WIDE-RANGING MAMMALS CONSERVATION TARGET ASSESSMENT REPORT

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PREPARED FOR: Southern Eastern Slopes Conservation Collaborative

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CANADIAN PARKS AND WILDERNESS SOCIETY
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SOUTHERN EASTERN SLOPES CONSERVATION COLLABORATIVE

The Southern Eastern Slopes Conservation Collaborative (Collaborative) is a coordinated group of conservation-based environmental organizations working together to create a bold, detailed, proactive land use vision for public and private lands along Alberta's Eastern Slopes that prioritizes conservation, and unites ENGOs to work more strategically to change policy, and landscape protection and management.

The Collaborative comprises four core organizations:

- Canadian Parks and Wilderness Society – Southern Alberta Chapter
- Miistakis Institute
- Southern Alberta Land Trust Society
- Yellowstone to Yukon Conservation Initiative

While the core group is driving the process, other conservation organizations and individuals are critical to the process and have been engaged throughout. Organizations that attended at least on of the full-day workshops include:

- Alberta Native Plant Council
- Alberta Riparian Habitat Management Society (Cows and Fish)
- Bragg Creek Environmental Coalition
- Bow River Basin Council
- Elbow River Watershed Partnership
- Foothills Land Trust
- Ghost Community
- Ghost Watershed Alliance Society
- Nature Conservancy of Canada
- Oldman Watershed Council
- Trout Unlimited Canada

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SUMMARY OF FINDINGS

Wide-ranging mammals, such as grizzly bears, wolverine, wolves, cougars, bighorn sheep, moose, deer and elk, require large blocks of habitat to survive and to enable seasonal and migratory movements important to long-term survival. Wide-ranging mammals are often considered umbrella species, since protecting enough habitat for these animals also results in the protection of many smaller animals and plants. Competing land uses in the Southern Eastern Slopes contribute to habitat loss and fragmentation of the landscape, reducing wildlife access to secure habitat and impeding wildlife ability to move around the landscape to access food, mates and shelter.

The current health of the wide-ranging mammals target was rated as fair,[1] defined as outside acceptable range of variation[2]. The score was derived from the following key ecological attributes (KEAs):

- Fair rating as only 27% of the recovery area deemed as secure grizzly bear habitat.
- Fair rating as only 30% of elk winter range is not disturbed by human features.
- Good rating for ungulate vehicle collisions (UVCs) on Highway 1 and Highway 3, with the caveat that there are plans for mitigating hotspots.
- Poor to Fair rating for human-caused grizzly bear mortality in BMA 5 and BMA 6.

Of the eight **critical threats** identified (see Table 1) that affect the health of the wide-ranging mammals target:

- four were ranked high:
    - motorized recreational activity (includes human use and tail footprint)
    - residential development
    - non-motorized recreational activity (includes human use and trail footprint)
    - surface disturbance (oil and gas)
- four were ranked medium:
    - linear disturbance (roads, rail and transmission lines)
    - altered fire regime
    - commercial logging
    - surface disturbance (industrial clearing)

A high-ranking threat is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site. A medium-ranking threat is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.

[1] Fair – Outside acceptable range of variation; requires human intervention.

[2] Acceptable Range of Variation – Key ecological attributes of focal targets naturally vary over time. The acceptable range defines the limits of this variation that constitute the minimum conditions for persistence of the target (note that persistence may still require human management interventions). This concept of an acceptable range of variation establishes the minimum criteria for identifying a conservation target as "conserved" or not. If the attribute lies outside this acceptable range, it is a degraded attribute.

Table 1: Critical Threats to Wide-Ranging Mammals

Threats		Wide-Ranging Mammals
1	Motorized recreational activities	High
2	Residential development (rural residential growth)	High
3	Non-motorized recreational activities	High
4	Surface disturbance (oil and gas)	High
5	Linear disturbance (roads, rails, and transmission lines)	Medium
6	Altered fire regime	Medium
7	Commercial logging	Medium
8	Surface disturbance (industrial clearing, mining)	Medium

Note that we maintained consistency in how threats were described between the conservation targets. Linear features, therefore, were not addressed specifically as one threat, but were instead considered within threats (e.g., trails that support motorized recreation are considered a high-ranking threat to large mammals). If all high-use linear features were considered as one threat, the ranking would be high, and strategies have therefore been developed to reduce overall linear features that support high levels of human use (roads, trails, transmission lines, railways).

Climate change and renewable energy development were identified as **emerging threats** for the wide-ranging mammals target but were not rated for this study.

Indirect threats are contributing factors that drive the direct threats to the wide-ranging mammals target:

- Highway 3 twinning and realignment currently in functional design stage.
- Regional population growth and urban sprawl leading to increased recreational pressure and rural residential development.
- Uncertainty around provincial and municipal land use planning.

A number of **opportunities** were also identified that might influence target health:

- South Saskatchewan Regional Plan, and various subregional plans, including the Livingstone-Porcupine Hills Land Footprint Management Plan and Recreation Management Plan, can support strategies to reduce impacts on wildlife.
- Draft Alberta Grizzly Bear Recovery Plan identified many strategies that are complementary to improving health of grizzly bears in the study area if implemented.
- Municipal government awareness and engagement on where wildlife core areas and corridors are located.
- Many successful community engagement programs, (e.g., Carnivore Working Group, managed by Waterton Biosphere Reserve; Roadwatch in the Pass, managed by Miistakis).
- Alberta Transportation and Alberta Minister of Environment support for wildlife mitigation on highways, including RFPs for Highway 3, Highway 1 and Highway 22 to inform mitigation.

These threat results were used to form strategies, including objectives and actions aimed at improving health of the wide-ranging mammals target.

The following five goals were identified to improve the wide-ranging mammals target health and reduce critical threats:

1. Current extent of wide-ranging mammals target is maintained and improved.
2. Increase grizzly bear secure areas, defined as 68% secure habitat, to ensure security for wide-ranging mammals.
3. Improve and maintain connectivity for wildlife across major highways and roads.
4. Stakeholders, including MDs and industry, incorporate wide-ranging mammal needs in land-use and development planning and implementation.
5. Meet mortality targets for grizzly bears of <4% overall, of which <1.2% is female.

BACKGROUND

The Collaborative is developing a conservation plan or blueprint for conservation groups to work toward maintaining a healthy landscape along Alberta's Southern Eastern Slopes. The Collaborative is using The Nature Conservancy Conservation Action Planning (TNC CAP) process as the foundation for developing conservation strategies. Process steps include:

1. Scope and target identification workshop: held in Calgary in May 2016 with the broad conservation community, where the study area was agreed to and a number of conservation targets were identified, including:
    - foothills grasslands
    - riparian areas
    - white spruce and lodgepole pine forests
    - wide-ranging mammals
    - native fish species
2. Conservation target health and critical threats assessment: conservation target assessment approach developed for the first three conservation targets to determine current health of the target, and critical threats affecting the target.
3. Goal setting and strategy development: facilitated workshops held in Calgary in November 2016 and February 2018 with broader conservation community to set conservation goals and develop strategies targets.
4. Target assessment report: Wide-Ranging Mammals Conservation Target Assessment Report drafted to inform development of goals and conservation strategies to maintain and restore the wide-ranging mammals target.

WIDE-RANGING MAMMALS CONSERVATION TARGET

Wide-ranging mammals, such as grizzly bears, wolverine, wolves, cougars, bighorn sheep, moose, deer and elk require large blocks of habitat to survive and to enable seasonal and migratory movements important to long-term survival. A larger territory provides more opportunities to find suitable and sustainable food sources. Wide-ranging mammals are often considered umbrella species, since protecting enough habitat for these animals also results in the protection of the many smaller animals and plants (Soulé and Noss 1998).

The Southern Eastern Slopes support a full complement of Alberta's large mammal species and represent important habitat and landscape connections for wildlife populations in the Canadian and US Rocky Mountains (Killeen et al. 2014; Apps et al. 2007). The Southern Eastern Slopes provide wide-ranging mammals with important core habitat to meet life requirements such as food, water and shelter.

A fundamental component to supporting wide-ranging mammals is maintaining landscape connectivity between core habitat patches (Crooks and Sanjayan 2006). Studying how the landscape facilitates or impedes animal movement between habitat patches is important for developing strategies to maintain healthy wildlife populations. The Southern Eastern Slopes represent an important component of a larger landscape where individual animals must move between habitats to ensure regional population stability. In addition, supporting genetic flow between populations contributes to a species' ability to better adapt to its localized environment.

An important challenge to maintaining healthy populations of wide-ranging mammals in the Southern Eastern Slopes is ensuring habitat security is improved and maintained, and animals are able to move unimpeded on the landscape. This is complicated by competing land uses in the Southern Eastern Slopes that contribute to fragmenting the landscape and impeding movement (Apps et al. 2007). A major concern in the study area is reduced movement opportunities due to avoidance behaviour and/or increases in animal mortality associated with roads (Clevenger et al. 2010).

An additional challenge is the difficulty in assessing landscape connectivity for multiple species. Landscape connectivity in its purest form is a measure of a species' ability to move through the landscape to meet daily and seasonal requirements and is therefore defined relative to how the species in question lives in and moves through a landscape. In other words, landscape connectivity is species-specific. None the less, connectivity is an important biodiversity principle and is an important consideration in maintenance of populations and species (Ryan et al. 2012).

Because it is not possible to assess the health of all wide-ranging mammals in this process, the Collaborative chose to represent this target using grizzly bears (*Ursus arctos*) and elk (*Cervus elaphus*) as surrogates.

Grizzly bears and elk act as good surrogates because of specific life characteristics:

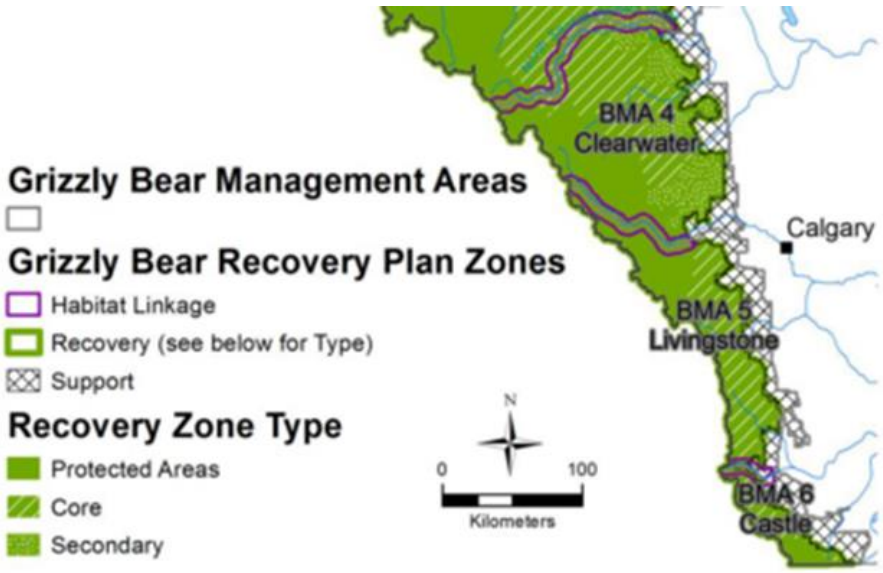
- They both require large home ranges (Alberta Sustainable Resrouce Development and Alberta Conservation Association 2010).
- They are both sensitive to human activity (Lamb et al. 2017; McLellan and Shackleton 1988 in Trombulak and Frissell 2000; Grover and Thompson 1986; Rost and Bailey 1979 in Trombulak and Frissell 2000).
- Grizzly bears are a species at risk in Alberta (Alberta Sustainable Resrouce Development and Alberta Conservation Association 2010).

