Ronald Lake Wood Bison Research Program: Semi-Annual Progress Report 2019

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Executive summary

Here we describe the progress to date on research conducted to better understand the ecology of the Ronald Lake bison herd (RLBH). Our research addresses knowledge gaps identified by the RLBH Technical Team. These knowledge gaps explore questions related to the RLBH's home range and distribution, the mechanisms influencing habitat selection and use (including wolf predation), population demographics and limitations, and predictions regarding the impact of future disturbance and reclamation. In this semi-annual update, we summarize the results of the research conducted since the Belanger et al. (2018) annual report and describe research objectives and methodologies for the 2019 spring/summer field season.

More specifically, we describe objectives, methods, and progress to date on addressing the following knowledge gaps:

- 1b – Northern range extent of the RLBH
- 2a, 2b, & 2c – Habitat use of wetlands and anthropogenic disturbances
- 3c & 3e – Diet and forage quality and quantity by season, and disturbance type
- 4a, 4b, 4c & 5a – Ecological drivers of habitat use and response to disturbances, including wolf predation
- 8c & 8g – Herd age structure and cow-to-calf ratio

Background

The Ronald Lake bison herd (RLBH) is a population of ca. 200 wood bison (*Bison bison athabascae*) located in northeastern Alberta. Federally, wood bison are designated as *Threatened* under the Species at Risk Act, and in Alberta they are considered a *Subject Animal* under the Wildlife Act (AEP & ACA, 2017). The RLBH has long been a central figure in the traditional practices of local Indigenous communities. More recently, the RLBH has become of interest to wildlife managers, land use planners, and industry as it is one of the few free ranging wood bison herds that is free of the diseases bovine brucellosis and tuberculosis, and is genetically distinct from all other wood bison herds (Shury et al. 2015; Ball et al. 2016). In 2013, an ecological research program was launched in response to a proposed surface mine that would overlap with the RLBH's home range. Since then, 64 bison (6 male, 58 female) in the RLBH have been outfitted with GPS radio-collars. These bison have provided location data that are being used by researchers from the University of Alberta and Royal Alberta Museum to study ecological knowledge gaps identified by the RLBH Technical Team (Table 1).

To date we have examined the movements, seasonal/annual home ranges, habitat selection, responses to natural and anthropogenic disturbances, and northern range limits for the RLBH (Tan el at. 2015, DeMars et al 2016, Belanger et al. 2017, Belanger et al. 2018). Key results from our research to date include:

(1) limited disparity in annual habitat selection, but seasonal variability of selected habitats, most notably a strong selection of graminoid rich habitats in the winter;
(2) summer habitat use is associated with greater forage availability, but also more biting insects and less stable footing;
(3) a distinct pattern of a spring migration that coincides with the bison calving period;
(4) marshes that are more common in the eastern parts of the range provided the greatest amount of preferred forage (i.e., graminoids);
(5) bison movement rates were faster when on linear disturbances; and
(6) northern range limits of the RLBH are associated with landcover types that the RLBH avoid.

As our research progresses, we build upon these results and explore knowledge gaps that have yet to be addressed.

Table 1. Below we provide a general reference guide to the knowledge gaps identified by the Ronald Lake bison herd technical team that the University of Alberta and Royal Alberta Museum researchers are addressing.

