Rocky Mountain Elk Foundation Bearmouth BMA #70 Multi-species Management Plan

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This multi-species management plan is meant to set out both recommendations and their context for how the Rocky Mountain Elk Foundation can better promote elk occupancy on their recently purchased Bearmouth property. Megafauna like elk are not alone in a vacuum, their survival and success depends on the habitats that they select to live in. Similar to how elk are dependent on their environment, so is a successful elk management plan dependent on its ability to manage an environment. By addressing key environmental disturbances in a holistic way, this plan will help facilitate elk back into having a more dominant presence in the Bearmouth landscape. Multiple studies have independently concluded that the excessive cattle on the landscape is of primary concern. Definitive actions such as repairing fencing and establishing a grazing plan should be undertaken as early as next spring. Continued restoration efforts such as replanting native plants in riparian areas disturbed by overuse from cattle and protecting young aspen stands over-browsed by cattle are quick follow-up steps to work in tandem with a grazing plan. Further surveys of the landscape should occur after these interventions to see if the removal of excessive cattle helps start the restoration process.

Categories and subject descriptors: Wildlife Biology; GIS; Computer Science

Keywords: multi-species; GIS; management plan; machine learning

1. BACKGROUND

Managing the Bearmouth property for optimal elk habitat primarily involves insuring that they have enough food to eat, water to drink, and safe habitat to hide in. Currently, the property is experiencing an over-use by cattle of almost every resource elk value: aspen groves, native grasses, deciduous/evergreen forest areas. Additional restoration efforts should also occur to ensure that the areas previously damaged by cattle can make a full recovery in order to encourage more elk activity on the property. By managing for food sources that elk prefer, increasing the cover and physical habitat they can feel safe in, and restoring the grassland vegetation communities from their current state fractured of invasive weed growth and overgrazing, we can promote a RMEF managed landscape that is not only more engaging for elk to inhabit it, but also for the recreationists that take their time to visit and utilize it.

1.1. Owner Information

The Bearmouth BMA #70 property was donated to the Rocky Mountain Elk Foundation in 2019 by John Greytak with the promise to keep the land public. RMEF plans to manage the property for the next 3-5 years and then sell it to a state agency such as Montana Fish and Wildlife or the Bureau of Land Management that will keep the land in the public domain.

1.2. Property Description

The Bearmouth BMA #70 property is located on the north side of I-90 off of the Beavertail Hill State Park exit. The property itself is hilly, with three large hills

being divided into two creek valleys (Ryan and Marcella Creeks). Two by two historic logging roads scatter the hillsides and create easier paths to travel for both recreationists and wildlife. The higher elevations of the Bearmouth property are mostly evergreen forests and shrublands, with the lower elevations exhibiting aspen groves, riparian areas along the streams, and grasslands that creep up the hills. It is open to the public for hunting and recreating, and numerous game species of wildlife have been spotted on the property such as mule deer, black bear, grouse, turkeys, and elk. Neighboring landowners have also claimed to have seen multiple grey wolves on the property. One wolf was spotted during our survey and signs of small canids are present as well.

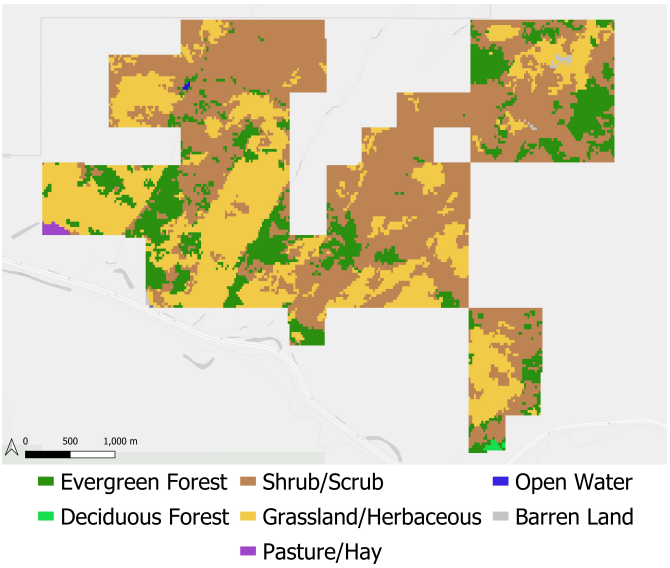

Figure 1. Landcover map of the RMEF property (NLCD 2016).

