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Rusty Blackbird (*Euphagus carolinus*) population and distribution data in the Athabasca and Cold Lake Oil Sands regions of Alberta using Automated Recording Units (ARUs)

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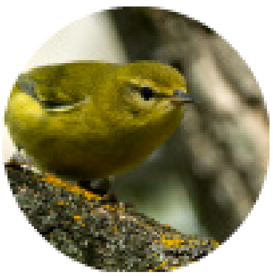


Executive Summary

The Rusty Blackbird (*Euphagus carolinus*) was listed as Special Concern on Schedule 1 of the federal Species at Risk Act (Government of Canada / Gouvernement du Canada 2009) in March 2009 because of large and long-term declines in population size. The Rusty Blackbird is a medium-sized, insectivorous subtropical migrant Icterid. It breeds in wetland habitats in the boreal forests of North America (bogs, fens, swamps, and ponds) and winters in the southeastern United states, into Mexico. Approximately 85.5% and 8.4% of the global breeding range of Rusty Blackbirds are found in Canada and Alberta, respectively. Once considered an abundant species, they are generally uncommon across their range today. Breeding Bird Survey (BBS) data, the primary source of trend estimates in Canada, indicate that the Rusty Blackbird population in Alberta and Canada has declined substantially since the mid 1960's. However, there are substantial methodological problems with this data, leading to uncertainty, especially in parts of the breeding range that have been infrequently sampled. The use of Automated Recording Units (ARUs) deployed by the Bioacoustic Unit can improve data about Rusty Blackbird populations in Alberta, specifically in the under-sampled Lower Athabasca Planning Region. ARUs deployed at 2399 stations from 2012 -2016 detected vocalizations by all nearby animals. Generally, ARUs appear to detect Rusty Blackbirds at a higher rate (>1 % of surveys) than previous methods. Using mixed effects logistic regression, Rusty Blackbird detection probabilities were shown to be greatest in fen habitats, increase linearly with latitude and, marginally increase with distance from roads. However, 82.1% of detections (198 / 241) detections occurred at stations nearby the McLelland Lake Fen Complex. Thus, the data suggests large, intact, and possibly remote, wetland complexes may be important areas for the remaining Rusty Blackbird populations in Alberta, and across the breeding range, and should be prioritized for future surveys. Conservation efforts intended to protect Rusty Blackbirds in the Lower Athabasca Planning Region need to address issues related to development near the McLelland Lake Fen Complex, where Rusty Blackbirds were detected in >5% of all surveys.

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Introduction

Rusty Blackbirds (*Euphagus carolinus*) are a medium-sized, insectivorous, subtropical, migrant Icterid (Avery 2013). Their breeding range spans the coniferous and mixed-wood forest of North America from the northern edge of the tundra southward toward deciduous forests and grasslands. Nearly all of the Rusty Blackbird's breeding range is found in Canada (~86% of the population; Partners in Flight Science Committee 2013), and it encompasses a large proportion of Alberta. Their winter range is primarily in the Grain Belt of southeastern USA, into Mexico. It is generally an uncommon species, and their density is low across the breeding range.

Studies in the southern part of their breeding range and their wintering grounds have shown that populations are declining rapidly. The number of Rusty Blackbirds detected on their breeding grounds has declined steadily since broad-scale Breeding Bird Surveys (BBS) began in the mid-1960's (Sauer et al. 2014) and similar trends have been identified on their wintering grounds. In Canada, BBS data between 1966 and 2009 indicated a population decline of >95% country-wide, though the precision of this estimate is likely low (Sauer et al. 2003). Declines appear to be range-wide, but limited data in the northern boreal, and in remote areas means large parts of the breeding region remain understudied

In Canada, the Rusty Blackbird was listed as Special Concern on Schedule 1 of the federal Species at Risk Act (Government of Canada / Gouvernement du Canada 2009). It was uplisted from a species of Least Concern to Vulnerable status in 2007 (www.IUCNredlist.org). However, detections of Rusty Blackbirds on which designations are based are sparse, owing to relatively inaccessible breeding habitat, low detectability, and confusion with other Icterids (Euphagus cyanocephalus, Quiscalus quiscula; Semenchuk 1992).

Automated Recording Units

Automated Recording Units (ARUs) were deployed by the Bioacoustic Unit from 2012 to 2016 in the Lower Athabasca Planning Region (LAPR) in northwestern Alberta. These devices were set to record at predetermined intervals each day. Most wildlife can be detected within 400 m of the unit. For Rusty Blackbirds, the use of ARUs allows for more comprehensive sampling at a site, a vast reduction in misidentifications, and easier access to remote habitats.