Theme	Gap #	Project	Personnel	Status	Citation
Bison range	1A	Season & sex-specific ranges	Tan, DeMars & others	Complete (future updates)	Demars et al. 2016
Bison range	1B	Northern extent (limits)	Belanger	Update in this report	Belanger et al. 2018
Bison range	1D	Migration routes	Tan, DeMars & others	Complete (future updates)	Demars et al. 2016
Habitat - Landcover	2A	Wetlands	DeMars, Belanger	Update in this report	Demars et al. 2016
Habitat - Landcover	2B	Human disturbances (energy)	DeMars, Belanger	Update in this report	Demars et al. 2016
Habitat - Landcover	2C	Human disturbances (forestry)	DeMars, Belanger	Update in this report	Demars et al. 2016
Habitat - Landcover	2D	Natural disturbances (fire)	DeMars	Complete (future updates)	Demars et al. 2016
Forage (bottom-up)	3A	Greenup/phenology	Hecker	Ongoing	
Forage (bottom-up)	3C	Forage quantity/quality	Belanger, Hecker	Update in this report	Belanger et al. 2018
Forage (bottom-up)	3E	Anthropogenic changes	Hecker	Update in this report	Belanger et al. 2018
Habitat use	4A	Wallows & water	Hecker & others	Update in this report	Belanger et al. 2018
Habitat use	4B	Trade-offs (insects/ground)	Belanger	Complete	Belanger et al. 2017
Habitat use	4C	Winter snow	Belanger, Hecker	Update in this report	Belanger et al. 2018
Habitat use	5A	Anthropogenic disturbances	DeMars, Hecker	Update in this report	Belanger et al. 2018
Popln ecol (top-down)	4C/8E	Wolf predation	Dewart	Update in this report	Belanger et al. 2018
Popln ecol (top-down)	8C/G	Cow-calf & age structure	Belanger	Update in this report	Belanger et al. 2018
Future scenarios	6A/C	Habitat supply forecasts	Nielsen & others	Ongoing (delayed to integrate forage)	

Research progress

Knowledge Gap 1b - Northern range extent of the Ronald Lake bison herd

Research objectives

Discussion regarding interactions between the Wood Buffalo National Park (WBNP) bison and the RLBH continues to be of interest as evidence of physical interaction between the herds is largely unknown (AEP, 2014). The RLBH's home range extends ca. 25 km into WBNP, with 8% of the home range occurring inside WBNP (DeMars et al., 2016). Genetic differences between these two herds, and the apparent absence of bovine brucellosis and tuberculosis from the RLBH, suggest little to no interaction (Ball et al., 2016). In our 2018 annual report, we reported on the influence of landcover type as a factor potentially limiting the RLBH's northward movement into WBNP. We reported greater amounts of landcover types avoided by bison in the northern region of the herd's home range, extending into WBNP, and east of Lake Claire. We will further investigate landcover type as a factor potentially limiting movement at finer temporal scales, and for different sexes of bison (i.e., bulls and cows).

Overview of research methods

With the combination of known annual movement patterns of the RLBH (e.g., DeMars et al., 2016) and currently unknown movement patterns (e.g., known occupancy) of WBNP bison, it remains unclear and indefinite whether these two herds are interacting. We have investigated the influence of landcover type on the RLBH's movement north by pooling all the available data from collared bison (Belanger et al., 2018). Here, similar to our 2018 analyses, we will model the distribution of bison in relation to landcover type at four temporal scales (i.e., calving period/spring, summer, rut/fall, and winter) and for both bull and cow bison.

Progress / preliminary results

Our analyses of the distribution of bison in relation to landcover type at various temporal scales are ongoing and will be reported in our December 2019 annual report.

Outstanding / upcoming work

To further investigate landcover type as a factor limiting interaction between the RLBH and WBNP herds, we will construct univariate, binomial models similar to those in our 2018 annual report. These models will be broken down by season adding a temporal scale to our 2018 analyses.

Knowledge Gaps 2a, 2b, & 2c - Habitat use of wetlands and anthropogenic disturbances:

Research objectives

From the analyses and results of the RLBH's resource selection functions (RSFs; DeMars et al., 2016) and similar habitat analyses (Belanger et al., 2018), much is now known regarding bison annual and seasonal use of landcover types. In the absence of GPS radio-collar data, plot-based animal scat surveys can be used to estimate relative use of landcover types for various species at a finer spatial scale (Alves et al., 2013). The objective of this research is to estimate seasonal habitat use of bison using non-invasive scat surveys. These surveys contribute as a long-term monitoring tool that is not dependent on GPS radio-collar data and is useful for estimating relative habitat use for different landcover types including anthropogenic disturbances.

Overview of research methods

In the summer of 2018, we established permanent plots in seven different landcover types including three disturbance types (i.e., cutblocks, seismic lines, and wellpads) by arranging six T-posts in a rectangular pattern encompassing a 500-m^2 area (Figure 1, "wildlife survey plots"). Two observers surveyed the entire area of each plot twice, with the second pass being perpendicular to the first because detectability rates of scat are likely to differ across landcover types (Alves et al., 2013). Surveys are conducted during snow-free periods: one survey in spring after snowmelt (an estimate of winter habitat use) and one survey in fall before leaf-fall (an estimate of summer habitat use). During surveys, scat from both bison and non-target species were counted and removed from plots. Surveys will be completed twice per year to index winter versus summer use. Sites will be re-visited in late April to obtain winter counts, and again in late October to obtain summer counts (intervals of 6 months). These counts will be used to calculate relative habitat use of different landcover types for bison using this non-invasive, low-cost approach.

