Ronald Lake Wood Bison Research Program:

Semi-Annual Progress Report 2018

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Executive summary

In this semi-annual report, we explore key knowledge gaps in the examination of the ecology of the Ronald Lake wood bison (*Bison bison athabascae*) herd including population demographics, habitat supply and use, range constraints, and response to natural and anthropogenic disturbance. In addition to building on previous work, we propose in this report to discuss research objectives and methodologies for the 2018 field season.

Specifically, we provide background and methodology for addressing the following research objectives:

(1) Estimate calf:cow, yearling:cow, and bull:cow ratios, for long-term monitoring of demographic trends.
(2) Determine the forage selected by the Ronald Lake bison and how the distribution of that forage fluctuates seasonally in terms of quality and quantity, to understand bison foraging habits, and estimating carrying capacity for the herd.
(3) Assess bison habitat availability and use in northern, central, southern, western, and eastern range extents to examine habitat suitability as a constraint to the herd's movement.
(4) Study bison selection and use of natural and anthropogenic disturbances through the examination of forage availability and environmental suitability.
(5) Estimate seasonal wildlife (e.g., bison, moose, wolves, bears, etc.) habitat use to examine population densities, competition for food, and predation pressure in different landcover types, including natural and anthropogenic disturbances.
(6) Assess decay-rate of bison dung in different landcover types to increase accuracy in the use of bison dung to estimate local use of habitat patches.

These study objectives are described in more detail in this semi-annual report, with results provided where identified. Outcomes and results of outstanding work will be presented in the Scientific Sub-Team's November semi-annual and annual reports.

Background

Federally, wood bison (*Bison bison athabascae*) are designated as *Threatened* with twelve extant, free-ranging populations remaining (COSEWIC, 2013; SARA 2016). In Alberta, wood bison in the Hay Zama and Ronald Lake herds are considered as *Endangered* and *Subject Animal*, respectively, with all other wood bison considered as *At Risk* (Mitchell and Gates, 2002). These remaining wild populations are threatened by introduced (i.e., bovine tuberculosis and brucellosis) and native (i.e., anthrax) pathogens, severe weather, and genetic introgression (COSEWIC, 2013; Shury et al., 2015). The Ronald Lake herd is small (~200 individuals), with ranges extending from the southern portion of Wood Buffalo National Park (WBNP), east of the Birch Mountains and west of the Athabasca River (Tan et al., 2015). Though most of the herd's annual home range occur south of WBNP (~92%), approximately 8% of their range overlaps with the park at the northern extent of their range. The study of Ronald Lake bison's ecology, habitat use, and response to natural and anthropogenic disturbances began in 2013 and continues to this date.

Previous studies on Ronald Lake bison have examined bison movement, seasonal and annual range extents, habitat use, and initial responses to natural and anthropogenic disturbances (DeMars et al. 2016; Belanger et al. 2017). There are four key results from our previous studies. First, there is low inter-annual variation in bison annual habitat selection, but high seasonal variation, particularly for habitat types with large quantities of graminoid biomass. Second, habitat use in the summer is influenced by multiple interacting factors, including forage availability, biting flies, and footing. Third, distinct patterns of seasonal migration are apparent, particularly in spring when bison are calving in the northwest part of their range. Fourth, wetlands, especially marshes, offered the greatest biomass of graminoids (i.e., potential forage for bison) by late in the summer when plants are senescing.

After reviewing these results, further examination of knowledge gaps related to range constraints, population demographics, habitat supply (in terms of forage quantity and quality), and response to natural and anthropogenic disturbances was needed. In this report, we summarize the work completed towards addressing these knowledge gaps and propose methodology for further examination during the 2018 field season.

Research Progress

(1) Ronald Lake bison demographics

Research objectives

Estimating mammalian population demographics can be used to monitor and assess population health and size trends (Brown 2011; Cameron et al. 2013). High calf or cow mortality rates in a year can result in decreased recruitment in the following year, and thus an overall population decline (Cameron et al. 2013). Surveys of the Ronald Lake bison herd estimate this population size to be ~200 animals (SARA 2013). Much less is known about the herd's demographics and long-term population trends. In 2015 and 2016, trail cameras were deployed in the Ronald Lake bison northwest and central range to estimate calf:cow, yearling:cow, and bull:cow ratios. These data, in conjunction with continued trail camera work, contributes toward assessing annual

population variation and provide a basis for assessing population trends for the Ronald Lake bison herd. The objective of this research is to estimate population demographics, health, and long-term trends. This research will be useful for documenting changes for the Ronald Lake bison population and assessing the potential effects of recent oil sands disturbances associated with exploration, as well as areas of recent forest harvesting.

