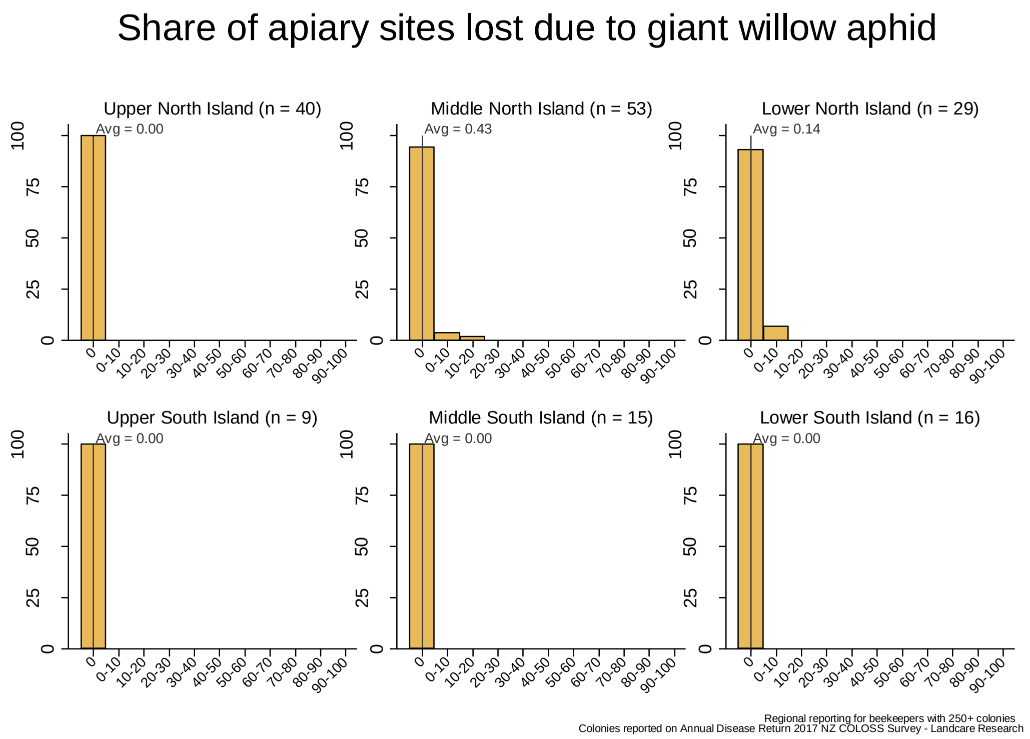

Figure 70: Share of apiary sites lost due to giant willow aphid during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

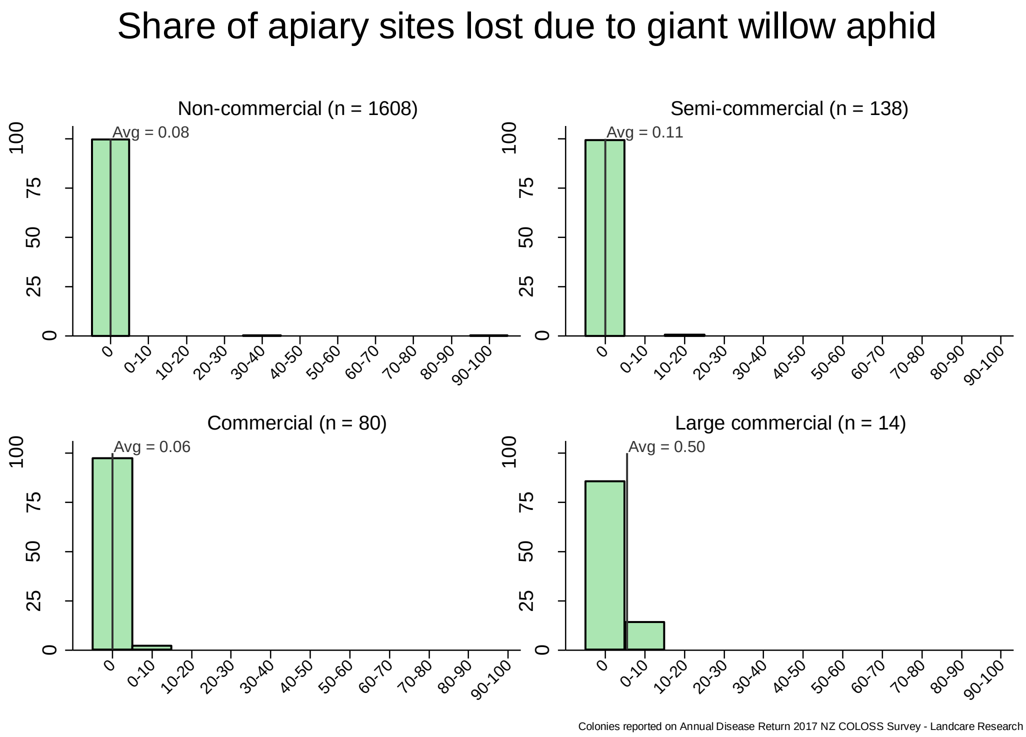

Figure 71: Share of apiaries lost due to giant willow aphid during the 2016/17 season, based on reports from all respondents, by operation size.

