Canadian Association of Professional Apiculturists
Statement on Honey Bee Wintering Losses in Canada (2022)

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Summary

The Canadian Association of Professional Apiculturists (CAPA) and Provincial Apiarists coordinated the annual honey bee wintering loss report for 2021-2022. As in previous years, the survey consisted of harmonized questions based on the national beekeeping industry, with Provincial Apiarists collecting survey data across all provinces. Respondents collectively operated 480 983 honey bee colonies across Canada, representing 59% of all colonies wintered during 2021-2022. The national winter loss, including non-viable bee colonies, was 45.5% with provincial losses ranging from 15.3% to 57.2%. The national colony loss reported in 2022 is almost twice the average of annual losses reported between 2007-2021 (25.8%). Despite these losses, Statistics Canada reports that the total national colony count increased by 37.5% from 2007 to 2021, through the hard work and expense of beekeepers replacing dead or weak colonies. Nevertheless, projected registered numbers of hives in 2022 will be difficult to determine, based on the high losses incurred last winter.

Each province ranked the top four suspected causes of colony losses as reported by respondents. In previous years, these have varied among provinces, however this year the reported causes were far more consistent. In 2021-22, the most frequently cited causes of colony losses were: ineffective varroa control, poor queens and weak colonies in the fall.

Beekeepers also responded to questions about the management of four serious parasites and pathogens to beekeeping: *Varroa destructor*, *Nosema* spp., American Foulbrood (*Paenibacillus larvae)* and European Foulbrood *(Melissococcus plutonius)*. Beekeepers in most provinces reported that they monitored for varroa mites, however a proportion of beekeepers in some provinces neglected to do so. The most commonly reported varroa treatments were: Apivar®, formic or oxalic acid treatments in the spring; Apivar® or formic acid in the summer/fall; and oxalic acid in late fall. Canadian beekeepers treated their colonies to manage the risk of nosemosis, as well as American foulbrood and European foulbrood. Across the country, registered antibiotics were the commonly used treatments, with methods and timing of applications varying among provinces.

Provincial Apiarists, technology-transfer personnel, and researchers have been working with beekeepers across Canada to encourage them to monitor for honey bee pests, especially varroa mites, brood diseases, and nosema, and to adopt recommended integrated pest management practices to keep these pests under control. CAPA members continue to collaborate through working groups encompassing diverse stakeholders to educate and to develop and improve management options for beekeepers to keep healthy bees and manage winter losses in Canada.

Disclaimer and Credits: Survey data were supplied by Provincial Apiarists (listed in Appendix A). Data were then compiled, further analyzed and an initial draft of this report written by Julie Ferland, Geoff Wilson and Medhat Nasr, with subsequent review by the CAPA National Survey Committee.

Introduction

For over a decade, many countries, including Canada, have surveyed beekeepers and reported overwintering mortality rates of honey bee colonies and management practices used for varroa mites, nosema, American foulbrood and more recently, European foulbrood. The Canadian Association of Professional Apiculturists (CAPA) has worked with the Provincial Apiarists on surveying beekeepers for winter losses of honey bee colonies and possible causes of bee mortality in Canada since 2007. The objective of this national report is to consolidate provincial honey bee data across the country based on information collected through harmonized survey questions. The possible causes of winter loss, as reported by beekeepers, and information on pest surveillance and control are collated herein. The survey responses aid in identifying gaps in current management systems, developing strategies to mitigate colony losses, and also provide guidance for improving bee health, biosecurity practices, and industry sustainability.

Methodology

In 2022, the Provincial Apiarists and the CAPA National Survey Committee members reviewed the questions used in the 2021 survey and made necessary revisions. Examples of these revisions include new treatments or strategies for beekeepers to manage pests and diseases as they are developed over the years. The result was an updated harmonized set of questions that was used in the 2022 survey (Appendix B). These questions took into account the large diversity of beekeeping industry profiles, management practices and seasonal activities within each province. Some provinces also included supplementary regional questions in their provincial questionnaire. The results of these regional questions are not included in this report but are discussed in the text. Further questions about results from a specific province may be accessed by contacting the Provincial Apiarist of the province in question (Appendix A).

Beekeepers that owned and operated a specified minimum number of colonies (Table 1) were included in the survey. The survey reported data from full-sized producing honey bee colonies that were wintered in Canada, but not nucleus (partial) colonies. Thus, the information gathered provides a valid assessment of honey bee losses and commercial management practices.

The common definitions of a honey bee colony and a commercially viable honey bee colony in spring were standardized as follows:

- Honey Bee Colony: A full-sized honey bee colony either in a single or double brood chamber, not including nucleus colonies (splits).
- Viable Honey Bee Colony in Spring: A honey bee colony that survived winter, with a minimum of 4 frames with 75% of the comb area covered with bees on both sides on May 1st (British Columbia), May 15th (New Brunswick, Nova Scotia, Ontario, Prince-Edward-

Island and Quebec) or May 21st (Alberta, Manitoba, Saskatchewan and Newfoundland and Labrador).

