TEMPORAL CHANGES IN HENSLOW'S SPARROW (*AMMODRAMUS HENSLOWII*) SONG RATES

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***Abstract*—**Henslow's Sparrow (*Ammodramus henslowii*) is a state-listed threatened species in New York State, and reliable surveys of existing populations are important for successful management. There are many accounts of Henslow's Sparrows singing at night, casting uncertainty on the efficacy of traditional point-count protocols in assessing this species' populations. Importantly, no studies have formally compared their song activity rates throughout a 24-hour (24-h) period. We examined song activity rates of Henslow's Sparrow over six 24-h periods during the breeding season, at the New York State Department of Environmental Conservation (NYSDEC) Perch River Wildlife Management Area, Jefferson County, New York. Seven listening stations were established in known, occupied territories of singing Henslow's Sparrows. We used one-way analysis of variance (ANOVA) to compare song activity rates across eight time periods and six dates. There was no significant difference in average number of songs/time period ($P = 0.140$). However, we did confirm that Henslow's Sparrow sing throughout the entire 24-h period. Song activity rates were generally highest between 0600-1200 and 1800-2100 (Fig. 1) and later in the breeding season. Song activity rates were lower between 2100-0600. In New York State, we recommend surveying for Henslow's Sparrows at multiple locations between 0600-1200 and 1800-2100 with survey dates extending into July.

The use of auditory signals from singing male birds to estimate population abundance or species presence is very common (Bull 1981, Mayfield 1981, Ralph et al. 1993, Sauer et al. 2017). To increase the accuracy of these estimates it is ideal to survey when bird vocal activity is at its peak, typically during the dawn chorus (Robbins and Van Velzen 1967, Skirvin 1981, Kalcelnik and Krebs 1983, Ralph et al. 1993). However, within- and among-species differences in detectability via auditory signals may be substantial, due to differences in vocal conspicuousness and behavioral variability related to time of day, season, age, and sex, not to mention variation in the ability of observers to detect vocalizations (Kepler 1981, Mayfield 1981 Ralph et al. 1993, Thompson 2002).

Detection by song is an extremely important method for assessing avian distribution and abundance, especially so in the cases of threatened or endangered species, for which accurate estimates are crucial to formulate and implement effective management plans. The guild of grassland birds in New England and New York is one group that requires special attention relative to survey techniques, as it has the most species listed as endangered, threatened, or of special concern in the region (Vickery 1992), and populations have been declining since the 1960s (Sauer et al. 2017).

Most studies that monitor grassland bird populations have concentrated survey efforts during the morning (Herkert 1994, Vickery et al. 1994, Bollinger 1995, Norment et al. 1999, Winter and Faaborg 1999, Johnson and Igl 2001, Diefenbach et al. 2007). However, not adjusting survey techniques to account for the nocturnal behavior of some species may result in underestimating the number of birds present. For example, Walk et al. (2000) found that just 57% of all breeding species present were recorded during sunrise counts, and some nocturnally active species such as American Woodcock (*Scolopax minor*), Short-eared Owl (*Asio flammeus*), Sedge Wren (*Cistothorus platensis*) and Henslow's Sparrow (*Ammodramus henslowii*) were either missed or under-sampled.

One grassland species in New York State that may be underestimated by diurnal surveys alone is the Henslow's Sparrow. The Henslow's Sparrow is listed as a threatened species in New York State (NYSDEC 2016); it has been considered as a candidate for federal protection under the Endangered Species Act (Pruitt 1996); and recently was listed as a species of management concern (U.S. Fish and Wildlife Service 2011). Although Henslow's Sparrows are considered a diurnal species, there have been references to their nocturnal singing behavior (Hyde 1939, Austin 1968, Smith 1992, Rising 1996, Herkert et al. 2002). For example, the Birds of North America species account describes Henslow's Sparrow as an inconspicuous bird and states that singing at night is fairly common, with individuals sometimes singing all night long (Herkert et al. 2002). Because they are visually inconspicuous, Henslow's Sparrows are most easily detected when males sing (Diefenback et al. 2007). Diefenback et al. (2007) examined the availability of Henslow's Sparrows and Grasshopper Sparrows (*A. savannarum*) for detection, but they focused only on the morning observation period [0600-1000 hours Eastern Daylight Time (EDT)], a practice common among researchers, as less than 4% of avian vocalization literature examines nocturnal vocalization (La 2012).

