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Short Communication

Relationship between pest birds and landscape elements in the Pampas of central Argentina

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Abstract. Many species of birds are considered pests in rural areas modified for agricultural production. We evaluated the abundance of four species of avian pests (Eared Dove (*Zenaida auriculata*), Monk Parakeet (*Myiopsitta monachus*), Picazuro Pigeon (*Patagioenas picazuro*) and Spot-winged Pigeon (*P. maculosa*)) in the Pampas of central Argentina. From 2006 to 2008, we surveyed 35 transects along secondary roads. All four species showed a response to the presence of exotic woodlots in rural areas. Monk Parakeets and the two pigeons were more likely to be found in woodlots with tall, perennial trees (*Eucalyptus* spp.), whereas Eared Doves were more likely to be found in woodlots with short, perennial trees (mainly species of *Pinus* and *Casuarina*). We did not detect any association between abundance of pest species and the presence of crops. These results suggest that management of exotic perennial trees in rural areas of the Pampas of central Argentina may provide a means of control of pest birds.

Additional keywords: agroecosystem, Eared Dove, Monk Parakeet, habitat management, Picazuro Pigeon, Spot-winged Pigeon, South America.

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Introduction

Throughout the southern hemisphere, many bird species are considered pests in landscapes heavily modified for agricultural production (Bruggers *et al*. 1998; Bomford and Sinclair 2002). Previous studies have focussed on the responses of pest-bird populations to modified elements of the landscape, such as crops, linear strips of roadside vegetation, woodlots and temporary waterbodies, because these modified environments provide important resources for those species (Bomford and Sinclair 2002; Warburton and Perrin 2006). Pest birds have been found to rely heavily on herbaceous vegetation and shrubs and trees in the landscape for feeding, nesting and shelter (Warburton and Perrin 2006; MacLeod *et al*. 2011).

Damage to crops by birds is an important problem in agroecosystems (Bruggers *et al*. 1998; Bomford and Sinclair 2002). Farmers often try to reduce the risk of damage and control pest by methods such as scaring, poisoning and shooting (Bomford and Sinclair 2002; Tracey *et al*. 2007). However, more basic information is needed on the patterns of abundance and associations of birds with landscape elements to effectively target control pest birds (Tracey *et al*. 2007).

In Argentina, the Eared Dove (*Zenaida auriculata*), Monk Parakeet (*Myiopsitta monachus*), Picazuro Pigeon (*Patagioenas picazuro*) and Spot-winged Pigeon (*P. maculosa*) are significant pests (Bruggers *et al*. 1998). These species have been found to be associated with a mosaic of landscape elements, such as feeding habitat (patches of Sorghum crops) and breeding habitat (patches of woodland) (Bucher and Ranvaud 2006). These prior studies were conducted in the Espinal phytogeographic region, where agriculture has replaced dry woodland (Murton *et al*. 1974).

The Pampas of central Argentina is one of the largest agricultural regions of the world (Soriano 1991). In the Pampas, the natural rangelands have been increasingly replaced by crops (Baldi and Paruelo 2008), which, in turn, have attracted pest birds (Bruggers *et al*. 1998). However, those pest species have not been well studied (Canavelli *et al*. 2011; Bilenca *et al*. 2012). Trees were originally absent from the Pampas (Soriano 1991) but woodlands of both native and exotic trees have self-established along riparian zones and roadsides, and there have been intentional woodlot plantings near rural buildings and in areas of cattle grazing (Ghersa *et al*. 2002; Zalba and Villamil 2002). The introduction of trees to the Pampas was followed by the expansion of opportunistic birds, such as doves, pigeons and parakeets (Daguerre 1936; Murton *et al*. 1974). Nowadays, these birds have become the most abundant species in avian assemblages of the Pampas (Codesido *et al*. 2012), and a major concern to agricultural associations. Despite this concern about pest

species, there have been no studies, in the Pampas, of the relationship between variations in the abundance of pest bird species and characteristics of the mosaic landscape of crops and woodlots. Here, we test the hypothesis that the abundance of pest birds is higher in landscapes that combine crops and woodlots (Bucher and Ranvaud 2006). The aim of the study is to determine if there is an association between populations of four pest-bird species (Eared Dove, Monk Parakeet, Picazuro Pigeon and Spot-winged Pigeon) in the Pampas of central Argentina and landscape elements (i.e. crops and woodlots). Additionally, we explore the characteristics of the woodlots (tall or short, perennial or deciduous) associated with the abundance of pest-birds.

