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EMILY JEAN TORIANI MOURA

BIOLOGIA REPRODUTIVA DO VESTE-AMARELA (*XANTHOPSAR FLAVUS*, GMELIN 1788) NOS CAMPOS DE CIMA DA SERRA, SUL DO BRASIL.

SÃO LEOPOLDO
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Emily Jean Toriani Moura

Biologia reprodutiva do Veste-amarela (*Xanthopsar flavus*, Gmelin 1788) nos Campos de Cima da Serra, Sul do Brasil

Dissertação apresentada como requisito parcial para a obtenção do título de Mestre pelo Programa de Pós-Graduação em Biologia da Universidade do Vale do Rio dos Sinos – UNISINOS

Orientadora: Dra. Maria Virginia Petry

São Leopoldo
2013

“Destello dorado de las pampas húmedas de antaño,
cuando lo vemos todavía resistiendo nuestro
ambate em banquinas y viejas arroceras
nos preguntamos por qué todo lo bello que nos rodea
parece fatalmente condenado.”

- Juan Carlos Chebez e Hernán Casañas
Tordo Amarillo em
Los que se Van

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CONTEÚDO

APRESENTAÇÃO

A presente dissertação é pré-requisito para a obtenção do título de Mestre em Biologia pela Universidade do Vale do Rio dos Sinos. É composta por dois capítulos que resultarão em dois artigos no intuito da descrição e avaliação de aspectos que dizem respeito à biologia reprodutiva de uma espécie de ave de campo, *Xanthopsar flavus*, na região fisiográfica Campos de Cima da Serra, sul do Brasil. As normas que norteiam a formatação desta dissertação são da Associação Brasileira de Normas Técnicas (ABNT), porém, os capítulos seguem as normas de formatação dos periódicos para as quais serão submetidos, sendo elas: Bird Conservation International e Journal of Field Ornithology para o primeiro e segundo capítulos, respectivamente.

O Capítulo I, titulado BREEDING BIOLOGY OF SAFFRON-COWLED BLACKBIRDS (*XANTHOPSAR FLAVUS*) IN SOUTHERN BRAZIL (BIOLOGIA REPRODUTIVO DO VESTE-AMARELA (*XANTHOPSAR FLAVUS*) NO SUL DO BRASIL) tem por objetivo a descrição da população brasileira e da biologia reprodutiva de *Xanthopsar flavus*, sendo destacado entre as características reprodutivas a construção de ninhos, a incubação e o cuidado parental.

O Capítulo II, aprofunda mais na biologia reprodutiva de *Xanthopsar flavus*, porém mantém como um capítulo separado. O capítulo NEST SITE SELECTION AND NEST SUCCESS OF A THREATENED SOUTH AMERICAN BLACKBIRD (SELEÇÃO DE LOCAL DE NIDIFICAÇÃO E SUCCESSO REPRODUTIVO DE UMA VULNERÁVEL AVE DA FAMÍLIA ICTERIDEAE) trata do efeito da paisagem e das características do local de nidificação, em particular a distância da borda, sobre o sucesso reprodutivo de *Xanthopsar flavus* nos Campos de Cima da Serra, sul do Brasil.

INTRODUÇÃO GERAL

Aves campestres têm sofrido vastos declínios populacionais ao longo das últimas décadas, o que tem sido associado com a alteração de seu habitat natural. Muitos estudos, na maior parte da América do Norte e Europa, têm documentado o declínio de muitas espécies especialistas e a mudança na composição da comunidade de aves neste ambiente (HERKERT, 1994; HERKERT, 1997; FULLER et al. 1995; JOHNSON e IGL, 2001; VICKERY et al. 2002; DONALD et al. 2006). De fato, campos de regiões de clima temperado compõe o bioma mundial mais ameaçado devido a discrepância entre a quantidade de área convertido para uso antrópico e a quantidade de área protegido (HOEKSTRA et al. 2005). Os campos de Santa Catarina e Rio Grande do Sul contêm 80% dos campos do Brasil e suportam altos níveis de biodiversidade (FONTANA et al. 2008). Os campos do sul da América do Sul compõem um dos sistemas campestres mais extensivos da região neotropical, mas apenas 1% dos ecossistemas Pampa e Campos estão sobre proteção (HENWOOD, 2010). A grande maioria da área tem sido convertida para usos de agropecuária e plantio de árvores exóticas.

A região fisiográfica dos Campos de Cima da Serra é uma das 234 Áreas Importantes para Aves (Important Bird Areas – IBA) do Brasil (BIRDLIFE, 2013). Devido a sua heterogeneidade natural, a diversidade de avifauna desta região é alta e muitas espécies raras e/ou endêmicas podem ser encontrados nos campos, banhados e fragmentos de floresta da região. A área também abriga muitas espécies de aves migratórias austrais (FONTANA et al. 2009). Esta IBA é mundialmente importante para a conservação de espécies de aves como, por exemplo, *Xolmis dominicanus*, *Anthus nattereri* e, a espécie foca desta dissertação, *Xanthopsar flavus*.

Além das espécies de aves encontradas nessa região, também há mais que 2.000 espécies vegetais e uma rica diversidade faunística (BOLDRINI, 2009; BENCKE, 2009). Porém apenas 50% da sua cobertura original ainda permanecem devido a ações antrópicas (CORDEIRO e HASENACK, 2009), o que se põe em risco cada uma destas espécies de fauna e flora e se torna cada vez mais preocupante a situação atual. Atualmente, somente 0,33% dos campos estão protegidos em unidades de conservação no Rio Grande do Sul (OVERBECK et al. 2007) e a maior parte dos campos está em áreas particulares com pastoril e com a ameaça de conversão para outros usos (PILLAR e VÉLEZ, 2010). A existência e continuação destes campos estão associadas com os distúrbios naturais de pastagem e fogo, que têm agido nessa região desde o início do Holoceno (BEHLING e PILLAR, 2007; PILLAR e VÉLEZ, 2010). Porém estes distúrbios são suprimidos pela lei nas propriedades particulares (fogo) e dentro das unidades de conservação (pastagem e fogo). Sem distúrbios, a floresta naturalmente avança e as características de campos são superadas, o que resulta na perda da biodiversidade campestre.

O veste-amarela é uma das espécies de aves que habita a região de Campos de Cima da Serra e utiliza os banhados e campos da região. É uma das espécies que está altamente ameaçada pela conversão de campo aos plantios de agricultura e silvicultura, bem como a supressão de distúrbios naturais como fogo. Esta espécie de ave campestre vulnerável (BIRDLIFE 2012) necessita de banhados com bastante vegetação emergente para nidificar e campos baixos para forragear (FONSECA et al. 2004, PETRY e KRÜGER 2010). Sem estes aspectos, a sua população continuará a reduzir. A sua biologia é ainda pouco conhecido pois só existe alguns trabalhos sobre este assunto, espalhados pelos várias países do sul de América do Sul (FRAGA et al. 1998, AZPIROZ 2000, FONSECA et al. 2004, FRAGA 2005, PETRY and KRÜGER 2010, KRÜGER e PETRY 2010). A biologia reprodutiva é um aspecto importante na historia natural de uma espécie e pode refletir melhor o status ou a saúde numa dado região do que sua presença e abundância. Também é uma fase difícil no ciclo de vida de uma ave, durante qual os adultos devem balançar seu tempo em cuidar de sua prole e obtiver seus próprios requerimento nutricionais (MARTIN, 1995). Assim, é importante que espécies tenham acesso às áreas onde podem atender todas suas necessidades e que estas áreas sejam de boa qualidade.

Assim, esta dissertação trata de estudar profundamente a biologia reprodutiva de uma das aves mais típicas e ameaçadas da região – o veste-amarela. Assim, entenderemos melhor como protege-la e manejar seu habitat numa maneira que garante a sua sobrevivência e continuação nos nossos campos sulinos. Os dois capítulos desta dissertação tratam de descrever a biologia reprodutiva do veste-amarelo e associar características locais e da paisagem com seu successo reprodutivo, com foco na relação entre efeito de borda e predação nos banhados dos Campos de Cima da Serra, Rio Grande do Sul, Brasil.

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CAPÍTULO 1

BREEDING BIOLOGY OF SAFFRON-COWLED BLACKBIRDS IN SOUTHERN BRAZIL

Toriani Moura, Emily J., and Maria Virginia Petry

Resumo

A biologia de membros da família Icteridae ainda são desconhecidos na América do Sul. O presente estudo apresenta informação sobre a biologia reprodutiva de uma população da espécie ameaçada o Veste-amarela (*Xanthopsar flavus*) nos campos de altitude do sul do Brasil. Foram encontrados 18 colônias reprodutivas de 28 ± 25 indivíduos, apresentando uma relação positiva entre o número de pares reprodutivos e o tamanho da colônia ($y = .967x + .296$; $r^2 = 0.929$, $P < 0.001$). Foram coletados dados sobre 47 ninhos encontrados durante duas estações reprodutivas de 2011 á 2013 na região fisigráfica dos Campos de Cima da Serra. Reprodução occorre entre os meses de Outubro e Fevereiro e bandos grandes de até 300 indivíduos são encontrados na região esporadicamente entre os meses de Março e Setembro. As fêmeas construem ninhos de formato de copo aberto de lâminas de grama grossas e finas em vegetação arbustiva aquática (em particular *Eryngium horridum*, *Baccharis trimera* e *Ludwigia multinervia*) á 45,12 ± 24,68 (dp) cm do chão ao longo de três á seis dias (média = 4 ± 1 d, n = 6). A postura média é de 3,78 ± 0,55 (sd) ovos, e os ovos tem uma largura de 2,18 ± 0,08 (dp) cm e altura de 1,62 ± 0,09 (dp) cm. Somenete a fêmea incuba os ovos para um período de 12 ± 1 dias (n = 5). Fêmeas são mais atenciosas ao cuidado da prole de manhã cedo e no meio da tarde. Machos ajudam alimentar os filhotes mas fazem menos visitas por hora que as fêmeas (U_{30}= 74, P = 0,04) e passam até 60% do seu tempo em vigilância. Houve uma relação positiva entre idade do ninhego e número de visitas ao ninho por hora (r^2= 0.395, P < 0.001). A época de reprodução desta espécie na região dos Campos de Cima da Serra difere em relação às outras regiões na América do Sul, o qual pode estar associado com a disponibilidade de recursos e qualidade do habitat. Em relação á postura e ás características dos ninhos, foram semalhantes aos dados encontrados em Uruguai e na Argentina. Embora seja extirpado na maioridade da sua distribuição original, *X. flavus* ainda reproduz em grupos relativamente grandes no noroeste do

Rio Grande do Sul e esforços de conservação desta espécie deveriam ser intensificados para garantir sua sobrevivência no Brasil.

Palavras chaves
Icteridae, América do Sul, postura, biologia reprodutiva

Abstract

The life history of many South American icterids is still relatively unknown. We present detailed information on the breeding biology of a population the vulnerable Saffron-cowled blackbird in the high altitude grasslands of southern Brazil. We found 18 breeding colonies of 28 ± 25 individuals, with a positive relationship between the number of breeding pairs and colony size (y = .967x + .296; $r^2 = 0.929$, $P < 0.001$). We collected data on 47 nests found over two breeding seasons from 2011 to 2013 in the Campos de Cima da Serra region. Breeding occurs from mid-October to late January/early February and groups move as large flocks of up to 300 individuals from March to September. Females build an open-cup nest of thick and thin grasses in emergent wetland vegetation or shrubs (mainly *Eryngium horridum*, *Baccharis trimera* and *Ludwigia multinervia*) at 45.12 ± 24.68 (sd) cm above the ground in three to six days (mean = 4 ± 1.26 d, $n = 6$). Clutch size is 3.78 ± 0.55 (sd) eggs (Range: 3 – 5), and eggs ($n = 19$) measure 1.62 ± 0.09 (sd) cm by 2.18 ± 0.08 (sd). Incubation is performed by the female and lasts 12 ± 1 days ($n = 5$). Females are most attentive during the early morning and the mid-afternoon. Males help feed nestlings but make less trips/hr than females ($U_{30}= 74$, $P = 0.04$) and spend up to 60% of their time guarding the nest. There was a positive relationship between nestling age and the number of trips/hr by parents ($r^2= 0.395$, $P < 0.001$). We found discrepancies between the breeding season of *X. flavus* in the Campos de Cima da Serra region and other parts of southern South America, which may be related to resource availability and habitat quality. The clutch size and nest characteristics were similar to those found for this species in Uruguay and Argentina. Although it has been extirpated from the majority of its original distribution, *X. flavus* still reproduces in relatively large groups in northeastern Rio Grande do Sul and conservation efforts should be intensified to assure its continued survival in Brazil.

