ZOOLOGIA 34: e20783
ISSN 1984-4689 (online)
zoologia.pensoft.net

RESEARCH ARTICLE

The breeding biology, nest success, habitat and behavior of the endangered Saffron-cowled Blackbird, *Xanthopsar flavus* (Aves: Icteridae), at an Important Bird Area (IBA) in Rio Grande do Sul, Brazil

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http://zoobank.org/68508FE5-9679-43E5-83AC-B2369249B68A

ABSTRACT. The Saffron-cowled Blackbird, *Xanthopsar flavus* (Gmelin, 1788), is a globally vulnerable icterid endemic to grasslands and open areas, and a priority species for research and conservation programs. This contribution provides information on the population size, habitat, behavior, breeding biology and nest success of *X. flavus* in two conservation units (CUs) in Viamão, state of Rio Grande do Sul, Brazil: the Environmental Protection Area Banhado Grande, and the Wildlife Refuge Banhado dos Pachecos, classified as an "Important Bird Area". Searches for *X. flavus* were carried out mainly in open areas, the type of habitat favored by the species. Outside the breeding season individual behavior was recorded by the *ad libitum* method; during the breeding season, selected *X. flavus* pairs were observed following the sequence sampling method. The research areas were visited once a month, totaling approximately 530 hours of observations (September 2014 to June 2016) over 84 days, which included two breeding seasons. The species was observed across all months (not necessarily within the same year) and several *X. flavus* flocks were encountered, some with more than one hundred individuals (range = 2-137). Additionally, the behavior and feeding aspects, habitat use and breeding information on *X. flavus* were recorded. Two breeding colonies were found, and eleven nests were monitored. The estimated nesting success was 10% in Colony 1, but zero in Colony 2, where all eggs and nestlings were predated. Saffron-cowled Blackbirds were recorded in mixed flocks, mostly with *Pseudoleistes guirahuro* (Vieillot, 1819), *P. virescens* (Vieillot, 1819) and *Xolmis dominicanus* (Vieillot, 1823), the last also a globally endangered species. The collected information highlights the importance of CUs for the maintenance of *X. flavus* populations in the region. Maintenance of proper areas for feeding and breeding is necessary and urgent. Information from current research is being employed in the management plan of the Wildlife Refuge Banhado dos Pachecos in which *X. flavus* is one of the conservation target-species.

KEY WORDS. Conservation, habitat degradation, natural history, vulnerable species.

INTRODUCTION

The Saffron-Cowled Blackbird, *Xanthopsar flavus* (Gmelin, 1788), is an endemic species of the grasslands of southern South America (Collar et al. 1992). The species is of high priority for conservation and research (Stotz et al. 1996, Fontana et al. 2013). This bird depends on heterogeneous areas of natural grassland, and uses different habitats for feeding and nesting (Fonseca et al. 2004, Fraga 2005, Azpiroz et al. 2012). It is currently listed as vulnerable at the regional, national and global levels (State Decree 51.797/2014, ICMBio/2014, IUCN 2016), largely due to the destruction and degradation of its habitat, and the consequent disruption of its biological cycle.

The geographical distribution of the Saffron-Cowled Blackbird includes southern Brazil (states of Santa Catarina and Rio Grande do Sul), southern Paraguay, Uruguay and northeastern

Argentina (Collar et al. 1992, Azpiroz 2000, Dias and Maurício 2002, Fonseca et al. 2004, Fraga 2005, Birdlife International 2016). According to Collar et al. (1992), Saffron-Cowled Blackbird populations are decreasing throughout their distribution range, and for this reason it is important to protect the areas that still remains adequate to its life-cycle (Azpiroz 2000, Azpiroz et al. 2012). The world population of the species is estimated at 10,000 individuals, at the most (Birdlife International 2016).

In Brazil, information on the species' natural history and conservation comes mainly from studies and observations carried out in the extreme north-eastern corner of the country (Belton 1994, Fonseca et al. 2004, Krüger and Petry 2010, Petry and Krüger 2010, Moura 2013) and on the southern coastal plain of the state of Rio Grande do Sul (Dias and Maurício 2002). Due to its status as a vulnerable species, new information on the species at other sites is both relevant and important. The current study provides data on the size of the Saffron-Cowled Blackbird population, habitat, behavior, breeding biology and nest success from an Important Bird Area (IBA) and its immediate vicinity, on the internal coastal plain of Rio Grande do Sul, Brazil.

MATERIAL AND METHODS

The study area lies in the municipality of Viamão, within the coastal plain of the state of Rio Grande do Sul, southern Brazil (Fig. 1). It comprises the "Wildlife Refuge Banhado dos Pachecos (WRBP)" (30°05'45.43"S, 50°51'46.38"W), and the "Environmental Protection Area of Banhado Grande (EPABG)" and its immediate vicinity. The study areas lie within an ecotone zone between the Atlantic Rain Forest and Pampas biome. Sandbank vegetation, pioneer shrub-tree woods, swampy areas with Cyperaceae and high grass, flooded fields, dry marshes, pastures and areas with anthropic activities (mainly livestock and rice fields) occur within the limits of WRBP and EPABG (Accordi and Hartz 2006).

