<u>**Canadian Association of Professional Apiculturists**</u>
<u>**Statement on Honey Bee Wintering Losses in Canada (2021)**</u>

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<u>Summary</u>

The Canadian Association of Professional Apiculturists (CAPA) and Provincial Apiarists coordinated the annual honey bee wintering loss report for 2020-2021. 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 398,961 honey bee colonies across Canada, representing 52% of all colonies wintered during 2020-2021. The national winter loss, including non-viable bee colonies, was 23.2% with provincial losses ranging from 12.2% to 32.2%. The overall national colony loss reported in 2021 is slightly less than the average reported losses since 2007 (25.8%). Despite these reported annual losses, through the hard work of beekeepers replacing dead and weak colonies and making increases, Statistics Canada reports that the total national colony count has increased by 26.7% during the period between 2007 and 2020.

Each province ranked the top four suspected causes of colony losses as reported by respondents. These varied from province to province. The most frequently cited causes of colony losses were poor queens, weak colonies in the fall and ineffective varroa control. When asked whether COVID-19 related issues had an impact on winter mortality, respondents reported a low impact (mean of 1.3 to 3 on a scale of 1 to 10). For beekeepers who reported a higher impact of COVID on winter mortality (score of 6 and more), the most frequent issues were access to labour, access to bees and access to supplies.

Beekeepers also responded to questions on the management of three serious parasites and pathogens to beekeeping: *Varroa destructor*, *Nosema spp*. and American Foulbrood: *Paenibacillus larvae*. The majority of beekeepers in most provinces reported that they monitored for varroa mites. The most commonly reported varroa treatments were: Apivar® or formic acid treatments in the spring; Apivar® or formic acid in the summer or fall; and oxalic acid in late fall. Many Canadian beekeepers treated their colonies to mange the risk of nosemosis and American foulbrood. Across the country, registered antibiotics were the commonly used treatments; nevertheless, methods and timing of application varied from province to province.

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 adopt recommended integrated pest management practices to keep these pests under control. CAPA members continue to work through working groups encompassing diverse stakeholders to educate and to develop and improve management options for beekeepers to keep healthy bees and manage winter loss in Canada.

Disclaimer and Credits: Survey data were supplied by the Provincial Apiarists (listed in Appendix A). Data were then compiled, further analyzed and an initial draft of this report written by Gabrielle Claing, 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 and American foulbrood. The Canadian Association of Professional Apiculturists (CAPA) has worked with the Provincial Apiarists on reporting 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 results 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 2021, the Provincial Apiarists and the CAPA National Survey Committee members reviewed the questions used in the 2020 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, and the impacts of COVID-19 on beekeeping practices. The result was an updated harmonized set of questions that was used in the 2021 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 and are reported in summary form. 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, an 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:

$$\text{Percentage Winter Loss} = \left(\frac{\text{Sum of the estimated total colony losses per province in spring 2021}}{\text{Sum of total colonies in operation in each province for 2020}}\right) \text{x } 100$$

Results

Throughout Canada, a total of 573 beekeepers responded to the 2021 survey. These respondents represented 39% of all the surveyed beekeepers. Respondents operated 52% of all registered colonies that were wintered in the fall of 2020. 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 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 23.2% with individual provinces ranging from 12.2% to 32.2%. The overall winter loss for 2020-2021 was lower than 2019-2020 which had a loss rate of 30.2%. The level of winter loss varied from province to province, and among beekeeping operations within each province. In general, most provinces reported similar or lower mortality in 2020-2021 than the previous year, the exception being British Columbia reporting higher mortalities than last year. British Columbia and Alberta reported the highest winter losses in 2021 (32.2% and 31.9%, respectively), with ineffective varroa control cited as the most frequent cause contributing to colony mortality. It is worth noting that aside from British Columbia and Alberta, all other province's winter loss was below 20%, with the lowest winter loss, reported by Nova Scotia, at 12.2%.

Overall, 73% of the colonies owned by respondents were wintered outdoors in fall 2020, with remaining colonies (27%) wintered indoors (Table 2). The highest percentage of colonies wintered indoors was in Nova Scotia (76%) and Quebec (70%), followed by Manitoba (53%) and New-Brunswick (51%), whereas in British Columbia, there were no colonies wintered outdoors.

