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American black bear–apiary conflicts in Michigan

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Abstract: American black bear (*Ursus americanus*) damage to apiaries can result in substantial economic loss. We used records of black–bear apiary conflicts collected by the Michigan Department of Natural Resources to characterize damage in the Upper and Northern Lower peninsulas of Michigan from April 2003 to May 2011. Most conflicts occurred between May and July, and the number of conflicts decreased across years. The number of reported conflicts was directly correlated with bear population size. However, we found no positive association between numbers of reported conflicts with bear condition as indexed by winter severity and hive abundance. Intolerance toward black bears increased 30% after >1 black bear–apiary conflict occurred. The effectiveness of direct or indirect management for reducing repeated conflicts was similar, and overall management actions may have reduced black bear–apiary conflict.

Key words: American black bear, apiaries, education, habituation, human–wildlife conflicts, management efficacy, Michigan, tolerance, *Ursus americanus*

American black bears (*Ursus americanus*) are ecologically important, historically significant, and increasingly encountered by people throughout bear range (Mattson 1989, Beckmann and Berger 2003). Some reasons for the increase of human–bear conflicts are population growth of humans and subsequent expansion into bear habitats, increased bear populations, and habituation of bears to anthropogenic resources (Mattson 1989, Beston 2011). Black bears can become habituated to human food resources, including trash, crops, and apiaries, because of easy access to these concentrated, high-energy food sources (Mattson 1989, Beckmann and Berger 2003). Economic loss from black bear damage to apiaries (i.e., beehives) is difficult to quantify, but bears can cause substantial economic loss for individual apiarists (Jonker et al. 1998, Clark et al. 2005; Figure 1). Honey production throughout the United States grossed $282 million in 2010 (National Agricultural Statistics Service 2011). In Michigan, honey production grossed an estimated $6.7 million in 2010, representing about 2% of the national honey production and 1% of Michigan's agricultural production (National Agricultural Statistics Service 2011).

Attitudes of people play an important role in black bear management (Baruch-Mordo et al. 2009), especially in areas with dense human populations (Gore et al. 2006, Carlos et al. 2009). Individuals whose livelihoods are directly impacted by wildlife damage tend to have the strongest negative attitudes toward the species causing damage (Conover 2002), which would be expected of apiarists experiencing black bear damage. Chronic black bear conflicts reduce public tolerance and can influence policies (e.g., acceptance of bear removal; Agee and Miller 2009).

Factors that influence the frequency of black bear damage to apiaries include black bear and apiary abundance, proximity of hives to bear habitat, availability of alternate foods, bear nutritional condition, and effectiveness of management actions to aversively condition bears (Beckmann et al. 2004). Most black bears hibernate during winter to conserve energy until food sources again become available in spring, resulting in a decrease in body mass of ≤30% (Larivière 2001, Lohuis et al. 2007). Such reduction in body mass greatly increases bears' energetic demands following den emergence (Belant et al. 2006), which, in turn, may influence the likelihood of apiary damage. Approaches for reducing apiary damage include electric fences (Sillings et al. 1989) and aversion conditioning (Huygens and Hayashi 1999). However, efficacy of management actions has received limited attention.

We characterized the frequency, timing, and distribution of black bear–apiary conflicts in Michigan. We also evaluated effects of winter severity as an index to bear condition, hive abundance, and bear population size on the number of bear–apiary conflicts reported annually. We then compared the efficacy of management practices implemented by Michigan Department of Natural Resources (MDNR) and apiary owners to reduce black bear–apiary conflicts. Lastly, we evaluated the level of tolerance expressed by apiary owners for black bear damage.

Figure 1. Bears are attracted to concentrated, high-energy food resources, such as found in apiaries.

Methods

We used records of reported black bear–apiary conflicts provided by MDNR from April 2003 to June 2011. These reports included date of damage, location (i.e., township, range, and section), bear attractants present, damage caused by the bear, actions taken in response to damage, level of tolerance of apiarists, and whether the apiary had been repeatedly damaged. Reported conflicts represent only those provided directly to MDNR personnel and likely are less than the total number of conflicts that occurred. We used the standard Public Land Survey System, where a township represents 36 2.56-km^2 sections of land (Holmberg 2006) to quantify conflicts at the section scale. Complaints from some areas were assumed to be from the same apiary unless the description of the reporter (i.e., homeowner or apiarist) varied or the description of the damage indicated different apiaries.