Progress / preliminary results

Spring surveys of the 17 plots and establishment of further plots are ongoing. We will report results of our spring and fall surveys in our 2019 annual report.

Outstanding / upcoming work

We will conduct winter and summer surveys of the 17 plots in April and October of 2019 and will establish further plots in areas of human disturbance (i.e., cutblocks, wellpads, and seismic lines). Our goal is to establish a single plot in 5 replicate sites per landcover type including upland pine, upland deciduous, meadow marsh, cutblock, wellpad, and seismic line (n = 30 plots). To corroborate that use of bison scat counts can be used as an effective method of estimating habitat use, we will use linear regression to investigate the relationship between bison scat counts and selection coefficients for the RLBH.

In our 2018 annual report we stated that we would investigate the efficacy of using trail cameras, in addition to scat surveys, to estimate wildlife habitat use. Here, we conclude that we will not be establishing trail cameras at our wildlife survey sites due to our trail camera resources being used to address other knowledge gaps.

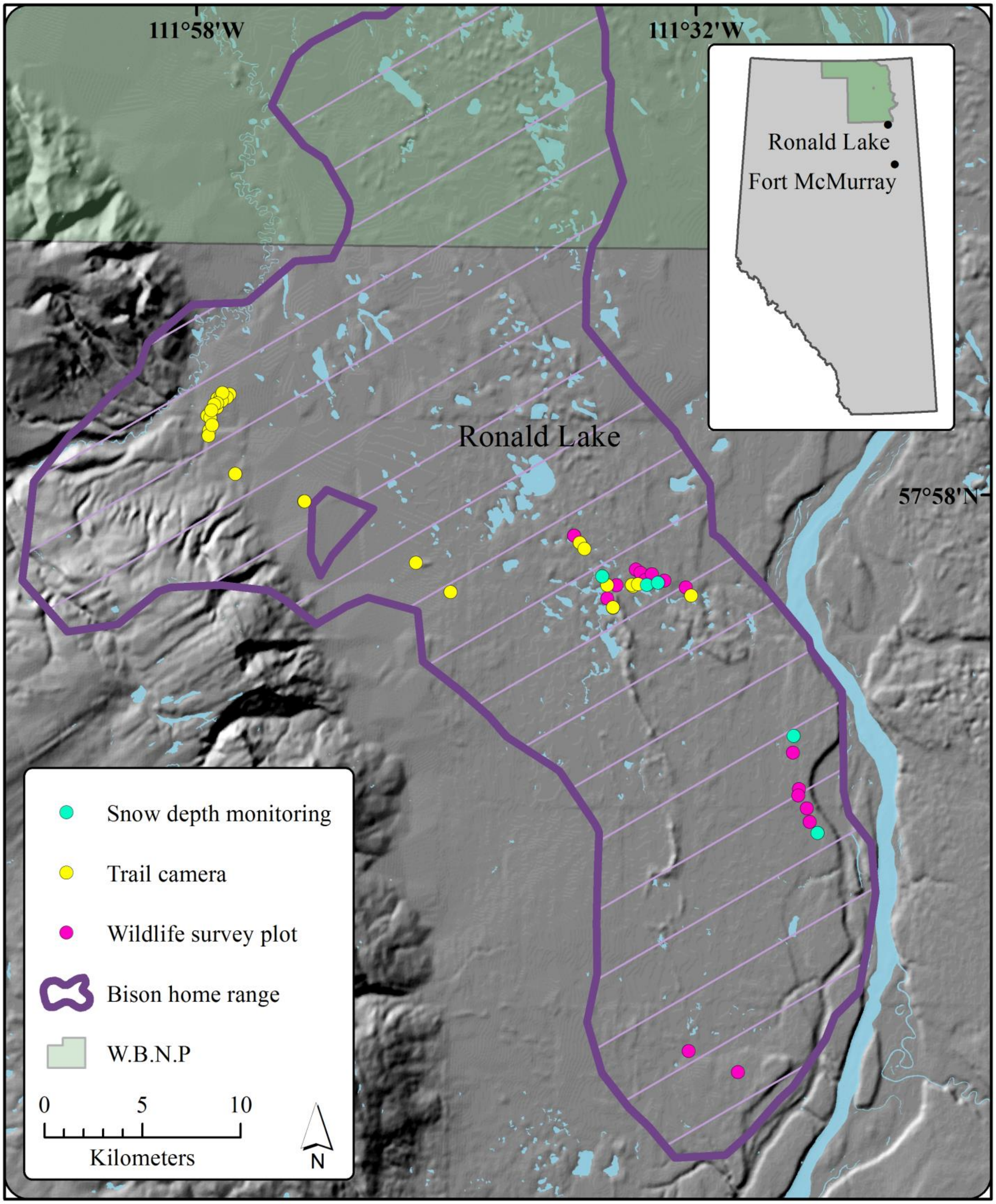

Figure 1: Current locations for snow depth monitoring sites, trail cameras, and wildlife survey plots. Bison home range depicted here is female 99% utilization distribution based on the 2017 GPS radio-collar data.

Knowledge Gaps 3c & 3e - Diet and forage quality and quantity by season, and disturbance type

Research objectives

Our objective is to determine the diet of the RLBH throughout the year and assess how that diet changes as the quantity and quality of available forage changes throughout the year. We intend to meet this objective by determining the biomass available to bison within different landcover types, analyzing the content of bison fecal samples, and assessing the quality of the species bison have foraged on. In August of 2017 and 2018 we estimated the biomass of four functional forage groups (browse, forbs, grasses, and sedges) within the 23 different Duck's Unlimited Enhanced Wetland Classification (EWC) landcover types (Belanger et al., 2018). Now, we seek to build upon the knowledge gained from those surveys by assessing how the quantity and quality of forage changes seasonally.

Overview of research methods

