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VERTEBRATE PESTS OF BEEKEEPING

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ABSTRACT: Information concerning vertebrate pests of beekeeping was gathered from state and provincial apiary inspectors through a questionnaire. Forty-eight states and 9 provinces responded. Additional pest information has been assembled from published articles. Bears represent the major vertebrate pest based on severity of damage to colonies. Total estimated losses reported amounted to \$623,000 annually. Loss estimates for the various pest species are probably grossly underestimated because many states with problems could not or did not provide loss estimates. Skunks and house mice represent the next most important species from a damage point of view, with annual damage averaging \$423,050 and \$100,450, respectively. Skunk and house mouse damage, although less severe than that of bears, is far more frequent and widespread. The principal method of damage prevention is the use of electric fencing for bears while trapping is the most used method for control of skunks. Exclusion is considered the best means of resolving house mouse problems. These and a variety of minor vertebrate pests are discussed along with methods or techniques used for their prevention and/or control.

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INTRODUCTION

Beekeeping as a hobby, business, or both is practiced widely in the United States and Canada. In addition to the enjoyment provided to hobby beekeepers, honeybees (*Apis mellifera*) produce honey, wax, and most importantly, provide an estimated \$3.2 billion in pollination services to agriculture (Robinson et al. 1989).

Given the great value placed on honeybees and the services they perform, we thought it would be informative to examine the impact of vertebrate pests on honeybee colonies and beekeeping operations in North America and the methods and techniques used by beekeepers to resolve these pest problems.

The beekeeping industry is highly regulated in the United States and Canada. Quarantines (state, provincial, and national), and apiary laws (state, provincial) regulate the movement and disease management of honeybee colonies to varying degrees. To enforce these laws and quarantines, state and provincial inspection services are present in most states and provinces. Inspectors are often quite knowledgeable about beekeeping in their state or province.

METHODS

To gather information on vertebrate pests of beekeeping in Canada and the United States, a one-page questionnaire was sent to each chief state or provincial apiarist. A self-addressed, stamped envelope was enclosed to facilitate a reply. A second questionnaire was sent to nonrespondents after 5 months.

RESULTS

A total of 48 states and 9 provinces responded. Two states had no information and two had very little. Two states sent back questionnaires from more than one person (Arizona - 3, New York - 8). These responses were condensed into one and averages used when applicable.

The first question requested that 8 listed vertebrate pests be rated on their importance in that state or province (1 = always serious, 2 = sometimes serious, 3 = always minor, 4

= sometimes minor, 5 = no problem). Nonlisted pests could be added in space provided.

Bears (*Ursus* spp.) were considered the most serious vertebrate pest with 19 responses in the "always serious" category and 13 as "sometimes serious" (Table 1). Twelve states and 1 province indicated "no problem." Similarly, bears were listed most frequently (question 2a) as the pest causing greatest economic loss in a state or province (Table 2). Estimates of losses (2b - How much monetary damage do you estimate they cause each year to beekeepers in your state?) totaled \$623,000 per year (Table 3). Bees were thought to be the most frequently occurring vertebrate pest by 12 respondents and the second most frequent by 5 respondents (Table 4).

The \$623,000 damage figure for bears is most likely an underestimate of actual losses since only 22 damage estimates were provided whereas 36 respondents listed bears as pests. Thus 39% of those with some bear damage provided no figure of losses. In a study by Lord and Ambrose (1981) the average annual losses from bears to beekeepers in the United States and Canada were calculated at \$334,493 with states and provinces providing estimates. Reported losses to bears in Florida totaled \$104,868 in a 1981 beekeeper survey (Maehr and Brady 1982). In Minnesota, the single greatest monetary loss from bears occurred to beehives and averaged \$10,000 per year (Garshelis 1989). He found that damage occurred from May through August, which is similar in duration with only a slight shift in months to the April through June period in which damage peaked in north Florida (Maehr and Brady 1982). Damage has been shown to correlate with peak honey flows which may attract bears; however, a cause-effect relationship has not been shown (Ibid).

While the vast majority of beekeepers probably never have problems with bears damaging or destroying their hives, some beekeepers suffer losses repeatedly. One California beekeeper averaged \$6,000 annually in black bear damage from 1974 to 1988 (Hartshorn 1988).

As indicated previously, bears may be attracted by the smell of honey; however, they consume both bee brood and

honey (Eckert 1941, Johansen 1975, Jadcak 1986). In consuming these, they scatter and break up the hive boxes and frames, frequently damaging them beyond repair.

