Numbers of invasive House Sparrows *Passer domesticus* in a rural landscape of Limpopo province, South Africa

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Abstract

The House Sparrow *Passer domesticus* is recognised as one of the commonest avian invasive species globally, with its occurrence associated with human existence. However, relatively little on population sizes of this species in rural landscapes has been documented. The study on House Sparrows was conducted in three areas in a rural landscape of Limpopo province, South Africa where it is an invasive, to 1) determine population numbers of the House Sparrow between the years 2014 and 2016, and 2) investigate the interaction between the number of House Sparrows and the number of their active nests. The House Sparrow population numbers showed no significant differences between 2014, 2015 and 2016. The House Sparrow numbers were influenced by the number of active nests in 2014 and 2016. The current study showed that the presence of House Sparrows was not affected by the house type they roosted in, and the number of active nests was not influenced by the house types available in each area. The results also showed that the House Sparrow occurs across a rural landscape with variation in numbers across seasons. The evidence reported provides significant insight into how invasive House Sparrows are well established in rural landscapes around human habitation, and it is recommended that this should be incorporated into the management of such alien invasive birds.

Keywords: alien invasive; house type bird species; management; seasonal variation

Introduction

Although originally native to Asia, Europe, and North Africa, the House Sparrow *Passer domesticusis* one of the avian species with a present global distribution (Robinson et al. 2005; Shaw et al. 2008; MacGregor-Fors et al. 2010; Hanson et al. 2020). The House Sparrow is considered one of the commonest avian invasive species globally and is established on every continent, except in Antarctica (Levesque and Clergeau 2002; Valkiūnas et al. 2006;

Hanson et al. 2020). Its occurrence has been associated with human existence from historical times (Wilkinson 2006; Khera et al. 2010). Humans have been responsible for introducing the House Sparrow intentionally as part of the pet trade, e.g. in Cambodia (Gilbert et al. 2012), and to control the cankerworms *Alsophila pometaria* in the United States of America in 1853 (Pimentel et al. 2005). The House Sparrow had also been unintentionally introduced as a hitchhiker on islands, such as the Galapagos (de Lourdes et al. 2018). The understanding of their impacts on native flora and fauna is generally limited (Chace and Walsh 2006; Downs and Hart 2020).

In most countries, the House Sparrow is among the invasive avian species that generally occur in towns and cities (Murgui 2009; Magudu and Downs 2015), but it can occur in agricultural (Moran 2003) or in rural landscapes (Robinson et al. 2005). The House Sparrow is regarded as an agricultural pest feeding in gardens and on commercial crops (Bomford and Sinclair 2002; Moran 2003; Khaleghizadeh 2011). Furthermore, they cause fouling of buildings, and when their nests are washed by heavy rains, they cause clogging of drainage systems and contamination of water channels (Bomford and Sinclair 2002). House Sparrows are also known to harass, compete for nesting sites, and displace native species, such as Bluebirds *Sialia currucoides*, American Cliff Swallows *Petrochelidon pyrrhonota*, Purple Martins *Progne subis*, and House *Wrens Troglodytes aedon* (Pimentel et al. 2005; Leasure 2013; Baker et al. 2014). Furthermore, the species has been reported to be a carrier of ~29 diseases, including Alphavirus and Newcastle disease virus that can be transmitted to humans and livestock (Pimentel et al. 2005; Zhu et al. 2010; Fassbinder-Orth et al. 2018). However, studies on diseases or viruses found on other species shown to originate from House Sparrows are limited.

