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Zoos must embrace animal death for education and conservation

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Giraffes congregate at the Copenhagen Zoo. The culling of a giraffe named Marius at this zoo in 2014 sparked a debate about the practice of euthanizing surplus animals at zoos. We argue that such practices are an essential part of animal welfare, public education, and conservation. Image credit: Wikipedia/Daderot.

Ten years ago, the culling of a healthy two-year-old giraffe, Marius, and its feeding to lions at the Copenhagen Zoo triggered a vigorous international debate regarding what zoos should do with their surplus animals (1). Unlike their wild counterparts, zoo populations are not exposed to predation and food shortages, and they're less affected by diseases and other threats. In addition, progress in animal husbandry means that individuals often live well beyond their natural age (2, 3), putting pressure on the finite holding capacities of zoos (4, 5). Although culling of surplus individuals offers a reasonable solution to this dilemma, many people are upset at the idea of euthanizing zoo animals before they reach old age, especially when it comes to charismatic mammals. Zoos suggesting culling as a strategy for population management have therefore faced the threat of public backlash and financial loss (6). We believe this opposition to be misguided.

Preventing animal reproduction currently stunts population turnover for many species. But while this approach has helped ease pressure on individual zoos in the short term (both practically and politically), it has failed the collective mandate of zoos with regard to animal welfare, public education, and conservation. Here, we

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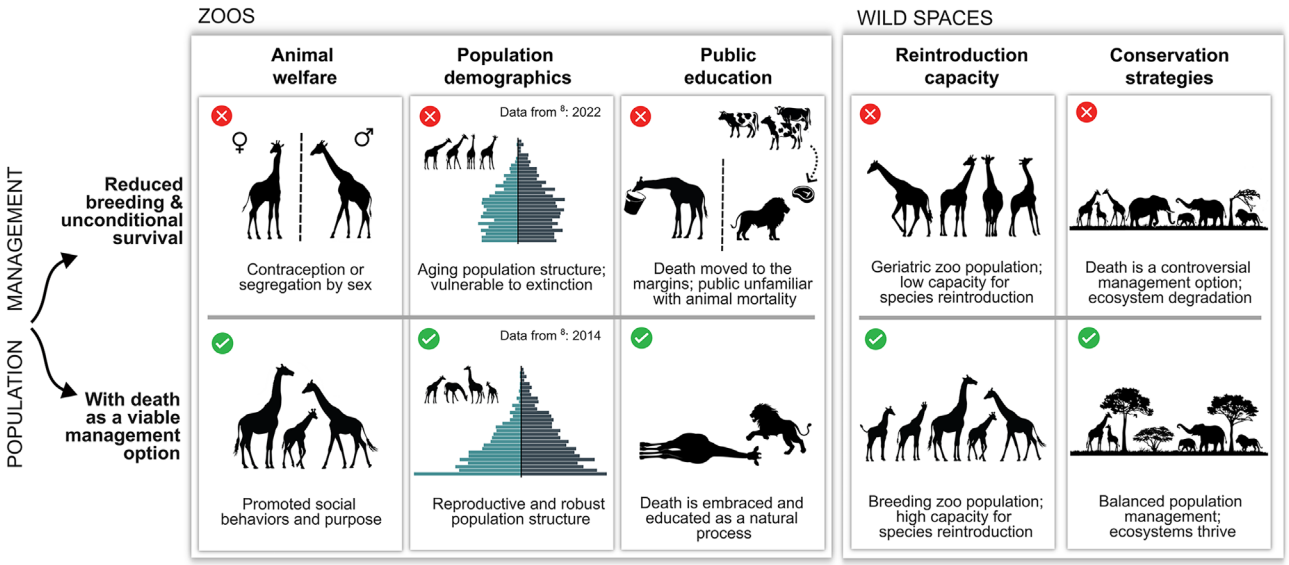

Fig. 1. Under a population-management system of reduced breeding and unconditional survival (*Upper Row*), individual zoo animal longevity is maximized, but at a cost to animal welfare and population sustainability. Such a system pushes animal mortality into the margins of public discourse, often hindering conservation strategies. With death as a management option (*Lower Row*), animal welfare is improved, and population structures are more robust. Zoos can educate about the role of death in natural processes, animal population management, and conservation, encouraging responsible duty of care and respect for nature. Global giraffe zoo population data from ref. 8 highlight rapid changes in metapopulation age structure following international debate surrounding the culling of giraffe Marius in 2014.

argue that planned and respectful culling of animals to maintain reproductively active zoo animal populations is a rational and responsible approach to zoo population management.