Table 1. Importance of various vertebrate pests to beekeeping in the United States and Canada.

Pest species	Importance Rating - Number of Replies (%)				
	always serious	some-times serious	always minor	some-times minor	no problem
Bears	19(36)	13(25)	4 (8)	4 (8)	13(25)
House mice	6(12)	20(39)	17(33)	5(10)	3 (6)
Skunks	12(23)	25(48)	9(17)	4 (8)	2 (4)
Meadow vole	1 (2)	4 (9)	7(15)	12(26)	22(48)
Horses	0	2 (4)	4 (8)	22(45)	21(43)
Eastern kingbirds	0	1 (2)	5(11)	18(39)	22(48)
Cattle	0	6(12)	6(12)	24(48)	14(28)
Sheep	0	1 (2)	3(43)	6(13)	37(79)
*					
Vandals (humans)	1(12)	6(75)	1(12)	0	0
Raccoons	0	7(64)	2(18)	2(18)	0
Deermice	0	3(75)	1(25)	0	0
Opossum	0	6(67)	2(22)	1(11)	0
Toads	0	1	0	1	0
Woodpeckers	0	0	1	1	0
Summer tanager	0	0	0	1	0
Tree swallow	0	0	0	1	0
Lizard	0	0	1	0	0

* Pests below the line were listed in the "other" category by respondents.

Electric fencing is considered the best and most frequently used method to protect hives. Other control methods in the order of most used include shooting, trapping, and relocating colonies or avoiding areas where bears are present.

These are similar to the responses received by Lord and Ambrose (1981). Electric fencing is recommended in many extension-type pamphlets and bulletins on controlling bear damage to honeybee colonies (Johansen 1975, Crazier 1984, Anonymous 1985). An electric fence construction guide is available from British Columbia (Porter 1983). Perhaps the earliest publication advocating electric fencing was by Storer et al. (1938). Elevating colonies was mentioned by one respondent and may be the best method when flood protection is also needed (Maehr 1984).

Some states and provinces have depredation laws or regulations where the beekeeper can trap or shoot a

depredating bear. Maine, Montana, and Colorado are examples.

Table 2. The vertebrate pest species that state and provincial apiary inspectors listed as one of the three most damaging to honeybee colonies in their state or province.

Pest species	Number of responses (%)		
	Most losses	2nd most losses	3rd most losses
Bears	26 (72)	6(17)	4 (11)
Blue jays	0	0	1
Cattle	1 (14)	2(29)	4 (57)
Deermice	1	2	0
House mice	13 (28)	15(33)	18 (39)
Opossum	0	1	3
Vandals	2 (22)	3(33)	4 (44)
Raccoons	0	1	1
Sheep	0	0	1
Skunks	15 (31)	21(44)	12 (25)
Toads	0	1	0
Varmints	0	0	1
Meadow voles	2	2	1
Woodpeckers	0	1	0

SKUNKS

Skunks (*Mephitis mephitis* and *Spirogale gracilis*) were listed most frequently as causing some degree of damage. There were 37 responses in the "always" or "sometimes serious" categories with 2 in the "no problem" category (Table 1). Skunks were similarly listed most often (48) as one of the three species causing the most losses (Table 2). Twenty-five respondents gave dollar estimates of damage caused by skunks. These damage estimates totaled \$423,050, but probably are significantly underestimated since 23 states and provinces which listed skunks as a pest did not give damage estimates.

Skunks were named as the most frequently and second most frequently occurring pest more than any other species (Table 4). A wide variety of control methods was listed as most effective for skunks, making them unique in this sense. Trapping was most often mentioned followed by exclusion, poisoning, elevating colonies, and shooting. Although no toxic materials are currently registered for skunks, poisoning is effective and has been used extensively in the past as a control method (Vansell 1929). Several other methods were listed 1 to 4 times. One was the spreading of high nitrogen fertilizer on the ground which supposedly causes a burning sensation to the skunks' feet.

Skunks can be kept away from the front of hives by excluding them with various devices such as boards with nails, tack strips, and rolls of chicken wire stapled to the front of

the hive box. When a skunk attempts to climb on the wire, its underside is exposed to bee stings and it is thus repelled (Caron 1978, Jadczyk 1986, Sammataro and Avitabile 1986).

Storer and Vansell (1935) give perhaps the best description of the signs and damage caused by skunks. Scratches in the earth and on the front of the hive are initial signs. The scratches on the ground develop into holes with repeated visits. Skunk scats can be frequently found around the apiary. Undigested parts of bees and other insects are obvious in droppings. Colonies may be weakened and become more aggressive when they have been visited and disturbed repeatedly by skunks.