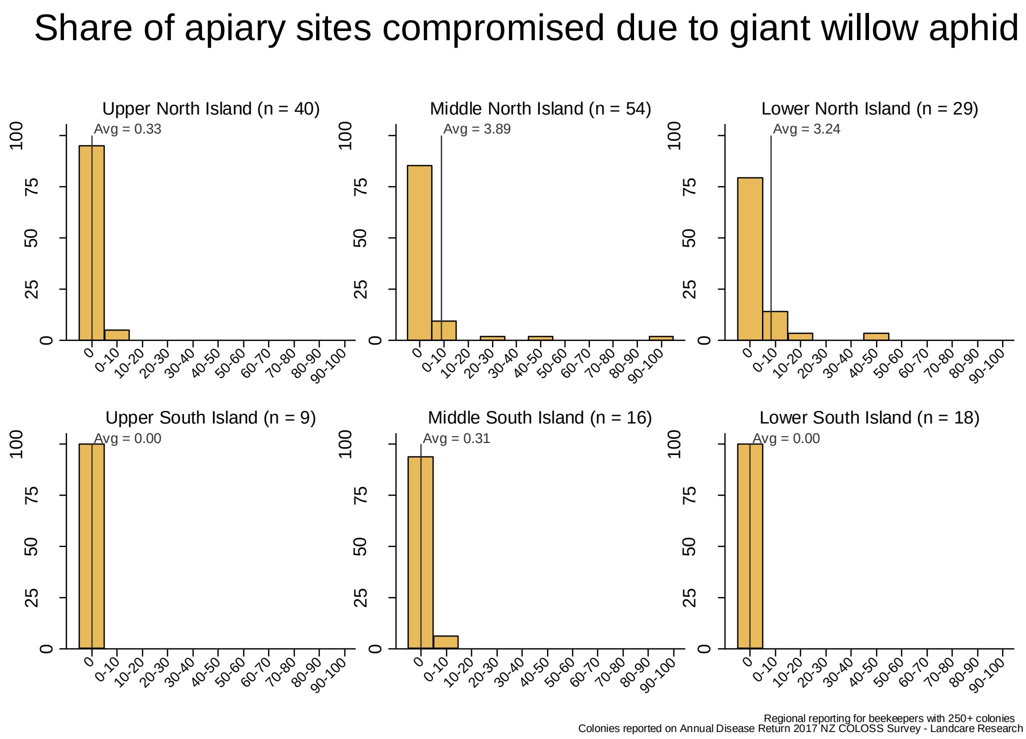

Figure 72: Share of apiary sites that were compromised due to giant willow aphid during the 2016/17 season, based on reports from respondents with more than 250 colonies, by region.

