Grizzly Bear
Cumulative Effects Assessment Report

Elk Valley, Kootenay-Boundary Region

Photo: Troy Malish

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Grizzly Bear Expert Team

Garth Mowat (FLNRORD, Team Lead), Cathy Conroy (KNC), Kevin Podrasky (Teck Coal), Don Morgan (MOE), Rhian Davies (FLNRORD), Ryan MacDonald (ALCES Landscape & Land Use Ltd.), Emily Chow (FLNRORD), Cassidy van Rensen (FLNRORD), Taye Ayele (FLNRORD)

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EXECUTIVE SUMMARY

The Elk Valley in British Columbia's East Kootenay is rich in biodiversity, culture and economic wealth. Management of cumulative effects in the Elk Valley has been of increasing concern due to resource development and residential and recreational pressures as well as natural events.

Grizzly bears are an important part of the BC ecosystem, where they are named as a valued component in the provincial Cumulative Effects Framework. They are recommended for listing as a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and are listed by the BC government as S3, a vulnerable species. Grizzly bears have high cultural, social and ecological values. Grizzly bears range widely and utilize a variety of habitats, seeking to find food (largely grasses, roots and berries) and avoid risk from human contact. Therefore, assessment of their status can help inform a wide range of decisions about resource management in the Elk Valley.

Spatial and non-spatial data were used to assess historic, current and potential future conditions, as well as to develop hazard maps. Three alternative future development scenarios, namely, business as usual, minimum, and maximum, and a higher natural disturbance scenario were defined to assess the response of indicators to variations in rates, spatial configurations, density or pattern of development and disturbance over the next 50 years using the ALCES Online model. Four indicators of Grizzly bear status were selected for assessment in this study:

1) Availability of four key habitat types (avalanche chutes and alpine, huckleberry and buffaloberry habitat, early seral forest, and riparian habitat), discounted for human settlements and road density;
2) Habitat connectivity;
3) Human-caused mortality;
4) Population trend.

Retrospective assessment compared present-day indicator status to conditions in the 1950s (or as far back as data were available) and attempted to identify patterns of change and their key causes. For the habitat indicators, retrospective assessment was only possible for avalanche chutes and alpine habitat. These habitats showed a slight decline since 1950 (2% for avalanche chutes, 4.3% for alpine), though this masks more substantial declines in a few landscape units. Avalanche chute habitat declined by 21% in Landscape Unit C21 (Fording River) and alpine habitat declined by 64% in C38 (East Elk) and by 20% in C21 (Fording River), mostly due to mining activity in those localities.

The Expert Team was not able to develop a metric that could index changes in habitat connectivity. However, several datasets exist that map contemporary grizzly bear habitat connectivity. Several potential movement corridors used by Grizzly bears in the Elk Valley cross

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Highway 3, putting bears at risk of mortality from vehicle strikes. Crossing structures with deflection fencing on high-use connectivity corridors may reduce this mortality.

Human-caused mortality of Grizzly bears in the Elk Valley is high. The recent mortality rate is approximately triple that of bears in the rest of the South Rockies Grizzly bear population unit, which itself has the highest average female and total mortality of any unit in the Kootenay region. Human-caused mortality rates in this unit have exceeded policy thresholds of 1.8% of the female population 6% of total population for the past decade.

The Grizzly bear population in the South Rockies unit has been declining steadily since 2007, perhaps because of poor berry crops, although Grizzly bear abundance within the Elk Valley appears to have increased since 2012. Based on mortality indicators and population trend, the Grizzly bear population hazard varied greatly within the Elk Valley and found to be relatively higher than other areas in the South Rockies.

The prospective assessment uses well validated landscape models to project how Grizzly bear indicators might respond to alternative future development scenarios. The simulations suggest that development rate has a relatively small effect on the availability or suitability of Grizzly bear habitat, largely because so many roads already exist on the landscape. (However, a 50-year projection may not be sufficient to reflect the full realm of possibilities due to changes in forest age dynamics resulting from development.) Therefore, results below are presented for the Reference scenario, which assumes business as usual.

Habitat availability for Grizzly bears varies across the study area, largely as a result of variation in the abundance of young, open-canopy forest where most berries occur. Avalanche slopes and alpine areas have a smaller influence due to their limited distribution and their permanency on the landscape. High road density and the patchy distribution of high-quality habitat result in negligible habitat suitability and high hazard across most of the central and southern portion of the Elk Valley. Road density, and therefore hazard, is lower in the protected northern portion of the valley.

Habitat availability declined by 24% during the 50 years of the simulation, particularly during the second and third decades, due to a decline in open-canopy forest (i.e., younger than 20 years) from 18% of the total area of the valley at present to less than 5% of the valley by the end of the third decade of simulation. More importantly, habitat suitability declined by 29%. Note that the simulated decline in open-canopy forest may be overestimated in these simulations, as open-canopy forest may persist in some forests older than 20 years. Simulations using a higher level of natural disturbance result in improved habitat quality for Grizzly bears because the disturbance leads to a higher proportion of younger forest.

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Future management efforts should focus on access management to reduce contact, and therefore conflict, between humans and Grizzly bears. Basin-wide closure of forest roads is likely to be politically infeasible. Efforts should, instead, target road closures (perhaps including seasonal closures during huckleberry season) where they will make the greatest difference to Grizzly bear habitat quality and hazard, such as in areas of high habitat value. Simulations suggest that such an approach can reduce hazard by about 50% and 40% with the closure of 50% and 25% of the roads in the study area, respectively.

Another effective management approach for Grizzly bears is to implement forest management measures to enhance berry production. Such measures could include preferential logging in areas likely to support berries post-harvest, burning to keep cut-blocks open, and tree pruning or reduced stocking standards for trees to reduce shading.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALCES	A Landscape Cumulative Effects Simulator
AW	Assessment Watershed
BCGW	British Columbia Geographic Warehouse
BEC	Biogeoclimatic Ecosystem Classification
CEA	Cumulative Effects Assessment
CEMF	Cumulative Effects Management Framework
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EVWQP	Elk Valley Water Quality Plan
FRPA	Forest and Range Practices Act
FLNRORD	Forest, Lands, Natural Resource Operations and Rural Development
GB	Grizzly bear
FWA	British Columbia Freshwater Atlas
KNC	Ktunaxa Nation Council
LU	Landscape Unit
NGO	Non-governmental organization
PEM	Predictive Ecosystem Mapping
QEP	Qualified Environmental Professional
RAR	Riparian Areas Regulation
RRZ	Riparian Reserve Zone
SARA	Species at Risk Act
TRIM	Terrain Resource Information Management
VC	Valued Component
VRI	Vegetation Resources Inventory
WHA	Wildlife Habitat Area
WSA	Water Sustainability Act

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DOCUMENT PURPOSE

The purpose of this document is to outline the rationale, methods, and results of the Cumulative Effects Assessment (CEA) of Grizzly bears in the Elk Valley as part of the Elk Valley Cumulative Effects Management Framework (CEMF). The various sections provide details about the existing policy framework, indicators, associated benchmarks, hazard ratings, description/interpretation of results, and management responses including mitigation measures for Grizzly bears in the Elk Valley.

The cumulative effects assessment methods were developed by a Working Group comprised of BC government staff, First Nations, industry partners, environmental non-governmental organizations (NGOs), municipalities, and consultants. The Grizzly Bear Expert Team refined the methods. Further review was completed by the Elk Valley CEMF Working Group and the broader stakeholders' Group (a.k.a. Workshop Group).

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1.0 INTRODUCTION

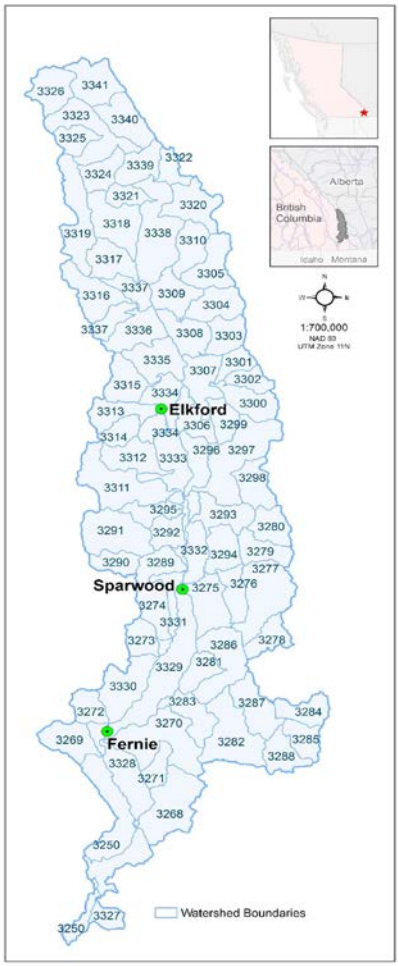

Figure 1. Elk Valley Study area and assessment watersheds (numbered).

1.1 ELK VALLEY CUMULATIVE EFFECTS MANAGEMENT FRAMEWORK

The Elk Valley is located in the East Kootenay of British Columbia. The study area for the Elk Valley CEMF extends from Mount Fox in the north to Lake Koocanusa in the south. (Figure 1). The Elk Valley is an area rich in biodiversity, culture and economic wealth. Coal mining and forestry are the biggest industries in the valley, with tourism playing a smaller but growing role. Furthermore, the Ktunaxa First Nations have a deep, long-standing connection to this valley in terms of resource and spiritual values.

The management of cumulative effects in the Elk Valley has been of increasing concern due to current and ongoing resource development including open pit coal operations, timber harvesting on public and private lands, increasing recreational pressures and municipal development, all of which are contributing to stresses on the watershed. There has been growing awareness of the need for a broadly accepted, credible, and workable approach to the assessment and management of cumulative effects in the Elk Valley, and provincially.

Cumulative Effects: *"changes to environmental, social and economic values caused by the combined effects of past, present and potential future activities and natural processes".*

Developing a cumulative effects management framework is a condition in Teck Coal's Line Creek Operations Phase II EA certificate. In recognition of this need, Teck Coal Ltd. and the Ktunaxa Nation Council (KNC) worked together to hold a multi-stakeholder workshop in July 2012. The Cumulative Effects Management Framework (CEMF) was launched during the initial workshop. Teck Coal Ltd. and KNC led this initiative until January 2015, when leadership was transitioned to the Ministry of Forests, Lands and Natural Resource Operations. A Working Group comprising 11 organizations (Appendix B) oversees the CEMF business. Annual workshops have been held for a broader stakeholder group.

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The purpose of CEMF is to develop a practical approach to assess historic, current and potential future conditions of selected valued components (VCs) and to provide a practical, workable framework that supports decisions related to assessment, mitigation and management of cumulative effects in the Elk Valley. The goal is to inform and support natural resource management decisions at appropriate levels.

The Elk Valley is a unique and challenging study area because 32% of the land is privately owned and there is extensive land use throughout. This presents some challenges with regard to the management and assessment of the values in the valley because legislation and guidelines vary between crown and private land management.

The Elk Valley CEMF is being implemented in four stages, the details of which are provided below:

1. **Context**: includes establishing spatial and temporal boundaries, and selecting valued components as the focus for the cumulative effects assessment. In general, the temporal coverage spans from 1950 to 2065.

2. **Retrospective Assessment**: includes assessing the historic and current condition of each VC using indicators of population status or quality and amount of required habitat. Additionally, benchmarks that reflect the hazard/risk to each indicator were set and VC conditions were assessed in relation to these.

3. **Prospective Assessment:** includes forecasting future conditions. Three alternative scenarios were created to assess how different rates of development may affect the valued components and their indicators into the future. In addition, two climate change scenarios, an increased natural disturbance scenario, and three mitigation options have been identified, and integrated with the future development scenarios to simulate potential future conditions.

4. **Management Action and Follow-up**: includes management recommendations and monitoring based on the results of the cumulative effects assessment.

The first three stages have been completed and stage 4 is on-going.

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1.2 Why Grizzly Bears?

Values are a set of held principles or beliefs about what we see as important. Valued components (VCs) for the CEMF were chosen based on a number of criteria including that they are sensitive to cumulative effects and that the results of the assessment will help inform, and support as many natural resource decisions as possible.

Grizzly bears are found across most of the province of British Columbia and are also a value in the Provincial Cumulative Effects Framework (CEF). They have high cultural and ecological value and contribute to the visual quality of the landscape. Since they are very wide-ranging and utilize a variety of habitats, the results of the assessment help inform many decisions related to the resources in the Elk Valley.

1.3 Knowledge Summary

Grizzly Bear Ecology and Habitat Requirements

Grizzly bears are a wide-ranging species that depend on multiple ecosystem types throughout the year. Habitat selection is largely related to available forage and risk avoidance (i.e. road density or distance to roads). Grizzlies are opportunistic omnivores, but are primarily herbivorous in this ecosystem. In the spring, they primarily feed on grasses and roots and early vegetation in riparian areas and in areas with early green-up such as warm-aspect avalanche chutes. As the snow clears, some follow the green-up and select emerging vegetation and other spring growth. In the summer and fall, buffaloberries (*Shepherdia canadensis*) and huckleberries (*Vaccinium membranaceum)* become important food sources as the bears attempt to build body fat for winter. In the Elk Valley, ungulates are an important food in the autumn and early spring. Carcasses of winter-killed individuals are scavenged in early-spring while gut piles from hunters are scavenged in fall. Grizzly bears also scavenge ungulates along the highway in road kill pits. Males hunt newborn ungulates in late spring.

Conservation Status and Threats

Grizzly bears are recommended for listing as a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In BC, they are listed as an S3, or vulnerable species, by the BC Data Conservation Data Centre.

There are many causes of direct and indirect Grizzly bear mortality in the Elk Valley. Hunter harvest and vehicle strikes are currently the greatest causes of direct mortality of adult bears. However, the cumulative effect of human development has been stated to be the largest threat to Grizzly bears in British Columbia (BC Conservation Data Center, 2012), and the Elk Valley is no exception. This includes destruction of habitat, loss of connectivity among populations,

alteration and alienation of habitats, and increased human access into previously secure areas; all of which can result in bears being killed by people.

"To prevent further loss of Grizzly Bears in British Columbia, we need to secure suitable habitat for the future, control potentially harmful land uses within the remaining habitat, and carefully manage human-related grizzly death rates." – Grizzly Bears in British Columbia: Ecology, Conservation and Management, 2002

POLICY AND LEGAL CONTEXT

Within provincial legislation, there are few explicit objectives or policies for Grizzly bears in British Columbia. There are more broad objectives for habitat conservation and maintaining populations. In BC, Grizzly bear mortality management is guided by the Grizzly Bear Harvest Management Procedure under the *Wildlife Act* and the species is protected from unrestricted hunting. This procedure sets limits for maximum allowable human-caused mortality. Another important piece of legislation is the *Forest and Range Practices Act* (FRPA). This supports land-use plans such as the Kootenay-Boundary Land Use Plan Implementation Strategy which contains procedures that support Grizzly bear habitat and population management objectives, and can establish wildlife habitat areas or general wildlife measures related to Grizzly bear habitat through the Identified Wildlife Management Strategy.

The Provincial Cumulative Effects Framework Grizzly bear team extensively reviewed existing objectives and proposed the following broad objectives for the cumulative effects assessment procedure of Grizzly bears:

1. At the population scale, manage for viable populations of Grizzly bear and avoid populations becoming threatened;
2. At the landscape scale, maintain the distribution of Grizzly bears and their habitats.

2.0 ASSESSMENT METHODS

2.1 ASSESSMENT UNITS AND REPORTING UNITS

The assessment was organized by A. Habitat Indicators; B. Habitat Connectivity; C. Human Caused Mortality; and D. Population Trend. The assessment for habitat indicators was conducted for several preferred habitats (avalanche chutes & alpine, huckleberry and buffaloberry habitat, early seral forest, riparian habitat) and given an overall rank for a subset of Landscape Units (LUs) and summarized by sub-basin watershed (Figure 2). Metrics related to road density and human settlements were also assessed and reported at the LU scale.

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Habitat values were summed to create an index of habitat availability. Habitat availability incorporates all positive habitat indicators (Figure 3). This measure is an index of the value of this area to bears for vegetative forage based on the current vegetation conditions. Habitat suitability is habitat availability with a discount for negative habitat stressors such as road density and human development. Hazard was calculated as the inverse of habitat suitability (i.e. low habitat suitability is high hazard).

Habitat connectivity is presented for the Elk Valley study area. Both human-caused mortality and population trend (presented together) were assessed at the Grizzly Bear Population Unit (GBPU) for the South Rockies GBPU.

