Biosecurity New Zealand

Tiakitanga Pūtaiao Aotearoa

Report on the 2018 New Zealand Colony Loss Survey

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Contents

Page

Executive Summary

The 2018 NZ Colony Loss Survey was used to estimate colony losses incurred between 1 June 2018 and the first spring inspection of 2018 (i.e. winter 2018). The questionnaire built on the 2015, 2016, and 2017 NZ Colony Loss Surveys, and, in so doing, provided an opportunity for monitoring trends in national-level losses as well as regional-level losses over the four years that this survey has been conducted.

The survey questionnaire was adapted from earlier waves of the survey. It included a core set of questions from a standardised survey that has been conducted in more than 30 countries. It was administered 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 encouraged by Apiculture New Zealand, New Zealand Beekeeping Incorporated, the Southern North Island Beekeeping Group, and many individual beekeepers as well as by reports in news and speciality media.

In total, 3,655 beekeepers completed the 2018 NZ Colony Loss Survey (including 21 who completed the survey offline), indicating a response rate of 47.1% of all registered beekeepers with valid email addresses. These response rates were more than double those obtained in similar surveys for any European country and approximately eight times the median European response rate in recent surveys. Together, these beekeepers reported on 365,986 production colonies as of 1 June 2018. This figure represents 42.5% of all colonies registered with an email address. In comparison, the share of colonies included in US calculations is approximately 13%.

Personal phone calls were made to all beekeepers with more than 250 colonies as a means of encouraging participation. As a result, 216 of the 540 New Zealand beekeepers with more than 250 colonies completed the survey, a response rate of 39.6% for this targeted group of beekeepers. Together, these beekeepers reported on 44.0% of all colonies registered to beekeepers with more than 250 colonies as of 1 June 2018.

The overall loss rate, i.e. total winter losses reported by survey respondents divided by the total number of colonies that were alive on 1 June 2018, was estimated to be 10.21%, with a 95% confidence interval of [9.85%, 10.58%]. Although these estimates of overall loss rates are statistically indistinguishable from those in 2017, they are significantly higher than for winter 2015 and winter 2016, providing evidence that loss rates have increased at a national level. Moreover, evidence from trend analysis indicates a positive time trend in overall loss rates between 2015 and 2018, suggesting that future overall loss rates are likely to be higher still.

Overall loss rates showed strong regional variation, ranging between 8.06% [7.45%, 8.71%] for the Lower North Island and 12.82% [12.00%, 13.68%] for the Upper North Island. Overall loss rates within regions also exhibited a great deal of fluidity over time. For example, overall loss rates for winter 2018 were statistically higher than overall loss rates for winter 2017 in the Upper North Island and across the South Island; only in the Lower South Island did winter loss rates fall significantly between winter 2017 and winter 2018. Again, evidence from trend analysis indicates a positive time trend in overall loss rates at the regional level between 2016 (the first year in which regional data were analysed) and 2018, although evidence for the Middle North Island is weaker than that for other parts of New Zealand.

As with previous waves of the survey, average loss rates over winter were significantly higher for non-commercial beekeepers. Nevertheless, as in previous years, the survey results indicated wide variation in individual loss rates for commercial and non-commercial beekeepers across space.

Colony losses were most frequently attributed to queen problems (38.5%) and suspected varroa and related complications (23.1%), followed by suspected starvation (9.3%), and wasps (9.2%). Losses were also frequently attributed to suspected nosema and other diseases (4.9%) and robbing by other bees (3.5%). Natural disasters, American Foulbrood, suspected exposure to toxins, thefts/vandalism, accidents, and Argentine ants were significantly less common than the causes listed above, but also contributed 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 provided 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 have seen 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% during that period. Between June 2015 and June 2016, registered colonies increased by 20.0%. Between June 2016 and June 2017, registered colonies increased by 17.7%. Between June 2017 and June 2018, registered colonies increased by 9.1%. As of 1 June 2018, 8649 New Zealand beekeepers operated 879,178 colonies.

Several features distinguish the New Zealand apiculture industry from its European and North American counterparts.

1. Mānuka honey continues to command significant price premiums (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.
2. Non-commercial beekeeping operations (fewer than 251 colonies) comprise 93.5% of the beekeeping operations and manage 14.2% of the colonies, while commercial beekeeping operations (over 250 colonies) comprise 6.5% of the beekeeping operations and manage 85.8% of the colonies. In contrast, fewer than one-tenth of one percent of beekeepers in Germany have more than 150 colonies (European Parliamentary Research Service 2017). In the United Kingdom, just 50 out of 37,888 beekeepers have more than 150 colonies (European Parliamentary Research Service 2017). Across the entire European Union, 6% of beekeepers have more than 150 hives and 2% have more than 300 hives (Chauzat et al. 2013). In Canada, 20% of beekeepers maintain 80% of colonies (Canadian honey Council 2019).
3. American Foulbrood disease (AFB) is one of only two animal diseases to have its own pest management agency, the other being bovine tuberculosis. New Zealand beekeepers are obliged to destroy colonies that are found to have AFB.
4. *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). The short time during which New Zealand has been contending with the management of varroa 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. This 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 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, 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. MPI has commissioned Manaaki Whenua – Landcare Research to conduct the NZ Colony Loss Survey annually since 2015. Using methods detailed below, overall loss rates for winter 2015 were estimated to be 8.37%, with a 95% confidence interval of [7.66%, 9.15%] (Brown & Newstrom-Lloyd 2016).[1] In winter 2016, overall loss rates were estimated to be 9.57% [9.10%, 10.05%] (Brown & Newstrom-Lloyd 2017).[2] In winter 2017, overall loss rates were estimated to be 9.70% [9.37%, 10.05%] (Brown & Robertson 2018).[3] This report highlights results from the fourth NZ Colony Loss Survey, which covered winter 2018.

2 Methods

2.1 SURVEY DESIGN

As with previous waves of the NZ Colony Loss Survey, the 2018 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 2018 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 reduces 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 by 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 included 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 has been 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 floral sources.

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.

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

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

[3] See https://www.mpi.govt.nz/dmsdocument/27825-report-on-the-2017-new-zealand-colony-loss-survey.

The 2017 questionnaire was kept very similar to the 2016 questionnaire in order to facilitate trend analysis. However, the 2017 questionnaire did include two important refinements. First, 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. Second, we added other important explanations for colony loss, including suspected varroa and related complications, suspected nosema and other diseases, and robbing by other bees.

The 2018 questionnaire included additional questions regarding the nature of queen problems, the leading cause of winter colony losses reported in the 2017 report. Specifically, the survey asked whether queens disappeared, whether queens were drone layers, or whether queens had poor brood pattern and/or poor hive build up. In addition, the questionnaire was refined to collect more detailed information about winter apiaries and where losses occurred. The 2018 survey was also transitioned to a new survey platform that supports matrix-style questions, thereby making completion of the survey faster and easier.

2.2 CATEGORIES OF COLONY LOSS USED IN THE 2018 SURVEY

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 issues, 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. Questions on the nature of queen problems were added in 2018.

2.3 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. More than 90% of registered New Zealand beekeepers provided email addresses to AsureQuality. AsureQuality provided these email addresses to Manaaki Whenua – Landcare Research for conducting the 2018 NZ Colony Loss Survey.

Manaaki Whenua – Landcare Research sent personalised email invitations to participate in the survey to 7,812 New Zealand beekeepers on 9 September 2018. In total, 56 emails bounced (probably due to invalid email addresses and/or overly aggressive spam filters) and 177 beekeepers asked to be removed from the list of email contacts. Non-respondents received up to five email reminders between 20 September 2018 and 31 October 2018.

Participation was encouraged by industry groups, including (in alphabetical order) Apiculture New Zealand, New Zealand Beekeeping Incorporated, and the Southern North Island Beekeeping Group as well as prominent individual beekeepers, most notably John Berry. Presentations of results at the 2015, 2016, and 2017 Apiculture New Zealand conferences, interviews on television and radio news, articles in newspapers and *The New Zealand BeeKeeper Journal*, and the opportunity to win vouchers for morning tea provided by Manaaki Whenua – Landcare Research also raised participation levels. In addition, all 559 beekeepers with more than 250 colonies registered with AsureQuality received personal phone calls to encourage completion of the survey; phone calls began in late 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.

In total, 3,655 beekeepers completed the 2018 NZ Colony Loss Survey (including 21 who completed the survey offline), indicating a response rate of 42.3% of all registered beekeepers and 47.1% of all registered beekeepers with valid email addresses. Among the beekeepers who completed the survey were 216 of the 540 beekeepers with more than 250 registered colonies, indicating a response rate of 40.0% among this group of beekeepers. These response rates were more than double those obtained for any European country and approximately eight times the median European response rate in recent surveys (Brodschneider et al. 2017).

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

Region	Non-commercial **(0–50** colonies)	Semi-commercial (51–**250** colonies)	Semi-commercial (251–**500** colonies)	Commercial (50**1–**3,000 colonies)	Large commercial (more than 3,000 colonies)
Upper North Island	836	40	16	25	↑
Middle North Island	652	56	30	37	
Lower North Island	597	44	17	19	24
Upper South Island	222	21	7	13	
Middle South Island	441	14	8	18	
Lower South Island	271	15	7	13	↓
Total	3,259	180	78	114	24

Notes: To preserve anonymity, large commercial beekeepers are not reported by region, and some beekeepers winter colonies in multiple regions. The total shown in the last row therefore reflects the total number of beekeepers in each size class and is not a column total. Five respondent beekeepers who operate in the Chatham Islands are not included.

Together, these beekeepers reported on 365,986 production colonies as of 1 June 2018, an increase of 50.1% compared with the 2017 sample. This figure represented 41.6% of all registered colonies and 42.5% of all colonies registered with an email address. Some 44.0% of all registered colonies among beekeepers with more than 250 colonies were covered. In comparison, the share of colonies included in US calculations is approximately 13% (Bee Informed Partnership 2017).

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

2.4 ESTIMATING COLONY LOSSES, CONFIDENCE INTERVALS, AND TREND

van der Zee et al. (2013) noted two alternative means of calculating loss rates. The 'overall loss rate' is calculated as the total winter losses by survey respondents divided by the total number of colonies that were alive on 1 June 2018. The 'average loss rate' is the average of the individual loss rates, i.e. the average of each respondent's total winter losses divided by the number of living colonies that he or she had on 1 June 2018. Although the loss rates experienced by beekeepers with different-sized operations are not equally variable, the latter approach weights losses equally. In addition, the average loss rate is strongly influenced by operation size. For these reasons, van der Zee et al. (2013) advocated reporting overall loss rates rather than average loss rates. This approach has been adopted by COLOSS for reporting wintering losses in Europe (Brodschneider et al. 2016, 2018) and by the Bee Informed Partnership for reporting wintering losses in the US (Lee et al. 2015, Seitz et al. 2015).

Confidence intervals (interpreted as the true value falling within this range 95% of the time a new sample of beekeepers is drawn from the population) are generally calculated using a binomial distribution, which in this case implies that the likelihood of survival for any given colony is independent of that for any other colony and that the probability of survival is the same for all colonies (van der Zee et al. 2013). However, the performance of one colony in an apiary often depends on the performance of other colonies in the same apiary. Location-specific impacts, such as disease and disaster, can have similar impacts. Such clustering of losses often leads to under- or over-dispersion in the data (McCullagh & Nelder 1989), which can affect standard errors and confidence intervals (Brodschneider et al. 2016). Thus, beginning with this report, standard errors were calculated using a quasi-binomial distribution and a logit link function, which derives a confidence interval for the overall loss rate based on the standard error of the estimated intercept in a model with only an intercept (McCullagh & Nelder 1989; VanEngelsdorp et al. 2012; van der Zee et al. 2013). This approach is consistent with that undertaken in Europe (Brodschneider et al. 2016, 2018) and the US (Lee et al. 2015; Seitz et al. 2015).

To evaluate annual trend in overall loss rates from 2015 through to 2018, we include survey year as a continuous covariate in the quasi-binomial model, with the base year specified as zero. Given that only four years of data are available for an estimate of the trend, results should be treated with caution. In particular, estimates of trend account both for any impacts to colony loss that occur over time and for any impacts that occur over four-year cycles. In addition, these estimates do not seek to explain variation over time and they impose the assumption of linearity.

In addition to inclusion of a continuous covariate in the quasi-binomial model, average loss rates (rather than overall loss rates) were grouped by year, and an extension of the Wilcoxon rank-sum test (Cuzik 1985) was performed to detect an annual trend in loss rates. This test is a non-parametric alternative to the quasi-binomial model described above in that, as it is a non-parametric test, it makes no assumption about the particular distribution from which the data are derived.

3 Survey Questionnaire

The main questions from the standardised international COLOSS survey were included to enable international comparison. Additional questions were added to reflect both the New Zealand context and feedback on the 2015, 2016, and 2017 NZ Colony Loss Surveys provided by scientists, beekeepers, and other end users. The survey was available online between 20 September and 10 November 2018.

The 2018 NZ Colony Loss Survey comprised four distinct parts. The first part of the survey obtained each respondent's consent and ensured that he or she was well positioned to complete the survey. The second, main part of the survey recorded the number of living colonies on 1 June 2018, the number of living colonies during the first spring round of 2018 (regardless of future viability), and the attributions of any losses in between those periods. The third part of the survey focused on topics such as queen performance, varroa monitoring and treatment, floral resources, supplemental feeding, and overcrowding during the 2017/18 season. The fourth part of the questionnaire included open-ended questions about challenges and opportunities in New Zealand beekeeping. Apart from obtaining consent and recording colony numbers at the beginning of winter and during the first spring round, all questions were optional.

The entire text of the survey questionnaire is included as an appendix at the end of this report.

4 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 is reported at an aggregated level (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 (Fig. 1).

Most information is also reported by the total number of colonies comprising each beekeeping operation as of 1 June 2018. In all figures, operation size is categorised into four size classes: 'non-commercial' for those with 0–50 colonies; 'semi-commercial' for those with 51–500 colonies; 'commercial' for those with 501–3,000 colonies; and 'large commercial' for those with more than 3,000 colonies. Beekeepers whose colony numbers changed between the 2017/18 season and 1 June 2018 are classified according to the latter date.[4]

Because 6.5% of New Zealand beekeepers operated 85.9% of production colonies as of 1 June 2018 (vs 6.7% of beekeepers on 1 June 2017), figures reported by aggregated region restrict the sample to

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[4] For example, if a commercial beekeeper with 600 colonies in January sold 300 colonies in May, that operation would be classified as semi-commercial for all reporting, including that for the 2017/18 season. Similarly, beekeepers who operated during the 2017/18 but who sold their operations before 1 June 2018 were categorised as non-commercial operators with 0 colonies.

beekeepers with more than 250 colonies (unless noted).[5] Figures reported by operation size include all respondents.

4.1 NATIONAL-LEVEL ESTIMATES OF COLONY LOSSES DURING WINTER 2018

In previous years, this report reported the overall loss rate described above in addition to two alternative estimates of losses (one based on average losses per beekeeper and one based on average losses per size class). It also reported confidence intervals based on the binomial distribution. For consistency and to facilitate international comparisons, we will only report overall loss rates and standard errors based on quasi-binomial distributions with the logit-link function beginning with this report. Refer to the Methods section for detail.

The overall loss rate during winter 2018 was 10.21%, with a 95% confidence interval of [9.85%, 10.58%].

Table 2 reports the overall loss rates and 95% confidence intervals for winter 2015–2018. To compare overall loss rates between years, we paired the loss data for every two consecutive years and ran a quasi-binomial model on each dataset. A dummy variable was included to distinguish between years, with statistical significance of the coefficient indicating a statistical difference between overall loss rates (at the 95% level). The overall loss rate for winter 2018 is statistically indistinguishable from the overall loss rates for winter 2016 and winter 2017. However, overall loss rates for winter 2018 are 6.7% and 21.9% higher than overall loss rates for winter 2016 and 2015 respectively, both statistically significant differences.

Table 2: Overall loss rates by year (winter)

Winter	Overall loss rate	95% confidence interval	Colonies reporting[6]
2018	10.21%	[9.85%, 10.58%]	365,988
2017	9.70%	[9.37%, 10.05%]	238,263
2016	9.57%	[9.10%, 10.05%]	275,209
2015	8.37%	[7.66%, 9.15%]	225,660

To evaluate annual trend in overall loss rates from 2015 through to 2018, we used a quasi-binomial model as described in the Methods section. Using this method, we reject the null hypothesis of 'no trend' in overall loss rates between 2015 and 2018 at the 99% confidence level ($|t| = 5.66$). We also estimated a non-parametric model, also detailed in the Methods section. Using this method, we reject the null hypothesis of 'no trend' in overall loss rates between 2015 and 2018 at the 99% confidence level ($z = 12.74$). Subject to the caveats noted in the Methods section, we take the evidence of these two tests to conclude that **there is a positive time trend in overall loss rates at the national level**.

Overall loss rates over winter 2018 were also calculated by region (as described in Figure 1, which shows the number of colonies as of 1 June 2018). Estimates for winter 2018 showed strong regional variation (Fig. 2). Overall loss rates were estimated to be 12.82% (with a 95% confidence interval of [12.00%, 13.68%]) for the Upper North Island, 9.92% [9.17%, 10.73%] for the Middle North Island, 8.06% [7.45%, 8.71%] for the Lower North Island, 9.99% [9.05%, 11.02%] for the Upper South Island, 11.36% [10.40%, 12.40%] for the Middle South Island, and 10.58% [9.14%, 12.23%] for the Lower South Island.

[5] Beekeepers who have more than 250 colonies were included in such reporting, even if those colonies were distributed across multiple regions.

[6] The number showing in the 'colonies reporting' column for 2018 differs slightly from the overall number of colonies reported above. Here, we account for any colonies that were either acquired or sold/given away over winter, and we remove any colonies for which loss information was not provided.

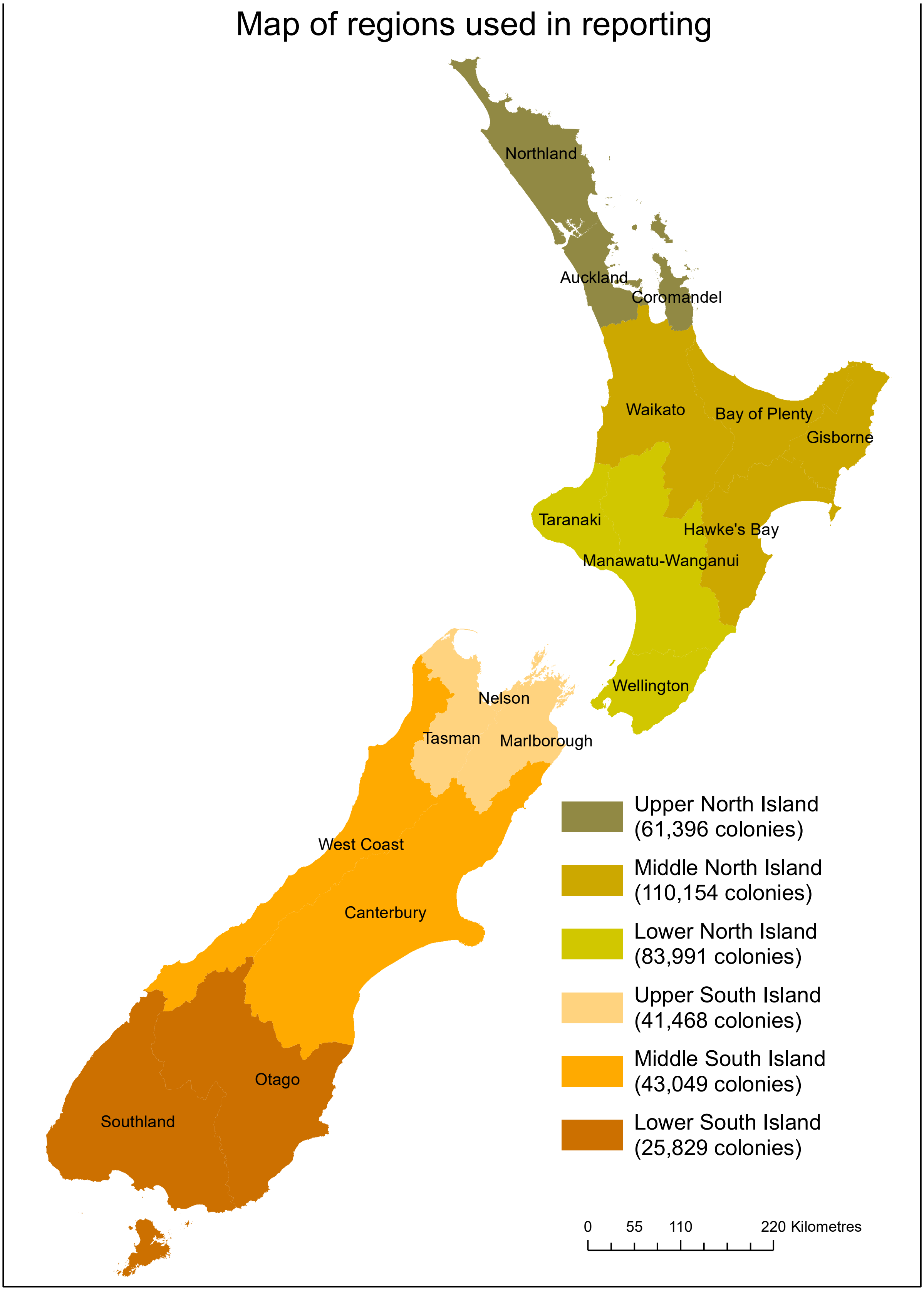

Figure 1: Reference map for reporting by region. Legend shows the number of colonies in each region. Includes all respondents in all operation size classes.

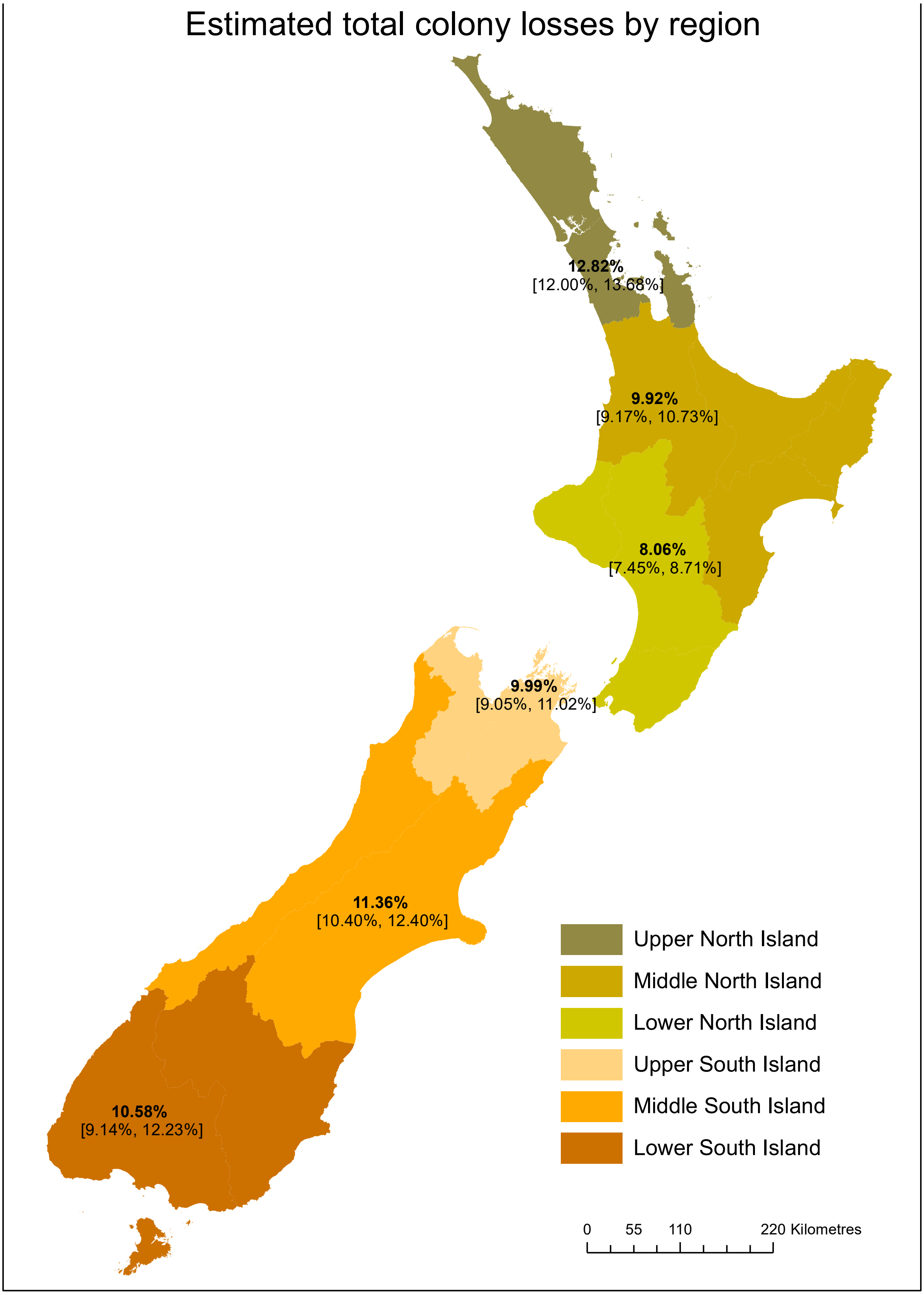

Figure 2: Estimated total colony losses by region. Includes all respondents in all operation size classes.

The share of overall loss rates for winter 2018 attributed to specific causes of colony loss is shown in Figure 3. Overall, 38.5% of total losses over winter 2018 were attributed to queen problems (compared with 34.3% in winter 2017), 23.1% to suspected varroa and related complications (16.9%), 9.3% to suspected starvation (13.9%), and 9.2% to wasps (9.7%). Disease accounted for 4.9% (2.6%) of overall losses while robbing by other bees accounted for 3.5% (4.2%). Natural disasters accounted for an additional 1.4% (4.3%) of overall losses. AFB was cited as the cause of 1.3% (2.8%) of total colony losses, followed by accidents at 0.7% (2.6%). Some 1.6% (2.0%) of total colony losses were attributed to suspected exposure to toxins, and 0.5% (1.9%) of losses to theft or vandalism. Argentine ants were responsible for 0.2% (0.8%) of total colony losses. Beekeepers report being unsure about the cause of 3.2% of losses.

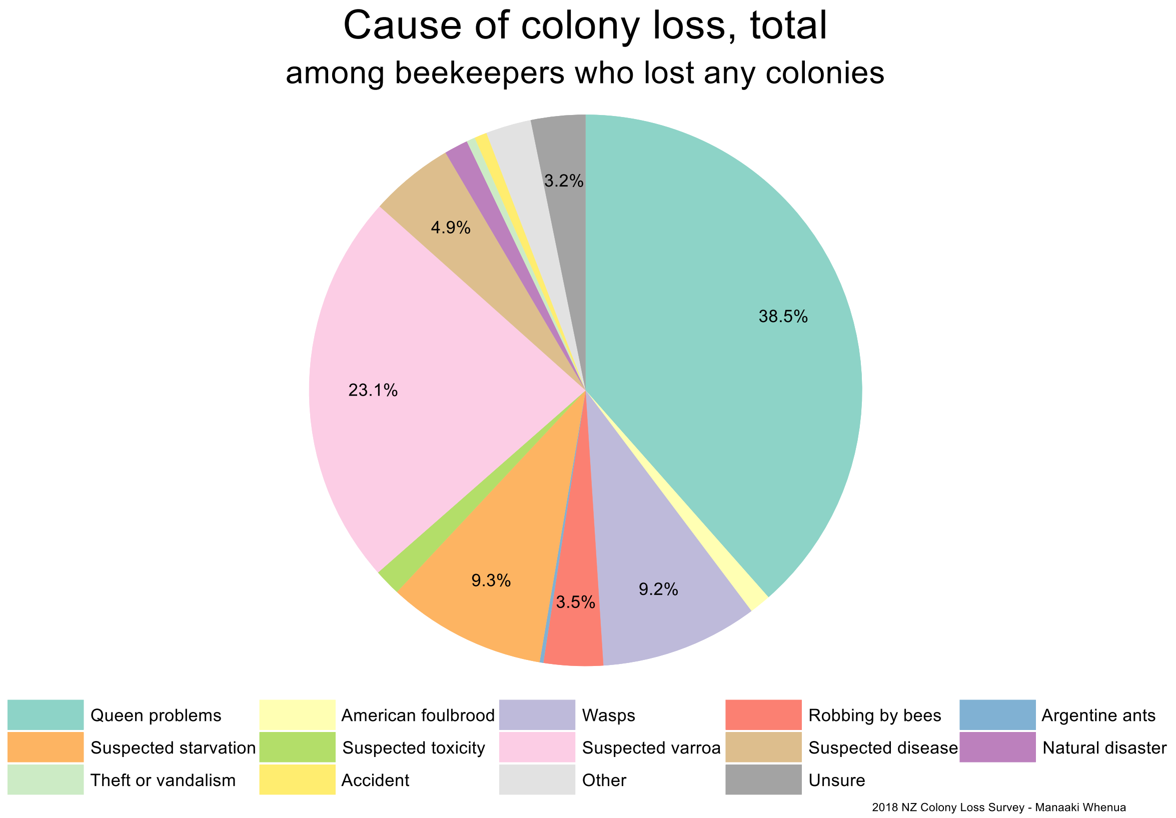

Figure 3: Share of total colony losses over winter 2018 attributed to various causes, based on reports from respondents who lost any colonies, by region.

Overall loss rates by region for winter 2016, 2017, and 2018 are reported in Table 3 (regions were defined slightly differently in our 2015 reporting and hence are not available for comparison; see Section 2.1 above).[7] Overall loss rates in winter 2018 in the Upper South Island were estimated to be 89.8% higher than in 2016 and 81.9% higher than in 2017. In the Upper North Island, winter losses in 2018 were estimated to be 32.0% higher than in 2017 and 58.9% higher than in 2016. In the Middle South Island, winter 2018 losses were estimated to be 48.1% higher than winter 2016 losses, and in the Lower South Island, winter 2018 losses were estimated to be 43.9% higher than winter 2016 losses. Winter losses were statistically unchanged from 2016 to 2018 in the Middle North Island. However, winter losses were estimated to be 31.8% lower in 2018 than in 2016 in the Lower North Island. Thus, while overall loss rates were statistically unchanged from winter 2017, overall loss rates varied dramatically between regions and, in many cases, between years within the same region.

[7] As noted above, the numbers provided in the table include any colonies that were either acquired or sold/given away over winter and remove any colonies for which loss information was not provided. As such, they differ slightly from the number of colonies presented in Figure 2, which reflects colonies as of 1 June 2018.

Table 3: Overall loss rates by year by region (winter)

Region	Winter	Overall loss rate	95% confidence interval	Reported colonies
Upper North Island	2018	12.82%	[12.00%, 13.68%]	61,401
	2017	9.71%	[9.05%, 10.42%]	54,297
	2016	8.07%	[7.20%, 9.03%]	45,435
Middle North Island	2018	9.92%	[9.17%, 10.73%]	110,561
	2017	10.37%	[9.70%, 11.08%]	83,922
	2016	10.65%	[9.77%, 11.59%]	96,472
Lower North Island	2018	8.06%	[7.45%, 8.71%]	84,239
	2017	9.11%	[8.30%, 9.98%]	50,584
	2016	11.82%	[10.45%, 13.34%]	62,218
Upper South Island	2018	9.99%	[9.05%, 11.02%]	39,782
	2017	5.27%	[4.48%, 6.18%]	12,741
	2016	5.49%	[4.55%, 6.62%]	15,382
Middle South Island	2018	11.36%	[10.40%, 12.40%]	43,526
	2017	11.28%	[10.20%, 12.46%]	18,636
	2016	7.67%	[6.81%, 8.63%]	30,820
Lower South Island	2018	10.58%	[9.14%, 12.23%]	26,390
	2017	9.79%	[8.80%, 10.88%]	18,083
	2016	7.36%	[6.49%, 8.32%]	24,882

Since regional reporting became consistent in 2016, estimates of trend at the regional level are based on results from 2016 through 2018 using quasi-binomial model. We reject the hypothesis of no trend over time with 99% confidence for the Upper North Island ($|t| = 7.93$), Lower North Island ($|t| = 5.72$), Upper South Island ($|t| = 6.57$), Middle South ($|t| = 5.23$), and Lower South Island ($|t| = 3.74$). We cannot reject the hypothesis of no trend in the Middle North Island ($|t| = 1.29$). Non-parametric testing reaches similar conclusions except that the time trend is statistically significant at the 99% confidence level for all six regions ($z = [3.49, 9.49]$), including the Middle North Island. Subject to the caveats described in the Methods section, we interpret the evidence of these two tests to conclude that there is a positive time trend in overall loss rates in the Upper North Island and across the South Island. There is a negative time trend in overall loss rates in the Middle North Island and Lower North Island, although the evidence of a time trend is weaker in the Middle North Island than for other regions.

Because regions show such variation, much of the analysis below focuses on performance across regions. The other primary unit of analysis is operation size.

4.2 RESPONDENTS BY REGION AND OPERATION SIZE

Figure 4 shows the region(s) in which the beekeepers who completed the survey overwintered their colonies in 2018.[8] Because beekeeping operations may span multiple regions, some beekeepers were included in more than one region. The distribution of beekeepers in our sample closely resembled the distribution of apiary register locations reported by AsureQuality as of 1 June 2018.

[8] Beekeepers who exited the industry during the 2017/18 season (and thus neither had any registered colonies on 1 June 2018 nor acquired any new colonies during winter 2018) were naturally omitted from all over-winter colony loss calculations.

Figure 5 shows the operation size reported by each respondent, as at 1 June 2018. Non-commercial beekeepers (1–50 colonies) comprised 88.1% of the sample; semi-commercial beekeepers (51–500 colonies) comprised 7.8% of the sample; commercial beekeepers (501–3,000 colonies) comprised 3.4% of the sample; and large commercial beekeepers (3,001 + colonies) comprised 0.7% of the sample.

