# Range contraction in the pampas meadowlark *Sturnella defilippii* in the southern pampas grasslands of Argentina

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**Abstract** The Vulnerable Pampas meadowlark *Sturnella defilippii* (Family Icteridae) is a Neotropical grassland bird that suffered a severe population reduction and range contraction during the 20th century. Formerly distributed across most of the pampas grasslands, it is now confined to the southern tip of its original range. There are small groups of wintering birds in southern Brazil, a small reproductive population in eastern Uruguay, and the main reproductive population occurs on the southern pampas grasslands of Argentina. In this paper we report the results of an extensive field survey of these southern pampas grasslands, carried out to estimate the pampas meadowlark's population size and to identify the factors potentially responsible for its range contraction. During the 1999 breeding season we surveyed a total of 296 sample locations (transects, randomly selected points, and sites checked for nesting site reoccupation).We found 66 reproductive groups of pampas meadowlarks. The minimum population size and extent of occurrence were estimated to be 28,000 individuals and 4,810 km$^2$, respectively. This value represents a range contraction of *c*. 30% compared to that estimated in a study carried out between 1992 and 1996. Pampas meadowlarks reoccupied natural grassland sites for nesting that were used in previous breeding seasons when these sites remained undisturbed. Habitat transformation appears to be the main factor causing the range contraction of the pampas meadowlark. We suggest that long-term monitoring of this population and its preferred habitat, the natural grasslands, is required in order to ensure the conservation of this species.

**Keywords** Distribution, habitat transformation, pampas grasslands, pampas meadowlark, population size, range contraction, *Sturnella defilippii*.

## Introduction

The pampas meadowlark *Sturnella defilippii* (Family Icteridae) is a Neotropical bird that inhabits the southern temperate grasslands of South America. Formerly a common species in the pampas grasslands (Hudson, 1920), the pampas meadowlark suffered a marked population decline and range contraction over the 20th century. Originally distributed from southern Brazil and Uruguay to central Argentina, most of the local extinction occurred between 1890 and 1950 (Tubaro & Gabelli, 1999) during a period of intense transformation of the natural grasslands (Soriano *et al*., 1991). At present the pampas meadowlark is found in marginal areas of its former distribution in southern Brazil (Collar *et al*., 1992), eastern Uruguay, and the southern pampas grasslands of Argentina (Tubaro & Gabelli, 1999). In southern Brazil only small groups of wintering birds ($< 100$ individuals) have been sighted during the last decade (Collar *et al*., 1992), and in eastern Uruguay there is a small reproductive population of $< 50$ individuals (A. Aspiroz, pers. comm.). The population in the southern pampas grasslands of Argentina constitutes the main reproductive population of this species (Tubaro & Gabelli 1999).

The pampas meadowlark is a sexually dimorphic species of 60–70 g in weight (Gochfeld, 1979a) that inhabits open grasslands. Males have a bright red throat and breast, and a dark blackish-brown body, whereas females are more dull and have a smaller and paler red breast area (Jaramillo & Burke, 1999). During the breeding season (October–December) birds nest gregariously and males defend small territories (Gochfeld, 1979a). Nests are built on the ground concealed under a tuft

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of grass. Pampas meadowlarks remain associated with natural grasslands that have low disturbance year round (Gochfeld, 1979a; Tubaro & Gabelli, 1999) and they usually avoid shrubby and forested areas and field edges. On the southern pampas grasslands the distribution of this species overlaps with two other species of *Sturnella*, the smaller white-browed blackbird *S. superciliaris* and the larger long-tailed meadowlark *S. loyca*.

Because of its population decline and range contraction, together with the rapid transformation of its preferred habitat, the pampas meadowlark is categorized as Vulnerable on the IUCN Red List (IUCN, 2003; Stattersfield & Capper, 2000). However, there has not been an accurate estimation of its population size and range, and the aim of our work was therefore to assess the species' population size and distribution in the southern pampas grasslands of Argentina. We carried out an intensive field survey of most of the area of the Argentinian pampas grasslands where this species had been reported during the last 10 years, and estimated its extent of occurrence and area of occupancy. The survey allowed us to assess population trends of pampas meadowlarks by monitoring sites historically used by the species (Tubaro & Gabelli, 1999), and to look for any evidence of changes in habitat use and habitat availability for the species.

