

An Estimate of Managed Colony Losses in the Winter of 2006 – 2007: A Report Commissioned by the Apiary Inspectors of America

by DENNIS VANENGELSDORP^{1,2}, ROBYN UNDERWOOD¹, DEWEY CARON³, and JERRY HAYES, JR.⁴

Summary

In an attempt to quantify the degree and extent of losses experienced in U.S. beekeeping operations between September 2006 and March 2007, members of the Apiary Inspectors of America (AIA) were asked to survey beekeepers who represent the hobby, sideline, and commercial beekeeping industries of their state. In all, 384 beekeeping operations were surveyed representing a total of 143,816 colonies plus 9,507 splits made between September and March. The total loss and average loss of bees in all operations was 31.8% and 37.6%, respectively. Of the surveyed beekeepers, 51.9% reported “abnormally heavy losses”; these beekeepers had a total loss of 55.4%, compared to the 15.9% total loss experienced by beekeepers who reported “normal losses”. Of responding beekeepers reporting the number of hives containing few or no bees in spring, 23.8% met the specified definition of Colony Collapse Disorder (CCD), meaning that 50% of their dead colonies were found without bees and/or with very few dead bees in the hive or apiary. CCD-suffering operations had a total loss of 45.0% compared to the total loss of 25.4% of all colonies experienced by non-CCD suffering beekeepers. Most hobbyist beekeepers believed that starvation was the leading cause of death in their colonies, while commercial beekeepers overwhelmingly believed invertebrate pests (Varroa mites, honey bee tracheal mites, and/or small hive beetles) were the leading cause of colony mortality. Considerable variability in losses and in the proportion of operations suffering from CCD was reported from the various states.

Key words: colony collapse disorder, survey, winter loss

The apicultural industry has seen a dramatic decline in the number of honey bee colonies managed in the United States since the introduction of the honey bee tracheal mite and the Varroa mite in the 1980s. Nationwide colony numbers have dropped from 4.5 million managed colonies in 1980 to 2.4 million in 2005¹. These numbers are derived from USDA-NASS figures,

which may underestimate the true decline of managed colonies. For example, in Pennsylvania, where state law requires the registration of all managed colonies, a 48% decline in the number of managed colonies between 1987 and 2005 was documented, while the decline derived from the USDA-NASS figures suggested a smaller, 41% decline for the same period.

Both state and national figures, however, may mask true losses experienced by the apicultural industry as these annual figures simply reflect gross aggregates of total losses and gains in colony numbers per year. Beekeepers have become adept at replacing dead colonies by making splits or purchasing packages. For example, after a winter of heavy losses in the northern U.S., a *Bee Culture* survey of beekeepers reported that 50% of Pennsylvania colonies were lost^{2, 3}, yet state figures documented only a slight decline of 5% over the two years (31,105 colonies in 2000 vs. 29,279 colonies in 2001). Overwintering losses in the Pennsylvania and mid-Atlantic regions in 2002 were 12%, but registrations in Pennsylvania actually increased from their 2001 level to 30,067 managed colonies. Continuing surveys in the mid-Atlantic region indicate that losses since 2000 have been averaging around 30%⁴.

In an attempt to quantify the degree and extent of losses experienced in beekeeping operations in the United States between September 2006 and March 2007, we requested that all members of the Apiary Inspectors of America (AIA) survey beekeepers in their state between March 14 and March 23, 2007. The survey asked beekeepers 1) how many colonies they had in September, 2) how many colonies they had in March, 2) if they made splits or increases over the period, 4) if they considered the losses they experienced to be normal, 5) how many lost colonies had no or very few bees in them, and 6) to what the beekeeper attributed the losses. AIA members were asked to contact beekeepers who they felt were representative of their state's apiary industry, while sampling beekeepers who represented the hobby, sideline, and commercial beekeeping industries in their state.

In all, AIA members from 15 states responded to the request. This includes two states, Vermont and Wisconsin, which reported that they could not complete the request because weather conditions did not facilitate the opening of hives in March.

In all, 396 beekeepers were surveyed. These beekeepers managed a total of 160,526 colonies at the end of September 2006. Two of these beekeepers did not report the number of bees they had remaining in March of 2007 and so were removed from the analysis. An additional 10 beekeepers indicated that they had made splits, but made no indication of how many increases they had made. These beekeepers were also removed from the analysis as their losses could not be calculated. In all, 384 beekeeping operations were left in this study, and the total number of colonies managed by these beekeepers in September 2006 was 143,816 and they reported having made 9,507 splits between September and March. The total loss ((number of colonies lost / (number of

¹ The Pennsylvania State University
Department of Entomology
501 ASI Building
University Park, PA 16802

² The Pennsylvania Department of Agriculture
Bureau of Plant Industry – Apiculture
2301 N. Cameron St.
Harrisburg, PA 17110

³ University of Delaware
Department of Entomology and Wildlife Ecology
250 Townsend Hall
Newark, DE 19716

⁴ The Florida Department of Agriculture
Bureau of Plant and Apiary Inspection
Apiary Inspection Section
Division of Plant Industry
P. O. Box 147100
Gainesville, FL 32614

Table 1: Average and total losses experienced by all responding beekeepers.

