Targeted Elk Brucellosis Surveillance Project
2021 Annual Report

EXECUTIVE SUMMARY

Montana Fish, Wildlife & Parks (MFWP) is conducting a multi-year targeted elk brucellosis surveillance project to evaluate 1) prevalence and spatial extent of brucellosis exposure in elk populations, 2) elk spatial overlap with livestock and interchange between elk populations, and 3) effects of brucellosis management hazing and lethal removal on elk distributions and spatial overlap with livestock. This report is an annual summary of the 2021 targeted elk brucellosis surveillance project. In January-February 2021, we sampled a total of 100 elk from the Ashland area and screened blood serum for exposure to *B. abortus*. All Ashland elk tested negative for exposure to *B. abortus* (prevalence = 0%, 95% CI: 0-3.7%, n = 100). In February 2021, we sampled a total of 100 elk in the Horseshoe Hills and screened blood serum for exposure to *B. abortus*. All Horseshoe Hills elk tested negative for exposure to *B. abortus* (prevalence = 0%, 95% CI: 0-3.7%, n = 100). Potential overlap with livestock and interchange between elk populations is being monitored with GPS radio collars. We collared 40 elk in the Ashland area and 29 elk in the Horseshoe Hills and are currently collecting elk movement information. We completed an evaluation of elk responses to management hunting and hazing used to redistribute elk off conflict zones in Sixmile and Madison. Hunting and hazing did reduce elk use of conflict zones, but the magnitude and duration of responses were mixed across both study areas. The proportion of elk using conflict zones was reduced by hunting, modestly reduced by hazing and increasing snowpack in Madison, increased at night and decreased across months from winter to spring. The time individual elk stayed away from conflict zones increased with the number of hazing events while they were away and increased slightly across months. Our results suggest using a combination of hunting and frequent hazing to reduce elk use of conflict zones. Night-time deterrents (e.g., motion activated noise makers) would also be helpful.

INTRODUCTION

Montana Fish, Wildlife & Parks (MFWP) has conducted surveillance for brucellosis in elk populations since the early 1980s. Surveillance consists of screening blood serum for antibodies signifying exposure to *Brucella abortus*, the bacteria that causes the disease brucellosis. Brucellosis may cause abortion in pregnant elk, typically from February through May (Cross et al. 2015) and is primarily transmitted through contact with infected fetuses, birthing fluids and material. Elk that test positive for exposure to *B. abortus* (seropositive) may or may not be actively infected with the bacteria. Although not a true indicator of infection or the ability of an animal to shed *B. abortus* on the landscape, detection of seropositive elk indicates brucellosis is present in the area and indicates the potential for elk to transmit the disease to livestock or other elk.

In an effort to increase understanding of brucellosis in elk populations, MFWP initiated a targeted elk brucellosis surveillance project in 2011. The goals of the project are to 1) evaluate the prevalence and spatial extent of brucellosis exposure in elk populations, 2) document elk movements to evaluate the extent of spatial overlap with livestock and interchange between elk populations, and 3) evaluate the effects of brucellosis management actions, such as hazing and lethal removal, on elk distributions and spatial overlap with livestock. In order to achieve these goals, MFWP has conducted targeted sampling and collaring efforts focused on 1 – 2 elk populations per year since 2011. Elk populations are identified through collaborative discussions between MFWP, the Montana Department of Livestock (DOL) and landowners. Selection is based on proximity to the known distribution of brucellosis and/or significant livestock concerns. Surveillance areas are both inside and outside the State of Montana brucellosis designated surveillance area (DSA, Figure 1).

SAMPLED POPULATIONS

Since 2011, we have sampled 21 elk populations (Figure 1). In January-February 2021, we sampled elk in the Ashland area (HD704) and in the Horseshoe Hills (HD 312). The purpose of sampling was to evaluate brucellosis presence and prevalence in the elk populations and identify elk movement patterns and interchange among populations. The Ashland area is also part of the Eastern Montana Elk Habitat Use Project.

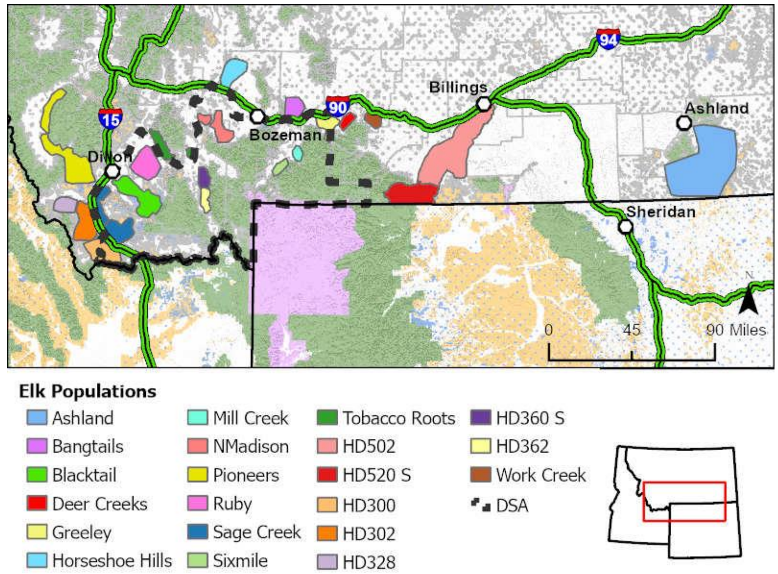

Figure 1. Elk populations sampled during the 2011 – 2021 targeted elk brucellosis surveillance project. The area inside the black dashed line is the Montana brucellosis DSA.

METHODS

To evaluate brucellosis presence and prevalence, we captured adult female elk using helicopter net-gunning and collected a blood sample to screen animals for exposure. Exposure was determined by the presence of antibodies to *B. abortus* in an animal's blood serum. Blood serum samples were tested at the Montana Department of Livestock Diagnostic Lab (Diagnostic Lab) utilizing the Rapid Automated Presumptive (RAP) and Fluorescence Polarization Assay (FPA) plate tests. Suspect or reactors to these screening tests were further tested with the FPA tube test. Final classification of serostatus (i.e., seropositive or seronegative) was based on test results received from the Diagnostic Lab.

We collared a sample of elk in the Ashland and Horseshoe Hills populations to track movements and evaluate risk of brucellosis transmission to livestock and other elk populations. We deployed satellite upload collars that allow for real-time movement tracking. The collars are programmed to record locations every hour and have a timed-release mechanism that releases the collar after 62 (Horseshoe Hills) or 156 (Ashland) weeks, allowing collars to be retrieved and redeployed. All collars have a mortality sensor that detects if the collar is stationary for > 10 hours. This report also summarizes movement data from the Bangtail Mountains elk population captured in 2019 and 2020, as well as the Ruby Mountain elk population captured in 2020. Movement data collection was completed for the Bangtail Mountains in June 2021 and will continue until January 2022 for the Ruby Mountains.

To evaluate the effects of brucellosis management hazing and lethal removal on elk distributions and spatial overlap with livestock, we monitored elk movements and brucellosis management actions (e.g., hazing, hunting) in the Sixmile Creek and Madison Valley areas. Data collection was completed in April 2019 for Sixmile Creek and in April 2020 for Madison Valley. Analysis and writing were completed in fall 2020 and the manuscript was accepted for publication in the Journal of Wildlife Management for fall 2021.