1.3. Target Species

This multi-species management plan will support the growth and perseverance of elk, *Cervus canadensis*, across the Bearmouth landscape through the modification of current vegetation management and a proposed intervention on cattle presence due to their significant strain on the available elk habitat. The aim of this management plan is to find a realistic compromise between the ideal state of an untouched habitat and the recreation opportunities RMEF would like to provide to the community once they've released ownership into public hands. This plan will encourage sustaining a healthy and diverse environment that elk will want to visit on their journey through the challenging corridors of public and private land.

2. MANAGEMENT OBJECTIVES

Over the course of this fall semester, students from Dr. Vicky Dreitz's class at the University of Montana have been monitoring various aspects of habitat at the Bearmouth property. The seven aspects monitored were: the streams/riparian areas, the bird populations, the primary mammalian game species, the overall biodiversity, the amphibians present, the grass ecosystems, and the health/quantity of the aspen groves. Due to the short data gathering time period, many of the studies recommend continued surveys throughout Rocky Mountain Elk Foundation's ownership of the land, which will be individually laid out in the final recommendations. This plan will additionally discuss the findings from the various monitoring projects to give greater context for the comprehensive management recommendations and as a benchmark for habitat metrics to be compared to at a later date.

2.1. Riparian Summary

Students involved in the monitoring of the riparian habitat with emphasis on the potential of the presence of Westslope cutthroat trout or rainbow trout focused primarily on measuring the pH and Dissolved Oxygen content (DO) of the Ryan and Marcella Creeks.

It has been shown that a DO of 5mg/liter or greater and an average pH of 6.5-8.5 is essential for aquatic wildlife such as westslope cutthroat or rainbow trout populations to be sustained (Wagner et al., 2001). As shown in Figure 2, all areas sampled across both streams exhibited pH and DO measurements within the established acceptable criteria, which is an excellent sign for stream health. They also found that there was a significant correlation between stream pH and DO, which could imply that larger management changes 'upstream', as it were, would impact other aspects of stream health (for better and for worse) and should be taken into consideration. The riparian group noticed that parts of Ryan Creek were extremely slow moving due to a lack of physical structure in portions of the stream where cows had trampled and flattened it. Additionally, they noticed that in these cow-heavy areas there was less vegetation growing by the stream. Less vegetation on stream banks causes mechanical and structural instability resulting in their eventual collapse (Orr et al., 2020). This results in the slowing of stream-flow and negatively impacts most riparian flora and fauna.

A subsection of riparian fauna that does not often get negatively impacted by slow-flowing water is amphibians. Another group of students set out to answer two questions: 1) Are there amphibians on the property (as they had never been historically documented) and 2) If they are present, where are they? The amphibian survey group found a significant number of long-toed salamanders, *Ambystoma macrodactylum*, along the ponds of the property and Ryan Creek. There were significant differences between the mean salamander populations of the two entrance ponds and the Ryan Creek transects (West pond = 0.75 salamanders/survey, East pond = 1.42 salamanders/survey, Ryan creek = 0.07 salamanders/survey). This significance was not found between the two entrance ponds, implying that they may be considered as one single community. The amphibian group reports that out of all of the waterways on the property, the two entrance ponds seem to be the best habitat for the long-toed salamanders. Although they did not get the chance to survey the larger pond above Ryan Creek, all indicators point to the assumption that it may be good habitat for amphibians as well.

