Kootenay Mule Deer Monitoring Project: 2018-19 Final Report

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Executive Summary

Mule deer (*Odocoileus hemionus*) are a highly valued species in British Columbia, and have declined across the Kootenay Region over the past three decades. The Ministry of Forests, Lands and Natural Resource Operations and Rural Development (FLNRORD) initiated a five-year project to monitor mule deer doe survival, fawn recruitment and cause of doe mortality in four populations that represent distinct habitat types occupied by mule deer across the region. This project aligns with two priority actions identified in the Upland and Dryland Action Plan, specifically action 3b to "support work towards conservation and improvement of important connectivity habitat (i.e. corridors, including high elevation) for wide-ranging animals (e.g. carnivores and ungulates)" and action 16, "monitor and assess ER work in restoring open range and open forest, including ungulate winter range".

To date, 136 GPS collars have been deployed on adult female mule deer since 2014/15 in three study areas: Grasmere [(Management Unit [MU] 4-02), Newgate (MU 4-03), Dutch-Findlay (MU 4-26) and West Kootenay (MUs 4-08, 4-09 and 4-15). There have been 84,035 monitoring days and 61 mortalities to date. Cause of mortality included 30 cougar kills, 10 wolf kills, 4 vehicle collisions, 2 unknown predator kills, 2 unlicensed hunting, 2 health-related mortalities, 1 natural mortality (avalanche), 1 bear predation, 1 coyote predation and 8 unknown mortalities. Preliminary survival rates for Year 5 (May 2018 – April 2019) were 0.77 for MU 4-26, 0.78 for MU 4-02 and 1.0 for MU 4-03. Fawn recruimtent surveys were completed in late March 2019 to estimate overwinter fawn survival in MUs 4-02, 4-03. We observed 345 mule deer with a fawn:adult ratio of 35:100. Overall project results suggest survival of adults may be limiting population growth in MU 4-26, while variations in fawn recruitment may be having a larger effect on population trend in MU 4-02 and 4-03, given the relatively stable adult survival rates.

In Year 5, a contractor was hired to investigate Ecosystem Restoration potential at sites selected by mule deer and five sites were identified as high priorities for treatments to improve forage and reduce conifer ingrowth. Analysis of migration data also identified several east-west and north-south migration corridors in the MU 4-02 study area. There were 9 mule deer collared within 2 km of ER sites treated in 2016 to assess habitat use following treatments and collar data have shown substantial use of these areas in the late fall and early spring; however the limited pre-treatment data make it difficult to assess change in use of these sites.

We recommend continued habitat enhancement projects across seasonal ranges in the Upper Kootenay and maintaining a subset of collared mule deer to assess effects of changes in survival and predation rates following reductions in white-tailed deer and cougar populations.

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1.0 Introduction

Mule deer *(Odocoileus hemionus*) are a highly valued big game species in the Kootenay Region of British Columbia but have declined in abundance over the past 3 decades. The Ministry of Forests, Lands and Natural Resource Operations and Rural Development (FLNRORD) initiated a 5-year project to monitor mule deer doe survival, fawn recruitment and cause of doe mortality in 4 populations that represent distinct habitat types occupied by mule deer across the region. The long-term objective of this project is to identify potential factors limiting population growth and provide recommendations to increase abundance. GPS collar data also provide opportunities to identify important seasonal habitats and migration routes for Ecosystem Restoration (ER) activities and assess use of previously restored sites, consistent with objectives listed in the Upper Kootenay Ecosystem Enhancement Plan specifically action 3b, "support work towards conservation and improvement of important connectivity habitat (i.e. corridors, including high elevation) for wide-ranging animals (e.g. carnivores and ungulates)" and action 16, "monitor and assess ER work in restoring open range and open forest, including ungulate winter range. Determine habitat response and influence on ungulate populations" (FWCP 2014).

The Columbia Basin Trust (CBT) and Fish and Wildlife Compensation Program (FWCP) funded collar purchase, deployment and monitoring for the Upper Kootenay area, where mule deer have been impacted from past hydroelectric development. This report provides an update on work completed up to March 2019 and outlines next steps for the project.

2.0 Goals and Objectives

The objectives for Year 5 (2018-19) were:

1) Maintain 80+ collars across four study areas
2) Assess important mule deer habitats, migration routes and barriers
3) Assess use of Ecosystem Restoration sites by collared mule deer
4) Identify potential factors limiting growth of mule deer populations in the Upper Kootenay

3.0 Study Area

The study area lies in southeastern British Columbia, including portions of the southern East Kootenay and West Kootenay. Collars were deployed in MUs 4-02, 4-03 and 4-26 in the East Kootenay, and MUs 4-08, 4-09 and 4-15 in the West Kootenay (Figure 1). Major mountain ranges include the Rocky Mountains in MU 4-02, the Purcell Mountains in MU 4-26 and the Valhalla Mountains in MU 4-15. The East Kootenay study areas fall within the "dry climatic region" and includes the Kootenay Dry Mild Interior Douglas Fir variant (*IDF dm2*) and the Dry Cool Montane Spruce (*MS dk*) biogeoclimatic subzones. The *IDF dm2* subzone occurs along the slopes of the Rocky Mountains, typically between 800 and 1,200 m in elevation. Douglas fir is the climax tree species; however due to past fire activity, mixed seral stands of

Douglas fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), western larch (*Larix occidentalis*) and trembling aspen (*Populus tremuloides*) are also common.

The *MS dk* subzone occurs above the *IDF dm2* zone, typically between 1,200 and 1,650 m in elevation. Dominant tree species include hybrid white spruce (*Picea engelmannii x glauca*), balsam fir (*Abies lasiocarpa*) and lodgepole pine. The Engelmann Spruce Subalpine Fir (*ESSF dk*) subzone occurs above the *MS dk* subzone (typically 1,650-2,100 m on south aspects). Tree species adapted to short growing seasons (e.g., Engelmann spruce [*P. engelmannii*] and balsam fir) occur in this subzone. Substantial low elevation winter range habitat was flooded in MUs 4-02 and 4-03 with the construction of the Libby Dam in 1975.