## Methods

This study was carried out in south-west Buenos Aires, Argentina, between October and November 1999, covering an area of 12,800 km$^2$. This area was divided into eight sectors corresponding to the 1:100,000 Landsat TM 5 satellite images of Saavedra, Tornquist, Saldungaray, Cabildo, Villa Iris, Felipe Solá, Chasicó and Napostá (Fig. 1). The north/north-east part of the region (corresponding to the Saavedra, Cabildo, Saldungaray and part of the Tornquist images; hereafter the north-eastern region) is characterized by highlands and mountains to an altitude 1,136 m, while the south/south-west part (corresponding to the Villa Iris, Felipe Solá, Chasicó, Napostá and part of the Tornquist images; hereafter the south-western region) comprises lowlands with several rivers running in a NE-SW direction. The habitat is a heterogeneous mosaic of natural grasslands of *Stipa* and *Piptochaetium* species (*S. ambigua*, *S. trichotoma*, *S. neesiana*, *S. clarazi*, *P. montevidense* and *P. stipoides*), crops (mainly wheat *Triticum aestivum* and corn *Zea mais*), and planted pastures of *Avena barbata*, *A. sativa*, *Bromus mullis*, *Lolium multilorum*, *Medicago sativa*, *Trifolium repens*, *Vicia angustifolia* and *V. sativa* (Tubaro & Gabelli, 1999).

We selected 110 sampling points within the study area to evaluate the distribution of the Pampas meadowlark between October and November 1999 and to estimate its population size using a stratified-random method (Bibby *et al.*, 1992). We identified two habitat classes: natural grassland fields, and agricultural fields that included crops and planted pastures. To position the sampling points we divided each satellite image into 24 grid cells of 5° latitude and longitude (*c.* 67 km$^2$). We placed points within each Landsat image using latitude and longitude coordinates generated at random. Selected points met two criteria: (1) no two points could fall inside the same

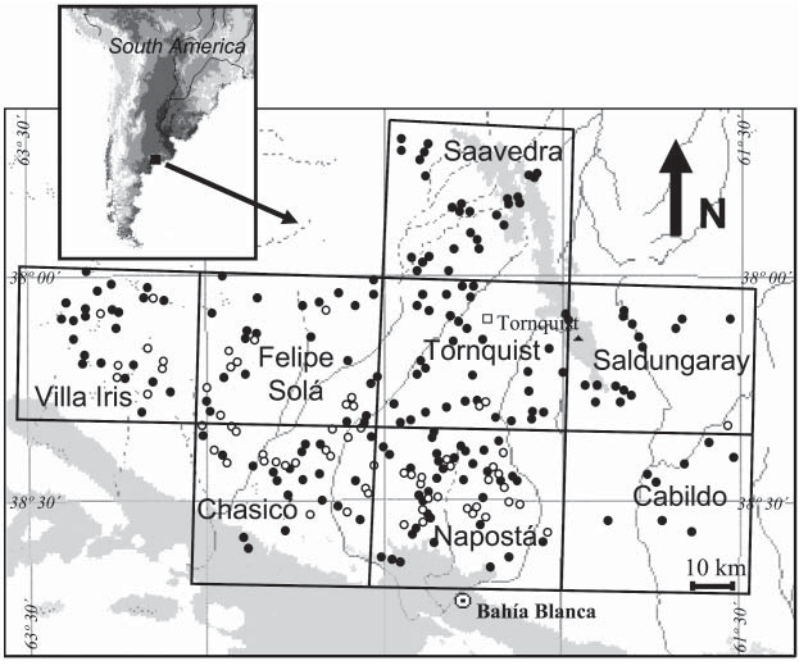


**Fig. 1** The study area in the southern pampas grasslands of Argentina. Areas shaded light grey in the north-east (the Sierra de la Ventana mountain system) and south-west (the Espinal region) were excluded from random sampling because there were no records there of the Pampas meadowlark. The grid indicates the coverage of the Landsat satellite images used for the analysis. Dots indicate sampled points (transects, surveyed points and sites checked for nest site reoccupation). Open dots represent the sites where pampas meadowlarks were sighted, and black dots represent sites where the species was absent.