The purpose of our study was to examine 24-hour song activity rates of Henslow's Sparrows in known occupied territories throughout the breeding season. Knowing when Henslow's Sparrow song activity is highest will help determine when to best survey for this secretive, rare, and declining species and allow for better population estimates in New York State. In addition, our study will contribute to the more general understanding of nocturnal song activity in passerines.

METHODS

Song detection—We examined song activity rates of Henslow's Sparrows over six 24-h periods at New York State Department of Environmental Conservation's (NYSDEC) Perch River Wildlife Management Area (herein Perch River) in Jefferson County, New York. Perch River has approximately 205 ha of cool season grassland surrounding the periphery of a large wetland complex. The cool season grasslands of Perch River are managed for grassland birds and have supported populations of Henslow's Sparrow for at least 30 years (McGowan 2008).

Seven listening stations were established a week prior to the start of the study; these were placed at locations with ≥ 1 singing male Henslow's Sparrow present, at a minimum distance of ≥ 75 m between fields separated by hedgerows. At night, Henslow's Sparrow song seemed evenly paced and the birds appeared to be mostly stationary; singing birds seemed to move little from the location at which they first were detected. Most of the time there were no more than three males singing simultaneously at any one listening station during the monitoring periods; occasionally there were four. Thus, we could distinguish song activity amongst individuals at one listening station from that at adjacent listening stations, due to a combination of field separation and the limited movement of singing birds.

We then examined Henslow's Sparrow song activity rates over six continuous 24-h periods, between 25 May 2005 and 15 July 2005. On average, surveys were conducted every 10 days. We conducted surveys under favorable weather conditions, with winds < 10 km/hr and no or very light rain. Two observers conducted all the surveys.

We listened for Henslow's Sparrow songs at each listening station every 3 hours during each 24-h sampling day, for a total of eight observation periods: 0000-0300, 0300-0600, 0600-0900, 0900-1200, 1200-1500, 1500-1800, 1800-2100, and 2100-2400 EDT. We counted the number of complete songs during 5-min intervals at each station. Due to travel time between listening stations, it took approximately 90 min to survey all seven stations. We compared song activity rates across the eight observation periods and six sampling dates (25 May, 6 June, 15 June, 22 June, 5 July, 12 July).

We did not mark birds individually because our focus on assessing temporal variation in song detection was intended to inform the most widely used methods for estimating regional, statewide, or national population indices (e.g. the Breeding Bird Survey: Sauer et al. 2017), which generally do not require recognition of individuals. Also, we felt that the secretive nature of Henslow's Sparrows would make observations of marks difficult, and marks would not be visible at night.

Statistical analysis—To test for differences in song rates among time periods, we averaged song rates across listening stations and dates; to test for differences

in song rates among dates, we averaged song rates across listening stations and time periods. We used the Anderson-Darling test to determine if our response variables were normally distributed, with a subsequent log transformation to correct for any nonnormality; we also tested for homogeneity of variances using Minitab (2017) software. Because our response variables met the assumptions of parametric statistics we used one-way ANOVAs to compare song activity rates across the eight time periods, and the six dates. The ANOVAs were run separately, without interaction terms, due to the unbalanced design. However, we did test for an interaction effect between date and time period using a generalized linear model, with time period as a factor and date as a covariate.

