COLUMBIA LAKE ECOLOGICAL CORRIDOR:

BACKGROUND INFORMATION AND RECOMMENDATIONS TO SUPPORT RECOGNITION

V7.0

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Prepared for:
BC Ministry of Water, Land and Resource Stewardship

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Kootenay Connect
on behalf of the Kootenay Connectivity Working Group

Prologue

Columbia Lake Ecological Corridor is part of a landscape where the Ktunaxa Nation has longstanding cultural, spiritual and historical connections and lies at the heart of their traditional territory, known as ʔamakʔis Ktunaxa (Figure Prologue-1). The area is at the heart of the **Ktunaxa Creation Story**[1]. We present that story here, with permission, as a prologue to situate the reader in the spiritual and cultural importance of this place. Artwork by Ktunaxa students.

In ancestral times, referred to by the Ktunaxa as the animal world, there were references made many times by the Creator to when there will be ʔaqłmaknik̓ (people).

At that time, there was some disturbance caused by a huge sea monster known as Yawuʔnik̓, who killed many of the animals. A council was called by the Chief animal, Nałmuqȼin. Nałmuqȼin was huge. He was so tall that he had to crawl on is hands and knees, for if he stood up his head would hit the ceiling of the sky.

It was decided that Yawuʔnik̓ had to be destroyed. A war party was formed. Yawuʔnik̓ plied the Kootenay and Columbia River system including Columbia Lake and Arrow Lakes.

Yawuʔnik̓ was sighted in the Columbia Lake near ʔakamanusuk̓pun (Canal Flats) and the chase was on. At that time, the Kootenay River and the Columbia Lake were joined. As the chase proceeded, Nałmuqȼin gave names to many locations along the Kootenay River, Kootenay Lake, Arrow Lakes and the Columbia River.

Yawuʔnik̓ was pursued down the Kootenay River past the Wasa sloughs, now called Wasa, BC. Skinkuȼ got into trouble here when he fell into the river and had to be rescued by Wasa, (horsetail).

The chase went on past ʔaq̓am (present day Reserve), where the St. Mary's River empties into the Kootenay River, then on down river to Kank̓ak (spring) where Mayuk (weasel) joined the war party. There were animals on both sides of the river as the chase continued, and among the party was a parasite, ʔa·kukłakuwum, who had to be carried on the backs of other animals. His name was Ȼ̓umtus and he was mean and bossy. The other animals grew tired of his nagging and dumped him into the river at a place now known as Yaqakił wat̓mitqułiłki Ȼ̓umtus.

Leaving the land of the Eagle, ʔa·knuqłułam̓ ʔamakʔis and into the land of the woodtick, Ȼam̓na ʔamakʔis, past Wasaʔki (Waldo) then on past the now 49th Parallel and then past Kaxax (turtle), now underwater, near Rexford, Montana. The chase went on by ʔa·kiʔyi (Jennings) and on by ʔaqswaq (Libby) then into Skinkuȼ ʔamakʔis (the land of Coyote), past ʔaq̓anqmi (Bonners Ferry, Idaho) before heading north again past the now international boundary into ʔaȼpu ʔamakʔis, the land of the Wolverine, past Yaqa·n Nuʔkiy (Creston) then up the Kootenay Lake past ʔaq̓asqnuk, (Kuskanook). The chase went on by ʔakuqłi (Akokli Creek), past Ksanka Creek. Then Yawuʔnik̓ chose to follow the Kootenay River past ʔaqyamłup (Nelson). The chase was now in Miȼ̓qaqas ʔamakʔis (the land of Chickadee).

At Kik̓siłuk (Castlegar), Yawuʔnik̓ went north into the Arrow Lakes, past ʔakink̓aʔnuk (Arrow Rock) where arrows were shot into a crevice in the rock. If the arrow was true, the journey continued, if the mark was missed, beware, danger ahead. The arrow was true and the journey continued past Ȼałnuʔnik̓ (Nakusp) then up past Ktunwakanmituk Miȼ̓qaqas (Revelstoke) where the Columbia River flows into the Arrow Lakes, then up and around the Big Bend then down past ʔaknuqłuk (Golden) past Yaknusuʔki (Brisco) then on past Yakyuȼki. The chase carries on through Kwataq̓nuk (Athalmer) then past Kananuk (Windermere) past ʔakisq̓nuk (Windermere Lake), then back into the Columbia Lake to ʔakamanusuk̓pun (Canal Flats). This completed the cycle of the chase.

Yawuʔnik̓ would once again escape into the Kootenay River and the chase would go on. The chase would go on and on. Every time the war party thought they had Yawuʔnik̓ cornered, Yawuʔnik̓ would escape again.

One day sitting on the riverbank observing the chase was a wise old one named Kik̓um. Kik̓um told Nałmuqȼin, "You are wasting your time and energy chasing the monster. Why not use your size and strength and with one sweep of your arm, block the river from flowing into the lake and the next time the monster enters the lake you will have him trapped." Nałmuqȼin took the advice of Kik̓um and did as he was told.

The next time Yawuʔnik̓ entered the lake, he was trapped.

Having successfully corralled Yawuʔnik̓, a decision had to be made as to whom the honor of killing Yawuʔnik̓ would be bestowed upon. The honor was awarded to Yamakpał (Pileated Woodpecker).

When Yawuʔnik̓ was killed, he was taken ashore and butchered and distributed among the animals. There remained only the innards and bones. The ribs were scattered throughout the region and now form the Hoodoos seen throughout the area, including Fairmont and ʔaq̓am.

Nałmuqȼin then took the white balloon-like organ, known as the swim bladder, and crumbled it into small pieces and scattered it in all directions saying, "These will be the white race of people." He then took the black ingredient from the inner side of the backbone, the kidney, and broke it into small pieces and scattered them in all directions declaring, "These will be the black race." He then took the orange roe and threw the pieces in all directions saying, "These will be the yellow race of people."

Nałmuqȼin looked at his bloody hands and reached down for some grass to wipe his hands. He then let the blood fall to the ground saying, "This will be the red people, they will remain here forever."

Nałmuqȼin, in all the excitement, rose to his feet and stood upright. Hitting his head on the ceiling of the sky, he knocked himself dead. His feet went northward and is today know as Ya·łiki, in the Yellowhead Pass vicinity. His head is near Yellowstone Park in the State of Montana. His body forms the Rocky Mountains. The people were now keepers of the land. The spirit animals ascended above and are the guiding spirits of the people.

Hoyas, taxas.

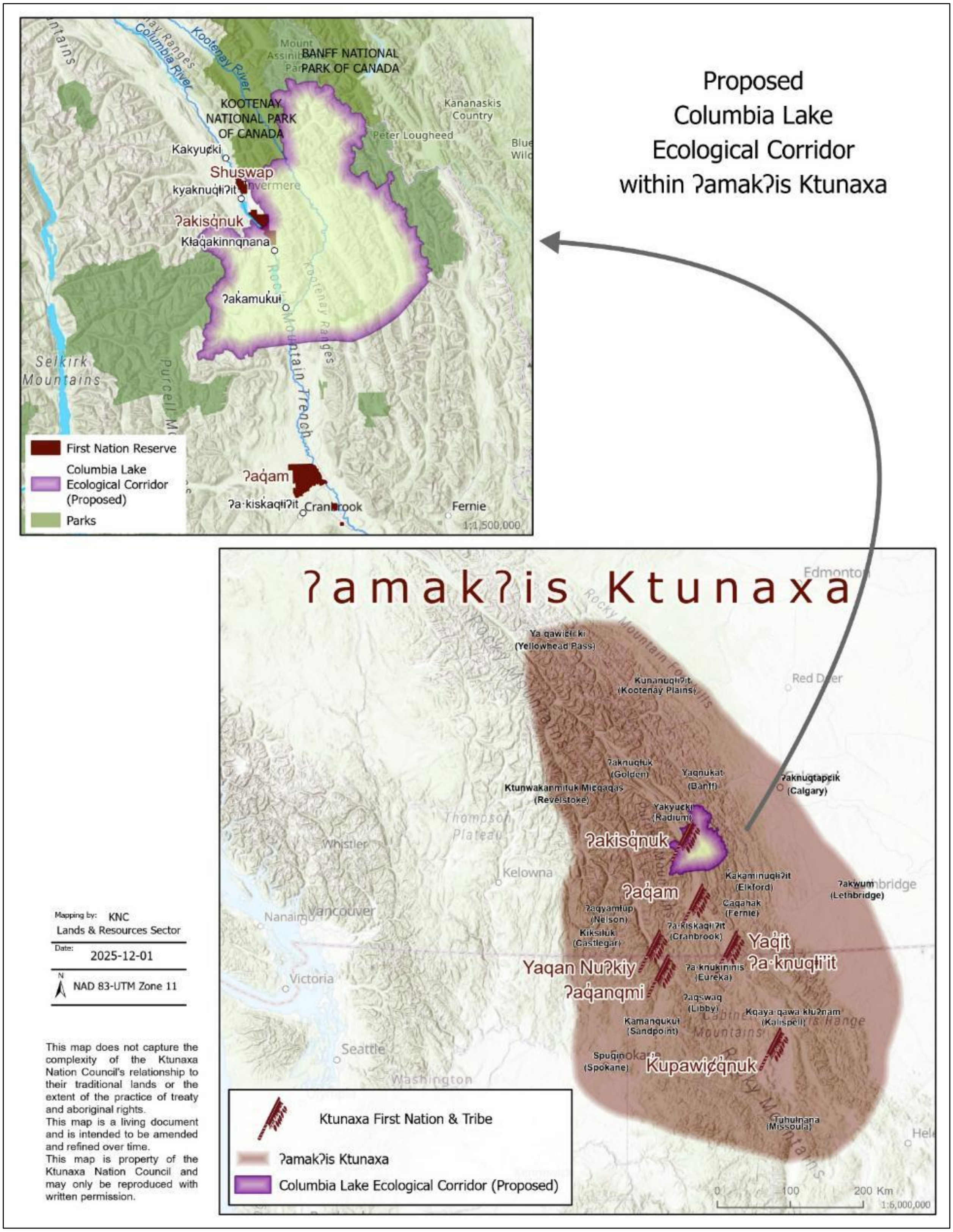

Figure Prologue-1: Location of Columbia Lake Ecological Corridor within ʔamakʔis Ktunaxa, asserted territory of Ktunaxa Nation.

Note to Reader regarding Endnotes.

Literature citations in this document use endnotes. These are denoted by superscript text. To facilitate navigation, these superscripts are hyperlinked to the citation. You can easily check the citation and then return to the same spot in the text as follows:

Word version:

- Double-click on the superscript to access the endnote citation.
- To return to the same spot in the text, double click on the endnote number.

PDF version:

- A single click on the superscript will access the endnote citation
- To return to the text, in Adobe Acrobat Reader in Windows, press Alt and the left cursor arrow. In Mac, CMD and left arrow should work. Other PDF readers may differ.

Executive Summary

An Ecological Corridor (EC) is a spatially defined area that is part of an ecological network recognized and managed for the movement of organisms, habitats, and ecological processes. ECs are not necessarily protected areas but may contain protected areas or other effective area-based conservation measures (OECMs) within them. Ideally the network consists of a suite of protected areas and other areas of ecological importance connected by lands and waters that contribute to connectivity. Ecological corridors have been developed to help mitigate and potentially reverse the emerging climate and biodiversity crises that are occurring across the globe.

We propose a multi-jurisdictional EC centered on Columbia Lake in the East Kootenays at the headwaters of the Columbia River (Figure ES-1). It is built from the principles of the International Union for the Conservation of Nature (IUCN) and Environment and Climate Change Canada (ECCC) ecological corridor programs and adheres to Ktunaxa law and the stewardship principle of *yaqaɬ hankatiɬiɬki na ʔamak*, which translates approximately to "our people care for the land, the land cares for our people."

Columbia Lake Ecological Corridor (CLEC) is part of a landscape where the Ktunaxa Nation has longstanding cultural, spiritual and historical connections and lies at the heart of their traditional territory, known as ʔamakʔis Ktunaxa. Throughout the document, we refer to Ktunaxa world view, language and stewardship priorities.

The corridor extends east to three protected areas: Kootenay National Park, Height of the Rockies and Elk Lakes Provincial Parks; and west to the Purcell Wilderness Conservancy. It includes provincial lands, ʔakisq̓nuk First Nation Reserve lands, and private lands in both the Regional District of East Kootenay and Village of Canal Flats.