This report aims to improve current knowledge of Rusty Blackbird occurrence and abundance in an understudied region of their breeding range: the Athabasca and Cold Lake Oil Sands regions of Alberta.

(Reeves, 2013)

In this region, data collection has occurred further north and further from roads than in most other Rusty Blackbird studies. This data may ultimately reveal population trend estimates that differ from those derived using other methods and help us to understand the abundance and distribution of this species.

Habitat and Diet

Rusty Blackbirds breed in boreal wetlands but are largely absent above the latitudinal tree line. They have been observed in various riparian habitats including peat bogs, riparian scrub, open moss- and lichen-spruce woodlands, marshes, and swampy shores along lakes and streams (Semenchuk 1992). Nesting sites tend to be in conifers, tall shrubs, stumps, willow and, birch (but primarily in small spruces that provide cover for the nest; Matsuoka et al. 2010, Avery 2013). Adjacent freshwater bodies with shallow water and emergent vegetation are important foraging substrates (Matsuoka et al. 2010, Greenberg et al. 2011). In New England Rusty Blackbirds were associated with the pools of shallow water and nearby upland typically had large (>70%) conifers for nesting substrates (Powell et al. 2014).

Rusty Blackbirds feed along edges of ponds, streams, and other wetlands. They have been observed using open pasture, agricultural fields and, feedlots with standing water. Virtually all foraging occurs along the ground or on emergent wetland vegetation. Insect larvae (particularly Odonata nymphs), snails, crustaceans, grasshoppers, beetles and, spiders comprise their diverse invertebrate diet (Avery 2013). In the winter and during migration, Rusty Blackbirds will take plants food sources, including crops, seeds, berries and, fruit (Edmonds et al. 2010, Avery 2013).

Distribution and Evidence for Declines

Rusty Blackbirds are found in every province and territory in Canada and typically overwinter in the southeastern United States (Figure 1; Avery 2013). As much as 85.5% of their breeding range is within Canada, while 8.4% of the breeding range is in Alberta (Birdlife International 2016). The Mississippi Alluvial Valley (west of the Appalachians) and southeastern Coastal Plain (east of the Appalachians) are considered core wintering areas (Greenberg et al. 2011, Avery 2013). In Canada, Rusty Blackbirds breeding pairs have become mostly absent in the southern extent of the breeding range (Greenberg et al. 2011) and in southern Alberta breeders have grown exceptionally rare. Breeding Rusty Blackbirds are thought to be most abundant in northern portions of the boreal forest, in Taiga Shield and Hudson Plains (BCR7) and Northwestern Interior Forest (BCR4) Bird Conservation Regions. In Alberta, the highest quality habitat for Rusty Blackbird is thought to be in the Boreal Taiga (BCR6), much of which overlaps the Athabasca and Cold Lake Oil Sands region (Figure 2).

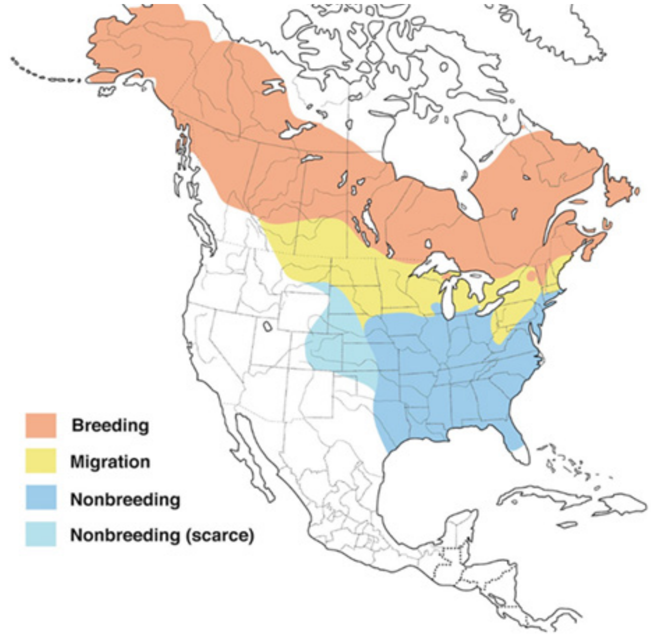

Figure 1. The range of Rusty Blackbirds in North America. Adapted from Birds of North America (BNA) online at https://birdsna.org (Avery 2013).

In general, this species appears to be declining range-wide. In Canada, BBS data between 1966 and 2009 indicates an annual decline of 9.4% Canada-wide (Avery 2013), while range-wide declines are estimated at 5.7% per year (Sauer et al. 2011).

