Using honey bees to save elephants

How can studying animal behaviour help create a sustainable solution to reduce human–elephant conflict in Africa? Zoologist Lucy King investigates

Bull elephant dusting himself. This observed behaviour in response to bee sounds may help knock bees out of the air

Elephants are slaughtered across the African continent in their tens of thousands to provide ivory trinkets for an insatiable market. Images of mutilated, de-tusked elephants lying next to their infants make the headlines, and global elephant populations are on the decline. Conserving this magnificent, intelligent, social species is on the top of the agenda for governments and international conservation bodies around the world (both Hillary Clinton and Prince William have started campaigns to save elephants). But there is another conflict in the elephants' world that is largely ignored but is just as serious a threat to their survival. That is the rise of human–elephant conflict.

Key words

Conservation
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Human–elephant conflict

African elephants require large tracts of land to satisfy their food, water, migratory and social needs. Home ranges vary between 1388 km² (an average from elephants studied in Kenya by Save the Elephants) and as much as 32 062 km² (recorded from one female elephant surviving in Gourma, Mali). Consequently, elephants and people live side by side across most of the 37 'elephant range states' in Africa. It is not unusual for children to be late for school because a 6 tonne elephant blocked the route while breakfasting on a tasty roadside acacia tree.

Elephants have learnt how to break fences to access farms at night — following their extraordinary sense of smell to track down juicy vegetables or harvested bags of maize. As elephants can eat up to 400 kg of food in a day, farmers have started to fight back. They shout, light fires, explode firecrackers, release barking dogs, hurl stones and chilli bombs, bang drums, crash metal sheets together, and finally, if all else fails, use guns and spears as a final attempt to scare the elephants away. This conflict is dangerous and both elephants and people are often injured or killed. Not surprisingly, the elephants become conditioned to distrust humans from such negative experiences and accidental confrontations with people walking harmlessly past an elephant at other times of the day or night can be fatal.

Is electric fencing the answer?

Attempts to reduce conflict between humans and elephants have led to the creation of large game parks across Africa. This has prompted the construction of expensive electric fences to separate farming areas from elephants. Although such fences can reduce conflict, they create other management problems. Vital **migration corridors** for all wildlife species are cut

off permanently. This negatively affects species that are reliant on those routes for accessing food and water. Closing corridors and dispersal areas concentrates large herbivores such as elephants in unnaturally small areas and forces them to overlap foraging activities with other elephants sharing the same space. This often leads to permanent damage of trees and shrubs.

Elephants protected, but also trapped, inside 'fortressed' game parks often start to breed successfully, causing localised population explosions. Rapidly growing fenced-in elephants have led to some extreme forms of population control being introduced into closed reserves, such as culling, and expensive trial methods using female contraceptive treatment. These population control methods confuse the public and contradict conservation efforts aimed at reducing the illegal killing of free-ranging elephants trying to survive outside of protected areas.

Awareness of this problem has recently led some game parks to re-evaluate their stance on fortress conservation. By starting to take down certain sections of their boundary fences they are now attempting to open up historical migration routes, creating an 'outlet' for elephants to move out of the confined park boundaries once again. Unfortunately these areas may already be heavily populated with newly developed farms and human settlements.

Understanding wild elephant behaviour

Save the Elephants, a scientific research charity based in Kenya, is seeking alternative solutions to the problem of human–elephant conflict. The team is made up of scientists who advocate the study of natural elephant behaviour as a priority on which to base elephant management decisions.

One such study turned to the natural world for a solution to keep elephants away from farmland. The team discovered that elephants were avoiding feeding on acacia trees that

Terms explained

Infrasonic rumbles Elephants emit low-frequency rumble vocalisations that can occur below the limit of the audible hearing range of humans (typically below 20 Hz). Infrasonic rumbles allow elephants to communicate with each other over great distances.