This is not a "corridor" in the more common concept of a narrow strip of land or water but a larger landscape of mostly intact habitats at a natural crossroads of ecosystems. *A significant feature of the CLEC is that the Corridor already supports ecological connectivity*. Formal recognition of this large, regional corridor allows current and future conservation and management to prioritize maintaining and improving connectivity, which is simpler and more cost-effective than restoring and reconnecting habitats in the future.

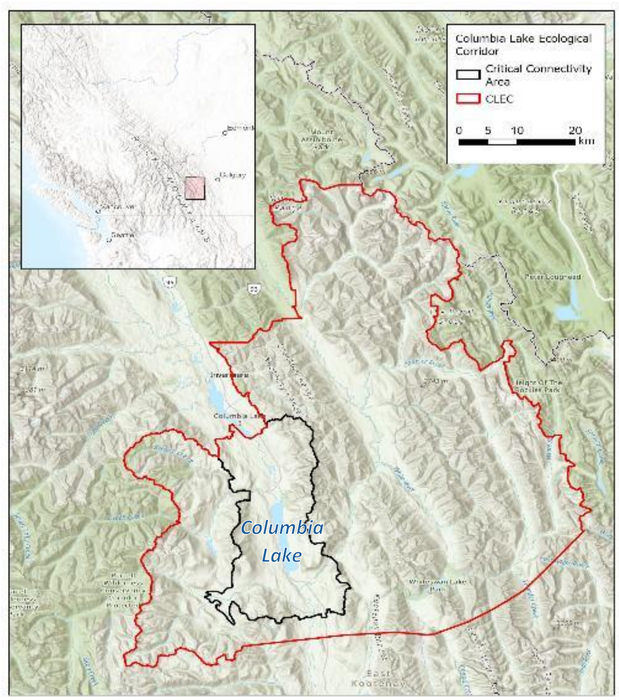

Figure ES-1: Extent of Columbia Lake Ecological Corridor and Critical Connectivity Area.

The CLEC is an excellent opportunity to integrate wildlife-friendly policy and stewardship initiatives on both public and private lands to ensure the needs of wildlife are met and promote coexistence. Among our several candidate corridors, the Kootenay Connectivity Working Group ranked the Columbia Lake Ecological Corridor highest for its ecological and cultural significance, existing conservation management, and high likelihood that our collective efforts could make a big difference in maintaining permeability and connectivity into the future. Notably, about 35% of the

Critical Connectivity Area (defined below) is already under some form of protection, such as land trust conservation lands or Wildlife Management Areas and Provincial Parks.

The ongoing work to improve connectivity and biodiversity in the corridor strengthens its case for being officially designated as an “Ecological Corridor,” since it already serves that role in practice. Recent actions include evaluating highway culverts for badger passage, using cultural and prescribed burning to benefit grasslands, constructing beaver dam analogues in wetlands to boost water storage, and compensating private agricultural landowners for ecosystem services, among other initiatives.

An important factor supporting connectivity within the CLEC is the existing suite of land use designations and regulations that currently govern management practices. These measures are likely sufficient to meet the needs of wildlife, biodiversity, and natural ecosystem variability, thereby enhancing ecological connectivity. We found that 89% of the CLEC is subject to various non-overlapping designations, each exerting some degree of conservation-focused management. *Thus, rather than recommending the province create a new designation or legal tools for conserving corridors,* ***we believe this suite of existing mechanisms are both capable of and presently effective in achieving landscape-scale ecological connectivity objectives.***

A portion of the CLEC qualifies as a Key Biodiversity Area based on national criteria and thresholds for multiple biodiversity elements, highlighting the ecological importance of Columbia Lake and its surroundings. The need for ecological corridors in Kootenay Region has been known for some time. The 1997 Kootenay Boundary Land Use Plan (KBLUP) Implementation Strategy called for a “system of regional connectivity corridors to enhance management of rare habitats, red/blue listed and other regionally significant species, and ecosystems.” The area has been the focus of work on grizzly bears, American badger, elk, mule deer, bighorn sheep, mountain goats, songbirds and more. Nearly thirty years after KBLUP, the need for corridor identification remains a conservation imperative.

We have partitioned the Columbia Lake Ecological Corridor (CLEC) into two main components:

- the larger landscape between the protected areas in the Rocky and Purcell Mountains east and west of Columbia Lake, and
- the smaller embedded Critical Connectivity Area (CCA) that includes land surrounding the lake in the valley bottom. The CCA is the arena of concentrated human presence where most of the challenges to wildlife movement occur.

There are four overall corridor objectives:

- **Movement** of individuals and geneflow of target focal umbrella species (grizzly bear, American badger, Rocky Mountain elk, bighorn sheep, mountain goat, and wolverine)
- **Maintenance/restoration** of ecological processes
- **Adaptation** to Climate Change
- **Enhancement** of species and habitat recovery and recolonization

Our approach entails identifying conservation values, clustering them into umbrella habitats, identifying threats to those habitats, developing Beneficial Management Practices (BMPs) to mitigate threats, and specifying recommendations and management options that are linked to achieving the objectives of the corridor (Figure ES-2).

Through ongoing engagement with local First Nations, government and independent biologists, local rod and gun clubs, land trusts, conservation groups, and other interested parties we have identified a common understanding of values and stewardship needed for improving habitats within the CLEC.

While the corridor is currently providing a reasonable degree of connectivity function, several threats have been identified. Note that some of these have *potential benefits*, such as forestry that reduces forest ingrowth and wildfire risk.

Development: Housing and resort development affects wildlife movement primarily in the CCA. New development is likely limited around Columbia Lake, as most development is already in place.

Forestry: Harvest of trees has mixed impacts in the CLEC. At lower elevations where fire suppression has led to ingrown forests, removal of trees to create open canopy forests is beneficial to a range of species and supports wildlife movement. While forestry is very important to the local economy, transitioning methods to remove less mature and old growth stands that are becoming rare and have high ecological value would be beneficial to old growth dependent species (e.g., various bats and birds). There are existing mechanisms in place to help conserve forest biodiversity values including Wildlife Habitat Areas, Ungulate Winter Ranges and Canfor's voluntary High Conservation Value Areas under their Forest Stewardship Council (FSC) certification.

Mining: There is little active mining occurring in the CLEC but emerging focus on "critical minerals" may expedite some of exploration activity.

Recreation: Known as a destination, recreational impacts to biodiversity are expanding in the CLEC. Motorized (on and off-road) and mechanized (e.g., mountain bikes) are both known to impact focal species including grizzly bears, badgers, bighorn sheep, elk, mountain goats, and wolverine. Managing for wildlife habitat security and refugia from recreation is an important aspect to successful corridor planning.

Agriculture: Ranching activities mostly support connectivity by maintaining large parcels of undeveloped land that can be semi-permeable to wildlife. Incentive programs like Farmland Advantage are helping to maintain working lands in agricultural production while following environmental stewardship objectives. Much of the CCA is within the Agricultural Land Reserve. However, eight-foot-high fencing that excludes many wildlife species is a threat to connectivity.

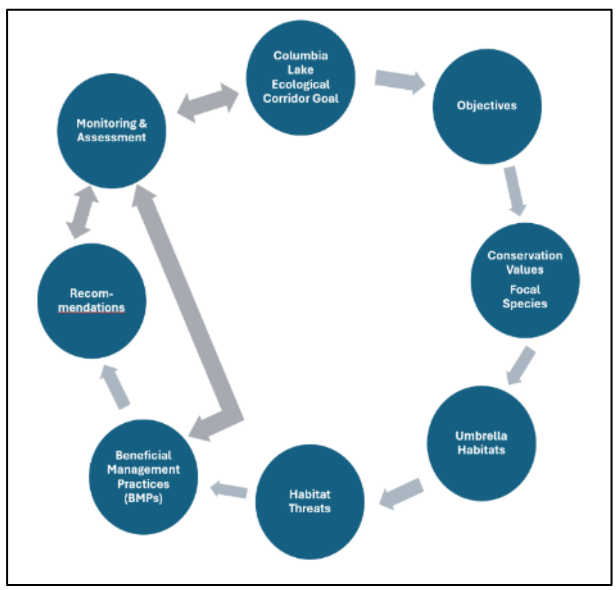

Figure ES-2: Schematic representation of approach to corridor planning.

Roads and Railways: Vehicles on highways cause direct mortality to wildlife, and forestry roads can also displace animals (e.g., elk and grizzly bear). Motor Vehicle Closure Areas within the CLEC exist in some places, but a few areas of high road density overlapping high habitat quality offer an opportunity for further access management.

Invasive Species: Invasive species are a major threat to biodiversity and functioning ecosystems. The impact of invasive plants in the CLEC remains relatively low compared to areas farther south in the Rocky Mountain Trench. Yet, they are present, spreading, and threaten grassland and rangeland health.

Fire: Many species in the CLEC are adapted to low-intensity, stand-maintaining fires which are important culturally to Ktunaxa and Secwépemc peoples. Over a century of fire suppression has led to the build up of fuels with the threat of catastrophic wildfire that is highly damaging to ecosystems. Combined with climate change impacts, fire intensity and frequency is predicted to increase. Application of cultural and prescribed fire is a key action for fire-maintained ecosystems in the CLEC and helps facilitate connectivity of grassland and open forest habitats.

Climate Change: Climate disruption is projected to drive major shifts in ecosystems within the corridor, reduce the availability of water sources, and increase the need for regional connectivity north-south and along elevational gradients. A separate assessment was prepared for the CLEC looking at climate projections and recommendations. Maintaining habitat refugia that can support lower temperatures, higher moisture, and forested ecosystems is recommended.

We recognize that the CLEC is a dynamic landscape and stewardship is an adaptive process that must remain open to updated information and approaches (Figure ES-2). For the purposes of this proposal, we identified the best Beneficial Management Practices (BMPs) available. Our research on BMPs produced well over a hundred practices which we have grouped by the primary habitats they address: Grasslands, Riparian, Wetlands, and Forests, as well as Climate Change Habitat Refugia and Access Management. Following are recommended actions that were identified in multiple habitats or stewardship issues. Addressing these may have benefits across habitat types and/or threats:

- Support ecosystem restoration activities, including cultural and prescribed fire.
- Ensure any future development does not restrict wildlife connectivity, particularly cross valley movements, by leaving open spaces around development.
- Road density should target a maximum of 0.6 km / km^2 because species such as elk and grizzly bear require a combination of high-quality habitat <u>and</u> habitat security from open roads.
- Retain the few remaining intact, roadless areas / drainages. No new roads should be constructed in these areas.
- Forestry prescriptions should account for biodiversity, habitat and habitat features, such as retaining stands of mature and old growth as steppingstones to facilitate movement between patches and protecting wildlife trees.
- Promote actions and activities that maintain or enhance groundwater and hydrologic connectivity for wetlands and riparian areas.
- Respect timing windows to avoid disturbance to species at sensitive times. i.e., breeding.
- Work to control invasive species, especially plants, because early control and removal are much easier, more effective and economical.

Because nature needs to move, our vision for the Columbia Lake Ecological Corridor is a landscape where all wildlife can find passage between patches of high-quality habitat and contribute to viable populations and fully functioning ecosystems across ʔamakʔis Ktunaxa and beyond. Future land use decisions should ask, "*How does this action affect connectivity?*" as a primary question. Actions that support connectivity are much easier and less expensive to undertake than restoring degraded lands and waters. We therefore call on all governing bodies and decision-makers to ensure the future stewardship of the CLEC is prioritized.

Acknowledgements

All living things are connected. The Columbia Lake Ecological Corridor lies within the biologically diverse area locally stewarded by the ʔakisq̓nuk First Nation and the Shuswap Band. The area is part of a landscape where the Ktunaxa Nation have longstanding cultural, spiritual and historical connections.

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This report has been written for the Kootenay Connectivity Working Group by Marcy Mahr, Michael Procter, Ian Adams, Marie-Ange Fournier-Beck, and Francois Blouin.

