RIPARIAN AREAS CONSERVATION TARGET ASSESSMENT REPORT

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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, unites ENGOs and works 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 one of the three 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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THE CALGARY FOUNDATION

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SUMMARY OF FINDINGS

The riparian areas target represents 18% of the landscape in the southern eastern slopes study area. Riparian areas were selected as a target because they are very productive in terms of biomass, are important to water conservation and provide critical wildlife habitat. A riparian area that is healthy in terms of composition, structure and function improves ecosystem resilience to climate change and extreme weather events. We are concerned about riparian areas because despite their important value, they comprise relatively small systems and impacts such as linear disturbance in watersheds can have a profound impact on the composition, structure and function of riparian systems.

The current health of the riparian areas target was rated as fair, defined as outside acceptable range of variation and requires human intervention. The score was derived from the following key ecological attributes (KEAs):

Riparian health scores in the Oldman Watershed were rated as >55% healthy with problems, indicating many riparian functions are still performing, but clear signs of stress are apparent. The upper reaches of the Bow Watershed were rated as healthy.

Watershed intactness measured as linear disturbance determined that the majority of watersheds were of a density >0.6 km/km^2, above acceptable level for Species At Risk.

Of the 10 critical threats identified that affect health of the riparian areas target, 3 were ranked as high, 3 as medium and 4 as low (see Table 1):

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

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

A low threat is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

Table 1: Critical Threats to Riparian Areas Target

Threat		Riparian Area
1	Commercial logging	High
2	Linear disturbance (roads, rails and transmission lines)	High
3	Urban development	High
4	Invasive species	Medium
5	Motorized recreation	Medium
6	Surface disturbance (gravel mining, clearing of riparian vegetation)	Medium
7	Agriculture cropland	Low
8	Dams and diversions	Low
9	Grazing	Low
10	Non-motorized recreation	Low

Climate change was identified as an **emerging threat** for the riparian areas conservation target, with the Rocky Mountains experiencing shorter, warmer winters (estimates range from 40–50% decrease in annual snowpack and increased fall precipitation), resulting in diminished spring/summer runoff. Strategies that promote ecosystem resilience by improving state of riparian areas health will be important considerations in strategy development.

Indirect threats are factors that influence the riparian areas target direct threats:

Timber harvest operating ground rules do not include setbacks for ephemeral and unnamed streams.

Failure to reclaim roads and trails no longer needed for industrial activity.

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

Westslope cutthroat trout recovery plans and bull trout recovery plans in development.
Better recognition of watershed importance from urban municipalities (interest in water).
New appreciation for the role that beavers can play in improving watershed resilience.

These results were used to develop strategies, including defining goals, objectives and actions aimed at improving the health of the riparian areas target. The following four **goals** were identified to improve riparian areas target health and reduce critical threats:

1. Restore riparian areas health to levels approximating natural range of variation, shifting riparian areas health scores to 60% healthy, and less than 15% unhealthy.
2. Minimize linear disturbance to <0.6 km/km^2 maximum on public lands and for sub-watersheds with Species At Risk (native fish/grizzly bears), restore to <0.2 km/km^2.
3. Reduce point sources of sedimentation.
4. No new surface development – buildings, clearing vegetation – in riparian areas. (Buildings defined as human structures – picnic shelters, parking lots, trailheads.)

BACKGROUND

The Collaborative has developed a conservation plan or blueprint for conservation groups to work toward maintaining a healthy landscape along Albert's southern eastern slopes. The Collaborative used The Nature Conservancy Action Planning Process (TNC CAP) 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 grassland, riparian areas, white spruce and lodgepole pine, wide-ranging mammals and native fish species.
2. Conservation target health and critical threat assessment: conservation target assessment approach developed for the first four 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 the broader conservation community to set conservation goals and develop strategies.
4. Target assessment report: Riparian Areas Conservation Target Assessment Report drafted to inform development of goals and conservation strategies to maintain and restore the riparian areas target.

RIPARIAN CONSERVATION TARGET

According to Fitch et al. (2003), riparian areas are the lands adjacent to streams, rivers, lakes and wetlands, where the vegetation and soils are strongly influenced by the presence of water (see Figure 1). Though riparian areas comprise only a small fraction of the land[1], they are among the most productive and valuable of all landscape types, and have been the focus of conflicts between resource users.

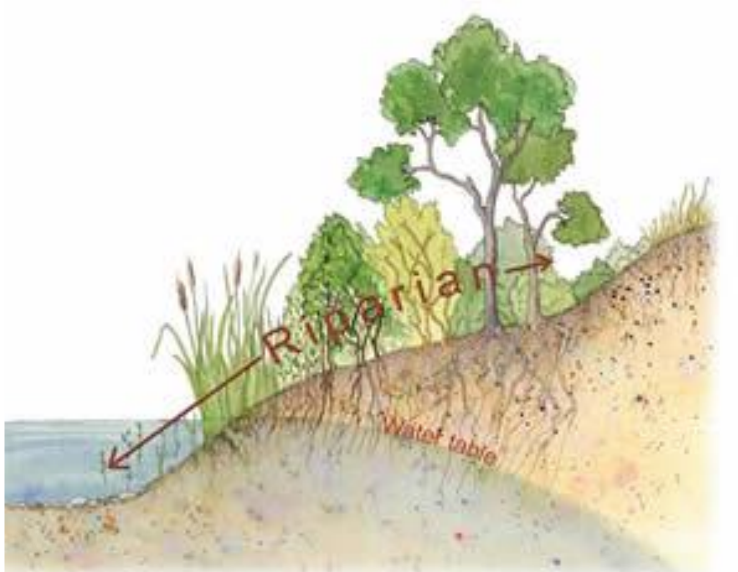
Typically, riparian areas have the following three characteristics:

Abundant water is present, seasonally or regularly, and that water is either on the surface or close to the surface.

Vegetation is present that responds to, requires and survives in ample water.

Soils have been modified by abundant water, stream or lake processes and there is lush, productive vegetation (Fitch et al. 2003).

Riparian area was defined as a transition area between upland and rivers, streams, lakes, wetlands, springs and seeps. To identify riparian areas in the study area, waterbodies (rivers, streams, lakes and wetlands) and elevation were used to determine where riparian areas are most likely to occur. The total extent of riparian areas in the study area is 4861 km^2, or 18% of the overall study area (see Figure 2). (Seeps and springs were not included in calculations.)



