2019 Beaverhill Natural Area Grassland Breeding Bird Census: Summary and Interpretation of Results

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Introduction

Landscapes, by nature, exist perpetually in a state of change; it therefore is imperative that this flux be well understood for any landscape, as such permits effective management and conservation of the landscapes themselves. However, the ecosystems of landscapes are holistic, and therefore must be understood in terms of their components; one of the most significant is the diversity and richness of resident species. Thus, it is of great pertinence to assess frequency and diversity of dominant species within an environment as a means of assessment (Austin, 2007). Birds are particularly useful as subjects for such studies, as their broad ecological diversity allows for gleaning of detailed data (Järvinen & Väisänen, 1979). However, their populations across seasons tend to experience fluctuations, and as such, bird monitoring programs necessarily run over many years, over the course of which data may provide insight into habitat changes, as well as indicate for any unexpected incongruities.

One such study has been (and currently is) taking place at Beaverhill Lake in central Alberta (Beaverhill Bird Observatory, 2019). The lake has historically proven to be a significant breeding ground for a diverse range of bird species (some of which are endangered). However, the past 14 years has seen a significant decrease in the water level of the lake. This has resulted in a transition in topography, with grasslands, willow shrub land and aspen forest spreading northward, and consequently, there has been a corresponding shift in the different nesting bird species, and their preferred locales. To effectively monitor the change on a holistic level, two grids have been established for annual survey – one located in the forested southeast of the observatory, and the other in the grasslands northeast (though some habitat overlap does exist).

Methods

Study Area

Established in 1992, the grassland breeding bird grid has since expanded to approximately 21.25ha; it lies on the north end of Beaverhill Bird Observatory, along the former south shore of Beaverhill Lake. Along the north-south axis, the study grid peaks at 400m, divided every 50m into a row (Z to H; row A adjacent north to Z). From east to west, the grid spans 600m, and is subdivided into columns (-1 to 11) at 50m intervals.

Broadleaf forest cut through rows Z, A and B, before transitioning into willow shrubland in rows C and D. E to H primarily featured grasslands interspersed with shrubbery throughout, however, furthest east the willow scrub extended as far as E10-E11. Soil waterlogging increased gradually towards the southeastern-most corner, culminating in the Sora's Pond wetland, which lay immediately south of A7-A9. Expansion of the pond had rendered Z7 nearly inaccessible, and, with increased precipitation during the latter half of the survey period, A7 and A8 became increasingly difficult to access as well.

Data Collection

Eight full surveys of the grid were completed over the course of 9 total visits. Though the first visit, on June 4, occurred in the early afternoon, activity was high enough that a full survey could be conducted. 6 following visits occurred in the mornings of June 9, 11, 13, 21, 23, and 27, each of which having saw a full survey completed. Two evening visits occurred June 12 and 22, with each surveying approximately half the grid. Survey points were established along intersections of aforementioned horizontal (Z, A-H) & vertical (-1 to 11) gridlines; each point being 50m from all immediate adjacent points. Morning surveys typically began around 04:30 and typically took 4h to complete. Afternoon evening began near 20:00, and took 2-3 hours.

Survey stops conducted at every transect point lasted approximately 3-5 minutes, depending on the level of bird activity encountered. Locations of transect stops were mapped on a Garmin GPS system, which served as the primary navigation tool during surveys. Species identified had approximate call positions mapped using a shorthand code corresponding to the species (Appendix I). Following bird census guidelines from Bibby *et al*. (1992), simultaneous calls from different individuals of the same species were connected with dotted lines; known movement on any individual was recorded using a solid line.

Data Interpretation

All data from survey maps were transcribed onto species-specific maps corresponding to each species observed during the survey period. Each data point was given a single-letter code (A-H) corresponding to which survey the point was picked up on. Because survey D was completed in two halves, D_1 and D_2 were respectively used for the first and second half-surveys. Generally, species were common and widespread enough in observations to warrant their own individual species maps. To make efficient use of space, less-common species may have been mapped together with other less-common species; species to be grouped was based on if their observed territories overlapped (grouping ensured that no two territories of differing species overlapped, to avoid causing undue confusion).