Key words

Icteridae, South America, clutch size, reproductive biology

Introduction

New-world blackbirds (the Icteridae) are one of the most intensively studied avian families, and have received much attention from demographic and behavioral studies. North American icterids have been studied more thoroughly than their South American allies, however, and basic information about the natural history and breeding biology of many South American species is still unknown. South American species with distributions that span across various countries may suffer from a wide array of threats and lack the cohesion necessary for international conservation plans. Thus, understanding the natural history and breeding biology of threatened species across international boundaries may help to develop international action plans for species conservation and management.

The Saffron-cowled Blackbird (*Xanthopsar flavus*, Gmelin, 1788) is a threatened icterid that inhabits wetlands of open environments in southern South America (Birdlife International 2012). It is a monotypic member of a clade that includes two other marsh-nesting monogomous species, the Brown-and-yellow (*Pseudoleistes virescens*) and Yellow-rumped (*Pseudoleistes guirahuro*) marshbirds (Searcy et al. 1999, Fraga 2005). This conspicuous species, which was seen in immense flocks in Uruguay by Darwin in 1832 (Chebez and Casañas 2008), is currently restricted to a few key locations of its historical distribution and can be found in fragments of its natural habitat in Uruguay, northeastern Argentina, southern Paraguay and southeastern Brazil (Hayes, 1995; Fraga et al. 1998; Azpiroz, 2000; Dias & Maurício, 2002; Fonseca et al., 2004). It requires open areas with low vegetation for foraging and densely vegetated humid fields or wetlands for breeding (Fraga et al. 1998; Belton 1985; Petry & Krüger, 2010). It inhabits areas that range in elevation from sea level to above 900 m (Días and Mauricio, 2005; Fonseca et al. 2004), and may be a partial migrant, or make local movements in search of food resources (Azpiroz, 2000). It is vulnerable in Rio Grande do Sul, Brazil (Fontana et al. 2002), Argentina (Bertonatti 1992), Paraguay (Esquivel et al. 2007) and globally (Birdlife 2013) due to a variety of anthropogenic impacts such as development of native grasslands, the draining of wetlands, the pet trade and agricultural intensification.

The Saffron-cowled blackbird is distributed throughout the grasslands of southern South America and is facing a steady population decline. In Paraguay, 250 birds were seen in a foraging flock in rice fields and flooded fields of the San Rafael National Park, and breeding groups of 30 to 50 individuals were seen in San Isidro, Ka'aguy, Rory and Kanguery (Esquivel et al. 2007). The second largest flock of blackbirds in Paraguay (300 individuals) was seen in Caazapá, Paraguay in April 2002 (Codesido and Fraga 2009), at a location that was heavily converted to soybean and corn crops by March 2004. In Argentina, the greatest number recorded was 240 individuals at Estancia La Guayna, and a few other colonies of about 30 individuals were found in 2003 along the Río Uruguay. A few disjunct populations of blackbirds have been found in the Gualeguaychú and Ibucuy departments (Codesido and Fraga 2009), but the principal locations for this species in this country are in Corrientes and Entre Rios, and it has not occurred in the province of Buenos Aires, Argentina since 1932 (Fraga et al. 1998). The Saffron-cowled blackbird population of Uruguay has also faced heavy declines and where it once inhabited areas in the West, East and South of the country, it is now concentrated in the southern part of the country in the Rocha province, particularly in the Bañados del Este Biosphere Reserve. This species was occasionally seen in groups greater than 100 individuals in Rocha, Uruguay and the average size of 60 groups seen in 1997 was 15.4 individuals (Azpiroz 2000).

The main strongholds for this species in Brazil are in the high altitude grasslands of Rio Grande do Sul and Santa Catarina, southern Brazil and the coastal plain of Rio Grande do Sul (Fonseca et al. 2004; Dias and Maurício, 2002). A colony of 60 individuals with only six reproductive pairs was documented near Pelotas, Rio Grande do Sul in 2002, where a reproductive success of 31-36% was estimated (Dias and Maurício, 2002). Colonies of up to 70 individuals were found near Bom Jesus, Rio Grande do Sul, and Lages, Santa Catarina, in 2007 (Fontana et al. 2008). The breeding habitat used by 30 individuals, including the characteristics of 15 nests, was described (Fonseca et al. 2004). In addition to these studies that focused on the breeding biology of *X. flavus* in Rio Grande do Sul, there are only three other works that cover some aspect of the life history of this species in Brazil. The relationship between *X. flavus* and *Heteroxolmis dominicanus* has been studied (Fontana and Voss, 1996) and the use of burned grasslands by *X. flavus* was described (Petry and Krüger, 2010). Due to the threatened status of this species, basic information about its breeding biology in Brazil that is still lacking is crucial to developing conservation actions.

Here, we describe the breeding biology of Saffron-cowled blackbirds in the Brazilian high altitude grasslands, with emphasis on basic aspects related to regional population size, breeding phenology, territoriality, nests, eggs, fledglings and parental care. This species shows biparental care, but we hypothesize that females invest more time in caring for young than males and that the amount of time spent caring for young increases as young advance in age.

Materials and methods

Study area

Our study was located in the southern Brazilian grasslands, or *Campos*, in northeastern Rio Grande do Sul (29°S, 50°W), in a region known as the Campos de Cima da Serra. The climate of this region is temperate humid, and precipitation is distributed throughout the year. The temperature varies between seasons, with a low of 10 to 12 ºC in July and a high of 24 to 27ºC in January (Almeida 2009). The average elevation is 1000 m. The region is composed of a mixture of open rolling hills with grasslands and small fragments of Atlantic Forest. Wetlands, which form in the depressions, are classified as palustrine permanent wetlands, and they are dominated by emergent plants (Maltchik et al. 2004). Plant diversity is high, and almost a quarter of the species found in the grasslands are from the Asteraceae and Poaceae families. Livestock fields are burned at the end of winter to produce new vegetation for cattle (Boldrini, 2009).

Data collection

We searched 600 km of primary and secondary roads intersecting fields, pastures and wetlands between São Francisco de Paula and Cambará do Sul, west towards Bom Jesus and east towards Aratinga, Rio Grande do Sul (Figure 1) from October to January, 2011-2012, and October to December, 2012. We stopped and listened for calls at all wetlands with dense, tall vegetation and at least some *Eryngium* spp. present. After locating breeding colonies, we selected five colonies to which we had easy access and permission from property owners to collect breeding biology information.

After locating breeding sites, we found nests by following behavioral cues of males and females. We looked for females building nests, returning secretively to the same location more than once or carrying food for young. We searched for males defending a small territory, perching in the same location more than once or carrying food for young. We gave each nest a unique code name and identified it on a map sketch of each wetland. We opted not to use flagging in order to not draw attention of predators. Each nest was also georeferenced on a handheld GPS device.

We visited nests every two to three days, when possible, in order to verify the content, and recorded the date on which a nest failed or fledged. We characterized nests by the type of substrate plant used (species and height) and the following measurements that were taken with 0.01 mm precision calipers and ruler: internal and external nest diameter, nest height and depth, number of branches supporting the nest, distance to the edge of the substrate plant and height above the ground and distance to nearest neighbor nest, if present. Some nests were collected after becoming inactive and were weighed to the nearest 0.01 g with a spring scale. Some eggs were measured to the nearest 0.01 cm.

We performed focal observations of parental behavior (nest construction, incubation and nestling care) with a spotting scope at a distance of at least 15 m for one to three hours in one of four time periods: Morning (6:00 – 9:00), Mid-morning (9:00– 12:00), Afternoon (12:00 – 15:00) and Late afternoon (15:00 – 18:00). During each observation, we described the behavior and the duration of specific activities performed by males and females. To calculate nest attentiveness, we divided the time in which the adult remained at the nest by the total time of observation or recording for each individual nest. We also noted the length of each visit and time spent away from the nest. We calculated parental nestling attentiveness by dividing the total amount of time spent at the nest by the total amount of recording time. We recorded the number of trips per hour made to feed nestlings by males and females, and, when possible, we recorded the type of prey items brought by males and females. We defined the nestling period as the period between hatching of the first chick to the fledging of the last nestling (Robinson et al. 2000) because the events occur synchronously. Upon fledging, several nestlings were banded and measured. These were banded shortly before fledging (after six days old) or soon after fledging while they remained nearby and could be caught by hand. A few adults were also captured with mist nets and banded with two colored bands and one aluminum band issued by the Brazilian banding authority, ICMBio/CEMAVE.

Statistical analyses

We compared nest attentiveness and parental nestling attentiveness at different times of the day with a one-way ANOVA and we tested for a correlation between nestling age and number of visits per hour by a linear regression in the statistical package PASW 18.0. The difference between the number of trips per hour by males and females was compared with a Mann-Whitney U test.

Results

Population size and distribution

We found 18 breeding colonies of Saffron-cowled blackbirds with six to 100 adults. The median colony size was 16. Colonies were found within 0.32 km of one another and up to 14.5 km from other colonies, but were an average of 4.66 ± 4.83 km from other colonies (Table 1, Figure 2). All but one colony was located on private property. We see in Table 1 that no colony further than 4.5 km from another colony had more than 16 individuals and there were three main wetland clusters used by colonies: 1: SF1, SF2 and SF3; 2: Cer1, Cer2 and Cer3 and 3: CS1, CS2 and CS3. The colonies remain in each wetland from October until March. From April to September, large flocks of up to 300 individuals were seen sporadically in different wetlands. On average there were 10 breeding pairs per colony, and this ranged from one to more than 30. There was a positive linear relationship between the size of the colony and the number of breeding pairs ($y = .967x + .296$; $r^2 = 0.929$, $P < 0.001$, Figure 3).

Nests and eggs

We found 47 *Xanthopsar flavus* nests over two reproductive periods. Of these nests, we found 13 (28%) during the nest-building period, 15 (32%) during incubation, and 19 (40%) during the nestling phase. Of the nests found, 19 (41%) fledged successfully, 24 (52%) failed and three (7%) were abandoned. Of the nests that failed, two were parasitized by *Molothrus bonariensis*, 11 were depredated during egg-laying or incubation and 11 were depredated during the nestling phase. The average nest measurements are presented in Table 2. Clutches contain a median of three eggs (Range: 2 – 5). Eggs (n = 19) measure 1.62 ± 0.09 (sd) cm by 2.18 ± 0.08 (sd) cm and are ovoid. Eggs ranged in color from white or off-white to light blue with dark red or maroon specks, which were most concentrated around the swollen section of the egg (Figure 4).

Breeding Chronology

The earliest nest found had eggs as of October 27 and the latest nest was found being constructed on January 27. Breeding colonies are established in October. Males and females arrive together and begin forming small groups of one female and up to three males that are disputing to be the breeding male. Males court the females by spreading their wings and tails and bobbing their heads, while emitting intermittent songs and calls. Mate pairing seems to occur before nest site selection. During the first few weeks, the colony forages in large groups. Even late into the breeding season, males were still disputing for female favor, while other pairs and small groups focused on breeding activities.

Nest construction

The low cup/fork nests (Simon and Pacheco 2005), constructed of grasses found within the wetland, are built within three to six days (mean = 4 ± 1.26 d, n = 6). Although males may hold pieces of thick grass or nesting material in their beaks, this is only a courtship behavior and only females build nests, although males often accompany their mates or stand guard at the nest site. First, females select a location and begin to gather thick pieces of grass, dropping them from a high perch above where the nest will be. They then form the nest and make several trips to collect thick pieces of grass. This process takes one to two days and females make up to 17 trips/hr to find and place material (mean = 15, n = 2). After constructing a tightly-fit bowl of thick (3 – 5 mm) grasses, the female inserts a layer of mud. After this mud dries partially, the female places a second layer of thin (1 – 2 mm) grasses as an inner lining. Nests were constructed in the following support plants: eight (17%) in *Baccharis* spp., 12 (25%) in *Ludwigia multinervia*, 14 (30%) in members of the family Poaceae, eight (17%) in *Eryngium horridum*, three (6%) in a species of broad-leaf plant and two (5%) in *Eupatorium* spp.