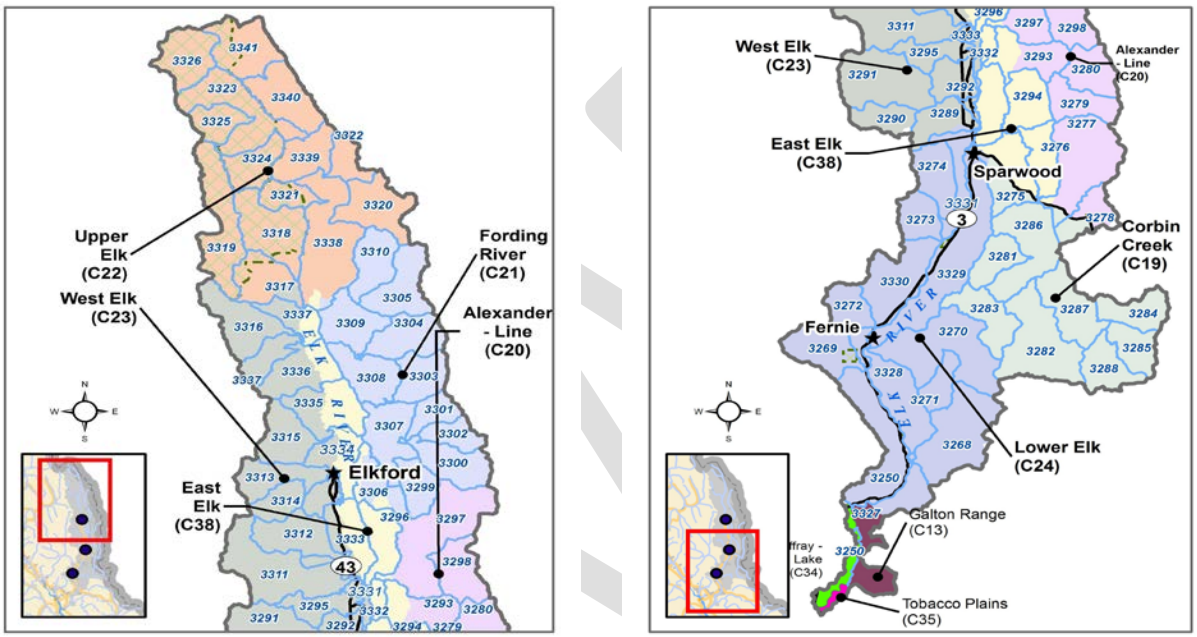

Figure 2. Assessment watersheds coloured by Landscape Unit in the north (left) and south (right).

2.2 Data Sources

Data were collected from various sources to calculate indicators. One of the key spatial layers was a road feature class. A roads product was created by Touchstone GIS Services Inc. based on a compiled road feature class that is a result of a script built by Sasha Lees (FLNRO) in 2013. The source roads feature classes are all from the BC Geographic Warehouse and include:

- As Built Roads
- Digital Road Atlas
- Forest Tenure
- TRIM

This script did not include overgrown, retired, or in-block roads (trails). Once the initial merge of the above roads was created, the roads were displayed on 2005 orthophotos and reviewed manually, vector by vector, to determine:

- If they existed on the ground in 2005 or not.
- If the road was missing, (i.e. existed on the orthophotos, but not in the digital set of polylines). Missing roads were digitized based on the orthophotos.

The year 2005 was chosen as it was the year that orthophotos were available for the whole of Elk Valley, and it is as close as possible to the change in management practices related to the Forest Practices Code of British Columbia Act and regulations, which came into effect on June 15, 1995.

The Predictive Ecosystem Mapping (PEM) dataset was used to identify habitat types that are important to Grizzly bears. A present and past PEM dataset were compared to get an understanding of historical condition. A 1950 PEM from Teck was updated for historical condition. Ecosystem corrections, particularly to the grasslands, were completed for the 2015 PEM within the Elk Valley.

To make a meaningful comparison between the two, these same corrections were made to the 1950 PEM. In addition to ecosystem corrections, codes corrections were required to bring the 1950 PEM in line with current conventions. These corrections were done by Deb McKillop, Audrey Ehman, and Rhian Davies (FLNRO).

The site series values used to compare avalanche chutes and alpine in the PEM dataset include:

- Vh - Avalanche - Herb
- Vs - Avalanche - Shrub
- Ag - Alpine Grassland
- Am - Alpine Meadow
- AtAg - Alpine Tundra/Alpine Grassland

Additional data sources are described below each indicator.

2.3 Indicators and Benchmarks

Values are not always measurable in their own right, and data that do measure a value directly may not always be readily available to guide decisions. Measurable indicators need to be identified to assess or evaluate the status of, or threats to, the VC.

The following section describes the indicators used for the cumulative effects assessment of Grizzly bears and the associated benchmarks/thresholds. Each of these indicators will be

assessed and summarized by Landscape unit or sub-drainage (these are described in the Riparian Narrative).

The indicators are described with the following structure:

- Scientific Context – description of the scientific basis for the selection of the indicator;
- Indicator Overview– description of the indicator;
- Data Sources;
- Caveats and Data Limitations – gaps or limitations in the data.

Indicators are the metrics used to measure and report on the condition and trend of a valued component.

Benchmarks are points along the continuum of a measured indicator that reflect the level of risk or hazard to a valued component.

It is noted that many of these indicators are only a proxy of population status and aren't necessarily an absolute indication of population condition. Population indicators are included in Tier II indicators.

The Grizzly bear assessment has three components (Figure 3), each with their own set of indicators: **habitat quality or amount, population connectivity, and population health.**

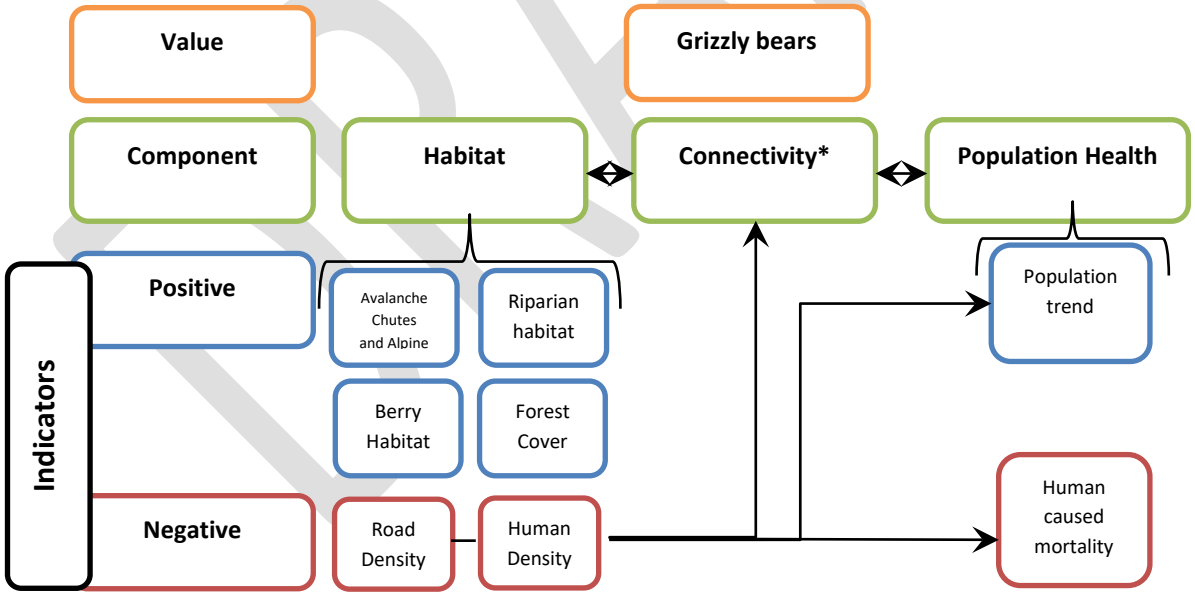

Figure 3. Grizzly bear CE Assessment Model for the Elk Valley Cumulative Effects Management Framework. * Connectivity indicators need further development.

A. HABITAT INDICATORS

For the four habitat indicators (avalanche chutes and alpine, huckleberry and buffaloberry habitat, early seral forest, riparian habitat), habitat types were ranked according to strength of selection by Grizzly bears based on available data and expert knowledge. These were then summarized to give an overall rank of the habitat for each sub-basin watershed. Additionally, benchmarks were set for human settlement and road density per watershed. If road density is greater than either 0.6 km/km^2 or 1.2km/km^2, the sub-watershed rating is discounted by a value of 1 or 2, respectively. Thus, an overall ranking of habitat suitability per watershed is calculated.

When calculating habitat availability and habitat suitability, habitat was assessed on a scale of 0 to 1, with a value of 1 equating to Rank 5 habitat, a value of 0.8 equating to Rank 4 habitat, and so on.

I) AVALANCHE CHUTES AND ALPINE

Scientific Context

Grizzly bears strongly select avalanche chutes and alpine areas, especially in spring and early summer (Mowat and Ramcharita 1999, McLellan and Hovey 2001). They may also exclude black bears from these areas so competition is reduced (Apps et al. 2006). Additionally, the food types in these habitats provide important early season forage for bears, with avalanche chutes and alpine areas often becoming snow free before other sites (McClellan and Hovey, 2001). Ski hills are included in this category because they contain similar forage to what would be found in natural avalanche chutes. We rated the entire recreation area one level below the highest rating for avalanche chutes (herbaceous chutes) because it is a mixture of open and forested habitats and there was no finer scale mapping available to assign ratings to each habitat type. Reclaimed mining areas were rated two levels below the herbaceous avalanche chutes because they were primarily low elevation and hence likely have value only in spring and not summer, the re-vegetation is spottier than on a ski hill, and the forage on mines is primarily non-native in composition.

Indicator Overview

The total area of PEM-defined avalanche chutes and alpine habitat classes, ranked by their value to Grizzly bears is presented in Table 1.

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Table 1. PEM defined avalanche chutes and alpine habitat classes, ranked by their value to Grizzly bears (0-5, lowest value to highest value to Grizzly bears).

Avalanche chute and Alpine Habitat Type	Rank (0-5)
Avalanche Herb	4
Alpine Meadow	4
Avalanche Shrub	3
Alpine Grassland	3
Alpine Grass/Heath	3
Ski hills	3
Reclaimed Mine	2
Alpine Tundra	2
Alpine fellfield	0
Alpine Nivation	0
Avalanche treed	0

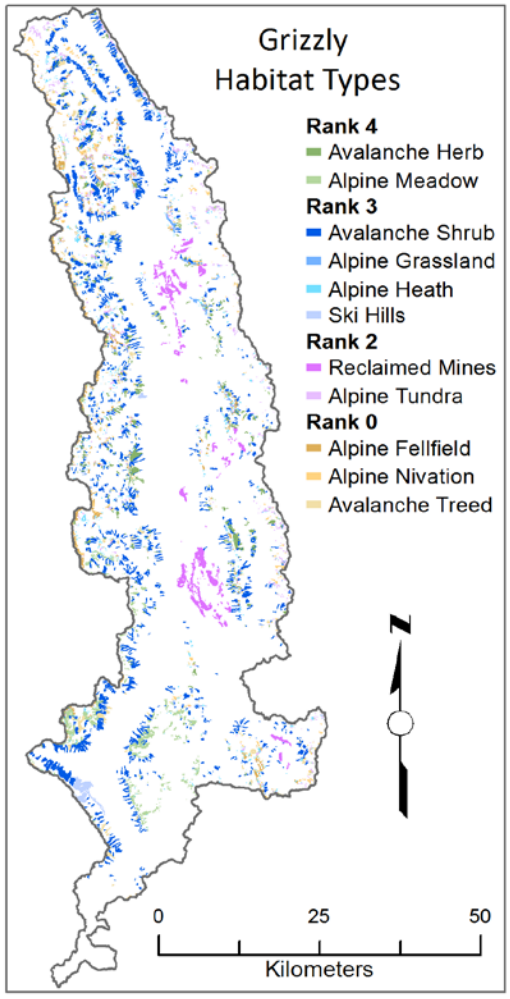

Figure 4. Alpine and Avalanche chute habitat types from the PEM with their associated rank

Data Sources

- Habitat classes were derived from 2015 PEM
- Habitat type rankings were developed based on expert opinion and scientific literature

Caveats and Data Limitations

These ratings are based on the potential forage production in these units. Some units such as Alpine fellfield or nivation may be used to hunt marmots or ground squirrels, which are not accounted for in our habitat ratings. PEM has reasonable resolution and modest accuracy which provides a source of error. Ski-hills were mapped as a single polygon which included forest and cleared runs. Mines had a single class of vegetation called 'reclaimed' which had quite variable vegetation cover when examined using aerial photos.

II) FOREST COVER

Scientific Context

Bears select open areas like early seral forests because these areas contain high quality forage. Several studies show negative selection for higher crown closure (i.e. bears select open areas) (Nielsen et al 2004) or a negative relationship between bear density and crown closure (Mowat et al. 2013).

Indicator Overview

The total area of PEM defined forest types ranked by habitat type is shown in Table 2.

Table 2. PEM defined forest types ranked by habitat type (0-5, lowest value to highest value to Grizzly bears)

Forest Cover Type	Rank (0-5)
Early seral stage, 1-10 years	3
Sub-alpine	3
Shrub stage, 11-20 years	2
Mid seral Stage, 21-80 years	0
Open mature/old, >80 years	1

Data Sources

- A curve was developed in ALCES to weight forest age, with mid-seral having the lowest weight. Habitat type rankings were developed based on expert opinion and scientific literature.
- Where VRI data was absent, a combination of data sources were used consisting primarily of the 2015 PEM (structural stages were converted to ages based on BEC i.e. age assigned using the midpoint of seral stage), disturbance history including pest outbreaks, fire and forest cutblocks, and NASA North American Carbon Program (NACP) Forest Age Maps at 1-km Resolution for Canada

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(https://daac.ornl.gov/NACP/guides/NA_Tree_Age.html). For remaining gaps, interpolation for forest age was done by converting the study area and surrounding area to a raster (25 m resolution) and using known ages adjacent to the raster cells to assign forest age. This resulted in the entire study area having an assigned forest age.

- The PEM was used to define sub-alpine habitat.

Caveats and Data Limitations

Where the VRI data was absent, the PEM, satellite imagery and interpolation were used to define forest age and the resulting seral stages. Accuracy has not been assessed for the structural stages derived from satellite image interpretation. Additionally, the conversion of PEM structural stages to seral stages is less detailed and accurate than VRI. Private lands do not have VRI available, except where JEMI VRI was provided and included in the analysis.

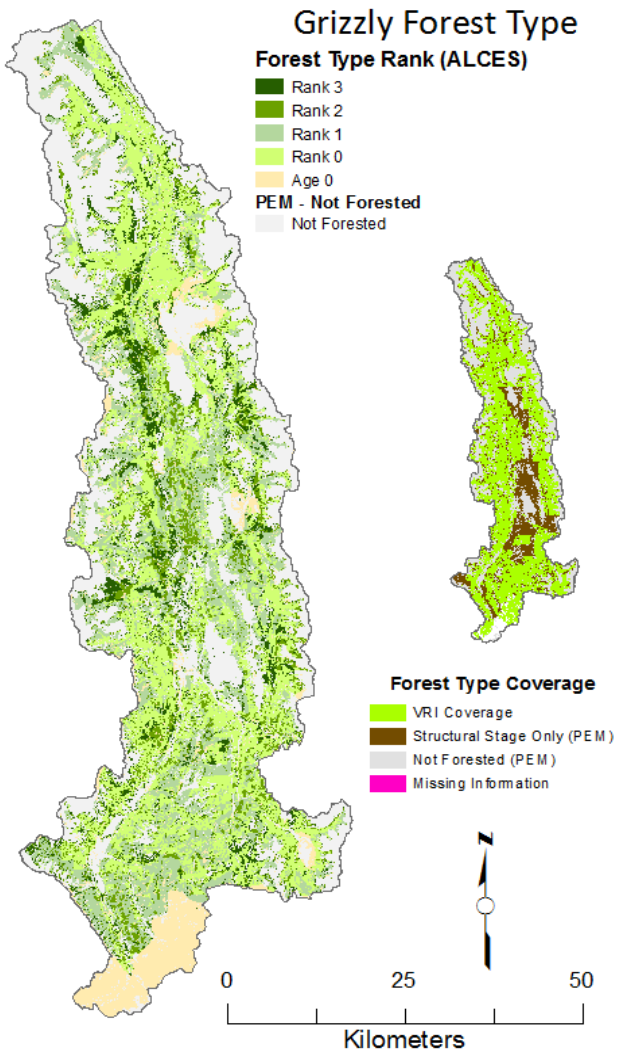

Figure 5. Forest Grizzly bear rank based on seral stage. The gaps in VRI were filled using the PEM data along with other sources from ALCES (described in data sources) including interpolation for missing information.

III) Riparian Habitat

Scientific Context

Several nearby studies have shown strong bear selection in the spring for well-developed riparian areas as these habitats contain sources of food when other habitats are still snow covered (McLellan and Hovey 2001). Forage in riparian areas is typically higher quality or more plentiful than what is available in other habitats at this time of year.

Indicator Overview

Riparian habitat was ranked based on stream order and the proximity of wetlands (Table 3).