Overview of research methods

Twenty-three trail cameras were deployed in a large, remote meadow in the northwest part of the Ronald Lake bison herd's range where bison are known to congregate in spring (DeMars 2015). Cameras were deployed in March 2015 and data retrieved in March 2016. In addition, ten trail cameras were deployed along game trails in the central region of the herd's annual home range during the summer of 2016 (Jun – Aug). Trail camera images were analyzed using Timelapse2 to identify sex, approximate age, and number of bison (Greenberg 2015). We identified bull, cow, yearling, and calf bison in the images. In a sequence of images (string of images with a similar time-stamp), individual bison were identified and recorded only once. We calculated calf:cow, yearling:cow, and bull:cow ratios for the northwest and central regions separately.

Progress / preliminary results

Images from the 23 cameras in northwest region were used in our analyses. We used images from only one camera in the central region due to an absence of bison in images on other cameras. In total, 436 and 128 unique images of individual bison from the northwest and central cameras, respectively, were used in our analyses. In general, the camera from the northwest region recorded more individual bison regardless of sex or age (Figure 1). We found that mature cows outnumbered bulls, yearlings, and calves in both regions. However, in the central range cows greatly outnumbered the bulls and yearlings in their groups with calf:cow ratios being fairly constant between the two regions (Figure 2). Interestingly, the single camera from the central range photographed a substantial number of bison travelling on a well-used game trail during a single event (July 15, 2016, camera time sequence 12:24 h – 12:31 h). During this time, 120 images captured 128 individual bison crossing.

Outstanding / upcoming work

In March 2016, we redeployed the 23 cameras in the northwest region and added ten more cameras for a total of 33. Data will be collected from these cameras in May 2018 and analyzed during the Summer/Fall of 2018. Similar analyses will be conducted with these data to estimate population demographics. After gathering these cameras, we will redeploy ten cameras in the northwest meadow and five cameras will be dispersed throughout the central region. The data collected from these cameras will further our understanding of the population demographics and trends of the Ronald Lake bison.