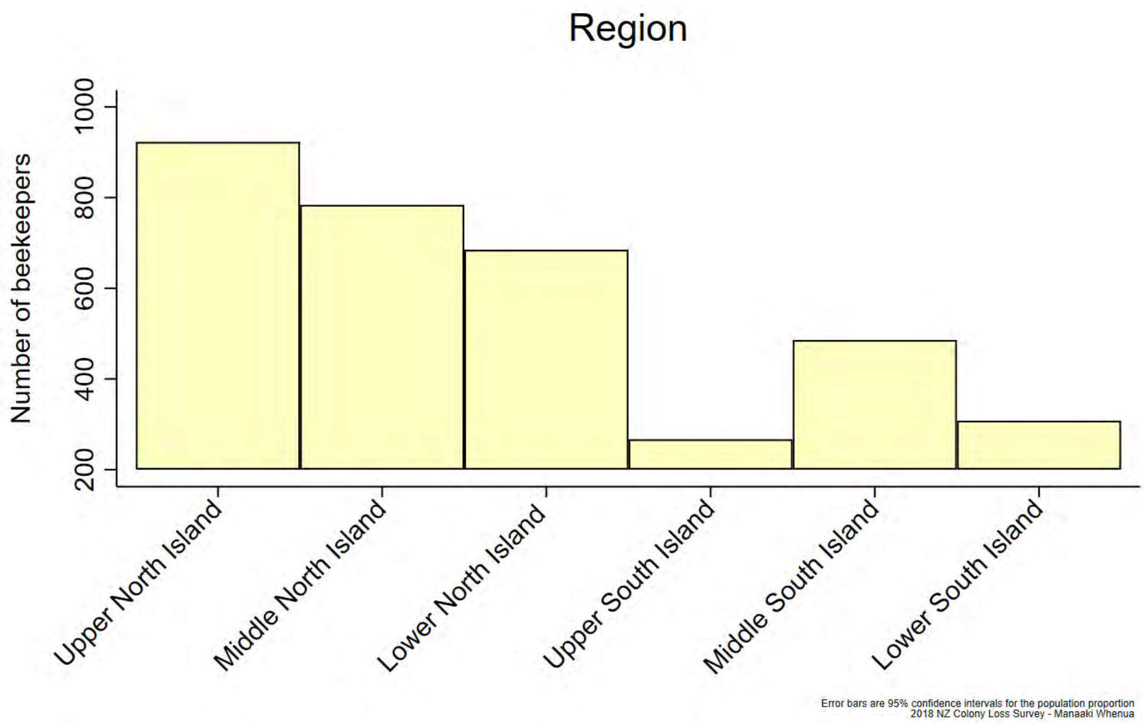

Figure 4: Number of respondents who operate in each region. Includes all respondents in all operation size classes.

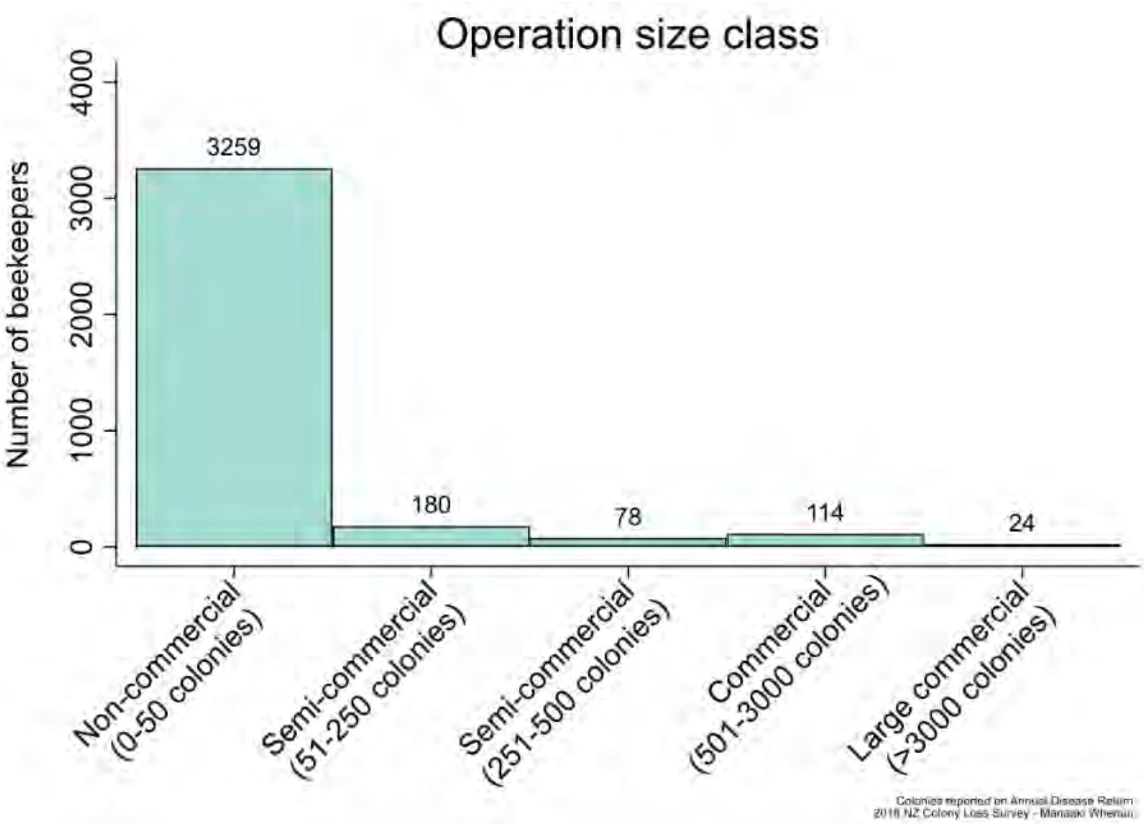

Figure 5: Operation size of respondents grouped into five size classes.

4.3 AVERAGE LOSS RATES OVER WINTER 2018

For the remainder of this report, numbers reported in figures are interpreted as averages within groups. For example, whereas Figure 2 shows overall loss rates (combining all colonies reported) within each region, Figure 6 reports the average loss rates for beekeepers within each region. For example, consider a region that consists of two beekeepers, one with 500 colonies and one with 5,000 colonies. Assume that the smaller beekeeper lost 8% of his or her colonies and that the larger beekeeper lost 12% of his or her colonies. The overall loss rate for the region was 11.64%, but the average loss rate was 10.00%.

While overall loss rates are useful for estimating total losses, average loss rates enable individual beekeepers to better understand the relative performance of their own colonies. However, as noted above, loss rates experienced by beekeepers with different sized operations are not equally variable and average loss rates are strongly influenced by operation size. Loss rates are also strongly influenced by region as, for example, wasps are especially problematic in certain parts of New Zealand and largely absent elsewhere. For these reasons, it makes little sense to compare averages for a large commercial operator in the Middle North Island alongside those of a small non-commercial beekeeper in the Upper South Island. Hence, the following results are presented by region (restricting the sample to beekeepers with more than 250 colonies) and by operation size (without regard to apiary location). These and all subsequent questions were optional, and many beekeepers chose not to provide these details; hence the number of respondents (n) is shown in each figure.

Among beekeepers with more than 250 colonies, the mean reported colony loss over winter 2018 was 10.0% (Figure 6), compared with 9.7% in 2017. However, individual beekeepers in all regions apart from the Upper South Island reported losing 30–40% of colonies, with even higher losses reported for two beekeepers in the Middle North Island. The average shares of colonies lost among beekeepers with more than 250 colonies in the North Island and South Island were 10.2% and 9.4%, respectively, with the highest average losses in the Upper North Island and Middle North Island at 11.4% and 11.5%, respectively. In 2017, the average shares of colonies lost among beekeepers with more than 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%.[9]

Non-parametric testing for time trend (described above) indicates that the time trend is statistically significant at the 99% confidence level for all six regions (z = [3.49, 9.49]). Subject to the caveats discussed previously, we interpret the evidence of these two tests to conclude that there is a positive time trend in average loss rates in the Upper North Island and across the South Island. There is a negative time trend in overall loss rates in the Middle North Island and Lower North Island,

Figure 7 shows the distribution of colony losses by operation size, including those with fewer than 251 colonies. Non-commercial beekeepers lost the highest share of colonies, on average, at 33.4% (compared with 15.7% in 2017), although the distribution was bimodal and 45.7% (compared to 65.7% in 2017) of non-commercial beekeepers reported having no losses. Semi-commercial beekeepers lost 13.5% (9.9%) of their colonies, on average, with 10.5% (14.1%) reporting no losses. Commercial beekeepers lost 9.4% (9.4%), on average, while large commercial beekeepers lost 9.2% (9.6%), on average. Some 93.9% 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.

[9] Among beekeepers with more than 250 colonies, 10.9% in the Upper North Island reported not losing any colonies during winter 2018 (compared with 10.3% during winter 2017); 3.2% in the Middle North Island reported not losing any colonies (compared to 3.2% during winter 2017); 7.1% in the Lower North Island reported not losing any colonies (compared to 9.6% during winter 2017); 4.2% in the Upper South Island reported not losing any colonies (compared to 10.5% during winter 2017); 3.9% in the Middle South Island reported not losing any colonies (compared to 15.6% during winter 2017); and 4.5% in the Lower South Island reported not losing any colonies (compared to 4.0% during winter 2017).

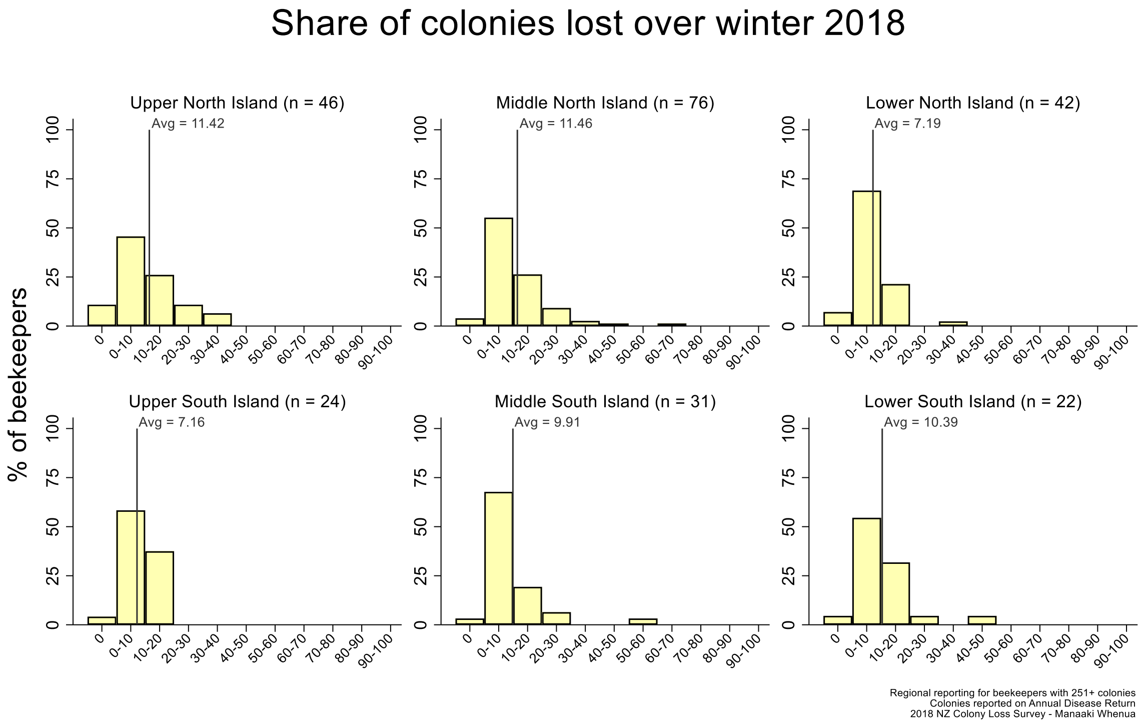

Figure 6: Winter 2018 colony losses as a share of total colonies on 1 June 2018, based on reports from respondents with more than 250 colonies, by region.

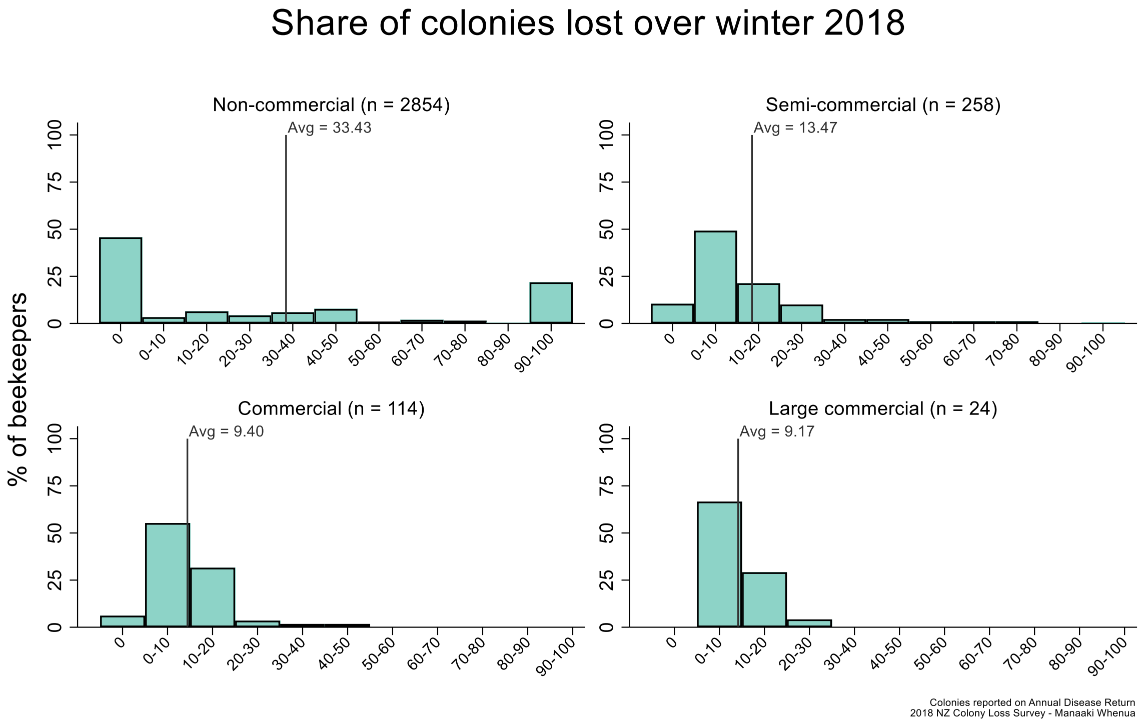

Figure 7: Winter 2018 colony losses as a share of total colonies on 1 June 2018 for all respondents, by operation size.

4.4 COLONY LOSSES BY CATEGORIES OF LOSS

Among beekeepers with more than 250 colonies, 94.4% reported experiencing colony losses over winter 2018. Figures 8 and 9 report the average share of colonies lost by category, by region for beekeepers with more than 250 colonies and by operation size, *among beekeepers who experienced* *any losses*. For example, 23.0% of all losses among non-commercial beekeepers were attributed to queen problems, as were 35.6% of all losses among semi-commercial beekeepers.

On average, queen problems accounted for 40.3% of colony losses over winter 2018 among beekeepers with more than 250 colonies[10] (compared with 43.3% in 2017); this figure ranged from 35.3% in the Middle North Island to 49.5% in the Lower North Island and Middle South Island. In addition, 22.6% of losses among commercial beekeepers were attributed to suspected varroa and related complications, on average (compared with 14.0% in 2017), as were 10.1% (10.1%) to suspected starvation, and 8.5% (7.3%) to wasps. Robbing by bees accounted for 4.1% (4.0%) of losses among commercial beekeepers, on average, and suspected nosema and other diseases accounted for 3.6% (2.0%) of losses among commercial beekeepers, on average.

On average, winter 2018 losses attributed to suspected toxic exposure comprised 1.9% (2.8%) of losses among commercial beekeepers. On average, winter 2018 losses attributed to AFB comprised 1.2% (2.8%) of losses among commercial beekeepers. Average losses attributed to theft and vandalism decreased from 1.5% of losses over winter 2017 to 0.4% of losses over winter 2018. Losses attributed to accidents (typically livestock knocking over hives) were uncommon (1.3% of winter 2018 losses among commercial beekeepers, on average), and those attributed to Argentine ants were rare (0.4% of commercial beekeepers, on average).

Non-commercial beekeepers attributed a lower share of losses to queen problems than semi-commercial and commercial beekeepers, on average. At the same time, non-commercial beekeepers attributed a higher share of losses to wasps, robbing by other bees, and to unknown causes than semi-commercial and commercial beekeepers, on average. Other causes of colony losses occurred with similar frequency across operation sizes.

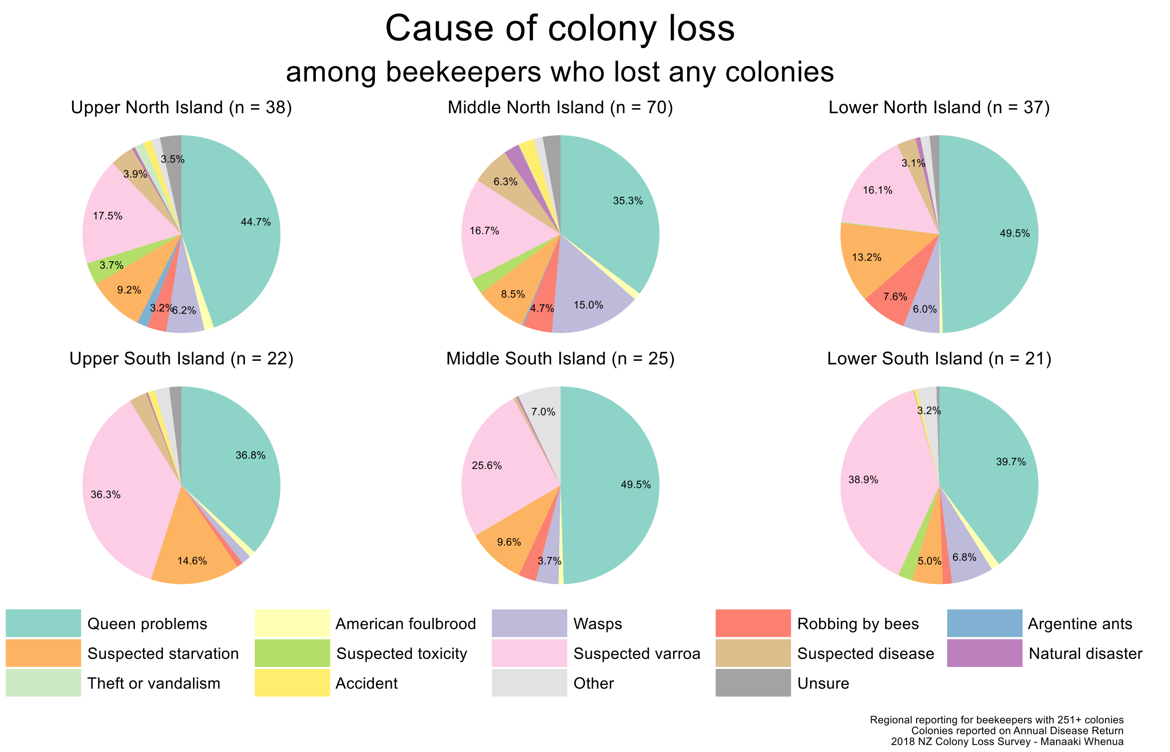

Figure 8: Share of colony losses attributed to various causes based on reports from respondents with more than 250 colonies who lost any colonies, by region.

[10] Some beekeepers operated in multiple regions and thus appear in figures that report results by region multiple times. Our calculation for the share of losses attributed to queen problems (40.3%) differs from the figure that is directly calculatable from the figure (41.9%) because we count each beekeeper just once. In any case, we note any differences in the two calculations that are not negligble.

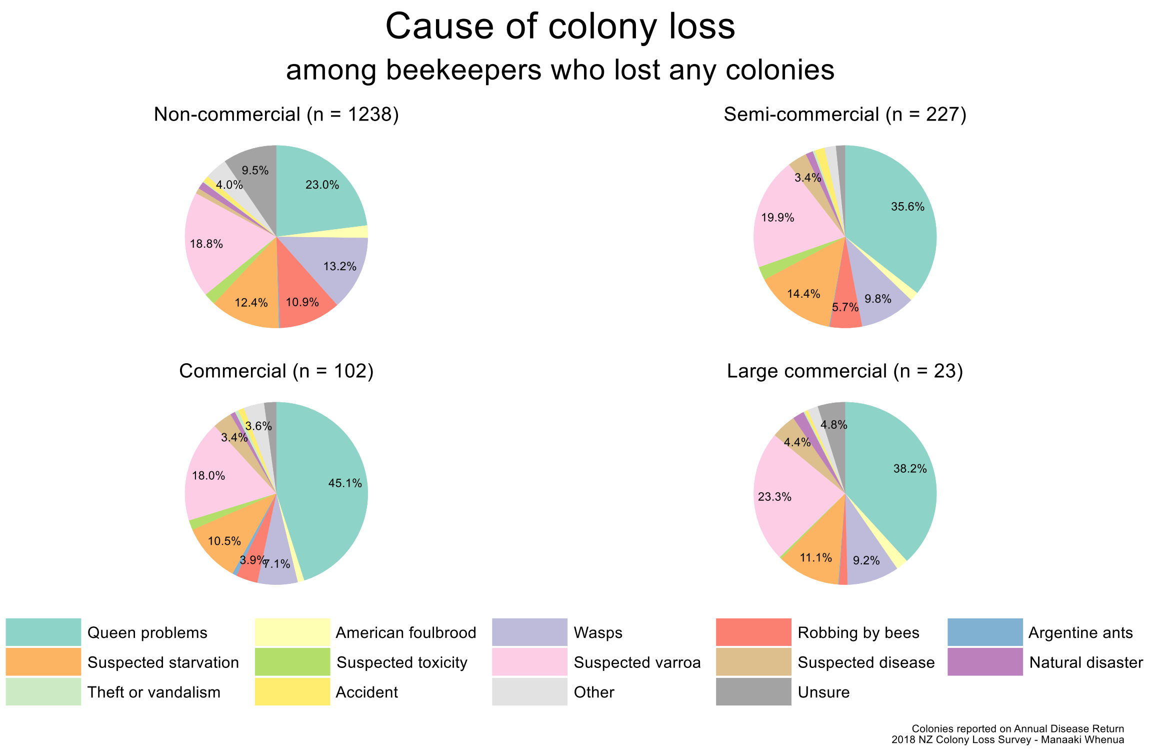

Figure 9: Share of colony losses attributed to various causes, based on reports from respondents who lost any colonies, by operation size.

4.4.1 Queen Problems

As colonies function as ‘superorganisms’, 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 to produce worker bees.

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 (Fig. 11). For example, non-commercial beekeepers who lost any colonies over winter 2018 attributed 23.0% of losses to queen problems, on average (compared with 23.3% in 2017), versus 38.5% of losses among commercial beekeepers (over 40% in 2017). The distribution of colony losses attributed to queen problems also depended on operation size: for example, 65.5% of beekeepers with 1–50 colonies who experienced colony losses attributed none of their colony losses to queen problems in 2018 (compared with 68.4% in 2017), versus 14.3% of beekeepers with more than 250 colonies (compared with 7.8% in 2017). Among commercial beekeepers, 49.5% of winter 2018 losses were attributed to queen problems, on average, in the Lower North Island and Middle South Island (Fig. 10); in contrast, 35.2% of winter 2018 losses were attributed to queen problems, on average, in the Middle North Island.

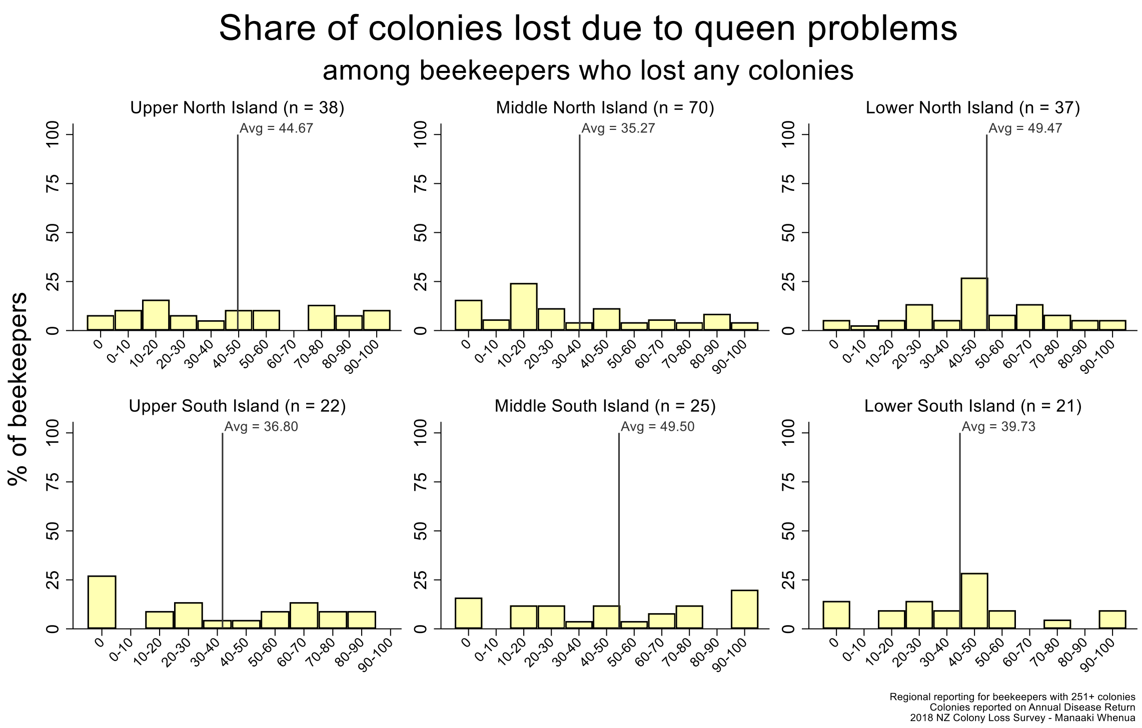

Figure 10: Winter 2018 colony losses that resulted from queen problems (including drone-laying queens and no queen), based on reports from respondents with more than 250 colonies who lost any colonies, by region.

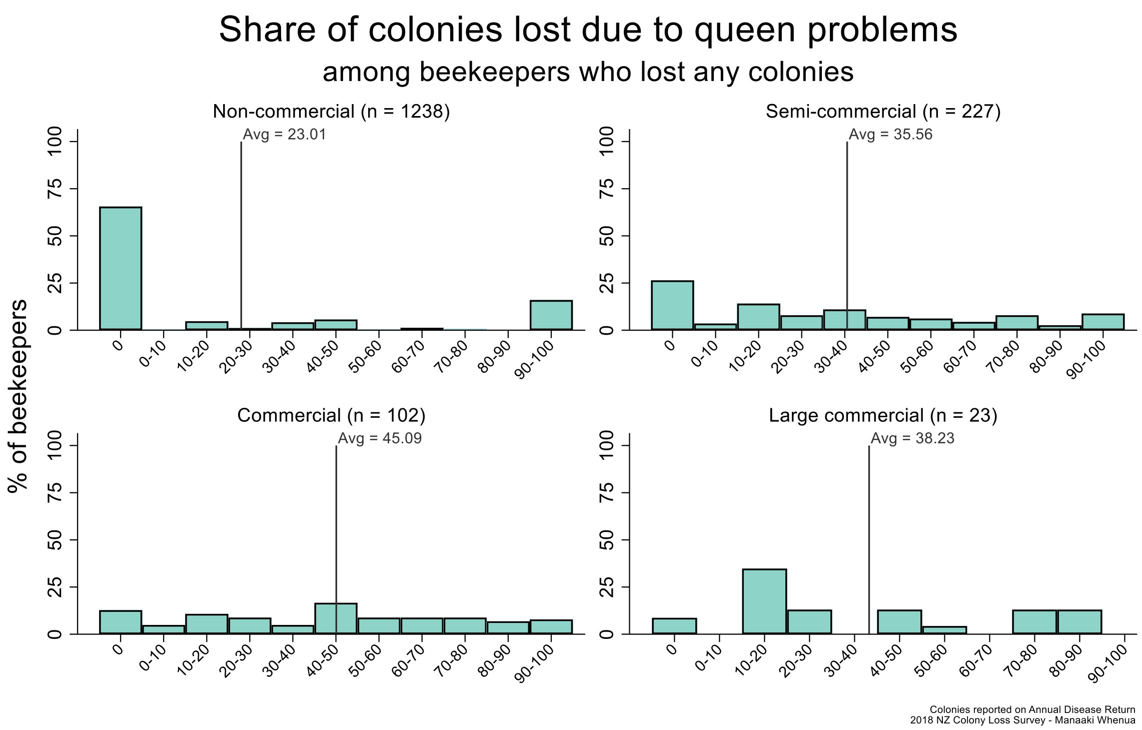

Figure 11: Winter 2018 colony losses that resulted from queen problems (including drone-laying and no queen), based on reports from all respondents who lost any colonies, by operation size.

Given the large proportion of overall losses attributed to queen problems in 2017, the 2018 NZ Colony Loss Survey included questions regarding the nature of those losses. Specifically, beekeepers were asked to specify whether queen problems lay with queens disappearing, drone-laying queens, or queen failure that resulted in poor brood pattern and/or poor hive build up. Among beekeepers with more than 250 colonies, drone-laying queens and queen failure were dominant problems (Fig. 12), occurring with similar frequency. Old queens were somewhat more likely to be drone layers than young queens, but old queens failed at a 47.9% higher rate than young queens for beekeepers with more than 250 colonies.

Across all size classes, old queens contributed to more problems than young queens (Fig. 13). Queens disappearing was a particular challenge among non-commercial beekeepers, occurring 83% more frequently than in any other size class.

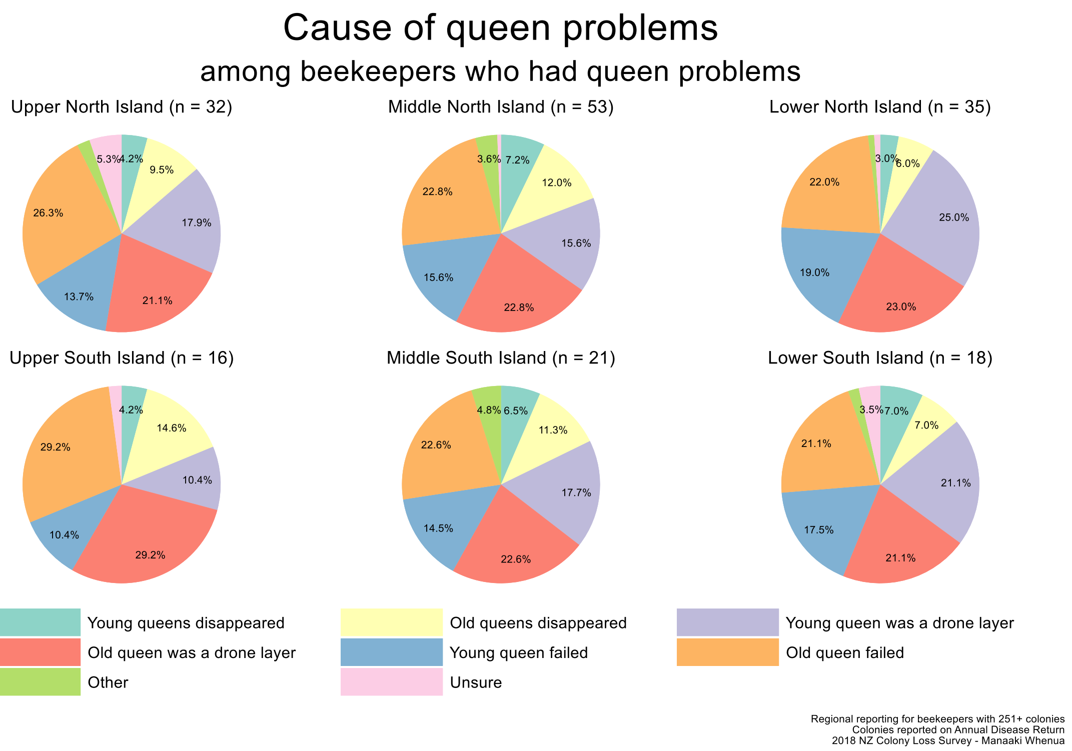

Figure 12: Cause of queen problems during winter 2018, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

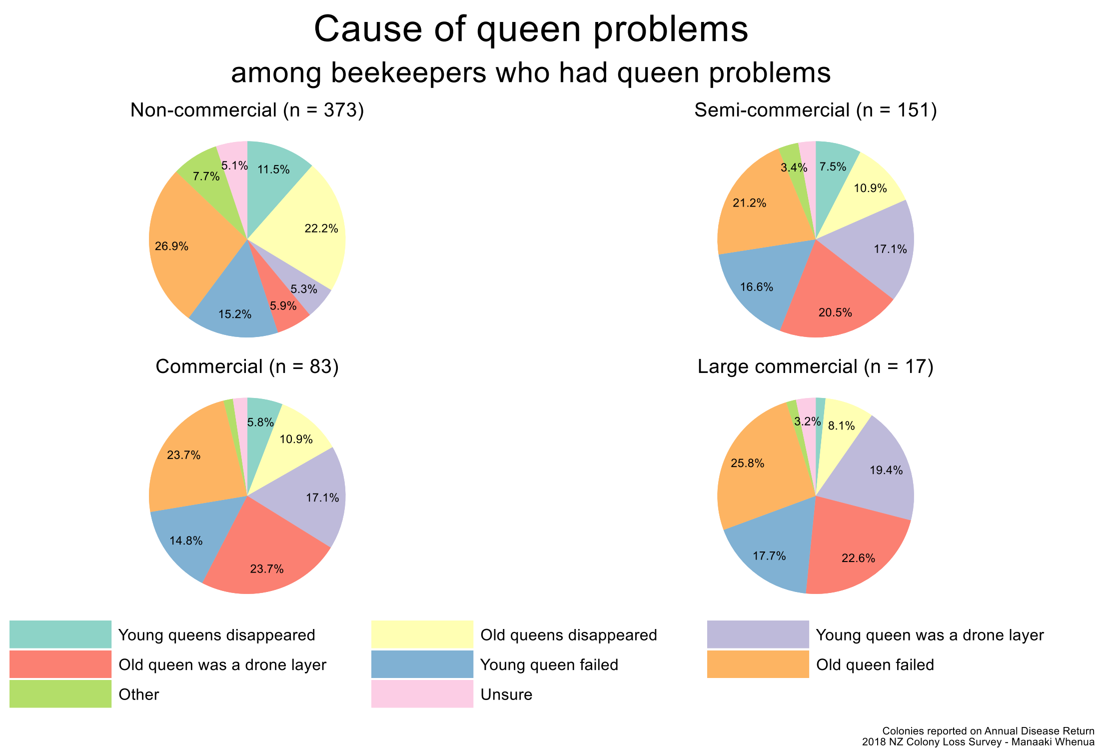

Figure 13: Cause of queen problems during winter 2018, based on reports from all respondents who lost any colonies, by operation size.

Re-queening is a common strategy for reducing potential queen problems, especially among commercial beekeepers. Indeed, among commercial beekeepers, 54.4% of colonies during the 2017/18 season were re-queened. Among beekeepers with more than 250 colonies, re-queening was particularly common in the Lower North Island (Fig. 14). Differences in re-queening rates across operation size classes were very small, on average (Fig. 15).

The 2018 NZ Colony Loss Survey asked about the source of new queens, and 63.9% of new queens derived from queen breeder stock. Virgin queens accounted for 27.3% of new queens. Among beekeepers with more than 250 colonies, 65.2% of new queens were derived from breeder stock, and 26.8% of new queens were virgins.

