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Density and population estimates of Rose-bellied Bunting (*Passerina rositae*), Cinnamon-tailed Sparrow (*Peucaea sumichrasti*), and Orange-breasted Bunting (*Passerina lechlancherii*) in the Sierra Tolistoque, Oaxaca, Mexico

Alan Monroy-Ojeda,[1,2]* Manuel Grosselet,[1] Arvind Panjabi,[3] Duane Pool,[3] Chris White,[3] and Georgita Ruiz-Michael[1]

ABSTRACT—Micro-endemic species are at greater risk of extinction because of their small populations and limited distribution. We conducted a breeding population survey of 3 little-known Mexican endemic bird species: Rose-bellied Bunting (*Passerina rositae*), Cinnamon-tailed Sparrow (*Peucaea sumichrasti*), and Orange-breasted Bunting (*Passerina lechlancherii*) in Sierra Tolistoque, Oaxaca. The purpose of the survey was to (a) determine the population density and size of these 3 species in the Sierra Tolistoque, (b) estimate the relative importance of various landscape features for each species, and (c) provide more rigorous scientific information to aid in the conservation and management of these species. In the case of Rose-bellied Bunting, we aimed to assess whether it prefers ravines over other landscape types during the breeding seasons, as stated in previous studies. Between late May and June 2012, we conducted point counts ($n = 209$) throughout the southern slope of the Sierra Tolistoque on the Pacific slope of the Isthmus of Tehuantepec, in Oaxaca, Mexico. Overall bird density was 0.98 birds/ha for Rose-bellied Bunting, 0.547 birds/ha for Orange-breasted Bunting, and 0.514 birds/ha for Cinnamon-tailed Sparrow. The estimated population in each landscape category showed that despite the existence of subtle interspecific preferences, hillsides are the major reservoirs for the 3 species. Rose-bellied Bunting did not occur in greater density in ravines compared to hillsides, which comprised more than twice the area of ravines. The importance of the Sierra Tolistoque for the long-term conservation of the 2 micro-endemic species is crucial considering our population estimates suggest that ~30% of the estimated world population of Rose-bellied Bunting and Cinnamon-tailed Sparrow are found within the range of the Sierra Tolistoque. *Received 6 September 2016. Accepted 21 September 2017.*

Key words: birds, Isthmus of Tehuantepec, micro-endemic, protected areas, tropical deciduous forest, wind energy, wind farms.

Densidad y estimaciones poblacionales del Colorín Azulrosa (*Passerina rositae*), Zacatonero Istmeño (*Peucaea sumichrasti*), y Colorín Pecho Naranja (*Passerina lechlancherii*) en la Sierra de Tolistoque, Oaxaca, México

RESUMEN (Spanish)—Las especies micro-endémicas se encuentran en mayor riesgo de extinción debido a sus pequeños tamaños poblacionales y su distribución limitada. Nosotros realizamos una estimación de la población reproductiva de 3 especies endémicas de México poco conocidas: el Colorín Azulrosa (*Passerina rositae*), el Zacatonero Istmeño (*Peucaea sumichrasti*), y el Colorín Pecho Naranja (*Passerina lechlancherii*) en la Sierra de Tolistoque, Oaxaca. Los objetivos del estudio fueron: (a) determinar la densidad poblacional y tamaño de estas 3 especies en la Sierra Tolistoque, (b) estimar la importancia relativa de los diferentes elementos del paisaje para cada especie, y (c) proveer de más información científica rigurosa para ayudar a los fines de conservación y manejo de estas especies. En el caso del Colorín Azulrosa, evaluamos si esta prefiere las cañadas sobre otros tipos de paisajes durante la temporada reproductiva, tal y como se asevera en publicaciones previas. Entre finales de mayo y junio del 2012, conducimos puntos de conteo ($n = 209$) a través de la ladera sur de la Sierra de Tolistoque en la vertiente pacífica del Istmo de Tehuantepec, en Oaxaca, México. La densidad general fue de 0.98 individuos/ha para el Colorín Azulrosa, 0.547 para el Colorín Pecho Naranja, y 0.514 para el Zacatonero Istmeño. La población estimada en cada categoría del paisaje mostró que, a pesar de la existencia de preferencias sutiles interespecíficas, las colinas son los mayores reservorios para las 3 especies. El Colorín Azulrosa no se encontró en mayores densidades dentro de las cañadas en comparación con las colinas, las cuales representan el doble de área que las cañadas en el área de estudio. La importancia de la Sierra Tolistoque para la conservación a largo plazo de estas 2 especies micro-endémicas es crucial considerando que nuestros estimadores poblacionales sugieren que ~30% de la población mundial estimada de Colorín Azulrosa y el Zacatonero Istmeño se encuentra dentro del área que representa la Sierra de Tolistoque.

