Biological Conservation 144 (2011) 764–771

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Protected wading bird species threaten relict centenarian cork oaks in a Mediterranean Biosphere Reserve: A conservation management conflict

Luis V. García [a,*], Cristina Ramo [b], Cristina Aponte [a], Adela Moreno [a], María T. Domínguez [a,c], Lorena Gómez-Aparicio [a], Ramón Redondo [d], Teodoro Marañón [a]

[a] Instituto de Recursos Naturales y Agrobiología de Sevilla (CSIC), P.O. Box 1052, 41080 Sevilla, Spain
[b] Estación Biológica de Doñana (CSIC), Avda, Américo Vespucio s/n, 41092 Sevilla, Spain
[c] Centre for Ecology and Hydrology, Environment Centre Wales, Deiniol Road, Bangor, Gwynedd LL57 2UW, United Kingdom
[d] Stable Isotope Laboratory, Facultad de Ciencias, Universidad Autónoma de Madrid, 28049 Cantoblanco, Madrid, Spain

ARTICLE INFO

Article history:
Received 26 January 2010
Received in revised form 30 October 2010
Accepted 6 November 2010
Available online 3 December 2010

Keywords:
Quercus suber
Stable isotopes
$\delta^{15}N$
$\delta^{13}C$
Indirect effects
Colonial waterbirds
Heronry
Doñana

ABSTRACT

Conservation management conflicts frequently arise when an overpopulation of a protected organism has negative effects on other valuable elements in the same ecosystem. We studied the interactions between a colony of protected tree-nesting wading birds and a remnant population of centenarian cork oaks that was part of the formerly dominant forests in the Doñana Biological Reserve (SW Spain). A significant increase in the tree mortality rates has been recorded in areas that are yearly influenced by the bird colony.

We analysed a cohort of surviving trees using a gradient of nesting bird influence. Tree-nesting history, bird isotopic signature ($\delta^{15}N$), tree health-related parameters (defoliation, $\delta^{13}C$ and leaf surface coverage by faeces) and several soil variables were evaluated. Bird influence was related to increased soil salinity. This increase correlated to increased water-use efficiency for the leaves and to crown defoliation, suggesting that the heavily occupied trees are under higher stress and in poorer health condition than the unoccupied ones. We tested structural equations models (SEM) that were based on hypothesised bird effects on the health of the trees. Soil-mediated effects of the nesting birds best explained the symptoms of the declining health of the trees, whereas the percent of leaves' surface that was covered by faeces did not improve the fitted SEM model.

For the reserve's managers, a challenging trade-off exists between preserving the relict trees, which have a high genetic diversity and a key ecological role in these savannah-like ecosystems, and maintaining the current nesting area for these protected, but expanding, wading birds.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

The establishment of natural reserves with a high protection status is a valuable tool to preserve endangered species and ecosystems (Arcese and Sinclair, 1997; Sinclair et al., 2002). However, in some cases, a high effective protection status is not enough to guarantee the conservation of a natural area. Unforeseen species-species or species-environment interactions may lead to undesirable results, including habitat degradation, a decline in the number of key species or losses in plant or animal diversity (Asner et al., 2009; Oro et al., 2009).

Under certain circumstances, plant–animal interactions may have detrimental effects on the plant communities in natural reserves. Overgrazing and overbrowsing by herbivores is frequently reported as an undesired result of the protection of some natural areas (Herrera, 1995; Henríquez and Simonetti, 2001; Harrison et al., 2008; Asner et al., 2009). Other potentially harmful effects of animals (such as nesting, roosting, trampling and burrowing), allied to intensive plant occupation or soil alteration, have also been reported in protected areas (Sobey and Kenworthy, 1979; Mulder and Keall, 2001; García et al., 2002; Hebert et al., 2005).

One specific example of the effects of animals in natural reserves is the damage done to trees by tree-nesting/roosting waterbirds colonies. This type of damage has been reported in natural areas of America (Miller, 1982; Dusi and Dusi, 1987; Belzer and Lombardi, 1989; Hebert et al., 2005), Australia (Baxter, 1992; Baxter and Fairweather, 1994), Korea (Mun, 1997), the Russian Federation (Zelenskaya and Khoreva, 2006) and Japan (Ishida, 1996, 1997; Fujiwara and Takayanagi, 2001; Mizota, 2009). In Europe, Ligeza and Smal (2003) and Żółkoś and Markowski (2006) have reported the deleterious effects of cormorants and protected wading bird colonies on centenarian trees in Polish natural reserves. Alterations in the composition of the soil and/or direct mechanical/

* Corresponding author. Tel.: +34 954624711x166; fax: +34 954624002.
E-mail address: ventura@cica.es (L.V. García).

0006-3207/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biocon.2010.11.007

chemical effects were the most cited causes of damage to the trees by the nesting/roosting colonial waterbirds. As far as we know, no studies have been carried out on the detrimental effects of these tree-nesting colonial birds on Mediterranean oak forests.

In previous studies in protected Mediterranean islands (García, 2005; García et al., 2002), we found that colonial-nesting seabirds induced significant changes in soil salinity. These changes were paralleled by increased ^{15}N levels and by ^{13}C changes in the leaves of shrubs, suggesting that the soil alterations could affect the water-use efficiency (WUE) of leaves. Bird-induced soil changes significantly affected the distribution of the woody salt-tolerant plant species that inhabit these islands. Therefore, we concluded that changes of a similar nature may be much more damaging for long-lived, salt-sensitive species such as the cork oak, which thrives on the leached, acidic sands in the Doñana Biological Reserve (DBR) (Clemente et al., 1988; Siljeström et al., 1994).