The colony loss and management questionnaire was provided to producers using various methods of delivery including mail, email, online and a telephone survey; the method of delivery varied by jurisdiction (Table 1). In each province, data were collected, summarized and analyzed by the Provincial Apiarist. All reported provincial results were then analyzed and summarized at the national level. The national percent winter loss was calculated as follows:

$$Percentage\ Winter\ Loss = \left(\frac{Sum\ of\ the\ estimated\ total\ colony\ losses\ per\ province\ in\ spring\ 2022}{Sum\ of\ total\ colonies\ in\ operation\ in\ each\ province\ for\ 2021}\right) x\ 100$$

Results

Throughout Canada, a total of 626 beekeepers responded to the 2022 survey. These respondents represented 44% of all the surveyed beekeepers. Respondents operated 59% of all registered colonies that were operated in all provinces in the 2021 season. The rate of participation and number of colonies continues to represent a substantial proportion of the commercial beekeeping industry in Canada.

The survey delivery methods, size of beekeeping operations and response rate of beekeepers for each province are presented in Table 1. It is important to note that the total number of colonies operated in a province reported by this survey may vary slightly from Statistics Canada's official numbers. In some provinces, the data collection periods for the provincial database and the Statistics Canada report at different times of year. This can result in minor discrepancies between the official Statistics Canada total number of colonies and this survey's total reported colonies per province.

Survey results showed that the national level of wintering loss, including non-viable colonies, was 45.5% with individual provinces ranging from 15.3% to 57.2%. The overall winter loss for 2021-2022 was almost the double of the 2020-2021 loss at 23.2%. The level of winter loss varied from province to province, and among beekeeping operations within each province. In general, all provinces reported higher mortality in 2021-2022 than the previous year, the exception being British Columbia which reported similar mortalities to last year. Manitoba and Prince Edward Island reported the highest winter losses in 2022 (57.2% and 51.9%, respectively), with ineffective varroa control cited as the most frequent cause contributing to colony mortality. It is worth noting that aside from Nova Scotia, New Brunswick and Newfoundland and Labrador, all other province's winter loss was over 30%. The lowest reported winter loss in 2022 was by Nova Scotia (15.3%).

Overall, 66% of the colonies owned by respondents were wintered outdoors in fall 2021, with remaining colonies (34%) wintered indoors (Table 2). The highest percentage of colonies wintered indoors was in Nova Scotia (69%) and Quebec (69%), followed by Manitoba (57%) and New-Brunswick (48%), whereas in British Columbia and Newfoundland and Labrador, only 1% of colonies were wintered indoors. The mortality rate for colonies wintered outdoors and indoors for each province is presented in Table 3.

For detailed information about the winter losses in each province, please contact the office of the Provincial Apiarist directly (see contact information in Appendix A).

Table 1: Survey parameters and honey bee colony mortality (2021-2022) by province

Province	Total number of colonies operated in 2021	Estimated number of colonies lost based on the estimated provincial winter loss	Type of data collection	Number of beekeepers targeted by survey	Number of respondents (% of participation)	Minimal size of beekeeping operations targeted by survey (# of colonies)	Number of respondents' colonies that were wintered in fall 2021	Number of respondents' colonies that were alive and viable in spring 2022	Percentage of surveyed colonies as a proportion of the total number of colonies in the province	Provincial Winter Loss including Non-viable Colonies
Newfoundland and Labrador	700	153	Email	12	11 (92%)	20	599	468	86%	21.9%
Prince Edward Island	6 800	3 527	Email	50	20 (40%)	1	5 294	2 548	78%	51.9%
Nova Scotia	27 115	4 137	Email	41	17 (41%)	50	17 722	15 018	65%	15.3%
New Brunswick	13 250	2 621	Email, mail, telephone	31	22 (71%)	50	10 408	8 349	79%	19.8%
Quebec	55 974	27 079	Online	130	80 (62%)	50	49 911	25 765	89%	48.4%
Ontario	102 328	49 940	Online, telephone	203	124 (61%)	50	62 558	32 027	61%	48.8%
Manitoba	114 837	65 662	Email, online	178	65 (37%)	50	71 492	30 614	62%	57.2%
Saskatchewan	115 000	39 724	Online	341	99 (29%)	50	45 833	30 001	40%	34.5%
Alberta	319 922	159 746	Online	182	82 (45%)	100	193 142	96 701	60%	49.9%
British Columbia	62 000	19 931	Online	262	106 (40%)	25	24 024	16 301	39%	32.1%
CANADA	**817 926**	**372 521**		**1 430**	**626 (44%)**		**480 983**	**257 792**	**59%**	**45.5%[1]**

[1] This number is the total loss calculated over all colonies in Canada.

Table 2: Overwintering method by province as reported by responding beekeepers - Fall 2021

Province	Outdoors		Indoors	
	Number of colonies	Percent (%)	Number of colonies	Percent (%)
NFL	596	99	3	1
PEI	4 715	90	543	10
NS	5 454	31	12 268	69
NB	5 364	52	5 044	48
QC	15 244	31	34 667	69
ON	39 555	63	23 003	37
MB	30 468	43	39 974	57
SK	34 156	75	11 677	25
AB	158 806	82	34 336	18
BC	21 755	99	257	1
Canada	**316 113**	**66**	**161 772**	**34**

Table 3: Indoor and outdoor wintering mortality as reported by responding beekeepers