Most of West Kootenay study area falls within the “moist climatic region”; however the part of the Lower Arrow Lake area is within the “dry climatic region”, where the Interior Douglas Fir undifferentiated zone (*IDFun*) occurs at low elevations. Other low elevation mule deer winter ranges in the West Kootenay include the Interior Cedar Hemlock (*ICH*) very warm (*xw*) and dry warm (*dw*) subzones (Braumandl and Curran 2002). The *ICH xw* occurs at low elevations (450-1,100 m) on warm aspects in this area and is characterized by mixed seral stands of Douglas fir and ponderosa pine (*P. ponderosa*), and climax stands of western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). The *ICH dw* subzone also occurs at low elevations (450-1,100 m) in the area but on cooler sites than the *ICH xw* and stands typically include a greater diversity of tree species in mixed seral stands (Douglas fir, paper birch [*Betula papyrifera*], western larch and western white pine [*P. monticola*]). Shrub-dominated hillsides created from past fire events (especially ungulate enhancement burns) are common on south-facing hillsides throughout this study area. Construction of the Keenlyside , Waneta and Seven Mile Dams caused substantial flooding of low elevation winter ranges in MUs 4-15 and 4-08.

Other ungulates occurring in the study areas include Rocky Mountain elk (*Cervus canadensis*), white-tailed deer (*O. virginianus*), moose (*Alces americanus*), bighorn sheep (*Ovis canadensis*) and mountain goats (*Oreamnos americanus*). Predators of mule deer in these areas include cougars (*Felis concolor*), wolves (*Canis lupus*), coyotes (*C. latrans*), grizzly bears (*Ursus arctos*) and black bears (*U. americanus*).

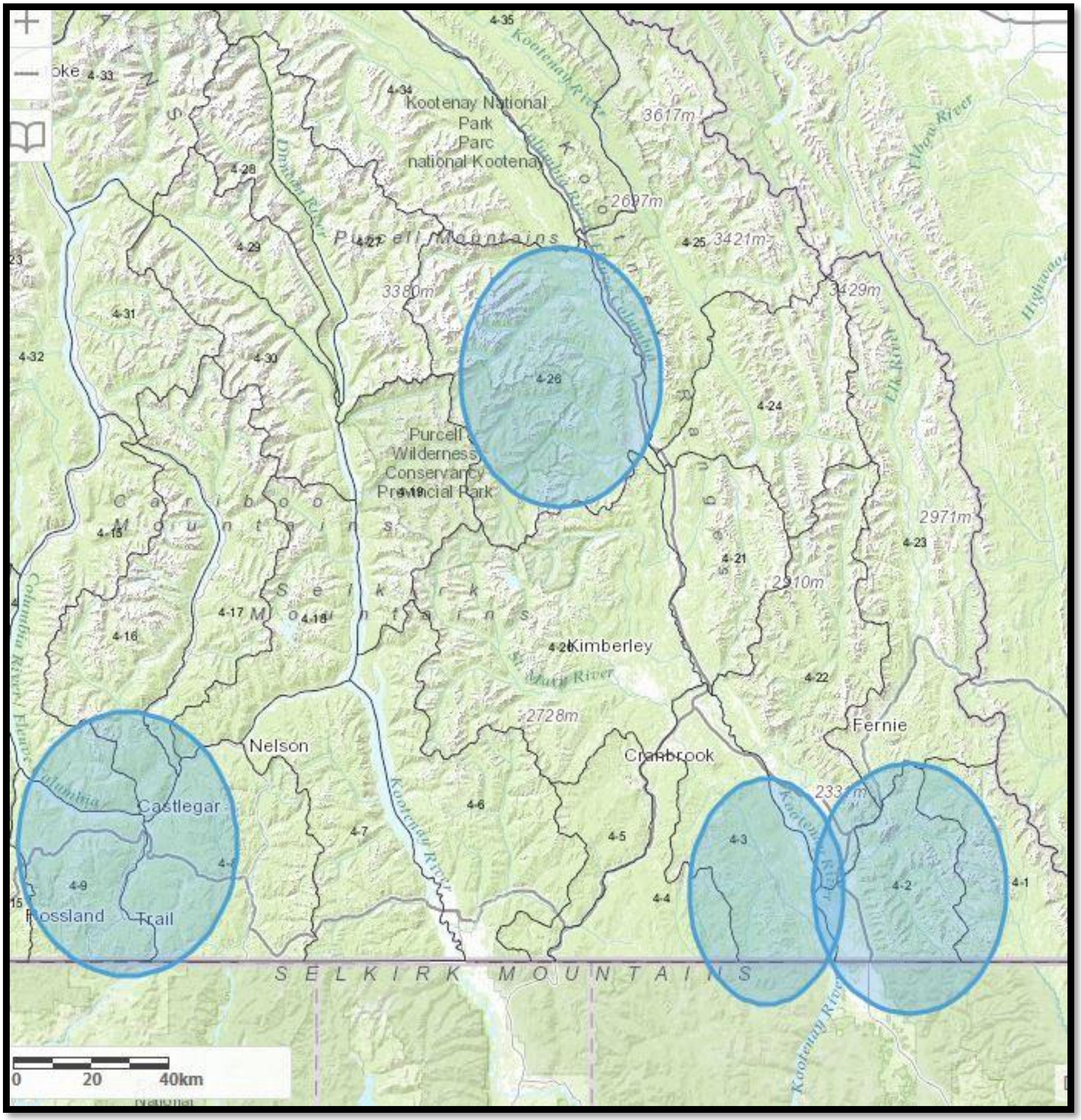

Figure 1: Mule deer monitoring areas (blue circles), where GPS collars have been deployed, December 2014-March 2016.

4.0 Methods

Collaring

We selected four study areas that represent distinctive habitat types occupied by mule deer in the Kootenay Region. We targeted a sample of ≥20 collared deer per study area so that annual survival rates could be estimated with reasonable precision. Mule deer were captured using helicopter net-gunning, which was the most efficient capture technique in Years 1 and 2. We attempted to distribute collars widely across winter ranges within each study area and collar multiple deer in proposed ER sites to monitor response of these animals to prescribed burning. GPS collar data are being collated in a local database and will be uploaded to the provincial database once the project is complete.

Captured mule deer were restrained, ear-tagged and fitted with Vectronic Vertex Survey collars (http://vectronic-aerospace.com/wildlife.php?p=VertexSurvey), which transmit 1-6 GPS fixes per day and have an expected battery life of ≥4 years. A sub-sample of mule deer were collared with high fix rate Vertex Iridium collars, which have been programmed to transmit multiple GPS fixes per day during the spring and fall so that we can identify specific migration routes. Both collar models transmit mortality alerts, which are sent via email and text message after collars are stationary for an eight hour period. We assessed body condition of all captured deer and collected blood, hair and fecal samples, which will be used to measure pregnancy rates and exposure to disease and parasites.