RESULTS

Brucellosis surveillance

In January and February 2021, we sampled 100 female elk in the Ashland area and

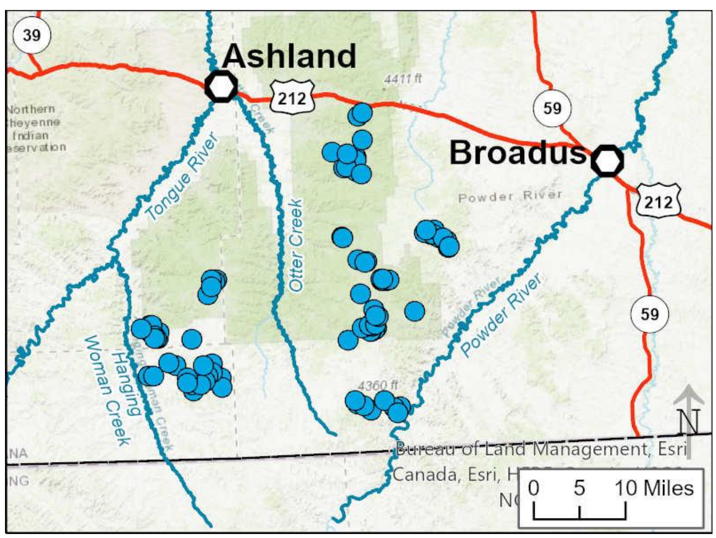

Figure 2. Capture and sampling locations of elk from the Ashland area in HD704 during January and February 2021.

deployed collars on 40 elk (Figure 2, Table 1). All elk tested negative for exposure to *B. abortus*, giving the population an estimated seroprevalence of 0% (95% CI = 0-3.7%; Table 1).

In February 2021, we sampled 100 female elk in the Horseshoe Hills and deployed collars on 29 elk (Figure 3; Table 1). All elk tested negative for exposure to *B. abortus* resulting in an estimated seroprevalence of 0% (95% CI: 0-3.7%; Table 1).

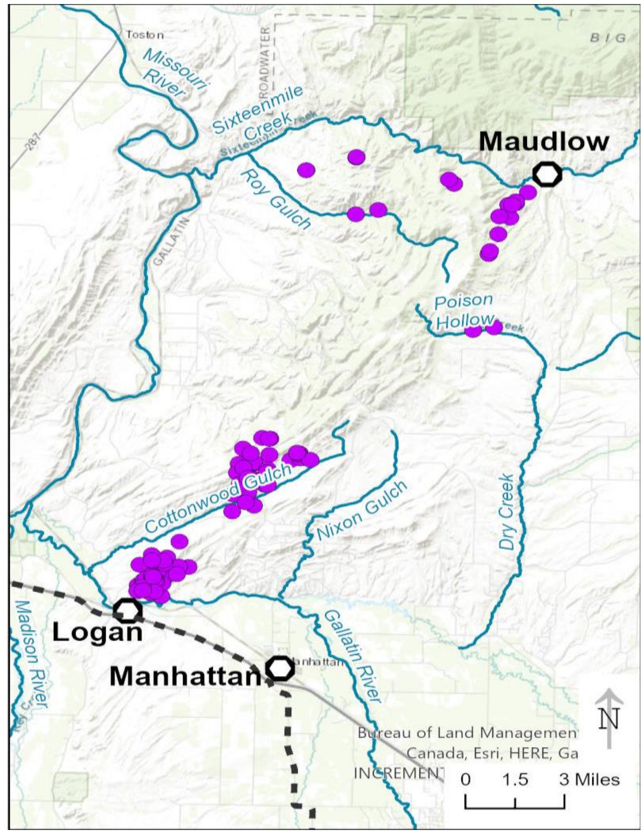

Figure 3. Capture and sampling locations of elk from the Horseshoe Hills population during February 2021.

Table 1. The elk populations, number of elk sampled for *B. abortus* exposure, number of elk collared, number of elk testing seropositive for exposure, and the estimated seroprevalence with 95% confidence intervals (in parentheses).

Population	Number Sampled	Number Collared	Number Seropositive	Estimated Seroprevalence
Ashland	100	40	0	0 (0, 0.037)
Horseshoe Hills	100	29	0	0 (0, 0.037)

Based on hunter harvest and targeted sampling data since the start of the Targeted Elk Brucellosis Surveillance Project (2010-2021), we estimate brucellosis seroprevalence in elk varies spatially across southwest Montana and ranges from 0 – 39% (Figure 4).

