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Ecology and conservation of grassland birds in southeastern South America: a review

Adrián B. Azpiroz,[1,8] Juan Pablo Isacch,[2] Rafael A. Dias,[3,4] Adrián S. Di Giacomo,[5] Carla Suertegaray Fontana,[6] and Cristina Morales Palarea[7]

[1]*Laboratorio de Genética de la Conservación, Instituto de Investigaciones Biológicas Clemente Estable, Av. Italia 3318 (C.P. 11600), Montevideo, Uruguay*
[2]*Instituto de Investigaciones Marinas y Costeras (IIMyC), Facultad de Ciencias Exactas y Naturales, Consejo Nacional de Investigaciones Científicas y Técnica, Universidad Nacional de Mar del Plata, Funes 3250, (7600) Mar del Plata, Argentina*
[3]*LABECO, Universidade Católica de Pelotas, R. Félix da Cunha 412, CEP 96010–000, Pelotas, RS, Brazil*
[4]*Programa de Pós-Graduação em Ecologia, Instituto de Biociências, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves 9500, CEP 91501–970, Porto Alegre, RS, Brazil*
[5]*Instituto de Ecología, Genética y Evolución de Buenos Aires (IEGEBA-CONICET), Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Int. Güiraldes y Av. Cantilo s/n, Pabellón II, Ciudad Universitaria, C1428EHA, Buenos Aires, Argentina*
[6]*Laboratório de Ornitologia, Museu de Ciências e Tecnologia, Curso de Pós-graduação em Zoologia, Pontifícia Universidade Católica do Rio Grande do Sul, PUCRS. Av. Ipiranga, 6681. CEP 90619-900. Porto Alegre, RS, Brazil*
[7]*Asociación Guyra Paraguay, Gaeano Martino 215 c/Tte. Ross, C,C:1132, Asunción, Paraguay*

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ABSTRACT. The grasslands of southeastern South America (SESA), comprising one of the most extensive grassland ecosystems in the Neotropics, have been negatively impacted by the development of the livestock industry, arable agriculture, and forestry. SESA grasslands have a rich avifauna that includes 22 globally threatened and near-threatened species, and many other species have suffered local population extinctions and range reductions. In addition to habitat loss and fragmentation, grassland birds in SESA are threatened by improper use of agrochemicals, unfavorable fire management regimes, pollution, and illegal capture and hunting. Studies to date have provided information about the distribution of grassland birds, the threats populations face, and the habitat requirements of some threatened species, but more information is needed concerning dispersal and migration patterns, genetics, and factors that influence habitat use and species survival in both natural and agricultural landscapes. There are few public protected areas in the region (1% of original grasslands), and many populations of threatened grassland birds are found on private lands. Therefore, efforts to preserve grassland habitat must reconcile the interests of land owners and conservationists. Current conservation efforts include establishment of public and private reserves, promotion of agricultural activities that reconcile production with biodiversity conservation, development of multilateral conservation projects across countries, and elaboration of action plans. Measures that result in significant losses to private land owners should include economic compensation, and use of economic incentives to promote agriculture and forestry in native grassland areas should be discouraged, especially in priority areas for grassland birds. Although more studies are needed, some actions, particularly habitat protection and improved management of public and private lands, should be taken immediately to improve the conservation status of grassland birds in SESA.

RESUMEN. **Ecología y conservación de aves de pastizal en el SE de Sudamérica: una revisión**
Los pastizales del sureste de Sudamérica (SESA), que conforman uno de los mayores ecosistemas de pastizales en el Neotrópico, han sufrido transformaciones importantes debido al desarrollo de la industria ganadera, la agricultura y la forestación. Los pastizales del SESA tienen una rica avifauna que incluye 22 especies amenazadas o casi amenazadas y muchas otras han sufrido extinciones poblacionales locales y reducciones muy sustanciales de sus rangos de distribución. Además de la pérdida de hábitat y la fragmentación, las aves de pastizal del SESA están amenazadas por el uso inapropiado de agroquímicos, regímenes desfavorables de manejo del fuego, contaminación, captura y caza ilegales. Los estudios al día de hoy han generado información sobre la distribución de aves de pastizal, las amenazas que sus poblaciones enfrentan y de los requerimientos de hábitat de algunas especies amenazadas, pero aun es necesaria más información sobre patrones de dispersión y migración, genética y los factores que afectan los patrones de uso de hábitat y la sobrevivencia de especies en paisajes naturales y agrícolas. Hay muy pocas áreas

[8]Corresponding author. Email: azpiroz@iibce.edu.uy

protegidas públicas en la región (1% de los pastizales originales) y muchas poblaciones de aves de pastizal amenazadas se encuentran en tierras privadas. Por ende, los esfuerzos que buscan preservar características de hábitat similares a las de los pastizales naturales deben reconciliar los intereses de productores y conservacionistas. Los actuales esfuerzos de conservación, incluyen, el establecimiento de reservas privadas y públicas, la promoción de prácticas agrícolas que reconcilien producción y conservación, el desarrollo de proyectos multilaterales de conservación entre varios países, y la elaboración de planes de acción. Las medidas que resultan en pérdidas significativas para los productores privados deberían incluir compensaciones económicas, y el empleo de incentivos económicos para fomentar la agricultura y forestación en pastizales nativos deberían ser desalentado, especialmente en el caso de áreas de prioridad para aves amenazadas. A pesar de que todavía se necesitan mas estudios, algunas medidas, en particular la protección y manejo de hábitat tanto en tierras públicas como privadas deberían aplicarse inmediatamente para mejorar el estado de conservación de las aves de pastizal en el SESA.

Key words: Argentina, Brazil, Brazilian Upland grasslands, Campos, Humid Chaco grasslands, Pampas, Paraguay, Río de la Plata grasslands, Uruguay

Grassland ecosystems are found on every continent except Antarctica, covering between 31 and 43% of the total land area of the world (World Resources 2000–2001). Grasslands have been identified as the terrestrial biome where biodiversity and ecosystem services are most at risk on a global scale due to the large disparity between loss of habitat and the low degree of protection (Hoekstra et al. 2005, Henwood 2010). Grasslands in the southeastern South America (SESA) region are one of the most extensive grassland ecosystems in the Neotropics and have been transformed by the development of a vast livestock industry, arable agriculture, and afforestation (Soriano et al. 1991, Overbeck et al. 2007). About 40 to 45% of the original cover remains, but even most grassland remnants have been modified by livestock grazing (Demaría et al. 2003, Bilenca and Miñarro 2004, Paruelo et al. 2004, Herrera et al. 2009). Only about 1% of the original extent of the Pampas and the Campos region is currently protected (Henwood 2010).

Loss and degradation of grasslands have negatively affected bird populations worldwide. In North America, 75% of grassland birds have experienced population declines over the past 30 years due to changes in land use (Askins et al. 2007). In Europe, 70% of grassland and steppe species have suffered drastic reductions of their populations due to changes in agricultural practices (Donald et al. 2001, 2006). The negative effects of native habitat replacement on grassland birds have also been reported in Asia, Oceania, and Africa (Goriup 1988). In the Neotropics, populations of several resident grassland birds have declined markedly (Fraga et al. 1998, Tubaro and Gabelli 1999, Fraga 2003, Di Giacomo and Di Giacomo 2004), and those of long-distance Nearctic migrants have also decreased since the 1800s (Lanctot et al. 2002, Vickery et al. 2010). Because nearly 10% of globally threatened bird species in South America inhabit grasslands, compared to 6.3% for the world as a whole (Collar et al. 1994), conservation of grassland birds in the Neotropics is a critical issue.

Here we review the status of grassland bird ecology and conservation in SESA. First, we briefly describe SESA grasslands and their associated avifauna, as well as land-use patterns and evidence of declining bird populations. We analyze factors affecting grassland birds in light of data collected during the last 15 years and highlight knowledge gaps. Finally, we describe current conservation strategies (and their limitations) and provide recommendations for further action.

We used Vickery et al. (1999) as a primary source for defining grassland habitat and grassland birds. According to these authors, grasslands are extensive areas with >50% grass (Poaceae) or sedge (Cyperaceae) cover and few scattered shrubs (<4 m high) and trees. We included habitats where the soil is saturated with water, namely wet-mesic grasslands in upland swales, but excluded those that remain flooded for long periods, such as freshwater, brackish, and saltwater wetlands. Following Vickery et al. (1999), we define a grassland bird as "any species that has become adapted to and reliant on some variety of grassland habitats for part or all of its life cycle." We used the list of grassland birds provided by Vickery et al. (1999) as a baseline for identifying species in our study area. We modified our list based on new information or based on our personal experience.

Our review is divided into six sections. The first three topics (SESA grassland birds, Declining populations of SESA grassland birds, and

Factors affecting SESA grassland birds) were developed primarily by reviewing all available literature we could access. Information was accessed using Google Scholar and the electronic databases ISI Web of Science, SCOPUS, and SCIELO. We also contacted experts to include unpublished information or clarify existing data, and used our own unpublished data when necessary.

For the "South American Grassland Birds: Knowledge and Gaps" section, we reviewed the literature to locate papers focusing on grassland birds in our study area. Papers were identified by searching all databases in ISI Web of Knowledge and SCOPUS spanning all available years up to 2011. We followed this method to limit our sampling to high-impact journals expected to contain the most relevant information. We conducted searches using the key words "bird pampas" and "bird grassland South America." We read all abstracts and available key words in the resulting papers to limit the information to our geographical and ecological areas of interest. Papers focusing on fossil and wetland birds were excluded. We did, however, include papers on waterbirds using grassland habitat. We also examined possible geographic and topic biases in the literature. To do so, we classified papers into 11 categories, including assemblages and community ecology, biology (including feeding, breeding, and social behavior), climate and weather impacts, conservation, distribution, genetics, habitat and land-use associations, methods, morphology, population monitoring (including migration), and toxicology, and compared the number of papers in each category for each country. In the last two sections ("Current bird conservation initiatives" and "Additional proposed conservation measures"), we summarize available information concerning grassland conservation issues in SESA as well as our own experiences developed through direct involvement with grassland bird conservation in the region.

DESCRIPTION OF SESA GRASSLANDS

The geographic extent of our review covers grasslands in Southeastern South America from 28° to 39° S. This region forms an arc around the Río de la Plata covering eastern and northeastern Argentina, southern Paraguay, southern Brazil, and Uruguay. The region is treated here as the SESA Grasslands and includes: (1) the "Río de la Plata grasslands" (*sensu* Soriano et al. 1991), (2) the upland grasslands of southern Brazil (*sensu* Overbeck et al. 2007; hereafter "Brazilian Upland grasslands"), and (3) the savanna grasslands in the Humid Chaco along the Paraguay river in southeastern Paraguay and northeastern Argentina (*sensu* Olson et al. 2001 and references therein; hereafter "Humid Chaco grasslands"; Fig. 1). All these grassland subregions have similar habitats and vegetation types, and support an assemblage of bird species that faces similar threats and conservation needs.