Mortality Investigations

Mortality investigations were conducted immediately after receiving a mortality notification to establish cause of death. Cause of death was assigned as either wolf, cougar, bear, disease, accident (e.g., road kill, rail kill, drowning, avalanche), unlicensed harvest (there is no hunting season for mule deer does in this Region), or unknown. We used a dichotomous key (FLNRO, unpublished doc.) to help differentiate among mortality causes when there was limited evidence. Detailed necropsies were conducted to determine whether disease or parasites factored in as the cause of death. We also collected a tooth from each carcass for aging. We determined if deer were nutritionally stressed prior to death by measuring back fact (from intact carcasses) and marrow fat content from a femur (from scavenged carcasses). Mortality information was entered into a database after each mortality investigation.

Fawn Carryover Surveys

We conducted helicopter surveys in late March 2015-2019 to measure fawn recruitment rates in MUs 4-02, 4-03 and 4-26. These surveys involved flying transects along winter ranges and classifying all mule deer encountered. Surveys were conducted in a Bell 206 Jet Ranger helicopter equipped with rear bubble windows. Surveys followed standards for mule deer composition surveys (RISC 2013). Fawn ratios were expressed as fawns:100 adults, as antlerless bucks could not be distinguished from does. We used buck ratio information from fall surveys (FLNRO, unpublished data) to correct for the expected number of bucks and does in the sample so that fawn ratios could be expressed as fawns:100 does in our population growth model.

Survival and Population Growth

Fate of mule deer was recorded in a database and annual survival was calculated for each sub-population for each biological year (i.e., May 1- April 30). Survival was estimated using the Kaplan-Meier estimator with the staggered entry modification (Pollock et al. 1989). This method allows additional animals to be added to the sample over the course of the study. Mule deer were entered into the analysis the day after collaring and removed when they died. Collar failures and capture mortalities were censored from the database. We inputted annual survival rate and fawn carryover rates into a finite population growth model (Hatter and Bergerud 1991) to predict population growth in each study area.

5.0 Results and Outcomes

Collaring

In 2018/19 we deployed 10 collars to replace mortalities in the Dutch/Findlay Creek (MU 4-26), Wigwam/Grasmere (MU 4-02) and Newgate/Gold Creek (MU 4-03) areas. All deer collared in Year 5 were captured using helicopter net-gunning. Vectronic collars continue to transmit well, with >90% fix success. The new collars deployed in March 2018 transmit 6 fixes per day and have an estimated battery life of ≥5 years.

Mortalities

There have been 84,035 monitoring days and 61 mortalities to date. Cause of mortality included 30 cougar kills, 10 wolf kills, 4 vehicle collisions, 2 unknown predator kills, 2 unlicensed hunting, 2 health-related mortalities, 1 natural mortality (avalanche), 1 bear predation, 1 coyote predation and 8 unknown mortalities. Preliminary survival rates for Year 5 (May 2018 – April 2019) were 0.77 for MU 4-26, 0.78 for MU 4-02 and 1.0 for MU 4-03. Survival rates were similar in MU 4-02 as 2017/18 (0.79), but higher in MU 4-26 and MU 4-03 than 2017/18 (0.61 and 0.80, respectively). Combined survival rates were 0.83 for all study areas combined, which is slightly higher than 2017/18 survival rates (Figure 2). Survival rates will likely decline slightly with the pulse of mortality expected in late April.

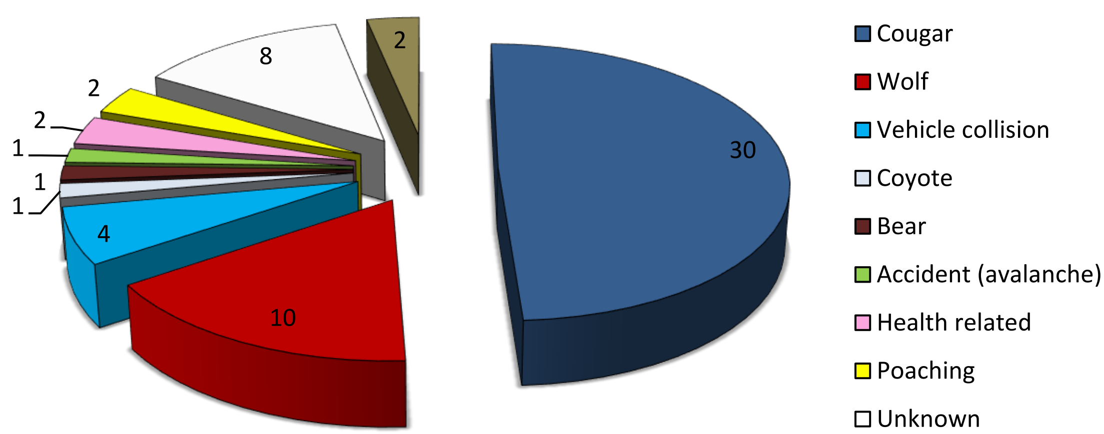

Figure 2: Cause of mortality of female mule deer collared in MU 4-02, 4-03 and 4-26, December 2014 - March 2018.

