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Perspective

# Livestock grazing in protected areas and its effects on large mammals in the Hyrcanian forest, Iran

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ABSTRACT

Protected areas are the most important tool to safeguard large mammals from overexploitation, but their effectiveness is insufficiently studied in temperate ecosystems. The Hyrcanian forest is one of the oldest and most threatened temperate forests globally. Anthropogenic activities are widespread and negatively affect wildlife species in the Hyrcanian forest. We conducted surveys in ~22% of the Hyrcanian forest by walking 1204 km in 93 16-km$^2$ cells distributed randomly in 18 protected and non-protected study sites. We used Bayesian occupancy modeling to measure the effects of livestock grazing, logging and poaching on distribution of six large mammal species. Our results explicitly show that grazing had negative and significant impact on the occupancy of very patchily distributed Persian leopard ($\beta = -1.65$, Credibility Interval $-2.85$ to $-0.65$), Caspian red deer ($\beta = -1.36$, CI $-2.34$ to $-0.45$) and roe deer ($\beta = -1.61$, CI $-2.96$ to $-0.58$) while logging did so for red deer ($\beta = -0.82$, CI $-1.69$ to $-0.03$). Poaching could not be determined due to low detectability of poaching signs. Grazing intensity was high in protected areas (IUCN category V), no-hunting and non-protected areas and much lower in national parks (II) and wildlife refuges (IV). Representing 66% of total reserves in the Hyrcanian forest, category V protected areas urgently require priority actions in assessment of grazing capacities, allocation and enforcement of grazing quotas, and better coordination between governmental conservation and natural resource management organizations to avoid further depletion of the large mammal community in the Hyrcanian forest.

## 1. Introduction

Protected areas are the cornerstone of conservation, but many of them lose rare and ecologically sensitive large mammals at alarming rates due to insufficient size and poor protection from overexploitation and other threats (Watson et al., 2014; Maxwell et al., 2016). Albeit many studies reporting local species extirpations from logging, grazing and poaching in tropical regions, the effects of these threats on

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temperate ecosystems remain understudied (Brodie et al., 2015) since most temperate forests have already lost many large species.

Livestock grazing, logging and poaching are among the main drivers of biodiversity loss but their effects can be both synergistic and contrasting across different species (Brodie et al., 2015; Maxwell et al., 2016). For example, logging and grazing may improve food supply for predators but also provoke human-predator conflicts and poaching (Laurance et al., 2008).

Livestock grazing inflicts intense landscape degradation and has multiple effects on large mammal distributions (Karanth et al., 2011; Ripple et al., 2014, 2015). Livestock causes large-scale changes in vegetation structure and adversely affects native herbivores via trophic competition (Maxwell et al., 2016; Gordon et al., 2017). Logging simplifies the complexity of forest ecosystems and reduces habitat quality (Müller et al., 2016). In addition, logging and grazing contribute to road development which increases habitat accessibility to poachers, thus exerting substantial effects on the survival of large mammals (Laurance et al., 2008; Brodie et al., 2015; Maxwell et al., 2016).

The Hyrcanian forest (hereafter, HF) located in Iran and Azerbaijan is a Tertiary relict temperate forest of high conservation value due to the exceptional diversity of landscapes and species converging between Asia, Europe and Africa (Fig. 1). It is part of the Caucasus Biodiversity Hotspot and harbors a diverse community of large mammals, such as the Persian leopard (*Panthera pardus saxicolor* Pocock, 1927), brown bear (*Ursus arctos* Linnaeus, 1758), grey wolf (*Canis lupus* Linnaeus, 1758), Caspian red deer (*Cervus elaphus maral* Ogilby, 1840), roe deer (*Capreolus capreolus* Linnaeus, 1758) and wild boar (*Sus scrofa* Linnaeus, 1758) (Olson and Dinerstein, 1998; Firouz, 2005). The last Caspian tiger (*Panthera tigris virgata*) was killed in 1953 in the Hyrcanian forest (Firouz, 2005). Sixty percent of the HF is under legal protection and natural resource use is managed by the government (Zehzad et al., 2002; Firouz, 2005; Makhdoum, 2008; Dabiri et al., 2010; Müller et al., 2017).

Several laws to protect plant biodiversity in Iran's forests have been implemented, such as the forest nationalization law (1963), the law banning livestock grazing inside core zones of protected areas and wildlife refuges (1982) and the law on livestock exclusion from all HF (1989). Since 1956, hunting inside protected areas is permitted only under special licenses (Firouz, 2005). Despite these legislative acts, human activities such as grazing, logging, poaching and wood collection are widespread and unorganized in the HF (Firouz, 2005; Makhdoum, 2008; Sagheb-Talebi et al., 2014; Ghoddousi et al., 2017a; Müller et al., 2017). Due to overexploitation, the forest cover of Iran has halved during the past five decades (Ghoddousi et al., 2017a). Nowadays, about 4 million livestock are roaming across the HF, leading to overgrazing (Sagheb-Talebi et al., 2014), deterioration of forest regeneration and forest recessions, especially in lowlands (Akhani et al., 2010). The Hyrcanian forest cannot supply sufficient fodder for livestock and its current economic use is unsustainable (Noack et al., 2010). In Golestan National Park, Iran's oldest reserve, the red deer population has declined by 89% since the 1970s due to poaching motivated by subsistence, leisure and hostility toward park staff and conservation laws (Ghoddousi et al., 2017b).