Operation Size	No. of Respondents	Colonies		
		Managed in September 2006 plus increases	Average Loss % (95% CI)	Total Loss % (95% CI)
1 to 50	268	2,684	37.1 (33.1 – 41.0)	35.4 (29.7 – 41.1)
51 to 500	67	11,235	40.2 (33.1 – 47.4)	38.0 (26.4 – 49.6)
500 +	49	139,404	37.3 (30.1 – 44.5)	31.2 (18.2 – 44.2)
Total	384	153,323	37.6 (31.5 – 43.7)	31.8 (27.1 – 36.5)

Table 2: Total losses experienced by beekeepers reporting “normal” and “non-normal” losses.

	Operation Size	No. of Respondents	Colonies Managed in September 2006 plus increases	Total Loss %
Normal	1 to 50	103	1,222	20.9 (18.6– 23.2)
	51 to 500	24	4,591	17.3 (16.2 – 18.4)
	500 +	20	62,122	15.7 (15.4 – 16.0)
	Total	148	67,935	15.9 (15.6 – 16.2)
Not Normal	1 to 50	89	1,092	60.5 (57.6 – 63.4)
	51 to 500	42	6,592	52.4 (51.2 – 53.6)
	500 +	29	77,282	43.7 (43.3 – 44.0)
	Total	160	84,966	55.4 (55.1 – 55.7)

colonies in September + splits or increases made)) x 100%) and average loss ((sum of individual operational losses/number of operations) x 100%) were calculated. All reporting beekeepers had a total loss of 31.8% and an average loss of 37.6% over the period (Table 1).

Generally, the total loss experienced by commercial beekeepers (managing more than 500 hives) was the lowest at 31.2% (Table 1) when compared to hobbyist (managing 1 to 50 colonies; 38.0%) and sideline (managing 51 to 500 colonies; 35.4%) beekeepers. However, the average loss reported by each group was approximately the same (Table 1).

Of those beekeepers who responded to the question of whether the losses they experienced were “normal” (n = 308), 51.9% reported non-normal losses. Overall, the average loss experienced in operations reporting normal losses was 27.5%, while the total loss experienced by this group was 15.9% (Table 2, Figure 1). This compares to the average loss of 64.0% and a total loss of 55.4% for beekeepers reporting a non-normal losses (Table 2, Figure 1). Hobbyist beekeepers reported higher losses (20.9% normal; 60.5% non-normal) than did sideline (17.3% normal; 52.4% non-normal) and commercial beekeepers (15.7% normal; 43.7% non-normal) in both the normal and non-normal groups (Table 2).

Colony Collapse Disorder (CCD) is characterized as a condition that leaves few, if any, dead bees in the collapsed hive or in the apiary. For the purposes of this report, an operation was considered to be suffering from CCD when one-half or more of the colonies lost in an operation were lost with few or no bees present in the hive or in the colony’s apiary. In all, 349 of the surveyed beekeepers reported on how many of the colonies they lost died

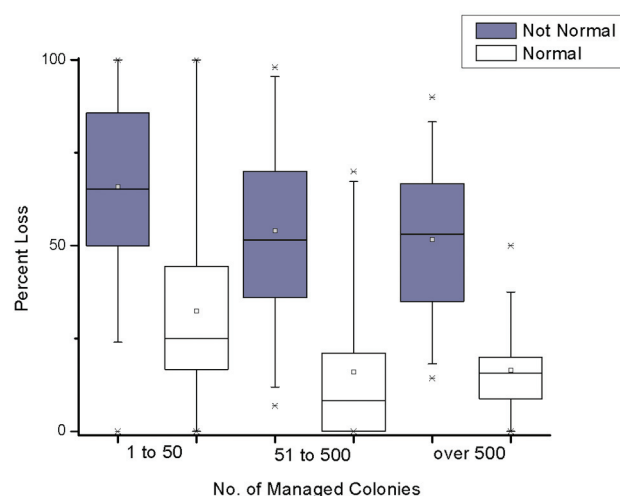


Figure 1. Box plot diagram of average losses experienced by beekeepers who considered their losses to be normal or not normal by operation size. Each box plot diagram indicates the mean (central rectangle), median (center horizontal line), 25th and 75th percentiles (bottom and top horizontal lines, respectively), 95% confidence intervals (top and bottom of the vertical lines, respectively), and 1st and 99th percentiles (x above and below, respectively).