Province	Outdoors			Indoors		
	Total number of colonies in fall 2021	Total number of viable colonies in spring 2022	Percent of losses of colonies (%)	Total number of colonies in fall 2021	Total number of viable colonies in spring 2022	Percent losses of colonies (%)
NFL	596	466	22	3	2	33
PEI	4 715	2 324	51	543	224	59
NS	5 454	4 490	18	12 268	10 528	14
NB	5 364	4 134	23	5 044	4 215	16
QC	15 244	8 723	43	34 667	17 042	51
ON	39 555	20 397	48	23 003	11 630	49
MB	30 468	13 859	55	39 974	16 755	58
SK	34 156	22 427	34	11 677	7 574	35
AB	158 806	81 570	49	34 336	15 131	56
BC	21 755	14 680	33	257	171	33
Canada	**316 113**	**173 070**	**45**	**161 772**	**83 272**	**49**

Contributing factors as cited by beekeepers

Beekeepers were asked to rank possible contributing factors to colony mortality. These responses are summarized in Table 4. Ineffective varroa control, poor queens and weak colonies in the fall were considered the most important factors for winter loss across the country.

Ineffective varroa control was reported as the first possible contributing factor to winter colony loss in five provinces. These were also the five provinces with the highest mortality rates. While varroa mites and their impacts on the honey bee health are still a serious issue for Canadian beekeepers, survey results indicate that many beekeepers are monitoring and treating for varroa using multiple treatments per year. Unfortunately, some individual producers monitored and treated for varroa too late by then, varroa levels are already at levels where damage to the colony will occur. This results in wintering bees being less healthy from the impacts of varroa and associated viruses. Monitoring varroa mite levels is becoming increasingly important especially when environmental factors such as temperature can impact can impact the bee growing season as well as the efficacy of miticides (e.g. formic acid and Thymovar®) used by beekeepers. Moreover, the suspected initial stages of emergence of resistance to Apivar® may be impacting the efficacy of this product and ability of mite population to rebound back unexpectedly. In addition, reinfestation of varroa mites from neighbouring beekeeping operations may also occur after a treatment has been applied. Therefore, monitoring varroa levels frequently, before and after treatment, testing for Apivar® resistance, selecting suitable effective treatments and verifying treatment efficacy are all necessary elements of an effective management strategy for this economically-important pest.

Moreover, in many provinces, there was a noticeable early start for the bee season in 2021. This early start, coupled with favourable weather conditions during the summer, maximized colony population growth and facilitated mite reproduction. High mite populations went unnoticed in many provinces or it was late to control them before causing serious damages to wintering bees. In many instances, by the time beekeepers started to administer fall treatments for varroa, the severity of mite-induced damage to bees was too great for colonies to survive the winter, even if mite loads were reduced.

Poor queens were reported as either the second or third most common factor contributing to winter losses in eight provinces. Poor queens can result in weakened colonies entering the winter with an insufficient number of bees to survive. If a queen becomes infertile or dies during the winter, the colony will also perish as there is no opportunity for the beekeeper to replace the queen or for the colony to naturally re-queen itself. Poor and failing queens may be the result of many factors including: inadequate rearing conditions, poor mating weather, reduced sperm viability, queen age or exposure to pesticides within the hive or from the environment. This marked increase in poor queen quality as a reported cause of winter mortality is a concern that merits further investigation.

Another contributing factor identified in eight provinces, was weak colonies in the fall. This can be caused by a variety of reasons including: underlying pest and disease issues, exposure to pesticides, poor foraging and nutrition or making too late splits (nuclei) that would not give enough time to have bee colonies with enough population to make it through the winter.

Based on reported wintering conditions, it was apparent that the unpredictable weather during the winter and early spring may have played a role in winter losses across Canada. In the Prairie Provinces (Manitoba, Saskatchewan and Alberta), unusual cold winter temperatures had the potential to affect wintering colonies. Across the country, colony build-up was hindered by a cold spring that caused surviving colonies to dwindle, greatly increasing the number of non-viable colonies.

Starvation was reported as a cause of winter mortality by beekeepers in some regions in Canada. Starvation can result from the inability of bees in weak colonies to store enough food during the fall, the inability of bees to move to new resources within the hive during winter, the rapid consumption of stored food because of early brood production, or insufficient feed provided by the beekeeper in the fall or spring. During 2021-22, starvation may also have been associated with increased consumption of stored honey or sugar syrup during the extended cold weather in the spring of 2022 in some areas.

Some beekeepers reported that they did not know why their colonies perished, although this answer was not identified among the top four causes for losses among most provinces. Inability to identify a possible cause for colony mortality may be associated with lack of applying best management practices including monitoring for pests, diseases and other general colony health parameters during the season, or a multitude of underlying problems that cannot be identified without the assistance from specialists.

Table 4: Top four ranked possible causes of honey bee colony mortality by province, as cited by beekeepers who responded to the 2021-2022 winter loss survey

Province	**1st.**	**2nd.**	**3rd.**	**4th.**
NL	Weak colonies in the fall	Other	Poor queens	Starvation
PEI	Ineffective Varroa control	Poor queens	Weak colonies in the fall	Other
NS	Weak colonies in the fall	Poor queens	Starvation	Weather
NB	Starvation	Poor queens	Weak colonies in the fall	Ineffective Varroa control
QC	Ineffective Varroa control	Weather	Poor queens	Don't know
ON	Ineffective Varroa control	Weak colonies in the fall	Weather	Other
MB	Ineffective Varroa control	Weather	Don't know	Weak colonies in the fall
SK	Weather	Ineffective Varroa control	Poor queens	Don't know
AB	Ineffective Varroa control	Poor queens	Weak colonies in the fall	-
BC	Weather	Poor queens	Weak colonies in the fall	Ineffective Varroa control

Operations that reported greater than 25% winter losses were asked to rank the top four possible causes of bee colony mortality in the 2021-2022 survey. These data are summarized in Table 5. Ineffective varroa control remained the most-cited cause of winter loss but tied with weather, followed by weak colonies in the fall. Overall, there appears to be a slight difference among reported causes of winter losses across provinces for these operations.