Source: Cows and Fish

Figure 1: Extent of Riparian Area

1 **Riparian areas represent 2% to 5% of the landscape (Fitch et al. 2003).**

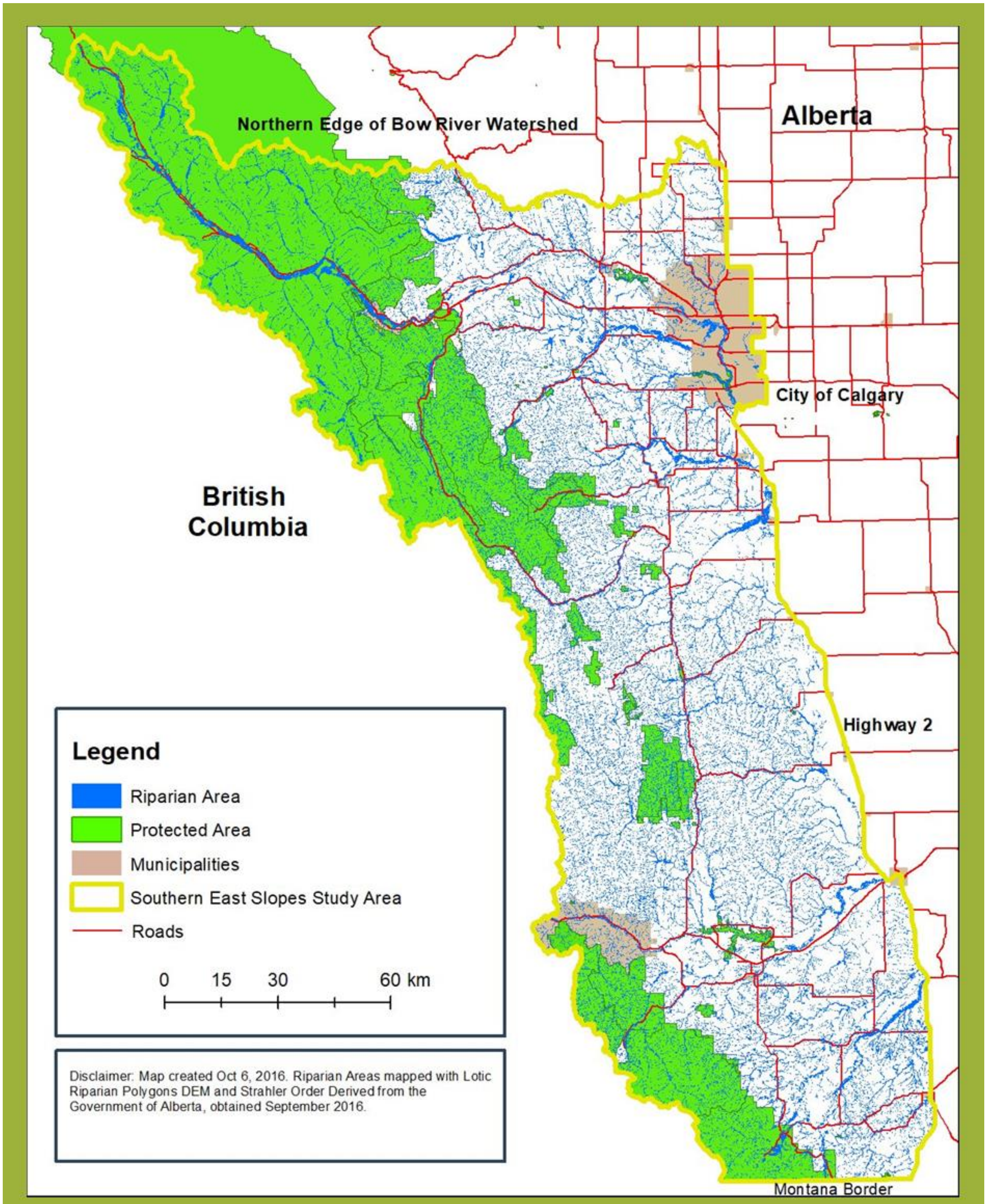


Figure 2: Map of the Riparian Areas Target

ECOLOGICAL AND ECONOMIC IMPORTANCE

Riparian areas are critical from both an ecological and economic perspective – they sustain us, our landscapes, our lifestyles and our businesses. The importance and significance of riparian areas is far greater than their size suggests, as they produce forage, shelter, fish, wildlife and water. They are part of a healthy, functioning landscape, and form part of an extensive watershed (Fitch et al. 2003).

According to Government of Alberta (2015), riparian areas provide important functions such as:

trapping and storing sediment
building and maintaining banks and shores
storing water and energy
recharging aquifers
filtering and buffering water
reducing and dissipating energy created by the waterbody
maintaining biodiversity
creating primary productivity like forage and browse

According to Cows and Fish (n.d.), though riparian areas provide similar functions for flowing (streams/rivers) and non-flowing (lakes/wetlands) systems, there are some differences (see Table 2).

Table 2: Comparison – Riparian Functions in Flowing and Non-Flowing Systems

Stream and Rivers	**Lakes and Wetlands**
trap sediment	trap and store sediments; prevent re-suspension of sediments
build and maintain banks	build and maintain shorelines and banks
reduce flood damage	reduce damage from high water levels and wave action
store water, especially flood water	store water, especially flood and spring runoff water; act as a surface reservoir
extend perennial flows or levels by recharging underground aquifers	extend seasonal or long-term levels by recharging underground aquifers
dissipate flow and ice energy	dissipate wave and ice energy
high primary production, including forage and shelter values	high primary production, including forage and shelter values
maintain or improve water quality	maintain or improve water quality
filter and buffer water, both from over-land flow (runoff) and water from within the channel	filter and buffer water, both from over-land flow (runoff) and water from within the basin
maintain **biodiversity**[1]	maintain **biodiversity**[1]
	trap nutrients and sediments to balance nutrient cycling, in-filling and primary production

[1]**biodiversity**
The variety of life in all its forms, levels and combinations. Includes ecosystem diversity, species diversity, and genetic diversity (IUCN, UNEP and WWF, 1991).

Landscape Resiliency and Biodiversity

Riparian areas enable our landscapes to be more resilient to extreme weather and a changing climate. Riparian areas are especially critical when drought or flood occurs as they act to buffer the destructive effects of both floods and droughts (Fitch et al. 2003).

From a drought perspective, the Government of Canada's 2008 Climate Change Report stated that increases in water scarcity resulting from climate change presents the greatest risk to the prairie provinces, including Alberta (Lemmen et al. 2008). A critical part of becoming more resilient to water scarcity is increasing or restoring the ability of natural landscapes to retain water – this includes maintaining healthy riparian areas (Miistakis Institute n.d.).

From a flooding perspective, riparian area vegetation is a key factor in reducing downstream flooding. As floodwater flows through a vegetated area, the plants resist the flow and dissipate the energy, increasing the time available for water to infiltrate into the soil and to be stored for use by plants (Natural Resources Conservation Service 1996). As noted by the Natural Resources Conservation Service (1996), because flooding occurs periodically, and groundwater moves through floodplain soils, the surface layers of soils in riparian areas are wetted and dried seasonally. The presence and movement of surface water and groundwater in riparian zones enhances the recycling of nutrients and other chemical reactions important to plant growth. Further, the timing of flooding is important to the life cycle of many aquatic and some terrestrial species. A naturally occurring flood pulse enhances survivability of organisms in the riparian zone and promotes both species diversity and biological productivity.

Fish and Wildlife Habitat

Riparian zones are the interface between terrestrial and aquatic habitats and perform several important ecological functions. They are also one of the rarest habitats in Alberta (Fitch et al. 2003). They provide nesting, breeding and feeding opportunities for many species and play an important role in maintaining water quality and other conditions critical to fish, amphibian and reptile survival (Blouin 2006). Trees and shrubs that border and overhang streams and lakeshores moderate the temperature through shading and the cooling effect of evapotranspiration, which directly benefits fish and aquatic invertebrates (Capital Region District n.d.).

