Nesting evidence, density and vocalisations in a resident population of Savannah Sparrow *Passerculus sandwichensis wetmorei* in Guatemala

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Summary.—We report the discovery of a resident population of Savannah Sparrows *Passerculus sandwichensis wetmorei* in grassland on a high plateau of the Sierra Los Cuchumatanes in western Guatemala. We observed a nest containing a nestling, and 11 fledglings of other breeding pairs in July 2016, which represent the first confirmation of the species nesting south-east of the Isthmus of Tehuantepec, *c*.700 km from the nearest known breeding locality in central Mexico. We provide the first description of juvenile plumage for this subspecies. Furthermore, we describe the song of *P. sandwichensis wetmorei* for the first time, which is similar in structure and signal characteristics to that of northern populations. Based on transects, we estimate a population density of 0.7–4.3 adults / ha in the study area, in the Parque Regional Municipal Todos Santos Cuchumatán, which is similar to published data from the USA and Canada. This is the first documentation of *P. sandwichensis wetmorei* since the type specimens were collected more than 100 years ago.

The Savannah Sparrow *Passerculus sandwichensis* complex is widespread in grasslands and other open habitats throughout North America, Mexico and northern Central America (Wheelwright & Rising 2008). Northern populations are migratory, spending the boreal winter in the southern USA, Mexico and Central America (Rising & Beadle 1996, Wheelwright & Rising 2008). Plumage coloration and morphology are variable, and currently three populations are often recognised as separate species from Savannah Sparrow: Belding's Sparrow *P. guttatus*, Large-billed Sparrow *P. rostratus* and San Benito Sparrow *P. sanctorum*, all in southern California and north-west Mexico (Rising 2010, 2011). In Guatemala, Savannah Sparrow is a rare winter visitor, as well as a local resident (Eisermann & Avendaño 2007). Resident Savannah Sparrows in the Guatemalan highlands have been described as *P. s. wetmorei*, which have darker upperparts than birds from the nearest resident population in the Mexican highlands (van Rossem 1938, Hubbard 1974). Material pertaining to *P. s. wetmorei* is very rare in ornithological collections and the eight syntypes in the Natural History Museum, Tring (NHMUK, including the holotype NHMUK 1899.2.1.2893; Warren & Harrison 1971) are probably the only specimens (A. C. Vallely pers. comm.). The validity of the subspecies is controversial. Dickinson & Christidis (2014) recognised it based on the most recent taxonomic review of Savannah Sparrows to have directly compared *P. s. wetmorei* (Hubbard 1974). However, Rising (2010, 2011) considered *P. s. wetmorei* synonymous with *P. s. sandwichensis*, based solely on observations in northern populations where most morphological variation is clinal. The resident status of Savannah Sparrow in Guatemala has also been questioned due to the lack of definitive nesting records (Land 1970, Howell & Webb 1995, Rising & Beadle 1996, Rising 2001, Wheelwright & Rising 2008, Rising 2011), and *P. s. wetmorei* has been considered probably extinct (Wheelwright & Rising 2008, Dickinson & Christidis 2014). Identification of subspecies of Savannah Sparrow in the field is difficult (Rising & Beadle 1996, Rising 2010). Repeated observations of the species in the Sierra Los Cuchumatanes, dpto. Huehuetenango, in western Guatemala,

during the boreal autumn to spring period, from September to May (Eisermann & Avendaño 2007; pers. obs.), could not be assigned to resident or migratory populations. We therefore revisited the area during summer 2016 to determine the status of Savannah Sparrow in the area. Here we report nesting evidence and density of a breeding population in the Sierra Los Cuchumatanes, and document the previously undescribed song of males in this population.