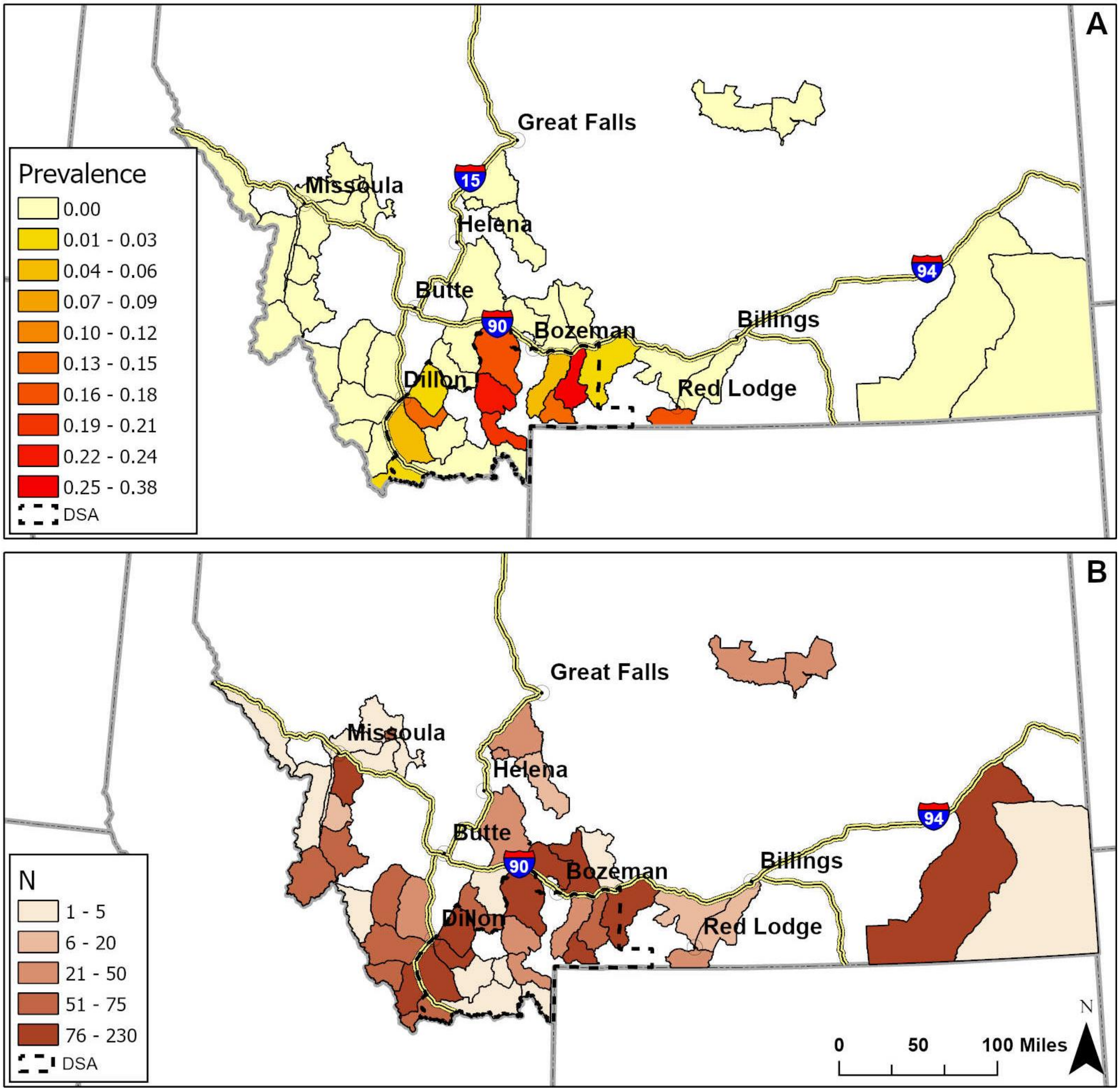

Figure 4. The estimated brucellosis seroprevalence (Panel A) and number of samples screened (n, Panel B) for adult female elk by hunting district* during 2010 – 2021. Samples include those collected opportunistically during fall hunter harvest and during targeted winter sampling. Note some seroprevalence estimates are derived from a low number of samples. The gray line denotes the boundary of the Montana brucellosis designated surveillance area (DSA). *Hunt district 520, west of Red Lodge, is divided in two along a legally defined sub-district boundary to reflect the limited sampling in the northwestern portion of the district.

Elk movements

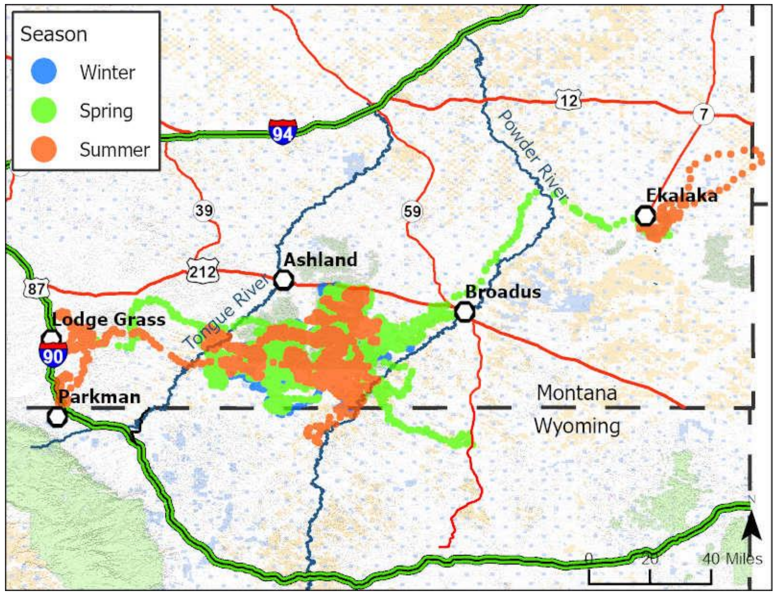

Figure 5. Annual locations (circles) of elk by season from the Ashland area population, January 2021 – July 2021.

In January - February 2021, we deployed 40 satellite upload collars in the Ashland area elk population (Figure 5). These elk are part of the Eastern Montana Elk Habitat Use Project and the collars are programmed to collect hourly locations for 3 years. All elk are alive with functioning collars. All elk wintered between the Tongue and Powder Rivers, south of Hwy 212 and north of the MT-WY border. Limited migration began in May as 2 elk moved just West of the Tongue River, 1 elk moved east of the Powder River, and 1 elk moved northeast towards Broadus before continuing northeast to Ekalaka in July. In June 1 elk moved west towards Lodge Grass. One elk migrated south into Wyoming in June but came back to winter range and then in July migrated west to Parkman, WY just south of the MT-WY border along Interstate-90. Most elk are still on their general winter range.

In February 2021, we deployed 29 satellite upload collars in the Horseshoe Hills (Figure 6). These collars are programmed to collect hourly locations for 1 year. Unfortunately, a hardware contamination issue is causing screws to back out of the drop off mechanisms, allowing the collars to fall off prematurely. As of August, 15 of the 29 collars have fallen off elk due to this issue, resulting in incomplete spring migration data for a number of those elk. We are currently monitoring the remaining 14 collars. Elk captured in the north and northeast near Maudlow, MT (n=6) moved northeast to Haw Gulch in March shortly after captures and have remained in that general vicinity, except for 1 elk that moved back south of Maudlow in June. Elk captured in the southwest (n=23) generally wintered along Cottonwood Gulch just North of Logan, MT. All but 1 elk migrated northeast in March and April towards Maudlow, with some elk staying in the Haw Gulch area and others continuing east and summering between the Middle and South Fork of Sixteenmile Creeks. Four elk migrated as far east as Lost Creek, just south of Ringling. Several elk spent part of the spring and summer near Blacktail Divide on the North end of the Bridger Mountains, with some moving back west to summer just East of Poison Hollow in the agricultural fields. One elk was a resident and remained along Cottonwood Gulch into June when her collar fell off.

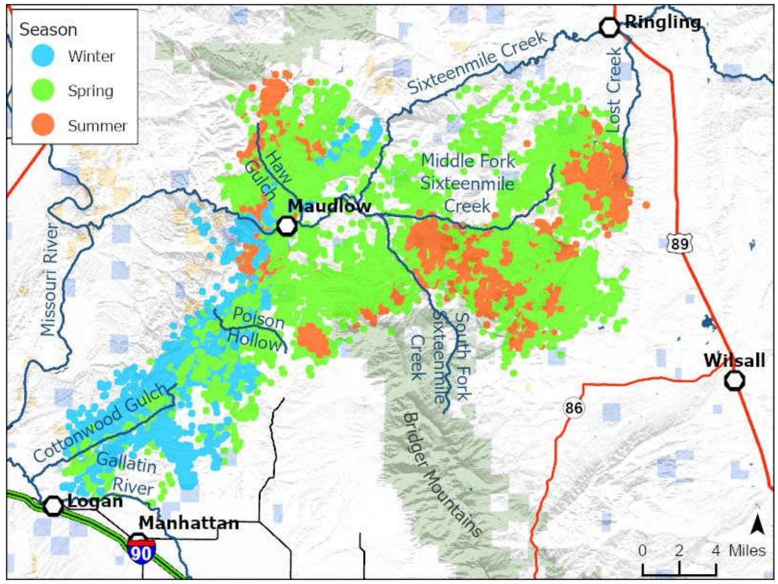

Figure 6. Annual locations (circles) of elk by season from the Horseshoe Hills population, February 2021 – July 2021.

We will continue to monitor movement of Horseshoe Hills elk, particularly regarding proximity to I90 and HD311 to the south where brucellosis was detected in the Black's Ford elk population in 2014. Within the last 5 years these two elk populations have been in proximity during winter and represents a potential transmission route for brucellosis to expand north.

