2024 Australian Honey Bee & Pollination Industry National Colony Loss Survey

By Michael J. Holmes and Sasha Mikheyev
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Foreword

The Australian honey bee and pollination industry plays a vital role in Australian agriculture, contributing more than AU$4.6 billion annually to the economy through pollination services and hive products, primarily honey. However, the industry faces many challenges, particularly since the parasitic mite, *Varroa destructor*, was declared established in New South Wales in September 2023.

Internationally, *Varroa* is often the leading cause of honey bee colony losses, and similar impacts were anticipated in Australia. Recognising the need to understand the effects of *Varroa* on bee colonies and other causes of colony loss, the industry initiated the first Australian Colony Loss Survey (COLOSS) for the 2023/2024 production season. This survey aimed to establish pre-*Varroa* baseline data for areas still free of the mite and assess its impact in regions where it is already present.

The survey revealed a national annual colony loss rate of 1.55%, providing a fragile baseline for the *Varroa*-free majority of the country. In NSW, where *Varroa* is already established, it was identified as a leading cause of colony loss, imposing substantial economic burdens on beekeepers through reduced honey production, additional labour and increased hive management costs.

Analysis of *Varroa* treatments indicated that synthetic acaricides like Bayvarol and Apivar were the most effective, with the highest efficacy and the lowest incidence of adverse effects. However, international experience shows that *Varroa* rapidly develops resistance to these chemicals, underscoring the need for an integrated pest management strategy to maintain their effectiveness.

This initial COLOSS survey provides valuable baseline data for the industry. Subsequent annual surveys may be conducted to collect additional data and monitor changes in colony loss over time. These surveys will provide essential information to guide the Australian honey bee industry through its transition to managing *Varroa*, with the goal of fostering a resilient, informed and sustainable future.

This project was completed as part of the AgriFutures Honey Bee and Pollination Program, which aims to foster a more productive, sustainable and profitable Australian beekeeping industry and secure the pollination of Australia's horticultural and agricultural crops. For more information and resources, visit agrifutures.com.au/rural-industries/honey-bee-pollination

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Michael J. Holmes and Sasha Mikheyev are researchers at the Australian National University with expertise in honey bee biology, ecology and the impacts of pests and diseases on apiculture.

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This project would not have been possible without ongoing consultation from Dr Pike Stahlmann-Brown (Manaaki Whenua Landcare Research New Zealand). Dr Stahlmann-Brown provided the New Zealand Colony Loss Survey Questionnaire, on which our survey was based. Dr Stahlmann-Brown also provided invaluable advice for every stage of the project.

Abbreviations

AHBIC	Australian Honey Bee Industry Council
ANU	Australian National University
DWV	deformed wing virus
EFB/AFB	European foulbrood/American foulbrood
EDM	electronic direct mail
IPM	integrated pest management
SHB	small hive beetle

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Executive summary

The Australian honey bee and pollination industry, a cornerstone of the nation's agricultural sector, is facing an unprecedented challenge with the establishment of the parasitic mite *Varroa destuctor* in New South Wales (NSW) in September 2023. To address the urgent need for robust, evidence-based management strategies, the inaugural 2024 Australian National Colony Loss Survey was conducted. This report presents the findings of that survey, establishing a critical baseline of colony health and identifying the initial impacts of *Varroa* on the industry.

The survey, which ran from February to April 2025, covered the 2023–24 production season and garnered 997 usable responses from beekeepers managing a total of 121,802 colonies. Commercial beekeepers (managing ≥ 50 hives) were significantly over-represented in the sample, accounting for 16% of respondents but 96% of all managed colonies, ensuring the data provides a strong reflection of the industry's economic core.

The key national finding was an overall annual colony loss rate of 1.55%. This low figure represents a fragile baseline for the *Varroa*-free majority of the country. Losses were slightly higher in the warm season (1.65%) than the cool season (1.44%). However, the data from NSW paints a starkly different picture, serving as a harbinger of the challenges to come. In NSW, *Varroa* was a leading cause of colony loss (0.82% of losses in cool season; 1.35% in warm season), second only to starvation for commercial beekeepers and the primary cause of cool-season losses (5.60%) for amateur beekeepers.

The economic burden of *Varroa* is substantial. NSW beekeepers reported spending an average of 23.5 minutes and AU$21.00 per hive on *Varroa* management. For a commercial operation with 1,000 hives, this extrapolates to an annual cost of $21,000 and 392 hours of additional labour. These figures do not include indirect costs such as income loss from movement restrictions, queen shortages or reduced honey production.

Analysis of *Varroa* treatments revealed that synthetic miticides (Bayvarol and Apivar) were perceived as the most effective with the fewest adverse effects. However, international experience demonstrates that *Varroa* rapidly develops resistance to these chemicals, highlighting the urgent need for a national integrated pest management (IPM) strategy to preserve their efficacy. The survey also uncovered a potential synergistic interaction between *Varroa* and small hive beetle, with losses to the latter being higher in areas where *Varroa* was present.

A significant methodological finding was the high proportion of losses attributed to "unsure" or "other reasons". The omission of "queen problems" as a specific loss category, a major driver of loss in international surveys, likely masked a fundamental issue in Australian colony health. Consequently, the causes of losses should be treated with caution.

This report recommends a multi-faceted approach. Beekeepers must adopt rigorous monitoring and IPM principles. Industry bodies should lead targeted education campaigns and advocate for survey improvements. Finally, research and funding bodies must prioritise investigations into queen health, pest synergies and the tracking of miticide resistance. The findings herein provide the foundational data necessary to guide the Australian honey bee industry through its transition to managing *Varroa*, with the goal of fostering a resilient, informed and sustainable future.

Introduction

1. The Australian beekeeping industry at a critical juncture

1.1 The economic and agricultural cornerstone of Australian pollination

The Australian honey bee and pollination industry is an indispensable component of the nation's horticulture and broader agricultural economy. Managed honey bees (*Apis mellifera*) provide essential pollination services to 67 distinct agricultural industries, with some crops being entirely dependent on commercial beekeepers for successful yields (Clarke and Le Feuvre 2024). The economic value of these services is profound, contributing an estimated AU$4.6 billion to the Australian economy each year (Gillespie et al. 2024). Beyond this, the direct production of honey, beeswax, queen bees and other hive products adds a further AU$1.01 billion in farmgate value (Clarke and Le Feuvre 2024).

The contribution of honey bee pollination extends beyond mere crop quantity. Effective pollination is a critical determinant of crop quality, directly improving fruit and vegetable development time, commercial grade and shelf life (Klatt, Holzschuh, et al. 2014; Ramos and Oliveira 2025; Kamper and Klein 2025). Research has demonstrated that bee-pollinated fruits are typically heavier, exhibit fewer malformations and are firmer, which translates to reduced post-harvest losses and higher market value (Klatt, Holzschuh, et al. 2014; Klatt, Klaus, et al. 2014). This vital—yet often underappreciated—aspect of pollination underpins the profitability and sustainability of a significant portion of Australia's food production system.