We are continuing our assessment of biomass available to bison by comparing the biomass at locations recently (<14 days) visited by bison, to random locations available to bison within their home range (see Knowledge Gaps 4a, 4b, & 5a for more information on bison and available locations).

To determine the actual seasonal diet differences of the RLBH, we are collecting fecal samples and recording signs of foraging at locations recently (<14 days) visited by bison. We only consider a site to have been foraged by bison when we are at a bison location, there are other signs of bison presence (e.g., tracks or fur shed), and vegetation has been foraged. If there are signs of other herbivores at the site, we note it. When we observe signs of bison foraging, we clip the same portion of the plant that was consumed by the bison from a nearby plant of the same species. These samples are then dried and stored for proximate analyses of the macronutrient composition of the forage items bison are selecting.

We also record the intensity of bison foraging on different plant species by estimating the area occupied by foraged plants within a 15-m radius of the bison location (Harvey and Fortin, 2013). This estimate of foraging intensity will help us ground-truth the results of the analysis of bison diet through fecal sample composition.

Progress / preliminary results

Our biomass estimates from 2017 and 2018 revealed that meadow marshes offered the greatest amount of biomass, particularly sedges, to the RLBH (Belanger et al., 2018). Additionally, preliminary results from our habitat selection analyses also indicated that the RLBH exhibits strong selection for meadow marshes (DeMars et al., 2016). Together these results suggest a selection for habitats dominated by their preferred forage (Jung et al., 2015).

In 2018 and 2019, we began collecting fecal samples for dietary analysis. To date we have collected 46 winter, 16 spring, and 18 summer fecal samples.

In the spring/summer of 2018, we surveyed locations recently visited by bison and recorded the species of vegetation that the bison foraged on. We observed bison mostly foraging on grasses, sedges, and prickly rose (*Rosa acicularis*) in the spring and a broader diet that included a number of forb (e.g., fireweed; *Epilobium spp.*) and shrub (e.g., lowbush cranberry; *Viburnum edule*) species during the summer (Belanger et al., 2018).