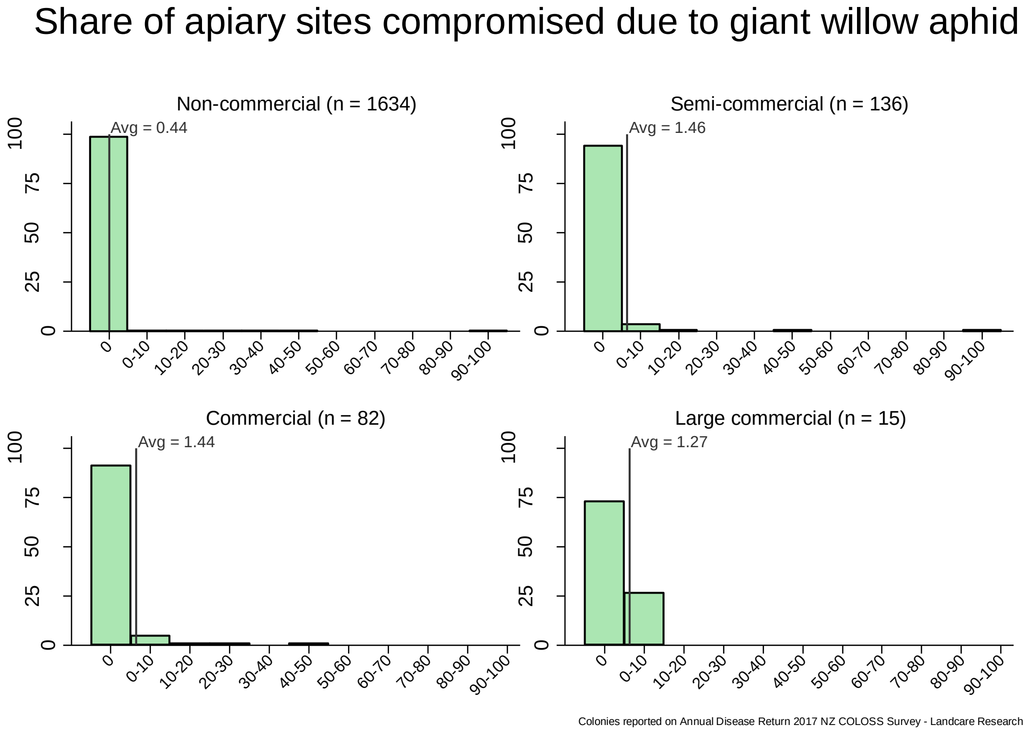

Figure 73: Share of apiary sites compromised due to giant willow aphid during the 2016/17 season, based on reports from all respondents, by operation size.

5.12 Acceptable Losses

In a new addition to the NZ Colony Loss Survey, beekeepers were asked to specify the level of over-winter losses (a concept that is referred to as ‘economic injury level in some scientific literature’) that they consider to be economically sustainable. Responses range from 0% to in excess of 80% for non-commercial beekeepers, and from 1% to 50% for beekeepers with more than 250 colonies. In each case, the median is 10.0%, although the mean is higher for non-commercial beekeepers (16.3%) than for semi-commercial and commercial beekeepers (12.7%). In either case, current levels of over-winter losses are clearly within the range considered to be acceptable by New Zealand beekeepers.

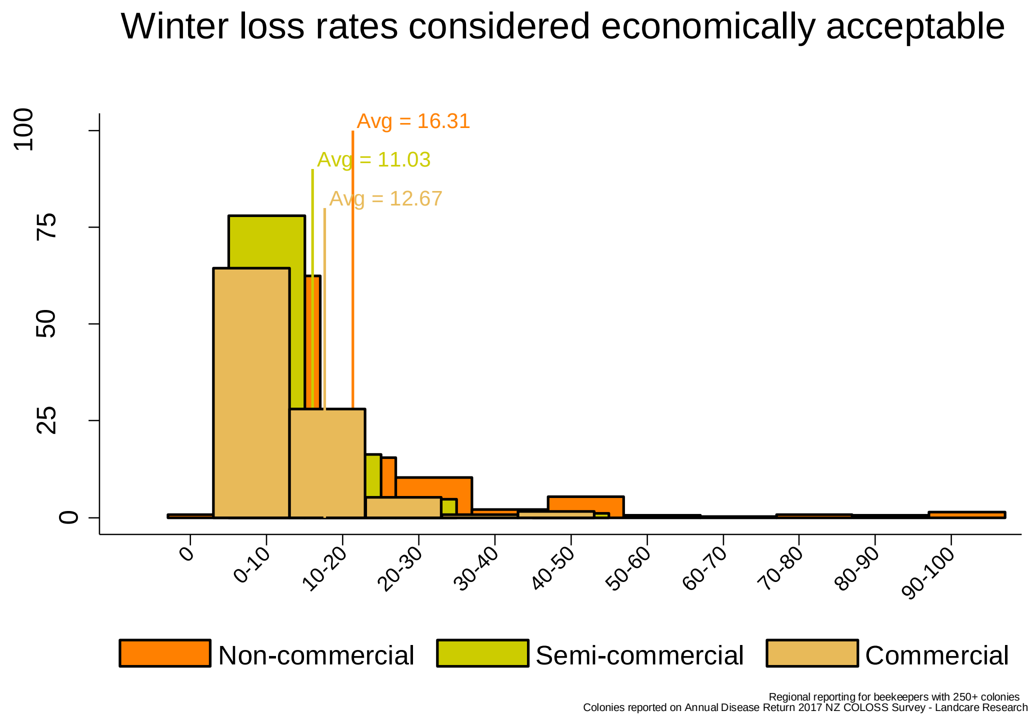

Figure 74: Winter loss rates that are considered economically acceptable, based on reports from all respondents.

6 The Future of the NZ Colony Loss Survey

Over-winter colony losses in New Zealand have been consistent and moderate for the past 3 years, and such findings may suggest that we don't need to be vigilant about monitoring colony losses in the future. However, recent experience from Europe suggests that loss rates are unlikely to remain static. For example, Slovakia, Finland, and Norway each had loss rates below those recorded in New Zealand both 3 years ago and 2 years ago. Moreover, the loss rates from 3 years ago were statistically indistinguishable from those of 2 years ago, suggesting consistency over time. Last year, however, Slovakia's estimated colony loss rates increased by 82.1% to significantly exceed New Zealand's. Finland's estimated colony loss rates increased by 97.7% and Norway's by 157.7% (see http://www.coloss.org/colony-losses-monitoring/). Thus, we believe that it is critical that government, industry, and beekeepers commit to long-term monitoring.

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