The linear nature of riparian ecosystems provides distinct corridors that are important as migration and dispersal routes, and as forested connectors between wildlife habitats (Natural Resources Conservation Service 1996). These riparian corridors are critical as wide-ranging mammals require landscape linkages, corridors and sufficient resources to thrive in their ever-diminishing habitat.

The southern Canadian Rockies represent one of the most important and strategic sections for carnivores in the entire interior mountain bioregion, stretching from Yellowstone to the Yukon and beyond (Nature Conservancy of Canada 2016). The southern part of the Rocky Mountains exhibits a broad array of ecological conditions that support the most diverse, intact system of carnivores in North America (Apps et al. 2007) and prime habitat for ungulates and other species in a variety of life stages (Killeen et al. 2014). Riparian areas are critical habitat areas, and will become even more critical as they serve as evolutionary migration routes for climate-affected species (Miistakis Institute n.d.).

Economic Value

Riparian areas provide incredible economic value in terms of the ecosystem services they provide. It can be challenging to assign a dollar value to these services.

Though not exclusively focused on riparian areas, Ribaudo et al. (1994) estimated that the 40 to 45 million acres of cropland retired under the Conservation Reserve Program in the United States, at an annual cost of $1 billion dollars, has generated $3.5 to $4.5 billion each year in water quality benefits, including:

reduced erosion
increased recreational fishing
improvements in waterway navigation
water storage and treatment
flood control

The authors posit that dollar values would be higher if more environmentally sensitive land had been targeted.

From a cattle grazing perspective, healthy, productive riparian areas represent an opportunity for ranchers to sustain their operation and potentially earn more revenue, since abundant water, shelter and forage translate into cash (Fitch et al. 2003).

Water Purification

Riparian areas trap sediment, nutrients and contaminants in surface runoff and in subsurface flow as it moves from uplands to the waterbody. Trapped nutrients and contaminants can be transformed to less harmful forms, or made unavailable for uptake by living organisms. Additionally, riparian vegetation slows down flowing water and stabilizes streambanks, thereby reducing erosion and sedimentation. These processes help maintain good water quality (Ambrose and Fitch 2016). The southern eastern slopes are an immensely important water source for many downstream communities, including the large cities of Calgary and Lethbridge.

Recreation

Riparian areas are important to a number of recreation pursuits in the southern eastern slopes. Given the importance of riparian areas to different life stages of songbirds and wildlife, riparian areas are important for bird and wildlife watching. Riparian areas also provide critical habitat for fish populations and recreational fishing. Properties that border or include riparian areas are usually valued more highly than those that do not (Capital Region District n.d.).

CURRENT STATUS OF CONSERVATION TARGET

KEAs were identified to determine current status of the riparian areas target, including both condition and landscape processes that are important to target health. There was no extent rating, as riparian area is a constant; it is the condition of the riparian area that changes (Ambrose and Fitch 2016). Table 3 outlines the KEAs, indicators, and health ratings (and justification for the ratings) of each riparian areas target KEA. Health scores were derived from expert opinion, and were informed by spatial analysis and literature review. For the analysis approach and results (including maps) for each KEA, see Appendix A, which also describes important limitations and data gaps in the process.

Table 3: Target Viability Assessment – Riparian Area Target

Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good
Riparian	Condition	Intactness of watershed	Density of linear disturbance by sub-watershed		Majority of watersheds >1.2 km/km^2	Majority of watersheds <1.2 km/km^2	
Riparian	Condition	Riparian health	Overall watershed health scores, rolled up to sub-watershed (State of the Watershed Reports)	Unhealthy overall	Healthy with problems overall and >50% individual assessments healthy with problems	Healthy with problems overall and <50% individual assessments healthy with problems	Healthy overall
Riparian	Landscape context	Flow regime	Altered flow regime				

The flow regime KEA was not ranked because the altered flow regime indicator could not be assessed within the confines of the budget. Dr. Stewart Rood indicated that the relationship between flow regime and riparian health (including riparian woodland regeneration) has a number of complexities. As a result, it is challenging to link poor riparian health directly to altered flow regimes. However, if there is good riparian health, one can likely conclude that flow regimes are not having a significant impact on riparian health. Dr. Rood also noted that the Government of Alberta has been using some positive practices in southern Alberta to operate dams in the South Saskatchewan River Basin for riparian woodland health.

Overall, current condition of the riparian areas target is **fair,** defined as outside acceptable range of variation and requires human intervention. Two conditions were rated as fair – watershed intactness and riparian health scores. Goals for the riparian areas target should therefore focus on improving the current condition in terms of linear footprint and conditions associated with health scores.

A critical threat analysis will help identify key riparian impacts and help inform strategies.

Data Gaps

Riparian health scores were not provided for 9 of the 15 sub-basins in the entire Bow River Basin.

Seeps and springs are important but are often not adequately considered during planning processes (i.e., forest harvest plans) given their ephemeral nature (Ambrose and Fitch 2016). The headwaters of both the Oldman and the Bow are a source-water area, and these seeps and springs are important contributors to flows in these watersheds. In the Porcupine Hills alone, Dr. Stewart Rood has identified over 1000 springs, which all contribute to streamflows. The important contribution of springs and seeps was not properly represented in the GIS analysis because of budget constraints, and is critical data to gather in future iterations of this process.

CRITICAL THREATS

To determine the critical threats for the riparian areas target, the sources of stress affecting KEAs were first determined. Sources of stress are typically degraded KEAs, so for the riparian areas target **reduced watershed intactness**, **reduced riparian health** and **altered flow regime** were identified as key sources of stress. Each source of stress was ranked for severity and scope based on expert opinion.

Critical threats were identified as stresses that affect the source of stress, such as commercial logging. Each critical threat was ranked according to its contribution and irreversibility. Lastly, threats that might have a future impact on the riparian areas target were identified.

For more information on stress and critical threat ratings, see Appendix B. The 10 threats identified for the riparian conservation target are listed in Table 4.

Table 4: Riparian Areas Target – Threats and Ratings

Threats		Riparian
1	Commercial logging	High
2	Linear disturbance (roads, rails and transmission lines)	High
3	Urban development	High
4	Invasive species	Medium
5	Motorized recreation	Medium
6	Surface disturbance (gravel mining, clearing of riparian vegetation)	Medium
7	Agriculture cropland	Low
8	Dams and diversions	Low
9	Grazing	Low
10	Non-motorized recreation	Low

Current Threats

Urban Development – High

According to Ambrose and Fitch (2016), urban development, including its transportation network, has taken place in floodplain areas throughout the study area. Berms and embankments have also been built in floodplains to protect urban development. Hardened surfaces that accompany urban development prevent natural infiltration, altering hydrological cycles in urban areas, which affects riparian areas. Calgary has taken some positive steps, including ensuring appropriate development setbacks from riparian areas, however much remains to be done throughout the study area. Urban development also leads to infilling of wetlands, straightening of streams (as is about to happen to the Elbow River for the southwest extension of the ring road in Calgary) and clearing of floodplain vegetation.