In January 2020, we deployed 43 satellite upload collars in the Ruby Mountains. One collar malfunctioned shortly after capture and her limited movement data is not included. Four additional collars have failed, hunters harvested 7 collared elk in fall 2020, and 1 elk died of winter kill in spring 2021. We are currently collecting data from the remaining 30 elk (Figure 7). These collars are programmed to drop off in January 2022. Elk captured on the east side of the Ruby Mountains (n=11), near the Ruby Reservoir, tended to winter near the reservoir, from Beatch Canyon south to Mormon Creek. One elk wintered just north of Sweetwater Basin for the last 2 years. Most elk moved short distances in April and May to summer range southwest of the reservoir, between Garden Creek and Cottonwood Creek. Two elk summered in Sweetwater Basin and 3 elk moved north to summer between Hinch Creek and Taylor Canyon. Most elk migrated back to winter range in September and October. Elk captured on the west side of the Ruby Mountains (n=32) tended to winter at low elevations from Stone Creek in the south to the Ruby River in the north. A limited number of elk spent at least 1 winter just north of Sweetwater Basin and 1 elk moved east to the Ruby Reservoir. Movement to higher elevations and summer range

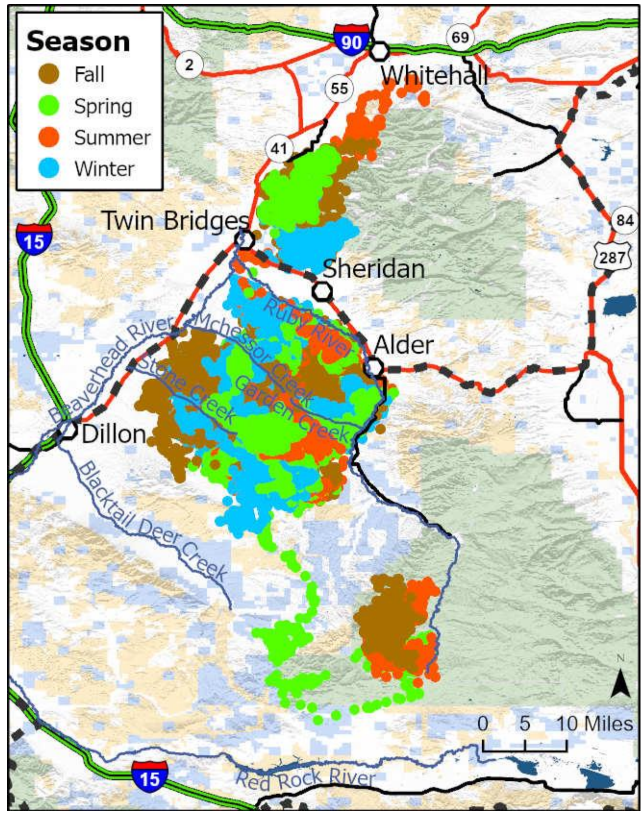

Figure 7. Annual locations (circles) of elk by season from the Ruby Mountains population, January 2020 – July 2021.

occurred in April, with many elk moving to the center and the southern end of the Ruby Mountains between the Middle Fork of Stone Creek and Mormon Creek. A small number of elk migrated a short distance to the northeast and spent at least 1 summer near the Ruby River. One elk migrated southeast and spent 1 summer along Sweetwater Creek. One elk migrated north in August 2020 and spent the fall of 2020 and spring of 2021 on the west side of the Tobacco Root Mountains, moving as far north as Dixon Gulch just south of Whitehall. This elk wintered near Wet Georgia Gulch just northwest of Sheridan and returned to the Ruby Mountains in May 2021 and spent the summer at high elevations there. Another elk migrated south to the east side of the Snowcrest Mountains near the headwaters of the Ruby River and was harvested during her fall migration in November 2020. Fall migration mainly occurred in September and October, with most elk returning to low elevations on the west side of the Ruby Mountains.

During the February through June risk period (Figure 8), Ruby Mountains elk were primarily on their winter range, generally along the west side of the Ruby Reservoir or in the foothills on the West side of the Ruby Mountains. As the risk period progressed and migration began in April, most elk moved to the southern end of the Ruby Mountains, with a few residing on the western or northern foothills through summer.

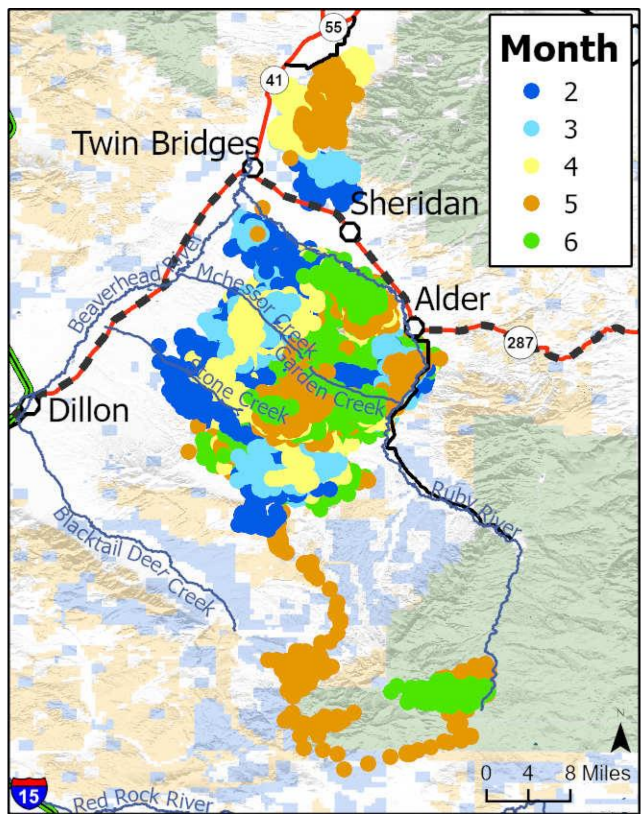

Figure 8. Risk period locations (circles) of elk by month from the Ruby Mountains population, February 2020 – June 2020 and February 2021 to June 2021.

We deployed satellite upload collars in the southern Bangtail Mountains in 2019 and 2020. Movement data for 2019 collars and 2020 collars through August 2020 was detailed in the 2020 Annual Report. This is a brief summary of the annual collar movement and includes the final fall migration in 2020 and winter range selection into 2021 (Figure 9). In January 2019 we deployed 15 collars. One collared elk was harvested 3 weeks after capture and her limited movement data is not included. A second collared elk was harvested in November 2019, after the GPS ability on the collar had failed in July 2019. Three collared elk died from unknown causes in November 2019 to January 2020. In February and March 2020, we deployed 17 collars. One collared elk from the 2020 deployment died shortly after capture and the collar on another elk failed, both in March 2020 and their collar data is not included. Another collared elk was harvested in December 2020. In total, we have collar location data from 29 elk, representing movement data from January 2019 through June 2021.