Grizzly Bear

Grizzly bears occur throughout the full extent of the study area, the Southern Eastern Slopes of Alberta, and are managed in two provincial bear management areas (BMA): BMA 5 – Livingstone and BMA 6 – Castle (Alberta Environment and Parks 2016), shown in Figure 1.

Grizzly bears are classified as Threatened in Alberta, and the province recently released a *Draft: Alberta Grizzly Bear (Ursus arctos) Recovery Plan* (Alberta Environment and Parks 2016). In a BMA are two types of Recovery Zones, Core and Secondary, which are almost exclusively on Crown land. These zones are used as a management tool to better identify the primary areas of habitat that must be managed to recover the grizzly bear population.

The Support Zone is an area outside core and secondary zones that includes significant areas of private land. It can contain important habitat or be on the periphery of critical habitat, and is an area where human–grizzly bear interaction commonly occurs and management of interactions is necessary to support recovery of the grizzly bear population.



(Source: Alberta Environment and Parks 2016)

Figure 1: Grizzly Bear Management Areas in Southern Eastern Slopes Study Area

It is important for grizzly bears to have secure habitat in these zones, "an area where an adult female grizzly bear can meet her daily foraging needs with a low probability of disturbance by people," which has a negative impact on survival of grizzly bears (Gibeau et al. 2001, p. 126).

Current Population Estimates for Study Area

The population estimate in BMA 5, which includes a portion of Banff National Park, in 2006 was 90 bears, which is "a density of about 12 bears/1000 km^{2}" (Alberta Grizzly Bear Inventory Team, 2007 in Alberta Environment and Parks 2016, p.22). BMA 6 had 51 bears in 2007 and "a density of 18.1 bears/1000 km^{2}" (Alberta Grizzly Bear Inventory Team 2008 in Alberta Environment and Parks 2016, p. 23).

In both BMAs is a trend toward eastward expansion of these populations (Alberta Environment and Parks 2016). "The grizzly bears in BMA 6 are the northern extension of the Northern Continental Divide population (including southeast British Columbia and part of northern Montana), which is estimated at about 1000 bears" (Mace et al. 2012; Procter et al. 2012) and this population "is estimated to be increasing at 3%/year" (Mace et al. 2012) or "4%/year" (Morehouse and Boyce 2016) depending on the study. Follow-up inventory work in BMA 6 has not been completed (Alberta Environment and Parks 2016).

Why We Are Concerned About Grizzly Bears

The many factors that can threaten the existence of grizzly bear on the landscape include:

- loss of habitat
- landscape fragmentation from roads and other linear features
- human-caused mortality from recreational access into grizzly bear habitat and collisions with vehicles or trains

As human use and development increases in the Southern Eastern Slopes of Alberta, grizzly bears suffer the loss of core habitat areas that are required for species survival and recovery (Proctor et al.

2015; Gibeau et al. 2001). Female grizzly bears are especially susceptible to the loss of core habitat, specifically security areas (Gibeau et al. 2001).

Roads affect grizzly bear populations because they are a contributing factor to habitat fragmentation due to avoidance behaviour, and grizzly bear mortality from collisions with vehicles (Proctor et al. 2015, 2012). Avoidance behaviour results in roads acting as barriers to habitat and movement of bears around the landscape. Human use of the road determines the level of avoidance exhibited by grizzly bears, with higher-use roads being avoided more often than lower-use roads (Northrup et al. 2012; Boulanger and Stenhouse 2014).

"Long-term persistence of small fragmented grizzly bear populations will require management of connectivity with larger populations" (Proctor et al., 2015, p. 544). A recent study by Lamb et al. (2018) "demonstrated that a policy target of reducing human access by managing road density below 0.6 km/km^2, while ensuring areas of high habitat quality have no roads, is a reasonable compromise between the need for road access and population recovery goals" for grizzly bears (Lamb et al. 2018).

Highways in the study area, and sensitivity of grizzly bears to highways, is one reason why grizzly bears were selected as a surrogate species to represent the wide-ranging mammals target. There are four major highways in the Southern Eastern Slopes study area:

- Highway 3
- Highway 2
- Highway 22
- Highway 1 (TransCanada Highway)

Northrup et al. (2012, p. 1159) recommends that "future management plans should employ a multi-pronged approach aimed at limiting both road density and traffic in core habitats. Access management will be critical in such plans and is an important tool for conserving threatened wildlife populations."

Lastly, grizzly bears are greatly susceptible to human-caused mortality. Between 2009 and 2013 in BMA 5, vehicle collisions (35%) were responsible for the greatest proportion of human-caused mortality. In BMA 6, poaching was the greatest proportion (source) of human-caused mortality (Alberta Environment and Parks, 2016, p. 23–24). In both BMAs it is common for grizzly bears to be relocated due to human–bear conflicts, including livestock or agricultural conflicts (Alberta Environment and Parks 2016). Problem bears, aboriginal harvest, accidental death and self-defence are other known types of human-caused mortality in BMA 5 and BMA 6 (Alberta Environment and Parks 2016, Table 5.8, p. 28).

Elk

Elk occur throughout the full extent of the Southern Eastern Slopes of Alberta study area. Elk is currently listed as a secure species in Alberta and hunting draws are available for this species (Alberta Environment and Parks 2017a, 2017b). Provincially, elk populations are managed based on Wildlife Management Units (WMU) (Government of Alberta 2017).

Elk require large areas of the landscape to access seasonal habitat, and are most limited and at risk during winter and during the calving period. It is therefore important to maintain movement corridors between seasonal ranges as well as to enable elk dispersal. "Elk herds in southwestern Alberta may be migratory, in which animals move to higher altitudes in spring and summer to gain access to high-quality forage, or partially migratory, in which some animals remain resident in winter ranges throughout the year" (Hebblewhite et al. 2008 in Killeen et al. 2014, p. 2).

Because dispersal habitat selection parameters can differ from home-range habitat selection parameters, to inform management decisions, it is important to understand habitat selection by animals during dispersal (Killeen et al. 2014). Killeen et al. recommend that "If managers are to implement initiatives to promote habitat connectivity, such as corridors, it would be ideal to prioritise data collection from individuals that are most likely to disperse" because they cover larger distance than other animals and they represent the characteristics for movement, which is "the primary purpose for habitat corridors" (2014, p. 8).

Why Are We Concerned About Elk?

Historically, elk ranged freely across the Southern Eastern Slopes of Alberta. As agriculture, recreational use, highways and other human use has increased across this landscape, elk have suffered a loss of seasonal habitat and a loss of connectivity corridors that connect seasonal habitats compared with their historic range (Benz et al. 2016).

Elk exhibit avoidance of highways, which leads to fragmentation of populations and limitation of movement to high-quality habitat (Benz et al. 2016; Prokopenko 2016; Prokopenko et al. 2017). Additionally, an increase in human-caused disturbances (roads, traffic, land-use type, off-highway vehicle use, hunting areas) and intensity of human activity (e.g., hiking vs. hunting) causes an increase in vigilance in elk, more than that caused by habitat factors and natural predators (Ciuti et al. 2012). An increase in vigilance is a negative impact on elk as it leads to a decrease in foraging and thus a decrease in reproductive success (Ciuti et al. 2012).

Although elk populations currently appear to be reasonably healthy, they are still an important and suitable target as they are a wide-ranging ungulate with diverse habitat needs and much of their winter range includes large areas of native vegetation.

MAPPING THE CONSERVATION TARGET

To represent the wide-ranging mammals target spatially, core habitat patches and corridors for grizzly bear and core winter habitat for elk were mapped and a composite map was developed that merged the layers from each species.

Grizzly Bear

To spatially represent the grizzly bear target, a model used to identify security areas in the Central Canadian Rocky Mountains (Gibeau et al. 2001) was replicated and a Least Cost Model (LCM) was then used to map corridors between security areas.

The 2010 AMBI land cover layer (Castilla et al. 2014) was used to develop a base layer for grizzly bear core areas. All native land cover classes (33, 50, 110, 210, 220, 230) were selected.

Linear features were removed from the native cover base layer using the 2014 Alberta Biodiversity Monitoring Institute (ABMI) human footprint layer (Alberta Biodiversity Monitoring Institute 2012). Linear features that support high human use, defined as >3 human events per day or 100 human events per month, were buffered by 500 m. See Appendix A for the list of linear features categorized as high.

Security areas were identified as remaining areas that were ≥9 km^2. Areas ≥5 km^2 were also identified as these were deemed important in providing habitat and movement areas for grizzly bears. The 9 km^2 represents secure areas, while the 5 km^2 adds areas grizzly bears use that are of value and important for movement around the landscape.

It is important to note that this does not reflect all areas used by grizzly bears. Grizzly bears use many other areas in the study area as habitat. This report identifies where grizzly bears have the best security from the risk of human-caused mortality. Some of the corridors identified might currently have high use by grizzly bears whereas others might have little or no current use but offer the best options for movement should the Recovery Plan be successful or if bears start to more actively use different habitat patches.

Grizzly bear corridors were identified using a two-phase process:

- Least Cost Model (LCM) using Linkage Mapper in Circuitscape
- expert opinion to inform final corridor identification

The LCM required two inputs:

- resource patches – grizzly bear security areas clipped to Grizzly Bear Recovery Zone
- resistance surface that represents relative ease or difficulty with passing through the landscape

A resistance raster (30 m pixels) was developed using the ABMI land cover dataset as a base layer. This was merged with the ABMI 2014 human footprint layer. Based on expert opinion, each pixel was rated for ease of movement on a scale of 1 to 5, with 1 representing no resistance to movement and 5 representing strong level of resistance to movement. (See Appendix B for resistance scores for each land cover and human feature type.)

Linkage Mapper is ideal for showing connectivity among habitats and potential corridors (Marrotte and Bowman 2017; Nordén 2016). Circuitscape is open-source software that borrows algorithms from electronic circuit theory to predict connectivity in heterogeneous landscapes (www.circuitscape.org). It was recently shown to outperform other models in predicting areas of wildlife–vehicle collisions (WVCs), a surrogate for movement areas across a highway (Girardet et al. 2015).

Model assumptions and limitations are as follows:

- No empirical data were used in the analysis, with resistance scores based on expert opinion.
- All linear features of a specified classification were rated as high or low human use (e.g., a paved road was considered high human use or >3 human events per day) though some roads might be closed to public use or parts of roads experience less use.
- Because human use is difficult to quantify on the landscape, ratings were based on expert opinion. Although trails were rated as high use in the security area model, some trails might not be documented in the AMBI dataset.
- To reduce error associated with the modelling edge, a boundary around the study area was not developed. One limitation, for example, was not acquiring data from British Columbia as this was beyond the scope of the project. East/west movement between British Columbia and Alberta is, therefore, not well-represented by this model.

Modelling results were reviewed by the expert panel and minor adjustments were made to address shortcomings:

- Grizzly bear east/west mountain passages from Weaver (2013) were included. Because the east/west mountain passage dataset concludes at the northernmost point indicated in Figure 2, additional east/west connections north of that point could be missing.
- Based on expert knowledge, a resource patch at Rock Creek deemed important as movement habitat linking to secure areas was added. This provides important additional movement areas across the Highway 3 transportation corridor.

- A patch just west of Twin Butte, outside Waterton Lakes National Park, where road and trail closures likely limit the human use element, was added.