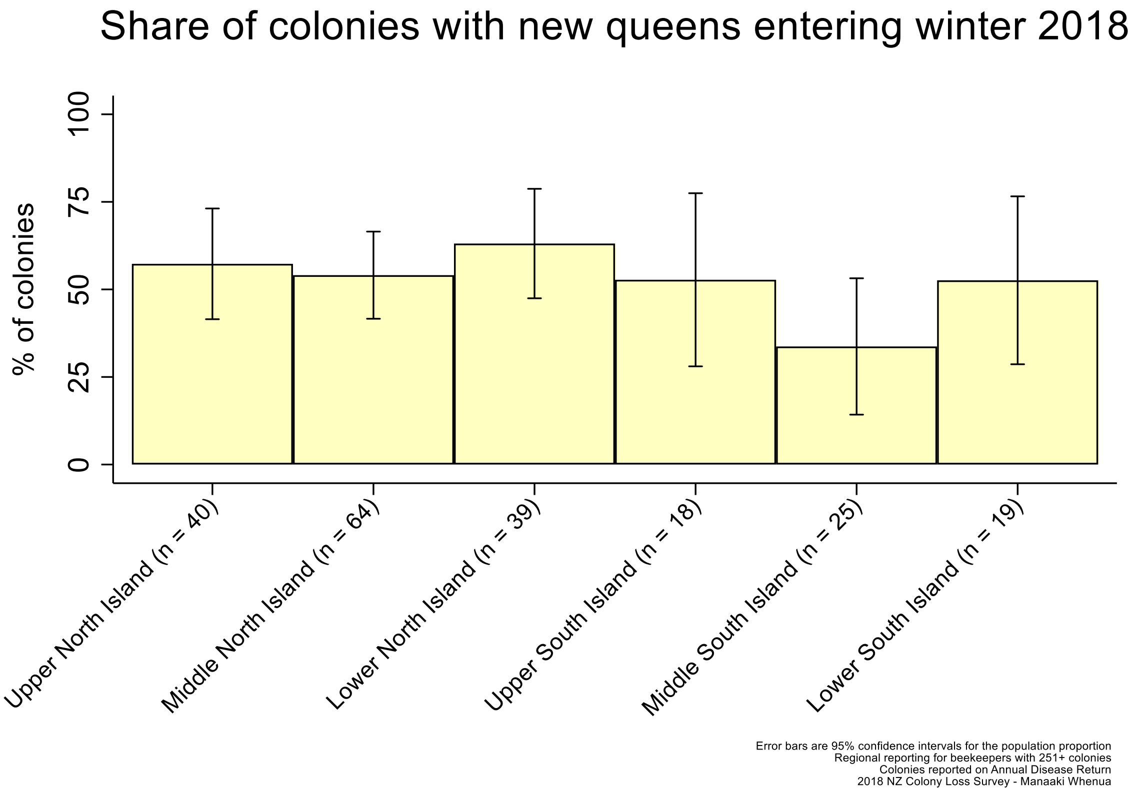

Figure 14: Share of colonies with new queens entering winter 2018, by region.

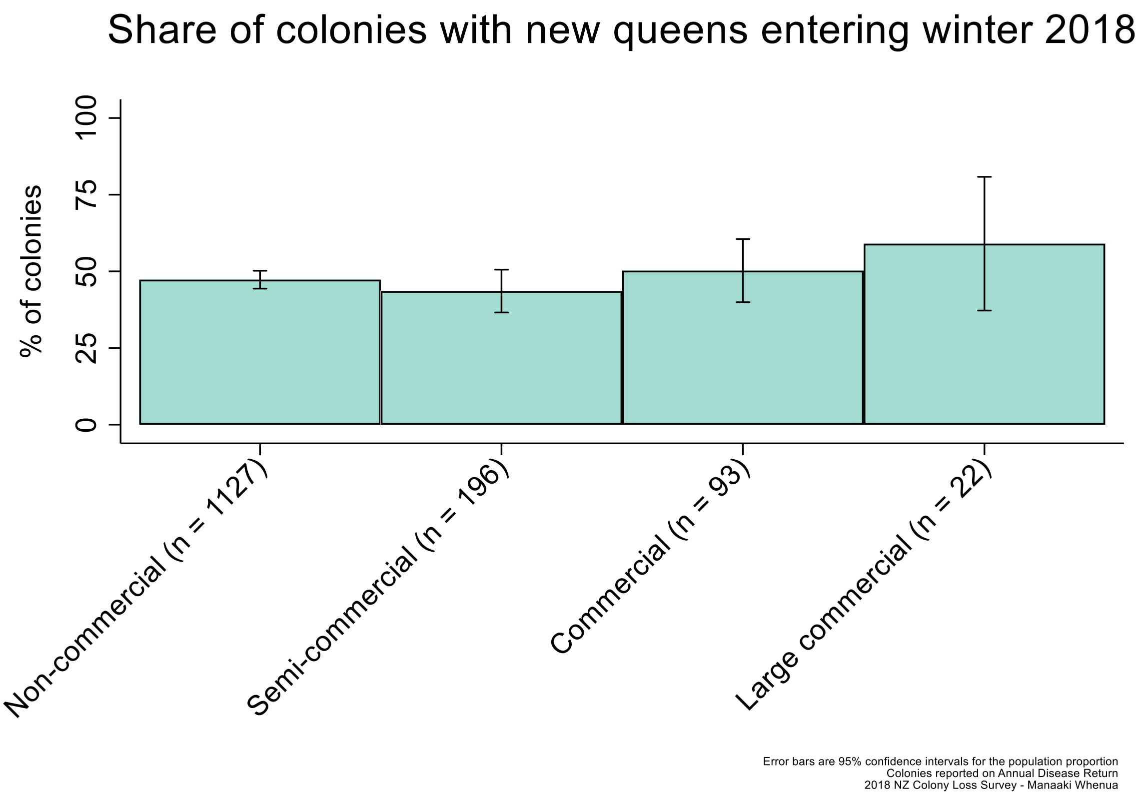

Figure 15: Share of colonies with new queens entering winter 2018, by operation size.

4.4.2 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 both 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, beginning in 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 22.6% of overall losses among commercial beekeepers were attributed to suspected varroa and related complications over winter 2018, on average (versus 14.1% for winter 2017). This figure ranged from 16.1% in the Lower North island to 38.9% in the Lower South Island. Notably, the average share of losses attributed to varroa and related complications in the Upper South Island increased from 3.9% in winter 2017 to 36.3% in winter 2018 (Fig. 16). Attributions of colony loss to varroa ranged from 18.8% for commercial beekeepers to 23.3% for large commercial beekeepers (Fig. 17).

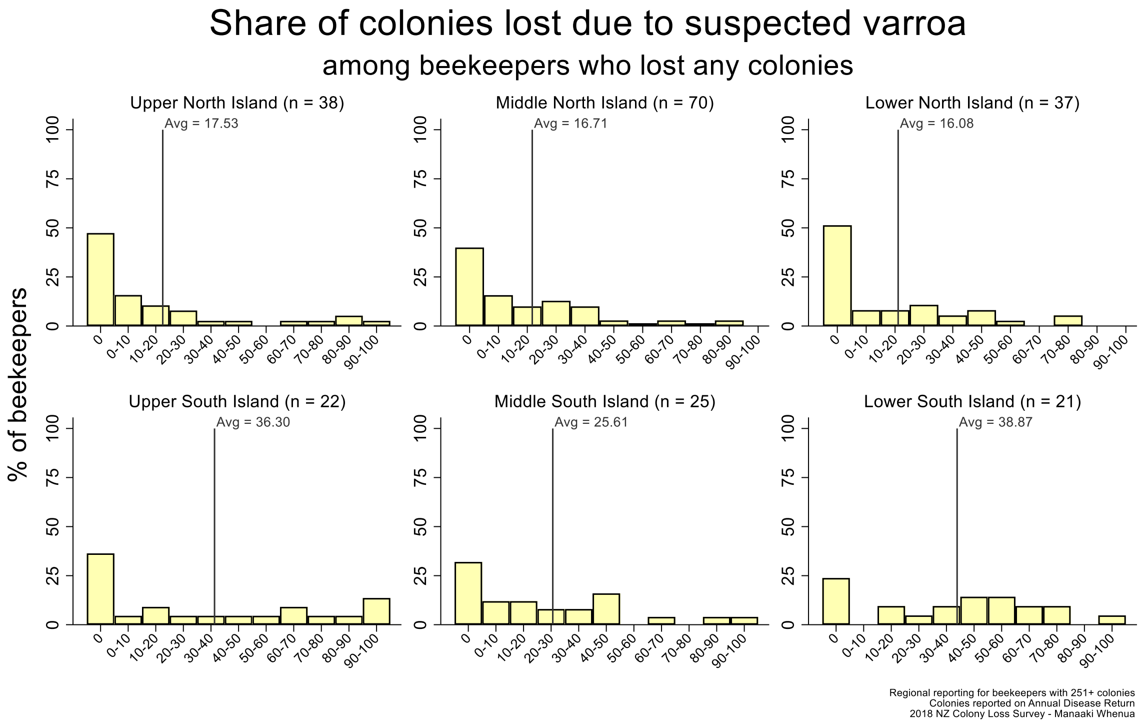

Figure 16: Winter 2018 colony losses that resulted from suspected varroa and related complications, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

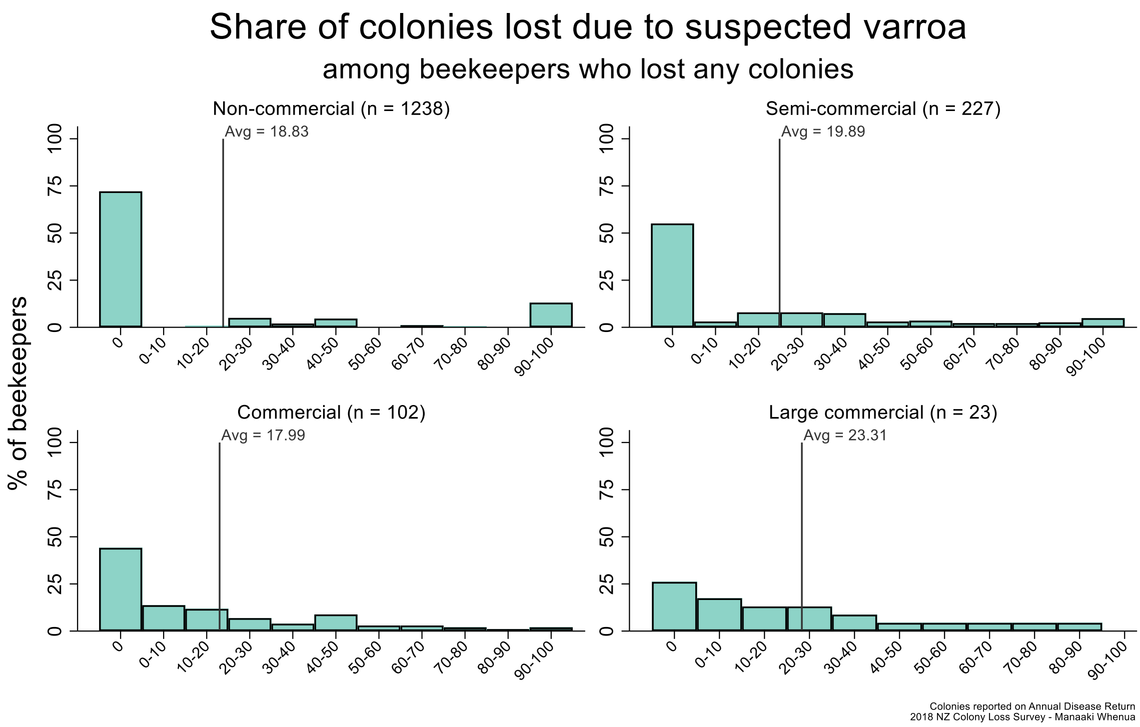

Figure 17: Winter 2018 colony losses that resulted from suspected varroa and related complications, based on reports from all respondents who lost any colonies, by operation size.

4.4.3 Suspected Starvation

Dead worker bees in cells with no food present in the colony is indicative of starvation. On average, 10.1% of 2018 winter losses were attributed to suspected starvation by beekeepers with more than 250 colonies (Fig. 18), compared with 10.3% of losses in winter 2017. Loss shares attributed to starvation were similar across operation size classes (Fig. 19), ranging from 11.1% for large commercial beekeepers to 14.4% for semi-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. In addition, colony weakening during times of pollen and nectar dearth and during bad weather is common, although these problems may be mitigated by supplementary feeding of sugar and protein.

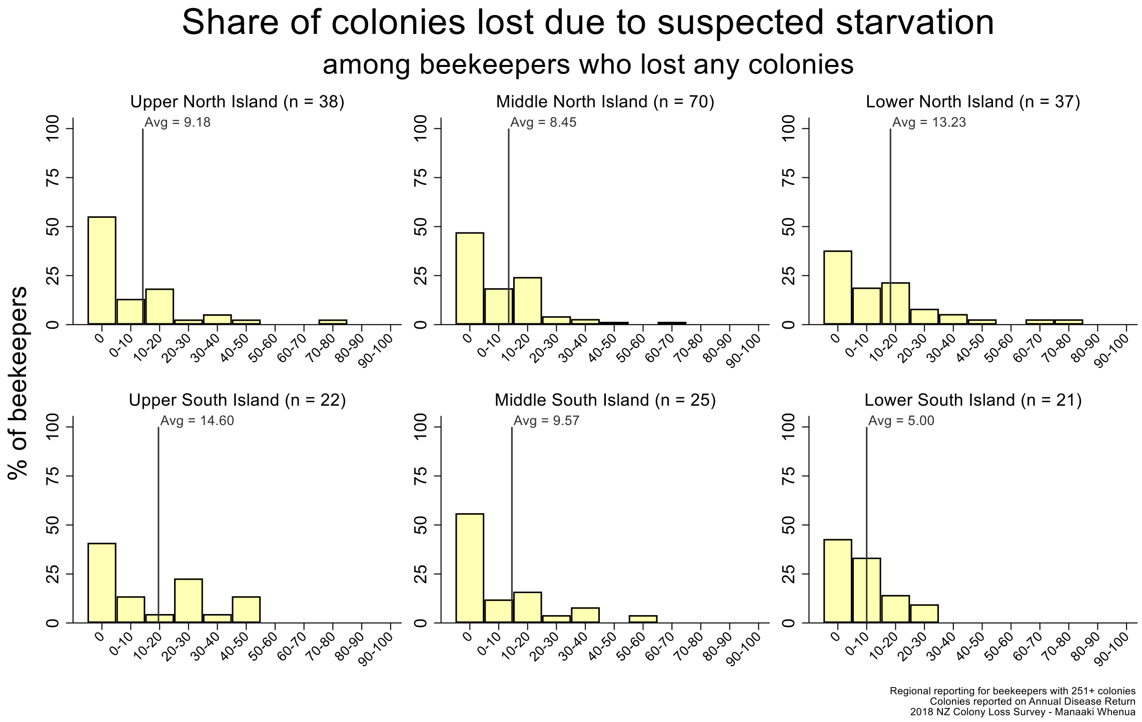

Figure 18: Winter 2018 colony losses that resulted from suspected starvation, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

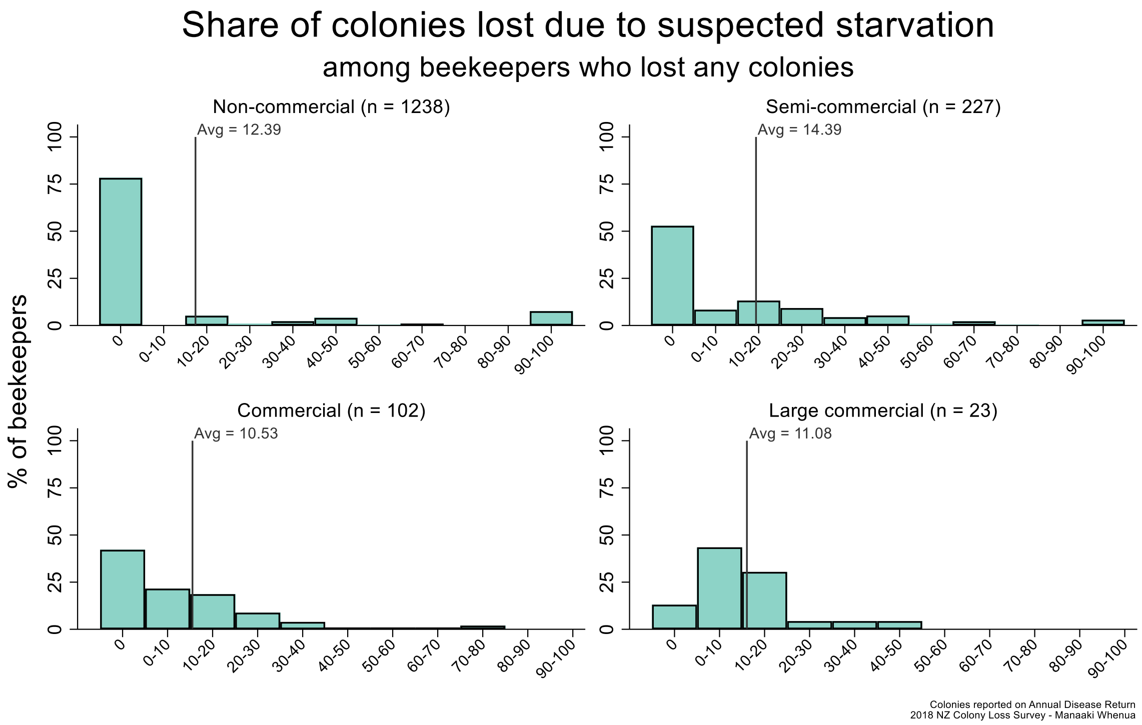

Figure 19: Winter 2018 colony losses that resulted from suspected starvation, based on reports from all respondents who lost any colonies, by operation size.

4.4.4 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 20, beekeepers with more than 250 colonies attributed 8.5% of winter 2018 colony losses to wasps, on average, versus 10.5% in winter 2017. The proportion was slightly higher for non-commercial beekeepers (13.2%) than for semi-commercial beekeepers (9.8%), commercial beekeepers (7.1%), and large commercial beekeepers (9.2%) (Fig. 21). Wasps contributed a much greater average share of colony losses in the North Island (10.4% among beekeepers with more than 250 colonies) than in the South Island (4.6%), with the highest average shares in the Middle North Island. Interestingly, the share of losses attributed to wasps in the South Island more than doubled from 2017 levels, driven primarily by large increases in the Lower South Island.

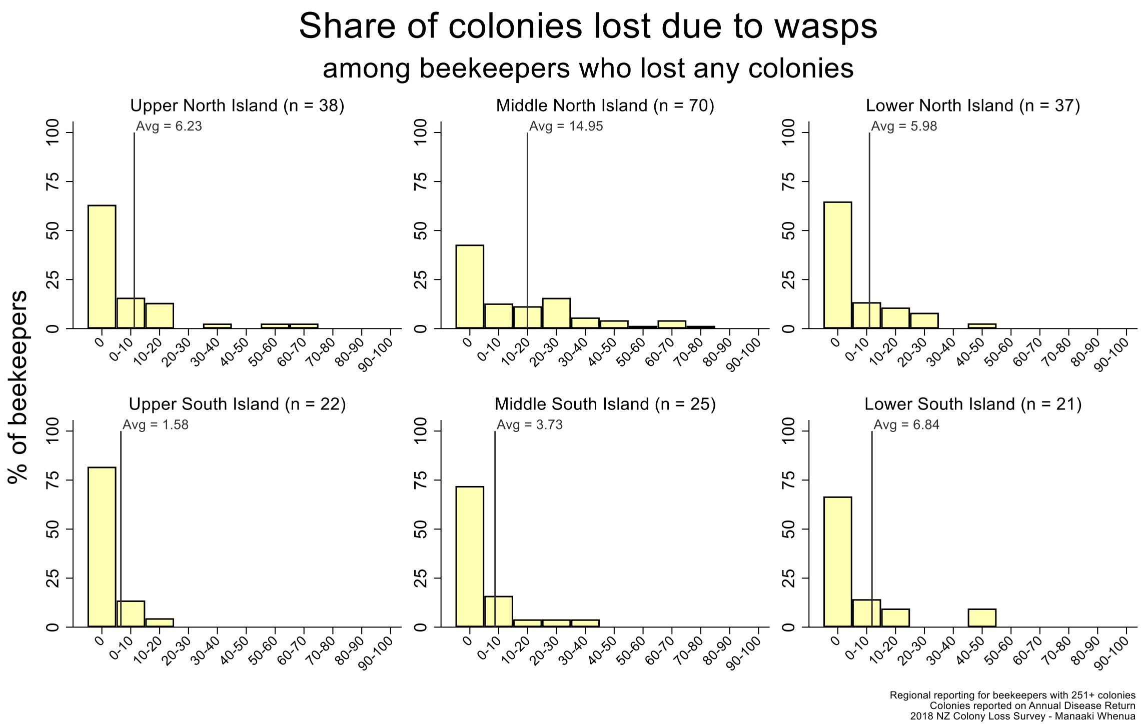

Figure 20: Winter 2018 colony losses that resulted from wasp problems, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

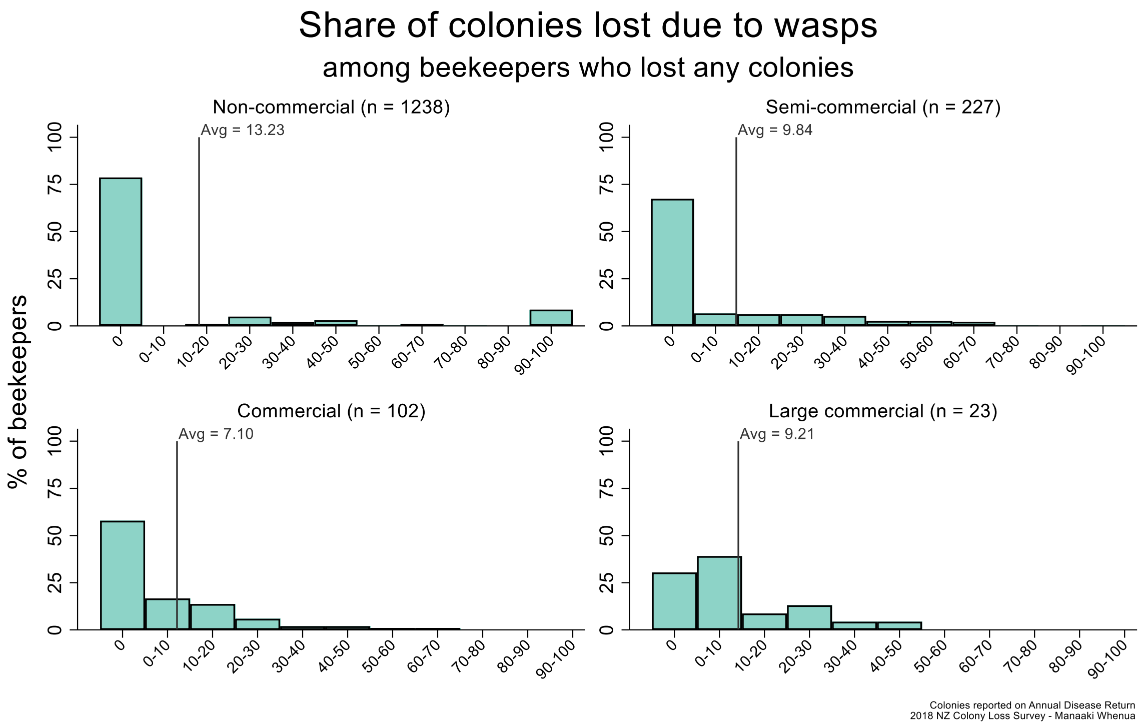

Figure 21: Winter 2018 colony losses that resulted from wasp problems, based on reports from all respondents who lost any colonies, by operation size.

4.4.5 Natural Disasters

A mild winter across much of New Zealand contributed to low losses due to natural disasters. Among beekeepers with more than 250 colonies, average losses attributed to natural disasters over winter 2018 were just 1.2%, compared with 4.7% over winter 2017 (Fig. 22), when severe flooding affected

Southland, the Bay of Plenty, and elsewhere. Still, one large commercial operator and one commercial operator reported (and subsequently confirmed) that over 30% of their colonies were lost to natural disasters in 2018 (Fig. 23).

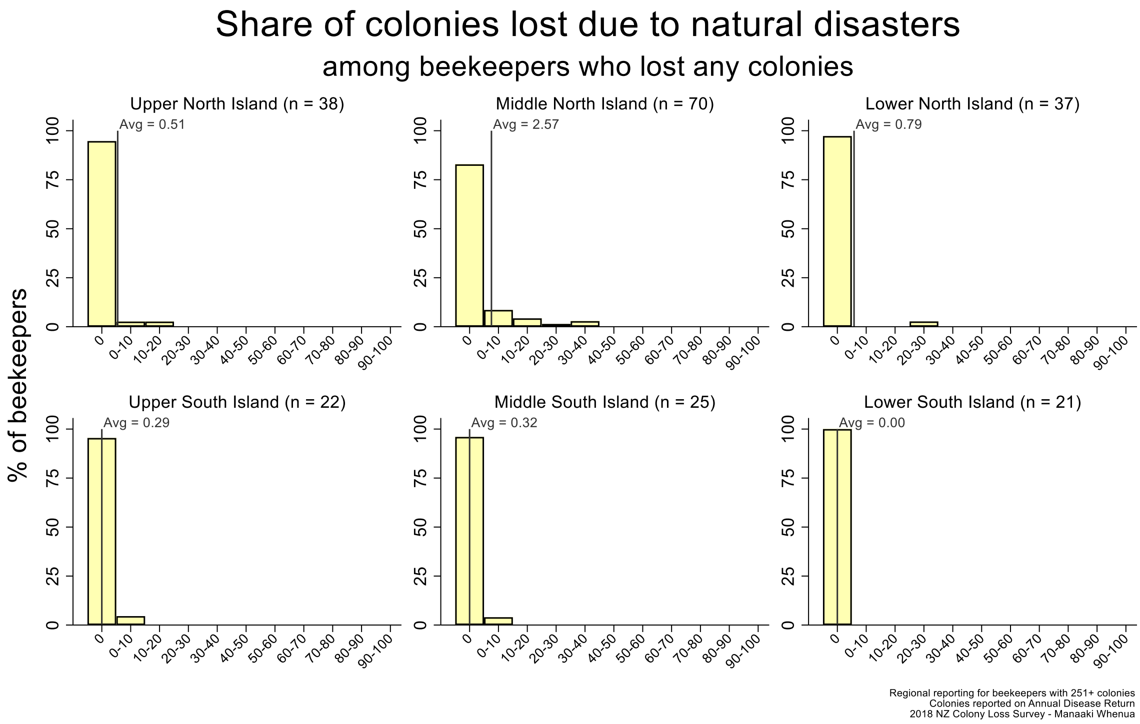

Figure 22: Winter 2018 colony losses that resulted from natural disasters, based on reports from respondents with more than 250 colonies who lost any colonies, by region. Natural disasters include gale force winds, flooding, etc.

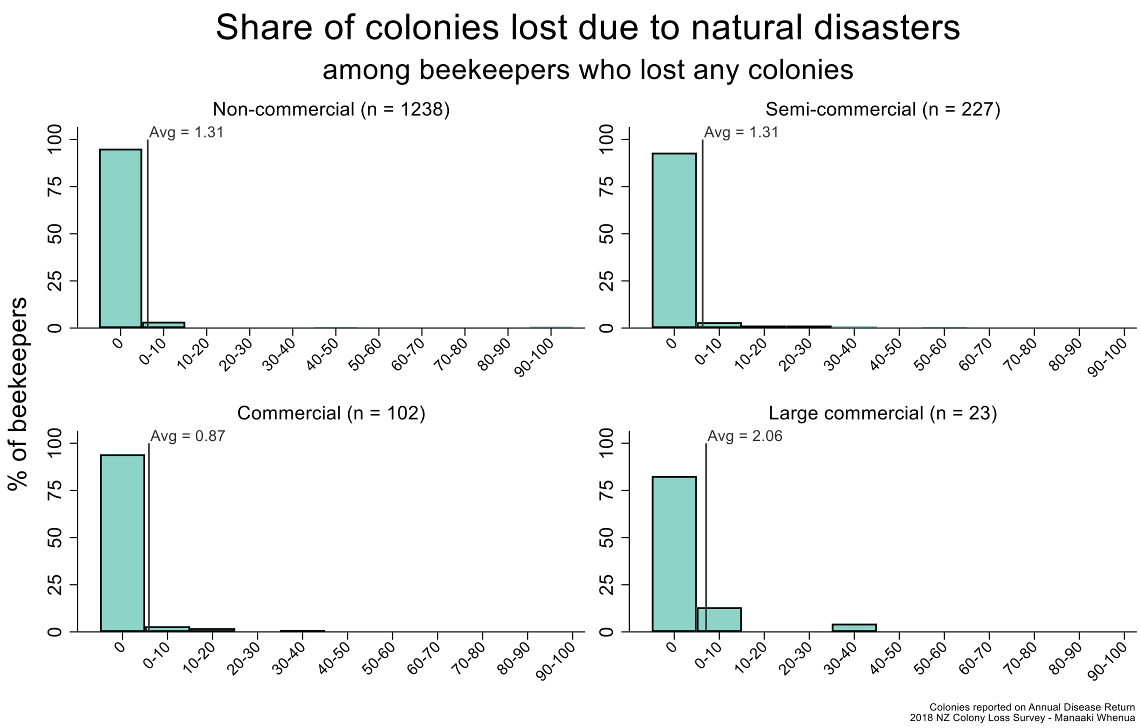

Figure 23: Winter 2018 colony losses that resulted from natural disasters, based on reports from all respondents who lost any colonies, by operation size. Natural disasters include gale force winds, flooding, etc.

4.4.6 Robbing by Other Bees

Weak colonies are susceptible to robbing from strong hives, particularly when there is a dearth of nectar sources. Robbing was significantly more common among non-commercial beekeepers than among commercial beekeepers (Fig. 25). Among beekeepers with more than 250 colonies, robbing accounted for 4.1% of losses over winter 2018, on average, a figure identical to that in 2017. Robbing was more common in the North Island, where mānuka-honey production is prominent (Fig. 24).

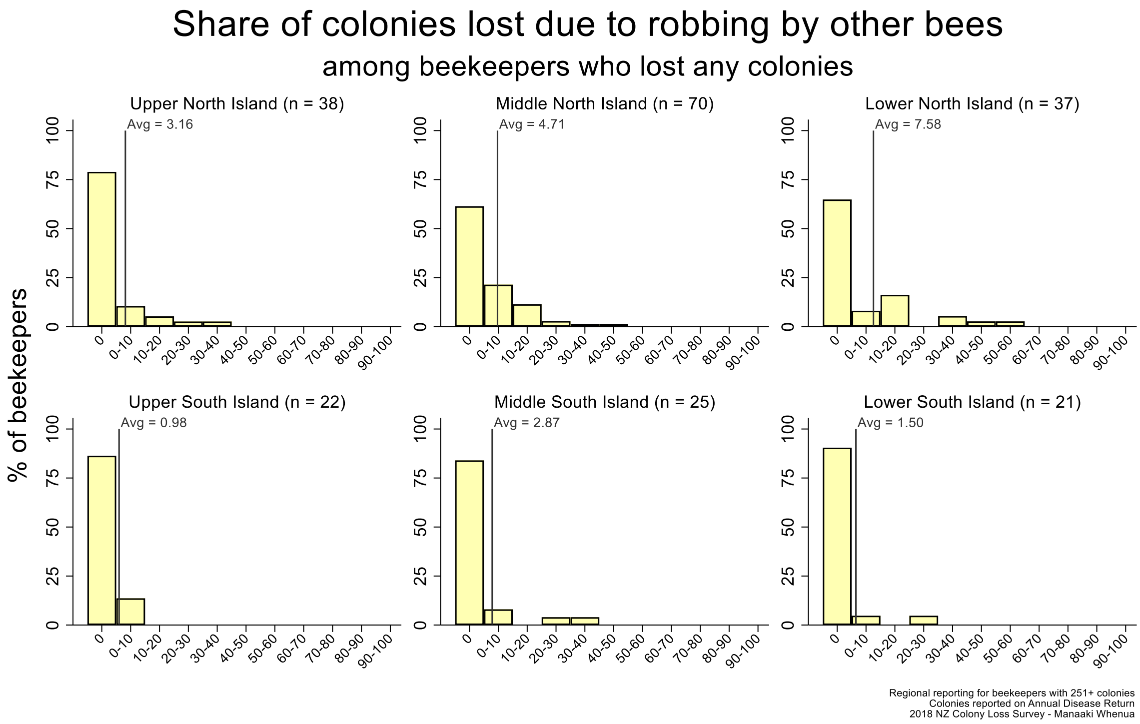

Figure 24: Winter 2018 colony losses that resulted from robbing by other bees, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

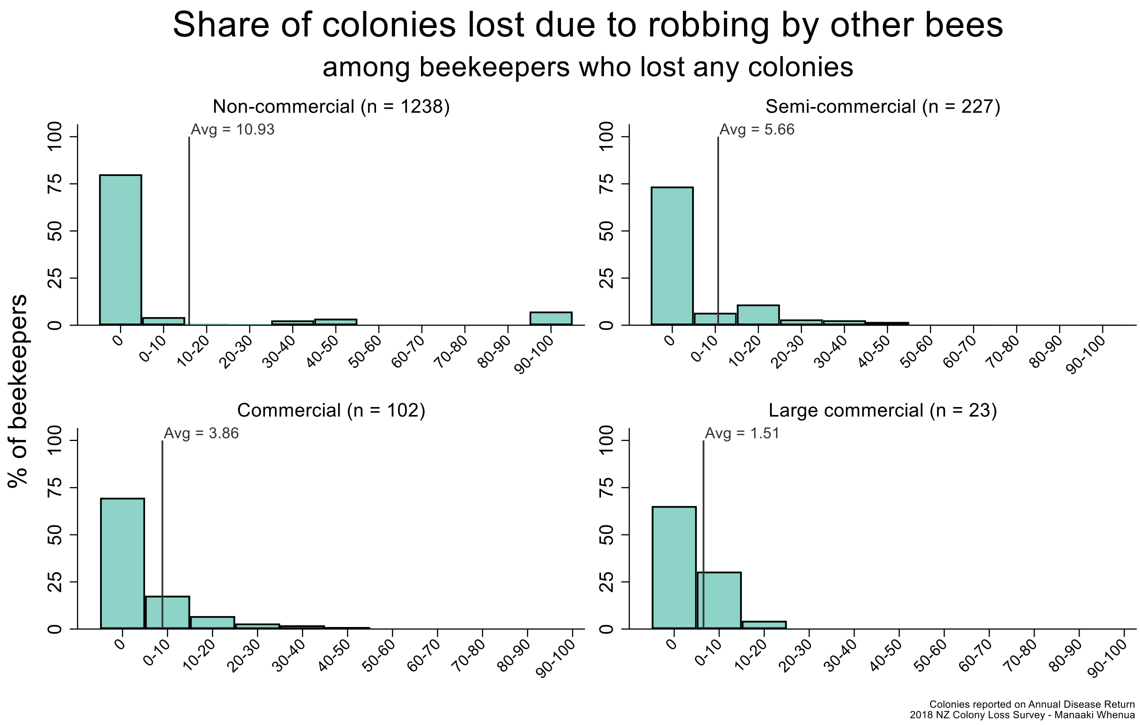

Figure 25: Winter 2018 colony losses that resulted from robbing by other bees, based on reports from all respondents who lost any colonies, by operation size.