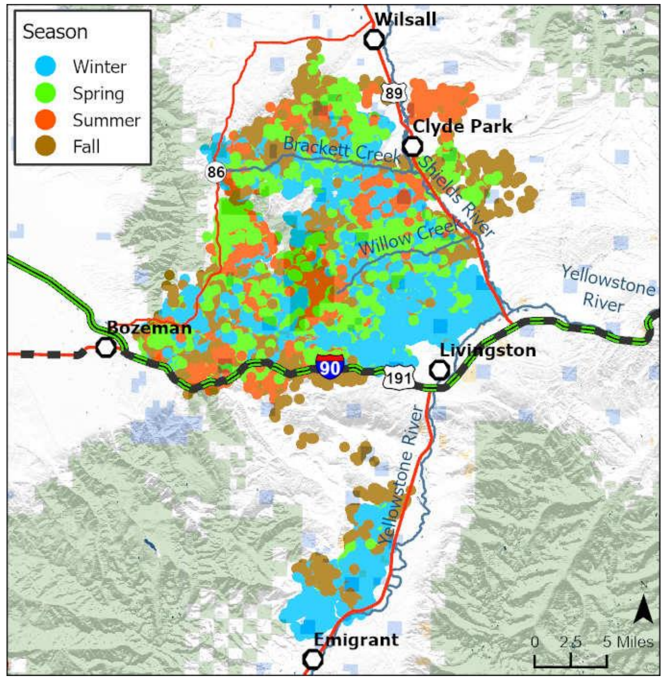

Figure 9. Annual locations (circles) by season of elk from the Bangtail Mountains population, 2019-2021.

In general, Bangtail elk winter in the foothills from Canyon Creek south to I90, and east to Hwy 89. Sixteen of the 29 elk were residents and remained in the southeastern Bangtails year-round; primarily along Willow, Ferry and Fleshman Creeks. The remaining 13 elk migrated, most to the west and primarily in May, with a couple cases each in June and April. Several elk did not migrate back to winter range in the fall and stayed on their summer range until their collars dropped the following spring. For elk that did migrate in the fall the timing stretched from October to March. Seven elk migrated to the Bozeman Pass, with all but 1 north of I90 in the Jackson and Spring Creek areas. The 1 elk that summered south of I90 migrated to Paradise Valley in the fall and wintered on the west side of the valley north of Emigrant. The remaining 6 elk migrated back to winter range sometime between December and February, with 2 of those elk returning again to the pass in April. Two elk migrated to the Story Hills just outside Bozeman. One died in February near the Bozeman Pass and the other briefly returned to winter range in March before going back to the Story Hills the same month. One elk migrated to Bridger Canyon and stayed there through the next winter. Two elk made short migrations north and stayed between Brackett Creek and Battle Ridge until the next spring when their collars dropped. One elk migrated east, crossing Hwy 89 and summered around Hammond Creek south of Clyde Park. This elk migrated west to Bangtail Creek in October, then back to Willow Creek in February and then drifted north again to Bracket Creek in April when her collar dropped.

During the February through June risk period (Figure 10), Bangtail Mountains elk were primarily on their winter range, generally from Fleshman Creek north to Willow Creek. As the risk period progressed and migration began in late April, elk moved relatively short distances (6-8 miles) west, north and east to their summer ranges.

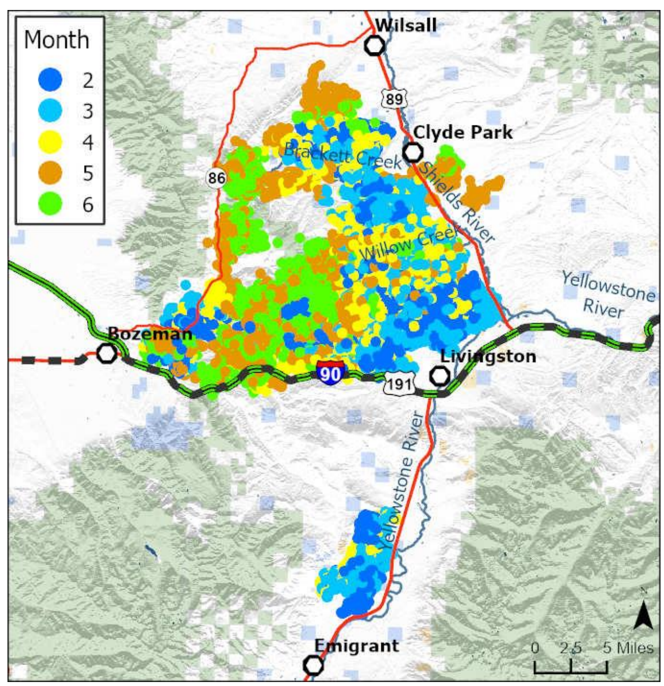

Figure 10. Risk period (Feb-June) locations (circles) by month of elk from the Bangtail Mountains population, 2019-2021.

Data from elk collars has improved our understanding of elk movement and potential routes for the spatial spread of brucellosis or other diseases among elk populations (Figure 11). Elk movements have been and will continue to be used to determine the timing and degree of spatial overlap between elk and livestock in focused analyses.

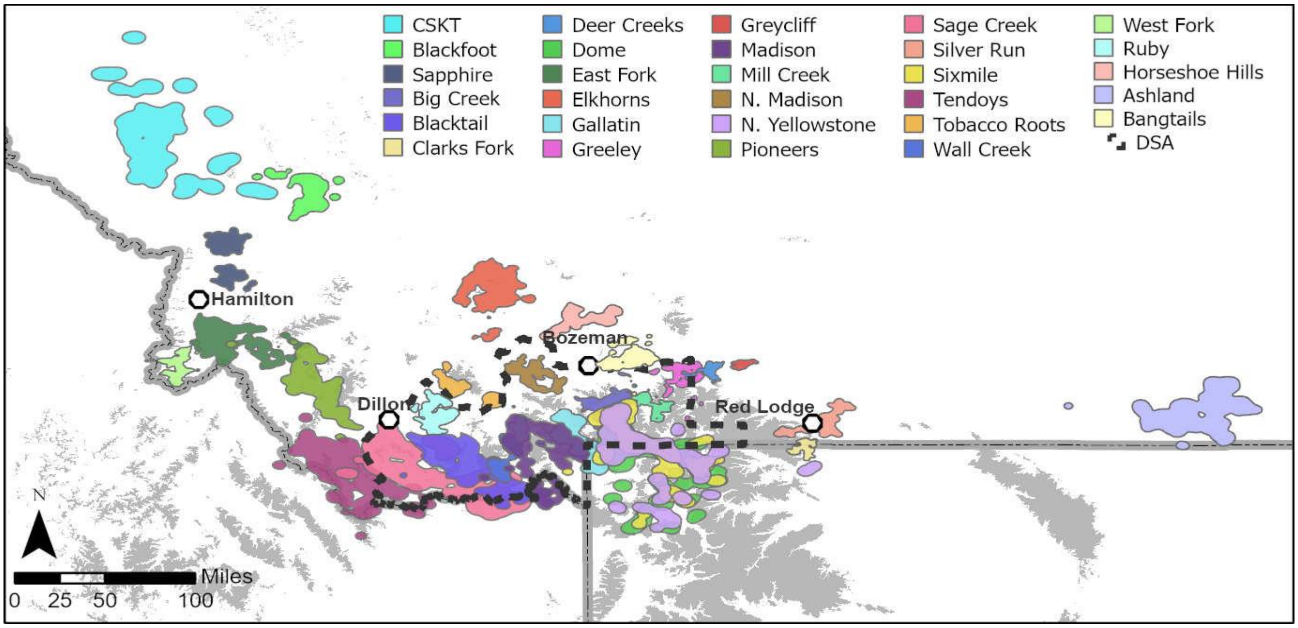

Figure 11. Annual kernel density distributions of sampled elk populations in Montana showing the potential overlap and interchange between populations. Gray polygons represent mountain ranges.