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 (2020-2021) by province

Province	Total number of colonies operated in 2020	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 2020	Number of respondents' colonies that were alive and viable in spring 2021	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	800	145	Email, telephone, text	12	12 (100%)	20	546	447	68%	18.1%
Prince Edward Island	5 500	883	Email, telephone	50	19 (38%)	1	5 045	4 235	92%	16.1%
Nova Scotia	26 323	3198	Email	44	19 (43%)	50	16 288	14 309	62%	12.2%
New Brunswick	12 963	1706	Mail, email, fax, telephone	32	23 (72%)	50	9 788	8 500	76%	13.2%
Quebec	55 508	10555	Online	118	68 (58%)	50	32 275	26 138	58%	19.0%
Ontario	96 799	17193	Online, telephone	252	90 (36%)	50	42 467	34 924	44%	17.8%
Manitoba	118 697	18299	Email, online	166	44 (27%)	50	48 045	40 638	40%	15.4%
Saskatchewan	100 000	13707	Online	363	129 (36%)	50	59 203	51 088	59%	13.7%
Alberta	288 320	91843	Online	169	83 (49%)	100	165 323	112 660	57%	31.9%
British Columbia	57 313	18444	Online	257	86 (33%)	25	19 981	13 551	35%	32.2%
CANADA	**762 223**	**175 974**		**1 463**	**573 (39%)**		**398 961**	**306 490**	**52%**	**23.2%**[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 2020

Province	Outdoors		Indoors	
	Number of colonies	Percent (%)	Number of colonies	Percent (%)
NFL	546	99	3	1
PEI	4 764	94	281	6
NS	3 954	24	12 334	76
NB	4 808	49	4 980	51
QC	9 761	30	22 514	70
ON	29 470	69	12 997	31
MB	22 678	47	25 367	53
SK	48 298	82	10 905	18
AB	137 587	83	27 736	17
BC[a]	58 232	100	0	0
Canada	**319 552**	**73**	**117 114**	**27**

[a] Includes AB colonies overwintered in BC

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

Province	Outdoors			Indoors		
	Total number of colonies in fall 2020	Total number of viable colonies in spring 2021	Percent of losses of colonies (%)	Total number of colonies in fall 2020	Total number of viable colonies in spring 2021	Percent losses of colonies (%)
NFL	546	447	18.1	3	3	0.0
PEI	4 764	4 010	15.8	281	225	19.9
NS	3 954	3 453	12.7	12 334	10 856	12.0
NB	4 808	4 140	13.9	4 980	4 360	12.4
QC	9 761	7 916	18.9	22 514	18 222	19.1
ON	29 470	23 278	21.0	12 997	11 646	10.4
MB	22 678	19 693	13.2	25 367	20 945	17.4
SK	48 298	42 564	11.9	10 905	8 524	21.8
AB	137 587	93 580	32.0	27 736	19 080	31.2
BC	58 232	39 598	32.0	0	-	-
Canada	**319 552**	**238 232**	**25.4**	**117 114**	**93 858**	**19.9**

Contributing factors as cited by beekeepers

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

Poor queens were reported as either the primary or second most common factor contributing to reported winter losses in nine 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 nine provinces, most frequently in second rank, was weak colonies in the fall. This can be caused by a variety reasons including: making late splits (nuclei) (as was reported by Newfoundland/Labrador beekeepers), underlying pest and disease issues, exposure to pesticides, or poor foraging and nutrition.

Ineffective varroa control was reported as the first possible contributing factor to winter colony loss in three provinces, which were also the three provinces with the highest mortality rates. While the varroa mites and their impacts on the honey bee health are still a serious issue for Canadian beekeepers, survey results indicate that most beekeepers are monitoring at least once a year and treating for varroa using multiple treatments per year. Unfortunately, some individual producers monitor and treat for varroa too late in the season when 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 is becoming increasingly important when the efficacy of treatments varies either through environmental factors such as cold temperature (the efficacy of some treatments is dependent on temperature (e.g., formic acid and thymovar)) or the development of resistance to treatments (e.g., fluvalinate (Apistan) and coumaphos (CheckMite+)). Monitoring varroa levels before and after treatment, selecting suitable effective treatments and verifying treatment efficacy are all necessary elements of an effective management strategy for this economically-important pest.