Palabras clave: áreas protegidas, aves, energía eólica, Istmo de Tehuantepec, micro-endemismo, parque eólico, selva caducifolia.

The Isthmus of Tehuantepec (IT) in southern Mexico is a biologically important region that supports high avian species richness and endemism and offers some excellent opportunities for biodiversity conservation, particularly in the dry lowlands of the Pacific slope (Peterson et al. 2003, McAndrews and Montejo-Díaz 2010). The IT has been considered by several authors as a distinct biogeographic province based on the endemic bird taxa found in the area (Smith 1941, Goldman and Moore 1945, Álvarez-Castañeda and de Lachica 1974, García-Trejo and Navarro 2004, Barber and Klicka 2010). Two such species, Rose-bellied Bunting (*Passerina rositae*) and Cinnamon-tailed Sparrow (*Peucea sumichrasti*), stand out as the

[1]Tierra de Aves A.C., Lomas de Bezares, Mexico City, Mexico
[2]Kiekari Terra A.C., Rancho Kiekari, Xico, Veracruz, Mexico
[3]Bird Conservancy of the Rockies, Brighton, CO, USA
* Corresponding author: vanellusva@gmail.com

most representative endemic species of the province, which also supports other endemic species of western Mexico, such as the Orange-breasted Bunting (*Passerina lechlancherii*) and Citreoline Trogon (*Trogon citreolus*), among others.

Despite its small geography, the Pacific slope of the Isthmus of Tehuantepec has the largest extent of tropical deciduous forest in Oaxaca (Meave et al. 2012), including part of the Chimalapas region, one of the best-preserved and most biodiverse forest areas in all of Mesoamerica (Peterson et al. 2003); however, no federal designations of protected areas have been made since 1995 when La Sepultura Biosphere Reserve was designated in the state of Chiapas.

A recent assessment identified a few of communal and private conservation initiatives, from which Sierra Tolistoque in Juchitan, Oaxaca, stands out as a novel "hotspot" for bird watchers targeting the Rose-bellied Bunting and tourists attracted by the natural springs. Despite the importance of community conservation initiatives, however, the current level of protection is inadequate because of the lack of sustained funding and the isolated and patchy distribution of the initiatives (Meave et al. 2012). Recent land use changes, including the construction of a new highway network (NSS Oaxaca 2017), expansion of agave plantations for production of mezcal, extensive increases in cattle pastures, new sorghum fields, growing industrial complexes mainly linked to the petroleum port of Salina Cruz (Meave et al. 2012), and, of particular concern, commercial-scale wind energy developments, are further fragmenting and reducing native habitats (AMDEE 2016). These activities threaten the persistence of the tropical dry forest on the Pacific slope of the IT and its rich and endemic biodiversity (Meave et al. 2012).

Species with small populations and restricted ranges are particularly sensitive to habitat loss and degradation. Improved knowledge of their distribution, abundance, and habitat use is needed to effectively manage and conserve such species in the IT. We conducted a breeding population survey of 3 Mexican-endemic bird species: Rose-bellied Bunting, Cinnamon-tailed Sparrow, and Orange-breasted Bunting. The Rose-bellied Bunting is a charismatic micro-endemic passerine. Adult males have a diagnostic electric-blue coloration, broken white eye-ring, and reddish-pink mottling on the chest, becoming salmon-pink on the belly and vent (Brewer 2017). They inhabit moist to semiarid thorn-forest, dense deciduous forest, and semi-humid deciduous gallery woodland within hilly areas at 150–800 m a.s.l. in the southern part of the IT region (Monroy-Ojeda et al. 2013, Brewer 2017). Despite being locally common within its limited range, it is listed as Threatened (SEMARNAT 2010) because of its small range and the possibility that its populations may be in decline owing to habitat loss and degradation, human extraction, hurricane side-effects, and infrastructure development (Arizmendi Arriaga 2006, Brewer 2017).