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cell, and (2) a similar number of points should fall inside each habitat class in every Landsat image. In three areas (Cabildo, Saldungaray and Saavedra) we could not take a similar number of samples per class because of the low proportion of remaining natural grasslands. Twelve sampling points were discarded because they were located on inaccessible areas. Additionally, we arbitrarily selected 15 sampling points in the Sierra de la Ventana mountain system in the north-east, and the Espinal region in the south-west, but these points were not included in the estimation of bird density.

From each sampling point we performed a bird count by walking a transect of at least 400 m in length. The direction of walk from each point was determined by the field conditions. Transects never crossed the limits of the field and included all grassland communities in each plot. Each transect was evaluated by two observers who noted the presence of pampas meadowlarks, estimated their distance to observers and measured the angle from the transect (Bibby et al., 1998) using an angle rangefinder. Transects were surveyed from 6.30 to 12.00 and from 16.00 to 20.00. In total we sampled 57 km of transect (27 km in natural grassland fields and 30 km in agricultural fields).

Because Tubaro & Gabelli (1999) suggested that pampas meadowlarks may reoccupy some nesting sites, we checked 55 out of 59 sites where these authors recorded the presence of reproductive groups during their 1992–1996 censuses. At these sites we noted the presence/absence of reproductive groups of pampas meadowlarks and the habitat class (natural grasslands or agricultural fields), to assess if site reoccupation was associated with habitat transformation.

In addition, we surveyed a further 65 random points in the study area, selected in a similar way to those chosen for transect sampling, and 39 additional arbitrarily selected points. At each of these points, observers walked throughout the field and noted the presence of reproductive groups, but not by walking along a fixed transect. Additionally, whilst we were travelling across the whole area we noted sites where we detected nesting groups of pampas meadowlarks (n = 33). These data, together with data from the transects and sites checked for nesting site reoccupation, were used to estimate the minimum geographical area covered by the pampas meadowlark (hereafter referred to as extent of occurrence; Mace & Stuart, 1994).

We used the software DISTANCE v. 3.5 (Thomas *et al.*, 1998) to estimate the density of pampas meadowlark from the transect data. Because male pampas meadowlarks are more conspicuous than females during the breeding season (Gochfeld, 1979a; Jaramillo & Burke, 1999), we assumed a 1:1 sex ratio for estimating density in each field. For estimating density in each of the two habitat classes we used various functions (half normal with cosine adjustment term, uniform with cosine adjustment term, uniform with simple polynomial adjustment term, hazard rate with Hermite polynomial adjustment term, and hazard rate with simple polynomial adjustment term) to estimate the probability of detecting birds, and chose the most appropriate function using Akaike's information criterion (Buckland *et al.*, 1993). As a preliminary study showed that the measured error of distance estimation was $< 5\%$, we assumed that the error was negligible for this variable. We estimated total population size by summing the products between the bird densities estimated for natural grasslands and agricultural fields and the corresponding habitat areas calculated from habitat classification (see below).

The extent of occurrence of the pampas meadowlarks was estimated by determining the minimum polygon area that included 100% of the sampled points where birds were present. This area was calculated using the software CALHOME – Home Range Analysis Program (Kie *et al.*, 1994). This estimated extent of occurrence for 1999 was compared with the extent of occurrence estimated from points where the species was detected in 1992–1996 by Tubaro & Gabelli (1999).

The area of occupancy (the fraction of the extent of occurrence effectively occupied by the species; Mace & Stuart, 1994) was calculated as the product between the proportion of natural grassland fields occupied by pampas meadowlarks and its availability. This criterion was adopted because pampas meadowlarks show a strong association with this habitat type (Fernández *et al.*, 2003). We estimated the natural grassland area from a vegetation map drawn using four Landsat TM 5 images from each of three dates across the growing season of 1998–1999 (12 images in total). We classified the images using the information from the sampled points and by interpreting cover types using vegetation reflection on bands 3, 4 and 5 of the images across the time period. We were able to discriminate between the two habitat types and also to identify hills, small lakes, towns and shrub lands.