HOUSE MICE

The house mouse (*Mus musculus*) was rated as a pest in 48 responses; however, it was most frequently classed as

"sometimes serious" or "always minor." Like skunks, house mice were rarely described as being "no problem" (Table 1). House mice were listed as one of the 3 most serious pests 40 times. They were listed almost equally first, second or third, with third having a slight edge (Table 2). Fifteen respondents estimated damage totaling \$100,450 (Table 3). The most frequently recommended control technique was exclusion with the use of entrance reducers or mouse guards to keep them out of colonies. Entrance reducers often have 3/8-in high by 3-in wide openings. However, small mice can get through an opening of this size. Using several 3/8-in diameter holes as openings stops mice from entering (Howes 1979). Reducing the opening height to 1/4-in high is also effective (Anonymous 1987). Poison bait was also a frequently (24) listed mouse control measure. Other techniques mentioned were fumigating of the warehouse (an indoor problem), strong colonies, and encouraging predators.

Table 3. Apiary inspectors' estimates of annual dollar* losses to beekeepers caused by the three most damaging vertebrate pest species in their state or province.**

State/ Province	Bears	Skunks	Mice	Vandals	Other (name)
Alberta	30,000	8,000	3,000		
Arizona		1,000	150	500	
Arkansas	5,500	4,250			4,000 (cattle)
California	275,000	175,000			27,000 (varmints)***
Delaware		100		1,000	100 (opossum)
Florida	50,000				
Indiana		2,000	20,000		1,000 (voles)
Kansas		3,000	2,000		
Maine	20,000	5,000			
Manitoba	5,000				
Maryland	1,500	1,200	3,000		
Massachusetts	25,000	1,000			1,500 (deermice)
Nebraska		4,500	4,500	5,000	4,000 woodpeckers
Nevada	700	100	400		
New Brunswick	10,000	1,500	1,000		
New Hampshire	12,500				
New Jersey	10,000	2,000	3,000		
New Mexico		250	1,000		250 (cattle)
New York	15,000	75,000			6,000 (deermice)
Nova Scotia	1,500	150	300		
Ontario	75,000	20,000	10,000		
Oregon	7,500				
Prince Edward Island		3,000	1,000		
Quebec	25,000	6,000			
Saskatchewan	13,000				
South Carolina	2,000	500			300 (blue jays)
Texas		100,000	50,000		
Vermont	2,500	4,500	500		
Virginia	6,000	4,000			
West Virginia	27,500				
Wisconsin	3,500	1,000	1,000		

*Canadian figures assumed to be in Canadian dollars.

**Many states and provinces reported damages by the three major pests but did not provide a dollar value.

***Other minor pests were just listed collectively as varmints.

Table 4. Vertebrate pests of beekeeping which apiary inspectors listed as occurring most or second most frequently in their state or province.

Pest species	Frequency-number of states or provinces	
	Most	2nd most
Bears	12	5
Cattle	--	--
Blue jays	--	--
Deermice	2	--
House mice	17	16
Opossum	1	1
Skunks	18	20
Toads	--	1
Vandals	2	2
Meadow voles	3	1

House mice enter hives in late fall or winter when bees are clustered together and cannot protect the colony. Mice build their nests in the hive, consume bees, honey and pollen, and defecate and urinate inside the hive as well. They also damage stored equipment in warehouses (Caron 1978, Howes, 1979, Jadczyk 1986). Mouse control, especially when compared to bear control, is relatively simple and inexpensive. For beekeepers who practice some preventative measures mouse damage should be relatively infrequent.

MEADOW VOLES

Meadow voles (*Microtus* spp.) were listed as "always serious" in Tennessee; however, most of the 46 responses listed them as "no problem" (22) or "sometimes minor" (12). They were listed five times as being one of the three most damaging species (Table 2). They were estimated to cause \$1,000 damage annually in Indiana, and the most listed control measures were exclusion and poisoning. Vole damage is similar to mouse damage though much less common. Like mouse control, vole control is relatively simple for the beekeeper.

DEERMICE

Deermice (*Peromyscus* spp.) are not very often thought of as a serious pest (Tables 1 and 2). They were estimated to cause \$6,000 damage per year in New York and \$1,500 in Massachusetts. Excluding them was the only control measure listed. Damage is probably similar in nature to house mice damage.