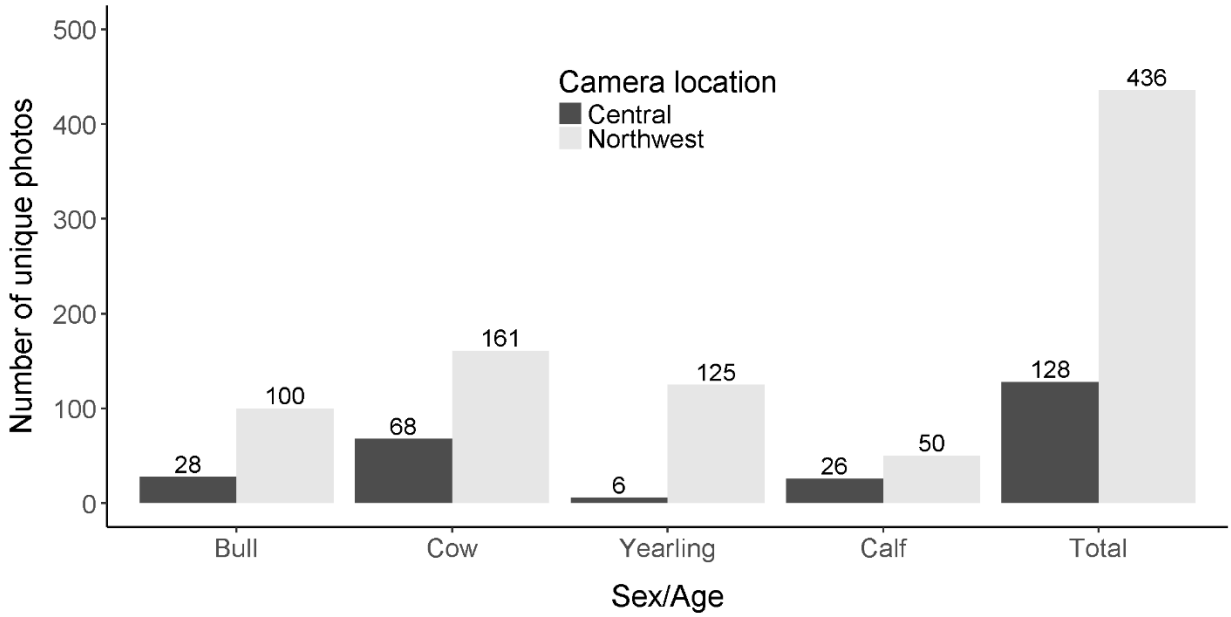

Figure 1: Number of unique bison images captured by trail cameras in two locations within the Ronald Lake bison home range: "northwest" and "central". Images from the northwest were captured between March 2015 and March 2016, and images from the central camera were captured between June and August 2016. Images were captured by twenty-three and one camera(s) in the northwest and central range, respectively. The northwest cameras were placed in an upland meadow, and the central camera was placed on a game trail.

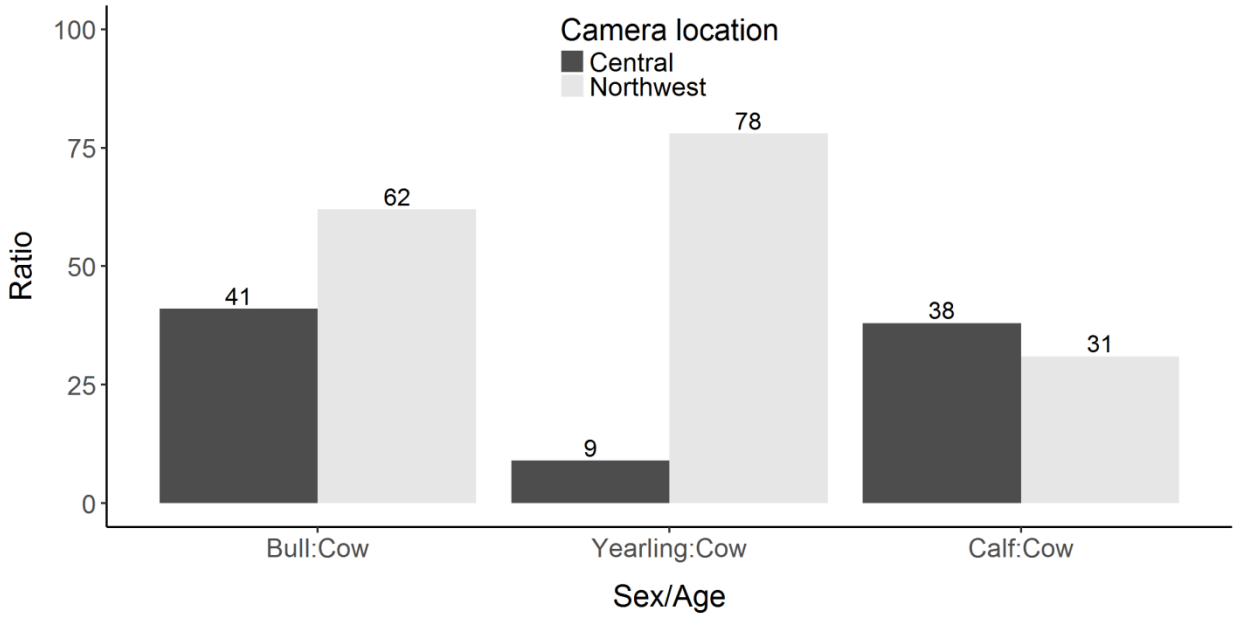

Figure 2: Ratios per 100 cows for Bull:cow, yearling:cow, and calf:cow derived from trail camera images captured in two locations within the Ronald Lake bison home range: "northwest" and "central".