Outstanding / upcoming work

During the spring and summer of 2019, we intend to continue research how seasonal changes in the quality and quantity of forage influence the diet of the RLBH. A primary objective for this field season will be to collect enough fecal samples for dietary analyses ($n \geq 40$). We are making this a priority because we intend to send fecal samples out for microhistology analyses and begin proximate analyses of vegetation samples in September. We also intend to continue recording signs of foraging and are incorporating an estimate of foraging intensity groups (see Knowledge Gaps 4a, 4b, & 5a for more information). When signs of foraging are observed, we will continue to clip the same species in a similar fashion as it was foraged. Additionally, we will continue estimating biomass of functional forage groups at bison use and random locations available to bison.

Knowledge Gaps 4a, 4b, & 5a – Ecological drivers of habitat use and response to disturbances

Research objectives

We seek to understand how habitat selection by the RLBH is influenced by the changes in forage quantity and quality (i.e., bottom-up effects) throughout the year. We are implementing second-order resource selection functions (RSFs) to explore this objective. Second-order RSFs examine habitat selection by a population within their home range (Johnson, 1980). In the spring and summer of 2018, we began field work exploring this objective by surveying bison use and random (i.e., available; hereafter referred to as 'available location') locations for comparison of habitat characteristics, forage biomass, and bison behaviour (Belanger et al. 2018).

Overview of research methods

To investigate the mechanisms influencing habitat selection by the RLBH within different landcover groups and disturbances, we are implementing a factorial experimental design. We used the biomass estimates provided by Belanger et al. (2018) to amalgamate the 30 EWC landcover types into seven key land cover groups: graminoid rich wetlands, shrubby wetlands, treed wetlands, upland conifer, upland pine, upland deciduous, and water/insignificant (Table 2). The water/insignificant group will not be surveyed in the field because these landcover types are either not used by bison or account for <1% of the RLBH's annual home range. Next, within each landcover group we identify four disturbance regimes: natural (i.e., undisturbed), linear, cutblocks, and recent (<10 yrs.) burns. We then randomly select recent (<14 days) bison and available locations for surveying within each landcover type and disturbance regime (e.g., upland deciduous, cutblock) for surveys.

At all locations, we measure habitat characteristics known to influence bison habitat selection, estimate available biomass, and quantify intensity of different behaviours. The landscape characteristics that we measure are slope, aspect, canopy cover, ground firmness (substrate type + soil moisture), distance to water (lentic and lotic), distance to graminoid rich landcover group, coarse woody debris (CWD; >10-cm diameter) density, sapling/shrub density, and tree density. Within the 15-m radius of each location we place three, 0.25-m^2 quadrats 10-m apart in which we visually estimate the percent cover of four functional forage groups: browse (i.e., shrubs and trees), forbs, grasses, and sedges (Figure 2).

Progress / preliminary results

During the spring/summer of 2018, we surveyed 178 locations (69 bison, 109 available locations). We ran logistic regression on data gathered during the spring/summer of 2018 to generate preliminary RSFs. The most parsimonious models all favored bison selection of particular habitat characteristics, not forage biomass. These models revealed the RLBH are selecting regions that are open and lacking physical obstructions (e.g., trees, shrubs/saplings, and CWD; Table 3). However, these results should be interpreted cautiously as selection coefficients only indicate minor avoidance of these habitat characteristics.

Outstanding / upcoming work

From May through August of 2019 we will continue to survey bison and available locations. This field season we will begin quantifying the intensity of five behaviours (grazing, browsing, bedding, traveling, and wallowing) as a function of the area that signs of each behaviour are observed within the total area (c.a. 707-m^2) of the survey plot (Figure 2; Harvey and Fortin, 2013).

Table 2: The original Duck's Unlimited Enhanced Wetland Classification (EWC) landcover types and the seven landcover groups they have been reduced to. Note only 22 of the 30 EWC landcover types are reported in this table. Of the eight remaining landcover types, two are biologically irrelevant (cloud and cloud shadow), two are upland forest habitats that will be assigned a landcover group in the field (upland mixedwood and upland other), and four are disturbances that are outdated and do not accurately reflect the current landscape (burn, cutblock, anthropogenic, and agriculture).