Materials and methods

Study area

The study was conducted in the Pampas of central Argentina (33–39°S, 57–63°W). Our study area was a rural landscape 500 × 450 km. The region is almost wholly flat, with only a few hills and rocky outcrops at isolated sites. Mean annual temperature (i.e., the mean of the daily minima and maxima) is ~15°C, with warm summers and cool winters; January mean daily temperature is 21.5–23.5°C, and July mean daily temperature 7.5–9.5°C. Mean annual precipitation is 800–1000 mm (Soriano 1991).

The natural vegetation of the study area was originally a tall grass-steppe dominated by grasses such as *Stipa*, *Piptochaetium*, *Aristida*, *Bromus* and *Poa*, intermingled with prairies, marshes and edaphic communities (Soriano 1991). More recently, the Pampas has been used for intensive crop production under no tillage system or cattle grazing (Bilenca *et al*. 2012). Planted stands of tall trees are new to the Pampas and have added structural complexity to the grasslands (Zalba and Villamil 2002). The study area is surrounded by the Espinal Ecoregion, which is characterised by low woodlands, savannas and grasslands (Burkart *et al*. 1999; see Fig. 1).

Sampling of pest birds

We conducted surveys of the four species of pest bird on 35 transects along secondary roads in agroecosystems. Each transect was 20 km long, with permanently marked points every kilometre (20 points per transect). Each transect was sampled twice by the same observer (M. Codesido): initial surveys were conducted between January and February 2006, and repeat surveys between January and February 2007 and January 2008. All surveys were conducted in January and February (summer months). At each survey point birds were counted using a point-count (Bibby *et al*. 2000): all pest birds seen or heard within a 200-m radius around each point in a 5-min period were counted, resulting in a total sampling effort of 116.7 h. Counts were conducted in the morning, within 3 h of official sunrise, and in during the last 3 h before official sunset.

Landscape cover

We measured percentage cover of vegetation or land-use when we conducted bird surveys. We visually estimated percentage area cover of each three broad landscape classes of vegetation or land-use within a 200-m radius of each survey point along each transect. We defined the following broad landscape classes (Codesido *et al.* 2013): (1) croplands, including annual crops, stubble and ploughed fields; (2) woodlots, including all treed vegetation types >0.2 ha; these were further classified as tall (>15 m high) or short (<15 m) and as perennial (e.g. *Eucalyptus* spp.) or deciduous; and (3) rangelands, which included perennial pastures, and short and tall grassland. The percentage cover of these land-use categories for all survey points along each transect was averaged to obtain one value for each transect. The values for each transect and each year were then averaged to give an overall estimate for each transect for 2006–08. The final value for each landscape class was the average of the 35 transects.

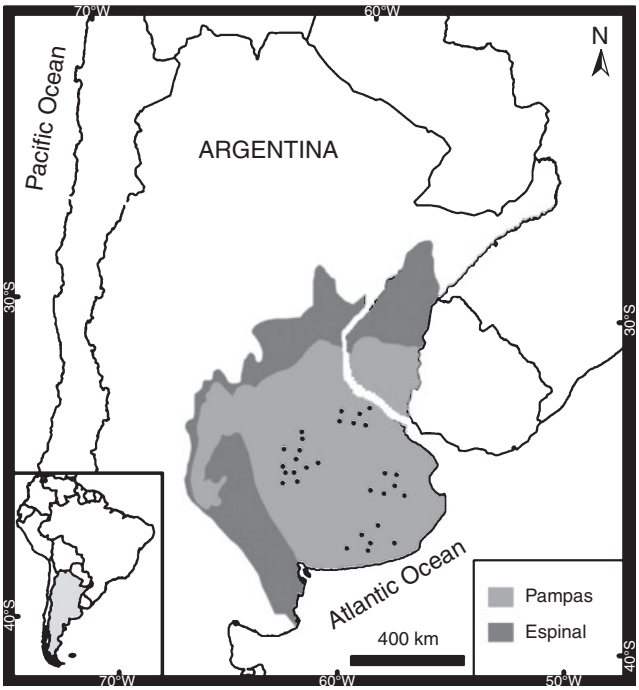

Fig. 1. Location of the 35 survey transects in the Pampas of Argentina.

Statistical analyses

We used linear mixed models (Zuur *et al*. 2009) to test the effects of the presence of crops and woodlots on the abundance of pest birds (as number of individuals per point). Each point was assigned to one of the following categories: (1) crops (woodlots absent), (2) rangeland and woodlots, (3) crops and woodlots, and (4) rangelands (woodlots absent). Values of each category were averaged over the two annual surveys. Separate models were built for each species, considering the abundance of birds as the response variable and a normal error-distribution specified. Land-uses were included in the analyses as a two-level fixed factor (crop or rangeland). Woodlots were also included as a two-level fixed factor (presence or absence), whereas transect was specified as a random effect. Preliminary analyses indicated that the residual spread increased for greater abundances of pest birds, so we controlled for this in the model by

applying a varident function of variance structure (Zuur *et al.* 2009). The final model was evaluated through Akaike's information criterion corrected for small samples (AICc).

