Alberta 2008 Survey of Honey Bee Colony Winterkill and Management Practices

Final Report

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By: Murray Hartman[1] and Medhat Nasr[2], Ph.D.

1. Oilseed Specialist, Crop Development – Food, Agriculture Research Division, Alberta Agriculture and Rural Development, 5030 - 50 Street Lacombe, AB, T4L 1W8
2. Provincial Apiculturist, Pest Management, Agriculture Research Division, Crop Diversification Centre North, 17507 Fort Road NW, Edmonton, AB, T5Y 6H3

Executive Summary

In the spring of 2008, Alberta beekeepers once again found high winterkill losses in overwintered bee colonies. To determine the extent and possible causes of the winterkill, Alberta Agriculture and Rural Development conducted a survey of 112 beekeepers, who have 400 or more colonies. Survey results show that 30% of Alberta bees were killed in the 2007/2008 winter, which is similar to the unusually high winterkill found the previous year. This recent high rate of winterkill is twice the long-term average in Alberta. Of the surviving colonies, 14% were weak with less than three frames covered with bees. The survivorship and production of these weak colonies in 2008 is uncertain. The winterkill plus weak colony percentages was highest in the Peace River area, followed by central regions and was lowest in southern Alberta. Throughout the entire province, 50% of the beekeepers reported losing one-third or more of their productive colonies in 2008 due to dead and weak colonies.

Overwinter losses in Alberta during 2007/08 may be attributed to a combination of several causes. Most beekeepers are now finding varroa mite infestations in the spring, despite more fall treatments. Most beekeepers are reporting varroa resistance to Check-Mite or Apistan. Because of this, they are changing to alternative treatments to combat the mites. However, the available alternative treatments (formic acid and oxalic acid) do not appear effective. Higher numbers of dead and weak colonies are associated with the presence of varroa mites in the spring and with resistance. The late discovery of varroa mite resistance has made it difficult to treat varroa in an acceptable time with alternative products to protect winter bees. Late and multiple treatments increase the stress on colonies, making them more vulnerable to winterkill factors. Survey participants ranked varroa mites as the most important factor contributing to winterkill, and many commented that additional effective control products are desperately needed.

The prolonged winter coupled with a cold, late spring aggravated the winterkill problem in Alberta. Outdoor wintered colonies experienced higher numbers of dead and weak colonies than indoor wintered colonies in the same region. Honey bees wintered out doors were not able to defecate in early spring. Consequently, high percentages of colonies died or were weakened by high levels of Nosema. Participants ranked winter weather as the second most important factor behind varroa mites, and cold spring weather was the most common comment provided that effected colony build up.

In the spring of 2008, most beekeepers reported Nosema-like symptoms despite fall treatment with fumagillin. Though beekeepers fed this medicated sugar syrup in the fall in order to control Nosema, the chemotherapy did not work effectively. Assuming these symptoms were caused by Nosema, the percentage infected positively correlates to the dead and dead plus weak colonies.

The combination of fall weather conditions during treatment time and labor availability affected some beekeepers and the development of winter bees in their colonies. The number of dead and weak colonies was substantially higher in this group.

Introduction

Over the winter of 2006/07, Alberta beekeepers experienced twice as much winterkill in overwintered colonies than usual. In the spring of 2008, Alberta beekeepers found high winterkill losses again. To determine the extent of winterkill damage, Alberta Agriculture and Rural Development conducted a survey of 112 beekeepers with 400 or more colonies. The Ag-Info Centre conducted the Bee Loss and Management Survey (Appendix 1) in May 2008. The results represent 201,000 colonies, representing about 75% of Alberta's colonies. A total of 91 responses were received (81 percent response rate).

The data is summarized by five agricultural regions (Appendix 2). Region 2 has a limited number of responses due to having a limited number of commercial beekeepers with 400 colonies or more. Statistical differences were determined by t-tests (one or two-tailed, depending upon hypothesis).

Results

From the descriptive statistics in Table 1, there were differences in the overwintering methods in the various regions. Beekeepers in central regions 2, 3 and 4 primarily overwintered colonies outdoors in Alberta. In the south region, the majority of colonies were overwintered outdoors in Alberta, but there were also a significant portion (30%) of colonies overwintered indoors. In region 5 (Peace River region), most colonies were overwintered indoors (37%) or in British Columbia (43%).

Table 1. Descriptive Statistics of Colonies and Wintering Method

Descriptive Statistic	Region					Overall AB
	1	2	3	4	5	
Total overwintered Alberta colonies in fall 2007						
# of cases	16	7	17	24	27	91
# of colonies	43649	15188	26730	56327	59114	201008
% of total colonies	22%	8%	13%	28%	29%	100%
Average colonies	2728	2170	1572	2347	2189	2209
Median colonies	1745	2044	1024	1707	1800	1688
Overwintered colonies outdoor in Alberta						
# of cases	13	7	17	22	13	72
# of colonies	29299	14428	23548	50232	12252	129759
Average colonies	2254	2061	1385	2283	942	1802
Median # of colonies	1600	2044	900	1454	750	992
Overwintered colonies indoor in Alberta						
# of cases	5	0	4	2	14	25
# of colonies	12950		2302	1295	21602	38149
Average colonies	2590		576	648	1543	1526
Median colonies	1050		458	648	1282	1050
Colonies from Alberta overwintered outdoors in British Columbia						
# of cases	1	1	1	2	10	15
# of colonies	1400	760	880	4800	25260	33100
Average colonies	1400	760	880	2400	2526	2207
Median colonies				2400	2625	1800

In most regions, the average number of colonies per beekeeper is skewed by a few large beekeeping operations, and thus the median (value where half the cases are higher and half are lower) better represents the "middle" or central value. After the high winterkill losses of 2007, Alberta beekeepers spent considerable efforts to replace 2006/2007 dead colonies and increase number of colonies. Therefore, the average colony numbers increased by 16 percent going into the winter of 2007/08 compared to 2006/07.

2007 Crops for Bee Forage

Almost all responses indicated that two or more crops were the source of bee forage. Honey produced in Alberta is mainly multifloral. Over all beekeeper responses, the average percentage of bee forage provided by the crops were: commercial canola (41 percent), canola hybrid seed (52 percent), clover (31 percent), hay (37 percent) and others (21 percent). Other crops were mainly alfalfa or borage. Many beekeepers had difficulty answering this question, since various colonies are moved around to different crops in many operations.