Commercial Logging – High

Commercial logging was ranked as high because the most common harvest method of clearcutting can lead to impacts on riparian systems. Logging can increase surface water runoff and erosion, particularly during heavy rain events. The loss of trees (and their influence on water retention after snowmelt) might have a significant impact on riparian zones. Additionally, the loss of trees and their role in water retention after snowmelt can have a significant impact on riparian zones. This concern might be heightened due to climate change, as Lapp et al. (2005) modelled a potential loss of 40% of current snow volume.

Rumsey et al. (2004) identified inappropriate harvest prescriptions and/or fire suppression as a major threat to the region. A study on the impacts of logging and linear disturbance on watershed health in the Crowsnest watershed (Mayhood et al. 2004) indicated the majority of the sub-watersheds are at high risk for erosion and stream channel damage. Buffers are not applied universally to all stream orders, and therefore not all riparian areas are protected during forest activities. Many headwaters streams have no buffer, yet according to a USGS study, they comprise 60–70% of stream length in a watershed (Fitch 2016).

Linear Disturbance – High

According to Ambrose and Fitch (2016), the linear footprint on the landscape is important in determining hydrological response during floods. Landscape footprint also determines hydrological response during low flows (disturbance leads to less water retention and reduced flows later in the season). Research in the Alberta tri-creeks area indicated that once a landscape footprint is larger than 20% of the landscape, hydrologic regime is drastically altered.

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[2] (ALCES 2007), predicted that road length is projected to increase from 7,136 km in 2005 to more than 16,200 km in 2055. Roads are one of the most damaging impacts on intact landscapes, particularly hydrological function and habitat fragmentation (Forman and Alexander 1998). In the study area, the average linear density is often orders of magnitude higher than the thresholds for many species' survival (Fitch 2016).

Linear corridors, such as seismic lines, roads and pipelines are "sources and vectors for non-native species invasion" (Bradley 2003). Trombulak and Frissell (2000) identify the spread of invasive species as one of the primary potential effects of linear disturbances on terrestrial and aquatic habitats. Drainage patterns and water quality in watersheds can be altered by increases in the compacted surface area. Seismic cutlines are of particular concern because regeneration is difficult due to soil and root disturbance, grass competition and continued use for vehicle access (Oldman Watershed Council 2010).

Water is affected by land-based recreation activities, including fishing, hiking and off-road vehicle travel, which occur on linear disturbances like trails, seismic lines and roads. According to Knight and Gutzwiller (1995), these effects can include altered flow regimes, elimination of protective cover afforded by overhanging banks, increased sedimentation and turbidity, introduction of pollutants such as gasoline and oil leaked by off-highway vehicles (OHVs), and disturbance of streambeds and lake bottoms. Traditionally, designated OHV use areas in Alberta have few, if any, restrictions on OHV users designed to protect fish and fish habitat from effects of stream fording by OHV users (Brewin et al. 2003).

Until recently, conservation officers could not issue tickets on the spot, but instead had to issue a court summons to press charges against violators who did not keep their "wheels out of the water" (Derworiz 2016).

Diminished flow later in the season is harmful to overwintering fish like bull trout (a Species At Risk in Alberta) that lay their eggs in the fall and require sufficient flow to incubate them over the winter. Bull trout also rely on sufficient flow to create the deep pools where they

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

overwinter. Additionally, sediment input to streams can affect the depths of these pools, hence bull trout, as they require pools over 1 m deep to survive. Westslope cutthroat trout, another Species At Risk in Alberta, are spring spawners. This species can be affected by increases in sediment pulses owing to linear and surface disturbance.

This threat was rated as high because of the proliferation of roads in the study area and because roads are rarely remediated to a natural state. Even forestry roads, which are often planned to be a temporary landscape feature, are seldom restored to a natural state. This is particularly true when motorized recreation users use roads as trails or do not respect road closures in place for road remediation efforts. Further, there are social and economic considerations: How many roads are we willing to eliminate, what are the costs of restoration and who will pay these costs?

Invasive Species – Medium

Invasive plants that take advantage of the good growing conditions found in riparian zones often invade these areas. As these plants dominate native plants, overall vegetative diversity decreases, resulting in less favourable habitat for most wildlife species (USDA NRCS 1996).

Terrestrial invasive species can affect the community structure (Gratton and Denno 2005) and biodiversity of an ecosystem (Brown and Gurevitch 2004) through displacement of native species (Tayeh et al. 2015). Invasive plant species might compete directly with native species and might cause changes in ecosystem processes that have profound effects on native species (Mack 1989; Howe and Knopf 1991; D'Antonio and Vitousek 1992; Christian and Wilson 1999) by altering the ecosystem dynamics and processes of an ecological community (Bart and Hartman 2000). Control and eradication methods are time consuming and costly, and are often only able to keep the plants at a tolerable level. As human activity continues to increase in the area, this threat will remain, and continue to grow without proper management (Nature Conservancy of Canada 2016).

Linear corridors, such as seismic lines, roads and pipelines are "sources and vectors for non-native species invasion" (Bradley 2003). Complete eradication of invasive species has proven difficult and is very expensive, time- and labour intensive, and in some cases might not be feasible due to growth patterns or dormancy potential. The lack of broad-scale knowledge of rates of spread, measures of success and comprehensive understanding of the potential outcomes of invasive species makes the irreversibility of invasive terrestrial plants a difficult aspect to approximate (Andersen et al. 2004).

Motorized Recreation – Medium

An important effect of logging is construction of cutblock access roads. Unfortunately, an unintended result is the access provided for OHVs, allowing them to reach otherwise inaccessible areas as a form of recreation. Once access is established it is very difficult to deny that access in future. This also allows for the introduction of invasive alien plants into areas where control is difficult (ALCES 2007).

In their comprehensive review of the potential effects of linear disturbances on terrestrial and aquatic habitats, Trombulak and Frissell (2000) identified seven primary concerns:

increased mortality from road construction
increased mortality from collisions with vehicles
modifications in animal behaviour
alteration of the physical environment
alteration of the chemical environment
spread of exotic species
increased alteration and use of habitats by humans

Additionally, people using linear corridors as pathways to access remote areas have the potential to adversely affect the environment through (Farrand and Finley 2003):

destruction or alteration of vegetation

change in aesthetics
soil erosion and compaction
sedimentation of watercourses
disturbance of environmentally sensitive areas
contribution to cumulative effects

There is a dearth of bridge crossings for recreation in the Oldman headwaters, as the Green Zone is a multiple use landscape that isn't managed for recreation. Though an illegal activity, many motorized users drive vehicles through streams and rivers, resulting in an influx of sediment and declines in water quality. Removal of riparian vegetation to allow for motorized vehicle fording leads to bank weakening and extension of the impacts of motorized recreation downstream. Roads and trails capture overland flow, redirect it, increase its speed and cause erosion of the landscape and sedimentation in waterbodies.

Surface Disturbance – Medium

Land use activities in the Oldman watershed include agriculture, forestry, mining, recreation, and oil and gas extraction. Total disturbance from land use activities covers approximately 60% of the watershed. Agricultural activities dominate while the remainder is made up of well sites and linear disturbances from roads, pipelines and cutlines (Oldman Watershed Council 2010). Most sand and gravel mines are located in floodplains because that is where the biggest and most accessible, hence cheapest, deposits exist (Ambrose and Fitch 2016).