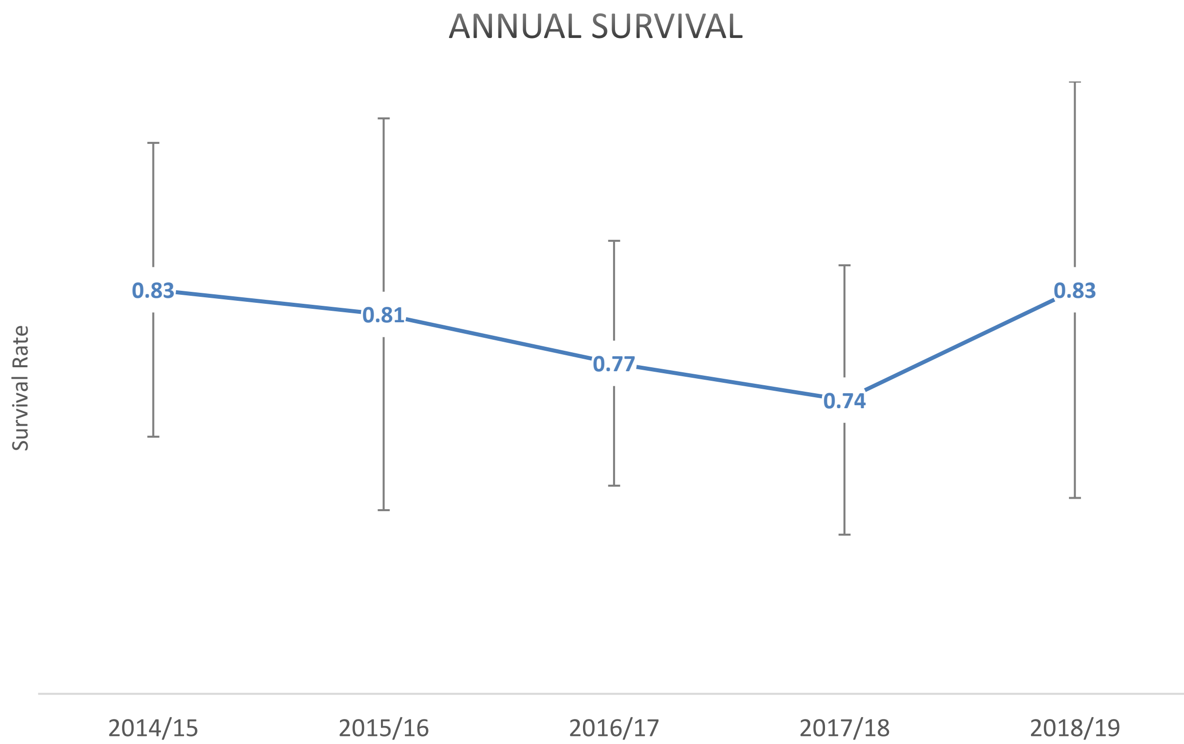

Figure 3. Combined annual survival rates for mule deer collared in Newgate, Grasmere/Wigwam and Invermere study areas, December 2014 – April 2019. Error bars are 95% confidence intervals.

Fawn Carryover Surveys

Fawn recruimtent surveys were completed in late March 2019 to estimate recuritment in MUs 4-02 and 4-03. We observed a total of 345 mule deer (89 fawns, 255 adults, and 1 unclassified). The fawn:adult ratio was 35:100, which was similar to 2017/18 but lower than 2014/15 and 2015/16 ratios (Figure 4). No surveys were conducted in MU 4-26 in 2018/19 due to limited budget and difficulties achieving a sample of >100 deer in 2017/18.

Figure 4: Mule deer fawn ratios recorded from early spring aerial surveys in Newgate, Grasmere/Wigwam and Invermere study areas March 2015-2019.

Migrations

Similar to previous years, nearly all collared deer migrated to higher elevations in spring 2018. Deer in MU 4-02 continued to have the longest migrations, with multiple deer migrating into the Wigwam, Flathead and Castle River drainages (Figure 5). Deer in MU 4-03 migrated to the upper Tepee, Bloom and Caven drainages, while most of the deer in MU 4-26 moved into summer range in Upper Dutch and Findlay Creeks (Figures 6 and 7). Most fall migrations to winter ranges occurred in October, however the earliest fall migration began on August 25th. Most migrations happened over a short time period (i.e., one week or less).