Although the House Sparrow is declining in many European countries (Summers-Smith 2003; Angelier and Brischoux 2019), this species has been shown to be increasing in some areas, such as Scotland and Wales (Crick et al. 2002), South Africa (van Rensburg et al. 2009; Magudu and Downs 2015) and Kenya (Schrey et al. 2014). In southern Africa, the House Sparrow is regarded as a synanthropic species living in anthropogenic habitats, such as city centres, factories, human habitats, parks, and recreational centres (van Rensburg et al. 2009; Schrey et al. 2014; Magudu and Downs 2015; Martin et al. 2017). In South Africa, the House Sparrow is generally more abundant in urban landscapes than rural landscapes (van Rensburg et al. 2009; Magudu and Downs 2015); however, there are relatively limited reports for this species' population sizes in rural landscapes. Three different villages across a rural landscape in Limpopo province, South Africa, were surveyed between 2014 and 2016 to 1) determine the population size of House Sparrows in this rural landscape, and 2) used active nest numbers to establish the presence of House Sparrows in this rural landscape between the sampled years. We therefore predicted that House Sparrow numbers associated with households in this rural landscape would be relatively low, but consistent, given that study a by Magudu and Downs (2015) reported a low number of this species near urban households.

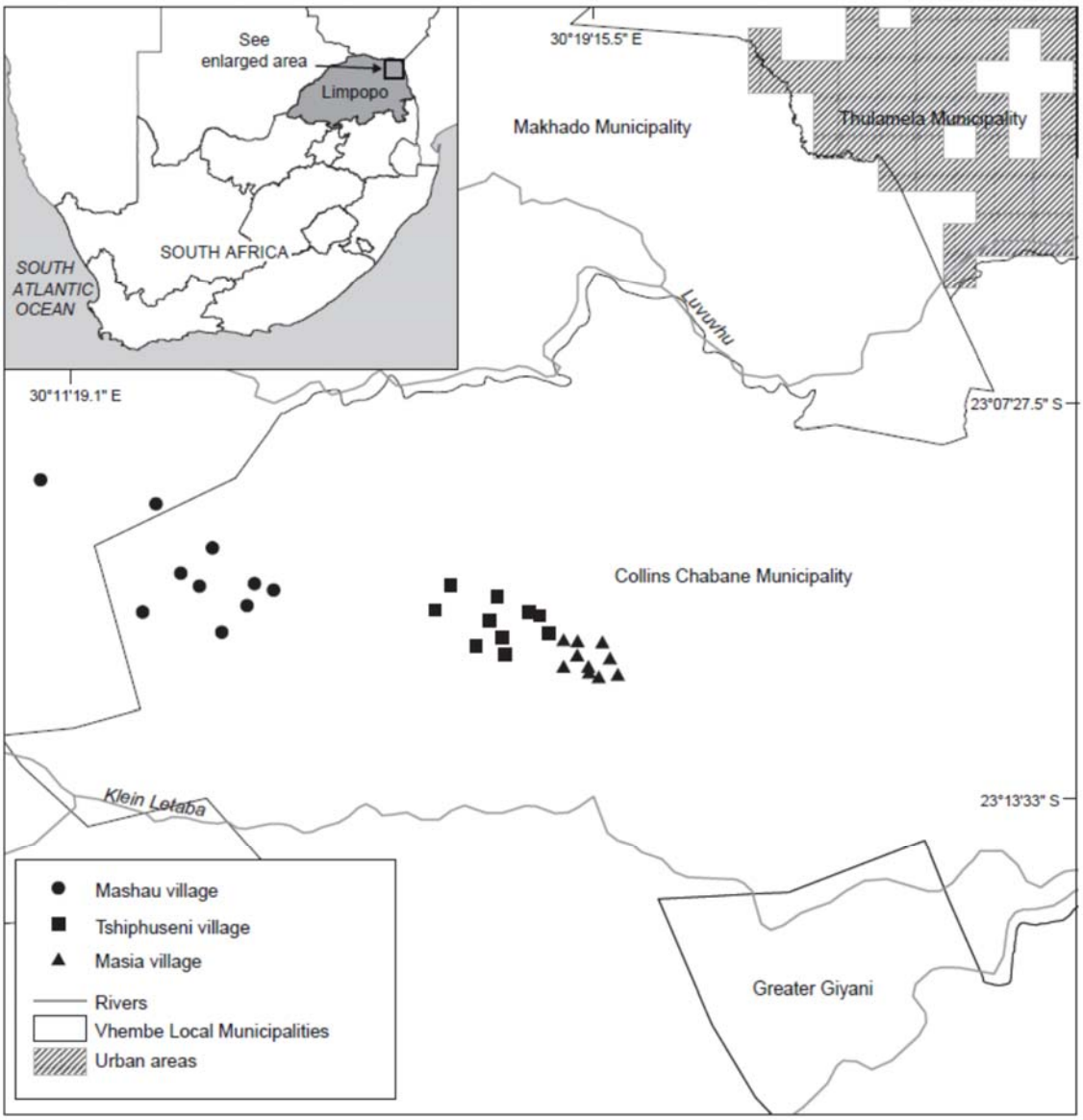

Figure 1: Map showing the three study areas in the rural landscape where populations of House Sparrows were counted in Limpopo province, South Africa, in the current study. Each area is shown by different symbols, and each had ten sites