1.2 A new and formidable threat: The arrival of *Varroa destuctor*

For decades, the Australian beekeeping industry has operated with a unique global advantage: freedom from the world's most destructive honey bee pest, the ectoparasitic mite *Varroa destuctor*. This paradigm shifted in September 2023 when *Varroa* was officially declared established in New South Wales (Chapman et al. 2023; Australian Government 2023). *Varroa* represents an existential threat to honey bee health. The mite feeds on the fat bodies of both larval and adult bees—organs critical for immune function, pesticide detoxification and nutrient storage—thereby weakening individual bees and the colony as a whole (Traynor et al. 2020; Ramsey et al. 2019).

More perniciously, *Varroa* is a highly efficient vector for a suite of debilitating and lethal viruses, most notably deformed wing virus (DWV) (Traynor et al. 2020; Wilfert et al. 2016). In *Varroa*-infested regions globally, the mite's ability to transmit viruses directly into the bee's haemolymph transforms otherwise low-level viral infections into colony-killing epidemics, leading to widespread and catastrophic colony losses (Traynor et al. 2020; Ramsey et al. 2019). While the full impact of *Varroa* on Australian apiculture is yet to be realised, international experience and preliminary expert assessments suggest it will be severe, fundamentally altering beekeeping management practices and the economic landscape of the industry (Chapman et al. 2023; Holmes et al. 2024; Stahlmann-Brown et al. 2022).

1.3 Rationale for the inaugural National Colony Loss Survey

The arrival of *Varroa*, coupled with existing challenges such as other pests, diseases and climatic volatility, has created an urgent need for a comprehensive, data-driven understanding of the factors driving honey bee colony losses across Australia. A key objective of the National Strategy for managing *Varroa* is to foster a "honey bee industry composed of well-resourced, informed and successful beekeepers" (Chapman et al. 2023). Achieving this goal is impossible without robust, national-scale data.

The timing of this inaugural 2024 Australian Colony Loss Survey is therefore of national and global significance. Conducted in the immediate aftermath of *Varroa*'s establishment in a single state, it provides a rare and invaluable baseline dataset. The data from *Varroa*-free states captures the condition of the national apiary industry on the cusp of a continental-scale biological invasion, representing one of the last large-scale, pre-*Varroa* datasets in the world (Stahlmann-Brown et al. 2022; Chapman et al. 2023). Simultaneously, the data from NSW offers a real-time case study of the mite's initial biological and economic impacts. This report, therefore, is not merely a summary of losses; it is a foundational document designed to establish a benchmark against which future impacts can be measured, to identify immediate management priorities and to guide the strategic allocation of resources to ensure the long-term resilience of this vital Australian industry.

Methodology

2. Designing and implementing a national survey

2.1 Project objectives

The primary objectives of this project were to: Conduct the first national survey of honey bee colony losses in Australia for the 2023–24 production season; establish a robust, national baseline for annual and seasonal colony loss rates; quantify the initial impacts of *Varroa destuctor* on colony losses and management costs in the affected region of New South Wales; and identify the major perceived drivers of colony mortality across different states and beekeeping operation scales to inform industry strategy and future research priorities.

2.2 Survey design and questionnaire development

The 2024 Australian Colony Loss survey was designed to be the first of its kind in the country, covering the period from 1 September 2023 to 31 August 2024. This timeframe was specifically chosen to encompass the first full production season and winter following the declaration of *Varroa* establishment in NSW (Chapman et al. 2023).

The survey instrument was structurally adapted from the established New Zealand Colony Loss Survey, with the most recent iteration being the 2023 report (Stahlmann-Brown and Robertson 2024). To ensure international comparability, the questionnaire incorporated core questions from the globally standardised COLOSS (prevention of honey bee COlony LOSSes) survey framework (Zee et al. 2013). This foundation was supplemented with questions tailored to the unique apicultural context of Australia, accounting for its broad range of climatic and geographic conditions. To capture seasonal variations without creating an excessively long questionnaire, the survey period was divided into two distinct seasons: a 'warm' season (1 September 2023–31 March 2024) and a 'cool' season (1 April–31 August 2024), with respondents answering parallel sets of loss-related questions for each period.

A dedicated block of questions was developed to address *Varroa* management. This section used conditional logic (branching), so that it was only presented to respondents who indicated they operated in an area of NSW where *Varroa* was present during the survey period. This approach minimised the time burden on beekeepers in *Varroa*-free regions.

The questionnaire underwent a rigorous two-stage review process. In November 2024, an initial draft was sent to a panel of scientific and industry experts for review of its scientific merit and alignment with international standards. Following the incorporation of this feedback, a test version was provided to the Australian Honey Bee Industry Council (AHBIC) member body delegates in December 2024. This group served as a crucial test audience of commercial beekeepers, providing feedback on the clarity, relevance and user experience of the survey. The final questionnaire was submitted to the

Australian National University Human Research Ethics Committee, which granted full approval on 31 January 2025 (Protocol 2024/1189).

Table 1. Expert panel for survey review

Expert	Field	Institution
Keegan Blignaut	Beekeeper	Duxton Bees
Nadine Chapman	Researcher, beekeeper	NSW DPI
Michael Clarke	Researcher, beekeeper	AgEconPlus
Theotime Colin	Researcher	Macquarie University
Allan Cotton	Beekeeper	Capilano Honey
Danny Le Feuvre	Beekeeper	AHBIC
David Lyall	Beekeeper	Bee Innovative
Ben Oldroyd	Researcher, beekeeper	University of Sydney
Michael Palmer	Beekeeper	Tasmanian Pollination Services
Cornelia Sattler	Researcher	Macquarie University

2.3 Survey administration and data collection

The survey was delivered online using the Qualtrics platform. This platform was selected for its robust capabilities, particularly its support for complex survey logic (branching) and its function for automatically compiling and housing response data, which eliminates the need for manual data entry and reduces the potential for error.

The survey was open to the general beekeeping population from 3 February 2025 to 10 March 2025. It was subsequently reopened from 1–11 April 2025 to facilitate a targeted distribution to AgriFutures Australia levy-payers. Information regarding the specific date of contact for levy-payers and the precise number of additional responses received during this second period is pending and will be included in subsequent reports.

