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Integrating the deer (*Cervus elaphus*) in the Portuguese forests: Impacts and new challenges for forest certification

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ABSTRACT

The ever growing presence of red deer (*Cervus elaphus*) in the forest perimeters of the Lousã Mountain area of central Portugal is causing local conflicts among stakeholders who report damage to agriculture and forest. One of the forest perimeter regions (Lousã) has been selected to develop a Portuguese Standard for the Forest Certification System (PEFCC). The aim of this study was to determine whether any real damage or impact caused by red deer had in fact occurred in the area. Four types of forest cover were considered and nine plots (150 m^2) were randomly selected within each type. All trees were recorded and the diameter at breast height (dbh) was measured. The characteristics of marks of each rubbed tree were recorded. The amount of foliage browsing was estimated visually as a percentage except in situations of regeneration where the total number of consumed leader or lateral shoots was counted. The shrub layer was scored according to height and cover. Altitude and distance to the nearest village, river or national road were measured in each plot to analyse their influence on the degree of damage. Cluster analysis allowed us to observe a damage pattern across the study plots that separated browsing damage from fraying damage. Pine regeneration type vegetation suffered significant damage by browsing but the percentage of damage due to fraying was not significantly different between forest types. Some species of trees, such as sweet chestnut (*Castanea sativa*), were more susceptible to fraying damage. In all cases, deer clearly preferred rubbing on the smallest trees.

A classification tree where the percentage of rubbed trees was the response variable, showed that diameter at breast height (dbh), distance to national road and the number of trees were primary contributors to probability of damage. We propose that new indicators should be introduced into the certification process and that there is also a need to find a balance between different stakeholders' interests and wildlife.

1. Introduction

Over the past century, red deer (*Cervus elaphus*) populations diminished in number and area in Portugal due to social and political change and shifts in land use towards agriculture and livestock (Fuller and Gill, 2001; Gordon, 2009). As a result only a few deer nuclei remained, confined within walled properties.

Populations slowly recovered towards the end of the 1970's, initially due to animals crossing the Spanish border. This natural expansion (Acevedo et al., 2011) was reinforced with reintroductions of deer by The Governmental Hunting Agency, resulting in the re-colonization of most of the deer's original distribution (Salazar, 2009). To sustain these governmental restocking initiatives, restricted hunting is allowed.

Due to the high socioeconomic importance of this species, many hunting areas in the center and south of Portugal also reintroduced the red deer into enclosed properties, to increase game diversity and safeguard the prior investment. The re-emergence of red deer is causing local conflicts with landowners who report damage in forested and agricultural areas (Rosa, 2006). Deer cause damage by browsing on both young and established trees or by 'fraying' bark from the main stem of small trees by rubbing them with their antlers to clean off shreds of 'velvet' (Putman and Moore, 1998). Few studies have been developed in Portugal to better understand this new situation (Soares, 2003; Ramos et al., 2006; Da Silva, 2009) and greater effort is needed to reconcile agroforestry systems with the wild herbivore species that inhabit them through species management and habitat improvement.

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Forest areas produce a wide array of goods and services. Diversification of products is desirable, as long as it adds value to forest areas and contributes to sustainability. The red deer, which is intimately associated with woodlands, offers new opportunities for recreational activities, hunting areas and to combat against rural desertification. This new approach to forest management (Ritter and Dauksta, 2006), which incorporates both ecological and social functions, encourages the implementation of the forest certification process, promoting sustainable forest management without compromising economic, social and environmental functions (IPQ, 2003). The Portuguese Regulation NP 4406 meets the requirements of both certification systems, namely the Forest Stewardship Council (FSC) and the Program for the Endorsement of Forest Certification Scheme Council (PEFC Council). Currently, the National Forestry Authority (AFN) is the governmental body responsible for the forest certification process in several pilot areas that will serve as models for future management strategies. Our study area includes four forest perimeters located in the Lousã Mountains in Central Portugal. The Lousã perimeter was chosen by AFN as a pilot management unit for the aforementioned certification schemes. It is located within a designated Natura 2000 site (PTCON0060 – Serra Lousã) and includes part of the Lousã national hunting area. For a period of six years starting from 1995 onwards, a total of 96 deer were introduced in the area and present day estimated densities are 0.01 animals/ha rising to 0.036 animals/ha in rutting areas (Soares et al., 2005).