## Results

We found 66 reproductive groups comprising a total of 693 sighted individuals, of which 44 groups (82%) were located in natural grasslands and 12 groups (18%) in agricultural fields. The groups ranged in size from 2 to 66 breeding males. Most of the groups (95%) were detected in the south-western region of the study area (Fig. 1). The density of both the pampas meadowlark and its available habitat varied spatially. In the south-western region 31% of the 203 sites sampled had reproductive groups of pampas meadowlarks, whereas they were present in only 3% of the 93 sites sampled in the



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north-eastern region. The availability of natural grassland fields was higher in the south-western region, representing 23% of the area (1,386 km$^2$). The north-eastern region is a more transformed landscape, with 89% of the total area comprising transformed fields (Fig. 2a). Density of pampas meadowlarks in natural grasslands in the south-western region was 0.5 individuals per ha (confidence interval 0.20–1.26; coefficient of variation 0.34), whereas density in the north-eastern region was only 0.04 individuals per ha (confidence interval 0.008–0.22; coefficient of variation 0.72). The estimated minimum population size for pampas meadowlarks in the whole area surveyed was 28,000 individuals.

The estimated extent of occurrence for pampas meadowlark in our study was 4,810 km$^2$. If we compare this value with that of 6,989 km$^2$ estimated from previous censuses (1992–1996) it represents a range contraction of 2,179 km$^2$ or 28% (Fig. 2b). The area of occupancy calculated using the available habitat estimated from the vegetation map was 517 km$^2$. The proportion of preferred habitat effectively occupied by the species (grassland fields with mean vegetation height $>12.6$ cm; Fernández *et al*., 2003) varied greatly, indicating the existence of a high proportion of unused habitat. Only 6.4% of the suitable natural grassland area was effectively occupied by breeding groups in the north-eastern region, whereas 52.5% was used by pampas meadowlarks in the south-western region.

A total of 22 of the 55 sites (40%) where pampas meadowlarks were recorded during 1992–1996 were re-used in 1999. Site reoccupation seems to be influenced by the degree of disturbance in the area. Agricultural fields