Canola Seed Pollination

Thirty-two (38 percent) of the responses indicated canola hybrid seed pollination, and 22 indicated that they rented colonies for hybrid seed pollination. About half of these were from region 1 and this represented more than 69 percent of the colonies in that region. The total colonies reported as rented for hybrid canola seed production and BC fruit were 47,459 and 12,250, respectively. Most beekeepers move colonies to another crop after hybrid seed pollination is completed. The canola hybrid seed industry in southern Alberta required about 45,000 colonies in 2006, 60,000 colonies in 2007, and 70,000 were estimated for 2008 (industry data provided to Dr. Nasr).

Honey Production

Honey production in 2007 for these commercial beekeepers was lower than 2006 but average (Table 2). Five year honey production average in Alberta has been between 110 and 134 lb/hive (Alberta Agriculture Statistics Yearbook, 2005). Honey production in region 1 is lower, partly due to high stocking rates needed for hybrid canola seed pollination. Decreased honey production may be partly due to weak colonies caused by more splitting of colonies in the spring to replace dead-outs and increased colony numbers after the reported high winter loss of 2006/07.

Table 2. Beekeeper Respondent 2007 Honey Production (lbs/hive)

Descriptive statistics	Region					Overall
	1	2	3	4	5	
# of cases	16	5	15	22	25	83
Average lbs per hive	100	109	132	152	147	134

2007 Precipitation

The survey asked beekeepers to rate their summer and fall precipitation (low, medium or dry). In region 1, the majority of beekeepers rated summer and fall moisture conditions as dry. Regions 2 and 3 rated summer/fall moisture as dry to medium. Region 4 was rated as medium for summer moisture but dry for fall. In the Peace region 5, the majority rated the summer and fall moisture as medium. This generally agrees with the Alberta precipitation map for May through August of 2006 (appendix 3). However, the Alberta fall precipitation map shows that drier conditions than normal were experienced in regions 3, 4 and 5 while southern areas of region 1 experienced above average fall rain (Appendix 4). The dry fall probably explains in part the lower honey production in the Peace and central regions.

Winterkill and Weak Colonies

There is a trend for winterkill to increase from south to north in Alberta – region 1 has the least, followed by regions 2, 3 and 4, and the Peace region is the highest (Table 3). This is largely due to colder winters of longer duration in northern Alberta. March and April temperatures in 2008 were colder than normal (appendix 5) which would affect the Peace region relatively more than other regions. In spring Chinook winds with high temperatures allow bees to go out of the hives and defecate in southern Alberta. Consequently, it reduces the negative impacts of Nosema on the survivorship of bee colonies in early spring. The winterkill indoors in every region was lower with outdoor wintering methods. For the two regions having the most indoor wintering (regions 1 and 5), there was a statistically lower mortality for indoors in region 5 and for overall in Alberta ($p=0.08$ and 0.07, respectively). The higher mortality with outdoor wintering methods suggests that winter weather is one factor contributing to the winterkill. Winter weather received the second highest ranking overall for the last survey question (beekeeper was asked to rank four suggested main causes). However, the mortality with indoor wintering in region 5 was higher than indoors in other regions ($p=0.005$), which may be due to the duration of winter in the north, but factors other than winter weather may be implicated. The type of wintered colonies can also be an important factor in wintering success. In Northern Alberta mature colonies and newly made colonies (splits) are wintered in doors, but Southern Alberta beekeepers winter newly made colonies (splits) in doors to provide better conditions for survivorship. Generally, new bee colonies made out of splits with young queen and strong healthy bee populations have low winter mortality.

The winterkill percentage was not statistically correlated to weak colonies. Similar to the dead data, weak colonies percentage was highest in region 5. Opposite to the dead data, the indoor wintering method was associated with an increased amount of weak colonies compared to outdoor ($p=0.01$). However, the weak colonies were similar between indoor and BC wintering methods.

Overall in the province, 50% of the beekeepers reported losing more than one-third of their productive colonies due to winterkill and weak colonies. The Peace Region suffered the highest losses, with half of the producers losing more than 50% of their colonies. The higher winterkill in the Peace region is likely due to a combination of many weather and management factors, some of which will be discussed later in this report.

Table 3. Dead and Weak Colonies Found in the Spring of 2008

Descriptive statistics	Region					Overall AB
	1	2	3	4	5	
% Winterkill 2007/2008						
Average % dead colonies outdoor AB	24	31	33	30	42	32
Average % dead indoor AB	19	-	15	17	32	26
Average % dead outdoor BC	19	20	30	28	33	30
Average dead % in region	22	29	30	29	36	30
Median dead % in region	19	20	24	25	33	26
Winterkill in previous 5 years						
Average % dead previous 5 years	15	21	22	17	20	19
Weak colonies in spring 2008						
Average % weak colonies outdoor AB	10	8	14	9	17	12
Average % weak colonies indoor AB	11	-	11	25	22	18
Average % weak colonies outdoor BC	6	14	0	30	19	17
Average weak colonies % in region	10	9	13	11	20	14
Median weak colonies % in region	6	10	10	9	15	11
Winterkill and weak colonies in 2007/2008						
Average % winterkill + weak colonies	32	38	43	40	56	44
Median % winterkill + weak colonies	25	30	34	34	48	37

Bee Disappearance and Starvation

Approximately half of the responses (Table 4) indicated that bees possibly disappeared (yes and not sure groups). Disappearance was reported in every region. Ignoring the not sure group, there was a tendency for higher losses in the group reporting disappearance ($p=0.10$ for dead percent, and $p=0.02$ for dead + weak percent). Currently, causes of disappearance are unknown.

Table 4. Bee Disappearance and Starvation Responses

Descriptive statistics	Region					Total	Overall Winterkill (%)
	1	2	3	4	5		
Disappearance:	Numbers of responses						
# of No responses	11	5	8	10	14	48	27
# of Yes responses	3	2	7	8	9	29	32
# Not sure	2	0	1	4	3	10	45
Starvation:							
# of No responses	8	7	9	18	19	61	33
# of Yes responses	7	0	7	5	7	26	26
# Not sure	1	0	1	0	1	3	31

The majority of responses did not report starvation (68%) as shown in Table 4. There was an unexpected tendency for lower mortality and dead + weak percent (data not shown) in the group reporting starvation. This discrepant result is likely due to a higher proportion of "yes" responses in the south region where losses are lower on average.

Starvation was ranked by participants as least important in the final question of the survey. The responses in this survey suggest that disappearance or starvation were not major factors in the higher overwinter losses in Alberta and that colony collapse disorder (as described in the USA) is not in Alberta.

