High Occurrence of Foot Deformities in a Non-breeding Population of Chipping Sparrows

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Abstract

The occurrence of deformities in wild birds can provide insights into how individuals and populations respond to environmental stressors, such as diseases and pollution. Chipping Sparrows (Spizella passerina) *were reported nearly 100 years ago to show high rates of foot deformities, presumed to be associated with the prevalence of avian pox infections. I captured Chipping Sparrows during the non-breeding season in south Louisiana over six winters to determine if contemporary populations of Chipping Sparrows continued to experience foot deformities. In my sample of 181 birds, 35 (19.3%) showed foot deformities, which was related to prevalence of visible avian pox inflections. Because adults were more frequently deformed and showed more extensive injuries (i.e., on more toes) than immatures, I posit that these deformities accumulated over time and were not necessarily lethal. As such, this species may serve as a useful model species for understanding cyclical epizootics, such as avian pox, on wild bird populations.*

Introduction

Reports of deformities in wild birds is rarely quantified, yet there is extensive literature on the topic providing anecdotal evidence of at least its semi-regular occurrence. Some of the most extensive documentation of avian deformities includes studies of the bill (Pomeroy 1962, Handel et al. 2010). Apparently less commonly examined are leg and foot deformities, particularly in small songbirds (Giesy et al. 1994). The presence of foot deformities may have important implications for a bird's success and survival, where the ability to perch and grasp may have deleterious effects. Furthermore, the cause of an observed deformity (e.g., developmental/mutagenic, injury-related, disease-related) often cannot be determined. By understanding such causal relationships, the role of pollution, climate change, and other anthropogenic alterations to the environment can be more effectively addressed.

It is well accepted that environmental contamination from pollution can lead to a wide variety of health and reproductive problems in wildlife, which potentially can lead to population-level effects (Blus 1982, Chapdelaine et al. 1987). Yet, the lack of baseline data in natural systems often makes it difficult to recognize and distinguish epizootics from natural background variation (Giesy et al. 1994, Hernandez et al. 2003). Long-term studies, such as constant-effort bird banding stations, play an important potential role in revealing underlying patterns and the emergence of new environmental stressors.

Nearly 100 years ago, Chipping Sparrows (*Spizella passerina*) had been found with high incidences of foot injuries; the outbreak appeared to be episodic and local, peaking in 1923 and disappearing by 1925 (Musselman 1928). Through a series of experiments, Musselman (1928) concluded the occurrence of injury appeared associated with avian pox. Avian pox is now understood to be widespread both in geography and in its diversity of hosts (Bolte et al. 1999). It is also often episodic, and may play important, yet complex, roles in regulating avian populations (Forrester 1991, van Riper et al. 2002). As host-vector-disease relationships may be shifting with climate change (including temperature and rainfall patterns), cascading effects of avian pox and other infectious diseases on birds may have consequences on population demographics (Harvell et al. 2002, Bradley et al. 2005).

To my knowledge it is not known if foot deformities in Chipping Sparrows were temporally limited to that era. Nearly 100 years after Musselman's (1928) research, after observing several cases of foot deformities in a non-breeding Chipping Sparrow population in south Louisiana, I quantified the rate of occurrence over six winters and examined the prevalence across bird ages. I predicted that the infection rate would be associated with deformities, and that if there were a consequence on survivorship then the prevalence rate of injuries

Methods

I opportunistically ran a single mist-net near a feeding station in Lafayette Parish, Louisiana (30 7' 34" N, 92 4' 37" W) between November and March in the winters of 2013-2014 to 2018-2019. The habitat was residential, but bordered by a north-south strip of bottomland hardwood forest along the Vermilion River to the west, a sugar cane field to the south, and mixed residential and pasture to the north.

Net effort between months and years was not standardized or carefully tracked, and I opened and closed the mist net depending on capture loads and other logistical constraints. This study and analyses, however, are not dependent on capture effort because I focus on the frequency of foot deformities among captured Chipping Sparrows, one of the two predominant species captured at this station (see also Johnson 2016). Captured birds were aged using molt limit, rectrix shape, and skull ossification criteria as described by Pyle (1997).

In the years before this study began, I noticed several Chipping Sparrows with foot deformities. In December 2013, and I began tracking and describing in earnest the frequency and type of foot and toe deformities by noting which foot was deformed and which digits were affected on each foot. Foot deformities were categorized, and in sequence of least to most severe included bent nail, missing nail, partially missing digit, entirely missing digit, and missing foot. I also counted the number of digits that were affected on each bird. Each bird was also carefully examined visually for active or past avian pox legions on the feet, legs, face, and bill (i.e., non-feathered areas of the bird). Active pox legions were often swollen and filled with puss, whereas past pox legions generally appeared like a small scar.