We summarized conflicts by year, month, and region (Upper Peninsula [UP] or Northern Lower Peninsula [NLP]). Conflicts from 2011 were not used for analyses because the number of reports was incomplete. We used Pearson's correlation coefficients to estimate the relationship between the annual number of conflicts and number of bears by region derived from mark-recapture surveys. We used MDNR survey estimates of black bear abundance. Black bear abundance was estimated by MDNR personnel across the UP from 1990 to 2009 using tetracycline-laden baits and hunter harvest in mark-recapture analyses with the Lincoln-Peterson estimator (Belant et al. 2011; Minnesota Department of Natural Resources, unpublished data). Black bear abundance in the LP was estimated during 2003 to 2009 using DNA from hair and tissue samples collected from both snares and harvested bears, respectively, in a capture-recapture methodology (Dreher et al. 2007; Minnesota Department of Natural Resources, unpublished data). As population estimates for UP and LP populations are typically performed every 2 to 3 years, we used regression techniques to obtain a best model fit from which annual population estimates were obtained. As population estimates were available through 2009, we did not use 2010 conflicts in correlation analysis. We qualitatively compared the number of bear–apiary conflicts and number of hives in both the UP and NLP of Michigan surveyed every 5 years by the U.S. Department of Agriculture (2009).

We used Pearson's correlation (Zar 2009) to evaluate the relationship between previous winter severity as indexed by the North Atlantic Oscillation (NAO) and the number of conflicts occurring state-wide the following year. North Atlantic Oscillation is a phenomenon associated with winter severity and indexed by taking the

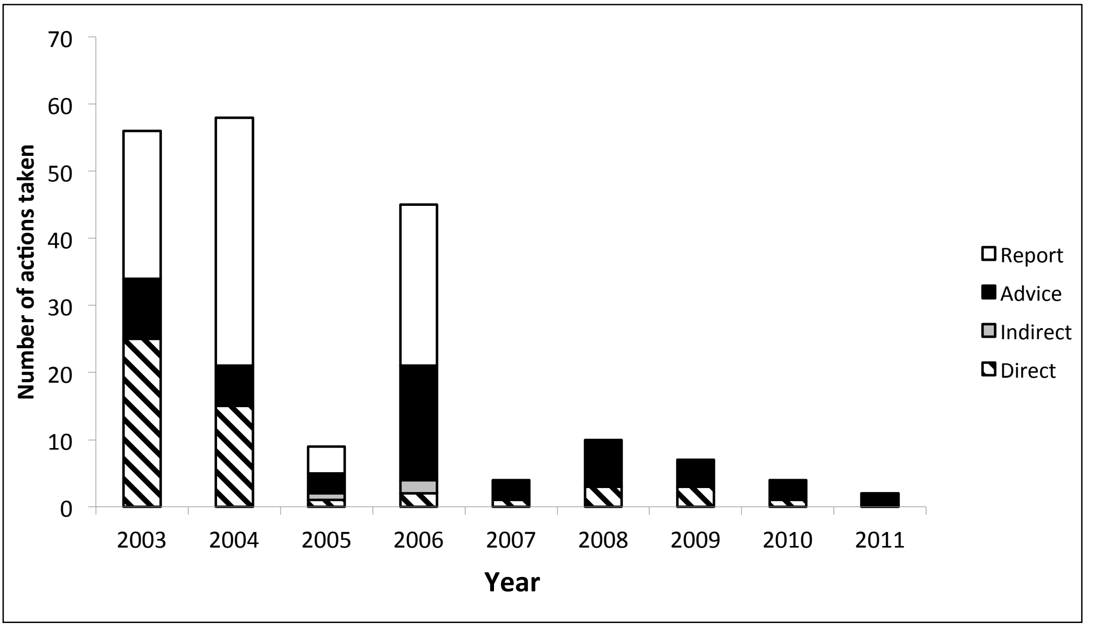

Figure 2. Number of black bear–apiary conflicts by type of management action taken by Michigan Department of Natural Resources (MDNR) personnel, April 2003 to June 2011. Direct actions included hazing, trapping, and electric fence installation. Indirect actions included site visits or referral of complainant. Advice included oral or written instructions to complainants. Report is documentation completed by only by complainant or DNR employee.