Adult Behavior During Incubation

Eggs are laid during the morning on consecutive days, one egg per day, for up to four days. The female incubates for 11.80 ± 0.84 days (from 11 to 13, n = 5). Based on 36 hours of observation, we found that females (n = 12) incubate for 22.52 ± 15.22 (sd) minutes at a time and average nest attentiveness was 64%. Incubation times ranged from 2.50 to 60 minutes and females spend most of their time on the nest in the early afternoon. Females spent the following percentages of time on their nests: 69% from 6:00 to 9:00, 67 % from 9:00 to 12:00, 82% from 12:00 to 15:00 and 40% from 15:00 to 18:00. More time was spent on nests during the first half of the afternoon, and the least time was in the last half of the afternoon ($F_{1,8}$= 1.887, P = 0.012). Females also spent greater amounts of time foraging in the afternoons ($F_{1,8}$= 6.74, P = 0.014), and foraging trips lasted from one to 36 minutes (mean = 10.14 ± 8.34 minutes). The amount of time that they spent watching over the nest from the vegetation ranged from 5% in the late morning to almost 15% in the afternoon. Males do not feed females on the nest, but do spend a large portion of their time watching over the female and the nest. Males (n = 4) spend 60% of their time perched less than two meters away watching, singing or preening and 40% of their time foraging. During this time, males forage for 7.71 ± 4.73 minutes at a time. Eggs hatch over two days. Seven nests had an egg that did not hatch. The two nests that were parasitized by *M. bonariensis* lost all of the eggs from the cowbird nestling expelling the blackbird eggs out of the nest.

Nestling care

Newly-hatched nestlings have orange-colored skin, closed eyes and light yellow down in the principal feather tracts, principally on the top of the head and on the back. The beak is yellow-orange with a light yellow commissure and an orange-red mouth (Figure 4). After four or five days, the eyes open and the nestlings have pin feathers in the dorsal, pelvic and ventral regions, as well as dark grey contour feathers. The nestlings fledge when they are 8.5 ± 0.55 days old (Range: 8 – 9d, n = 6). At this point, the remiges and coverts are partially complete (a dark brown-gray with a yellow edge), the retrices are just beginning to develop (black with yellow edges), the ventral region is covered in lemon yellow contour feathers and the flight capacity is limited. Fledglings measure 9.53 cm (sd = 0.65 cm, range = 8.80 - 10.50 cm, n = 6), and there may be up to an 8 mm difference in body length between first and last-born chicks by time of fledging.

Females make more trips per hour to feed nestlings than males (n = 64h observation time; females = 4.19 ± 1.01, males = 3.54 ± 1.12 trips/hr; U_{30}= 74, P = 0.04). When the chicks are 1-2d old, males make 2.61 ± 0.49 and females make 3.57 ± 0.49 trips/hr; at 3-4d, males make 2.62 ± 0.44 and females make 3.38 ± 0.53 trips/hr; at 5-6d, males make 4.04 ± 1.40 and females make

4.20 ± 1.47 trips/hr and at 6-7d, males make 4.88 ± 1.68 and females make 5.62 ± 1.15 trips/hr. Males forage for 7.18 ± 7.00 minutes at a time and females forage for 7.68 ± 5.54 minutes at a time. The presence of helpers does not affect the amount of time spent caring for young by the female and breeding male. Helpers were occasionally seen helping to defend an area while a female was incubating, and they help feed older young. However, helpers were rarely seen feeding nestlings under 5 days of age. There is a positive relationship between nestling age and the number of trips/hr (r^2= 0.395, P < 0.001, Figure 5). A large portion of the nestling diet is Lepidoptera larvae, but other items included arachnids, grasshoppers and coleopterans. Ants and small spiders composed most of the diet fed to 1-3d nestlings. Fecal sacs were removed by both males and females. On two occasions, males were seen courting a second female, but no copulation occurred.

After fledging, fledglings stay inside of the wetlands for up to two weeks and are fed by the adults. Around the second week, juveniles begin to follow the adults out of the wetlands into the foraging areas on the perimeter of the wetlands. Juveniles remain with their parents for up to at least 30 days after fledging.

Adult territoriality

Both females and males defend the nest. Adults will leave their own nests to help attack a larger predator such as a fox or a snake. On several occasions, adults were seen chasing away a Long-winged Harrier (*Circus buffoni*) and Southern crested caracara (*Caracara plancus*), and a group mobbed the green snake *Philodryas patagoniensis* on two occasions. Adults seem to defend a circular area with a two meter radius around the nest, even chasing off other blackbirds and the conspecific *Pseudoleistes guirahuro*. Oftentimes nests were found by watching the area that one or two males defended. The level of aggression in their defense is related to the age of the brood/nestling. When the nestlings are several days old, a handful of blackbirds may help defend, but when older fledglings give out a distress call, almost the entire colony will mob the predator.

Discussion

The Saffron-cowled blackbird population of southern Brazil seems to be larger than any other South American population of this species. We estimate the population just between São Francisco de Paula and Cambará do Sul to have around 500 adult individuals. Just as we saw during this study, it is common for blackbirds to form large non-breeding seasonal flocks. However, this study is the first to document a breeding colony of more than 100 individuals. There were several wetlands with only six to 12 adults, which may represent sink wetlands. The presence of solitary pairs in Uruguay has been attributed to a declining population in that country, due to habitat loss and fragmentation (Azpiroz 2000). Smaller reproductive colonies could suffer from a greater risk of predation and reduced genetic diversity and reproductive success (Mumme 1992), especially if dispersal is limited by man-made barriers such as pine or eucalyptus plantations in native grasslands. Thus, areas in which this species is found in greater numbers are of particular importance to its conservation. In our study we found three main groups of wetlands which each consisted of at least three wetlands within 4 km of one another. During field observations, we observed a female collect nesting material to build a nest 0.32 km away. Blackbirds of one wetland were often seen foraging near another wetland. One female that was banded in December 2011 in SF1 (29° 36' S, 50° 42' W) was seen in a group without any other banded individuals in Cerr1 (29° 32' S, 50° 46' W) in November 2012, almost five km away. Nearby wetlands may help alleviate pressure to find food and nesting resources during hot, dry years. Further research should examine the role that the spatial arrangement of wetlands in the landscape plays in the viability of this population of blackbirds.

In the Campos de Cima da Serra region, northeast Rio Grande do Sul, Saffron-cowled blackbirds reproduce from mid October to late January. This breeding season differs from other documented breeding seasons for this species. The breeding season in Argentina is from October 18 to November 13 (Fraga et al. 1998), in Uruguay is September to December (Azpiroz et al. 2000) and in southern Rio Grande do Sul is December to January (Dias and Maurício 2005). Either there is high variability in this species' breeding season or there has been some inconsistency in sampling methods. In 2012, breeding did not begin until December in a wetland that was 0.2 km from a wetland where every breeding attempt in October and November failed. Breeding dates are highly synchronous within a breeding colony, but may vary from colony to colony depending on the amount of vegetation available for nesting substrate and the availability of food resources in the surrounding fields. Breeding did not begin until late December in 2011 in one wetland, when the *Ludwigia multinervia* was well-developed, and both nests found in this wetland were placed in *L. multinervia*. Fretwell (1972) developed the theory that resource availability affects populations in seasonal environments and in examining this hypothesis, Turner and McCartney (1998) found that the breeding success of Red-winged blackbirds was indeed positively related with the emergence of their principal food resource, odonates. Chestnut-capped blackbirds (*Agelaius ruficapillus*) breeding in rice plantations in southern Brazil began their breeding season two or three months late, in alignment with rice planting and harvesting regimes (Cirne and López-Iborra 2005). Temperate region grasslands experience a variety of seasons and disturbances, which creates a heterogeneous, dynamic environment for the species that breed in these regions. Thus, the breeding season of *X. flavus* probably depends on the availability of its main food resource, arthropods, which may vary from region to region.

Parasitism by *M. bonariensis* does not seem to be a principal threat to Saffron-cowled blackbirds in southern Brazil. Out of 47 nests observed, only two were parasitized. This is much lower than the seven of 10 nests parasitized in Uruguay (Azpiroz 2010). Cowbirds tend to be associated with agricultural and urbanized areas and the Campos de Cima da Serra region, although it suffers high rates of agricultural and silvicultural development, still has a large amount of open fields and livestock pastures. Shiny cowbirds are not seen in great numbers in this region, which may be due to elevation (950 m).

Nests were similar to those of other populations of *X. flavus* in Uruguay and Argentina. The external diameter of the nests in our study was slightly larger than nests in Argentina (11.2 cm; Fraga et al. 1998) and slightly smaller than nests in Uruguay (13.5 cm; Azpiroz 2000). The nests were found at a similar height above the ground (50.32 cm) as in Uruguay (47 cm, Azpiroz 2000), southern Rio Grande do Sul (50 cm, Dias and Maurício 2005) and in northern Rio Grande do Sul (57.08, Fonseca et al. 2004). Nests were also placed in similar-sized vegetation in our study (93.65 cm) and in the study by Fonseca et al. (2004; 94 cm). The nesting substrate used in this study was also similar to other studies and shows that *X. flavus* prefers wetlands with plants such as *Eryngium horridum* or *Eryngium* spp. and *Ludwigia multinervia*. Such similar findings show that this species is highly selective of nesting substrate and may depend on wetlands that offer vegetation with a specific level of development for nesting purposes. Often times the fields in which the wetlands are located are burned for pasture management and fire occasionally enters the wetlands. This fire may have an immediate negative impact on the vegetation structure, but on a long-term basis, it may help to keep wetlands from developing into a more advanced successional state with small trees and large bushes. Long-term studies on the dynamics of fire management in these fields and wetlands would be beneficial to understanding the adaptability of Saffron-cowled blackbirds and other species breeding in these habitats.

Clutch and egg sizes were also similar to what has been stated in the literature. The clutch size was 3.68 in this study and 3.67 in Argentina (Fraga et al. 1998). Clutch size has been shown to increase with latitude, and passerines in the middle latitudes generally lay four to five eggs (Murray 1985, Yom-Tov 1994). The clutch size of Saffron-cowled blackbirds is slightly higher than the average clutch size for members of the family Icteridae in South America (3.297, n = 12; Yom-Tov 1994). This clutch size may be higher to compensate for high rates of parasitism in Uruguay (Azpiroz 2000) and high rates of predation in southern Brazil (Toriani Moura, unpublished data, Fraga et al. 1998), and the fact that this species has only one brood per breeding season. Further studies should examine the role that helpers play on raising young in this species and whether environments that do not support enough individuals for there to be helpers at each nest influences the amount of offspring produced per colony.

Female blackbirds are most attentive to broods of eggs during the early morning and mid-afternoon. The higher amount of nest attentiveness in the early morning may be a defense mechanism against cowbird parasitism (Neudorf and Sealy 1994), or it may be a function of the lower morning temperatures. The amount of time spent at the nest throughout the day may also be related to the availability of food resources and foraging strategy utilized. Females of species in which only the female incubates eggs face a trade-off of time allocation for incubating eggs and meeting their own nutritional needs and must regulate their on- and off- bouts (Conway and Martin 2000). Females that take shorter foraging trips more often may attract attention from predators (Skutch 1985, Martin 1995), but females that employ an active energy-consuming foraging strategy, such as actively searching for insects on the ground, will need to spend more time finding resources. In our study, incubating females stayed off the nest for an average of 22.5 minutes per hour, and the longest off-bout was 60 minutes. Females spent about 80% of their time on the nest during the afternoon hours, between 12:00 and 15:00, and only 40% of their time from 15:00 to 18:00. The hottest portion of the day occurs from 12:00 to 15:00, when temperatures can reach 90°F on a summer afternoon. Females may be spending this time shading the eggs from direct sunlight and maintaining a cooler nest temperature. The lesser amount of time spent on the nest in the afternoon is most likely related to the trade-off in foraging time. Colonies were often active at the end of the afternoon, when insect movement was high. Individuals were seen both foraging on the ground and catching insects from the air. The Saffron-cowled blackbird would be an interesting species to use to study the relationship between predation and time allocation by females since the females perform incubation and may have added assistance in nest guarding from helping males.