The Río de la Plata grasslands (Fig. 1) occupy a region of more than 700,000 km^2 in central-eastern Argentina (eastern Corrientes, Entre Ríos, southern Cordoba, southern Santa Fe, Buenos Aires, eastern La Pampa, and eastern San Luis), Uruguay, and southern Brazil (southern and western Rio Grande do Sul; Soriano et al. 1991). These grasslands are characterized by flat to undulating relief with elevations < 900 m. The region has mesothermic features mostly regulated by the tempering effect of the Atlantic Ocean, with annual mean temperatures ranging from 14° in the south to 18° in the north (Soriano et al. 1991). There is also a rainfall gradient (1600 mm in the northeast to 500 mm in the southwest) with high interannual variability that determines incipient water excess and water deficits, respectively (Burgos and Vidal 1951, Overbeck et al. 2007). Paleontological and palynological evidence suggest that grasslands have dominated the region at least since the Neogene (Prieto 2000, Behling et al. 2005). The southern half of this region is a seral graminoid steppe of medium height ($\sim$0.4–1 m), where dominant genera are *Stipa*, *Poa*, *Piptochaetium*, and *Sorghastrum*; in the northern half, cespitose grasslands with grasses of the genera *Andropogon*, *Aristida*, *Briza*, *Erianthus*, *Piptochaetium*, *Poa*, and *Stipa* predominate (Soriano et al. 1991, Overbeck et al. 2007). Broadleaf genera such as *Eryngium* and *Baccharis* are widespread in the Southern and Northern Campos (Soriano et al. 1991, Overbeck et al. 2007; Fig. 1). Grassland regions adjacent to areas originally covered by Atlantic Forest, especially in the northern and eastern sectors of the Northern Campos, are characterized by forest-grassland mosaics, parkland, and shrubland (Pillar and Quadros 1997, Cordeiro and Hasenack 2009, Boldrini et al. 2009). Wetlands occur in coastal

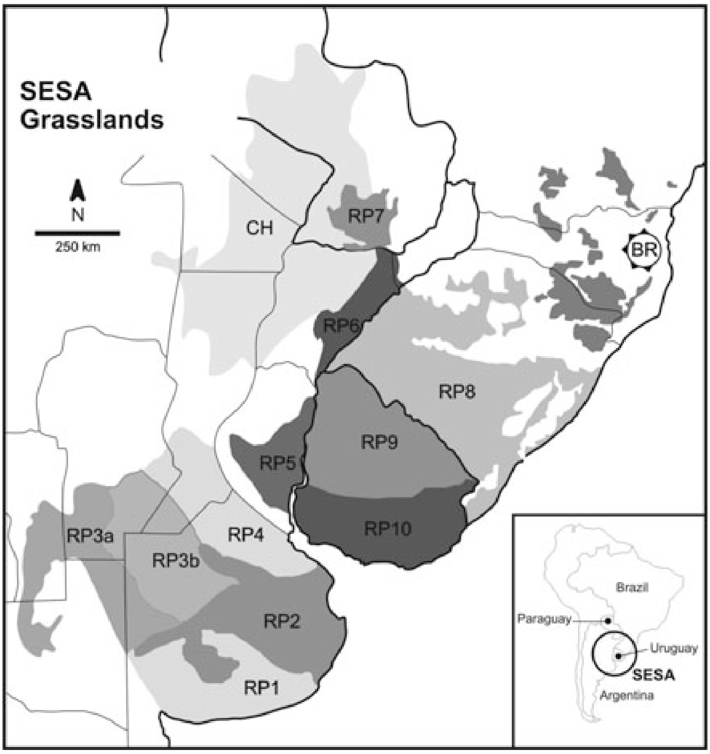

Fig. 1. Southeastern South American Grasslands (modified from Soriano et al. 1991, Olson et al. 2001 and references therein, Guyra Paraguay 2005, and Overbeck et al. 2007), including the Río de la Plata Grasslands (RP1: Southern Pampa, RP2: Flooding Pampa, RP3a West Inland Pampa, RP3b: Flat Inland Pampa, RP4: Rolling Pampa, RP5: Mesopotamic Pampa, RP6: Northern Campos in Argentina, RP7: Southern Paraguayan grasslands, RP8: Northern Campos in Brazil, RP9: Northern Campos in Uruguay, and RP10: Southern Campos), Brazilian Upland grasslands (BR), and Humid Chaco grasslands (CH). Bold black lines in main picture represent approximate country limits and fine black lines show relevant province and state limits for Argentina and Brazil, respectively.

areas and floodplains along rivers and lagoons (Soriano et al. 1991, Cordeiro and Hasenack 2009). Grasslands in southern Paraguay have recently been considered as an extension of the Río de la Plata grasslands (*sensu* Soriano et al. 1991) on the basis of close vegetation and avifaunal affinities with the Northern Campos of Argentina (Guyra Paraguay 2005, Clay et al. 2008). These grasslands occupy an area of ~2,035,400 ha in central-southern Paraguay (Misiones, western Itapua and Caazapá, and south of Paraguarí).

The Brazilian Upland grasslands are upland formations (700–1800 m asl) that covered ~60,000 km^2 in northeastern Rio Grande do Sul, Santa Catarina, and Paraná states in Brazil (Overbeck et al. 2007, H. Hasenack, pers. comm.). These grasslands are distributed as large discrete patches on gently rolling terrain amid Araucaria forest in the Southern Brazilian Plateau (Klein 1978, Leite 2002, Cordeiro and Hasenack 2009). Annual precipitation is high (1500–2000 mm) and evenly distributed throughout the year; mean annual temperatures range from 10–22°C, with frequent frosts and occasional snow during winter (Overbeck et al. 2007). These grasslands are characterized by a high diversity of Asteraceae and Poaceae and high levels of endemism (Boldrini et al. 2009). Cespitose grasses predominate in hilltops, especially *Andropogon lateralis*, whereas drainages are covered with Cyperaceae and the spiny *Eryngium pandanifolium*, a ubiquitous element in boggy swales (Boldrini et al. 2009).

Humid Chaco grasslands are part of a complex mosaic of palm and tree savannas, forests, and marshes. In Argentina, they occupy the eastern portion of the provinces of Formosa, Chaco, Santa Fe, and western and central Corrientes. In Paraguay, these grasslands are found mainly in the departments of Cordillera, Central, Paraguarí, and Ñeembucú, and eastern portions of Pte. Hayes. Relief is flat and the climate is humid temperate with high interannual variability (Gorleri 2005). Mean annual temperature drops from north to south (23 to 18°C) and annual rainfall varies from 1300 mm in the east to 750 mm in the west. Vegetation in Chaco grasslands is dominated by tall grasses such as *Paspalum*, *Sorgastrum*, *Andropogon*, *Imperata*, and other medium-size grasses such as *Elionurus* and *Schizachiryum*. In marshy areas, the dominant vegetation is represented by *Panicum* and *Cyperus* species (Maturo et al. 2005).

LAND-USE PATTERNS AND HABITAT ALTERATION IN SESA GRASSLANDS

Conversion of SESA native grasslands to cultivated fields and grazing rangelands has varied with land-use and land-cover patterns in different areas (Baldi and Paruelo 2008, Cordeiro and Hasenack 2009). Although climate shifts and the arrival of humans at the beginning of the Holocene brought major alterations to grasslands (Behling et al. 2005), current impacts are related to European colonization that started in the late 15th century. Horses and cattle were introduced in the Río de la Plata grasslands during the 16th century (Soriano et al. 1991). Livestock flourished in these grasslands, and fire was commonly used as a management tool to increase forage quality of grasslands. By the end of the 19th century, substantial areas of native grasslands had been converted to pastures sown with non-native species (e.g., *Festuca* sp., *Lolium* sp., and *Medicago* sp.) to further improve forage quality, and crops (Soriano et al. 1991). When Darwin arrived at the Río de la Plata grasslands (1831–1832), the landscape had changed substantially and large native herbivores such as guanacos (*Lama guanicoe*), Pampas deer (*Ozotoceros bezoarticus*), and Greater Rheas (*Rhea americana*) had disappeared from several areas (Soriano et al. 1991).

During the 20th century, many original natural grasslands in the Pampas' subregions and a smaller proportion in the Campos subregions were replaced by cropland (wheat, maize, sorghum, and soybean) and sown pastures for livestock. During the last few decades, in particular, agricultural intensification has been supported by technological developments (tillage, transgenic seeds, and high agrochemical input) and market factors (Paruelo et al. 2005, Baldi et al. 2006). This has favored the further expansion of crops over lands traditionally devoted to cattle ranching. In fact, 6% of the native grassland area in the Río de la Plata (*sensu* Soriano et al. 1991) was lost between 1985 and 2005, mainly due to expansion of annual crops (Baldi and Paruelo 2008). In Argentina, soybean-cultivated areas have multiplied and currently represent 50% of the total crop area in that country (mainly in the Pampas and Chaco ecoregions; Aizen et al. 2009). In the Inland Pampa in western Argentina, habitat alteration has resulted in a dramatic loss of grasslands. During a 16-year period (1985–2001), total grassland cover in this subregion was reduced from 84% to 38% at a regional scale (Demaría et al. 2008). This loss of native vegetation is probably irreversible (Demaría et al. 2008).

In Buenos Aires, nearly 33% of the total area of the province (~10,000,000 ha) consisted of cultivated annual crops in 2003–2004 (FAUBA 2011). In the Northern Campos of southern Brazil, agricultural practices have followed a pattern similar to that in Argentina and soybeans, maize, and rice are the dominant crops (Crawshaw et al. 2007, Overbeck et al. 2007). In Brazilian Upland grasslands, in addition to soybeans and maize, potatoes, wheat, and apples are dominant crops. In Rio Grande do Sul, grassland conversion has been substantial, with 15.6% of native grasslands lost in a 27-year period (1976–2002) at an annual conversion rate of ~1000 km^2 (Cordeiro and Hasenack 2009). By 2002, only 25% of the original grasslands remained in the state (Cordeiro and Hasenack 2009). In western Uruguay, croplands have also increased, especially soybeans, wheat, and corn, while the vast ricelands in the east have remained stable (Paruelo et al. 2006). In Paraguay, ~50% of the grassland area has been transformed from traditional cattle ranching to monocultures of rice, soybeans, and eucalyptus (*Eucalyptus* spp.; Morales et al. 2010).

In extensive areas of grasslands of northeastern Argentina, Uruguay, southern Paraguay, and southern Brazil, afforestation with non-native species has expanded over traditional cattle production areas (Overbeck et al. 2007, Baldi et al. 2008, Morales et al. 2010). In Argentina, afforestation has particularly occurred in Corrientes province, with ~500,000 ha of pines planted in natural grasslands, and this is expected to reach 1,000,000 ha (12% of the provincial area) in the next several years. In southern Brazil, exotic pine (*Pinus* spp.) plantations used for timber and resin extraction cover large expanses of upland grasslands over the three southern states and the coastal grasslands in Rio Grande do Sul. Afforestation with pines is probably the most serious threat to Brazilian Upland grasslands (Bristot 2001, Fontana et al. 2009) and grasslands in Corrientes province, Argentina (Di Giacomo and Krapovickas 2001). In both regions, there are several species of threatened grassland birds sensitive to forestry activity (Di Giacomo and Krapovickas 2001, Bencke et al. 2003, Di Giacomo 2005b, Fontana et al. 2009, Di Giacomo et al. 2010, BirdLife International 2012). In Corrientes, afforestation has been subsidized by the government, but legislation has not considered its impacts on grassland biodiversity. In Brazil, eucalyptus grown for the pulp-wood industry is planted largely in grasslands in the southern and midwestern portions of Rio Grande do Sul. About 4% of the Southern and Northern Campos of Uruguay and southern and western Rio Grande do Sul (1,362,000 ha), most of which originally were covered with grasslands, are currently afforested (Martino and Methol 2008, H. Hasenack, pers. comm.). In both regions, afforestation is encouraged by the government, which markets large areas of grassland remnants as afforestation-prone (Hasse 2006, Paruelo et al. 2006). Afforestation has altered additional grassland areas because plantations can be established even in areas where conventional farming is impractical due to soil limitations.