Text descriptions of Rusty Blackbirds in the early 1900's described the species as "abundant", while they are typically referred to as "uncommon" in modern descriptions (Greenberg and Droege 1999). The declining trend observed in BBS data is corroborated by the Christmas Bird Count (CBC) data across the wintering grounds which estimates declines at 4.5% annually from 1996-2005 (Niven et al. 2004). The BBS and

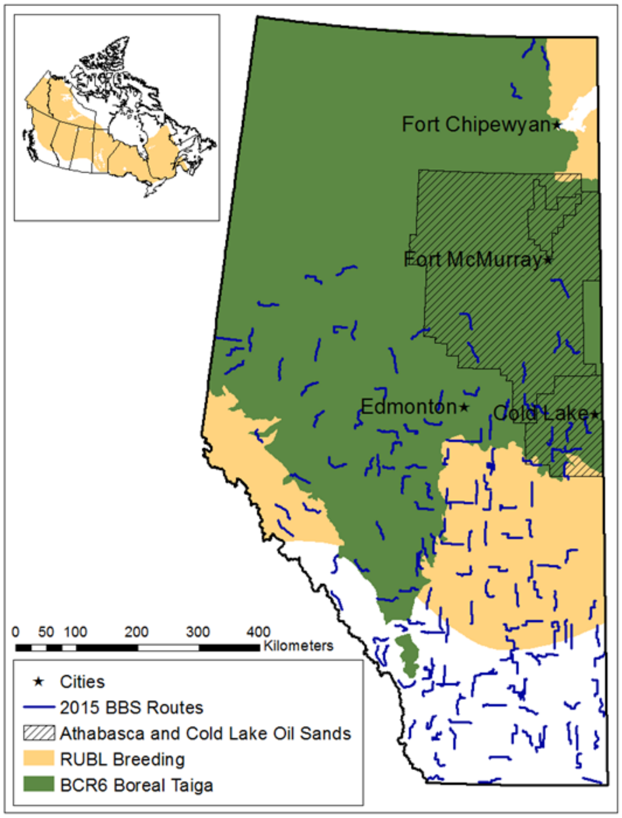

Figure 2. The Rusty Blackbird (RUBL) Breeding Range in Canada and Alberta (Birdlife International 2016). The best Rusty Blackbird habitat in Alberta is thought to include the Boreal Taiga Bird Conservation Region (BCR6). Their breeding range encompasses the Athabasca and Cold Lake Oil Sands region, but few Breeding Bird Surveys (BBS) have been conducted here. range of Rusty Blackbirds in North America. Adapted from Birds of North America (BNA) online at https://birdsna.org (Avery 2013).

CBC annual decline estimates correspond to >95% and 85% declines in Rusty Blackbird populations since 1996, respectively (Greenberg et al. 2011).

However, the relatively small number of Rusty Blackbirds detections on Canadian BBS routes (~150 from 1966 - 2005) has resulted in large confidence intervals for estimated declines (Greenberg et al. 2011), and there is concern about the validity of trend estimates from detection-poor data (Sauer et al. 2003). Additional drawbacks of BBS data include: surveys were conducted exclusively along roadsides, were limited to 30% of the Rusty Blackbird range in Canada, few were conducted in the BCR6, and fewer still in the Athabasca and Cold Lake Oil Sands region (Figure 2). Given these limitations, it is possible that the declining trend based on BBS data is not representative of under-sampled regions of the breeding range, such as the Athabasca and Cold Lake Oil Sands regions. Elsewhere, populations in the MacKenzie Valley, Northwest Territories have not changed substantially based on occupancy of 61 wetlands in 1975 compared to a recent re-survey of those wetlands (Machtans et al. 2007). The Athabasca and Cold Lake Oil Sands region represents an under sampled region of Alberta and sampling this potentially good quality Rusty Blackbird habitat should improve understanding of the location and stability of the remaining Rusty Blackbirds in Alberta.

Sources of Declines

Ultimately, the causes of the Rusty Blackbird declines are not fully understood. Pollution and degradation of wetland habitat, and conversion of boreal wooded wetlands in the breeding and migratory range are considered the most likely causes of declines in Canada (http://www.registrelep-sararegistry.gc.ca). Greenberg and Droege (2003) propose three mechanisms driving decline range-wide. On the wintering grounds (i) the conversion and hydrologic alteration of wetland has resulted in habitat loss and degradation and (ii) the intentional killing of mixed-species blackbird flocks with the goal of eliminating pest species has resulted in direct mortality. In Canada, the (iii) degradation of breeding habitat resulting from a) climate change and, b) direct human activity such as logging and industrial development has led to acidification and mercury intensification in wetlands.