Table 3. Ranks of riparian habitat based on stream order and the proximity of wetlands

Riparian Habitat Type	Rank (0-5)
Stream order >= 6 (Elk River) and all PEM wetlands within 300m, and all PEM wetlands contiguous to the rank 3 polygons	3
Stream order = 5 and all PEM wetlands within 200m, and all PEM wetlands contiguous to the rank 2 polygons	2
Stream order = 4 and remaining unranked PEM wetlands	1

Data Sources

- Habitat wetland classes were derived from the 2015 PEM
- Streams were from the WSA Stream Centreline Network from the BC Geographic Warehouse (BCGW)
- Habitat type rankings were developed based on expert opinion and scientific literature

Caveats and Data Limitations

- This analysis assumes that higher order streams are preferred by bears more than lower order streams. We made this assumption because larger streams often have better developed riparian areas. This assumes that the riparian areas are all functional. This could lead to an overestimation of suitable, healthy and functional riparian habitat for Grizzly bears, but the focus of the assessment was on presence not riparian functionality.

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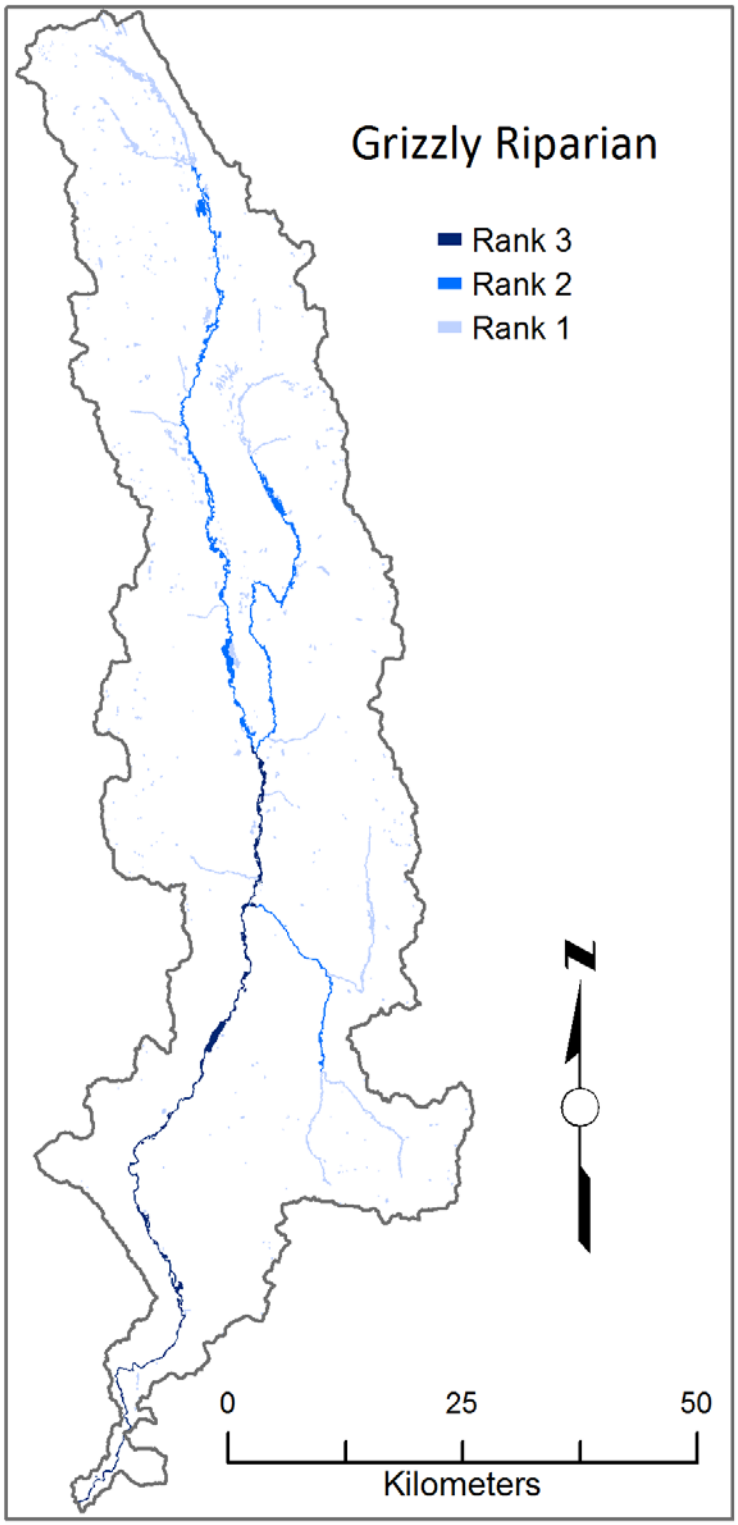

Figure 6. Riparian habitat and the associated rank

IV) BERRY HABITAT

Scientific Context

Grizzly bears rely on buffaloberries and huckleberries to accumulate winter fat and for reproductive success in subsequent years (McLellan 2011, 2015). Berries are the principal summer diet item, are high in energy content and are easily digestible (Bunnell and Hamilton 1983, Pritchard and Robbins 1990).

Indicator Overview

The total area of berry habitat ranked by habitat type is summarized in Table 4.

Table 4. Berry habitat ranked by habitat type

Berry Habitat Type	Rank (0-5)
Huckleberry Habitat	5
Buffaloberry habitat (<10 years forest)	4
Buffaloberry habitat (>2200 m)	4
Buffaloberry habitat (10-20 years forest)	3
Buffaloberry habitat (subalpine)	3
Buffaloberry habitat (>20 years forest)	0

The occurrence of huckleberries was mapped using all permanent forest sample plots available in the region. The model was then constrained to areas <50% crown closure using a general merged crown closure layer. This map was then reduced by a second model that maps Grizzly bear habitat selection during the huckleberry season. The map shows only the patches that bears were predicted to use based on past behaviour of radio collared bears. This is roughly equivalent to habitat suitability.

Buffaloberry was mapped as above and also limited to places with <50% crown closure but the occurrence map was not refined based on habitat selection by radio-collared bears. Thus, the buffaloberry map is similar to a capability map for that berry species. To avoid assigning buffaloberry habitat to closed canopy forest, the buffaloberry rating was adjusted during the simulation so that buffaloberry capability occurring in forest 10 years or younger had a rank of 4, buffaloberry capability occurring in forest between 10 and 20 years had a rank of 3, and buffaloberry capability occurring elsewhere had a rank of 0 (i.e., due to the effect of crown closure). The forest age data indicates some areas of young forest that have not been disturbed in recent decades. This issue is most prevalent in high elevation forest, where open canopy forest may persist in the absence of disturbance events due to marginal conditions (climates, soils) for forest growth. In such areas, using forest age as an indicator of canopy closure may be inaccurate. To address this dynamic, buffaloberry capability remained at rank 4 at elevations higher than 2200 m and at rank 3 in remaining subalpine areas, regardless of forest age.

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Data Sources

A number of spatial layers were used to build the map and the training of the map used the provincial permanent sample plot data. See Lamb and Procter (2015) and Proctor and Lamb (2016) for a detailed description of methods and data.

Caveats and Data Limitations

The huckleberry occurrence map was truncated to include only those areas with <50% crown closure. The crown closure data from the provincial VRI is poorly described and likely inaccurate in many places. This metric is known to change rapidly in young stands so the age of the data can also greatly affect accuracy. Some areas of potential huckleberry or buffaloberry were likely excluded that have since been logged or burned and may now present good forage opportunities. The huckleberry map was further refined to areas where bears were actually selecting huckleberry patches using Grizzly bear radio telemetry data from the West Kootenay. While this is a much better representation of use of berries by bears, it is possible the process of huckleberry habitat selection is different in the East Kootenay because the habitat is more open and huckleberry patches tend to be larger. Bears in the East Kootenay may use small berry patches less than bears in the West Kootenay, although at this time we have no indication that this is true.

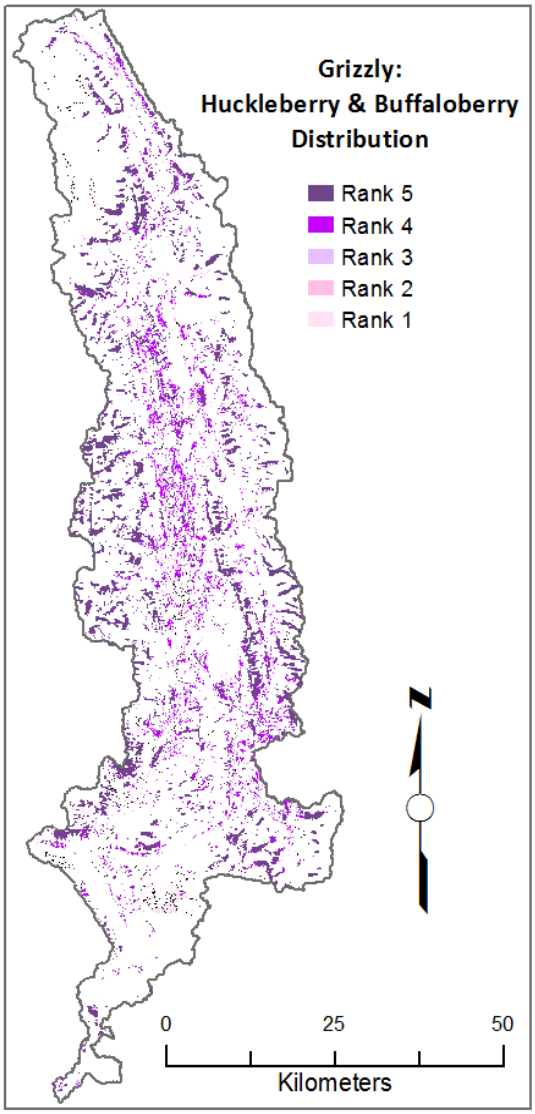

Figure 7. Huckleberry and buffaloberry habitat and the associated rank value

The buffaloberry model simply denotes where the species is likely to be found without regard to relative berry production or habitat choice by bears and obviously identifies much more habitat than bears actually choose when feeding on buffaloberry (see Figure 7). We reduced the habitat rating in older, more closed forests in an attempt to account for the selection process but did not examine the habitat selection process of Grizzly bears feeding on buffaloberry.

As discussed above, the forest age data may be underestimating forest age in higher elevation forests. As well, forest age may not be a reliable index of canopy closure in these areas that are close to the tree line. We attempted to capture this dynamic by assuming that forests higher than 2200 metres or within the subalpine remained open canopy (and therefore high habitat value) regardless of their age. However, the subalpine area only accounts for a portion of the

forest classified as young without a history of recent disturbance. Questions that warrant future investigation are: whether young forests are actually as abundant as the forest age data suggests; and whether time since disturbance is an adequate predictor of canopy closure, especially in higher elevation areas.

V) Human Density

Scientific Context

Areas of high human density can increase risk of mortality to Grizzly bears (Mowat et al. 2013). Fruit trees and roadkill pits can be attractive to bears and increase human and bear conflict.

Indicator Overview

The total area of the PEM defined built-up areas (this includes urban areas) + 500m buffer. All built-up areas are given a rank of zero.

Data Sources

- Habitat classes were derived from the 2015 PEM and then buffered.
- Habitat type rankings and buffer width were developed based on expert opinion and scientific literature.

Caveats and Data Limitations

The assumption that built up areas exclude bears and therefore offer no habitat benefits is likely accurate even though the 500 m buffer is admittedly arbitrary and we know of cases when bears will use habitat in or near built-up areas in cases where Grizzly bear foods are particularly rich. We were not able to include the reduction in habitat effectiveness due to rural residential areas because we did not have maps of this area. This is a significant weakness because rural residences are likely to increase more in the future than built-up areas. Rating the impact of rural housing would be arbitrary because bears do use these areas though likely less effectively.

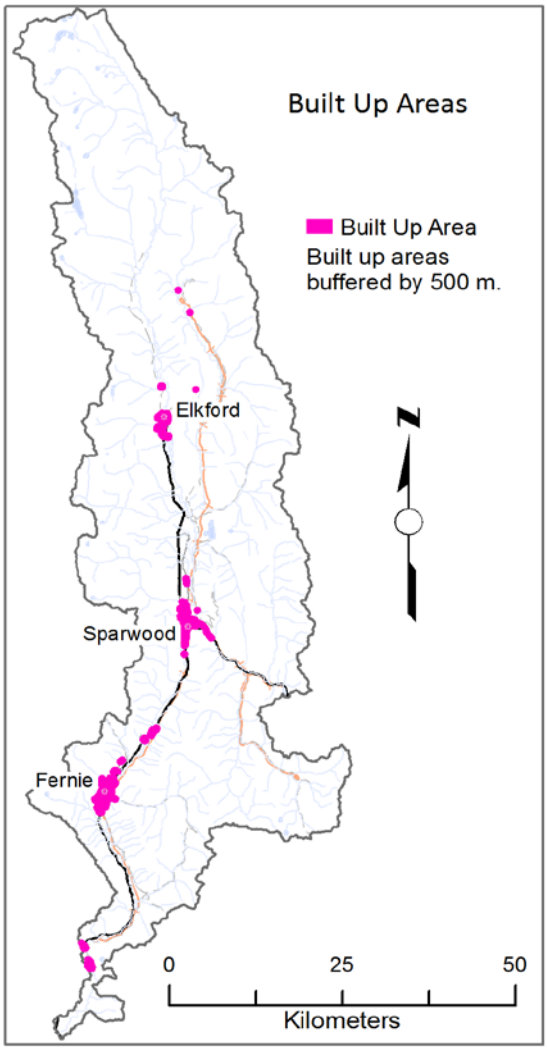

Figure 8. Built up areas in the Elk Valley buffered by 500 meters

VI) ROAD DENSITY

Scientific Context

Grizzly bear mortality is correlated with road density (Boulanger and Stenhouse 2014, Lamb et al. *In submission*, and see references therein). Over 90% of all bears ever killed in the Flathead, AB and MT are within 500 m of a road (pers. comm. Clayton Lamb). According to Bruce McLellan (2015), "Where people and Grizzly bears share the landscape, >75% of bears >2 years of age are eventually killed by people (McLellan et al. 1999, Schwartz et al. 2006) and most are killed near roads and settlements (McLellan 1989b, Nielsen et al. 2004a, Schwartz et al. 2010)." Additionally, roads reduce habitat effectiveness of adjacent areas because traffic on the roads often scares bears away from these adjacent areas.

Indicator Overview

- Linear km of road/km^2 by assessment watershed
- The lower benchmark was also used by the Provincial Cumulative Effects Framework Grizzly Bear Assessment Team (Table 5)
- Minor roads were removed from the density calculation in the following watersheds according to the presence of access management plans (Figure 9):
    - Alexander Creek
    - Barnes Lake
    - Chauncey Todhunter
    - Corbin Creek
    - Galton Range
    - Grave Prairie
    - Sheep Mountain
    - Upper Elk Valley- Fording River A,B,C
    - Upper Flathead
    - Weigert Creek
    - Wigwam Flats

Table 5. Habitat values discounted for road density.

Road Density	Habitat Discount
Low = <0.6 km/km^2	No reduction to habitat value
Moderate = 0.6-1.2 km/km^2	-1
High = >1.2 km/km^2	-2

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Data Sources

- Provincial road layer corrected by Touchstone GIS Consulting for this project (Figure 9)
- Trails or in-block roads were not included
- Minor roads with closures in Access Management Areas were not included in road density calculation
- Habitat discounts were developed based on expert opinion and were applied to all units in the landscape unit

Caveats and Data Limitations

The provincial Grizzly bear CE assessment did not exclude trails or spur roads. We chose to exclude them because roads that are designated as trails are often in very poor condition in the Kootenays and hence have low use. Also, in-block roads lead only into a cutblock and have low use because they do not allow further access. Our method of rating the effect of the road as a stressor to bears is admittedly simple. The actual process as to how roads affect bears is certainly much more complicated and involves both loss of habitat effectiveness due to disturbance and increased risk of mortality from people using the roads. Further consideration of roads within the Access Management Area is required due to the seasonal use of some roads.

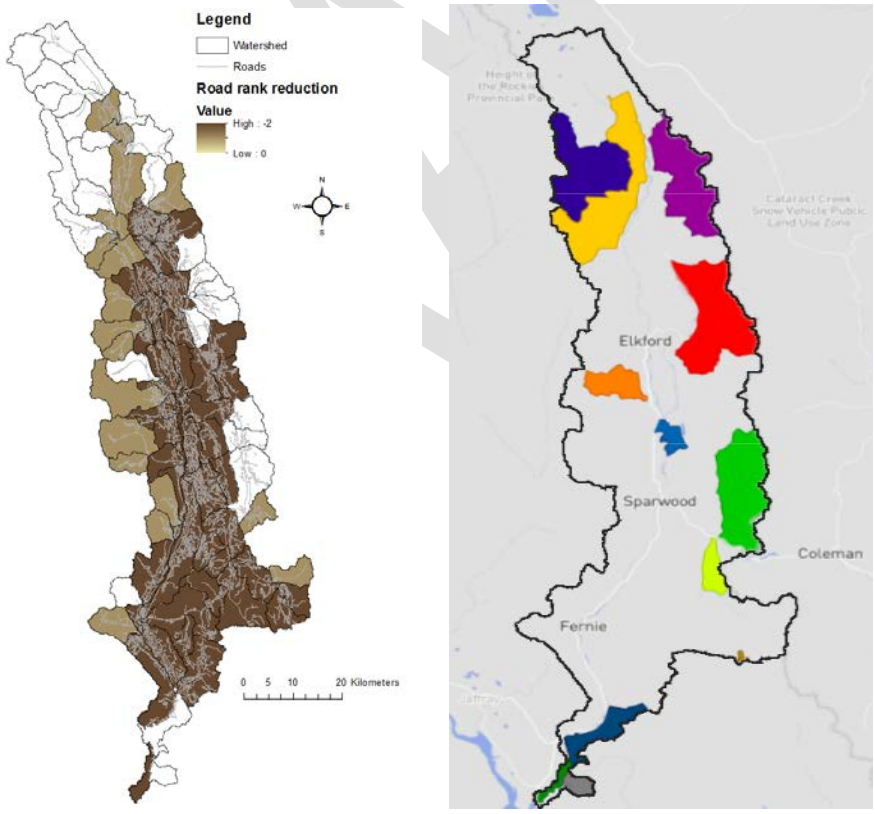

Figure 9. Road density habitat ranking discount and road types (left). Minor roads in the access management areas (coloured by each area) were not included in density calculations (right).