Material and methods

Study areas

The study was conducted in Limpopo province, situated in the north-eastern part of South Africa (Figure 1). The human population size in this province is approximately 5.4 million, and its size is approximately 125 755 km² with a total of 134 889 households (https://census2011.adrianfrith.com/place/9). The study was conducted in three areas that were predominately rural landscapes namely; Ha-Masia Tshikwarani Thondoni (23°11'03.3'' S, 30°19'02.8'' E) with a human population size of ~1 307, ~322 households and the size of the area ~1.33 km2; Ha-Masia Tshiphuseni (23°10'39.1'' S, 30°17'38.1'' E) with an area size of ~1.37 km2, human population size of ~1 636 and ~425 households, and Ha-Mashau village (23°08'48.5'' S, 30°11'53.2'' E) with an area size of ~17.11 km2, human population

size of ~15 210 and ~3 876 households (https://census2011.adrianfrith.com/place/9). The distances between these villages are ~6 km. All these villages form part of Makhado local municipality with a total population size of ~516 031 and covering an area of ~8 299.7 km2(https://census2011.adrianfrith.com/place/9). The climate is warm and temperate, with mild cold winters and hot sunny summers and with a minimum mean annual temperate of 13.4 °C and a maximum mean annual temperature of 21.9 °C (https://en.climate-data.org/africa/south-africa/limpopo/louis-trichardt-645/). It receives an average annual rainfall of 793 mm. The type of vegetation within Makhado municipality is Makhado Sweet Bushveld (Ofoegbu et al. 2017). The households in the current study were designated as a rural zoning where each household had sufficient space for subsistence farming.