The authors acknowledge the Kootenay Connectivity Working Group's strong spirit of collaboration in weaving together different perspectives and knowledge to advance ecological connectivity and identify corridors across multi-jurisdictional boundaries in the Columbia Valley. Past and present core members include: Anna McIndoe (MWLRS); Colin Bergeron, Rebecca Smith and Elizabeth Vincer (Parks Canada Mt. Revelstoke-Glacier National Park); Jeanette Goulet, Megan Goudie and Charlie McLellan (Parks Canada Lake Louise-Yoho-Kootenay National Park); Kris Belanger, Sebastien Martinez, Nikki Heim, Araleigh Alexander, Claire Peyton and Naya Duteau (Ktunaxa Nation Council); Chris Joseph, Lorne Shovar, Tyra Joe and Yvonne Patterson (ʔakisq̓nuk First Nation); Richard Klafki and Julie Couse (Nature Conservancy of Canada) and Rhiannon Kirton (Shuswap Band). Advice, discussions and edits by Audrey Roburn, Eric Telford and James Quayle (MWLRS) have contributed significantly to this corridor proposal. We greatly appreciate a review of stewardship recommendations by Kari Stuart-Smith (Canfor).

The dedication of the Kootenay Connectivity Working Group has been instrumental in shaping the vision and proposal for provincial recognition of the Columbia Lake Ecological Corridor. It is through the collaboration of these diverse partners that significant strides will be made toward protecting and enhancing connectivity in this remarkable landscape. We recognize the wisdom, commitment, and contributions of all individuals and organizations who have supported this initiative and look forward to continued partnerships as we work together for the future health of this significant ecological corridor.

Cover: Looking southwest across the north end of Columbia Lake in spring to eastern front of the Purcell Mountains. Photo: Pat Morrow.

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Columbia Lake Ecological Corridor:
Background Information and Recommendations to Support Recognition

1. Purpose

The Columbia Lake Ecological Corridor (CLEC) proposal was developed over five years by the Kootenay Connectivity Working Group, a technical partnership focused on collaboratively conserving multi-species corridors across different land ownerships and jurisdictions in the Upper Columbia Valley.

In 2021, organizations including Kootenay Connect, Provincial Together for Wildlife Program, Parks Canada, BC Parks, Ktunaxa Nation (including ʔakisq̓nuk First Nation and the three other Canadian Ktunaxa First Nations: Yaqan Nuʔkiy, Yaq̓it ʔa·knuqⱡi'it, and ʔaq̓am as represented by the Ktunaxa Nation Council), Shuswap Band, Biodiversity and Ecosystems-Ministry of Water, Land and Resource Stewardship, and Nature Conservancy of Canada began collaborating to protect connectivity across jurisdictions (see Appendix 3: Columbia Lake Ecological Corridor Partners). Coordinated by Kootenay Connect, the Working Group brings together expertise from biologists, ecologists, foresters, land managers, Ktunaxa knowledge holders, and GIS providers from member organizations. This group has selected the Columbia Lake Corridor as a focal area to develop shared policies and practices to support its formal recognition as an ecological corridor. The primary purpose of this proposal is to describe the values, threats, opportunities, and recommendations to inform formal corridor recognition by governments of British Columbia, Canada, Ktunaxa Nation and Regional District of East Kootenay.

2. Ecological Connectivity: Essential for Biodiversity and Ecosystem Resilience

Protected areas and other effective area-based conservation measures (OECMs) are essential components to an international conservation strategy called 30 x 30 with commitments by both Canadian and British Columbia governments to protect 30% of lands and waters by year 2030. Although essential, protected areas alone are insufficient to maintaining biodiversity and climate resilience across broader landscapes[2,3]. As lands and waters are developed for human use, intact, functioning ecosystems are left fragmented. A large body of literature focuses on the ecological impacts of this isolation and its effects on various species.

Ecological connectivity is an essential component of maintaining healthy biodiversity and ecosystems as landscapes change[4,5,6]. Ecological connectivity' is defined by the IUCN as "the unimpeded movement of species and the flow of natural processes that sustain life on Earth".[7] It plays a role in ecological functioning, the survival of wildlife and plant species, maintenance of genetic diversity, and adaptation to climate change across different ecosystems and spatial scales. The physical structure of a landscape influences movement of organisms and flow of processes. In short, the more movement the more connectivity, which contributes to conserving biodiversity.

Ecological corridors can provide the architecture for large-scale conservation in fragmented landscapes by connecting intact areas and maintaining biodiversity through landscape connectivity[8]. An ecological corridor is defined by Parks Canada[9] as "a clearly defined geographical space where governance, management and stewardship over the long term maintain or restore effective ecological connectivity while upholding Indigenous stewardship values". Corridors are indispensable parts of ecological networks for conserving biological diversity and metapopulations. They are expected to endure over significant periods of time, so long as the natural attributes and connectivity values for which they are designated remain. They are not intended to become parks although they may include and link protected and conserved areas.

Facilitating wildlife movement between protected areas requires stewarding the intervening lands to provide connected habitat and allow natural processes. A wealth of literature supports the value and imperative of connecting landscapes within protected area – corridor networks.[4-6] What is lacking are detailed plans to implement these corridors through land use planning, regulations or other actions. In their review of connectivity conservation planning and implementation, Keeley et al.[10] collected 109 corridor plans from around the world with 49 identified as shovel-ready and 60 as vision plans.

To date, we are aware of few implemented corridor plans, e.g., Costa Rica[11] and Florida.[12] Although there are no off-the-shelf examples or blueprints for us to use, we have gleaned what we could from those initiatives to inform our approach to addressing key science-based factors and policy implications for identifying priority ecological corridors and managing for connectivity across multiple jurisdictions.

2.1 Ktunaxa Law

The Ktunaxa phrase that captures the interconnectedness and the stewardship concepts applicable to land stewardship is *yaqał hankatiłiłki na ʔamak*. This phrase translates to "our people care for the land, the land cares for our people." It is about our relationship with the land. Ecological corridor and connectivity principles echo the Ktunaxa worldview, honouring the autonomy of *ʔa·kxam̓is q̓api qapsin* (all living things) and supporting their ability to live out their full life cycles.

ʔaknumuȼtiłił is the word for the law given to the Ktunaxa by the Creator who put us here for a reason and that purpose is to take care of the land and its resources. The law is grounded in the fact that all things are connected and must be kept in balance. It is also the foundation of Ktunaxa spirituality to be humble in our limited understanding; of being respectful of humans' role within nature including other creatures. The land gives us the resources to survive, and in return, we uphold our covenant with the Creator to protect and not overuse the land.

The foundation of the Ktunaxa's philosophy of stewardship is the recognition that we are part of the land. Connectivity means more than spatially connecting ecosystems and habitats. Connectedness requires respect for all things, for anything that affects one affects everything else.

The Ktunaxa have terms that address the natural world and how people are a part of it. *ʔa·kuk̓pukam* speaks to anything that gets life from the earth through roots. *ʔakuk̓pukamnam* adds the human dimension whereby the Earth's life is translated into human life and roots that tie Ktunaxa to the territory. We are of the Earth and, by extension, what we do to the Earth, we do to ourselves.

2.2 IUCN Guidelines

Connectivity conservation is dependent upon maintaining, enhancing, or restoring ecological connectivity. It is a direct response to the degradation and fragmentation of habitats and loss of species and is key to safeguarding habitats, biodiversity, and ecosystem processes such as migration, predator-prey cycles, fire dynamics, hydrology, nutrient cycling, pollination, seed dispersal, forest regeneration, disease resistance, and climate resilience.

The IUCN identifies seven purposes for connectivity corridors.[4] Connectivity can be established or maintained for any one or a combination of the following purposes, all of which depend on movements between habitat patches.

1. Movement of individuals to meet life cycle needs, including migration.
2. Genetic exchange.
3. Provision of habitat for daily to multi-generational movement.
4. Maintenance of ecological processes.
5. Movement and adaptation responses to global change, including climate change.
6. Recovery and recolonization after disturbance.
7. Prevention of undesirable processes.

2.3 Criteria for Ecological Corridors in Canada

Canada's federal government approach to ecological corridors aligns with the IUCN. They stress that "Ecological corridors are not protected areas. Rather, they form part of ecological networks for conservation along with Protected Areas (PAs), Other Effective Area-based Conservation Measures (OECMs) and unprotected natural habitat".[9] The term "unprotected natural habitat" refers to areas with documented and recognized ecological and cultural values but that are not formally protected or conserved. Examples include, but are not limited to, Key Biodiversity Areas[13], Biosphere Reserves[14], Important Bird and Biodiversity Areas[15], and other sites that are not under formal protection.

Specific criteria for ecological corridors within Canada are:

- Corridors are spatially defined.
- Corridors are delineated on publicly available maps and build ecological networks for conservation.
- Corridor goals and objectives are documented, and outcomes are monitored.
- The management intent is described and documented.
- Means or mechanisms are in place and provide the ability to prevent, control or manage/steward what occurs within the corridor.
- Decision-makers act in a manner that is compatible with the corridor goals and objectives.
- Long-term means or mechanisms are in place and in effect year-round.

3. Significance of the Columbia Lake Ecological Corridor

Since time immemorial, the Columbia Lake landscape has been an important meeting place for water, wildlife, plants and people. The high biodiversity of this area is due to the intermixing of species from farther north and south. The Columbia Lake Ecological Corridor (CLEC; Figure 1) includes significant overlap with a proposed Key Biodiversity Area for bank swallow, Lewis's woodpecker, American badger and southern maidenhair fern. That this area meets standardized national criteria and thresholds for multiple biodiversity elements is an excellent indicator of the ecological importance of the Columbia Lake and surrounding area.

The CLEC is part of a regional corridor network identified by Kootenay Connect for the Upper Columbia Valley[16] that identified four east-west wildlife corridors that spanned across the valley from Canal Flats (*ʔak̓amuk̓uɬ*) to Golden (*ʔaknuqɬuk*). The locations of these corridors were determined from modeling of high-quality habitat for target species such as grizzly bear, Rocky Mountain elk, American badger, bighorn sheep, mountain goat and wolverine. Of these corridors, the CLEC was determined to be an excellent area and opportunity for integrating wildlife-friendly policy and stewardship initiatives on both public and private lands to protect the needs of wildlife and promote coexistence. The Working Group ranked the CLEC highest for its ecological and cultural values, diverse conservation lands managed by the provincial government and land trusts, and likelihood that our collective efforts could make a big difference in maintaining permeability and connectivity into the future. Further, the area is anchored by large National and Provincial Parks that have most of their watersheds ecologically intact. Conversely, the lands between these areas within the CLEC have lower amounts of intact watersheds (Figure 2).

Yet a significant attribute is that *most of the Columbia Lake Ecological Corridor is currently supporting ecological connectivity.* Unpublished data on badger, grizzly bear, bats, elk and bank swallows indicate that the area is functioning for connectivity. Taking positive actions now will help defer the need for more controversial and expensive restoration and reclamation efforts in the future. The importance of this is that current and future conservation and management can focus on maintaining and enhancing connectivity, which is far more easily achieved and economical than re-connecting habitats in the future.

An important contributor to connectivity is an existing suite of land use designations and regulations that are already governing management practices in ways that may very likely meet the needs of wildlife, biodiversity, and natural ecosystem variability – which in turn contribute to ecological connectivity in the Columbia Lake Corridor. *Thus, rather than recommending the province create a new designation or legal tools for conserving corridors,* ***we believe this suite of existing mechanisms can, and currently does, reach the objective of managing this landscape for ecological connectivity****.* (See Section 8 for a discussion of land designations contributing to connectivity).

Grizzly bears are possibly one of the most sensitive species to fragmentation by human disturbance. In their Wildlife Monograph, Proctor et al. 2012[17] found some degree of fragmentation across the Columbia Valley reduced movement. However, an Ecological Corridor just needs to be open to some level of movement as it navigates human developed areas. Route-finding by radio-collared "Drone Bear" (see Features: *Drone Bear – Route-finding in a Conservation Corridor*) was a piece of evidence that clearly illustrated that the Columbia Lake Ecological Corridor was still permeable and functioning as a corridor. This male grizzly crossed the valley in several places by navigating residential developments, towns and highways as he hopscotched from land trust lands and working ranches to provincial parks and Wildlife Management Areas.