We adjusted our analyses for Monk Parakeets by considering only those transects that lay within the distribution of this species reported by Narosky and Di Giacomo (1993). This excluded 13 transects, which allowed us to avoid non-detection of the species simply because the species is absent from a site (Codesido *et al.* 2011). In addition, the two species of pigeon were analysed together because they have similar habits, morphology and occupy similar habitat and have lower relative abundances (Bruggers *et al.* 1998).

We also performed a linear regression to fit models of abundance of pest birds on the relative frequency of woodlot features (tall or short perennial, tall or short deciduous) along transects. All statistical analyses were conducted using R (R Development Core Team 2013).

Results

Croplands and rangelands were the main types of land-cover. Overall mean percentage cover (percentage area, for transects and years combined) of annual crops was 43% (range 5–75%, $n = 35$ transects); at the time of sampling, annual crops were in vegetative growth-stages, with a mean height of ~50 cm. Soya Beans (*Glycine max*) represented nearly 70% of all crops, followed by Maize (*Zea mays*; 17%) and Sunflowers (*Helianthus annuus*; 7%). Overall mean percentage cover of rangelands was 41% (range 10–74%, $n = 35$). Mean percentage cover of woodlots was 8% of the rural landscape (range 1–24%, $n = 35$). The remaining 8% was constituted by water bodies (mainly) and rural facilities. Of woodlots, 48% comprised short perennial trees, 34% short deciduous trees and 30% tall perennial trees. Tall deciduous trees (e.g. poplars *Populus* spp.) were rare.

We recorded a total of 1590 individuals of the four pest species: 702 Eared Doves (44% of total), 503 Monk Parakeets (32%), 289 Picazuro Pigeons (18%) and 96 Spot-winged Pigeons (6%). Eared Doves and the two pigeons combined were significantly more abundant when woodlots were present in the rural landscape (Table 1, Fig. 2*a*, *b*). Monk Parakeets were significantly more abundant at survey points with land-cover of both woodlots and rangelands (Table 1, Fig. 2*c*). We did not detect any association between the abundance of pest birds and the presence of crops.

The abundance of Eared Doves increased significantly with the frequency of woodlots composed of short perennial tree species, mainly *Pinus* spp. and *Casuarina* spp. (linear regression: $F_{1,34} = 16.8$, $P < 0.001$; Fig. 3*a*). Conversely, the abundance of Monk Parakeets and the two species of pigeons combined increased significantly with the frequency of woodlots composed of tall perennial tree species, mainly *Eucalyptus* spp. (linear regression: pigeons: $F_{1,34} = 15.4$, $P < 0.001$, Fig. 3*b*; Monk Parakeet: $F_{1,21} = 17.1$, $P < 0.001$, Fig. 3*c*).

Discussion

This is, to the best of our knowledge, the first assessment of pest-bird abundance and their associations with landscape elements in the Pampas of central Argentina. In the Espinal, Bucher and Ranvaud (2006) found that the abundance of pest-birds was higher in landscapes that contain both crops and woodlots than in landscapes without these landscape elements. However, our results in the Pampas did not fit this pattern; in fact, we found that the abundance of the Eared Dove, the Monk Parakeet and the two species of pigeon were influenced by the presence of woodlots composed of species of exotic perennial trees rather than by the occurrence of croplands. The differences on responses of pest birds between the Pampas (this study) and the Espinal (Bucher and Ranvaud 2006) could be explained by either 1) treed vegetation types (ours implanted exotic woodlots, theirs native woodland) and/or 2) the identity of the dominant crop (ours soybean, theirs sorghum).

Analysis of the patterns of abundance of individual species showed that the Eared Dove was more abundant in woodlots of short perennial tree species, such as *Pinus* spp. and *Casuarina* spp.; Eared Doves opportunistically nest and roost in those species (Murton *et al.* 1974). Seeds of crops, such as Sorghum or Sunflower, have been found to be a substantial proportion of the diet of Eared Doves (Bucher and Nores 1973; Bucher and Ranvaud 2006) and other studies have reported Eared Doves damaging Soya Bean crops during the germination period, feeding on sprouting plants (Bruggers *et al.* 1998; Canavelli *et al.* 2011). However, we found no association between Eared Doves and crops, although this may be because the dominant crop, of Soya Beans, was in a vegetative stage during our study and had already passed the germination period. Both the type of crop and stage of its growth seem to influence the abundance of Eared Doves.