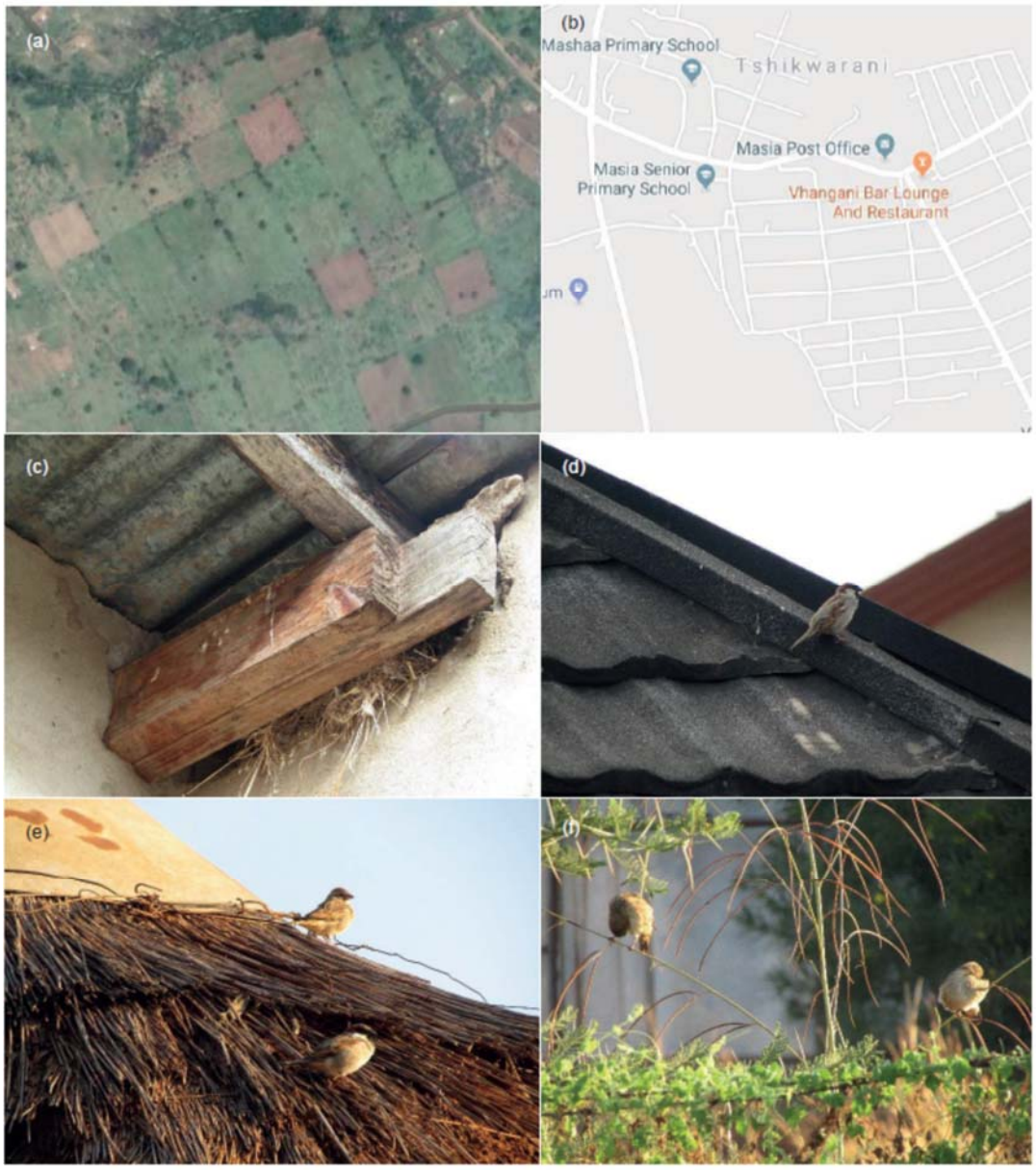

Figure 2: A photographic representation of (a) type of land-use surrounding the study sites and (b) rural household zonation style; whereas (c) shows a House Sparrow nest built between the roofing timber of corrugated iron house, and (d), (e) and (f) show House Sparrows prior to roosting time (Photograph credits: TC Shivambu)

The three rural landscape areas were selected for the current study, because 1) no prior studies on House Sparrows have been conducted here, 2) the House Sparrow has been present in these areas for decades, and their populations are well established (SABAP2 2019), and 3) the areas are predominantly communal farmlands dominated by households that practice subsistence agriculture, which may provide relatively enough food for these species. In the vicinity, there were relatively few extensive urban areas with shopping complexes that can play a role in the persistence of House Sparrows, as described in Murgui and Macias (2010) and Magudu and Downs (2015). The types of crops farmed in these areas included citrus, guava, mango, macadamia, maize, pawpaw, sorghum, pumpkins, watermelons, and a variety of vegetables. However, crops like maize, watermelon, sorghum, and pumpkin are planted in both household gardens, and small-scale farms measured ~9 040.63 m2 (Figure 2a).

Sampling

A one-week scouting survey was done during 14 to 22 February 2014 to search for any household having House Sparrows either breeding or roosting. This involved opportunistic surveys of residences from the respective villages where House Sparrows were sought. The surveys were undertaken only at households that granted permission for House Sparrow surveys to be conducted. For the current study, a total of three villages in rural landscapes were surveyed, each with ten households, so a total of 30 study sites were surveyed (Figure 1). Sites were randomly selected using the online Random Point Generator (http://www.geomidpoint.com/random/) with the distance between the sites set at 2 km.