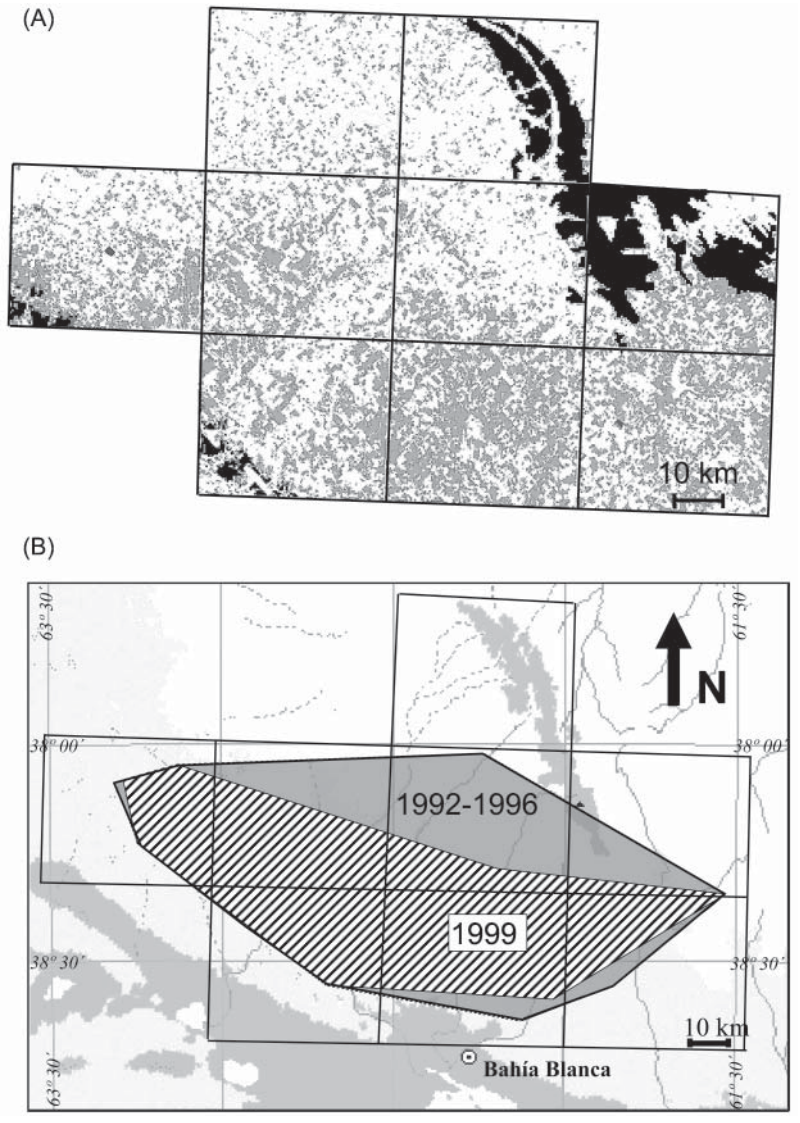


**Fig. 2** (A) Spatial distribution of remnant patches of natural grasslands (grey shaded area) in the southern pampas grasslands of Argentina in 1999 . Areas shaded black were excluded from analysis (see Fig. 1). For this analysis the Landsat image of Goyena (top left) was also included. (B) Extent of occurrence of the pampas meadowlark (see text for details) estimated using the minimum convex polygon method. The darkest, outer polygon represents the extension of occurrence estimated for the 1992–1996 breeding seasons (Tubaro & Gabelli, 1999). The striped polygon is the extent of occurrence for the sampling performed in 1999.



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had a lower site reoccupation than grassland fields (Fisher exact test, $P < 0.01$), and site reoccupation on undisturbed grassland fields was higher than in sites disturbed by the presence of a significant cattle load, predators, or recent burning (Fisher exact test, $P < 0.001$). Of 15 grassland fields supporting pampas meadowlarks during 1996 only two out of eight transformed natural grassland sites were reoccupied in 1999, in contrast to the seven sites left undisturbed (Fisher exact test, $P < 0.01$). The probability of fields changing habitat type was significantly different (McNemar Chi-square tests, $\chi^2_1 = 7.04$, $P < 0.01$). Between 1992 and 1996, 8 out of 22 (36%) grassland fields were transformed into agricultural fields but none of the agricultural fields were transformed into grassland fields. Similarly, we found that 32% of all grassland fields (7 of 22) visited during the 1996 breeding season were transformed into agricultural fields by 1999, whereas only 5 of 19 (26%) agricultural fields had reverted to natural grasslands.

## Discussion

Of the 66 areas that we found to be occupied by reproductive groups, 33 of them were in areas not previously surveyed. Most of the reproductive groups were located west of the Sierras de la Ventana, and concentrated on natural grassland fields. Based on transect sampling we estimated a minimum population size of 28,000 individuals, a value 4 times higher than the previous estimate, and the estimated area of occurrence was found to be *c*. 3 times higher (517 vs 150 km$^2$; Tubaro & Gabelli, 1999). These apparent discrepancies can be explained by the difference in sampling efforts between the two studies. In the first study Tubaro & Gabelli (1999) searched for pampas meadowlarks either side of main roads in order to obtain preliminary estimates of population size and extent of occurrence. Because of this logistical restriction many of the reproductive groups could have remained undetected. In addition, this sampling might have underestimated the availability of grassland fields, as most of the fields along the main roads are markedly transformed. However, although their surveying methods resulted in an inaccurate estimation of area of occupancy and population size, Tubaro & Gabelli (1999) located reproductive groups of pampas meadowlarks in areas where they were absent in the present survey. This second study had the advantages of a more accurate sampling design, improved methods for area and density estimation, and more exhaustive sampling, covering areas that had previously been overlooked.