I summarized the data as the frequency of individuals in early winter (Nov-Dec) and late winter (Jan-Mar) across years with and without foot deformities. I used Chi-square analyses to examine the relationship of foot deformities to indications of avian pox infections, differences in occurrence frequencies between early and late winter, and differences between immatures (first cycle) and adults (definitive cycle)

Results

Among 181 Chipping Sparrows examined, 35 (19.3%) had foot deformities (Table 1). Among these birds with foot deformities, the majority of individuals had missing nails (62.9%); partially missing digits was the next most common deformity type (20%; Figure 1). Most birds with foot deformities had only one affected toe (51.4%) and all except the single bird with a missing foot had one to three affected toes (97.1%; Figure 2). The frequency of injuries did not differ between early winter and late winter in adults ($X^2_1 = 0.040$, $P = 0.812$) or immatures ($X^2_1 = 0.020$, $P = 0.890$), but adults were significantly more likely to have foot injuries than immatures ($X^2_1 = 8.473$, $P = 0.004$). Adults also tended to be more likely than immatures to have more than one affected toe ($X^2_1 = 3.37$, $P = 0.067$), but were more likely to have a less severe injury (a bent or missing nail) than a more severe ($X^2_1 = 5.64$, $P = 0.018$).

Avian pox was visually detected in 13 (7.2%) Chipping Sparrows. The observed frequency of pox in the first three years of study was 8.4% (12 of 143 captures) compared to 2.6% (1 of 38 captures) in the second three years of study, but this difference was not significant ($X^2_1 = 1.569$, $P = 0.210$). Among the 13 cases of pox, five birds exhibited foot deformities, whereas eight did not.

Although there was a trend for the presence of pox to be associated with foot deformities, this was not statistically significant ($X^2_1 = 3.284$, $P = 0.070$).

Discussion

A relatively high frequency of foot deformities were found over this six-year study, with nearly one in five birds having a deformed or missing claw, partially or entirely missing digits, or in one case a missing foot. All birds were newly captured in this study, suggesting that neither the bands nor handling was responsible for these deformities. Furthermore, among 549 other captures of 31 passerines and near-passerines over the same period, only four were noted to have a foot deformity (in two American Goldfinches [*Spinus tristis*], one Northern Mockingbird [*Mimus polyglottos*], and one Indigo Bunting [*Passerina cyanea*]). In other words, this issue seemed to be somewhat unique to Chipping Sparrows at this study site.

Although the impact of foot deformities on survival of the birds could not be directly assessed, in part because of low recapture rates, there are two pieces of evidence to suggest that these deformities do not substantially suppress survivorship. First, there was not a change in deformity frequency between early and late winter, whereas one might hypothesize that a decreased frequency of occurrence through the winter may be a consequence of decreased survivorship in injured birds. Second, the frequency of foot injury was nearly three times higher in adult birds compared to immatures. This is consistent with the possibility that foot injuries accumulate through time, particularly the occurrence of a missing nail. Adults were also more likely to have more than one affected toe, again suggesting that deformities accumulate over time, perhaps most often affecting the loss of a nail. In contrast, the frequency of deformed or missing toes did not appear to be substantially different between adults and immatures, suggesting that this more severe type of injury may be experienced during early development.

The cause of these foot deformities is unknown, but several lines of evidence suggest that there may be more than one cause. Avian pox may be one source; although not statistically significant, the presence of pox (which was only ever noted on the legs and feet) was often associated with a foot injury, consistent with findings by Musselman (1928). This would also potentially explain the increased frequency of deformities seen in adults compared to immatures. Birds can regularly recover from acute avian pox infections, as documented through banding recaptures (Senar and Conway 2004), but it can leave visible scarring, and by extension likely contribute to the eventual loss of a nail or digit.

Alternatively, avian pox infections may instead be a symptom of the same root cause of these foot deformities, if both were expressions of a suppressed immune system. Exposure to environmental toxins, such as methylmercury and selenomethionine, have been demonstrated experimentally to cause deformities in some waterbirds (Heinz et al. 2012). Other heavy metals, such as zinc and manganese, can cause leg deformities in ostriches (Mushi et al. 1999).

Nearly 100 years after Musselman's (1928) extensive studies on foot deformities in avian pox in Chipping Sparrows, I demonstrated two important findings. First, that both avian pox and foot deformity prevalence today appear consistent with the findings by Musselman (1928). And second, that the outbreak appears cyclical. As such, although the purpose of this research was to demonstrate the prevalence of injuries and disease symptoms, the Chipping Sparrow may serve as an important model species for research to understand epizootics, such as avian pox, in wild birds.

Acknowledgements

Thanks to the members and board of the Baton Rouge Audubon Society, which supports Louisiana Bird Observatory banding studies, including this one. This is manuscript # 8 in the Louisiana Bird Observatory Technical series.