EPABG, a Sustainable Conservation Unit of approximately 133,000 ha, was established in 1998 (State Decree 38.971/1998). WRBP is an Integral Protection Conservation Unit, with 2,543.46 ha, established in 2002. No environmentally degrading anthropic activity is allowed there (State Decree 41.559/2002). The preserved areas protect the region's wetlands and water sources. The WRBP is classified as an "Important Bird Area" (IBA), highly relevant for bird conservation, particularly for species that depend on dense marshes and wet grasslands, including endangered species (Bencke et al. 2006). The research in the two protected areas was authorized by the Department of Environment (SEMA) of the state of Rio Grande do Sul (Authorization 01/2015).

The areas for the study of the Saffron-Cowled Blackbirds (SCB) were selected based on the results of Accordi and Barcellos (2006), Accordi and Hartz (2006), and on observations in the region during January 2014, when 12 SCBs and a bird couple with nest and two nestlings were reported in the EPABG. Monthly reports on SCB occurrences (from September 2014 to June 2016) were the result of research within the WRBP, and on the main and secondary roads in the area surrounding the EPABG. Roads were traversed by car at low speed (<10 km/h) and on foot. Research efforts focused on marshy areas and grasslands characterized by *Eryngium* sp. L. (Apiaceae), Cyperaceae and Asteraceae which may be used for breeding and in fields or pasturelands, with low vegetation, used for feeding.

When a SCB was detected, the number of individuals in the flock was counted, and the associated species, or species that interacted with SCBs, were identified. The birds were taxonomically identified and quantified by direct observation, or identified by their calls. Classification followed Piacentini et al. (2015). After the counting of individuals, each area was observed for 60 minutes to investigate individual arrivals and their behavior. Outside the breeding season, all SCB occurrences were noted, along with associated behaviors (Franchin et al. 2010). During the breeding season both *ad libitum* and sampling sequences methods were used (Franchin et al. 2010). In the latter case, selected pairs were monitored. However, whenever the birds seemed uncomfortable with the presence of the observer, monitoring was temporarily interrupted. Areas with SCB occurrences were visited once a month, totaling approximately 530 hours of field observations during 84 days (between September 2014 and June 2016), including two breeding seasons, across 22 months. Observations were conducted in the morning, during the day, and in the afternoon.

In the breeding seasons, two nesting areas were found and named "Nesting Colony 1" and "Nesting Colony 2". After the first report of breeding activity, the colonies were assessed for four consecutive days, after which nests were visited every three days (with one exception in each area when four days had passed). Once the nesting areas were abandoned, each nest's internal and external diameter, internal nest depth, external nest height and nest height from the ground were measured. All plant species supporting nests were identified and their heights were measured. All plants more than 60 cm high within a 1 m radius of the nest were also identified (Fonseca et al. 2004, modified), since they could support nests or predators. The tallest and the shortest plants (including leaves and inflorescences when present) were measured. Variables for each nesting colony were compared with a t-test using the statistical program Past 3.13 (Hammer et al. 2001).

Since no nest was found either under construction or during egg-laying, egg and nestling numbers are reported, but clutch size was not. To avoid research activities causing any reproductive loss, eggs and nestlings were not measured, and no specimens were captured or marked. To make comparisons possible, reproductive success was presented in two ways: first based on fledged chicks/eggs or nestlings rates so as to be comparable with some previous studies (Fraga et al. 1998, Dias and Mauricio 2002), and by apparent success (number of successful nests/total number of nests) to be comparable with others (Moura 2013). In the current study, nests were considered successful when at least one chick fledged.