Cinnamon-tailed Sparrow is one of the most restricted avian species in Mexico, with a distribution range of ~9,700 km^2 (Wolf 1977), limited to the Pacific slope of southeastern Oaxaca and extreme southwestern Chiapas. It inhabits slightly open areas in arid tropical scrub (with *Jatropha* and *Ipomoea* trees) up to 6 m tall and thickets and grassy clearings (Rising 2017). The total population estimate is $<$50,000 individuals, estimated to be almost 50% of the original number (Berlanga et al. 2010, Partners in Flight 2017). It is listed as Endangered (SEMARNAT 2010).

Orange-breasted Bunting is a colorful cardinalid endemic to the tropical dry forest of the Pacific coast of Mexico. It inhabits arid and semiarid deciduous thorn-forest, brushy deciduous woodland, field edges, and overgrown clearings (Howell and Web 1995). It is found from sea level up to 1,200 m, but mostly below 900 m. It is largely sedentary but may move to riparian forest patches during the dry season (Brewer and de Juana 2011). This species is not globally threatened, but its populations are believed to be declining because of habitat degradation and capture for the caged-bird trade.

Sierra Tolistoque in Juchitan, Oaxaca, was selected as the study site because (1) it represents one of the largest blocks of contiguous habitat in the center of distribution of the Rose-bellied Bunting and Cinnamon-tailed Sparrow; (2) it is a proposed area for large-scale wind farm development, which is expanding rapidly in the region; (3) it is part of a cluster of communal protected areas owned by indigenous local communities; and (4) it has become an important birdwatching destination, increasing the importance of ecotourism as a source of local revenue. The purpose of this

survey was to (a) estimate the population density and size of the 3 focal species in the Sierra Tolistoque, (b) determine the relative importance of topography and landscape features for each species, and (c) provide scientific information for the conservation and management of the focal species, including for environmental assessments required for evaluating land use change permits in Mexico. In the specific case of Rose-bellied Bunting, we also wanted to assess whether it is most abundant in ravines during the breeding season, as stated in previous studies (Pérez-Sánchez et al. 2011).

Methods

Study area

We conducted point-transects (Buckland et al. 2001) in the Sierra Tolistoque (elevation range 150–800 m a.s.l.; Binford 1989), a small (8,000 ha) mountain range with a west–east orientation located on the Pacific slope of the Isthmus of Tehuantepec in Oaxaca, Mexico. This region is characterized by a warm subhumid climate (García 1988), with an average annual temperature of 27.4 °C (Trejo 2004). Tropical deciduous forest with an average canopy height of 7 m is present along the hillsides. Tropical semi-deciduous forests also exist but are restricted mainly to ravines and alluvial plains where relative humidity is higher (INEGI 2000, Rzedowski 2006).

The study area was delineated in ArcView 3.2 by creating a polygon that included the Sierra Tolistoque and a buffer area (~500 ha) of surrounding lower elevations. Based on field survey data, we identified 5 distinct landscape categories that corresponded to differences in habitat features and extrapolated these to the entire study area: "lowlands" at the base of the mountain range, "foothills" between the lowlands and steeper slopes of the mountain range, "ravines" that dissect the mountain range and include the extreme slopes and gorges from the stream edge to the transition to more navigable hillsides, "hillsides" that include the hillsides and hilltops of the mountain range, and "transition hillside/ravines" that include the ecotone between these 2 strata (Fig. 1).