Eighty-two percent of the reproductive groups of pampas meadowlarks were found on natural grasslands. This fact, together with the data showing that the area covered by such grasslands is lower than that covered by agricultural fields, indicates that the species prefers the former habitat. Preference of pampas meadowlarks for natural grasslands is also indicated by the inverse relationship between the degree of habitat transformation and the probability of site reoccupation for nesting. Fernández *et al*. (2003) found that local (i.e. vegetation cover and habitat type) but not landscape variables (i.e. connectivity and habitat fragmentation) can predict the presence of reproductive groups of pampas meadowlarks. Paradoxically, a high percentage of the preferred natural grassland habitat was unused. Although this may appear to weaken the hypothesis that habitat loss is a major factor affecting the species' decline, our simple habitat classification may have underestimated the habitat variables used by the birds for assessing habitat quality. The total population of the species is small in relation to the current available habitat, and it is possible that suitable habitat could be a necessary, but not sufficient factor, for breeding pampas meadowlarks, with other factors, such as competitors, predators or parasitic species limiting population size. The other two *Sturnella* species present on the southern pampas, the white-browed blackbird and the long-tailed meadowlark, may compete with pampas meadowlarks, as suggested by the interspecific aggression observed between the pampas meadowlark and these other two species (Gochfeld, 1979a; Tubaro & Gabelli, 1999). Habitat transformation has favoured the expansion of the white-browed blackbird, which is particularly abundant in modified agroecosystems. In addition, the long-tailed meadowlark, originally restricted to Patagonian steppe, is expanding northwards into pampas grasslands (Short, 1968). Thus, these two species may be having adverse effects on the distribution and abundance of the pampas meadowlark.

Brood parasitism by the shiny cowbird *Molothrus bonariensis* a generalist brood parasite widespread in Neotropical lowlands, might also have contributed to the decline of the pampas meadowlark. The shiny cowbird usually reduces its host's reproductive output by removal or destruction of the host's eggs, a reduction in hatching success, or losses of the host's nestlings through competition, and has been favoured by habitat transformation brought about by agricultural development (Payne, 1977; Rothstein, 1990). Cowbirds parasitize pampas meadowlark's nests, but their effect on the host's breeding success has not been evaluated (Gochfeld, 1979b).

An alternative explanation for the discrepancy between habitat availability and habitat use by the pampas meadowlark involves differences in habitat change rates. Natural grasslands could have been increasing in area during the last few years faster than the pampas meadowlarks' response to these changes of



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habitat. This is unlikely, however, because although 25% of the resampled sites changed from agricultural fields to grassland fields between 1992 and 1999, the rate of change in the opposite direction was three times as great.

The available evidence suggests that, for pampas meadowlarks, the primary cause of population contraction is the loss of their preferred habitat. Reproductive groups abandoned most of the surveyed natural areas that were transformed into crops or planted pastures in the following breeding seasons. In a similar way, reproductive groups reoccupied natural areas in which the vegetation structure had not changed in successive breeding seasons. Additionally, we detected a marked and sustained transformation of natural grasslands into crops and planted pastures. More than 50% of natural grassland sites surveyed from 1992 to 1999 were transformed into agricultural plots, whereas $< 20\%$ of the transformed plots recovered their original grassland structure during this period. The estimated extent of occurrence in this study was 30% lower than that estimated in the survey carried out in 1996 (4,810 $km^2$ vs 6,989 $km^2$). The major change in distribution occurred in the north-eastern region, which showed a marked habitat transformation into agricultural fields within the last decade. In this region only *c*. 10% of the area has retained its natural grasslands, compared with 30% at the south-western region, where the pampas meadowlark population is now concentrated. We suggest that this decreasing trend in the extent of occurrence of the pampas meadowlark is related to habitat transformation.

The small and restricted populations of pampas meadowlarks in Uruguay and Brazil, together with our data from the southern pampas grasslands of Argentina, support the categorization of pampas meadowlarks as Vulnerable on the IUCN Red List (Stattersfield & Capper, 2000; IUCN, 2003). We have estimated the population size in Argentina to be $>5{,}000$ individuals and the area of occupancy to be $>500$ $km^2$, although the estimated extent of occurrence is smaller than that required for the Endangered category (4,810 $km^2$ vs 5,000 $km^2$). With respect to the IUCN criteria we have also detected important changes in the extent and quality of the preferred habitat of the pampas meadowlark, and consequently in its distribution range, in a relatively short period of time (1996–1999). It remains unclear whether the decline of the meadowlark's population is associated with its range contraction because the previously inaccurate population estimate precludes an assessment of any population trend. However, it is clear that the pampas meadowlark's numbers and range have declined during the 20th century. Based on habitat deterioration and continued contraction of its range, the pampas meadowlark requires close monitoring, even though the species is not as scarce as previously estimated.