Table 5: Top four ranked possible causes of bee colony mortality by province, as cited by beekeepers who reported greater than 25% losses in the 2021-2022 winter loss survey

Province	1st.	2nd.	3rd.	4th.
NL[a]	Weather	Starvation	Weak colonies in the fall	Poor queens
PEI	Ineffective Varroa control	Poor queens	Weak colonies in the fall	Other
NS	Weak colonies in the fall	Ineffective varroa control	Weather	Starvation
NB	Ineffective Varroa control	Starvation	Weather	Weak colonies in the fall
QC	Ineffective Varroa control	Weather	Don't know	Other
ON	Ineffective Varroa control	Weather	Other	Don't know
MB	Ineffective Varroa control	Weather	Don't know	Weak colonies in the fall
SK	Weather	Ineffective Varroa control	Poor queens	Don't know
AB	Ineffective Varroa control	Weather	Nosema	Weak colonies in the fall
BC	Weather	Poor queens	Weak colonies in the fall	Ineffective Varroa control

[a] No varroa mites are found in Newfoundland and Labrador.

Bee Pest Management Practices

In recent years, Integrated Pest Management (IPM) has become the most important practice to maintain healthy honey bees. To successfully manage bee health, beekeepers must identify and monitor pests and diseases to take timely action in accordance with approved methods. This survey focused on asking beekeepers questions about their management of four serious threats that may impact bee health, survivorship and productivity (Appendix B).

A. Varroa monitoring and control

The varroa mite continues to be considered by beekeepers and apicultural specialists as one of the main causes of honey bee colony mortality.

During the 2021 beekeeping season, a large proportion of surveyed beekeepers monitored varroa mite infestations at least once a year, with some monitoring more than three times per year (Table 7). Alcohol washes using 300 bees per colony was the preferred method of detection in all provinces except Quebec, where beekeepers favoured the use of sticky boards and British Columbia, where beekeepers preferred the technique using icing sugar to dislodge mites from bees. The frequency of use for the alcohol wash technique ranged from 39% in New Brunswick to 80% in Alberta. The frequency of use for the sticky board method ranged from 12% in Saskatchewan to 55% in Quebec. Some beekeepers used both sticky boards and alcohol wash methods to evaluate levels of mites. These results demonstrate that many Canadian beekeepers recognize the value of monitoring varroa. Nevertheless, the desired goal is to have **all beekeepers regularly monitoring** varroa populations throughout the beekeeping season, particularly prior to treatment application windows, as well as subsequent to treatment to verify efficacy. Such sampling will ensure optimal timing of treatments and selection of the most effective treatment options for varroa control. While education and extension programs delivered to Canadian beekeepers have facilitated the adoption of recommended practices for managing varroa, ongoing innovation and improvement must continue.

Table 7: Varroa monitoring methods as cited by the respondents of the 2021-2022 winter loss survey.

Province	Beekeepers screening for varroa mites (%)					
	Technique		Frequency			
	Sticky boards	Alcohol wash	Only in spring	Only in fall	In spring and fall	3 times a year and more
NL[a]	0	1	0	0	0	0
PEI	-	-	11	17	22	22
NS	24	53	18	29	18	18
NB	16	48	0	24	12	16
QC	55	46	10	11	34	28
ON	21	66	6	15	17	46
MB	19	78	6	15	59	11
SK	12	68	4	6	70	-
AB	33	80	1	21	62	49
BC	20	50	-	-	-	-

[a] No varroa mites are found in Newfoundland and Labrador.

In Canada, there are a variety of registered miticides available to beekeepers for mite control. Beekeepers are encouraged to use the most effective miticide that fits their region, season and operation. Beekeepers are also encouraged to rotate miticides to prevent the development of resistance to these products. In the current survey of bee winter losses, beekeepers were asked "what chemical treatment was used for varroa control during the 2021 season". Beekeeper's responses are summarized in Table 8. In the spring of 2021, the percentage of beekeepers that treated with chemical methods ranged from 52% to 97% in provinces where the mite is present. New Brunswick had the lowest percentage of beekeepers (respondents) who treated for varroa in the spring (52%). For Canadian beekeepers who did treat in the spring, the main miticide used for spring varroa control was Apivar® (active ingredient: amitraz). The second most common treatment was formic acid in various forms, followed by oxalic acid. In fall of 2021, most Canadian beekeepers (71% to 99% depending on province) treated their colonies for varroa. The main miticides used at this time of the year were oxalic acid, formic acid and Apivar®. It was noted that some beekeepers used Apivar® twice in the same year in 2021, once in spring and again in fall. In some provinces, a greater number of beekeepers have started to combine Apivar® with formic or oxalic acid during the fall for keeping control of mite populations. As varroa is not present in Newfoundland and Labrador, no treatments were required in that province.

