A burned baby lesser anteater (*Tamandua tetradactyla*).
Photo: JR Pachaly

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Wildlife management in Brazilian wildfires: a One Health approach

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"Wild animals are very much victims of wildfires, but there are also wider impacts that require a more holistic approach."

Introduction

Despite the clear threats from wildfires to biodiversity, until recently wildlife has not been seen as a priority in fire management. In Brazil, for example, before 2000 there was no specific legislation to protect wild animals from the impacts of wildfires, nor any structured rescue programmes or response centres. At that time, it was mainly zoos and a few wildlife rehabilitation centres with specialized teams of veterinarians, biologists, etc., that filled the gap by caring for burned animals.

Recently, however, the effects of fire on fauna have been more deeply analyzed, along with an extrapolation to ecosystem and human health. In December 2021, the Food and Agriculture Organization, the World Organization for Animal Health, the World Health Organization and the United Nations Environment Programme published a statement confirming their support for the One Health concept (FAO-OIE-WHO-UNEP 2021).

Carbonized lesser anteater (*Tamandua tetradactyla*). Photo: Tiago Boscarato

This is an integrated, unifying approach that aims to sustainably balance and optimize the health of humans, domestic and wild animals, vegetation, ecosystems and the broader environment.

This concept focuses on zoonoses (diseases which can be transmitted from animals to humans) and health issues, and recognizes the interconnectivity of environmental issues. One Health deals with sector-specific topics across disciplines — including prevention, mitigation, preparedness, and response and recovery — that improve and promote health and sustainability. Increasingly, this concept is being discussed in disaster situations, including wildfires.

Wildfires can be considered a threat to health – similarly to a disease. As with diseases, wildfires cause negative impacts on humans, animals, vegetation and ecosystems, and are an ecological stress factor. Fires may also support good health, as their occurrence is in part responsible for maintaining a balance in communities of living organisms. In other words, the absence of fire does not necessarily mean that an environment is healthy, since at certain levels and intensities fire may also help to ensure a sustainable ecosystem.

Fire-fauna relationships

Wildfires affect wildlife in all ecosystems, and their effects on fauna are diverse and complex (Lyon et al. 2000). The severity of impacts varies according to factors associated with fire regimes, the vulnerability of ecosystems, and other aspects, including the time of occurrence (day/night, season), uniformity, intensity, size, periodicity and duration.

The amount and location of combustible material (fuels) as well as weather and topography determine the speed of a fire and its duration, and thus directly affect animals' ability to escape. The time of the year when a fire occurs also influences combustion and spread; this is related to the humidity of vegetation, and may determine impacts on certain animals. This includes, for example, the impacts if a fire occurs during nesting season when chicks are unable to escape, or at a time when reptiles are shedding their skins. In many regions, climate change is leading to increased fire occurrence and longer duration of droughts in early spring. These factors can have more severe impacts on fauna. Increased fire frequency and intensity are also closely related to high vegetation mortality, which reduces the availability of food, shelter and breeding/nesting sites.

People used to think that only young or sick animals or species with little ability to escape were severely affected by fire and that adult animals were only occasionally injured or killed. It was thought that mortality was limited to a relatively small part of wildlife populations, and that high numbers of dead animals were mostly associated with high-intensity events. However, in almost all cases, unbalanced fire regimes — that result from human activities in the context of climate change — severely affect all fauna. On the other hand, however, in environments with healthy burning regimes, the benefits of fire for fauna can outweigh the negative effects on an individual scale, with some species benefitting from the presence of occasional fire.

Species that inhabit environments with a history of fire occurrence have co-evolved survival adaptations. These may include keeping their distance from flames, development of dense fur or other outer coatings, reactivity in searching for shelter in safe places, adaptation to high temperatures, ability to enter a state of inactivity, and using burned areas for food and/or for breeding and rearing young (Nimmo et al. 2021).

An animal's response to fire is related to its size and displacement capabilities (ability to escape). Small mammals tend to show more exaggerated flight reactions, whereas large and medium-sized reptiles, birds and mammals show smoother movements. Small and medium-sized mammals, reptiles and amphibians can take refuge from fire in burrows in the ground, where temperature increases are relatively small, and the availability of such burrows is an important factor in

an animal's ability to survive. Larger animals with high mobility can escape along or away from the fire front, or take refuge in safer areas such as lakes and rivers.