Starvation was reported as a cause of winter mortality by beekeepers in several regions across 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 2020-21, starvation may also have been associated with increased consumption of stored honey or sugar syrup during the extended cold weather in the spring of 2021 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 2020-2021 winter loss survey

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

Operations that reported greater than 25% winter losses were asked to rank the top four possible causes of bee colony mortality in the 2020-2021 survey. These data are summarized in Table 5. Poor queens, weak colonies in the fall and ineffective varroa control remain the 3 most-cited causes of winter loss. Overall, there were no striking differences between reported causes of winter losses across the provinces and for those operations that reported 25% or more losses.

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 2020-2021 winter loss survey

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

[a] No beekeeper reported losses greater than 25%.

COVID-19 impact on winter mortality as cited by beekeepers

The pandemic brought numerous additional problems to the beekeeping industry in 2020, beyond the simple risk of contracting COVID-19 and falling ill. With international flights delayed and cancelled, there were issues importing queens and bee packages. Temporary foreign workers workers were faced with difficulties getting visas, travel arrangements, entering the country, and quarantining. Some supplies, such as sugar, were limited in supply. Travel restrictions were imposed in and among some provinces or regions.

Surveyed beekeepers were asked to score the impact of COVID-19 related issues on winter mortality on a scale of 1 to 10, with 1 being no impact and 10 being a major impact. Respondents reporting a high impact (6 and above) were asked to rank the issues having impacted their mortality. The results are presented in Table 6.

Table 6: Impact of COVID-19 related issues on winter mortality as cited by the respondents of the 2020-2021 winter loss survey

Province	Mean score of covid impact on mortality (on scale of 1 to 10)	Median score of covid impact on mortality (on scale of 1 to 10)	For beekeepers that reported an important impact of COVID-19 on winter mortality (scores of 6 and above)		
			1st ranked issue	2nd ranked issue	3rd ranked issue
NL	2.50	1.00	Other	Access to labour (ex: temporary foreign worker)	Movement restrictions (e: between regions or provinces)
PEI	2.00	1.00	N/A	N/A	N/A
NS	1.30	1.00	Movement restrictions (ex: between regions or provinces)	Access to labour (ex: temporary foreign worker)*	Access to bees (queens, packages of bees, etc.)*
NB	1.65	1.00	Access to bees (queens, packages of bees, etc.)	N/A	N/A
QC	2.15	1.00	Access to bees (queens, packages of bees, etc.)	Access to necessary supplies for beekeeping management (ex: syrup)	Access to labour (ex: temporary foreign worker)
ON[a]	-	-	Access to necessary supplies for beekeeping management (ex: syrup)	Access to bees (queens, packages of bees, etc.)	Access to labour (ex: temporary foreign worker)
MB	1.50	1.00	Access to labour (ex: temporary foreign worker)	Access to necessary supplies for beekeeping management (ex: syrup)	Access to bees (queens, packages of bees, etc.)
SK[b]	-	-	Access to labour (ex: temporary foreign worker)	N/A	N/A
AB	3.00	1.00	Access to labour (ex: temporary foreign worker)	Access to bees (queens, packages of bees, etc.)	Access to necessary supplies for beekeeping management (ex: syrup)
BC	-	-	-	-	-

* Issues ranked equally.

[a] Ontario beekeepers were asked whether they encountered the listed issues related to COVID-19, and not to score the impact of the pandemic.

[b] In Saskatchewan, 6 beekeepers stated that COVID-19 affected mortality (without score).

In general, COVID-19 related issues had a low impact on winter losses. In each province, respondents gave the impact an average score below 3 out of 10. The median[2] answer for all provinces was 1, meaning that at least half the respondents saw no impact of the pandemic on their winter losses.

The most frequently reported issues related to COVID-19 having had an important impact on winter losses were access to labour, access to bees and access to supplies. Movement restrictions (e.g., between regions or provinces) and illness (e.g., workers, family, etc.) were not reported as having had an important impact on winter losses.