difference of normalized sea level barometric pressures between Portugal and Iceland (Møller 2002, Edge et al. 2011). Positive values of NAO are indicative of higher temperatures on the East Coast of the United States; the reciprocal is true of negative NAO values (Climate Prediction Center 2011). The NAO has been used to assess predator–prey relationships in Michigan (Vucetich and Peterson 2004, Edge et al. 2011).

We first categorized actions taken following a conflict as direct or indirect to address whether management actions were effective in reducing bear–apiary conflict. We defined direct actions as the use of hazing (e.g., cracker shells or discharging a firearm to scare the bear), trapping and relocation, or electric fence installation by a MDNR employee or designee (e.g., apiary owner), and indirect actions as written or verbal advice given by MDNR personnel, site visits by MDNR personnel, referrals to cooperative private businesses, or completion of a damage report by the apiary owner. Because most management actions taken were indirect, we further categorized indirect actions as advice only, report only, and other. If damage was not reported in a section for >1 year following the initial management action subsequent conflicts were considered independent.

To evaluate the effectiveness of management, we used chi-square analysis (Zar 2009) to compare the frequency of bear–apiary conflicts occurring in the same or following year after initial direct or indirect management was conducted. We also used chi-square analysis to determine if damage was more likely to occur in the same or following year after initial direct or indirect management based on whether the initial complaint to MDNR was made after a single or multiple conflicts.

The level of tolerance for black bear damage to apiaries was determined by MDNR personnel receiving the call and categorized as slight, moderate, intolerant, and agitated. Because of potential ambiguity assigning categories, we classified slight and moderate categories as low intolerance, intolerant and agitated as high intolerance; reports where the level of tolerance could not be assigned a category were excluded. We qualitatively described apiarists' level of tolerance to recurrence of damage. All analyses were considered significant at $\alpha < 0.05$.

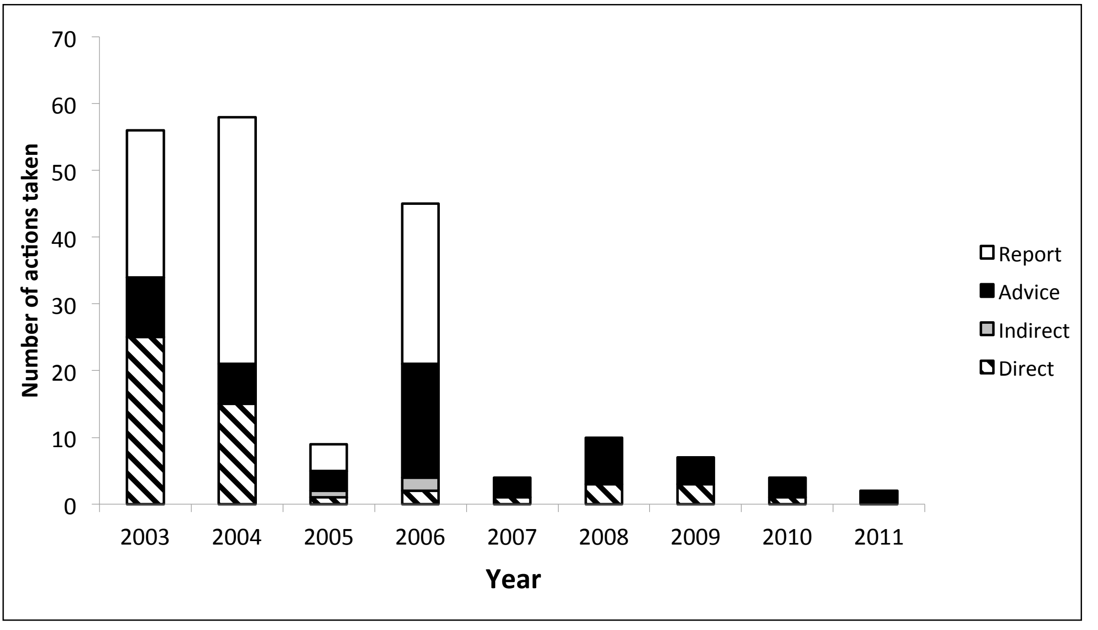

Figure 3. Number of oral complaints about American black bear–apiary conflicts recorded by Michigan Department of Natural Resources (MDNR) personnel, Michigan, April 2003 to June 2011.