4.4.7 American Foulbrood Disease

New Zealand has a Pest Management Plan (PMP) under the Biosecurity Act 1993 that aims to eradicate AFB nationwide. Controls on spread of AFB under the PMP include beekeeper training, annual inspections, and a requirement to burn colonies with any signs of AFB infestation. Among the 365,986 colonies reported on by all beekeepers, of which 347,007 had detailed loss information, 435 cases of AFB were reported for winter 2018 (cf. 651 cases out of 242,924 colonies for winter 2017). Among beekeepers with more than 250 colonies who reported losing any colonies during winter 2018, 1.2% were attributed to AFB, on average, compared with 2.8% for 2017 (Fig. 26). Losses of at least 20% were reported among individual commercial beekeepers in the Upper North Island and the Middle North Island. AFB losses as a share of all losses were significantly lower in the Middle South Island over winter 2018 (.8%) than over winter 2017 (8.0%).

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, 0.27% of the colonies included in the 2017 NZ Colony Loss Survey, and 0.13% of the colonies included in the 2018 NZ Colony Loss Survey.

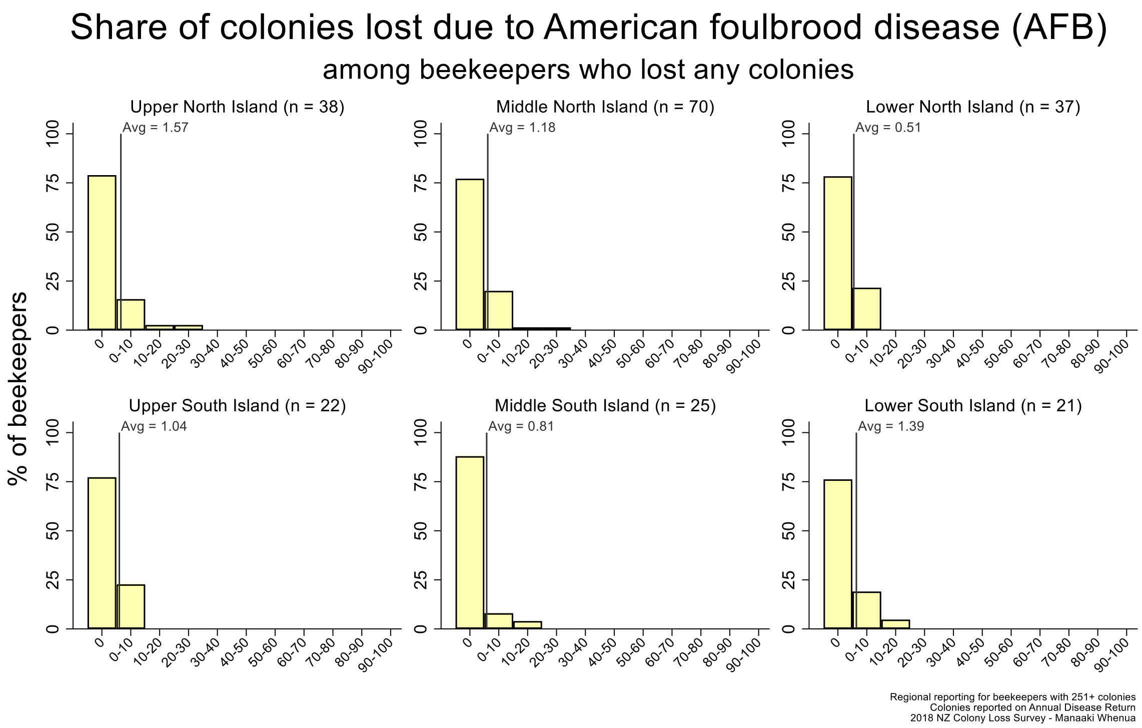

Figure 26: Winter 2018 colony losses that resulted from AFB, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

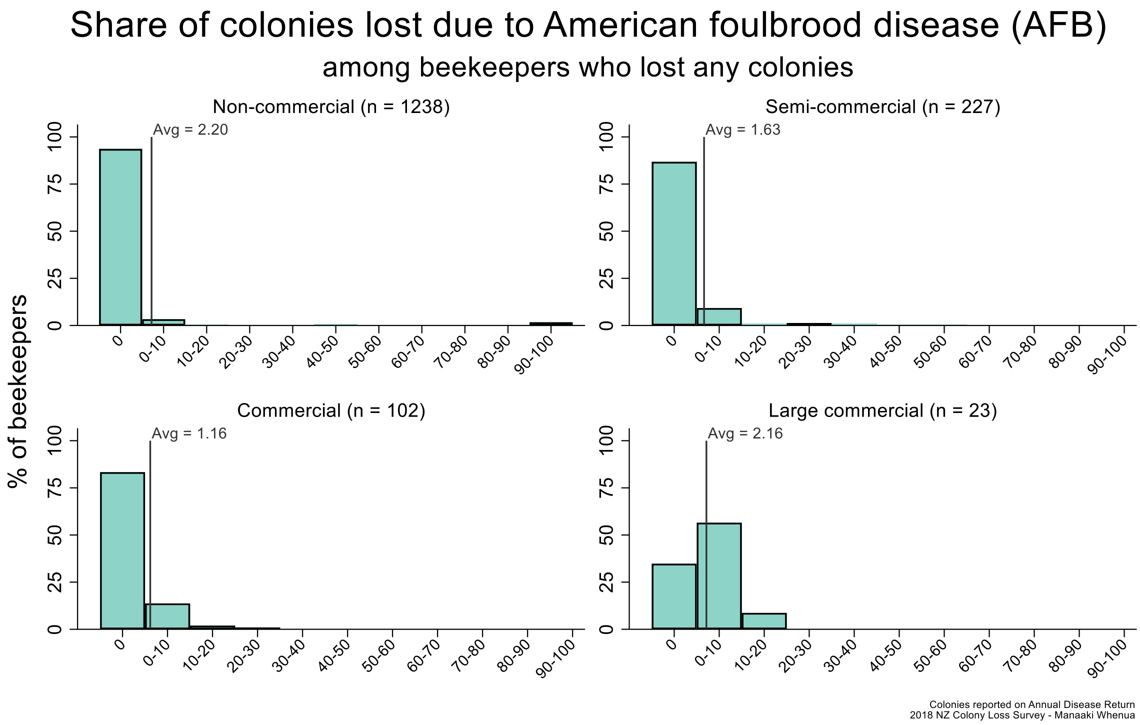

Figure 27: Winter 2018 colony losses that resulted from AFB, based on reports from all respondents who lost any colonies, by operation size.

4.4.8 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. Over winter 2018, 1.9% of losses among commercial beekeepers were attributed to suspected toxic exposure, on average (Fig. 28), compared with 2.4% over winter 2017. Notably, the average share of losses attributed to suspected toxic exposure over winter was 0.02% in the Middle South Island, a radical change from winter 2017, when 7.2% of Middle South Island losses were attributed to toxic exposure, on average. Importantly, the survey does not distinguish between insecticides/agrochemicals and naturally occurring karaka poisoning (Palmer-Jones & Line 1962). Regardless, exposure to toxicity was qualitatively lower among large commercial beekeepers than among other beekeepers (Fig. 29).

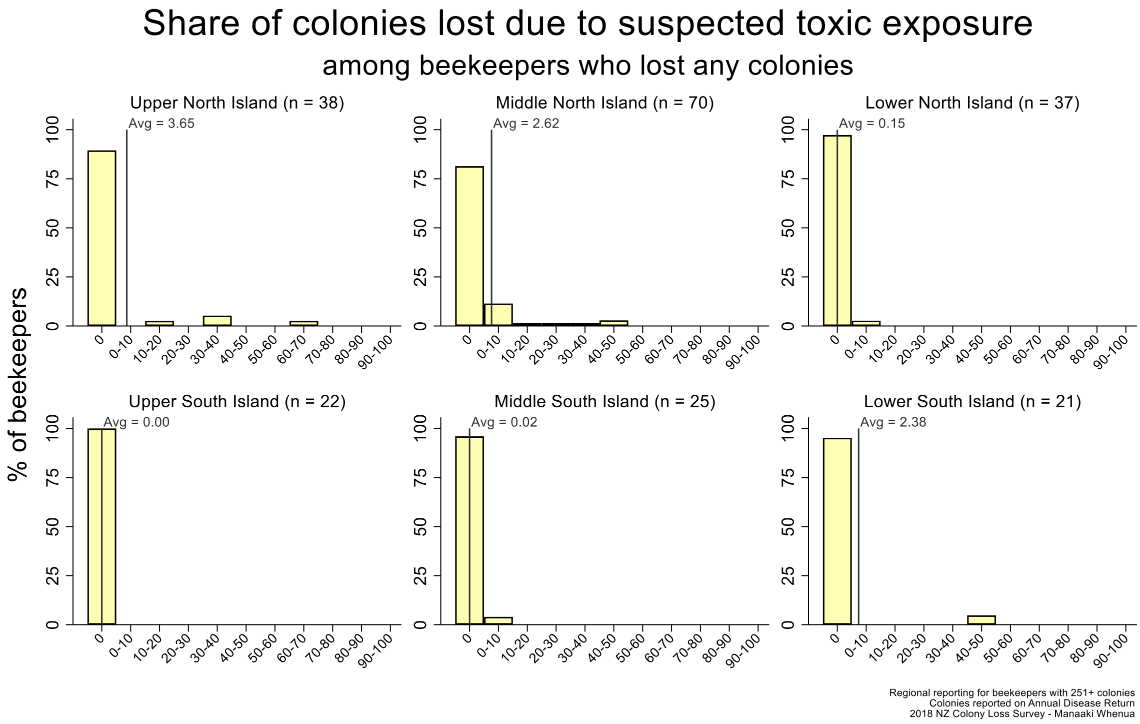

Figure 28: Winter 2018 colony losses that resulted from suspected toxic exposure, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

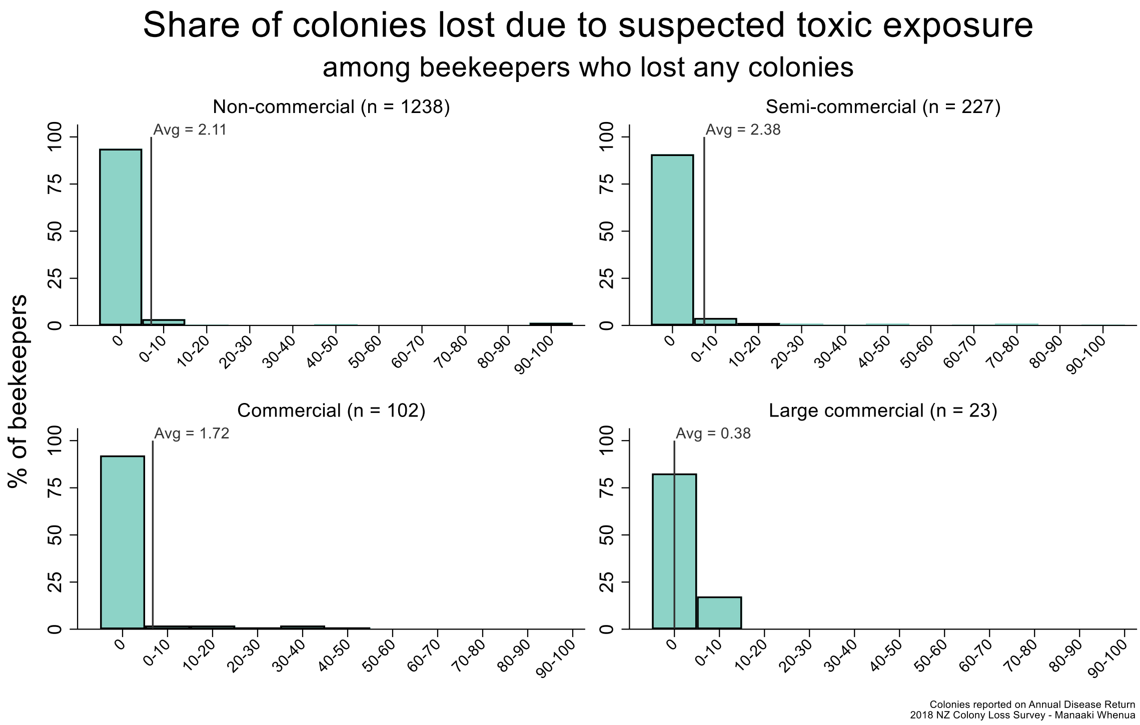

Figure 29: Winter 2018 colony losses that resulted from suspected toxic exposure, based on reports from all respondents who lost any colonies, by operation size.

4.4.9 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 signs of which include high levels of faeces on the front of the hive. On average, commercial beekeepers attributed 3.7% of losses incurred over winter 2018 to suspected nosema and other diseases (compared with 2.0% for winter 2017), with significantly higher shares in the Middle North Island of 6.3% (compared with 1.0% for winter 2017). While suspected nosema and other diseases were recorded as the cause of 6.7% of Middle South Island for winter 2017 among commercial beekeepers, that figure dropped to 0.6% for winter 2018. Nevertheless, two large commercial beekeepers each reported that at least 40% of their losses were attributed to suspected nosema and other diseases (Fig. 31), which drove averages higher.

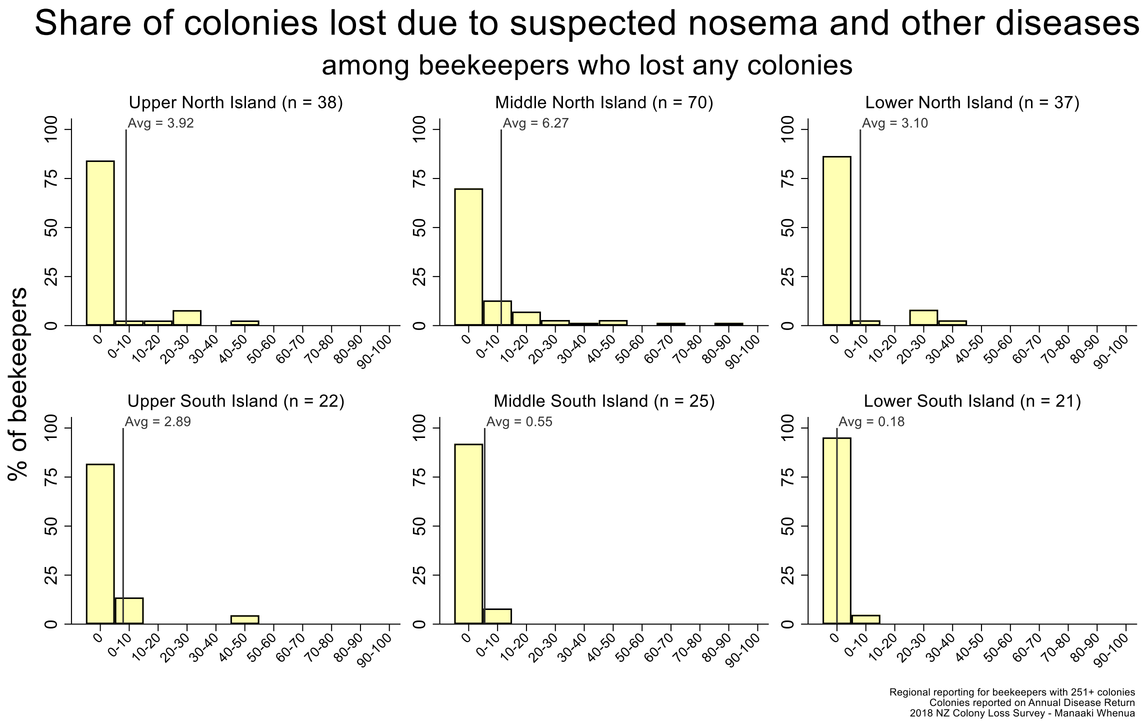

Figure 30: Winter 2018 colony losses that resulted from suspected nosema and other diseases, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

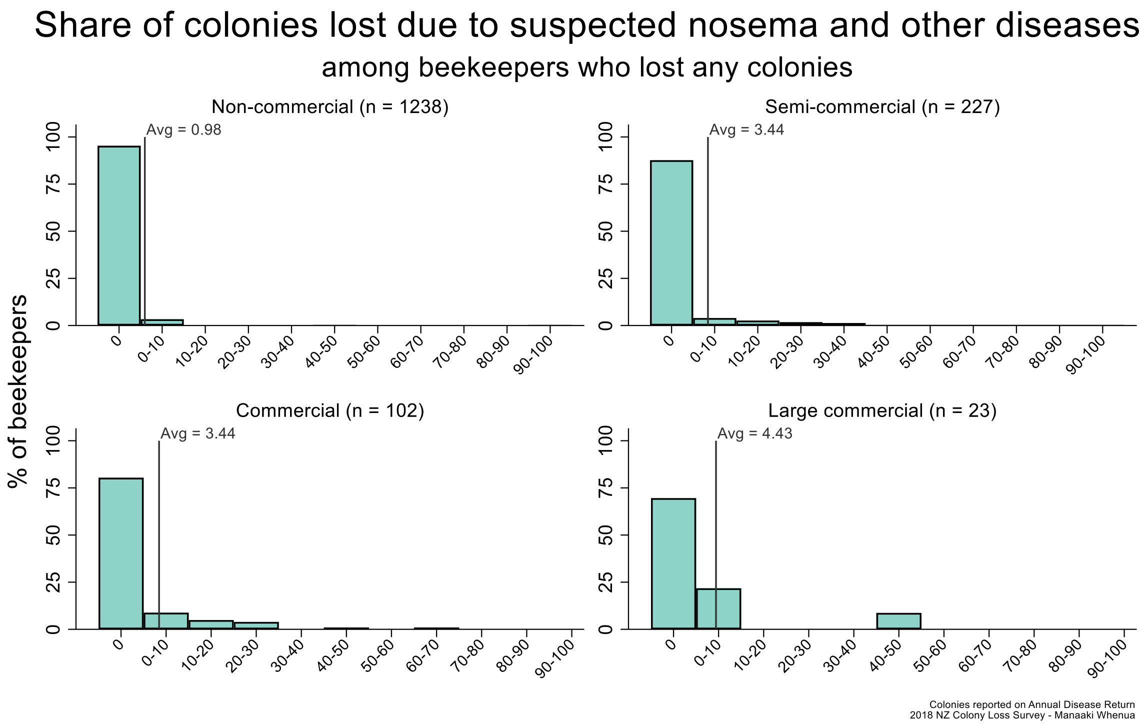

Figure 31: Winter 2018 colony losses that resulted from suspected nosema and other diseases, based on reports from all respondents who lost any colonies, by operation size.

4.4.10 Theft or Vandalism

Theft and vandalism were rare overall but more common in mānuka-producing areas than elsewhere. On average, 0.4% of winter 2018 colony losses among commercial beekeepers were attributed to theft or vandalism (Fig. 32), all on the North Island. In comparison, 1.5% of losses among commercial beekeepers were attributed to theft or vandalism in 2017. One commercial operator reported losing at least half of his or her colonies to theft or vandalism over winter 2018 (Fig. 33).

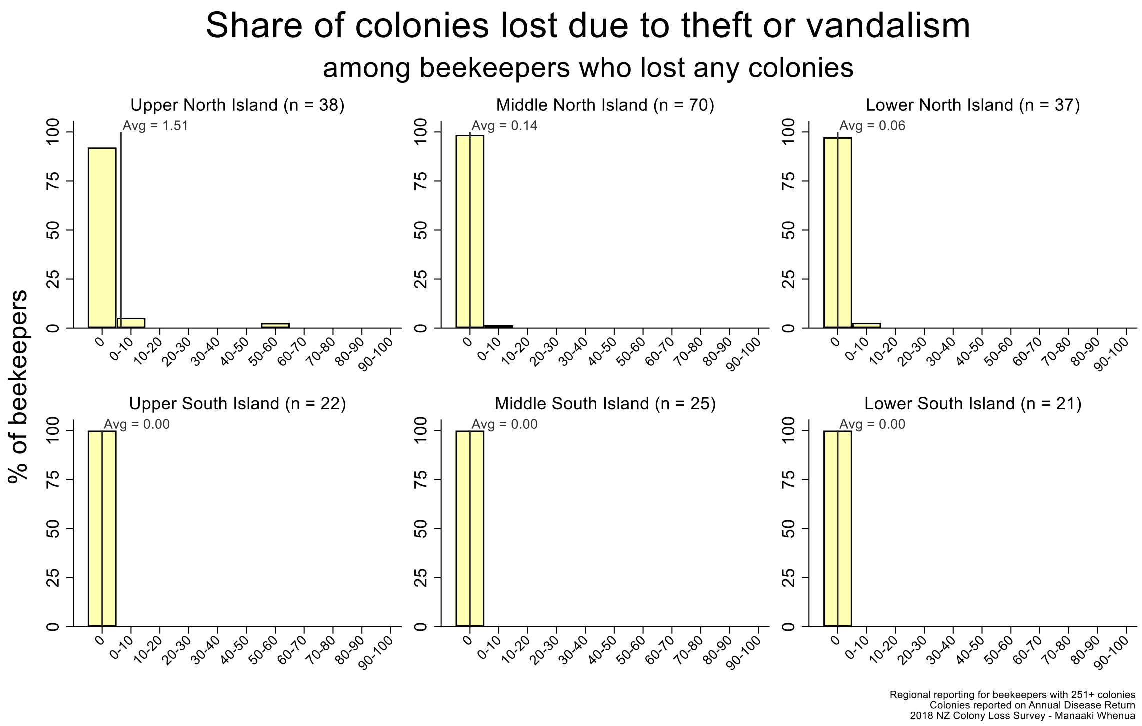

Figure 32: Winter 2018 colony losses that resulted from theft or vandalism, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

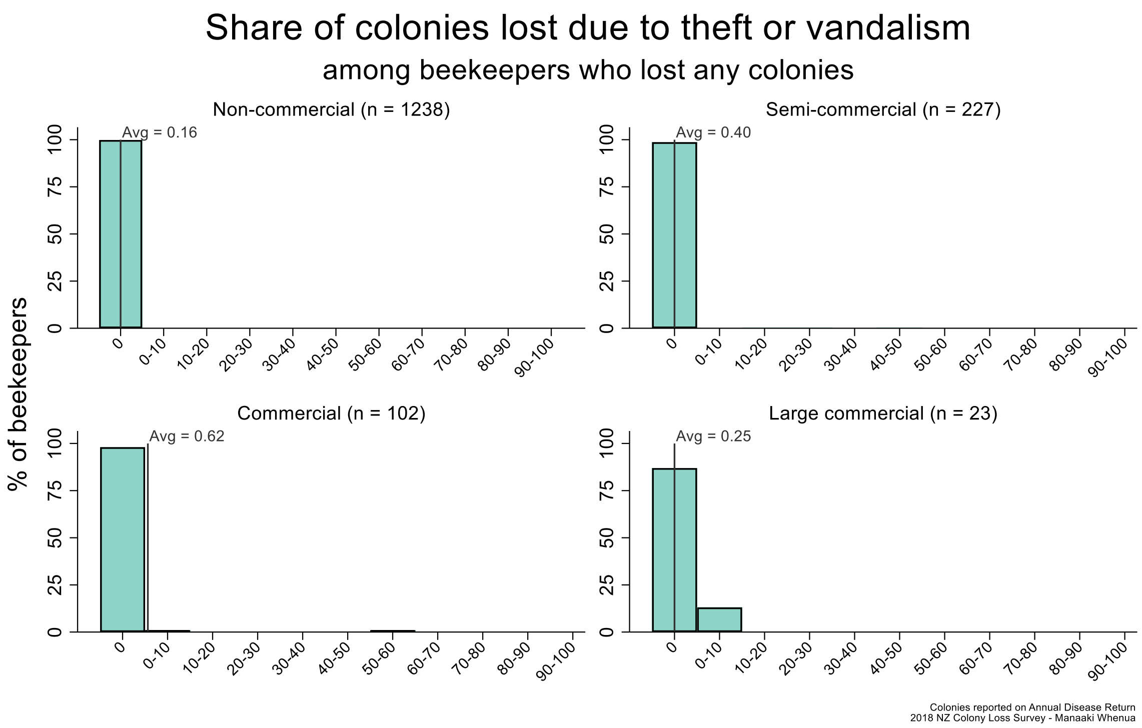

Figure 33: Winter 2018 colony losses that resulted from theft or vandalism, based on reports from all respondents who lost any colonies, by operation size.

4.4.11 Other Attributions of Colony Losses Over Winter 2018

Losses attributed to accidents, Argentine ants, and other causes are reported in Figures 34–35, Figures 36–37, and Figures 38–39, respectively.

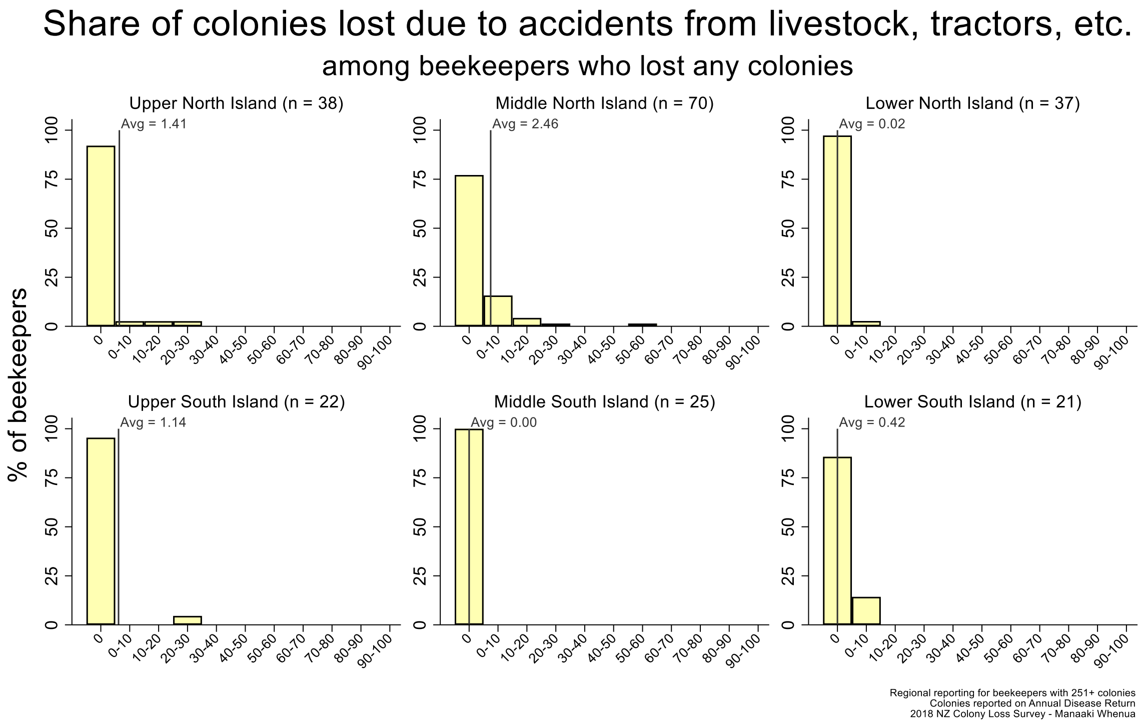

Figure 34: Winter 2018 colony losses that resulted from accidents such as livestock, tractors, etc., based on reports from respondents with more than 250 colonies who lost any colonies, by region.

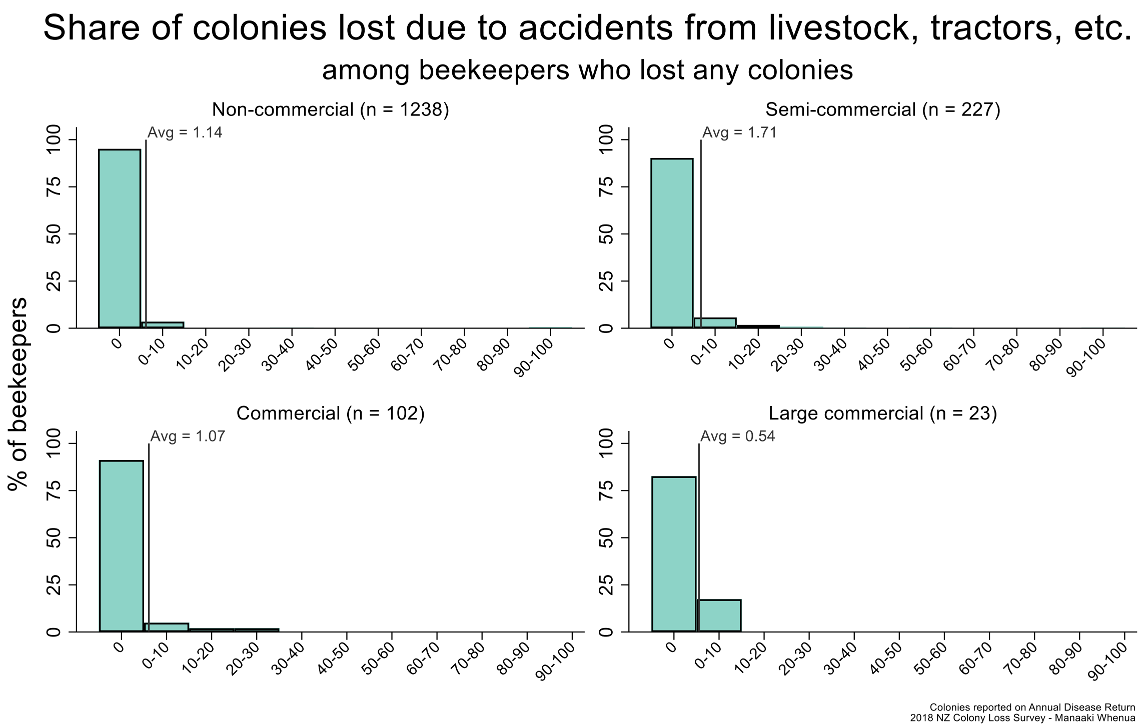

Figure 35: Winter 2018 colony losses that resulted from accidents such as livestock, tractors, etc., based on reports from all respondents who lost any colonies, by operation size.

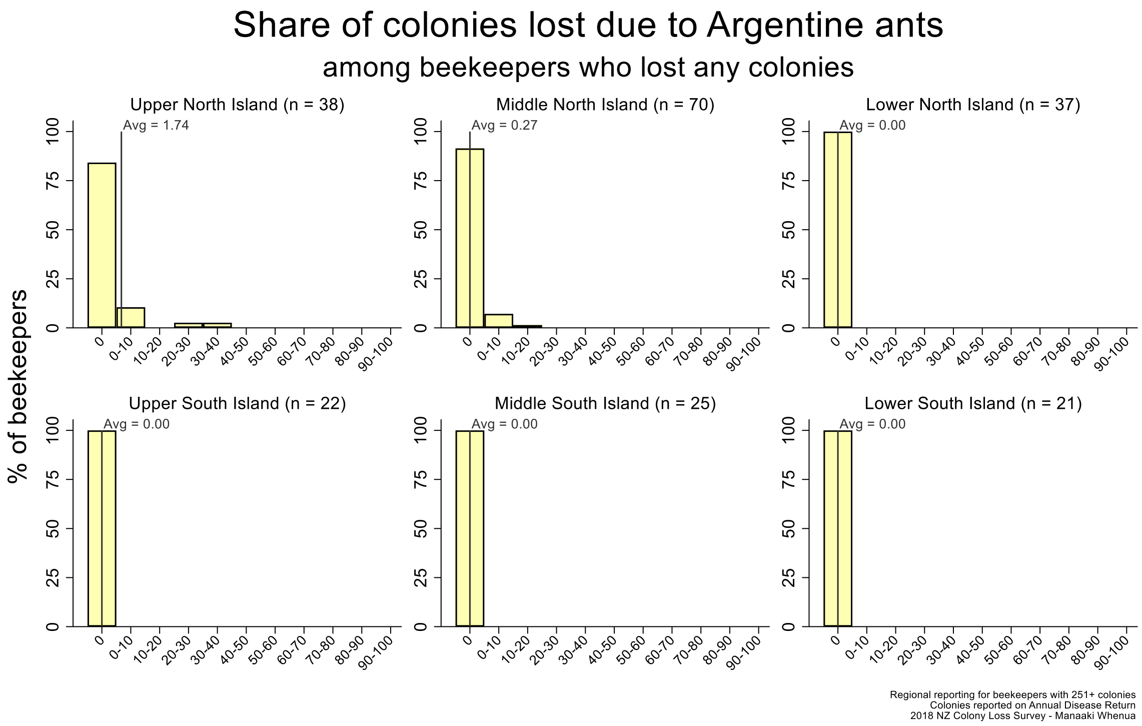

Figure 36: Winter 2018 colony losses that resulted from Argentine ant problems, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

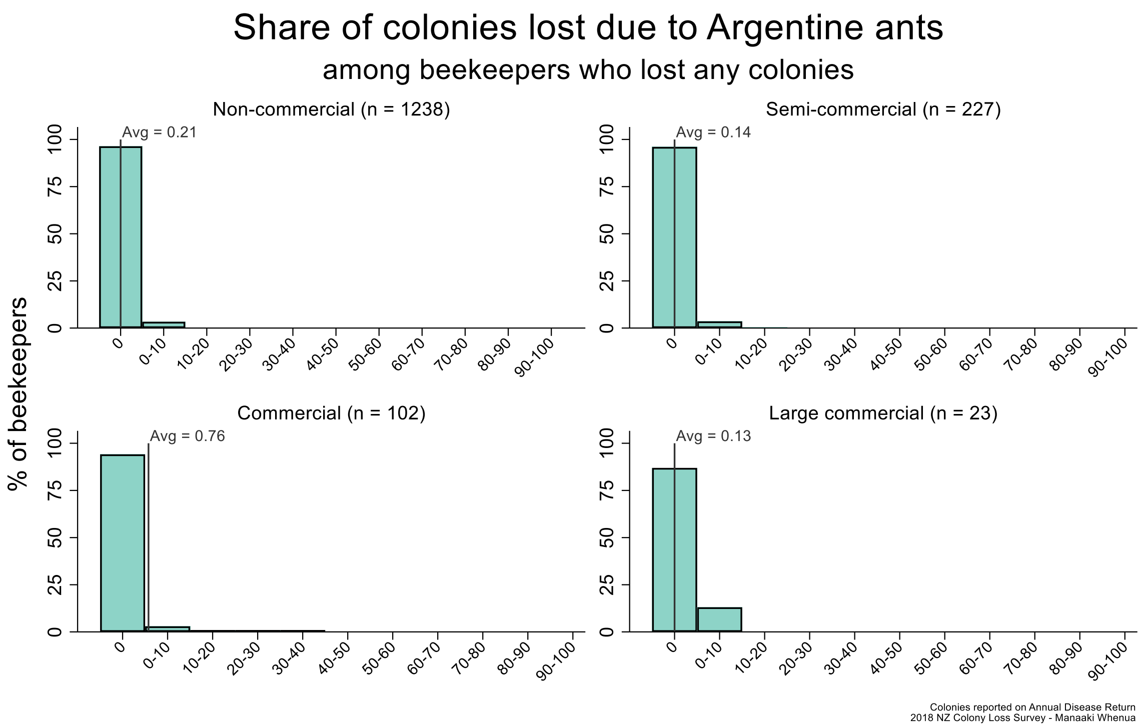

Figure 37: Winter 2018 colony losses that resulted from Argentine ant problems, based on reports from all respondents who lost any colonies, by operation size.