Elk

To map elk winter range, AEP provincial winter elk range was used as a base layer and the layer was then reviewed with experts. Minor adjustments were made to the southern portion of the study area, and expert opinion identified the northern portion of the study area as data deficient. The northern portion of the study area (north of Chain Lakes) was adjusted using an additional four independent datasets:

1. FWMIS records and aerial survey data for elk and sheep (elk records extracted) were provided by AEP, and winter records were pulled out and analyzed using a kernel density approach to identify elk winter range.
2. Jamieson (1969) developed elk winter range maps based on a summary of aerial survey data in 1969. The winter elk polygons were digitized and added to the elk winter range layer.
3. GPS elk data were provided by Kathreen Rusktahl and Benn Edwards from the University of Calgary.
4. Grant Chapman, AEP, provided expert opinion to identify new areas where elk are wintering that were not represented in the other four datasets.

The five datasets were merged so that the source for each polygon is classified as a processing step to enable AEP to update the layer as new data are available.

The datasets were then compiled to create one elk winter range layer (see Figure 3). Elk movement corridors were identified for the southern region using research by Dale Paton, but corridors in the northern portion of the study area have not yet been identified, which is a data gap that needs to be resolved over time.

Mapping the Wide-Ranging Mammals Target

The target was mapped using a combination of grizzly bear secure areas and corridors, and elk winter range for the southern region of the study area (see Figure 4). While both species do in fact overlap and use a significant portion of the combined target area, utilization rates by either species do vary across the target. Again, the target is meant to show those areas of the landscape that currently have the best potential to support these two species, and, to support other wide-ranging mammals that share similar habitat requirements to grizzly bears and elk.