B. Habitat Connectivity

Scientific Context

Connectivity as an indicator refers to lower-resistance habitat that bears use to cross isolating features, such as major highways or low elevation settled areas (Proctor et al. 2015). Managing low-resistance habitat to encourage movement can enable bears to cross these isolating features. In the short term this allows adjacent populations to rescue each other when one population experiences a decline. This meta-population effect is key to long-term population stability (Proctor et al. 2012).

Indicator Overview

The Expert Team has not been able to derive a metric that can be incorporated into the analysis that is sensitive to changes in landscape or road porosity such as following construction of a wildlife crossing structure. Mapping of corridors was shown in the results.

Data Sources

- Proctor, Michael F., et al. "Grizzly bear connectivity mapping in the Canada–United States trans-border region." The Journal of Wildlife Management 79.4 (2015): 544-558.

C. Human-Caused Mortality

Human-caused mortality is the only legally regulated indicator for Grizzly bears. This indicator relates to population level conservation concerns.

Scientific Context

Human-caused mortality is usually the strongest limiting factor to Grizzly bear populations (Schwartz et al. 2006, Lamb et al. 2016). This includes:

- Highway and rail mortality;
- Hunting mortality; and
- Non-hunting mortality related to conflicts with humans.

Indicator Overview

Total mortality thresholds as a percentage of population estimates over the last 5 years as described in the Grizzly bear harvest procedure is shown in Table 6.

Table 6. Total mortality thresholds as a percentage of population estimates over the last 5 years as described in the Grizzly bear harvest procedure

Type	Threshold/ Management Trigger
Total mortality	Total mortality must not exceed 6% of population estimate
Female mortality	Female mortality must not exceed 30% of mortality target or 1.8% population estimate

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Data Sources

- Compulsory Inspection Database and provincial population estimate document (Hamilton 2012)

D. POPULATION TREND

Scientific Context

Looking at population trend is the best measure of current population health.

Indicator Overview (benchmarks)

- <3 year of statistically significant negative growth = moderate hazard
- 3-5 years of statistically significant negative growth =high hazard
- >6 years of statistically significant negative growth = very high hazard

Data Sources

- Population monitoring and estimated trend for the 2006-2013 period (Mowat and Lamb 2016).

Caveats and Limitations

It is difficult to detect significant population changes over 3 years because of the difficulty in achieving sample sizes large enough in this short time period to minimize imprecision in the estimation of growth rate.

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2.4 Retrospective Assessment

The purpose of the retrospective assessment is to map the historic and current conditions of Grizzly bear habitats. The primary questions addressed in the retrospective assessment are:

- What did conditions look like in 1950s?
- What do conditions look like now?
- What have been the rates or patterns of change?
- What have been the key stressors or causes of change?

The completion of the retrospective assessment will provide the following information for use in the Prospective Assessment:

- Current status relative to benchmarks for Grizzly bear condition in the Elk Valley.
- Trends observed from past data relative to benchmarks.
- The most important (strongest and most impactful) relationships between the condition of Grizzly bear habitat and stressors to the habitat.

2.5 Prospective Assessment

In the prospective assessment, models are developed based on the retrospective assessment and expert knowledge. The models are used to predict how indicators may respond to future conditions and changes in the landscape. These changes are due to a combination of natural and human-induced phenomena.

ALCES (A Landscape Cumulative Effects Simulator) technology was used to model potential future conditions based on alternative future scenarios.

The outcome of the prospective assessment will allow us to assess how Grizzly bears and their indicators may respond to alternative future development scenarios, different mitigation options and climate change scenarios.

1.4.1 Future Development Scenarios

Current practice in prospective assessment places particular emphasis on the development of **alternative future scenarios**. Modelling of the different future scenarios will illustrate the response of indicators to variations in rates, spatial configurations, density or pattern of development and disturbance over the next 50 years. The following four alternative future development scenarios were defined:

1) Reference Scenario: This scenario represents a “business as usual” progression in development. Current rates of change in indicators were used to model future conditions.

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2) Minimum Scenario: This scenario is meant to present a case where the intensity of human activities in the Elk Valley declines. This scenario takes the reference case and either subtracts from it or substitutes activities which are assumed to be associated with fewer environmental impacts.

3) Maximum Scenario: This scenario is meant to provide decision-makers with an understanding of cumulative effects from the combination of all currently proposed or projected (as of 2015) human activities in the Elk Valley.

4) Higher Natural Disturbance Scenario: This scenario is meant to assess the effects of human activities from the Maximum Scenario in combination with elevated rates of natural disturbance on the landscape as expected with a four degree increase in annual average air temperature. This is similar to climate change projections under RCP 8.5, where there would be no substantial reduction in greenhouse gas emissions. It is meant to provide decision-makers with an understanding of the combined cumulative effects of human activity and maximum development with increased rates of fire and insect outbreak due to climate change.

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3.0 RESULTS

3.1 RETROSPECTIVE ASSESSMENT – HISTORIC AND CURRENT CONDITIONS

A. HABITAT INDICATORS

The results for the habitat indicators are provided in the prospective assessment section, which describes the magnitude and changes in current condition and the future condition of habitat capability and suitability (see 3.2). The change in Avalanche Chutes and Alpine from 1950 to current was possible to assess using the 1950's Predictive Ecosystem Mapping (PEM) layer.

A.1 AVALANCHE CHUTES AND ALPINE HISTORIC CHANGE

The comparison of the total area of avalanche chutes and alpine between 1950 and 2015 was summarized by landscape unit (Table 7, Appendix A). Overall, there was a 2% decrease in avalanche chute habitat, which included site series Vh (avalanche herb) and Vs (avalanche shrub). Avalanche herb is forb, dwarf shrub or grass-dominated ecosystems in avalanche tracks. Avalanche Shrub is shrub-dominated ecosystems in avalanche tracks. The decrease was greatest in avalanche herb meadow (4%). Landscape Unit C21 (Fording River) had the greatest decline (21%) in avalanche chute habitat, primarily due to mining.

Alpine habitat, which included alpine grasslands (Ag), alpine meadows (Am) and alpine tundra/grassland (AtAg) declined by 4.3% since 1950 (Table 8, Appendix A). Alpine grassland is well-vegetated and grass dominated ecosystems of dry, cold climates with low but significant snow load and well-developed soils. Alpine meadow is well-vegetated and forb dominated ecosystems of sub-alpine and alpine elevations. It was not possible to calculate Alpine Tundra/ Grassland (AtAg) in 1950 because this category was added only recently and didn't exist in the 1950 PEM. Alpine meadow/Alpine tundra is a lumped PEM unit: well-vegetated ecosystems of mixed composition commonly with an abundance of dwarf woody plants (Alpine Tundra), well-vegetated and grass dominated ecosystems of dry, cold climates with low but significant snow load and well-developed soils (Alpine Grassland). The dominant loss has been of alpine grasslands (13%). C38 (East Elk) has had the greatest decline (64%) in total alpine habitat, likely due to the removal of alpine grasslands for mining. Also, C21 (Fording) has had significant losses of alpine habitat (20%) since 1950.

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Table 7. Comparison of Avalanche chute area (ha) in 1950 and 2015 based on the PEM site series Vh (Avalanche Herb) and Vs (Avalanche Shrub). Percent change is (2015-1950)/1950*100.

LU	Avalanche Herb Meadow (Vh) (Ha)		% change	Avalanche Shrub (ha)		% change	Total 2015 (ha)	Total 1950 (ha)	% total change
	2015	1950		2015	1950				
C19	24.3	24.3	0	459.9	460.7	-0.18	484.2	485.0	-0.2
C20	316.8	322.5	-1.8	617.8	688.0	-10.21	934.6	1010.6	-7.5
C21	119.3	156.9	-24.0	287.5	359.5	-20.04	406.7	516.5	-21.3
C22	214.9	214.9	0	3389.4	3389.4	0.00	3604.2	3604.2	0
C23	618.2	618.2	0	2374.1	2374.1	0.00	2992.3	2992.3	0
C24	45.6	45.6	0	2432.1	2432.1	0.00	2477.7	2477.5	0
C38	43.1	55.7	-22.6	229.1	246.9	-7.24	272.2	302.6	-10.1
Grand Total	**1382.1**	**1438.1**	**-3.9**	**9789.8**	**9950.8**	**-1.6**	**11171.9**	**11388.9**	**-1.9**

Table 8. Comparison of Alpine area (ha) in 1950 and 2015 based on the PEM site series Ag (Avalanche Herb) and Am (Avalanche Shrub). Percent change (% chng) is (2015-1950)/1950*100.

LU	Alpine Grassland (Ag) (ha)		% chng	Alpine Meadow (Am) (ha)		% chng	Alpine Tundra/ Grassland (At/Ag) (ha)		% chng	Total 2015	Total 1950	% chnge
	2015	1950		2015	1950		2015	1950				
C19	2.0	2.0	0	131.0	131.0	0	0	0	0	133.0	133.0	0
C20	9.0	9.0	0	34.2	34.2	0	4.6	4.6	0	47.8	47.8	0
C21	222.7	266.9	-16.6	18.6	35.1	-47.0	0	0	0	241.3	302.0	-20.1
C22	70.2	70.2	0	76.0	76.0	0	0	0	0	146.2	146.2	0
C23	0	0	0	128.8	128.8	0	1.1	1.1	0	129.9	129.9	0
C24	0.8	0.8	0	972.6	972.6	0	1.8	1.8	0	975.2	975.2	0
C38	6.9	7.4	-7.1	1.4	15.8	-91.3	0	0	0	8.3	23.2	-64.4
Total	**311.5**	**356.3**	**-12.6**	**1362.5**	**1393.4**	**-2.2**	**7.6**	**7.6**	**0**	**1681.6**	**1757.2**	**-4.3**

B. Habitat Connectivity

A number of potential movement corridors used by Grizzly bears span Highway 3, e.g. near Elko, north and south of Fernie and south of Sparwood (Figure 10; yellow). Improved crossing structures with fencing on high connectivity corridors could reduce mortality from vehicle strikes.

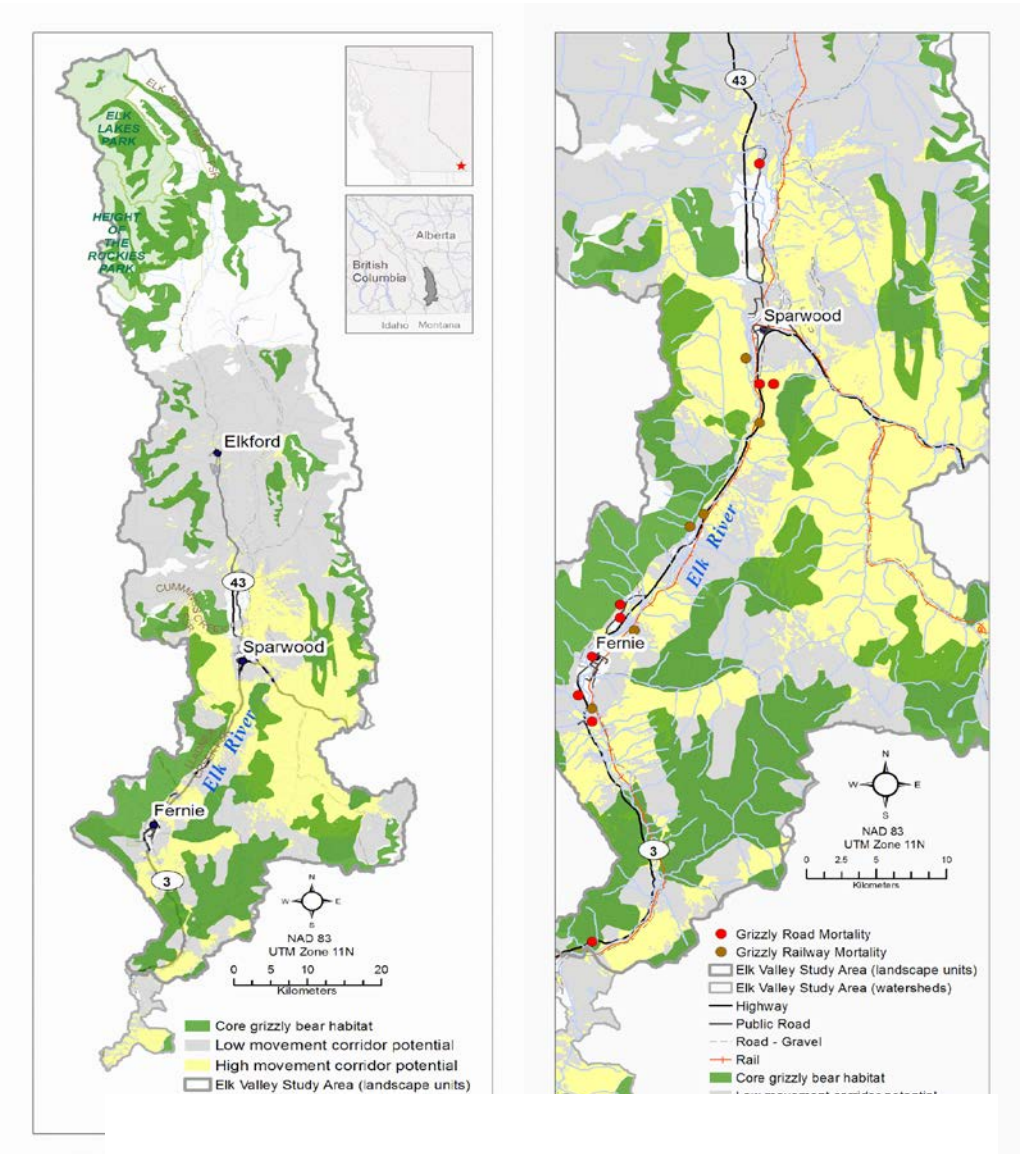

Figure 10. Grizzly bear connectivity maps showing potential movement corridors at the Elk Valley scale (left) and with road mortality locations at South Elk Valley scale (right). Data sourced from Proctor et al. (2015).

C. Human-caused Mortality and Population Trend

The Elk Valley is in the South Rockies population unit (Figure 11). Allocation periods are 3-5 year periods of time over which managers create and manage mortality targets. Kettle-Granby, South Selkirk and Yahk have been closed to Grizzly bear hunting for two or more decades. Central Selkirk, Central South Purcells and Valhalla are hunted in part of the unit while the remainder are open to hunting throughout the unit excluding National Parks. The South Rockies unit has had the highest average female and total mortality averaged across the first, second and third allocation period of any unit in the Kootenay region (Figure 11). The Grizzly bear mortality rate in the Elk Valley is approximately triple the mortality rate observed in the rest of the South Rockies unit (Lamb et al. 2016). Mortality data is from the BC Compulsory Inspection Database (FLNRO).