Though a total of 9 independent visits to the grid were conducted, because two were half-surveys (and thus only 8 full surveys were yielded), guidelines laid out that two encounters minimum within close vicinity of one another would qualify as a territorial cluster (Bibby *et al*. 1992). Guidelines in Bibby *et al.* (1992) also mandate a minimum of 10 days between the two most temporally distant points in a grouping before it qualified as a cluster; however, this protocol had to be loosened for this study, as the survey period lasted only 3-4 weeks, as opposed to the recommended 8 weeks. Therefore, it was deemed that any grouping of 3 or more points which included a sighting during a terminal survey (A or H) could qualify as a cluster, so long as the two most temporally distant points had at minimum 5 days separation. Else, the 10-day mandate stood.

Results

The 2019 grassland census noted a total of 225 recorded territories. Compared to immediately prior years, this is a sharp increase, and marks the end of a 3-year trend of decreasing territory counts. The clay-coloured sparrow was again the most prevalent species, with 49 reported territories, followed by LeConte's sparrow, with 39 territories reported. Additionally, three new species were reported for the first time – the Virginia rail, common snipe, and sedge wren. Savannah sparrows were again found to be less abundant than historically reported, with only 14 territories (though this is an increase from 2018).

Shannon-Wiener, Pielou's evenness, and Simpson's indices were all calculated for the 2019 observational values. These were then compared to the same index values of previous years, to contextualize changes in diversity and richness of species recorded during the survey. The reported Shannon-Wiener value of 2.427 and Pielou's index value of 0.840 both rank highest in recorded history of the grasslands survey, while the Simpson's index value of 0.112 ranks lowest. Meanwhile, the reported species richness of 18 different species ranks second highest, after the 2016 survey.

Table 1. Breeding territories by species, recorded per prior year of grasslands breeding bird censuses.

Species	**Year of Breeding Bird Census**								
	1992	1993	2004	2013	2014	2016	2017	2018	2019
Mallard	4	6	0	0	0	3	0	2	0
Gadwall	0	0	0	0	0.5	0	0	0	0
Northern Shoveler	1	0	0	0	0	2	0	0	0
Blue-winged Teal	3	0	0.5	0	0	1	0	0	0

Lesser Scaup	6	0	0	0	0	0	0	0	0
Duck spp.	6	2	0	0.2	0	0	1	0	0
Sora	0	0	0	0	0	2	0	0	2
American Coot	0	0	0	0	1	0	0	0	0
Wilson’s Phalarope	11	5	0	0	0	0	1	1	1
Common Snipe	0	0	0	0	0	0	0	0	7
Virginia Rail	0	0	0	0	0	0	0	0	2
American Bittern	0	0	0	0	0.5	1	0	0	0
Broad Winged Hawk	0	0	0	0	0	1	0	0	0
Northern Harrier	0	1	1	0	0	0	0	0	0
Short-eared Owl	0	0	1	0	0	0	0	0	0
Alder Flycatcher	0	0	0	0	1.5	13	5	12	10
Least Flycatcher	0	0	3	3.8	8	27	3	2	16
Marsh Wren	0	0	0.5	0	0	0	0	0	0
House Wren	0	0	0	0	0	1	4	1	2
Sedge Wren	0	0	0	0	0	0	0	0	5
American Robin	0	0	0	0	0.5	0	0	0	2
Grey Catbird	0	0	0	0	1	0	0	3	0
Yellow Warbler	2	2	4.5	7.8	6	43	24	20	25
Yellow-rumped Warbler	0	0	0	0	0	16.5	4	6	0
American Redstart	0	0	0	0	0	7	0	0	0
Common Yellowthroat	1.5	2.5	4	0	0	0	1	9	19
Savannah Sparrow	48	35	32	25.4	11	53	32	6	14
Clay-colored Sparrow	6	5	16	43.4	10	83	42	23	49
Le Conte’s Sparrow	4	6	1	0	0.5	7	0	0	39
Lincoln’s Sparrow	0	0	1	0	1	0	0	1	0
Sharp-tailed Sparrow	9	7	4	0	0	0	0	0	0
Song Sparrow	0	0	1	0	0	0	3	4	7
Vesper Sparrow	0	0	0	0	0	16	0	0	0
Rose-breasted Grosbeak	0	0	0	0	0	4	0	0	0
Red-winged Blackbird	16.5	17	0.5	0.2	2	1	4	2	16
Yellow-headed Blackbird	3	0	0	0	0	0	0	1	0
Brewer’s Blackbird	0	0	1	0	1	0	0	0	0
Baltimore Oriole	0	0	0	0	0	5.5	0	0	0
Brown-headed Cowbird	0	0	0	0	2	10	0	2	0
Black-capped Chickadee	0	0	0	0.8	0	0	0	0	7
Warbling Vireo	0	0	0	0.8	0	0	0	0	3
Total	121	88.5	71	82.4	47.5	299	125	95	226