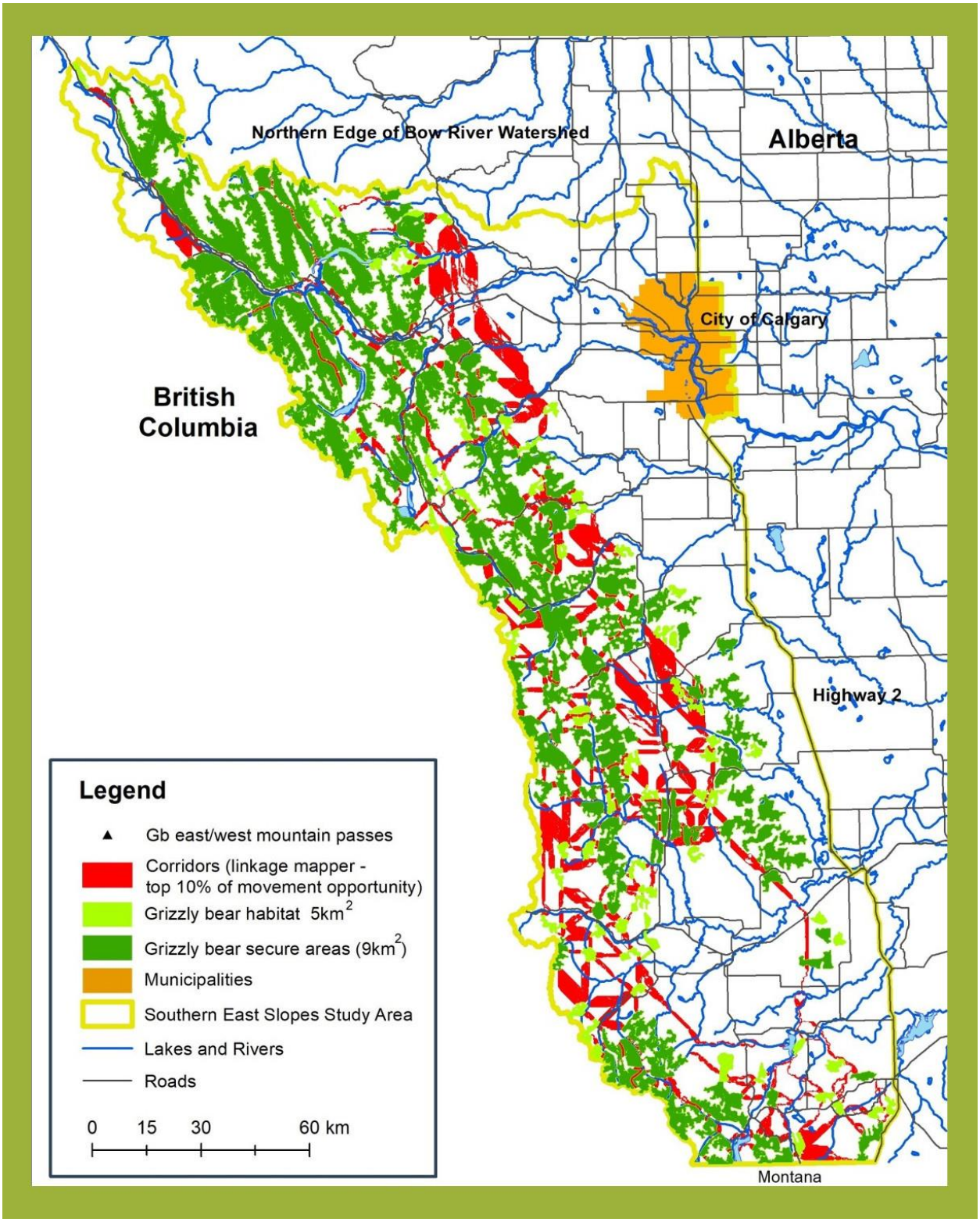


Figure 2: Grizzly Bear Secure Habitat and Corridors

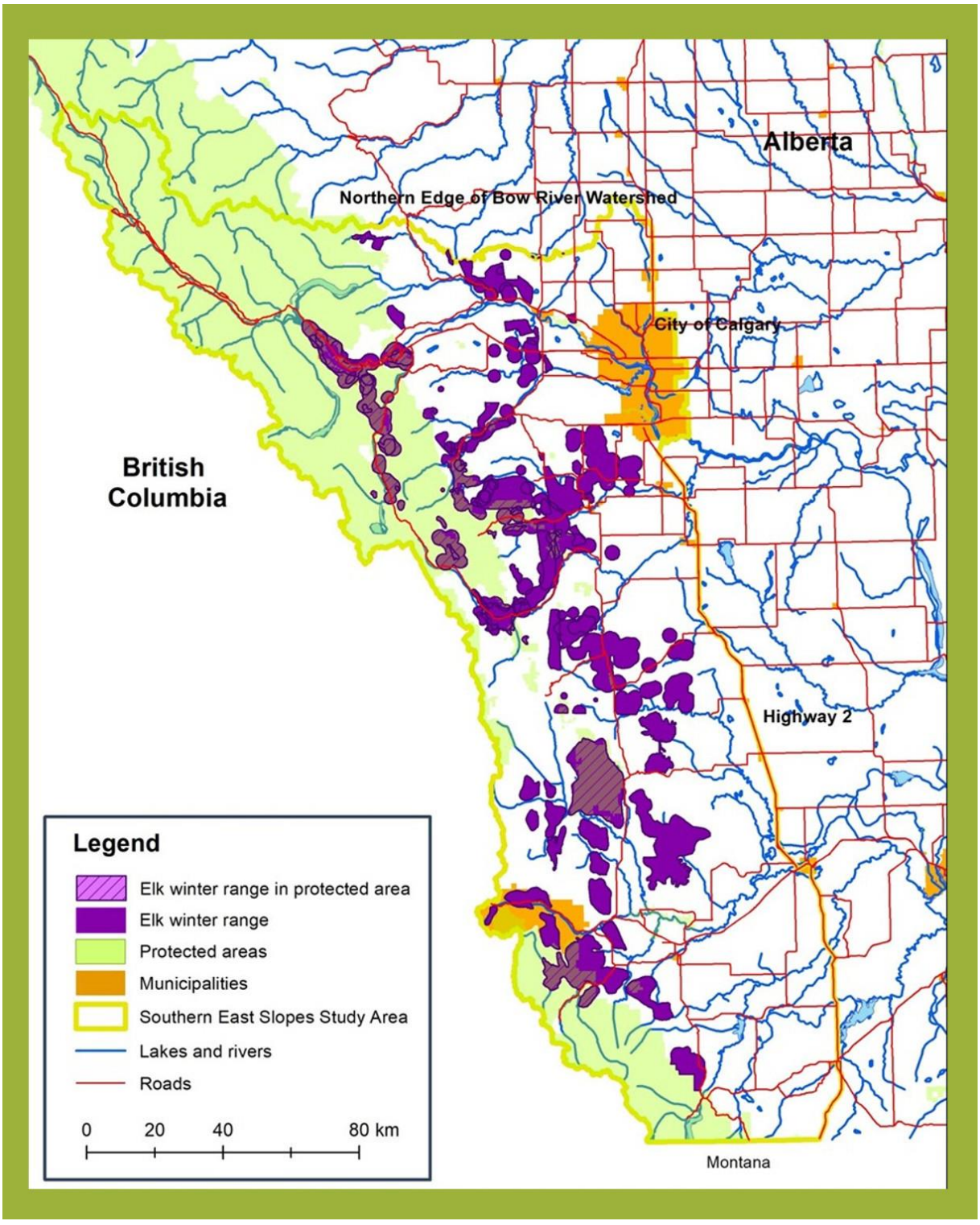


Figure 3: Elk Winter Range and Corridors

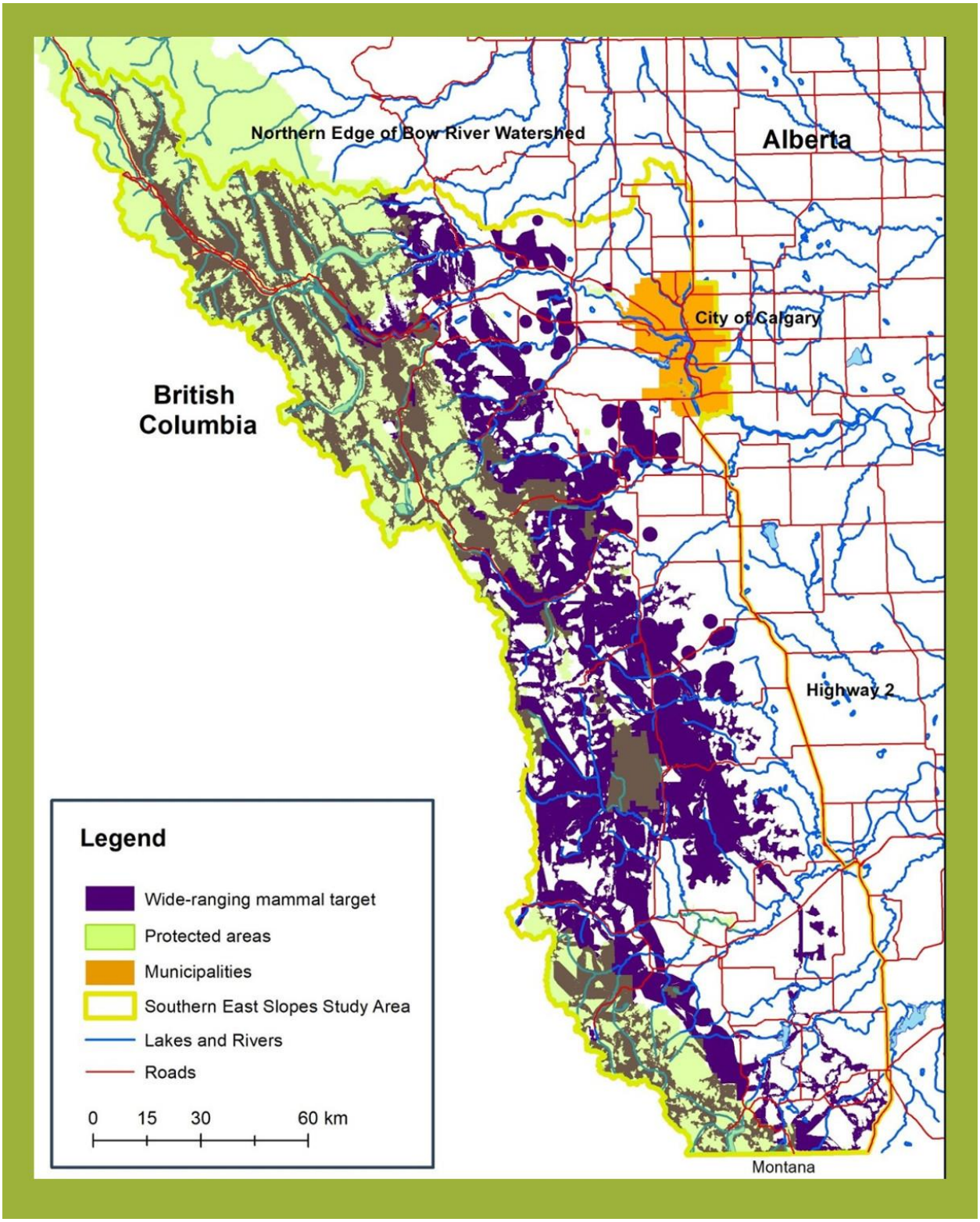


Figure 4: Wide-Ranging Mammals Target

CURRENT STATUS OF CONSERVATION TARGET

KEAs were identified to determine the current status of the wide-ranging mammals target, including size, condition and landscape processes that are important to target health. Table 2 lists the KEA, indicators and health ratings (and justification for the ratings) of each wide-ranging mammals target KEA.

Health scores were derived from expert opinion, and were informed by spatial analysis and literature review. A current limitation of this assessment is that indicators were developed only for the current health rating and not for all possible health scores. Ideally, this could be addressed in future report iterations. Appendix C outlines the analysis approach and results (including maps) for each key attribute and describes important limitations and data gaps in the process.

Table 2: Target Viability Assessment Table – Wide-Ranging Mammals Target

Conservation Target	Category	KEA	Indicator	Poor	Fair	Good	Very Good
Wide-ranging mammals	Size	Percentage of grizzly bear secure habitat (≥9 km^2) remaining in grizzly bear recovery zone	Percentage of grizzly bear secure habitat (≥9 km^2) remaining in grizzly bear recovery zone		≥30% of grizzly bear recovery zone is secure habitat		
Wide-ranging mammals	Size	Percentage of intact elk winter range	Percentage of elk winter range that does not have human disturbance		≥30% of elk winter range that does not have human disturbance		
Wide-ranging mammals	Landscape	Ungulate success crossing Highway 1 and Highway 3	Number of ungulate–vehicle collisions along Highway 1 and Highway 3 per year			<60 UVC along Highway 1 per year <135 UVC along Highway 3 per year	
Wide-ranging mammals	Condition	Grizzly bear survival	Human-caused grizzly bear mortality rate		Human-caused mortality rate is >4% per year of the provincial population per year, of which the female mortality rate is >1.2% per year	Human-caused mortality rate is <4% per year of provincial population per year, of which the female mortality rate is <1.2% per year	

Overall, current health of the wide-ranging mammals target is **fair,** defined as outside acceptable range of variation, and requires human intervention to improve and maintain secure habitat connectivity for grizzly bear and elk populations. This is driven by the grizzly bear human-caused mortality rate and amount of secure grizzly bear habitat in the recovery zone. The health of elk was considered fair due to less human disturbance in winter range and current rate of ungulate vehicle collisions occurring along Highway 1 and Highway 3. Note that mortality from collisions with vehicles is also a human safety concern, and this was not considered when rating the ecological health of wide-ranging mammals.

Goals for the wide-ranging mammals target should focus on improving and conserving the remaining grizzly bear secure areas, as well as maintaining connectivity between secure areas. In addition, reducing human-caused grizzly bear mortality is necessary to ensure maintenance of the grizzly bear population. A critical threat analysis will help identify key impacts on the wide-ranging mammals target and help inform strategies.

CRITICAL THREATS

To determine the critical threats for wide-ranging mammals, the sources of stress affecting KEAs were first determined. Sources of stress are typically degraded KEAs, so for the wide-ranging mammals target, reduced secure areas for grizzly bears, increased human-caused grizzly bear and elk mortality, and altered connectivity were identified as key sources of stress. Each source of stress was ranked for severity and scope based on expert opinion.

Severity considers the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given continuation of the existing situation):

- **Very High:** The threat is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site.
- **High:** The threat is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site.
- **Medium:** The threat is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.
- **Low:** The threat is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

Scope is defined as the geographic scope of the impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstance (i.e., given continuation of the existing situation).

- **Very High:** The threat is likely to be widespread or pervasive in its scope and affect the conservation target throughout the target's occurrence at the site.
- **High:** The threat is likely to be widespread in its scope and affect the conservation target at many of its locations at the site.
- **Medium:** The threat is likely to be localized in its scope and affect the conservation target at some of the target's locations at the site.
- **Low:** The threat is likely to be very localized in its scope and affect the conservation target over a limited portion of the target's location at the site.

Critical threats were identified as stress that affects the source of stress, such as linear disturbance, which directly affects connectivity of wide-ranging mammals. Each critical threat was ranked based

on its contribution and irreversibility. Lastly, threats that might have a future impact on wide-ranging mammals were identified.

Contribution is defined as the expected contribution of the source, acting alone, to the full expression of a stress under current circumstances:

- **Very High:** The source is a very large contributor of the particular stress.
- **High:** The source is a large contributor of the particular stress.
- **Medium:** The source is a moderate contributor of the particular stress.
- **Low:** The source is a low contributor of the particular stress.

Irreversibility is defined as the degree to which the effects of a source of stress can be restored:

- **Very High**: The source produces a stress that is not reversible.
- **High:** The source produces a stress that is reversible, but not practically affordable.
- **Medium:** The source produces a stress that is reversible with a reasonable commitment of resources.
- **Low:** The source produces a stress that is easily reversible at relatively low cost.

For more information on stress and critical threat ratings, see Appendix D. Of the eight threats identified for the wide-ranging mammals conservation target (see Table 3), four of the threats – motorized recreational activities, residential development, non-motorized recreational activities, and oil and gas surface disturbance – are considered high.

Current Threats

Table 3: Wide-Ranging Mammals Threats and Ratings

Threats		Wide-Ranging Mammals
1	Motorized recreational activities	High
2	Residential development (rural residential growth)	High
3	Non-motorized recreational activities	High
4	Surface disturbance (oil and gas)	High
5	Linear disturbance (roads, rails and transmission lines)	Medium
6	Altered fire regime	Medium
7	Commercial logging	Medium
8	Surface disturbance (industrial clearing, mining)	Medium

Motorized Recreational Activities – High Threat

Motorized recreation is widespread spatially on public lands in the study area, and recreational use continues to climb with little effect from the implementation of beneficial management practices (BMPs) (ALCES 2015). Concerns for wildlife associated with motorized vehicles in wilderness areas include loss of habitat and wildlife avoidance behaviours due to human presence on the landscape, and increased risk of human-caused mortality due to access. The need to better manage motorized use was stressed during public consultations for South Saskatchewan Regional Plan (SSRP) and is a key focus of subregional Land Footprint and Recreation Management plans mandated by the SSRP.

A primary concern regarding motorized recreational activities is noise pollution, which can lead to avoidance behaviours in wildlife. Alberta Tourism, Parks and Recreation (2012, p. 6) has noted "significant increases in numbers of off highway vehicles, especially quads and motorcycles" in the McLean Creek area of the study area, and in other areas outside the study area.

Currently, the *Draft: Alberta Grizzly Bear (Ursus arctos) Recovery Plan* recognizes that "at this time the extent that OHVs contribute to human-caused grizzly bear mortality is a knowledge gap" (Alberta Environment and Parks 2016, p. 45) but there is strong evidence of other negative impacts that motorized recreational activities can have, potentially leading to a decline in reproductive fitness in not only grizzly bears but the majority of terrestrial mammals (Boyle and Samson 1985; Hermanutz and Stavne 2009; Lamb et al. 2018; Ladle et al. 2018) Research by Ladel et al. (2018) found that although grizzly bears still use areas where motorized recreation occurs, their use of these areas is reduced.

The study found grizzly bear foraging time was reduced along trails with motorized recreation, which can have consequences on animal health and long-term consequences on grizzly bear reproduction, ultimately affecting recovery efforts (Ladle et al. 2018). A recent study by Lamb et al. (2018) noted that access management can play an important role in improving grizzly bear density: "Road closures resulted in an 50% increase in bear density since 1997 suggesting increased landscape and species conservation from management agencies played a significant role in that increase. However, bear density was lower where road densities exceeded 0.6 km/km^2 and higher where motorized vehicle access had been restricted." This highlights the need to decrease linear features where road densities exceed 0.6 km/km^2 and the importance of AEP Footprint and Recreation Management subregional plans.

In 2016, the Government of Alberta launched a "rejuvenated public land compliance program" which allows better tracking of enforcement actions related to human use in public lands (Public Land Enforcement Committee 2017, p. 2). Such tracking allows for comparison of changes in human-use activities or changes in compliance levels from year to year, which in turn can aid in better management decisions. "As recreational pressures on Alberta's public land continue to increase, our recreational management and enforcement strategies must continue to evolve to meet these challenges" (Public Land Enforcement Committee 2017, p. 11).

This threat was rated as **high** because it has a substantive negative impact on the wide-ranging mammals surrogate species. Knowledge gaps in the effects that motorized recreational activities have on wildlife will need to be addressed to allow for proper management of this type of land use, including updated information on the extent of current trail systems, intensity of use, placement on the land base and the level of misuse and neglect.

Undesirable activities, like mud bogging, also take place on these landscapes, causing significant environmental damage. This threat is reversible but not practically affordable to reverse, which also contributes to the high rating. Management of this type of activity is difficult. This threat needs enforcement. If there was strong legislation to close roads seasonally or permanently, the threat would be rated medium.

Residential Development (Rural Residential Growth) – High Threat

Results of the Southern Foothills Study[3] suggested that the number of residential acreages will almost triple from 500 to 1400 by 2055 (ALCES 2007). Most of the potential growth is expected to continue southwest of Calgary and between Cochrane and Airdrie to the northwest. This trend will also increase current road density and add roads in previously roadless areas (ALCES 2007).

This threat was rated as **high** because once housing developments are in place they are typically permanent. Wide-ranging mammals habitat is lost directly to rural residential development and fragmentation of habitat from rural residential development can lead to reduced movement opportunities and avoidance behaviour exhibited by wildlife. Additionally, an indirect impact on wide-ranging mammals as a result of residential development is an increase in human use and, therefore, increased risk of human-caused mortality.

Non-Motorized Recreational Activities – High Threat

Non-motorized recreational activities include, but are not limited to hiking, camping, golfing, skiing, snowshoeing, fishing, hunting, mountain biking and equestrian riding. ALCES (2015) stated that with regard to all recreational use (motorized and non-motorized) "the demand for recreation in the watershed is high and projected to increase with little effect from the implementation of BMPs." Foot traffic is often localized in the study area and people prefer areas where motorized recreational use is not allowed (Nature Conservancy of Canada 2016).