During extreme events, individuals of some species may also show unexpected behaviour, such as the aquatic displacement of arboreal howler monkeys (*Alouatta caraya*), and the defensive behaviour of striking in the flame's direction, as seen with some snakes (e.g., urutu/*Bothrops alternatus* and *B. moojeni)*. However, the co-evolutionary adaptations developed by various species are often no longer able to provide sufficient protection, and wildfires kill or injure wild animals of all sizes. Even if a fire kills a relatively low number of animals, this can represent significant losses that could have an impact on the continued local survival of a species' population.

Mass fauna mortality and One Health risks

The need for significant change became impossible to ignore during the 2020 wildfires in South America's Pantanal biome, which provides habitat for hundreds of endangered species. One estimate indicated that almost 65 million native vertebrates and four billion invertebrates were killed that year. More than four million hectares were affected. Such mass fauna mortality events can lead to the local extinction of species that provide an important buffer against zoonotic disease emerging in humans.

High species richness and equalized abundance allow organisms to compete ecologically. This creates a dilution effect, where a high diversity of vectors that are less able to spread disease reduces the infection risk for host species, including humans. Emerging and re-emerging diseases, about 70% of which are zoonoses, reinforce the need to better understand the integrated and inconstant epidemiological relationships between animals and people, especially in unhealthy ecosystems (Daszak and Cunningham 2002). In addition, wildfires can compromise the long-term viability of species and ecosystem stability, with potential impacts on human health in the long term.

As seen with the Covid-19 pandemic, the health of humans, wildlife and ecosystems are closely related, and local health problems can become global threats. Severe acute respiratory syndrome (SARS) and Covid-19 are both caused by previously unknown coronaviruses, and their emergence and dispersion show that even well-adapted infectious agents can move from their original ecological niches and assume new pathogenic characteristics (Mangini and Silva 2007).

Nine-banded armadillo (*Dasypus novemcinctus*) carbonized in Ilha Grande National Park, Brazil. Photo: Tiago Boscarato

Another interesting example is Nipah, a virus that was first reported in Malaysia in 1998. Its emergence could be attributed to the uncontrolled use of fire to clear forests for agricultural expansion, along with other human-caused factors. Whatever the cause, the resulting landscape alteration led bats to migrate into cultivated orchards and human-inhabited areas, creating the conditions for this disease to emerge (Raval and Mehta 2020).

Emergency responses

In is only in the past few years that emergency management frameworks for wildlife and wildfires began to be implemented in Brazil, alongside similar initiatives elsewhere in Latin America, notably in Argentina and Chile (Salaberry-Pincheira and Oliva 2018;

Dead urutu (*Bothrops alternatus*) with burns inside its mouth and on its head. Photo: Leticia Koproski

A rodent (family: Cricetidae) rescued from a fire in Ilha Grande National Park, Brazil. Photo: Tiago Boscarato

Muñoz-Pedreros et al. 2020). The Brazilian effort involves the joint actions of many institutions in collaborative wildlife emergency preparedness, response and recovery. These include the Ministry of Environment, Brazilian Institute of Environment and Renewable Natural Resources, National System for Prevention and Combat of Forest Fires, state fire services, civil defence bodies, state environmental agencies, federal and state veterinary boards, veterinary rescue teams, wildlife rehabilitation centres, zoos, NGOs and universities.

Response actions have been defined, based mainly on the affected fauna group, but they need to be improved to create best-practice measures that better meet wildlife needs by considering a much broader range of factors. It is important to incorporate not only the specificities of the ecosystem and the type of fire, but also scene recognition (i.e., analyzing and identifying a location), and the necessity for and practical considerations in search and rescue, triage, treatment and animals' final destination.

Scene recognition, for example, is very important when planning fauna protection. It involves analyzing fire characteristics and environmental conditions alongside wildlife occurrence records. After initial assessment, monitoring can then include the identification of the direct effects of fire on fauna through estimating the impact on animals, alive or dead, in various locations (DELWP 2018).

Search and rescue are the main objectives of response actions, to capture those animals directly affected by fire that have suffered burns or severe dehydration. Removing animals from areas at imminent risk of burning, through preventive capture and other evacuation strategies, is not simple, however, and may not be practicable due to the safety considerations for fire crews. One successful example, was the evacuation of 20 endemic birds (Eastern bristlebird/*Dasyornis brachypterus*) during the 2019–20 wildfires in Australia, eight of which were later returned to the wild (Parrot et al. 2021). All individuals with obvious burns and respiratory damage should be removed, but not all animals need to be rescued. Deciding which animals to rescue should be based on an assessment of behaviour, mobility, body posture, dehydration, external damage, respiratory impacts, and other clinical signs.