Dams and Diversions – Low

Dams affect timing and magnitude of streamflows, and also water quality and other ecosystem characteristics. The South Saskatchewan Regional Plan (Government of Alberta 2014) highlights concerns about the health of riparian areas and the impact of withdrawals and altered flow regimes on aquatic ecosystems in both the Bow and Oldman watersheds. The magnitude of influence from dams and diversions is much higher than changes in flow pattern due to watershed condition, and the magnitude of the influence scales in proportion to the size of the dam. Small check dams have a smaller influence individually, but still contribute cumulatively to altered flow regimes (Rood 2016). It is important to recognize that woodland clearing; wetland destruction, road construction, and other development alter passage of precipitation and melt patterns (Rood 2016).

Altered flow regimes can also affect hydrochory. According to Nilsson et al. (2010), hydrochory is the passive dispersal of organisms by water, and it is an important means of propagule transport, especially for plants. Dams affect the natural process of hydrochory (dispersal of seeds and conal fragments), and sedimentation, which has an effect on riparian areas (Rood 2016).

Bow River Basin

According to the Bow River Basin Council (2010), determining water quantity is a critical initial step toward understanding other water-related issues, including fisheries and fish habitat, vegetation in both aquatic and riparian areas, biology and aquatic species, erosion and deposition, and river channel shape.

Significant and cumulative changes to flow regimes, causing more frequent or sustained high or low flows, could cause a river to transition into a different ecological state with potentially different aquatic populations and riparian communities. Maintenance and health of existing ecosystems and populations requires maintaining aspects of the natural flow regime, including fluctuations (Bow River Basin Council 2010).

Streamflows upstream of the Town of Banff can be considered relatively natural, however most of the Bow River is highly altered from its natural flow regime. Hydroelectric facilities, water withdrawals, diversions, irrigation canals and wastewater discharges contribute to alterations in the natural flows of the Bow River. About 40% of the Bow River Watershed's total annual natural flows are altered, making it the most regulated river in Alberta (Nature Conservancy of Canada 2016).

Impacts of flow regulation for hydropower production are observed in the Bow River above Calgary. The productivity of fish populations is limited by the habitat instability caused by the large hourly flow fluctuations in water released from the dams (Nature Conservancy of Canada 2016). Though water withdrawals in the Bow River above Calgary are not large compared with other rivers, summer flows are lower than natural due to water releases throughout the year producing flows higher than normal, especially in winter (Bow River Basin Council 2010).

Oldman River Basin

The waters of the Oldman watershed are highly regulated and extensively used. There are three major onstream storage reservoirs – Oldman River, Waterton and St. Mary reservoirs – with a total storage capacity of about 970,000 dam^3. In addition, there are over 660 000 dam^3 of offstream storage, some of which is located outside the Oldman watershed. These storage reservoirs are used primarily to better match temporal and geographic variations in water supply and demand (primarily irrigation demand) through flow regulation, and to maintain in-stream flow targets (Oldman Watershed Council 2010). Water demand is generally low in upper stream reaches in the watershed, but increase to high levels in lower reaches of most streams.

The Oldman Watershed Council (2010) rated water quantity for the Oldman watershed as fair, with the following ratings for the sub-basins in the study area:

Mountains sub-basin – good
Foothills sub-basin – fair
Southern Tributaries sub-basin – poor
Oldman River main stem – poor

Grazing – Low

Inappropriately managed grazing can result in negative impacts on an ecosystem, including degraded soil and water quality, or conversion of the poorly managed land to a less-productive community (Adams et al. 2005). Overgrazing concentrates livestock in riparian areas for extended periods, reduces the vegetation and tramples streambanks (USDA NRCS 1996). Impacts can occur over the entire property (through overgrazing or overstocking), or be focused around watering sources, riparian areas or other localized areas where cattle tend to congregate (Nature Conservancy of Canada 2015). Where vegetation has been removed by heavy grazing, logging or other development, the cohesive nature of streambanks breaks down and streams become wide and shallow. These channels can be unstable, with lower water tables that shrink the size of the riparian area and its productive nature (Ambrose and Fitch 2016).

Livestock grazing affects species composition through active selection by herbivores for or against a specific plant taxon, and differential vulnerability of plant taxa to grazing (Szaro 1989). Ecosystem function can be affected by commercial grazing through disruption of successional processes and prevention of seedling establishment (Longhurst et al. 1982), and structure can be affected by soil compaction, introduction of invasive species and removal of key plant species and litter layer (Fleischner 1994). Unsustainable grazing management is a major threat to riparian zones due to trampling and browsing damage, sedimentation/turbidity and destabilization (Alberta Environment 2003) on both large ranches and small hobby farms.

Typically, ranchers understand that health of riparian areas, range health and habitat management are important to the sustainability of their farm and livestock (Nature Conservancy of Canada 2015). Where grazing management is an issue, detrimental effects are quite high, from overgrazing, excessive trampling, riparian damage, stream damage and increased fecal counts among other water quality aspects (Nader et al. 1998).

Unmanaged riparian areas increase the "horsepower" (water flow) and therefore reduce the resistance to, or defence against, erosion along the watercourse (Fitch et al. 2003). Rehabilitation of streams and aquatic habitats affected by grazing seem to be showing promising results, with time being a key factor. With the proper management regime and commitment to long-term strategies based on rotational grazing, resting periods, offsite watering and other management strategies, rehabilitation of unmanaged/mismanaged grazing sites is feasible (Fitch et al. 2003). Roni et al. (2008), however, described the lack of long-term studies evaluating the results over time as an issue.

Emerging Threats

Climate Change

It is challenging to rate the threat presented by climate change to the riparian areas target given the 10-year timeframe of the conservation action planning process. However, climate change and variable wicked events present a "wild card" in how altered flow regimes will affect riparian health (Ambrose and Fitch 2016).

The literature indicates that the Rocky Mountains could experience shorter, warmer winters (estimates of 40–50% decrease in annual snowpack and increased fall precipitation), resulting in diminished spring/summer runoff (Leung and Ghan 1999; Lapp et al. 2005).

Indirect Threats

Indirect threats are contributing factors that drive direct threats and must be considered in strategy development. For the riparian areas target, the following examples of indirect threats were identified:

Timber harvest operating ground rules do not include setbacks for ephemeral and unnamed streams.

Failure to reclaim roads and trails no longer needed for industrial activity.

OPPORTUNITIES

The following opportunities were identified as important examples of things to consider in strategy development:

Westslope cutthroat trout recovery plan and bull trout recovery plan (in development).
Recognition of importance of watershed from urban municipalities (urban interest in water).
New appreciation for the role that beavers can play in improving watershed resilience.

STRATEGIES

The next step in the process is to develop goals/objectives and strategic actions to address critical threats and/or improve target health. Objectives tend to be measurable statements of what we as a community want to achieve in relation to the foothills grassland target. Objectives can include activities related to policy and law, stewardship protection of land, water or species management, education and awareness, and livelihood, economic and other incentives.