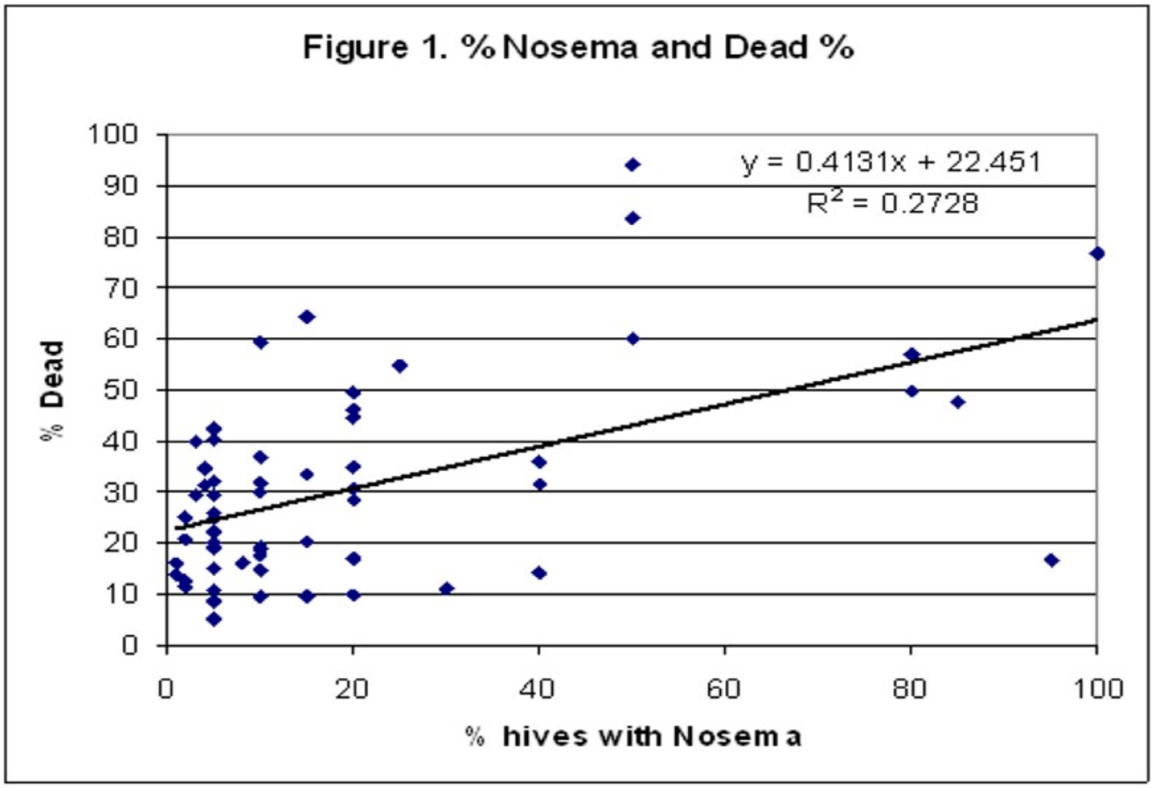
Nosema

The majority (78%) of responses indicated that Nosema-like infection symptoms were noticed in the spring of 2008, and in every region (Table 5). The symptoms of Nosema infection include disjointed wings, distended abdomens and fecal materials on combs and the entrance of hives. The particular symptom of fecal materials on combs and the entrance of beehives are often correlated with dysentery. When dysentery occurs, the disease is aggravated and effectively spread in the colony and the colony deteriorates beyond help. Results from 2006/2007 confirmed that colonies with symptoms of Nosema-like infection were infected with Nosema. Using genome analyses, *Nosema ceranae*, a new species of Nosema, was found in Alberta in addition to the known *N. apis.* Microscopic confirmation was not conducted for 2008. Therefore, the reported infection is referred to as Nosema-like infection. The winterkill percentage was not statistically different between the no and yes groups overall. This may be due to a large number of yes responses involving low levels of Nosema (see Figure 1).

In the yes group reporting Nosema-like infection, the percentage of colonies infected is highest in regions 4 and 5. There were a few high responses that skewed the averages in several regions, and thus median values are usually much lower.

Table 5. Nosema-Like Infection Responses

Descriptive statistics	Region					Overall AB	Overall Winterkill (%)
	1	2	3	4	5		
Nosema-like symptoms	Number of responses						
# of No responses	1	0	3	4	8	16	28
# of Yes responses	15	5	14	17	19	70	31
# Not sure	0	2	0	2	0	4	39
Yes group only	% colonies with Nosema-like symptoms						
Average % colonies	14	16	15	23	22	19	
Median % colonies	5	15	5	10	20	10	
% using fall fumagillin	88%	57%	71%	78%	96%	82%	



Using only "Yes" responses to Nosema symptoms noticed in the spring, positive correlations between percentage of colonies with Nosema and dead percentage or dead + weak percentage were statistically highly significant (r^2=0.27, p=0.00001 and r^2=0.22, p=0.0001, respectively). Using only region 5 data (highest Nosema and highest winterkill), there was a highly significant correlation of percent colonies infected with Nosema and winterkill percentage (p=0.01, r^2 =0.35). The low r^2 values show that Nosema explains a minority of the winterkill variation.

Overall, Nosema infection in the spring of 2008 was associated with higher percentage of dead and weak colonies. In northern climates, Nosema is considered as a silent killer of honeybees, and an infection often will increase winterkill and weak colonies in the spring. Although most (82 percent) of the beekeepers in this survey fed Nosema medication (fumagillin) in their fall feed, the efficacy of this practice appears poor. The group that fed fumagillin in the fall of 2007 reported the same incidence of Nosema symptoms in the spring of 2008 as the group that did not fall treat (data not shown, 75 percent versus 78 percent). Also, the percentage of colonies infected by Nosema was not statistically different (p=0.39) between the fall fumagillin treated and untreated groups overall. Nosema was ranked third in the final survey question as a factor explaining winterkill.

Varroa mites

The majority of respondents (81 percent) found varroa mites in the spring of 2008 (Table 6) in spite of most (89 percent) beekeepers having treated in the fall of 2007 (Table 7). In contrast, from the survey conducted in 2007, 58 percent of the respondents found varroa in the spring of 2007. The presence of varroa mites in the spring of 2008 was associated with significantly higher dead and dead + weak percentage of colonies (p=0.04 and 0.002 respectively). The majority (89 percent) of beekeepers felt they had enough time to treat for varroa mites in the fall of 2007 after harvesting honey (Table 8). In the fall untreated group, 56 percent reported varroa the next spring, compared to 85 percent in the treated group. The percentage of dead colonies in the spring of 2008 was statistically similar between the fall varroa treated and untreated groups (0.26). There was a tendency (p=0.10) for a fall varroa treatment to increase dead + weak percentage the next spring. This situation could occur if the treatment was ineffective on varroa but added some stress to wintering bees. For example, after noting failure of treatments by Apistan or Check-Mite, some beekeepers then treated with formic or oxalic acid late in the fall, but the early cold onset of winter greatly reduced the efficacy of the treatment. By this time, varroa had already damaged winter bees and additional treatments added more stress on the honey bees. Formic acid was the most popular varroa treatment in the fall of 2007. It was used as a single treatment or in a combination with other treatments such as oxalic acid. Compared to the fall of 2006, Apistan and CheckMite$^+$ use has declined, whereas formic and oxalic acid has increased, apparently due to decreasing efficacy and development of resistance by mites to the first two miticides.