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## References

Bibby, C.J., Burgess, N.D. & Hill, D.A. (1992) *Bird Census Techniques*. Harcourt Brace and Company Publishers, New York, USA.

Bibby, C.J., Jones, M. & Marsden, S. (1998) *Bird Surveys*. Royal Geographical Society, London, UK.

Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) *Distance Sampling: Estimating Abundance of Biological Populations*. Chapman & Hall, London, UK.

Collar, N.J., Gonzaga, L.P., Krabbe, N., Madroño Nieto, A., Naranjo, L.G., Parker, T.A. & Wege, D.C. (1992) *Threatened Birds of the Americas: The ICBP/IUCN Red Data Book* (3rd edition). International Council for Bird Preservation, Cambridge, UK.

Fernández, G.J., Posse, G., Ferretti, V. & Gabelli, F.M. (2003) Bird-habitat relationship for the declining pampas meadowlark populations in the southern pampas grasslands. *Biological Conservation*, **115**, 139–148.

Gochfeld, M. (1979a) Interspecific territoriality in red-breasted meadowlarks and a method for estimating the mutuality of their participation. *Behavioral Ecology and Sociobiology*, **5**, 159–170.

Gochfeld, M. (1979b) Brood parasite and host coevolution: interactions between shiny cowbirds and two species of Meadowlarks. *American Naturalist*, **113**, 855–870.

Hudson, W.H. (1920) *Birds of La Plata*. J.M. Dent & Sons, New York, USA.

IUCN (2003) *2003 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland [http://www.redlist.org, accessed 4 February 2004].

Jaramillo, A.P. & Burke, P. (1999) *New World Blackbirds: The Icterids*. Princeton University Press, Princeton, USA.

Kie, J.G., Baldwin, J.A. & Evans, C.J. (1994) *CALHOME – Home Range Analysis Program*. US Forest Service, Pacific Southwest Research Station, California Department of Fish and Game, USA.

Mace, G. & Stuart, S. (1994) Draft IUCN Red List categories, version 2.2. *Species*, **21–22**, 13–24.

Payne, R.B. (1977) The ecology of brood parasitism in birds. *Annual Review of Ecology and Systematics*, **8**, 1–28.

Rothstein, S.I. (1990) A model system for coevolution: avian brood parasitism. *Annual Review of Ecology and Systematics*, **21**, 481–508.

Short, L.L. (1968) Sympatry of red-breasted meadowlarks in Argentina, and the taxonomy of meadowlarks (Aves: *Leistes*, *Pezites*, and *Sturnella*). *American Museum Novitates*, **2349**, 1–30.

Soriano, A., León, R.J.C., Sala, O.E., Lavado, R.S., Deregibus, V.A., Cauhepe, M.A., Scaglia, O.A., Velazquez, C.A. & Lemcoff, J.H. (1991) Rio de la Plata Grasslands. In *Ecosystems of the World 8A. Natural Grasslands* (ed. R.T. Coupland), pp. 367–407. Elsevier, London, UK.

Stattersfield, A.J. & Capper, R. (2000) *Threatened Birds of the World*. Lynx Edicions, Barcelona, Spain.

Thomas, L., Laake, J.L., Derry, J.F., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Strindberg, S., Hedley, S.L., Burt, M.L., Marques, F., Pollard, J.H. & Fewster, R.M. (1998) *Distance 3.5. Research Unit for Wildlife Population Assessment*. University of St Andrews, St Andrews, UK.

Tubaro, P.L. & Gabelli, F.M. (1999) The decline of the Pampas meadowlark *Sturnella defilippii:* difficulties of applying the IUCN criteria to Neotropical grassland birds. *Studies in Avian Biology*, **19**, 250–257.

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