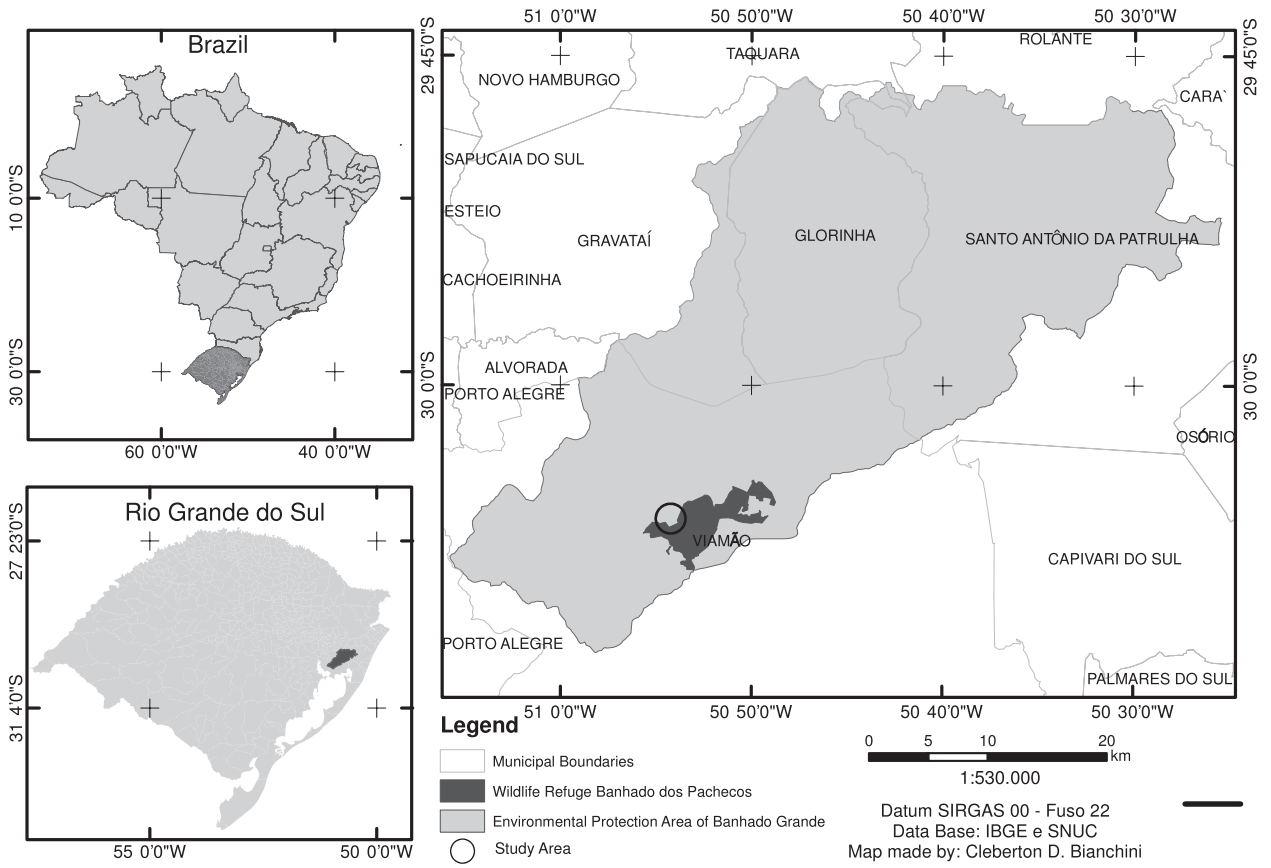

Figure 1. Map of study area, with the Wildlife Refuge Banhado dos Pachecos (WRBP) and, in its immediate vicinity, the Environmental Protection Area of Banhado Grande (EPABG), in the state of Rio Grande do Sul, Brazil.

RESULTS

SCBs in the WRBP mainly occupied a landscape characterized by fields and wetlands dominated by *Eryngium* sp. and *Typha domingensis* (Pers.) (Typhaceae). In the immediate vicinity of EPABG *X. flavus* was reported in dry field areas, mainly with *Schizachyrium microstachyum* (Desv. ex Ham.) Roseng., B.R. Arrill. and Izag. (Poaceae), in wet fields with *Eryngium* sp. occupied by livestock and horses, and in rice fields.

SCB were not encountered in the study areas in January and May, 2015, and in February, 2106. In the non-breeding season (during the austral autumn), the largest SCB flock (137 individuals) was reported in March 2015. Other sizeable flocks were reported in February 2015, January, April and May 2016, with 69, 96, 75 and 70 individuals, respectively. All reports occurred in areas close to the WRBP within the EPABG. During the first breeding season, the largest SCBs flock (16 individuals) was reported (November and December 2014) at a Nesting Colony 1 and a flock of 21 SCBs outside the nesting colony, on the edge of WRBP. In the second breeding season (November and December 2015) the largest flocks observed were 10 SCBs in Nesting Colony 2 and with 35 SCBs in a flock which was feeding within an adjacent area outside the Nesting Colony.

The habitats most commonly used by *X. flavus* for feeding were fields covered with short grasses and rice fields during the early maturation stages and post-harvest period. SCBs were mainly observed feeding on insects and insect larvae, usually foraging for them on the ground, while probing soil and vegetation. While some individuals were feeding on the ground, others took the role of sentinels, perched on eucalyptus *Eucalyptus* sp. L'Hér. (Myrtaceae) and maricá trees *Mimosa bimucronata* (DC.) Kuntze (Fabaceae). During the breeding season, two males, while acting as sentinels at the nest, were observed capturing flying insects and eating them in a manner similar to flycatchers.

In the non-breeding season, when SCBs were foraging in intraspecific flocks, two or three males took the role of sentinels and, through vocalization, appeared to warn off the other individuals to move away when researchers or possible

predators came close. Sentinels rested on the ground and perched on trees (*Eucalyptus* sp. and *M. bimucronata*). In the non-breeding season, SCB individuals were seen in mixed flocks with *Pseudoleistes guirahuro* (Vieillot, 1819) (Icteridae), *P. virescens* (Vieillot, 1819) (Icteridae), *Agelasticus thilius* (Molina, 1782) (Icteridae), *Sicalis luteola* (Sparrman, 1789) (Thraupidae), *Chrysomus ruficapillus* (Vieillot, 1819) (Icteridae), *Zenaida auriculata* (Des Murs, 1847) (Columbidae) and *Xolmis dominicanus* (Vieillot, 1823) (Tyrannidae). Within these *P. guirahuro* and *P. virescens* acted as sentinels.