Table 6. Varroa Mites Found in the Spring of 2008

Descriptive statistics	Region					Total AB	Overall dead %	Dead + weak %
	1	2	3	4	5			
# of No responses	4	2	3	6	2	17	24	31
# of Yes responses	12	5	14	17	24	72	32	48

The most popular varroa spring 2008 treatment was formic acid by itself in a combination with other treatments (Table 9). In contrast, the most popular varroa treatments the previous two springs were Apistan (2007) and untreated (2006). Beekeepers are responding to finding varroa more frequently. They are treating more for varroa, and changing varroa mite control products to avoid or deal with resistance.

Table 7. Varroa Mites - Fall 2007 Treatments

Treatment method	Responses
A	6
A,F	5
A,F,OL	2
A,OL	2
C	9
C,A,OL	1
C,F	8
C,OL	4
F	28
F,OL	3
F,OL,OS	1
F,OS	5
N	10
OL,OS	1
OS	4
Total	89

% of responses that included treatment:				
None	Apistan	Check-Mite	Formic	Oxalic acid Liq / sub
11	18	21	57	16 / 12
% dead in fall treated: 32 % dead in fall untreated: 25 % dead + weak in fall treated: 46 % dead + weak in fall untreated: 34				
2006 Fall treatments % of responses				
19	24	22	40	14

A – Apistan; C – CheckMite$^+$; F -- Formic acid; N – none; OL /OS – Oxalic acid liquid / sublimation.

Table 8. Was There Enough Time to Treat for Varroa Mites in the Fall 2007?

Descriptive statistics	Overall	Overall winterkill %
# of No responses	10	30
# of Yes responses	77	31

Most of the respondents indicated that they had varroa resistance to CheckMite$^+$ or Apistan or were not sure (Table 10). Only 10 % reported no resistance to CheckMite$^+$, 19% reported no resistance to Apistan and eight per cent reported no resistance to both. The winter losses are lower (p values 0.05 and 0.06) in groups reporting no resistance compared to the combined “yes” and “not sure” groups. The small group reporting no resistance to both CheckMite$^+$ and Apistan had the lowest winter losses (20% dead, 30% dead + weak). Varroa was ranked most important by beekeepers in the last survey question (rank suggested causes of winter losses). The data discussed above suggests that the recent high winter losses can be partly attributed to an increasing infestation of Alberta bee colonies by varroa mites, and resistance to certain popular registered miticides.

Table 9. Varroa Mites - Spring 2008 Treatments

Treatment method	Responses
A	11
A,F	9
A,F,OS	1
A,OL	1
A,OS	3
C	9
C,A	1
C,F	6
C,F,OS	1
C,OL	2
C,OS	1
F	23
F,OL	2
F,OS	2
N	12
OL	2
OS	4
Total	90

Percentage of responses that included treatment:				
None	Apistan	Check-Mite	Formic	Oxalic Acid liquid / sublimation
13	29	20	44	7/12
2007 spring treatments				
11	39	22	27	9 / 2
2006 spring treatments				
33	27	24	15	8

A – Apistan; C – CheckMite^{+}; F - Formic acid; N – none; OS/OL– oxalic acid liquid / sublimation.

Table 10. Dead and Weak Colonies Percent in Groups With Resistance to CheckMite^{+} or Apistan

Resistant to CheckMite^{+}			
	No	Not sure	Yes
# of responses	9	43	36
% dead	25	31	33
% dead and weak	34	45	48
Resistant to Apistan			
	No	Not sure	Yes
# of responses	17	36	35
% dead	25	33	33
% dead and weak	37	50	46

Tracheal Mites

The majority of respondents are treating for tracheal mite in the spring of 2008 (Table 11) and fall of 2007 (Table 12) whereas two years ago, 57% were not treating in the spring. When treating for tracheal mite, most beekeepers use formic acid. Analyses of 2006/2007 bee samples showed that tracheal mite prevalence was quite low in most of beekeeping operations where formic acid was used.

In 2008, there was no difference in dead or dead+weak percent between fall tracheal mite treatments and untreated groups (both 31 and 45% respectively). Keep in mind that formic acid can be used to treat for both varroa and tracheal mites, with more applications needed for varroa. Thus, since most beekeepers treat for varroa with formic acid, then tracheal mites are also being controlled.

Table 11. Tracheal Mite Treatments in the Spring of 2008

Treatment method	Responses		Percentage of responses that included treatment:				
F	41		None	Formic	Oxalic	Menthol	Other
F,Ox	2		38	49	9	2	4
F,Ox,Ot	1						
M	2		2007 Spring treatment %				
N	34		43	41	3	8	5
Ot	3						
Ox	6		2006 Spring treatment %				
Total	89		57	26	8	-	13

F- formic acid; M – menthol; N – none; Ot – other treatments; Ox – oxalic acid.

Table 12. Fall 2007 Tracheal Mite Treatments

Treatment method	Responses		Percentage of responses that included treatment:				
F	56		None	Formic	Menthol	Oxalic	Other
F, Ox	1		26	63	6	3	1
M	5						
N	23						
Ot	1		Fall 2006 treatment %				
Ox	13		38	50	-	3	10
Total	89						

F- formic acid; M – menthol; N – none; Ot – other treatments; Ox – oxalic acid.

American foul brood

The majority of respondents treated for American foul brood in the spring of 2008, usually with oxytetracycline (Table 13). The treatments are similar to those used in the spring of 2007.

There was no difference in winter losses between the untreated and treated group (data not shown).

Table 13. American Foul Brood Treatments in the Spring of 2008					
Treatment method	Responses		Percentage of responses that included treatment:		
N	31		None	Oxytetracycline	Tylosin
O	34		41	47	12
O,T	1				
T	8		Spring 2007 treatment %		
Total	76		36	52	13

N – none; O – oxytetracycline; T – Tylosin.

Fall feed
Nearly all the respondents used sugar syrup as the fall food source (Table 14) and that bees took some or most of the fall feed source down in the hive (Table 15).