Feeding rates were similar between individuals of our study and in Uruguay. Based on observations of only one nest, Azpiroz (2000) found that females make 3.5 trips/hr and males make 2.5 trips/hr, which concur with our findings. Parental care in Saffron-cowled blackbirds is performed by both males and females, but it is female-biased. The rate of trips/hr increases as the nestlings age, which may explain the presence of helpers later in the nesting cycle. However, it is still unclear as to how the presence of helping individuals affects parental care by males and females. Almost every nest had one helper during nestling feeding, but help from this individual was often inconsistent, came later in nestling development, and oftentimes this individual served more as a guard than a feeder. The occurrence of cooperative breeding in species may be determined by ecological factors such as resource limitations (Brown 1987). We noticed that in environments with poorer quality or less preferred nesting vegetation, there were few to no helpers. This occurred often in groups of 12 or less individuals, made up of exactly six pairs. This species is highly gregarious and colonies under a specific size may not be viable (Fraga et al. 1998). If we assume the critical size appropriate for population viability to be 30 individuals, then only six of the 18 wetlands in this study will continue to serve as population sources for this species in this region. Long-term demographic studies with each of the 18 colonies found in this study and estimation of mortality and recruitment would be highly beneficial in understanding whether or not these wetlands are serving as sources or sinks to this population.

Conservation

On a final note, we address the conservation of this species. In 1996, the status of Saffron-cowled blackbird changed from endangered to vulnerable (Birdlife 2013). This status change was likely due to an increased effort made by ornithologists and bird enthusiasts to find blackbird colonies. However, this species still faces serious population threats from wetland draining, pine and eucalyptus plantations, urbanization and agricultural intensification. In

Argentina, where this species has suffered a 50% reduction, it has been extirpated from Buenos Aires and most of its historical range, and it currently does not occur in national parks or provincial reserves (Fraga et al. 1998). A similar situation has occurred in Uruguay, where the species has been extirpated from Montevideo and there have been no records since 1990 in the states of Paysandú, Soriano, Colonia and San José, which were the western and southwestern portion of its range in this country. It currently only occurs in two locations in Uruguay which are 400 km apart (Arballo and Cravino 1999, Azpiroz 2000) and one of the parks in which it occurs has no effective management plan (Bañado los Índios). In Brazil, only a handful of scientific studies have documented this species presence and the two main areas of occurrence are in the eastern part of the state. However, sightings by bird enthusiasts have documented this species throughout the western and northern portion of Rio Grande do Sul and in southeastern Santa Catarina. In Rio Grande do Sul, no park protects this species in the southern portion of its range (Dias and Maurício 2005) and it occurs sparingly in only three parks in the northern part of its range (Aparados da Serra National Park, Aratinga Ecological Station and Tainhas State Park, personal observation). This species does not breed within the Aparados da Serra National Park because grassland management practices are not employed and the wetlands within this park do not have the appropriate surrounding grass structure. Scientific studies are often tied to major universities and often lack the funding to conduct research in areas that are further away from urban centers. Thus, the western portion of Rio Grande do Sul has been little explored and has not received the same focus that the areas around the federal and state universities of Porto Alegre and Pelotas, Rio Grande do Sul have received. Infrastructure for visiting researchers is also lacking in many of the state and national parks throughout this state, which makes it difficult for researchers at major universities to plan projects that involve many days of field work. Considering the issues stated, we urge the following conservation actions for this species: 1) long-term demographic studies, 2) revision of habitat management plans in current conservation units, 3) protection of current locations of occurrence, 4) international financial support for long-term projects and 5) creation of new conservation units. Fontana et al. (2008) propose four new areas for the conservation of this species and other similarly threatened bird species. Studies such as this that propose concrete conservation actions must receive more attention from within Brazil and from the international community. Due to its flocking behavior, Saffron-cowled blackbirds may appear to occur in large numbers. However, without urgent conservation actions, this species may continue to decline to unrecoverable numbers.

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Tables

Appendix 1 – Table 1

Table 1. Location and description of 18 colonies of Saffron-cowled blackbirds (*Xanthopsar flavus*) found in the Campos de Cima da Serra region, Northeast Rio Grande do Sul, southern Brazil in 2011 and 2012. Not all colonies were observed enough to estimate number of breeding pairs (?).

			Colony size		Breeding pairs		
Wetland name	Latitude (S)	Longitude (W)	2011	2012	2011	2012	Distance to nearest neighbor (m)
SF1	29° 36' S	50° 42' W	30	20	12	8	570
SF2	29° 36' S	50° 41' W	-	30	-	12	570

SF3	29° 37' S	50° 42' W	60	40	-	12	730
SF4	29° 39' S	50° 30' W	-	100+	-	30+	4100
SF5	29° 42' S	50° 30' W	-	12	-	?	4100
SF6	29° 41' S	50° 46' W	0	6	-	2	5880
SF7	29° 35' S	50° 61' W	-	14	-	?	12700
SF8	29° 37' S	50° 37' W	8	0	3	0	4660
Ara1	29° 30' S	50° 24' W	-	12	-	?	11000
Cer1	29° 32' S	50° 46' W	-	20	-	?	0.51
Cer2*	29° 32' W	50° 46' W	-	8	-	?	0.51
Cer3	29° 31' W	50° 49' W	-	60	-	?	3.63
CS1	29° 18' W	50° 19' W	60	45	20	16	0.32
CS2	29° 18' W	50° 19' W	-	30	-	11	0.32
CS3	29° 18' W	50° 19' W	-	25	-	12	0.39
Jaq1	29° 09' W	50° 23' W	14	14	2	?	9.75
Jaq2	29° 02' W	50° 29' W	16	16	5	?	9.75
SJA1	29° 02' W	50° 11' W	6	0	1	0	14.5

* Cer2 may be a foraging area for the Cer1 colony.

Appendix 2 – Table 2

Table 2. Nest site characteristics for 47 Saffron-cowled blackbird (*Xanthopsar flavus*) nests in the Campos de Cima da Serra region, southern Brazil. Means are presented with standard deviation of the mean (SD).

Measurement	Mean ± SD	Range
Height from ground (cm)	45.12 ± 24.68	20 - 120
Height support plant (cm)	88.38 ± 34.94	34 - 178
Distance from edge of support plant (cm)	8.35 ± 5.97	0 - 25
Number of supporting branches, if present	8.18 ± 3.61	3 - 20
Distance to nearest neighbor nest (m)	9.61 ± 4.99	
% Cover	55.87 ± 24.32	5 - 90
Nest height (cm)		
Internal	5.58 ± 0.77	4 - 7
External	10.25 ± 1.24	8 - 14
Nest diameter (cm)		
Internal	7.16 ± 0.83	5 - 8.80
External	11.55 ± 0.94	10 - 13.8

Figures

Appendix 3 – Figure 1

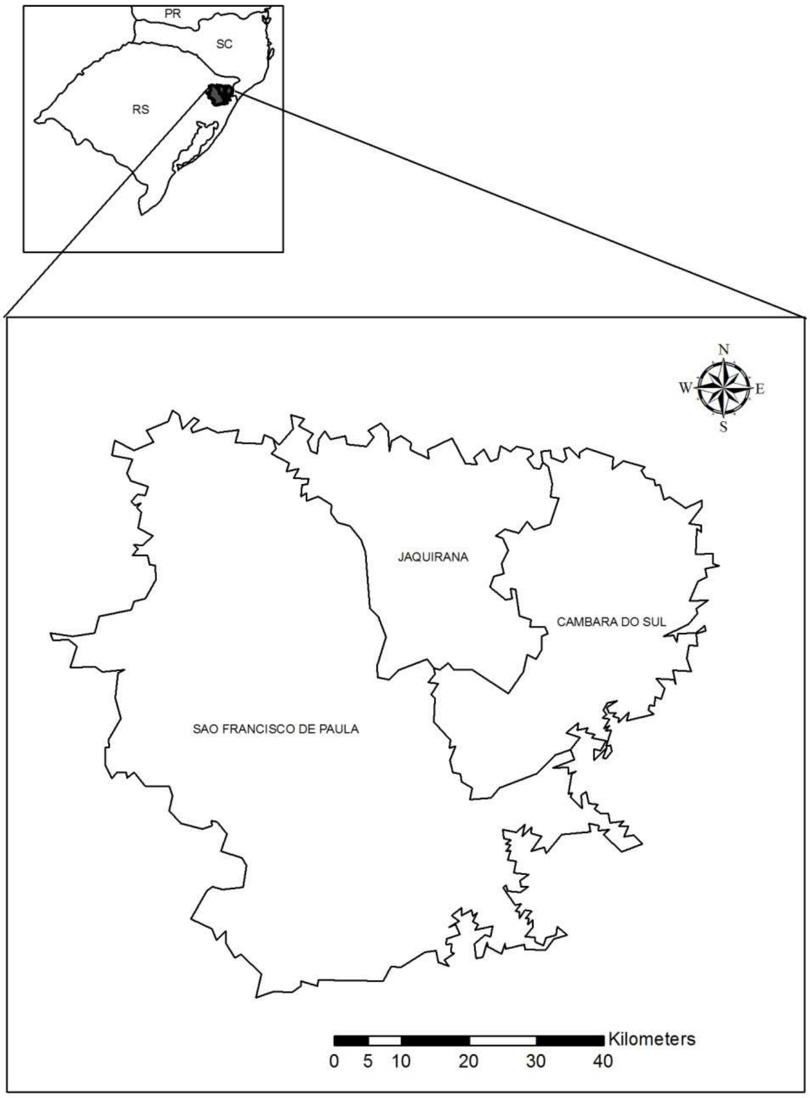

Figure 1. Map of study area: A. The state of Rio Grande do Sul, southern Brazil and B. Counties included in the Campos de Cima da Serra region.

Appendix 4 – Figure 2

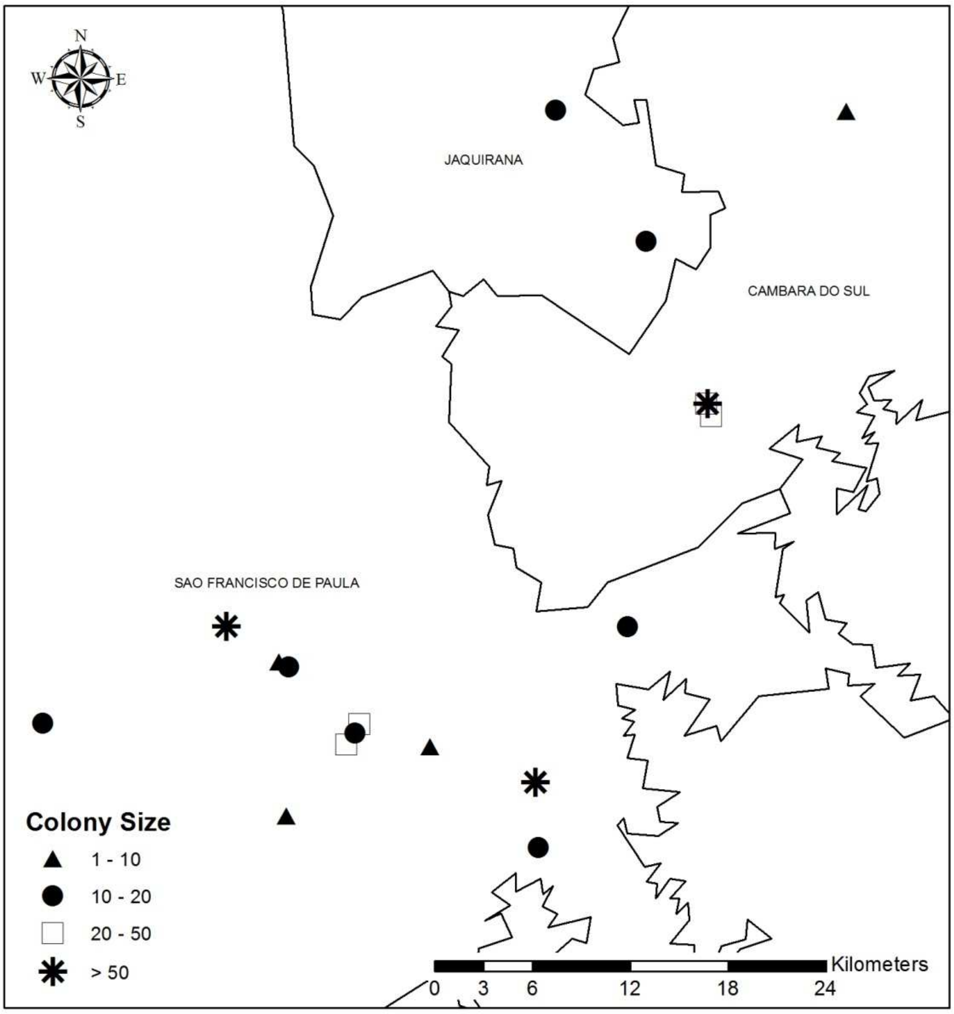

Figure 2. Map showing 18 wetlands with breeding colonies of Saffron-cowled blackbirds (*Xanthopsar flavus*) in the Campos de Cima da Serra region, southern Brazil. The symbols represent the size of each colony.