Brucellosis management actions

Elk use of private land is often in conflict with livestock production operations because the elk consume agricultural products and represent a risk for disease transmission to livestock. The most common mitigation measures for this kind of elk conflict is to redistribute elk through hunting or hazing. We used radio-collar location data collected from female elk in the Sixmile and Madison populations from 2017–2020 to evaluate population- and individual-level responses to management actions (i.e., hunting, hazing) and environmental factors (i.e., weather, season, time of day). In both study areas, we defined conflict zones as areas with livestock where elk presence was not desired due to disease transmission risk concerns, and we evaluated how management hazing and hunting affected use of the conflict zones (Figure 12).

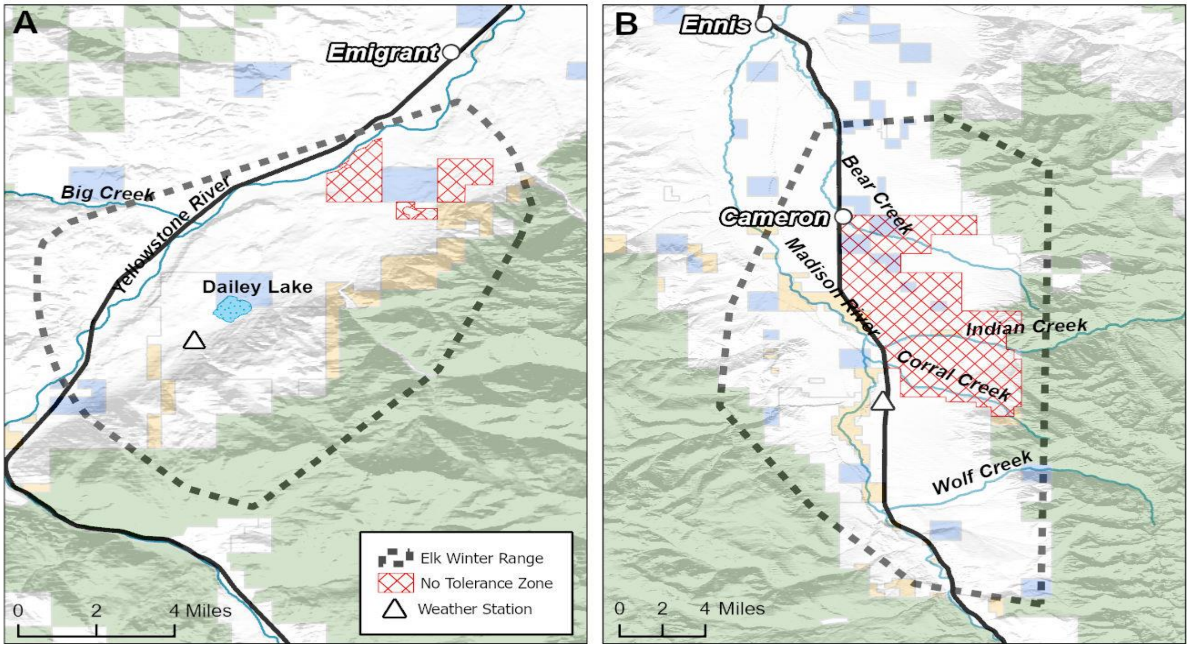

Figure 12. Conflict Zones for A) Sixmile and B) Madison elk populations used to evaluate elk response to hazing and management hunting pressure.

We recorded information on 142 hazing events and 77 hunting days in Sixmile, and 137 hazing events and 144 hunting days in Madison (Figure 13). We collected location data during the management hazing and lethal removal period from 40 individuals and 83 animal-years in Sixmile and from 40 individuals and 81 animal-years in Madison. On average, in Sixmile, 80% of collared animals used a conflict zone each year (range = 65% to 90%) and individuals that used the conflict zone used it on 6 days (min = 1, max = 24). On average, in Madison, 88% of collared animals used a conflict zone each year (range = 80% to 95%) and individuals that used the conflict zone used it on 12 days (min = 1, max = 30).