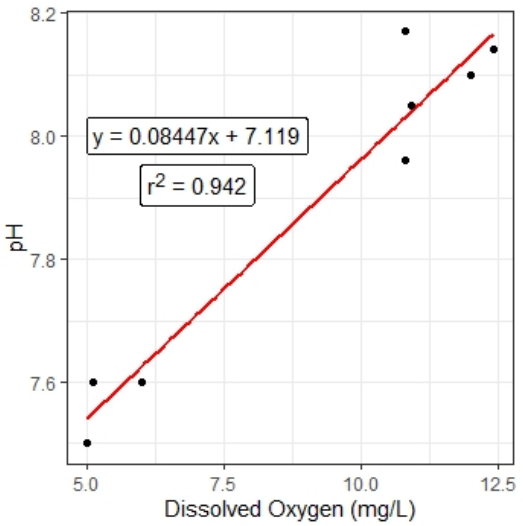

Figure 2. Dissolved Oxygen plotted against pH of streams on the RMEF property

2.2. Aspen Summary

A common denizen in many riparian areas across western Montana is the aspen tree. Aspen is also prime real estate for elk populations and the various wildlife associated with elk. A separate group of students worked on an initial survey to better understand aspen health on the Bearmouth property. There were some disagreements in the literature, but ultimately the group decided that in the presence of elk 'healthy' aspen groves, unimpeded by other abiotic factors, would exhibit 50% or less browse of their leaves.

Table 1 shows that no aspen stand on the property fell below the 50% browsed threshold. Their definition of 'aspen health' was based on a comparison between established normal aspen growth rates and localized signs of 'browsing intensity'. They found that all stands exhibited either medium or high levels of browse. They also found that although the estimated death rate of mature aspen trees was in line with the established metrics, juvenile trees did not seem to be reaching maturity at acceptable growth rates. This implies that with the medium and heavy browsing of stands, the aspen struggle to reach maturity, an essential step for prime elk habitat. The group found no signs of elk browse on any of the stands they surveyed, with a large majority of the signs of browse being from cattle.

Table 1. Percent Aspen Browsed Across Surveyed Stands

Aspen Stand	Percent Browsed
1	56%
2	100%
3	59%
4	98%
5	81%
6	59%
7	87%

2.3. Biodiversity Summary

Three groups of students engaged in an exploratory study of biodiversity and presence of wildlife on the Bearmouth property. Each group measured different aspects of the native fauna: bird biodiversity, mammal biodiversity, and game species habitat selection. The bird diversity group used historical seasonal Ebird data for comparison with point counts they did in the field to estimate species richness. They also compared the elevation and distance from water associated with their sampling locations as studies in the past had found these covariates to be significant, but statistical tests for bird data in the Bearmouth area proved inconclusive, finding no signifcant interactions. Less than half of the historically recorded bird species were observed by the end of their point count survey, but considering the short data collection time frame this should not be any cause for concern. They advise for further surveys to take place over multiple and different seasons to get a more comprehensive picture of