Sampling

We used a 500 m regular grid to establish random transect starting points at the base of the Sierra Tolistoque. Between late May and June 2012, we conducted 20 point-transects throughout the southern slope of the sierra and conducted counts ($n = 209$) at intervals of ~150 m. Each day we climbed from the lowest point to the highest/farthest point, conducting an average of 10 point counts per day, from sunrise until 5 h thereafter. Occasionally, point count locations were modified slightly in the field to avoid obstacles or hazards. We timed sampling to coincide with the peak breeding season for the 3 species (Brewer and de Juana 2011, Brewer 2017, Rising 2017). Territorial behavior was displayed by all 3 species, and nesting was observed in the case of Rose-bellied Bunting (Monroy-Ojeda et al. 2013).

We conducted 5 min point counts, during which all visual and aural detections of the 3 target species were recorded. The radial distance to the original position of each bird was measured using a laser range finder. No audio stimuli were used that could modify the detection probability of the birds. All point counts were conducted and distances measured by a single observer. After each point-count survey was finished, the observer recorded the type of vegetation and landscape category.

Data analysis

We used the analysis software Distance 6.0 (Thomas et al. 2010) to estimate detection probabilities and density using our point-count data. Analysis of distance data was accomplished by fitting a detection function to the distribution of recorded distances. We obtained more than the minimum 80 independent detections for all 3 target species and thus had sufficient data to estimate densities for these species. We fit a half-normal key function and hazard rate key function with cosine series expansions and up to 2 adjustment terms to the distribution of distances for each species (Buckland et al. 2001). We used Akaike's information criterion corrected for small sample size and model selection theory to select the most parsimonious detection function for each species (Burnham and Anderson 2002).

Density estimates were post-stratified by landscape category. To estimate the area of each landscape category, we determined the number of 15×15 m pixels that each category covered in the study area polygon and multiplied the area of each

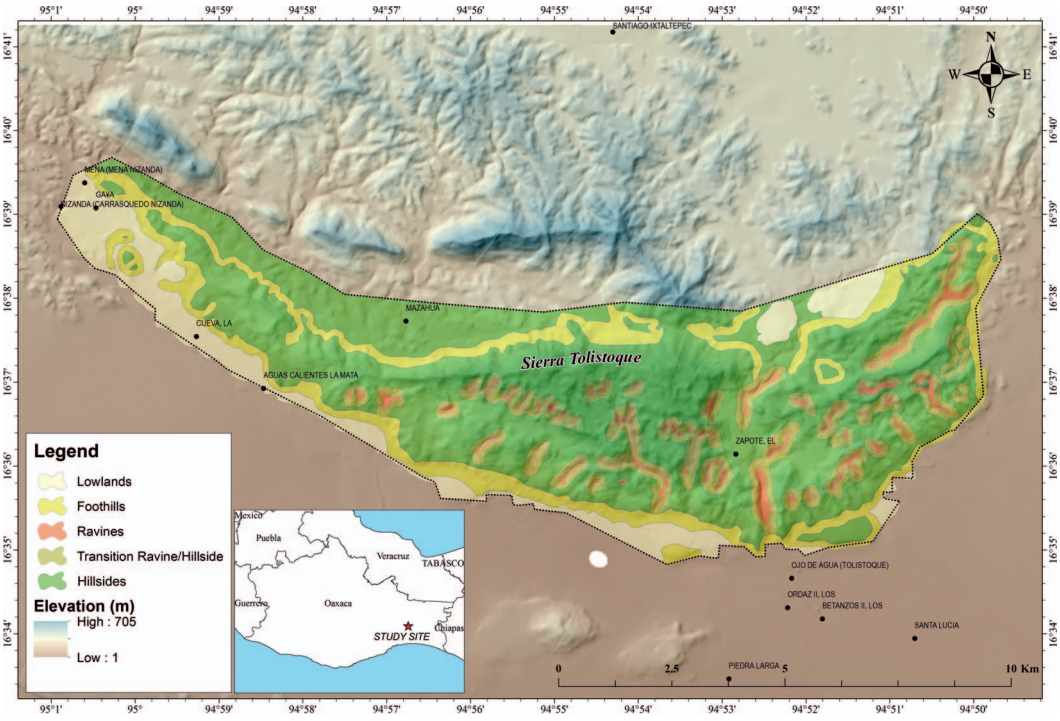

Figure 1. The Sierra Tolistoque study area, including elevational gradient and landscape categories.

pixel times the number of pixels per category. Estimated population per landscape category was obtained by multiplying the estimated species density by the area of each stratum in the polygon. The relative importance per landscape category is directly related to the estimated population per landscape category.