Table 14. Fall 2007 Bee Feed Source	
Fall Food Source	% of responses
Corn syrup	1
Sugar syrup	88
None	1

Table 15. Observations on Bees Taking Fall Food Source Into Hive	
Did bees take feed down	% of responses
No	1
Yes	88

The majority of respondents (72%) reported that brood chambers were not plugged with honey, and the winterkill was similar between the no and yes groups (Table 16).

Table 16. Brood Chambers Filled With Honey							
Region	1	2	3	4	5	Prov	Overall winterkill %
# of No responses	15	6	10	16	16	63	30
# of Yes responses	1	1	7	6	10	25	33

Time for development of winter bees

The majority of respondents (82%) felt that there was enough time for winter bees to develop in the fall of 2007 (Table 17). There was more dead (p=0.004) and dead+weak (p=0.002) in the combined group "not enough time + not sure" than the group reporting enough time for winter bee development. The late fall temperatures in 2007 that were slightly warmer than normal (see appendix 5) and early harvest of honey likely contributed to the good winter bee development in most cases.

Table 17. Was There Enough Time in the Fall for Winter Bees to Develop?								
Descriptive statistics	Region					Total	Overall AB dead	Overall dead + weak colonies
	1	2	3	4	5			
	number of responses						%	%
No responses	0	0	3	3	3	9	44	56
Not sure	1	2	2	0	2	7	49	63
Yes responses	15	5	12	20	22	74	27	42

Ranking of 4 suggested winterkill causes

This question was not answered consistently by beekeepers – some just checked relevant causes (no ranking), others only indicated one or two major causes, and others added other pertinent factors. Varroa mite was ranked the most important factor (highest number of responses as 1 and 2), followed by winter weather, then by Nosema and starvation was rated least important.

Comments provided by participants

Most participants provided comments that have been summarized into the following topics (number of responses in brackets):
The spring of 2008 was exceptionally cold which contributed to winterkill (15).
Varroa mites were a significant problem (14).
Need more pest control products registered, especially miticides (9).
High queen loss or problems with various queen sources (10).
Harsh winter (3).
Poor fall forage (2).
Nosema was a significant problem (5).
Need to open borders for packages (3).
There were two aspects identified in the comments that were not addressed by the survey questions. The very cold spring weather in 2008 was mentioned most often, and April / early May temperature departures support this (see Appendix 6). The impact of queen source, and queen health impacts from multiple pest treatments was often mentioned, and this may be contributing to recent high winterkill.

Conclusions

Survey results show that 30% of Alberta bees died during the 2007 / 2008 winter, similar to the previous year. These recent winterkills are twice the long-term average in Alberta. It was also reported that 14% of the surviving colonies were weak with less than three frames covered with bees. The recovery of these weak colonies was hindered by the cold spring. The survivorship and production of these weak colonies in 2008 is questionable. The winterkill plus weak colonies percentage was lowest in region 1, followed by central regions 2, 3 and 4, and region 5 was the highest. Overall in the province, 50% of the beekeepers reported losing more than one-third of their productive colonies in 2008 due to winterkill and weak colonies. The Peace region suffered the highest losses.

The average number of overwinter colonies per beekeeper increased in the fall of 2007 compared to 2006, which indicates that they spent considerable efforts to rebuild after the high winterkill losses of 2006/07.

In Canada, the overall overwinter mortality in 2006/2007 was 29%, which is twice the long-term average (15%). Average wintering losses in certain provinces such as New Brunswick (59%, representing only 3% of the country's colonies) and Ontario (37%, representing 11.7 percent of the country colonies) were very high in 2006-07. The reported high regional losses are of much greater concern across Canada. In 2007/2008 the Canadian overall average of winterkill and spring dwindling (weak colonies) is 28%. Average winter losses with spring dwindling was the highest in Alberta (44%), followed by BC (38%), Prince Edward Island (36%), Manitoba (28%) and Ontario (27%)

(CAPA report 2008:http://www.capabees.com/main/files/pdf/08canbeelossreport.pdf).

This year, losses in Alberta may be attributed to a combination of several potential causes:

- **Increasing infestation by varroa mites and failure of chemical control products.** Most beekeepers are now finding varroa mite infestations in the spring in spite of more fall treatments. They are changing varroa mite control products to avoid or deal with resistance, but the efficacy of available treatments appears poor. Most beekeepers are reporting varroa resistance (or not sure) to CheckMite+ or Apistan. Higher numbers of dead and weak colonies are associated with the presence of varroa mites in the spring and with resistance to either CheckMite+ or Apistan. Varroa mites unexpectedly developed resistance to the recently registered CheckMite+ a couple of years ago. Resistance to Apistan and the newly used CheckMite+ has continued to spread across the province. Consequently, increasing varroa mite infestations are damaging winter bees. This has made it very difficult to treat varroa in an appropriate time with alternative products to protect winter bees. Late and multiple treatments of various alternatives increase the stress on colonies, making them more vulnerable to winterkill factors. These varroa-infested and treatment-stressed bees cannot withstand winter stresses, resulting in increased secondary viral infections in bee colonies and loss of ability to thermo-regulate their cluster. Survey participants ranked varroa mites as the most important factor contributing to winterkill, and many commented that additional effective control products are desperately needed.

- **The unusually cold conditions during the 2008 late winter/spring.**The prolonged winter with a cold, late spring aggravated the winterkill problem in Alberta. Outdoor wintered colonies experienced higher numbers of dead and weak colonies than indoor wintered colonies in the same region. Honey bees wintered out doors experienced very cold spring and they were not able to defecate in early spring. Consequently, high percentages of colonies died or were weakened (spring dwindled) by high levels of Nosema. Participants ranked winter weather as the second most important factor behind varroa mites, and cold spring weather was the most common comment provided.

- **Nosema infestations are prevalent and control product efficacy is questionable.** Nosema is often responsible for winter loss, late winter and early spring dwindling and supersedure. In the spring of 2008, most beekeepers reported Nosema-like symptoms in spite of fall treatment with fumagillin. Though beekeepers fed this medicated sugar syrup in the fall to control Nosema, the chemotherapy did not work effectively. Assuming Nosema-like symptoms were caused by Nosema, the percentage of infection by Nosema was positively correlated with winterkill and winterkill plus weak colonies. In addition, prolonged cold spring weather increased the incidence of Nosema-like symptoms in northern and central regions of Alberta. Beekeepers rated Nosema as the third most important factor explaining winterkill.

- **A small group did not have enough time for winter bee development.** The combination of fall weather conditions and labor availability affected some beekeepers and the development of winter bees in their colonies. The number of dead and weak colonies was substantially higher in this group.