Migration corridors These are protected strips of natural habitat that allow animals to move safely between one protected area and another. They help to keep populations of the same species connected, which is essential for both genetic diversity and for seasonal dispersal for animals to access food and water supplies.

Referential signalling Elephants produce an acoustically distinct alarm call that warns other elephants about the specific threat of honey bees. This alarm call (the signal) is so specific that the listener will learn quickly that there are bees (the reference) nearby. Once this information is communicated, these elephants can make an informed decision as to how to react and ultimately learn to avoid getting stung.

had active beehives in them. This observation led to a number of research questions. Were elephants avoiding the bees because they were scared of being stung? Can bees even sting through an elephant's tough skin? Were elephants able to remember which acacia trees had beehives in and would they avoid those trees in the future even if the bees had left the hive? Could live beehives be used as an active deterrent to scare elephants away from entering farmland?

Bee playback experiments

To investigate this, we took a high quality recording of disturbed bee sounds from a wild colony of African honeybees (*Apis mellifera scutellata*). We played this bee recording to elephants by placing a fake tree trunk containing a camouflaged wireless speaker system into the bushes 10–20 metres from different elephant families that were stationary and resting peacefully under trees during the heat of the day. We filmed the response of the elephants to the playback from a safe distance and at a minimum of a 45° angle to the elephants so they

Lucy with members of the local community finishing building a beehive fence at Tsavo, Kenya

(a)

(b)

Figure 1 (a) Camera set up to film the reaction to the sound of disturbed bees of an elephant family resting under a tree **(b)** Sensitive Earthworks microphones placed near the elephants during the experimental playback trials captured their infrasonic response to disturbed bees as they moved away

could not mistake our presence nearby for the sound of the angry bees.

The reaction from the elephants was striking. Sixteen of 17 elephant families that heard the bee sounds ran away shaking their heads as if to knock any bees out of the air. We also discovered that retreating elephants were emitting **infrasonic rumbles** to each other as they ran, as if to warn others of the pending threat of bees. We showed this by using three very sensitive Earthworks microphones that are capable of recording infrasonic sounds down to 3 Hz, well below the average lowest human hearing range of 20 Hz. When we took those recorded rumbles and analysed them using acoustic software, we found that the infrasonic rumbles being produced had much higher, elevated vocal structures to the call than those rumbles emitted by elephants in response to our control sound of white noise (Figures 1 and 2).

This discovery suggested that the elephants were using a specific call to warn each other about the threat of bees. We tested this hypothesis further by playing the sound of Samburu warrior voices to the same elephant families. As predicted, the elephants produced a different structured alarm call to warn each other of possible Samburu warrior threat. Whether we have started to unravel an 'elephant language' is still to be determined but we can say with some certainty that elephants do use different call types to refer to different threat levels in their environment. Known as **referential signalling** this could have important conservation consequences for understanding how elephants perceive different threats in their environment.
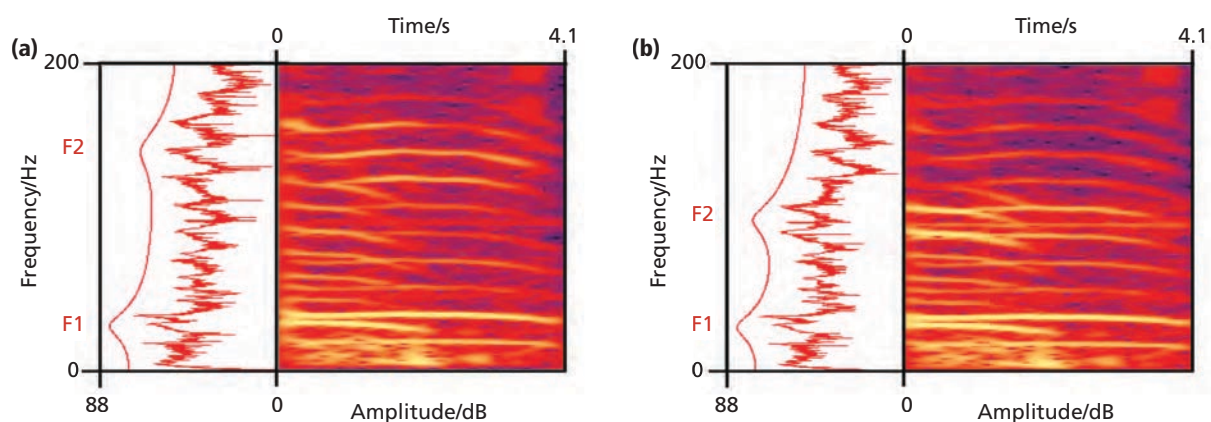