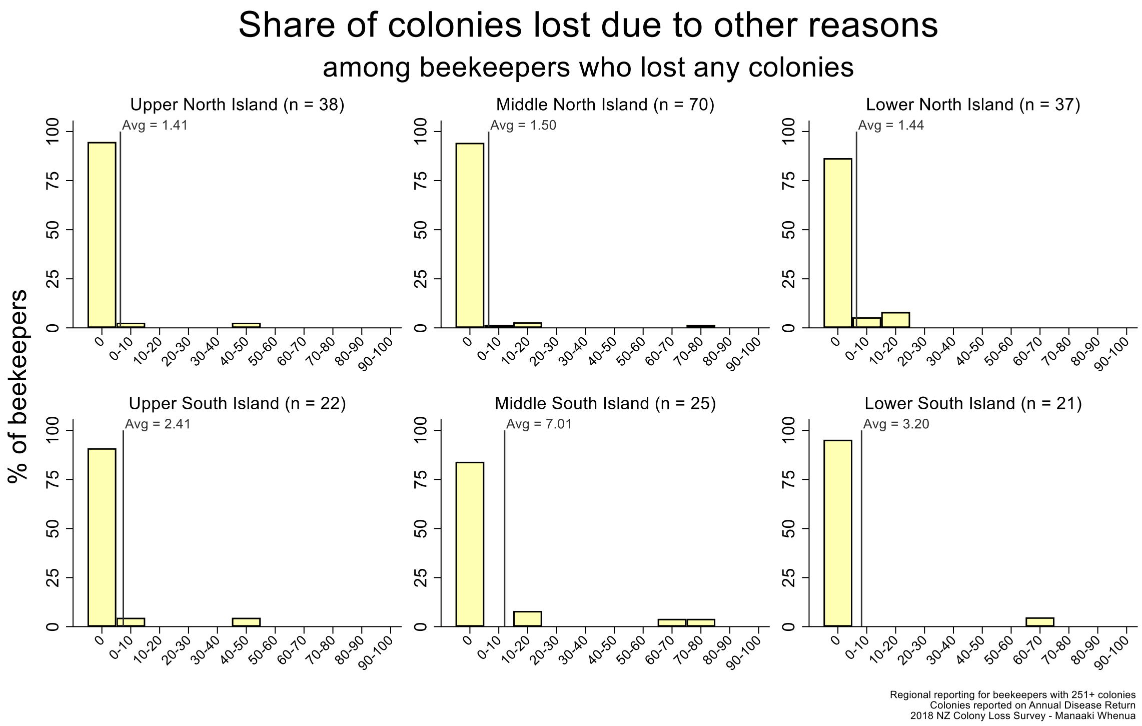

Figure 38: Winter 2018 colony losses that resulted from other problems, based on reports from respondents with more than 250 colonies who lost any colonies, by region.

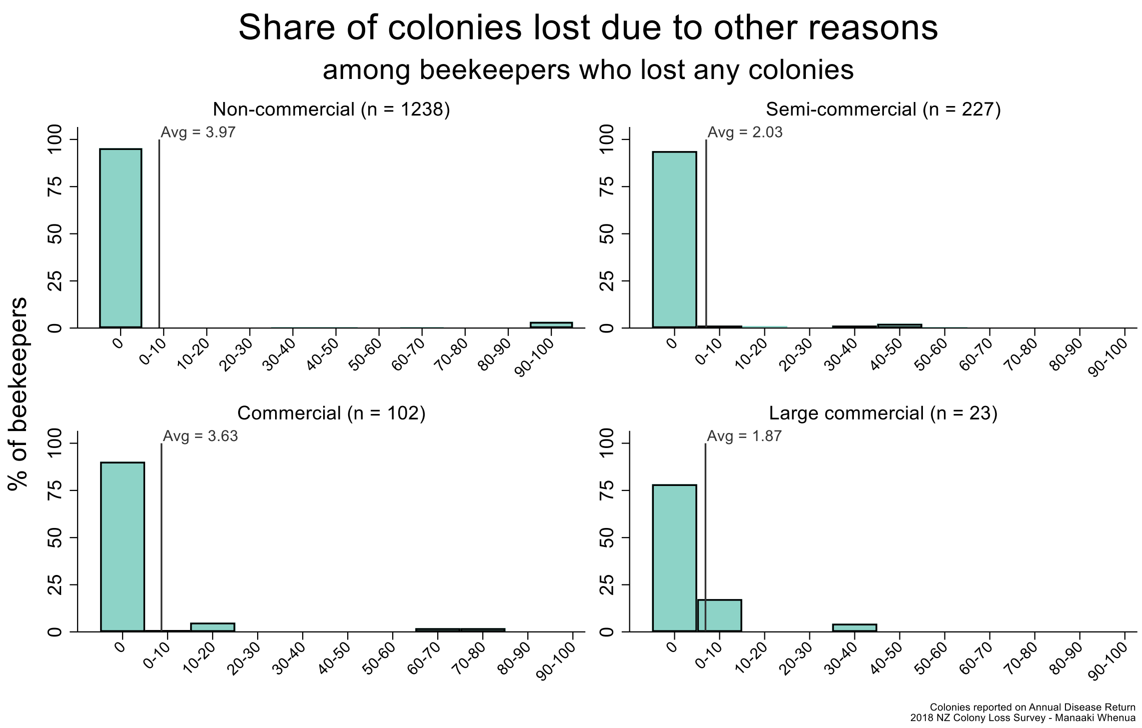

Figure 39: Winter 2018 colony losses that resulted from other problems, based on reports from all respondents who lost any colonies, by operation size.

4.5 STATE OF SURVIVING COLONIES

Production colonies may survive winter but enter spring in a weakened state. In spring 2017, beekeepers with more than 250 colonies reported that 17.0% of their colonies were weak but queenright, on average. 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. Beekeepers were not systematically asked about weak colonies in spring 2018.

4.6 2017/18 SEASON

The third part of the 2018 NZ Colony Loss Survey asked respondents to reflect on the previous year. Specifically, it focused on topics such as queen performance, varroa monitoring and treatment, floral resources, supplemental feeding, and overcrowding during the 2017/18 season. All questions were optional, so data were available for a subset of respondents. The number of respondents (n) is shown in each figure.

4.6.1 Queen Performance

Nearly half of all reporting beekeepers and 60.6% of all commercial beekeepers reported that queen performance in 2017/18 was similar to that in 2016/17 (Figs 40 and 41). However, the remaining North Island commercial beekeepers were 109.1% more likely to report that queen problems were worse in 2017/18, on average, while South Island commercial beekeepers were 33.3% more likely to report that queen problems were better in 2017/18, on average. Not surprisingly, non-commercial beekeepers were the most likely to report being unsure about comparative queen performance (non-commercial beekeepers had significantly less experience than semi-commercial and commercial beekeepers, on average, and 21.4% of reporting non-commercial beekeepers report having 1 year of experience or less). In contrast to 2016/17, when large commercial beekeepers reported the largest decline in queen performance, beekeepers in different size classes reported similar relative queen performance for the 2017/18 season.

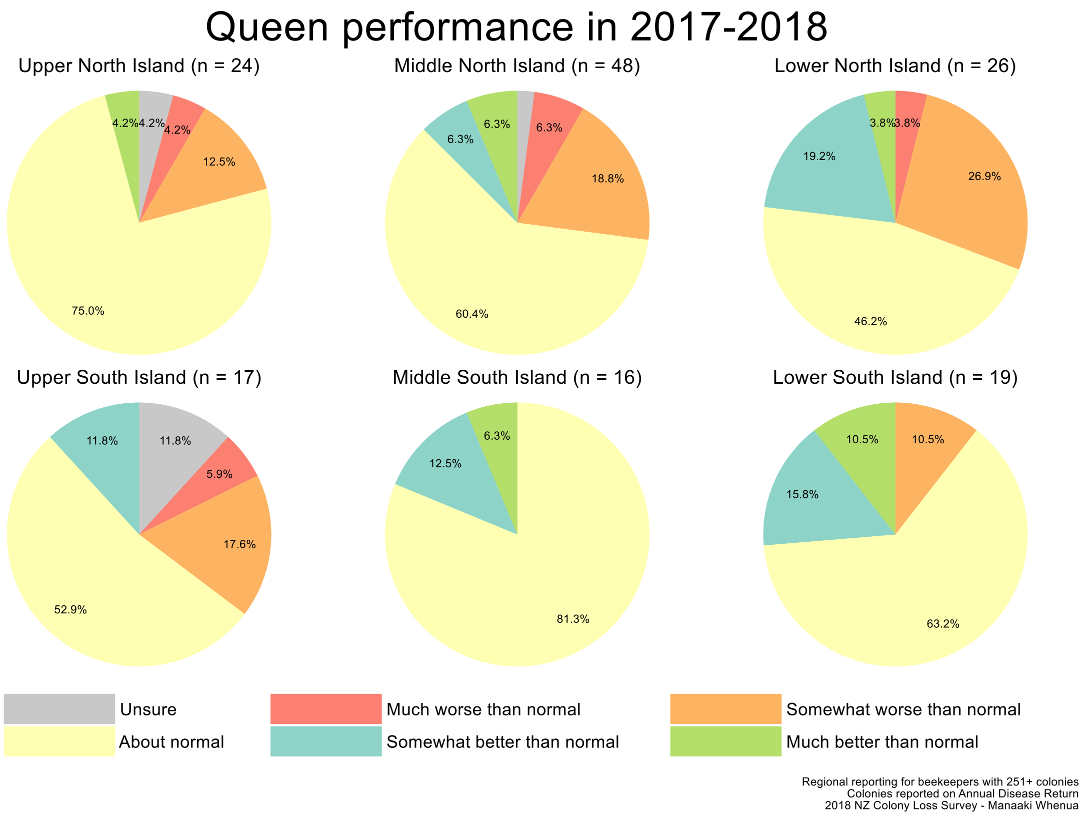

Figure 40: Queen performance during 2017/18 compared with previous years for respondents with more than 250 colonies, by region.

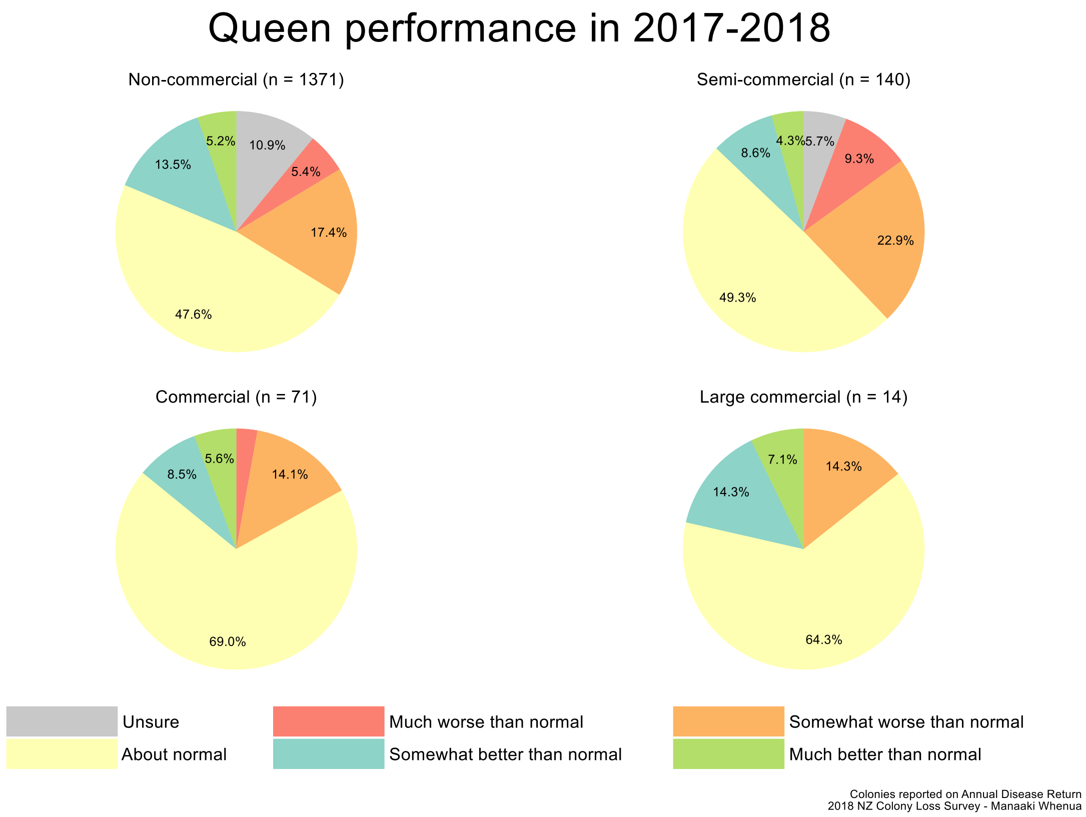

Figure 41: Queen performance during 2017/18 compared with previous years for all respondents, by operation size.

4.6.2 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 is highly correlated 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, 46.4% of beekeepers reported having noticed bees with crippled or deformed wings during the 2017/18 season (Fig. 43) compared with 43.5% during the 2016/17 season. Among semi-commercial, commercial, and large commercial beekeepers, the figure for 2017/18 was 73.6%. As in 2016/17, nearly nine out of ten commercial beekeepers with apiaries in the Upper South Island reported seeing these DWV symptoms (Fig. 42). Similarly, 33.7% of surveyed non-commercial beekeepers and 63.4% of commercial beekeepers reported noticing symptoms of PMS (Fig. 45), including every reporting beekeeper in the Upper South Island (Fig. 44); the corresponding figures for the 2016/17 season were 20.3% and 63.2%, respectively.

Whereas commercial beekeepers had 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 (Fig. 47). However, all but large commercial operations disproportionately relied on visual inspection for varroa monitoring: only 49.8% of non-commercial beekeepers, 35.9% of semi-commercial beekeepers, and 36.6% of commercial beekeepers used alcohol washes, sticky boards, sugar shakes/rolls, or lab sampling to monitor varroa, whereas 64.3% of large commercial beekeepers relied on these methods. During the 2016/17 season, 48.0% of non-commercial beekeepers, 34.2% of semi-commercial beekeepers, 35.1% of commercial beekeepers, and 60.0% of large commercial beekeepers used alcohol washes, sticky boards, sugar shakes/rolls, or lab sampling to monitor varroa. Among commercial beekeepers, strong regional trends were evident (Fig. 46) as nearly half undertook no varroa monitoring in the Lower South Island, where losses due to suspected varroa and related complications were highest (Fig. 8).

Beekeepers across all regions and across all operation sizes reported using flumethrin and amitraz to treat varroa much more commonly than any other method (Figs 48 and 49).

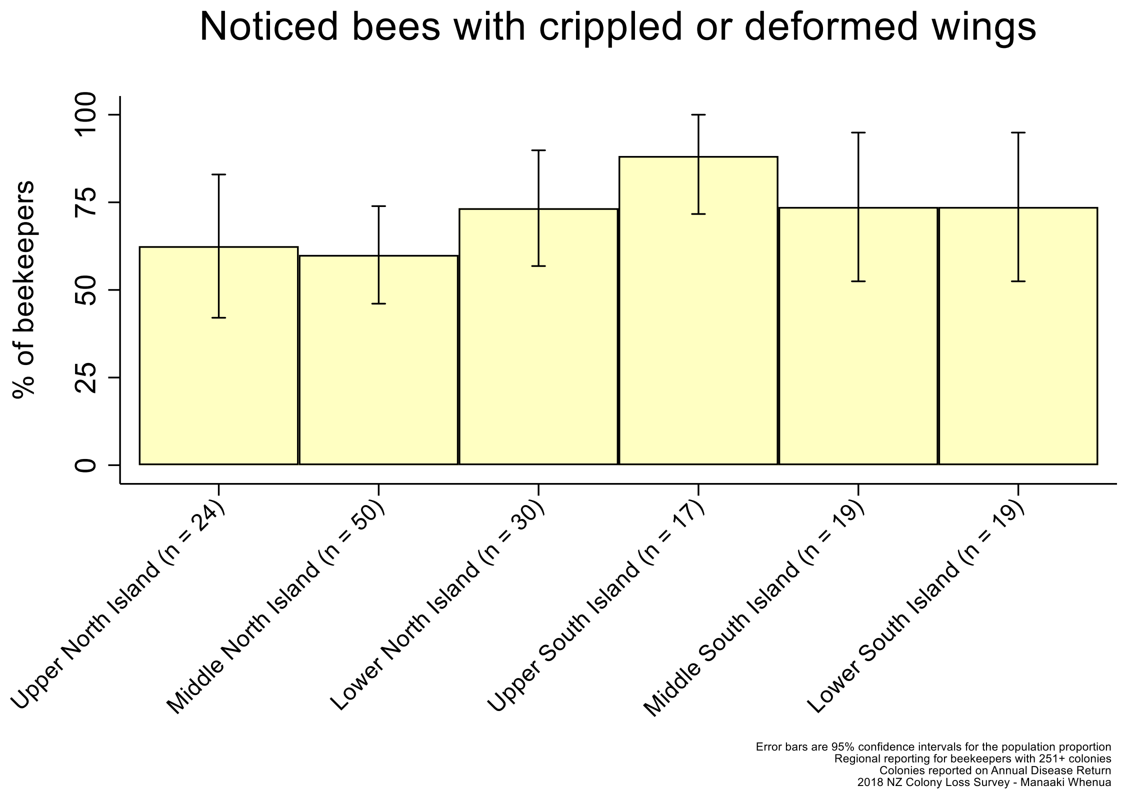

Figure 42: Share of respondents who observed crippled or deformed wings during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

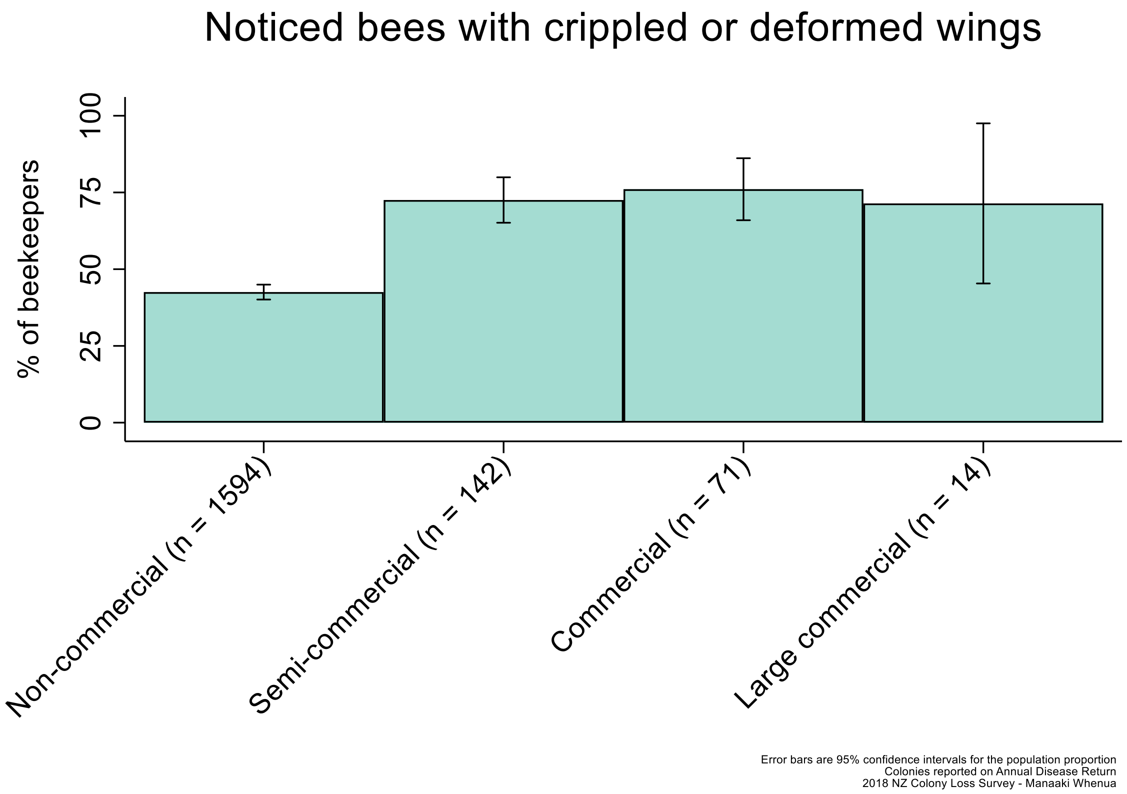

Figure 43: Share of respondents who observed crippled or deformed wings during the 2017/18 season, based on reports from all respondents, by operation size.

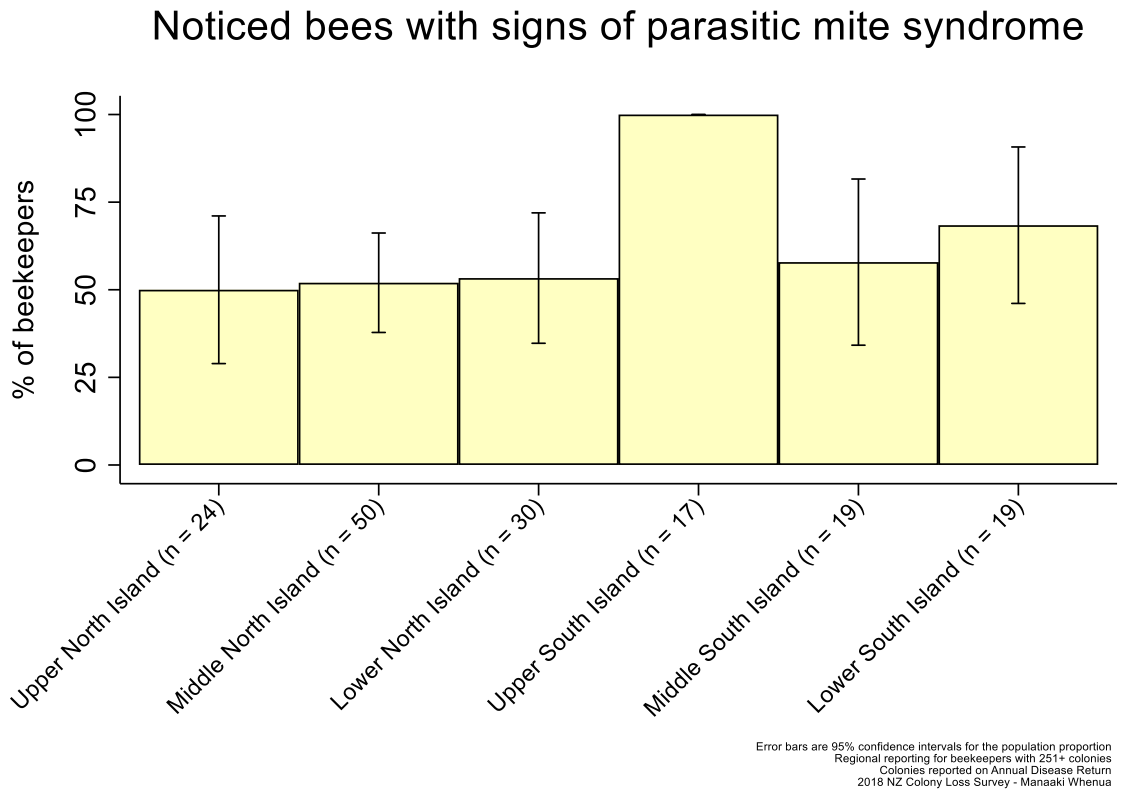

Figure 44: Share of respondents who noticed symptoms of parasitic mite syndrome during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

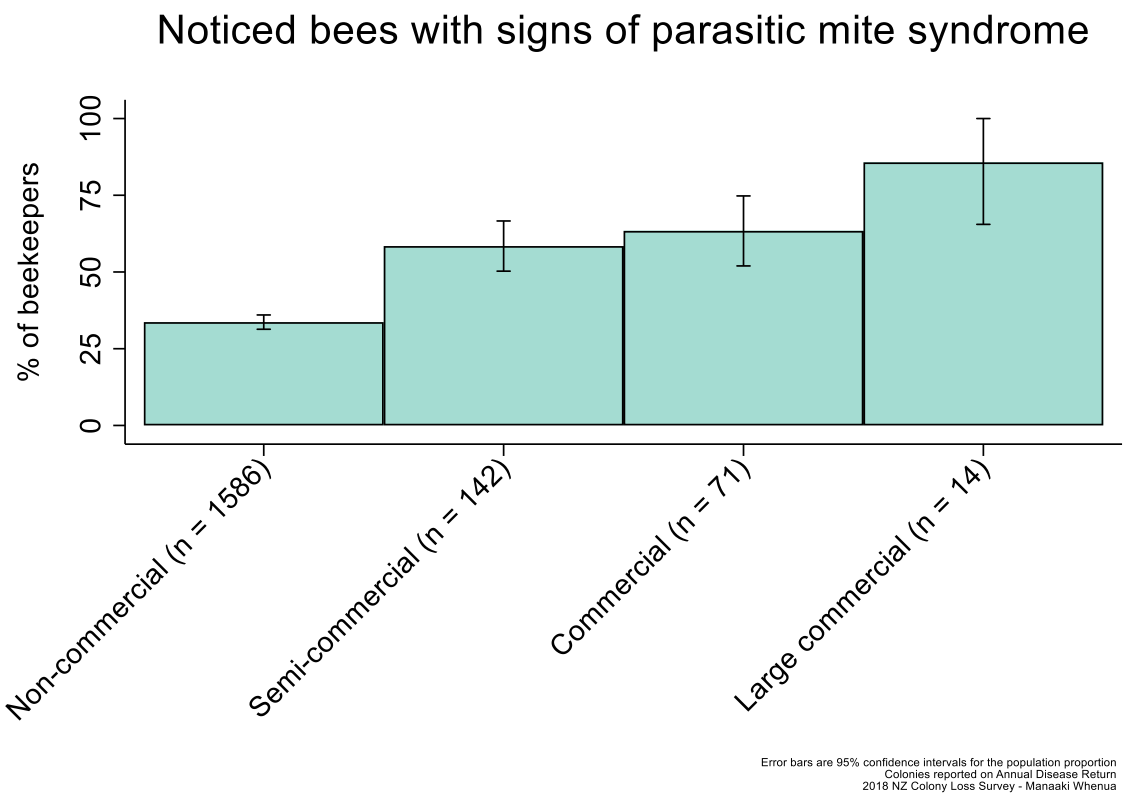

Figure 45: Share of respondents who noticed symptoms of parasitic mite syndrome during the 2017/18 season, based on reports from all respondents, by operation size.

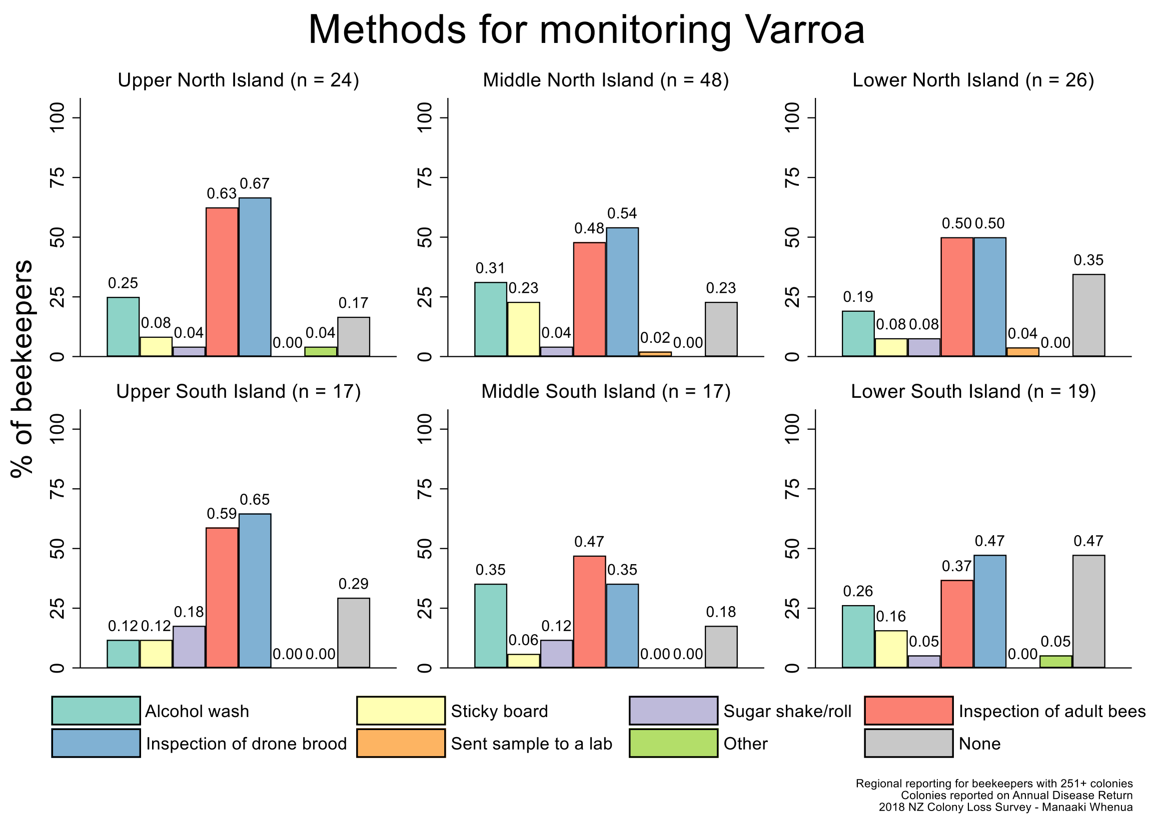

Figure 46: Methods for monitoring varroa during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

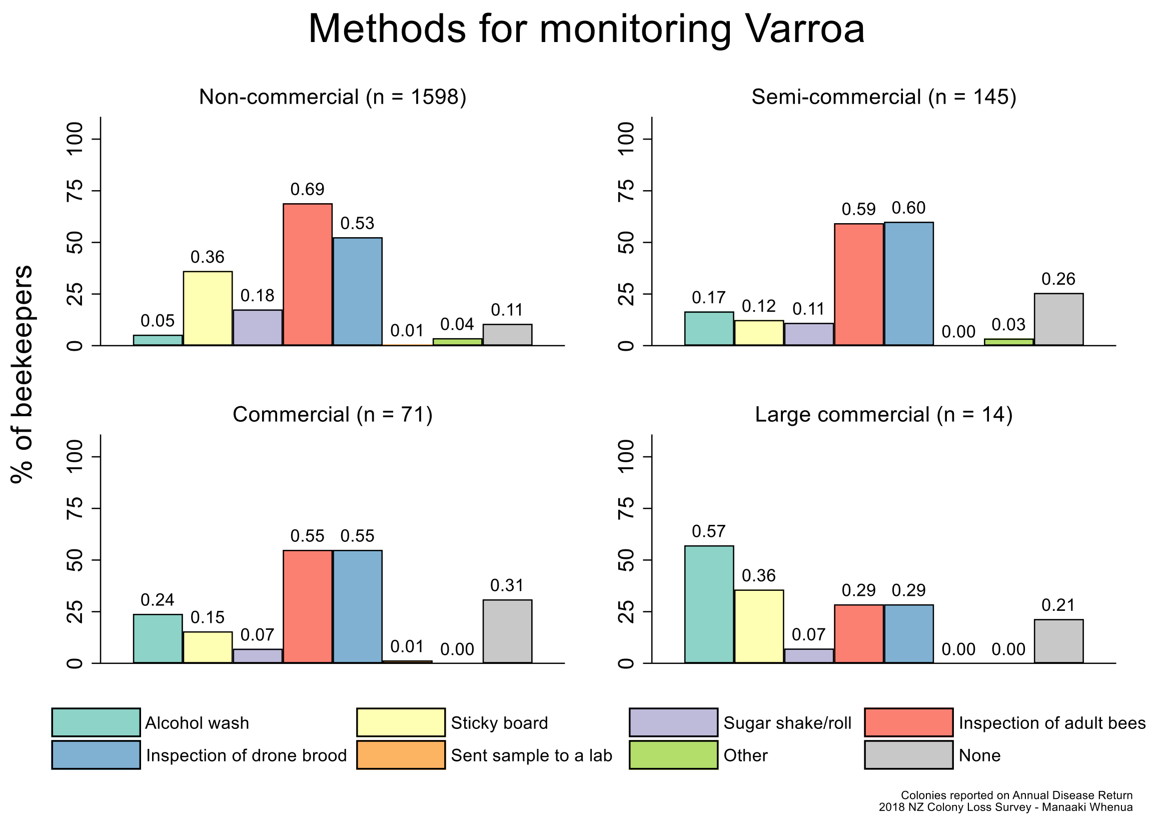

Figure 47: Methods for monitoring varroa during the 2017/18 season, based on reports from all respondents, by operation size.