Climate change has the potential to dramatically affect breeding Rusty Blackbirds. Widespread drying of wetlands in the northwestern boreal means loss of suitable Rusty Blackbird habitat (Klein et al. 2005). Further, there have been changes in water chemistry and decreases in macroinvertebrate abundance associated with wetland drying (Klein et al. 2005, Riordan et al. 2006). The potential impacts of these changes on Rusty Blackbird populations are widespread but poorly understood. Additionally, climate change driven increases in surface air temperatures have been positively related to fire intensity and frequency (Soja et al. 2007), with unknown consequences for boreal wetlands.

Direct human impacts are also likely affecting Rusty Blackbird habitat. For example, industrial development may have may altered underground and surface water volumes. Wetland pollution in the form of acidification, calcium depletion and, mercury overabundance broadly affects boreal wetland foragers and breeders (Greenberg et al. 2011). Although direct human impacts may contribute to Rusty Blackbird population declines, Gauthier and Aubry (1996) estimated that only 8% of the boreal forest had been directly impacted by industrial development in 2003. Pollution concerns may be most apparent in eastern Canada and the United States where cities and industry occur at the highest densities (Greenberg and Droege 1999). Wetland forest complexes used by Rusty Blackbirds for nesting habitat typically have limited value for most forestry activities.

Vocalizations

Both males and females sing during the breeding season, while only males sing (sporadically) during spring and fall migratory period (Saunders 1935, Rosenberg 1991). Neither the function, nor the diurnal pattern of vocalization are well understood. The male song will span roughly 1 s when including an introductory note and the principal screech (sometimes described as a rusty gate; Figure 3). Songs are often accompanied with harsh cheks. Rusty Blackbirds may vocalize infrequently resulting in low detection likelihood with single visit or short duration survey designs. Personal experience following Rusty Blackbirds indicates there are large gaps in time between singing bouts. Thus, frequent sampling, across days or weeks by ARUs should provide improved estimates of the presence or absence of the species.