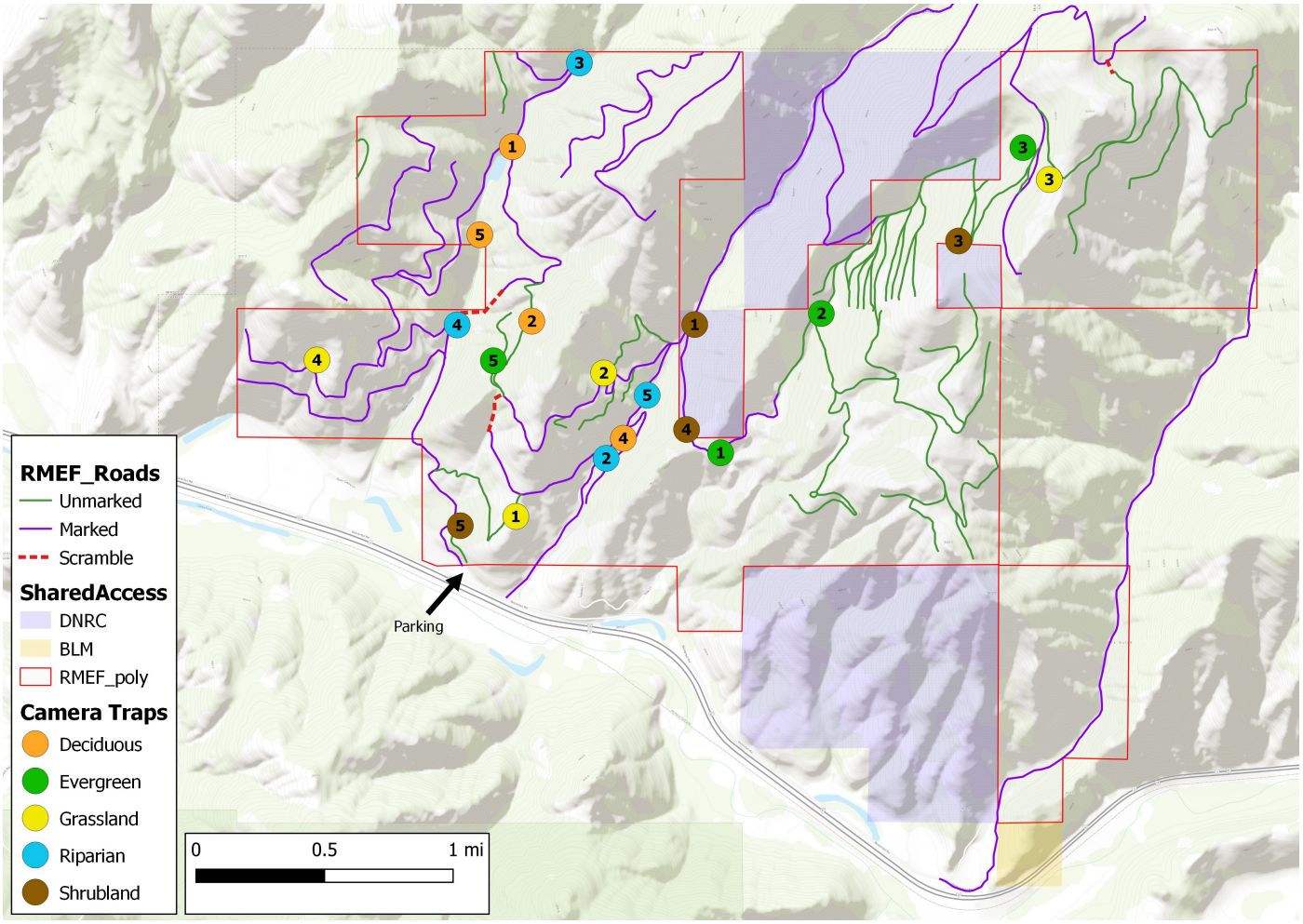

Figure 3. Game camera sampling map of the RMEF property with marked and unmarked trails annotated in addition to unofficial scrambles. This was given out to everyone involved with setting up game cameras before going out into the field

bird diversity as well as to install water sources at higher elevations where water is scarce.

As can also be seen in Table 2, mammals were surveyed in addition to birds. Fewer mammal species were observed on the property than had been historically observed in the area.