2.4 Communications and beekeeper engagement

A multi-channel communications and engagement strategy was implemented to maximise survey participation across all sectors of the beekeeping community. The primary approach focused on leveraging trusted industry and government sources to build credibility and encourage participation. Key channels included:

- **Industry engagement:** Electronic direct mail (EDM) campaigns and website articles were distributed by AHBIC and AgriFutures Australia. In addition, the AHBIC CEO conducted personal outreach to commercial beekeepers in multiple states via text message.
- **Government channels:** State government departments of primary industries promoted the survey through their established communication channels including EDMs and social media platforms.
- **Media activities:** A formal media release prepared by AgriFutures Australia was published on 10 February 2025, resulting in coverage in mainstream agricultural outlets. Explanatory articles authored by the research team were also published on specialist platforms such as the ExtensionAUS Professional Beekeepers website and in the *ANU Reporter*.
- **Social media:** A coordinated social media campaign was executed across the platforms of all project stakeholders (ANU, AHBIC, AgriFutures Australia and state governments), supported

by promotional materials created by the ANU media team and the NSW DPIRD Varroa T2M Public Information team. A dedicated Facebook page for the survey was also established to engage directly with the beekeeping community.

2.5 Statistical analysis

To ensure statistical robustness, all analyses of colony loss percentages were conducted using bootstrapping techniques. This method was used to calculate the mean percentage loss and to generate 95% confidence intervals for all reported loss rates. Bootstrapping is particularly well-suited for survey data of this nature as it does not rely on assumptions of normal distribution and provides a more accurate representation of the confidence in the estimates, especially when dealing with variable sample sizes states, seasons and beekeeper categories.

Results

3. National beekeeper demographics and overall colony losses

3.1 Profile of survey respondents

A total of 1,063 beekeepers commenced the survey, yielding 997 complete and usable responses for analysis. Of these respondents, 163 (16%) were classified as commercial beekeepers (managing 50 or more hives), while the remaining 834 (84%) were classified as amateur or small-scale beekeepers. Collectively, the survey participants managed a total of 121,802 colonies across Australia. The commercial beekeepers in the sample accounted for 116,837 of these colonies, representing 96% of the total hive count reported in the survey. The distribution of respondents and the number of colonies they managed across states and territories are detailed in Table 2.

Table 2. Number of commercial and amateur beekeepers and colonies by state colony numbers are averaged across the warm and cool seasons.

Location	< 50 colonies (Amateur)	< 50 colonies (Amateur)	≥ 50 colonies (Commercial)	≥ 50 colonies (Commercial)	Total	Total
	Respondents	Colonies	Respondents	Colonies	Respondents	Colonies
ACT	9	110	0	0	9	110
NSW	307	1,942	59	47,029	366	48,971
NT	1	42	0	0	1	42
Qld	64	540	25	11,505	89	12,045
SA	105	418	21	13,165	126	13,585
Tas	82	421	9	9,219	91	9,640
Vic	254	1,388	26	25,593	280	26,980
WA	12	104	23	10,324	35	10,428
Total	**834**	**4,965**	**163**	**116,837**	**997**	**121,802**

3.2 Representativeness of the survey sample

The demographic profile of the survey respondents shows a significant over-representation of commercial beekeepers. While this group constituted 16% of the survey sample, national industry data indicates that commercial operators make up approximately 6% of all registered beekeepers in Australia (Clarke and Le Feuvre 2021). This statistical bias, however, can be interpreted as a methodological strength. The high level of engagement from this key group, which manages the vast majority of the nation's hives and provides critical pollination services, indicates that the survey was perceived as highly relevant and trustworthy. Consequently, the findings related to commercial operations—including loss rates, economic costs and treatment experiences—are based on a robust and highly engaged sample, lending significant weight to their validity and applicability to the economic core of the industry.

The geographic distribution of respondents also aligns with known industry demographics. The majority of beekeepers who responded (65%) operated in NSW and Victoria, and these respondents managed 62% of all colonies reported in the survey. This concentration is consistent with previous data on the structure of the Australian beekeeping industry (Clarke and Le Feuvre 2021).

3.3 National and seasonal colony loss rates

The headline finding from the 2024 survey is a national overall colony loss rate of 1.55% for the 2023–24 production season. This figure represents the first national benchmark for honey bee colony mortality in Australia. When disaggregated by season, the analysis revealed a slightly higher loss rate during the warm season (1.65%) compared to the cool season (1.44%). The bootstrapped estimates and their corresponding 95% confidence intervals are presented in Table 3, providing a statistically robust measure of these national loss rates.

Table 3. Bootstrapped percent colony loss in each season across Australia Includes upper and lower 95% confidence intervals.

Season	Percent loss	Lower CI	Upper CI
Cool	1.44	1.23	1.66
Warm	1.65	1.43	1.86
Overall	**1.55**	**1.39**	**1.70**

4. State-by-state analysis of colony loss drivers

4.1 Overview of attributed causes

Respondents were asked to attribute their colony losses to a predefined list of potential causes. Across all states, and for both commercial and amateur beekeepers, the percentage of losses attributed to any single cause was generally low, typically less than 1% of the total managed hives. A consistent trend observed was that amateur beekeepers experienced higher proportional colony losses across most categories compared to their commercial counterparts, which is likely a function of the smaller number of hives under their management, where the loss of a single colony represents a larger percentage of their total operation. The attributed causes of loss for commercial and amateur beekeepers are detailed in Table 4 and Table 5, respectively. Due to low respondent numbers, data for the Australian Capital Territory and the Northern Territory are excluded from this detailed analysis.

4.2 Primary causes of loss in commercial operations

For commercial beekeepers, the most significant drivers of colony loss varied by state and season, though common themes emerged (Table 4). 'Suspected starvation' and 'Other reasons not listed above' were consistently reported as the top two causes of loss across multiple states. For example, in NSW, suspected starvation was the leading cause of cool season loss (2.55%), while 'Other reasons' was the leading cause in the warm season (3.89%). A similar pattern was observed in Victoria and Western Australia. In Tasmania, 'Other reasons not listed above' was by far the most significant cause of loss in the cool season, accounting for 8.81% of losses.

Table 4. Bootstrapped percentage colony losses by cause for commercial beekeepers. The highest identified cause of colony loss in each state is highlighted in bold text. Upper and lower 95% confidence intervals are provided. ACT and NT are excluded due to low sample sizes.