Results

From April 2003 to May 2011, 217 bear–apiary conflicts were reported from 148 apiaries in 33 counties and 132 sections. The number of conflicts decreased 98% from 2003 to 2010 (Figure 2). The number of hives was similar during 1997 to 2002 censuses (78,331 to 79,341) and declined only 6% by 2007 (74,362). Most (72%) conflicts were reported from May to July (Figure 3). Most (85%) reported conflicts were from the NLP; only 32 (15%) complaints were from the UP. Fifty-one bear complainants (23%) reported estimates of monetary loss ranging from \$100 to \$2,000 per incident, with overall total honey losses estimated at \$28,000. Fifty-nine percent of complainants received information about damage mitigation techniques from MDNR personnel.

There was a positive correlation between bear abundance and the number of apiary conflicts in the UP (r_7 = 0.76, P = 0.05) and the NLP (r_7 = 0.80, P = 0.03). Annual bear abundance in the UP and NLP decreased from 10,054 to 8,266, and 1,852 to 1,458, respectively (Minnesota Department of Natural Resources, unpublished data). Winter severity as indexed by NAO was not associated with the number of black bear–apiary conflicts reported the following year (r_8 = -0.17, P = 0.87).

Sixty-two percent of initial complaint records reported damage after >1 damage incident. Five apiarists failed to report whether repeated damage occurred. Sixteen percent of apiarists reported repeated damage within the same year, and 5% reported incidents the following year. Repeat damage in the same year following direct or indirect management was equally likely to occur (χ^2_1 = 0.13, P = 0.72). There were too few (n = 8) instances of damage occurring the year following management for analysis; however, all damage occurred after indirect initial management actions. Apiaries reporting repeated damage were not more likely to have damage the following year (χ^2_1 = 0.07, P = 0.79).

Overall, most complainants (74%) reported low levels of intolerance to loss or damage of their hives. However, 52% (n = 21) of apiarists were highly intolerant of initial bear damage, whereas 82% (n = 101) were highly intolerant of repeated bear damage.

Discussion

Reported bear–apiary conflicts varied across years but declined overall. This could be explained in part by decreasing black bear abundance in the UP and NLP. However, the overall 98% decline in number of conflicts reported annually was much greater than the

18% decline in bear abundance (UP and NLP, combined) during this same period. Another possible reason for this decline may be a decrease in the percentage of actual conflicts reported to MDNR. The distribution of conflicts across months was indicative of black bears exploiting hives for larvae soon after emerging from dens when honey production is at its peak (Mattson 1989) and when natural food sources are typically less abundant (Nelson et al. 1983, Mattson 1989, Clark et al. 1994). During summer and when entering hyperphagia during late summer or fall, bears generally consume abundant natural foods (Mattson 1989, Nelson et al. 1983); however, honey production typically slows as the number of flowering plants decreases (Pyke et al. 2011).

Both the number of hives and winter severity did not explain variation in annual numbers of reported conflicts. The population of American black bears in the UP was about 6 times greater than the NLP during our study, suggesting that NLP bears have a greater number of hives available to exploit or hives in the UP may be less vulnerable due to control actions (e.g., electric fences). The statewide 6% decrease in number of hives would not explain the overall annual reduction in bear–apiary conflicts. However, greater declines in number of hives in some areas of the state could explain some of the observed variation. While winter severity can influence natural food abundance (Pitt et al. 2008) and bear physical condition (Belant et al. 2006, Breck et al. 2009), it was not associated with the annual decline in conflicts reported in Michigan.