Because habitat loss and modification usually result in fragmentation (Viglizzo et al. 2001, Demaría et al. 2008), natural grasslands in several areas of SESA are substantially fragmented (Viglizzo et al. 2001). Agriculture-related disturbances have resulted in significant changes in area and patch configuration (Baldi et al. 2006). Again, patterns reflect agriculture suitability that have resulted in significant spatial heterogeneity. Within the Río de la Plata Grasslands, the Flat Inland and Rolling Pampas in Argentina (Fig. 1) show the greatest grassland conversion and fragmentation index, with 34.1–55.7% of grassland cover scattered within an agricultural matrix (Baldi et al. 2006, Baldi and Paruelo 2008, Demaría et al. 2008). In contrast, the Flooding Pampa is the least fragmented subregion of the Argentinean Pampas, with larger (>200 ha) grassland patches making up the landscape matrix (Bilenca and Miñarro 2004). The Southern and Northern Campos of Uruguay and Brazil as well as the Southern and Mesopotamic Pampas of Argentina have intermediate levels of fragmentation (Baldi et al. 2006, Baldi and Paruelo 2008). Large grassland remnants in Uruguay are found primarily in the northern half of the country, and are restricted to the western part of the state in Rio Grande do Sul (Cordeiro and Hasenack 2009, H. Hasenack, pers. comm.). In the Humid Chaco grasslands of Paraguay, agriculture expansion, deforestation, and the invasion of alien species (De Egea et al. 2012) represent serious threats to SESA grassland birds.

SESA GRASSLAND BIRDS

In the SESA grasslands, 109 species of birds have been recorded, with 82 using grasslands on a regular basis (Appendix 1; nomenclature and sequence follow Remsen et al. 2012). These include 22 globally threatened and near-threatened species (BirdLife International 2012; Appendix 1). In addition, many long-distance migrants use the SESA grasslands as wintering or breeding grounds. Non-breeding migrants include 12 Patagonian species present mainly during austral fall and winter, and eight Nearctic visitors that stay during the austral spring and summer (Appendix 1). Breeding migrants are represented by 13 species, with all moving north in the Neotropics during austral winter (Narosky and Di Giacomo 1993, Belton 1994, Stotz et al. 1996). Pampas Pipits (*Anthus chacoensis*) are also migrants, but their breeding and wintering grounds are restricted to SESA (Casañas et al. 2007), so they are treated as a resident in terms of their presence in the region. Populations of some SESA grassland species make local or regional movements (e.g., Bearded Tachuris, *Polystictus pectoralis*, and Spectacled Tyrants, *Hymenops* *perspicillata*; Narosky and Di Giacomo 1993), but, because some of these movements are still not clearly characterized, we did not identify any partial migrants.

Based on Narosky and Di Giacomo (1993), Belton (1994), Vickery et al. (1999), and our own observations, we placed grassland birds in SESA in three categories based on use of grassland habitats (Appendix 1): (1) species restricted to grassland habitats, (2) species that make extensive use of grassland habitats, but also use wetlands (including beaches), shrublands, savannas, and row-crop habitats in the region, and (3) species that make extensive use of grassland habitats in some subregions, but not others. The 12 species in the first group are thought to be particularly sensitive to grassland modification. Some birds in the second group can also be locally sensitive to grassland loss, especially those unable to use cropland as a substitute for grasslands or species that depend on non-substitutable resources available both in grasslands and other natural habitats, such as wetlands. Examples of the latter are Black-and-white Monjitas (*Xolmis dominicanus*) and Saffron-cowled Blackbirds (*Xanthopsar flavus*) that forage in grasslands, but depend on adjacent wetlands for breeding and roosting, and many *Sporophila* seedeaters that regularly use herbaceous wetlands amid grasslands for feeding and nesting (Bencke et al. 2003). However, we do not expect all species among or within any of these groups to respond uniformly to transformation of native grasslands because sensitivity to habitat loss and fragmentation is species-specific (Manning et al. 2004, Fischer and Lindenmayer 2007, Johnson et al. 2011). Species in the third group include birds whose dependence on grasslands varies regionally. Black-and-rufous Warbling-Finches (*Poospiza nigrorufa*), for example, inhabit mostly tall grasslands in the Flooding Pampa of Argentina, but make extensive use of other habitats (marsh edges and brushy vegetation) outside this subregion (Narosky and Di Giacomo 1993, Belton 1994, JPI, pers. observ.).

Vegetation height is one of the main drivers of bird diversity and composition in grasslands (Fisher and Davis 2010). Thus, we further discriminated species restricted to homogeneous short grass (<20 cm) or tall grass (>40 cm) and those that use both short and tall grasslands or require patches of short grass within a matrix of tall grass (Appendix 1). For this classification, we followed Belton (1994), Comparatore et al. (1996), Isacch et al. (2005), Azpiroz and Blake (2009), Isacch and Cardoni (2011), and our own personal observations (Appendix 1). In SESA, 23 species of birds are restricted to short grass grasslands, 25 to tall grass, and 61 make broader use of grassland types. Tall-grass species tended to be of greater conservation concern than short-grass species (Appendix 1).

DECLINING POPULATIONS OF SESA GRASSLAND BIRDS

Human-induced habitat homogenization in SESA agroecosystems has negatively affected bird diversity, leading to local extinctions (Comparatore et al. 1996, Bencke et al. 2003, Di Giacomo and Di Giacomo 2004, Codesido et al. 2011). Populations of several species have declined over the last 100 years in association with land-use changes or hunting (Collar et al. 1992). As a result, 22 species are considered globally threatened or near-threatened (BirdLife International 2012; Appendix 1) and many others are considered in peril at national or regional levels (Bencke et al. 2003, Straube et al. 2004, López-Lanús et al. 2008, Fontana et al. 2009, Santos and Scherer-Neto 2009, IGNIS 2010).

In the absence of long-term monitoring efforts, evidence of declining populations of SESA birds comes from chronological records of the disappearance of local or regional populations. Saffron-cowled Blackbirds (*Xanthopsar flavus*), Black-and-white Monjitas (*Xolmis dominicanus*), Strange-tailed Tyrants (*Alectrurus risora*), and Pampas Meadowlarks (*Sturnella defilippii*) have been extirpated from large areas of their historical ranges and these range contractions have been related to changes in land-use patterns.

In Argentina, Saffron-cowled Blackbirds and Black-and-white Monjitas have suffered range reductions of 50% and 31%, respectively (Fraga et al. 1998, Fraga 2003). Although there are no specific estimates for other countries, both species may be declining throughout their entire ranges, despite no obvious range contractions (Collar et al. 1992, Azpiroz 2000, Dias and Mauricio 2002, Bencke et al. 2003, ICMBio, in press). Population strongholds for these two grassland birds currently include a few small, disjunct areas in eastern Argentina and neighboring western Uruguay, southeastern Paraguay, and especially in eastern Uruguay, southeastern Rio Grande do Sul, and the Brazilian Upland grasslands of northeastern Rio Grande do Sul and southeastern Santa Catarina (Bencke et al. 2003, Fontana et al. 2009, Santos and Scherer-Neto 2009, IGNIS 2010, BirdLife International 2012, ICMBio, in press).

Strange-tailed Tyrants currently inhabit only 10% of their historical range in Argentina, and current populations are restricted to provinces in the northeast and neighboring southern Paraguay (Di Giacomo and Di Giacomo 2004, Codesido and Fraga 2009, BirdLife International 2012). In Argentina, populations of summer breeders have been extirpated in Buenos Aires, Cordoba, Santa Fe, and Entre Ríos provinces (Di Giacomo and Di Giacomo 2004). In Paraguay, populations have declined locally (BirdLife International 2012) and there are few recent records (Arballo and Gambarotta 1987) in Uruguay, where these tyrants were relatively common summer breeders in the 19th century (Gibson 1885). In southern Brazil, Strange-tailed Tyrants were last recorded in 1914 (Bencke et al. 2010) and may now be extirpated.

Pampas Meadowlarks have suffered a 90% contraction of their historical range (Tubaro and Gabelli 1999). In Argentina, the largest population is in southern Buenos Aires province, with a few scattered records in San Luis, La Pampa, and Corrientes provinces (Chebez 2008). In Uruguay, these meadowlarks were widespread in the past, but only a single population (~300 pairs) remains in southeastern Salto department (Azpiroz 2005, unpubl. data). In Brazil, there are two records from south Rio Grande do Sul that probably date from the 19th century (Ihering 1899, Belton 1994, Bencke 2001, Bencke et al. 2010), and two doubtful observations from Paraná and Santa Catarina (BirdLife International 2012).

Cock-tailed Tyrants (*Alectrurus tricolor*), Sharp-tailed Tyrants (*Culicivora caudacuta*), and Black-masked Finches (*Coryphaspiza melanotis*) were previously considered near-threatened (Collar and Andrew 1988, Collar et al. 1992), but have been up-listed to vulnerable because of local extinctions in Argentina, Paraguay, and Brazil (BirdLife International 2012). In Argentina, Cock-tailed Tyrants were recorded in the provinces of Corrientes and Misiones, but are now thought to be extirpated, with no confirmed records in the last several decades. In southern Brazil, Cock-tailed Tyrants were reported from Rio Grande do Sul in the 19th century (Wied 1831, Bencke et al. 2010) and currently only a small population subsists in the Brazilian Upland grasslands of Paraná state (Straube et al. 2004, ICMBio, in press). The species is also rare in Paraguay (BirdLife International 2012), with only a few scattered populations (Del Castillo and Clay 2004). Sharp-tailed Tyrants were formerly present in several provinces of Argentina, but are now found at scattered sites in Misiones, Corrientes, Santa Fe, and Formosa (Di Giacomo 2005b). In southern Brazil, the species occurs in Brazilian Upland grasslands of Paraná, Santa Catarina, and northeastern Rio Grande do Sul states, where they appear to be numerous, and in a few localities in the western sector of the latter state, where they are rare (Straube et al. 2004, Fontana et al. 2008, Bencke et al. 2010, Repenning et al. 2010, ICMBio, in press). Black-masked Finches were formerly present in the provinces of Chaco, Santa Fe, Corrientes, and Misiones in Argentina, but recent records are few and limited to northern Corrientes (Chebez 2008). In Paraguay, there are only a few records from Ñeembucu and San Pedro departments (C. Morales, unpubl. data).

Buff-breasted Sandpipers (*Tryngites subruficollis*) are near-threatened migratory grassland shorebirds that have shown a gradual, but marked, decline in numbers (Lanctot et al. 2002, Isacch and Martínez 2003a). Historical evidence indicates that this species was abundant, with flocks of 200 to 500 individuals regularly observed during migration in the southern SESA grasslands (Hudson 1920). Regular counts at the most important wintering site in Argentina (Medaland Ranch) reveal a marked decrease in numbers during the last 30 years. Myers and Myers (1979) estimated a maximum of 2000 individuals at that ranch in 1975, but only ~360 individuals were observed in 1991 (Blanco et al. 1993) and, more recently (1996–2000), numbers rarely exceeded 100 individuals at the site (Isacch and Martínez 2003a). Data for other grassland shorebirds obtained in 1992–1993 and 2006–2007 in Argentina suggest range contractions and declining populations of American Golden Plovers (*Pluvialis dominica*), and Upland (*Bartramia longicauda*) and

Pectoral (*Calidris melanotos*) sandpipers (Isacch and Martínez 2003a, A. S. Di Giacomo, unpubl. data).