(2) Forage quantity / quality

Research objectives

Habitat selection is influenced by at least one of the following ecological processes: forage availability (i.e., bottom-up), predation (i.e., top-down), and intra- and/or interspecific competition (Coulson et al., 2001). Understanding how these processes influence a population's selection of habitat is central to understanding their distribution and movement across the landscape. Used versus available study designs are commonly used to address the question of how animals select habitat (Boyce et al., 2002). A thorough understanding of the forage biomass available to the Ronald Lake herd and how biomass changes in quality and quantity seasonally has been identified as a key knowledge gap (DeMars et al., 2016). This knowledge will inform management of the herd and potentially future reclamation. We will address the issue by quantifying the forage biomass available to the Ronald Lake herd within each landcover type by season. Furthermore, we will assess the quality of forage at a sample of bison use locations and within each landcover type (i.e., available) by season. Additionally, we have identified inaccuracies within landcover classifications provided by Ducks Unlimited Enhanced Wetland Classification (EWC). Therefore we will evaluate the accuracy of questionable landcover types from the within the Ronald Lake bison's range and add a landcover type (upland meadow) not currently included the EWC.

Overview of research methods

To evaluate the accuracy of the EWC, we will use a combination of ground and aerial (i.e., helicopter) surveys. Ground surveys will be conducted simultaneously during biomass surveys where the observed landcover type will be recorded and compared with the landcover type provided by the EWC. Using similar techniques, aerial surveys will be used to assess more remote regions. We will also add disturbance layers to describe different anthropogenic (e.g., well pads, cut-blocks, seismic lines) and natural disturbances (i.e., fire) for two different age classes: recent (≤5 years) and legacy (>5 years). Additionally, we are adding a new landcover type to the bison range called "upland meadow", which will be classified using elevation data and the current EWC to describe upland meadows like the one found in the northwest region of the herd's home range where bison congregate during the calving season. With the addition of ground survey data, we will update the landcover product for the Ronald Lake herd's range.

We will continue to quantify forage biomass using the same techniques as Belanger et al. (2017) where 0.5 m^2 vegetation plots were sampled along 60-m transects in different landcover types and forage was separated into four functional groups: grasses, sedges, shrubs, and forbs. The remaining EWC landcover types, upland meadows (a new category proposed by the research team), and different types of natural and anthropogenic disturbances will be surveyed in August 2018. These surveys will complete the estimation of forage quantity during late summer when forage biomass is at its maximum.

To assess the quality of vegetation consumed by and available to bison, we will sample vegetation plots at bison use locations (based on GPS telemetry) and random locations that represent each landcover type. Proximate analyses will be used for these samples to assess and compare the macronutrient composition between bison use and random locations.

Progress / preliminary results
In August 2016 and 2017 vegetation biomass in sixty sample plots were estimated for thirteen landcover types in the herd's central range (Belanger et al., 2017). This study revealed high levels of graminoid biomass in wetlands (marshes) demonstrating greater potential forage in these areas. Upon visiting plots, seven transects were located within land cover types misclassified by the EWC data and reclassified were reclassified (Table 1).

Outstanding / upcoming work
The field work we propose for the spring and summer of 2018 will focus on estimating the quantity and quality of forage available to the Ronald Lake herd. Starting in May we will begin visiting bison locations (i.e., used) and landcover plots (i.e., available) to estimate forage quality and quantity in spring. These surveys will continue through August to estimate quality and quantity differences as forage matures throughout the summer. Additional vegetation surveys will be conducted in October for fall estimates. The landcover plots that do not currently have estimates of forage biomass will have vegetation clipped, dried, and weighed for biomass estimates. One group of landcover types that currently do not have biomass estimates are disturbances. We intend to classify disturbances as seven unique landcover types: legacy (>5 years) exploratory well pads, recent (<5 years) exploratory well pads, legacy linear disturbances, recent linear disturbances, legacy cut-blocks, recent cut-blocks, and recent wildfires. Once biomass estimates are completed they will be used to assess the carrying capacity of the Ronald Lake Bison's home range and may be used to help assess the effects of the proposed mine development on range-wide changes in forage quantity.

Table 1. Landcover types that were reclassified for 7 of the 60 vegetation survey plots in August 2016 and 2017.