Sustainable Populations

Most zoos currently prioritize individual animal longevity. However, a hyperfocus on longevity increases pressure on the holding capacity of zoos. It also comes at a broader cost to animal welfare and sustainable population management. For example, the increased use of contraceptives to stop reproduction may be invasive (e.g., surgical implants) and carries the risk of pathological side effects and irreversibility, while separation by sex affects social behaviors and may also jeopardize subsequent breeding (4). Stopping reproduction also deprives zoo animals of one of their most basic evolutionary drives: to pass on their genes to the next generation. Without births, females miss the opportunity to be mothers; groups miss the opportunity to interact with young (Fig. 1, *Upper Row*). Furthermore, as animals age beyond their natural longevity, their need for health interventions increases dramatically. Indeed, a whole new subdiscipline of veterinary care has recently developed for the many geriatric animals now living in zoos (7), while zoo staff are becoming less experienced in reproduction-related husbandry.

At the population level, the widespread prevention of reproduction has altered the age profile of zoo populations—and not for the better. For example, a decade after Marius was euthanized, the population pyramid of giraffes in zoos has quickly shifted toward an older population (Fig. 1, *Upper Row*). And reproduction is not simply a switch you can turn on and off. In many cases, when contraceptives are removed, or breeding is prevented by other means for a longer period, females experience fertility problems (4) or have become too old to reproduce (7). A recent population viability assessment of zoo breeding programs in North America predicted a decline in 64% of 137 species over the next 25 years, with low reproductive rates cited as one of the most important causes (5). Stopping reproduction to alleviate pressure on individual zoos thus comes at a clear cost to the collective mission of self-sustaining zoo animal populations.

At first blush, other alternatives may seem feasible. For example, why not simply move surplus animals elsewhere? Zoos already engage in the translocation of animals to other institutions, a process governed by collaborative population management. However, the holding capacity across zoos and private institutions is finite, and zoos don't have the space to expand significantly in the near future.

And why not release surplus zoo animals into the wild? Unfortunately, this is usually very challenging. Animal reintroductions require careful preparation of release animals (e.g., learning feeding behaviors, predator avoidance), as well as coordinated development and protection of natural habitats, which takes time and incurs large financial costs. In the absence of such measures, release programs will likely result in negative outcomes, including animal death, human–wildlife conflict, and a loss of public support (9).

Some might also suggest that zoos focus on keeping only endangered species in order to free up space. But zoos already craft regional species plans to determine which species to keep, based on conservation status (10). These plans also note that species not endangered today may still serve important roles in education, and those species may be next in line for rescue programs in the future due to the rapid decline of natural habitats around the globe. Carefully deciding on which species to maintain in managed care will not alleviate the fundamental issue of finite holding capacities and the need to maintain sustainable breeding populations.

A Practical Alternative

A more ethical, practical, and goal-oriented solution for zoos is to embrace Nature's own form of population management: death. While the culling of invertebrates, fish, amphibians,

reptiles, livestock, or animals perceived as pests does not generally receive adverse public reactions, culling more charismatic mammals meets more resistance (11, 12). However, by selecting and culling certain individuals guided by age-specific natural mortality rates (e.g., at dispersal age, when young would leave their parents), less reproduction prevention will be necessary—and such policies could enhance the lives of individual animals and improve population stability. Moreover, culling can facilitate more sustainable zoo operations, as carcasses from the harvested individuals can be fed to the zoo's predator population under a "breed-and-feed" program. One zoo that adopted such a program in Germany can source up to 30% of its meat from within its own institution according to coauthor and zoo veterinarian Marco Roller, thus reducing its carbon emissions and the need for commercially slaughtered livestock (Fig. 1, *Lower Row*). Indeed, the welfare of "out-of-sight and out-of-mind" domestic livestock animals is most likely poorer than those raised under the strict welfare standards of zoos.

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Then there's the matter of public perception and education. Each year, about 700 million people across the world visit zoos to learn about wildlife and contribute to conservation (13, 14). Yet, by moving death to the margins of visibility, zoos have contributed to a shifting public perception of animal mortality and natural ecological processes. Animal demographics in the wild are determined by dynamic mortality from predation and competition, with occasional population crashes due to disease and starvation. Under such conditions, maintaining high reproductive potential is a precondition for population survival (15). However, while this evolutionary strategy promotes resilience at the population level, it comes at a cost to individuals. In other words, for animal populations to thrive long-term, not every individual can survive until old age. By limiting reproduction and pursuing unconditional survival of individuals, many zoos foster the illusion that all animals that are born will live to old age. In the wild, few do.

Breed-and-feed offers a clear opportunity for zoos to educate visitors about the role of animal death in natural processes, population management, and conservation. Individuals in the wild are particularly vulnerable to dying around their dispersal age (2). Their high mortality is a key element of natural selection, provides food for predators, and prevents overpopulation. When selecting individuals to be culled, zoos could mimic periods of elevated mortality in nature. Such programs would provide zoos with a platform to educate the public on fundamental ecological processes from the life history of prey species to predator diets (2, 15).