SCB were recorded with the Black-and-White Monjitas (BWM), *X. dominicanus*, only in the autumn and winter, in April, May, June, July and August. During these months, the largest BWM gatherings respectively comprised of 2, 15, 20, 15 and 15 individuals. Largest mixed flocks of SCBs and BWMs were, respectively, 14 and 36 in June 2015; 15 and 15 in July 2015; 70 and 15 in May 2016; and 30 and 12 in June 2016.

In October, during the two breeding seasons evaluated, and approximately one month prior to the discovery of nests, SCB males were displaying to females in aerial courtship flights. Females in Nesting Colony 1 were reported inspecting *Eryngium* sp., while males perched close by. In the breeding season, SCB individuals were reported close to *Tyrannus savanna* Daudin, 1802 (Tyrannidae), *Progne tapera* (Vieillot, 1817) (Hirundinidae) and *Sturnella superciliaris* (Bonaparte, 1850) (Icteridae). During territorial disputes and defense, SCBs attacked individuals of the same and of other species, including *P. virescens* and *P. guirahuro*, and each defended a territory some 3 m-radius around the nest. On one occasion, a nesting pair in Nesting Colony 2 joined a mixed flock of *P. virescens* and *P. guirahuro* to feed in a field area approximately 30 m from the colony. Several times, SCB gathered together with specimens of *P. guirahuro*, *P. virescens*, *T. savanna*, *P. tapera* to drive off such predators as *Circus buffoni* (Gmelin, 1788) (Accipitridae), *C. cinereus*, Vieillot, 1816 (Accipitridae), *Milvago chimango* (Vieillot, 1816) (Falconidae) and *Falco femoralis* Temminck, 1822 (Falconidae).

In the first breeding season assessed, there were six nests (1-6) in Nesting Colony 1, five of which were measured (Table 1). One nest was damaged by water, making it impossible to take the full set of measurements. It should be underscored that in the same area, in January 2014, a pair with a nest containing two nestlings was recorded. During the second breeding season, five nests (7-11) were found and measured in Nesting Colony 2 (Table 1). Colonies were separated by some 3 km from one another. Nesting Colony 1 was characterized by small, near-isolated, clusters of *Eryngium* sp., whilst Nesting Colony 2 was composed of isolated *Eryngium* sp. individuals and a small dense cluster of these plants, although the nests lay at the edge of the site, in a matrix of otherwise low-lying grazed grassland. All nests in Nesting Colony 1 were attached to *Eryngium* sp., the dominant plant in the region, and were, on average, 51 cm from the ground. Only one nest (Nest 1) was fixed on the tallest plant in the area, even though this was only 35 cm from the ground. In Nesting Colony 1, the closest nests were 5 m apart, whilst the most distant were 52 m apart. In Nesting Colony 2, the closest nests were separated by 4.5 m, and the most distant by 70 m. One nest was fixed only to a *Scirpus* sp. L. (Cyperaceae); three nests were fixed to *Scirpus* sp. and *Eryngium* sp. simultaneously, and one nest was attached only to grass. The latter was closest to the ground. No nest was fixed to the tallest plant within the area surrounding the nests. In Nesting Colony 2, nest diameters and depths were greater than those of Nesting Colony 1 (Table 1), but there was no significant variation in all nest measurements between the two colonies during the two breeding seasons under analysis ($p > 0.05$). Although the variables mean heights of the tallest plant and mean height of the shortest plant around the nests differed significantly between the two nesting colonies analyzed ($p < 0.05$ for both), the mean height of the plants supporting the nests were not significantly different between sites ($p > 0.05$).

Table 1. Mean ± standard deviation (SD) of measurements of Saffron-Cowled Blackbirds' nests.

Measures (in cm)	Nesting Colony 1			Nesting Colony 2		
	N	Mean ± SD	Range	N	Mean ± SD	Range
Height of the nests' supporting plants	6	105.17 ± 23.80	84.0–147.0	5	89.8 ± 21.88	58.0–113.0
Height of tallest plants*	6	140.67 ± 17.10	122.0–164.0	5	96.8 ± 24.59	61.0–125.0
Height of shortest plants*	6	83.00 ± 9.70	72.0–98.0	5	46.8 ± 23.05	11.0–63.0
Nest height above the ground	6	51.33 ± 13.10	35.0–68.0	5	46.4 ± 18.65	21.0–73.0
Nest internal depth	5	5.24 ± 0.15	5.1–5.4	5	5.7 ± 0.51	5.1–6.3
Nest external height	5	12.38 ± 0.57	11.6–13.0	5	11.82 ± 1.58	10.5–14.5
Nest internal diameter	5	6.32 ± 0.35	5.9–6.7	5	6.88 ± 0.52	6.4–7.6
Nest external diameter	5	10.92 ± 0.31	10.4–11.2	5	11.67 ± 0.5	11.1–12.3

*Leaves and inflorescence.

Based on the number of eggs and nestlings observed in the two colonies (2-5), the average number of eggs per nest was calculated as 3.6 (± 0.84). One egg was laid per day and eggs hatched after 11-12 days (n = 1). Nestling lifespan (the time it took from egg-hatching to fledging) was analyzed following Azpiroz (2000). Nest 1 was discovered on November 28th, 2014 with four nestlings, aged one or two days. The nestlings vanished between the 9th and 12th day of life: it is possible that they flew out of the nest, but not probable. Since those nestlings were too young and were unable to take long flights, it would be expected that, if they were alive and well, they would be found nearby, but this did not happen.