Table 2. Species richness, and Shannon-Wiener, Simpson’s and Pielou’s evenness indices of prior year grasslands breeding bird censuses.

Census Year	**Species Richness**	**Shannon-Wiener Index**	**Simpson’s Index**	**Pielou’s Evenness Index**
1992	14	0.506	0.201	0.192
1993	11	0.544	0.217	0.227
2004	15	0.557	0.267	0.206

2013	8	1.184	0.384	0.570
2014	16	0.513	0.149	0.185
2016	21	2.284	0.143	0.750
2017	13	1.825	0.785	0.712
2018	16	2.264	0.141	0.817
2019	18	2.427	0.112	0.840

Discussion

Population Trends

2019 marks the first year in the census history where no reports of resident ducks occurred. However, in addition to three new species recorded during the census period (common snipe, Virginia rail, & sedge wren), five species were recorded to have returned after two or more years of absence – sora, black-capped chickadee, warbling vireo, American robin, and LeConte's sparrow. Notably, LeConte's sparrow was recorded a total of 39 times, significantly higher than any other year of grasslands census (the next highest being 7 records in 2016); they made up the second most abundant bird species.

Four species of bird continued to appear this year, as well as all previous years of the grassland survey, these being the red-winged blackbird, savannah sparrow, clay-coloured sparrow, and yellow warbler. Of these four species, only the savannah sparrow showed a continued low from historical numbers (though it still was an increase from the 2018 survey year; Helliker, 2018). All three other species showed an increase in the past 2 years, with the red-winged blackbird boasting its highest record numbers since 1993.

Non-Cluster Records

It is noteworthy that several distinct records were made, but were disqualified from being classed as a cluster, due to either failing to meet the criteria laid out (both in Bibby *et al*. (1992) and in the methods section) or being isolated in incidence. Two species, the brown-headed cowbird and Lincoln's sparrow, were only known from such records (and consequently deemed as non-resident). Brown-headed cowbirds, despite prevailing even through the final survey, were never recorded grouped together in abundance enough for any territorial clusters to be confirmed. Meanwhile, Lincoln's sparrow failed to appear with a high enough prevalence for a cluster to be confirmed, though sightings were reported as early as survey 4 part 1 (June 12), and persisted intermittently through to the final survey.

Weather

Initially, surveys were to be spread relatively evenly across the month, with an approximate interval of 2 surveys per week, spread out by 4-5 days between. However, rainfall proved to be a significant limiting factor during the survey period. Furthermore, significant rainfall caused severe waterlogging of the survey site, as well as increase in the depth of Sora's Pond, beginning as early as the inter-survey period between the first and second visit (June 4 and 9); intermittent bouts of heavy rainfall occurred throughout the month, and were most intense between surveys 5 and 6 (June 13 and June 21). Prior to rainfall immediately post-survey A (and beyond), flooding of the survey area was far less pronounced.