Location	Reason	Cool mean	Cool lower	Cool upper	Warm mean	Warm lower	Warm upper
NSW	**Suspected starvation**	**2.55**	**0.58**	**5.04**	2.68	0.74	4.89
NSW	Other reasons not listed	1.61	0.81	2.55	**3.89**	**2.33**	**5.22**
Qld	**Other reasons not listed**	**4.83**	**1.48**	**6.53**	**5.13**	**1.71**	**7.36**
Qld	Suspected starvation	3.11	0.07	7.58	0.29	0.05	0.73
SA	**Other reasons not listed**	**2.61**	**1.38**	**3.96**	**1.56**	**0.72**	**2.63**
SA	Reasons that you are unsure	1.64	0.09	3.37	1.25	0.10	3.47
TAS	**Other reasons not listed**	**8.81**	**0.86**	**16.80**	**2.02**	**0.89**	**3.13**
TAS	Suspected starvation	1.06	0.17	2.80	0.96	0.34	1.90
Vic	**Other reasons not listed**	**3.07**	**1.04**	**5.44**	**4.79**	**1.63**	**8.16**
Vic	Suspected starvation	2.31	0.62	3.99	1.65	0.23	3.42
WA	**Suspected starvation**	**3.32**	**1.07**	**6.66**	0.86	0.03	2.29
WA	Other reasons not listed	2.81	1.00	4.66	**3.19**	**1.68**	**5.37**

4.3 Primary causes of loss in amateur operations

Among amateur beekeepers, the drivers of colony loss showed some notable differences from commercial operations (Table 5). In NSW, 'Suspected *Varroa* and related issues' was a dominant

factor, recorded as the highest cause of loss in the cool season (5.60%) and the second highest in the warm season (7.46%). 'Small hive beetle' was also a major issue for NSW amateurs, particularly in the warm season (8.15%). In most other states, 'Suspected starvation' was a primary concern, especially during the cool season in Victoria (3.88%), Tasmania (2.80%) and Western Australia (32.76%, though this figure is associated with a very wide confidence interval, suggesting high variability in a small sample).

Table 5. Bootstrapped percentage colony losses by cause for amateur beekeepers. The highest identified cause of colony loss in each state is highlighted in bold text. Upper and lower 95% confidence intervals are provided. ACT and NT are excluded due to low sample sizes.

Location	Reason	Cool mean	Cool lower	Cool upper	Warm mean	Warm lower	Warm upper
NSW	**Suspected *Varroa* and related issues**	**5.60**	**3.64**	**7.85**	7.46	5.17	11.09
NSW	Small hive beetle	4.49	1.58	8.72	**8.15**	**5.93**	**11.40**
QLD	Reasons that you are unsure	1.27	0.00	4.00	0.17	0.00	0.46
QLD	Other reasons not listed	0.52	0.00	1.16	**1.39**	**0.21**	**2.24**
SA	**Other reasons not listed**	**3.83**	**1.09**	**6.78**	3.23	1.17	5.23
SA	Suspected starvation	2.23	0.91	3.47	**3.28**	**0.96**	**6.04**
TAS	Suspected starvation	2.80	1.59	4.24	2.62	1.00	4.85
TAS	Other reasons not listed	1.10	0.24	2.23	0.52	0.00	1.39
VIC	**Suspected starvation**	**3.88**	**2.59**	**5.32**	**1.61**	**0.94**	**2.71**
VIC	Other reasons not listed	0.89	0.17	1.92	1.06	0.57	1.60
WA	**Suspected starvation**	**32.76**	**1.67**	**68.09**	1.90	0.00	5.54
WA	Other reasons not listed	1.06	0.00	2.78	**11.73**	**0.00**	**28.47**

4.4 The critical knowledge gap: Unspecified losses

A crucial finding emerged not from the answers given, but from the limitations of the questions asked. Across multiple states and for both beekeeper types, 'Reasons that you are unsure' and 'Other reasons not listed above' were two of the most frequently selected causes for colony losses. This points to a significant knowledge gap in the industry's ability to diagnose colony mortality.

The design of the survey questionnaire itself provides a likely explanation for this ambiguity. The list of selectable causes of death did not include 'queen problems' (e.g., queen failure, drone-laying queen, poor performance) as a distinct option. This is a notable omission as international colony loss surveys, such as the New Zealand survey on which this one was partly based, consistently identify queen problems as a major driver of losses, often second only to *Varroa* (Stahlmann-Brown and Robertson 2024; Stahlmann-Brown et al. 2022). It is highly probable that a substantial portion of the losses categorised as 'Unsure' or 'Other' in this survey were, in fact, attributable to issues with the queen. This is not merely a methodological artifact; it is a significant finding that suggests a fundamental aspect of colony health and productivity may be under-recognised as a primary cause of loss in the Australian context.

5. A Focused analysis of *Varroa destuctor* in New South Wales

5.1 Direct contribution to colony losses

As *Varroa destuctor* was largely confined to NSW during the 2023–24 production season, the data from this state provides the first quantitative measure of *Varroa*'s impact on Australian beekeeping. The results are unambiguous: *Varroa* is already a major driver of colony mortality. For commercial beekeepers in NSW, 'Suspected *Varroa* and related issues' was the second-highest cause of colony loss in both the warm season (1.35%) and the cool season (0.82%). For amateur beekeepers, the impact was even more pronounced. *Varroa* was the second-highest cause of warm-season losses (7.46%) and the single highest cause of cool-season losses, accounting for 5.60% of colony deaths.

5.2 The economic burden of management

The arrival of *Varroa* has imposed significant new financial and labour costs on beekeepers. NSW respondents who were managing *Varroa* reported an average financial cost of AU$21.00 per colony and an average time cost of 23.5 minutes per colony for *Varroa* treatment and monitoring over the season.

Table 6. Costs of managing *Varroa* in NSW in 2023–24

Cost type	Cost
Time cost per hive (minutes)	$23.50
Financial cost per hive (AU $)	$21.00

To contextualise these figures, a commercial operator with 1,000 hives under their care can expect to spend an additional $21,000 in direct costs and 392 hours of labour—equivalent to 49 eight-hour workdays—on managing *Varroa* in their business each year. This represents a substantial new operational burden that directly affects profitability and business viability.

5.3 Indirect and systemic impacts

Beyond the direct costs of treatment and colony death, *Varroa* has had several indirect impacts on beekeeping businesses in NSW. The survey found 10.5% of beekeepers reported a loss of income due to colony movement restrictions imposed as part of the biosecurity response. A further 9.5% indicated they had been affected by new research, training and compliance costs, while another 9.5% were impacted by queen shortages, a likely consequence of increased colony losses and restrictions on queen movement. An additional 10.5% of beekeepers reported being affected by other impacts not specified in the survey options, underscoring the wide-ranging disruption caused by the incursion.

5.4 Potential pest interaction: *Varroa* and small hive beetle (SHB)

The analysis of loss drivers within NSW revealed a novel and concerning trend. In the warm season, losses attributed to small hive beetle (SHB) were notably higher in areas where *Varroa* was present compared to *Varroa*-free areas. This pattern was observed for both commercial and amateur beekeepers. This correlation suggests a potential synergistic interaction between the two pests. The potential causal mechanism is that *Varroa* infestation weakens a colony's population and overall health, thereby compromising its ability to defend against SHB infestation. A healthy, populous colony is the primary defence against SHB; when weakened by *Varroa*, a colony may succumb to an SHB challenge that it would have otherwise survived.

