Large terrestrial mammals are more vulnerable to acoustic impact of drones than to visual impact

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The study analyses the reaction of 18 species of large mammals to noise emitted by a drone in the large ex situ areas of the São Paulo Zoo (Brazil). Credit: University of Barcelona

Large terrestrial mammals are vulnerable to the acoustic sounds of drones, technological systems which are increasingly used to study the wildlife in open habitats such as the savanna and marshes.

This is one of the conclusions revealed in a new study published in the journal *Drones*, which has been led by the experts José Domingo Rodríguez-Teijeiro, from the Faculty of Biology and the Biodiversity Research Institute of the University of Barcelona (IRBio); Margarita Mulero-Pázmány, from the University of Malaga, and Serge A. Wich, from the Liverpool John Moores University (United Kingdom).

Several studies state that drones that are used for scientific and recreational purposes can become a new source of disturbance for many animal species. However, there are still few studies identifying the actual factors associated with these devices that can negatively affect the animals' behavior.

Drones and wildlife: Opportunity or threat?

The use of unmanned aerial systems (UAVs or drones) is becoming increasingly widespread in wildlife monitoring and conservation studies. Obtaining scientific data with a high spatial and temporal resolution, low operational costs, and simple logistics—without compromising the physical safety of researchers—would explain the widespread scientific use of this technology, especially in the study of large mammals in open or inaccessible areas.

The first author of the new study is Geison Pires Mesquita, from the Baguaçu Institute for Biodiversity Research (IBPBio, Brazil), an organization committed to research, environmental education and biodiversity conservation. The study analyzes the reaction of 18 species of large mammals to noise emitted by a drone in the large ex situ areas of the São Paulo Zoo (Brazil).

The 18 species studied belong to 14 families, namely: addax (Addax nasomaculatus); cattle (Bos taurus); waterbuck (Kobus ellipsiprymnus); dromedary (Camelus dromedarius); maned wolf (Chrysocyon brachyurus); red deer (Cervus elaphus); sambar (Rusa unicolor); Asian elephant (Elephas maximus); imperial zebra (Equus grevyi); jaguar (Panthera onca); Bengal tiger (Panthera tigris tigris); giraffe (Giraffa camelopardalis); hippopotamus (Hippopotamus amphibius); giant anteater (Myrmecophaga tridactyla); white rhinoceros (Ceratotherium simum simum); warthog (Phacochoerus africanus); tapir (Tapirus terrestris) and the spectacled bear (Tremarctos ornatus).

Birds and mammals, the most studied using drones

Birds and mammals are the two groups of animals most studied with drones and the most affected by the recreational use of these devices. "Especially, large mammals are the most studied with drones because of their size, as they are easier to identify using aerial images," says Geison Pires Mesquida, postdoctoral researcher, who included this study in his doctoral thesis defended in February 2022. "In addition to size, the type of habitat of the species is another determining factor for using drones in wildlife studies."

The drone survey of wildlife was adapted to the Brazilian National Civil Aviation Agency (ANAC) regulations, which limit drone flights to a maximum of 120 meters. In addition, all flights were VLOS (Visual Line-Of-Sight) flights, i.e. they were required to be within the pilot's line of sight. All flights were conducted at times when there were no visits to the zoo in order to avoid any disturbance due to external factors. Audiograms were also available in the scientific literature for 12 of the 18 species analyzed—of the same or similar species—allowing for a more specific analysis of the influence of the frequency and intensity of drone-generated sleep.

The flights started at a maximum altitude of 120 meters. Once the drone was over the individuals, it began to descend until the animal showed an atypical behavior. "A limit of 10 meters above the animals was established if the animal showed no behavioral changes, but in no case did the drone descend to that height because the animals showed behavioral changes at a higher altitude," says Pires Mezquita.

The Asian elephant, sensitive to low-frequency sounds

In general, species with higher biomass—elephants, rhinos, giraffes, zebras and the waterbucks—showed a change in behavior with drones at higher altitudes (and therefore lower decibels). As this group of animals is the most studied on land using drones, especially in open habitats such as the African savannah, terrestrial mammalian megafauna would be more likely to suffer from the effects of drone noises.

The results reveal that the low-frequency sound pressure level particularly affected the behavior of the Asian elephant, but not that of the other species studied, which were more sensitive to noise at medium and high frequencies.

"These results explain why the elephant is one of the few mammal species capable of hearing low-frequency sounds (below 0.25 kHz), or infrasound (frequencies below 0.0125 kHz). Both the size of the tympanic membrane and the size of the ossicular chain and the spaces in the middle ear are compatible with sensitivity to low frequencies," says José Domingo Rodríguez-Teijeiro, professor emeritus in the UB's Department of Evolutionary Biology, Ecology and Environmental Sciences.

"Low-frequency sounds —the expert continues— propagate more easily due to the physical characteristics of their sound waves than high-frequency sounds. It is believed that elephants can communicate more

than 10 kilometers away by emitting and receiving these infrasounds."

Each type of animal exhibits a specific behavior of caution, irritation or escape. In addition, animals in ex situ environments, such as zoos, may exhibit even more specific behaviors. For this reason, the study involved the participation of Luan Henrique Morais, the zoo's head of mammal management. This expert has known each of the animals for years and informed the team if he noticed that any animal was affected by the noise of the drone.

In the case of the Asian elephant, head-shaking movements were observed in the presence of the drone. In the felines, grunting and sudden body movements; in the spectacled bear, sudden leg and head movements. In the case of deer and warthogs, attempts to escape from their location are examples of behaviors that showed adverse reactions in response to the drone noise.

It is noteworthy that "most of the species we studied did not show any behavioral reactions to the presence of the drone at an altitude of 100 meters or higher, which is the altitude at which it usually flies over the ground to carry out wildlife censuses. This confirms that the responsible use of these systems is a low-impact tool for the study of mammals," says lecturer Margarita Mulero-Pázmány (UMA).

Visual versus acoustic impact

Although this experiment does not allow us to fully discriminate between the effects generated by the impact of the acoustic or visual stimulus of the drone on the fauna, it was possible to indirectly deduce that the first effect caused by the drone on the species is acoustic. This conclusion was reached through the analysis of visual acuity—measured in cycles per degree (c/g)—which determines the ability to detect, discriminate and recognize objects against a background.

"All the species studied have a visual acuity of less than 50% of that of the human species (60 c/g). We can therefore deduce that the first impact caused by the drone on the species was acoustic, if we take into account the reduced visual capacity of the mammals analyzed, the difficult detection of the drone used by the human eye at 50 meters, and the fact that the heights at which changes in behavior occurred were on average higher than 50 meters," says the researcher.

"According to the available information, this is the first time this factor has been analyzed. Understanding that drone noise has an impact on some mammal species earlier than visual noise can help to improve current drone studies on these species and minimize the negative effects of recreational use in areas where these species are present."

In wildlife studies, the sound profile of the drone model should also be considered, it is a factor that has so far not been considered if its negative impact is to be minimized. "Although there are many drone models on the market, there are still few commercial models being used to study wildlife. Trying to understand how much noise these models generate is a necessary step to make the use of drones in wildlife studies more effective," concludes José Domingo Rodríguez-Teijeiro.

More information: Geison Pires Mesquita et al, Terrestrial Megafauna Response to Drone Noise Levels in Ex Situ Areas, *Drones* (2022). DOI: 10.3390/drones6110333

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