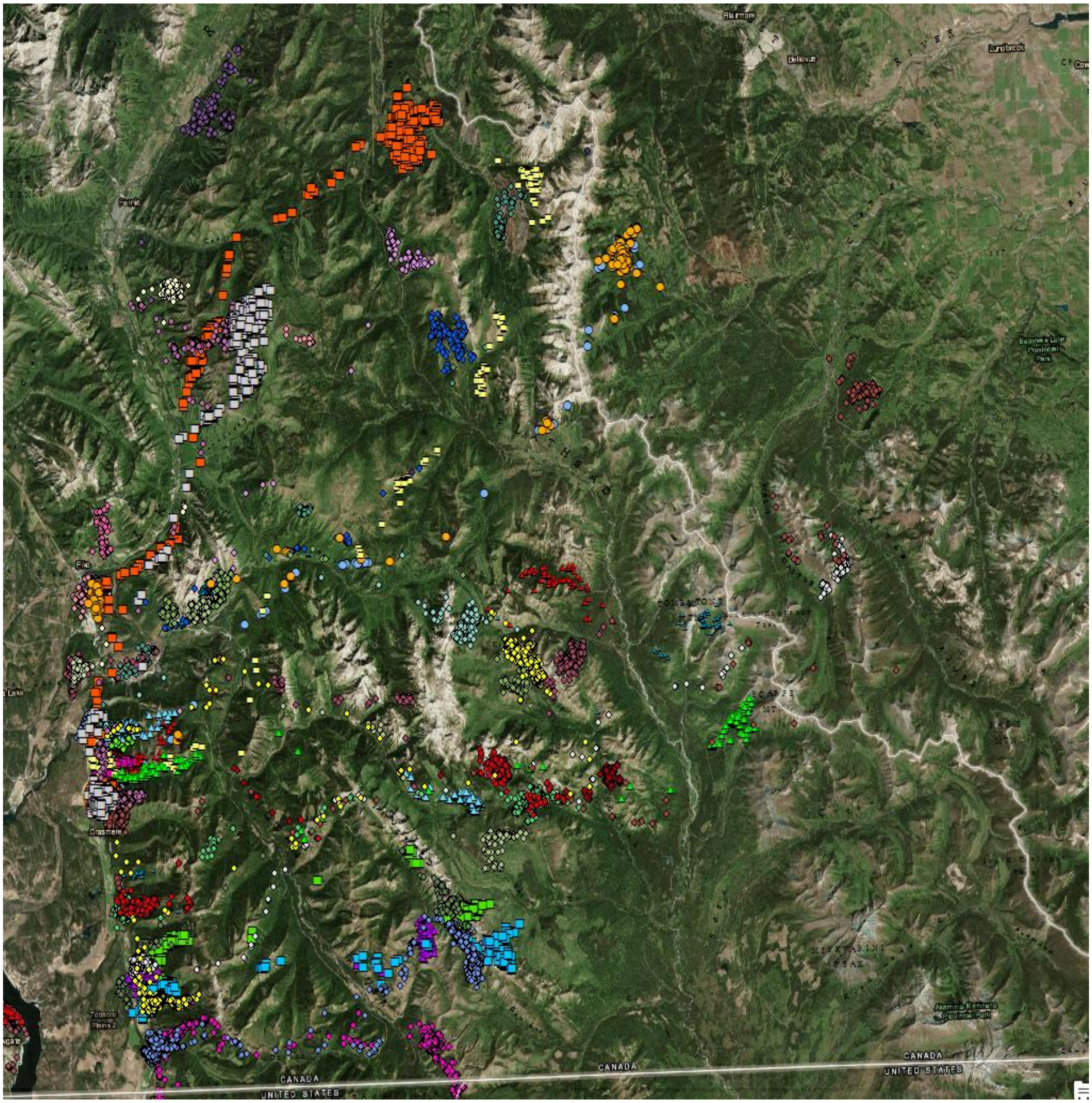

Figure 5. Movements of collared migratory mule deer in MU 4-02, December 2014 – December 2018 (each colour/symbol combination represents an individual deer).

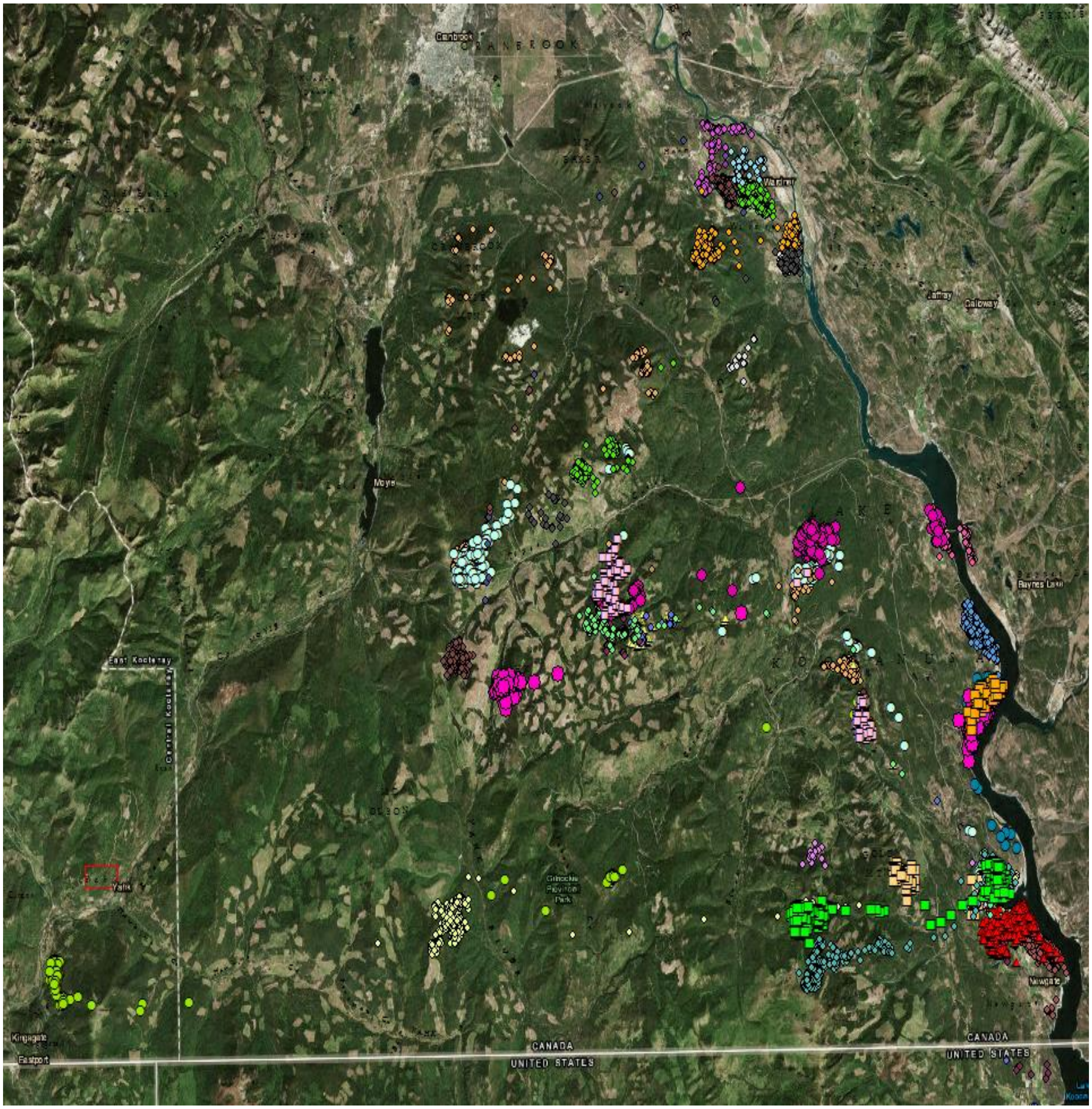

Figure 6. Movement of collared mule deer in MU 4-03, December 2014 – December 2018 (each colour/symbol combination represents an individual deer).