Surveys were conducted during the first three hours after sunrise from 06h00 to 10h30, and later in the afternoon between 17h30 and 18h30. In the current study, each site was surveyed for 10 min following Bibby et al. (2000). To ensure the detectability of birds, surveys were conducted on days with no rain and with the wind velocity <4 km h−1(Bibby et al. 2000). At each site, the number of House Sparrows was counted, and the number of active House Sparrow nests present at the time of the survey, because this gave an understanding of the reproductive status of the species. The active nests were located by following parent House Sparrows entering nests, generally with food for chicks. This occurred mainly during the breeding season, between March and May, July and September, and between September and November each year. However, the clutch size and number of chicks were not counted, because it was difficult to access most of the nests. The current study was conducted for a period of three years between 2014 and 2016 (32 months), and the counts were conducted across the four seasons annually, namely autumn (start 1 April 2014), winter, spring, and summer (end 30 December 2016). The sampling was done three days per month per site. The household on which House Sparrows were observed roosting and nesting were also considered to determine the house types used. In this case, house types were categorised as traditional (houses built with mud bricks and thatched with grasses and huts) and modern (houses built with cement blocks or roman face bricks and roofed with aluminium sheets or slate) (Figure 2).

Statistical analyses

The data were analysed using STATISTICA 7 (Stat soft Inc, Tulsa, U.S.A.) and R statistical software (version 3.6.1, R Core Team 2018). The mean and standard deviation (mean + SD) for the number of House Sparrows counted across the season between 2015 and 2016 in 30

sites were computed. To compare the differences between the numbers of House Sparrow counted across the seasons among years, a Kruskal–Wallis test was performed. Pearson correlation (r) was used to determine the relationship between the number of active nest and the number of House Sparrows present in the rural landscape. A Wilcoxon matched pairs test was done to determine whether the house type significantly influenced the number of House Sparrows. This test was performed because the assumption of data normality proved to be incorrect.

Results

In total, 1 657 (9.2 ± 5.72 per site) individuals of House Sparrow were counted in 2014, 1 907 (10.6 ± 8.52) in 2015, and 1 900 (10.72 ± 9.0) in 2016 from the 30 sampling sites. No significant difference were found in the number of House Sparrows among the three study areas in 2014, 2015 and 2016 ($\chi 2 = 3.93$, df = 2, $p = 0.14$). Population numbers for House Sparrows in 2014 showed significant difference among sites in the three areas of the rural landscape ($\chi 2 = 8.197$, df = 2, $p < 0.001$), with Masia Tshikwarani and Mashau areas having significantly different number of individuals across all seasons. The population numbers of House Sparrows in 2015 showed no significant difference among sites in the three areas ($\chi 2 = 0.98$, df = 2, p = 0. 61), but Mashau Village recorded more individuals (9.4 ± 8.0, Table 1). Similarly, the population numbers for 2016 showed no significant difference among sites in the three areas ($\chi 2 = 2.83$, df = 2, $p = 0.24$), but Masia Tshiphuseni recorded more House Sparrows (8.8 ± 11.5, Table 1). The number of active House Sparrow nests differed significantly between the years among the three areas ($\chi 2 = 20.38$, df = 2, $p < 0.001$). No significant differences were found in number of active nests between the three study sites in 2014, 2015, and 2016 (Table 1). Significant differences in House Sparrow numbers between years and between seasons were found with summer (16.15 ± 10.15) having greater numbers of House Sparrows in all sampling years, followed by winter (13.15 ± 8.13) with large numbers in 2015 and 2016 (Figure 3). In general, our results showed variation in the number of House Sparrows counted within each sampling year and across seasons (Figure 3).