While some might recoil at the prospect of culling, recent data suggest that the public is more willing to learn about animal mortality than polarizing media reports often suggest. For example, a detailed analysis of social media posts following the death of Marius the giraffe concluded that 80% were neither negative nor positive, but neutral toward the euthanizing (1). The zoo director responsible for Marius' death was elected "citizen of the year" in Copenhagen that same year, after interviews in which he explained the practical and biological reasons for this population management strategy. Similarly, a recent survey of 36 zoos in Germany, Austria, and Switzerland found that the majority of visitors (78%) did not have negative response across 223 events involving feeding of the zoos' own animals to the zoos' own predators (12). These findings indicate that the public may be open to science-based arguments for planned mortality as a management strategy. Zoos have a clear opportunity to guide the narrative of animal mortality toward one of responsible duty of care.

Aiding Conservation

There's also an important conservation component here that must not be overlooked. Limited reproduction is an unsustainable population-management approach that's putting zoo animal populations at risk (5), and thus imperiling one of the main purposes of modern zoos: to prevent species extinction. Successful zoo breeding programs have facilitated the reintroduction of species that were previously extinct in the wild, such as the Arabian oryx (*Oyrx leucoryx*), California condor (*Gymnogyps californianus*), or Przewalski's horse (*Equus przewalskii*) (16). The International Union for Conservation of Nature (IUCN) recognizes zoos as an important part of the "One Plan Approach" for conservation, in which both in situ and ex situ population management play important roles (17). Indeed, the IUCN Red List specifically mentions ex situ conservation with captive breeding, such as in zoos, as an important conservation action for 2,762 animal species (18).

In the coming decades, many more species will face extinction due to human activities. It is therefore critical that all zoo animal populations have long-term sustainability and that reproductively active zoo animal populations are maintained, along with zoo staff who are experienced in caring for reproducing and young animals (19). We don't want a collection of geriatric animals and veterinarians preoccupied with palliative care.

Beyond zoos, prevailing Western attitudes toward animal mortality are shaping conservation practices worldwide. For example, in European rewilding projects, natural peaks in ungulate death appear to be unacceptable to some members of the general public, with vigilantes often intervening with supplementary feed for animals during the winter (20). A misconceived aversion toward animal mortality in the Global North also curtails conservation options in the Global South. Recently, countries in Europe, North America, and Australasia have passed legislation that prevents trophy hunting imports from overseas, despite warnings from both scientists (21) and the IUCN (22) of the negative impacts this will have for local communities. While many find the practice of trophy hunting repugnant, it does—in the absence of viable alternatives—serve an important role in maintaining biodiversity and healthy ecosystems. Scientific assessments show that without hunting, the land will likely be used for an alternative revenue stream (e.g., agriculture), and the whole ecosystem will be negatively impacted.

In response to these laws, the president of Botswana offered to send 20,000 elephants to Germany so that Europeans would have to "live together with the animals, in the way you are trying to tell us to" (23). This disconnect between conservation concerns in the Global North and the realities of conservation

challenges in the Global South can partly be blamed on a system that outsources and conceals animal death from the public. With tourists from the Global North comprising an important part of wildlife tourism in low-income countries, the narrative surrounding animal mortality is increasingly changing how conservation managers across the world are able to care for their wild spaces and local communities. Simply put, an aversion to death in the Global North should not limit the capacity of wildlife managers in the Global South to utilize death in their management practices.

The Right Time and Place

There are circumstances when planned mortality is most appropriate. Clearly, it should be an option when zoo capacity is full. The more vulnerable a population is to extinction, the more important that its reproduction is not to be halted and that robust population structures are maintained. Culling practices may face more opposition for certain animal groups (e.g., great apes or cetaceans; ref. 12), so to facilitate education best, we suggest that zoos should begin with species whose deaths have public acceptance, such as typical prey species.

In the long-term, however, planned mortality may be the most appropriate management tool in any animal species. Importantly, this means that culling for population management must become a legally accepted practice for zoos, so that they may fulfill their mandate of education and species conservation. Needless to say, zoos should be transparent about their decision to euthanize, and the euthanizing of animals should only be undertaken by qualified persons and in compliance with strict animal welfare regulations.

We live at a time when outsourcing unpleasant truths about animal deaths is no longer adequate. To do so shirks our duty of care to species under human protection—in the interest of minimizing the potential for backlash from the public. Animal death is a fundamental natural process, part of allowing predators to live and populations to thrive. Whether ex situ in zoos or in situ in natural habitats, almost all populations of large animals today are managed, at least to some degree, by humans (24). We must therefore take responsibility for the welfare-oriented way in which animals live and die under our care, while educating the broader public about the biological and ethical reasons for using death as an effective and sustainable population-management strategy.

At present, perceived public pressure and legal jurisdiction often prevent zoo and wildlife professionals from effectively using such approaches. We wish to ensure that wildlife managers can ethically and objectively consider planned mortality as a viable solution. Doing so is vital to the long-term survival of the species they are dedicated to protect.

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