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 three serious threats that may impact bee health, survivorship and productivity (Appendix B).

A. Varroa monitoring and control[3]

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 2020 production season, a large majority (50 to 87% depending on the province) of surveyed beekeepers monitored for varroa mite infestations at least once a year (Table 7). The alcohol wash of a sample of 300 bees per colony was the most preferred technique 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 in various provinces ranged from 31% to 80%. The frequency of use for the sticky board method ranged from >1% to 55%. Some beekeepers used both sticky boards and alcohol wash methods to evaluate levels of mites. These results demonstrate that most 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 at times prior to treatment application windows, and 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

[2] The median is the middle number in a sorted, ascending or descending, list of numbers. In a skewed distribution (i.e.: when there are outliers in the sequence that might skew the average of the values), it can be more descriptive of that data set than the average.

[3] Although data is presented for this province, it must be reminded that no varroa mites are found in Newfoundland and Labrador.

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 2020-2021 winter loss survey.

Province	Beekeepers screening for varroa mites (%)						
	Technique		Frequency				
	Sticky boards	Alcohol wash	No monitoring or no response	Only in fall	Only in spring	In spring and fall	3 times a year and more
NL[a]	<1	73	48	13	<1	38	<1
PEI	16	42	15	6	26	26	27
NS	16	53	31	5	32	16	16
NB	17	57	13	4	39	22	22
QC	55	36	35	6	18	22	19
ON	18	63	16	8	11	27	38
MB	11	68	19	5	14	51	11
SK	12	77	19	-	-	81	-
AB	20	70	10	12	2	23	53
BC	26	31	-	-	-	-	-

[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 2020 season". Beekeepers' responses are summarized in Table 8. In the spring of 2020, the percentage of beekeepers that treated with chemical methods ranged from 56% to 98% in provinces where the mite is present. In provinces with lower treating rates like Quebec (56%) and New Brunswick (57%), this means that the most common scenario in spring is actually the absence of treatment. 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 2020, most Canadian beekeepers (71% to 100% depending on province) treated their colonies for varroa. The main miticides used at this time of the year were oxalic acid, Apivar® and formic acid. It was noted that some beekeepers used Apivar® twice in the same year in 2020, 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 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.

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 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. Beekeepers are 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. Good biosecurity and food safety practices will also promote healthy bees and safe, high quality hive products while reducing disease pressure. 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 integrated varroa management strategy in Canada.

Table 8: Varroa chemical control methods as cited by the respondents of the 2020-2021 winter loss survey. Chemical treatment is in order from most to least commonly used.

Provinces	Varroa control: treatment and methods			
	Spring 2020		Summer/Fall 2020	
	% of beekeepers	Methods of treatment	% of beekeepers	Methods of treatment
NL[a]	0	N/A	0	N/A
PEI	79	Apivar (amitraz), 65% formic acid – 40 ml multiple application, Bayvarol (flumethrin)	100	Oxalic acid, Formic Pro (formic acid), Apivar (amitraz)
NS	84	Apivar (amitraz), Apistan (fluvalinate), 65% formic acid – 40 ml multiple application	84	Apivar (amitraz), Formic Pro (formic acid), Oxalic acid
NB	57	Apivar (amitraz), Formic Pro (formic acid), Oxalic acid	100	Apivar (amitraz), Oxalic acid, Formic Pro (formic acid)
QC	56	65% formic acid – 40 ml multiple application, Apivar (amitraz), 65% formic acid – 250 ml single application	97	65% formic acid – 40 ml multiple application, Oxalic acid, Apivar (amitraz)
ON	79	Apivar (amitraz), 65% formic acid – 40 ml multiple application, Oxalic acid	96	Apivar (amitraz), Oxalic acid, Formic Pro (formic acid)