Few beekeepers used Apistan® (a synthetic miticide with the active ingredient tau-fluvalinate) or Checkmite+® (a synthetic miticide with the active ingredient coumaphos). Beekeepers may be wary of these products because of previously reported resistance to these active ingredients in Canada. Bayvarol® (a synthetic miticide with the active ingredient flumethrin) was also rarely used; there have been concerns and reports from beekeepers about the limitations in the efficacy of this product, which have been confirmed by research projects in Canadian provinces. Thymovar® (a miticide with the active ingredient thymol) was also reported used in some provinces.

Once again, these surveys show that Apivar® is one of the most commonly used miticides for treating varroa in Canada. Because of the repeated use of Apivar®, it is only a matter of time before the development of resistance to this miticide. Preliminary findings of slight decreased efficacy have been observed in some provinces. It is becoming increasingly important that beekeepers become aware of the principles associated with resistance development and the importance of monitoring the efficacy of all treatments, in particular Apivar®. This will help to mitigate abrupt and widespread failures of treatments on time before mites cause irreparable damage to bees. Beekeepers are also encouraged to incorporate resistance management practices such as using appropriate thresholds for treatment, following the label instructions, never leaving treatments in the hive beyond the appropriate treatment period or reusing chemical strips, and alternating miticides with different modes of action in their varroa treatment programs. In addition, having a wide suite of legally registered treatments with different functional activities and methods of application available to beekeepers is critical for maintaining a sustainable successful integrated varroa management strategy in Canada.

Table 8: Varroa chemical control methods as cited by the respondents of the 2021-2022 winter loss survey. Chemical treatment is in order from most to least commonly used.

Provinces	Varroa control: treatment and methods			
	Spring 2021		Summer/Fall 2021	
	% of beekeepers who treated	Methods of treatment	% of beekeepers who treated	Methods of treatment
NL[a]	0	N/A	0	N/A
PEI	78	Apivar (amitraz), 65% formic acid – 40 ml multiple applications, Formic Pro (formic acid)	94	Oxalic acid, Formic Pro (formic acid), Bayvarol (flumethrin)
NS	76	Apivar (amitraz), Thymovar (thymol), Apistan (fluvalinate)	82	Apivar (amitraz), Formic Pro (formic acid), Oxalic acid
NB	52	Apivar (amitraz), Oxalic acid, 65% formic acid – 40 ml multiple applications	92	Apivar (amitraz), Oxalic acid, Formic Pro (formic acid)
QC	63	65% formic acid – 40 ml multiple applications, Apivar (amitraz), Oxalic acid	96	Oxalic acid, 65% formic acid – 40 ml multiple applications, Apivar (amitraz)
ON	94	Apivar (amitraz), Oxalic acid, 65% formic acid – 250 ml single application	96	Apivar (amitraz), Oxalic acid, 65% formic acid – 40 ml multiple applications
MB	97	Apivar (amitraz), Oxalic acid, Thymovar (thymol)	99	Oxalic acid, Apivar (amitraz), Formic Pro (formic acid)
SK	95	Apivar (amitraz), Oxalic acid, Formic Pro (formic acid)	81	Oxalic acid, Apivar (amitraz), Formic Pro (formic acid)
AB	83	Apivar (amitraz), Oxalic acid, 65% formic acid – 40 ml multiple applications	98	Oxalic acid, Apivar (amitraz), 65% formic acid – 40 ml multiple applications
BC	84	Apivar (amitraz), Formic acid (no distinction between products), Oxalic acid	92	Oxalic acid, Formic acid (no distinction between products), Apivar (amitraz)

[a] No varroa mites are found in Newfoundland and Labrador.

B. Nosemosis management practices

Nosema is a fungal parasite that infects honey bees. *Nosema ceranae* has gradually replaced *Nosema apis* to become the most frequently found nosema species in Canada. The real role of *N. ceranae* in honey bee colony survival during winter may vary by climatic region and bee populations in Canada. Several studies from central Canada have demonstrated that *N. ceranae* did not impact winter mortality, however the parasite was found to potentially impact the development of honey bee colonies in early spring (Emsen *et al*., 2016; Emsen *et al*., 2020; Guzman *et al*., 2010). A recent study from the Canadian Prairies (Punko 2021; Punko *et al*., 2021), found that Nosema can increase colony mortality. The impact of Nosema was not cited by Canadian beekeepers in this survey as a possible cause of colony mortality during the 2021-2022 winter loss survey, with the exception of Alberta operations reporting greater than 25% losses.

In the survey, beekeepers reported the use of fumagillin for the treatment of nosemosis in spring and/or in fall of 2021 (Table 9). The percent of beekeepers that reported using this drug varied widely from province to province. Beekeepers were also asked to report all alternative treatments that they used during the spring or the fall to control nosemosis. Fumagilin-B® is the only product registered by Health Canada for nosema treatment. Any other products mentioned by beekeepers are not currently registered for the treatment of this disease, though some are marketed and used as general promotors of honey bee health. It is also worth noting that there are some regions of Canada where Fumagilin-B® is not used by most beekeepers. This may be due to the recent research in Canada clarifying the regional impacts of nosema on winterloss. Overall, Nosemosis is still an issue impacting bee health and further research is required to understand its role in colony population build up, honey production and colony loss throughout Canada.