While understanding of the effects of human threats on the distribution of large mammals is among the top conservation priorities in this region, it largely remains overlooked by scientists and conservationists. The paucity of information and conservation guidance is particularly evident at large scales, which is critical considering the spatial requirements of populations of these species (Ripple et al., 2015). In this study, we combined intensive field surveys and Bayesian occupancy modeling to document the effects of overgrazing, logging and poaching on the distribution of six large mammal species throughout the HF. We also assessed the efficiency of protected area categories in preservation of large mammals. Further, we discuss the management actions required to address declines of large mammals in the Hyrcanian forest.

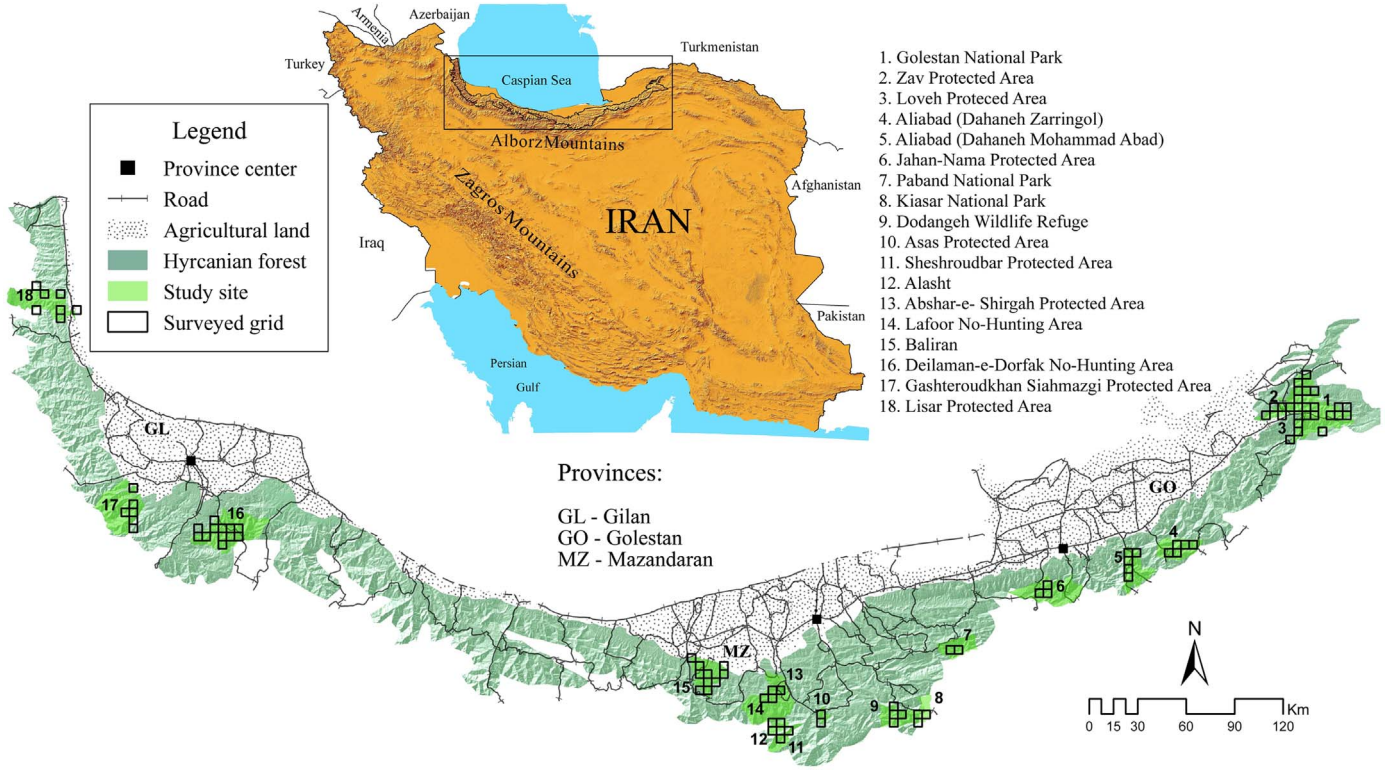


**Fig. 1.** The map of the study areas across the Hyrcanian forest, northern Iran.