Populations of other long-distance migrant grassland birds also show evidence of recent declines in wintering areas in SESA. Di Giacomo et al. (2005) compared historical and current records of Bobolinks (*Dolichonyx oryzivorus*) and found a 25% range reduction in wintering areas in Argentina. Similarly, Swainson's Hawks (*Buteo swainsoni*) suffered massive mortality due to insecticide poisoning during the 1990s in Argentina (Woodbridge et al. 1995, Goldstein et al. 1996, 1999a,b). For some *Sporophila* seedeaters, such as Black-bellied Seedeaters (*Sporophila melanogaster*), "Yellow-billed" Plumbeous Seedeaters (*Sporophila* aff. *plumbea*), Marsh Seedeaters (*Sporophila palustris*), and Chestnut Seedeaters (*Sporophila cinnamomea*), SESA grasslands contain key breeding and feeding areas (BirdLife International 2012). Morphological and behavioral evidence suggests that the 'Yellow-billed' Plumbeous Seedeater, currently restricted to grasslands between 700 and 950 m in altitude on mountain slopes near some rivers in the Brazilian Highland Grasslands is a valid species (Repenning and Fontana, unpubl. data). Although published information is lacking, preliminary data indicates that the 'Yellow-billed' Plumbeous Seedeater has the smallest population of the *Sporophila* seedeaters in southern Brazil (CSF, pers. observ.). As with other seedeaters, the population decline is due to habitat destruction and alteration, as well as capture for the illegal bird trade (Repenning 2012). The entire breeding population of Black-bellied Seedeaters is restricted to the Brazilian Upland Grasslands and faces similar threats (Fontana et al. 2009, Repenning et al. 2010, BirdLife International 2012, Rovedder 2011, ICMBio, in press). Although information about population trends is largely lacking for seedeaters, local declines are also suspected for the remaining species (Bencke et al. 2003, ICMBio, in press).

Among Patagonian migrants, three sheldgeese species (Ruddy-headed Geese *Chloephaga rubidiceps*, Upland Geese *Chloephaga picta,* and Ashy-headed Geese *Chloephaga poliocephala*) that winter in southern Buenos Aires have suffered marked population declines (Chebez 2008) due to hunting (Rumboll 1975, 1979). The mainland population of Ruddy-headed Geese is thought to consist of <1000 individuals (Blanco et al. 2003, Madsen et al. 2003). Consequently, all three species are considered threatened in Argentina (López-Lanús et al. 2008).

Other grassland birds of SESA are probably also declining due to habitat loss and modification, but lack of data precludes thorough conservation assessments. For example, based on historic and current records for Buenos Aires province, Narosky and Di Giacomo (1993) identified several species thought to have either declined in numbers or disappeared from certain areas, including Greater Rheas, Red-winged Tinamous (*Rynchotus rufescens*), Elegant Crested-Tinamous (*Eudromia elegans*), Spotted Nothuras (*Nothura maculosa*), Plumbeous Ibises (*Theristicus caerulescens*), Rufous-chested Dotterels (*Charadrius modestus*), Least Seedsnipes (*Thinocorus rumicivorus*), and Hudson's Canasteros (*Asthenes hudsoni*). Comparison of the results presented by Narosky and Di Giacomo (1993; prior to the massive planting of transgenic soybeans, Aizen et al. 2009) and information gathered more recently in the Pampas of central Argentina (Codesido et al. 2011) also reveals substantial range contractions of some common grassland species, such as Spectacled Tyrants (*Hymenops perspicillatus*), Great Pampa-Finches (*Embernagra platensis*), and Brown-and-yellow Marshbirds (*Pseudoleistes virescens*).

FACTORS AFFECTING SESA GRASSLAND BIRDS

Factors driving declines in bird populations throughout SESA are diverse and act at various scales, and studies have revealed that grassland birds show different responses to land transformation in the region (Comparatore et al. 1996, Lanctot et al. 2002, Isacch et al. 2005, Azpiroz and Blake 2009, Di Giacomo et al. 2010, Isacch and Cardoni 2011, Codesido et al. 2012). Particularly during the last century, suitable soil and climatic conditions resulted in the transformation of SESA native grasslands into croplands and this has resulted in substantial grassland alteration and fragmentation (Viglizzo et al. 2001, Baldi et al. 2006, Crawshaw et al. 2007).

Crop cultivation and afforestation. Throughout the SESA grasslands, the area devoted to annual crops, sown pastures, and forestry is increasing (Bilenca and Miñarro 2004, Viglizzo et al. 2005, Martino and Methol 2008). Over the past 15 years, conversion of grasslands to cropland has resulted in loss of habitat for many grassland birds (Vickery et al. 2003, Gabelli et al. 2004, Sarasola et al. 2007, Thompson and Carroll 2009, Codesido et al. 2011). These activities usually result in the total replacement of native vegetation that can trigger changes in bird species richness, composition, and abundance (Filloy and Bellocq 2007, Pedrana et al. 2008). Conversion to cropland can also affect the persistence of species through increased population isolation (Giordano et al. 2009). Croplands and sown pastures have lower species richness than natural grasslands (Leveau and Leveau 2004, Isacch et al. 2005, Di Giacomo et al. 2010). In other cases, greater numbers of bird species in mixed grazing-cropping systems have been explained by the presence of different vegetation characteristics associated with alternative land uses such as crops and sown pastures (Azpiroz and Blake 2009).

The composition of bird assemblages in croplands and sown pastures differs from that in natural grasslands. In the Northern Campos of Uruguay, facultative grassland species tended to be associated with mixed grazing-cropping systems, but this was not the case for most grassland obligate species (Azpiroz and Blake 2009). In the West Inland Pampa, however, where bird richness is relatively low, replacement of natural grasslands with sown pastures may not have produced substantial changes in the composition of grassland bird assemblages (Isacch et al. 2005).

Grassland birds differ in their sensitivity to conversion of grasslands to cropland and pasture. Several species respond negatively to conversion, including Greater Rheas (Giordano et al. 2009), Long-winged Harriers (*Circus buffoni*; Pedrana et al. 2008), Pampas Pipits (Isacch et al 2005), Hellmayr's Pipits (*Anthus hellmayri*), Ochre-breasted Pipits (*Anthus nattereri*; Azpiroz and Blake 2009), and Pampas Meadowlarks (Fernandez et al. 2003, Gabelli et al. 2004). Alteration of vegetation structure and composition of native grasslands in croplands and exotic pasturelands (Isacch et al. 2005) can affect bird survival and reproduction (Johnson et al. 2006, Rovedder and Fontana, unpubl. data). Associated activities such as crop harvesting and mowing can also disturb and kill birds or destroy nests (Fernandez et al. 2003, Giordano et al. 2009). In contrast, other species of birds seem more tolerant of intensive farming systems. For example, Darwin's Nothuras (*Nothura darwinii*), Correndera Pipits (*Anthus correndera*), and Grassland Yellow-Finches (*Sicalis luteola*) use sown pastures in the Inland or Southern Pampas (Leveau and Leveau 2004, Isacch et al. 2005).

Effects of habitat modification due to agriculture on species such as Spotted Nothuras and Swainson's Hawks remain unclear. Some authors have suggested that these species are well adapted to or benefit from such changes (Bucher and Nores 1988, Canavelli et al. 2003), whereas others believe otherwise (Narosky and Di Giacomo 1993, Pinheiro and Lopez 1999, Sarasola et al. 2007, Thompson and Carroll 2009). In any case, habitat use patterns do not necessarily reflect habitat preferences or habitat quality (Krausman 1999). In fact, studies of grassland birds in North America have shown that bird densities may not correlate positively with reproductive success (Vickery et al. 1992).

Use of land for crop production seems particularly detrimental to birds in SESA (Johnson et al. 2011). Whereas 70% of the species that responded to the agricultural gradient were negatively affected by the intensity of crop production, only 22% increased in abundance with a growing percentage of land used for crop production, and none of the latter were typical grassland species (Filloy and Bellocq 2007). The expansion of agriculture in the last 15 years and simultaneous modification of native grasslands traditionally used for cattle ranching (Bilenca and Miñarro 2004, Martino and Methol 2008) will probably result in further changes in bird population dynamics, including declines in the populations of many species (Isacch et al. 2005, Filloy and Bellocq 2007, Azpiroz and Blake 2009, Codesido et al. 2011).

Another negative result of agriculture expansion is related to an indirect effect on neighboring cattle-raising areas. In southern Brazil, despite the continuing conversion of grasslands for soybean, wheat, and maize cultivation since 1970, the size of the cattle herd has increased (Crawshaw et al. 2007). Because the area of sown pastures and conversion of other vegetation types into pastures was negligible, Crawshaw et al. (2007) concluded that the density of cattle increased 20% in the remaining natural grasslands. High cattle densities alter vegetation structure with important consequences for birds (Isacch and Cardoni 2011).

Afforestation on natural grasslands can have adverse effects on water and soil characteristics as well as biodiversity (Jobbágy and Jackson 2004, Brockerhoff et al. 2008, Berthrong et al. 2009, Silveira and Alonso 2009). Plantations of non-native trees can have detrimental effects on birds, especially in grassland-dominated landscapes such as the southern Río de la Plata grasslands (Filloy et al. 2010). Alternatively, species such as Swainson's Hawks can benefit from availability of novel resources such as stands of introduced exotic trees for use as roost sites (Sarasola and Negro 2006). Introduction of exotic trees may have resulted in the recent expansion of this raptor in the Argentine Pampas (Sarasola and Negro 2006). Other endemic and threatened grassland species, however, can be negatively affected by even small stands of planted trees (Allan et al. 1997). Not surprisingly, the composition of bird assemblages in grasslands and tree plantations differs, with beneficial effects for edge species and negative effects for grassland taxa (Lantschner et al. 2008). Throughout the region, afforestation for pulp-wood affects well-drained grasslands along hillcrests and slopes, threatening a series of common grassland birds and eliminating foraging habitat for Saffron-cowled Blackbirds, Black-and-white Monjitas, and Black-bellied Seedeaters, among others (Fontana et al. 2009, RAD, pers. observ.). Although swales used by these and other species of conservation concern are legally protected and remain free from conversion, little is known about how indirect effects of neighboring plantations affect the physical and biotic characteristics of these wet grasslands, especially alteration of water regimes, facilitation of shrub encroachment, and direct disturbance of open-area species. In South Africa, areas spared from afforestation in plantations are often too small and suffer alteration of vegetation enhanced by the surrounding tree stands and forestry management practices that result in unsuitable habitat for grassland specialists (Lipsey and Hockey 2010). Furthermore, rates of nest predation in open vegetation areas adjacent to tree plantations increase in response to changes in the composition and configuration of the landscape, and perhaps also by an increase in abundance of generalist, forest-associated predators (Reino et al. 2010). Licensing and certification of tree plantations in priority areas for conservation, such as Important Bird Areas (Devenish et al. 2009), should be discouraged.