Table 9: Antibiotic (fumagillin) and alternative treatments for nosemosis as cited by the respondents of the 2021-2022 winter loss survey

Province	Use of antibiotic and alternative treatments for nosemosis (% of respondents)					
	Spring treatment			Fall treatment		
	Fumagillin	Other product	main alternative products	Fumagillin	Other product	main alternative products
NL	0	0	N/A	0	0	N/A
PEI	6	0	N/A	0	0	N/A
NS	12	0	N/A	24	0	N/A
NB	16	0	N/A	28	4	Hive Alive
QC	3	5	Nozevit, Apple cider vinegar, Complete Bee = Hive Alive	5	8	Apple cider vinegar, Nozevit, Complete Bee = Hive Alive
ON	6	2	Essential oils, Hive alive	6	2	Essential oils, Hive Alive
MB	14	8	N/A	12	8	N/A
SK	24	26	N/A	29	23	N/A
AB	39	5	Bee Strong, Beevital lysozyme, Apiforte	58	7	Bee Strong, Beevital lysozyme, Apiforte, Pro Health
BC	21	18	N/A	0	0	N/A

C. American and European foulbrood management practices

American foulbrood (AFB) is a bacterial disease of brood caused by *Paenibacillus larvae*. AFB is considered endemic in Canada. It is also of great concern to beekeepers as active infections may result in large-scale loss of honey bees and equipment and can spread within regions if proper steps are not taken to eliminate infective honey bee colonies and equipment. Oxytetracycline and more recently Tylosin and lincomycin are antibiotics registered for treating AFB in Canada. The pattern of use for these antibiotics, as reported by beekeepers, is presented in Table 10. Oxytetracycline was more frequently used by beekeepers in spring and fall than other treatments. Provincial recommendations on antibiotic use (e.g., prophylactic vs therapeutic) vary, therefore treatments may be or may not be reflective of active infections depending on the province.

Table 10: Antibiotic treatments for American foulbrood (Oxytetracycline, Tylosin and Lincomycin) as cited by the respondents of the 2021-2022 winter loss survey

Province	Use of American Foulbrood Treatments (% of respondents)					
	Spring treatment			Summer/Fall treatment		
	Oxytetracycline	Tylosin	Lincomycin	Oxytetracycline	Tylosin	Lincomycin
NL	0	0	0	0	0	0
PEI	0	0	0	0	0	0
NS	29	0	0	12	0	0
NB	44	0	0	32	0	0
QC	5	0	0	3	0	0
ON	57	0	0	47	1	0
MB	34	2	0	25	3	0
SK	39	0	0	42	3	0
AB	14	3	0	14	5	0
BC	9	3	0	10	4	0

In the recent years, some beekeepers have reported increasing impact of and difficulty controlling European foulbrood (EFB) in their operation, a bacterial disease of brood caused by *Melissococcus plutonius*. Oxytetracycline, although typically used as a treatment for AFB, has started being used also to treat overt EFB outbreaks. For the second year, surveyed beekeepers were asked if they used oxytetracycline for the treatment of EFB (Table 11). In most provinces, the numbers reported coincide with those for oxytetracycline treatment of AFB, which suggests that beekeepers probably use this product for both diseases, or did not confirm diagnostically before treating overt infections. However, in Prince Edward Island, Quebec and Alberta, the number of beekeepers having treated with oxytetracycline for EFB in the spring is higher than the number of beekeepers having treated with oxytetracycline for AFB. Also observed was that in Prince Edward Island, Nova Scotia and Alberta, the number of beekeepers having treated with oxytetracycline for EFB in the fall is higher than the number of beekeepers having treated with oxytetracycline for AFB.

Table 11: Antibiotic treatments for European foulbrood (Oxytetracycline) as cited by the respondents of the 2021-2022 winter loss survey

Province	Use of European Foulbrood Treatments (% of respondents)	
	Spring treatment	Summer/Fall treatment
	Oxytetracycline	Oxytetracycline
NL	0	0
PEI	22	11
NS	18	18
NB	44	32
QC	6	3
ON	39	34
MB	20	11
SK	36	34
AB	35	20
BC	0	0

<u>Honey Bee Winter Loss and Population in Canada Since 2007</u>

Reported winter loss has been variable from year to year in Canada since 2007. This year, the reported winter mortality averaged 45.5%. This is three times higher than the long-term suggested baseline/ threshold for winter losses of 15%. In fact, since the beginning of this survey in 2007, this suggested acceptable level of loss has never been attained. As can be seen in Figure 1, national winter losses were highest in 2022, 2008 and 2009 which ranged from 45.5% to 33.9%. From 2007 to 2022, national winter losses ranged from 15.3% to 45.5%, averaging 27%. During the period between 2007 and 2021 Statistics Canada reports showed that total colonies in Canada increased by 37.5%. We anticipate that the number of colonies operated in Canada in 2022 will decrease due to the abnormally high mortalities incurred during the winter of 2021-2022.