Nest 2 was discovered on November 28th, 2014, with four one-day-old nestlings. They vanished during the night on the fourth day. This nest was the first monitored nest to be preyed upon. It was the farthest from the others, but the closest to the ground, on the edge of an irrigation canal. Paw tracks of the pampas fox *Lycalopex gymnocercus* (G. Fischer, 1814) (Canidae)

were found nearby. Nest 3 was discovered on November 29th, 2014 with two eggs. Then, on the following days, two more eggs were laid, one on each day. Nestlings were seen exiting the nest on the 9-10th day. This was sooner than the 12th day in the results of Azpiroz (2000). This accelerated fledging may owe to the intense heat on the nest, since it was exposed to the sun.

Nest 4 was discovered ready, but empty, on November 29th, 2014. It remained empty and it was impossible to say whether there had been eggs and/or nestlings in it, or whether it was abandoned right after it was built. Nest 5 was discovered on November 29th, 2014 with three nestlings, which were observed till the 9th day. They were not seen after this, even though they could fly out of the nest, albeit not for long flights. They were not seen within the area close to the nest. Nest 6 was found on November 30th, 2014 when it contained four eggs and a nestling aged one or two days. The latter was observed during the following eight days but was not seen after the 11th day. It may have flown out of the nest since it was not seen in the immediate vicinity. The eggs were neither predated nor removed from the nest. They still had not hatched on the last day of observations, on January 14th, 2015.

Based on the ratio of successful nests (at least one chick produced)/total number of nests evaluated for Nesting Colony 1, five out of six nests were successful (83%). On the other hand, only two fledgling birds at different stages of development were reported between December 10th, 2014 and December 23th, 2014 in the vicinity of Colony 1. Since they were only capable of hopping and short flights around the area, it is possible that they were the fledglings from Nests 1 or 5 and 3. If reproductive success is, following Fraga et al. (1998), calculated as the number of fledged chicks/eggs laid or nestling observed, then our estimates are close to 10%. In fact, out of the 20 possible individuals observed that could have developed in the Colony, only these two were observed.

Eight well-developed juvenile SCBs and two adult females were reported at another site, on the edge of the WRBP, on November 30th, 2014. They were perched on *M. bimucronata* and then flew together to the interior of the WRBP. At another area, on the edge of the WRBP, a pair was seen feeding four well-developed fledglings accompanied by a male helper. While the male flew in search of food, the female and the helper attacked a low-flying *C. buffoni* together. The four fledglings hid among cattail brushes (*T. domingensis*). In addition, a male with two juveniles were seen close by.

Although two pairs of Shiny Cowbirds, *Molothrus bonariensis* (Gmelin, 1789) (Icteridae), had been seen in Nesting Colony 1 in October, they were not observed there during the breeding period. Also, parasitism by this species on SCB nests was not observed. During a two-hour morning observation on Nest 2, a SCB pair was observed feeding four nestlings every 12 minutes on average (range 4-30 min). During the observation period of one hour and fifteen minutes, in the late afternoon, the average interval of feeding the nestlings of *X. flavus* was 12.3 minutes (range 10–13), with only the female engaged in this activity. During this period, the male was seen engaging in territorial defense in the nesting area.

During the second breeding season, Nest 7 was found on November 13th, 2015 with three eggs; the nest had two nestlings and one egg on November 21th, 2015; there were three nestlings on November 22th. Four days later, all the nestlings had been preyed upon. Nest 8 was discovered on November 13th, 2015 with three eggs, but only two eggs remained on November 15th. On November 21th, there was a nestling in the nest, but it was not seen again after November 26th. The pair associated with this nest was also not observed after this date. Nest 9 was seen between November 14th and November 16th with four eggs, but it was empty on November 18th. Traces of eggshells were seen on the ground close to the nest. Nest 10 was recorded in the morning (10 a.m.) of November 15th with four eggs, but it was empty in the afternoon (04:15 p.m.). The eggs were likely preyed upon during the day, but there were no traces of eggshells. Nest 11 was observed on November 15th with two eggs; two nestlings were recorded on November 21th; there was only one nestling on November 26th, and the nest was empty on December 1st. The fledgling may have flown out of the nest, but it was not seen in the vicinity.

Apparently, in Colony 2 there were two successful nests out of five (40%). However, we have almost certainly overestimated the reproductive success of the parent birds, since the fledged and juvenile offspring were not observed in the area close to the nests. It is possible that successful breeding did not occur at all in the colony. Beyond those attempts related above, the colonies were not observed making any new breeding endeavors during the study period.

DISCUSSION

Habitat

The habitats used by individual SCBs were the same as those recorded in other studies (Belton 1994, Azpiroz 2000, Dias and Maurício 2002, Fonseca et al. 2004). SCBs engaged in activities such as resting, concealment and feeding of young mainly in wetlands containing *Eryngium* sp. and *T. domingensis*. *X. flavus* feeds in low grassland areas. As there is no active land management at WRBP, the grasslands have a high percentage of tall vegetation, making them inappropriate as SCB feeding areas. As a result, the birds must fly long distances to find suitable feeding areas. In some of our observations, adults had to fly between 0.6 and 1km to obtain food.