Table 2. Historic observations vs species observed during study

	Observations		
Animal Type	Historical	During Study	% Observed
Mammals	12	8	67%
Birds	73	31	42%
Amphibians	0	2	*NA*

The two other groups that surveyed mammals shared a network of camera traps that randomly sampled an equal distribution of habitats across the property. Five habitats were sampled: evergreen forest, deciduous forest, riparian, shrubland, and grassland. These habitats were derived and defined from the 2016 National Landcover Database (NCLD 2016) provided by the USGS (Figure 1). A random stratified sampling design was chosen that placed equal numbers of cameras across each land cover type. In future studies it may be prudent to instead distribute cameras proportionally to the cumulative size of each land cover type, but due to the limited time and necessity for multiple student groups to have equal access to the camera network it was agreed that an equal division of cameras per land cover type would be appropriate. The mammal biodiversity group observed eight of the historically recorded twelve mammalian species on the Bearmouth property such as: mule deer, elk, mountain

lions, American black bears, American red squirrels, and striped skunks. The group found no statistically significant difference of mammalian biodiversity across habitat types.

Both mammal groups indicated that the two week data capture window was likely too short for significant results. However, the game species monitoring group did find significant interactions with how mule deer select their habitat (Figure 4).

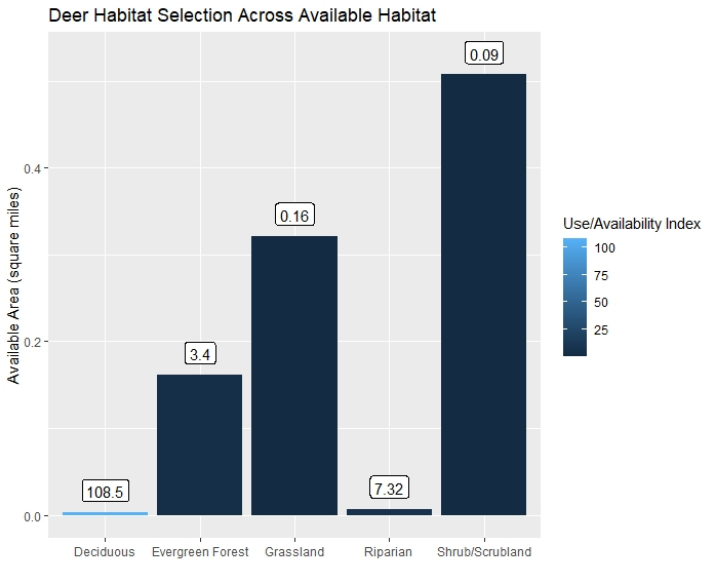

Figure 4. Use/Availability index (shown as a value at the top of each land cover column) is a unit-less measurement, with the difference between index values showing a relationship between how deer select habitat types and how common those habitat types are on a landscape. Higher values show larger preferences for habitat types. (ANOVA $p < 0.01$).

Even though riparian and deciduous habitat types are the least abundant habitat present on this property, they exhibit the highest Use/Availability index values, demonstrating the importance of their restoration and conservation across the Bearmouth property. One observation both mammal groups found in common was a large number of cattle across the landscape. For context most groups made note of how abundant deer where when they spent time out at the property, and around 200 images of deer were captured over the two week survey. During the same time span over 60,000 images of cattle where captured and processed. The biodiversity group found no camera without imagery of cattle and that in most habitats they dominated the landscape with specifically riparian sampling locations seeing significant cattle disturbance.

Without telemetry or extensive data analysis it is difficult to estimate an exact head of cattle, but with the use of a machine-learning algorithm the game species group found that cattle unequivocally dominated the landscape in the context of time spent occupying a space. This can be seen in Table 3 where occupation, defined as the difference between when an imageset of a specific detection starts and when it ends, is compared across cattle and deer (the two most common detections).