Inappropriate use of agrochemicals. The quality of agricultural land as bird habitat is reduced by the effects of agrochemicals (Thompson 2004, Zaccagnini 2004, as cited in Bernardos and Zaccagnini 2008). In the Argentinean Pampas, most cropland is subject to misuse of agrochemicals (Zaccagnini 2004). A survey conducted in 1998 indicated that 32% of agricultural lands treated with pesticides represented some risk of mortality for birds (Rivera Milán et al. 2004). Herbicides such as glyphosate are widely used in soy crops to eliminate "weeds" used by birds for perching or foraging and thus can further reduce their presence by simplifying vegetation structure (Leveau and Leveau 2004). In addition, there have been many cases of bird mortality where organophosphate insecticides such as monocrotophos were likely involved (Hooper et al. 2003). Direct mortality has been documented for several grassland birds and, for some long-distance migrants such as Ruddy-headed Geese, Swainson's Hawks, Upland Sandpipers, and Bobolinks, agrochemicals may be one of the main threats in non-breeding areas (Woodbridge et al. 1995, Blanco et al. 2003, Vickery et al. 2003, 2010, Bernardos and Zaccagnini 2008). Swainson's Hawks have probably been affected most because they feed on grasshoppers targeted for chemical control (Woodbridge et al. 1995). During 1995–1996, ~20,000 individuals (5% of the world's population) were killed by inappropriate use of organophosphate insecticides (Goldstein et al. 1999a, b). Although monocrotophos was banned in 1999, other highly toxic organophosphate products are still used in the Río de la Plata grasslands (Hooper et al. 1999, 2003). Bobolinks are considered agricultural pests and are actively killed with pesticides in rice fields in Argentina (López-Lanús and Marino 2010). Migratory shorebirds that also use rice fields are exposed to agrochemicals (Blanco et al. 2006). Although evidence of acute exposure has not been recorded, sub-lethal effects were observed in Buff-breasted Sandpipers exposed to organophosphate and carbamate in Argentinean rice fields (Strum et al. 2010).

Livestock ranching and fire management. Because cattle grazing changes vegetation structure and composition (Sala et al. 1986, Pillar and Quadros 1997), grazing management can affect bird diversity (Isacch and Martínez 2001, 2003b, Zalba and Cozzani 2004, Isacch et al. 2005, Azpiroz and Blake 2009, Di Giacomo et al. 2010, Isacch and Cardoni 2011). In the West Inland Pampa, moderate grazing of native grasslands can increase structural heterogeneity and plant species richness relative to undisturbed grasslands, resulting in greater bird species richness and abundance (Isacch et al. 2003). Apart from the effects of grazing on habitat quality, livestock can also affect bird populations through direct disturbance of individuals (Thompson and Carroll 2009) and nest trampling (Azpiroz 2000, Zalba and Cozzani 2004, A. Di Giacomo, unpubl. data).

Effects of cattle grazing on SESA grassland birds vary. In the Flooding Pampa, ungrazed or lightly grazed sites are dominated by tall-grass species of birds such as Bay-capped Wren-Spinetails (*Spartonoica maluroides*) and Grass Wrens (*Cistothorus platensis*), whereas moderately grazed areas favor generalist tall grass species such as Great Pampa-Finches, Grassland Yellow-Finches, and Brown-and-yellow Marshbirds (Isacch and Cardoni 2011). In heavily grazed grasslands, a short-grass assemblage of birds is present, including Bar-winged Cinclodes (*Cinclodes fuscus*), Rufous-backed Negritos (*Lessonia rufa*), and Southern Lapwings (*Vanellus chilensis*; Comparatore et al. 1996, Isacch and Cardoni 2011). The presence of Buff-breasted Sandpipers and other Patagonian shorebirds in coastal halophytic short grasslands is directly linked to the presence of livestock grazing (Lanctot et al. 2002, 2004, Isacch and Martínez 2003b, Blanco et al. 2004, Alfaro et al. 2008, Isacch and Cardoni 2011).

Grassland specialists such as Hudson's Canasteros, Black-and-white Monjitas, and Pampas Meadowlarks seem to favor a mosaic of tall and short vegetation that is usually maintained by moderate grazing pressure. These species feed in patches of short grass and nest in tall herbaceous vegetation (Fontana 1994, Isacch et al. 2001, Fraga 2003, Isacch and Cardoni 2011, Azpiroz, unpubl. data).

Several globally threatened grassland birds in our study region depend on tall herbaceous vegetation for feeding, breeding, and roosting. Strange-tailed Tyrants are scarce in grazed grasslands of northeast Argentina, and the absence of livestock in some protected areas such as Rio Pilcomayo National Park and Iberá Natural Reserve has resulted in recovery of their populations (Di Giacomo 2005a, Di Giacomo et al. 2010). Areas with light or no grazing are necessary to ensure viable populations of specialized tall-grass species (Cardoni 2011, Isacch and Cardoni 2011) and these areas could act as "source" areas able to repopulate neighboring sites (Zalba and Cozzani 2004). Ungrazed or lightly grazed grasslands are also important for other tall-grass birds such as Bearded Tachuris (*Polystictus pectoralis*), Sharp-tailed Grass Tyrants, and seedeaters (*Sporophila* spp.) throughout SESA (Codesido and Fraga 2009).

In some SESA grasslands, especially in northern Argentina and the Brazilian Upland grasslands, fire is used as a management tool, mainly to improve forage quality for cattle (Isacch et al. 2004, Boldrini et al. 2009, Di Giacomo et al. 2011a). Fire frequency and intensity also affect vegetation and have indirect effects on bird assemblages, especially on species composition (Comparatore et al. 1996, Isacch and Martínez 2001). The timing of burns is also important because burning during the breeding season can have negative effects on reproductive success (Petry and Kruger 2010, Di Giacomo et al. 2011a). Burning can also affect availability of roost sites of gregarious species (López-Lanús and Marino 2010). In addition, excessive burning may reduce habitat availability for threatened species such as Bay-capped Wren-Spinetails (Isacch et al. 2004). Other species (Southern Lapwings and Correndera Pipits), however, use burned fields shortly after fires (Isacch et al. 2004). Fire can also affect habitat use during the breeding season. Strange-tailed Tyrants and Black-bellied and "Yellow-billed" Plumbeous Seedeaters avoid burned plots for nesting (Di Giacomo et al. 2011a, Rovedder 2011, Repenning 2012). For Strange-tailed Tyrants, relocation to nesting areas in nearby unburned sites does not affect reproductive success, suggesting the species is adapted to regular fires (Di Giacomo et al. 2011a). During the third breeding season after a fire, individuals did not discriminate between burned and unburned sites. Thus, for Strange-tailed Tyrants, burning regimes in a given grassland patch must guarantee availability of unburned areas, and burning intervals longer than two years should be considered. Unfortunately, most current fire management practices in northeast Argentina involve annual burning.

Change in interspecific relationships. Grassland birds do not always use all available suitable habitat (Fernández et al. 2003, Gabelli et al. 2004, Giordano et al. 2009). The presence of competitors, predators, or brood parasites may limit use of sites otherwise suitable (Fernández et al. 2003, Gabelli et al. 2004). For example, the recent expansion of the ranges of Pampas Meadowlark congenerics (White-browed Blackbirds, *Sturnella superciliaris*, and Long-tailed Meadowlarks, *S. loyca*) may have had adverse effects on the distribution and abundance of this threatened species (Gabelli et al. 2004). In addition, intense agriculture and livestock grazing have contributed to an expansion of the range and increase in numbers of Shiny Cowbirds (*Molothrus bonariensis*), and this brood parasite may exert further pressure on declining populations of grassland specialists such as Pampas Meadowlarks, Black-and-white Monjitas, and Saffron-cowled Blackbirds (Fraga et al. 1998, Azpiroz 2000, Gabelli et al. 2004, Zalba and Cozzani 2004). Because cowbirds associate with cattle and can move long distances between feeding and breeding areas, the negative consequences of brood parasitism may reduce the value of small grassland patches (Zalba and Cozzani 2004). Grazing and crop production can also facilitate tree propagation in grasslands and this may also contribute to increased numbers of predators and brood parasites (Isacch et al. 2005).

Urban development and sewage pollution. Although the area covered by urban settlements and transportation networks is relatively small (Baldi et al. 2006), habitat loss due to urbanization appears to have resulted in the local extinction of populations of some grassland birds. This is probably the case for Black-and-white Monjitas, with extensive urban development along the Río de la Plata coastline destroying habitats and eliminating local populations. The current isolation of populations in Buenos Aires Province may have been the result of urban development (Fraga 2003).

An experimental study looking at the behavior of grassland birds in a suburban setting (*Cortaderia selloana* grassland in the Pampas) showed that grassland specialists tend to avoid feeding near unfamiliar objects (Echeverría et al. 2006). In addition, grassland generalists exhibit greater neophobia than generalist urban species (Echeverría et al. 2006). These factors may explain in part the greater vulnerability of grassland birds to urban development.

Bird species richness and abundance may increase near nutrient-discharge sources in cordgrass-dominated communities. In the Southern Pampa, nutrient enrichment from sewage input resulted in alterations to vegetation structure that positively affected bird diversity, especially common and generalist grassland species (Cardoni et al. 2011). Nutrient management, however, is key to avoiding habitat degradation that would have negative effects on birds, such as favoring conditions for parasites (Cardoni et al. 2011). Ecological trap conditions may also be an issue. Although these nutrient-rich sites can be attractive for grassland birds because of increased food availability, they may provide poor breeding conditions for species nesting near or on the ground and vulnerable to flooding (Cardoni et al. 2011).

Trapping and hunting. Some SESA grassland birds are illegally captured and hunted (Chebez 2008). In Rio Grande do Sul, populations of 18% of threatened bird species are affected by hunting and trapping (Bencke et al. 2003). These activities are conducted even in protected areas. Although the impact of illegal hunting and trapping has not been assessed, these are common and widespread activities throughout the region (Chebez 2008, BirdLife International 2012, RAD and CSF, pers. observ.).

Greater Rheas are hunted for their meat, feathers, and skin and are also hunted as agricultural pests in some areas because of their negative impacts on crops and the assumption that they compete with cattle for forage (Pereira et al. 2003, Bellis et al. 2004a, b, Herrera et al. 2004). Diet studies have shown, however, that the latter assumption is not justified (Martella et al. 1996, Comparatore and Yagueddú 2007). In Rio Grande do Sul and Uruguay, rhea eggs are gathered for consumption (CSF and ABA, pers. observ.).

Three species of sheldgeese (Ruddy-headed Geese, Upland Geese, and Ashy-headed Geese) have also been persecuted as agricultural pests in southern Buenos Aires province (Blanco et al. 2003). Birds have been hunted and even scared away with aircraft (Blanco et al. 2003). Although sheldgeese are currently protected by law, hunting is still a threat (Chebez 2008).

Other grassland birds are illegally captured for the cage-bird trade and sold at wildlife markets. Saffron-cowled Blackbirds are targeted in Argentina and Uruguay, and trappers have been responsible for the disappearance of entire colonies (Chebez 2008). Several species of *Sporophila* seedeaters are globally threatened because their small or geographically restricted populations are subject to high rates of capture for the illegal wildlife market (BirdLife International 2012). An important issue is that mature male seedeaters are targeted and this may have direct demographic implications (e.g., *S.* aff. *plumbea* in southern Brazil; Fontana et al. 2009).