EWC classification	Reclassification
Meadow marsh	Shrub swamp
Shrubby rich fen	Shrubby poor fen
Shrubby rich fen	Shrub swamp
Treed rich fen	Treed bog
Treed poor fen	Upland pine
Tamarack swamp	Shrubby rich fen
Upland conifer	Upland pine

(3) Ronald Lake bison home range constraints

Research objectives
Discussions regarding potential interactions between Wood Buffalo National Park (WBNP) and Ronald Lake bison herds continues to be of interest (AEP 2014). Qualitative analyses of 2013 to 2016 Ronald Lake bison GPS radio collar data describe the extent of the herd's annual home ranges (DeMars et al. 2016). The Ronald Lake bison's annual home ranges extend ~25 km into WBNP, with ~8% of bison GPS locations occurring inside WBNP. With known Ronald Lake bison movement patterns into WBNP, and relatively unknown movement patterns of WBNP bison, it remains uncertain if these herds are interacting with one another. GPS radio collar data suggests that Ronald Lake bison movements north may be constrained due to landscape features

and landcover types that bison avoid (e.g., shrubby wetland). Thus, natural changes in landscape features may be limiting interactions between Ronald Lake and WBNP bison. The objective of this research is to investigate the hypothesis that landscape features and landcover types may be constraining the Ronald Lake bison's movement north, into WBNP.

Overview of research methods

We will identify landscape features (e.g., water availability), and landcover types avoided (e.g., shrubby wetlands) and selected (e.g., meadow marsh) by bison that may limit north-south and east-west movement by generating constrained resource selection functions (RSF) to quantify selection of landcover types for northern, central, southern, eastern, and western ranges. The area investigated using RSF's will be a 10 km buffer around the most northern, southern, western, and eastern extents of the Ronald Lake bison home ranges and will encompass the average of Ronald Lake bison annual home range extents using 2013 – 2017 GPS radio telemetry data (Figure 3). The results of the RSF analyses will help guide future work (if necessary) including aerial observations to validate landcover as a possible movement constraint.

Progress / preliminary results

The Scientific Sub-Team is currently reviewing hypotheses and methods to analyze the potential environmental constraints limiting the Ronald Lake bison's movement north.

Outstanding / upcoming work

We anticipate acquiring high-resolution remote sensing data to better investigate landscape features and habitats as constraints to bison movement north into WBNP. We also anticipate conducting aerial surveys to look for the presence of weeds (i.e., poor quality forage) in the northern regions of the herd's range.