Study area and methods

We studied a population of Savannah Sparrows in the central part (locally known as 'Planes del Diablo', 15°31'14"N, 91°33'56"W) of the Parque Regional Municipal "K'ojlab'l Tze' Te' Tnom Todos Santos Cuchumatán" (hereafter: PRM Todos Santos Cuchumatán), Sierra Los Cuchumatanes, dpto. Huehuetenango, in western Guatemala. The area is *c*.24 km north-west of the type locality of *P. s. wetmorei* at Hacienda Chancol (van Rossem 1938). Sierra Los Cuchumatanes is the highest non-volcanic mountain range in Central America, reaching 3,800 m. The upper part of this sierra consists of upper-Paleozoic to Mesozoic sediments (Anderson *et al*. 1973). PRM Todos Santos Cuchumatán is part of a plateau at 3,700 m. Landscape in the study area was shaped by glaciers during the late Quaternary (Lachniet & Roy 2011) and is characterised by undulating terrain with moraines and small temporal lakes. Vegetation is *páramo* grassland dominated by *Muhlenbergia quadridentata* (Fig. 1), interspersed by exposed rocks, herbs and some juniper shrubs *Juniperus standleyi*. The region has been used for sheep grazing for centuries (Steinberg & Taylor 2008) but, following the establishment of PRM Todos Santos Cuchumatán in 2009, grazing has been restricted to certain areas. The *páramo* is bordered by open pine forests dominated by *Pinus hartwegii*. A temperate climate prevails with a mean annual min. temperature of 5°C and a mean annual max. of 20°C. Mean annual precipitation is 1,500 mm, and mean monthly precipitation is 10–25 mm during the dry season (December–March) vs. 70–300 mm during the wet season (April–November) (MAGA 2002).

Figure 1. Habitat of a breeding population of Savannah Sparrow *Passerculus sandwichensis wetmorei* at 3,700 m in PRM Todos Santos Cuchumatán, dpto. Huehuetenango, Guatemala, 5 June 2016; the undulating landscape, shaped by glaciers during the late Quaternary, is currently covered with grassland dominated by *Muhlenbergia quadridentata* (Poaceae) (Knut Eisermann)

We observed Savannah Sparrows in the study area on 30 April, 3–5 June, 2–3 July and 27–28 August 2016. To rapidly assess population size, we conducted a census of Savannah Sparrows by walking five 310–530-m transects on 3 July. We recorded all individuals within a perpendicular distance of 30 m from each transect (strip width: 60 m), together with information on age (adult, fledgling). We assumed that most adults were attending fledglings or young in nests, and therefore should be foraging and easily detected. Detection probability of Savannah Sparrows decreases sharply beyond 50 m (Diefenbach *et al*. 2003). To estimate population density of adults, we assumed that most birds would flush at a distance of within 30 m from the observers, and discarded the number of adults recorded >30 m from the transect line, as well as any fledglings. To calculate population density, counts were transformed into *n* / ha, using each transect as a sample unit. Upper and lower limits of number of adults were calculated based on a 95% confidence interval of the mean. Means are given with standard deviation (SD).

To determine the size of the grassland area at 'Planes del Diablo', we mapped the habitat based on a satellite image with 0.5 m ground resolution from January 2014. We used software ESRI ArcView 3.2 for mapping and spatial analyses.

KE recorded vocalisations of Savannah Sparrows in the breeding population at PRM Todos Santos Cuchumatán using a Fostex FR-2LE digital recorder (enhanced by Oade Brothers Audio with an ultra-low noise, high-speed FET preamp) and Sennheiser M67 directional microphone with a sample rate of 96 kHz. Sonograms were produced using Raven Pro 1.5 (Bioacoustics Research Program 2012). We marked onset and offset of signals in the sonograms using the curser in Raven Pro 1.5, and measured duration and peak frequency (frequency with max. power [dB]). Some cuts from the recordings are available online at http://xeno-canto.org using the XC catalogue number given in the text.

Results

Nesting evidence.—During a brief visit to 'Planes del Diablo' on 30 April 2016, we observed at least 30 adult Savannah Sparrows along a driving route of *c*.4 km, including display flights of males. Song activity was low but some males gave single songs.