Other threats. Grassland birds face additional threats, the effects of which have not been adequately quantified. Transportation networks may represent a potential hazard to tall-grass specialists in areas where suitable habitat is largely available as vegetation strips along roads. Grassland birds that forage and nest near roads are prone to accidental collisions with vehicles. Additionally, collisions with towers and transmission lines can affect negatively resident and, especially, migratory grassland birds in Rio Grande do Sul (Fontana et al., unpubl. data). Greater Rheas have also suffered losses due to entanglement in wire fences (ABA and RAD, pers. observ.).

Severe weather sometimes causes breeding failure and additional mortality. Rainstorms can affect ground-nesting grassland birds such as Greater Rheas, Spotted Nothuras, Ochre-breasted Pipits, and Pampas Meadowlarks (ABA, pers. observ.). Severe hailstorms are frequent in Pampas subregions of Argentina and have been responsible for mass mortality of Swainson's Hawks (Sarasola et al. 2005). The impact of these causes of mortality may be significant when combined with the effects of other negative factors (Sarasola et al. 2005).

In northern Argentina and southern Paraguay, construction of the Yacyretá Dam has affected local populations of threatened grassland birds, such as Saffron-cowled Blackbirds, Cock-tailed Tyrants, and Black-masked Finches, that have almost disappeared from the Argentine side of the Paraná River and nearby islands after extensive areas of grassland were inundated (Di Giacomo 2005b, Chebez 2008, Codesido and Fraga 2009). In southern Brazil, construction of a series of dams is also expected in the next few years (Hüffner and Engel 2011). Construction of the Paiquerê hydroelectric dam on the Pelotas River would be especially problematic because it would seriously imperil populations of "Yellow-billed" Plumbeous Seedeaters and other threatened grassland birds (Fontana et al. 2009).

Construction of small impoundments is also widespread in Rio Grande do Sul and southeastern Uruguay to ensure water availability for agriculture and cattle ranching (Azpiroz and Rilla 2007, RAD, pers. observ.). These impoundments are frequently built in grassy swales used by Black-and-white Monjitas, Saffron-cowled Blackbirds, and *Sporophila* seedeaters (Dias and Maurício 2002, Bencke et al. 2003).

Expansion of wind energy in southern Brazil may also have negative impacts. Installation of several wind farms is planned throughout the region, especially in the upland grasslands of Santa Catarina and Rio Grande do Sul and in coastal grasslands in the latter state (Camargo 2002, RAD, pers. observ.). Birds are known to collide with wind turbines and power lines and can be negatively affected by the disturbance caused by turbines (Langston and Pullan 2003, Barrios and Rodríguez 2004). Because most negative impacts of wind farms on birds can be prevented by carefully planning their locations (Langston and Pullan 2003), adequate zoning of wind-development facilities is needed in southern Brazil.

SOUTH AMERICAN GRASSLAND BIRDS: KNOWLEDGE AND GAPS

We identified 60 papers about SESA grassland birds published in high-impact journals from 1999 to 2011, with most (52, or 87%) published since 2004. However, geographic and topic biases were evident. Most studies (48, or 80%) were conducted in Argentina. Studies dealing with habitat and land-use associations predominated (23, or 38%). Other topics that were the focus of multiple papers included biology (including feeding, breeding and social behaviors; 13, or 21.7%), conservation (6, or 10%), geographic distribution (4, or 6.7%), assemblages and community ecology (3, or 5%), genetics (3, or 5%), population monitoring and migration (3, or 5%), and toxicology (2, or 3.3%). Climate and weather impacts, methods, and morphology were each the focus of one paper.

Studies in SESA have provided information about the distribution of grassland birds, factors affecting their populations, and habitat requirements of some threatened species. Studies of the effects of habitat fragmentation and area sensitivity patterns are, however, lacking. These topics are especially relevant to reserve design and land-management planning. Because SESA grasslands have been subject to large-scale modification, the possible role of small grassland patches in sustaining bird assemblages must be evaluated (Zalba and Cozzani 2004). These analyses should consider land-use matrix characteristics, which can have a significant influence on processes within patches (Prevedello and Vieira 2010). More data concerning how habitat transformation and edge effects impact reproductive success are also needed (Fernández et al. 2003, Zalba and Cozzani 2004, Johnson et al. 2011), as well as assessments of the genetic variability of isolated populations of threatened birds.

Given the current state of grasslands in some subregions of SESA, programs to enhance recovery of almost extinct vegetal communities and their associated fauna should be implemented. Data are available concerning how grassland vegetation responds to different land uses and environmental conditions, and this knowledge could be used to assess the possibility of restoring native conditions (Aguilera et al. 1998, Laterra et al. 1998, León and Burkart 1998). Unfortunately, information concerning how grassland birds might respond to restoration efforts and how factors such as distance to source areas and size of restored patches might influence outcomes is lacking (Fuhlendorf and Engle 2001).

Most studies of SESA grassland birds have been short-term, resulting in a lack of long-term data about species and their populations. Some studies, however, have revealed significant inter-annual variation in grassland bird populations (Isacch and Martínez 2003a), highlighting the need for volunteer-based, long-term monitoring programs such as North America's Breeding Bird Surveys and Christmas Bird Counts. Such initiatives could provide data needed to distinguish between natural fluctuations and human-induced declines (Butcher et al. 1990), and could also be useful for monitoring populations of species of conservation concern (Gabelli et al. 2004, Sarasola et al. 2007). A good example of this is the Nearctic Grassland Shorebird Survey that targets plovers and sandpipers that winter in the SESA region and is sponsored by the Alliance for the Grasslands (http://www.pastizalesdelconosur.org). Another example is the annual monitoring of birds in agroecosystems of east-central Argentina initiated in 2002 by the National Agency for Agricultural Technology – INTA (Canavelli et al. 2004, Schrag et al. 2009). More monitoring programs are also needed in protected areas to determine population trends and estimate the viability of threatened species in reserves through population modeling (Beissinger and Westphal 1998, Brook et al. 2000, Prugh et al. 2008).

Population and ecological studies of threatened species that expand our knowledge of dispersal and migration patterns, mating systems, and genetic variability, among others, will be key for conservation management. Factors that influence habitat use patterns and species survival in both natural and agricultural landscapes in SESA are poorly known (Thompson 2004, Filloy and Bellocq 2007, Medan et al. 2011). In addition, most available information is based solely on presence/absence data or species' density estimates. Such data, however, may not be informative about habitat preferences or quality for grassland birds (Vickery et al. 1992, Thompson 2004). With the exception of a few species (e.g., Strange-tailed Tyrants, Di Giacomo et al. 2011b), basic information about the population status and reproduction of SESA grassland birds is lacking (Vickery et al. 1999, Medan et al. 2011), precluding an adequate assessment of population viability in given habitats or sites (Morris and Doak 2002, Giordano et al. 2009).

Ecology-oriented molecular studies of Neotropical grassland birds are scarce. These could shed light on several issues directly related to management and conservation. For example, for small, isolated populations, increased variance in reproductive success may reduce effective population size (Nunney 1993, 1996, Hedrick 2005). More taxonomic studies are also needed because the status of several grassland species, particularly in the genus *Sporophila*, is still unclear (Areta 2008, Machado and Silveira 2011).

By considering the threatened status of SESA grasslands, future research programs should also prioritize studies that promote establishment of creative and practical measures for conserving grassland birds in economically productive contexts. Large-scale experimental studies focusing on the effects of land-use practices (e.g., fire regimes, cattle grazing rotation rates, and urbanization) should be developed (Thompson 2004, Sarasola et al. 2007) by cooperating researchers, non-governmental organizations, and rural and territorial planners (Isacch and Cardoni 2011). There is also a need to determine the real magnitude of crop and pasture losses caused by birds considered pests (Blanco et al. 2003) and to quantify impacts of agrochemicals on bird populations (Vickery et al. 2010).

Human impacts affecting grassland birds in SESA are often the same irrespective of borders. Thus, there is an urgent need to promote and implement coordinated studies designed to assess these impacts and offer management tools in a broader context throughout the entire SESA region.

CURRENT BIRD CONSERVATION INITIATIVES

Current conservation efforts include elaboration of action plans, establishment of public and private reserves, promotion of agricultural activities that reconcile production with biodiversity conservation, and development of multilateral conservation projects across countries. The Brazilian government has recently completed an action plan for the conservation of grassland birds must be implemented in five years (ICMBio, in press). Because species share common threats, the plan assumes that well-planned actions can optimize conservation and benefit entire assemblages (ICMBio, in press). Actions include the implementation of reserves, empowerment of law reinforcement agencies, and development of land-use ordination schemes (ICMBio, in press).

The restricted network of public protected areas in the region has made a limited contribution to grassland conservation within SESA (Bilenca and Miñarro 2004, Azpiroz and Rilla 2007, Overbeck et al. 2007). Together, these areas protect ~1% of the land originally covered by grasslands. In Uruguay, no current or proposed sites of the National Protected Area Systems (DINAMA/MVOTMA 1999, Ghione and Martino 2008) include large continuous tracts (>5000 ha) of native grasslands. Only 1.48% and 2% of the areas originally encompassed by grasslands are protected in Rio Grande do Sul and Paraná states, Brazil, respectively (Brandão et al. 2007, Santos and Scherer-Neto 2009). Protected grasslands in southern Brazil are not managed adequately and suffer from shrub encroachment, reducing their value for grassland species (Pillar and Vélez 2010). There have been several initiatives to identify sites of conservation priority in grassland ecosystems (Bilenca and Miñarro 2004, Di Giacomo 2005b, MMA 2007, Fontana et al. 2008, Di Giacomo and Parera 2008, Cartes and Clay 2009, Develey and Goerck 2009), but there has been little progress toward increasing the amount of protected habitat. In 2010, Brazil established a goal of conserving 10% of all its biomes (Vélez et al. 2009). To achieve this goal, creation of 21 new protected areas encompassing 979,966 ha was recommended in grassland regions of southern and western Rio Grande do Sul state (E. Vélez, pers. comm.), but the process has been placed on hold by the Brazilian Environmental Ministry.

In southern Brazil, licensing renewal for the Barra Grande Dam required creation of an ecological corridor along the Pelotas River (Refugio de Vida Silvestre Corredor do Rio Pelotas). The goal is to connect the trough region of the river and its main tributaries with protected areas such as São Joaquim and Aparados da Serra National Parks through creation of a 270,000-ha conservation unit. The area would protect about 46% of the natural Brazilian Upland grasslands in Rio Grande do Sul and Santa Catarina states (APREMAVI 2012), and would include three of four grassland-bird priority areas identified by Fontana et al. (2008) in southeastern Brazil. This initiative is now under consideration by the Brazilian Government.

Apart from habitat protection in public reserves, grassland bird conservation is also occurring on private lands. There are 73,229 ha of private reserves in southern Brazil, but most protect forests and other vegetation types (Vélez et al. 2009). Furthermore, management plans are seldom elaborated and implemented (Vélez et al. 2009), and private reserves tend to be concentrated in certain regions. A few private reserves, however, play important roles in the conservation of threatened grassland birds. For example, El Bagual Reserve in Formosa Province, Argentina, has breeding populations of several globally threatened species, and these birds have been studied and monitored since the 1990s through an agreement between landowners and the NGO Aves Argentinas (Di Giacomo 2005a). In Corrientes, Argentina, The Conservation Land Trust acquired >150,000 ha of critical habitat for globally threatened grassland birds to be appended to the Reserva Provincial del Iberá that covers ~700,000 ha of mainly flooded areas (Di Giacomo 2005a).