The need for ecological corridors in Kootenay Region has been known for some time. The 1997 Kootenay Boundary Land Use Plan Implementation Strategy[18] (Section 3.3) includes "use the system of regional connectivity corridors to enhance management of rare habitats, red/blue listed and other regionally significant species, and ecosystems that are under-represented in the protected areas" as a management objective. Fifteen years ago, Columbia Wetland Stewardship Partners commissioned a series of three reports on connecting the Upper Columbia Valley.[19,20,21] Areas both north and south of Columbia Lake were identified as obvious east-west corridors to link the Purcell and Rocky Mountains. Nearly thirty years after KBLUP, the need for corridor identification remains a conservation imperative.

4. Goal and Objectives of the Columbia Lake Ecological Corridor

The goal of the Columbia Lake Ecological Corridor is to facilitate movement of multiple species of wildlife across the Columbia Lake region while upholding *ʔaknumuȼtiǂiǂ* (Ktunaxa Law) and stewardship values of the Shuswap Band.

Key connectivity areas immediately surrounding Columbia Lake are to be maintained, enhanced or restored to connect with the broader landscape that extends from the valley bottom to the Rocky and Purcell Mountains.

Four objectives for the Columbia Lake Ecological Corridor broadly link to the IUCN objectives. These objectives target wildlife movement, ecological processes, responses to climate change, and stewardship and restoration efforts. Each objective is referenced to a connectivity purpose(s) identified by the IUCN.

Objective 1: Movement of individuals (IUCN #1,2,3)
Allow for the movement, geneflow, and migration of target species such as grizzly bear [22,23,24]*, American badger*[25]*, Rocky Mountain elk*[26,27]*, bighorn sheep*[28]*, mountain goat*[29] *and wolverine*[30] *from valley bottom to uplands daily, seasonally, and annually to meet life requirements.*

Outcomes measured and monitored by – wildlife cameras, telemetry, field observations

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Objective 2: Maintenance/restoration of ecological processes (IUCN #4)

Support keystone species such as beavers and encourage stewardship of processes that support habitat connectivity through riparian and wetland restoration, thinning forest ingrowth, and cultural and prescribed burning.

Outcomes measured and monitored by – # hectares of wetlands restored, forest thinned, prescribed burns

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Objective 3: Climate change adaptation (IUCN #5)

Facilitate responses to climate change by enabling species to move, shift ranges, and colonize suitable habitats and adapt to climatic conditions. Movement of species throughout the landscape requires maintaining permeability and habitat connectivity along riparian corridors connecting valley bottom to upland habitats, access to north-south & east-west elevational habitats, and cultural and prescribed burning to minimize catastrophic fires and urgency for escape routes[31]*.*

Outcomes measured and monitored by – # hectares of habitat types changed over time; G. Utzig[32] recommended several measures, e.g., access to mountain passes, habitat refugia, fire resistant trees, maintain old growth to preserve genotypes for longevity

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Objective 4: Enhance recovery and recolonization (IUCN #6)

Enhance recovery of target species and the habitats they depend upon through stewardship and restoration efforts that maintain movement and habitat connectivity across multi-jurisdictional landscapes. Support recolonization following disturbance, displacement or removal.

Outcomes measured and monitored by – # hectares conserved and managed by land trusts; # farmers working with Farmland Advantage with Environmental Farm Plans, # hectares being stewarded for wildlife benefits on working farmland; # hectares being conserved and restored; # beaver dam analogs (BDAs) constructed; # hectares of forest thinned; # hectares burned by cultural and prescribed burning; # hectares managed for invasive species.

5. Landscape

> "A glance at the map will reveal a curious fact in the physical geography of [British Columbia]. Almost the whole of the south-eastern portion is occupied by three parallel ranges of high mountains – the Rockies on the east, further west the Selkirks [including what are now called Purcell Mountains], and still further the Gold Range [part of Monashees]. It is only in the valleys, which in some parts attain to the dignity of plains between these ranges, that any room can be found for a man to live and plant domestic animals and vegetables, without being in danger of falling off a ledge or slipping into a mountain torrent.
>
> "Close to the intersection of lat. 50° and long. 116° is the Upper Columbia Lake, the head waters of the mighty river of that name, which flows out of the lake in a northerly direction. It will be seen that another river, the Kootenay, which rises in the Rockies north of this point, almost runs into the same lake, the strip of land which separates them being in fact little more than a mile in width. Having avoided that premature termination to his career, the Kootenay continues his southerly course across the border into Montana and Idaho. There, apparently not thinking so much of Republican institutions as those who have not tried them are apt to do, he takes a sudden turn northwards and again becomes a British river shortly before flowing in placid grandeur into the great Kootenay Lake.
>
> "In the meantime the Columbia, repenting of the precipitate behaviour which led her to turn her back on the Kootenay in the giddy days of her youth, has about lat. 52° made an equally sudden turn to the south, and arrived so close to the Kootenay that it is an easy matter for the latter to simply rush into the arms of his long-lost love; after which they no doubt live happily ever afterwards. The result of this coquettish separation and subsequent reunion is that the land on which the Selkirks [including the Purcells] stand would be an island but for the narrow isthmus close to the Columbia Lake already spoken of."
>
> - J. Lees and W. Clutterbuck[33]

Columbia Lake is the headwaters of the Columbia River. Lying in the Rocky Mountain Trench in the East Kootenay region of British Columbia, the lake flows north into the Columbia River (Figure 1). with communities of Canal Flats (*ʔakamanusuk̓pun*[a]) at the south end and Fairmont Hot Springs (*Kɫa q̓akinukqnana*) at the north, Springs rising from the wetlands at the lake's south end provide much of its

[a] The place known today as "Canal Flats" has multiple Ktunaxa names. We have used *ʔakamanusuk̓pun* which is listed as an "older name" for Canal Flats meaning "trees with high limbs" (per Joe Pierre), which seems appropriate for the Creation Story. Other names include *Yaqan Nuʔkiy*, same as the Creston, which translates roughly to "place of standing stones." A more recent name is *ʔak̓amuk̓uɫ*, which translates to "channel", a reference to William Baillie Grohman's ill-fated steamboat navigation enterprise, which led to its current English name.

source, as well as various creeks entering from both the east and the west. Dutch Creek, flowing from the Purcell Mountains to the west, formerly was the main contributing watershed to the lake but it now flows directly into Columbia River immediately below the lake.

The Kootenay River flows out of the Rocky Mountains on the east side of the CLEC reaching the Rocky Mountain Trench at the south end of Canal Flats. As Lees and Clutterbuck noted,[34] the Kootenay misses Columbia Lake by a very short distance before turning south. Main tributary watersheds contributing to the Kootenay River within the CLEC include Cross, Palliser and White Rivers in the Rocky Mountains and Findlay Creek in the Purcell Mountains on the west side of the CLEC.

The Columbia Lake area is the centrepiece of the Ktunaxa Creation Story where *Yawuʔnik̓*, the predatory water monster, was finally cornered and killed (see Prologue). The story recounts how humans were created here and scattered throughout the world. Indigenous people or *ʔaqⱡsmaknik* – perhaps more specifically Ktunaxa *ʔaqⱡsmaknik* – were given sacred stewardship responsibility for all living things or *ʔa·kxamis q̓api qapsin*. The east side of Columbia Lake, known as *kinq̓uq̓anki*, is co-stewarded by the ʔakisq̓nuk First Nation, Ktunaxa Nation Council, Province of British Columbia and non-governmental land trust agencies (see Feature: *kinq̓uq̓anki Stewardship Project*).

"We [coasted] along the low rush-grown shore towards the south-western corner, keeping a bright look-out for any channel which had any appearance of being used. We soon became aware that this marshy waste of rushes, grass, willows, and water swarmed with every sort of moisture-loving bird, from geese down to sandpipers. All the commoner ducks were plentiful, though wild, while the snipe and dowitchers were so tame as to be uninteresting.

"…we began to paddle up what' we guessed to be the arm leading to the landing. More than a mile we followed this delusive stream, remarkable for the numerous springs which everywhere gushed up from crater-like basins at the bottom, while round them grew the most beautiful and luxuriant water-weeds ever seen, their delicate filigree-work of many-hued leaves and tendrils all clearly defined in the limpid water.

Lees and Clutterbuck at south end of Columbia Lake in September, 1887.

As the origin of both a river and a Nation, this lake and its adjacent lands are a sacred place. As an ecological crossroad between mountain ranges with conserved lands on either side, the area presents an ideal opportunity to provide connectivity both east-west between major mountain ranges and north-south along the Rocky Mountain Trench.

The Rocky Mountain Trench is a fault line between the much older Purcell Mountains to the west and relative newcomers, the Rocky Mountains to the east. By some 60 million years before present, the Rockies had largely completed their uplift, and the underlying plates began to relax and shift. The crust foundered and the fault fell by as much as 1000 metres, creating "the Trench".[35] The coming ice ages then completed the local renovations of this landscape.

The valley bottom was largely shaped by retreating glaciers from 15,000 to 11,000 years ago. These meltwaters deposited sands and gravels with silts at the lake bottom. Glacial Lake Invermere formed where Columbia and Windermere Lakes are today but were approximately 40 to 50 metres higher than present lake elevations. These ancient lakes laid down much of the silt banks that today support bank swallow colonies and provide key landmarks in the area. The Rocky Mountain Trench and side valleys are thought to have been ice-free by 11,000 years before present with mountain glaciers not much more extensive than modern times.[36]

Today, the lake itself is relatively shallow with a mean depth of just 2.9 metres and a maximum depth of just over 5 metres. Historically, chinook salmon reached here to spawn and rear new generations. Bull trout and rainbow trout contribute to 14 fish species known from the lake.

The lands surrounding the lake include a diversity of ecosystems owing to the rugged mountain terrain. The valley bottom lies in the very dry, cool Interior Douglas-fir (IDFxk) biogeoclimatic ecosystem classification (BEC) subzone. This area features open forests and grassland areas, including the Marion Bench on the southwest side of Columbia Lake and the open grassland areas at lower elevations on the Lake's east side. These grasslands extend into the lower levels of the Kootenay dry mild IDF (IDFdm2) variant, which is found just above the IDFxk on much of the west side of the lake and the southeast corner (Figure 3).

To the north, benchlands transition to the Columbia dry cool IDF (IDFdk5) variant. The change on the landscape is noticeable with a much more forested landscape interspersed with smaller patches of grassland and open forest. Ponderosa pine, for example, is much less prevalent here, largely reaching its range limit with the IDFdm2-IDFdk5 transition.

Montane spruce BEC zone above the IDF sees similar shifts in variants with the dry cool MSdk extending to the north and dry warm MSdw to the south. This change in BEC variants indicates the transitional position of the Columbia Lake area. Ponderosa pine is much less common north of the lake as an example of this subtle change in climate.

Farther back from the lake and at higher elevation are variants of the dry cool Engelmann Spruce Subalpine Fir subzone (ESSFdk). Demonstrating the diversity in climate and habitat, pockets of Interior Cedar-Hemlock (Kootenay moist cool, ICHmk5) are found in side drainages off the upper Kootenay River east in the Rocky Mountains.

Kootenay National Park to the east and the Purcell Wilderness Conservancy to the west make excellent ecological bookends for landscape level continuity across the diverse ecosystems and habitat types that extend from the higher elevation and drier Rocky Mountains across rich wetlands and grasslands in the valley bottom lands to the wetter Purcell Mountains.

6. Approach

The Working Group gathered scientific and Ktunaxa knowledge on large mammals, species at risk, and culturally important species much of which was accumulated within Kootenay Connect's related Priority Places Project funded by the Canada Nature Fund's Community Nominated Priority Places program and managed by the Kootenay Conservation Program.[b]

The Working Group selected the Columbia Lake area as the ecological corridor of focus after considering criteria such as, available species and habitat data or models, corridor potential for our focal species, connectivity to protected areas, degree of human settlement and infrastructure, relevance to climate models (e.g., whether the corridor will enhance climate adaptation), and how well the corridor captures

[b] For more information on Kootenay Connect Priority Places visit: https://kootenayconservation.ca/kootenay-connect-priority-places/

small, conserved areas and designations such as Wildlife Management Areas, BC Parks, and land trust properties, and its political and public viability (i.e., chance of success).

The extent of the 4434 km^2 Columbia Lake Ecological Corridor connects protected areas in the Rockies with the Purcell Wilderness Conservancy meeting ecological needs for connectivity in addition to park-to-park connectivity objectives. Because many of the activities that fragment our natural systems are in the valley bottoms where people live, we also identified a Critical Connectivity Area (CCA) within the larger Columbia Lake Corridor. The 596 km^2 CCA is where most threats are greatest and, therefore, the greatest impediments to the overall corridor achieving its goal.