Appendix 5 – Figure 3

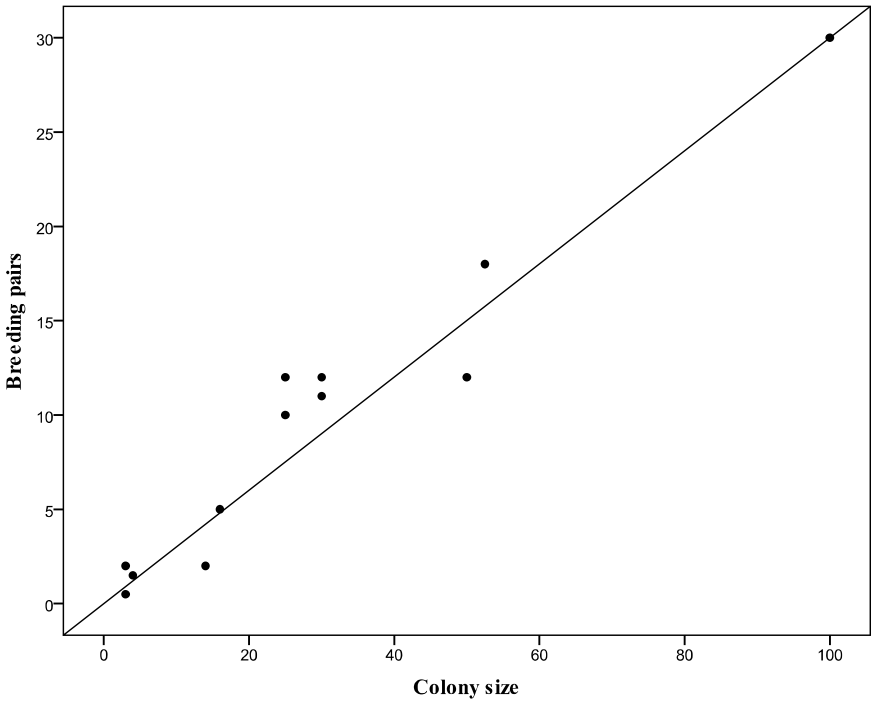

Figure 3. Linear relationship between the colony size and number of breeding pairs in Saffron-cowled blackbirds (*Xanthopsar flavus*) in the Campos de Cima da Serra region, Rio Grande do Sul, Brazil ($y = .967x + .296$; $r^2 = 0.929$, $P < 0.001$).

Appendix 6 – Figure 4

Figure 4. Nest between *Eryngium horridum* leaves and *Ludwigia multinervia* (a), Nest with eggs (b), day-old nestlings (c), 2-3 day-old nestlings (d), 4-5 day-old nestlings (e), 5-6 day-old nestlings (f) and 7-8 day-old fledgling (g) of Saffron-cowled blackbird (*Xanthopsar flavus*) and Shiny cowbird (*Moluthrus bonariensis)* nestling in a blackbird nest (h) in Rio Grande do Sul, southern Brazil.

Appendix 7 – Figure 5

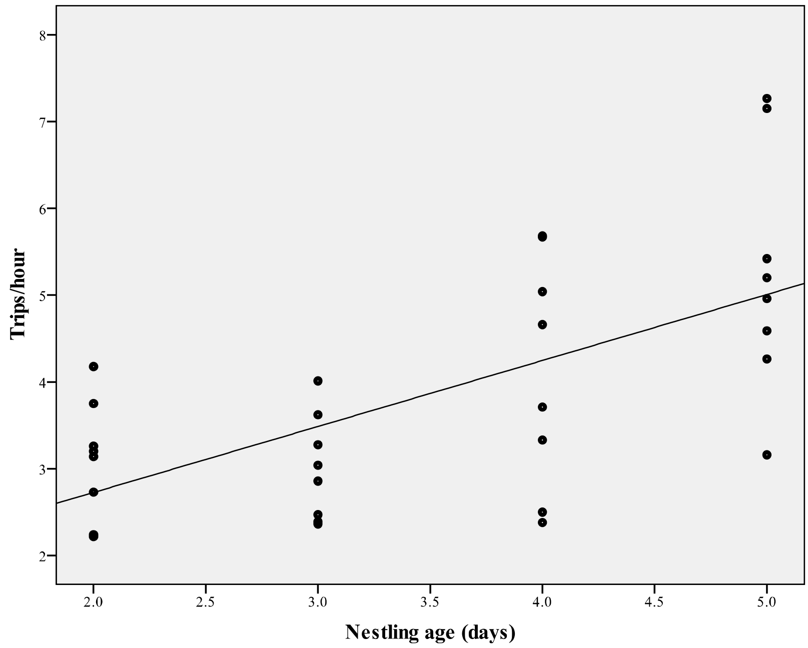

Figure 3. Linear relationship between nestling age and number of feeding trips/hr in Saffron-cowled blackbirds (*Xanthopsar flavus*) in the Campos de Cima da Serra region, Rio Grande do Sul, Brazil ($r^2 = 0.395$, $P < 0.001$).

CAPÍTULO 2

NEST SITE SELECTION AND NEST SUCCESS OF A THREATENED SOUTH AMERICAN BLACKBIRD

Toriani Moura, Emily J., Maria Virginia Petry and James J. Roper

Resumo

A predação é a principal causa de perda de ninhos em Passeriformes e pode estar influenciado pelos fatores como a distância até a borda de um habitat e a qualidade do habitat. A maior parte de estudos sobre o efeito de borda têm focado no efeito de borda entre grandes fragmentos de floresta e campo, e poucos têm focado em áreas úmidas. O presente estudo avalia a influência da paisagem e características do local de nidificação na seleção de locais e o sucesso reprodutivo do Veste-amarela (*Xanthopsar flavus*). Foram monitoradas cinco colônias reprodutivos de *X. flavus* de Outubro á Dezembro de 2012 em áreas úmidas circundadas por atividades agrícolas ou pastorís na região fisiográfico dos Campos de Cima da Serra, sul do Brasil (50ºW, 28ºS). A região dispõe de áreas abertas intercaladas com manchas de Mata Atlântica e áreas úmidas. Foram monitorados 29 ninhos até cada um foi successo ou faliu. Então foram medidos características de locação de ninhos. Foi calculada a taxa de sobrevivência diária e foram construídos modelos para avaliar o efeito de borda no sucesso dos ninhos. Ninhos de sucesso e falha foram comparados com um teste t. Ninhos em áreas úmidas com agricultura em volta (n = 11) tiveram menos sucesso do que ninhos em áreas úmidas com pecuária em volta (n = 18) (12 vs. 33%). Áreas úmidas agrícolas tiveram uma densidade maior de *Eryngium horridum* (t_4 = 2.75, P = 0,05) e mais solo exposta (t_4 = 3.06, P = 0,02). Os ninhos das áreas úmidas pecuárias foram mais perto do chão (30,7 ± 10,6 vs. 48,9 ± 26,8 cm; t_{27} = 2.57, P = 0,02) e construídos em plantas mais baixas (71,7 ± 24,6 vs. 110,7 ± 32,1 cm; t_{27} = 3.68, P = 0,001). Ninhos perto da borda falharam com mais frequência (93%, n =15) do que ninhos do interior (66%, n = 14, P < 0,05). Os valores de AIC_c mais baixos foram encontrados no modelo que separa os grupos pela distância até a borda (AIC_c = 101,156). Os resultados demonstram que para esta espécie de ave do sul da América do Sul, bordas de habitat são associadas com a perda de ninhos. Se a perda de ninhos for tão alto que a reprodução é insuficiente para repor a

população, ambientes com bordas se tornam sumidouros de populações. Se, por falta de opções, estas aves continuam utilizando áreas úmidas sumidouras, a população declinará.

Palavras chave

efeito de borda, Mata Atlântica, campos de altitude, sucesso reprodutivo

Abstract

Predation is the leading cause of nest failure in passerines and may be influenced by factors such as distance to the edge and habitat quality. Most edge studies have focused on edge effects between large fragments of forest or grassland habitat, and few have focused on wetland environments. We describe and test the influence of landscape and nest site characteristics on nest site selection and nesting success of Saffron-cowled blackbirds (*Xanthopsar flavus*). We monitored five colonies of blackbirds during the 2012 breeding season in wetlands surrounded by either agricultural or pastoral activities in the Campos de Cima da Serra region, southern Brazil (50ºW, 28ºS). The region comprises high altitude grasslands with pockets of mixed Atlantic Forest and small permanent wetlands. We monitored each nest (n = 29) every other day until it failed or fledged and measured nest placement variables within a week afterwards. We calculated the daily survival rate for nests and constructed models to evaluate the effect of edge on nest success. Nest placement characteristics of successful and failed nests were compared using a t - test. Nests in agricultural wetlands (n = 11) were less successful than in pasture wetlands (n = 18) (12 vs. 33%). *Eryngium horridum* plant density was greater (t_4 = 2.75, P = 0.05) and there was less exposed ground (t_4 = 3.06, P = 0.02) in the agricultural wetlands. Nest height was lower (30.7 ± 10.6 vs. 48.9 ± 26.8 cm; t_{27} = 2.57, P = 0.02) and nests were in shorter plants (71.7 ± 24.6 vs. 110.7 ± 32.1 cm; t_{27} = 3.68, P = 0.001) in the livestock wetlands. Edge nests failed (93%, n =15) more often than interior nests (66%, n = 14, P < 0.05). The lowest AIC_c values were found in the group model (AIC_c = 101.156). These data show, in this southern South American species, that edges are associated with nest failure. If nest failure is such that reproduction is insufficient for replacement, edges become population sinks. If, for lack of options, blackbirds continue to use sink wetlands, population decline will follow.

Key words

edge effects, Atlantic Forest, high altitude grasslands, nesting success

Introduction

While predation and nest parasitism are the principle causes of reproductive failure in birds (Ricklefs 1969), a variety of factors influence reproductive success. Habitat quality, edge effects, nest placement and experience can all influence nest success (Martin 1993, Picman et al. 2002, Bernstein et al. 1991, Pugesek and Diam 1983). Reproductive success is a good indicator of a species overall chance of survival under various environmental circumstances and oftentimes a better indicator of population stability. When mortality is greater than reproduction a reproductive sink occurs because recruitment is too low to overcome mortality (Vierling 2000). The underlying causes of reproductive success or failure plays an essential role in the adaptation of species to their environments, and this aspect of life history has been relatively unexplored in South American icterids (but see Duca and Marini 2008).

Loss and degradation of natural habitat are the greatest threats to birds (Johnson 2007), and grassland birds have suffered increasing declines over the past few decades (Stotz et al. 1996). Habitat fragmentation causes changes in the local landscape structure and vegetation, and many grassland birds are sensitive to landscape modification. These species either cannot use cropland as a substitute or depend on particular resources available in grassland and other habitats, such as wetlands (Azpiroz et al. 2012). Studies have shown that vegetation is highly associated with food resource abundance and may be a good indicator of territory quality, which is correlated with reproductive behavior (Rubenstein 2007; Rubenstein 2011). However, our understanding of the habitat characteristics that are important in nest site selection by grassland birds, and particularly wetlands within natural grasslands, and the importance of these characteristics to reproductive success is still lacking, especially in temperate South America, where grasslands have been devastated by agriculture and afforestation.

Edge effects are increased probability of nest depredation rates near habitat edges (Paton 1994; Driscoll and Donovan 2004). Edges can serve as ecological sinks, or traps, for bird species if their apparently favorable nesting conditions attract breeding birds to areas that have higher nest predation levels than non-edge habitats (Gates and Geysel 1978, Marini et al. 1995). Several studies have shown that predation decreases as nests are further from the edge, but these studies have conflicting results (see Paton 1994 for review). Additionally, most studies have focused on edge effects between large fragments of forest or grassland (Gates and Gysel 1978; Chasko and Gates 1982; Andrén et al. 1985; Wilcove 1985; Andrén & Angelstam 1988; Yahner et al. 1989; Gibbs 1991; Burkey 1993; Marini et al. 1995, França and Marini, 2009), but few have examined this effect on a smaller, more local scale or in wetland environments (but see Picman et al. 1993, Jobin and Picman 1997, Hoi and Krištofík 2001, Báldi and Batáry 2005, Trnka et al. 2009).