Further research is required before any causal link between losses attributed to *Varroa* and SHB can be confirmed. However, this preliminary finding serves as a critical early warning that the impact of *Varroa* may not be simply additive but could be multiplicative when combined with existing endemic stressors. This factor should be considered in management strategies for regions with high SHB pressure, such as Queensland and coastal NSW.

Additionally, the fact that the survey data has revealed a potential interaction between these two pests emphasises the value of an annual colony loss survey to the Australian honey bee industry. Whether this effect continues to be apparent will be a major point of interest in the 2025 survey and beyond.

5.5 Impact on feral honey bee population

To garner an indication of whether *Varroa* has begun to affect feral honey bee populations, we asked NSW respondents whether they had personally observed a difference in the number of feral colonies in the areas in which they operate in the 2023–24 production season compared with previous seasons. Results were inconclusive; 54% of respondents indicated they were 'Unsure' whether there was any difference. 23% of respondents indicated they felt the number of feral colonies was similar to prior seasons, whereas 21% indicated the number of feral colonies had decreased and 3% that the number had increased.

6. Beekeeper experiences with *Varroa* treatments

6.1 Treatment landscape and beekeeper usage

An essential aspect of adapting to *Varroa* is understanding the efficacy and potential drawbacks of available treatments within the Australian context. The survey asked beekeepers managing *Varroa* in NSW to report on the treatments they used, their perceived success and any adverse effects observed. A wide range of treatments were reportedly used, though adoption rates varied dramatically. For example, 308 beekeepers reported using Bayvarol, while only two reported using thymol vaporisation. This wide variation in sample size means the results for treatments with a low number of users should be interpreted with considerable caution.

6.2 Efficacy vs. adverse effects

Beekeepers rated treatment success on a four-point scale (1 = Not at all effective, 4 = Completely effective) and reported the presence of any adverse effects (e.g., queen death, loss of workers or brood). The data, summarised in Table 7, allows for a comparative analysis of treatment performance.

Table 7. Average treatment success rating and incidence of adverse effects. *Active ingredients are given in parentheses. Three treatments with average success ratings >3 and adverse effect incidence <50% are highlighted in black.*

Treatment	No. of beekeepers reporting on success	Average success level (1–4)	No. of beekeepers reporting adverse effects	Incidence of adverse effects (%)
Api-Bioxal (oxalic acid)	**12**	**3.67**	**4**	**25.0**
Apiguard (thymol)	58	1.83	20	50.0
Apivar (amitraz)	**62**	**3.23**	**28**	**25.0**
Apistan (tau-fluvalinate)	22	2.91	7	71.4
Apitraz (amitraz)	18	1.67	7	57.1
Bayvarol (flumethrin)	**308**	**3.32**	**126**	**35.7**
Did not treat	36	0.56	24	75.0
Drone uncapping	90	1.24	44	20.5
Formic acid – vapourisation	14	2.86	4	50.0
FormicPro (formic acid)	214	2.14	64	87.5
Other treatment (not listed)	38	2.53	22	36.4
Oxalic acid – dribbling	14	2.43	4	50.0
Oxalic acid - strips	144	2.58	47	40.4
Plant essential oils	6	2.33	0	0.0
Queen caging (forced brood break)	18	1.67	10	50.0
Thymol – vapourisation	2	2.00	1	100.0

6.3 Identifying the 'best' current options

Based on the criteria of high success (average rating >3.0) and low incidence of adverse effects (<50%), three treatments emerged as the most effective options currently available to Australian beekeepers: Bayvarol (flumethrin), Apivar (amitraz) and Api-Bioxal (oxalic acid).

6.4 Analysis by chemical class

The survey results reveal distinct patterns when treatments are grouped by their chemical class:

- **Synthetic chemicals:** Bayvarol (a synthetic pyrethroid) and Apivar (a formamidine) demonstrated high success ratings combined with a relatively low incidence of adverse effects. This efficacy reflects their action on a *Varroa* population that has not yet been subjected to long-term selection pressure. However, this period of high effectiveness is likely to be temporary. Global experience shows unequivocally that *Varroa* populations rapidly develop resistance to these chemical classes when they are used repeatedly without rotation (Jack and Ellis 2021; Rosenkranz, Aumeier and Ziegelmann 2010). The high success rates reported here must be viewed as a fragile baseline that will inevitably decline without proactive resistance management.

- **Organic chemicals:** Treatments based on organic acids and essential oils, such as FormicPro (formic acid) and Apiguard (thymol), generally had lower success ratings and were associated with a very high incidence of adverse effects. FormicPro, for instance, was linked to adverse effects in 87.5% of reported applications. These effects often include damage to brood or the loss of the queen, which can set a colony back significantly.
- **Non-chemical methods:** Cultural and mechanical controls like drone brood uncapping were perceived by beekeepers as having low success in reducing *Varroa* populations.

This data highlights a critical challenge for the Australian industry. The current reliance on highly effective synthetic miticides represents a 'honeymoon phase'. Without the immediate and widespread adoption of an integrated pest management (IPM) framework that emphasises strategic rotation of chemical classes and the integration of non-chemical controls, Australia is on a predictable path toward the same intractable resistance problems that have plagued beekeeping industries worldwide (Jack and Ellis 2021; Rosenkranz, Aumeier and Ziegelmann 2010).

Discussion

The findings of the 2024 National Colony Loss Survey present a stark dichotomy. On one hand, the national loss rate of 1.55% is remarkably low by international standards and paints a picture of a relatively stable and healthy national apiary.

7. A tale of two industries: The *Varroa* divide

The findings of the 2024 National Colony Loss Survey present a stark dichotomy. On one hand, the national loss rate of 1.55% is remarkably low by international standards and paints a picture of a relatively stable and healthy national apiary. This figure, however, is a fragile baseline, representing a reality that is rapidly receding for a growing portion of the industry. On the other hand, the data from New South Wales provides a clear, data-driven forecast of the severe biological and economic challenges that will almost certainly confront the rest of the country as *Varroa* inevitably spreads. The elevated losses directly attributed to *Varroa* in NSW, combined with the significant financial and labour costs of management, illustrate the paradigm shift that is underway. This report captures the Australian beekeeping industry at a critical inflection point, documenting both the 'before' and the initial 'after' of this continental-scale biological invasion.

7.1 The true cost of *Varroa*

The quantified economic impact—an average of $21.00 per hive in direct management costs—should be considered a conservative baseline. This figure does not capture the full spectrum of economic disruption. It excludes the indirect costs of replacing queens in failed or weakened colonies, the increased need for supplemental feeding to support colonies under parasitic stress and the reduced productivity in terms of lower honey yields and potentially less-effective pollination services from smaller, weaker hives. Furthermore, the 392 additional hours of labour for a 1,000-hive operation represents a significant opportunity cost, diverting time and resources from other value-adding activities such as honey production, queen rearing or business expansion. The true economic burden of *Varroa* is a systemic one that will impact every facet of a beekeeping operation's profitability.