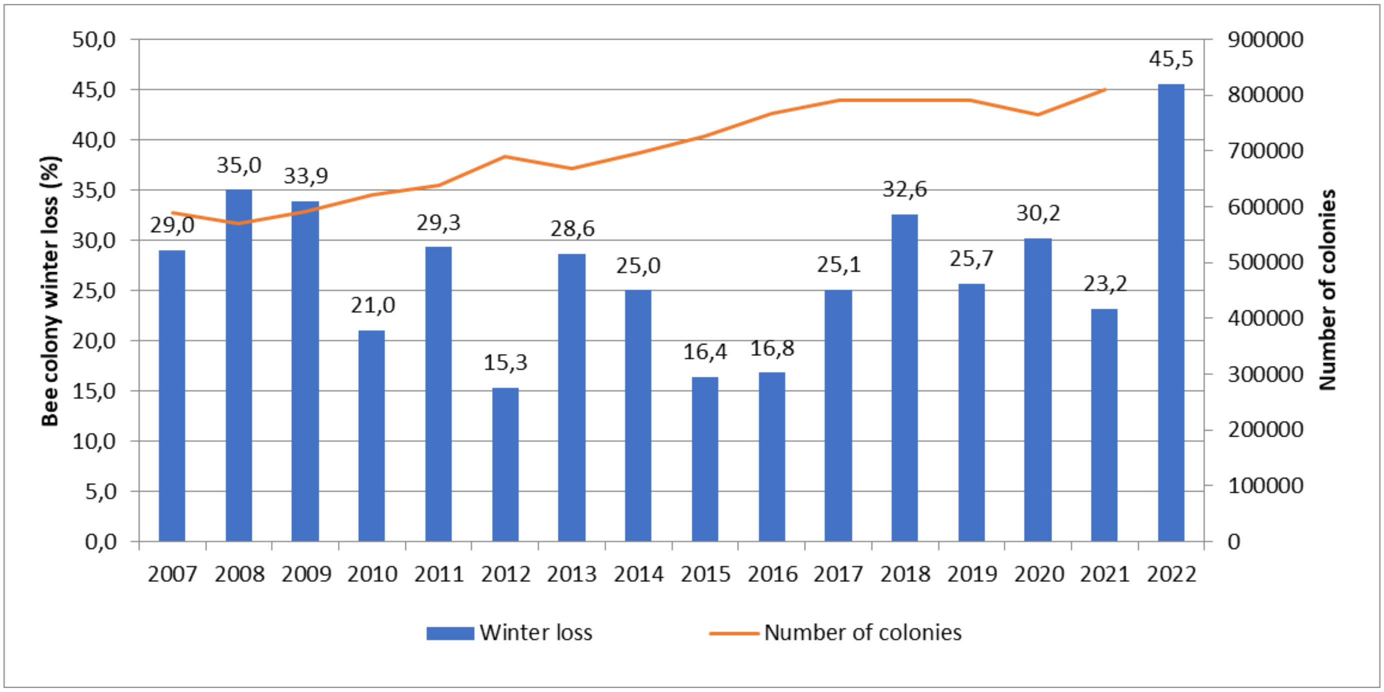

Figure 1. Summary of bee colony numbers and bee losses in Canada from 2007-2022 (based on data as reported by Stats Canada). Note that the number of colonies as reported by Stats Canada is not available for the current year.

Overall, there is more to these opposing trends than the graph may highlight. As demonstrated this year, high levels of colony winter mortality are a threat to the sustainability of the beekeeping industry in Canada. Beekeepers must be vigilant and practice pest management for serious pests endemic to the honey bee population in Canada (e.g. varroa mites), with little room for error. A changing climate must also be considered due to impacts on bee growth, varroa population development, treatment type and frequency of application. Individual beekeepers experiencing high winter losses face considerable expenses replacing dead colonies. These increased expenses greatly affect profitability and productivity and can put some beekeeping operations at risk of insolvency. As well, this survey and report do not take into account mid-season losses of honey bee colonies or queens that beekeepers may be experiencing through the beekeeping season. Nevertheless, the Canadian beekeeping industry as a whole has been resilient and able to grow, as proven by the overall increase in the number of bee colonies since 2007 (Figure 1) despite the difficulties faced every winter. Next spring, we will see how Canadian beekeepers have been able to replace and rebuild bee populations across the country. While provincial estimates demonstrate regional trends in winter loss, within each province the results vary among regions and beekeeping operations. While there are operations that have been highly successful, the risks of losing large proportions of colonies are real in Canada, and continued vigilance is required to maintain bee health and profitable beekeeping operations.

Bee health concerns include pest management, climatic conditions, nutrition, and pesticide exposure within hives and from the environment. Another added challenge facing beekeepers is the economics of beekeeping which include variable honey prices and increasing costs of production. Even though responses from this annual survey have provided evidence that some beekeepers are using recommended practices for monitoring and managing honey bee pests and diseases, there are always the opportunities to make further improvements. As such, the detailed management data from beekeepers summarised in this report has been used by some apiary and extension programs to focus education, training, and communication efforts to beekeepers in improvement in management for honey bee pests.

It would appear that stress caused by parasites in combination with other stressors warrant further study to provide alternative management practices for maintaining honey bee health. At this time, beekeepers have a limited number of products to control varroa, and all of these options have their limitations. New options are important to mitigate the risk of developing resistance. Additionally, the only product registered for the treatment of nosema is fumagillin. If resistance develops to the primary treatment for varroa (e.g., Apivar®) or to nosema (i.e. fumagillin), beekeepers could experience even greater and likely extreme difficulties keeping their bees alive. Ultimately, beekeepers will need more effective and additional options (miticides, antibiotics and non-chemical management options) in their "tool box" if they are to continue effective integrated pest management to maintain healthy bees.