Triage is also needed. This means that the priority of care is decided depending on the severity of health conditions, potential response to treatment and post-rehabilitation return to the wild, and the species' conservation status. During triage, euthanasia must also be considered in cases when burns cover more than 20% of an animal's body or affect critical regions such as the genitals and cornea, if continuous and prolonged treatment would be required, if severe dehydration suggests renal failure, if there is a loss of metabolic, respiratory and cardiovascular capacities, or if there are comorbidities, infectious diseases or fractures.

Rehabilitation includes the treatment of injuries, the reconditioning of animals that have a favourable prognosis, their return to the wild, and monitoring afterward. Rehabilitation also allows additional assessments to be made to identify pathogens associated with rescued species. This is part of a broader effort to monitor emerging zoonotic diseases in order to carry out preventive surveillance of infectious agents in wild animal populations.

Mitigation actions

In order to reduce fire intensity and the size of the area burned, integrated fire management is a mitigation measure that can also decrease animal mortality. In addition it can lead to the development of landscape mosaics that provide refuges for animals and minimize their displacement. Environmental fragmentation can contribute to population isolation and decline over the long term, reducing animals' ability to survive by taking shelter in adjacent areas. In landscapes that are increasingly fragmented, animals are forced to search for resources in more distant areas, and may therefore carry pathogens to new areas where they did not previously occur and so could affect new hosts, including humans. Animals are also vulnerable to the impacts of hunting and trampling.

In Brazil, there are successful examples of prescribed burning carried out by traditional communities (Xerente and Oliveira 2021), and by managers in the country's conservation units (Schmidt et al. 2018; Barradas and Ribeiro 2021). These aim to reduce the availability of combustible material, and it is expected that such activities will be regulated in the future as public policy. However, few studies recognize the effects of fire management on wildlife. One study, carried out in native grasslands in the Araucaria Plateau in southern Brazil, identified higher avifauna richness and abundance in the fire treatment area after burning (Petry et al. 2011). Prescribed fire initiatives could include more actions that reduce or minimize risks to the health of wildlife, and that could be carried out in plot sizes that correspond to the mobility of local fauna to move away from and through burned areas. Additionally, the timing of controlled burns must not correspond to peak reproduction periods.

Prevention

Brazil has instruments and regulations on responsible fire management and fire suppression, e.g., Decree 97.635/1989, Law 9605/98, Decree 2661/98, Decree 6514/2008 and Law 12651/2012. Supported by good governance, these can break the cycle of wildfires as disaster events, alongside effective enforcement that either prohibits the use of fire or promotes controlled burns. The controlled use of fire reduces damage to and losses of native wildlife, and is supplemented by government policies for wild animal protection; e.g., Law 5197/67 and Law 9605/98.

In 2021, the National Wildlife Rescue Program was initiated by Brazil's Ministry of the Environment, within the legal framework for reducing the impacts of wildfires on wildlife. Its main objectives are to provide legal tools for animal rescue, emergency veterinary medical care, and assistance to vulnerable wild fauna in risk situations. Objectives also include mitigating the loss of biodiversity resulting from extreme natural events or from environmental accidents caused by human actions. It is being implemented in the Pantanal region, mainly in Mato Grosso do Sul State; a veterinarian field hospital was established there in October 2021, under the command of the firefighters. In this initiative, wildlife responders are integrated in the Incident Command System that is part of Fire Response Operations. This organizational structure aims to support the rapid and effective rescue, transportation and rehoming of wildlife to improve survival rates.

Building resilience

Wildlife management must be integrated into wildfire protection and management policies. It must include multisectoral and interdisciplinary coordination that plans and implements strategies to minimize risks and vulnerabilities, and to maximize the quality of care for affected animals. At the same time, it is necessary to establish regional and international policies and cooperation, since ecosystems, wildlife, pathogens and wildfires recognize no borders. Since the health of animals, humans and ecosystems is intimately integrated and interdependent, sustainable wildlife management in wildfires can also improve outcomes for biodiversity conservation and contribute to One Health resilience.

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