Rainfall during June 2019 was noticeably above average, with a total monthly precipitation of 117.4mm (The Weather Network, 2019). This is approximately 33% above the average monthly rainfall for June for the past 30 years (88mm), and a dramatic increase from the previous two years (both years only reaching ~60mm of total monthly rainfall in June).

Recordings incongruous with previous years align well with the waterlogging of the survey area. Most pertinent are the appearance of the sora and sedge wrens, which apparently occurred after the initial flooding between June 4 and June 9; both were absent from the first survey, yet were prominent second survey and onwards. Both non-resident species recorded also appeared only after waterlogging occurred, as did several other species; however, since these species had been previously recorded as being resident, it is harder to draw connections with the rain (though it may be worth investigating later on).

Index Comparisons

With 226 recorded territories belonging to 18 resident species, the 2019 grasslands census produced the second-highest yield of both territory count and species richness in the history of the census, with only the 2016 census surpassing in both counts. However, the 2019 census also yielded the highest Shannon-Wiener and Pielou's evenness index values, along with the lowest Simpson's index value to date, all of which implicates the 2019 survey as recording the greatest level of species evenness in the history of the grassland survey. Compared to previous years, the 2019 census continues an increase in a trend tending towards evenness, with both Shannon-Wiener and Pielou's index values increasing steadily, and Simpson's index decreasing steadily. However, the territorial count produced also dramatically reverses the trend of decrease in terms of overall number of territories counted, seen in the previous 3 years (2016-2018).

Other Factors

One major factor playing into the change in avian composition of the grassland breeding bird grid is the succession in the region formerly occupied by the bed of Beaverhill Lake. A typical trend observed of succession following the drying-up of a wetland is the encroachment of upland flora species, not unlike that which is observed in secondary succession processes occurring under different circumstances elsewhere (Klein *et al.*, 2005). This is affirmed by the noticeable northward procession of both the deciduous forest edge, as well as the of the willow scrubland. In turn, this may account for the increase in the frequency of forest-dwelling species encountered, such as the black-capped chickadee and warbling vireo (Cornell Lab of Ornithology, 2019), whose reappearances marked the ends approximate 6-year absences (neither had been seen since the 2013 survey). Other notable species include the least flycatcher, song sparrow, and American robin, which all have correspondently reappeared and/or increased in frequency within the past four surveys.

Post-survey, increased intensity of rainfall continued through July 2019. This occurred to an arguably greater degree versus the June survey period, as July 2019 saw upwards of 163.4mm of total precipitation, an increase of ~147.6% compared to the 30-year monthly average (66mm). Though no surveys were conducted during July (as it was outside the survey period), heightened rainfall is likely to influence bird nesting success in following years (Zuckerberg *et al.*, 2018). This effect on its own is likely to be positive, as the rain may increase food and cover availability, however if rainfall trends continue or repeat during the nesting season, an overall negative impact will prove the likelier observation.

An important, but not as immediately impactful (though arguably with greater overarching significance) issue is that of the climate. Specifically, an increase in the global temperatures is likely to shift the breeding behaviors of various species, pushing them to breed in earlier months, shift breeding territories into cooler habitats located further towards the poles, or in areas of higher altitude (Crick, 2004). Such patterns have been reported all over the world, for instance the upward altitudinal shifts in mountainous avian communities of Costa Rica observed by Pound *et al*. (1999), and the shifts in breeding habitat of the snow bunting (*Plectrophenax nivalis*) from their traditional breeding grounds in the Grampian Mountains of Scotland, noted by Berry *et al.* (2001). Currently, no such study exists regarding the birds of the south Beaverhill lakeshore grassland in which the census took place, and conduction of such a study would need to take into account shifts due to the natural successional transition of the former lakebed; however, it is almost certain that climactic shifts have and will continue to impact the census site as others, and therefore such a study should be considered for the near future.