Landcover Group	**EWC Landcover Type**
Graminoid rich wetlands	Meadow marsh
	Emergent marsh
	Graminoid rich fen
Shrubby wetlands	Graminoid poor fen
	Shrubby rich fen
	Shrubby poor fen
	Shrub swamp
	Conifer swamp
Treed wetlands	Hardwood swamp
	Mixedwood swamp
	Tamarack swamp
	Treed rich fen
	Treed bog
Upland deciduous	Upland deciduous
Upland conifer	Upland conifer
Upland pine	Upland pine
Water/Insignificant	Open water
	Aquatic bed
	Mudflats
	Open bog
	Shrubby bog

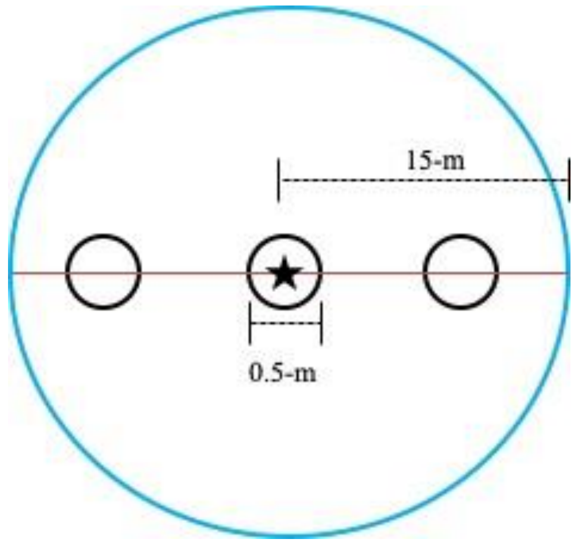

Figure 2: Sketch of the plots that are surveyed at all bison and available locations. The black star represents the selected location and the large blue circle illustrates the 15-m radius in which behavioural intensity is measured. The red line is a belt transect along which tree, shrub/sapling, and coarse woody debris density is measured. The black circles are the three quadrats for visually estimating forage biomass.

Table 3: Preliminary results from logistic regression models derived from data collected during the spring/summer 2018 field season. For brevity, only the ten most parsimonious models and the null model (intercept) are displayed. Note that due to small sample sizes we did not attempt to differentiate habitat preferences between the seasons.

Covariates	Coef.	AIC	ΔAICc	Weight
~CWD density + tree density + shrub density	-0.007 -0.048 -0.184	204.1	0	0.997
~CWD density + shrub density	-0.006 -0.053	215.8	11.7	0.003
~CWD density	-0.061	221.8	17.7	<0.001
~CWD density*CWD height	-0.117	222.3	18.2	<0.001
~CWD density*CWD decay	-0.104	222.9	18.7	<0.001
~shrub density	-0.009	226.5	22.4	<0.001
~tree density	-0.161	229.4	25.3	<0.001
~CWD*CWD height*CWD decay	-0.012	230.5	26.4	<0.001
~Canopy cover	-0.012	236.4	32.3	<0.001
~	-0.457	239.7	35.6	<0.001
~distance to marsh	-0.003	240.3	36.2	<0.001

Knowledge Gap 4c – Ecological drivers of habitat use: wolf predation

Research objectives

The sustainable management of wildlife populations requires knowledge of their habitat preferences and the processes influencing selection and avoidance. Mortality risk is one of many biological factors that may influence habitat use (Nielsen et al., 2010). Investigating the influence of predation will allow us to estimate the spatial distribution of predation risk (Legendre et al., 1989) for the RLBH and provide insight into the influence predation has on bison habitat selection. We will study the effect of wolf predation on the survival and habitat selection of the RLBH. Our first objective is to estimate the level of predation and prey selection by wolves on the RLBH and explore potential influence of environmental conditions on predation. Our second objective is to investigate the influence of wolf predation on the herd's use and selection of habitats throughout the year.

Overview of research methods

We deployed GPS radio-collars on wolves, pre-programmed at a two-hour fix acquisition interval (Webb et al., 2008). We will first use the recorded wolf location data and GPS cluster analyses to identify potential kill sites (Webb et al., 2008). These sites will be searched by field crews to identify prey types / diet content, estimate level of predation on bison, and investigate how environmental conditions may influence prey selection and rate of predation. Prey species, age, sex, and health will be identified depending on evidence found. Field crews will measure the same habitat characteristics as described in the section addressing knowledge gaps 4a, 4b, & 5a to better understand factors that influence bison habitat selection and the effect of habitat characteristics on predation risk. Field measurements of environmental conditions are collected via three passive monitoring stations and augmented by data from local weather monitoring stations.