Our approach to corridor planning is to link our goal and objectives with identifying key conservation values, clustering these values into umbrella habitats, identifying threats to those habitats, developing BMPs to mitigate threats, and specifying recommendations and management tool options that are linked to achieving the objectives of the corridor (Figure 4).

This CCA will be the primary focus of this corridor proposal, while also keeping a wider perspective on the larger park-to-park corridor area. The larger area is in line with International Union for Conservation of Nature (IUCN) guidelines and the trend across the globe – to develop a protected area-corridor network across regions that is large enough to respond to dynamic conditions and achieve its specific ecological connectivity objectives over the long term (See Section 2.2). Such a network allows an entire region to contribute to wildlife movement, ecological processes, and climate resilience, rather than just a suite of isolated protected areas.

7. Conservation Values

A list of focal species as conservation values was generated during working group meetings through 2024 (Appendix 1: Focal Species).

The list includes federally and provincially listed species known to occur in the corridor as well as those of particularly high cultural significance and public interest. Additionally, some degree of "umbrella species", meaning they act as indicators of their particular habitat, was used to identify key species.

The list reflects species most selected by Working Group members and those that are more specialist than generalist in their life requirements and habitat associations in an effort to tie to specific management objectives. In particular, the list includes species of importance to Ktunaxa such as *naqamɇu* (bitterroot), *ʔa·kuk̓pɫuɫaɫ* (Rocky Mountain juniper) and *niɫksaq̓* (porcupine).

Species may be added to the list; however, we don't want it so large that it is unwieldy to translate into clear management and stewardship practices. The list may be refined over time to meet our desired management objectives for corridors.

Wide-ranging mammals are the primary consideration for the CLEC, as they are the species most likely to exhibit large, cross-valley movements. Grizzly bear, American badger and elk are examples of such species (See Feature: *Drone Bear – Route-finding in a Conservation Corridor*). Bighorn sheep, which exhibit seasonal migrations, also are important indicators of connectivity but only occur on the east side of the CLEC (Table 1).

Beyond these key species, a range of taxa and habitat associations are included in the list. Each species was labeled as associated with one or more coarse habitat types found in the corridor. This facilitates Beneficial Management Practices which are grouped into umbrella habitat types (Figure 5).

Beavers provide important ecological functions of water retention and riparian structure[37,38] (See Case Study: Marion *Creek Beavers and the Four Amigos*). Especially with climate change predictions (see section 9.8), retention of water within an otherwise increasingly arid landscape is very important.

8. Current Corridor Conditions

8.1 Land Status in Critical Connectivity Area

The Critical Connectivity Area is a mosaic of land tenures including provincial crown land, ʔakisq̓nuk First Nation Reserve lands, private parcels (some owned by land trusts or with conservation covenants), Provincial Parks, Ecological Reserves, and Wildlife Management Areas. In addition, three Fish and Wildlife Reserve parcels west of Columbia Lake are managed by the BC Ministry of Water, Land and Resource Stewardship under Section 16 of the provincial *Land Act* (Figure 6).

Land use in the CCA is largely governed by the Fairmont Hot Springs & Columbia Lake Area Official Community Plan[39], most recently updated in 2017. The area north of Dutch Creek and west of Columbia River falls under the Lake Windermere Official Community Plan[40], most recently updated in 2019.

Land use zoning in the Fairmont Hot Springs area is very diverse (Figure 7). The Rural Resource zoning is likely the most conducive to ecological connectivity but provides limited opportunities for corridors through the Fairmont area (See Case Study: *Navigating Development and Yawuʔnik̓'s Ribs*). South of Canal Flats, the area is zoned entirely Rural Resource. Canal Flats zoning is limited to within currently built-up areas. Ultimately, for private land, landowner interest in conservation is the primary factor. Beyond the CCA, the vast majority of the land is provincial land. Clusters of private parcels are found in the Whitetail Lake and Findlay Flats areas west of Canal Flats.

8.2 Existing Conservation Designations throughout Columbia Lake Ecological Corridor

Ecosystem changes from human settlement and use in this area of high ecological and cultural value have stimulated various government agencies and private land trusts to protect much of the area around Columbia Lake using various public and private conservation designations. As of late 2025, 4% of the CLEC landscape has some level of formal legal protection by parks, ecological reserve, and fee simple private land owned by Nature Trust of British Columbia (NTBC) or Nature Conservancy of Canada (NCC) (Table 2), mostly in the CCA where 21.7% of land is safeguarded. Including the East Side Columbia Lake Wildlife Management Area (ESCL-WMA), 34.8% of the CCA benefits from some level of conservation measures (Table 2).

The ESCL-WMA is an extensive 70 km^2 area that encompasses habitat on most of the east side of the lake and wraps around the south end to include an important riparian-wetland area at the Columbia River's headwaters (Figure 6). The ESCL-WMA surrounds other conservation lands including Columbia Lake Ecological Reserve which protects calcicolous vegetation and ecosystems representative of the IDF. Higher slope is Mount Sabine Ecological Reserve which protects a small parcel representative of the MS BEC zone. Extensive Warden Reports and other materials are available for both Columbia Lake[41] and Mount Sabine[42] Ecological Reserves

There is a suite of land use designations with conservation-oriented regulations or Best Management Practices (BMPs) that are currently in place and being adhered to across the entire CLEC that contribute towards conservation of wildlife, biodiversity, and natural ecosystem variability which in turn contribute to ecological connectivity. Table 3 shows is a list of existing land use designations and regulations that govern management practices and, in our view, meet the needs of ecological connectivity. *Thus, rather than recommending the province create a new designation or legal tools for conserving corridors,* ***we believe this suite of existing mechanisms are both capable of and presently effective in achieving landscape-scale ecological connectivity objectives.***

Each land management tool has guidelines and/or legal rules for governing activities within their respective designated areas. In total, **89%** of the CLEC has some form of designation contributing to ecological connectivity. This includes all the current regulations and designations with overlapping areas removed. In other words, only 11% of the 4434 km^2 CLEC is without some designation that directly or indirectly supports connectivity (Figure 8; Table 3). Note that if regulatory areas are allowed to overlap, the coverage is 233% of the area. This means that much of the area is regulated for conservation in more than one way. It should also be noted that some of the land use designations are not permanent. One reason for this is they may need to change in response to a changing environment. This dynamic nature makes them no less legal. For example, access management areas may shift over time to respond to habitat quality changes for the species that are trying to protect, due to environmental change associated with fire, forest disease, or flooding.

The lake and surrounding lands are also in a proposed Key Biodiversity Area (KBA). KBAs are sites of national and/or global importance for the persistence of biodiversity by recognizing several different ecological attributes.[43,44] In the case of the proposed Upper Columbia Valley KBA, the abundance of bank swallow colonies in the area is of national importance, as are the local populations of Lewis's woodpecker and American badger. Fairmont Hot Springs supports the only occurrence of southern maidenhair fern in Canada. KBAs are intended as an information source and hold no legal status but are a scientifically robust designation that demonstrate biodiversity values meet national or global importance.

The west side of the lake is marked by Canadian Pacific - Kansas City railway that closely follows the shoreline. Private land covers most of the west shore with sections of more dense housing developments. Ranches and larger parcels line the two-land highway along the bench above the lake. West of Highway 93/95, there are large parcels of private land owned by NTBC and NCC. This includes most of the iconic hoodoo formations along Dutch Creek at the north end of the lake, which are the ribs of *Yawuʔnik̓* the sea monster in the Ktunaxa Creation Story (see Prologue). These lands complement the ESCL-WMA across the lake, providing excellent north-south connectivity opportunities for terrestrial biodiversity.

On Columbia Lake's northeast corner, the 290-ha Columbia Lake Provincial Park connects to the ESCL-WMA along the lakeshore and encompasses a riparian-wetland complex at the north end of Columbia Lake. There are numerous conservation properties owned by NTBC (including Hoodoos and Columbia Lake Westside properties), and NCC (Marion Bench and Lot 48 properties) in the CCA that significantly benefit wildlife and the habitats upon which they depend.

The north end of Columbia Lake represents a "pinch point" that, relative to the larger CLEC, contains many of the barriers that often inhibit wildlife movements. Fortunately, conservation efforts by a diverse suite of organizations have created a potential “passage area” that facilitates wildlife movements through this pinch point (see Case Study: Navigating Development and YawuʔnikꞋ’s Ribs). The combination of Provincial Parks, Wildlife Management Areas, private land conservation efforts in the form of land trust acquisitions (Nature Conservancy Canada and Nature Trust of BC) and the cooperation of agricultural landowners provides an opportunity for wildlife movement across the valley bottom.

As part of their Forest Stewardship Council (FSC) certification, Canfor has identified High Conservation Value Area (HCVAs). These areas have specific conservation values with specific management strategies to maintain them. There are two types of management areas, HCVA-M which allow harvest within the management strategy or HCVA-R (reserve areas) which do not allow harvest (Figure 9). Several of these HCVAs align well with focal species and conservation values for the broader CLEC, including the CCA. As part of the FSC certification, Canfor is regularly audited to ensure the management strategies are being followed. Though not formal protected areas but rather a voluntary designation by the forest licensee, HCVA-Rs contribute significantly to maintaining habitat values within the CLEC.

Canfor also has Cultural Conservation Value Areas (CCVAs) under their FSC certification. These were developed with Ktunaxa Nation and are specific to each Community. The areas contain sensitive information and are not disclosed here. Conservation values include species at risk habitat (e.g. American badger, Lewis’s woodpecker, flammulated owl), ungulate winter range, cottonwood forests, kokanee spawning reaches and bighorn sheep habitat.

The two Official Community Plans in the area have mapped Development Permit Areas for Ecologically Sensitive Areas (Figure 9). These designations require landowners to seek qualified professionals to assess the areas prior to development or subdivision to ensure ecological values are maintained. Values include grasslands, riparian and wetland areas, and habitat for species at risk.

9. Threats

Following is a description of the current threats to natural and cultural landscapes of the Columbia Lake Ecological Corridor, based on IUCN direct threats classification.[45] This assessment includes threats to species and/or ecosystems as well as impediments to a functioning ecological corridor. Other factors may be beneficial and/or facilitate wildlife movements and processes, provided activities are done in a manner that maintains the corridor’s functions and integrity.

9.1 Development

IUCN Threat 1: The main clusters of developments are at Fairmont Hot Springs and Canal Flats. Around Columbia Lake there are developed subdivisions at Columere Park at northwest corner of the Lake, and along the west side including Bella Vista, Spirits Reach and Columbia Ridge. Eagle Nest Estates and Painted Ridge subdivisions at Canal Flats are on the southeast corner of the lake. Areas for new developments in both CCA and broader corridor appear limited as most land zoned for subdivision has already been developed. The degree to which new development may impede corridor planning needs to be more fully defined.

9.2 Forestry

IUCN Threat 5.3: Forestry can have mixed effects on the corridor landscape. Beneficial effects at lower elevations in the Rocky Mountain Trench in the CCA include thinning ingrown forests to restore historical open forest-grassland conditions and contribute to wildfire resiliency, fuel reductions and construction of fire breaks. The Rocky Mountain Trench Ecosystem Restoration Program operated between the late 1990s and late 2010s with the goal of restoring fire-maintained ecosystems that support wildlife, ranching and help reduce risk of catastrophic wildfire.[46] The program was recognized with the Land Trust Alliance of BC's outstanding land program award in 2011 for work on 4500 ha on the Dutch-Findlay project on the west side of Columbia Lake in the heart of the CCA. Ecosystem Restoration work, including wildfire risk reduction forest thinning around communities continues in the area.

Many species at risk in the area, especially in the lower elevation CCA, also benefit from forest thinning actions such as American badger and Lewis's woodpecker. Maintaining open areas supports bighorn sheep winter range and migration corridors to high elevation summer range.

At higher elevations and valleys east and west of the Rocky Mountain Trench, beyond the CCA, larger-scale industrial forestry has more mixed impacts and reduce habitat quality. Roads constructed to access timber negatively impact many species, especially grizzly bears[47, 48] and elk.[49]

Ktunaxa Nation Council (KNC) has developed a Forestry Standards document[50] that provides guidance to government and licensees on forestry practices that are consistent with Ktunaxa world view and law (See Feature: *Ktunaxa Forestry Standards*). Many of the guidelines and recommendations within the Standards are consistent with BMPs discussed here, with the overall goal of maintaining all forest values.