Goals, objectives and example actions were identified through a workshop with ENGOs, community members and stakeholders interested in protecting the southern eastern slopes. Participants were asked to review KEAs, critical threats, indirect threats and opportunities for the riparian areas target.

Goals

The following four goals were outlined for the riparian areas target:

1. Restore riparian health to levels approximating natural range of variation, shifting riparian health scores to 60% healthy, and less than 15% unhealthy.
2. Minimize linear disturbance to <0.6 km/km^2 maximum on public lands and for sub-watersheds with Species At Risk (native fish/grizzly bears), restore to <0.2 km/km^2.
3. Reduce point sources of sedimentation.
4. No new surface development (buildings, clearing vegetation) in riparian areas. (Buildings defined as human structures – picnic shelters, parking lots, trailheads.)

Goal 1: Restore riparian area health to levels approximating natural range of variation, shifting riparian health scores to 60% healthy, and less than 15% unhealthy.

Objective 1: Manage forests for the primary purpose of maintaining/improving the ecological function (as per key criteria).

Example Actions:

Work with forestry companies on managing for ecological function
Identify partners (e.g. ranchers, industry).
Use planning tools (e.g. SSRP) as leverage to highlight goal.
Share case studies that highlight impacts on ecology/economy.
Explore innovation in forest products support.

Objective 2: Strengthen and supply timber harvest ground rules (i.e., setbacks to all waterbodies).

Data Gaps:

Identify seeps and springs.

Objective 3: Apply BMP for grazing in riparian areas.

Example Actions:

Grazing management (number of animal units, rotations).
Fencing.
Offsite watering.
Support incentive programs for private landowners.

Objective 4: Promote more natural (bioengineering) of streambanks.

Example Actions:

Locate/remove areas with bank armouring.
Promote more natural (bioengineering) of streambanks.

Objective 5: Explore use of beavers as watershed management tool.

Example Actions:

Increase number of beavers (within natural range).
Work with municipalities and landowners to promote co-existence with beavers.
Educate about tools for coexistence.
Explore barriers to translocation (policy change needed).

Objective 6: Appropriate recreation management.

Example Actions:

Manage camping in a way that encourages people to camp in more appropriate places.
Identify and designate alternative locations for camping.
Enforce existing regulations.
Restrictions on random camping.
Education and awareness programs on trail use and maintenance (not making new trails).

Goal 2: Minimize linear disturbance to <0.6 km/km^2 max on public lands and for subwatersheds with Species At Risk (native fish/grizzly bears) restore <0.2 km/km^2.

Objective 1: Develop offset policy for industrial roads, where any new road development is offset by removal of an existing road.

Objective 2: Restore watershed below acceptable linear disturbance levels by removing linear features or enabling return to natural state.

Example Actions:

Identify trails that need to be restored, and enable natural restoration by preventing access.
Identify roads that need to be removed.
Adequate enforcement to ensure restoration process.
Education and awareness focused on trail and road closure.

Goal 3: Reduce point sources (crossings and bridges) of sedimentation.

Objective 1: Identify priority point sources of sedimentation.

Objective 2: Identify and close redundant crossings.

Objective 3: Apply BMP for all crossings and bridges.

Example Actions:

Build clearspan bridges.
Bioengineered eroded streambanks.
Trail design improvements (so that water does not stay on trail).
Compile BMP for Alberta and share.

Objective 4: Determine appropriate number of crossings per watershed and implement thresholds for number of crossings.

Goal 4: No new surface development (buildings, clearing vegetation) in riparian areas. (Buildings defined as human structures – picnic shelters, parking lots, trailheads.)

Objective 1: Work with municipalities to establish appropriate bylaws.

Objective 2: Work with Government of Alberta to establish appropriate policy for campgrounds.

Objective 3: Education and outreach focused on importance of riparian areas target.

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APPENDIX A: RIPARIAN AREAS TARGET VIABILITY ASSESSMENT

This appendix describes the KEAs and indicators used to measure health of the riparian conservation target. Indicators were developed considering the target's 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 the expert opinions of Lorne Fitch, Norine Ambrose, Rachelle Haddock and Tracy Lee. Though not part of the rating process, Dr. Stewart Rood provided information helpful to assigning ratings to the KEAs.

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 data sets were used in the analysis:

- Lotic Riparian Polygons DEM-Derived, Government of Alberta – obtained September 2016.
- Lotic Riparian Polygons Strahler Order-Derived, Government of Alberta – obtained September 2016.
- Base Features, Government of Alberta – obtained from Altalis September 2016.
- Watersheds of Alberta, Government of Alberta – obtained August 2016.

KEY ECOLOGICAL ATTRIBUTES – RIPARIAN AREAS TARGET

Size: Extent of Characteristic Communities/Ecosystem

To generate a map of the riparian areas target, riparian areas were created by merging Lotic Riparian Polygons DEM-Derived and Strahler Order-Derived. Polygons were clipped to the study area, and area calculated in km^2. Total size of riparian areas is 4861 km^2 or 18%.

Condition: Riparian Health

Riparian systems play important roles in trapping sediment, recharging groundwater, storing floodwater energy, reducing and dissipating stream energy, filtering and buffering water, promoting primary productivity and supporting biodiversity (Fitch et al. 2009). Riparian health assessments use visual observation of vegetative and physical parameters to help understand the health of the riparian system. Cows and Fish developed a system of assessing health using 11 questions with a series of categories for answers that equate to 100:

How much of the riparian area is covered by vegetation?
How much of the riparian area is covered by weeds?
How much of the riparian area is covered by disturbance-caused vegetation?
Is woody vegetation present and maintaining itself?
Is woody vegetation being used?
How much deadwood is there?
Are the streambanks held together with deep-rooted vegetation?
How much of the riparian area has bare ground caused by human activity?
Have the streambanks been altered by human activity?
Is the reach compacted, bumpy or rutted from use?
Can the stream access its floodplain?

A riparian area is scored up to 100% as one of the following:

Healthy (80–100%) – all riparian functions are performing and the reach exhibits a high level of riparian condition.

Unhealthy but with problems (60–79%) – many riparian functions are performing, but clear signs of stress are apparent.

Unhealthy (<60%) – most riparian functions are severely impaired or have been lost.

Methods

To assess the riparian health KEA, existing State of the Watershed (SoW) data provided by the Bow River Basin Council and Oldman Watershed Council were used, and the results then tested with expert opinion.

The riparian health of the Bow River Watershed was rated for four sub-basins in the Bow River State of the Watershed Report (BRBC 2010) that align with the study region:

The Upper Bow River sub-basin was rated as **natural** (the conditions for this indicator are considered to be in a natural state)[3].

The three other sub-basins with ratings – Seebe to Bearspaw, Bearspaw to Western Irrigation District, Western Irrigation District to Highwood – were rated as **fair** (the conditions for this indicator are shifting away from a desired state, but have not yet reached a cautionary threshold)[4].

According to the Oldman Watershed Council (2010), the overall riparian health of the Oldman Watershed, based on over 400 sites, is rated as:

15% healthy
55% healthy but with problems
30% unhealthy

For comparison, the riparian areas of the Oldman Watershed are less healthy than riparian areas in Alberta as a whole, where 21% are healthy, 51% are healthy with problems and 28% are unhealthy (Fitch et al. 2003).