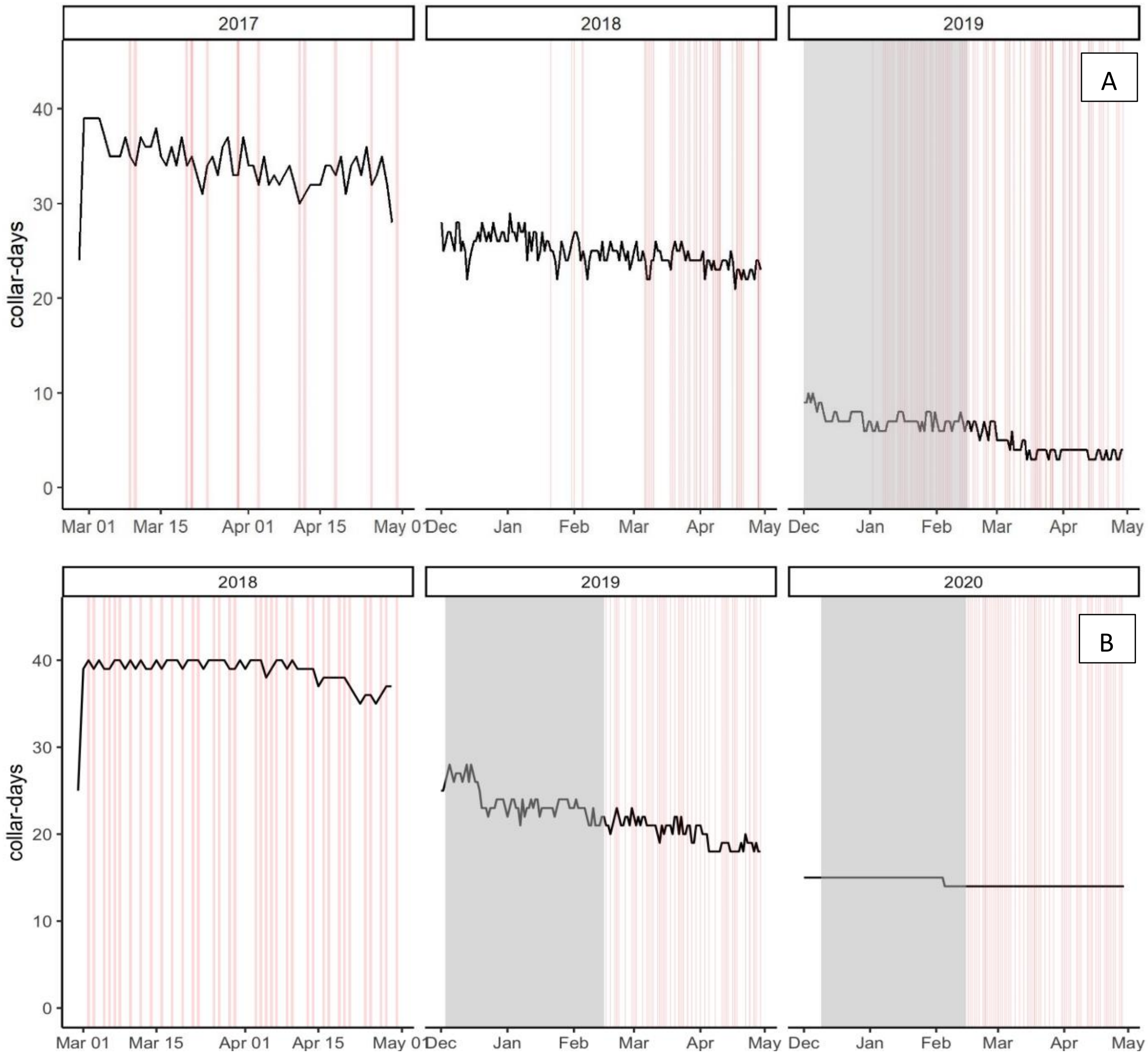

Figure 13. The number of functioning collars (black line), hazing events (red line), and hunting days (gray rectangle) for the Sixmile (Panel A) and Madison (Panel B) areas.

We evaluated how factors including weather and management activities affected the number of collared individuals using a conflict zone and the duration that individuals remained away from the conflict zone. Responses of elk varied across factors and between the study areas. The proportion of elk using conflict zones was reduced by hunting, modestly reduced by hazing and increasing snowpack in Madison, increased at night and decreased across months. Our models predicted that hunting would lower the proportion of individuals using a conflict zone from 0.09 to 0.07 in Sixmile and from 0.31 to

0.17 in Madison (Figure 14). Hazing had a modest effect in Madison with the predicted proportion of elk using a conflict zone rising from 0.49 the day after hazing to 0.61 four days later (Figure 14). For Madison, increasing snowpack, as measured by snow water equivalence (SWE), was predicted to decrease the proportion of individuals from 0.54 at the 25% percentile of the observed SWE values to 0.45 at the 75% percentile of SWE values (Figure 14). Use of conflict zones increased from 0.09 during the day to 0.14 at night in Sixmile, but only increased from 0.31 during the day to 0.34 at night in Madison (Figure 14).

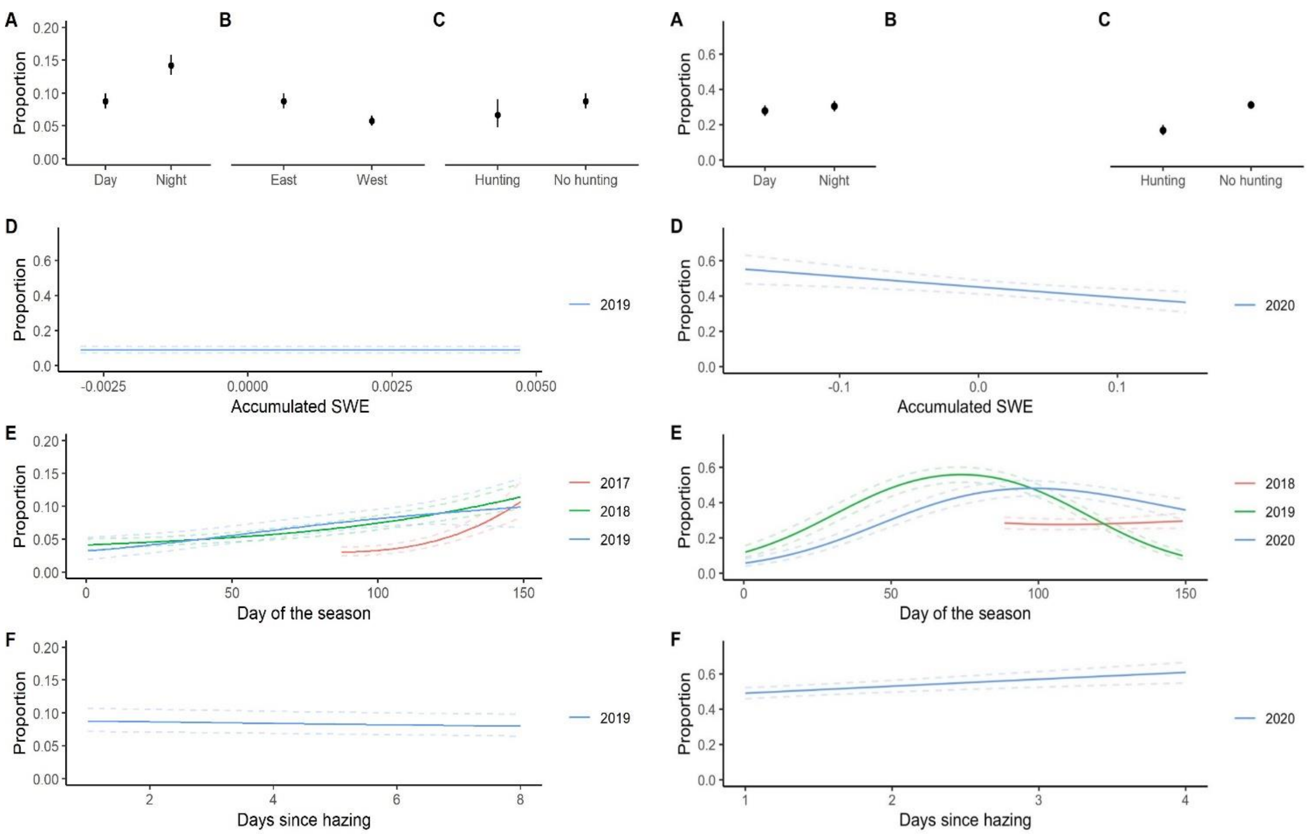

Figure 14. Predictions for Sixmile (left) and Madison (right) of the predicted proportion of elk using a conflict zone as a function of time of day (A), location of the conflict zone (B, Sixmile only), hunting period (C), snow water equivalence (D), day of the season (E, day 0 = 1 Dec), and days since hazing. For D-E, the line denotes the mean and the dashed line the 95% confidence interval.

Individual elk remained away from conflict zones longer if more hazing events occurred and tended to stay away longer later in the season. On average, after leaving a conflict zone elk stayed away for 2.3 days (range = 0-98.5) in Sixmile and 2.10 days (range = 0-53.1) in Madison (Figure 15). The time it took an elk to leave a conflict zone and then return (time to return) was not influenced by whether an individual was hazed out or left on their own (Figure 15). There was evidence that the number of hazing events while an elk was away increased the time to return. For Sixmile, the time to return increased from 0.42 days with 0 hazes to 8.9 days with 5 hazes (Figure 15). For Madison, time to return increased from 0.39 days with 0 hazes to 15.96 days with 5 hazes (Figure 15). Hunting increased the predicted time to return from 0.39 days with no hunting to 0.88 days with hunting (Figure 15); a biologically trivial increase. Similarly, increasing snowpack kept elk away longer in Madison, but the effect size was negligible, increasing from 0.23 days at the 25% percentile of SWE values to 0.56 days at the 75% percentile (Figure 15).