Table 1: Summary of the median (25th percentile (Q1) to 75th percentile (Q2)) numbers of House Sparrows and active nests counted in three areas in a rural landscape of Limpopo province, South Africa between 2014 and 2016 in the current study. An asterisk (*) indicates significant differences between study sites. Degrees of freedom for the Kruskal–Wallis test = 2

Sampling years	Study area	House Sparrows numbers		Median (Q1–Q2)	Kruskal–Wallis test
		Median (Q1–Q2)	Kruskal–Wallis test		
2014	Masia Tshikwarani	10 (8–14)*	$\chi^2 = 8.197$, $p < 0.001$	3 (1–4)	$\chi^2 = 0.222$, $p = 0.893$
	Masia Tshiphuseni	9 (6–12)		4 (2–5)	
	Mashau	8 (3–10)*		3 (1–5)	
2015	Masia Tshikwarani	8 (4–14)	$\chi^2 = 0.977$, $p = 0.612$	4 (2–5)	$\chi^2 = 3.276$, $p = 0.186$
	Masia Tshiphuseni	11 (4–18)		3 (1–5)	
	Mashau	10 (5–14)		4 (2–5)	
2016	Masia Tshikwarani	8 (5–12)	$\chi^2 = 2.828$, $p = 0.241$	2 (1–4)	$\chi^2 = 3.370$, $p = 0.208$
	Masia Tshiphuseni	9 (6–14)		3 (1–5)	
	Mashau	8 (6–14)		2 (1–4)	

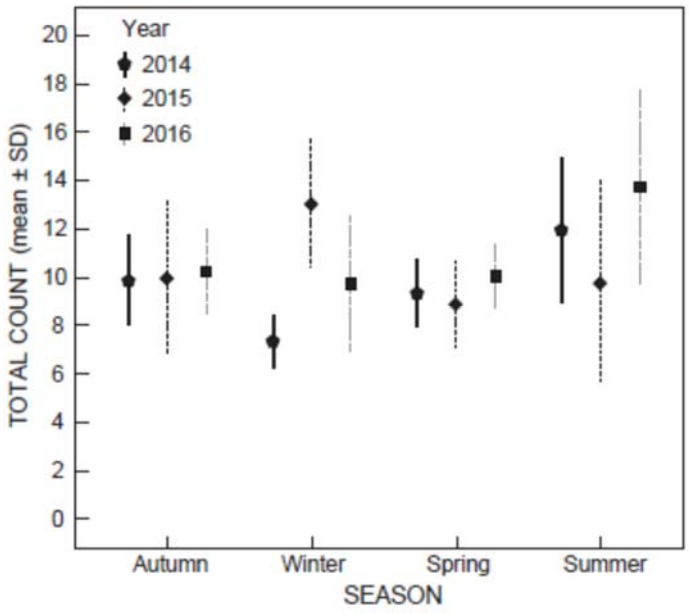

Figure 3: Mean (± SD) of the total numbers of House Sparrows observed in the rural landscape of Limpopo province, South Africa in the current study

The number of House Sparrows generally increased significantly with an increase in the number of active nests present between 2014 ($R2 = 0.86$; $p < 0.001$) and 2016 ($R2 = 0.84$; $p < 0.001$) (Figure 4). On the contrary, the number of House Sparrows counted in 2015 was not influenced by the number of active nests ($R2 = -0.004$; $p = 0.067$; Figure 4b).

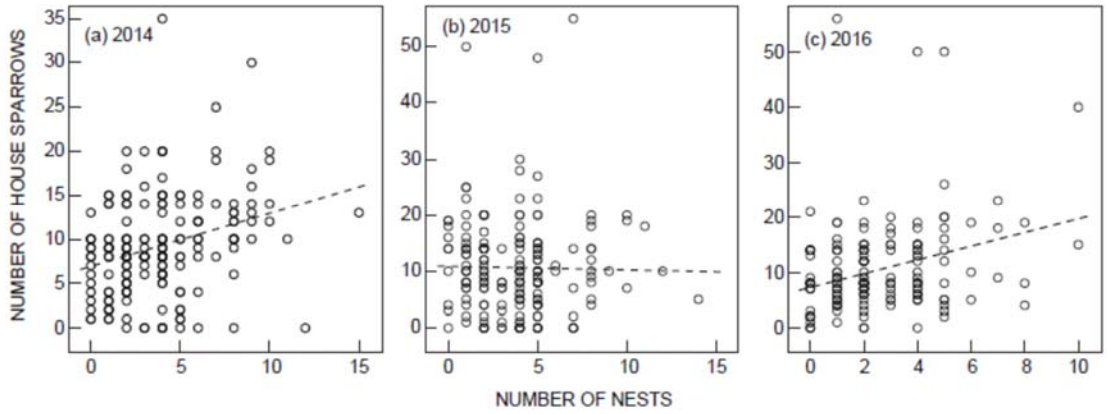

Figure 4: The relationship between number of House Sparrows and nests available, where (a) represents counts in 2014, (b) counts in 2015, and (c) counts in 2016 in 30 locations across a rural landscape in Limpopo province. Black dotted line represents the regression line