One of the most important aspects of human–wildlife conflicts is the attitudes of people, as they can influence conservation and management goals and decisions (Teel and Manfredo 2009). Farmers who suffer economic loss due to wildlife damage are more likely to be intolerant of incidents, especially after previous loss. The level of tolerance can be influenced by education and appropriate mitigation techniques (Marker et al. 2003, Linkie et al. 2007, Treves et al. 2009). Attitudes of most apiarists in this study shifted in degree of tolerance from some level of tolerance to intolerance of damage after the first incident of apiary damage. The attitudes of apiarists depended in part on the response of MDNR to damage complaints, which typically provided either information to help reduce future conflicts or direct management action. We encourage increased educational outreach to apiarists to increase their understanding of bear ecology and foraging dynamics. Further, we recommend increased training and use of control techniques (e.g., electric fences), especially in high conflict areas, to reduce bear damage to apiaries.

Our data suggest that bear–apiary conflicts were not strongly influenced by bear abundance, winter severity, or apiary abundance. Management actions could not be directly attributable to the decline in conflicts. The black bear observation data maintained by MDNR were useful for initial characterization of bear–apiary conflicts; however, some information was incomplete or ambiguous. Increased quantification of information received, for example a gradient scale to record and monitor the level of tolerance to damage (with definitions for each category) would improve our ability to quantify information to better inform management. Increased communication and cooperation between apiarists in Michigan and MDNR will help both to reach production and management goals, increase education on techniques for reducing black bear–apiary conflicts, and reduce the number of conflicts.

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Literature cited

Agee, J. D., and C. A. Miller. 2009. Factors contributing toward acceptance of lethal control of black bears in Central Georgia, USA. Human Dimensions of Wildlife 14:198–205.

Baruch-Mordo, S., S. W. Breck, K. R. Wilson, and J. Broderick. 2009. A tool box half-full: how social science can help solve human–wildlife conflict. Human Dimensions of Wildlife 14:219–223.

Beckmann, J. P., and J. Berger. 2003. Rapid ecological and behavioural changes in carnivores:

the response of black bears (*Ursus americanus*) to altered food. Journal of Zoology 261:207–212.

Beckmann, J. P., C. W. Lackey, and J. Berger. 2004. Evaluation of deterrent techniques and dogs to alter behavior of “nuisance” black bears. Wildlife Society Bulletin 32:1141–1146.

Belant, J. L., D. R. Etter, S. L. Mayhew, L. G. Visser, and P. D. Friedrich. 2011. Improving large scale mark-recapture estimates for American black bear populations. Ursus 22:9–23.

Belant, J. L., K. Kielland, E. H. Follmann, and L. G. Adams. 2006. Interspecific resource partitioning in sympatric ursids. Ecological Applications 16:2333–2343.

Beston, J. A. 2011. Variation in life history and demography of the American black bear. Journal of Wildlife Management 75:1588–1596.

Breck, S. W., N. Lance, and V. Seher. 2009. Selective foraging for anthropogenic resources by black bears: minivans in Yosemite National Park. Journal of Mammalogy 90:1041–1044.

Carlos, A. W. D., A. D. Bright, T. L. Teel, and J. J. Vaske. 2009. Human–black bear conflict in urban areas: an integrated approach to management response. Human Dimensions of Wildlife 14:174–184.

Clark, J. D., D. L. Clapp, K. G. Smith, and B. Ederington. 1994. Black bear habitat use in relation to food availability in the interior highlands of Arkansas. International Conference on Bear Research and Management 9:309–318.

Clark, J. D., S. Dobey, D. V. Masters, B. K. Scheick, M. R. Pelton, and M. E. Sunquist. 2005. American black bears and bee yard depredation at Okefenokee Swamp, Georgia. Ursus 16:234–244.

Climate Prediction Center. 2011. North Atlantic Oscillation (NAO), <http://www.cpc.ncep.noaa.gov/data/teledoc/nao.shtml>. Accessed June 25, 2014.

Conover, M. R. 2002. Economics. Pages 91–128 *in* Resolving human-wildlife conflicts: the science of wildlife damage management. Lewis Publishers, Boca Raton, Florida, USA.