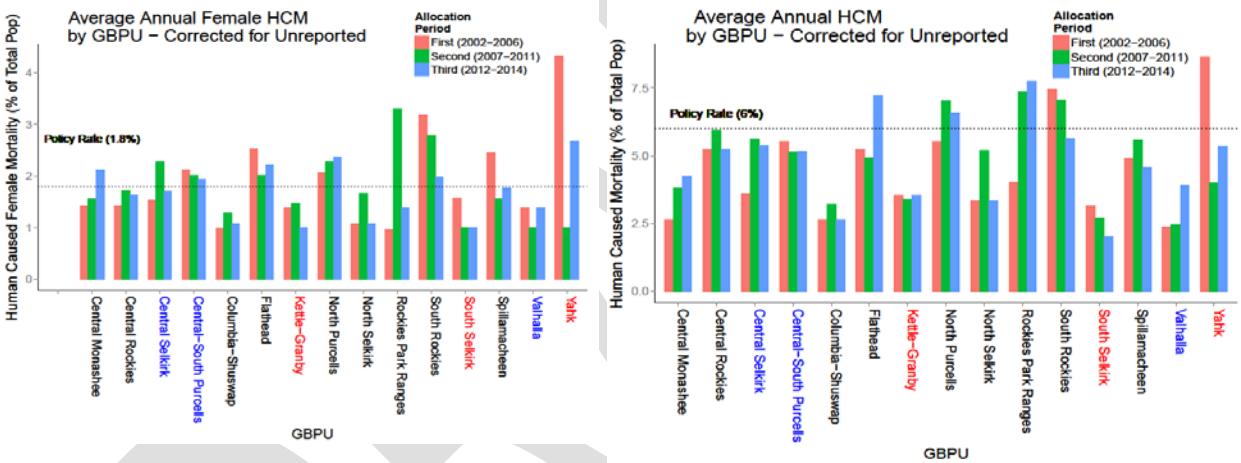

Figure 11. The average human caused mortality (HCM) for females (top) and all bears (bottom) by Grizzly bear population unit (GBPU) from 2002 to 2014. The policy maximum target for female mortality is 1.8% and total mortality policy maximum rate is 6%. Units labelled in red text have been closed to hunting for two or more decades. Units labelled in blue text are hunted in part of the unit while those in black font are open to hunting throughout the unit excluding National Parks. Data source: BC Compulsory Inspection Database

Population trend in the South Rockies population unit has been declining since 2007, though a preliminary analysis of very recent data suggests there has been a very recent population increase in the Elk Valley since 2012 (Figure 12). A similar decline was documented in the neighboring Flathead grizzly bear population but this population began to recover in about 2010. The underlying cause of the decline in the Flathead was believed to be a decade of poor huckleberry crops (McLellan 2015) and food failure may be one of the issues in the South Rockies as well. Mortality rates in the South Rockies, and especially the Elk Valley, have been much higher than the Flathead and the mortality rate is probably what is limiting recovery.

Research is currently underway to identify the causes of mortality. Hunting in the South Rockies was closed beginning in 2017 to stimulate recovery. However, due to strict hunting limitations it is expected that hunting was not the major cause of mortality in the Elk Valley during the decline period. Based on mortality indicators and population trend, the Grizzly bear population hazard varied greatly within the Elk Valley, and was found to be relatively higher than other areas in the South Rockies.

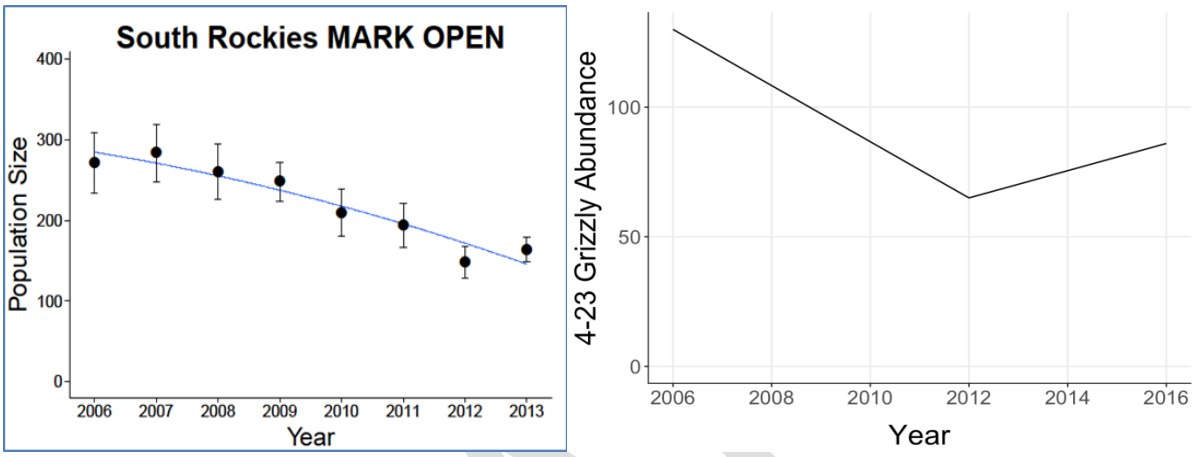

Figure 12. Population size of Grizzly bears in the South Rockies population unit from 2006 to 2013 (left) and Grizzly bear abundance in the Elk Valley from 2006- 2016 (right).

3.2 Prospective Assessment- Future Condition Analyses

3.2.2 Future Development Scenario Outcomes

Habitat availability varies substantially across the study area (values were normalized between 0 and 1), with an average value of 0.30 (Figure 13). Habitat availability declines by 24% during the 50-year simulation. The dominant driver of high quality habitat in the model is young forest with open canopy that supports berries (assuming huckleberry crops can establish and produce after being cut); alpine and avalanche areas have a smaller influence due to their limited distribution (Figure 14). Habitat suitability declines by 29% during the simulation (Figure 15). Habitat suitability is substantially lower than habitat availability due to the effect of roads (Figure 9). As highlighted by the road density map (Figure 9), the majority of sub-basin watersheds in the central and southern portions of the basin exceed the high road density threshold of 1.2 km/km^2, leading to an increase in current hazard (Figure 16). The high density of roads, combined with the patchy distribution of high quality habitat, results in negligible habitat suitability and high hazard across most of the central and southern portion of the Elk Valley. For those sub-basin watersheds with high road density, hazard is highest where higher habitat availability exists and therefore where the potential reduction in habitat due to roads is greatest. Road density is substantially lower in the protected northern portion of the Elk Valley and other mountainous sub-basin watersheds along the basin's perimeter.

Habitat availability declines during the second and third decades of the Reference Scenario (Figure 17) due to a decline in open canopy forest capable of supporting buffaloberry (i.e., forest younger than 20 years). Habitat suitability exhibits a similar response to that of habitat availability (Figure 19), with a decline during the second and third decade due to the aging of young forest. Development rate (as reflected by the difference between minimum, reference and maximum scenarios) has a relatively small effect on habitat availability (Figure 17) and habitat suitability (Figure 19), which is related to the high density of roads already on the landscape that exist under the Reference Scenario. For this reason, maps are shown only for the Reference Scenario. The minimal differences between scenarios suggests that a 50-year time span may not be enough to see changes resulting from a forest age dynamic. More influential was the natural disturbance rate, with a higher disturbance rate having a positive effect on habitat availability due to the creation of open canopy forest (Figure 17).

According to the forest age information that was used, open canopy forest currently covers 18% of the Elk Valley but declines to less than 5% of the Elk Valley by the end of the third decade of the simulation (Figure 18). The decline does not begin until the second decade because high timber harvest in the CanWel Building Materials Group Ltd. tenure during the first decade of the forecast creates substantial young forest; thereafter, young forest declines. The decline in open canopy forest is intuitive in areas with high levels of harvest in recent decades. However, the simulated decline in open canopy forest in other areas, especially forests at higher elevations, may be exaggerated. Open canopy forest in these areas may persist in the absence of disturbance events due to marginal conditions (climate, soils) for forest growth. We attempted to capture this dynamic by assuming that forests higher than 2200 metres or within the subalpine remained open canopy (and therefore high habitat value) regardless of their age. However, the subalpine area only accounts for a small portion of the forest classified as young without a history of recent disturbance, so the analysis may still exaggerate decline in open canopy forest during the simulation.

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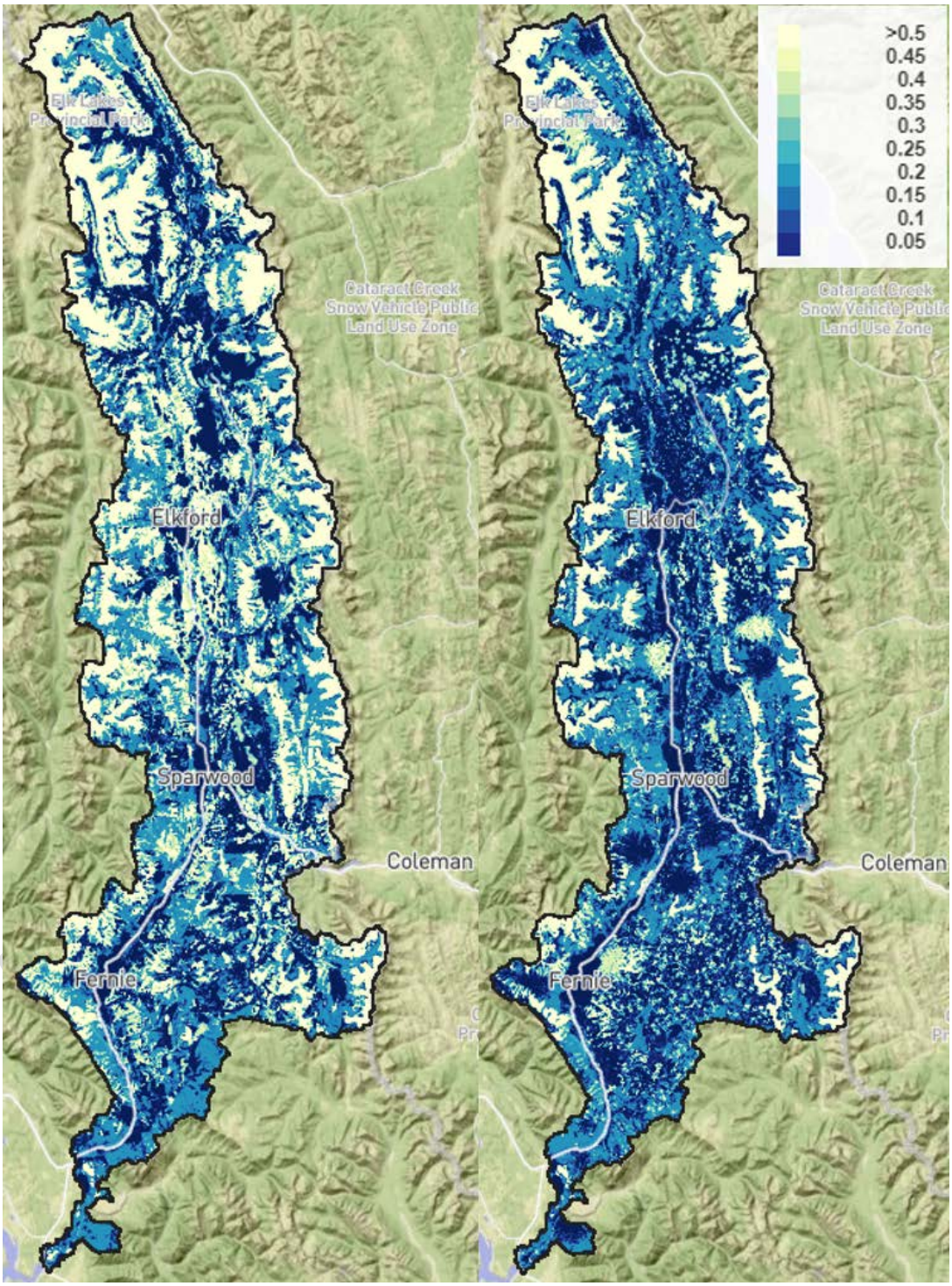

Figure 13. Grizzly bear habitat availability today (left) and after five decades (right) under the Reference scenario. Higher values (lighter colours) indicate greater Grizzly bear habitat value. Habitat availability does not take into account the impact of roads. Habitat availability declined by 24% during the 50-year simulation.

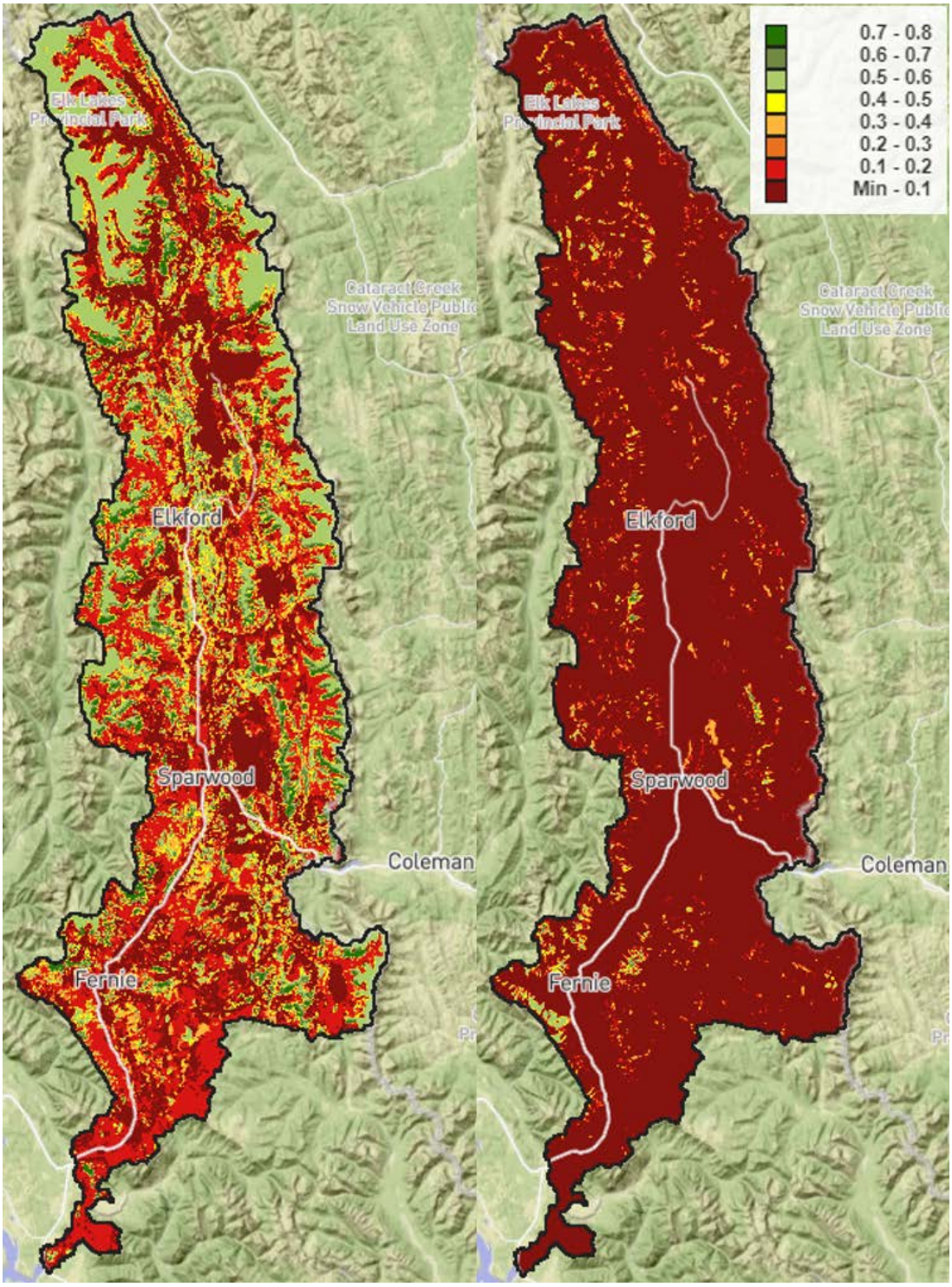

Figure 14. Current Grizzly bear habitat provided by forest and berry habitat (left) and avalanche/alpine areas (right). Higher values (green) indicate greater Grizzly bear habitat value.

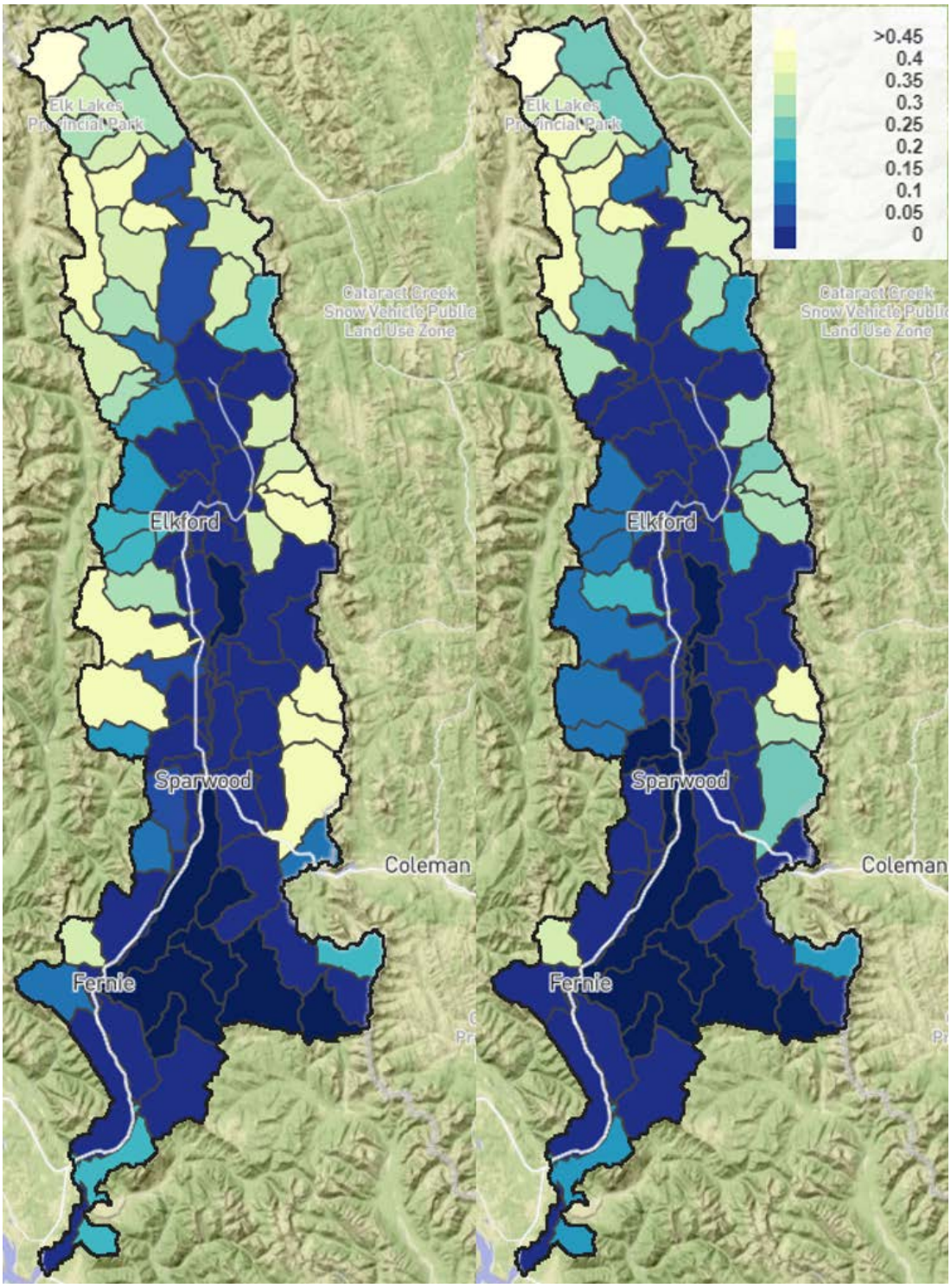

Figure 15. Grizzly bear habitat suitability today (left) and after five decades (right) under the Reference scenario. Higher values (lighter colours) indicate higher habitat suitability. Habitat suitability declined by 29% during the simulation.