Results

The riparian health KEA was rated as **fair** given that the analysis for the Oldman and Bow State of the Watershed reports indicate that the majority of sub-basins for which we have data are in fair condition (healthy but with problems). This estimate aligns with expert opinion (Ambrose and Fitch 2016). Ambrose and Fitch (2016) indicated that the Bow Watershed has better riparian health than the Oldman given that the majority of its headwaters are protected, whereas the Oldman contains a great deal of linear disturbance in the Green Zone, White Area public lands and other lands under agricultural production (ranching and farming).

Ambrose and Fitch (2016) also indicated that there is a pattern in Alberta of healthy riparian areas in the highest parts of the headwaters and that riparian health declines as one moves downstream in watersheds to more settled areas. Additionally, ALCES has done work that indicates landscape features are highly predictive of riparian health. Landscape parameters (e.g., slope, elevation, land use) can predict riparian health 76% of the time.

Condition: Watershed Intactness

Riparian areas are greatly influenced by impacts occurring in the surrounding watershed. Increased linear disturbance in a watershed can result in changes to the composition, structure and function of riparian systems and have a more profound impact than linear disturbance in a riparian system

[3] **We assumed that a "natural" rating was equivalent to a "very good" rating for the target viability assessment.**
[4] **We assumed that a "fair" rating was equivalent to a "fair" rating for the target viability assessment.**

(Folliot et al. 2002). Linear density per watershed (see Table A-1 and Figure A-1) was assessed based on two key thresholds:

0.6 km/km^2 for watersheds supporting bull trout or westslope cutthroat trout (see Figure A-2)
1.2 km/km^2 for watersheds without these Species At Risk

Methods

Using Alberta's base features, the following linear features were combined: power lines, pipelines, railways, roads, cutlines and trails. These data were used with ArcGIS Line Density tool to create a density grid, with output cell size set to 1000, search radius kept at the default 8300 m and km^2 used for area units. This grid was clipped to the study area.

Zonal Statistics as Table was used to create a table of mean density per watershed. Base feature data ends at the British Columbia and Montana borders so pixels within 8300 m of the border will have a reduction in density due to the lack of data.

Watershed boundaries were derived by Kienzle and Muller (2013) from the University of Lethbridge.

Results

Table A-1: Linear Density Per Sub-Basin

Linear Feature Density	Number of Sub-Basins
0–<0.2 km/km^2	2
0.2–0.6 km/km^2	3
0.6–1.2 km/km^2	8
1.2–1.5 km/km^2	16
>1.5 km/km^2	28

The watershed intactness KEA was rated as **fair**. Linear disturbance increases downstream of the headwaters. Downstream, cultivated land has a linear edge. Linear disturbances change how water moves through landscapes as they compact soils and reduce water infiltration. Basically, roads and trails collect water flows, speed them up, contribute to incisement, remove deep root-binding mass and sever the floodplain from the groundwater – all of which are detrimental to riparian health (Ambrose and Fitch 2016).