The landscape context in which a patch is found influences the predator community, and edge effects may depend on the composition of the landscape surrounding the habitat (Andrén 1995, Lahti 2001). Therefore, wetlands within an agricultural landscape could be expected to exhibit different edge effects than those found within a forested or native grassland matrix. Draining of local wetlands for agricultural land and livestock fields is a common practice throughout the state of Rio Grande do Sul that has left few high quality wetlands for use by native wildlife. These wetlands are often embedded in highly agricultural landscapes and reduced in size, which could increase the impact of edge effects on bird species using these areas for reproductive purposes.

One of the southern South American grassland species that has suffered a considerable reduction in its historical range is the Saffron-cowled Blackbird (vulnerable: Birdlife International 2012). Most studies of this blackbird have focused on general natural history (Fraga et al. 1998; Azpiroz 2000; Dias & Maurício 2002; Fonseca et al. 2004; Fraga 2005), foraging (Petry and Krüger 2010) or intra-specific interactions (Fontana 1994, Krüger and Petry 2010). This species prefers recently burned areas in which to forage (Petry and Krüger 2010), breeding habitat requirements consequences for reproductive success are unknown. Saffron-cowled blackbirds reproduce in colonies and each female may have up to three males helping raise offspring (Fraga 1998).

In the Campos de Cima da Serra, southern Brazil, this species is found in breeding colonies of eight to 60 individuals (pers. observ.), and the greatest concentrations of colonies are near the cities of Cambará do Sul and São Francisco de Paula. This region is one of the last strongholds for this species. The three wetlands in Cambará do Sul are in an agricultural landscape, with potatos planted up to the edge of one of the wetlands. Although they are adjacent to a heavily used highway, the two wetlands in São Francisco de Paula are surrounded by low-density cattle pastures, with little anthropogenic disturbance.

In this study we 1) characterize the type of breeding habitat selected by Saffron-cowled blackbirds, 2) compare the reproductive success of blackbird colonies in wetlands from two different land-use surroundings (agricultural crops vs. low-density livestock) and 3) test nest site choice and its influence on nesting. Our hypotheses are that wetlands surrounded by more intensive landuse, as is found in agricultural areas, will have lower reproductive success than wetlands in more natural environments. We also predict that predation pressure will be heavier around the borders of wetlands than in the less-accessible inter portions, thus making the shape and amount of edge in each wetland an important aspect for conservation management. The results of this study will be incorporated in future management plans by personnel of the three conservation units near the study sites, areas in which this species occurs only sporadically due to lack of appropriate habitat management.

Materials and Methods

Study Area

The study took place in the physiographic region of the Campos de Cima da Serra, in the cities Cambará do Sul and São Francisco de Paula, Rio Grande do Sul, Brazil (50º32.00’W, 28º23.00’S). The climate of this region is temperate humid, with precipitation distributed throughout the year. The average annual temperature varies from 14 to 16ºC, with an average low of 10 to 12 ºC in July and an average high of 24 to 27ºC in January. The average elevation is 1000 m (Almedia 2009).

The vegetation of the region is composed of large extensions of grasslands with pockets of Atlantic Forest and small marsh-like wetlands. The wetlands are classified as palustrine permanent wetlands with a predominance of emergent plants (Maltchik et al. 2004). The fields contain a high plant species diversity, with almost a quarter of the species from the families Asteraceae and Poaceae. Fields used for livestock are burned at the end of winter every one to two years to produce new vegetation (Boldrini 2009).

The Campos de Cima da Serra is one of Brazil´s 234 Important Bird Areas (Birdlife 2013). Due to the natural physical complexity of the region, the avifaunal diversity is high, and many rare, threatened and endemic species can be found in the fields, wetlands and forests of this region. The area is also of particular importance to austral migrants (Fontana et al. 2009). This IBA is globally important for the conservation of species such as *Xolmis dominicanus*, *Anthus nattereri*, and the focal species of this study, *Xanthopsar flavus* (Birdlife 2013).

Data Collection

Wetland vegetation measurements

To test the influence on the selection of breeding areas by blackbirds, we measured vegetation structure in eight wetlands with blackbird colonies and eight wetlands without blackbird colonies throughout the Campos de Cima da Serra region (Figure 1). The eight wetlands with blackbird colonies included the five wetlands in which nesting success was estimated and an additional three wetlands with breeding colonies. The eight wetlands without blackbird colonies were selected randomly from similarly-sized wetlands along the main or access roads used to access the principal wetlands.

We established 5m^2 sampling plots in each wetland, in the area that was most representative of the vegetation used for nesting. We measured the height and density of the wetland plants with a height of 30 cm or more as a measure of vegetation structure. In each plot, we measured density of the three most common species and height of three plants each for the three most common species. The most prevalent species of plants in these wetlands are *Eryngium horridum* and *Eryngium panadifolium*, *Baccharis trimera*, *Ludwigia multinervia* and species of the families Cyperaceae and Poaceae. This method was designed to be an easy-to-use method that local park rangers and biologists can apply within their conservation units to determine the suitability of a wetland to serve as a possible breeding ground for the blackbirds. Thus, we measured the following vegetation characteristics: a. Density of *Eryngium horridum*, b. Height of *Eryngium horridum*, c. Density of *Baccharis trimera*, d. Height of *Baccharis trimera*, e. Density of the third most prevalent plant (either *Ludwigia multinervia* or a member of the family Poaceae), f. Height of the third most prevalent plant species, g. Overall density of plants over 30 cm and h. Average height of plants over 30 cm. We also measured the amount of exposed soil under the vegetation. Saffron-cowled blackbirds haves been associated with areas in which prescribed fire has been used to control vegetation growth and needs low vegetation to forage for insects (Krüger and Petry 2010). Therefore, we also measured the mean height of ten samples of grass within 10 m of the edge of each wetland.

Nest measurements

To test the influence of nest site selection on nest success, we measured the following variables one week after a nest failed or fledged: a. Distance between the edge of the wetland and the nest; b. Distance to the closest neighbor nest, if present; c. Distance to the ground or water surface; d. Supporting plant species; e. Distance between nest and outer edge of supporting plant; f. Number of supporting branches; g. Height of supporting plant and h. Percent cover. To test whether plant structure around each nest influences success, we counted and measured the height of a representative proportion of plants around each nest.

Nest success

We visited five colonies of blackbirds at two- to three-day intervals from October to December, 2012. We located nests by using behavioral cues such as females carrying nesting material, male guarding behavior, females returning to the same location and either adult carrying food. We labeled each nest on a croquis of each wetland and monitored the contents every other day, when possible. We recorded the following dates for each nest: initial and final nest building activities; egg laying, incubation, hatching, predation or abandonment; nestling care and fledging or depredation. The objective of this monitoring was to compare the daily survival rate and breeding success among these colonies, as well as determine whether developmental stage affected mortality.

Data Analysis

Wetland vegetation characteristics that determine site selection were compared by independent samples *t* tests.

We used Program MARK to estimate and compare daily nest survival for two sets of nest groups: 1) between nests in São Francisco de Paula, in which the wetlands are surrounded by open livestock grazing pastures, and Cambará do Sul, in which the wetlands are surrounded by heavy agricultural activities such as potato and broccoli crops; and 2) between edge and interior nests. Distance of nests from edge was divided into two groups: edge, less than the average distance, and interior, greater than average distance. We used Program MARK to construct four models to evaluate the effect of edge and time of construction on nest success and Aikake's Information Criterion were used to determine the best fit model. The models were: 1. Constant survival, control; 2. Location (interior vs. edge); 3. Time and 4. Time and location. Nest placement characteristics of successful and failed nests were compared using a *t* - test. Nest placement characteristics were also compared with a *t* test between failed and successful nests to determine the variables most responsible for nest failure. All tests were considered statistically important using alfa = 0.05.

Results

Wetland vegetation

The average plant density m^{-1} and height (cm) for the wetlands with and without blackbird colonies are presented in Table 1. Vegetation density and height did not differ greatly between the wetlands with and without blackbird colonies, however the average height of vegetation was greater in the blackbird wetlands (99.86 ± 7.70 > 69.93 ± 4.66 cm; $t_{14} = 3.33$, $P = .01$). *Ludwigia multinervia* in the blackbird wetlands and a species of grass in the wetlands without blackbirds varied the most between the two treatments. Average height of *L. multinervia* was 107.04 ± 9.84 (sd) cm in the blackbird wetlands, and the grass was 64.35 ± 4.98 cm tall. Grass within 10 m of the edge of the wetland was more than twice as high in wetlands without blackbird colonies ($t_{14} = 3.06$, $P = 0.01$). Finally, vegetation structure was almost three times more sparse (greater % exposed soil or water surface) in the wetlands without blackbirds ($t_{14} = 3.06$, $P = .01$). Vegetation in these wetlands is denser and taller, which explains the low amount of exposed soil. *Ludwigia multinervia* was often absent from the wetlands without blackbird colonies and in higher densities in the areas used for reproduction by blackbirds in the wetlands utilized by colonies.

Vegetation structure did not differ greatly between the wetlands in Cambará do Sul and São Francisco de Paula (Table 2). However, Cambará do Sul wetlands seemed to be in a more advanced successional stage than the São Francisco de Paula wetlands. Overall vegetation height was 16 cm greater in the Cambará do Sul wetlands ($t_4 = 3.61$, $P = 0.02$) and the *Eryngium* *horridum* was also twice as dense in these wetlands (t_4 = 2.75, P = 0.05). Wetlands in Cambará do Sul were much more closed, with 0% exposed ground, as opposed to 22% exposed ground in the São Francisco de Paula wetlands.

Nest Survival and site characteristics – livestock vs. agriculture

Nests in the livestock treatment (São Francisco de Paula) were more successful than nests in the agricultural treatment (Cambará do Sul) with 33 and 12% nest success, respectively (Table 3). Nests were built further from the ground in Cambará do Sul (48.89 ± 6.31 cm) than in São Francisco de Paula (30.73 ± 3.21 cm) and the supporting plants were taller in Cambará do Sul (110.67 ± 7.56 cm) than in São Francisco de Paula (71.68 ± 7.41 cm) (Table 3). Surrounding plant plant height also differed between the two treatments (t_{27} = 3.291, P = 0.003). Distance to the edge, distance to nearest neighbor nest, distance to edge of the support plant, plant cover and density of surrounding plants were all similar in the two treatments (Table 4).

Nest Survival and site characteristics – failed vs. successful nests

With a nesting cycle of 24 days, the edge nests failed more than interior nests at 7 and 34% success, respectfully. The two best models differed by only 1.38 Delta AIC_c. However, the lowest AIC_c values were found in the group model (AIC_c = 101.156, Table 5). The low difference between models is likely due to one of two factors: a small sample size (n=29) or a high proportion of edge nests due to sampling difficulties. If we assume that nest survival was constant over the nesting period, then it was best explained by a linear effect of distance to edge, with success increasing as distance increases.

Distance to the edge of the wetland, distance to the edge of the support plant and density of plants surrounding the nests tended to be greater in successful nests (Table 6). On average, successful nests were five meters further from the edge of the wetland, 3.5 cm further from the edge of the supporting plant and the plants surrounding the nest within a one meter radius were slightly denser (8.86 ± 0.52 cm > 7.31 ± 0.45 cm). Although failed nests were 12.15 m away from the nearest neighbor nest on average, this was not significantly higher than the 9.25 m distance of successful nests. Both types of nests were built 42 cm from the ground, independent of support plant height. This preferred nest height may be negatively impacted by the availability of nest substrate in lower quality wetlands. The amount of cover did not vary greatly between failed and successful nests, and in both cases the percent coverage was greater than 50%. Out of the 17 nests that were depredated, over half were still in the laying or incubation phase (Figure 2).

Discussion

Wetland selection

Survival in bird species depends on their ability to select and utilize areas with decreased susceptibility to predation and abundant food resources. Although we did not measure the amount of prey available in the study areas, our data support the idea that Saffron-cowled blackbirds select wetlands with tall, dense vegetation inside the wetland and a low vegetation structure around the wetland. In fact, grassland birds are more influenced by the vegetation structure than by the species composition of an area (Wiens 1974, Winter et al. 2005). While we did find this to be generally true in our study, there was one discrepancy. The plant *Ludwigia multinervia*, a wetland plant found in this region, was found in low numbers or was absent from the wetlands not used by blackbird colonies. In our study, a third of all nests were placed in this species and 13 of 15 Saffron-cowled blackbird nests were found attached to this species in a work by Fonseca et al. (2004). We can assume that this plant species is an important component of breeding sites for Saffron-cowled blackbirds in southern Brazil. Our results also concur with Petry and Krüger (2010), who showed that there was a high association between Saffron-cowled blackbirds and recently burned fields. The grass within 10 m around the wetland was much lower in the wetlands used by blackbird colonies in our study. Saffron-cowled blackbirds forage for arthropods on the ground and are favored by low vegetation (Fraga et al. 1998).