Table 1. Summary of linear mixed models testing the effects of landscape classes (presence or absence; explanatory variables) on abundance of pest birds (response variable; number of individuals per survey point) in the Pampas of central Argentina

Significant explanatory variables are in bold. Land-use = cropland or rangeland

Fixed effects	Eared Dove		Picazuro and Spot-winged Pigeons combined		Monk Parakeet	
	F (d.f. = 1, 83)	P	F (d.f. = 1, 83)	P	F (d.f. = 1, 56)	P
Intercept	49.8	<0.0001	62.9	<0.0001	15.6	<0.0002
Land-use	1.3	0.26	1.3	0.27	1.7	0.2
Woodlot	**8.7**	**<0.004**	**16.9**	**<0.0001**	5.1	0.03
Land-use × Woodlot	0.4	0.55	1	0.32	**4.6**	**0.04**
Random effects	Variance	%	Variance	%	Variance	%
Transect	0.34	26	0.04	4	0.52	20
Residual	1.33	74	0.78	96	2.54	80

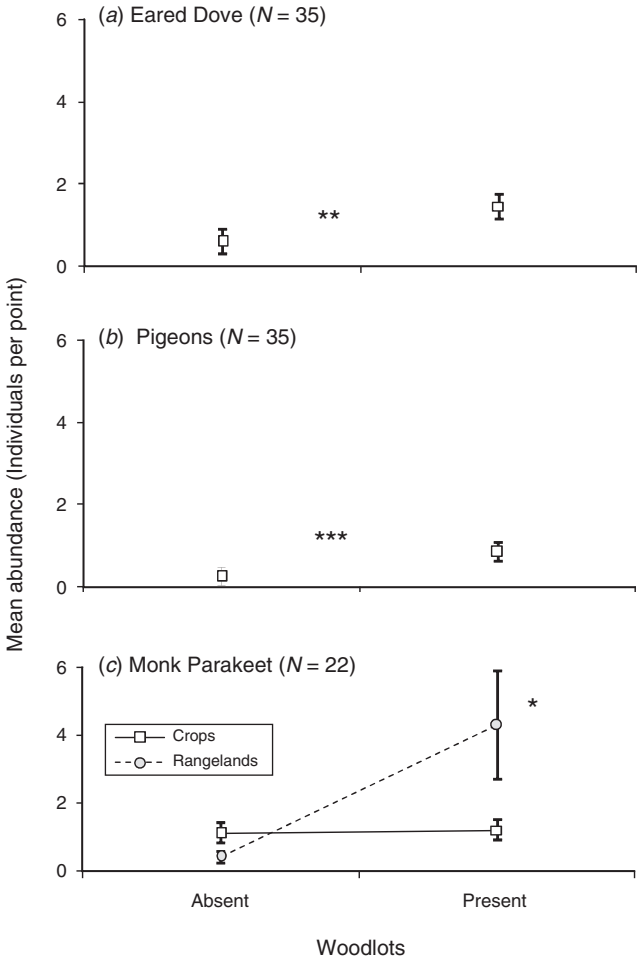

Fig. 2. Mean abundance of pest birds (individuals per survey point) in relation to landscape classes in the Pampas of central Argentina: (*a*) Eared Dove with or without woodlots; (*b*) Picazuro and Spot-winged Pigeons combined with or without woodlots; and (*c*) Monk Parakeet with the interaction of the presence of woodlots and rangelands. Whiskers = s.e.; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; *N*, number of transects included in analyses.