RESULTS

There was no significant difference in average number of songs/time period ($F = 1.69_{[7, 40]}$, P = 0.140), although there was some tendency for Henslow's Sparrows to sing less frequently between 2100 and 0600 (Fig. 1). However, we did confirm that Henslow's Sparrows sing throughout the entire 24-h period, with song activity generally highest between 0600-1200 and 1800-2100 (Fig. 1). There also was no significant difference in average number of songs/day ($F = 2.05_{[5, 36]}$, $P = 0.095$), although there was some tendency for higher song rates to occur during the later survey dates, which occurred during July (Fig.2). The generalized linear model showed no significant interaction between date and time period ($P = 0.110$).

During surveys, we rarely heard only one male Henslow's Sparrow sing at a listening station; if one bird began singing, at least one neighboring male usually joined in. Males thus appeared to be stimulated by their neighbor's song, which resulted in bouts of counter-singing and localized clusters of song activity that varied with time of day across the seven listening stations.

There was no change in the number of listening stations at which singing males were present across the range of sampling dates; this figure represents the minimum number of males present in our study area (Table 1). However, assuming males did not move between listening stations, the maximum number of singing males present in our sampling area did increase as the season progressed (Table 1).

Table 1. Number of singing male Henslow's Sparrows detected during a 24-hour period.

Date	Minimum	Maximum
25 May 2005	7	15
08 June 2005	6	17
15 June 2005	7	19
22 June 2005	7	21
05 July 2005	7	24
12 July 2005	7	23

DISCUSSION

Knowing when a bird species is most likely to be detected by song will enable researchers to better design survey protocols and increase the accuracy of abundance and distribution estimates. This is especially important for relatively inconspicuous species of conservation concern, such as the Henslow's Sparrow. Because Henslow's Sparrow songs can be easily overlooked (Sibley 2000), knowing more about the species' temporal pattern will better inform survey designs. We found no significant temporal differences in the species' song rates across the 24-h day and breeding season, although there was some tendency for Henslow's Sparrows to sing more between 0600-1200 and 1800-2100, and later in the breeding season.

We anticipated that Henslow's Sparrow song activity rates would be highest early in the breeding season, when males are establishing territories and females are laying eggs, and then decline as the season progressed (Skirvin 1981, Merila and Sorjonen 1994, Gil et al. 1999). However, Henslow's Sparrow song rates did not decrease as the season progressed (Fig. 2). Holmes and Dirks (1978) observed a similar pattern in Golden-crowned Sparrows (*Zonotrichia atricapilla*) at 62º N latitude, where song activity peaked later in the season than expected. Mid-season increases in song activity could occur because Henslow's Sparrows may breed into August and September across their range (Herkert et al. 2002), including New York State (McGowan 2008); Mazur (1996) found that as many as 50% of the male Henslow's Sparrows in her study population at Saratoga National Historical Park, New York, arrived and established territories after 31 May.

Despite the large amount of variation in song rates across the 24-h day and breeding season, we found no evidence that it is better to survey Henslow's Sparrows at night, at least in our study area. This contradicts Walk et al. (2000), who found that Henslow's Sparrows in Illinois were detected more frequently at night than at sunrise. However, our study is in partial agreement with Heller and Hughes (1997), who reported that Henslow's Sparrows in Indiana were most vocal from 0500 to 0600, with high levels of song activity continuing until 1200. In addition, Heller and Hughes (1997) reported a nighttime resurgence of song activity from 2230 to 0130. Differences between our data on song activity rates and those from studies in the Midwest (Heller and Hughes 1997, Walk et al. 2000) suggest that there may be regional differences in Henslow's Sparrow song behavior and detection probabilities, as has been found for European Robin (*Erithacus rubecula*) populations in Wales and Ireland (Thomas et al. 2003). Regional differences in singing behavior appear to parallel geographic differences in grassland bird ecology (Wiens 1981), such as intraspecific differences in habitat selection between the Midwest and Northeast (Bollinger 1995, Norment et al. 1999). Regional differences in song behavior suggest that regional differences in peak detection period and factors that influence availability for detection by song probability may also vary regionally.