The wetlands selected by blackbird colonies also had less open area on the ground, inside of the wetland. It has been suggested that deeper water levels in marshes reduce the amount of predators of marsh-nesting passerines and that the distance to the edge of the marsh is unimportant (Picman et al. 1993). This may hold true in marshes with deep water levels; however, the wetlands in this region of southern Brazil do not have water deep enough to be considered marshes, and there may be other selective forces acting on predator abundance in this environment. Thus, water level as a defense mechanism may be replaced by vegetation closedness, or density. *Eryngium horridum* is a member of the Apiaceae family with hairless, spiny leaves. Predators such as the Pampas fox (*Pseudalopex gymnocercus*), which is one of the primary predators of bird nests in the Campos de Cima da Serra region, may be deterred by thickets of *E. horridum*, even in areas of low water level and easier access. Saffron-cowled blackbirds were also found in wetlands with a strong presence of *Eryngium pandanifolium* in the coastal region of Rio Grande do Sul, Brazil (Dias and Maurício 2002) and with *Eryngium pandanifolium* and *Baccharis trimera* in the Rocha department of Uruguay (Azpiroz 2000). Conservation efforts in local conservation units and parks should prioritize preserving wetland vegetation that includes native plants such as *Eryngium* spp. and *Ludwigia multinervia*, and biologists or rangers should manage the height of the grass around the wetlands.

Nest Survival – livestock vs. agriculture

Landscape attributes may influence how a breeding site serves as a reproductive source or sink, and the greater the anthropogenic disturbance, the greater the presence of new predator communities may be (Vierling 2000). Our data support this theory: the São Francisco de Paula blackbird nests were more successful than those in Cambará do Sul. The nest placement parameters did not vary greatly between the two regions, which may indicate factors acting on a larger scale to influence habitat quality. The São Francisco de Paula wetlands are surrounded by livestock pastures that receive non-uniform (or patchy) prescribed fire every other year while the wetlands in Cambará do Sul are surrounded by plantations such as potatoes, broccoli and soy, usually with the crop extending up to 15 m of the wetland. Agricultural intensification has been shown to reduce the availability of food resources for grassland bird species in Europe (Brickle et al. 2000) and may also influence the predator community present. It has been shown that grasslands under grazing regimes support higher species richness than ungrazed grasslands (Isacch et al. 2004), and total bird species diversity and grassland obligate richness is highest in areas that experience a patch-burn regime, which creates a mosaic of vegetation patches in various stages of recovery (Coppedge et al. 2008). Although it is currently illegal, this type of burning occurs in the São Francisco de Paula region when ranchers burn small sections of their lands in attempt to avoid attention from environmental authorities. A study in the Brazilian cerrado found a positive relationship between arthropod abundance and burn frequency (Uehara-Prado et al. 2010), and other studies have found both negative and positive effects of fire on the arthropod community. Swengel (1996) found that fire promoted butterfly abundance in prairies.

Lepidopteran larvae and arachnids make up the greater percentage of Saffron-cowled blackbird nestling food (pers. observ.), and this species would therefore be benefited by areas with higher abundance of these important prey items. A more heterogenous environment, which is created by patch burning, offers a greater variety of refugia both for grassland birds and their prey and may benefit Saffron-cowled blackbirds and other species inhabiting wetlands with surrounding grasslands.

Many grassland bird species are also favored by decreased grass height since a reduced structure increases their ability to search for prey (Brickle et al. 2000). While not breeding, Saffron-cowled blackbirds fly great distances in search of food (> 200 m). During the breeding season, they often forage within 50 m of the wetland in which they are nesting (pers. observ.) and they take nesting material from within or from the edge of the wetland. Therefore, nesting success would be favored by an increased amount of ideal foraging area nearby where adults can readily find food for nestlings and females can find prey quickly and return to incubating eggs. Thus, the wetlands in São Francisco de Paula may offer not only a more heterogeneous environment for blackbirds to nest, but also a more favorable foraging environment due to the frequent burning and livestock grazing that occurs there. Occasionally fire enters the wetlands and burns the vegetation, which may also help to create the ideal vegetation structure for Saffron-cowled blackbirds nesting in these wetlands.

Another explanation of the different success rates between agricultural and pastoral wetlands is the predator community. During our study, twice we observed blackbirds mobbing the green snake *Philodryas patagoniensis* and on several occasions one or several blackbirds mobbing a Long-winged Harrier *Circus buffoni*. *Philodryas patagoniensis*, a known nest predator in the Campos de Cima da Serra region, was only seen in the Cambará do Sul wetlands. One of the Cambará do Sul wetlands in our study was completely depredated. Of the nine nests found in this wetland, eight were depredated during the egg phase and one during the nestling phase. Rodent feces were found in five of the nests and three nests had holes in the bottom. An abundance of both predators could be associated with the surrounding agriculture, which provides tall grass in which small mammals and snakes can easily hide. An increase in numbers of small mammals present may also attract larger predators such as the Pampas Fox, which is an omnivore and although attracted to the small mammal population, would also take advantage of easy-to-reach bird nests. Šalek et al. (2010) found that a high abundance of carnivores in habitat edges was associated with the increased number of small mammals at these edges. Three of the five nests that failed in São Francisco de Paula were depredated during the nestling period, and we observed several nests already empty, torn out of position. The likely predators of nests in these wetlands are the Pampas Fox, which had a den between the two wetlands; a Long-winged Harrier, which was often seen being chased away by male and female blackbirds; or a Southern Crested Caracara, which congregates in groups of up to 30 individuals around one of the two wetlands, next to a pine tree plantation. Birds are a known item in the diet of the Pampas Fox (García and Kittlein 2005), Southern Crested Caracara (Travaini et al. 2001) and Long-winged Harrier (Bó et al. 1996). In the United States, the colonial nesting strategy of Red-winged blackbirds was more effective in reducing predation by avian predators, and eastern and western populations of blackbirds suffer pressure from different predator communities (Weatherhead and Sommerer 2001). The Saffron-cowled blackbird is also a colonial nester and this behavior may be more effective in defending against large mammals and birds than against small mammals and reptiles.

Nest site characteristics – failed vs. successful nests

Only one nest in our study was parasitized, so parasitism was unimportant for nest failure. This may be due to the presence of conspecifics with similar biology and parasitism vulnerability, such as the Yellow-rumped Marshbird *Pseudoleistes guirahuro*. This phenomenon was seen in a study by Fernandez and Mermoz (2000), in which Brown-and-yellow Marshbirds suffered a much higher egg loss and hatching failure due to parasitism by *Molothrus* spp. than the sympatric Scarlet-headed Blackbird *Amblyramphus holosericeus* in wetlands inhabited by both species. In our study, the wetland in which the nest was parasitized was the only wetland in which *P. guirahuro* was not nesting simultaneously and where several small flocks of *Molothrus bonariensis* were seen on several occasions.

The development and intensification of agricultural and pastoral activities in native grasslands has caused widespread habitat loss throughout South America, and the remaining habitat is often greatly reduced in size or of poorer quality. Many areas that once served as population sources can easily become sinks if the quality is significantly impacted by development activities. We saw in our study that successful blackbird nests were further from the edge of the wetland, further from the edge of the supporting plant and in denser vegetation than unsuccessful nests. Edges can negatively impact birds through greater levels of nest predation by predators of two ecotones and those using edges as travel lanes and higher levels of nest parasitism by cowbirds (Gates and Gysel 1978, Brittingham and Temple 1983, Wilcove 1985, Paton 1994, Bollinger and Switzer 2002, Winter et al. 2005). As habitat fragmentation increases, so too does the amount of edge relative to area in habitat patches, and edge-sensitive species will become increasingly disadvantaged. The higher rate of predation in edge nests in our study can also be explained by the preference of some predators to edge environments (Heske et al. 1999). Gates and Gysel (1978) coined the term ecological trap when referring to edge habitats that offer nesting locations, but may have higher rates of predation. Some wetlands found in the Campo de Cima da Serra region may serve as ecological traps for nesting bird species if predation rates are indeed higher on the edges, which are structurally similar to the interior. In fact, Albrecht (2004) showed that edge habitats may not be perceived as suboptimal habitats by breeding Scarlet Rosefinches in wetlands, despite high rates of brood loss there. Báldi and Bátari (2005) also found that predation rates were greater and more variable on the edge of reedbeds and lower and more stable on the interior of these wetlands. Thus, conservation of large wetlands with a more circular shape that offers more interior habitat for nesting birds should be a priority in the Campos de Cima da Serra region.

Conclusions

Grasslands are one of the biomes in which habitat loss has been most extensive. While over half of these areas have been converted to anthropogenic uses, only 5% of the world’s grasslands are under legal protection (Stotz et al. 1996, Hoekstra et al. 2005) and only about 1% of the southern South American Pampas and Campos regions are protected (Henwood, 2010). Now covering only 25% of their original extension, the grasslands in Rio Grande do Sul are being rapidly converted to agricultural and silvicultural lands (Bilenca & Miñarro, 2004; Pillar 2003; Cordeiro and Hasenack, 2009) and the wetlands of Rio Grande do Sul are suffering vast changes and loss from antropogenic activities such as farming, livestock industry and urbanization (Carvalho and Ozorio, 2007). Thus, species such as the Saffron-cowled Blackbird that need both of these threatened environments to survive are at an even greater risk of population decline.

The reproductive success of these blackbird colonies was low, particularly in nests closer to the edge and in nests within an agricultural landscape. These data show, in this southern South American species, that edges are associated with nest failure. If nest failure is such that reproduction is insufficient for replacement, edges become population sinks. If, for lack of options, blackbirds continue to use sink wetlands, population decline will follow.

The wetlands of this study were all located on private property because this blackbird does not reproduce in the national parks of the region. This discrepancy is likely due to the lack of grass height management in local conservation units (Pillar and Veléz 2010). Prescribed fire is a federal offense in Brazil and the use of this management tool is illegal. Cattle owners who use fire to create new growth for livestock receive heavy financial penalties and parks are not permitted to burn. We saw in this study that this threatened species, and likely other species that inhabit these wetlands, depend on wetlands with dense, heterogeneous vegetation with a surrounding area of short grass. However, extensive and frequent burning could reduce habitat availability for some threatened species (Isacch et al. 2004) and burning during the breeding season can negatively influence reproductive success of breeding birds (Di Giacomo et al. 2011). Further studies are needed to evaluate the effect of the shape and size of these wetlands and the direct impact of management regimes that include fire and grazing on birds and other wildlife utilizing these wetlands.

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Tables

Appendix 1 – Table 1

Table 1. Vegetation characteristics of 16 wetlands in the Campos de Cima da Serra region, southern Brazil. Means presented ± standard error (SE) and significance of *t* - tests between treatment groups (P).

	With colonies n = 8	Without colonies n = 8	*P*
Density plants/m2			
Eryngium horridum	12.95 ± 1.58	9.78 ± 1.56	0.17
Baccharis spp.	1.38 ± 0.36	1.77 ± 0.27	0.40
Ludwigia multinervia or Poaceae	1.28 ± 0.28	0.80 ± 0.29	0.25
Average density	19.03 ± 1.19	16.60 ± 2.21	0.35
Height (cm)			
Eryngium horridum	97.44 ± 11.27	73.35 ± 5.55	0.08
Baccharis spp.	94.44 ± 9.57	70.52 ± 5.95	0.06
Ludwigia multinervia or Poaceae	107.04 ± 9.84	64.35 ± 4.98	0.002
Average height	99.86 ± 7.70	69.93 ± 4.66	0.01
Surrounding grass	10.80 ± 1.68	23.05 ± 3.54	0.01
% Exposed soil	10.63 ± 4.48	28.75 ± 3.87	0.01

Appendix 2 – Table 2

Table 2. Estimates of daily nest survival and overall percent survival for the entire nesting period (28d) for Saffron-cowled blackbirds (*Xanthopsar flavus)* studied at two sites in the Campos de Cima da Serra region, southern Brazil, 2012.