9.3 Mining

IUCN Threat 3.2: Mineral exploration claims are area-based designations where claim-holders may explore for mineral resources with approved applications. These areas are not subject to provisions for species at risk stewardship under the Identified Wildlife Management Strategy, including Wildlife Habitat Areas or Ungulate Winter Range orders. There is potential, though small, for any of these areas to have a proven resource developed for an operational mine. However, even exploration activities can include new roads which increase public access and disturbance to an area.

The current focus on Critical Minerals by provincial and federal governments is strongly supporting development of these sites and exploration activities to prove available resources with the hope of mine development. This has the potential to disrupt intact habitats by directly removing them and fragmenting the remainder by increasing road access into otherwise roadless backcountry.

Compared to other areas of the Kootenays, there are relatively few mineral claims in the area. They are limited to Findlay Creek (a legacy of the gold rush here in the late 1800s) and the west slope of Mount Grainger (Figure 10). Just outside the Critical Connectivity Area, the newly developed Kootenay West gypsum mine, approximately nine km upstream of Canal Flats, will have localized impacts on the surrounding area and increase industrial traffic on the resource road between the mine site and Canal Flats. There is also a decades-old gypsum mine still operating in Windermere Creek valley and a magnesium oxide mine in the northern part of the CLEC near Mt Assiniboine Provincial Park.

West of the Critical Connectivity Area, large claim areas abut the Purcell Wilderness Conservancy, including roadless portions of the Middle Findlay which, if developed, would invoke the Purcell Wilderness Conservancy Corridor allowance, permitting a road along Findlay Creek valley to access mineral values.

9.4 Recreation

IUCN Threat 6.1: The Kootenays are known internationally as a destination for adventure tourism and recreation. Communities regularly market themselves for active lifestyles with opportunities at your doorstep. However, recreational activities frequently come into conflict with ecological and cultural values and have potential to disrupt wildlife movement patterns and disturb habitats.

Recreational activities are divided into *Motorized* – ATVs, snowmobile, dirt bikes, off-road vehicles; *Mechanized* – mountain biking and *Non-motorized* – back-country skiing, hiking. All of these activities have documented impacts on local wildlife including grizzly bear, wolverine, American badger and mountain goats.

Managing recreational activities and providing refugia for wildlife is an important aspect to successful corridor planning. Natural areas set aside for corridors are often also desired areas for recreation. Trail establishment, especially for motorized and/or mechanical activities in particular can lead to wildlife conflicts and encounters. Areas closest to Canal Flats and Fairmont face the largest recreational impacts.

9.5 Agriculture

IUCN Threat 2.1 and 2.3: Agriculture in the CLEC is primarily ranching activities with hay production and cattle grazing. In general, these agricultural practices are conducive to connectivity as they maintain large parcels of mostly undeveloped land that are at least permeable to wildlife, if not supporting them. For plants and native ecological communities, however, conversion of land for agricultural purposes can alienate these attributes. The Farmland Advantage program seeks to “partner with farmers and ranchers in BC to protect and conserve critical lands, streams, and habitats.” This program provides opportunities and financial incentives for farmers and ranchers to steward lands in ways that benefit species and ecosystems while also maintaining viable agricultural operations.

Farmland Advantage is currently focused on private agricultural land on the north end of Columbia Lake. These "keystone" private lands are located in the pinch point between the north lakeshore and Fairmont's residential development, an area critically important for wildlife movement across this part of the valley (see Case Study: *Navigating Development and Yawuʔnik̓’s Ribs* and Feature: *Drone Bear – Route-finding in a Conservation Corridor*).

British Columbia’s Agricultural Land Reserve (ALR) is designed to prioritize and help protect agriculturally viable lands for food production and other agricultural uses in the face of spreading urban development. Large sections of the valley bottom areas, especially in the CCA, are within the ALR (Figure 12).

An impediment to agricultural lands facilitating wildlife movement is the proliferation of eight-foot-high page wire fencing throughout the region. Several parcels within the CCA are within “high fence” (red polygons in Figure 12), which are likely affecting local wildlife movements. High fencing along highway corridors can also lead to increased highway mortality, especially when newly installed as wildlife adjust to new barriers.

9.6 Roads

IUCN Threat 4.1: Roads and Railroads are a major threat to biodiversity in different ways. Roadkill is the primary threat to badgers[51] (see Case Study: *Why Did the Badger Cross the Road?*) and road density is known to be a factor affecting grizzly bear use.[52,53] Highway 93/95 is a major threat to wildlife that traverses the corridor north-south. Traffic, especially in summer, can be very high leading mortality of deer, elk, badgers, bears and many smaller animals. Mainline resource roads, such as Findlay Forest Service Road (FSR) and Kootenay FSR also experience significant vehicle use, and there is an extensive network of smaller roads throughout the area that may cause wildlife avoidance of human activities.

To help alleviate this threat, the Province has identified several Motor Vehicle Closure Areas throughout the corridor through a Regulation under *The Wildlife Act*[54] (Figure 13). These restrict motorized traffic to primary roads or are closed entirely. Most of the East Side Columbia Lake Wildlife Management Area (ESCL-WMA) has a motor vehicle closure, but compliance has been an issue, particularly at the south end of the WMA. There are also Motor Vehicle Hunting Closure Areas that seasonally close areas. These areas prohibit use of “a motor vehicle for the purpose of hunting or a related transportation activity.” [55] The effectiveness of these motorized closures is limited by lack of enforcement.

Underpasses also help alleviate threats. Badgers are known to readily use culverts and other underpasses[56] and they are highly efficient for many other small animals, including amphibians and reptiles. Areas where turtles must crossroads to access nesting areas leaves them particularly prone to roadkill.[57]

Eight-foot-high page wire fencing used mainly to exclude elk and deer from hay fields can alter ungulate movements and exacerbate road mortality when used along highways. Fields along Highway 93/95 at various places within the CCA are fenced, in some places on both sides of the highways, which can create a highly hazardous situation where wildlife cannot move away from the highway corridor.

Resource (aka logging) roads away from developed areas also have an impact on wildlife movement and displacement. Road density is particularly important for species such as grizzly bears[58] and elk[59] that are known to avoid areas of Resource roads. Closing and deactivating these roads is a contentious issue, though there are clear ecological benefits to closing roads, public demand for access is very high (See Case Study: Access *affects Elk and Grizzly Bear Habitat Quality*).

9.7 Invasive Species

IUCN Threat 8.1: Invasive species are a major threat to biodiversity and functioning ecosystems around the globe[60,61] and the Columbia Lake area is no exception. Invasive species outcompete native species or present toxic alternatives to otherwise naïve species. Invasive species cause a wide range of harm, including local environmental, social and economic impacts.[62] Examples of local introduced and invasive species include diffuse knapweed, spotted knapweed, cheatgrass/downy brome, bull thistle, leafy spurge, largemouth bass and pumpkinseed fish, to name a few. The terrestrial component of the Columbia Lake Ecological Corridor remains relatively little impacted by invasive plants, compared to areas farther south in the Rocky Mountain Trench. However, they are present and threaten grasslands and range in particular.

More recently, the discovery of the protozoan that causes Whirling Disease in fish, *Myxobolus cerebralis*, in Kicking Horse River, a tributary of the Columbia River downstream of Columbia Lake is of significant regional concern.[63] Another emerging disease threat to local wildlife is Chronic Wasting Disease. Known from areas farther south in the East Kootenay, it has not yet been identified in the CLEC.

9.8 Fire

IUCN Threat 7.1: The distinction between catastrophic and unpredictable wildfire and low-intensity fire in areas pre-treated with fuel reductions and fire breaks is important (see Feature: *Good Fire – Bad Fire*). Many species in the area are adapted to low-intensity, stand-maintaining fires which were important cultural aspects to Ktunaxa and Secwépemc peoples. From settlement in the late 1800s until recently, this practice has been absent. The Rocky Mountain Trench Ecosystem Restoration Program began thinning ingrown forests and reintroducing prescribed fire to the region in the late 1990s[64] and fuel reductions around communities in wildland-urban interface areas and habitat restoration continue. Reintroducing cultural fire is an important goal for Ktunaxa communities.

Wildfire frequency and intensity are predicted to increase across western North America in the coming years as a result of decades of fuel buildup from fire suppression and climate change related heat and drought.[65, 66] Since 2017, BC has seen consistently increased wildfire activity, including the East Kootenay region.

Two major fires in 1985 continue to shape portions of the Critical Connectivity Area (CCA). Mount Allen fire burned 155 km^2 of the southwest corner of the CCA from Mount Allen south of Findlay Creek north along the Marion Bench. Forty years later, the area continues to support badger and Lewis's woodpeckers. The smaller Hoodoo-Hoeffert fire north of Dutch Creek was much smaller, 16.4 km^2, but equally as destructive.

Although the CCA has not seen significant wildfire since 1985 (Figure 11), areas within the larger Columbia Lake Ecological Corridor have had large, severe wildfires in the last decade including North White River (2017), Doctor Creek west of Canal Flats (2020), Mia Creek between Kootenay and White Rivers (2023) and Ravenshead east of Kootenay River (Figure 11).

Increased wildfire frequency and intensity present challenges to landscape level planning such as connectivity corridors. Identifying mature and old growth areas or riparian zones as targets for movement pathways can be disrupted by intense wildfire that removes all canopy cover. Areas designated and managed for an ecological corridor can be quickly altered and rendered unsuitable by catastrophic wildfire. High intensity burns in particular can take decades for soils and forests to recover and significantly alter habitats and movement for many wildlife species. Managing lands to reduce the chances of catastrophic wildfire will be an important part of corridor management.

9.9 Climate Change

IUCN Threat 11: Climate change impacts are a reality around the world and no different at the headwaters of the Columbia River and its surrounding mountain ranges. Hotter, drier summers along with warmer winters with increasing rain events and smaller snowpacks create a range of effects that ripple through natural and human landscapes. Increased wildfire frequency and intensity as well as flooding are the most immediate risks. Conservation ecologist and climate modeler Greg Utzig[67] analyzed climate data and predictions to map potential wildlife and ecological processes adaptations to climate change.

Climate disruption is projected to drive major shifts in ecosystems within the corridor, reduce the availability of water sources, and increase the need for regional connectivity. Extreme events, wildfire and pest infestations are likely to increase stress on forested ecosystems and provide the triggers for a shift to grassland/ steppe communities in the lowest elevations of the corridor area over the coming decades.

Upland forested ecosystems are already facing increased risk of stand-replacing wildfire, drought and pests (e.g., mountain pine beetle, Douglas-fir beetle). Thinning over-stocked stands and reintroducing fire is a high priority to reduce drought stress and increase resilience to fire. Utzig also mentions the particular importance of conserving riparian-wetland habitats for both north-south and east-west connectivity. Given the increasing drought conditions in the bottom of the Rocky Mountain Trench, riparian forests and wetland communities will play a key role in providing "islands" of forest and wetland habitats as species seek escape routes from disasters or shift their ranges northward and/or to higher elevations in their race against climate change. For more detailed treatment of this topic, see Utzig (2025).[68]

10. Stewardship Recommendations

Our approach entails identifying conservation values, clustering them into umbrella habitats, identifying threats to those habitats, developing Beneficial Management Practices (BMPs) to mitigate threats, and specifying recommendations and management tool options that are linked to achieving the objectives of the corridor. Spatializing these components helps interested parties such as, provincial land use managers, Regional District planners, foresters, farmers, recreationists and sportsmen identify important habitats on the land and consider relevant management options.

We envision the mechanism of implementation for this proposed corridor be accomplished by the following recommendations being integrated within the existing land-use management toolboxes of the relevant organizations, agencies, or government department (e.g., Regional government planning department, Provincial lands division, Canadian Forests Products (Canfor). We are not recommending any additional bureaucracy at any level of government. Our assessment of the existing mechanisms across governments are adequate to manage this corridor for wildlife connectivity. Our suite of recommendations would inform land use decisions with the inclusion of wildlife connectivity as another factor. A manager might ask, "how does this development proposal affect connectivity?" They would then access the following recommendations, as well as the appended more detailed files, to practices consistent with connectivity.