7.2 Implications for national biosecurity and industry sustainability

The survey's findings on treatment efficacy carry profound implications for the long-term sustainability of the industry. The current high effectiveness of synthetic miticides like Bayvarol and Apivar will not last without a concerted national effort to manage the evolution of acaricide resistance. The principles of integrated pest management (IPM)—monitoring mite levels, establishing

treatment thresholds and rotating chemical modes of action—are not merely ‘best practice’, but an urgent biosecurity imperative (Jack and Ellis 2021; Rosenkranz, Aumeier and Ziegelmann 2010). Failure to broadly adopt an IPM approach will lead to the rapid loss of our most effective chemical tools, leaving the industry in a far more vulnerable position.

Furthermore, the spread of *Varroa* will have significant ecological consequences. *Varroa* is expected to cause the collapse of Australia’s large feral honey bee population (Australian Government 2023; Holmes et al. 2024). While these feral colonies act as an unmanaged reservoir for *Varroa*, they also provide billions of dollars in ‘free’ pollination services to agriculture and play a complex role in the pollination of native flora (Stahlmann-Brown et al. 2022). The decline of this population will place a greater burden on managed beekeepers to meet pollination demands and could have unpredictable ripple effects throughout Australian ecosystems.

Based on our results, it is too early to tell if this collapse has begun in NSW. Twenty-one per cent of NSW respondents indicated they observed a decrease in the feral population, which was similar to the percentage that indicated they had not observed a change (23%). The majority of respondents (54%) were unsure. As it will take time for a decline in the feral population to become noticeable, it will be interesting to see if a greater number of beekeepers report declines of feral colonies in future surveys.

7.3 Knowledge gaps and future research priorities

This inaugural survey has been as valuable for the questions it raises as the answers it provides. Two critical knowledge gaps have been identified that demand immediate attention. First, the high incidence of unspecified colony losses, likely masking the true impact of queen-related problems, highlights a fundamental blind spot. Understanding the role of queen health, genetics and performance as a primary driver of colony viability is a top priority. Second, the data suggesting a synergistic interaction between *Varroa destuctor* and small hive beetle is a novel and alarming finding. If *Varroa*-weakened colonies are indeed more susceptible to collapse from SHB, the combined impact in warm, humid regions could be far greater than the sum of their individual effects. These two areas represent urgent priorities for targeted research to equip the industry with the knowledge it needs to manage these complex, interacting threats.

Recommendations

8. For a resilient national beekeeping industry

Based on the findings of the 2024 Australian National Colony Loss Survey, the following recommendations are proposed to enhance the resilience, profitability and sustainability of the industry as it adapts to managing *Varroa destuctor*.

8.1 For beekeepers (commercial and amateur)

- **Implement rigorous monitoring:** Adopt regular *Varroa* monitoring (e.g., alcohol wash, soapy water wash) as a standard and non-negotiable component of hive management. Treatment decisions should be based on established economic thresholds, not on a fixed calendar schedule, to ensure that treatments are applied only when necessary.

- **Adopt integrated pest management (IPM):** Proactively manage the threat of acaricide resistance by implementing an IPM strategy. This must include the strategic rotation of chemical treatments with different modes of action (e.g., alternating a synthetic pyrethroid with an organic acid or amitraz-based product) between seasons to slow the selection for resistant mites.

- **Enhance record-keeping:** Improve apiary records to more accurately diagnose causes of colony loss. Specifically, beekeepers should track queen age, performance (e.g., brood pattern) and supersedure events to better understand the contribution of queen health to overall colony mortality.

8.2 For industry bodies (AHBIC, state associations)

- **Develop and disseminate best management practices (BMPs):** Lead the development of state-specific BMPs for *Varroa* management that account for regional differences in climate, floral resources and the prevalence of other stressors like small hive beetle.

- **Launch targeted extension and education campaigns:** Use the findings of this report to create and deliver educational materials focused on key management priorities. For example, the ANU media team assisted in the production of infographics designed to convey the key results of the survey in a form that can be easily interpreted by target audiences (see Appendix II). These infographics can be readily modified and updated as new survey data becomes available. Campaigns should emphasise the critical importance of treatment rotation, the high risk of adverse effects associated with some organic treatments (particularly FormicPro) and the necessity of monitoring before and after treatment to verify efficacy.

- **Advocate for survey continuation and refinement:** Formally recommend to the survey administrators and funding bodies that future iterations of the National Colony Loss Survey include ‘queen problems’ as a specific, selectable category for the cause of colony loss to close this critical knowledge gap.

- **Advocate for survey continuation and refinement:** Improve survey based on feedback. Critically, the colony loss survey increases in value over time, monitoring changes as they occur. This is particularly true in Australia, most of which has not yet been affected by *Varroa*. Addressing mechanisms for continued survey delivery will be essential to capture these dynamics and to generate value from the current work.

8.3 For researchers and funding bodies (AgriFutures Australia)

- **Prioritise research on queen health:** Direct funding toward research investigating the role of queen bee health, genetics and performance as a primary driver of colony loss in the Australian context. This should include assessing the impact of various stressors on queen viability.

- **Fund research into pest synergies:** Support targeted research to validate and quantify the suspected synergistic interaction between *Varroa destuctor* and small hive beetle. This research is critical for developing integrated management strategies in regions where both pests are prevalent.

- **Establish longitudinal monitoring of acaricide resistance:** Fund and support the establishment of a long-term monitoring program to track the efficacy of registered miticides over time. This program will serve as an early warning system for the emergence of resistance in Australian *Varroa* populations, allowing the industry to adapt its management recommendations proactively.

Appendices

Appendix I: 2024 Australian Colony Loss Survey questionnaire

The full text of the survey questionnaire is provided below for methodological transparency.

Consent

Welcome to the 2024 Australian Colony Loss Survey! Thank you for participating in the 2024 Australian Colony Loss Survey (COLOSS). The Australian Colony Loss Survey will provide vital information regarding the impacts of *Varroa*, what treatments are working and what it is costing the average beekeeper to manage. Your participation is crucial to our understanding of the most important issues affecting Australian beekeepers and will inform policies to ensure the future of the Australian beekeeping industry. This survey is for every beekeeping operation, large or small. Whether you lost 0% or 100% of your hives, please complete the survey. The project is funded by the Commonwealth Department of Agriculture, Fisheries and Forestry National *Varroa* Transition to Management Program and is managed by AgriFutures Australia. It is being undertaken by a consortium of researchers and Australian Honey Bee Industry representatives. Your participation makes it possible to identify trends in Australian beekeeping and to understand better the impact *Varroa* is having. Bringing together the experience of beekeepers, this survey will also show what countermeasures are working across Australia.