Winter Season	Captures	With Pox	With Foot Deformities	Deformities with Pox	Foot Deformities without Pox
2013-2014	73	4	10	0	10
2014-2015	51	3	8	0	8
2015-2016	19	5	7	4	3
2016-2017	21	0	6	0	6
2017-2018	4	0	0	0	0
2018-2019	13	1	4	1	3
TOTAL	181	13	35	5	30

Table 1. Summary of the number of Chipping Sparrow captures, birds with visible avian pox infections, and birds with foot deformities

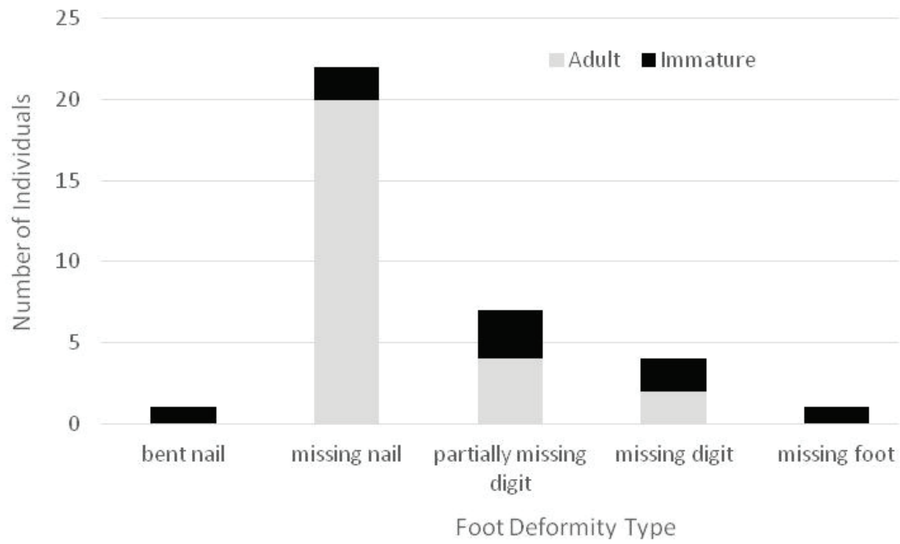

Fig. 1. The number of Chipping Sparrows captured with foot deformities by injury type and age in southern Louisiana between 2013-2014 and 2018-2019.

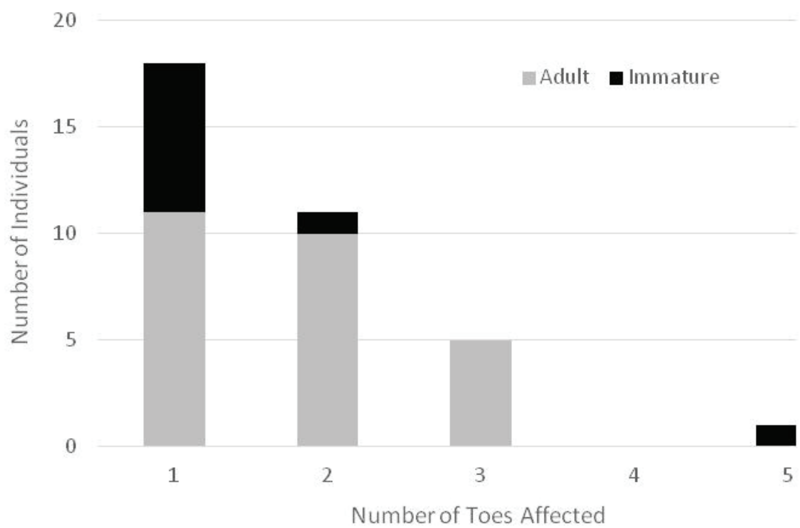

Fig. 2. The number of Chipping Sparrows captured with foot deformities by the number of toes (across both feet) affected in southern Louisiana between 2013-2014 and 2018-2019.

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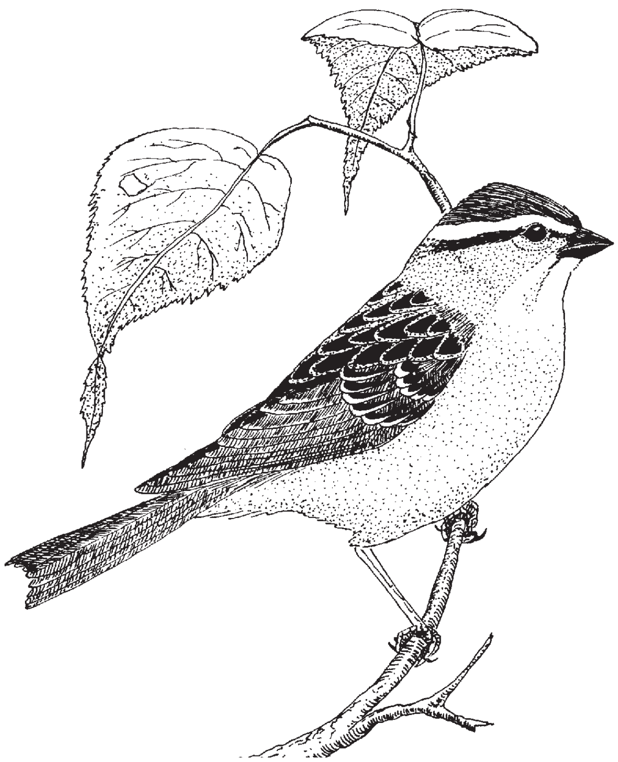

Chipping sparrow
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