Provinces	Varroa control: treatment and methods			
	Spring 2020		Summer/Fall 2020	
	% of beekeepers	Methods of treatment	% of beekeepers	Methods of treatment
MB	86	Apivar (amitraz), Oxalic acid, Formic acid (no distinction between products)	94	Oxalic acid, Apivar (amitraz), Formic acid (no distinction between products)
SK	98	Apivar (amitraz), Oxalic acid, Formic acid (no distinction between products)	71	Apivar (amitraz), Oxalic acid, Formic acid (no distinction between products)
AB	79	Apivar (amitraz), Oxalic acid, 65% formic acid – 40 ml multiple application	95	Oxalic acid, Apivar (amitraz), 65% formic acid – 40 ml multiple application
BC	72	Formic acid (no distinction between products), Apivar (amitraz), Oxalic acid	90	Formic acid (no distinction between products), Oxalic acid, 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. More recently, several Canadian 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; Punko and Rosanna, 2021). It was not cited by Canadian beekeepers in this survey as a possible cause of colony mortality during the 2020-2021 winter loss survey, except in Alberta.

In the survey, beekeepers reported the use of fumagillin for the treatment of nosemosis in spring and/or in fall of 2020 (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 impacts of nosema on winterloss, research on new active ingredients by Canadian researchers, and biosecurity practices (i.e. replacement of brood comb) that are promoted to complement the use of treatments. Nosemosis is still an issue impacting bee health and further research is required to understand its role in colony or production loss throughout Canada.

Table 9: Antibiotic (fumagillin) and alternative treatments for nosemosis as cited by the respondents of the 2020-2021 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	<1	0	N/A	<1	0	
PEI	11	0	N/A	16	0	N/A
NS	37	5	Hive alive	37	16	Hive alive, Lemongrass
NB	17	0	N/A	26	0	N/A
QC	2	0	N/A	3	6	Apple cider vinegar
ON	4	1	N/A	8	1	N/A
MB	10	12	N/A	12	10	N/A
SK	33	9	Prebiotics, Probiotics	39	12	Prebiotics, Probiotics
AB	33	5	Bee pro, Nosevit, Pro health	57	3	Nosevit
BC	16	-	-	13	-	-

C. American 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 curative) vary, therefore treatments may be or may not be reflective of active infection depending on the province.

Table 10: Antibiotic treatments for American foulbrood (oxytetracycline, tylosin and lincomycin) as cited by the respondents of the 2020-2021 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	5	0	0	0	0	0
NS	21	0	0	5	0	0
NB	43	0	0	22	0	0
QC	6	0	0	3	0	0
ON	61	0	0	52	1	0
MB	46	0	0	31	12	0
SK	41	0	0	36	4	0
AB	15	4	1	15	6	0
BC	8	0	0	4	2	0

In the recent years, some beekeepers have reported increasing impact of and difficulty controlling European foulbrood (caused by *Melissococcus plutonius*) in their operation. Oxytetracycline, although typically used as a treatment for AFB, has started being used specifically to treat overt EFB outbreaks. This 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 in prevention for both diseases, or did not confirm diagnostic before treating overt infections. However, in Alberta, where prophylactic use is not recommended, the number of beekeepers having treated with oxytetracycline for EFB in the fall is double 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 2020-2021 winter loss survey

Province	Use of European Foulbrood Treatments (% of respondents)	
	Spring treatment	Summer/Fall treatment
	Oxytetracycline	Oxytetracycline
NL	0	0
PEI	5	0
NS	11	0
NB	39	22
QC	6	3
ON	43	43

Province	Use of European Foulbrood Treatments (% of respondents)	
	Spring treatment	Summer/Fall treatment
	Oxytetracycline	Oxytetracycline
MB	46	31
SK	-	-
AB	18	34
BC	-	-

Honey Bee Winter Loss and Population in Canada Since 2007

Reported winter loss has been variable from year to year in Canada since 2007. This year, the reported Canadian winter mortality averaged 23.2%. This is 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 threshold has never been reached for the Canadian average. As can be seen in Figure 1, the national winter losses were highest in 2008, 2009 and 2018 which ranged from 32.6% to 35.0%. From 2007 to 2021, the national winter losses ranged from 15.3% to 32.6%, averaging 25.8%. During the period between 2007 and 2020 Statistics Canada reports showed that the total colonies in Canada increased by 26.7%.