The lack of established SBC breeding areas at WRBP may be due to the distances between potential nesting sites and feeding areas within the protected area. In the immediate vicinity of EPABG, SCBs were frequently reported feeding in areas with rice crops, in dry fields and in wet fields with *Eryngium* sp. In the fields with *Eryngium* sp., there were also livestock and horses.

Although these herbivores impair the growth of plants that SBCs use for nest building, they keep the vegetation stature low, which is appropriate for the foraging of *X. flavus*.

Number of Blackbird

According to the Birdlife International (2016), there are approximately 10,000 SCB individuals within the four countries where this bird is distributed. Reports from Uruguay indicate flocks averaging 60 specimens (1-135) (Azpiroz 2000), whereas in Paraguay, flocks are composed of 30-50 individuals, but up to 250 specimens were observed feeding in wetlands and rice fields (Esquivel et al. 2007), and some 300 SCBs were recorded at an area where soybean and corn were being cultivated (Codesido and Fraga 2009). Flocks of up to 240 specimens have been reported from Argentina (Fraga 2005).

In Brazil, flocks with more than 70 individuals have been reported in Bom Jesus (RS) and Lages (SC) (Fontana et al. 2008). In the natural higher-altitude grasslands of Rio Grande do Sul, at a locally known as "Campos de Cima da Serra", flocks of up to 30 individuals have been recorded (Fonseca et al. 2004), with up to 100 individuals in breeding colonies, and 300 birds outside the breeding season (Moura 2013). Flocks with approximately 60 individuals have been reported from the southern coastal plain of Rio Grande (Dias and Maurício 2002). The occurrence of *X. flavus* in the region under study (EPABG and WRBP) has been known for at least fifteen years (Accordi and Hartz 2006). In the past, flocks with 52 specimens, with estimates of no more than 100 specimens, were recorded (Bencke et al. 2003). Therefore, the frequent observations of flocks with fewer individuals during the current study, flocks ranging between 50 and 90 specimens on 18 occasions, and a flock of 137 specimens on a single occasion, are important findings, since they show that the species is present in the region and demonstrate the importance of landscape heterogeneity for the conservation of the species.

During the two breeding seasons in this study, the number of individuals was seldom greater than the number of couples engaged in building and taking care of their nests. In contrast, during the summer and the beginning of autumn, when juvenile birds were present, the most numerous flocks were reported. Since breeding success was very low and no more than a single nesting attempt was observed per colony per year, the occurrence of juvenile SCBs in the study area indicates that other colonies are extant in the region and that at least a portion of the population undertakes annual movements. According to Fraga et al. (1998), flocks may make irregular dispersive movements and may be highly mobile in the non-breeding season, which accounts for variations in the number of individuals.

Foraging habitats

The most common foraging habitats of the birds observed in this study were areas of low-growing native grassland or with rice stubble. This is consistent with observations made in other locations (Belton 1994, Dias and Maurício 2002, Fraga 2005, Bencke et al. 2003). In the current study, SCBs were seen perching on exotic and native trees on which they rested during feeding intervals. Fraga et al. (1998) also observed it in Argentina. In the breeding season, two males were observed capturing insects in the air and eating on them, which is rather unusual. Since they were defending their territory and females were absent, we believe that this is a way by which they can eat and guard the site at the same time.

Social behavior and interactions with other species

When it comes to interspecific interactions, SCBs interacted most frequently with *P. guirahuro* and *P. virescens*, while foraging outside the breeding season. Similar interactions were also reported by Fraga et al. (1998), Azpiroz (2000) and Dias and Maurício (2002). Frequently, the marshbirds acted as sentinels and benefitted the SCBs as they are ground-based feeders. In the non-breeding season, two or three SBCs acted as the sentinels in the intra-specific flocks, perching either on the ground or on trees.

Between April and August, we often observed SCBs feeding with the BWM, *X. dominicanus*. This is also an endangered species, in the same category as the SCB. In fact, SCBs were always observed following BWMs during foraging. This association is beneficial since BWMs play the role of sentinels (Fraga 2005, Kruger and Petry 2010), and since the two species differ in their foraging modes, they are not in competition with each other. Frequently, BWMs were more conspicuous than the SCBs in mixed flocks. Their association has been defined as a proto-cooperation relationship (a non-mandatory ecological relationship in which both species benefit) (Bencke et al. 2003). This type of interaction was observed in Brazil (Dias and Maurício 2002, Fonseca et al. 2004, Mohr et al. 2012), and elsewhere (Azpiroz 2000, Fraga et al. 1998). BWMs occur in the region only during the austral autumn and winter (Accordi and Hartz 2006), and show seasonal dispersion movements. The significant numbers of BWMs encountered shows that the study region is also important to the life cycle of this vulnerable species. The current study found almost three times as many BWM specimens than previously reported for the WRBP region (Bencke et al. 2003).