Kananaskis Country covers a large portion of the study area. Kananaskis is the most heavily used recreation area in the province and has seen an increase in the number of "guides and outfitters (e.g., equestrian, hiking, whitewater)" from 8 to 100 since 1988 (Government of Alberta 2012, p. 6). Additionally, campgrounds and day-use areas in Kananaskis have "experienced increases in use" since 1988 (Alberta Tourism Parks and Recreation 2012, p. 6). The close proximity to the expanding city of Calgary and other communities is partially responsible for the increased human use in this area (Alberta Tourism Parks and Recreation 2012; ALCES 2007).

Ladel et al. (2018) tested if grizzly bears avoid areas where motorized and/or non-motorized recreational activity is present in central Alberta, and concluded that the answer was not clear (though they did find less use of trails where motorized recreation occurred). Hojnowski (2017) looked at the spatial temporal pattern of grizzly bears in Kananaskis, which "…revealed that when bears were in habitats adjacent to recreation infrastructure, they modified their behavior in response to daily, weekly and seasonal fluctuations in human activity, avoiding the times and places of highest recreation."

Furthermore, "Spatiotemporal patterns of occurrence of large mammals, recreationists and domestic dogs were assessed using camera traps deployed within critical wildlife habitat bordering the town of Canmore, Alberta. Recreation was categorized by type of user, and daily numbers of recreationists and domestic dogs were quantified over a twenty-month period. Coyotes (*Canis latrans*) demonstrated the clearest temporal shifts in response to recreation intensity, and hikers and off-leash dogs spatially displaced several species (Hojnowski 2017)."

An elk study found that intensity of human activity (e.g., hiking vs. hunting) causes an increase in vigilance in elk, more than that caused by habitat factors and natural predators (Ciuti et al. 2012). An increase in vigilance is a negative impact on elk as it leads to a decrease in foraging and thus a decrease in reproductive success (Ciuti et al. 2012).

[3] The Southern Foothills Study area is very closely aligned with the Collaborative's study area, so results of the Southern Foothills Study are presented as an important source of information throughout this section.

Though high levels of non-motorized recreation do not necessarily result in avoidance by large mammal species, they do potentially displace large mammals from foraging and trail use.

This threat was rated as **high** because of high amounts of non-motorized use in the study area. Although non-motorized recreational activities are less impactful than motorized recreational activities, the disturbances caused can have a negative impact on wide-ranging mammals.

Surface Disturbance (Oil and Gas) – High Threat

ALCES (2007, p. 16) projected "that the total cumulative producing wells by 2055 will be 1104 conventional gas, 378 conventional oil, 1972 CBM and an additional 1500 other wells (delineation, dry)." A number of global forces, however, including global oil prices and a transition to renewable energy, might now result in a more conservative projection. If the price of oil returns to previous values, there is a potential of existing licences being reopened, leading to an increase in activity. Even more important for the Southern Eastern Slopes will be the price of natural gas, which is the more abundant fossil fuel in the study area.

Despite the small size of the actual hydrocarbon industry footprint in the study area, its effects on water quality, landscape fragmentation and wildlife habitat are large (ALCES 2015). Habitat loss, access road creation and increased human use of the area are the primary concerns related to oil and gas surface disturbance. For grizzly bears in Alberta, forest edges on Crown land, produced by oil and gas and forestry disturbance, are considered a primary sink (high-quality habitat and high mortality risk) (Nielsen et al. 2006).

Although some of this sector's footprint has been reclaimed in past decades, the pace of new features has outpaced the reclamation rates (ALCES 2015). Additionally, there is the burgeoning issue of abandoned wells. As of 2009, there were over 45,000 abandoned wells in Alberta that are not certified as reclaimed (Horner 2012).

Relative to the "business as usual scenario," the hydrocarbon industry footprint can be reduced by adopting BMPs, including smaller seismic lines, greater spatial overlap between existing linear features and new pipelines, using multi-well pads where feasible, and an aggressive approach to reclaiming existing linear features. In combination, these BMPs result in a reduced footprint and mitigation of damage to water, landscape and wildlife (ALCES 2015).

This threat was rated as **high** given the current habitat loss and increase in human use associated with this type of surface disturbance. Reclamation of these sites is challenging and includes the added legal complexity of abandoned wells. However, current lagging oil prices and the adoption of BMPs could reduce the impact of new development.

Linear Disturbance (Roads, Rails and Transmission Lines) – Medium Threat

According to ALCES (2007), the landscape is becoming increasingly fragmented due to new roads, industrial development from the energy and forestry sectors, and new residential acreages. The Southern Foothills Study (ALCES 2007), projected road length to increase from 7136 km in 2005 to more than 16,200 km in 2055. Roads are one of the most damaging impacts on intact landscapes, particularly because of habitat fragmentation (Forman and Alexander 1998). Linear corridors, such as seismic lines, roads, railways and pipelines all contribute to the linear distance that affects wide-ranging mammals movement. Trombulak and Frissell (2000, p. 19) outlined seven general ways that roads affect ecosystems:

> "(1) increased mortality from road construction, (2) increased mortality from collision with vehicles, (3) modification of animal behavior, (4) alteration of the physical environment, (5) alteration of the chemical environment, (6) spread of exotic species and (7) increased alteration and use of habitats by humans."

WVCs along roadways are a concern when it comes to wide-ranging mammals and their habitat connectivity. There are four major highways in the study area, along with countless secondary and tertiary roadways. Road density is shown to have a strong correlation with human-caused mortality of elk, grizzly bear and other mammals (Mattson et al. 1996; Clevenger et al. 2009; Alberta Environment and Parks 2016; Prokopenko et al. 2017).

Human transportation corridors, such as roads and trails, also create habitat fragmentation and reduced movement along wildlife corridors as species exhibit avoidance of the human activity along these busy roadways (Prokopenko et al. 2017; Proctor et al. 2015; Benz et al. 2016; Ciuti et al. 2012; Forman and Alexander 1998; Trombulak and Frissell 2000; Proctor et al. 2012; Northrup et al. 2012; Paton et al. 2017). Wildlife movement mitigation measures along highways (overpasses, underpasses, fences) aid in wildlife movement across transportation corridors but measures are often too far apart to alleviate this threat in all areas (Clevenger et al. 2009).

This threat was rated as **medium** because of the proliferation of roads and other linear features in the study area, and because while small linear features can be reclaimed, roads are rarely remediated to a natural state.

Surface Disturbance (Industrial Clearing, Mining) – Medium Threat

Though there is currently no active coal mining in the study area, this industry has legacy effects in the region. There are current plans to extract coal from the Grassy Mountain area – three exploratory expeditions in Bellevue, Adanac and Lynx Creek – and a separate freehold land package near the Grassy Mountain site that might be used for infrastructure for the other mining projects (Riversdale Resources 2014).

Gravel mining is the most common type of surface excavation, as aggregate product is used for construction of all land use footprints (e.g., roads, wellsites, residential, industrial). Though their individual size is small, these features are generally not reclaimed, cause topsoil loss and are common sites for introduction of invasive plants (ALCES 2015).

Habitat loss, access road creation and increased human use of the area are the primary concerns related to industrial clearing/mining surface disturbance, which was rated as a **medium** threat because numerous mines are planned for the region, though the impacts will be localized. The surface mining disturbance will serve as a vector for increased human use and loss of habitat. Restoration is possible in the long term, therefore contributing to the threat being rated medium.

Commercial Logging – Medium Threat

Forestry has a long history, and large footprint, in the study area that continues to this day (ALCES 2015). Commercial loggers are required to hold a Forest Management Agreement (FMA) "to harvest the net merchantable area at least every 100 years" (ALCES 2007, p. 15). ALCES (2015) models projected that from 2010–2040, cutblock area will increase to 313–450 km^2. In addition to the direct loss of habitat due to commercial logging, there is an increase in access via the logging roads created, which can lead to an increase in off-highway vehicle use (ALCES 2007).

For grizzly bears in Alberta, forest edges on Crown land produced by oil and gas and forestry disturbance are considered a primary sink (high-quality habitat and high mortality risk) (Nielsen et al. 2006).

The commercial logging threat was rated as **medium**.

Altered Fire Regime – Medium Threat

The presence of agriculture and ranching, and increased residential development and recreation use at the wildland interface are major factors in promoting fire suppression (Nature Conservancy of Canada 2016). The *Alberta Grizzly Bear Recovery Plan 2008-2013* stated that "fire suppression has resulted in forest harvest replacing fire as the major mechanism of forest removal and renewal on the landscape" (Alberta Sustainable Resource Development Fish and Wildlife Division 2008). Forest harvest, however, does not allow for nutrient replacement and the random distribution pattern needed for regeneration of native habitat and it "adds to the buildup of fuel sources" (Nature Conservancy of Canada 2016, p. 20).

Fire suppression is seen as a threat to the long-term viability of the wide-ranging mammals target due to the reduction in fire frequency, which disrupts natural disturbance patterns and succession processes, thereby encouraging the encroachment of woody vegetation (Anderson 2006).

For grizzly bears, "fire suppression has reduced value and quantity of grizzly habitat" (Alberta Sustainable Resource Development 2008, p. 16). For grizzly bears and other mammal species, fire suppression does not allow for the production of the variety of succession species that mammal species rely on through the year for forage (Nature Conservancy of Canada 2016).

Grizzly bears do best in post-fire vegetation communities, due to the benefits of fire for two major food items, buffaloberry (*Shepherdia canadensis*) (Hamer and Herrero 1987a, 1987b; Hamer 1996) and yellow hedysarum (*Hedysarum sulphurescens*) (Hamer and Herrero 1987a, 1987b; Hamer 1999). The majority of important food sources for grizzly bears are found in open and early seral communities (Hamer and Herrero 1987a; Gibeau and Stevens 2005). For grizzly bears, high-energy foods such as berries and ungulates become abundant post-fire and decline with succession (Herrero 2005).

Despite the ecological impacts, this threat was rated as **medium** because letting fires burn and using prescribed burns are challenging given the proximity of the study area to people and settlements. The Government of Alberta, however, does engage in prescribed burns on Crown lands. Additionally, forest harvest does assume part of the role of fire in regard to disturbance, but it is missing key aspects of natural fire, such as patch distribution. Fire suppression is reversible and is financially inexpensive but the fire cycle takes time, therefore contributing to the medium threat rating.

Emerging Threats

Renewable Energy

The Government of Alberta recently committed to invest in renewable energy. Paired with announcements from the Paris COP 21 meetings, this commitment to renewable energy has been predicted to increase development of large-scale solar and wind farms in the study area. There is potential for solar farms to be a significant land use in southern Alberta within the next 10 years.

This threat was rated as emerging given that there are limited proposals for renewable energy development across the study area, compared with areas farther east. Threats associated with access road and transmission line creation as a result of renewable energy are captured under the linear disturbances threat. It was challenging to rate the potential impact of solar and wind farms on wide-ranging mammals given that this land use is in a nascent stage in Alberta. It is an important land use trend to track.

Climate Change

It is challenging to rate the threat presented by climate change to wide-ranging mammals given that threats were considered based on a 10-year timeframe for the conservation action planning process. The literature indicates that the Rocky Mountains could experience shorter, warmer winters

(estimates of 40–50% decreases in annual snowpack and increased fall precipitation), resulting in diminished spring/summer runoff (Leung and Ghan 1999; Lapp et al. 2005).