Figure 2 Frequency spectrograms of elephant rumbles in response to **(a)** the bee playback stimulus showing two formants (peaks, F1 and F2) that indicate where the stress in the vocal chords emphasises the communication information in the elephant rumble **(b)** Representative spectrogram of a typical elephant rumble from those recorded in response to control white noise playback. Note the different position of F2

Figure 3 (a) Beehive fence protecting a field of maize next to Tsavo East National Park in Southern Kenya **(b)** This couple benefit from a beehive fence protecting their farm, which has the added benefits of pollinating their crops and enabling them to harvest and sell honey

Beehive fences to protect farmers and elephants

Next we wanted to find out whether live bees in beehives could be used to scare elephants away from vulnerable farmland. Several test sites have now been set up around Kenya where we have built novel beehive fences around the outer boundary of some of the worst affected farms to see if we can reduce the amount of crop-raiding that is causing conflict with farmers in the country.

Our beehive fences consist of a series of beehives placed every 10 metres around the outer boundary of the farm linked by plain wire fencing (see Figure 3). The linking of all the beehives to each other ensures that, should an elephant try to push between two of the hives to access the farm, all the connected hives swing erratically, releasing the bees to come and sting the elephant. As we know from our experiments even the *sound* of disturbed bees can scare elephants away from an area, so it is probably the combination of a swinging fence, buzzing bees, stinging bees and the warning smell of honey that works as a 24 hour natural protection system. The beehives are also hung between two posts that we coppice from a local species of *Commiphora* tree that re-grows once it has been replanted. Consequently, our beehive fence posts

soon sprout into new trees and provide extra shade and forage for the bees.

Triple benefits for beehive fence farmers

To date, our field trials have shown on average 80% success in keeping crop-raiding elephants away from the farms, and at the same time we are helping the farmers to produce 'elephant-friendly honey' (see Figure 4) from the beehives to boost their income and to support more sustainable livelihoods. In the future we hope to produce elephant-friendly candles from residual beeswax left over from the honey harvesting process. Soon we may have the ability to commercially harvest some of the other valuable products that bees make, such as extractions of royal jelly and pollen that have certain healing and antibiotic properties. Additionally, the bees are visiting and pollinating the crops being grown in the protected farms so we anticipate our bees will also start to increase yield productivity for our participating farmers in the years to come.

This triple benefit of beehive fences helping rural farmers in Africa live more harmoniously and profitably with elephants all began with a desire to better understand elephant foraging behaviour. Before we turn to expensive, and possibly more harmful, methods to reduce human–wildlife conflict, we must not forget to understand the behaviour of the animals we want to protect better through good research. Too often wildlife management decisions are taken to maximise benefit for human inhabitants but without fully understanding the natural behaviour of the species in question first. Ill-informed decisions can lead to bad management practices to the detriment of successful wildlife conservation.

Figure 4 Jars of elephant-friendly honey being produced by farmers and The Elephants and Bees Project

As part of her DPhil in zoology at Oxford University **Dr Lucy King** explored the use of honeybees as a natural deterrent for crop-raiding elephants. She now works in partnership with Disney's Animal Kingdom and Save the Elephants in Kenya running The Elephants and Bees Project.