We observed SCBs defending small areas around the nests, but even when these birds were close to the colonies, they did not defend their feeding areas. They joined flocks of individuals from other species to mob and drive off *C. cinereus*, *C. buffoni* (several times), *M. chimango* and *F. femoralis*. Other studies also have described SCBs and other species chasing predators away (Fraga 2005, Fraga et al. 1998).

Breeding biology and nest success

The characteristics of the nests of *X. flavus* were similar to those described by Azpiroz (2000). The nests were fixed to plants such as *Eryngium* sp. and *Scirpus* sp., as reported for other sites (Fraga et al. 1998, Azpiroz 2000, Dias and Maurício 2002). We did

not observe nests on *Baccharis* sp. L. (Asteraceae) and *Ludwigia* sp. L. (Onagraceae), even though in the highland grasslands of Rio Grande do Sul those two plants are used by SCBs to build nests (Fonseca et al. 2004, Moura 2013).

All measurements of internal and external diameter, internal depth and external height of nests obtained in Uruguay (Azpiroz 2000) were greater than in the current research, and in Fonseca et al. (2004), in Rio Grande do Sul, Brazil. Contrastingly, mean height of nest attachment from the ground was greater in the current study than in the data of Azpiroz (2000), but less than in Fonseca et al. (2004). Overall, the mean height of the nest-supporting plants was greater than reported by Fonseca et al. (2004).

Mean heights of the tallest and shortest plants surrounding the nest and the mean height of plants on which the nests were fixed were smaller for the colony evaluated during the second breeding season, albeit not significantly. The isolated nests near the ground, and not covered by vegetation were the first to be preyed upon. The height of the supporting plant does not seem to be a selection factor for nest building, since no nest was fixed on the tallest of the plants in the studied area around the nests.

The laying of one egg per day by SCBs was reported by Azpiroz (2000) and Moura (2013). The mean number of eggs laid was lower than reported by Moura (2013) for the highland fields of Rio Grande do Sul. The four unhatched eggs in Nest 6 were not preyed upon, which may owe to the fact that this nest was the highest from the ground, with the tallest *Eryngium* sp. surrounding it. Some fledglings survived long enough to leave the nest, but they would not have been sufficiently well developed to fly. Additionally, they were not seen near the nests. Two nestlings were recorded jumping out of the nest prior to being fully-fledged. It is possible that this premature nest fledging was due to the heat, since the nest was unprotected from the sun. Females were frequently reported feeding nestlings, while males were on territorial duty. This was also reported by Moura (2013).

Comparing the rate of fledged chicks/eggs or nestlings observed, the estimated breeding success for Nesting Colony 1 (10%) was higher than the 8.4% in Argentina, calculated by Fraga et al. (1998), but lower than for Uruguay (42.9%: Azpiroz 2000) and the southern coastal plain of the state of Rio Grande do Sul, Brazil (Dias and Maurício 2002). Dias and Maurício (2002) estimated a breeding success between 31.8% and 36.3% in the southern region of the state.

In the highland fields of Rio Grande do Sul, and using the apparent reproductive success, Moura (2013) reported that 19 of 47 nests produced nestlings (41%). Regarding to the apparent success reported in the current analysis, the rate of Colony 2 was (40%), close to the above, whilst the rate of Colony 1 was much higher (83%). In these cases, the apparent success based on nests that produced at least one chick, seems to overestimate reproductive success in the colony, since it is not possible to know the fate of the chicks. This is pertinent since in Colony 1 only two juveniles were observed, and none in Colony 2. It is likely that any other juveniles raised in the study colonies would have been seen close-by, since they were not able to undertake long flights.

It is highly probable that the Nesting Colony 1 area has not been used again for breeding, since the landowner removed approximately 60% of the *Eryngium* sp. late in September 2015. Petry and Krüger (2010) observed that, after a burning event that destroyed the vegetation in a wetland used for breeding, SCBs took three years to return to the site. If the Nesting Colony 1 area is not severely altered again, it will perhaps be used in the future by *X. flavus*, as several SCB specimens have been reported using the area for resting and foraging throughout the year.

Although two Shiny Cowbird pairs (*M. bonariensis*) were seen at Nesting Colony 1 on October 2014, parasitism of SCB nests was not recorded. While at some locations no nest parasitism is reported even when the Shiny Cowbird is commonly observed (Belton 1994, Dias and Maurício 2002), its parasitism has been reported in other areas of the state of Rio Grande do Sul (Moura 2013). Nest parasitism by this species has been considered one of the main drivers of low breeding success of the SCB in Uruguay and Argentina (Fraga et al. 1998, Azpiroz 2000).

Predation on nestlings and eggs was higher at Nesting Colony 2, where, for example, four eggs from the same nest were preyed upon on the same day. It was there that the nest placed nearest to the ground and built on grasses might have facilitated the predatory activities. Traces of eggshells were discovered near another nest; possible predators of eggs and nestlings may have been the colubrid snake *Philodryas patagoniensis* (Girard, 1858) (Dipsadidae), or the pampas fox, observed close to the colony area, among others.