Table 3. Average Occupation in Habitat (minutes)

Land Cover Type	Cows	Deers
Deciduous	80	18
Evergreen	16	3
Grassland	25	1
Riparian	142	40
Shrubland	5	21

The final mammal group, who focused on habitat selection, compared a trained form of the popular image classifier Resnet V2 (Schneider et al., 2020) and an official github repository from Microsoft to automate processing over 100,000 images. The group trained a Resnet V2 model on images from Lila.Science and created infrastructure that was inspired by Microsoft's AI for Conservation camera trap application, which utilized two-pronged approach: step 1) identify if any wildlife is in-frame, step 2) classify the wildlife. This trained model was meant as a learning exercise with Microsoft's AI for Earth camera trap classification package doing the actual heavy lifting for processing imagery so other groups could quickly get access to it. In the end the Microsoft classification package outperformed our attempt with over 30% more accurate results, with our trained version of Resnet V2 struggling to accurately identify if wildlife was in or out-of-frame compared to Microsoft's classification package. Once the images were classified an R script was used to define unique instances of habitat use across species, the general workflow is present in Figure 5. After manual validation Microsoft's camera trap classification software achieved 98% accuracy of identifying wildlife (or cows) in frame and performed consistently around 92%-99% accuracy in regards to individual species classifications, with specific exception to striped skunks, which both algorithms struggled to identify (Resnet V2 = 40% accuracy, Microsoft = 82% accuracy).

Cougars, wolves, and elk were spotted in camera trap imagery, but in such small numbers that it wasn't reasonable to draw any conclusions about habitat preference. Ultimately, both mammal groups came to a

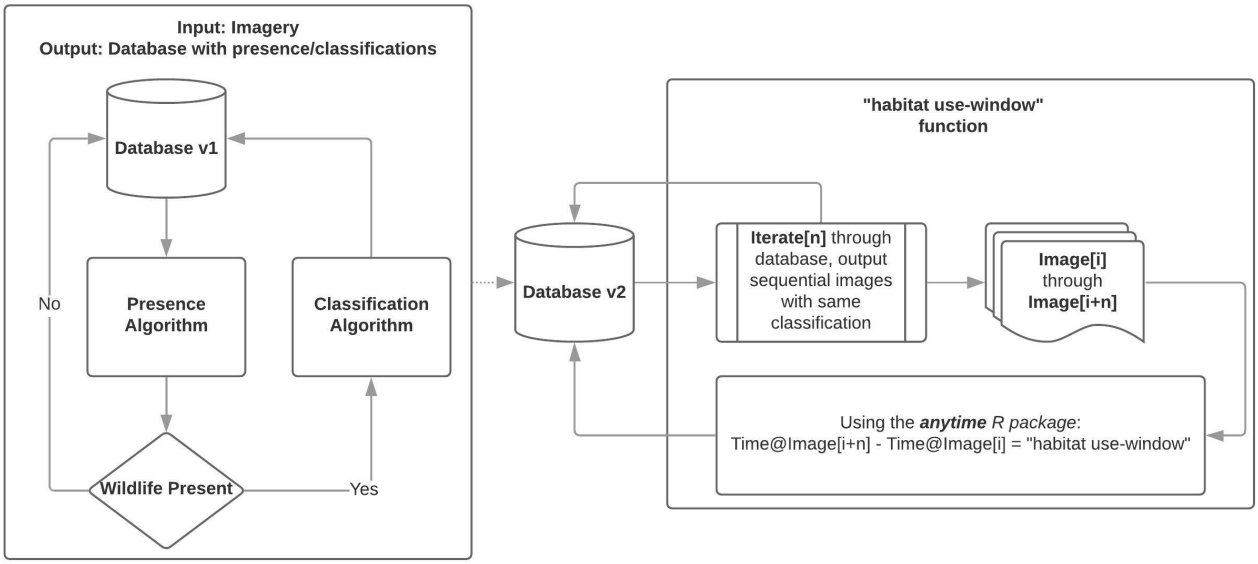

Figure 5. Workflow for general imagery processing. After image classification an R script that isolated multiple camera trap images into unique instances was created to get a better understanding of how long and how often different species were using different land cover types

consensus that the cattle presence on the landscape was directly out-competing the target game species we had come to survey.