This proposal has sought to identify the best Beneficial Management Practices (BMPs) at this time. We recognize that stewardship is an adaptive process that must remain open to updated information and change in approach (Figure 4).

Our research on BMPs produced well over a hundred practices. For the purposes of this corridor proposal, we have minimized the number of BMPs by grouping them by the primary habitats they use (See Appendix 5: Beneficial Management Practices; also Figure 5), with the rationale that wildlife management is most often achieved through habitat stewardship. For example, many local species use grasslands including American badger, Rocky Mountain elk, long-billed curlew, bitterroot and balsamroot. We therefore developed a grasslands BMP that would accommodate the needs of these and other grassland species. BMPs were developed by a wildlife and habitat professional and reviewed by species experts. They were also reviewed by individuals representing grassland user groups. Other habitat types with BMPs include riparian-wetlands, agricultural lands, and forests. The specific recommendations within these BMPs attempt to accommodate the variation within broad habitat types (See Appendix 5: Beneficial Management Practices).

10.1 Grasslands and Open Forest

We have partitioned grassland by landowner type (Figure 14). Although identification and mapping of grasslands in the East Kootenays is not an accurate accounting of its overall distribution, this coarse analysis demonstrates the vulnerability of grasslands and open forests to various threats.

Twenty-eight percent of identified grassland habitat in the CCA is non-protected private lands while 47% occurs on non-protected provincial lands.

Consideration of grassland management actions outlined in grassland BMPs on non-protected private lands may be carried out through one of several options including, but not limited to, land trust purchase or conservation easement, Farmland Advantage (payment for enhanced conservation land use practices), or Regional District zoning of Ecological Sensitive Areas (ESAs) using Development Permits. Connectivity management may be applied through various provincial tools including expansion of WMAs, WHAs, or GAR orders (Government Action Regulation) and more.

Ecological Significance:
Grasslands are the most imperiled ecosystem in the world.[69] In BC, grasslands occupy less than 1% of the province's total area. While small and scarce, they are significant as they provide important forage for the ranching industry, medicines for First Nations, as well as habitat for a wide variety of plants and animals, including wild ungulates and more than 30% of BC's Species at Risk that depend on them for their survival[70]. Across the province, grassland plant communities vary considerably depending on latitude, elevation, climate, and soils. Ninety percent of the grasslands in the Rocky Mountain Trench are found in the Interior Douglas-fir (IDF) Biogeoclimatic Zone. A few patches occur in the Montane Spruce and higher zones. They occur as open grasslands, open forests with grass-dominated understory, or shrub-dominated grasslands. The low elevation grasslands and open forests in the trench are fire-maintained ecosystems as the vegetation has adapted to frequent, low intensity fires resulting from lightning strikes or Indigenous cultural burning.[71]

Conservation Priority Species Associated with Grassland and Open Forest Habitat in the Columbia Lake Corridor:
American badger, Rocky Mountain elk, Rocky Mountain bighorn sheep, bobolink, common nighthawk, long-billed curlew, arrowleaf balsamroot, bitterroot, blue elderberry, rose species, saskatoon, snowbrush, Rocky Mountain juniper, meadow deathcamas, mountain goat (high elevation only).

Importance to Corridors and Connectivity:
Based on their level of mobility, different animal species operate at different scales in the environment. Wide-ranging grassland-dependent animals, such as ungulates (e.g., elk and bighorn sheep) and badgers, rely on safe seamlessly connected or stepping -stone (series of small accessible habitat patches) habitat corridors to facilitate their movement (connectivity) between large grassland patches within their annual ranges. These areas are necessary to maintain access to resources (food, mates, refuge), to prevent genetic isolation, and to sustain ecological processes in an interconnected network

of habitat patches.[72, 73] Other less mobile species may find their ecological requirements within the habitat patches of a wide-ranging species, and as such, these patches acts as core habitat to them. Alternatively, their low mobility may restrict their dispersal movements to linear corridors, be reliant on dispersal vectors or their use of stepping-stone patches takes place at a lower scale.[74] Human activity may completely impede wildlife movement within these corridors (e.g., through urban or industrial development or building of ungulate fences) or reduce their permeability through partial barriers that either reduces movement between populations or increases the risk of mortality (e.g., roadways, railways, land use or land cover changes).

Primary Threats:
Development; invasive weeds; fire suppression / exclusion leading to ingrowth and encroachment; recreation impacts; over-grazing; drought.

Specifically:

- Loss or fragmentation of grassland habitat (urban, residential, agricultural, road development, mining).
- Degradation of grassland habitat (invasive plants, over-grazing or poor range management, woody encroachment and ingrowth, conversion to agronomics).
- Loss of connectivity/permeability (e.g., fences, transportation corridors)
- Human-related mortality via over-hunting / trapping; persecution and extermination of wildlife including direct or secondary poisoning[75].
- Human-related mortality (transportation and service corridors).
- Human intrusions and disturbance in sensitive habitats or at sensitive times (access, recreational activities / tenures; resource extraction).
- Fire suppression leading to forest ingrowth and encroachment
- Private agricultural land with the potential for high risk of contact and disease transmission from domestic sheep/goats.

Key Actions to Reduce Threats and Support Grassland Connectivity:

- Conduct Ecosystem Restoration activities that relieve ingrowth and encroachment, either hand-felling / brushing or mechanical treatments including feller-buncher or mastication. Follow the Ecosystem Restoration BMPs developed by the Trench ER Committee[76]. Reintroduce low-intensity fire with a combination of prescribed and cultural burning.
- In areas that have experienced extensive natural disturbances, look to integrate and connect grassland patches, where feasible, rather than replanting to forest.
- Conduct detailed range assessments to determine available forage and appropriate grazing levels. Minimize the introduction and spread of invasive non-native plants and continue researching effective actions against invasive weeds.
- Construct and maintain crossing structures (e.g., culverts[77], underpasses/overpasses)
- Reduce fence damage and harm to wildlife by installing and maintaining wildlife friendly fencing and encourage virtual fencing[78].
- Remove ghost fencing (old wire fencing that is partially fallen down or otherwise dysfunctional).

- Minimize human-related disturbance to wildlife in sensitive wildlife areas and during sensitive times.[79, 80, 81]
- Plan and design recreational trails to avoid native grasslands and other high value wildlife habitats and wildlife corridors.[82]
- Maintain the extent of important grassland areas through regional and community development planning.
- Apply a combination of practices to maintain or increase the extent and health of grasslands.
- Create or maintain a mosaic of open forest cover with patches of more dense thickets.
- Minimize the impact of off-road vehicles, including bicycles on grasslands and open forests.
- Minimize or eliminate environmental contaminants that may poison or harm unintended species, including species at risk.
- Make water tanks, troughs, and dugouts wildlife-friendly.
- Tolerate the presence of burrowing mammals.

10.2 Riparian

Riparian areas are the transitional zone between bodies of water—such as streams, lakes, or wetlands—and uplands. They include an abundance of water, either on the surface or close to the surface, even when the waterbody may appear dry. Riparian areas are commonly distinguished on a landscape by unique assemblages of diverse and productive vegetation that require and are adapted moist soils, high water tables and hydrologic processes involving sediment deposition and nutrient cycling.[83] In the Columbia Lake Corridor, riparian habitat occurs in a variety of shapes and sizes from narrow ribbons in the headwaters to broad, complex floodplain along the Columbia River in the valley bottom.

Ecological Significance: Riparian areas perform many important ecological functions. They create habitat for plants, fish and other wildlife and travel corridors for many wide-ranging species. Riparian areas also trap sediment which helps hold topsoil and store moisture. They maintain bank and shore stability thus reducing erosion, improving water quality and clarity, and providing fish habitat. Riparian areas store water for flood and drought control and release it slowly over time. They recharge aquifers and sustain healthy floodplains. By filtering and buffering a water body, riparian areas can filter out contaminants before they reach the water.[84] Maintenance and persistence of functional riparian areas is important to resist some effects of climate change to maintain species richness and biodiversity.[85, 86, 87]

Conservation Priority Species Associated with Riparian Habitat in the Columbia Lake Corridor: Canadian beaver, American mink, bank swallow, barn swallow, blue elderberry, great blue heron, grey wolf, grizzly bear, hoary bat, Lewis's woodpecker, little brown myotis, Canada lynx, moose, muskrat, rose species, saskatoon, silver-haired bat, western painted turtle, and western toad.

Importance to Corridors and Connectivity: Riparian areas play a vital role as habitat patches for some plants and animals, and as “stepping-stone” or ribbon habitats connecting core habitat patches for wide ranging mammals and migratory birds. These areas offer a consistent source of water for drinking, bathing, and breeding, abundant food sources and security.

Primary Threats:

Logging, drought, channelization, water diversions, fire, insect attack, livestock damage

Specifically:

- Climate change-driven drought reduces available surface and groundwater impacting health of riparian habitats and floodplain ecosystems.
- Insect attack, particularly bark beetles, that target mature, large diameter trees.
- Forestry activity that removes overstory and understory habitat and habitat features (e.g., veteran trees, snags, shrubs, large woody debris), in riparian areas or modifies hydrology.
- Streamside side clearing of riparian areas and removal of woody debris for agricultural, residential, commercial and industrial purposes.
- Catastrophic wildfire that burns through and removes riparian habitat.
- Widespread suppression of forest fires and silviculture practices that reduce the amount of new or renewed early seral habitat for beaver and moose.
- Loss of habitat for perching, nesting, roosting and hibernating to forestry or other resource extraction activities.
- Hydrologic modifications such as diverting and/or dewatering streams during the growing season that reduces water supply to water bodies.
- Stream channelization increases stream velocity and degrades riparian habitat.
- Livestock trampling of vegetation along to streambank and shoreline riparian areas.
- Spread of invasive species (e.g., purple loosestrife, burdock)
- Direct impacts from human disturbance / activity produced by recreational and off-road vehicles to habitat quality and security in terms of wildlife flight / displacement and energetic cost.

Key Actions to Reduce Threats and Support Riparian Connectivity:

- Create Riparian Management Areas (RMA) and retain large mature trees, especially cottonwoods and other large, open-canopied deciduous tree species for bats and cavity nesters.
- Maintain or increase the habitat value of wetlands in managed forests by maintaining existing windfirm security cover around all wetlands, waterbodies and streams with a defined riparian area. Avoid locating new roads within 200 m of wetlands, waterbodies and watercourses containing important grizzly foods (cow parsnip, sedges, horsetail, skunk cabbage, glacier lily, spring beauty) where practicable.
- Leave security cover wide enough so that a grizzly bear feeding in wetlands and riparian areas with important spring grizzly foods cannot be easily seen from the nearest open road (i.e., a road open to motorized vehicle use) especially during feeding in early spring before the understory is fully leafed out.
- Maintain or increase the habitat value of wetlands and riparian zones in managed forests by leaving existing large (and smaller) pieces of coarse woody debris and uprooted trees, where this will not significantly increase forest health risks (i.e., spruce beetle, Douglas-fir beetle).In areas with a historic low severity or mixed severity fire regime, use a combination of mechanical treatments (e.g., thinning, pile burning) and low intensity prescribed fire to restore the riparian ecosystem.[88]
- Avoid taking prescribed fire all the way down to the main river or stream channel, as this can remove important habitat, damage streambanks, and increase nonpoint source pollution.
- Leave large (and smaller) pieces of coarse woody debris and uprooted trees within riparian areas to offer shelter, protective cover, and wintering areas for some amphibians, reptiles,

hibernacula for bats, denning sites for some mammals, nesting cover for some birds and small mammals.