Fledgling SCBs from Nests 8 and 11 were sufficiently old to fly off the nest but they were not seen in the area. Normally, juveniles remain for almost a month within the nest area after their first flight (Azpiroz 2000). Since juveniles were not reported in the area close to the nests, lack of breeding success in the colony is suspected. However, the 14 SCB juveniles in the area at the edge of WRBP in November 2014 and the 15 juvenile specimens seen in the EPABP in January 2016 indicate that there are other breeding colonies of *X. flavus* in the region. Due to the development stage of these specimens and to reports in the areas under analysis, it is not likely that they belonged to the assessed colonies.

Conservation

Overall, the Birdlife International (2016) considers *X. flavus* as being in rapid and continuing decline. The main causes of this are destruction and degradation of its natural habitats, mainly the transformation of natural grasslands into monocultural fields, and the drainage of wetlands. The SCB is no longer found at traditional sites for the species in Rio Grande do Sul, such as Novo Hamburgo, Guaíba and others (Belton 1994, Bencke et al. 2003).

Within the area analyzed, the main threats in areas adjacent to the WRBP are the transformation of open fields (used for cattle) into rice fields and the removal of the shrubs and *Eryngium* sp., which SCBs use to support their nests. The "cleansing" of the fields is a culturally common practice in the state; it is considered to provide more space for livestock. According to the legislation that accompanied its establishment, EPABG should be sustainable and preserve the Gravataí River basin and associated wetlands. However, few wardens are allocated for its protection and environmental degradation is constantly on the increase. On the positive side, there are no livestock and agricultural activities at the WRBP, an area that is completely protected. As a rule, open natural grassland communities within conservation areas in southern Brazil are few and small (less than 0.5%) (Overbeck et al. 2007). This is also the case of the WRBP, where the few areas of natural grassland lack management and therefore are prone to invasion by shrubs and woodlands. Given their preference for rough grassland for nesting, SCBs at WRBP may have areas appropriate for nesting, but not for long term feeding. This may have been the cause of their movement to areas adjacent to the EPABG. The WRBP has extensive and continuous wetlands, with plants that are appropriate for the breeding of *X. flavus*, but they could not be reached due to the swampy features of the land. It is considered likely that this area is used as a dormitory by SCBs. Despite the evidence (observed juveniles) of other breeding colonies near the study area, such other sites were not found. Although there are reports of more than one hundred individuals in the study area, the population may be isolated from other flocks in the state, favoring inbreeding and the loss of genetic variability (Frankham et al. 2003).

Xanthopsar flavus seems to be adapted to cattle-breeding and agriculture environments, although they require open fields and wetlands with vegetation for nest construction (Fraga et al. 1998, Dias and Maurício 2002, Fonseca et al. 2004). Like many other endangered birds, *X. flavus* and *X. dominicanus* have great mobility and the delimitation of conservation units for the protection of these species is rather difficult (Fraga et al. 1998). In fact, *X. dominicanus*, like *X. flavus*, also build their nests in wetland areas, and the fact that their dispersion movements include the areas under analysis indicates the existence of other nearby areas where the species can breed. However, the distances that these species may travel remain unknown, and the possible location of these sites is difficult to estimate.

Like Petry and Krüger (2010), we would like to emphasize the relevance of conservation units that include areas of open natural grassland and to highlight the importance of the preservation of such areas with wetlands outside the CUs. Since 1998, a 380 household-strong settlement, called "Filhos de Sepé", has been established in the EPABG surrounding the WRBP. All reports of *X. flavus* from the EPABG have come from within the settlement (including the rice fields). Farmers from Filhos de Sepé are not allowed to use pesticides on their crops. This will certainly minimize the impacts of agricultural activities in the region and contribute to the maintenance of biodiversity, including the food items consumed by SCBs.

Subsidies for livestock production coupled with the preservation of native fields similar to the "Alianza del Pastizal" in Pampa biome countries, payment for environmental services, establishment and implementation of conservation units and increase in research activities will certainly assist the conservation of the species and the preservation of their environment (Develey et al. 2008, Fontana et al. 2013). Genetic and demographic analyses and investigation of regional movements should be prioritized when planning further studied on the conservation biology of *X. flavus*. More measures are required to protect the environmental mosaic needed for the maintenance of *X. flavus*, *X. dominicanus* and other endangered plant and animal species in the region. Information derived from current research is already being used in the preparation of a Management Plan for WRBP in which *X. flavus* is one of the target species for conservation.

ACKNOWLEDGEMENTS

We are grateful to Centro Universitário Univates and to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the scholarship granted to Luciane Mohr. Thanks are also due to Enerplan Group and Logos/Bioimagens Consultoria Ambiental for subsidizing several practical activities undertaken; to the farmers of the Assentamento Filhos de Sepé who allowed us access to their farms; to André Osório, the manager of WRBP and to Cleberton Bianchini, Jonas John, Samuel Gaedke, Camila Schmidt, Rafael Dalssotto, Ricardo Stertz, Manfred Ramminger and Andrea F. Steffens for helping with data collection. Adrian Barnett helped with the English.

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Submitted: 15 September 2016
Received in revised form: 3 February 2017
Accepted: 10 March 2017
Editorial responsibility: Luís Fábio Silveira

Author Contributions: LRSM and ARM conducted the field work; LRSM wrote most of the paper input from all other authors, whom also contributed to the data analysis.

Competing Interests: The authors have declared that no competing interests exist.