On 3–5 June 2016, males were frequently singing. From a point overlooking an area of *c*.1.5 ha, we saw four singing males. Two copulations were recorded during the period, but no other breeding behaviour was witnessed, presumably because the nesting season had only just started. Fig. 2 presents different adult Savannah Sparrows of the breeding population.

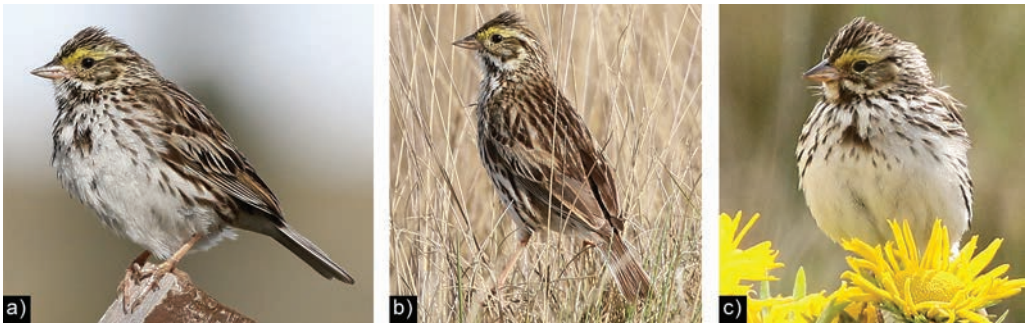

Figure 2. Different adult Savannah Sparrows *Passerculus sandwichensis wetmorei* of a breeding population in PRM Todos Santos Cuchumatán, dpto. Huehuetenango, Guatemala: (a) lateral; (b) dorsal, 5 June 2016; and (c) frontal view showing the neatly marked median crown-stripe, 2 July 2016 (Knut Eisermann)

Figure 3. Nesting evidence of Savannah Sparrow *Passerculus sandwichensis wetmorei* in PRM Todos Santos Cuchumatán, dpto. Huehuetenango, Guatemala: (a) nest with a single nestling, 2 July 2016 (a second nestling was found dead 20 cm from the nest); (b) recently fledged juvenile, barely able to fly, 3 July 2016, (c–d) two fledglings well able to fly, tail *c*.40% grown, 3 July 2016; (e) dependent juvenile with tail *c*.80% grown, 3 July 2016; and (f) immature, 27 August 2016 (Knut Eisermann)

On 2–3 July 2016, we found a nest of Savannah Sparrow with a nestling and a dead young 20 cm away (presumably removed from the nest by the adults). The nest was a cup of grass, placed in a depression on the ground, hidden in 15–20 cm-tall grass (*Muhlenbergia*

quadridentata; Fig. 3). The outer diameter of the nest was 9 cm, inner diameter 7 cm, and the cup was 5 cm deep.

Additionally, we recorded a total of 11 fledglings of Savannah Sparrow throughout the area. These ranged in age from recently fledged and barely able to fly, to several days post-fledging with tails *c*.80% grown (Fig. 3). Their plumage differed from adults by lacking a yellow supercilium, by having a buff breast with dark streaks (whitish with dark streaks in adults) and by beige-tipped greater wing coverts forming a narrow wingbar. The bill of juveniles was darker (mainly greyish with a small pinkish area) than in adults (mainly pinkish with a greyish culmen). Most of the fledglings uttered intense begging calls.

On 27 August 2016, most of the Savannah Sparrows observed at close range were adult-like (n = 32), with yellow supercilia. One was identified as a young bird (Fig. 3f) based on the lack of yellow on the supercilium, slightly buff breast with dark streaks, and beige tips to the greater wing-coverts. Song activity was low on this day, and no behaviour indicating nesting (adults carrying nesting material or food, copulations, intense alarm calls of adults, begging calls of juveniles) was observed during four hours of observation along a line covering *c*.5 km.