Change in forage community health as a result of shifting range due to climate change could affect the forage patterns of elk and other ungulate species. The overall change in the habitat condition impacts movement patterns of wide-ranging mammals but since elk and grizzly bear can move across the landscape, there is a degree of flexibility to move as habitat conditions change placing more emphasis on the importance of connectivity.

Indirect Threats

Indirect threats are contributing factors that drive direct threats and must be considered in strategy development. Indirect threats to the wide-ranging mammals target include:

- Highway 3 twinning and realignment currently in functional design stage.
- Regional population growth and urban sprawl leading to increased recreational pressure and rural residential development.
- Uncertainty around provincial and municipal land use planning:
    - minimum size for subdivision is currently a quarter section (80 acres) which could change to a minimum of 40 acres through a bylaw change; such uncertainty is the indirect threat
    - how wildlife movement is incorporated in municipal planning.

OPPORTUNITIES

The following opportunities were identified as examples of important consideration to strategy development:

- South Saskatchewan Regional Plan, and the various subregional plans, including Livingstone-Porcupine Hills Land Footprint Management Plan and Recreation Management Plan, may support strategies to reduce impacts on wildlife.
- Draft Grizzly Bear Recovery Plan identified many strategies that are complementary to improving health of grizzly bears in the study area if implemented.
- Municipal government awareness and engagement on where wildlife core areas and corridors are located.
- Many successful community engagement programs, such as the Carnivore Working Group, managed by Waterton Biosphere Reserve.
- Alberta Transportation and Alberta Minister of Environment support for wildlife mitigation across Highways, including RFPs on Highways 3, 1 and 22 to inform mitigation.

STRATEGIES

The next step in the process is to develop goals, objectives and strategic actions to address critical threats and/or improve target health. Goals are formal statements of the ultimate accomplishments you hope to achieve in the study area, and are usually based on the desired future status of the wide-ranging mammals target.

Objectives tend to be measurable statements of what as a community we want to achieve relative to the target. Objectives are formal statements detailing a desired outcome, intermediate result or change in the key factors (direct, indirect threats and opportunities) that you would like to achieve in the short and medium term, ultimately leading to abating threats or restoring or maintaining KEA of biodiversity targets (CMP 2013 and TNC 2007).

Strategic actions can include activities related to:

- policy and law
- stewardship protection of land
- land, water or species management
- education and awareness
- livelihood, economic and other incentives

Goals

Seven goals were outlined for the wide-ranging mammals target.

Goal 1: Current extent of wide-ranging mammals target is maintained and improved.

Objective 1: Reduce open public and restricted industrial linear footprint (<0.6 km/km^2).

Objective 2: Industry planning (logging, mining, oil and gas) incorporates wide-ranging mammals secure habitat and connectivity in operational plans, including new linear development and logging operations.

Example Actions:

- Support the provincial government in creating and implementing land footprint management plans and recreational management plans that take into account the needs of wide-ranging mammals.
- Ensure land-use plans include strategies that incorporate recreational restrictions, thresholds on trials, signage, road closures and footprint restoration.
- Promote alternative forestry models and practices that prioritize core habitat and movement of wide-ranging mammals.
- No new roads or commercial forestry in remaining secure areas (e.g., West Chain Lakes, Kananaskis).

Goal 2: Increase grizzly bear secure areas, defined as 68% secure habitat, to ensure security for wide-ranging mammals.

Objective 1: Support the continuation of community-based mitigation programs for grizzly bears, including carcass pickup and composting, attractant management.

Objective 2: Support development of programs to improve elk–human co-existence.

Objective 3: Reduce open public and restricted industrial linear footprint (<0.6 km/km^2) by supporting the provincial government in creating and implementing land footprint management plans and recreational management plans that take into account the needs of grizzly bears and other wide-ranging mammals.

Objective 4: Increase support and identify additional tools for private land conservation in wide-ranging mammals target areas.

Goal 3: Improve and maintain connectivity for wildlife across major highways and roads.

Objective 1: Support highway mitigation that enables the safe passage of wildlife across Highway 1, Highway 22, Highway 3 and secondary highways to reduce wildlife mortality.

Objective 2: Secure land (private and public) adjacent to prioritized highway mitigation sites (Highways 1, 3, 22 and secondary highways).

Objective 3: Municipal and provincial planning allows for wildlife movement adjacent to mitigation sites.

Example Actions:

- Ensure provincial land footprint and recreational planning allows for wildlife movement adjacent to mitigation sites.
- Continue securing private land parcels adjacent to mitigation sites (i.e., West Block??, Rock Creek).
- Provide landowners information and education on the location and importance of wildlife movement corridors.

Goal 4: Stakeholders, including MDs and industry, include wide-ranging mammals' needs in land use and development planning and implementation.

Objective 1: Provide municipalities and industry with information on wildlife core habitat and corridor locations.

Objection 2: Build awareness, and engage and empower municipalities and industry to incorporate the needs of wide-ranging mammals in planning and implementation, including movement corridors.

Example Actions:

- Meet with municipalities and share resources on wildlife core habitat and corridors.
- Encourage MDs to use provided maps and information as a planning tool.
- Establish discussion on how to better include wildlife concerns in municipal planning (area structure plans, municipal development plan). Encourage MDs to work together and promote a joint MD focus on the wide-ranging mammals target.
- Prompt the Government of Alberta to show leadership by example by incorporating wide-ranging mammals movement in public lands planning.
- Introduce co-existence best management practices.

Goal 5: Meet mortality targets for grizzly bears of <4% overall, of which <1.2% is female.

Objective 1: Support the continuation and expansion of community-based mitigation programs, including carcass pickup, attractant management, composting livestock carcasses.

Objective 2: Support the finalization of the *Draft Alberta Grizzly Bear (Ursus arctos*) Recovery Plan through peer-review followed by implementation.

Objective 3: Reduce expansion of rural residential development and fragmentation where it conflicts with wide-ranging mammal core habitat or corridor habitat.

Example Actions:

- Support private land conservation to increase security.
- Work with MDs on placement and zoning so that developments are placed to avoid core habitats and corridors.
- Engage the Government of Alberta to develop dedicated funding and programs for continuation and further development of mitigation programs.
- Encourage the Government of Alberta to conduct a peer review of the Draft Grizzly Bear Recovery Plan and ensure plan is consistent with best-available science. Encourage the Government of Alberta to release a final science-based Recovery Plan.

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APPENDIX A: HUMAN LINEAR FEATURES

Linear features were extracted from ABMI 2014 human features (ABMI 2012). High-use (H) linear features were determined to be linear features expected to support ≥3 human events per day, and low-use (L) linear features were determined to be features with <3 human events per day. High-use features were buffered by 500 m, while low uses were not buffered.

Table A-1: Human Linear Features

Human Feature	Use
AIRP-RUNWAY	H
INTERCHANGE-RAMP	H
PIPELINE	L
PRE-LOW-IMPACT-SEISMIC	L
RLWY-ABANDONED	L
RLWY-DBL-TRACK	H
RLWY-MLT-TRACK	H
RLWY-SGL-TRACK	H
RLWY-SPUR	H
ROAD-GRAVEL-1L	H
ROAD-GRAVEL-2L	H
ROAD-PAVED-1L	H
ROAD-PAVED-2L	H
ROAD-PAVED-3L	H
ROAD-PAVED-4L	H
ROAD-PAVED-5L	H
ROAD-PAVED-6L	H
ROAD-PAVED-DIV	H
ROAD-PAVED-UNDIV-1L	H
ROAD-PAVED-UNDIV-2L	H
ROAD-PAVED-UNDIV-4L	H
ROAD-UNCLASSIFIED	H
ROAD-UNIMPROVED	H
ROAD-UNPAVED-1L	H
ROAD-UNPAVED-2L	H
RUNWAY	L
TRAIL	H
TRAIL-ATV	H
TRANSMISSION-LINE	H
TRUCK-TRAIL	H
VEGETATED-EDGE-RAILWAYS	L
VEGETATED-EDGE-ROADS	L

APPENDIX B: RESISTANCE SURFACE SCORES

To develop the resistance surface, data were compiled from two sources: Alberta Biodiversity Monitoring Institute 2010 land over data (ABMI 2010) and 2014 human feature layer (ABMI 2012). Resistance was measured on a scale of 1 to 5, where 5 is barrier to movement and 1 is no barrier to movement.

Table B-1: Resistance Surface Scores

LC_Class	Class Name	Resistance Code Grizzly Bear Movement (1–5)
20	Water	3
31	Snow/Ice	4
32	Rock/Rubble	4
33	Exposed Land	2
34	Developed	5
50	Shrubland	1
110	Grassland	1
120	Agriculture	3
210	Coniferous Forest	1
220	Broadleaf Forest	1
230	Mixed Forest	1
HF_Class		
	AIRP-RUNWAY	5
	CFO	5
	COUNTRY-RESIDENCE	5
	FACILITY-OTHER	5
	FACILITY-UNKNOWN	5
	INTERCHANGE-RAMP	5
	MINES-PITLAKE	5
	MISC-OIL-GAS-FACILITY	5
	OIL-GAS-PLANT	5
	OPEN-PIT-MINE	5
	RECREATION	5
	RESERVOIR	5
	ROAD-PAVED-4L	5
	ROAD-PAVED-5L	5
	ROAD-PAVED-6L	5
	ROAD-PAVED-DIV	5
	ROAD-PAVED-UNDIV-4L	5
	RURAL-RESIDENCE	5
	SUMP	5
	TAILING-PILE	5
	TRANSFER_STATION	5
	URBAN-INDUSTRIAL	5
	URBAN-RESIDENCE	5
	GRVL-SAND-PIT	4
	LAGOON	4
	LANDFILL	4
	RESIDENCE_CLEARING	4

	ROAD-PAVED-3L	4
	RUNWAY	4
	TRAIL-ATV	4
	CAMPGROUND	3
	CANAL	3
	CLEARING-WELLPAD-UNCONFIRMED	3
	CROP	3
	DUGOUT	3
	GOLFCOURSE	3
	GREENSPACE	3
	MINES-COAL	3
	ROAD-GRAVEL-1L	3
	ROAD-GRAVEL-2L	3
	ROAD-PAVED-1L	3
	ROAD-PAVED-2L	3
	ROAD-PAVED-UNDIV-1L	3
	ROAD-PAVED-UNDIV-2L	3
	ROAD-UNCLASSIFIED	3
	ROAD-UNIMPROVED	3
	ROAD-UNPAVED-1L	3
	ROAD-UNPAVED-2L	3
	TRAIL	3
	TRUCK-TRAIL	3
	WELL-ABAND	3
	WELL-CASED	3
	WELL-DRILLED-OTHER	3
	WELL-GAS	3
	WELL-OIL	3
	WELL-OTHER	3
	WINDMILLS	3
	CLEARING-UNKNOWN	2
	CULTIVATION_ABANDONED	2
	DISTURB_VEG	2
	PIPELINE	2
	PRE-LOW-IMPACT-SEISMIC	2
	RLWY-DBL-TRACK	2
	RLWY-MLT-TRACK	2
	RLWY-SGL-TRACK	2
	RLWY-SPUR	2
	ROUGH_PASTURE	2
	SURROUNDING-VEG	2
	TAME_PASTURE	2
	TRANSMISSION-LINE	2
	VEGETATED-EDGE-ROADS	2
	BORROWPIT-DRY	1
	BORROWPITS	1
	BORROWPIT-WET	1
	CUTBLOCK	1
	RLWY-ABANDONED	1
	VEGETATED-EDGE-RAILWAYS	1

APPENDIX C: WIDE-RANGING MAMMALS TARGET VIABILITY ASSESSMENT

This appendix describes the KEA and indicators used to measure the health of the wide-ranging mammals conservation target. Indicators were developed considering target size (extent), condition and landscape processes as described in the TNC CAP process. KEA analysis was undertaken by Ken Sanderson, and health scores for all indicators were rated based on expert opinion: Mike Gibeau, Dale Paton, Craig Harding and Tracy Lee.