There is also the possibility for other factors existing which may not be immediately determinable, such as any changes that may have occurred to food densities of the area. It is also likely that many species-specific factors are also at play, as these would likely explain why some species in particular have experienced dramatic chagnes to their record frequencies within the past several years (e.g. savannah sparrows' and LeConte's sparrows' frequency changes).

Inefficacies

Throughout the conduction of the study, it is likely that several factors would have played into reducing its effectiveness. A major factor influencing this survey (and others of a similar nature) is observer bias. Differences in physical ability (e.g. hearing) compounded with differences in experience (Sauer *et al*., 1994; Faanes & Bystrak, 1981). Most important is the ability to distinguish species apart from other, similar-sounding species. These differences are exacerbated between individuals, with differences in frequencies of some species reaching upwards of 50% in one survey (Sauer *et al.*, 1994). Under- and overestimates of frequencies observed may also vary between individuals, depending on how observations in the field are recorded and interpreted.

Conduction of the surveys themselves also produced some issues, specifically with regards to the rate of visits conducted, and the survey period. Bibby *et al.* (1992) recommends 10 visits spread over 8 weeks, however only 8 were conducted over a 23-day survey period – well below the recommended length. To compensate for any incidences of birds whose residency terms did not fully fall into or cover the survey period, it was decided that three records within 5 days would be sufficient to mark a territory, should one of the three records have occurred on either the first or last surveys; else, two or more records with 10 days between them would qualify as a territory.

. However, this disqualifies several groupings from being designated a territorial cluster, including clusters not spread apart by 10 days nor contain a terminal record, nor groups with only two records which still contain a terminal sighting and are within 5 to 10 days apart. This proved particularly problematic due to the spacing of the visitations, as heavy rainfall and scheduling conflicts near the middle of the survey term meant most visits were clustered towards the beginning or the end of the month. Consequently, disproportionate emphasis was placed on records collected during terminal surveys, as in many cases, it would be these records which determined if a species could be logged for the 2019 census term or not. This also proved especially problematic for species which appeared after the flooding of the grassland, and thus could not, in the early half of the census term, rely on the aforementioned exception (as they were absent for the first survey).

Rarer species were also particularly problematic, as they would occur in lower concentration, and thus, clusters were often harder to define. This was most evident for Lincoln's sparrow, whose records were far too disparate to yield any meaningful clusters whatsoever, despite having been recorded several times. This is a pervasive problem with the breeding bird census as a whole, as there is a density-dependent reliance on marking record clusters, which is much more difficult with rarer species (Bibby *et al.*, 1992). Furthermore, species-specific behavior (especially extra-territorial) and territorial shifts were not taken into account.

Conclusion

The 2019 census marks the fourth year in which census data has consecutively been collected from the grasslands breeding bird grid. The species richness was also the highest since 2016, with the highest species evenness in the history of the survey; however, some inefficacies may have skewed results. Some trends observed in recent years has continued to be observed, while other, new trends appeared, and warrant attention. The consecutiveness of data allows for a finer resolution by which monitoring of the changes to the behavior of the resident species, as well as to the environment itself can be undertaken. Ultimately, the 2019 census further provides valuable data additions to the project of monitoring the environmental changes at Beaverhill Lake.

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Appendix I

Bird Species Map Codes:

AF – Alder flycatcher

AR – American robin

BCC – Black capped chickadee

BHC – Brown-headed cowbird

CCS – Clay coloured sparrow

CYT – Common yellowthroat

HWrn – House wren

LeS – LeConte's sparrow

LF – Least flycatcher

LiS – Lincoln's sparrow

RWBB – Red-winged blackbird

Snpe – Common snipe

Sora - Sora

SoS – Song sparrow

SvS – Savannah sparrow

SWrn – Sedge wren

VRl – Virginia rail

WPh – Wilson's phalarope

WV – Warbling vireo

YW – Yellow warbler