Acknowledgements

The authors gratefully acknowledge the Alberta Ag-Info Centre staff (especially Janet Fletcher survey lead), for conducting the survey again this year.

Appendix 1

Alberta Bee Winter Kill in 2007/2008
Alberta Agriculture and Rural Development – Agriculture Research Division

All personal information collected is protected and confidential.

Beekeeper Name: ______________________________
City/Town: ________________________
Telephone __________________________

Total number of colonies to over-winter in fall of 2007: __________________

Answer the following questions e-i only for colonies overwintered outdoors in Alberta:
Number of colonies wintered outdoor in Alberta in fall of 2007: __________________
Number of colonies found dead in spring 2008: _________
Number of colonies found weak with 1 to 3 frames in spring 2008: _____
Number of colonies surviving with 4 to 8 frames in spring 2008: _______
Number of colonies surviving with more than 8 frames in spring 2008 _______

Answer the following questions j-n only for colonies overwintered indoors in Alberta:
Number of colonies wintered indoors in Alberta in fall of 2007: __________________
Number of colonies found dead in spring 2008: _________
Number of colonies found weak with 1 to 3 frames in spring 2008: _______
Number of colonies surviving with 4 to 8 frames in spring 2008: _______
Number of colonies surviving with more than 8 frames in spring 2008 _______

Answer the following questions o-s only for colonies overwintered outdoors in BC:
Number of colonies wintered outdoors in B.C. in fall of 2007: _____________
Number of colonies found dead in spring 2008: ____________
Number of colonies found weak with 1 to 3 frames in spring 2008: _____
Number of colonies surviving with 4 to 8 frames in spring 2008: _______
Number of colonies surviving with more than 8 frames in spring 2008: _______

Percentage of bee forage provided by the following 2007 crops:
Canola (non-seed) ____ Canola hybrid seed production _____Clover ____ Hay _____
others ______________
Average 2007 honey production: _______________lb /hive
Rain in summer 2007: Heavy ____ Moderate ____ Dry ____
Rain in fall 2007: Heavy ____ Moderate _______ Dry ______
Average percentage winter mortality in the previous 5 years: _____%
Number of colonies rented in 2007 for: Hybrid canola:___________ BC berries:_________
Spring 2008 management and observations:

Did bees disappear: Yes ___ No ___ Not sure _____

Did bees starve: Yes ___ No ___ Not sure _____

ab. Did you see any Nosema infection symptoms: Yes ___ No ___ Not sure ____

ac. Percentage of colonies with nosema like infection signs:____%

ad. Did you see varroa mites in spring 2008: Yes ___ No ___

ae. Varroa treatment in the spring 2008:

None ___ CheckMite ___ Apistan ___ Formic Acid ___ Oxalic acid liquid ___
Oxalic acid sublimation _____

af. Tracheal mite treatment in Spring 2008:

None ___ Formic Acid ___ Menthol____ Oxalic acid ___ Others ___________________

ag. American Foul Brood Treatment: None ___ Oxy tet ___ Tylosin ___

Fall 2007 management and observations:

ah. What did you feed bees in the fall:

Nothing ___ Sugar syrup ___ Corn syrup ___

ai. Did the bees take the feed down: Yes ___ No ___

aj. Did you feed Fumagillin in the fall of 2007: Yes ___ No ___

ak. Were brood chambers plugged with honey in the fall of 2007: Yes ___ No ___

al. Do you think your bees had enough time to produce winter bees for 07/08 winter:

Yes ___ No ___ Not sure ___

am. Did you have enough time to treat for varroa after harvesting honey in 2007: Yes ___ No ___

an. Varroa treatment in the fall of 2007:

None ___ CheckMite ___ Apistan ___ Formic Acid ___ Oxalic acid liquid ___
Oxalic acid sublimation _____

ao. Does the varroa in your colonies have resistance to CheckMite: Yes ___ No ___ Not sure _____

ap. Does the varroa have resistance to Apistan: Yes ___ No ___ Not sure _____

aq. Tracheal mite treatment in the fall of 2007:

None ___ Formic Acid ___ Menthol_____ Oxalic acid ___ Others ___________________

Spring 2007 management:

ar. Varroa treatment in the spring of 2007:

None ___ CheckMite ___ Apistan ___ Formic Acid ___ Oxalic acid liquid ___
Oxalic acid sublimation _____

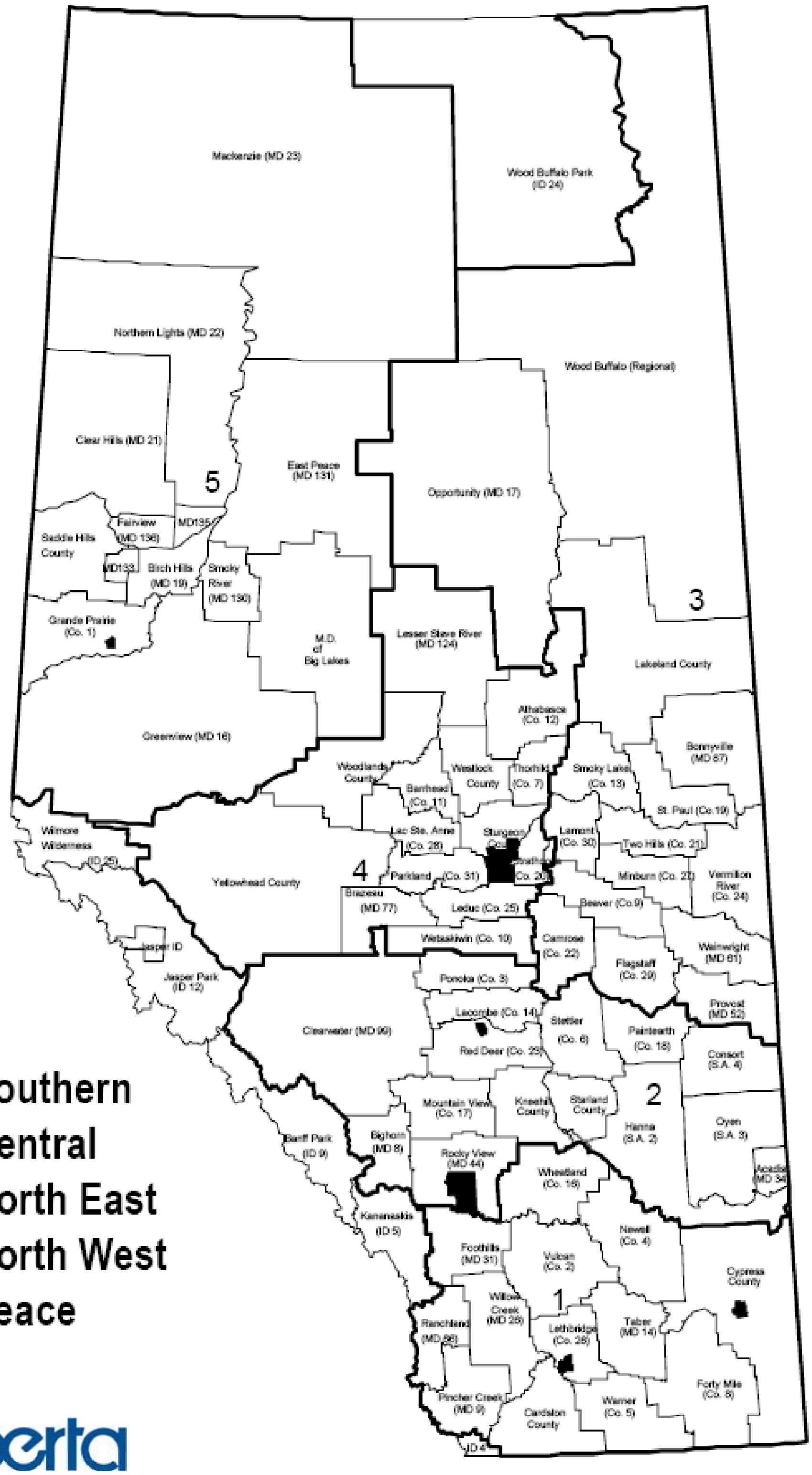
as. Tracheal mite treatment in the spring of 2007:

