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Editorial: Advances in the conservation of large terrestrial mammals

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Editorial on the Research Topic
Advances in the conservation of large terrestrial mammals

Introduction

Large mammals are threatened worldwide (Ceballos and Ehrlich, 2002; Schipper et al., 2008; Bowyer et al., 2019; Torres-Romero et al., 2020; Greenspoon et al., 2023). These iconic animals possess life histories characterized by long life spans, delayed age at first reproduction, iteroparity, small litter sizes, and high maternal investment in large offspring, which predispose many large mammals to elevated risks of extinction (Eberhardt, 2002; Bonenfant et al., 2009; Bowyer et al., 2014). Those risks include habitat loss, habitat degradation, effects of climate change, illegal killing, disease, or inbreeding (Davidson et al., 2017; Bowyer et al., 2019), and have important implications for conservation especially for large herbivores (Atwood et al., 2020). Understanding how to counter those threats effectively is essential to conserving wild populations now and in the future. This Integrated Research Topic provides an overview of the challenges to conserving viable populations of large terrestrial mammals in modern landscapes.

Collectively, these works provide new insight into factors underlying successes and failures of historical conservation efforts for large mammals, including recommendations for the future. The roles of pernicious diseases, mismatches in adaptations of translocated animals to their new surroundings, and differences in survival between resident and translocated animals are investigated. New evidence that climate change results in interspecific competition between large mammals via a reduction in ephemeral resources is presented. Conservation efforts are linked to the critical role nutritional condition plays in shaping the dynamics of ungulate populations. Tradeoffs made by ungulates between predation risk and acquisition of forage, and the efficacy of predator control in ungulate conservation are investigated. A new method to strengthen predictions about habitat suitability is offered, and measures are developed to examine connectivity across variable land-use and species matrices to improve conservation of iconic mammals.

Conservation concerns

We offer new information relevant to the conservation of mule deer (*Odocoileus hemionus*) and bighorn sheep (*Ovis canadensis*), both of which have had conservation successes but remain subject to threats that warrant further attention. Whiting et al. explore the past challenges bighorn sheep have faced, and the ways in which some of those obstacles have been overcome, including intensive and successful efforts to restore those native ungulates to historical habitat (Brewer and Bleich, 2023). Whiting et al. also emphasize some short-comings associated with past efforts, while calling attention to remaining challenges, with a focus on habitat enhancements, genetic issues, selection of translocated stock, predation, and disease transmission—all of which are likely to affect future decisions regarding the restoration of bighorn sheep.

As noted by Whiting et al., diseases have played a prominent role in the conservation of bighorn sheep. Walsh et al. address this issue in greater detail and conclude that bighorn sheep in free-ranging herds are unlikely to confer immunity to novel strains of *Mycoplasma ovipneumoniae*, a pathogen that has been implicated in losses of entire populations. Separation of domestic sheep from bighorn sheep, and the implementation of management practices that prevent co-mingling of those species, likely will be the most effective approach for reducing the effects of disease and achieving bighorn sheep conservation goals (Walsh et al.).

A rapidly changing climate is predicted to modify numerous aspects of ecosystem structure and function, including community composition and distribution of many species (Walther et al., 2002). Such alterations are likely to increase risks of extinction for large mammals (Urban, 2015; Bowyer et al., 2019), especially at high elevations or extreme latitudes (Berger et al., 2018). Moreover, effects of climate change on interspecific competition are an important but often overlooked aspect of a warming climate. Berger et al., for instance, document how changes in abiotic resources (minerals, water, snow, and shade) at high elevations foster active competition between ungulates, including mountain goats (*Oreamnos americanus*) and bighorn sheep, for limited resources. Mountain goats dominated bighorn sheep in nearly all social interactions, indicating the importance of understanding effects of climate on abiotic resources and subsequent shifts of behavioral ecology of large herbivores.

Lamb et al. demonstrate that maternal nutritional condition in mule deer influences health of young from gestation through recruitment, highlighting the importance of considering direct maternal effects when examining population dynamics and reproductive success in long-lived mammals. As a result, conservationists are reminded that management plans for ungulates should include assessments of nutritional condition of adult females to maximize likelihood of effective conservation.

Cain et al. ascertain that sites at which female mule deer have been killed by mountain lion (*Puma concolor*) were associated with decreasing horizontal visibility and available forage protein of vegetation, indicating that deer may be selecting for forage quality at the cost of predation risk. Mule deer also selected for areas with higher visibility when risk of mountain lion predation was higher. This tradeoff between forage and predation risk likely holds consequences for nutritional condition and population-level vital rates of mule deer (Cain et al.).

McMillan et al. address one of the most controversial issues confronting wildlife managers—predator control. Following a detailed meta-analysis, they report that consecutive years of coyote (*Canis latrans*) removal increased survival of neonatal mule deer more than did a single year of removal, and that removals of coyotes in close proximity to birthing sites was more effective than removals farther away, the latter of which did not influence survival of young mule deer. Their results underscore the need to employ removal efforts over consecutive years, conduct targeted removal efforts within fawning habitat, and concentrate control efforts on the period when additive mortality is apt to be high.

Smedley et al. explore factors affecting success of translocation efforts for female mule deer, including techniques used to reduce 'problem' populations (Mayer et al., 1995), augment existing populations (Cronin and Bleich, 1995), or to reestablish populations in novel areas (Heffelfinger and Latch, 2023). Smedley et al. compared survival of translocated individuals with that of resident animals, and report differences during the first, but not the second, year following translocation. Younger deer also had higher survival rates than older animals. These data highlight the need to consider the age-class of individuals selected for translocation and monitor the status of translocated animals for multiple years.

Habitat connectivity contributes to biodiversity and conservation. In particular, loss and fragmentation of habitats represent substantial threats to biodiversity (Lõhmus et al., 2017), with detrimental effects on species' dispersal and gene flow (Foltête et al., 2020). Researchers previously have used network connectivity analyses to inform conservation efforts (Gil-Tena et al., 2013; Saura et al., 2018), but spatial structure of many landscape connectivity models or a species-specific approach to connectivity modeling can yield disappointing outcomes (Avon and Bergès, 2016). Camera-trap data and incorporating additional habitat features (e.g., edges) can improve model outcomes, illustrating how this novel approach can strengthen predictions of habitat suitability (Tang et al.). Additionally, selecting multiple species that have an appropriate relationship to landscape characteristics and scale can enhance model efficacy and help meet connectivity goals. This approach, termed "umbrella connectivity", as advocated by Dutta et al., encompasses areas most likely to be used by several co-occurring species and thereby enhances objectivity in selecting which, and how many, species are required for connectivity conservation. Further, this approach fosters well-informed decisions that benefit entire communities or ecosystems. To be effective, conservation measures must consider connectivity across variable land-use and species matrices, as emphasized both by Tang et al. and Dutta et al., approaches that have important implications for conserving large terrestrial mammals.

Contributions to this Research Topic provide the underpinnings necessary for successfully identifying, promoting, and implementing a number of conservation measures for large terrestrial mammals. Further, these works broadly encompass causes and consequences of conservation issues that help focus research and promote acquisition of future knowledge concerning iconic large mammals.

Author contributions

RB: Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. VB: Conceptualization, Validation, Writing – original draft, Writing – review & editing. PW: Conceptualization, Validation, Writing – original draft, Writing – review & editing. JR: Conceptualization, Validation, Writing – original draft, Writing – review & editing.

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Conflict of interest

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

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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