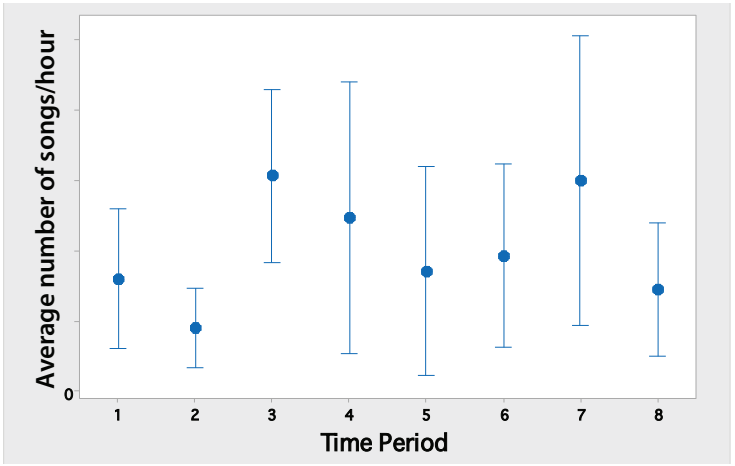

Figure 1. Variation in Henslow's Sparrow song rates across the eight time periods sampled at Perch River Wildlife Management Area, NY; bars enclose 95% confidence intervals; circles represent mean song rates. Time periods: 1 =0000-0300, 2 = 0300-0600, 3 = 0600-0900, 4 = 0900-1200, 5 = 1200-1500, 6 = 1500-1800, 7 = 1800-2100, and 8 = 2100-2400 Eastern Daylight Time.

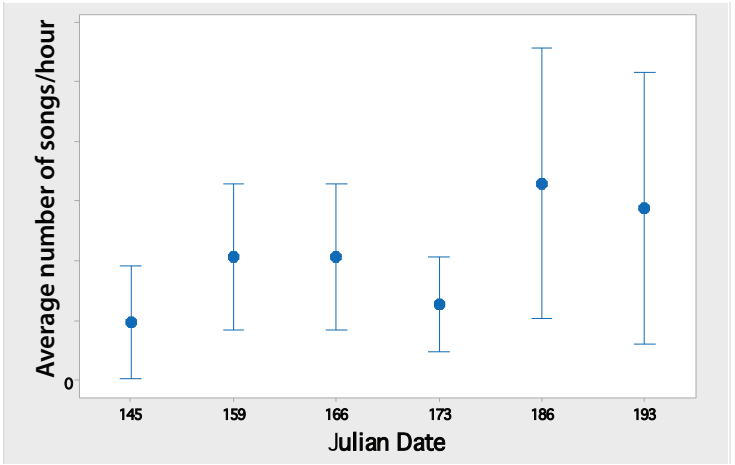

Figure 2.Variation in Henslow's Sparrow song rates across six dates at Perch River Wildlife Management Area, NY; bars enclose 95% confidence intervals; circles represent mean song rates. Julian Dates: 145 = 25 May, 159 = 6 June, 166 = 15 June, 173 = 22 June, 186 = 5 July, 193 = 12 July.

Finally, Henslow's Song activity at our study site did not follow the typical pattern of decrease in activity associated with the progression of the breeding season. Barclay et al. (1987) found no apparent association between nocturnal

song rates and nesting stage for Marsh Wrens (*Cistothorus palustris*). Perhaps establishing territories later in the season and singing more later in the season is a way to limit interspecific song competition. Additionally, it may be that the scarce distribution and ephemeral nature of Henslow's Sparrow habitat in northern New York means that it takes longer for males to locate and establish territories.

To maximize the probability of Henslow's Sparrow detection in northern New York we recommend surveying multiple locations between 0600-1200 and 1800-2100, with survey dates extending into July. Nocturnal surveys may increase detection probabilities depending upon the particular geographic location. However, given the observed variation in song activity, a better sampling design would involve methods that incorporate those of MacKenzie et al. (2004) and Diefenbach et al. (2007): temporal replication at a number of sites to simultaneously estimate availability, detection probability and occupancy.

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