Table 3: Total losses experienced by beekeepers suffering from and not suffering from CCD.

	Operation Size	No. of Respondents	Colonies Managed (plus Increases) in September 2006	Total Loss % (95 % CI)
CCD	1 to 50	41	426	45.3 (40.6-50.0)
	51 to 500	20	3,501	47.3 (45.6-49.0)
	500 +	19	50,308	44.8 (44.4-45.2)
	Total	80	54,235	45.0 (44.9-45.1)
not CCD	1 to 50	194	1,865	32.5 (30.4-34.6)
	51 to 500	41	6,770	30.6 (29.5-31.7)
	500 +	21	49,018	24.4 (24.0-24.8)
	Total	256	57,653	25.4 (25.0-25.8)

Table 4: The five most commonly mentioned suspected causes of CCD (n = 71 operations) and non-CCD losses (n = 165 operations). Numbers indicate the percent of respondents who mentioned each cause. "Invertebrate Pests" includes Varroa and tracheal mites, along with small hive beetles. "Queen or genetics" includes queen loss, bad queens, and bad stock.

	Operation Size	Starved	Weak in fall	Weather	Invertebrate Pests	Queen or Genetics
CCD	1 to 50	40%	16%	6%	8%	12%
	51 to 500	35%	30%	15%	10%	15%
	500 +	7%	0%	7%	43%	7%
	Overall	36%	17%	8%	14%	12%
Non-CCD	1 to 50	43%	12%	18%	11%	8%
	51 to 500	53%	19%	16%	34%	13%
	500 +	17%	8%	17%	67%	42%
	Overall	47%	13%	17%	20%	11%

without any or with very few bees. While 127 respondents reported some losses with no or very few bees in dead colonies, only 80 met our specified definition threshold of 50% of the operation's lost colonies being found without bees.

Overall, the total losses in operations suffering from CCD were nearly twice as high (45.0%) as the total losses experienced in the non-CCD suffering group (25.4%; Table 3, Figure 2). When losses were stratified by operation type, they revealed that the distinction between CCD sufferers and non-sufferers was evident only when total losses were considered. When average losses were compared, differences among operation types were not evident.

Although this survey was not designed to determine the cause of winter losses, respondents were asked to identify why they thought their colonies died. Five main reasons were reported (Table 4). The most commonly mentioned cause was starvation, followed by invertebrate pests (Varroa mites, tracheal mites, and/or small hive beetles), weather, weak colonies in the fall, and queen/genetic problems. Most respondents cited multiple reasons for their losses. Surveys of beekeepers specifically designed to identify the cause(s) have been initiated^{5, 6, 7}.

Considerable variability in total and average losses was reported from the various states (Table 5). The number of respondents, as well as the number of hives managed in each state, was also

variable. The uneven sampling that occurred in different states suggests that responses from more heavily sampled states may have biased the reported average and total loss figures (Tables 1 and 2). However, the mean average loss experienced by all states (34.6%) is reasonably close to the average loss calculated from all individual respondents (37.6%). Similarly, the mean total loss experienced by all states (33.2%) was similar to the total loss as calculated by summing all the losses of all respondents (31.8%).

New Mexico reported the lowest average loss (14.4%) and total loss (2.9%), while Ohio had the highest average and total loss (61.4 and 71.5%, respectively). The proportion of operations suffering from CCD in states varied, with zero Michigan beekeepers meeting the case definition for CCD, while more than 80% of South Dakota beekeepers met CCD-qualifying conditions (Figure 3). In several cases, including one beekeeper from Michigan, respondents identified CCD as the cause of the colony loss. However, these beekeepers did not meet our specified definition of CCD of 50% loss without dead bees present and so were not included as CCD cases for purposes of this paper.

It should be noted that while the absence of dead bees in colonies or collapsed apiaries is a key symptom of CCD, other characteristics such as the rapid loss of adult bee populations are also defining symptoms that help differentiate this condition from losses associated with varroa and honey bee tracheal mites.