Conflicts started with landowners in 2002, resulting in the AFN requesting that a Global Management Plan for ungulates be drawn up that included deer hunting, an activity that had previously been forbidden. Several studies have shown that forest function is compromised above a certain threshold of deer abundance (Gill, 1992a, 2000; Rooney, 2001; Rooney and Waller, 2003) although this relationship is not clear. This study investigates whether real damage or impact by red deer has in fact occurred based on three classes of deer abundance derived from information provided by AFN (based on the work of Soares et al., 2005). We intend to (1) identify whether the damage caused was via feeding or behavioral habits, (2) assess the severity of damage across different classes of vegetation, (3) identify the most severely affected tree species, (4) identify the principal factors determining spatial damage patterns. Based on these results, we discuss the importance of social concerns in finding a balance between different stakeholders and wildlife needs, and contribute towards the certification process.

2. Material and methods

2.1. Study area

The study was carried out in 2009 in the four forest perimeters of the Lousã Mountains, central Portugal (40°5′N; 8°8′W; Fig. 1). This area comprises approximately 9564 ha of communal lands, managed by the AFN through the Regional Forest Management Plan of Pine stands of the North Interior Region. Much of this area falls within the Natura 2000 network site PTCON 0060 – Lousã Mountain where traditional land use comprises managed forest and natural rangelands.

The climate is mild (average annual rainfall 1400 mm–1600 mm, mean annual temperature 10 °C–12.5 °C) and site elevation ranges from 600 to 1100 m. The landscape is dominated by shrubs (21%) and coniferous forest (50%), in particular the maritime pine *Pinus pinaster*. Remaining vegetation cover consists of riparian woodland, fragments of original oak forest (*Quercus spp.*), birch (*Betula celtiberica*) and mixed forest. The pine stands are irregular with closed understory vegetation, indicating poor forestry management. Present day threats in the area include the presence of exotic species (*Acacia dealbata*) and the occurrence of severe wildfires. The Forest Management Plan intends to partially replace pine stand with mixed/deciduous forest to reduce fire risk and improve heterogeneity. Since reintroduction, red deer numbers have slowly increased, although distribution patterns are patchy in the Lousã Mountains, with areas of low, medium and high abundance. This simplistic approach to assessing the relative density of deer will be used as a starting point in sampling design.

2.2. Data collection

The study area was divided into four different types of tree cover: pine stands, scrubland with pine, mixed forest (mainly deciduous trees) and stands of regeneration/plantation with young Maritime pine trees.

We randomly selected nine sampling sites for each cover type, distributed equally among the three categories of deer abundance considered in the study area. A 10 m × 15 m plot (150 m^2) was established at each site to evaluate tree damage due to fraying or browsing. A total of 36 plots (9 × 4 forest types) were established 15 m from the boundary of each vegetation stand (Harper et al., 2005), following the line of the maximum slope. The edge of a site was defined as where there was a distinct change in land use and adjacent areas that consisted of unplanted ground e.g. roads, open ground, scrubland or forest stands with different age (see Welch et al., 1991). To test for differences in the proportion of damage between the edge and the forest interior, a second plot was located in the interior of the forest stand, about 60 m distant from the edge (Murcia, 1995) within the same forest type. This condition occurred in only twelve of the study sites because the local landscape is characterized by a mosaic of small patches of different vegetation types. Thus, we sampled a total of 48 plots: 24 sites with a single plot on the forest edge and 12 sites with a plot situated on the forest edge and a plot situated in the interior.

In each plot we recorded the total number of trees and the number of groups of deer pellets. Each tree was classified as damaged or undamaged, regardless of type (browsing or fraying) and as alive or dead. All vegetation types, except regeneration stands, were considered when measuring the diameter at breast height (dbh) in trees >2 cm diameter. Basal area was also calculated.

The amount of foliage browsing was visually estimated for each browsed tree and expressed as percentage, except in regeneration type vegetation where the total number of leaders and lateral shoots damaged by browsing were counted. We analyzed the damage caused by rubbing in each tree by measuring and recording (i) the distance between ground and the beginning of the rub and (ii) total length of the rub.

The shrub layer, a food source for deer, was scored from 0 (unsuitable) to 1 (optimal) in each plot according to height ($\leqslant$1 m = 1; <1 $\leqslant$ 1.5 m = 0.75; >1.5 m = 0.25) and cover (% of occupation) (0.33 = <50%; 0.67 between 50–80% and 1 to >80%). Altitude (measured using a GPS), nearest distance to village, river and national road (estimated using GIS software) were measured in each plot to analyze the influence of these parameters on the degree of damage caused by deer.

2.3. Data analysis

We used cluster analysis (city-block distance with Ward's method) using standardized data for assessing total damage, damage by rubbing and the number of deer pellet groups counted in each plot to examine if there was a pattern of the damage according deer abundance categories. Each plot was labeled with a letter according its location in areas with "high (h), moderate (m) and low density (l)". Thus, the "location of plots" was considered as an integral variable that was not used in the cluster analysis.