The number of House Sparrows did not differ significantly between years for the two-house types (Wilcoxon matched-pairs test: $p > 0.05$, Figure 5). The number of active House Sparrow nests for 2014 and 2015 also showed no significant difference with house type (Wilcoxon matched pairs test: $p > 0.05$), whereas for counts in 2016 there was a significant difference in the number of active nests between house types (Wilcoxon matched pairs test: $p < 0.05$).

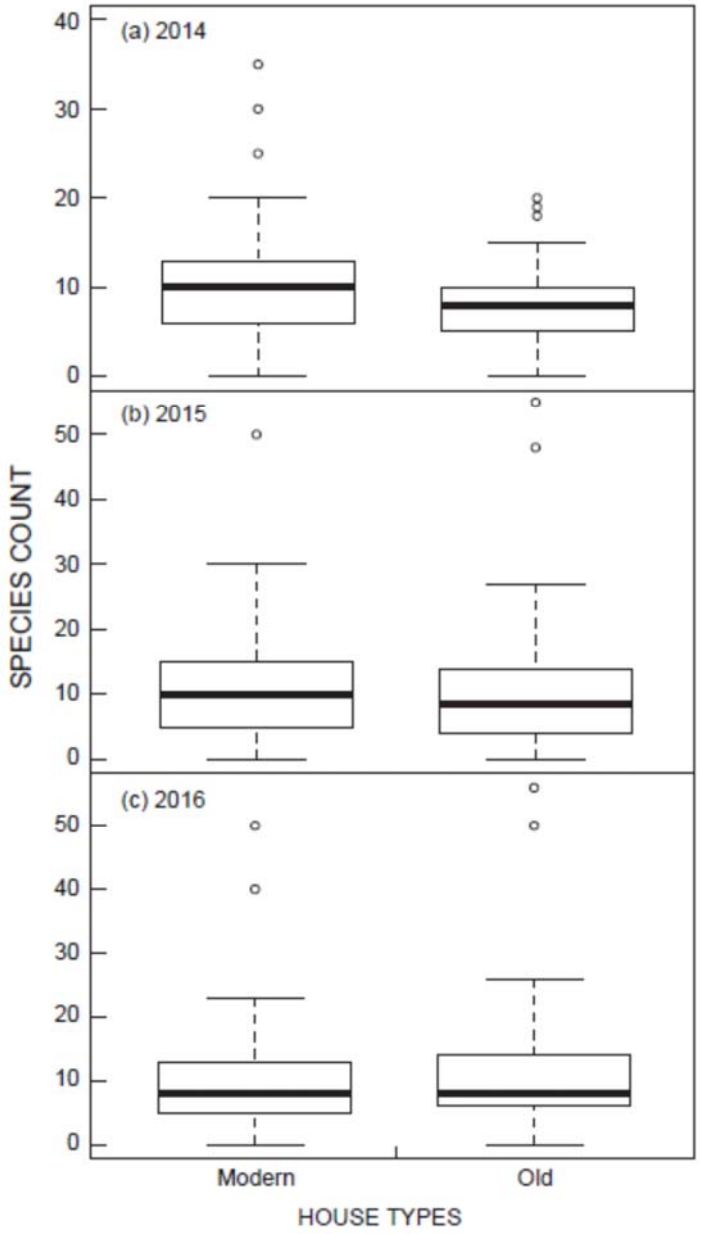

Figure 5: Annual variation in the number of House Sparrows with house type across 30 locations in a rural landscape of Limpopo province in the current study