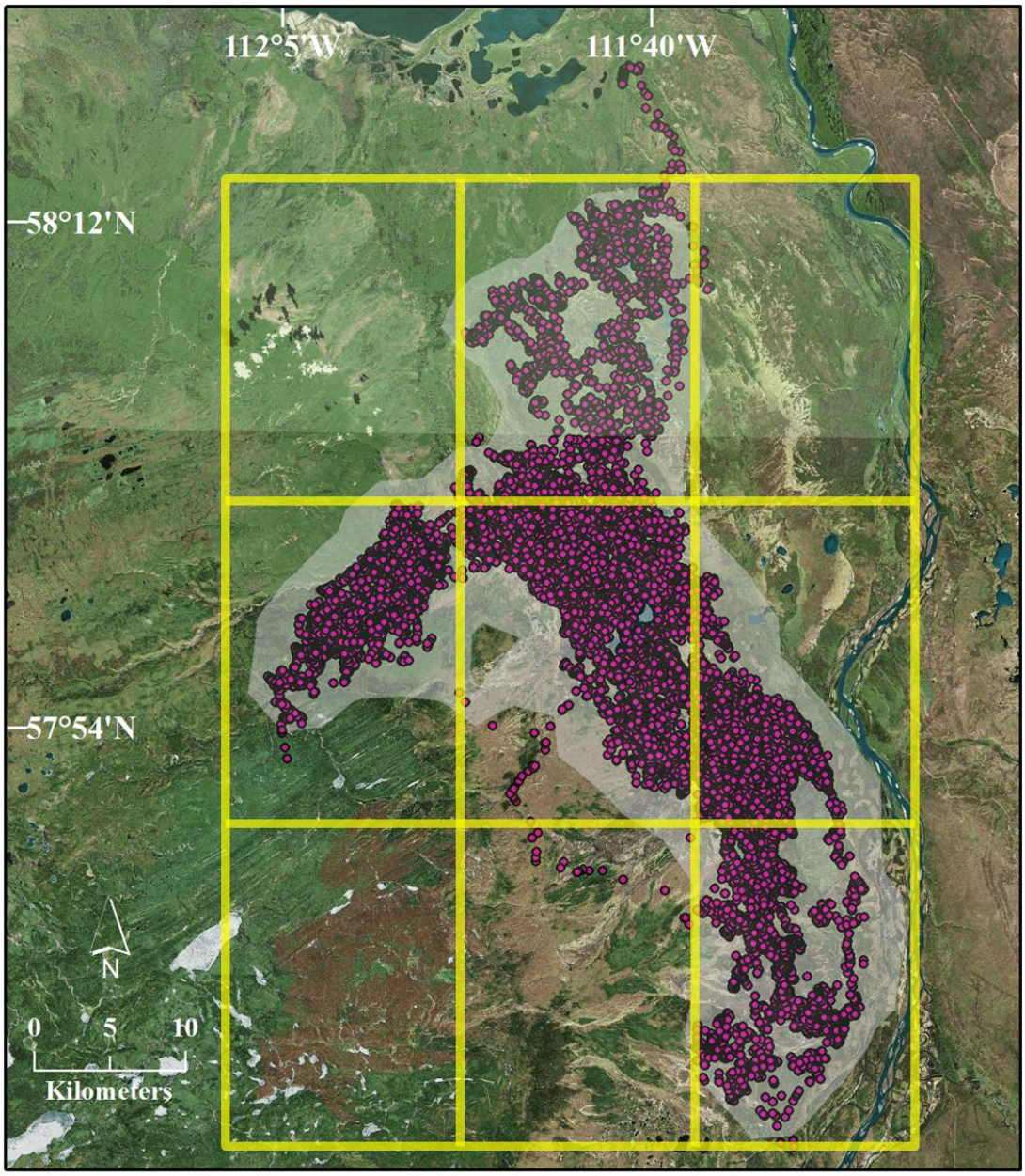

Figure 3: Proposed constrained resource selection function (RSF) for combined northern, central, southern, western, and eastern portions of the Ronald Lake bison herd. Landcover availability and RSF beta values will be estimated for each region. Bison 2016 GPS locations and 99% utilization distribution are shown and used as an example in this figure.

(4) Bison response to disturbance

Research objectives

Within the Ronald Lake herd's range, landscape disturbances are caused by both anthropogenic and natural sources. To date, resource selection functions have shown a general avoidance of anthropogenic disturbances and variable responses to natural disturbances (DeMars et al., 2016). However, further research is needed to assess the influence of different types of anthropogenic disturbance (oil exploration or timber harvest) and age of disturbance (recent ≤5 years). Furthermore, the factors that influence these selection patterns need additional exploration.

The Ronald Lake bison have been exposed to the industrial activities associated with resource extraction for forestry and exploration disturbances from energy. DeMars *et al.* (2016) reported that the Ronald Lake bison avoided anthropogenic disturbances that had active industrial activity occurring on them during the winter. A follow up study that investigated which industrial activities (i.e., timber harvest, oil and gas exploration, or both) demonstrated general avoidance of all three activities, but only oil and gas exploration had a significant affect (Belanger et al., 2017).

Overview of research methods

We intend to analyze the Ronald Lake herd's use of disturbances by comparing the environmental features and forage quantity and quality at bison use locations to random available locations within different landcover types (including disturbances). The same methods will be used to collect and quantify forage biomass and quality as in our prior work (Forage Quantity/Quality section). We will also examine features known to influence bison presence such as EWC habitat type, snow depth, canopy cover, number of snags (>10cm diameter), ground firmness, distance to water, distance to nearest disturbance, and visually estimate vegetative structure within a 10-meter radius of bison use locations (Bruggeman et al. 2006; Nippert et al. 2013; DeMars et al. 2016; Belanger et al. 2017). These measurements will allow for investigations of within patch (4^{th} order) habitat selection from two perspectives: forage availability and environmental suitability.