Health score rating thresholds were developed for each indicator based on the following defined categories in the TNC CAP process:

- Very Good – Ecologically desirable status; requires little intervention for maintenance.
- Good – Within acceptable range of variation; some intervention required for maintenance.
- Fair – Outside acceptable range of variation; requires human intervention.
- Poor – Restoration increasingly difficult; could result in extirpation of target.

The following datasets were used in the analysis:

- ABMI Wall-to-Wall Land Cover Map Version 2.1 (ABMIw2wLCV2010v1.0) was used, in whole or part, to create the wide-ranging mammals target. More information on ABMI can be found at: http://www.abmi.ca.
- ABMI Human Footprint Inventory for 2014 conditions (Version 3) was used, in whole or part, to inform indicators used in this report. The ABMI Human Footprint was used to represent anthropogenic features on the landscape. This data layer is updated by ABMI every 2–3 years and can therefore help monitor anthropogenic changes on the landscape at a provincial scale. More information on the Institute can be found at: http://www.abmi.ca.

KEY ECOLOGICAL ATTRIBUTES – WIDE-RANGING MAMMALS TARGET

SIZE: % Grizzly Bear Secure Habitat (≥9 km2) Remaining in Grizzly Bear Recovery Zone

Objective 4 of the draft grizzly bear recovery plan is to maintain or improve habitat security for grizzly bears in the recovery zone, which includes national parks, core and secondary habitat (Alberta Environment and Parks 2016). In this KEA we are interested in the percentage of the grizzly bear recovery zone that represents secure grizzly bear habitat, as outlined by Gibeau et al. (2001). Ideally, these areas would be maintained or even recovered over time to improve secure habitat for grizzly bears.

Methods

We digitized and used the grizzly bear recovery zone from the *Draft: Alberta Grizzly Bear (Ursus arctos) Recovery Plan*. We then calculated the percentage of secure grizzly bear habitat in the recovery zone, based on a model developed by Gibeau et al. (2001), and shown in Figure C-1.

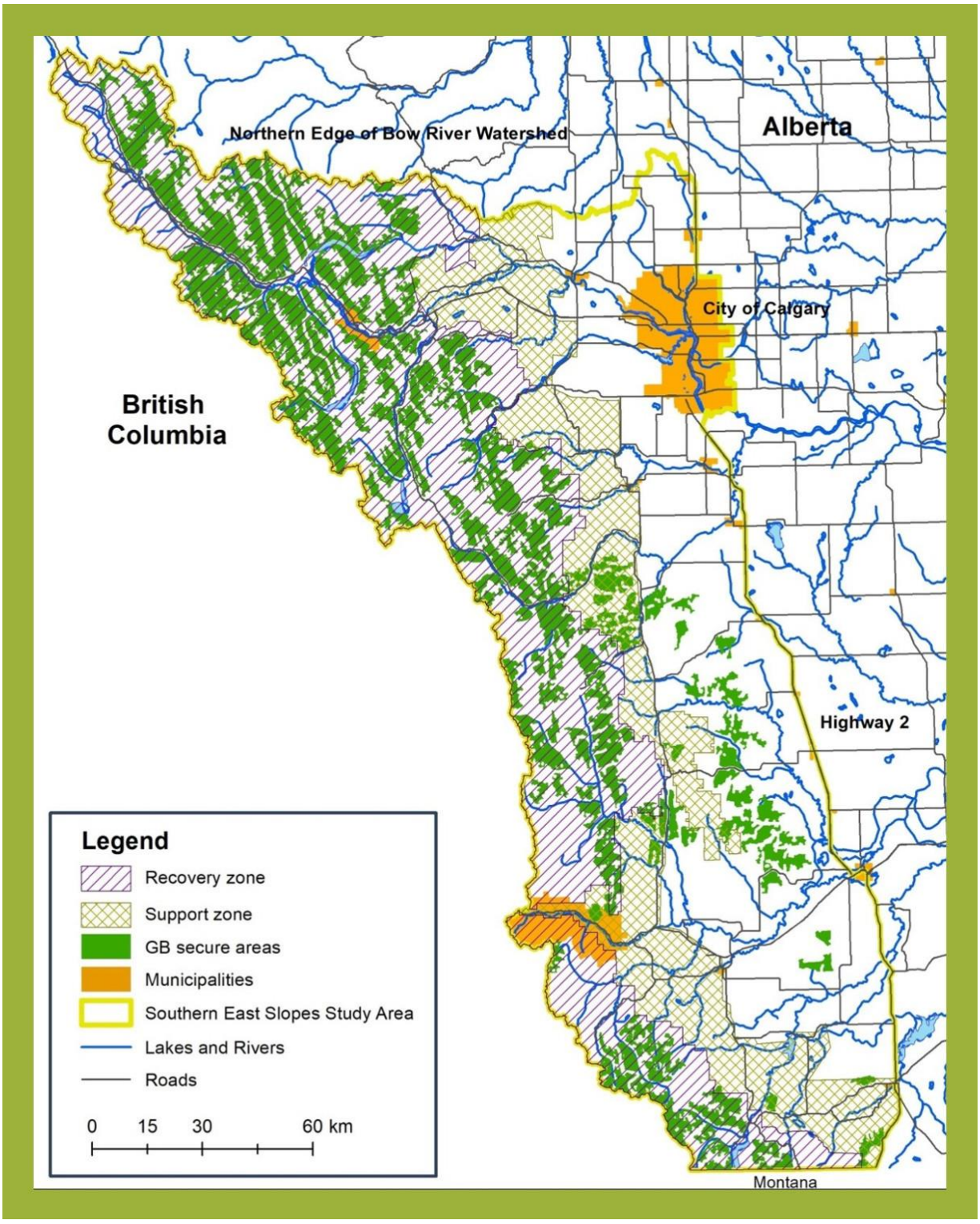

Figure C-1: Secure Grizzly Bear Habitat (≥9 km2) in Recovery and Support Zone

Results

The total recovery areas for grizzly bears is 12,330 km^2, of which 3423 km^2 is secure habitat as defined in this report. Therefore, 28% of the recovery zone is defined as secure habitat for grizzly bears.

This wide-ranging mammals KEA was rated as fair, as 28% of the recovery zone is defined as secure habitat for grizzly bears, which is well below the desirable level of 68% secure habitat (Gibeau et al. 2001). A rating of fair indicates the target is outside the acceptable range of variation and requires human intervention. If left unchecked, the target will be vulnerable to serious degradation.

SIZE: Percentage of Intact Elk Winter Range

Because elk are most limited during winter, secure winter habitat is important for survival. Human development continues to occur in the Southern Eastern Slopes, resulting in habitat loss in core winter ranges.

Methods

The indicator for this KEA is the percentage of elk winter range habitat without human disturbance. We used the elk winter range data publically available from Alberta Environment and Parks, with adjustments by Dale Paton and Grant Chapman of AEP (see Figure 3). The existing human footprint was divided into high and low human use (based on same assessment as grizzly bears) where the high human-use features were buffered by 500 m and then (from 2014 ABMI dataset) removed from the core elk winter range and percent reduction of habitat was calculated.

Results

The total area of elk winter range is 3999 km^2, of which 1774 km^2 is not affected by human footprint. Because 30% of elk winter range does not have human disturbance, these areas are considered low-risk areas for elk.

This wide-ranging mammals KEA was rated as **fair** given that the percentage of elk winter range habitat that does not have human disturbance is low. A rating of fair indicates the target is outside the acceptable range of variation and requires human intervention. If left unchecked, the target will be vulnerable to serious degradation.

LANDSCAPE: Success of wildlife crossing mitigation on Highway 1 and Highway 3

Many species of wildlife avoid crossing roads, creating movement barriers across the landscape. These barrier effects reduce the amount of habitat available to wildlife, alter predator–prey interactions, and can reduce the viability of populations through genetic isolation. For some species, like large carnivores, mortality from vehicle collisions is often the greatest cause of death. As such, roads can pose a major hurdle to wildlife management and conservation objectives. Major east/west highways in the Southern Eastern Slopes study area, including both Highway 1 and Highway 3, fragment the landscape to both elk and grizzly bear movement and can lead to direct mortality from collision with vehicles (Alberta Environment and Parks 2016; Benz et al. 2016).

Highway mitigation is a widespread and highly effective means to resolve issues of road–wildlife interaction. Mitigation can involve making drivers more alert (e.g., animal detection systems, variable message signs), separating wildlife and motorists (e.g., exclusion fencing and crossing structures – overpasses and underpasses), and modifying animal behaviour near the road (e.g.,

large boulder fields, vegetation manipulation). There have been mitigation efforts to improve movement along Highway 1 and Highway 3.

To determine ungulate vehicle collision rates per year, the following reports were used:

- *Transportation Mitigation for Wildlife and Connectivity in the Crown of the Continent Ecosystem* (Clevenger et al. 2010)
- *Highway Wildlife Mitigation Opportunities for the TransCanada Highway in the Bow Valley* (Lee et al. 2012)

In the future, this analysis could be based on Alberta Transportation's Wildlife Watch program (initiated May 2017), whereby highway maintenance contractors and government staff report wildlife mortality along highways via a smartphone application.

Methods

The following datasets were used to determine the number of WVCs on Highway 3:

- Highway Maintenance Contractor data (2000–2015)
- Alberta Fish and Wildlife Enforcement database (2000–2014)

The follwing datasets were used to determine the number of WVCs on Highway 1:

- Clevenger – data collected by Tony Clevenger systematically from April to October 1998 to 2002. Other months (Nov–March) and from 2003 to 2005 data were collected by Alberta Environment and Sustainable Resource Development (AESRD) Fish and Wildlife.
- ENFOR – Enforcement Occurrence Record database, information collected by AESRD Fish and Wildlife Officers and Parks Conservation Officers. When they encounter road kill or respond to a public call about a WVC, the officer is required to fill out an ENFOR Occurrence Record.
- WOD – Wildlife Observation Database, includes records from public calling in a road kill either directly to Kananaskis Emergency Services (KES) or to the AESRD office. Officers and other staff will also on occasion call in road kill information to KES.
- KES – Kananaskis Emergency Services database replaced WOD in 2006.
- Logbook – a logbook of road kill information maintained in the AESRD office of records of wildlife sightings and mortalities witnessed by staff.

Results

Along Highway 3 (44-km from the Alberta/British Columbia border to Lundbreck, Alberta) 2039 ungulate–vehicle collisions (UVC) were recorded from 2000 to 2015. On average there are **135 UVCs per year,** with a low of 78 UVCs per year and a high of 170 UVCs per year.

Table C-1 shows the average number of animals per year based on a 15-year dataset per species along Highway 3.