None ___ Formic Acid ___ Menthol_____ Oxalic acid ___ Others ___________________

at. What do you think caused your 2008 winterkill? Rank each of the following based on their importance (1 is most important):

Varroa mite control failure _______ Nosema control failure ______
Starvation ________ Harsh winter weather ________

Appendix 2



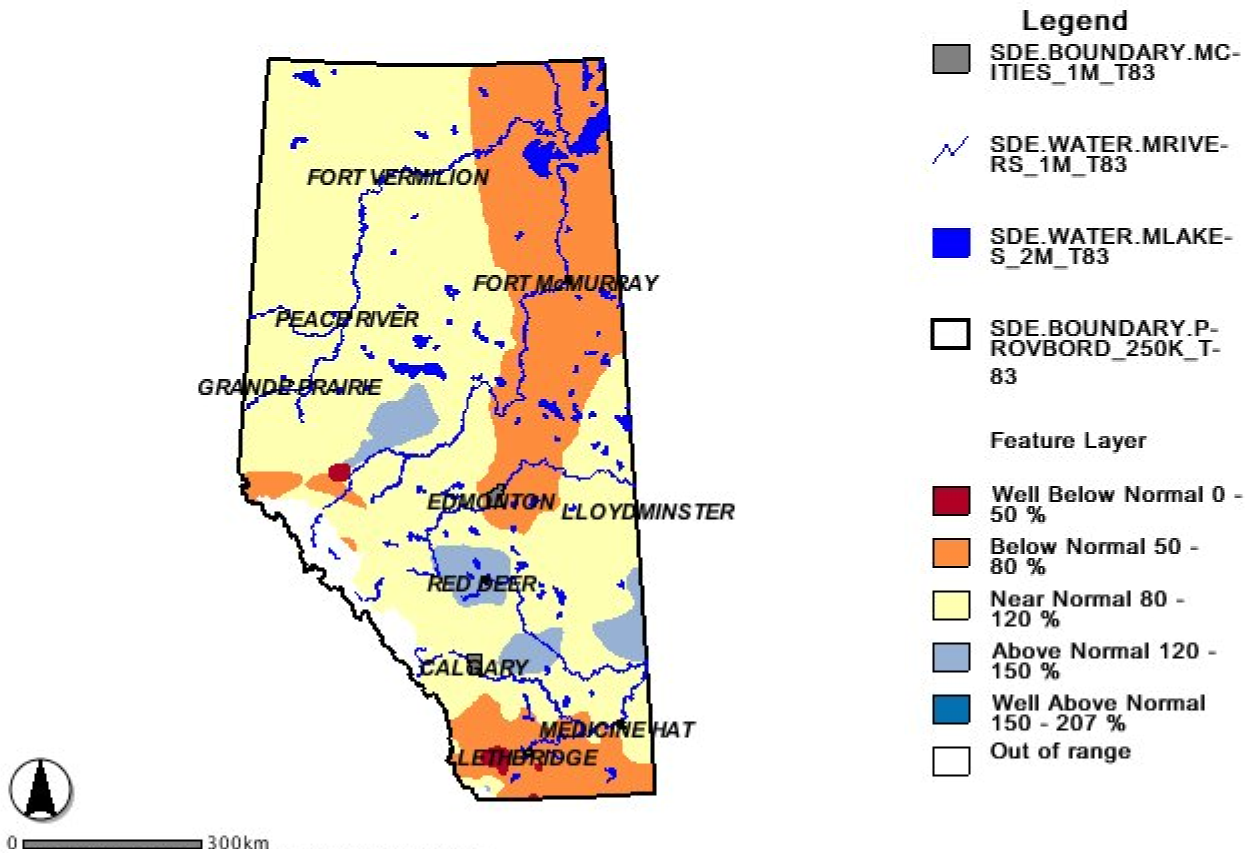
1 **Southern**
2 **Central**
3 **North East**
4 **North West**
5 **Peace**