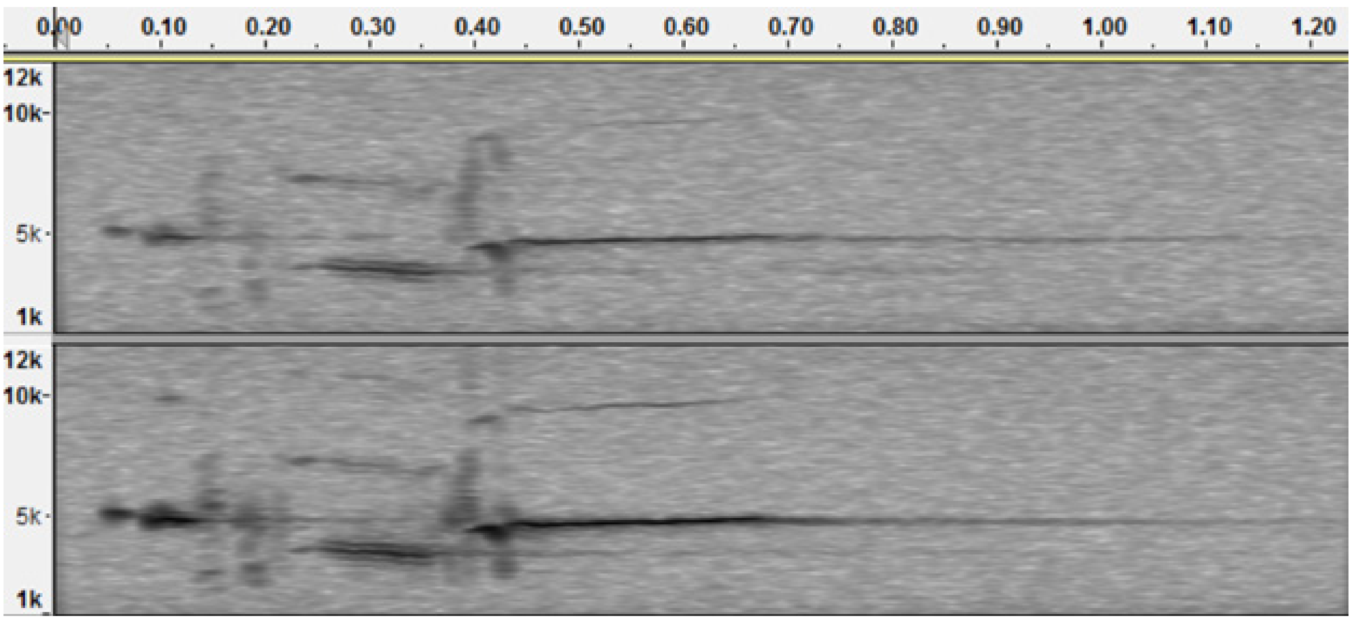

Figure 3. 2-channel spectrogram of a Rusty Blackbird vocalization detected in 2013 from a recording at a wetland site in the Lower Athabasca Watershed region. The vocalization was detected using a Wildlife Acoustics (https://www.wildlifeacoustics.com/) SM2 Automated Recording Unit (ARU) and the spectrogram was generated using Audacity ® (http://www.audacityteam.org/).

Methods

ARU Deployment

Wildlife Acoustics (https://www.wildlifeacoustics.com/) model SM2, SM3 and, SM4 ARUs were deployed throughout the LAPR, with stations spanning from Cold Lake in the south to Fort Chipewyan in the north (~ 70 000 km2). ARUs were deployed in wetlands, upland forests (deciduous, coniferous and, mixed stands), and at sites with varying industrial intensities. All Terrain Vehicles (ATVs) were routinely used to access ARU stations, while others were accessed using helicopters and watercraft. Thus, many sample locations were far from road access. ARU stations were typically grouped in clusters of 5 or more (>= 400 m apart) referred to as "sites". Daily preprogrammed recording schedules were variable. Important schedules included (i) priority sampling at sunrise with repeated sampling each hour to capture the active singing period for most birds. (ii) Nocturnal sampling with the goal of detecting owls and other nocturnal organisms and, (iii) sampling throughout the day.

Recordings of two durations, 3 and 10 minutes, were processed by trained staff (listeners) to document all vocal animals through the duration of the recording. Recordings were visualized using spectrograms ranging from 1 – 12 kHz which were generated using Adobe Audition (Adobe Systems Inc. 2012) or Audacity ® (http://www.audacityteam.org/). In this report, different sampling methods are adjusted for statistically using categorical predictor variables. The majority of listening focussed on the sunrise sampling periods, when the largest majority of songbirds were vocalizing.

Spatial Data

We plotted each ARU location, and all associated Rusty Blackbird detection information. We mapped the historical breeding range of Rusty Blackbirds using the range provided by Birdlife International (Birdlife International 2016). To explore the spatial attributes of locations where Rusty Blackbirds were detected, we extracted information from two primary sources. First, the habitat types that Rusty Blackbirds are associated with were extracted as point level and percentage within 100 m buffers around each station from the Ducks Unlimited Enhanced Wetland Classification layer (Ducks Unlimited 2011). The DU data had high spatial resolution (30 x 30 m) and included bogs, fens, marshes, swamps and, upland habitat types. We selected a 100 m buffer because Rusty Blackbird nest sites were found at a maximum distance of 95 m from wetlands (Powell et al. 2010), which may indicate an upper estimate at which this species is selecting breeding sites. We used road information from Alberta Transportation (Alberta Transportation 2015) to assess two non-exclusive possibilities that (i) Rusty Blackbirds tended to breed away from roads or (ii) roads tended to be constructed away from their typical breeding habitat. All spatial analyses were done using ArcGIS Version 10.2 (ESRI 2013).

Statistical Analysis

We modelled Rusty Blackbird detections data at two levels. (i) at the recording level and (ii) at the station level to examine when and where Rusty Blackbirds were likely to be detected, respectively. We used mixed effect logistic regression where Rusty Blackbirds detections were treated as events while each recording or station was a trial. Though multiple detections sometimes occurred at a given recording or station, these were rare enough that the poisson models of count data were not appropriate. For the recording level analyses, we used nested random effects for site and station to control for spatial clustering at a given site and lack of independence among multiple recordings from one station, respectively. At the station level, we used a random effect for site to control for spatial clustering among stations at a given site.

At the recording level we wanted to understand what time of day, and time of year Rusty Blackbirds were likely to be detected vocalizing. We categorized time of day into early morning (05:00 – 09:00), daytime (09:00– 21:00), and night (21:00 – 05:00) based on ARU schedules. We also modelled Julian date as linear and quadratic functions.