Progress / preliminary results

Bison habitat use has been quantified using dung counts and selection ratios for different landcover types (Belanger et al., 2017). Results from this study suggested that marshes had the highest selection ratios in both summer and winter compared to all other landcover types. The next step is to visit known bison locations, provided by GPS collared animals, to explicitly investigate and quantify the forage availability in terms of quantity and quality, and landscape characteristics.

Outstanding / upcoming work

Field work for this aspect of the project will begin in May and continue through August 2018. We intend to conduct these surveys during each season (winter, spring, early summer, later summer, and fall).

(5) Wildlife habitat use

Research objectives
In addition to GPS radio collar and trail camera data, plot-based animal dung surveys can be used to estimate habitat use and population densities with less financial cost (Alves et al. 2013). The objective of this research is to estimate seasonal wildlife (e.g., bison, moose, wolves, etc.) habitat use and local abundance. This research will corroborate bison resource selection function habitat use analyses using GPS radio collar data and be used to estimate habitat use and population densities for other wildlife which may affect populations of bison.

Overview of research methods
Permanent plots will be established across different landcover types representative of the study area. Our goal is to select ten random sites for each landcover class in-which plots will be established for long-term revisits. A permanent, steel stake will be fixed to the center of each plot for repeated measures. During initial surveys of plots, all dung will be removed. Plots will be re-visited during all seasons. We will identify dung to the species level (when possible). Dung data will be compiled and analyzed to estimate seasonal habitat use by mammalian megafauna.

Progress / preliminary results
Dung surveys were conducted during the summer of 2016 in four habitat types. These surveys suggested that bison use of meadow marshes is greater in winter, while use of jack pine and deciduous forest is greater in summer than in winter (Belanger et al. 2017).

Outstanding / upcoming work
Dung survey plots will be established during our 2018 summer field season and revisited in spring and fall 2019. Our goal and hypotheses are that dung counts can accurately be used in habitat selection analyses and corroborate habitat selection analyses using GPS radio collar telemetry data, as well as index local abundance and trends in other ungulates like moose, which can affect wolf activity and abundance. It also allows a more direct comparison of forage quantity and quality at a site with use of that site based on bison dung counts since only a sample of animals is collared at any one time.

(6) Dung decay rate

Research objectives
Dung decay rates vary between habitat types and seasons (Brodie 2006). Knowing the rate of dung decay is therefore needed to accurately estimate habitat use and population indices using dung surveys (Theurerkauf & Rouys 2008). The objective of this research is to estimate decay rate of bison dung in different habitat types used by bison. This research will contribute to improving accuracy of bison habitat use and population indices.

Overview of research methods
Fresh summer and winter bison dung will be opportunistically gathered in the field and placed in different habitat types used by bison. Small (30 x 30 x 30 cm), steel wire enclosures will be placed over dung to protect dung from disturbance while maintain dung exposure to elements. Dung decay will be assessed using a five-point decay survey (Brodie 2006) upon re-visitation.

Number of days to 50% and 100% decay will be documented following the methods of Brodie (2006).

Progress / preliminary results

In 2016, dung was used to estimate bison habitat use. During this time, we observed differences between winter and summer dung and hypothesized that decay rates for winter and summer dung may vary between each other due to differences in composition. In addition, we hypothesized that dung decay may vary between dung deposited in different landcover types (e.g., marsh meadow vs. pine forest). The research team is currently reviewing methodology of dung decay that will improve habitat analyses using dung data.

Outstanding / upcoming work

Our dung decay study will commence during the 2018 summer field season with progress reported in our 2018 annual report.

Closing

In this report we provide a baseline estimate of Ronald Lake bison population demographics. This baseline estimate is useful for assessing current population demographics of the Ronald Lake bison and will serve as a point for comparing the population's health as mine development progresses. We also proposed methodology to address knowledge gaps related to bison movement, habitat supply and use, and responses to natural and anthropogenic disturbances. Outstanding work related to these questions will begin in the summer or 2018 and reported on in our November 2018 annual report. The work undertaken in 2018 will contribute to increasing our knowledge and further help develop questions regarding Ronald Lake bison ecology and factors that affect their behaviour and abundance.

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