Nearly all large grassland remnants in SESA are privately owned, including most priority areas for grassland bird conservation. Most are rangelands used for cattle, sheep, and horse ranching, where native grasslands are threatened by inappropriate management or risk of conversion to cropland or forests (Bilenca and Miñarro 2004).

There are legal measures that protect natural vegetation on private lands, but most are not followed or enforced (Vélez et al. 2009). In Brazil, the "Código Florestal" (Forest Code) is perhaps the most important legal instrument to regulate land use on private lands (Vélez et al. 2009). Economic use of legal reserves (one of the main conservation instruments of the code) is allowed as long as natural vegetation is not altered; initiatives to promote sustainable cattle production in these areas are being developed (IBAMA 2009). Unfortunately, the code is currently being revised to address issues raised by agricultural interests and its future is uncertain (Metzger et al. 2010).

There is currently interest in promoting wildlife-friendly practices in agricultural lands by governmental and non-governmental institutions throughout SESA (Marino 2008). This is especially important in SESA grasslands, where establishment of state-owned reserves is precluded by financial and social issues related to land expropriation. In the case of livestock ranching, sustainable practices can increase profitability of the beef industry and ensure maintenance of rangelands and grassland biodiversity (Netto 2009).

An example of this type of initiative at a regional level is the Alliance for the Grasslands (www.pastizalesdelconosur.org) created by several NGOs in 2006. Today, the Alliance involves more than 40 institutions representing different social sectors, with an emphasis on ranchers and conservationists from all countries in the SESA grasslands. One objective of the Alliance is to promote certified beef production in natural grasslands.

Other initiatives with similar objectives are also being encouraged. Researchers and technicians from Argentina, Brazil, and Uruguay recently formed a technical working-group to develop guidelines for sustainable livestock ranching on natural grasslands (Vélez et al. 2009). In Uruguay, the Responsible Rural Production Program (PPR Program; www.cebra.com.uy/presponsable/) is sponsored by the Uruguayan government and promotes application of integrated and efficient management systems that use natural resources, including biological diversity. For grassland birds, the latter has provided financial support to private ranchers for actions that favor habitat features important to threatened species (ABA, pers. observ.). In Argentina, a recent (2010) GEF-funded project with similar aims has already produced management guides and educational material for farmers. In Brazil, there are also at least seven programs focusing on promoting sustainable livestock raising on natural grasslands (Vélez et al. 2009).

Another multilateral initiative is a grassland bird conservation agreement recently developed under the auspices of the Convention on Migratory Species (CMS) and signed by governments of all four countries of the SESA region (and Bolivia). The aim of this agreement is to address the needs of threatened migratory grassland birds that cross international borders in southern South America. Through development of an action plan, specific research and conservation priorities have already been identified. These activities will require substantial funding, and it is unclear how financial support will be obtained.

Despite the many conservation projects and initiatives discussed above, prospects for native grasslands remain grim and few concrete actions have been taken to prevent loss of grassland birds. Although there are many gaps in our knowledge of grassland bird biology and ecology that could improve the situation, we agree with Vélez et al. (2009) that the lack of programs to promote conservation and public and political support are probably the main reasons why little has been accomplished. More must be done to reverse the existing negative trends of grassland bird populations and guarantee the persistence of threatened birds over the long term.

ADDITIONAL PROPOSED CONSERVATION MEASURES

Several grassland birds depend on grasslands unaltered by agriculture or cattle grazing (Zalba and Cozzani 2004, Giordano et al. 2009, Isacch and Cardoni 2011). The current public reserve system, however, offers limited opportunities for preservation of such grasslands (Fraga 2003). As discussed above, opportunities to create new reserves are generally limited. In addition, the characteristics of species can limit the effectiveness of protected areas. For example, Saffron-cowled Blackbirds move over extensive areas in search of foraging sites during the non-breeding season. These erratic movements represent a challenge to protection efforts based on establishing small reserves restricted to breeding areas (Fraga et al. 1998). The size of new reserves is also critical because small patches of grassland may not guarantee maintenance of bird diversity (Zalba and Cozzani 2004).

Because most populations of threatened grassland birds in SESA are on private lands, recent interest in promoting improved agricultural practices is encouraging. Land management programs in agricultural areas need to focus on reconciling the interests of producers and conservationists to preserve habitat features similar to those of native grasslands (Giordano et al. 2009). Several species depend on protection of nesting sites and on adequate field and grazing management policies, including careful use of fire (Fernandez et al. 2003, Vickery et al. 2010, Di Giacomo et al. 2011a,b). There is also a need for regional strategies and planning because, at large scales, grassland bird diversity can be enhanced by maintaining a mosaic of patches with different cattle-grazing intensities (Isacch and Cardoni 2011, Johnson et al. 2011).

Government agencies should also promote best cultivation practices, with special attention on reducing use of agrochemicals (Vickery et al. 2010). Use of the Ecotoxicologic Risk Calculator (Zaccagnini et al. 2005, Bernardos et al. 2007), developed by the National Institute of Agricultural Technology (INTA) of Argentina, should be promoted. This software tool calculates the risk of poisoning for birds exposed to agrochemicals by considering the kind of agrochemical, its dosage and concentration, and crop type (Bernardos and Zaccagnini 2008).

Management measures that result in significant losses to landowners, such as land set-asides, should include mechanisms for economic compensation (Isacch 2008). Management alternatives that benefit targeted grassland species should also be promoted. The Uruguayan PPR project provides a good example of public-private partnerships working towards native grassland conservation. Conversely, economic incentives for agriculture and forestry in grassland priority areas should be revised.

Governments should also evaluate the possibility of establishing grassland easements like those in North America (Vickery et al. 2010, Johnson et al. 2011). These agreements could be particularly useful in largely modified landscapes and areas with highly threatened bird populations. One way to compensate for land set-asides could be through ecotourism development. Some private initiatives are being developed on Argentinean ranches (JPI, pers. observ.), and others have been recommended for application in Brazilian Upland Grasslands (Fontana et al. 2009). In Rio Grande do Sul, for example, eco-touristic regions and routes are being identified by the state's tourism agency with support from the private sector (Vélez et al. 2009; RAD, pers. observ.). There is a huge potential for expansion of bird-watching and bird photography in the SESA grasslands, but much remains to be done to encourage these activities. Training and capacity-building are also needed to provide local people with the necessary tools to apply such bird-friendly alternative practices (Johnson et al. 2011).

Land-use planning is still incipient in the region. Many activities that alter grasslands could be constrained if land-use regulations are implemented. In Rio Grande do Sul, an environmental zoning scheme for the wood industry was recently completed. Despite some important limitations, this scheme has incorporated objective technical criteria to ensure the environmental viability of this activity in the state (Vélez et al. 2009). Studies are also needed to better solve energy and water demands in a way that avoids irreversible damage to bird populations such as that caused by the Barra Grande Dam in southern Brazil (Fontana et al. 2009).

Given the conservation status of many long-distance migrants, development and implementation of effective conservation strategies will also require international collaboration (Woodbridge et al. 1995). For example, several SESA grassland passerines winter in the Cerrado region of central South America where they suffer similar threats (Vickery et al. 1999, Lopes et al. 2010). It would be particularly helpful if governments of the SESA countries could provide much-needed funding that would allow application of specific measures detailed in the new CMS action plan that focus on threatened migratory birds. Most of these actions would also benefit many other grassland species.

Many aspects of bird conservation in SESA grasslands would also benefit from public awareness programs. These could not only reduce threats posed by hunting, trapping, and agrochemical abuse, but would help build political support for conservation initiatives. Communication networks (e.g., web-based) between researchers, conservationists, managers, and farmers are needed to guide decision-making about agricultural practices, promote law enforcement, and manage wildlife in agro-ecosystems (Rivera Milán et al. 2004, Medan et al. 2011, Johnson et al. 2011). Public campaigns, targeted at farmers and other relevant stakeholders, would help raise awareness about the importance of conserving grasslands and grassland birds (Vickery et al. 2010).

CONCLUSIONS

Although grassland birds do not respond uniformly to habitat change, current land-use trends toward conversion to high-intensity croplands in some regions will likely result in further declines in bird populations (Filloy and Bellocq 2007). In the case of livestock grazing, SESA grassland birds likely evolved in ecosystems subjected to moderate grazing regimes and frequent fires, and these conditions must be recreated to provide adequate habitat for certain species (Isacch et al. 2004, Zalba and Cozzani 2004, Isacch and Cardoni 2011). At large scales, grassland bird diversity can be enhanced in some regions by maintaining a mosaic of patches with different cattle-grazing intensities (e,g., Bahía Samborombón grasslands, Isacch and Cardoni 2011; Iberá grasslands, A. S. Di Giacomo, unpubl. data). Several grassland species have suffered substantial range contractions and subsist as small isolated populations. Conservation of these species will require effective action on both public and private lands. The burden of protecting grassland birds, however, should not be put solely on farmers; national governments must assume responsibility for long-term conservation of grassland-associated biodiversity (Isacch 2008, Johnson et al. 2011).

The response of species to diverse habitat-altering factors and threats can vary geographically so management actions should consider these regional differences. In addition, many species do not use all available suitable habitats. This has important implications for reserve design and management because unoccupied habitats may still be valuable. In addition, presence/absence data or even abundance patterns may be misleading regarding long-term persistence of bird populations, especially for small patches of native vegetation or highly modified grasslands (e.g., crops). In fact, it is not clear if small areas of grassland are areas with high breeding success (sources) or whether they are ecological traps (Zalba and Cozzani 2004). Agro-ecosystems could also be acting as ecological traps for grassland-specialist birds (Giordano et al. 2009).

Although our knowledge of grassland birds in SESA is increasing, additional studies are needed to improve our understanding of the ecology of grassland birds in the region. However, we are also aware that recent land-use changes threaten bird populations as never before. Successful recovery of threatened populations will depend in part on our ability to generate key ecological data. More importantly, rapid and effective management strategies are needed to improve the status of threatened species and grassland bird assemblages. We hope this review will stimulate both additional research and effective conservation action.

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APPENDIX 1

Bird species associated with grasslands in Southeastern South America, with type of grassland and other habitats used, preferred grass height, conservation status (Birdlife International 2012), and migratory status (following Narosky and Di Giacomo 1993, Belton 1994, Stotz et al. 1996, Joseph 1997, Sick 1997).