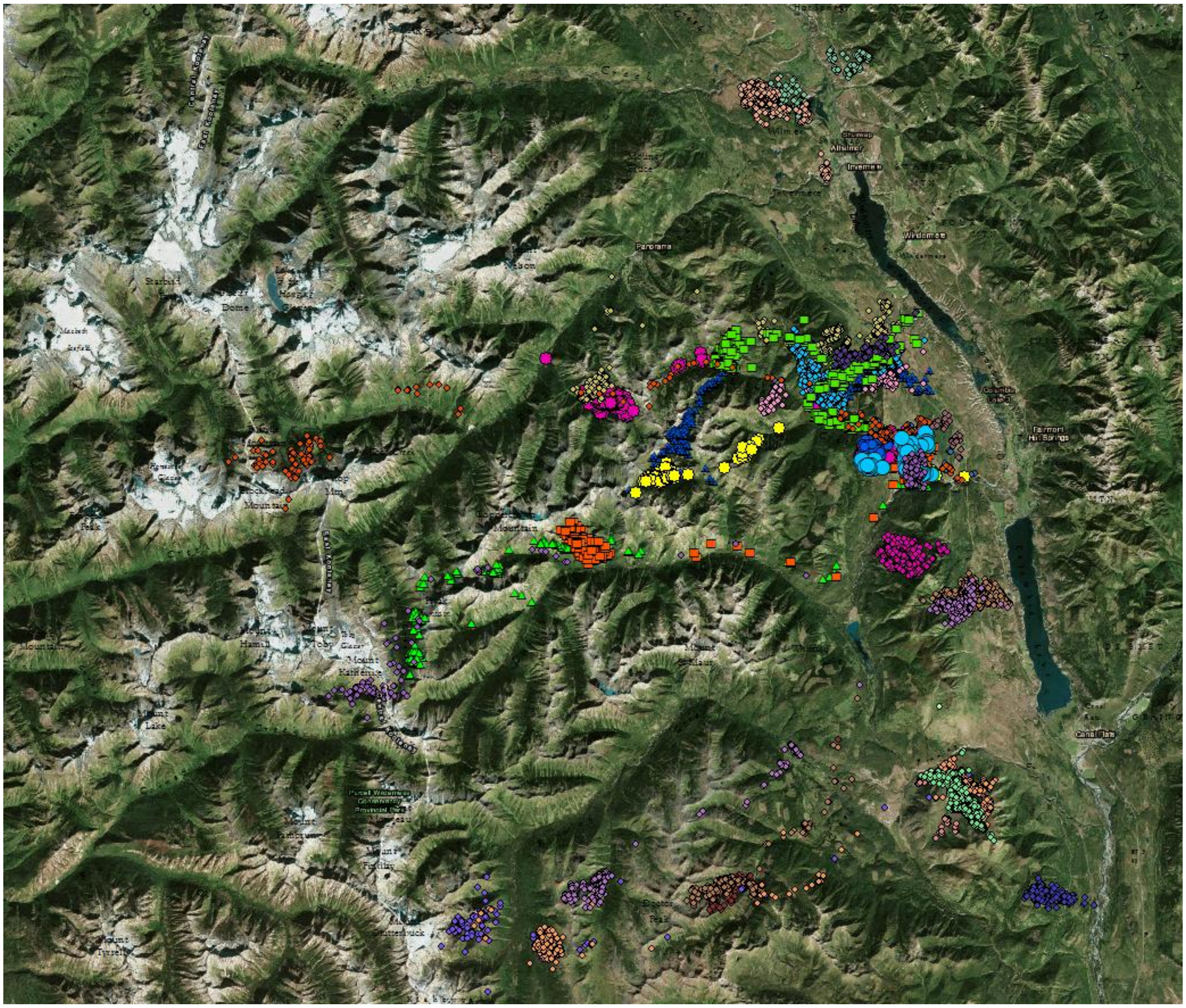

Figure 7. Movement of collared mule deer in MU 4-26, December 2015 – December 2018 (each colour/symbol combination represents an individual deer).

There were 15 high fix rate collars deployed in the Wigwam/Grasmere study area to better understand migration routes. Data from these collars were run through the Migration Mapper program (https://migrationinitiative.org/content/migration-mapper), which identified several spring and fall migration corridors and stopover sites in the Maguire/Raymond Creek, Elk Valley and Phillips Creek areas (Figure 8 & 9). We assessed migration routes in Figures 8 & 9 for potential barriers that have been known to restrict movement or contribute to mortality in other populations (i.e., exclusion fencing, railways, highways, areas of high industrial activity). These disturbances are primarily at valley bottoms in the study areas and the majority of east-west migrants do not appear to be constrained by these impacts as summer and winter ranges are above valley bottom. We will also be delineating migration routes at a broader scale with lower fix rate collars to supplement this analysis.