Results

During the 209 point counts, we recorded 291 Rose-bellied Buntings, 185 Orange-breasted Buntings, and 147 Cinnamon-tailed Sparrows. The average number of individuals observed per point count was 1.39 (SD 1.27) for Rose-bellied Bunting, 0.88 (0.979) for Orange-breasted Bunting, and 0.70 (0.98) for Cinnamon-tailed Sparrow. Overall density in the Sierra Tolistoque was 0.98 birds/ha for Rose-bellied Bunting, 0.547 birds/ha for Orange-breasted Bunting, and 0.514 birds/ha for Cinnamon-tailed Sparrow (Table 1). The highest density estimates for all 3 species were on hillsides. The landscape category with the second highest density estimate was different for each species: ravines for Rose-bellied Bunting, foothills for Orange-breasted Bunting, and lowlands for Cinnamon-tailed Sparrow (Table 1). The distribution of point counts among the categories was as follows: lowlands ($n = 25$), foothills ($n = 31$), hillsides ($n = 82$), ravines ($n = 66$), and transition hillside/ravines ($n = 5$).

The area estimates for each landscape category based on the classified raster cell (15 × 15 m) count resulted in a total study area of 8,176 ha (363,421 cells): 376 ha correspond to foothills (16,714 cells), 3,908 ha (173,717 cells) to hillsides, 1,772 ha (78,773 cells) to ravines, 1,639 ha (72,865 cells) to transition areas going from hillsides to ravines, and 481 ha (21,365 cells) to surrounding lowlands (Table 2). The estimated population per landscape category showed that despite small differences in density among the strata, hillsides are the major reservoirs for the 3 species in the Sierra Tolistoque (Table 2), followed by ravines. Interestingly, the density between the 2 micro-endemic species is markedly different; Cinnamon-tailed Sparrow is more abundant in

Table 1. Estimated breeding density (and upper and lower 95% confidence intervals) for 3 endemic bird species in each landscape category in the Sierra Tolistoque, Oaxaca.

	Density (birds/ha)		
Landscape category	Rose-bellied Bunting	Orange-breasted Bunting	Cinnamon-tailed Sparrow
Foothills	0.18 (0.13–0.251)	0.663 (0.560–0.785)	0.446 (0.350–0.567)
Hillsides	2.923 (2.112–4.046)	1.327 (1.122–1.570)	0.998 (0.784–1.270)
Ravines	2.447 (1.768–3.387)	0.259 (0.218–0.306)	0.254 (0.200–0.324)
Transition hillside/ravines	0.181 (0.130 -0.251)	0.048 (0.040–0.057)	0.106 (0.083–0.135)
Lowlands	0.203 (0.147–0.282)	0.437 (0.369–0.517)	0.764 (0.600–0.973)
Overall density	0.980 (0.729–1.317)	0.547 (0.463–0.647)	0.514 (0.404–0.654)

lowlands and foothills and Rose-bellied Bunting is more abundant in hillsides and ravines.

Discussion

This study represents the first population size and density estimates generated using robust sampling and analytical procedures for these 3 endemic species in any part of their range. Previously, researchers estimated the relative abundance of Orange-breasted Bunting in localities of Jalisco (Loera et al. 2011) and Chiapas (Altamirano et al. 2002), Rose-bellied Bunting in Chiapas (Altamirano et al. 2002), and Cinnamon-tailed Sparrow in Oaxaca (Lazo-Sánchez 2010, Villegas-Patraca et al. 2012). Arizmendi Arriaga (2006) evaluated the conservation status of populations of several *Passerina* species in Mexico, including Rose-bellied Bunting and Orange-breasted Bunting, but no density estimates or relative abundance data were provided. Methodological differences in abundance estimation by various authors, such as the use of mist netting (Loera et al. 2011), the use of acoustic alluring (Altamirano et al. 2002), and incomparable population parameters (Lazo-Sánchez 2010, Villegas-Patraca et al. 2012) prevent us from comparing densities of the species sampled in the Sierra Tolistoque with populations elsewhere.