Population density and habitat extension.—We recorded a total of 40 adult and eight juvenile Savannah Sparrows during transects on 3 July 2016. The mean number of adults / ha was 2.1 ± 1.7 (n = 5 transects, 95% confidence interval: 0.7–4.3 adults / ha), discarding birds further than 30 m from the transects, and all recorded juveniles. Grassland habitat at 'Planes del Diablo' in the central PRM Todos Santos Cuchumatán covers *c*.300 ha. Based on the size of available habitat and the estimated density, the population of Savannah Sparrows at the 'Planes del Diablo' is estimated to be 210–1,280 adults.

We recorded singing males at other sites also in Sierra Los Cuchumatanes during June–July 2016: near Chichim (15°33′13″N, 91°34′46″W), east of Laguna Ordóñez (15°30′14″N, 91°32′17″W) and near Paquix (15°26′01″N, 91°27′34″W) (Fig. 4).

Vocalisations.—KE recorded the song of four males (XC333471–473). All songs had a similar structure, comprising 2–4 introductory *chip* notes, followed by a middle section with several *ch*-notes, short trills and descending short whistles, a dominant buzz, and a terminal section consisting of a short descending whistle and a short trill running into a whistle. The introduction, dominant buzz and terminal section had the same structure in all songs recorded. The middle section varied (Fig. 5). Song duration was 2.1–3.1 seconds (mean 2.5 ± 0.3, n = 37 songs of four males). Of 37 songs, 19 had three introductory *chip* notes, 16 had two introductory notes and two songs had four introductory notes. Table 1 summarises the mean duration and peak frequency of the notes in all songs.

Discussion

Our observations of nesting Savannah Sparrows in the Sierra Los Cuchumatanes in the western Guatemalan highlands represent the first confirmation of a breeding population south-east of the Isthmus of Tehuantepec. Residency has been previously suggested based on specimens collected in June 1897 (van Rossem 1938), but it has been doubted due to the lack of additional documentation (Howell & Webb 1995, Wheelwright & Rising 2008, Rising 2011). Jones (2002) erroneously reported a nest from dpto. Totonicapán, Guatemala, although the observer did not in fact observe any nesting behaviour (J. Berry pers. comm.).

The nesting season of Savannah Sparrow in Guatemala appears to be synchronised with the wet season. Based on our observations in 2016 (display flights of males on 30 April, frequent singing and copulations on 3–5 June, nest and fledglings on 2–3 July), the breeding season extended from late April to July (peak activity June–July), and probably into August. The first four months of 2016 were unusually dry in the Sierra Los Cuchumatanes. Peak