In this paper, we studied the bird–soil–tree interactions in a cohort of centenarian cork trees that were distributed along a gradient of influence of colonial-nesting wading birds in the DBR (SW Spain). Along the last four decades, the cork oak tree mortality rate in the areas repeatedly occupied by wading birds during the nesting season has been significantly higher than the mortality rate recorded in the areas that have not been frequented by nesting birds (Ramo et al., 2009).

The aims of the study are the following: (1) to determine whether the cork oak decline detected in the Doñana Reserve is related to the present and past influence of nesting wading birds; (2) to investigate the mechanisms involved in the bird–soil–tree interactions by testing alternative structural equations models (SEM) on different direct and indirect (soil-mediated) bird effects on the health status of the trees; (3) to provide the Reserve managers with information to allow them to make evidence-based adaptive decisions and (4) ultimately, contribute to solve a potential conflict in this conservation management.

We hypothesise that the present health status of the trees may be explained, for the most part, by their history of wading bird occupation. We also hypothesise that changes in the soil composition that were caused by these birds, particularly those that increase solute concentrations in the soil as a result of the mineralisation of large amounts of bird debris, may play a central role in the observed centenarian tree decline.

2. Materials and methods

2.1. Study site and species

Doñana (SW Spain) is one of the main European protected areas for waterbirds (Rendón et al., 2008). In 1964, 6795 ha were protected under a Biological Reserve order; in 1969, it was extended to 54253 ha and declared a National Park (1969), Biosphere Reserve (1981) and World Heritage site (1994). The climate in this area is of Mediterranean-type, with an average annual rainfall of about 550 mm, which mainly occurs (>80%) between October and March and an average temperature of 16–17 °C. Some valuable aquatic and terrestrial Mediterranean ecosystems surround the Guadalquivir river estuary in this area, which were threatened by agricultural (the drainage and cultivation of marshlands, forest cutting and intensive farming of crops on the inland sands) and touristic development before being protected (Fernández-Delgado, 2006). The National Park comprises about 30,000 ha of clayey marshlands and about 25,000 ha of dunes, sparse forests and shrublands on sandy soils (Montes et al., 1998). The cork oak (*Quercus suber* L.) forests were devastated (>95%) by human exploitation (mainly for timber and charcoal) during the 17th to 20th centuries. The few thousand remaining trees formed a savannah-like scrubland ("dehesa") that was historically managed for cork and cattle production and for game hunting (Granados-Corona et al., 1988). Currently, these trees grow on acidic and nutrient-poor sandy soils that have a seasonally shallow water-table (1–3 m) (Clemente et al., 1988; Siljeström et al., 1994).

The present study was carried out in the Biological Reserve (6795 ha) at the core of the National Park. Following the Biological Reserve creation, all tree exploitation practices, such as cutting, pruning and cork extraction, ceased in order to preserve the remaining large centenarian trees. In addition, an important wading bird colony was naturally established in the reserve. Seven protected wading bird species nested on the centenarian cork oaks and in the nearby riparian vegetation: the white stork (*Ciconia ciconia*), the spoonbill (*Platalea leucorodia*), the grey heron (*Ardea cinerea*), the little egret (*Egretta garzetta*), the cattle egret (*Bubulcus ibis*), the squacco heron (*Ardeola ralloides*) and the black-crowned night-heron (*Nycticorax nycticorax*). Currently, these species usually occupy the trees in a broad ecotone between the scrublands and the marshlands known locally as "Vera", during the nesting season (from February to July). The number of birds in the colony varies from year to year (from 150 to 13,000 pairs), depending on the marsh flood level (Ramo et al., 2009). We estimate that approximately 70% of the centenarian cork oaks of the "Vera" have been affected at some level by the colony. This percentage decreases to 30% if we consider the total number of centenarian cork oaks in the Biological Reserve. About 40% of the centenarian trees in the ecotone have died in the last four decades (Ramo et al., 2009).

2.2. Data gathering

We selected 60 centenarian cork oak trees that spanned the gradient of the wading bird occupation. This selection was based on the frequency of the occupation experienced by each tree over the precedent 24 nesting seasons (NestFreq, data gathered by the Doñana Monitoring Team). In the late dry season (August–September) of 2008, we collected information about the crown health for each tree and simultaneously sampled soil and leaves for analysis.

2.2.1. Crown health evaluation

Crown health status was evaluated by two methods: (1) by a visual estimation of the crown density on a standardised and fixed scale of six degrees (from 0, a dead tree, to 5, a healthy reference tree), which is locally used every year for monitoring purposes and is known as the Crown Density Index (CDI) and (2) by a quantitative estimation of the crown transparency (CT, the amount of skylight visible through the live portion of the crown) by digitally processing lateral digital photographs of the tree crowns using the program ENVI v4.0 (RSI, 2003).

2.2.2. Sampling of leaves and soil

In each tree, the leaves were sampled at about a 6 m height at the four cardinal orientations of the outer canopy and were mixed to form a single sample (per tree) for the analysis. Topsoil (0–10 cm depth) and subsurface soil (10–25 cm) samples were collected at the projection of the leaf sampling points and bulked to get a single sample per tree.

Leaf samples were washed for about 20 s with a solution of 0.1 g L^{-1} phosphate-free detergent and rinsed twice with distilled water. They were oven-dried (70 °C) and finely ground. Soil samples were air-dried, crushed, sieved (<2 mm) and finely ground.

2.2.3. Percentage of the leaf surface covered by faeces

In each of the four cardinal leaf sampling points, five leaves were sampled at random at a middle height of the outer of the canopy. These 20 leaves were independently evaluated by two different observers for the percentage of their surface that was covered by bird faeces. For each tree, the average percentage of the leaf sur-

Download English Version:

https://daneshyari.com/en/article/6301252

Download Persian Version:

https://daneshyari.com/article/6301252

Daneshyari.com