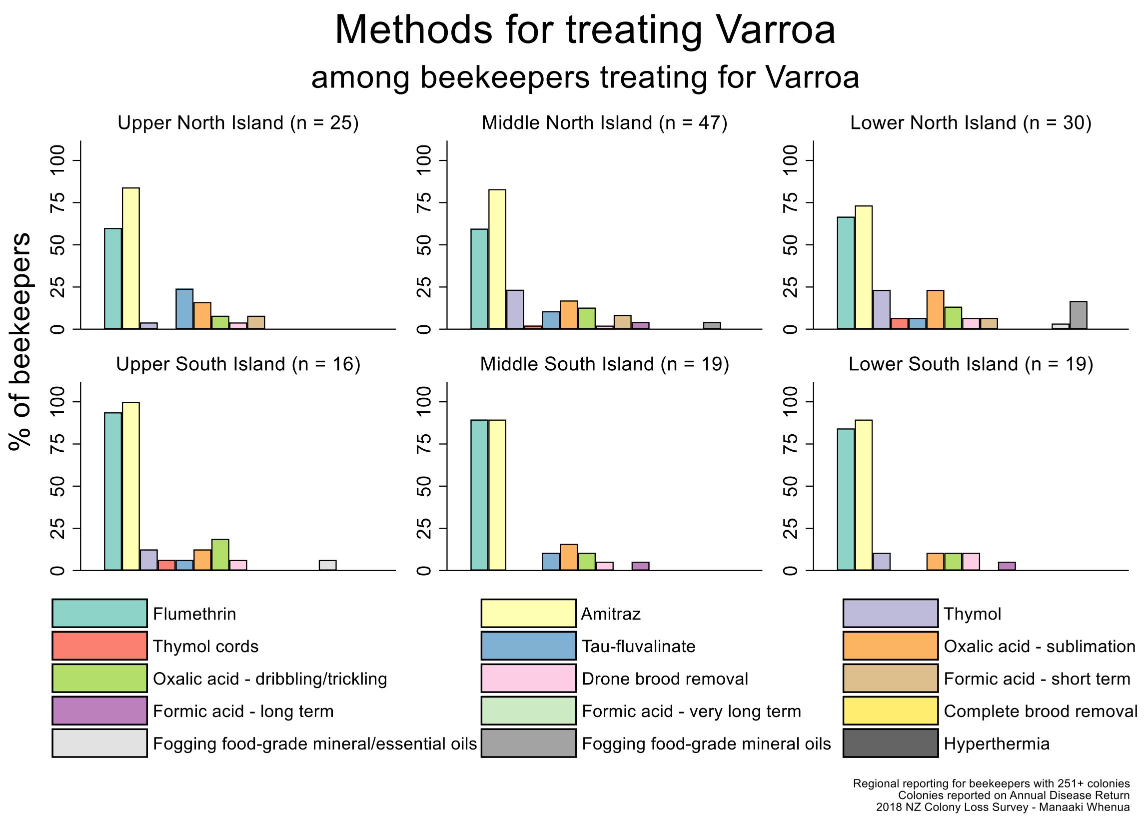

Figure 48: Varroa treatment methods during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

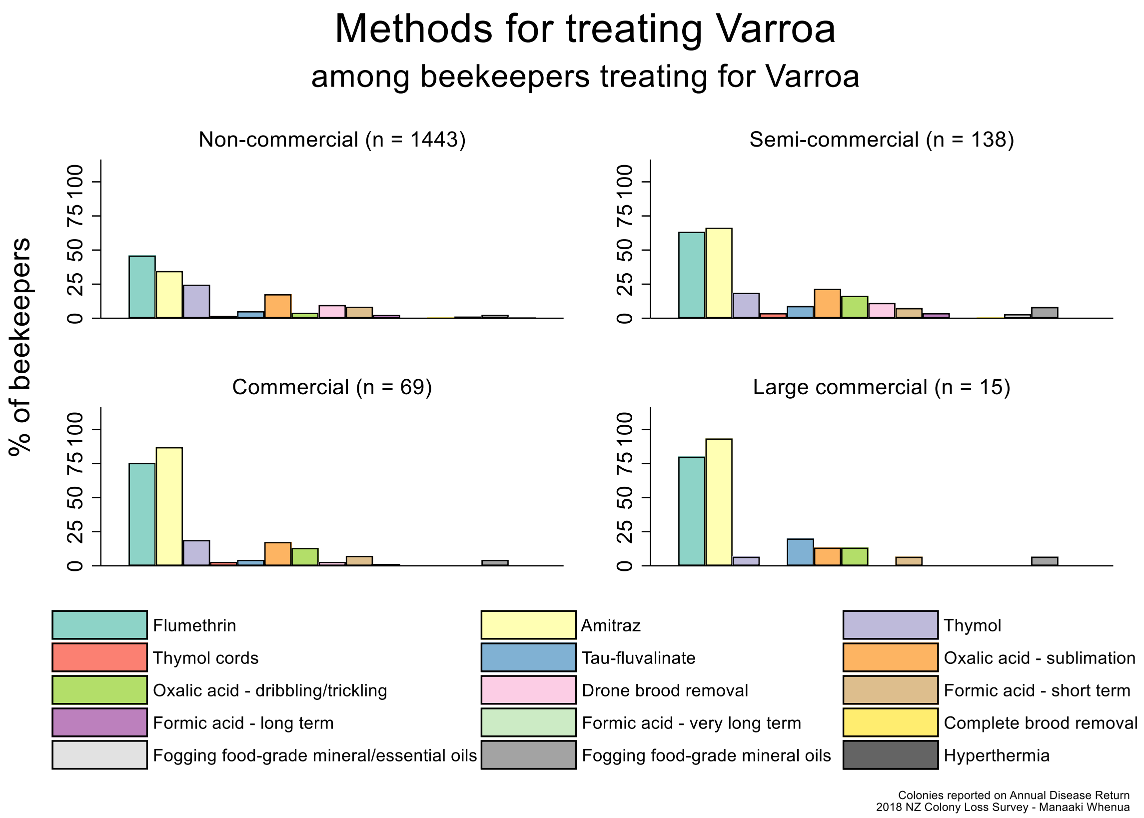

Figure 49: Varroa treatment methods during the 2017/18 season, based on reports from all respondents, by operation size.

4.6.3 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 15.2% of brood combs during the 2017/18 season, on average, compared to 16.7% for the 2016/17 season. The highest average replacement levels occurred in the Lower North Island and Middle South Island (Fig. 50). Non-commercial beekeepers reported replacing just 6.7% of brood combs, on average, which was significantly lower than other beekeepers (Fig. 51). Overall, 67.8% of non-commercial beekeepers reported that they did not replace any brood combs with foundation during the 2017/18 season, compared with 36.7% of semi-commercial beekeepers, 17.4% of commercial beekeepers, and 7.1% of large commercial beekeepers. Corresponding figures for the 2016/17 season were 66.5%, 26.4%, 27.7%, and 26.7%.

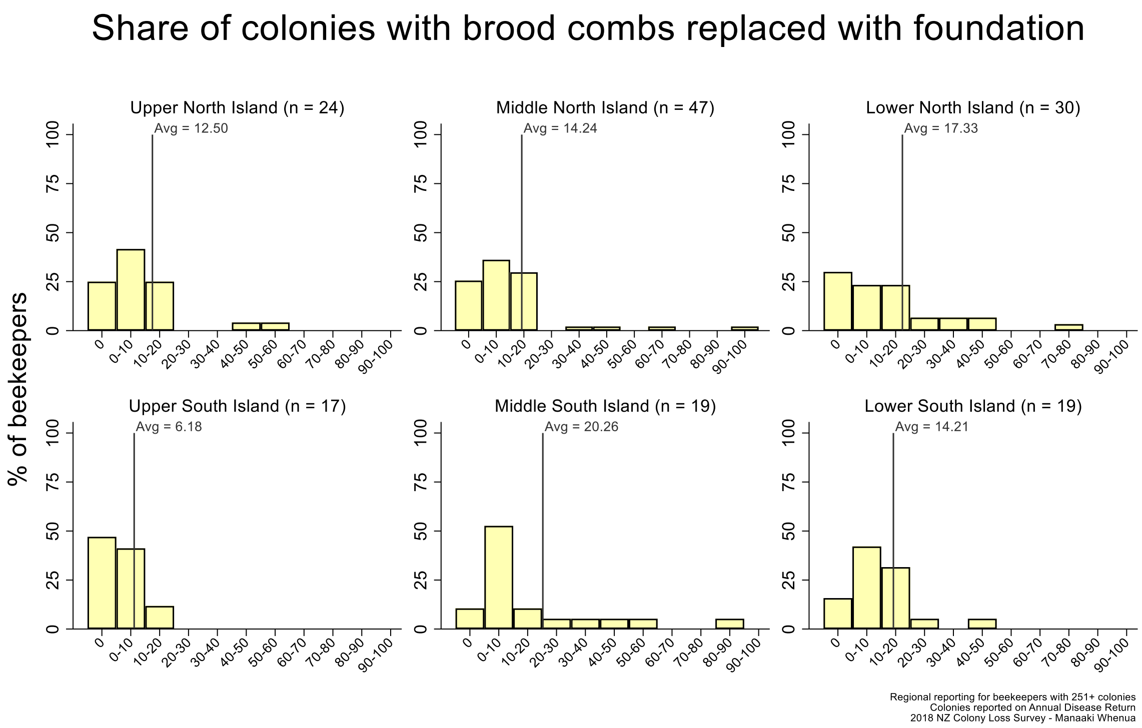

Figure 50: Share of brood combs replaced by comb foundation (per colony) during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

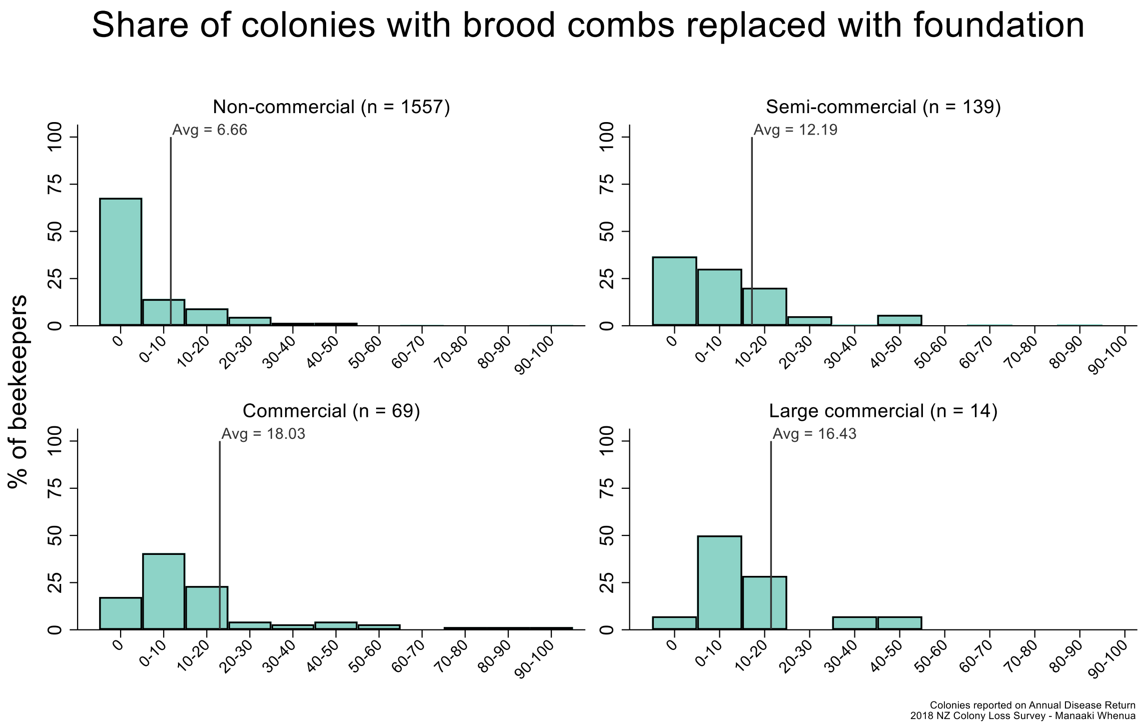

Figure 51: Share of brood combs replaced by comb foundation (per colony) during the 2017/18 season, based on reports from all respondents, by operation size.

4.6.4 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. Indeed, during the 2016/17 season, just 37.3% of beekeepers reported providing any pollination services. For the 2017/18 season, this figure dropped to 35.3% (Fig. 53). Pollination services were most common in areas with heavy concentrations of avocado (Upper North Island, Middle North Island), kiwifruit (Middle North Island), and seed crop production (Middle South Island) (Fig. 52).

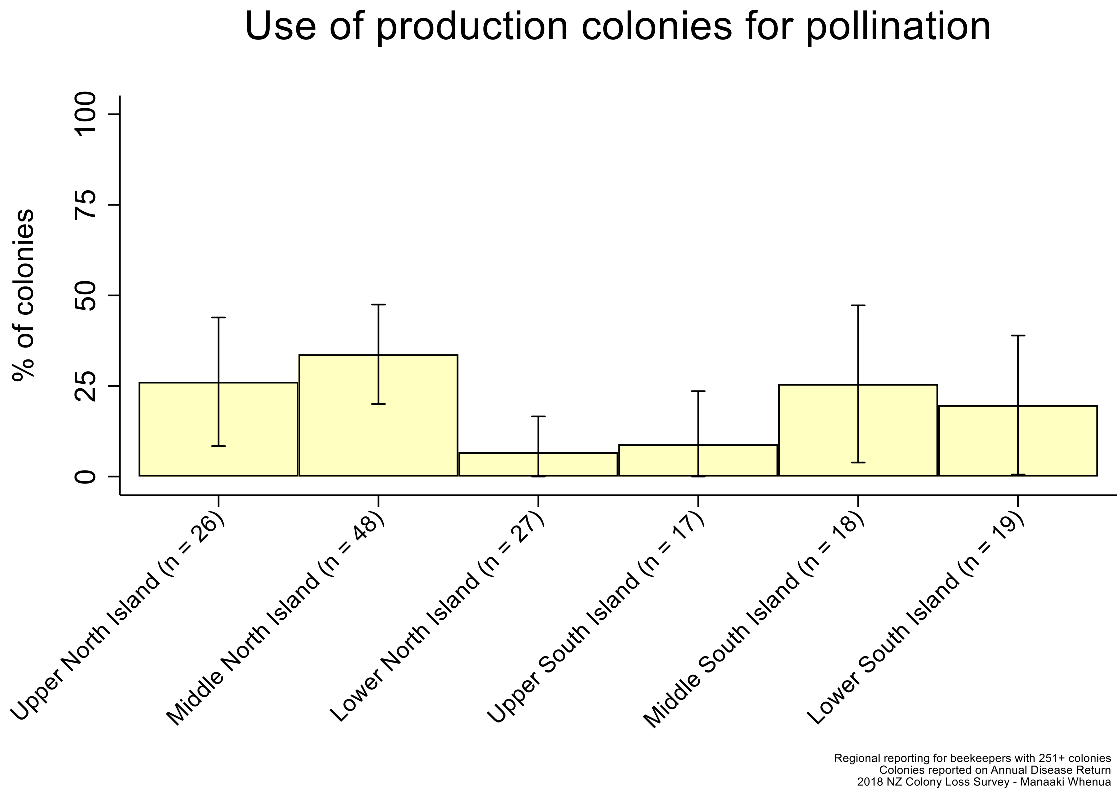

Figure 52: Use of production colonies during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

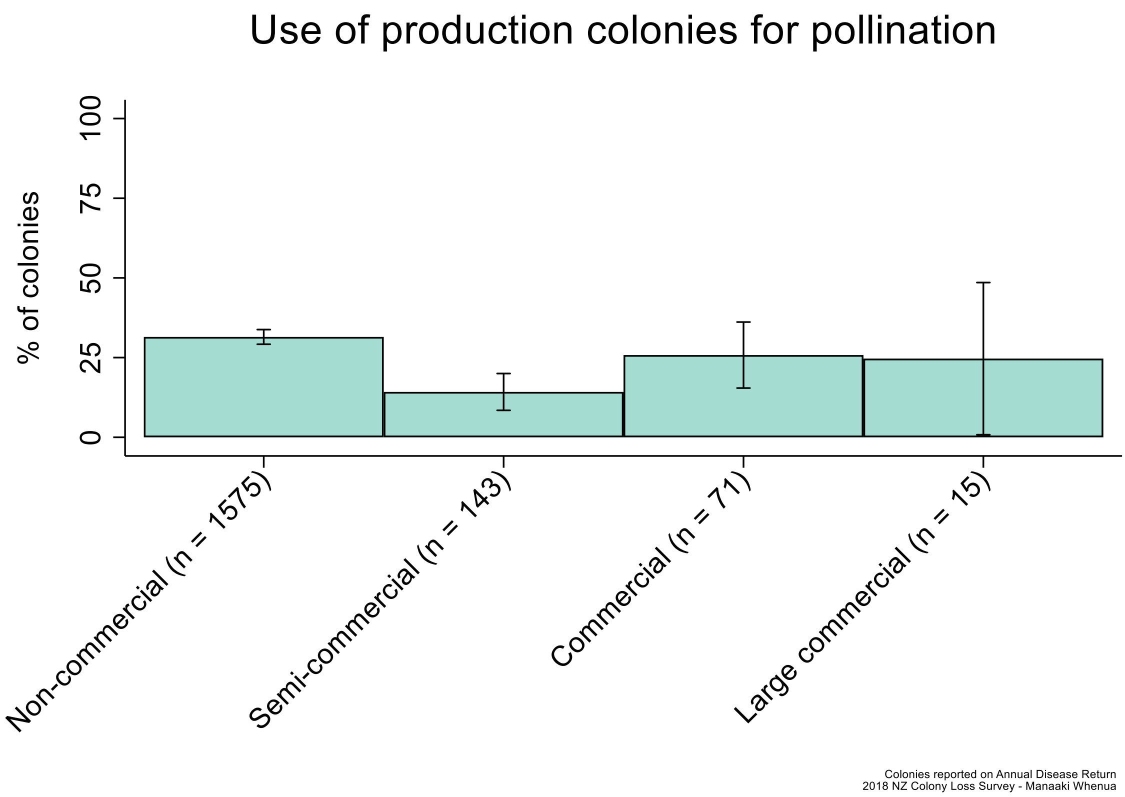

Figure 53: Use of production colonies during the 2017/18 season, based on reports from all respondents, by operation size.

Nectar flows across regions are reported in Figure 54. Among beekeepers with more than 250 colonies in the Upper North Island, mānuka, kānuka, and native bush blend were very common, together with clover/pasture. Clover dominated in the Middle North Island and Lower South Island. Mānuka dominated in the Lower North Island. Mānuka, kānuka, and blends were common in the Upper North Island and Upper South Island. Native bush blends were common across the country. Rewarewa was common across the North Island; Pohutukawa was common in the northern parts of the North Island while rātā was common in the northern parts of the South Island. Beech honey dew was common in the Upper South Island while spring willow honeydew provided the second-most common flow in the Lower South Island.

Commercial and large commercial beekeepers focused more on mānuka than smaller beekeepers, while semi-commercial bees had a comparatively high flow on clover pasture (Fig. 55). Only non-commercial and semi-commercial beekeepers' bees had a significant flow from urban floral and garden sources.

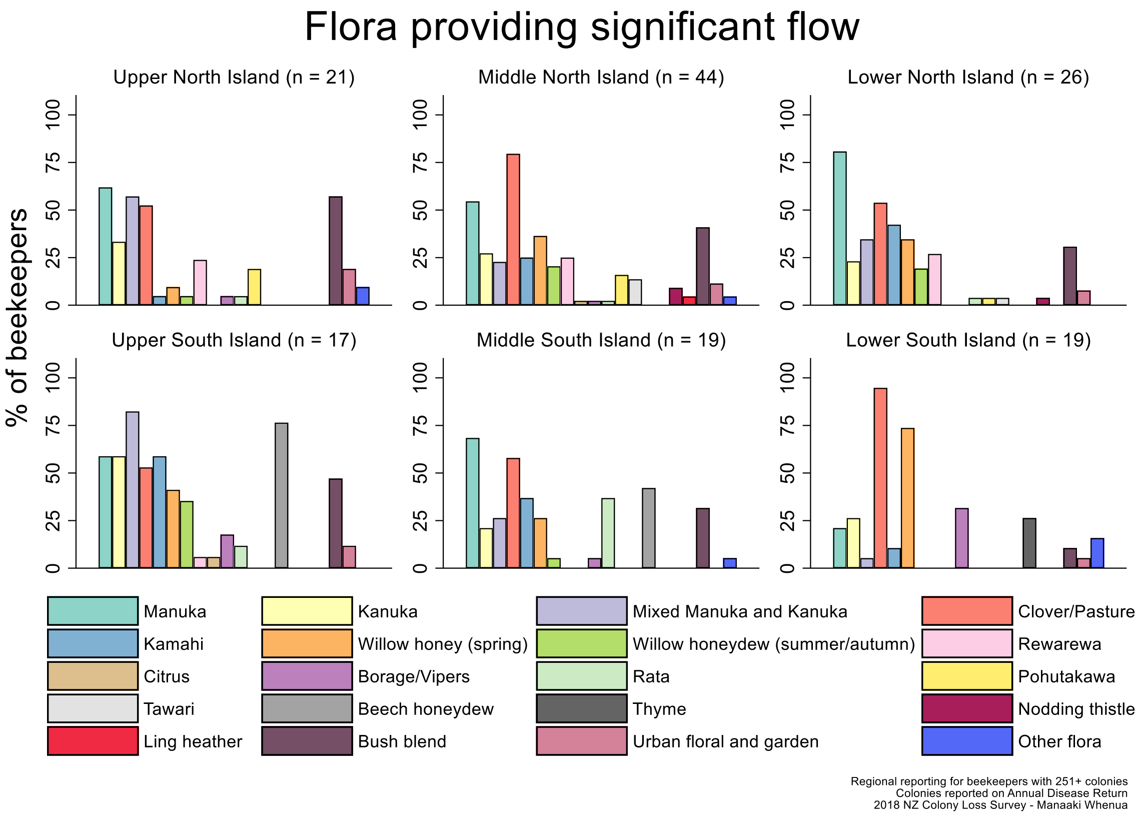

Figure 54: Sources of significant flow during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

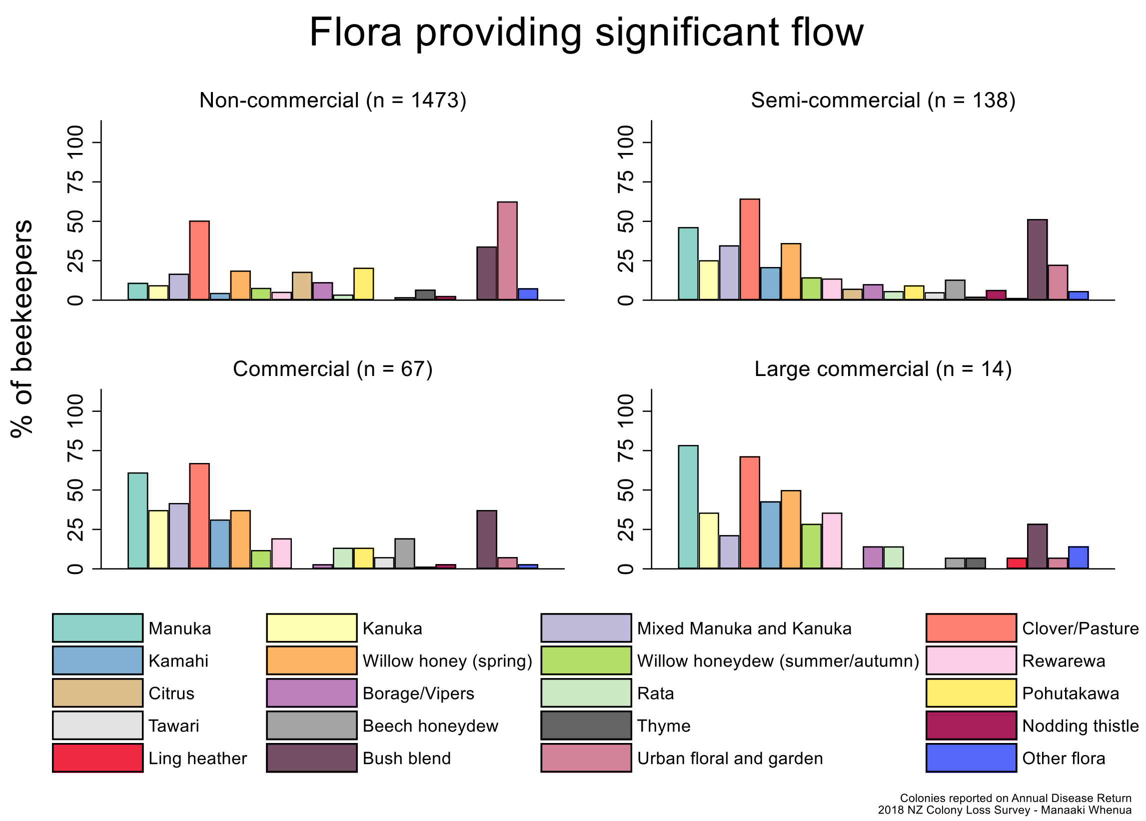

Figure 55: Sources of significant flow during the 2017/18 season, based on reports from all respondents, by operation size.

4.6.5 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 species that provide 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 (96.2%) with more than 250 colonies used supplemental sugar during the 2017/18 season (Fig. 56). Sugar feeding among these large beekeepers was common across the entire country. Supplemental feeding was also increasing among non-commercial beekeepers, 70.0% of whom provided supplementary feed in the form of sugar during the 2017/18 season (Fig. 57), compared with 61.0% during the 2016/17 season. Sugar solution was most commonly used across all regions and size classes, although invert sugar was also widely used in the North Island and raw sugar was also widely used in the South Island.

Some 70.5% of beekeepers with more than 250 colonies provided supplemental protein to their bees (Fig. 58). MegaBee was the most commonly used protein supplement, used by 43.7% of commercial beekeepers (FeedBee was used by 23.2%). Supplemental protein feeding was especially common among the beekeepers with the most colonies, who substituted or augmented commercial products with homemade products (Fig. 59). Only 19.6% of non-commercial beekeepers reported providing supplemental protein in 2017/18, nevertheless a sizable increase over the 14.0% reported for the 2016/17 season.

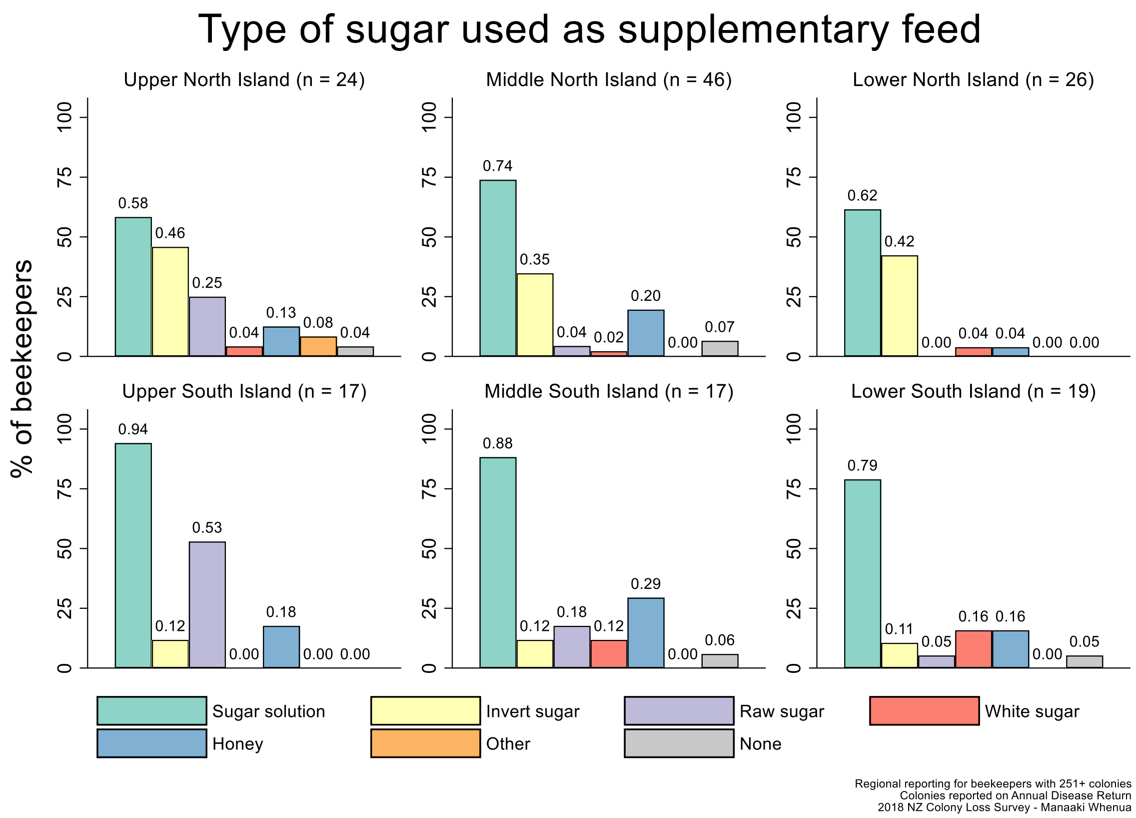

Figure 56: Types of supplemental sugar feed provided to production colonies during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

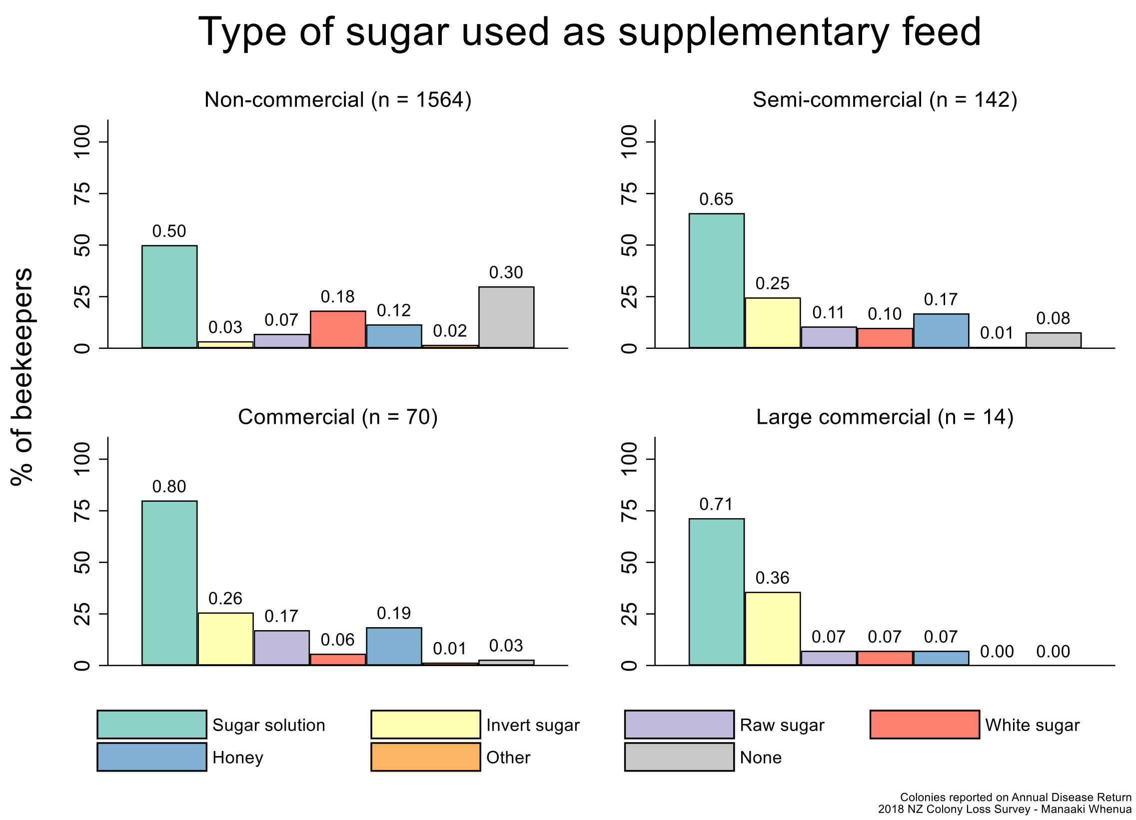

Figure 57: Types of supplemental sugar feed provided to production colonies during the 2017/18 season, based on reports from all respondents, by operation size.

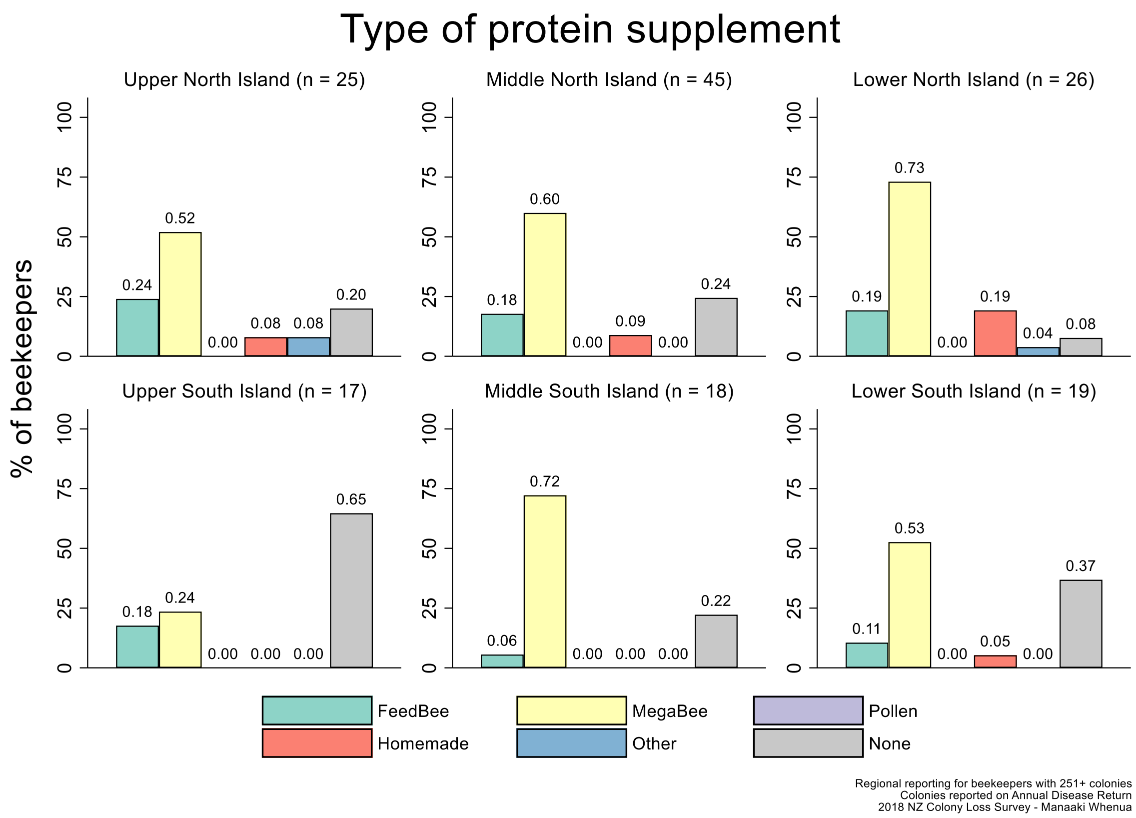

Figure 58: Types of supplemental protein feed provided to production colonies during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

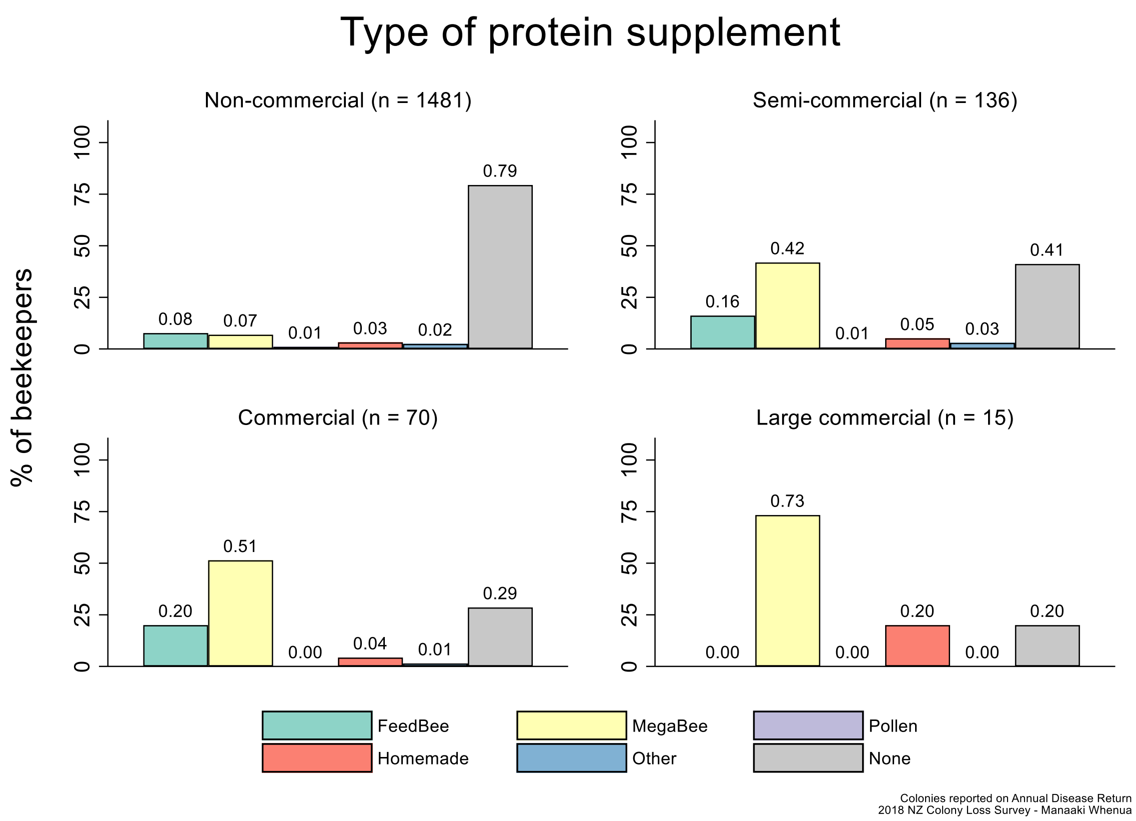

Figure 59: Types of supplemental protein feed provided to production colonies during the 2017/18 season, based on reports from all respondents, by operation size.