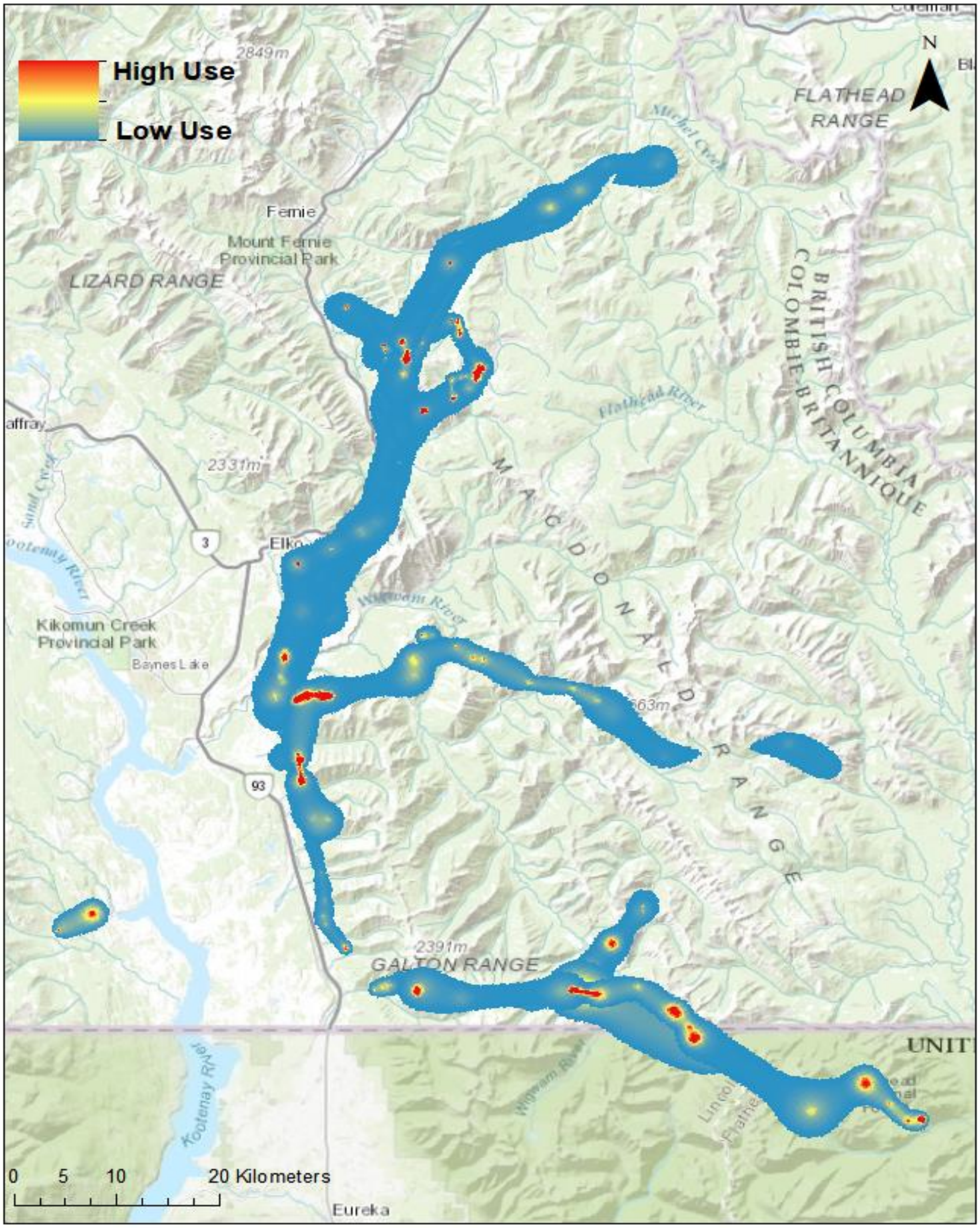

Figure 8: Spring migration routes from collared mule deer in the Grasmere (MU 4-02) and Newgate (MU 4-03) study areas from 15 GPS collars, 2016-2018.

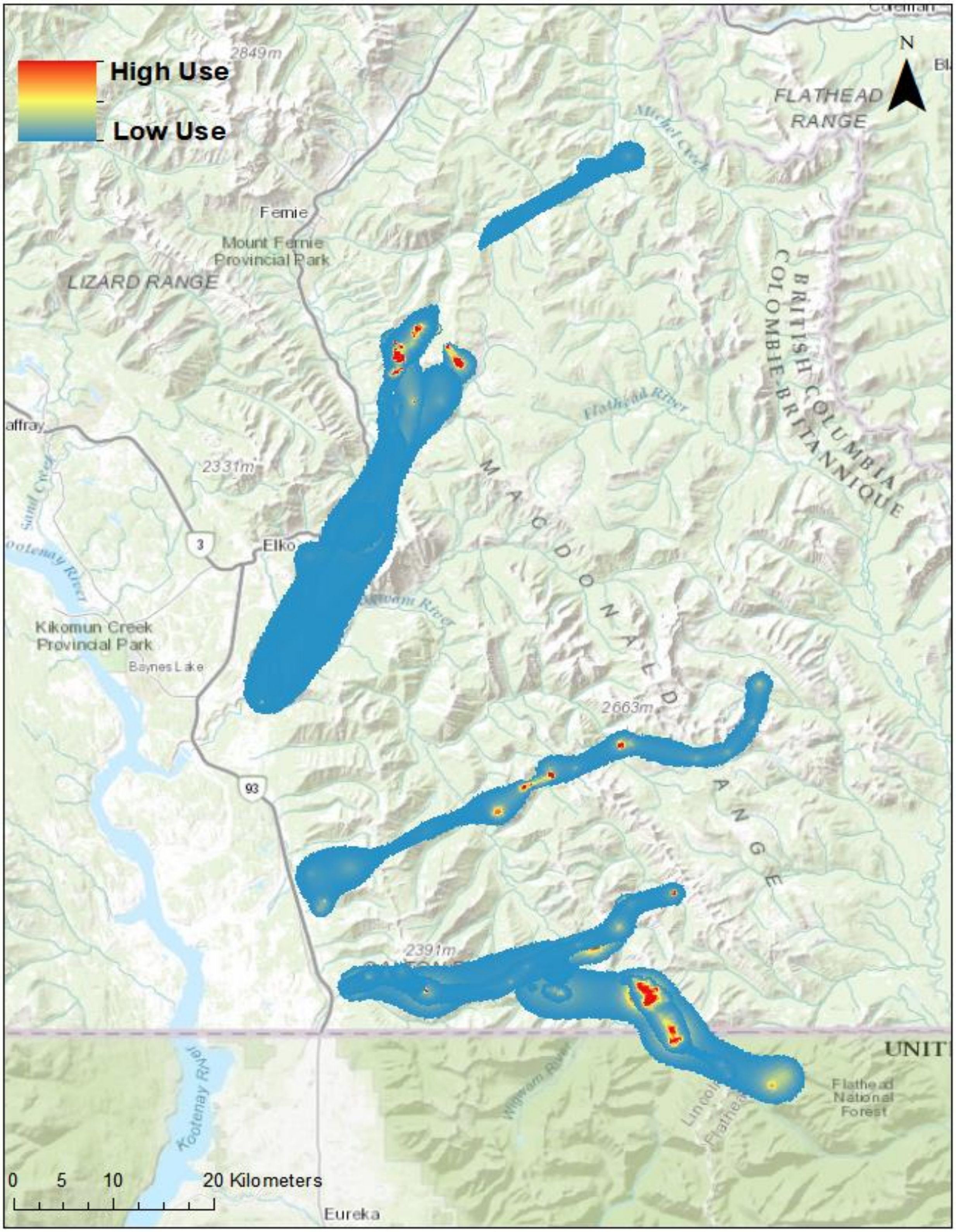

Figure 9: Fall migration routes from collared mule deer in the Grasmere (MU 4-02) and Newgate (MU 4-03) study areas from 15 GPS collars, 2016-2018.

Ecosystem Restoration Assessment

We contracted a biologist and restoration expert to investigate key winter and transitional ranges in MUs 4-03 and 4-26 for habitat restoration potential. The contractor reviewed GPS collar data and mapped areas selected by collared deer as well as historic winter ranges that are not currently being used by collared deer. The contractor collected data describing access to the site, stand structure, presence of invasive plants and potential for prescribed burning, slashing and/or forest harvest. There were 11 winter and transitional range sites investigated in summer & fall 2018 and five sites (Allen Creek, Brewer Creek, Brewer Ridge, Davis Ridge and Thorald Creek) were identified as high priorities for treatments to improve forage and reduce conifer ingrowth.

Figure 10: Mule deer winter range on Plumbob Mountain (MU 4-03), used by multiple collared mule deer and visited for potential restoration opportunities in summer 2019 (Photo credit: G. Tipper).