We will also examine and compare the movement and habitat use of wolves and bison throughout the year to develop RSF models (Johnson, 1980) to estimate encounter risk. These models will provide indication of habitat characteristics that are important to both wolves and bison (Boyce et al., 1999), and will allow us to estimate the spatial and seasonal pattern of predation risk between bison and wolves within the study area.

Progress / preliminary results

In April 2019, we deployed GPS radio-collars on three wolves in two separate packs via helicopter net gunning by Bighorn Helicopters. Location data from these GPS collars is being retrieved consistently and the first cluster sites were visited on April 25th, 2019. An aerial crew travelled to and investigated 20 cluster sites, one of which was an adult moose kill site.

Outstanding / upcoming work

Wolf locations will continue to be monitored for potential kill sites that will be prioritized through cluster analysis using a stratified random design. Cluster sites will continue to be visited by ground or air in three week increments for one year (April 2019 - May 2020). Our next set of cluster sites to be investigated will be visited on May 21st, 2019.

Knowledge Gap 8c & 8g: Herd age structure and cow-to-calf ratio

Research objectives

Estimating mammalian population demographics can be used to monitor population health and size trends (Brown, 2011; Cameron et al., 2013). For example, high annual calf or cow mortality rates can result in decreased recruitment the following year and subsequent population decline (Cameron et al., 2013). The RLBH is estimated at ca. 200 bison (AEP & ACA, 2018). Much less is known about the herd's demographics including age and sex structure. Starting in 2015, trail cameras were deployed in the Ronald Lake area to estimate calf:cow, yearling:cow and bull:cow ratios. These data, in conjunction with continued trail camera work, will contribute towards assessing variation in the annual population structure and trends over time for the RLBH. The objective of this research is to estimate population demographics and observe long-term trends. Specifically, this research will document changes in the RLBH's population structure.

Overview of research methods

In March 2015, we deployed 16 trail cameras in a large, remote meadow in the northwest portion of the RLBH's home range where the bison congregate in spring during the calving season (DeMars et al., 2015). To capture photos of bison, we deployed cameras in areas of high bison activity (e.g., game trails and wallows). Since 2015, we have continued to redeploy cameras in this large meadow, as well as other areas of the herd's home range. We currently have deployed 34 trail cameras, 17 of which are located in the large meadow and 17 in other regions of the RLBH's home range (Figure 1).

Using Timelapse2, we count the number of individual bison in five different categories according sex (i.e., bull, cow) and age group (i.e., adult, yearling, calf), including bull, cow, sex unknown adult, yearling, and calf (Greenberg, 2015). In a sequence of images (string of images with a similar time-stamp), we record individual bison only once. To avoid double counting of calves/yearlings, images were pooled for one year cycles that coincide with calving (01 May – April 30).

Progress / preliminary results

We are currently gathering and summarizing trail camera data from the past year.

Outstanding / upcoming work

We are currently in the process of gathering and analyzing trail camera data from 2017-2018 and will report these and previous demographic estimates in our December 2019 annual report.

Summary

In this semi-annual report, we have summarized the current progress and described objectives and methodologies used to address several of the knowledge gaps identified by the RLBH technical team. We will construct univariate, binomial models that examine the potential for interaction between WBNP bison and the RLBH. We have established 17 monitoring plots for long-term assessment of habitat use and plan to add an additional 13 plots in the spring of 2019. We will complete scat and forage sample collection in the spring/summer of 2019, so that bison diet and forage quality analyses can be analyzed in the fall of 2019. Our initial analyses of ecological drivers of habitat use indicated selection for open habitat types. We will continue to survey bison use and available locations throughout 2019 to build upon these initial results. We have deployed GPS radio-collars on three wolves, representing two unique packs in the Ronald Lake area. Our surveys of wolf kill sites will begin at the end of April 2019. Additionally, we have deployed 34 trail cameras, the data from which will be used with that of the previous years for the study of demographic changes in the RLBH population. As we continue to gain a better understanding of the RLBH's ecology based on the knowledge gaps, we are considering how these results can be applied to modeling the impact of future disturbances on the RLBH.

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