At the station level we were interested in the habitat types and spatial patterns where Rusty Blackbirds were detected. Using the Ducks Unlimited Enhanced Wetland Classification layer (Ducks Unlimited 2011) we used a categorical variable to model probability of detection in each habitat type. We also used distance to roads, according to Alberta Transportation (Alberta Transportation 2015) to determine whether detections were farther from roads than those stations without detections. Finally, we used latitude as a linear predictor variable to determine if Rusty Blackbird detection probability increased in the northern extent of our study area.

(Royal Alberta Museum , 2013)

Results

18 152 recordings (3 or 10 minutes in length) were processed at 2399 unique ARU stations (7.6 ± 8.2 SD recordings per station) in the LAPR from 2012 – 2016 (Figure 4). We detected ≥1 Rusty Blackbird on 241 recordings (1.3% of all recordings). Rusty Blackbirds were detected in recordings from fen stations ~4 times as often (2.6%) as the second highest category (swamps; 0.7%) and were detected in <1.0% of all non-fen habitat recordings (Table 1).

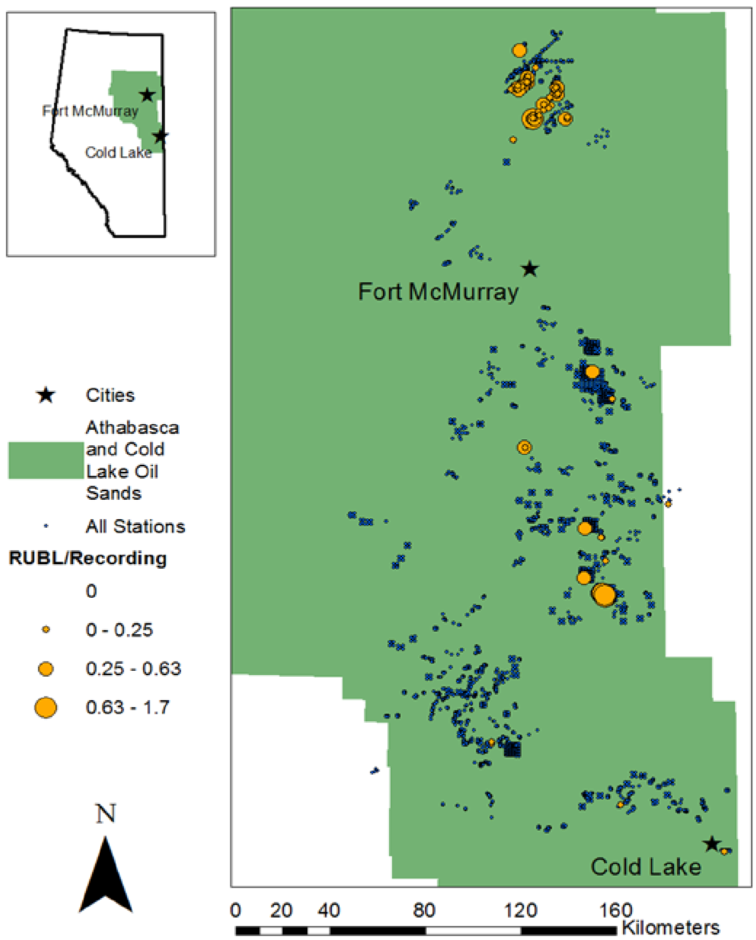

Figure 4. Automated Recording Units (ARUs) deployed in the Athabasca and Cold Lake Oil Sands region, as well as orange circles indicating Rusty Blackbird (RUBL) Detections per recording at each Station.

Table 1. Habitat classifications from the Ducks Unlimited Enhanced Wetland Classification layer (Ducks Unlimited 2011), as well as the number of Automated Recording Unit (ARU) stations, number of recordings, and the binary presence (RUBL), count (1,2,3) and, percentage (%) of Rusty Blackbird detections on recordings in that habitat type.

Habitat Classification	Station Count	Recordings Count	RUBL	1	2	3	%
Bog	117	925	4	4	0	0	0.4
Fen	902	8098	214	172	38	4	2.6
Marsh	28	414	1	1	0	0	0.2
Other	24	146	0	0	0	0	0
Swamp	276	2342	17	16	1	0	0.7
Upland	1050	6227	5	4	1	0	0.1
Total	2399	18152	241	197	40	4	1.3

Rusty Blackbirds were more likely to be detected on early morning recordings (β=4.7, p<0.001) and during the daytime (β=2.6, p=0.001) than night. However, few individuals were detected during the daytime recordings (n = 4 / 1633 recordings). The probability of detecting a Rusty Blackbird decreased linearly as julian date increased (β=-0.019, p=0.03), and this was primarily driven by a decrease in detections in late June and July. There was no evidence for a quadratic relationship between julian data and Rusty Blackbird detection. Site (β=7.4 ± 2.0 SE) and station (β=2.3 ± 0.6 SE) level random effects explained a significant amount of variation in our analysis.