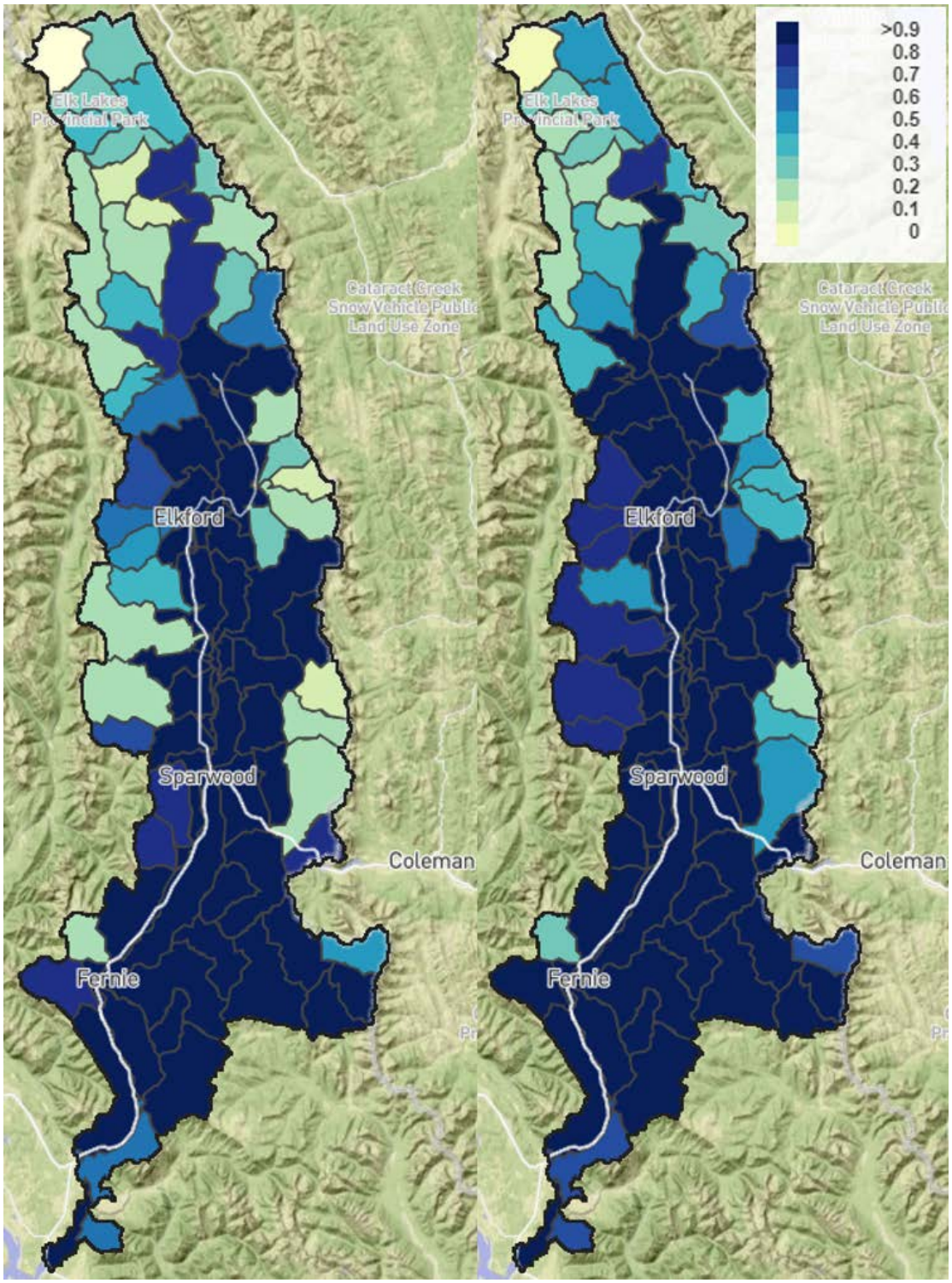

Figure 16. Grizzly bear hazard today (left) and after five decades (left) under the Reference scenario. Hazard is calculated as 1 minus habitat suitability and ranges from 0 to 1, with 1 being the greatest hazard.

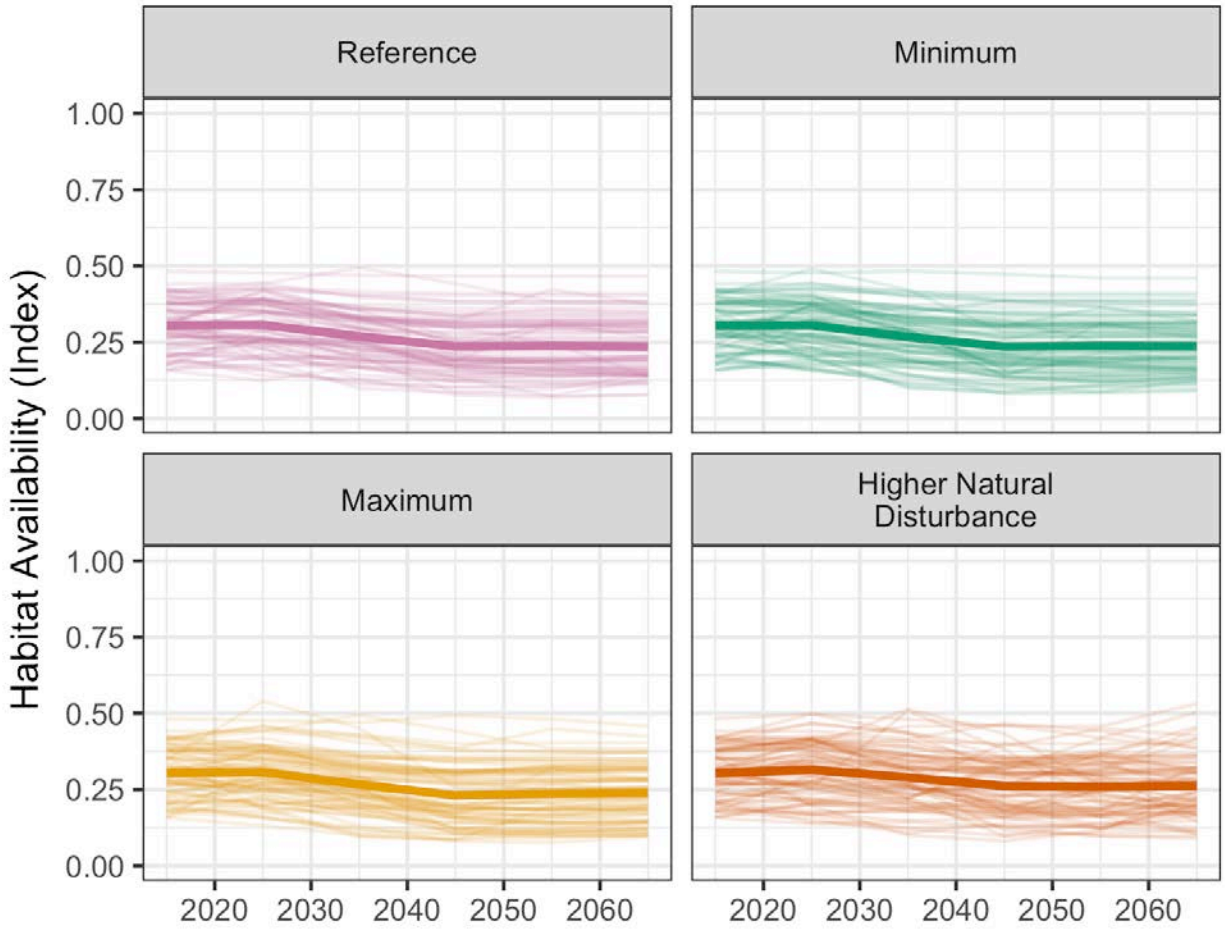

Figure 17. Response of Grizzly bear habitat availability to land-use and natural disturbance scenarios.

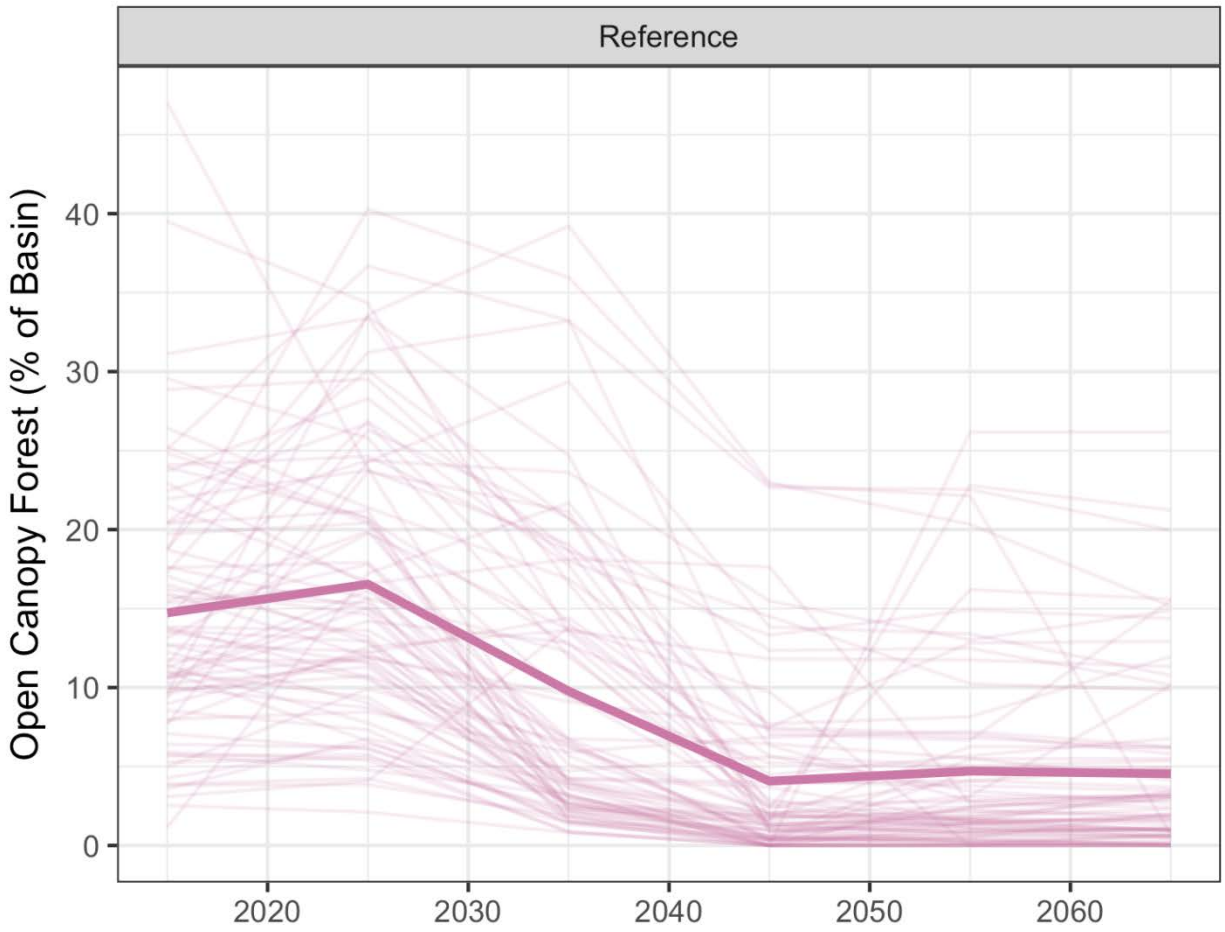

Figure 18. Response of open canopy forest to the Reference scenario. Open canopy forest is defined as forest 20 years or younger.

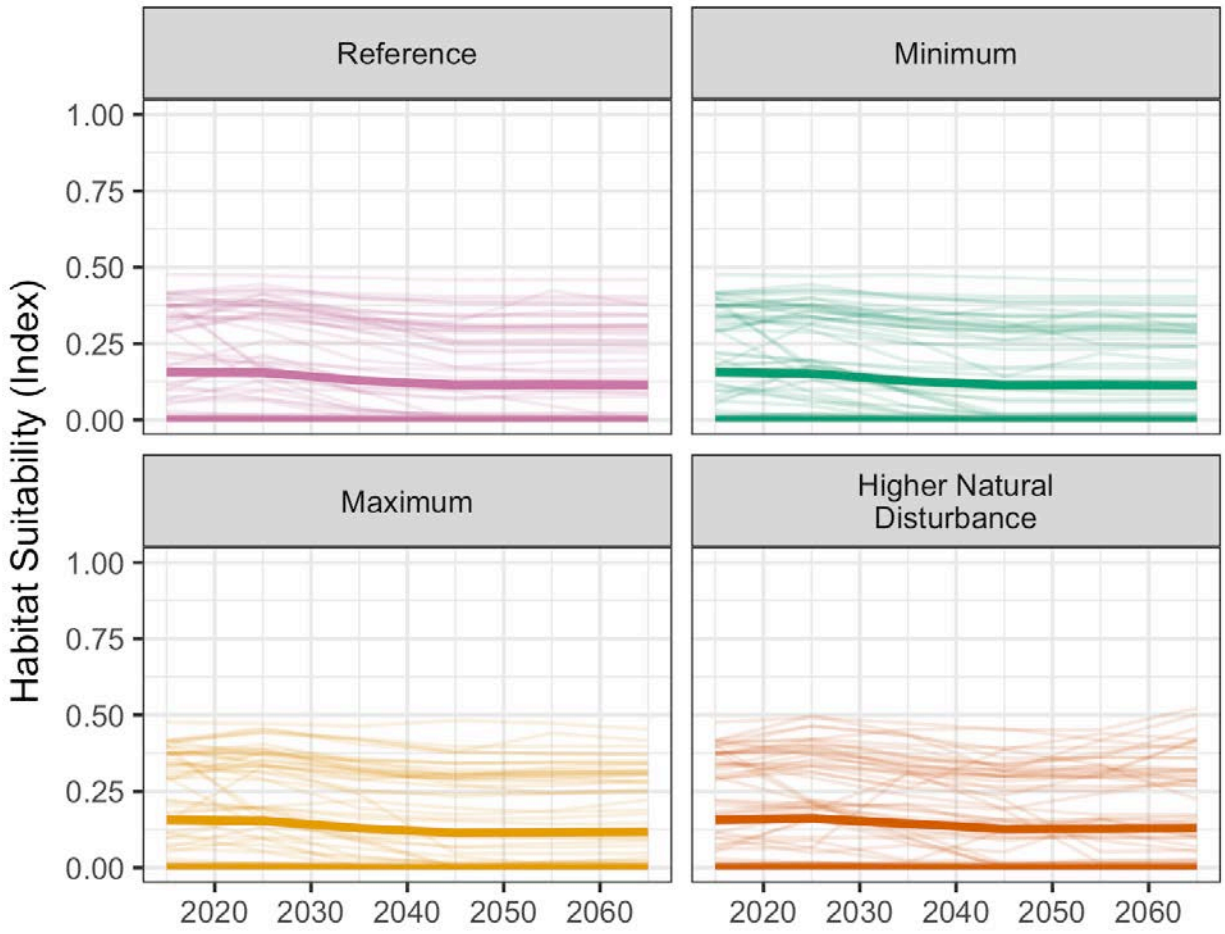

Figure 19. Response of Grizzly bear habitat suitability to land-use and natural disturbance scenarios.