Further Work

CAPA members continue to work closely with industry stakeholders, and provincial working groups to address bee health and industry economics. Members of CAPA and Provincial Apiarists have also been involved in conducting surveillance programs at the provincial levels and across the country to monitor the status of bee health including emerging pests. CAPA members, the Provincial Apiarists, and Technology Transfer Programs are involved in conducting outreach and extension programs to promote IPM and biosecurity practices to beekeepers. Researchers within CAPA are active in evaluating alternative control options for varroa mites and nosema and developing genetic stocks more tolerant to pests which will enhance the integrated pest management (IPM) practices and address honey bee health sustainability.

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Appendix A: List of Canada's Provincial Apiarists

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Appendix B: CAPA - 2022 Core Winter loss survey questions

The followings are the core questions that will be used in 2022 by each provincial apiarist for reporting the colony winter losses at the national level. As it has been since 2007, the objective is to estimate the winter kills with a simple and standardized method while taking into account the large diversity of situations around the country. This is a survey so these questions are to be answered by the beekeepers.

1. How many full sized colonies[2] were put into winter in fall 2021?

Outdoor wintering	Indoor wintering	Total

2. How many full sized colonies[1] survived the 2021/2022 winter and were considered viable[3] on May 1st (British Columbia), May 15th (Ontario, Quebec and Maritimes) or May 21st (Alberta, Manitoba, Newfoundland and Saskatchewan)?

Outdoor wintering	Indoor wintering	Total

3. Which method of treatment did you use for varroa control in **spring 2021**? What percent of hives were treated? *(Choose all that apply)*

	Treatment	Percent of hives treated (%)
☐	Apistan (fluvalinate)	
☐	CheckMite+ (coumaphos)	
☐	Apivar (amitraz)	
☐	Thymovar (thymol)	
☐	ApiLifeVar (Thymol and essential oils)	
☐	Bayvarol (flumethrin)	
☐	65% formic acid – 40 ml multiple application	
☐	65% formic acid – 250 ml single application	
☐	Mite Away Quick Strips (formic acid)	
☐	Formic Pro (formic acid)	

[2] Does not include nucleus colonies

[3] Viable : A viable colony, in a standard 10-frame hive, is defined has having 4 frames or more being 75% bee-covered on both sides.

NB: You must not include in this data new colonies created by division or purchased in spring 2021. You must however include overwintered colonies that would have been sold before May 1st (British Columbia), May 15th (Ontario, Quebec and Maritimes) or May 21st (Alberta, Manitoba, Newfoundland and Saskatchewan).

☐	Oxalic acid	
☐	Hopguard II (hop compounds)	
☐	Other *(please specify)* ________________________	
☐	None	

4. Which method of treatment did you use for varroa control in late **summer/fall 2021**? What percent of hives were treated? *(Choose all that apply)*

	Treatment	**Percent of hives treated (%)**
☐	Apistan (fluvalinate)	
☐	CheckMite+ (coumaphos)	
☐	Apivar (amitraz)	
☐	Bayvarol (flumethrin)	
☐	Thymovar (thymol)	
☐	ApiLifeVar (Thymol and essential oils)	
☐	65% formic acid – 40 ml multiple application	
☐	65% formic acid – 250 ml single application	
☐	Mite Away Quick Strips (formic acid)	
☐	Formic Pro (formic acid)	
☐	Oxalic acid	
☐	Hopguard II (hop compounds)	
☐	Other *(please specify)* ________________________	
☐	None	

5. Regarding varroa monitoring:

   a. Have you monitored your colonies for varroa during the 2021 season?

      ○ Yes – sticky board
      ○ Yes – alcohol wash
      ○ Yes – other (*please specify*) ______________________________
      ○ No

   b. How often do you monitor your colonies with either sticky board or a washing technique (alcohol, powder sugar or gas)?

      ○ Just in the Spring
      ○ Just in the Fall
      ○ Both Spring and Fall
      ○ At least 3 times a year

6. Which method of treatment did you use for **nosema** control in **spring 2021**? What percent of hives were treated?

	Treatment	Percent of hives treated (%)
☐	Fumagillin	
☐	Other (*please specify*) ____________________	
☐	None	

7. Which method of treatment did you use for **nosema** control in **fall 2021**? What percent of hives were treated?

	Treatment	Percent of hives treated (%)
☐	Fumagillin	
☐	Other (*please specify*) ____________________	
☐	None	

8. Which method of treatment did you use for **American or European foulbrood** control in **spring 2021**? What percent of hives were treated? *(Choose all that apply)*

	Treatment	Percent of hives treated (%)	
		AFB	EFB
☐	Oxytetracycline		
☐	Tylosin		
☐	Lincomycin		
☐	None		

9. Which method of treatment did you use for **American or European foulbrood** control in **fall 2021**? What percent of hives were treated? *(Choose all that apply)*

	Treatment	Percent of hives treated (%)	
		AFB	EFB
☐	Oxytetracycline		
☐	Tylosin		

☐	Lincomycin		
☐	None		

10. To what do you attribute the main cause of death of your colonies? (Please check every suspected cause and rank the causes according to their relative importance.)

	Cause of death	**Rank (1 = the most important)**
☐	Don't know	
☐	Starvation	
☐	Poor queens	
☐	Ineffective varroa control	
☐	Nosema	
☐	Weather	
☐	Weak colonies in the fall	
☐	Other (*Please specify*) ________________________	
☐	Other (*Please specify*) ________________________	
☐	Other (*Please specify*) ________________________	