Use of Ecosystem Restoration Sites

To assess use of past and future ER sites, we deployed 9 deer collared close to Raymond and Donald winter range ER sites, which were treated with prescribed fire in Fall 2016. Five deer were collared in Raymond and Donald ER sites prior to treatment, of which two died prior to treatment. Two deer didn't use the treatment area, while one deer used the Raymond face area intensively pre and post-treatment, showing no obvious shift in habitat use following treatment. Three of the four deer collared post-treatment used the treatment area in the early winter and early spring, while one animal did not use the treatments. It is difficult to identify changes in use post-fire due to the limited pre-treatment data and high fidelity to relatively small winter ranges. This is demonstrated by several deer that migrated directly through the ER treatments to previously used winter ranges. Observations from composition surveys suggest these treatments are seeing substantial use in the late fall and early spring but we are not able to show any change in habitat use with our collar data.

6.0 Discussion

Year 5 activities focused on maintaining and monitoring 20 collars per study area, completing mortality investigations, fawn recruitment surveys, ER assessments and beginning analysis of factors limiting population growth in the Upper Kootenay. This project is the first to investigate mule deer survival, cause of mortality and migration in the East Kootenay. Survival rates from 2018 (range = 0.77-1.0) were similar to previous years (range = 0.61-0.90) when accounting for variance in estimates. Survival of adult females has been consistently lower in MU 4-26 and we did not observe a density dependant increase in fawn recruitment in the spring surveys, suggesting predation is likely limiting growth of this population. Survival rates have been consistent in MUs 4-02 and 4-03 (0.69 – 1.0) and within the range reported in other studies from northwestern USA and southeastern BC (Forrester and Wittmer 2013).

We observed major variations in fawn recruitment rates (29-67 fawns:100 adults), with lowest fawn ratios recorded following the severe winters of 2016/17 and highest fawn ratios following mild winters of 2014/15 and 2015/16. Research from Idaho has also demonstrated extreme variation in fawn survival over time, which has been shown to have major effects on future population growth rates (Hurley et al. 2017). Our results generally align with this research and we expect the past fluctuations in mule deer abundance in the Upper Kootenay are partially due to large variations in fawn survival. Fawns also experience a pulse of mortality in the early spring, therefore true recruitment rates might be slightly lower than indicated by our survey data. Variables influencing fawn survival are complex but research has demonstrated the importance of climate variables on fawn survival, particularly summer precipitation and winter severity (Hurley et al. 2017).

Cougar predation has been the primary mortality cause in each year of the project and outnumbered wolf predation events by a ratio of 3:1. Cougar populations have gone through major fluctuations in the Kootenay Region, including a major decline in the late 1990s, followed by recovery of populations throughout the early 2000s (FLNRORD, unpublished data). Research has suggested that mule deer are more susceptible to cougar predation than white-tailed deer and in areas where both species overlap, mule deer suffer higher cougar predation rates than white-tailed deer that can limit population growth (Robinson et al. 2002). Opportunities to reduce cougar predation rates on mule deer involve reducing cougars directly (i.e., Hurley et al. 2011) or managing primary prey to lower levels of abundance (Serrouya et al. 2015). Management regimes in the Kootenay Region have shifted towards maintaining lower abundance of white-tailed deer and cougar populations to support recovery of mule deer populations. Ongoing monitoring of collared mule deer will allow us to determine if there is any effect on cougar predation rates and survival rates of mule deer.

This project provided valuable information on mule deer seasonal ranges and movements, which will support future restoration projects in areas that have been impacted by forest encroachment and other land use change. ER assessments were focused on MUs 4-03 and 4-26 as these areas have received less attention than MU 4-02 over the past 5 years. We will pursue funding opportunities to prepare prescriptions for sites identified as high priorities for ER. GPS collar data are also being used to assess winter habitat selection and refine ungulate winter range orders to ensure sufficient canopy cover is retained during forest harvest operations.

The analysis of collared deer selection of ER sites did not show any definitive trends in use following treatment, despite observations of substantial numbers of deer using these sites in the early winter and spring. Treatment outcomes associated with increased forage value and longer sight lines to detect predators were not captured by our analysis but are demonstrated benefits to habitat enhancement can increase survival rates, reproductive rates and fawn birth rates (Bishop et al. 2008; Tollefson et al. 2010). Improving condition of winter, summer and transitional ranges will be a crucial component of mule deer recovery in the Upper Kootenay.

Figure 11: Cougar on a mule deer kill in Phillips Creek (MU 4-02), August 2018. Photo credit: TJ Gooliaff.

7.0 Recommendations

- Complete ER prescriptions for sites identified as high priority in the ER assessment report (based on FWCP board's recommendation and Hurley [2014]) and promote ER in other areas to enhance mule deer habitat.
- Continue monitoring subset of collared mule deer to assess survival rates, following changes in white-tailed deer and cougar abundance.
- Expand on migration analysis to include corridors selected by animals with 1 & 2 fix per day collars.
- Include mapped migration routes in landscape planning to maintain connectivity between summer and winter ranges.

8.0 Acknowledgements

We would like to thank the Columbia Basin Trust, Fish and Wildlife Compensation Program, Habitat Conservation Trust Foundation and Southern Guides & Outfitters for contributing funding to this project. The project would not be possible without the assistance of the following FLNRO staff and contractors: Tara Szkorupa, Gerry Kuzyk, Dave Lewis, Larry Ingham, Stu Clow, Allana Oestreich, Emily Chow and TJ Gooliaff. We would also like to thank the following helicopter pilots for carrying out capture and composition surveys: Clay Wilson, Taylor Wilson, Dave Hawrys, Ben Berukoff and Dave Nairn.

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10.0 Confirmation of FWCP Recognition

We prepared three non-technical project updates that were distributed to a broad group of hunters, outfitters, landowners and local residents who have shown interest in this project (Figure 10). We also completed a media interview with Angus Glass in July 2016. Preliminary project results were presented to the following stakeholder groups:

- BC Wildlife Federation (BCWF) AGM (April 2015)
- Provincial FLNR wildlife section biannual meeting (October 2015)
- East Kootenay Wildlife Association meeting (January 2016)
- Southern Guides & Outfitters AGM (July 2017)
- Lake Windermere Rod & Gun Club AGM (January 2017)
- Tobacco Plains Indian Band (May 2017)
- East Kootenay Ungulate Winter Range Working Group (April 2019)

FWCP has been acknowledged as a major funding contributor in presentations and progress updates.