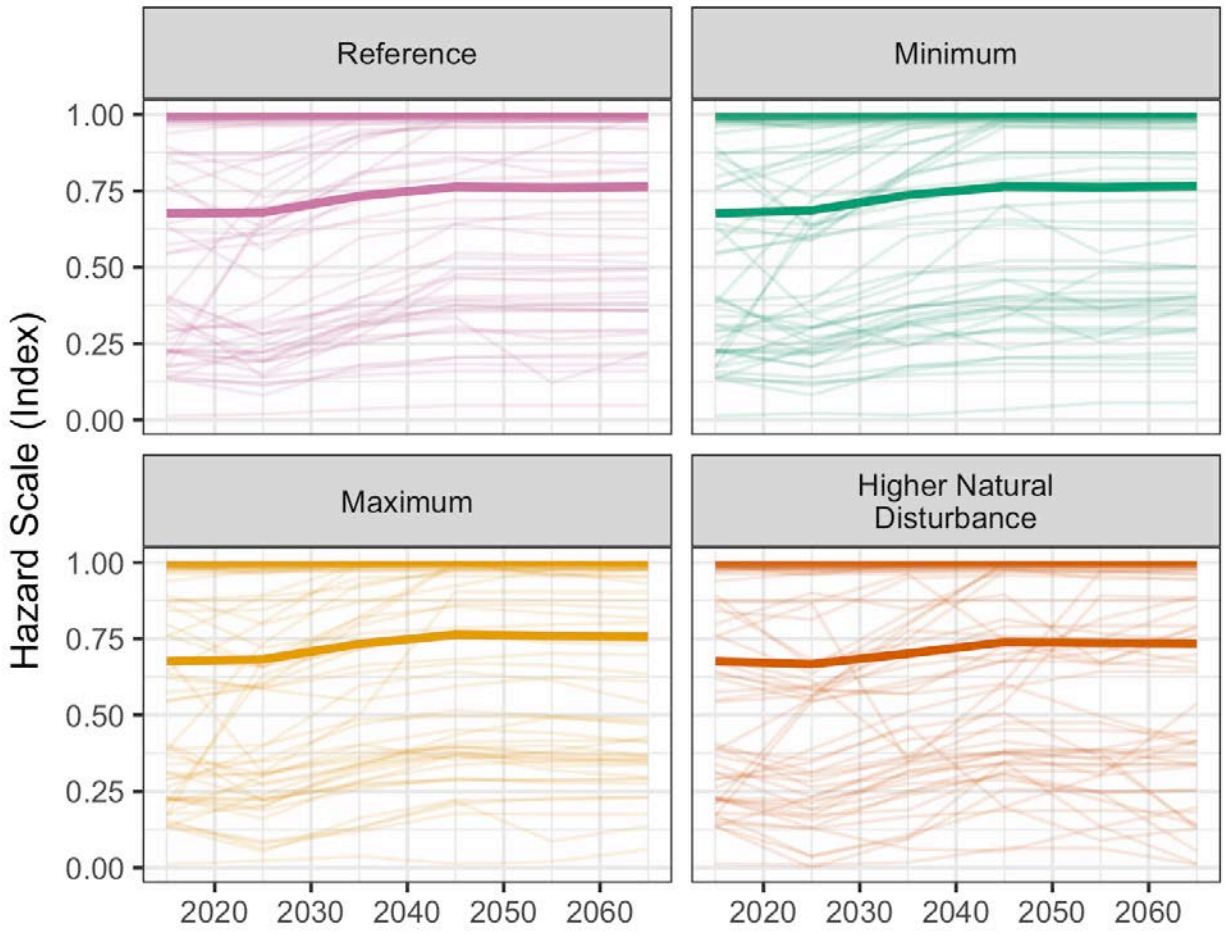

Figure 20. Response of Grizzly bear hazard to land-use and natural disturbance scenarios.

4.0 MITIGATION AND MANAGEMENT RECOMMENDATIONS

Management responses can be divided into three categories: operational, tactical and strategic responses. These are defined in the Cumulative Effects Framework Interim Policy (2016) and described in more detail below.

4.1 EXTENT OF CURRENT MANAGEMENT AND MITIGATION PRACTICES

Objectives for Grizzly bear are derived from various provincial legislation, regulations, and policy and guidance that provide both implicit (broad objectives) and explicit (specific objectives) direction about sustaining Grizzly bears and their habitats, including:

- British Columbia Grizzly Bear Conservation Strategy
- *Forest and Range Practices Act* (FRPA) – orders specifying area designations and management measures (guided by the Identified Wildlife Management Strategy (IWMS))
- *Oil and Gas Activities Act* (OGAA) – orders specifying area designations may be made, as well, Grizzly bears are identified, through policy, as a high priority wildlife species under the Environmental Protection and Management Regulation
- Grizzly Bear Harvest Management Procedure (*Wildlife Act*)
- Orders under the *Land Act* (FLNRO, 2013)
- Strategic Land Use Plan Agreements, Land and Resource Management Plans, Sustainable Resource Management Plans

There are few legal objectives for Grizzly bears. Population objectives are found in the Grizzly bear harvest procedure; these rules apply mainly to mortality management, and are applied to Grizzly bear population units. CEMF study area is about one third of the South Rockies Grizzly bear population unit, hence these procedures apply at a scale above the CEMF analysis.

4.2 MITIGATION SCENARIOS MODELLING

Three levels of mitigation measures were simulated in ALCES (Table 9):

1. Current mitigation practices: Business as usual with regard to development and current mitigation practices

2. Moderate mitigation: Improved mitigation on future developments, or restoration on past developments (e.g., no net loss)

3. Intensive mitigation: forward management and mitigation of development, and retrospective reclamation

Table 9. Mitigation scenarios developed for Grizzly bear indicators. Mitigation strategies that were modelled in ALCES are highlighted in **bold**.

Factor/Indicator	Current mitigation	Moderate mitigation	Intensive mitigation
Berry habitat	• No specific prescription for berry species in land use practices; Canfor does occasional prescribed burns for berries	• **Improve habitat quality by site specific forestry techniques in areas that support berries** • Reduction of huckleberry harvest through road closures	• **Improve habitat quality by controlled burns in areas that support berries** • Reduction of huckleberry harvest through road closures and regulation
Habitat Loss	• Reclamation based on legal requirements	• Reclaim habitat to species prescribed in reclamation plan	• Reclaim habitat to species prescribed in reclamation plan or preferred berry species
Human disturbance	• Natural regeneration of road right of ways	• **Close new and old roads that access key foraging areas; Reduce road density below 1.2 km/km^2**	• **Reduce road density below 0.6 km/km^2**
Back-country mortality risk	• On-going road reclamation practices	• **Close new and old roads that access key foraging areas; Reduce road density below 1.2 km/km^2**	• **Reduce road density below 0.6 km/km^2** and implement back-country Bearsmart measures

Due to the large influence of roads on habitat suitability, road closure was explored as a mitigation strategy in the prospective assessment. The intensive mitigation scenario of closing roads across the basin resulted in a two-fold improvement in habitat suitability (Figure 21) and associated reduction in hazard. In practice, however, basin-wide road closure is unlikely. Implementing road closures for a subset of priority sub-basin watersheds is a more practical option for balancing Grizzly bear conservation with development. Rather than simulate a single moderate mitigation scenario that closed a subset of the basin's roads, an analysis was completed to assess the implication of a range of road closure levels to Grizzly bear hazard. The analysis was completed by incrementally removing the effect of roads one sub-basin watershed at a time, starting with those watersheds that exhibit the largest reduction in hazard with road closure. As roads were closed across more and more of the basin's watersheds, incrementally more of the Grizzly bear hazard was eliminated (Figure 22). For example, the simulations suggest that such an approach can reduce hazard by about 50% and 40% with the closure of

50% and 25% of the roads in the study area, respectively. A map of hazard reduction with road closure provides insight into which sub-basin watersheds should be prioritized for road closure (Figure 23). The high hazard in the central and southern portions of the basin indicates high potential to improve habitat through road closures. However, the decline in habitat suitability in these watersheds during the simulations indicates that road closures may be insufficient as a mitigation strategy unless combined with strategies to maintain or increase the availability of open canopy forest habitat through time.

Closing roads in areas of high habitat values would help reduce mortality risk and reduce disturbance and hence increase habitat effectiveness. Closing roads can be considered operational if it happens during the logging plan. But many roads are closed after the logging is long over and these sorts of closures usually involve a strategic planning process.

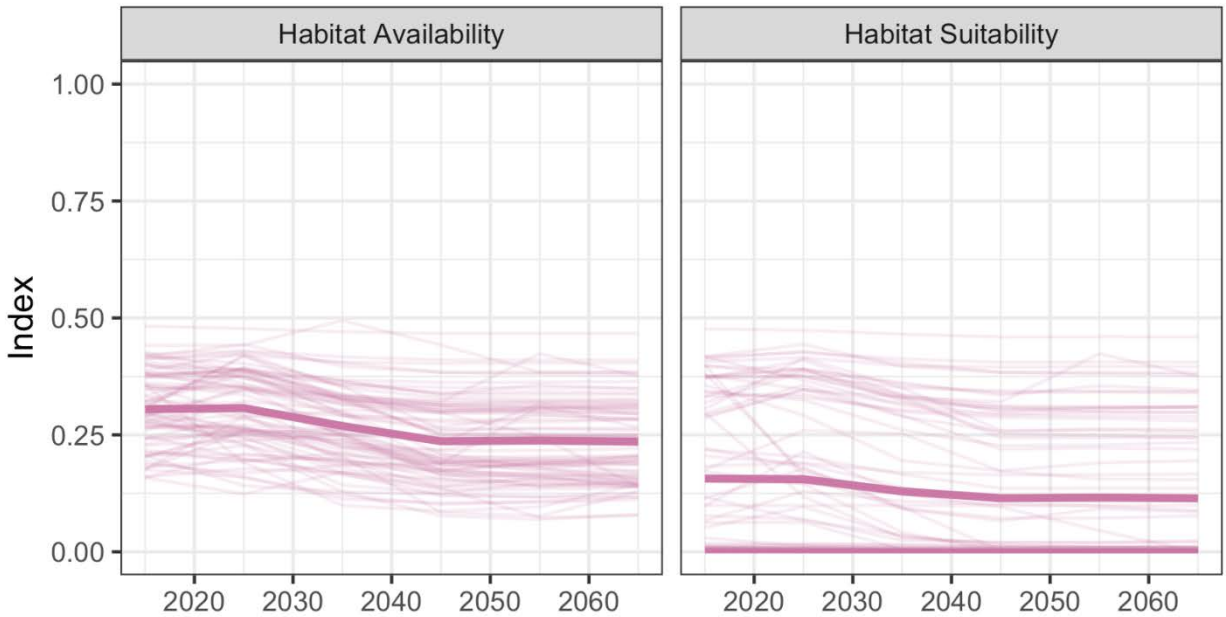

Figure 21. Grizzly bear habitat suitability and habitat availability under the Reference development scenario. Habitat suitability incorporates the effect of roads, whereas habitat availability does not. As such, the difference between habitat availability and habitat suitability represents the improvement in Grizzly bear habitat that would result if all roads were closed across the basin.

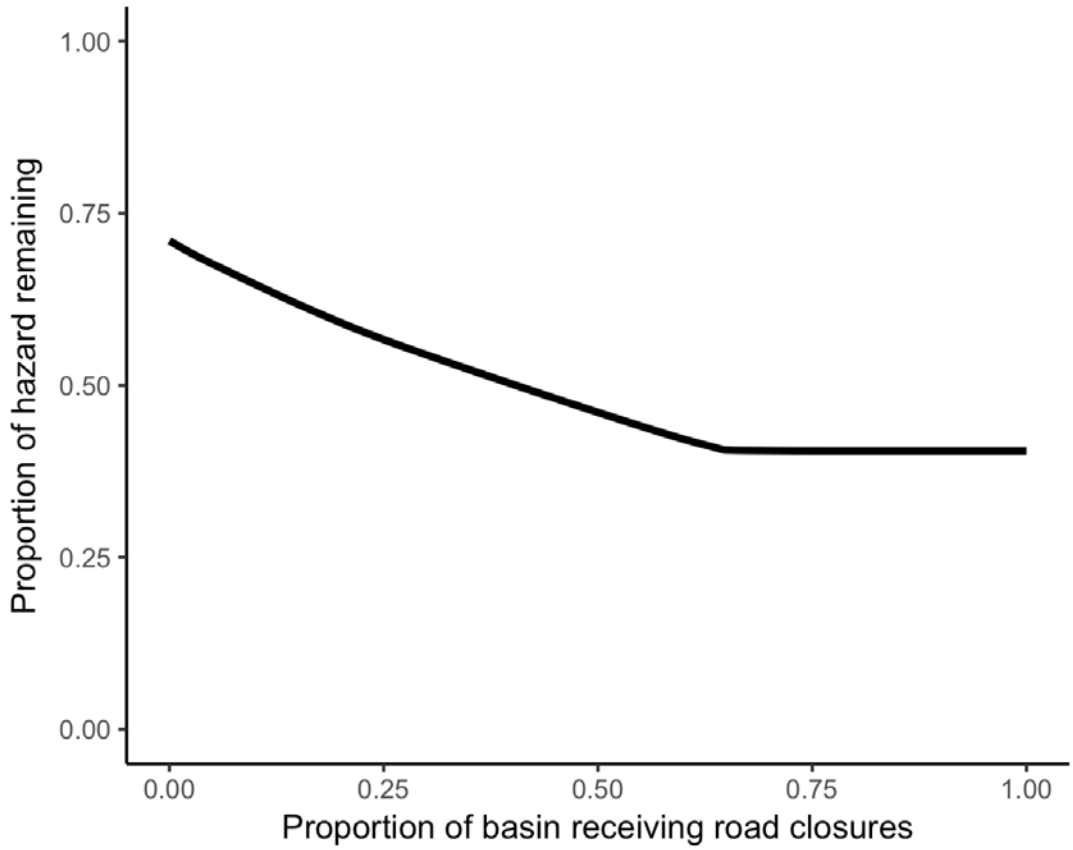

Figure 22. Reduction in Grizzly bear hazard with increasing proportion of the basin under road closure

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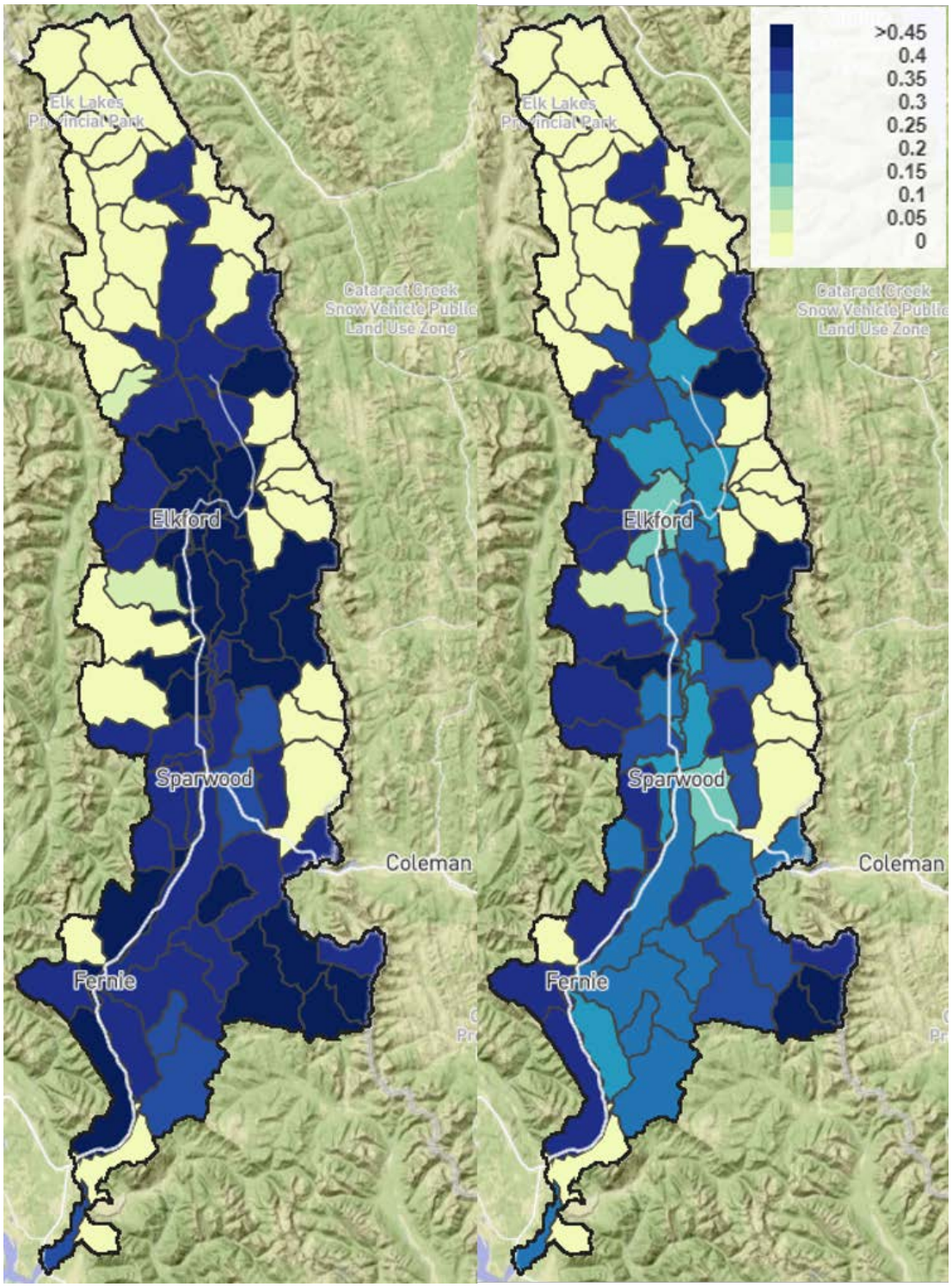

Figure 23. Reduction in hazard achieved through road closure from today (left) and in five decades (right) under the reference scenario.