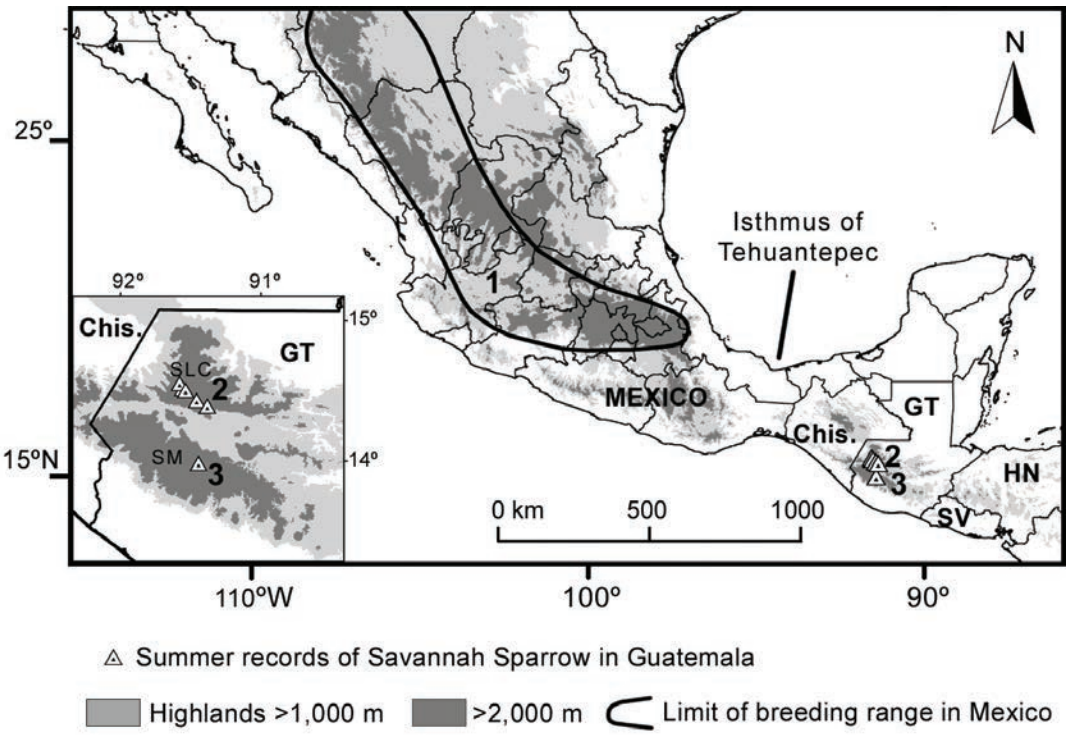

Figure 4. (1) Approximate breeding range of Savannah Sparrow *Passerculus sandwichensis* in Mexico (*sensu* Howell & Webb 1995); (2) summer records in the Sierra Los Cuchumatanes, Guatemala, including recent nesting and other summer records (June–July 2016), and historic summer records (June 1897, van Rossem 1938); and (3) summer record from Sierra Madre range in June 2002 (J. Berry *in* Eisermann & Avendaño 2007). Chis. = Chiapas, Mexico, GT = Guatemala, HN = Honduras, SV = El Salvador. Inset map shows location of summer records of Savannah Sparrow in the Sierra Los Cuchumatanes (SLC) and Sierra Madre (SM) ranges in Guatemala.

breeding may begin earlier (April–May) in years with a normal wet season, which usually starts in April (MAGA 2002). It remains unknown if adults raise two broods per season, as in some northern populations (Wheelwright & Rising 2008). Future research in other *páramo* grasslands in the Guatemalan highlands, especially in dptos. San Marcos, Quetzaltenango, Totonicapán and Quiché, should enable an assessment of the total population of breeding Savannah Sparrows in the Guatemalan highlands. Breeding Savannah Sparrows should also be looked for in the highlands of Chiapas, Mexico.

Our recent observations in the Sierra Los Cuchumatanes during June–July 2016 are the only documented summer records of Savannah Sparrow in Guatemala since the specimen records at Hacienda Chancol in June 1897 (van Rossem 1938), *c.*24 km south-east from the recent nesting record, and undocumented observations from the Sierra Madre Mountains near San Francisco El Alto, dpto. Totonicapán, in 2002 (J. Berry *in* Eisermann & Avendaño 2007) (Fig. 4). We attribute the scarcity of records in Guatemala during summer to an observational lacuna, not to the sparrow's extreme rarity. The population density of 0.7–4.3 adults / ha at our study site in the Sierra Los Cuchumatanes is similar to study sites in the mainland USA and Canada, where breeding bird densities of 0.7–2.3 pairs / ha have been reported (see Wheelwright & Rising 2008). We consider Savannah Sparrow to be locally common in the Sierra Los Cuchumatanes. We recognise that our numbers are rough estimates, because the small number of transects and records did not permit us to calculate