Alberta

eMapGIS 2004(c) 02/09/2004

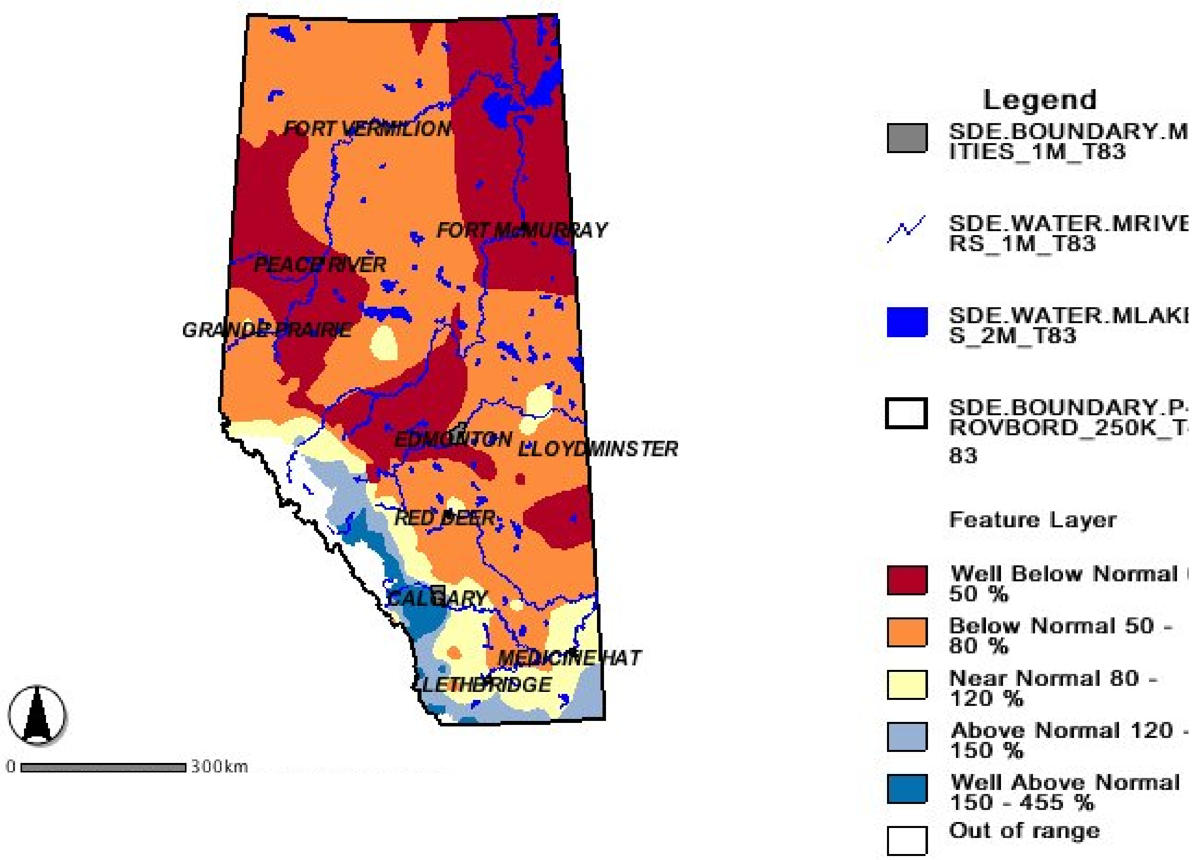
APPENDIX 3

Precipitation % of Normal From: 2007-05-01 To: 2007-08-31



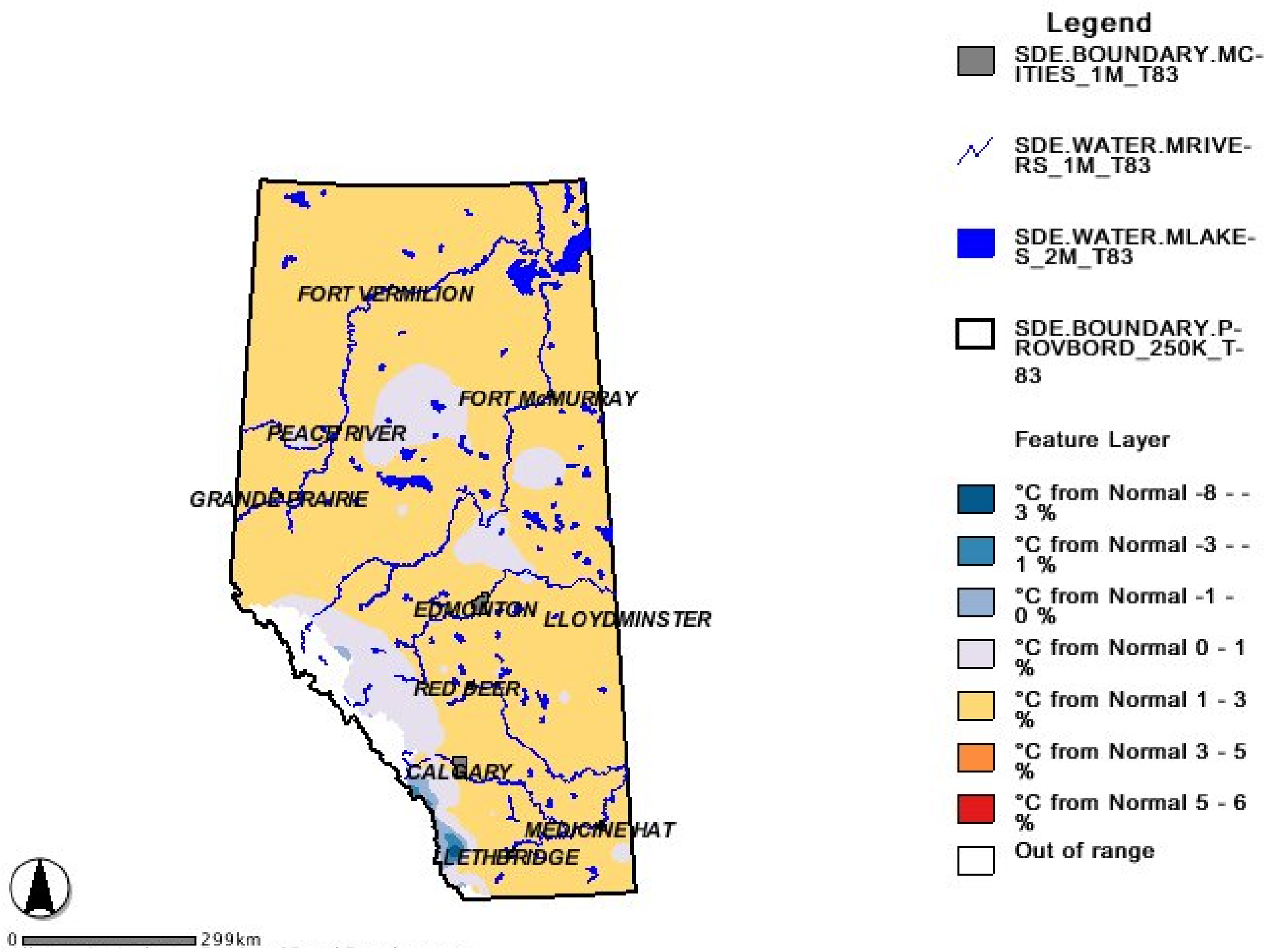
APPENDIX 4

Precipitation % of Normal From: 2007-09-01 To: 2007-10-31



APPENDIX 5

Average Daily Temp. Departures From: 2007-10-15 To: 2007-11-30



APPENDIX 6

Average Daily Temp. Departures From: 2008-04-01 To: 2008-05-16