Of 2399 stations sampled, at least one Rusty Blackbird was detected at 103. Stations where Rusty Blackbirds were detected tended to have larger proportion of fen within 100 m (85.5% ± 25.6) and smaller proportion of upland (3.6% ± 13.1) compared to fen (34.1% ± 35.5) and upland (47.3% ± 40.8) at stations without detections (Table 2).

The probability of detecting a Rusty Blackbird at a given station was positively related to latitude (β=1.4, p<0.001). There was some evidence that detections increased by ~20% with each km from roads (β=0.2, p=0.07). The probability of detecting Rusty Blackbirds was higher in fens (β=1.8, p=0.003) and swamps (β=1.6, p=0.02) than upland habitat, while probability of detection in marsh (β=1.6, p=0.27) and bog (β=1.1, p=0.29) habitats was not significantly different from upland. The random effect for site explained a significant amount of variation in our analysis (β=5.3 ± 1.7 SE).

Importantly, the spatial relationships in our study were partly dependent on clustering of Rusty Blackbird detections at the McClelland Lake Fen Complex (MFC; Figure 5). 198 Rusty Blackbirds were detected (82.1 % of total detections at 78 stations) from the MFC (3914 recordings at 313 stations in this region). The MFC stations comprised a large portion of northernmost stations. Stations in the MFC tended to be farther from roads on average (3.3 km) than stations elsewhere (0.9 km), and thus were largely responsible for the significant spatial trends in the analysis.

Table 2. The percentage (± SD) of habitat types at Automated Recording Unit stations with (RUBL) and without (no RUBL) Rusty Blackbird detections. Percentages were calculated from the Ducks Unlimited Enhanced Wetland Classification layer (Ducks Unlimited 2011).

	RUBL	no RUBL
Bog	1.2 ± 4.0	5 ± 13.5
Fen	85.6 ± 25.6	34.1 ± 35.5
Marsh	1.4 ± 10.1	1.5 ± 8.2
Other	0 ± 0.0	0.1 ± 3.0
Swamp	6.8 ± 18.7	10.1 ± 19.9
Upland	3.6 ± 13.1	47.3 ± 40.8
Water	1.4 ± 5.9	1.2 ± 5.5
n	103	2296