In the case of Rose-bellied Bunting, we specifically wanted to assess whether they preferred ravines over other landscape types, considering that Pérez-Sánchez et al. (2011) stated that the species mostly uses ravines for nesting. This assertion was based on the number of nests they found; however, they focused their nest searches mainly in ravines (Monroy-Ojeda et al. 2013), thus biasing their conclusion. We found little support for that hypothesis; population density during the breeding season did not differ between ravines (with tropical semi-deciduous forests) and hillsides (with tropical deciduous forests). The results of our study suggest the hillsides in the Sierra Tolistoque are likely more important for the species, considering that the area of hillsides compared to ravines is at least 2.2 times larger and supports 70.4% of the estimated study area population.

The importance of hillsides is even clearer for the other 2 species, given that 83.9% and 77.1% of the estimated study area populations of the

Table 2. Estimated population per landscape category (and upper and lower 95% confidence intervals) for 3 endemic bird species in the Sierra Tolistoque, Oaxaca.

		Estimated population size		
Landscape category	Area (ha)	Rose-bellied Bunting	Orange-breasted Bunting	Cinnamon-tailed Sparrow
Foothills	376	68 (49–94)	249 (210–295)	168 (132–213)
Hillsides	3,908	11,424 (8,254–15,813)	5,186 (4,385–6,136)	3,900 (3,064–4,964)
Ravines	1,772	4,337 (3,133–6,002)	459 (386–542)	450 (354–574)
Transition hillside/ravines	1,639	297 (213–411)	79 (66–93)	174 (136–221)
Lowlands	481	98 (70–136)	210 (177–249)	364 (289–468)
TOTAL	8,176	16,244 (11,719–22,456)	6,183 (5,224–7,315)	5,056 (3,975–6,440)

Orange-breasted Bunting and Cinnamon-tailed Sparrow, respectively, are found on hillsides. Further population density estimates should be made to compare different times of year (e.g., breeding vs. nonbreeding seasons; wet vs. dry seasons) and different conditions of the habitat (e.g., primary forest vs. degraded/fragmented habitat), especially given observational data that suggest Rose-bellied and Orange-breasted Buntings may use different types or attributes of the habitat depending on the time/season of year (AM-O and MG, pers. obs.). In the case of the Cinnamon-tailed Sparrow, Lazo-Sánchez (2010) estimated density in an area surrounding our study site and found 5.27 birds/ha in lowland undisturbed tropical deciduous forest, 1.11 birds/ha in a mixed habitat consisting of cropland and tropical deciduous forest, and 0.55 birds/ha in pasture land. Despite using different approaches for measuring density, both Lazo-Sánchez (2010) and our study found the highest densities of the Cinnamon-tailed Sparrow in undisturbed forested habitats.

Considering how little is known of the 3 species, these insights into differential densities across landscapes provide important guidance for managing and conserving their populations. Future natural history studies should focus on understanding seasonal movements and habitat use throughout the year and on the impacts of habitat loss and fragmentation.

Conservation issues

The importance of the Sierra Tolistoque for the long-term conservation of the 2 micro-endemic species is crucial considering our population estimates suggest that ~30% of the estimated world populations of Rose-bellied Bunting and Cinnamon-tailed Sparrow (Partners in Flight 2017) are found there. The loss or fragmentation of habitat in Sierra Tolistoque could have considerable consequences for these species given that they prefer extensive, undisturbed forested sites (Altamirano et al. 2002, Pérez-Sánchez et al. 2011).

Modeled scenarios (Arizmendi Arriaga 2006) showed that Rose-bellied Bunting populations could be reduced by 15–43%, solely from the incidence of hurricanes in the area. Moreover, significant reductions in population should be expected as habitat loss continues due to anthropogenic land use, especially in the lowlands. Changes such as clearing land for grazing and agriculture and the construction of a new 80 km highway (Oaxaca-Istmo; NSS Oaxaca 2017), together with the intensive and extensive development of wind farms in the area (AMDEE 2016), represent an unprecedented and potentially severe threat for endemic species in the IT region. For these reasons, the conservation of remaining large tracts of intact habitat is even more important. Future territorial planning and/or development plans should aim to conserve all well-preserved habitat and biological corridors. Hillsides represent the major population reservoirs for the 3 species within the Sierra Tolistoque, and likely elsewhere within their range, especially for the Rose-bellied Bunting.

