Acta Oecologica 58 (2014) 35–43

Contents lists available at ScienceDirect

Acta Oecologica

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

Original article

Local habitat and landscape influence predation of bird nests on afforested Mediterranean cropland

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ARTICLE INFO

Article history:
Received 27 March 2014
Accepted 2 May 2014
Available online 22 May 2014

Keywords:
Artificial nests
Farmland habitat
Land use types
Magpie abundance
Pine plantations

ABSTRACT

Afforestation programs such as the one promoted by the EU Common Agrarian Policy have contributed to spread tree plantations on former cropland. Nevertheless these afforestations may cause severe damage to open habitat species, especially birds of high conservation value. We investigated predation of artificial bird nests at young tree plantations and at the open farmland habitat adjacent to the tree plantations in central Spain. Predation rates were very high at both tree plantations (95.6%) and open farmland habitat (94.2%) after two and three week exposure. Plantation edge/area ratio and development of the tree canopy decreased predation rates and plantation area and magpie (*Pica pica*) abundance increased predation rates within tree plantations, which were also affected by land use types around plantations. The area of nearby tree plantations (positive effect), distance to the tree plantation edge (negative effect), and habitat type (mainly attributable to the location of nests in vineyards) explained predation rates at open farmland habitat. We conclude that predation rates on artificial nests were particularly high and rapid at or nearby large plantations, with high numbers of magpies and low tree development, and located in homogenous landscapes dominated by herbaceous crops and pastures with no remnants of semi-natural woody vegetation. Landscape planning should not favour tree plantations as the ones studied here in Mediterranean agricultural areas that are highly valuable for ground-nesting bird species.

1. Introduction

A significant amount of abandoned cropland, low productive cropland and pastureland has been converted into tree plantations in the last few decades, and ca. 7% of the total forest land in the world are tree plantations at present (FAO, 2011). Different afforestation programs have contributed to the spread of such tree plantations at the regional level. Thus, the Common Agricultural Policy (CAP) has favoured the conversion of farmland into tree plantations in the European Union since 1992 by means of a scheme of aid for forestry measures in agriculture (EEC Council Regulation No. 2080/92), which has resulted in the afforestation of >8 million ha to date (European Commission, 2013a,b). Further, afforested cropland is expected to increase in the near future in countries such as Spain due to subsidies to afforestation of extirpated vineyards (Spanish Agrarian Guarantee Fund, 2012). This afforestation program pursues both societal and environmental benefits, including control of erosion, prevention of desertification, regulation of the water regime, and increasing the fixation rate of carbon dioxide. However, whereas tree plantations provide a number of benefits (Rey Benayas et al., 2007), they may have noticeable effects on biological communities, as it has been exemplarily shown with birds (Shochat et al., 2001; Santos et al., 2006; Bremer and Farley, 2010; Felton et al., 2010; Lindenmayer et al., 2010; Rey Benayas et al., 2010).

Agro-ecosystems are important for maintenance of bird diversity in Europe, especially for species of conservation concern (BirdLife International, 2004). The Directorate-General for Agriculture and Rural Development (2012), using *the common farmland bird index* as "a barometer of change for the biodiversity of agricultural land in Europe", shows a decline in these bird populations of ca. 20% between 1990 and 2008 (see also Gregory et al., 2005; Butler et al., 2010; Guerrero et al., 2012). Cropland afforestations in southern Europe are mostly based on coniferous species such as *Pinus halepensis* and *P. pinaster*, and are an example of novel and hybrid ecosystems sensu Hobbs et al. (2009). These plantations may cause damage to open habitat species, especially birds, by replacing high quality open farmland habitat and increasing risk of

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http://dx.doi.org/10.1016/j.actao.2014.05.001
1146-609X/

predation (Díaz et al., 1998; Cresswell, 2008; Reino et al., 2009). Predation has both direct and indirect effects on bird populations (Batáry and Báldi, 2004), the latter related to the avoidance of use of habitats that are perceived as risky (Murcia, 1995) or fecundity reduction (Bonnington et al., 2013). Besides hindering the persistence of established ground-nesting bird populations, predation may impede the colonization of the new afforested habitat by bird species (Murcia, 1995; Lindenmayer and Fischer, 2006).

Tree plantations act as sources of generalist predators of various types, including rodents, lagomorphs, feral cats, dogs, and corvids (Andren, 1992; Pita et al., 2009; Reino et al., 2010; Suvorov et al., 2012). These generalist predators usually have very low densities at treeless open habitats, but thrive in mosaic habitat landscapes where they exhibit an exploratory behaviour (Andren, 1992; Pita et al., 2009; Reino et al., 2010). Particularly, predation by corvids is enhanced in humanized landscapes where they attain high densities (Jokimaki et al., 2000; Newson et al., 2010), and Salek (2004) experimentally showed that the presence of magpie (*Pica pica*) nests increased predation rates on bird eggs. Accordingly, Castilla et al. (2007) attributed in part the relatively low predation on Red-legged Partridge (*Alectoris rufa*) eggs at Mediterranean fallow fields to the low presence of magpies due to their capture by humans. Magpies are strongly attracted by trees in deforested landscapes for nesting, and this phenomenon is highly noticeable at relatively small and isolated tree plantations in Mediterranean cropland afforestations.