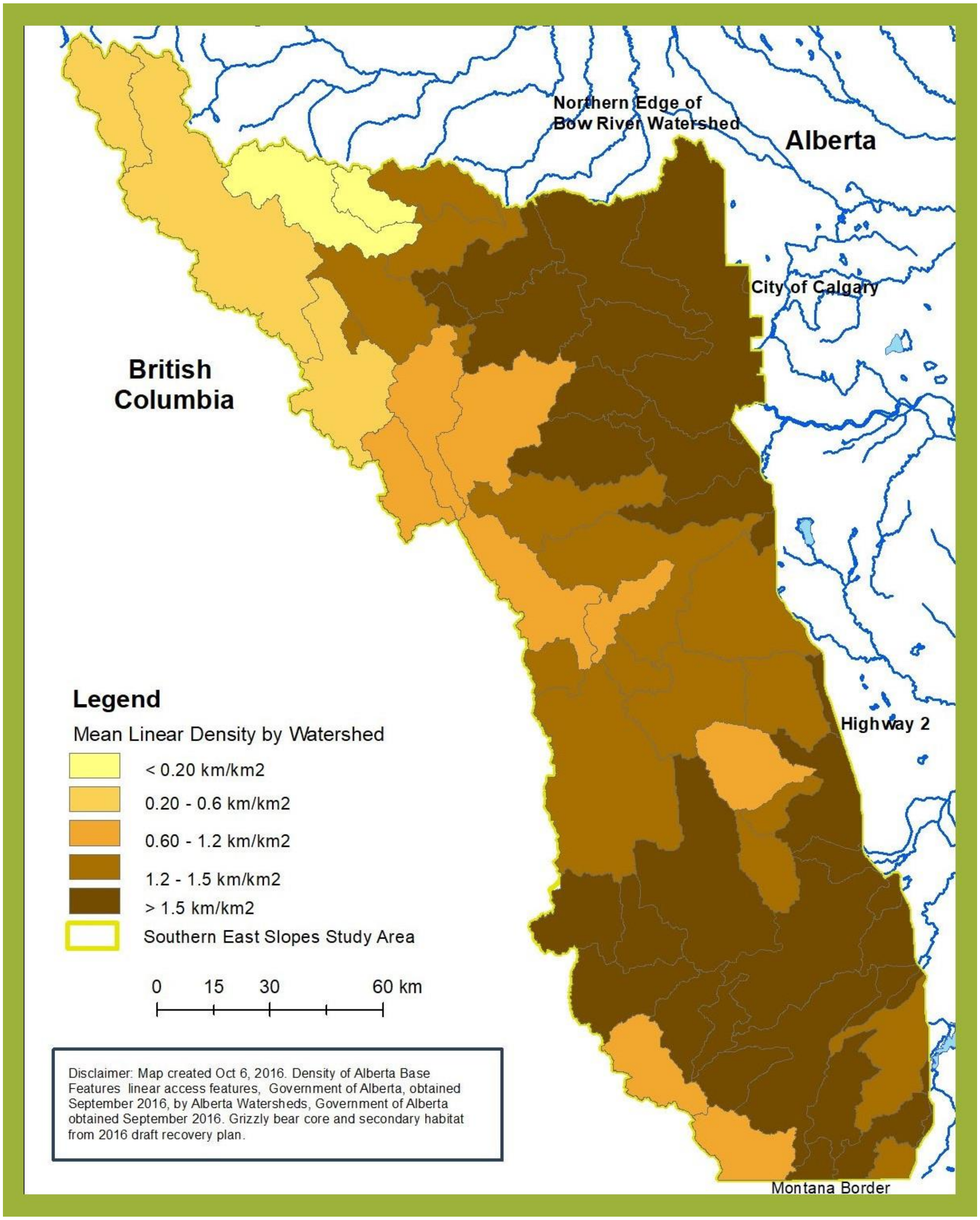

Figure A-1: Linear Density for the Riparian Areas Target

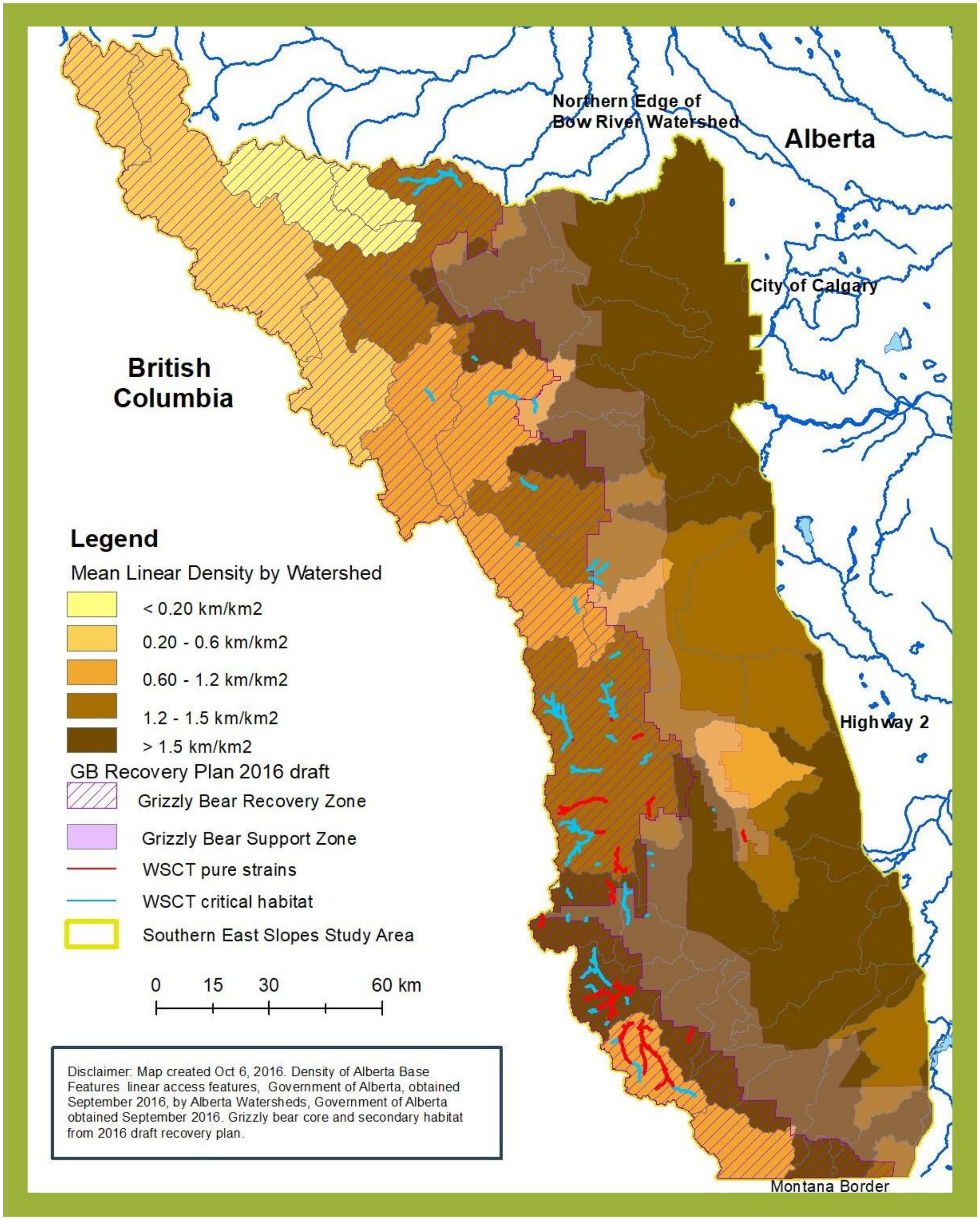

Figure A-2: Watersheds With Species At Risk

APPENDIX B: THREATS AND STRESSES – RIPARIAN AREAS TARGET

For each KEA identified for the riparian conservation target, sources of stress were identified and rated for their severity and scope based on categories defined by the TNC CAP process (TNC 2007). Stresses (see Table B-1) and threats (see Table B-2) were rated based on the expert opinions of Lorne Fitch, Norine Ambrose, Rachelle Haddock and Tracy Lee. Each source of stress was rated in terms of its contribution and irreversibility.

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 B-1: Sources of Stress for Riparian Areas Target

Stresses	Severity	Scope	Stress Rank
Reduced watershed intactness	High	High	High
Reduced riparian health	High	High	High
Altered flow regimes	Medium	High	Medium

Severity considers the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (continuation of 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 geographic scope of impact on target at the site that can reasonably be expected within 10 years under current circumstance (continuation of 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 B-2: Threats for Riparian Areas Target

Threats – Sources of Stress		Reduced Watershed Intactness	Reduced Riparian Health	Altered Flow Regimes	Threat to Target Rank
Stress		1	2	3	
Rank		High	High	Medium	
1	Threat	Urban development			High
	Common Taxonomy				
	Contribution	Medium	Medium	Very High	
	Irreversibility	Very High	High	Very High	
	Threat Rank (override)				
	Threat Rank	High	Medium	Medium	
2	Threat	Commercial logging			High
	Common Taxonomy				
	Contribution	Very High	High	High	
	Irreversibility	High	Medium	Medium	
	Threat Rank (override)				
	Threat Rank	High	Medium	Low	
3	Threat	Linear disturbance (roads, rails and transmission lines)			High
	Common Taxonomy				
	Contribution	Very High	Medium	Very High	
	Irreversibility	Medium	Medium	Medium	
	Threat Rank (override)				
	Threat Rank	High	Medium	Medium	
4	Threat	Dams and Diversions			Low
	Common Taxonomy				
	Contribution	Low	Low	Low	
	Irreversibility	Low	Low	Low	
	Threat Rank (override)				
	Threat Rank	Low	Low	Low	
5	Threat	Grazing			Low
	Common Taxonomy				
	Contribution	Medium	Medium	-	
	Irreversibility	Low	Low	-	
	Threat Rank (override)				
	Threat Rank	Low	Low	-	
6	Threat	Surface disturbance (gravel mining, clearing of riparian vegetation, etc.)			Medium
	Common Taxonomy				
	Contribution	Low	Low	Low	
	Irreversibility	High	High	High	
	Threat Rank (override)				
	Threat Rank	Medium	Medium	Low	
7	Threat	Non-motorized recreation			Low
	Common Taxonomy				
	Contribution	Low	Low	Low	
	Irreversibility	Low	Low	Low	
	Threat Rank (override)				
	Threat Rank	Low	Low	Low	
8	Threat	Agriculture Cropland			Low
	Common Taxonomy				
	Contribution	Medium	Medium	Medium	
	Irreversibility	Low	Low	Low	
	Threat Rank (override)				
	Threat Rank	Low	Low	Low	
9	Threat	Invasive Species			Medium
	Common Taxonomy				
	Contribution	High	Medium	Low	
	Irreversibility	Low	Medium	Low	
	Threat Rank (override)				
	Threat Rank	Medium	Medium	Low	
10	Threat	Motorized recreation			Medium
	Common Taxonomy				
	Contribution	High	Medium	Low	
	Irreversibility	Low	Medium	Low	
	Threat Rank (override)				
	Threat Rank	Medium	Medium	Low	