Population monitoring and management

Monitoring deer browsing and density in Mediterranean forests: impacts of introduced fallow deer are larger than those of native roe deer

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DOI: 10.20315/evmc.2025.046

Herbivory by wild ungulates may trigger significant impacts on vegetation, and recent studies suggest scale-dependent effects of population density. Yet, there is no agreement on whether impacts should be related to densities and about the scale of effect. Gaining knowledge on such issues would be crucial to target the appropriate spatial scale over which effective ungulate management should be conducted. Additionally, deer browsing pressure in Mediterranean forests has been understudied compared to temperate forests. During 2019-2023, we investigated whether multi-scale, spatiotemporal variations in densities of introduced fallow deer (*Dama dama*) and native European roe deer (*Capreolus capreolus*) drove the browsing impact on forest vegetation, within a Mediterranean protected area.

We found no effect of deer densities on browsing at the finest, sampling plot-scale. Higher browsing pressure was associated with greater fallow deer densities at both the home range and study area scales, but not with roe deer densities. We obtained the same results when considering browsing pressure on forest patches as a whole and separately on the dominant woody plants in the study area (*Quercus ilex*; *Phillyrea* spp.). Browsing indices decreased by 75% in 2019-2023, matching the steady decline in fallow deer population density (–25%). Throughout the study period, fallow deer density in any year was unrelated to relevant culling pressure in the previous year. Conversely, the decreased fallow deer density was related to the increased grey wolf (*Canis lupus*) numbers (for which the fallow deer is a major prey), suggesting consumptive effects by predators achieving top-down control of deer impact on vegetation.

Our study offers practical insights into population monitoring and management of wild ungulates, as well as their impact on natural ecosystems. First, we showed how the population density of the introduced deer species –but not that of the native one– was related to browsing impact on forest vegetation. Hence, browsing pressure by wild ungulates can be used as a surrogate for monitoring spatiotemporal variations in population densities, although we suggest caution in contexts with co-occurring species, as not all of them have the same impact. Moreover, this finding emphasises the major role of introduced ungulates in eliciting impacts on natural habitats, advocating proper management actions. Second, we identified the spatial scales at which deer densities would be more likely to impact forest vegetation. Third, we showed a potential example of recolonizing predators helping in the control of both ungulate densities and, as a consequence, their impacts on ecosystems.