This study aimed to investigate the predation of bird eggs set on artificial nests at young (<20 yr) tree plantations established on former cropland and at the open habitat adjacent to such tree plantations in a farmland and woodland Mediterranean mosaic. We hypothesized that nest predation will be affected by both (1) the features of local breeding habitat and (2) the features of landscape – namely proportion of land use types – surrounding local habitat. At tree plantations, we predicted that (i) a reduced area and a high edge-area ratio will favour permeability to predators and hence increase nest predation rates and (ii) magpie abundance and predation rate will be positively correlated. At open farmland habitat adjacent to tree plantations, we predict that predation rates will be influenced by (i) plantation area (positive effect), (ii) distance from plantation (negative) and (iii) magpie abundance (positive).

Our experimental study sheds light on the risk of nest predation at Mediterranean landscapes that have been subjected to afforestation projects of former cropland, and provides insights for impact assessment and management of such projects at the local habitat and landscape scales.

2. Methods

2.1. Study area

Field work was carried out in afforested cropland and open farmland located in Campo de Montiel (La Mancha natural region, southern Spanish plateau, 38°41′53″N, 2°51′54″W, Figure S1 in Supplemental Material). The study area spreads on ca. 440 km^2 with altitude ranging between 690 and 793 m a.s.l. The climate is continental Mediterranean with dry and hot summers and cold winters. Mean annual temperature and total annual precipitation in the area during the last 30 years were 13.7 °C and 390 mm, respectively (Agencia Española de Meteorología, 2012). These figures were 16.6 °C and 359.9 mm in 2011 and 15.8 °C and 362.9 mm in 2012, when our nest predation experiments took place (Junta de Castilla-La Mancha, 2013).

The area is a representative mosaic of different crops, pastures and semi-natural or planted woody vegetation that are characteristic of large areas in Mediterranean landscapes. Croplands were mostly occupied by herbaceous crops (wheat and barley) and permanent woody crops (olive groves and vineyards). Natural vegetation consisted of holm oak (*Quercus rotundifolia* L.) woodland and riparian forests that have been mostly extirpated from this region. Until 1992, woodland cover was restricted to open holm oak parklands, usually grazed by sheep and goats. Major land use changes in the last 20 years are the abandonment of herbaceous cropland and vineyard extirpation and their subsequent afforestation with the native Aleppo pine (*Pinus halepensis* Mill.) alone or mixed with holm oak and *Retama sphaerocarpa* (L.) Boiss (Rey Benayas et al., 2010). These tree plantations are noticeably dominated by pines as they establish better and grow faster than the other planted species.

2.2. Selection of tree plantations for predation experiments

The constraints associated with each habitat type, namely tree plantations and open farmland adjacent to tree plantations, prevented homogeneous experimental designs and sampling methods, and consequently data from the different experiments were not directly analysed together (see below). Thus, we run two independent experiments of bird nest predation, (1) at tree plantations and (2) on open farmland. First, all tree plantations in the study area were located using both orto-photos (Geographic Information System of Farming Land, 2010; hereafter SigPac) and Google Earth®, and were later verified in the field. We found 99 tree plantations on former cropland that took place in 1992 or later. Only tree plantations >0.78 ha were selected for the predation experiments to take advantage of bird survey plots of this size in the study area. In addition, a target tree plantation for the experiment on adjacent farmland had to be placed at least 2-km away from another plantation to avoid that experimental nests associated with a given tree plantation were affected by another tree plantation. Following these criteria, we finally selected 30 tree plantations for the experiment at tree plantations and 38 tree plantations for the experiment on farmland adjacent to the tree plantations, with 20 plantations that were used in both experiments (Figure S1 in Supplemental Material).

2.3. Survey of magpie abundance

We recorded the abundance of magpie as a potential nest predator in the studied tree plantations and open farmland habitat adjacent to such plantations. At every tree plantation, magpies were surveyed using point-count stations (Bibby et al., 2000) lasting 10 min in May 2011. The point-counts were located at the centre of each tree plantation. All auditory and visual contacts were recorded, but only those within a 50-m radius (0.78 ha; Figure S2 in Supplemental Material) were used in subsequent analyses, in order to increase the probability of detection. Every point-count station was surveyed by two censuses in different days, one within the first 4 h in the morning and another in the afternoon beginning 3 h before sunset. We used the average of the two counts as a measure of magpie abundance. The same trained person conducted all the censuses (JSS-O) on nearly windless (wind speed <3 m s^{-1}) and rainless days.

The open farmland habitat adjacent to 38 tree plantations was also surveyed for magpie abundance by means of one line transect of 400-m length and 200-m width in may 2012 (Figure S2 in Supplemental Material). Again, all censuses were conducted by the same well trained field ornithologist (JSS-O) on windless (wind speed <3 m s^{-1}) and rainless days. We employed two different census methods and years for sampling magpie relative abundance according to the limitations imposed by the size of pine plantations, where transects were not possible due to their small area.