4.7 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 18.2% beekeepers with more than 250 colonies reported losing one or more apiary sites to other beekeepers during the 2017/18 season, an improvement relative to 32.6% reported for the 2016/17 season. This problem was pronounced outside the Lower South Island (Fig. 60), particularly among large commercial beekeepers, who reported that 2.8% of apiary sites were overtaken by other beekeepers during the 2017/18 season (Fig. 61). Again, this was a marked improvement vis-à-vis 2016/17, when large commercial beekeepers reported losing 8.9% of all apiaries to other beekeepers; in contrast, only 1.1% of non-commercial beekeepers reported having had sites overtaken by other beekeepers, accounting for just 0.4% of their apiaries.

Losing apiaries to overcrowding (as opposed to be overtaken by other beekeepers) has also coincided with growth in the mānuka honey industry, a challenge that may be exacerbated by the potential for new beekeepers to be less cognisant of sustainable stocking rates. Overcrowding was particularly problematic in the Upper North Island, where commercial beekeepers reported having lost 2.1% of apiaries due to overcrowding in the 2017/18 season (Fig. 62), down from 4.3% during the 2016/17 season. In contrast to the 2016/2017, overcrowding during the 2017/18 season was a more significant problem for non-commercial beekeepers than for commercial beekeepers (Fig. 63).

While losing entire apiary sites due to overcrowding was not common, apiaries being compromised by overcrowding was common, particularly in the Upper North Island, where 63.6% of beekeepers with more than 250 colonies reported that overcrowding had compromised their apiaries during the 2017/18 season (Fig. 64) compared with 86.3% during the 2016/17 season. Semi-commercial, commercial, and large commercial beekeepers noted that 10.2%, 15.6%, and 9.0% of their apiaries had been compromised due to overcrowding, respectively, compared with 4.6% of non-commercial beekeepers (Fig. 65). Relative to the 2016/17, overcrowding during the 2017/18 was somewhat less of a problem for large commercial beekeepers and somewhat more of a problem for non-commercial beekeepers.

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, one commercial beekeeper in the Upper North Island reported having lost over 40% of his or her apiary sites due to pollen and nectar sources being removed (Fig. 66). Losing apiary sites due to removal of pollen/nectar sources was most common in the Lower North Island during the 2017/18 season, although the share of apiary sites affected was modest. In addition, 17.6% of North Island beekeepers with more than 250 colonies reported that apiary sites had been compromised due to lost pollen and nectar sources (Fig. 68) during the 2017/18 season, compared to 11.0% during the 2016/17 season; apiaries in the Lower North Island were most compromised due to pollen and nectar sources being removed, although this challenge affected South Island beekeepers as well. The overall share of apiary sites lost or compromised due to lost pollen and nectar sources was generally low (Figs 67 and 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 0.03% of their apiary sites as a result of infestation by giant willow aphid during the 2017/18 season (Fig. 70), compared with 0.4% during the 2016/17 season. A further 3.0% of their apiaries were compromised due to giant willow aphid (Fig. 72), as were 4.8% of apiary sites in the Lower North Island and 4.4% of apiary sites in the Upper South Island. One large commercial beekeeper reported that all of his or her apiaries in the Middle North Island had been compromised by giant willow aphid (Fig. 73).

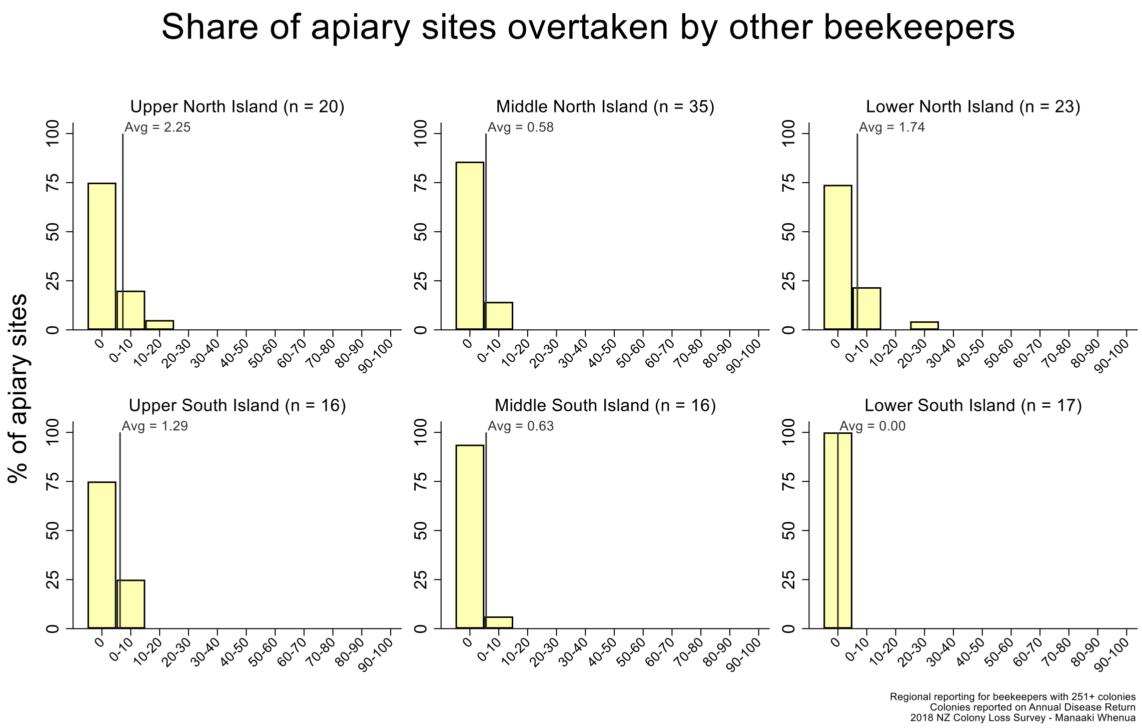

Figure 60: Share of apiary sites lost due to being taken over by other beekeepers during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

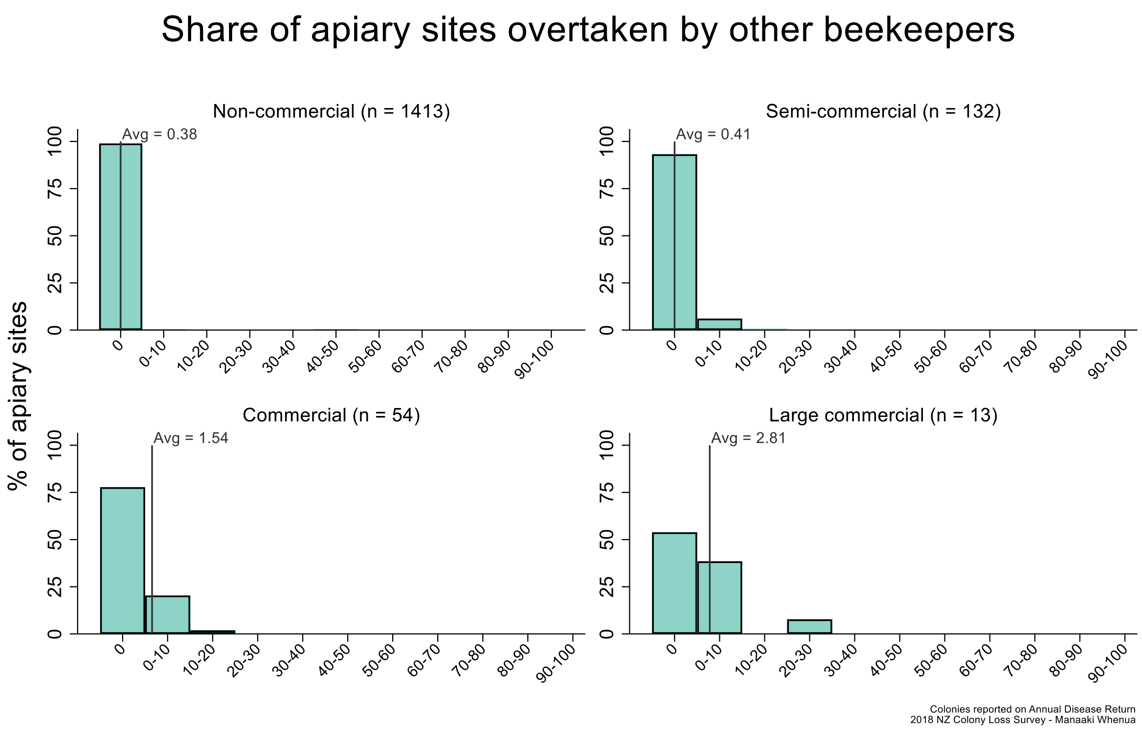

Figure 61: Share of apiary sites lost due to being taken over by other beekeepers during the 2017/18 season, based on reports from all respondents, by operation size.

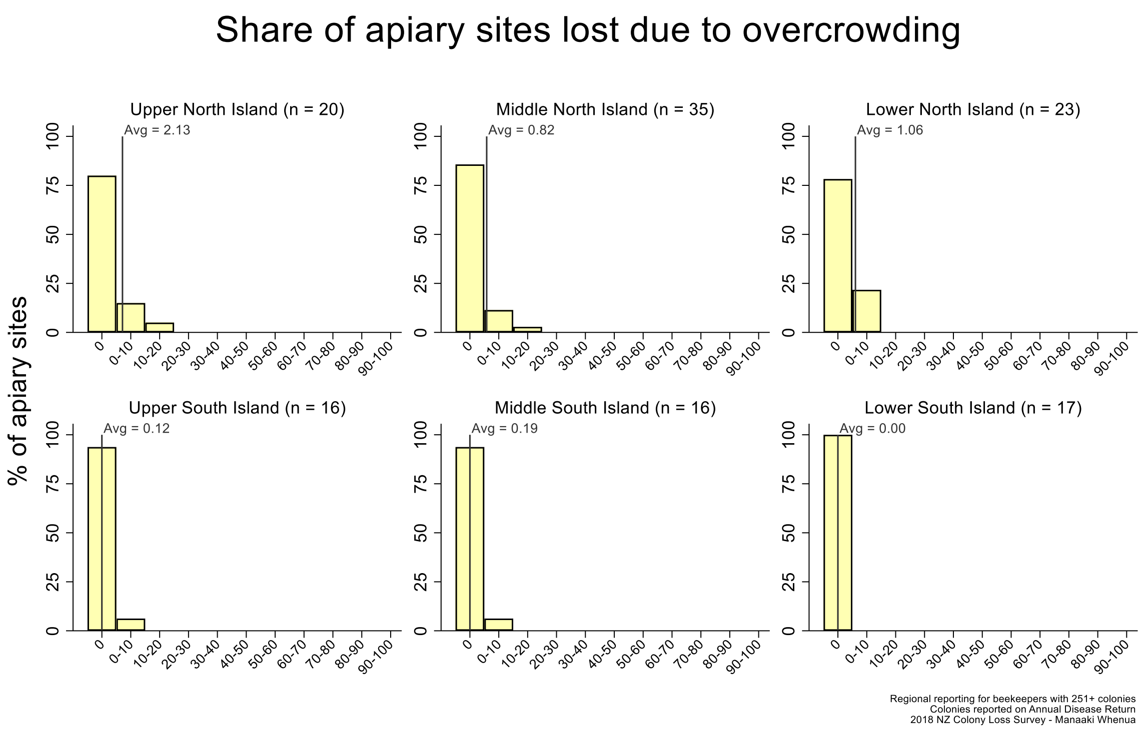

Figure 62: Share of apiary sites lost due to overcrowding during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

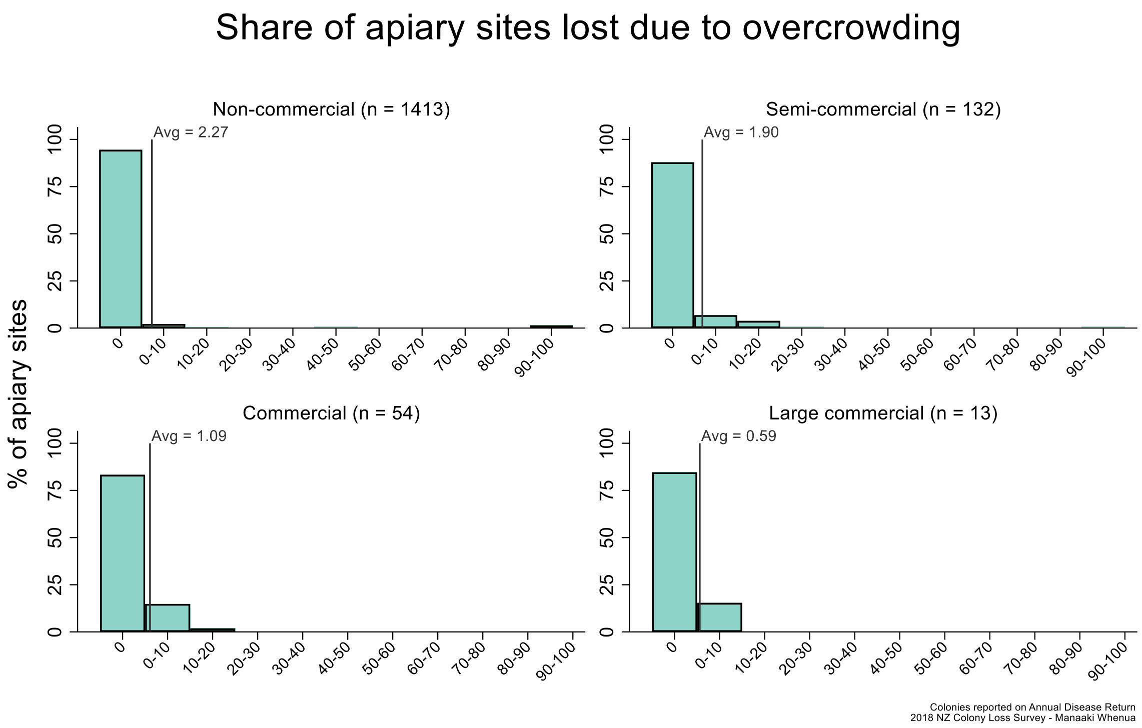

Figure 63: Share of apiary sites lost due to overcrowding during the 2017/18 season, based on reports from all respondents, by operation size.

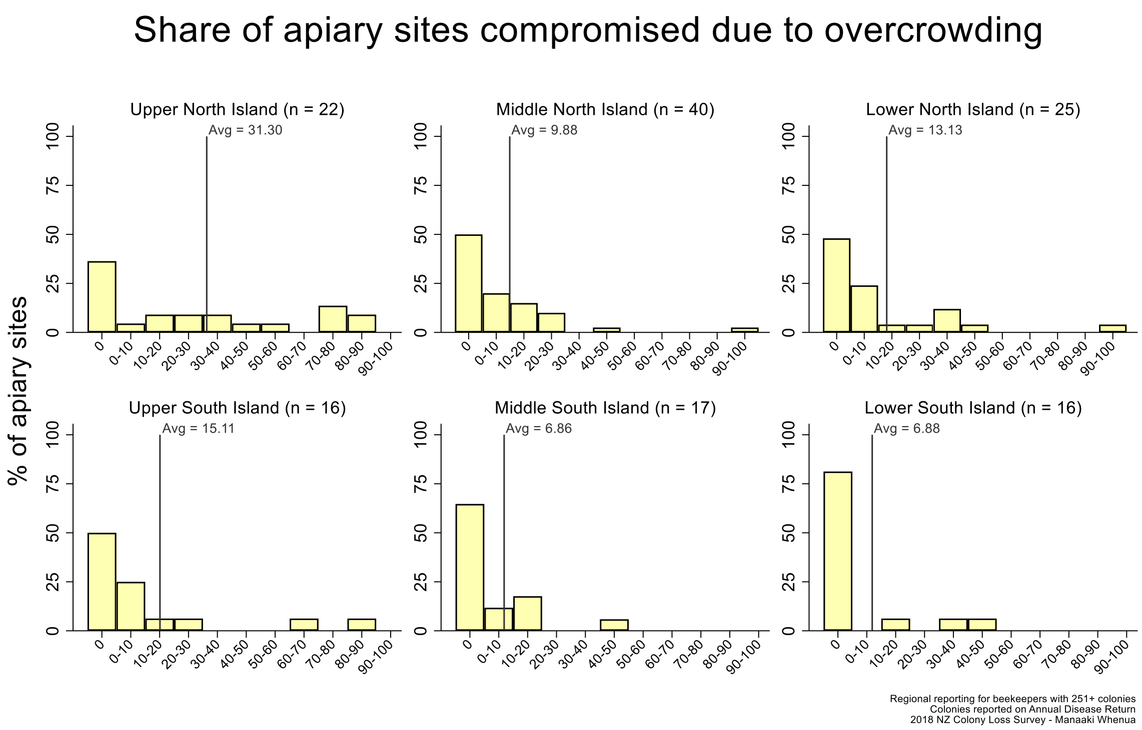

Figure 64: Share of apiary sites compromised due to overcrowding during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

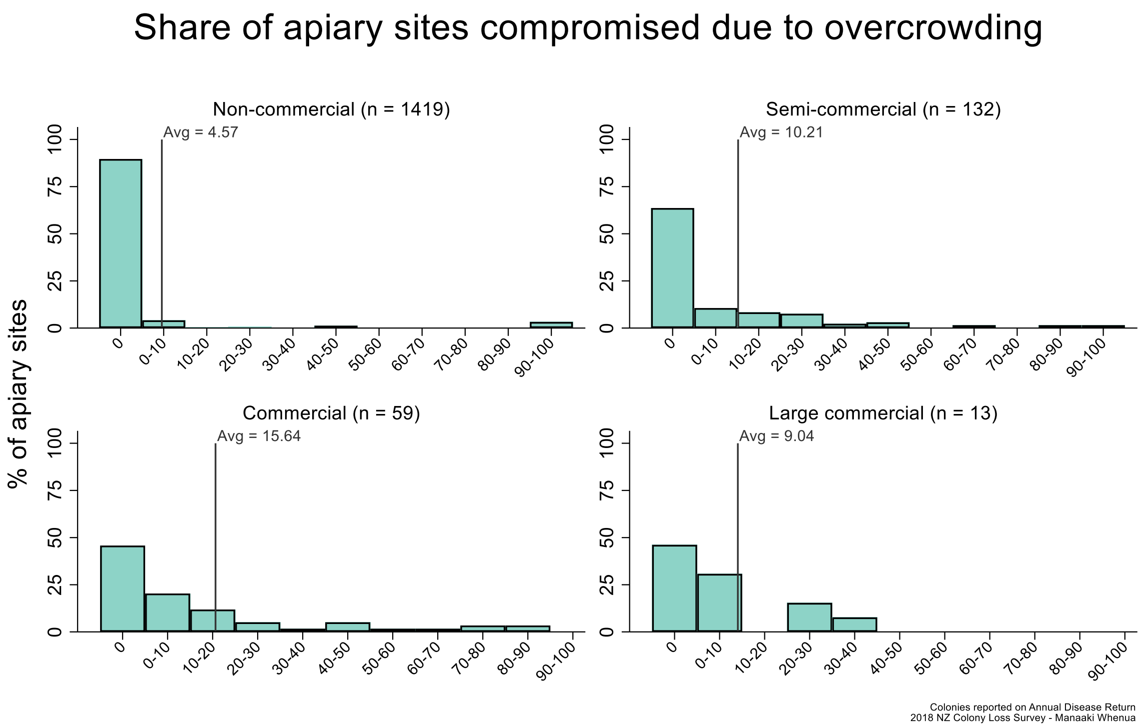

Figure 65: Share of apiary sites compromised due to overcrowding during the 2017/18 season, based on reports from all respondents, by operation size.

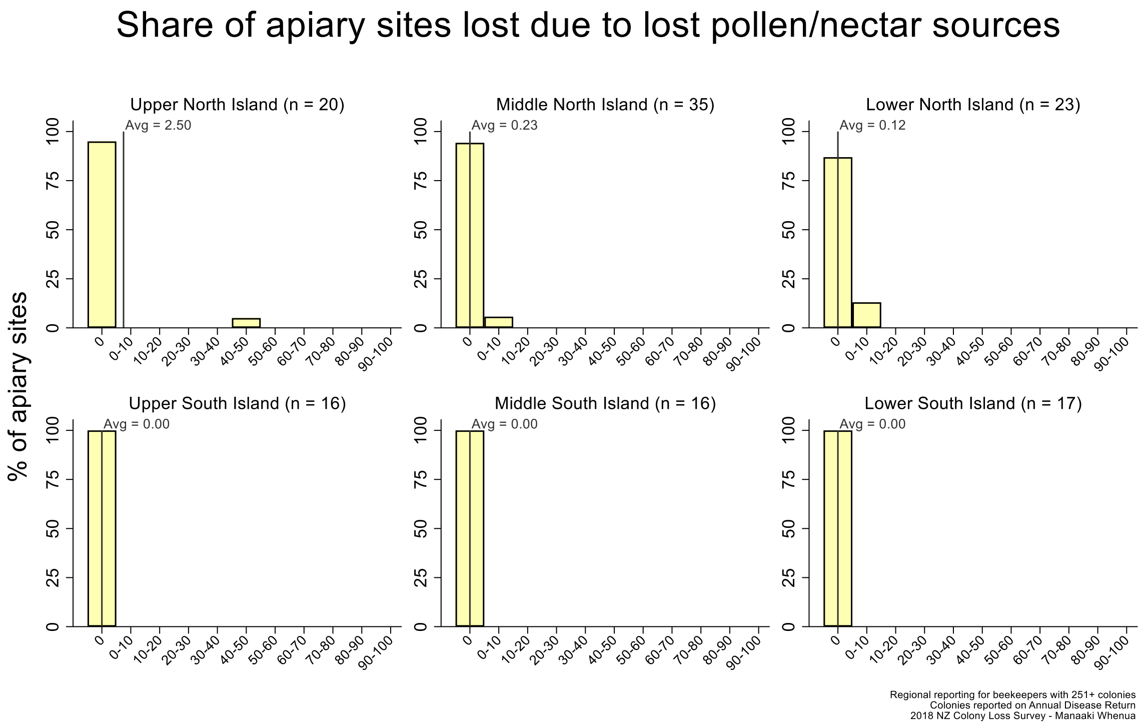

Figure 66: Share of apiary sites lost due to sources of pollen and nectar being removed during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

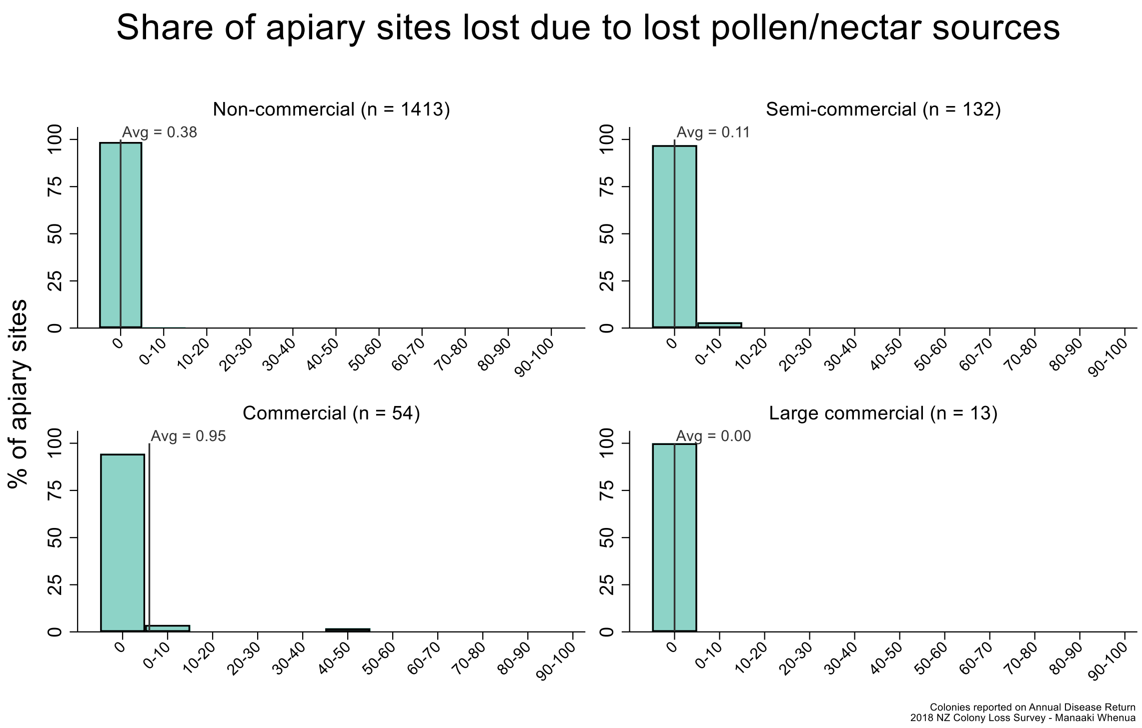

Figure 67: Share of apiary sites lost due to pollen and nectar sources being removed during the 2017/18 season, based on reports from all respondents, by operation size.

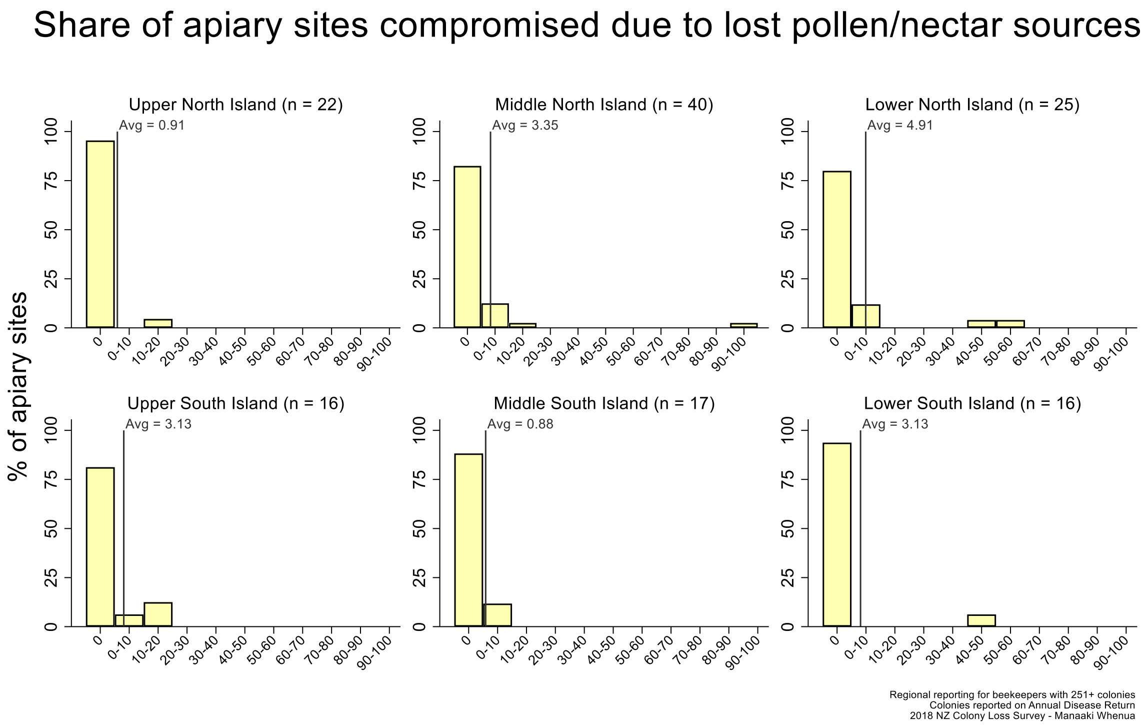

Figure 68: Share of apiary sites compromised due to pollen and nectar sources being removed during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

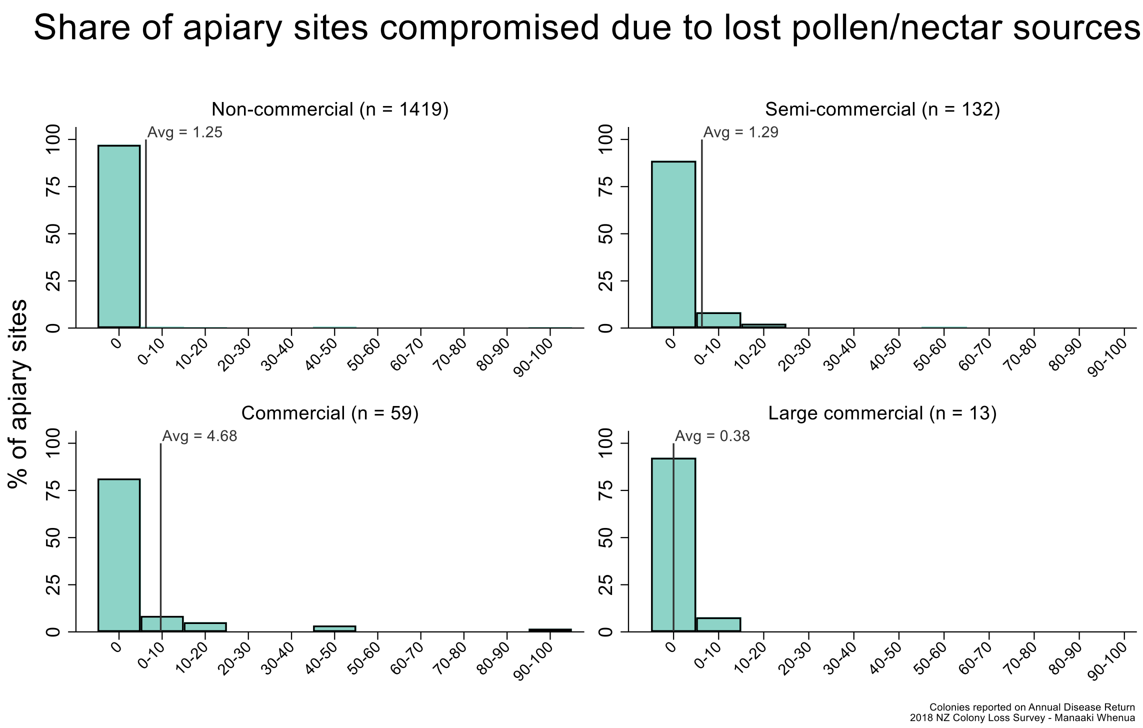

Figure 69: Share of apiary sites compromised due to pollen and nectar sources being removed during the 2017/18 season, based on reports from all respondents, by operation size.

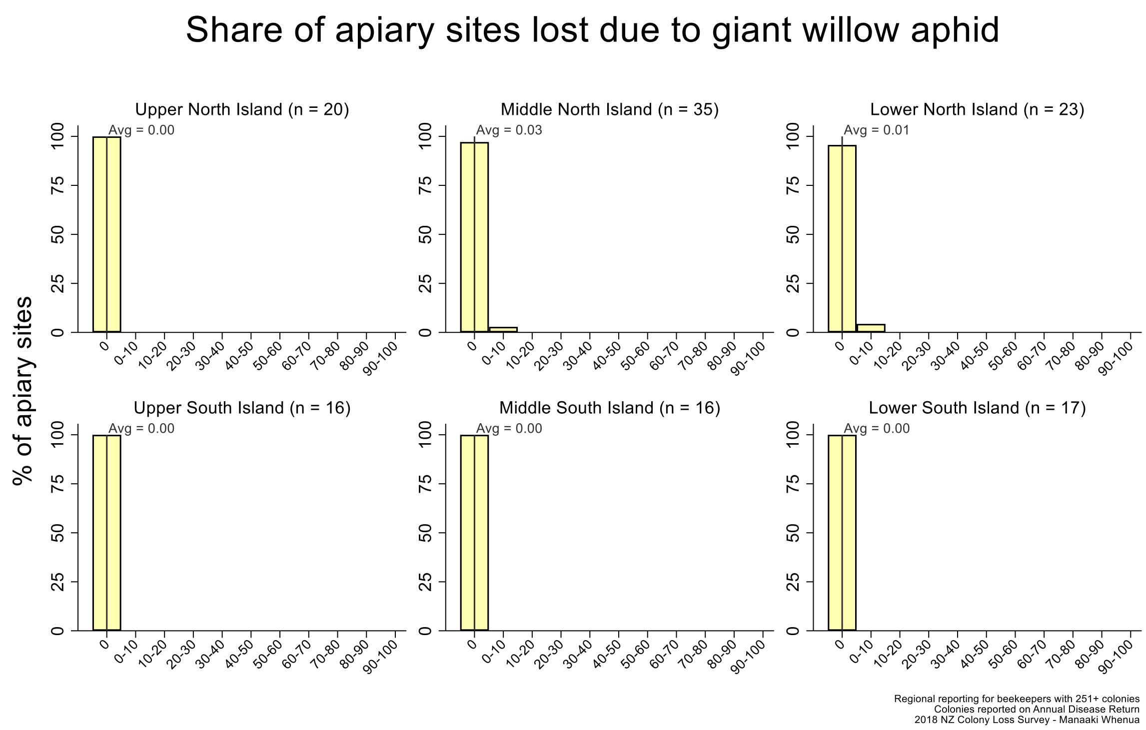

Figure 70: Share of apiary sites lost due to giant willow aphid during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

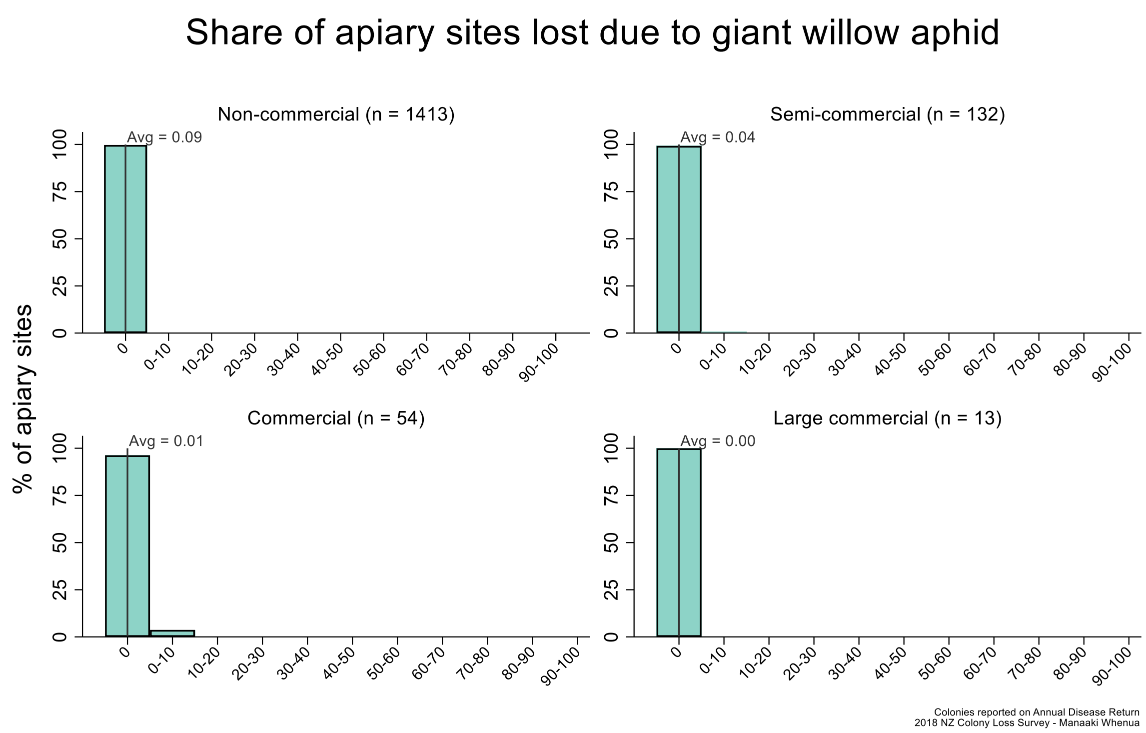

Figure 71: Share of apiaries lost due to giant willow aphid during the 2017/18 season, based on reports from all respondents, by operation size.