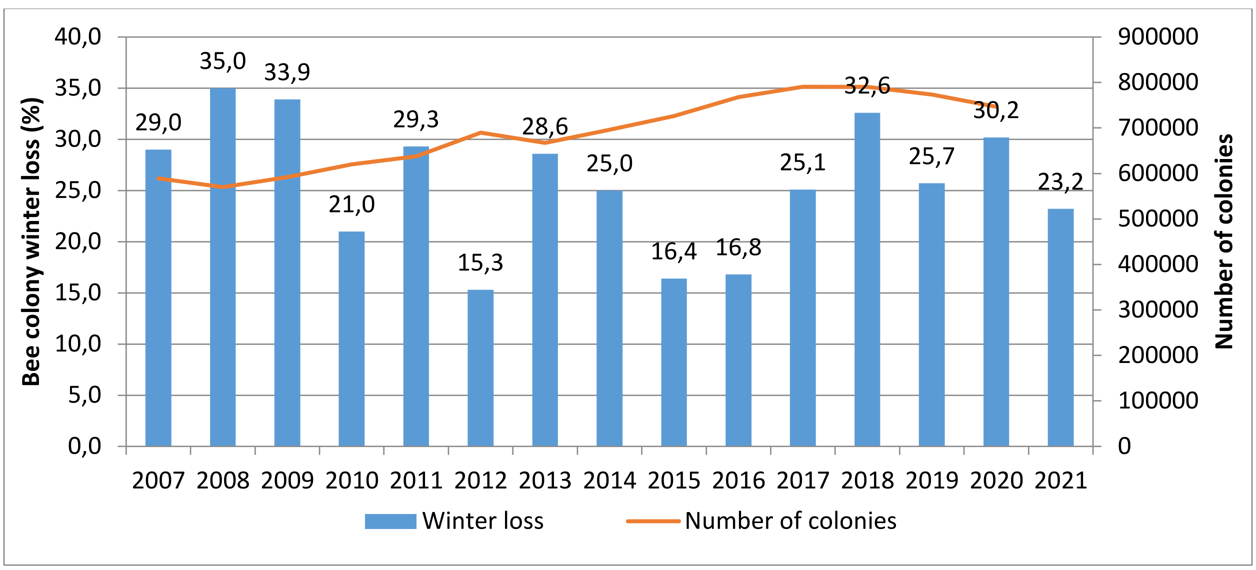

Figure 1. Summary of bee colony numbers and bee losses in Canada from 2007-2021 (based on data as reported by Stats Canada). Note that the number of colonies as reported by Stats Canada is not available for the current year.

Overall, there is more to these opposing trends than the graph may highlight. High levels of colony winter mortality are still a threat to the sustainability of the beekeeping industry in Canada. Beekeepers must be vigilant and practice expert pest management for serious pests endemic to the honey bee population in Canada (e.g. varroa mites), with little room for error.

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 going out of business. As well, this survey and report do not take into account mid-season losses of honey bee colonies or queens that beekeeper 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. While provincial estimates demonstrate regional trends in the overall winterloss, within each province the results vary between different regions and beekeeping operations with some experiencing greater or lower losses than the provincial average. Both of these extremes demonstrate that while there are operations that have been highly successful, the risks of losing large proportions of colonies is still present 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 stresses caused by parasites in combination of 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 (Apivar®) or to 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 - 2021 Core Winter loss survey questions

The followings are the core questions that will be used in 2021 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[4] were put into winter in fall 2020?

Outdoor wintering	Indoor wintering	Total

2. How many full sized colonies[1] survived the 2020/2021 winter and were considered viable[5] 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 2020**? 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)	

[4] Does not include nucleus colonies
[5] 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 2020**? 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 2020 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 2020**? 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 2020**? 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 2020**? 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 2020**? 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*) ________________________	

11. On a scale of 1 to 10, how would you rate the impact of issues linked to the COVID-19 pandemic on your winter mortality?

Score (on a scale of 1 to 10)

a. *If you answered 6 or more, please answer the following question:*
   What is the nature of the issues related to COVID-19 that had a significant impact on your winter mortality?

☐	The person/people looking after my hives, myself or a loved one became ill
☐	Access to supplies necessary for my beekeeping management (ex: syrup)
☐	Access to bees (queens, packets of bees, etc.)
☐	Access to labour (ex: temporary foreign worker)
☐	Movement restrictions (ex: between regions or provinces)
☐	Other: __________________