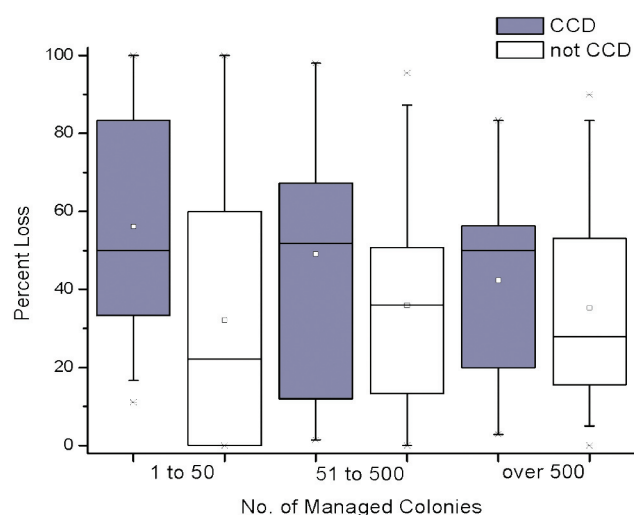


Figure 2. Box plot diagram of average losses experienced by beekeepers who are considered to not be suffering from CCD or suffering from CCD by operation size. Each box plot diagram indicates the mean (central rectangle), median (center horizontal line), 25th and 75th percentiles (bottom and top horizontal lines, respectively), 95% confidence intervals (top and bottom of the vertical lines, respectively), and 1st and 99th percentiles (x above and below, respectively).

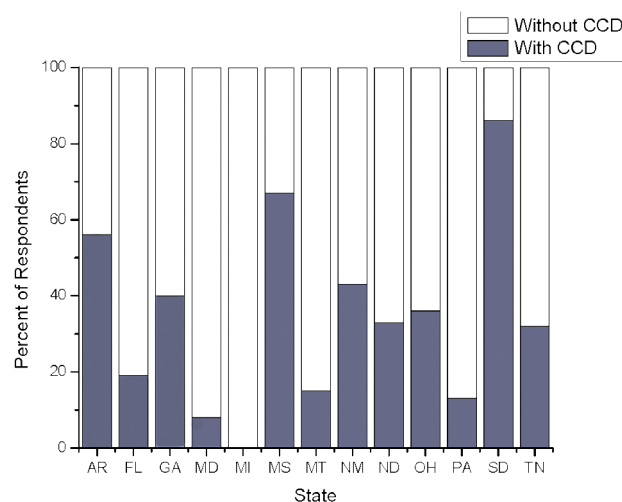


Figure 3. Percent of respondents suffering from CCD by state.

Table 5. Average and total losses experienced by beekeepers in different reporting states.

State	n	Colonies Managed in September 2006 plus increases	Average Loss % (95% CI)	Total Loss % (95% CI)
Arkansas	9	1,259	26.2 (0 – 54.9)	5.6 (4.3 – 6.9)
Florida	28	6,850	40.4 (22.2 – 58.6)	37.2 (36.1 – 38.3)
Georgia	6	18,136	32.1 (0 – 69.5)	49.6 (48.8 – 50.3)
Maryland	13	364	27.8 (3.4 – 52.2)	23.4 (19.1 – 27.7)
Michigan	7	2,209	59.4 (23.0 – 95.8)	52.2 (50.1 – 54.2)
Mississippi	17	2,375	20.8 (1.5 – 40.0)	31.2 (29.3 – 33.1)
Montana	13	31,672	18.9 (0 – 40.1)	27.2 (26.7 – 27.7)
New Mexico	7	9,950	14.4 (0 – 40.4)	2.9 (2.6 – 3.2)
North Dakota	17	40,011	45.9 (22.1 – 69.6)	25.1 (24.6 – 25.5)
Ohio	47	6,222	61.4 (47.4 – 75.3)	71.5 (70.4 – 72.6)
Pennsylvania	187	17,702	34.7 (27.8 – 41.5)	47.9 (47.2 – 48.6)
South Dakota	7	10,179	31.5 (0–65.9)	26.0 (25.1 – 26.9)
Tennessee	34	619	35.4 (19.3 – 51.5)	30.9 (27.3 – 34.5)

As the rate of adult population loss could not be ascertained from the survey, losses classified in this report as meeting our specified definition of CCD may include colonies lost by mite pressure. Both varroa and honey bee tracheal mite populations in examined CCD-colonies were low.

Conclusions

Overall, U.S. beekeepers suffered an average loss of 38% of their colonies during the winter of 2006-2007. There was a total loss of 32% of managed colonies in the 13 states reporting. If these states are representative of the nation, between 651,000 and

875,000 of the nation's estimated 2.4 million colonies were lost over the winter. Respondents to the survey considered their losses to be abnormally high when over 40% of their colonies died. Although losses were higher in operations that we considered to be suffering from CCD, losses were still generally high (many losing >30% of colonies) in operations that were not suffering from CCD. Among the reasons given for the losses, starvation, invertebrate pests, and weather were the most common. CCD was identified in 12 of the 13 states reporting with >50% of respondents from Arkansas, Mississippi, and South Dakota having CCD.

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