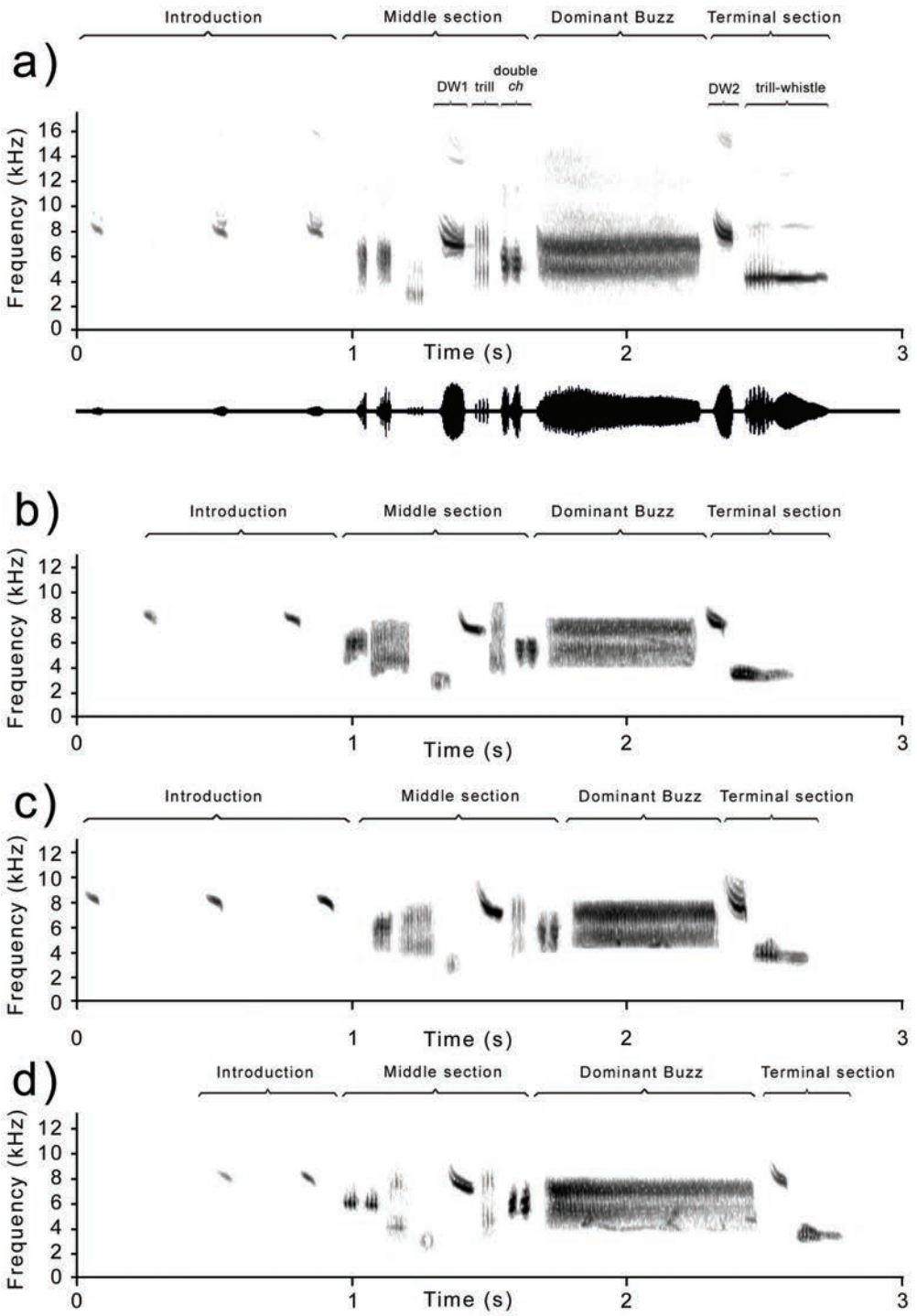

Figure 5. Sonograms of songs of four male Savannah Sparrows *Passerculus sandwichensis wetmorei* in PRM Todos Santos Cuchumatán, dpto. Huehuetenango, Guatemala: (a) 5 June 2016 (Knut Eisermann, XC333471), including waveform, (b) 5 June 2016 (Knut Eisermann, XC333471), (c) 3 June 2016 (Knut Eisermann, XC333472), (d) 3 June 2016 (Knut Eisermann, XC333473). DW = descendent whistle. See Table 1 for signal measurements of marked notes.