Family/Species	Common name	Grassland use[a]	Other habitats[b]	Grass height[c]	Conservation status[d]	Migratory status[e]
Rheidae						
Rhea americana	Greater Rhea	2	Agr	Broad	NT	RES
Tinamidae						
Rhynchotus rufescens	Red-winged Tinamou	2	Sav	Broad	LC	RES
Nothura darwinii	Darwin's Nothura	2	Agr, Sav	Broad	LC	RES
N. maculosa	Spotted Nothura	2	Agr	Broad	LC	RES
Anatidae						
Chloephaga picta	Upland Goose	2	Agr	Short	LC	SACT
C. poliocephala	Ashy-headed Goose	2	Agr	Short	LC	SACT
C. rubidiceps	Ruddy-headed Goose	2	Agr	Short	LC	SACT
Ardeidae						
Bubulcus ibis	Cattle Egret	2	Agr, Wet	Broad	LC	RES
Threskiornithidae						
Theristicus caudatus	Buff-necked Ibis	2	Agr, Sav, Wet	Short	LC	RES
T. melanopis	Black-faced Ibis	2	Agr	Short	LC	SACT
Accipitridae						
Elanus leucurus	White-tailed Kite	3	Agr, Sav	Broad	LC	RES
Circus cinereus	Cinereous Harrier	2	Agr, Wet	Broad	LC	RES
C. buffoni	Long-winged Harrier	2	Agr, Wet	Broad	LC	RES
Buteogallus meridionalis	Savanna Hawk	3	Agr, Sav	Broad	LC	RES
B. coronatus	Crowned Eagle	3	Sav	Broad	EN	RES
Geranoaetus albicaudatus	White-tailed Hawk	2	Sav	Broad	LC	RES
G. melanoleucus	Black-chested Buzzard-Eagle	2	Sav	Broad	LC	RES
Buteo swainsoni	Swainson's Hawk	2	Agr	Broad	LC	PNW
Charadriidae						
Vanellus chilensis	Southern Lapwing	2	Agr, Wet	Short	LC	RES
Pluvialis dominica	American Golden-Plover	2	Agr, Wet	Short	LC	PNW
Charadrius modestus	Rufous-chested Dotterel	2	Wet	Short	LC	SACT
Oreopholus ruficollis	Tawny-throated Dotterel	2	Agr	Short	LC	SACT
Scolopacidae						
Numenius borealis	Eskimo Curlew	1	–	Short	CR	PNW
Bartramia longicauda	Upland Sandpiper	2	Agr	Broad	LC	PNW
Tryngites subruficollis	Buff-breasted Sandpiper	2	Agr, Wet	Short	NT	PNW
Thinocoridae						
Thinocorus rumicivorus	Least Seedsnipe	2	Agr	Short	LC	SACT
Strigidae						
Athene cunicularia	Burrowing Owl	2	Agr	Short	LC	RES
Asio flammeus	Short-eared Owl	2	Agr, Wet	Broad	LC	RES
Caprimulgidae						
Chordeiles nacunda	Nacunda Nighthawk	2	Agr, Wet	Broad	LC	SATT
Caprimulgus longirostris	Band-winged Nightjar	3	Sav	Broad	LC	SACT
Eleothreptus anomalus	Sickle-winged Nightjar	2	Wet	Tall	NT	RES
Trochilidae						
Polytmus guainumbi	White-tailed Goldenthroat	3	Sav	Broad	LC	RES
Picidae						
Colaptes campestris	Campo Flicker	3	Agr, Sav	Broad	LC	RES
Cariamidae						
Cariama cristata	Red-legged Seriema	2	Sav	Broad	LC	RES
Falconidae						
Caracara plancus	Southern Caracara	2	Agr, Sav, Wet	Broad	LC	RES
Milvago chimango	Chimango Caracara	2	Agr, Sav, Wet	Broad	LC	RES
Falco sparverius	American Kestrel	3	Agr, Sav	Broad	LC	RES
F. femoralis	Aplomado Falcon	2	Agr, Sav	Broad	LC	RES

Continued

APPENDIX–Continued

Family/Species	Common name	Grassland use[a]	Other habitats[b]	Grass height[c]	Conservation status[d]	Migratory status[e]
Furnariidae						
Geositta cunicularia	Common Miner	2	Wet	Short	LC	RES
Furnarius rufus	Rufous Hornero	3	Agr, Sav	Broad	LC	RES
Cinclodes pabsti	Long-tailed Cinclodes	1	–	Short	NT	RES
C. fuscus	Buff-winged Cinclodes	3	Wet	Short	LC	SACT
Phacellodomus striaticollis	Freckle-breasted Thornbird	3	Sav, Wet	Tall	LC	RES
Anumbius annumbi	Firewood-gatherer	3	Sav	Broad	LC	RES
Asthenes hudsoni	Hudson's Canastero	2	Wet	Broad	NT	RES
A. modesta	Cordilleran Canastero	1	–	Short	LC	RES
Cranioleuca sulphurifera	Sulphur-throated Spinetail	3	Wet	Tall	LC	RES
Spartonoica maluroides	Bay-capped Wren-Spinetail	2	Wet	Tall	NT	RES
Tyrannidae						
Polystictus pectoralis	Bearded Tachuri	1	–	Tall	NT	SATT
Pseudocolopteryx flaviventris	Warbling Doradito	3	Wet	Tall	LC	RES
Culicivora caudacuta	Sharp-tailed Tyrant	2	Wet	Tall	VU	RES
Lessonia rufa	Austral Negrito	2	Agr, Wet	Short	LC	SACT
Knipolegus lophotes	Crested Black-Tyrant	2	Sav	Broad	LC	RES
Hymenops perspicillatus	Spectacled Tyrant	2	Wet	Broad	LC	RES
Agriornis montanus	Black-billed Shrike-Tyrant	1	–	Short	LC	RES
Xolmis cinereus	Gray Monjita	2	Sav	Broad	LC	RES
X. irupero	White Monjita	3	Agr, Sav	Broad	LC	RES
X. dominicanus	Black-and-white Monjita	2	Wet	Broad	VU	RES
Neoxolmis rufiventris	Chocolate-vented Tyrant	2	Agr	Short	LC	SACT
Gubernetes yetapa	Streamer-tailed Tyrant	2	Wet	Tall	LC	RES
Alectrurus tricolor	Cock-tailed Tyrant	1	-	Tall	VU	RES
A. risora	Strange-tailed Tyrant	2	Wet	Tall	VU	RES
Machetornis rixosa	Cattle Tyrant	3	Agr, Sav	Broad	LC	RES
Tyrannus savana	Fork-tailed Flycatcher	3	Agr, Sav	Broad	LC	SATT
Hirundinidae						
Alopochelidon fucata	Tawny-headed Swallow	2	Wet	Broad	LC	RES
Progne tapera	Brown-chested Martin	2	Agr, Sav	Broad	LC	SATT
Tachycineta leucorrhoa	White-rumped Swallow	3	Agr, Sav, Wet	Broad	LC	RES
T. meyeni	Chilean Swallow	3	Agr, Wet	Broad	LC	SACT
Hirundo rustica	Barn Swallow	3	Agr, Wet	Broad	LC	PNW*
Petrochelidon pyrrhonota	Cliff Swallow	3	Agr, Sav	Broad	LC	PNW*
Troglodytidae						
Cistothorus platensis	Sedge Wren	2	Wet	Tall	LC	RES
Mimidae						
Mimus saturninus	Chalk-browed Mockingbird	3	Agr, Sav	Broad	LC	RES
Motacillidae						
Anthus lutescens	Yellowish Pipit	2	Agr, Wet	Short	LC	RES
A. furcatus	Short-billed Pipit	2	Agr	Short	LC	RES
A. chacoensis	Pampas Pipit	2	Agr	Broad	LC	RES
A. correndera	Correndera Pipit	2	Agr, Wet	Broad	LC	RES
A. nattereri	Ochre-breasted Pipit	1	–	Broad	VU	RES
A. hellmayri	Hellmayr's Pipit	1	–	Broad	LC	RES
Thraupidae						
Donacospiza albifrons	Long-tailed Reed Finch	2	Sav, Wet	Broad	LC	RES
Poospiza nigrorufa	Black-and-rufous Warbling-Finch	3	Wet	Tall	LC	RES
Sicalis citrina	Stripe-tailed Yellow-Finch	2	Sav	Short	LC	RES
S. lebruni	Patagonian Yellow-Finch	1	–	Broad	LC	RES
S. luteola	Grassland Yellow-Finch	2	Agr, Wet	Broad	LC	RES
Emberizoides herbicola	Wedge-tailed Grass-Finch	2	Sav	Tall	LC	RES
E. ypiranganus	Lesser Grass-Finch	2	Wet	Tall	LC	RES
Embernagra platensis	Great Pampa-Finch	2	Wet	Broad	LC	RES
Volatinia jacarina	Blue-black Grassquit	2	Agr, Wet	Tall	LC	SATT
Sporophila aff. plumbea	Plumbeous Seedeater	1	–	Tall	LC	SATT

Continued

APPENDIX–Continued

Family/Species	Common name	Grassland use[a]	Other habitats[b]	Grass height[c]	Conservation status[d]	Migratory status[e]
S. collaris	Rusty-collared Seedeater	3	Wet	Tall	LC	RES
S. bouvreuil	Capped Seedeater	2	Wet	Tall	LC	SATT
S. hypoxantha	Tawny-bellied Seedeater	2	Wet	Tall	LC	SATT
S. ruficollis	Dark-throated Seedeater	2	Wet	Tall	NT	SATT
S. palustris	Marsh Seedeater	2	Wet	Tall	EN	SATT
S. hypochroma	Rufous-rumped Seedeater	2	Wet	Tall	NT	SATT
S. cinnamomea	Chestnut Seedeater	2	Wet	Tall	VU	SATT
S. melanogaster	Black-bellied Seedeater	2	Wet	Tall	NT	SATT
Catamenia analis	Band-tailed Seedeater	1	–	Broad	LC	RES
Coryphaspiza melanotis	Black-masked Finch	2	Sav	Broad	VU	RES
Emberizidae						
Ammodramus humeralis	Grassland Sparrow	2	Agr	Broad	LC	RES
Icteridae						
Agelasticus thilius	Yellow-winged Blackbird	3	Wet	Broad	LC	RES
Xanthopsar flavus	Saffron-cowled Blackbird	2	Agr, Wet	Broad	VU	RES
Pseudoleistes guirahuro	Yellow-rumped Marshbird	2	Agr, Wet	Broad	LC	RES
P. virescens	Brown-and-yellow Marshbird	2	Agr, Wet	Broad	LC	RES
Molothrus rufoaxillaris	Screaming Cowbird	3	Sav	Broad	LC	RES
M. bonariensis	Shiny Cowbird	3	Agr, Sav	Broad	LC	RES
Sturnella superciliaris	White-browed Blackbird	2	Agr	Broad	LC	RES
S. defilippii	Pampas Meadowlark	1	–	Broad	VU	RES
S. loyca	Long-tailed Meadowlark	2	Agr, Sav	Broad	LC	RES
Dolichonyx oryzivorus	Bobolink	3	Agr, Wet	Tall	LC	PNW

[a]Grassland-use categories are: (1) species restricted solely to grassland habitats (i.e., do not use alternative habitats throughout the SESA grasslands), (2) species that make extensive use of grassland habitats, but also use other habitats in the SESA grasslands, and (3) species that make extensive use of grassland habitats only in certain subregions of the SESA grasslands.
[b]Alternative habitats used are: Agr: row crop habitats, Sav: shrub and savanna habitats, and Wet: wetland habitats; hyphens denote species that do not use alternative habitats in the SESA grasslands.
[c]Association with homogeneous short (Short) and tall (Tall) grass; the Broad category indicates species that are less selective in terms of grassland height and can make broader use of grassland structure.
[d]CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened, and LC: Least Concern.
[e]Migration systems (sensu Joseph 1997): RES: Resident, PNW: Pan New World Migration System, SACT: South American Cool-Temperate Migration System, and SATT: South American Temperate-Tropical Migration System; * = breeding populations recently established within SESA.