Grand challenges in animal conservation

Health & Medicine

Climate change, habitat loss, degradation and fragmentation, invasive species, novel pathogens, noise disturbance, light pollution, giant floating islands of trash, anthropogenic alteration of the microbiome, ecological traps, inbreeding depression, roadkill, microplastics, stressors, subsidized predators, bushmeat crisis, wildlife trade, bird-window collisions, trophic cascades. The list could be greatly extended, but such is the litany of threats facing animal species today. We see growing consensus that we are living through Earth's sixth mass extinction event (Barnosky et al., 2011 ; Ceballos et al., 2020). Even for species not facing imminent extinction, numbers are plummeting (Dirzo et al., 2014): 3 billion birds lost in North America over the past five decades (Rosenberg et al., 2019). Further, the factors underlying biodiversity collapse are often intractable (Tittensor et al., 2014). We can view this crisis through the lens of inevitability, or we can see it is as a rallying cry to do something to turn the tide. Indeed, many audacious plans to address the biodiversity crisis have had prominent advocacy (Wilson, 2016).

Sobering progress and predictions aside, we also know that conservation can work, and a number of notable species have witnessed reversals of fortune. There are of course a few well-known stories, those of the California condor (*Gymnogyps californianus*) or the Arabian oryx *Oryx leucoryx*), wrested from extinction at the last moment possible. Indeed, using the IUCN Red List of Threatened Species, Hoffmann et al. (2010) demonstrated that a number of vertebrate species have experienced improvement in their status (40 birds, four amphibians, and 24 mammals). This is not meant to detract from the

more ominous overarching message (52 species of vertebrate moving closer to extinction each year), but shows it can be done.

What predicted success? Investment of resources. Resources, political will, and public support are a powerful recipe for advancing the cause of animal conservation (McCarthy et al., 2012 ; Pereira et al., 2012). By one estimate, all listed species (animals and plants) could realize improved conservation status with an investment of < $5 billion annually, with another $76 billion required annually to manage protected areas to maintain viable populations of all species remaining on Earth (McCarthy et al., 2012). While that may seem a large number, for comparison it represents about one-fifth the annual global expenditure on soft drinks.

The *Animal Conservation* core area of *Frontiers in Conservation Science* , therefore, has a broad and critical remit. While defining conservation problems, identifying threats, and engaging in research in novel fields that have conservation implications are suitable topics for the journal, and play an important role in moving forward the conservation agenda, we also sorely need success stories. We desperately need to know what is working in conservation for two equally important reasons. First, like the general public, scientists are not immune to the despair and fatigue associated with an endeavor that appears Sisyphean: like the Greek mythological figure Sisyphus, we may feel we are rolling a boulder up a hill only to see it come crashing down again. Such an endeavor can be de-motivating and self-defeating, and many will require a dose of optimism to keep soldiering on (Swaisgood and Sheppard, 2010 ; Garnett and Lindenmayer, 2011 ; McAfee et al., 2019). Publishing conservation successes, successes in the making, or

even tactics or actions proven to be effective can be empowering. Second, by understanding what has worked, we began to build a toolbox of effective tools and approaches to tackle conservation problems, even wicked ones. We also need to know what is not working in conservation, so mistakes are not repeated, and lessons learned are incorporated into future research and conservation strategy.

To advance conservation, ultimately research must be applied to ask and answer a conservation question. We must move beyond *implications* , and put more of our energy into testing conservation *applications* . Much of this will fall in the general domain of adaptive management, wherein management actions are tested, outcomes evaluated, and new knowledge applied to reduce uncertainty regarding management actions. An adaptive management framework incorporates several phases in the cycle: assess, plan, implement, analyze and adapt, and share, and it is indeed a high bar to meet all of these criteria (Westgate et al., 2013). The process engages key stakeholders and experts to capture all opinions and alternative actions, cultivating buy-in from all stakeholders.

Equally important is research designed to inform conservation policy, so that decision-makers can use the best available science to guide decisions. This information will of course be useless if it is not made available to those making management and policy decisions, and bridging the scientist-practitioner gap will require novel approaches to communication and collaboration, and may require a sea change in the cultures of both sides of the divide. Conservation Evidence (https://www. conservationevidence. com/

), an online compilation of published conservation interventions, is a good foundation on which to build.

It is a truism that ecosystems are comprised of individual species: Aldo Leopold opined nearly a century ago that intelligent tinkering required saving all the pieces. The *Animal Conservation* core area will be used to highlight how efforts to conserve animal species contribute to broader conservation goals. Animal conservation has as its focus the development of actionable measures that bring about recovery of species. Today, we are no longer tinkering, but engaging in bold intervention. While careful planning for conservation interventions is always required (see above), we no longer live in an era where hands-off preservation strategies meet many of our conservation challenges. We must not let fear of failure stall our efforts to implement and test conservation interventions (Meek et al., 2015).

A focus on animal species does not imply that studies addressing broader ecosystem issues are unwelcome. Species interactions, such as those with invasive species or with native species critical to persistence of the species of interest, will define many conservation problems. Understanding and managing a species' habitat is foundational to management of at-risk species (Morris, 2003), and will always occupy an important position in animal conservation science.

While proven-effective traditional approaches to animal conservation science are welcome at *Frontiers in Conservation Science* , emerging approaches and technologies hold great promise for more successful conservation applications. Horizon scans (Sutherland et al., 2019) can identify emerging

conservation challenges that may influence animal conservation strategies; remaining focused on addressing the threats in front of us now may leave us ill-prepared to address the threats looming on the horizon.

Approaches to animal conservation are undergoing rapid change, both to confront rapidly escalating environmental pressures and to incorporate emerging technologies. Biologging devices, for example, are revolutionizing animal ecology and conservation research (Rutz and Hays, 2009 ; Wilmers et al., 2015 ; Wilson et al., 2015), especially when coupled with new analysis approaches (Jacoby and Freeman, 2016). Networks of environmental sensors can be used to define the habitat and climatic conditions in which animals live with unprecedented fine-scale spatial and temporal detail. Animals can carry devices that record far more than just location: accelerometers open up a brave new world of field energetics, proximity sensors reveal the intricacies of social networks, and animal-borne video provides intimate perspectives on animal's lives (Moll et al., 2007). These emerging technologies can be used to quantify human disturbance and human-wildlife conflict, understanding habitat requirements and threats, modeling disease transmission and outbreaks, and so much more. Camera traps, initially widely used primarily to determine presence/absence of a species in an areas, can now be set out in extensive arrays to capture much more, including estimates of population density (Nakashima et al., 2018), global biodiversity monitoring (Steenweg et al., 2017), and documenting behavioral patterns that inform conservation (Caravaggi et al., 2017).

Of course, new horizons are not governed solely by technology, but also by new ideas, such as the importance of preserving animal culture (Brakes et

al., 2019) or behavior (Greggor et al., 2016 ; Goymann and Küblbeck, 2020), the idea of using ecological replacements to fulfill the ecological role of long-extinct species (Corlett, 2016), or integrating disease ecology with behavioral ecology to better manage pathogens impacting animal populations (Herrera and Nunn, 2019). Some disciplines, like animal behavior (Greggor et al., 2016) and physiology (Cooke and O'Connor, 2010) have yet to fulfill their conservation potential, so offer especially rich opportunities for future application. In short, whatever approach—whether new and innovative or tried and true—that produces compelling science that advances the cause of conservation can find a home in *Animal Conservation* core area of *Frontiers in Conservation Science* .

Author Contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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