Dreher, B. P., S. R. Winterstein, K. T. Scribner. P. M. Lukacs, D. R. Etter, G. J. M. Rosa, V. A. Lopez, S. Libants, and K. B. Filcek. 2007. Noninvasive estimation of black bear abundance incorporating genotyping errors and harvested bear. Journal of Wildlife Management 71:2684–2693.

Edge, J. L., D. E. Beyer Jr., J. L. Belant, M. J. Jordan, and B. J. Roell. 2011. Livestock and domestic dog predations by wolves in Michigan. Human–Wildlife Interactions 5:66–78.

Gore, M. L., B. A. Knuth, P. D. Curtis, and J. E. Shanahan. 2006. Education programs for reducing American black bear–human conflict: indicators of success? Ursus 17:75–80.

Holmberg, J. J. 2006. Land measurement and survey: an introduction for woodland owners. Pacific Northwest Extension, PNW 581. Corvalis, Oregon, USA.

Huygens, O. C., and H. Hayashi. 1999. Using electric fences to reduce Asiatic black bear depredation in Nagano prefecture, central Japan. Wildlife Society Bulletin 27:959–964.

Jonker, S. A., J. A. Parkhurst, R. Field, and T.K. Fuller. 1998. Black bear depredation on agricultural commodities in Massachusetts. Wildlife Society Bulletin 26:318–324.

Larivière, S. 2001. *Ursus americanus*. Mammalian Species 647:1–11.

Linkie, M., Y. Dinata, A. Nofrianto, and N. Leader-Williams. 2007. Patterns and perception of wildlife crop raiding in and around Kerinci Seblat National Park, Sumatra. Animal Conservation 10:127–135.

Lohuis, T. D., H. J. Harlow, T. D. I. Beck, and P. A. Iaizzo. 2007. Hibernating bears conserve muscle strength and maintain fatigue resistance. Physiological and Biochemical Zoology 80:257–269.

Marker, L. L, M. G. L. Mills, and D. W. MacDonald. 2003. Factors influencing perceptions of conflict and tolerance towards cheetahs on Namibian farmlands. Conservation Biology 17:1290–1298.

Mattson, D. J. 1989. Human impacts on bear habitat use. International Conference on Bear Research and Management 8:33–56.

Møller, A. P. 2002. North Atlantic Oscillation (NAO) effects of climate on the relative importance of first and second clutches in a migratory passerine bird. Journal of Animal Ecology 71:201–210.

National Agricultural Statistics Service. 2011. Agricultural statistics 2011. U.S. Government Printing Office, Washington, D.C., USA.

Nelson, R. A., G. E. Folk, Jr., E. W. Pfeiffer, J. J. Craighead, C. J. Jonkel, and D. L. Steiger. 1983. Behavior, biochemistry, and hibernation in black, grizzly, and polar bears. International

Conference on Bear Research and Management 5:284–290.

Pitt, J. A., S. Larivière, and F. Messier. 2008. Survival and body condition of raccoons at the edge of the range. Journal of Wildlife Management 72:389–395.

Pyke, G. H., D. W. Inouye, and J. D. Thompson. 2011. Activity and abundance of bumble bees near Crested Butte, Colorado: diel, seasonal, and elevation effects. Ecological Entomology 36:511–521.

Sillings, J. L., T. N. Tomas Jr., and J. E. Forbes. 1989. Demonstrating electric fences to control black bear damage to apiaries in New York state. Eastern Wildlife Damage Control Conference 4:142–146.

Teel, T. L., and M. J. Manfredo. 2009. Understanding the diversity of public interests in wildlife conservation. Conservation Biology 24:128–139.

Treves, A., R. B. Wallace, and S. White. 2009. Participatory planning of interventions to mitigate human–wildlife conflicts. Conservation Biology 23:1577–1587.

U.S. Department of Agriculture. 2009. 2007 census of agriculture. National Agricultural Statistics Service, Washington, D.C., USA.

Vucetich, J. A., and R. O. Peterson. 2004. The influence of top-down, bottom-up, and abiotic factors on the moose (*Alces alces*) population of Isle Royale. Proceedings of the Royal Society of London B 271:183–189.

Zar, J. H. 2009. Biostatistical analysis. Fifth edition. Prentice, Upper Saddle River, New Jersey, USA.

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