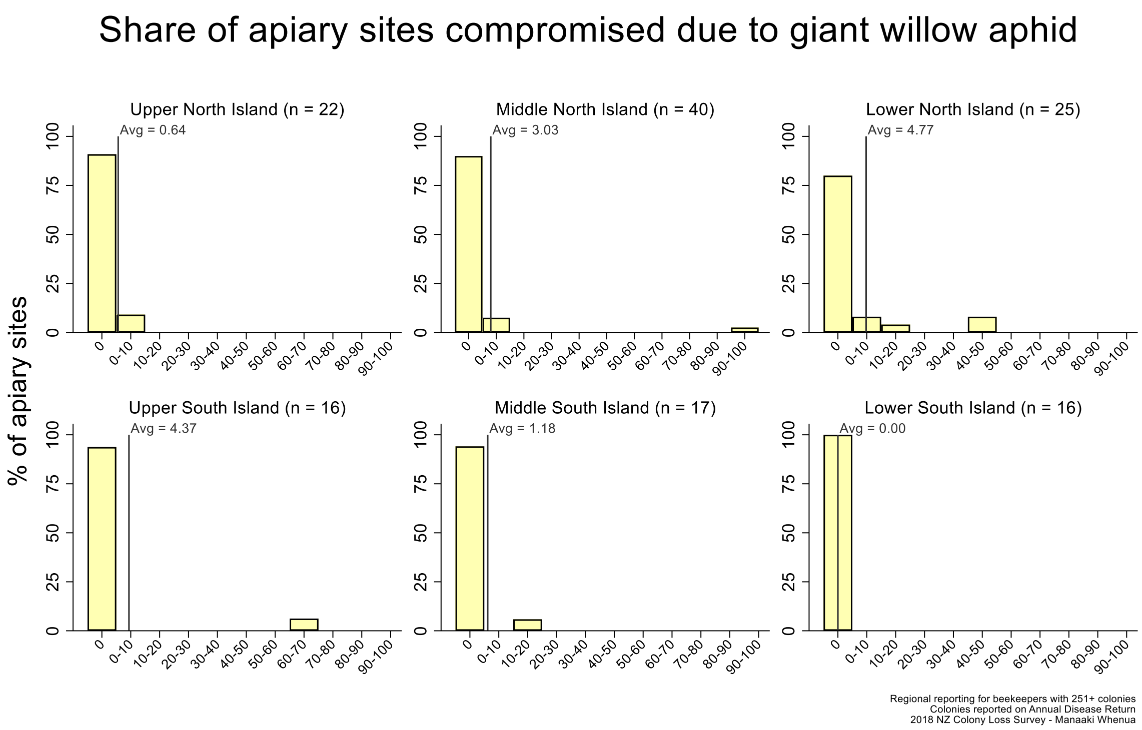

Figure 72: Share of apiary sites compromised due to giant willow aphid during the 2017/18 season, based on reports from respondents with more than 250 colonies, by region.

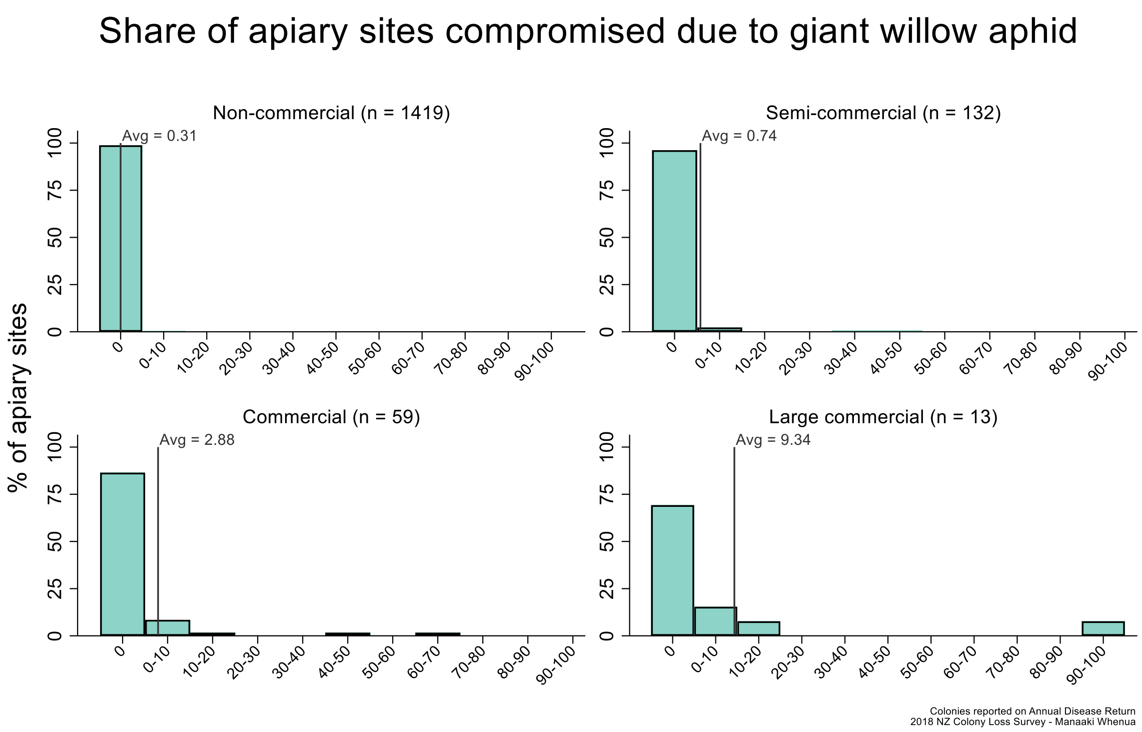

Figure 73: Share of apiary sites compromised due to giant willow aphid during the 2017/18 season, based on reports from all respondents, by operation size.

4.8 ACCEPTABLE LOSSES

Beginning in 2017, beekeepers were asked to specify the level of over-winter losses (a concept that is referred to as ‘economic injury level’) that they considered to be economically sustainable. In the 2018 NZ Colony Loss Survey, responses ranged from 0% to 100% for non-commercial beekeepers, and from 2% to 50% for beekeepers with more than 250 colonies. In each case, the median was 10%. The mean acceptable loss for non-commercial beekeepers reported in the 2018 NZ Colony Loss Survey was 18.7% (Fig. 74), compared with 16.3% in 2017. Among semi-commercial beekeepers, these figures were 11.2% for 2018 and 12.7% for 2017. Among commercial beekeepers, these figures were 11.9% for 2018 and 12.7% for 2017. For semi-commercial and commercial operators, these lower levels of acceptable loss may reflect weakening prices for whole prices for mānuka.

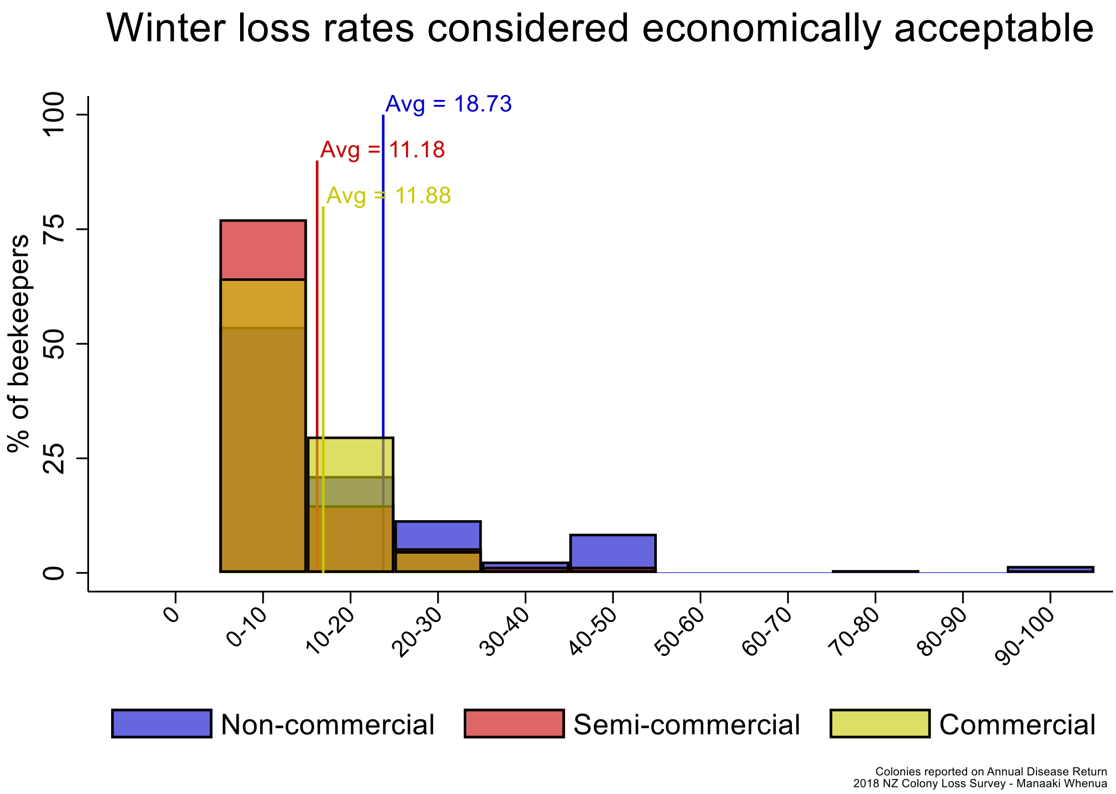

Figure 74: Winter loss rates that are considered economically acceptable, based on reports from all respondents.

5 The Future of the NZ Colony Loss Survey

Overall loss rates over winter 2018 were higher than those reported at the inception of the NZ Colony Loss Survey in 2015. Indeed, the overall loss rate for winter 2018 was 22.0% higher than the overall loss rate for winter 2015, a difference that is both meaningful and statistically significant. Moreover, all but two regions (Middle North Island and Lower North Island) saw marked increases in overall loss rates relative to 2016 and/or 2017: for example, overall loss rates were estimated to be 81.9% higher in winter 2018 than in winter 2017 in the Upper South Island. Changes in overall loss rates may portend emerging problems that may otherwise go unreported or undiscovered. We are therefore pleased that the contract signed between the Ministry for Primary Industries and Manaaki Whenua – Landcare Research for the 2018 NZ Colony Loss Survey specified a contract duration for up to 3 years with rights of renewal at 12-monthly intervals.

In future rounds of the survey, we seek to work with several prominent beekeepers and the industry more generally to ensure that the survey continues to report on outcomes of greatest interest to them. We are especially eager to refine questions related to queen performance, as suggested by MPI. We have also committed to developing infographics to help disseminate key results to the wider beekeeping community.

6 Acknowledgements

We gratefully acknowledge the 3,655 beekeepers who shared their time and expertise in responding to the survey. We are also grateful to colleagues from AsureQuality, who do yeoman's work to maintain New Zealand hive statistics.

John Berry's endorsement of measuring and monitoring colony losses contributed significantly to higher participation rates, as did encouragement from Apiculture New Zealand, New Zealand Beekeeping Incorporated, and the Southern North Island Beekeeping Group. Samantha Keene made hundreds of phone calls to remind beekeepers to check their email, and Christine Harper worked with individual beekeepers to complete the survey.

Dr Lou Gallagher provided valuable comments on a draft of this report.

We are further grateful to the dozens of individual beekeepers and scientists who have provided feedback on the questionnaire and who have contributed to its design in many important ways. Finally, we acknowledge Robert Brodschneider for pointing us to the most recent literature on calculating overall loss rates and for sharing his calculation tool.

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Appendix 1 – Survey

Consent

Thank you for participating in the 2018 NZ Colony Loss and Survival survey!

This survey is about colony losses over winter 2018. The questionnaire was adapted from similar surveys undertaken in more than 30 countries by the COLOSS honey bee research association. The survey is funded entirely by the Ministry for Primary Industries and Manaaki Whenua – Landcare Research, a Crown Research Institute.

The NZ Colony Loss Survey was conducted in 2015, 2016, and 2017. Last year, more than 2000 beekeepers representing about a quarter million production colonies completed the survey. Click here to see a summary of last year's results.

The survey is designed to be completed after hives have been opened in spring 2018.

Your participation will make it possible to identify trends in New Zealand beekeeping, to compare loss rates across countries, and to use international data to better understand risk factors. There are also several questions that are specific to the challenges and opportunities facing New Zealand beekeepers.

The data collected in the survey are confidential, meaning that you will not be identifiable based on answers that you provide. Read about Manaaki Whenua – Landcare Research's statement on survey privacy and ethics here.

By completing the survey, you will be eligible for a prize draw for a $100 supermarket voucher. Winners will be contacted in December and will be announced on the Manaaki Whenua – Landcare Research website.

The survey takes 10-20 minutes to complete, on average. It can be done on a computer, a tablet or a smartphone. We think it works best on a computer.

Important note: At the end of each page of questions, click the Next button to move forward. If you don't see the Next button, please scroll down.

Please click YES to begin the survey:

- YES, take me to the survey
- NO, I don't want to do the survey

Role

Which of the following best describes your role in this beekeeping operation?

- Owner/partner
- Apiary manager

Do you personally manage all apiaries?

- Yes
- No

Ideally, managers will complete the survey for the apiaries that they manage. Do you want 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 "Apiary managers will complete the survey".

- I will complete the entire survey myself
- Apiary managers will complete the survey
- I will complete the survey for some apiaries and apiary managers will complete the survey for other apiaries

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 apiary manager(s).

Enter each address on a new line.

Thanks for helping with the 2018 NZ Colony Loss Survey. We will contact the apiary managers to complete the survey.

Colonies on 1 June 2018

Did you have at least one productive colony at the beginning of winter (1 June 2018)?

Please consider colonies that you considered to be queenright and likely to be strong enough to provide a honey harvest and/or pollination services as production colonies.

Please check your answers. You won't be able to move back after this page.

- Yes
- No

Winter 2018 colony losses

In which region(s) were your apiary sites located during your first spring round (spring 2018)?

Tick all that apply. Note that Coromandel is listed separately from Waikato and that Wairarapa is listed separately from Wellington.

- 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

How many production colonies did you have on 1 June 2018? How many production colonies did you acquire or sell/give away over winter? And how many production colonies did you have during your first spring round (spring 2018)?

Enter whole numbers only. If you do not have an exact figure, please estimate. Note that Coromandel is listed separately from Waikato and that Wairarapa is listed separately from Wellington.

Please check your answers. You won't be able to move back after this page.

	Viable production colonies 1 June 2018	Production colonies acquired after 1 June 2018	Production colonies sold/given away after 1 June 2018	Living production colonies first spring round 2018
Northland	0	0	0	0
Auckland	0	0	0	0
Coromandel	0	0	0	0
Waikato (apart from Coromandel)	0	0	0	0
Bay of Plenty	0	0	0	0
Gisborne	0	0	0	0
Hawke's Bay	0	0	0	0
Taranaki	0	0	0	0

	Viable production colonies 1 June 2018	Production colonies acquired after 1 June 2018	Production colonies sold/given away after 1 June 2018	Living production colonies first spring round 2018
Manawatu-Wanganui	0	0	0	0
Wairarapa	0	0	0	0
Wellington (apart from Wairarapa)	0	0	0	0
Tasman / Nelson	0	0	0	0
Marlborough	0	0	0	0
Canterbury	0	0	0	0
West Coast	0	0	0	0
Otago	0	0	0	0
Southland	0	0	0	0
Chatham Islands	0	0	0	0
Total	0	0	0	0

Winter 2018 colony losses – Corrections

It appears that you ended winter with more production colonies than you started with plus what you acquired (in one or more regions). Please check your answers below.

Please tell us about the number of production colonies that you had at the beginning of winter, that you acquired or sold/gave away during winter, and that were alive during the first spring round of 2018.

Enter whole numbers only. If you do not have an exact figure, please estimate. Note that Coromandel is listed separately from Waikato and that Wairarapa is listed separately from Wellington.

	Production colonies 1 June 2018	Production colonies acquired after 1 June 2018	Production colonies sold/given away after 1 June 2018	Production colonies first spring round 2018
Northland	${q:/C	${q:/C	${q:/C	${q:/C
Auckland	${q:/C	${q:/C	${q:/C	${q:/C
Coromandel	${q:/C	${q:/C	${q:/C	${q:/C
Waikato (apart from Coromandel)	${q:/C	${q:/C	${q:/C	${q:/C
Bay of Plenty	${q:/C	${q:/C	${q:/C	${q:/C
Gisborne	${q:/C	${q:/C	${q:/C	${q:/C
Hawke's Bay	${q:/C	${q:/C	${q:/C	${q:/C
Taranaki	${q:/C	${q:/C	${q:/C	${q:/C
Manawatu-Wanganui	${q:/C	${q:/C	${q:/C	${q:/C
Wairarapa	${q:/C	${q:/C	${q:/C	${q:/C
Wellington (apart from Wairarapa)	${q:/C	${q:/C	${q:/C	${q:/C
Tasman / Nelson	${q:/C	${q:/C	${q:/C	${q:/C
Marlborough	${q:/C	${q:/C	${q:/C	${q:/C
Canterbury	${q:/C	${q:/C	${q:/C	${q:/C
West Coast	${q:/C	${q:/C	${q:/C	${q:/C
Otago	${q:/C	${q:/C	${q:/C	${q:/C
Southland	${q:/C	${q:/C	${q:/C	${q:/C
Chatham Islands	${q:/C	${q:/C	${q:/C	${q:/C
Total	0	0	0	0

Winter 2018 colony losses – attributions

Out of all of your queenright hives in spring 2018, how many were weak?

Northland (out of ${e://Field/Spring%20Northland} living production colonies in your first spring round)	0
Auckland (out of ${e://Field/Spring%20Auckland} living production colonies in your first spring round)	0
Coromandel (out of ${e://Field/Spring%20Coromandel} living production colonies in your first spring round)	0
Waikato (out of ${e://Field/Spring%20Waikato} living production colonies in your first spring round)	0
Bay of Plenty (out of ${e://Field/Spring%20BOP} living production colonies in your first spring round)	0
Gisborne (out of ${e://Field/Spring%20Gisborne} living production colonies in your first spring round)	0
Hawke's Bay (out of ${e://Field/Spring%20HB} living production colonies in your first spring round)	0
Taranaki (out of ${e://Field/Spring%20Taranaki} living production colonies in your first spring round)	0
Manawatu-Wanganui (out of ${e://Field/Spring%20Manawatu-Wanganui} living production colonies in your first spring round)	0
Wairarapa (out of ${e://Field/Spring%20Wairarapa} living production colonies in your first spring round)	0
Wellington (out of ${e://Field/Spring%20Wellington} living production colonies in your first spring round)	0
Tasman / Nelson (out of ${e://Field/Spring%20Tasman-Nelson} living production colonies in your first spring round)	0
Marlborough (out of ${e://Field/Spring%20Marlborough} living production colonies in your first spring round)	0
Canterbury (out of ${e://Field/Spring%20Canterbury} living production colonies in your first spring round)	0
West Coast (out of ${e://Field/Spring%20WC} living production colonies in your first spring round)	0
Otago (out of ${e://Field/Spring%20Otago} living production colonies in your first spring round)	0
Southland (out of ${e://Field/Spring%20Southland} living production colonies in your first spring round)	0
Chatham Islands (out of ${e://Field/Spring%20Chathams} living production colonies in your first spring round)	0
Total	0

How many losses of production colonies do you attribute to each of the following causes?

Please use your best judgement. If you are uncertain, please list those losses under "Unsure".

	Northland Please check that total = ${e://Field/Losses%20Northland}	Auckland Please check that total = ${e://Field/Losses%20Auckland}	Coromandel Please check that total = ${e://Field/Losses%20Coromandel}	Waikato Please check that total = ${e://Field/Losses%20Waikato}	Bay of Plenty Please check that total = ${e://Field/Losses%20BOP}	Gisborne Please check that total = ${e://Field/Losses%20Gisborne}	Hawke's Bay Please check that total = ${e://Field/Losses%20HB}	Taranaki Please check that total = ${e://Field/Losses%20Taranaki}	Manawatu-Wanganui Please check that total = ${e://Field/Losses%20Manawatu-Wanganui}	Wairarapa Please check that total = ${e://Field/Losses%20Wairarapa}	Wellington Please check that total = ${e://Field/Losses%20Wellington}	Tasman/Nelson Please check that total = ${e://Field/Losses%20Tasman-Nelson}	Marlborough Please check that total = ${e://Field/Losses%20Marlborough}	Canterbury Please check that total = ${e://Field/Losses%20Canterbury}	West Coast Please check that total = ${e://Field/Losses%20WC}	Otago Please check that total = ${e://Field/Losses%20Otago}	Southland Please check that total = ${e://Field/Losses%20Southland}	Chatham Islands Please check that total = ${e://Field/Losses%20Chathams}
Queen problems (queen loss, drone-laying queen, etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AFB American foul brood disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wasps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Robbing by other bees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Argentine ants (ants that attack the brood and honey)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Suspected starvation (dead workers in cells and no food present in the hive)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Suspected toxic exposure (many dead bees in or in front of the hive)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Northland *Please check that total = ${e://Field/Losses%20Northland}*	Auckland *Please check that total = ${e://Field/Losses%20Auckland}*	Coromandel *Please check that total = ${e://Field/Losses%20Coromandel}*	Waikato *Please check that total = ${e://Field/Losses%20Waikato}*	Bay of Plenty *Please check that total = ${e://Field/Losses%20BOP}*	Gisborne *Please check that total = ${e://Field/Losses%20Gisborne}*	Hawke's Bay *Please check that total = ${e://Field/Losses%20HB}*	Taranaki *Please check that total = ${e://Field/Losses%20Taranaki}*	Manawatu-Wanganui *Please check that total = ${e://Field/Losses%20Manawatu-Wanganui}*	Wairarapa *Please check that total = ${e://Field/Losses%20Wairarapa}*	Wellington *Please check that total = ${e://Field/Losses%20Wellington}*	Tasman/Nelson *Please check that total = ${e://Field/Losses%20Tasman-Nelson}*	Marlborough *Please check that total = ${e://Field/Losses%20Marlborough}*	Canterbury *Please check that total = ${e://Field/Losses%20Canterbury}*	West Coast *Please check that total = ${e://Field/Losses%20WC}*	Otago *Please check that total = ${e://Field/Losses%20Otago}*	Southland *Please check that total = ${e://Field/Losses%20Southland}*	Chatham Islands *Please check that total = ${e://Field/Losses%20Chathams}*
Suspected [illegible] and related issues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Suspected Nosema (Nosema apis may be marked by a high level of feces on the frames of the hive; Nosema ceranae has no such diagnostic) and other diseases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural disasters (Cyclone, floods, flooding, etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Theft or vandalism	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accidental damage (from livestock, tractors, etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unsure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Queens

Did any of the production colonies that you had at the beginning of winter 2018 have new queens (own source or commercial source)?

	Yes	No
Northland		
Auckland		
Coromandel		
Waikato		
Bay of Plenty		
Gisborne		
Hawke's Bay		
Taranaki		
Manawatu-Wanganui		
Wairarapa		
Wellington		
Tasman / Nelson		
Marlborough		
Canterbury		
West Coast		
Otago		
Southland		
Chatham Islands		

How many of the production colonies that you had at the beginning of winter 2018 had new queens? How many new queens were from queen breeder stock?

If exact numbers are not known, please estimate.

	New queens	How many of the new queens were from queen breeder stock?	How many of the new queens were virgin queens?
Northland (out of ${e://Field/Use%20Northland} production colonies at the start of winter)	0	0	0
Auckland (out of ${e://Field/Use%20Auckland} production colonies at the start of winter)	0	0	0
Coromandel (out of ${e://Field/Use%20Coromandel} production colonies at the start of winter)	0	0	0
Waikato (out of ${e://Field/Use%20Waikato} production colonies at the start of winter)	0	0	0
Bay of Plenty (out of ${e://Field/Use%20BOP} production colonies at the start of winter)	0	0	0
Gisborne (out of ${e://Field/Use%20Gisborne} production colonies at the start of winter)	0	0	0
Hawke's Bay (out of ${e://Field/Use%20HB} production colonies at the start of winter)	0	0	0
Taranaki (out of ${e://Field/Use%20Taranaki} production colonies at the start of winter)	0	0	0
Manawatu-Wanganui (out of ${e://Field/Use%20Manawatu-Wanganui} production colonies at the start of winter)	0	0	0
Wairarapa (out of ${e://Field/Use%20Wairarapa} production colonies at the start of winter)	0	0	0
Wellington (out of ${e://Field/Use%20Wellington} production colonies at the start of winter)	0	0	0
Tasman / Nelson (out of ${e://Field/Use%20Tasman-Nelson} production colonies at the start of winter)	0	0	0
Marlborough (out of ${e://Field/Use%20Marlborough} production colonies at the start of winter)	0	0	0
Canterbury (out of ${e://Field/Use%20Canterbury} production colonies at the start of winter)	0	0	0
West Coast (out of ${e://Field/Use%20WC} production colonies at the start of winter)	0	0	0
Otago (out of ${e://Field/Use%20Otago} production colonies at the start of winter)	0	0	0
Southland (out of ${e://Field/Use%20Southland} production colonies at the start of winter)	0	0	0
Chatham Islands (out of ${e://Field/Use%20Chathams} production colonies at the start of winter)	0	0	0

Which of the following queen problems did you experience over winter 2018?

Tick all that apply

- Young queens disappeared
- Old queens disappeared
- Young queen was a drone layer
- Old queen was a drone layer
- Young queen failed (poor brood pattern and/or poor hive build up)
- Old queen failed (poor brood pattern and/or poor hive build up)
- Other (please explain below)
- Unsure

How did production colonies with young queens survive winter 2018 relative to production colonies with old queens?

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	N/A

Continue

Thank you. The part of the survey that focuses on winter 2018 colony losses is complete.

The rest of the survey focuses on topics such as queen performance, varroa monitoring and treatment, floral resources, supplemental feeding, and overcrowding during the 2017-2018 season. There are also some open-ended questions about challenges and opportunities in New Zealand beekeeping.

Are you willing to share more of your experience and expertise with us?

Please check your answers. You won't be able to move back after this page.

- YES, take me to the additional questions
- No, skip to the end of the survey

2017-2018 season - yes / no

Did you have at least one production colony during the 2017-2018 season?

Please consider colonies that were queenright and strong enough to provide a honey harvest and/or pollination services as production colonies.

- Yes
- No

How many production colonies did you have during your first spring round of 2017? How many production colonies did you acquire or sell/give away over winter?

Enter whole numbers only. If you do not have an exact figure, please estimate.

- 0 Viable production colonies first spring round of 2017
- 0 Production colonies acquired during the 2017-2018 season
- 0 Production colonies sold/given away during the 2017-2018 season

In which region(s) did you keep your production colonies at any time during the 2017-2018 season?

Tick all that apply. Note that Coromandel is listed separately from Waikato and that Wairarapa is listed separately from Wellington.

- 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

2017-2018 season

In general, how do you replace your queens?

Tick all that apply

- Queen cells (without removing old queen)
- Queen cells (removing old queen)
- Mated queens
- Virgin queens
- Other (please explain below)
- No queen replacement strategy

In terms of queen problems, how did the 2017-2018 season compare to previous seasons?

Much worse than normal	Somewhat worse than normal	About normal	Somewhat better than normal	Much better than normal	Unsure	N/A

Did you notice bees with signs of deformed wing virus or parasitic mite syndrome in your production colonies during the 2017-2018 season?

	Signs of deformed wing virus e.g. crippled or deformed wings		Signs of parasitic mite syndrome e.g. spotty brood patterns, larvae and pupae of brood dead, and/or cells being capped/uncapped by workers	
	Yes	No	Yes	No
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				

Did you monitor your production colonies for varroa during the 2017-2018 season?

- Yes
- No

What methods did you use to monitor your production colonies for varroa during the 2017-2018 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 (enter explanation below)

Did you treat varroa during the 2017-2018 season?

	Yes	No
» 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		

What methods did you use to treat varroa during the 2017-2018 season?

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
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 i.e. evaporation																		
Oxalic acid - dribbling / trickling																		
Drone brood removal																		
Formic acid - short term 7 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 essential oils e.g. thymol, wintergreen																		
Fogging food-grade mineral oil																		
Hyperthermia i.e. heat treatment of brood / bees																		
Other (please explain below)																		

Please indicate when you started treatment for varroa during the 2017-2018 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 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	March 2018	Apr 2018	May 2018
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 i.e. evaporation											
» Oxalic acid - dribbling / trickling											
» Drone brood removal											
Formic acid - short term 7 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 essential oils e.g. thymol, wintergreen											
» Fogging food-grade mineral oil											
Hyperthermia i.e. heat treatment of brood / bees											
» Other (please explain below)											

Did you replace any brood combs with comb foundation during the 2017-2018 season?

	Yes	No
» 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		

Approximately what proportion of brood combs did you replace with comb foundation (per colony) during the 2017-2018 season?

	<10%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	Unsure
Northland												
Auckland												
Coromandel												
Waikato												
Bay of Plenty												
Gisborne												
Hawke's Bay												
Taranaki												
Manawatu-Wanganui												
Wairarapa												
Wellington												
Tasman / Nelson												
Marlborough												
Canterbury												
West Coast												
Otago												
Southland												
Chatham Islands												

During the 2017-2018 season, approximately what share of productive colonies were used for pollination, for honey production, and for both pollination and honey production?

Pollination only	0 %
Honey production only	0 %
Both pollination and honey production	0 %
Total	0 %

Did the majority of your bee colonies have a significant flow on one or more of the following plants during the 2017-2018 season?

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
Mānuka																		
Kānuka																		
Mixed mānuka and kānuka																		
Clover / pasture																		
Kamahi																		
Willow honey (spring)																		
Willow honeydew (summer-autumn)																		
Rewarewa																		
Citrus																		
Borage / Viper's bugloss																		
Rata																		
Pohutukawa																		
Tawari																		
Beech honeydew																		
Thyme																		
Nodding thistle																		
Ling heather																		
Native bush blend																		
Urban floral and garden																		
Other (please specify)																		

During the 2017-2018 season, approximately what share of the mānuka flow came from plantation mānuka?

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

How did the nectar flow from selected native monoflorals in 2017-2018 compare to 2016-2017?

	Much worse	Somewhat worse	About the same	Somewhat better	Much better	Unsure	N/A
Kamahi							
Rewarewa							
Rata							
Pohutukawa							
Tawari							

Did you give any of your colonies a supplemental sugar feed or protein supplements during the 2017-2018 season?

Supplemental sugar feeds include sugar solution, invert sugar, raw sugar, white sugar, and honey. Protein supplements include FeedBee, MegaBee, dry pollen, and homemade supplements.

	Yes	No
Supplemental sugar feed		
Protein supplements		

What type of sugar did you use as a supplementary feed during the 2017-2018 season?

Tick all that apply.

- ☐ Sugar solution
- ☐ Invert sugar solution
- ☐ Raw sugar
- ☐ White sugar

- [ ] Honey
- [ ] Other (please specify below)

How much sugar did you use per production colony, on average?

0 litres of sugar solution and/or invert sugar solution

0 kgs of dry sugar (raw and/or white)

0 frames of honey

What type of protein supplement did you use during the 2017-2018 season?

Tick all that apply:

- [ ] FeedBee
- [ ] MegaBee
- [ ] Dry pollen
- [ ] Homemade protein supplement
- [ ] Other (please describe below)

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

0 kgs of supplement

Between the first spring round of 2017 and the first spring round of 2018, was one or more apiary sites compromised or lost in its entirety?

Possible causes include being overtaken by other beekeepers, overcrowding, lost pollen and nectar sources, and effects of giant willow aphid.

	Compromised		Lost in its entirety	
	Yes	No	Yes	No
» Northland				
» Auckland				
» Coromandel				
» Waikato (apart from Coromandel)				
» Bay of Plenty				
» Gisborne				
» Hawke's Bay				
» Taranaki				
» Manawatu-Whanganui				
» Wairarapa				
» Wellington (apart from Wairarapa)				
» Tasman / Nelson				
» Marlborough				
» Canterbury				
» West Coast				
» Otago				
» Southland				
» Chatham Islands				

What percentage of all your apiary sites were compromised between the first spring round of 2017 and the first spring round of 2018 due to each of the following reasons?

If you operate in multiple regions, please report the percentage of hives in each region. If an exact answer is not known, please estimate.

	Northland	Auckland	Coromandel	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Whanganui	Wairarapa	Wellington	Tasman / Nelson	Marlborough	Canterbury	West Coast	Otago	Southland	Chatham Islands
Overcrowding (too many hives close to your apiaries)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollen and nectar sources were removed and not replaced	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Effects of giant willow aphid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (please describe below)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

What percentage of all your apiary sites were lost in their entirety between the first spring round of 2017 and the first spring round of 2018 due to each of the following reasons?

If you operated in multiple regions, please reply with the percentage of hives in each region. If an exact answer is not known, please estimate.

	Northland	Auckland	Coromandel	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Whanganui	Wairarapa	Wellington	Tasman / Nelson	Marlborough	Canterbury	West Coast	Otago	Southland	Chatham Islands
Overtaken by another beekeeper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Overcrowding (too many hives close to your apiaries)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollen and nectar sources were removed and not replaced	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Effects of giant willow aphid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (please describe below)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Qualitative

Thank you for sharing your experience with us!

The following questions are optional, but they are very helpful for understanding the current situation for beekeeping in New Zealand.

Approximately how many years of beekeeping experience do you have?

0 years of beekeeping experience

What percent of overwinter losses do you consider to be economically sustainable?

0 % of overwinter losses

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

What are the key opportunities facing New Zealand beekeepers?

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