Before you begin, here are a few important notes related to your privacy: * Your participation is voluntary and you can stop the survey at any time. * Following Australian law, neither the researchers nor AgriFutures will share your data with anyone else. * The data you enter are anonymous. * If you choose to provide contact details, which is optional, we will use your them for future surveys, which will allow us to track changes over time across Australia. You will be able to opt-out and have your contact details deleted at any time. Your contact details will not be associated with your responses for the purposes of data analysis or reporting.

A few notes about how the survey works: * This 2024 Australian Colony Loss Survey takes about 7 minutes for small operators and ~15 minutes for commercial beekeepers. * The questions are easy to answer but may require you to look up some of your records. * We recommend using a computer, but the survey also works on mobile devices (for best results, we suggest turning your phone sideways). * We thank you for your patience and appreciate your contribution to making this project possible.

The ethical aspects of this research have been approved by the ANU Human Research Ethics Committee (Protocol 2024/1189). Click YES to begin the survey, then NEXT (scroll down if needed) to continue. * YES, take me to the survey * NO, I don’t want to do the survey this year

Number of colonies

Did you have any bee colonies under your management at any one time between 1 September 2023 and 31 August 2024? A ‘colony’ is a queenright unit of bees, including queenright nucs, splits and successfully captured swarms and feral colonies. Do not include mating nucs. * yes * no

0 colonies

Thanks for participating in this survey! It is designed to record the experiences of beekeepers who actively managed colonies between 1 September 2023 and 31 August 2024. Since you didn’t manage any colonies during this time, your survey will be quite short.

Why did you have no colonies between 1 September 2023 and 31 August 2024 (inclusive)? Please select the best answer from the list below. * I am a new beekeeper. * I am an experienced beekeeper. I didn't have colonies over the last year, but I plan to return to beekeeping in the future. * I am an experienced beekeeper. I didn't have colonies over the last year, and I am not currently planning to return to beekeeping in the future. * I am an experienced beekeeper. All of my hives were euthanised during the *Varroa* incursion response, and I have not yet been able to replace them. * Other (please describe)

Location

The 2024 Australian Colony Loss Survey begins with questions about the 2023/24 production season (i.e., between 1 September 2023 and 31 March 2024), especially colony losses and *Varroa*. Most questions cover the entire period, but some focus on seasons. They are defined as: warm season/summer (1 September 2023 - 31 March 2024) and cool season/winter (1 April - 31 August 2024).

In which region(s) were your apiary sites located during the 2023/24 production season? Select all that apply. * ACT * New South Wales * Northern Territory * Queensland * South Australia * Tasmania * Victoria * Western Australia

What methods did you use to monitor your colonies for *Varroa*? Select all that apply. * Alcohol wash * Soapy water wash * Sticky board (or other collection tray below the hive) * Sugar shake / roll * Visual inspection of adult bees * Visual inspection of drone brood / uncapping brood * Sent sample to a lab * Other (please describe) * None of the above

Were you affected by the *Varroa* epidemic? Check all that apply. * Queen shortages * Loss of income due to colony movement restrictions * Research, training and compliance costs (not counting surveillance costs) * Other

Varroa

Were you in the New South Wales red zone before *Varroa* eradication was stopped in September 2023? * Yes * No

Did you see any issues with deformed wings or other developmental abnormalities in any of your colonies in New South Wales? * None * Limited * Extensive * Unsure

Did you see any issues with spotty brood patterns in any of your colonies in New South Wales? * None * Limited * Extensive * Unsure

What methods did you use to treat *Varroa*. Tick all that apply * Did not treat * Api-Bioxal® * Apiguard® * Apistan® * Apivar® * Apitraz® * Bayvarol® * FormicPro® * Queen caging (forced brood break) * Formic acid - vapourisation * Thymol - vapourisation * Oxalic acid - strips * Oxalic acid - dribbling * Plant essential oils eg. oregano oil, eucalyptus oil, etc. * Drone uncapping * Other treatment

Warm season colony losses

The questions below will focus on warm season losses (1 September 2023 – 31 March 2024). Enter whole numbers only.

How many colonies did you have in [state where respondent kept bees] during the warm season?

How many of the colonies that were dead upon inspection at the end of the warm season for each of the following reasons? * Foulbrood (EFB or AFB) * Robbing by other bees * Suspected starvation * Suspected *Varroa* and related issues * Suspected nosema and other diseases * Small hive beetle * Other reasons not listed above * Reasons that you are unsure

Cool season colony losses

The questions below will focus on cool season losses (1 April 2024 – 31 August 2024). Enter whole numbers only.

How many colonies did you have in [state where respondent kept bees] during the cool season?

How many of the colonies that were dead upon inspection at the end of the cool season for each of the following reasons? * Foulbrood (EFB or AFB) * Robbing by other bees * Suspected starvation * Suspected *Varroa* and related issues * Suspected nosema and other diseases * Small hive beetle * Other reasons not listed above * Reasons that you are unsure

Demographics

This part of the survey focuses on who you are as a beekeeper.

Approximately how many years of beekeeping experience do you have?

Which of the following best describes your role in this beekeeping operation? * Owner * Paid employee * Unpaid helper * Other (please describe)