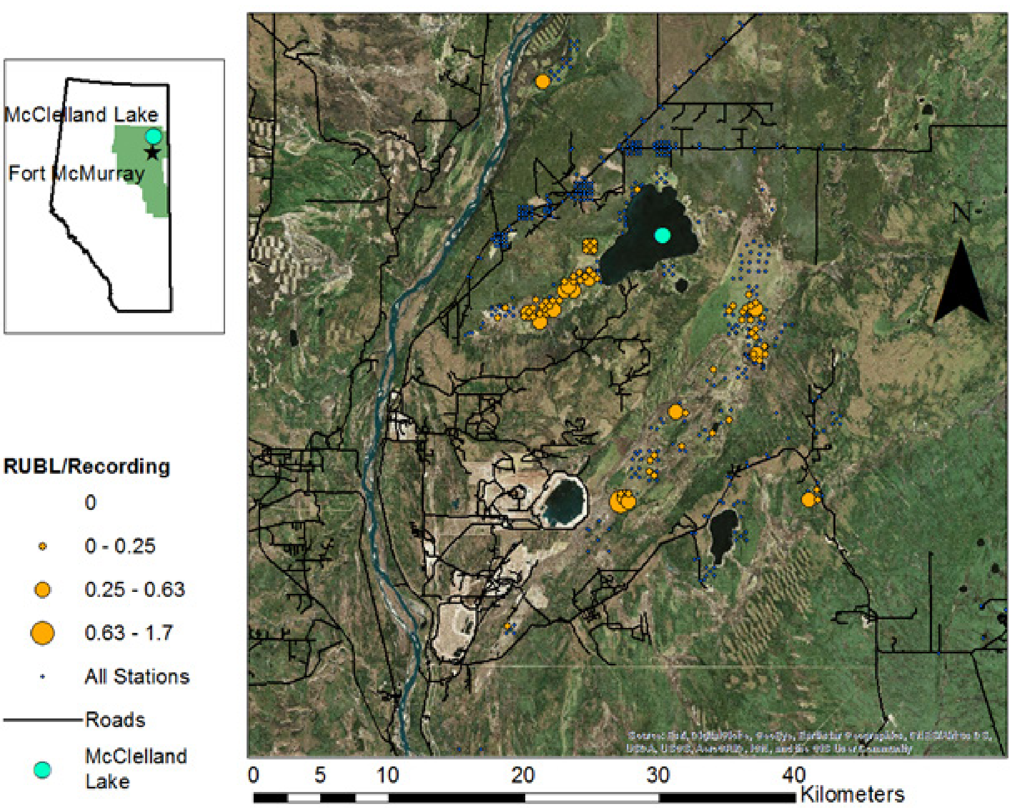

Figure 5. High density of Rusty Blackbird detections using Automated Recording Units (ARUs) around the McLelland Lake Fen Complex, north of Fort McMurray, Alberta. These stations at the northern extent of the stations sampled, and tended to be relatively far from road access.

Discussion

Rusty Blackbirds were generally uncommon in this study, with detections in 1.3% of recordings. Broadly, this agrees with statements elsewhere that Rusty Blackbirds are now considered uncommon or rare (Greenberg and Droege 1999, Niven et al. 2004, Greenberg and Matsuoka 2010, Sauer et al. 2014). Yet, a detection rate of 1.3% is considerably higher than previous estimates in Alberta. BBS, for example, detected only 21 Rusty Blackbirds at 2771 survey routes (~138550 survey stops) in Alberta, a detection rate of 0.017% (Pardieck 2016). Thus, ARUs may be an effective tool to reduce the large confidence intervals around current population estimates based on detection-poor surveys.

We were able to detect Rusty Blackbirds during daytime recordings but these were rare events. We expect that, like most bird species, morning surveys after sunrise will be most effective for Rusty Blackbird detection. However, additional sampling during the daytime may reveal that Rusty Blackbirds do vocalize during the day more frequently than currently believed. Although Rusty Blackbird detection probabilities decreased toward the end of the nesting season, there was no clear pattern from mid-April through mid-June. Thus, we expect researchers can likely detect Rusty Blackbirds fairly consistently during the egg-laying and brood-rearing periods. This species arrives earlier from migration than many other species so earlier sampling in the season may be more effective.

We found an overwhelming association of Rusty Blackbirds with fen habitat. Typically, studies have reported a more general wetland habitat use (Powell et al. 2010, Avery 2013, Luepold et al. 2015), perhaps owing to the lack of wetland classification of equal quality as the DU Enhanced Wetland Classification data (Ducks Unlimited 2011). We found a fairly small amount of upland near stations with RUBL detections, though other researchers found upland an important component for RUBL (Powell et al. 2014, Luepold et al. 2015). However, most or all of the fen sites sampled had some black spruce (Picea mariana) or larch (Larix larcina). Thus, the habitat associations in this study most closely agree with Matsuoka et al. (2010), who found that nests were typically found in conifers, specifically black spruce. In 2015, we located 8 nests in the McLelland fen. In all cases, these nests were found in very old larch trees with large amounts of hanging lichens that surrounded the nest. The trees were in small patches in an otherwise graminoid habitat.

While this study was able to increase detection rates of Rusty Blackbirds compared to BBS surveys, it is unclear what role sampling further from roads might have played. There was a marginal effect of distance from road on detection probability, but this was at least partly driven by the presence of a large number of detections in the remote stations in the MFC. Thus, this does not necessarily suggest that Rusty Blackbirds are more abundant away from roads. Instead, a more appropriate interpretation is that large, intact wetland complexes in the northern boreal are important for Rusty Blackbirds, and these locations may not necessarily be easily accessible for traditional surveys. For example, many of the sites in MFC were accessed via helicopter, particularly on the eastern side of the complex. Although we found some evidence for relatively abundant Rusty Blackbirds (compared to previous estimates) in the LAPR, a general lack of sampling across a massive portion of the breeding range remains an critical problem for Rusty Blackbirds.

Broadly, these results suggest that conservation initiatives with the goal of maintaining or recovering Rusty Blackbird populations should focus on increasing survey efforts in the remote northern boreal. Special survey effort may be given to large, intact wetland complexes elsewhere in the boreal to determine if they are important habitat for the species across their range.

Conservation efforts for Rusty Blackbirds in the LAPR should focus on the MCF, and the protection of similar habitats elsewhere in Canada may prove an important conservation strategy. It may be important to identify whether Rusty Blackbirds farther north in BCR7 and BCR4 have experienced less extreme population declines, in agreeance with the study by Machtans et al. (2007) in the MacKenzie Valley, North West Territories.

Acknowledgements

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