2.4. Invasive Summary

As evident of the consistent and dominant presence of cattle is an accompanying infestation of spotted knapweed (Centaurea maculosa). Knapweed is an invasive plant to Montana and is common in areas with disturbance such as overgrazing. Population blooms of knapweed in properties like Bearmouth have been known to reduce biodiversity, reduce available food resources for grazers such as elk, and increase the possibility of damaging erosion (Sheley et al., 1998). The final study group sought to discover how pervasive knapweed was on the property through a series of transects. They accounted for several common covariants: aspect, hillslope, and elevation, but found that none had any significant influence on where knapweed did or did not grow on the property.

3. FINAL RECOMMENDATIONS

Almost all aspects of further habitat and species management can be put on hold until the management of cattle on the landscape is modified. Aside from the bird diversity group, all other studies independently came to similar conclusions that there is a statistically measurable effect cattle are having on the landscape in their current form. With this in mind, the most pressing action Rocky Mountain Elk Foundation should take before any other form of monitoring or management is investing resources to repair broken fences and ensure that cattle straying from the nearby landowners do not continue to make the Bearmouth property their residence. This should be done in accordance with a grazing plan similar to one recommended by the invasive weed study group, which will not only severely reduce the impact cattle are currently having on the property, but also help fight the knapweed infestation without using costly chemicals that could damage parts of the habitats elk need, resulting in saved time and money. A result of this grazing plan is the installation of water tanks, which will help encourage further avian diversity with more plentiful water sources as was recommended by the bird diversity group. Due to the large costs associated with the fencing of large area, multiple groups found grants that are applicable to Rocky Mountain Elk Foundation for this purpose: the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and the Landscape Scale Restoration Grant (LSR) from the Montana Department of Natural Resources. Once cattle have been sufficiently managed, secondary management steps can then be approached, such as restoring previously disturbed riparian areas by planting native plants, not only promoting more elk habitat but also ensuring quality

downstream habitat for the amphibians found on the property. To further promote the growth of elk habitat, RMEF should fence off at-risk aspen stands until 75% of the juvenile tree cohort exceeds two meters in height (Halofsky Ripple, 2008). It would be prudent to conduct another round of surveys following a season of successful cattle management to better understand what habitat management practices are needed in a post cow-dominant Bearmouth area. A survey for all aspen stands on the property should be executed as only the front quarter was surveyed in this baseline study. Large-scale camera trap surveys for not only biodiversity but also occupancy and population size estimates should also continue as a means to see if other protected wildlife are on the landscape. If any are proven to be present, the Rocky Mountain Elk Foundation could apply for grants that include the protection of those species in order to obtain more funding that will enable the RMEF team to more effectively manage the Bearmouth property.

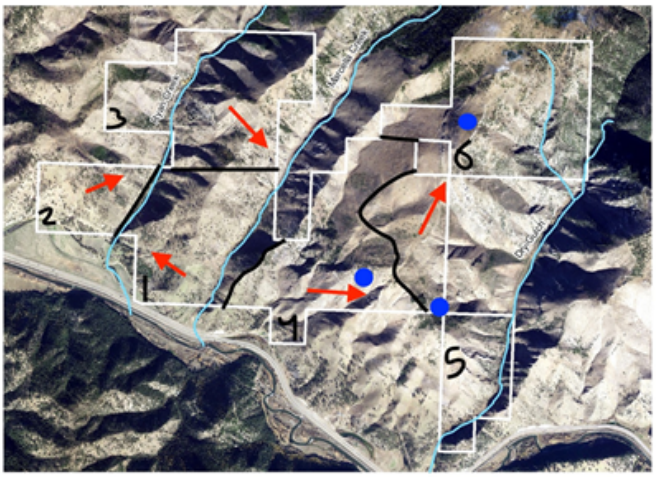

Figure 6. Grazing plan provided by the invasive plant monitoring group. Grazing sections are labeled 1-6 with arrows showing a proposed rotation of cattle across the Bearmouth property. Blue dots are locations of proposed water tanks. (group 6)

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