Site	Population size (mean ± sd)	Daily survival	% Nest success	Number of Nests	Observer days
Cambará do Sul	40 ± 20	0.91466	11.8	18	64
São Francisco de Paula	53.3 ± 41.6	0.95428	32.5	11	64

*Overall survival = (daily survival) 28

Appendix 3 – Table 3

Table 3. Vegetation characteristics of 6 wetlands in the Campos de Cima da Serra region, southern Brazil, separated by region. Cambará do Sul is predominantly agricultural landscape and São Francisco de Paula has a predominantly livestock landscape. Means ± standard error (SE) and *t* -tests between treatment groups (P).

	Cambará do Sul (n = 3)	São Francisco de Paula (n = 3)	*P*
Density plants/m2			
Eryngium horridum	3.36 ± 0.38	1.85 ± 0.39	0.05
Baccharis spp.	1.93 ± 0.93	0.87 ± 0.18	0.32
Ludwigia multinervia or Poaceae	1.60 ± 0.53	0.73 ± .37	0.25
Average density	21.27 ± 1.22	17.80 ± 2.69	0.31
Height (cm)			
Eryngium horridum	116.34 ± 18.7	73.94 ± 18.74	0.19
Baccharis spp.	104.11 ± 13.98	70.72 ± 13.41	0.16
Ludwigia multinervia or Poaceae	108.44 ± 8.71	105.44 ± 28.70	0.93
Average height	109.63 ± 6.99	83.92 ± 17.31	0.02
Surrounding grass	11.73 ± 2.87	12.48 241 ± 3.32	0.87
% Exposed soil	0	21.67 ± 6.01	0.07

Appendix 4 – Table 4

Table 4. Nest site characteristics for Saffron-cowled Blackbird nests in the Campos de Cima da Serra region, southern Brazil, divided by city. The surrounding landuse in São Francisco de Paula was low-density livestock and of Cambará do Sul was agriculture. *t* tests for comparisons of nest means between regions.

	Nest location		
	São Francisco de Paula (n=11)	Cambará do Sul (n=18)	*P*
Distance to edge (m)	9.77 ± 2.40	7.50 ± 1.13	0.41
Dist. to nearest neighbor (m)	11.36 ± 2.14	10.69 ± 1.08	0.76
Height above ground (cm)	30.73 ± 3.21	48.89 ± 6.31	0.04
Height support plant (cm)	71.68 ± 7.41	110.67 ± 7.56	0.002
Dist. To edge of support plant (cm)	6.64 ± 1.81	6.44 ± 0.87	0.915
% Cover	55.00 ± 7.57	57.22 ± 6.66	0.832
Plant density/m	7.99 ± 0.64	7.93 ± 0.46	0.934
Plant height	58.61 ± 5.18	90.51 ± 6.86	0.003

Appendix 5 – Table 5

Table 5. Nest survival models for Saffron-cowled blackbird nests (n = 29) in the Campos de Cima da Serra region, southern Brazil. Models show the best model (lowest AICc value), candidate models and null (constant survival) model. Also included are the number of parameters (k) and AICc weights (w) for each model. Global models include linear effects of group (interior vs. edge), linear effects of date, and age-date interaction.

Model	k	AICc	Delta AICc	w
Constant survival	1	102.541	1.38	0.33354
Group	2	101.156	0	0.66646
Date	48	184.985	83.83	0
Date + group	87	327.744	226.59	0

Appendix 6 – Table 6

Table 6. Nest site characteristics for Saffron-cowled Blackbird (*Xanthopsar flavus*) nests in the Campos de Cima da Serra region, southern Brazil, divided by outcome. *t* test significance presented for comparisons of nest means. Means ± standard error of the mean.

	Nest outcome		
	Failed (n=17)	Successful (n=12)	*P*
Distance to edge (m)	6.40 ± 0.96	11.13 ± 2.22	0.04
Dist. to nearest neighbor (m)	12.15 ± 1.57	9.25 ± 1.00	0.17
Height above ground (cm)	42.00 ± 5.54	42.00 ± 7.39	1
Height support plant (cm)	97.29 ± 8.21	93.88 ± 10.84	0.26
Dist. To edge of support plant (cm)	5.06 ± 0.94	8.58 ± 1.42	0.04
% Cover	51.76 ± 7.04	62.92 ± 6.47	0.28
Plant density/m	7.31 ± 0.45	8.86 ± 0.52	0.03
Plant height	76.76 ± 6.57	80.75 ± 9.70	0.73

Figures

Appendix 7 – Figure 1

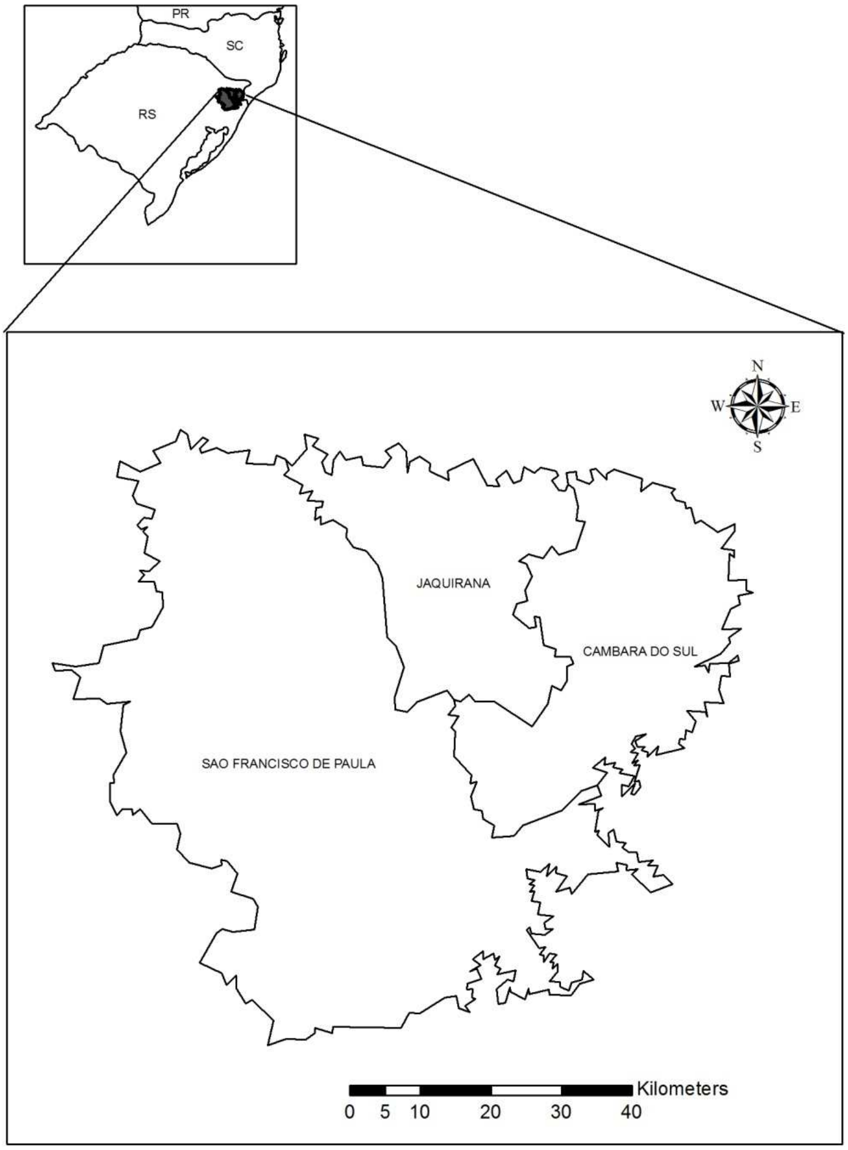

Figure 1. Map of study area: A. The state of Rio Grande do Sul, southern Brazil and B. Counties included in the Campos de Cima da Serra region.

Appendix 8 – Figure 2

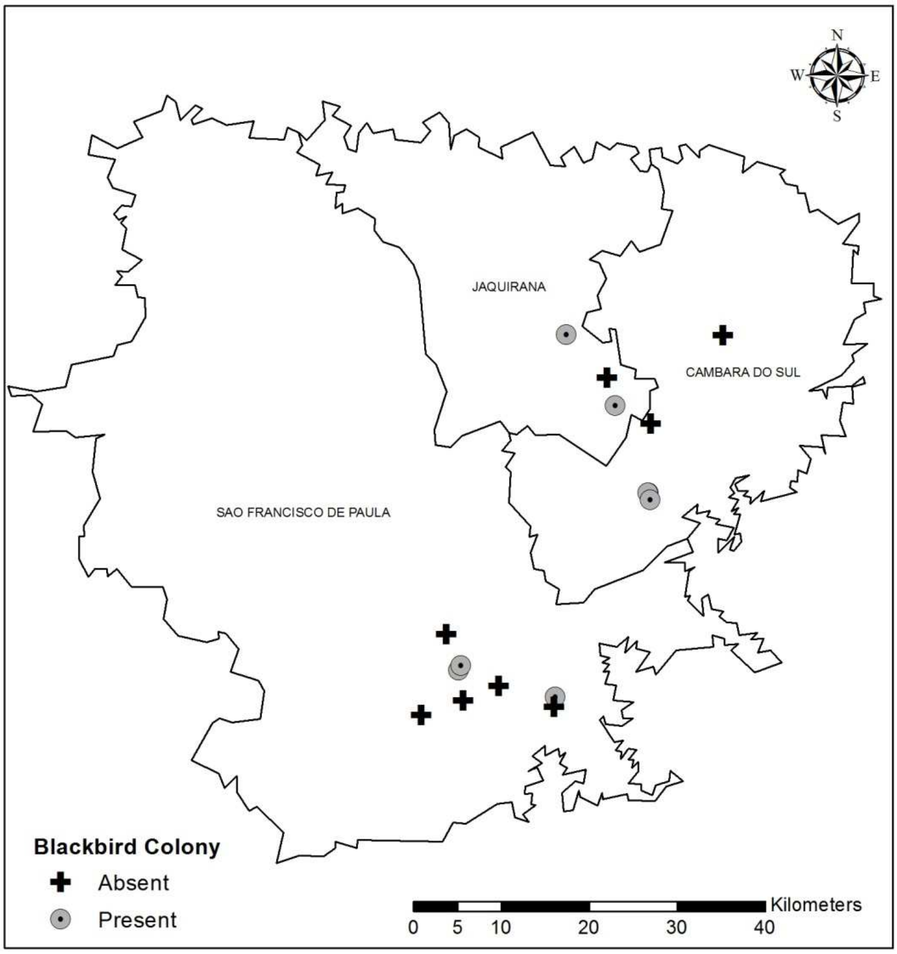

Figure 2. Map of 16 wetlands sampled for vegetation characteristics in the Campos de Cima da Serra region, southern Brazil. Eight wetlands had breeding colonies of blackbirds (circles) and eight did not (crosses).

Appendix 8 – Figure 3

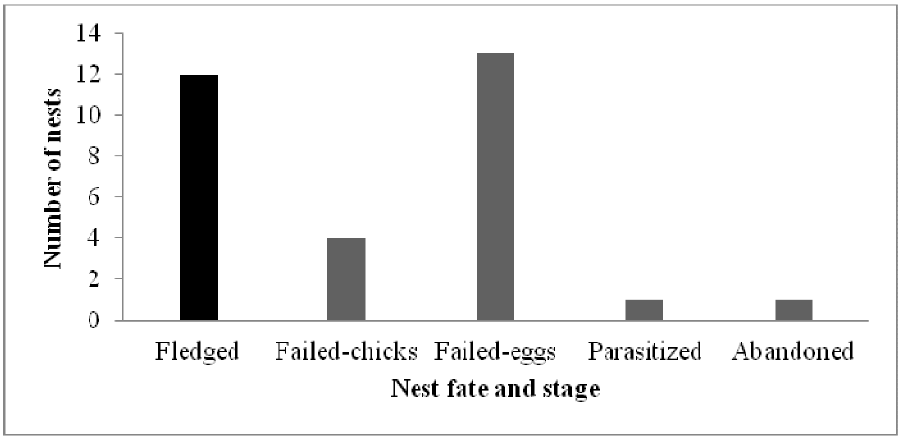

Figure 2. Nest fate of 30 Saffron-cowled blackbird nests monitored during the 2012 breeding season in the Campos de Cima da Serra region, southern Brazil. One nest was parasitized by one *Molothrus bonariensis* chick.