TABLE 1
Mean (± SD) and range of signal characteristics of songs of breeding Savannah Sparrows *Passerculus sandwichensis wetmorei* in PRM Todos Santos Cuchumatán, dpto. Huehuetenango, Guatemala, in June 2016, *n* = 37 songs of four males.

Song section (see Fig. 5)	**Duration (seconds)**	**Peak frequency (kHz)**
Entire song (*n* = 37)	2.5 ± 0.3 (2.1–3.1)	
Introduction:		
Chip note (*n* = 97)	0.06 ± 0.01 (0.04–0.12)	7.906 ± 202 (6.938–8.250)
Middle section:		
Descending whistle (DW1) (*n* = 37)	0.10 ± 0.01 (0.08–0.11)	6.927 ± 132 (6.750–7.125)
Trill (n = 37)	0.05 ± 0.01 (0.03–0.06)	6.471 ± 1.268 (4.125–7.500)
Double *ch* note (*n* = 37)	0.08 ± 0.004 (0.07–0.10)	5.063 ± 378 (3.188–5.625)
Dominant section:		
Buzz (*n* = 37)	0.60 ± 0.06 (0.5–0.8)	6.456 ± 646 (4.688–6.938)
Terminal section:		
Descending whistle (DW2) (*n* = 37)	0.08 ± 0.005 (0.07–0.09)	7.566 ± 222 (7.313–8.063)
Trill-whistle (n = 37)	0.29 ± 0.07 (0.16 – 0.39)	4.074 ± 355 (3.375–4.313)

detection probabilities and therefore prepare more reliable estimates using distance sampling methodology (Buckland *et al*. 2001).

Only male Savannah Sparrows are known to sing (Wheelwright & Rising 2008). Songs in northern populations are 2–3 seconds long and very variable. The song in all populations documented to date comprises a long buzz, preceded by several introductory notes and varied chips, trills, short buzz notes or whistles, and terminated by a trill (Sung & Handford 2006, Wheelwright & Rising 2008, Williams *et al*. 2013). The song of *P. s. wetmorei* was previously undescribed; the songs we recorded in the breeding population at PRM Todos Santos Cuchumatán had a similar structure to those of northern populations (Fig. 5).

Most of the more than 20 named subspecies of Savannah Sparrow are not recognised by Rising (2007, 2011) and Rising *et al*. (2009), because most geographic variation is clinal and many subspecies descriptions are not based on quantitative data. Breeders in the Guatemalan highlands are, however, morphologically distinctive compared to the nearest breeding population in the central Mexican highlands (van Rossem 1938, Hubbard 1974), *c.*700 km north-west of the isthmus (Fig. 4). Van Rossem (1938) described the eight specimens of *P. s. wetmorei* collected by W. B. Richardson in June 1897 as dorsally 'darker and browner' than residents in the central Mexican highlands (*P. s. brunnescens*), with upperparts similar to the darkest specimens of Savannah Sparrow (*P. s. alaudinus*) from around San Francisco, California, but with underparts 'much less heavily streaked'. Our confirmation of a breeding population in the Guatemalan highlands, together with its isolation from the nearest breeding population in the Mexican highlands, separated by the lowlands of Tehuantepec, may justify a taxonomic re-evaluation of *P. s. wetmorei*. We hope that this study will motivate more research into the life history, demography and taxonomy of this little-known race of Savannah Sparrow.

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specimens of grasses (Poaceae). We thank Andrew C. Valley, Harry Barnard, Kevin Easley and Mike Mulligan for company and support during some of our field trips to Sierra Los Cuchumatanes. We appreciate constructive comments on the manuscript by Andrew C. Vallely and an anonymous reviewer, as well as the editorial efforts by Guy Kirwan. This study was funded by Cayaya Birding, Guatemala.

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