Discussion

The current study reports on the variation in the number of House Sparrows observed in a rural landscape of Limpopo province, and our results showed no decline in the numbers with time. The persistence of this species in the rural landscape can be explained by factors, such as food availability, greener spaces and less competition (Shaw et al. 2008; Murgui 2009; Murgui and Macias 2010). Based on our observations, House Sparrows were the dominant bird species around homesteads with few native species present (TCS pers. obs.). The number of House Sparrows observed in the current study varied between different years among the villages, but did not decline. Other studies in South Africa, particularly in the urban settings indicated the persistence of this species (Dean 2000; van Rensburg et al.

2009). In contrast, in Great Britain, the House Sparrow's population was reported to decline by 47% between landscapes (Robinson et al. 2005; Peach et al. 2018).

The current study is one of the first to show the population dynamics of invasive House Sparrows in a rural landscape, because other studies have generally focused on urban areas (Peach et al. 2008; van Rensburg et al. 2009; Magudu and Downs 2015). In Kenya, this species was also reported to expand its population across urban farmland landscapes (Schrey et al. 2014; Martin et al. 2017). The population counts obtained from studies by van Rensburg et al. (2009) and Magudu and Downs (2015) for this species were not different from those reported in the current study. This showed that rural landscapes can also harbour this alien avian species in numbers similar to those in an urban landscape. Dean (2000) and Bernat-Ponce et al. (2018) reported that House Sparrow and other alien bird populations in South Africa and Spain colonised successfully, because of climate change, anthropogenic landscape-level changes, and food availability. In the current study, factors like availability of active nests played a role in the number of the House Sparrow in some of the areas; as a result, this may implicate potential increment to the numbers of the House Sparrow in these areas. The presence of active nests has been reported to be positively linked to reproduction success (Peach et al. 2008), and the colonisation rate of House Sparrows (Narayana 2016), which can result in relatively large impacts as they are implicated in facilitating transmittable diseases, e.g., in Nebraska a large number of active nests were affected by the Buggy Creek Virus (O'Brien and Brown 2011).

The study also showed that House Sparrow numbers were not influenced by the types of human habitats available in some areas, whereas in some areas, the opposite was true. This may be explained by the fact that House Sparrow can adapt well and can generally persist in any type of anthropogenically modified landscape (Peach et al. 2008; Narayana 2016). In India, populations of House Sparrow occurred in a range of landscapes with differing human habitation available (Narayana 2016). Other studies reported that the occurrence of this species appears to be affected by house type, particularly modern houses, which may explain that House Sparrow is well adapted to urban spaces (Chamberlain et al. 2007; Shaw et al. 2008; Narayana 2016; Bernat-Ponce et al. 2018). In the current study, house type did not generally have an impact on the higher number of active nests in some areas, whereas in 2016 the number of active nests was related to traditional house type. This indicated that House Sparrows do not exclusively rely on house type availability to nest, but any suitable nesting space available at the time as in other studies (Narayana 2016; Reynolds et al. 2019).

Based on these findings, it is recommend that additional studies be undertaken in rural landscapes outside the natural range, because they can harbour large numbers of House Sparrows. Feeding behaviour, competition by this species with native species, and impacts on human livelihoods through the possible transmission of diseases, because they are known to harbour zoonotic diseases transferable to humans and other birds (Zhu et al. 2010; Fassbinder-Orth et al. 2018) must be considered. This is crucial, because the House Sparrow consumes human stored grain and fouls on buildings (TCS pers. obs.).

Conclusions

The current study showed that the House Sparrow persists in the rural landscape of the current study in South Africa with variation in numbers across seasons and between sampling years. There appeared to be an increase in the numbers of House Sparrow influenced by the number of active nests in different house types and this differed between areas. The evidence reported herein provides significant information on the House Sparrow and on how they have successfully colonised a rural landscape. As a result, this may have to be incorporated in the management plans of alien invasive birds in the rural landscapes, because many have been reported to cause decline to native bird species (MacGregor-Fors et al. 2010).

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