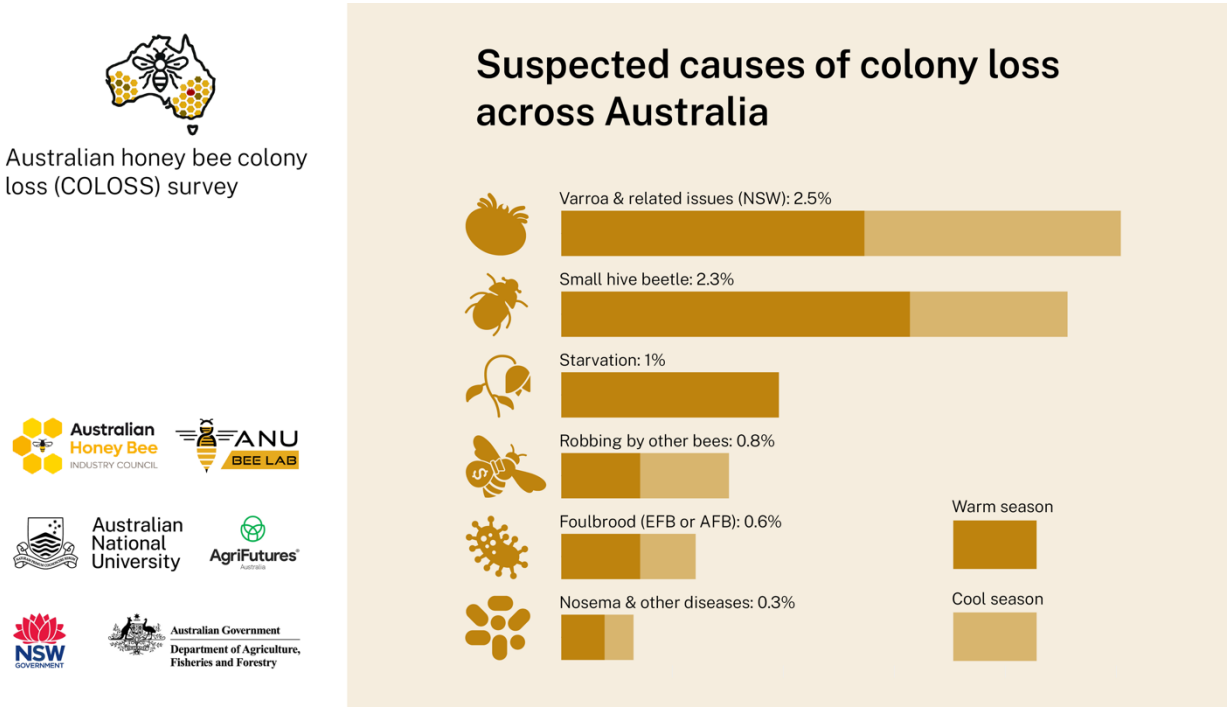
Qualitative

Would you like to provide your contact details so that we can send you the results of this survey and get in touch with you about future surveys? Your contact information will NOT be linked to your responses, which will be kept anonymous.

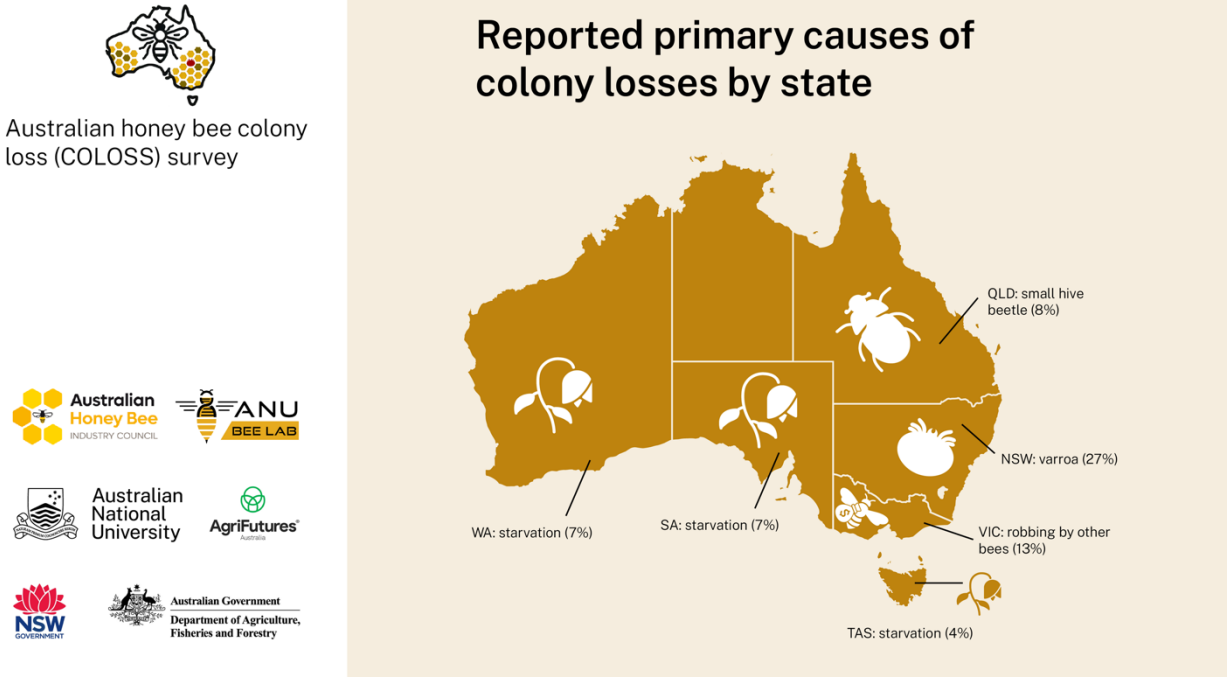
Appendix II: Infographics based on survey data

Infographics created by ANU media team to help communicate key findings to target audiences.

Infographic 1. Suspected causes of colony loss across Australia.

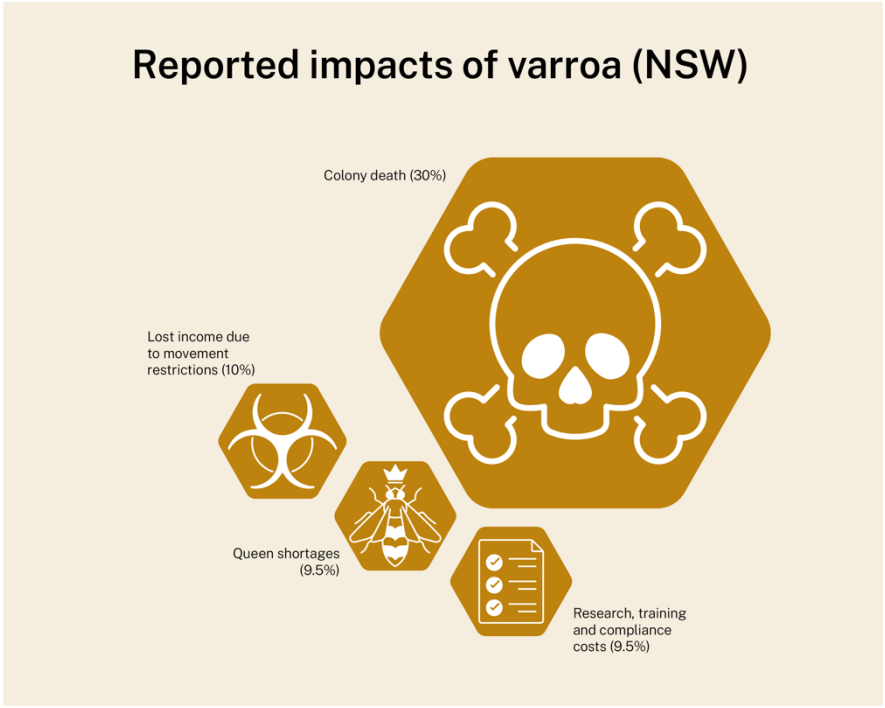


Infographic 2. Reported primary causes of colony losses by state.



Infographic 3: Reported impacts of *Varroa* (NSW).

Australian honey bee colony loss (COLOSS) survey



Infographic 4: Treating *Varroa*: what's working.

Australian honey bee colony loss (COLOSS) survey

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