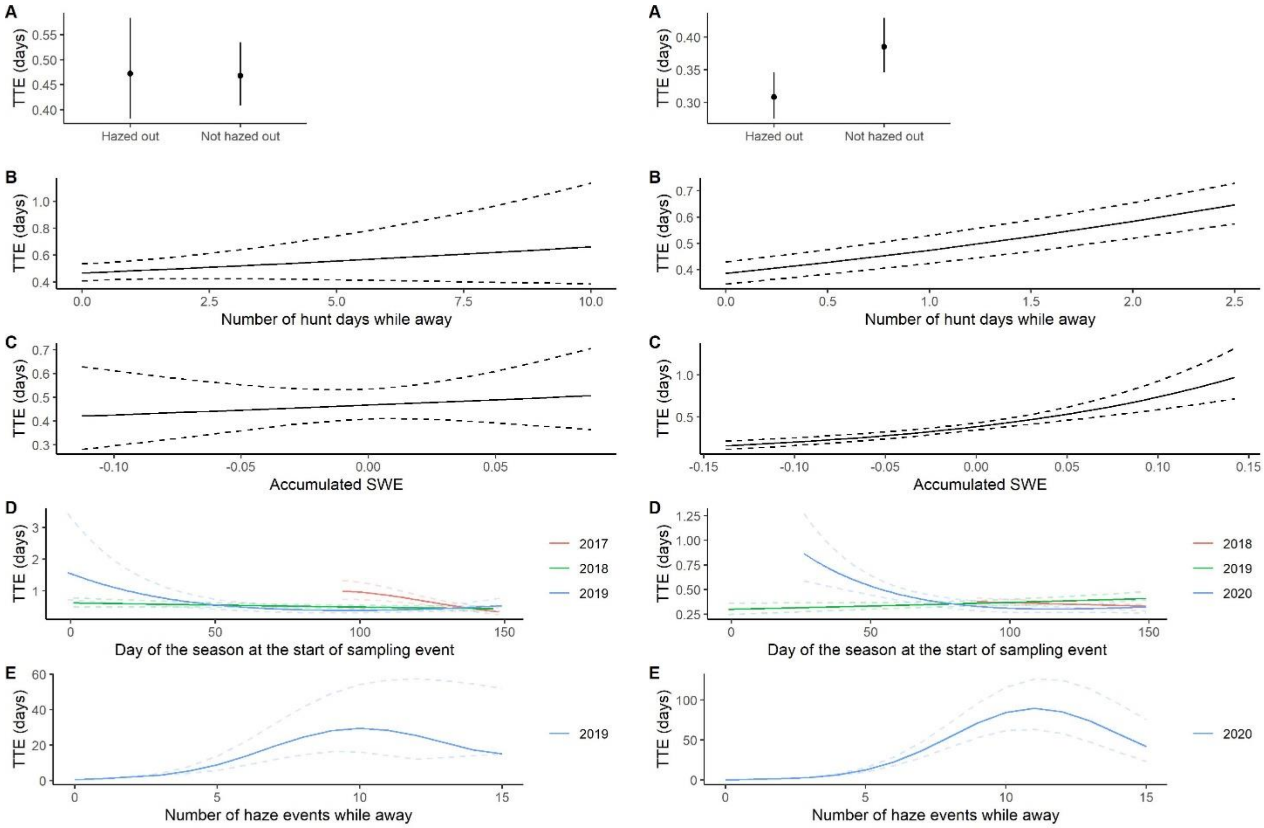

Figure 15. Predictions for Sixmile (left) and Madison (right) of the predicted time to entry (TTE) as a function of being hazed out (A), hunting days (B), snow water equivalence (C), day of the season (D, day 0 = 1 Dec), and the number of hazing events (E). For B-E, the line denotes the mean and the dashed line the 95% confidence interval.

Our findings suggest that hazing is more effective when applied frequently and that a combination of hunting and hazing is the most effective way to reduce conflicts. Differences between study areas suggests that site-specific characteristics may alter the effectiveness of management actions. For instance, use of conflict zones decreased under higher snowpack levels, but only for Madison, suggesting that hazing should be increased there during snow-free months. Because elk use of conflict zones increased at night, any action (e.g., automated frightening devices) that could be taken then would help deter use. A manuscript detailing the methods and results of this study will be published in fall 2021 in the Journal of Wildlife Management.

Next Steps

In 2021, we plan to capture 100 elk in the southern Tobacco Root Mountains (HD320; Figure 16) north of Sheridan and Ennis, MT. We sampled 70 elk from this area in 2014 but given the recent detection of brucellosis in elk immediately south in the Ruby Mountains a thorough resampling is necessary to retain confidence in our designation of not detected for this area. The Tobacco Root Mountains are just outside the brucellosis DSA and movement data from 1 Ruby Mountains elk that migrated north and spent nearly a year, from August 2020 to May 2021 on the southern and western side of the Tobacco Root Mountains shows potential for interchange (Figure 7). We also plan to capture 100 elk in the northeastern Tobacco Root Mountains just west of Harrison, MT (HD333; Figure 16). This portion of the Tobacco Root Mountains has never been sampled and is immediately west of the Black's Ford elk population where brucellosis was detected in 2014. The focus of next year's effort will be to 1) continue to document the spatial extent of the disease, and 2) to finish evaluation of the epidemiology portion of the project, including an examination of pregnancy fate and necropsy sampling of seropositive elk.

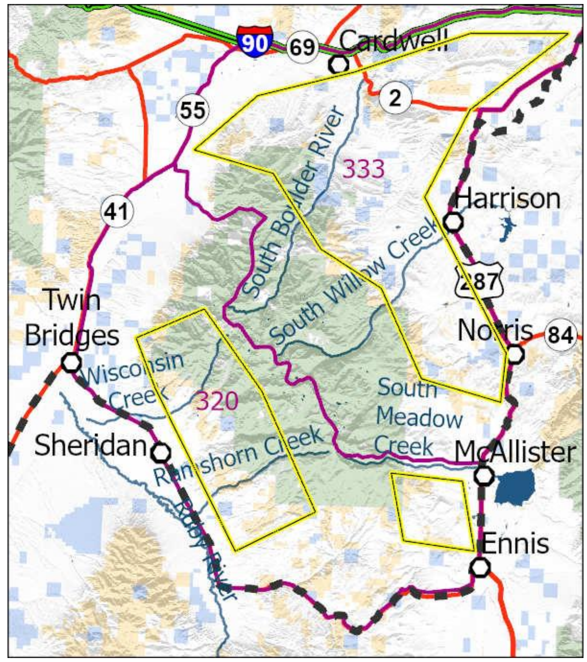

Figure 16. Planned sampling area (yellow & black polygons) for 2022 in the Tobacco Root Mountains near Sheridan, Ennis and Harrison, MT.

Acknowledgements

We would like to thank the landowners and hunters that supported this project. Without landowner cooperation, this project would not be possible. Funding for the project was supplied by USDA-APHIS through an agreement with Montana Department of Livestock and MFWP, a Federal Aid in Wildlife Restoration grant to MFWP, the sale of hunting and fishing licenses in Montana, and the Rocky Mountain Elk Foundation. We would also like to thank the MFWP biologists, pilots, and wardens for their efforts in helping with landowner contacts, capture and field operations, collar retrieval, and continued support of the project. Drs. M. Zaluski, E. Liska and T. Szymanski from Montana Department of Livestock provided important insights and advice throughout the project.

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