4.3 Operational Management Responses

Operational responses include consideration of site- or project-level guidance or implementation of measures to mitigate the effects of projects or activities typically undertaken by proponents. These include the mitigation measures described in section 4.2 above. Operational responses by proponents may include avoiding high value habitats with the proposed developments, particularly avalanche chutes and berry fields. A reduction in roads and/or access management could have the added benefit of reducing recreational and commercial huckleberry harvesting. An operational response of government could be to review future developments that are in high quality bear habitat. In the case of forestry, preference could be given to logging areas that may support berries post-harvest and using silvicultural practices that promote huckleberry or buffaloberry regeneration. This could involve broadcast burning to treat cut-blocks or reduced stocking standards for trees to reduce shading of the shrubs growing in the understory.. In the case of land that is being reclaimed post-mining, the best long-term options for bears is to encourage the growth of high values native forbs, examples of which include *Hedysarum* sp., *Claytonia lanceolata.*, *Erythonium grandiflorum.*, and cow parsnip, or shrubs such as huckleberry or buffaloberry.

Bottom-up effects (food supply or disturbance):

- Many important habitats such as avalanche chutes and alpine meadows are mostly static; there are few options for improving habitat in these areas.
- Huckleberry and buffaloberry habitat can be improved by logging or burning. Lower stocking densities and selective logging that result in broken canopies can also benefit berry production.
- Ungulate numbers are unlikely to significantly influence bear populations because bears are not efficient predators on their own. The numbers of animals killed by other predators, vehicles, trains and hunters, or that die during winter months, is likely to be important because those animals are available for bears to scavenge.
- Kokanee runs in the study area attract bears into valley bottoms where conflict with people is more likely but also provide important fall food.
- Lost habitat such as mine spoils or gravel pits can be improved by reclamation to support Grizzly bear objectives.
- Disturbance can be reduced by vegetative cover or limiting human access.

Top-down effects (mortality risk):

- Non-hunting mortality can be reduced by limiting access, but this does not reduce front country mortalities which occur in human inhabited areas.

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- Attractant management, including livestock husbandry, urban fruit trees, roadkill carcass pits and garbage, and agency responses to conflict between the public and bears influence front country mortality risk. Many of these problems can be mitigated.
- Create structures to reduce highway mortality (wildlife overpasses may be most effective for bears).

4.3.1 Road Closure Prioritization

Access management can be an effective management strategy to conserve Grizzly bears. Reducing the number of human and bear interactions near important foraging habitat may provide the greatest benefit given current road densities and the broad use of habitats by bears in different seasons. Maps that show the road types and proximity to predicted huckleberry patches used by Grizzly bears are not included in this report due to the sensitivity of huckleberry locations related to concerns around commercial huckleberry harvesting, which is currently unregulated. These maps may be made available upon request. Huckleberries that are used by bears were predicted in three areas of the Elk Valley: Elk Lakes and Height of the Rockies provincial parks, the Lizard range, primarily Sand Creek, and in the Morrissey and Coal creek drainages. There is no motorized access into parks and little access into the Lizard range, except for Sand Creek, that may conflict with bears foraging on huckleberries. Most potential conflict is east and south of Fernie along the Morrissey Forest Service Roads, particularly the Matheson Creek road. We recommend verifying that these areas do support huckleberries that are used by Grizzly bears by talking with local residents. Visiting these areas, including the cut-blocks on the Lladner forestry service road and examining Grizzly bear telemetry data can also help confirm use. If these areas have a productive berry patch and presence of bears based on field verification, then we suggest access management that includes consideration of Ktunaxa title and rights. Huckleberries are typically used from August 1 (though some low elevation stands produce fruit in early July) to September 15, hence seasonal closures can be effective for this purpose.

4.4 Tactical Management responses

Tactical responses include processes to improve consistency and/or coordination in applying current policy direction, or to collect information or data, that may be undertaken by government, proponents, stakeholders and/or First Nations. This can include assessment, monitoring, evaluation, research, coordination, collaboration, guidelines, management plans etc.

Currently, there is a Bearsmart coordinator in Fernie, but the focus is on education primarily in schools. There is on-going road and rail management. Future potential tactical responses include:

- Achieve Bearsmart status in all communities; have Bearsmart coordinators for all rural areas; stronger enforcement of rules around when the public may destroy a bear. Additionally, evaluate the effectiveness of each Bearsmart program including delivery and messaging.
- Conduct conflict and attraction reduction in urban and rural areas.
- Investigate ways to reduce railway strikes on bears, and on ungulates if they are the attractant.
- Investigate unreported Grizzly bear mortality and the related causes of unreported mortality.
- Research to understand the relative importance of buffaloberry to Grizzly bear population health and where bears are selecting the resource (relate occurrence data to better define use of buffalo berries).
- Investigation into the importance of grouseberry, bilberry and Saskatoon as Grizzly bear food values.
- Implement forest management strategies that incorporate High Conservation Value Forest (HCVF) or Cultural Conservation Value Forest (CCVF) programs and planning.
- Investigate harvesting, silviculture and reclamation techniques that support protection or enhancement of berry habitat following anthropogenic disturbance.

In the future, the analysis described here could be included in Timber Supply Reviews to evaluate the impact these measures might have to timber supply. A working group or panel could be established to investigate improved stocking standards including spacing.

4.5 STRATEGIC MANAGEMENT RESPONSES

Strategic responses include measures to define or establish strategic direction for the management of land and/or resource values, typically led or coordinated by government. This can include new objectives for valued components, new acts and/or regulations.

None of the above measures are legislated or enshrined in permits or policy. New policy may be required to apply the above measures consistently. In addition, a legislated strategic framework for access management or access control program should be developed. This should be lead by FLNRORD. The existing Timber Supply Areas (TSAs) and Annual Allowable Cut (AAC) should be considered with any proposed changes to policy. The Integrated Silviculture Strategy (ISS) could potentially be a good platform to address sensitivity to policy changes.

There is a need for accepted silviculture practices and methods to support and create Grizzly bear habitat. Examples include the use of broadcast burning for post-harvest treatment in key berry-producing sites and the allowance of reduced stocking standards in select site series with high berry-producing potential or requiring site-specific harvesting prescriptions for high

conservation value forests with high berry potential. Landscape-scale, strategic fire breaks that support wildlife values could be applied in the future.

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Andy Cagle and Kathleen McGuinness provided extensive GIS support for this assessment. Bruce McClellan and Tony Hamilton shared their expertise in the development and interpretation of the assessment methods and results. Michael Proctor and Clayton Lamb provided key berry maps and data to support the assessment.

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APPENDIX

APPENDIX A. ALPINE AND AVALANCHE CHUTE 1950 AND 2015 COMPARISON

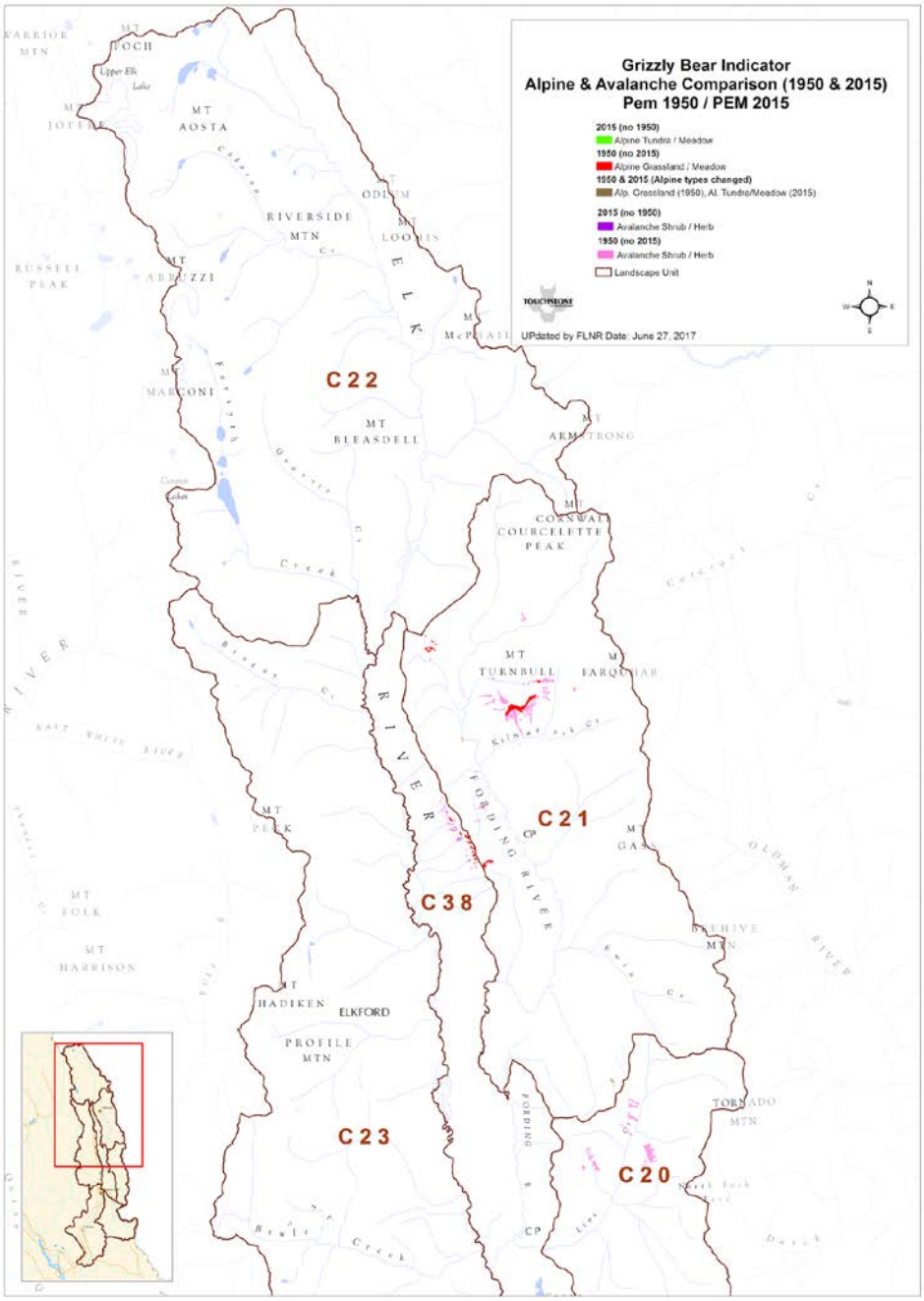

Figure A.1. Comparison of alpine and avalanche between 1950 and 2015 in the north.

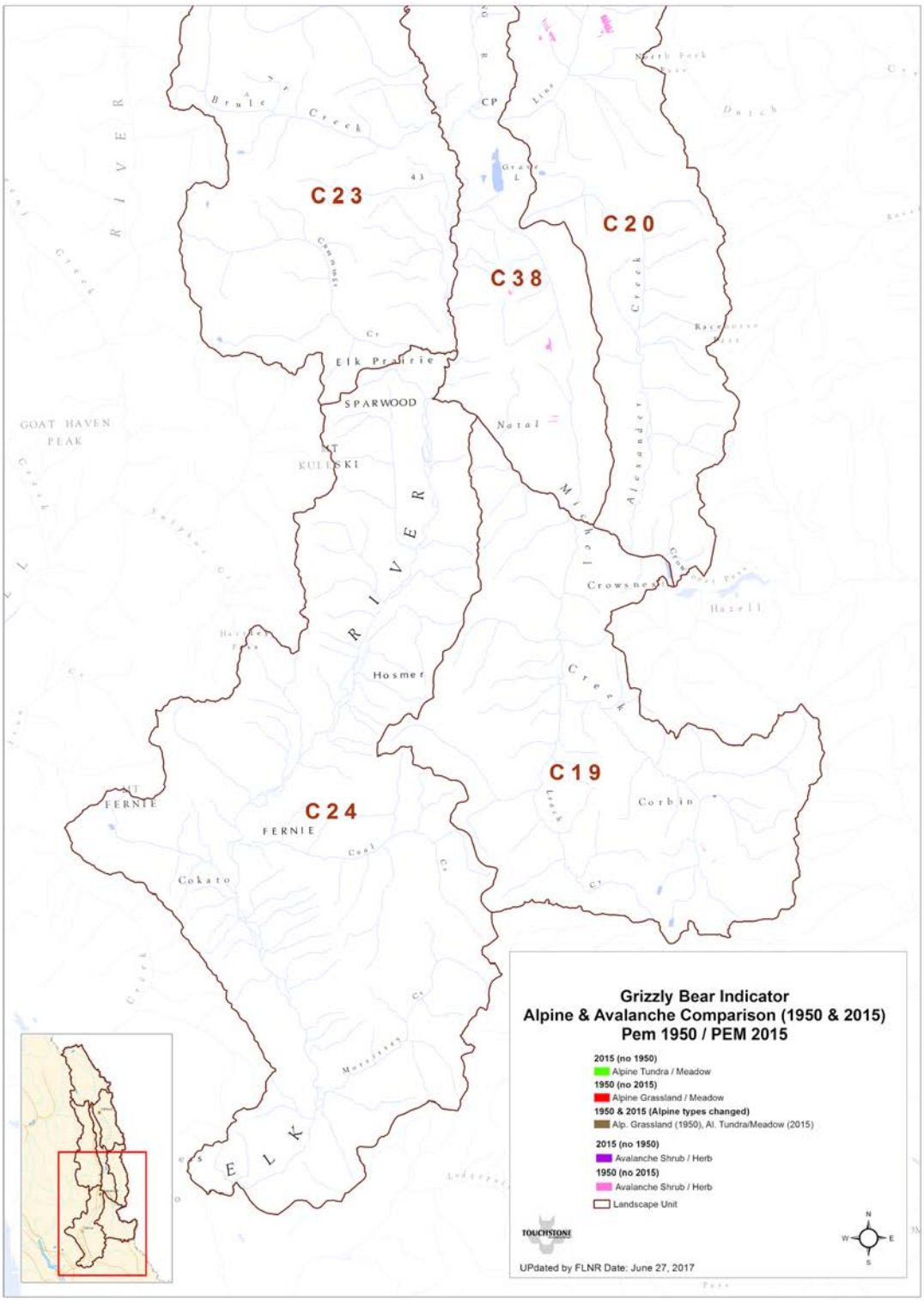

Figure A.2. Comparison of alpine and avalanche between 1950 and 2015 in the south.

APPENDIX B. LIST OF CURRENT CEMF WORKING GROUP MEMBERS

#	Name	Organization
1	Taye Ayele	Chair, FLNRORD
2	Marcin Haladaj	FLNRORD
3	Lyle Saigeon	FLNRORD
4	Cassidy van Rensen	FLNRORD
5	Bill Green	KNC
6	Alison Burton	KNC
7	Warn Franklin	Teck Coal Ltd.
8	Steve Hilts	Teck Coal Ltd.
9	Kevin Podrasky	Teck Coal Ltd.
10	Lee-Anne Walker	Elk River Alliance
11	Kari Stuart-Smith	CANFOR
12	Terry Melcer/Scott Beeching	District of Sparwood/Elkford
13	Brian Dureski	CanWel Building Materials Group Ltd
14	Mark Hall	MoE
15	Darin Welch	MoTI
16	Mark Vendrig	CanAUS Coal Ltd
17	John Pumphrey	CanAUS Coal Ltd
18	Jeff Berdusco	CanAUS Coal Ltd
19	Art Palm	Jameson Resources Crown Mountain Project
20	Michael Keefer	Jameson Resources Crown Mountain Project
VC TEAM LEADS		
1	Peter Holmes	Old & Mature Forest, FLNRORD
2	Herb Tepper	WCT, FLNRORD
3	Alan Davidson	Riparian Habitat. FLNRORD
4	Kim Poole	BHS, Aurora Wildlife Research
5	Garth Mowat	Grizzly bear, FLNRORD
TECHNICAL SUPPORT		
1	William Burt	FLNRORD
2	Rhian Davies	FLNRORD
3	Ryan MacDonald	ALCES Group
3	Kathleen McGuinness	Touchstone GIS Services Inc.

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