Table C-1: UVC Per Year Along Highway 3

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Av/Year
mule deer	43	38	66	76	79	65	67	92	77	80	100	122	116	88	114	65	1288	86
white tailed deer	33	28	28	39	22	32	25	26	24	39	33	38	37	35	40	42	521	35
elk	7	6	5	10	4	4	2	4	1	8	5	23	8	4	12	7	110	7
sheep	2	2	2	9	3	8	7	9	2	2	5	5	5	13	3	1	78	5
moose	1	1	2	1	0	4	1	1	2	1	1	1	2	0	1	0	19	1
deer fawn	2	3	1	2	0	0	0	0	0	0	0	0	0	0	0	0	8	1
deer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
Grand Total	**88**	**78**	**104**	**137**	**108**	**113**	**102**	**132**	**106**	**130**	**144**	**189**	**168**	**140**	**170**	**121**	**2030**	**135**

Along Highway 1 (39-km from Banff National Park to Highway 68 junction) 293 UVCs were recorded from 2006 to 2010, on average there are **59 UVCs per year**, with a low of 52 UVCs per year and a high of 63 UVCs per year. Table C-2 shows the average number of animals per year based on a five-year dataset per species along Highway 1.

Table C-2: UVC Per Year Along Highway 1

Species	2006	2007	2008	2009	2010	Total	Av/Year
elk	12	23	19	22	21	97	19
deer	15	16	14	16	25	86	17
white-tailed deer	25	13	16	9	16	79	16
mule deer	5	7	3	2	1	18	4
bighorn sheep	2	3	0	3	0	8	2
moose	3	1	0	1	0	5	1
Total	**62**	**63**	**52**	**53**	**63**	**293**	**59**

This wide-ranging mammals KEA was rated as **good**, as the current UVC rate was not deemed likely to affect local ungulate populations, except for bighorn sheep along Highway 3, where in some years more than 10% of the local population was affected. Recent mitigation along Highway 3 at Emerald Lakes has likely helped to reduce bighorn sheep mortality. This should be tracked over time and if bighorn sheep mortality due to collisions with vehicles does not reduce, additional adjustments might be required and the score for UVCs might need to be reconsidered.

A good rating means that the indicator is within acceptable range of variation; some intervention required for maintenance. For Highway 3, a good rating was considered to be less than 135 UVCs per year based on average UVCs over a 15-year period. In recent years UVCs have exceeded this rate, but efforts underway to mitigate Highway 3 will lead to a reduction in UVCs, and the current rate is expected to decline over time. For Highway 1 a good rating was considered less than 60 UVCs per year based on the average UVCs over a five-year period.

CONDITION: Grizzly Bear Survival

To understand the current health of the wide-ranging mammals target, we used an indicator of human-caused grizzly bear mortality. We assessed the human-caused grizzly bear mortality over six years using mortality numbers from the *Draft Alberta Grizzly Bear (Ursus arctos) Recovery Plan* (Alberta Environment and Parks 2016). The Southern Eastern Slopes study area covers BMA 5 – Livingstone and BMA 6 – Castle.

This measure evaluates the number of grizzly bears killed annually due to human causes as a percentage of the total population size per BMA (Alberta Environment and Parks 2016, p. 14). "The AGBRP (2008) used population viability analysis results (McLoughlin 2003) to determine

that the grizzly bear population should increase if the number of known human-caused mortalities is ≤4% of the provincial population per year, and within that total, the female mortality rate does not exceed 1.2%" (Alberta Environment and Parks 2016)(p. 6).

One of the recovery objectives in the *Draft Alberta Grizzly Bear (Ursus arctos) Recovery Plan* (Alberta Environment and Parks 2016) is "in the recovery and support zones, the known human-caused mortality rate is ≤4%, of which the female mortality rate does not exceed 1.2%, except in BMA 5 and BMA 6 where the mortality rate is less than 6%, of which the female mortality rate does not exceed 1.8%" (p. 32). The rationale behind the variation for BMA 5 and BMA 6 is that in these areas the goal is for the population to remain stable "in order to not further exacerbate the very high rates of human–grizzly bear conflict associated with livestock and livestock feed currently occurring in the Support Zone" (p. 32–33). To the best of our knowledge there is no scientific support for the 1.8% female mortality leading to a stable population.

Methods

Mortality data from the *Draft Alberta Grizzly Bear (Ursus arctos) Recovery Plan* (Alberta Environment and Parks 2016, p. 28, Table 5.8) were used to determine the human-caused mortality rates for BMA 5 and BMA 6. "For the purpose of reporting on mortality rates, bears that are captured and removed from a BMA are considered a mortality for the donor BMA but do not count as a mortality if they should later die due to human-caused mortality in the recipient BMA" (Alberta Environment and Parks 2016, p. 6). We also used data and statements from the *Draft Alberta Grizzly Bear (Ursus arctos) Recovery Plan* (Alberta Environment and Parks 2016) that provide the rates of human-caused mortality/translocation for each BMA.

Results

From 2009–2013 (five-year period) the total human-caused grizzly bear mortality in BMA 5 was **21** grizzly bears (of 26 reported grizzly bear mortalities in this period) with the leading human causes being (from highest mortality to lowest) road kill, illegal, self-defence and aboriginal harvest (p. 28, Table 5.8). The number of grizzly bears moved during this period was 36 (p. 23). "The known human caused mortality rate excluding relocations in this BMA is slightly over the 4% threshold estimated to allow for population growth. Likewise, the female mortality is over the 1.2% threshold. However, if relocated bears (outside BMA 5) are factored into the mortality estimates for BMA 5 the mortality rate is substantially over the thresholds" (p. 22).

Table 5.1 (p. 14) shows that grizzly bear human-caused mortality rates and relocations from BMA 5 is 7.8% per year and the female rate is 2% per year based on data from 2008–2013 (six-year period).

From 2009–2013 the total human-caused grizzly bear mortality for BMA 6 was **12** grizzly bears (of 14 reported grizzly bear mortalities in this period) with the leading human-causes being (from highest mortality to lowest): illegal, problem, aboriginal harvest, accidental and self-defence (p. 28, Table 5.8). The number of grizzly moved during this period was 42 (p. 24) due to human and wildlife conflict. Table 5.1 (p. 14) shows that the human-caused mortality rate and relocations from BMA 6 is 10.5% per year and the female rate is 3.6% per year based on data from 2008–2013 (six-year period).

This wide-ranging mammals KEA was rated as **fair to poor** as the mortality (majority is human-caused) and translocation rates greatly exceed the recommended thresholds for BMA 5 and BMA 6. The rating of fair is a combined rating of both BMA 5 and BMA 6; it should be acknowledged that each of these BMAs has a different rating but the combination is determined to be on the low end of fair. A rating of fair means the indicator lies outside the acceptable range of

variation and requires human intervention. If left unchecked, the target will be vulnerable to serious degradation.

APPENDIX D: THREATS AND STRESSES – WIDE-RANGING MAMMALS

For each KEA identified for wide-ranging mammals, sources of stress were identified and rated for their severity and scope based on the following categories defined by the TNC CAP process (TNC 2007). Stresses and threats were rated based on expert opinion: Dale Paton, Michael Gibeau, Craig Harding and Tracy Lee.

Severity considers the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation):

- Very High: The threat is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site.
- High: The threat is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site.
- Medium: The threat is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.
- Low: The threat is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

Scope is defined as the geographic scope of the impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstance (i.e., given continuation of the existing situation):

- Very High: The threat is likely to be widespread or pervasive in its scope and affect the conservation target throughout the target's occurrence at the site.
- High: The threat is likely to be widespread in its scope and affect the conservation target at many of its locations at the site.
- Medium: The threat is likely to be localized in its scope and affect the conservation target at some of the target's locations at the site.
- Low: The threat is likely to be very localized in its scope and affect the conservation target in a limited portion of the target's location at the site.

Table D-1: Sources of Stress for Wide-Ranging Mammals Target

Stresses	Severity	Scope	Stress Rank
Reduced secure areas	High	High	High
Human-caused mortality	High	High	High
Reduced connectivity	Medium	High	Medium

Expert opinion was used to rate each source of stress in terms of its contribution and irreversibility. TNC (2007) defines these terms as follows:

Contribution is defined (TNC 2007) as the expected contribution of the source, acting alone, to the full expression of a stress under current circumstances:

- Very High: The source is a very large contributor of the particular stress.
- High: The source is a large contributor of the particular stress.
- Medium: The source is a moderate contributor of the particular stress.
- Low: The source is a low contributor of the particular stress.

Irreversibility is defined as the degree to which effects of a source of stress can be restored:

- Very High: Source produces a stress that is not reversible.
- High: Source produces a stress that is reversible, but not practically affordable.
- Medium: Source produces a stress that is reversible with reasonable resource commitment.
- Low: Source produces a stress that is easily reversible at relatively low cost.

Table D-2: Threats for Wide-Ranging Mammals Target

Tables generated by Nature Conservancy of Canada and exported from Miradi software.

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Motorized Recreational Activity	Reduced Extent of Core Habitat	High	High	High	High	High
Motorized Recreational Activity	Increased Human Use	Very High	High	High	High	High
Motorized Recreational Activity	Reduced Connectivity	Medium	High	Medium	High	High
Motorized Recreational Activity	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Linear Disturbance (Roads, Rails, and Transmission Lines)	Reduced Extent of Core Habitat	High	High	High	Medium	Medium
Linear Disturbance (Roads, Rails, and Transmission Lines)	Increased Human Use	Very High	High	High	High	Medium
Linear Disturbance (Roads, Rails, and Transmission Lines)	Reduced Connectivity	Medium	High	Medium	High	Medium
Linear Disturbance (Roads, Rails, and Transmission Lines)	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Commercial Logging	Reduced Extent of Core Habitat	High	High	High	Medium	Medium
Commercial Logging	Increased Human Use	Very High	High	High	High	Medium
Commercial Logging	Reduced Connectivity	Medium	High	Medium	Medium	Medium
Commercial Logging	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Residential Development (Rural Residential Growth)	Reduced Extent of Core Habitat	High	High	High	High	Very High
Residential Development (Rural Residential Growth)	Increased Human Use	Very High	High	High	High	Very High
Residential Development (Rural Residential Growth)	Reduced Connectivity	Medium	High	Medium	High	Very High
Residential Development (Rural Residential Growth)	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Non-Motorized Recreational Activities	Reduced Extent of Core Habitat	High	High	High	High	High
Non-Motorized Recreational Activities	Increased Human Use	Very High	High	High	High	High
Non-Motorized Recreational Activities	Reduced Connectivity	Medium	High	Medium	High	High
Non-Motorized Recreational Activities	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Surface Disturbance (Industrial Clearing, Mining)	Reduced Extent of Core Habitat	High	High	High	Medium	High
Surface Disturbance (Industrial Clearing, Mining)	Increased Human Use	Very High	High	High	Not Specified	Not Specified
Surface Disturbance (Industrial Clearing, Mining)	Reduced Connectivity	Medium	High	Medium	Medium	High
Surface Disturbance (Industrial Clearing, Mining)	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Altered fire regime	Reduced Extent of Core Habitat	High	High	High	Not Specified	Not Specified
Altered fire regime	Increased Human Use	Very High	High	High	Not Specified	Not Specified
Altered fire regime	Reduced Connectivity	Medium	High	Medium	Not Specified	Not Specified
Altered fire regime	Altered Fire Regime	High	Medium	Medium	Very High	Medium

Threat	Stress	Severity	Scope	Magnitude	Contribution	Irreversibility
Surface Disturbance (Oil and Gas)	Reduced Extent of Core Habitat	High	High	High	Medium	High
Surface Disturbance (Oil and Gas)	Increased Human Use	Very High	High	High	High	High
Surface Disturbance (Oil and Gas)	Reduced Connectivity	Medium	High	Medium	Medium	High
Surface Disturbance (Oil and Gas)	Altered Fire Regime	High	Medium	Medium	Not Specified	Not Specified