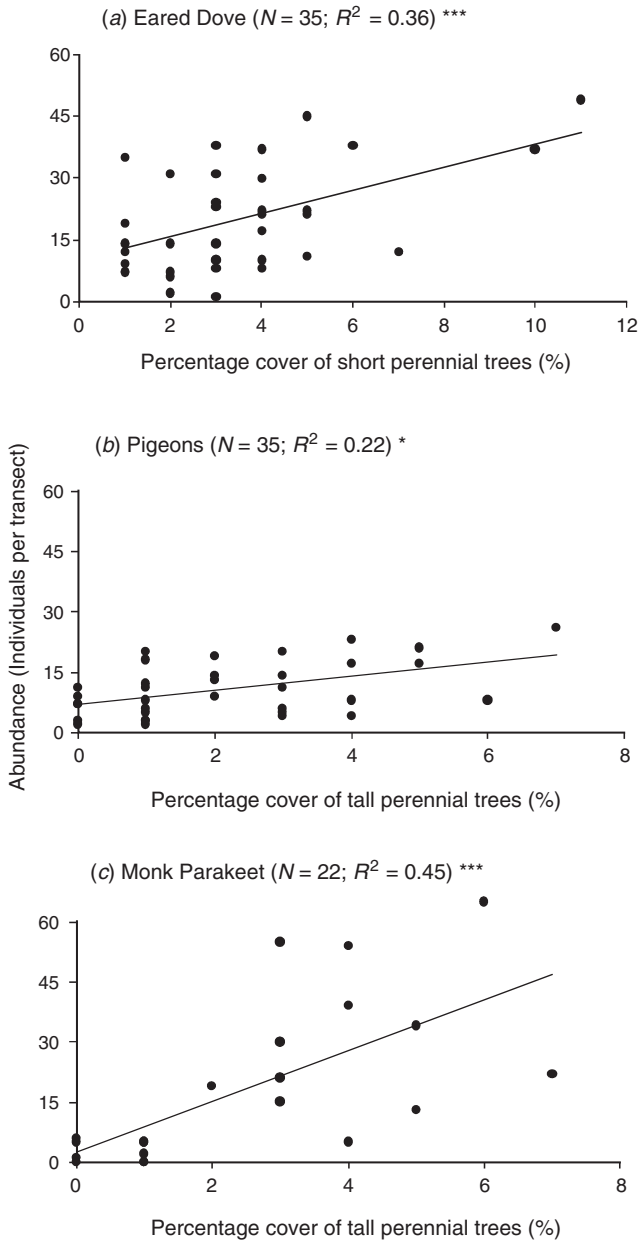

Fig. 3. Relationship between abundance of pest birds (individuals per transect) and percentage cover of treed vegetation types: (*a*) Eared Dove and percentage cover of short perennial trees; (*b*) Pigeons and percentage cover of tall perennial trees; and (*c*) Monk Parakeet and percentage cover of tall perennial trees. *, $P < 0.05$; ***, $P < 0.001$; *N*, number of transects in analyses.

Like Eared Doves, the Picazuro and Spot-winged Pigeons were not associated with Soya Bean crops. These pigeons were more abundant in the presence of woodlots, specifically those composed of tall perennial tree species (mainly *Eucalyptus* spp.). Pigeons have expanded their range in the Pampas, using woodlots as habitat (Narosky and Di Giacomo 1993). Although some studies have shown that both these species of pigeon are significant consumers of seeds and sprouting plants, and damage crops of Sunflowers and Soya Beans during their germination periods (Bruggers *et al*. 1998), we did not observe either species of pigeon feeding on Soya Bean seeds left in the stubble of the preceding crop.

The Monk Parakeet was the only species whose numbers were significantly higher in areas with a combination of woodlots (tall perennial trees such as *Eucalyptus* spp.) and rangelands cover. The association between Monk Parakeets and tall *Eucalyptus* trees is likely to be linked to their preference for nesting and roosting in such trees, where they benefit from lower predation risk and human control measures (Bruggers *et al*. 1998; Bucher and Aramburú 2014). Parakeets were not considered a pest problem in the Argentine Pampas before the introduction of *Eucalyptus* trees because there was little vegetation for them in which to nest and roost (Bruggers *et al*. 1998). In the Pampas, the lack of association between the abundance of Monk Parakeets and croplands (i.e. in rural landscapes dominated by Soya Bean crops), may be related to its broad diet, which includes fruits,

sprouting plants and seeds of native, non-crop plants (Aramburú 1997; Aramburú and Corbalán 2000).

Management implications

Understanding the behavioural ecology of pest birds is important in developing management strategies to control such species (Murton *et al*. 1974; Bruggers *et al*.1998). In the Pampas, the presence of woodlots of exotic trees appears to be an important factor influencing the abundance of pest birds and the type and density of exotic trees is an important consideration in the management of pest birds. However, woodlots provide benefits for agriculturalists, such as wind reduction and shading for cattle (Zalba and Villamil 2002), so a detailed cost–benefit analysis needs to be a priority before undertaking any habitat manipulation. We suggest that effective control of these species of pest bird could be attained by managing exotic perennial trees: (1) by reducing the areal cover of woodlots near crops; (2) by planting short and deciduous species of trees instead of tall perennial tree species (Bilenca *et al*. 2012); and (3) by reducing the height of standing trees to $\leq$15 m, making them less suitable for nesting and roosting by Monk Parakeets (Volpe and Aramburú 2011).

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