Considering the necessity to preserve these species and the area of tropical deciduous forest they require in the IT region, the current extent of protected habitat provided by Natural Protected Areas is insufficient. Meave et al. (2012) also concluded that the voluntary natural protected areas approach has not proven adequate to preserve Oaxaca's tropical dry forests and the species that depend on them. A larger area, similar in concept to Mexico's Biosphere Reserves with legal restrictions on land use change in key habitats, is necessary to effectively conserve these forest-dependent bird species. Currently, La Sepultura Biosphere Reserve in Chiapas represents the only federally protected area where both Rose-bellied Bunting and Orange-breasted Bunting can be found; however, the potential habitat for Rose-bellied Bunting and Orange-breasted Bunting represents only 4.2% and 3.4% of the reserve surface (167,309 ha), respectively (González-Ortega 2000, González-Ortega et al. 2002). In Oaxaca, the communal and private areas for conservation—where owners voluntarily commit their lands as protected areas—constitute the only form of protected areas where the 3 species can be found. In Sierra Tolistoque, the communal protected areas are owned by indigenous groups and cover an area of 5,299.65 ha (i.e., Zona de Uso Común Río Verde del Cerro Tolistoque, Zona de Uso Común en Ojo de Agua del Cerro Tolistoque, Zona de Uso Común en Cerro Bandera de la Sierra Tolistoque, Zonas 1 y 2 del Área de Uso Común, Área de Uso Común Cerro El Chilar; Ortega-del Valle et al. 2010). Operationally, these conservation areas lack funds and personnel that could

ensure the conservation measures stated in the management plans, so their effectiveness to maintain biodiversity and conserving habitats is unproven. However, considering the major role that local communities play in the conservation and use of the habitat, further support should focus on funding and enhancing participatory community-based conservation initiatives.

Considering the information presented here, we suggest a strong biological justification exists to protect the whole extent of the Sierra Tolistoque. In addition to the importance of this site to our focal species, the region is part of one of the most important bird migration corridors in North America (Zalles and Bildstein 2000) and is crossed by millions of Swainson's Hawk (*Buteo swainsoni*) and Turkey Vulture (*Cathartes aura*) during fall and spring migration (Fuller et al. 1998, Bildstein 2004, Ruelas-Insunza 2010, Villegas-Patraca et al. 2014). The area is also home to at least 169 bird species (Berlanga et al. 2008), including the Mexican endemic West Mexican Chachalaca (*Ortalis poliocephala*), Yellow-winged Cacique (*Cassiculus melanicterus*), and Beautiful Hummingbird (*Calothorax pulcher*) (AM-O, pers. obs.). In addition, the Sierra Tolistoque supports mature forests of the nationally threatened ponytail palm (*Beucarnea recurvata*) and other listed species of reptiles and mammals, such as the Oaxacan spiny-tailed iguana (*Ctenosaura oaxacana*) and the Geoffroy's spider monkey (*Ateles geoffroyi*; SEMARNAT 2010).

The urgent need to protect the habitats of the species in this study within the Sierra Tolistoque becomes even more important under the proposed mass establishment of wind turbines throughout the Isthmus of Tehuantepec (McAndrews et al. 2008, AMDEE 2016). The IT region has the greatest potential for wind energy yield in the country and one of the greatest in the world; as of 2016, 20 wind farms, one located 2 km southeast of the Sierra Tolistoque, were already operating in the region, producing 1,751.47 MW of energy (AMDEE 2016). The future establishment of wind farms and supporting infrastructure in the Sierra Tolistoque would almost certainly negatively affect resident endemic and migratory species through habitat degradation and fragmentation, as well as potential collisions with wind turbines on a massive scale, whereas the protection of the Sierra Tolistoque could provide a future stronghold for the conservation of these species.

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