RACCOONS AND OPOSSUMS

Raccoons (*Procyon lotor*) and opossums (*Didelphis marsupialis*) were listed 11 and 9 times respectively as causing some degree of damage to honeybee colonies (Table 1). In Delaware, the opossum was considered the most damaging vertebrate pest aside from man; however, damage was estimated at only \$100 annually. Both of these species may

damage colonies in ways similar to that caused by skunks. In addition, opossums also cause damage by chewing wood at the hive entrance and may chew into the brood area (Caron 1978, Delaware questionnaire). Raccoons are very capable of tipping hives over and to some extent breaking them up, which may be sometimes confused with bear damage according to the response from Minnesota.

Trapping was the most listed control method overall (4 responses) for these two species. Other methods of control included shooting, exclusion, poison for opossums, and elevating colonies.

VANDALS

Vandals were the most serious of the vertebrate pest species included in the "other" category (Table 1). Humans were listed eight times as being one of the most damaging species to honeybee colonies (Table 2), with respondents estimating damages totaling \$6,900 annually (Table 3). Hiding yards or camouflaging colonies were the most suggested control measures.

Branding colonies and placing them in an exposed area where vandals would be more likely observed seen were also mentioned.

BIRDS

Four birds were listed as pest species: summer tanagers (*Piranga rubra*), woodpeckers (*Picidae*), tree swallows (*Tachycineta bicolor*), blue jays (*Cyanocitta cristata*), and eastern kingbirds (*Tyrannus tyrannus*).

The eastern kingbird was most often "no problem" or a "sometimes minor" problem. The other species were only written in on the questionnaire once or twice (see Tables 1 and 2). The blue jay was the only reported (written-in) bird species with a damage estimate included amounting to \$300 per year in South Carolina.

The most effective control measure given for eastern kingbirds was shooting. Relocating colonies and hazing were each mentioned once as solutions. Shooting and the use of hawk silhouettes were suggested for woodpeckers.

Woodpeckers damage hive boxes, and Ambrose (1978) in his review of literature found wrapping colonies with wire mesh to be an effective preventive measure.

Note that a permit must be obtained from the U.S. Fish and Wildlife Service to kill depredating woodpeckers in the United States.

The eastern kingbird, though not a major pest, can cause significant damage to queen producers since it may catch queens on their mating flights (Gochnauer et al. 1975).

The other bird species, aside from the woodpecker, are thought to cause only minor damage from their bee-eating activities-most likely less than the eastern kingbird.

LIZARDS

Lizards (*Lacertilia*) were listed as an "always minor" problem by one of the three Arizona respondents (Table 1). Elevating the colony was the preventive measure used.

TOADS

Toads (*Bufo* spp.) were mentioned as being pests in Arizona and Hawaii (Table 1), and were considered the second most damaging species by one of the three responses from Arizona. Elevating the colonies and night hunting were the control techniques recommended. Cane toads (*Bufo marinus*), which were introduced into Hawaii from Central

America for insect control, are a problem for beekeepers in that state. Cane toads have not reached Florida and may become a problem there in the future (Morse 1975, Krochmal 1986). An early California beekeeping manual lists toads as being an occasional beekeeping pest (Vansell 1929).

LIVESTOCK

Horses, cattle, and sheep were each usually considered "no problem" or a "sometimes minor" problem by respondents. Sheep were listed as causing "no problem" 37 times compared to 21 for horses and 14 for cattle (Table 1). Cattle were listed as the most damaging pest in Arkansas and damage was estimated at \$4,000 annually (Tables 3 and 2).

Fencing was the most-listed control technique. Avoiding livestock or relocating colonies were also suggested. Another suggestion that may work when the previous ones cannot be used is to group colonies together so they are less likely to be knocked over.

SUMMARY

The responses to our survey coupled with a review of the available literature indicate that there are a variety of vertebrate pests of beekeeping in the United States and Canada. Most of these are of minor or relatively minor concern to beekeepers. Three exceptions to this are bears, skunks, and house mice.

Bears can cause greatest amounts of damage, especially where no precautionary measures are taken to protect apiaries. The damage caused by skunks and mice is more widespread in distribution than bear damage but is also less severe and spectacular. The costs of controlling bear damage by fencing can be high while, by comparison, trapping skunks and mouse-proofing hives are of low cost. Relatively effective preventive and/or control measures exist for all of the significant pests. Vandalism, although not normally included as a vertebrate pest problem, can be serious in some situations and its prevention is not easy.

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