- For bat roosts, retain large cottonwood trees and deciduous trees with large open crowns, rock crevices, and mature forest patches to allow them to seek out the appropriate microclimates necessary for their stage of reproduction.[89]
- Prevent the fragmentation and degradation of riparian habitats by discouraging ATV, horse or mountain bike riders and pets from entering riparian areas to access water bodies. Use educational signage on public trails to inform about the value and sensitivity of these habitats and promote responsible use of trails.[90]
- Maintain important riparian areas through regional and community development planning within RDEK's Regional Sustainability Strategy (RSS) by a) identifying key wetlands and riparian areas as "environmentally sensitive areas" (ESAs), b) designating land uses and prescribe densities that concentrate development in areas away from ESAs, and c) addressing ESA conservation and connectivity through conservation zoning, parks and natural areas policy, and through Environmentally Sensitive Development Permits.[91]

10.3 Wetlands

Wetlands are among the most biologically diverse and productive of all ecosystems. The development of wetlands is a complex and dynamic interaction of climate, hydrology, chemistry, geomorphology and biology. They are distinct ecologically because, as the name suggests, they are characterized by wet land that is saturated by water, either permanently or seasonally. This prolonged inundation of water leads to poorly drained soils and resulting low oxygen levels. These unique conditions are suitable for water-loving plants and various kinds of biological activities which are adapted to wet environments. Wetland types in the Columbia Valley include marshes, fens, swamps and shallow open water (including ponds, alkaline sloughs and potholes). In the Columbia Lake Corridor, wetlands in the valley bottom include the large wetland at the source of the Columbia River at Canal Flats in addition to wetlands in the floodplain at the outflow of Columbia Lake at Fairmont. Smaller wetlands and beaver-created complexes occur on benchlands above the west side of the lake.

Ecological Significance: Wetlands play a vital role in ecological functions and ecosystem services. Among their key benefits are regulating peak water flows and storage, replenishing groundwater supplies, enhancing soil absorption, and sustaining low water levels to help prevent droughts. They also contribute to improved water quality by capturing nutrients, filtering pollutants, and minimizing sediment runoff. Additionally, wetlands support biodiversity, offering essential habitats for amphibians, reptiles, bats, beavers, moose, many migratory birds and many other species. Wetlands also provide a natural system for carbon sequestration and, given concerns about the impacts of climate change, naturally functioning wetlands are essential to mitigating devastating effects of flooding, drought and fire linked to a changing climate.

Conservation Priority Species Associated with Wetland Habitat in the Columbia Lake Corridor: Canadian beaver, American mink, bank swallow, barn swallow, blue elderberry, great blue heron, grey wolf, grizzly bear, hoary bat, Lewis's woodpecker, little brown myotis, long-billed curlew, Canada lynx, moose, muskrat, rose species, saskatoon, silver-haired bat, western painted turtle, saskatoon, silver-haired bat, wapato (broadleaf arrowhead) and western toad.

Importance to Corridors and Connectivity: Wetlands play a vital role as habitat patches for many plants and animals, and as "stepping-stone" or ribbon habitats connecting core habitat patches for wide ranging mammals and migratory birds. These areas offer a consistent source of water for drinking, bathing, and breeding, in addition to abundant food sources and security.

Primary Threats: Drought, water diversions, loss of beaver colonies, cattle access, recreation

Specifically:

- Climate change-driven drought reduces available surface and groundwater impacting health of wetlands in benchland and floodplain ecosystems.
- Forestry activity that removes overstory and understory habitat and habitat features (e.g., veteran trees, snags, shrubs, large woody debris) in wetlands or modifies hydrology.
- Hydrologic modifications such as draining of wetlands and filling in for agricultural, residential, commercial and industrial purposes.
- Catastrophic wildfire that burns through and destroys wetland habitat.
- Widespread suppression of forest fires and silviculture practices that reduce the amount of new or renewed early seral habitat for beaver and moose.
- Loss of nearby habitat for perching, nesting, roosting, and hibernating to forestry or other resource extraction activities.
- Livestock trampling of vegetation along edges of wetlands.
- Spread of invasive species (e.g., purple loosestrife, burdock).
- Direct impacts from human disturbance / activity produced by recreational and off-road vehicles to habitat quality and security in terms of wildlife flight/displacement and energetic cost.

Key Actions to Reduce Threats and Support Wetland Connectivity:

- Maintain or increase the habitat value of wetlands and riparian zones in managed forests by leaving existing large (and smaller) pieces of coarse woody debris and uprooted trees, where this will not significantly increase forest health risks (i.e., spruce beetle, Douglas-fir beetle).Open up the canopy and encourage early seral conditions with the presence of broadleaf shrub and trees in and adjacent to riparian areas where excessive fuel has accumulated as a result of fire suppression and spread of invasive species.
- Maintain or increase the habitat value of wetlands in managed forests by maintaining existing windfirm security cover around all wetlands, waterbodies and streams with a defined riparian area. Avoid locating new roads within 200 m of wetlands, waterbodies and watercourses containing important grizzly foods (cow parsnip, sedges, horsetail, skunk cabbage, glacier lily, spring beauty) where practicable.
- Leave security cover wide enough so that a grizzly bear feeding in wetlands and riparian areas with important spring grizzly foods cannot be easily seen from the nearest open road (i.e., a road open to motorized vehicle use) especially during feeding in early spring before the understory is fully leafed out.
- Time prescribed fire to avoid sensitive wildlife timing windows during denning, calving, nesting, roosting, and spawning seasons.

- Minimize impact of prescribed fire or other treatments on species at risk and other conservation values by avoiding sensitive Wildlife Habitat Features near wetlands (e.g., denning sites, nesting / roosting trees, hibernacula, mineral licks) and designated critical habitat during the project planning phase.
- Maintain suitability and safety of aquatic habitats by controlling water levels and not altering natural patterns of flooding and drying of ponds, wetlands, and other larger waterbodies, especially in the spring during waterbird nesting period and amphibian development.[92, 93]
- Leave large (and smaller) pieces of coarse woody debris and uprooted trees within wetlands to offer shelter, protective cover, and wintering areas for some amphibians and reptiles, hibernacula for bats, denning sites, and nesting cover.
- For bat roosts, retain large cottonwood trees and deciduous trees with large open crowns, rock crevices, and mature forest patches[94]
- Prevent the fragmentation and degradation of riparian habitats by discouraging ATV, cattle, horse or mountain bike riders and pets from entering wetland areas to access water. Use educational signage on public trails to inform about the value and sensitivity of these habitats and promote responsible use of trails.[95]
- Maintain important wetland areas through regional and community development planning within RDEK's Regional Sustainability Strategy (RSS) by a) identifying key wetlands and riparian areas as "environmentally sensitive areas" (ESAs), b) designating land uses and prescribe densities that concentrate development in areas away from ESAs, and c) addressing ESA conservation and connectivity through conservation zoning, parks and natural areas policy and through Environmentally Sensitive Development Permits.[96, 97]

10.4 Forests

Forests in the Columbia Lake Ecological Corridor are diverse in their composition, canopy closure, stand age, and ecology. They range from open forests of ponderosa pine, Douglas-fir and western larch to high elevation closed canopy forests of Engelmann spruce and subalpine fir stands. There are wetter areas of western redcedar and western hemlock and mid-elevation stands dominated by lodgepole pine and high elevation open areas of whitebark pine. Wildfire, forestry, insect outbreaks, and other disturbances create a mosaic of successional stages within each broad forest type.

Ecological Significance:

Forests provide a wealth of biological diversity and ecological services. From economic benefits via forest harvesting and subsequent milling to non-wood products such as foods and medicines derived from berries, roots and bark, and important habitats for wildlife. Forests provide homes, cover and food to a wide suite of species from generalists to specialists across all taxa, including several species at risk. Growing forests also sequester carbon, while decaying and burning trees release it back to the atmosphere[98].

High Elevation Forests: Whitebark pine is found at high elevations throughout the CLEC and is federally listed as an Endangered Species. Whitebark pine is considered a keystone species for high elevation ecosystems and a key food source for species such as grizzly bear and Clark's nutcracker. The species is threatened primarily by fungal infections from white pine blister rust, mountain pine beetle outbreaks and fire-suppression leading to competition from shade-loving tree species.[99] Englemann Spruce – Subalpine Fir forests otherwise dominate the upper elevation forests of the CLEC. Whitebark pine forests support a variety of focal species including Clark's nutcracker and grizzly bear and provide important summer range for Rocky Mountain elk and mule deer.

Mid-Elevation Forests: Forests in Montane Spruce (MS) BEC zone dominate backcountry river valleys such as the Kootenay, White, Palliser, Findlay and Brewer Creek drainages. Largely shaped by wildfire and logging, these areas are often large stands of even-aged lodgepole pine mixed with Douglas-fir and western larch. Wetter sites on the east side of the CLEC are in the Interior Cedar-Hemlock (ICH) BEC zone. Several of the focal species that require larger areas of mature forest occur in these mid-elevation forests including northern goshawk and American marten (Appendix 1: Focal Species). However, these mid-elevation areas have the highest densities of roads and forest fragmentation as well (Figure 15).

Conservation Priority Species Associated with Forests in the Columbia Lake Corridor:

American marten, grizzly bear, Canada lynx, wolverine, Rocky Mountain elk, white-tailed deer, mule deer, moose, porcupine, little brown myotis, silver-haired bat, hoary bat, Townsend's big-eared bat, Clark's nutcracker, flammulated owl, Lewis's woodpecker northern goshawk, olive-sided flycatcher, western toad, whitebark pine, red-stem ceanothus, Rocky Mountain juniper, rose species, saskatoon, soopolallie (soapberry), and huckleberry.

Importance to Corridors and Connectivity: Forests are the predominant land cover in the Columbia Lake Ecological Corridor. Though they differ in species composition, canopy closure, age and other factors, areas where trees are the major feature contributing to ecological communities. Frequent fire, particularly and mid-to low elevations, maintained a mosaic of forest types and ages in the area.[100]

While fragmentation of forests has long been recognized as an overall threat to biodiversity,[101] edge habitats can support locally increased species richness.

Many focal species rely on relatively intact forests, including American marten, northern goshawk, silver-haired bat, Canada lynx. Non-wood products are important as well. Many foods and medicines are derived from forest products including berries,

Primary Threats: Forest harvest, insect attack, wildfire, drought, storms, roads, recreation disturbances, climate change

Specifically:

- Fire suppression of areas with ingrown open forest, especially at lower elevations.
- Increased catastrophic wildfire frequency and intensity.
- Timber harvesting in mature and old forests, particularly clearcutting without residuals leading to habitat loss.
- Ecosystem modification due to climate change resulting in mis-matched tree species and climate.
- Introduction and spread of invasive plant species.
- Loss of large-seeded pines such as limber and whitebark pine.
- Blister rust infecting and killing whitebark pine.
- Recreational development, camping and trails.
- Motorized and mechanical (mountain bike) disturbance to soils and understory vegetation.

- Clearcutting without leaving sufficient residuals as seed trees, wildlife patches, and deciduous refugia from climate change
- Post-fire salvage logging that does not leave sufficient residuals and/or live trees within the burn area.[109,110]
- Insects out of ecological balance leading to severe infestations of bark beetles such as mountain pine, spruce and Douglas-fir beetles, along with several weevils and defoliators.

Key Actions to Reduce Threats and Support Forest Connectivity:

- During the planning phase of forest management, review known conservation value occurrences for species at risk and Wildlife Habitat Areas (WHA); to determine whether planned operations include or are near recorded occurrences. Pre-development targeted surveys (e.g., call-playback surveys) by a qualified professional are recommended in suitable habitats within forestry development areas around confirmed species at risk occurrences and WHAs for Species at Risk to improve knowledge of species, Wildlife Habitat Features, and to inform forest management. This does not imply that targeted surveys need to be conducted for each CV potentially occurring in the development area.
- Retain well-functioning old-growth stands and high habitat value large-diameter trees. Timber harvest planning (site prescriptions) that takes wildlife habitat and biodiversity into account.
- Avoid new road-building and recreational trail development in intact (roadless) drainages. In areas with high habitat values for grizzly and bull trout (WHAs, HCVAs) rehabilitate roads and manage open road access with a goal of achieving a density no greater than 0.6 km/km^{2}Use of prescribed burns to remove forest ingrowth to create open forest stands and reduce the risk of severe wildfires.
- Minimize the introduction and spread of invasive plants on burned soils during post-burn salvage logging. Create Wildlife Tree Retention Areas (WTRA) to protect high value wildlife trees, wildlife habitat features, and other stand level biodiversity features. Within WHAs, follow (legally) required General Wildlife Measures. Manage Ungulate Winter Range (UWR) according to the General Wildlife Measures identified in Government Actions Regulation (GAR) Orders, and consider associated guidelines in the Ktunaxa Forestry Standards Document.[102] In Open Forest and Open Range, implement the Ecosystem Restoration BMPs developed by the Trench ER Committee[103].
- Consider using selection harvest within Douglas-fir and western larch dominated stands with large trees. Follow BC[104] or Canfor BMPs for post-fire salvage logging and stand recovery.
- Maintain open forests with prescribed fire, partial cuts and no post-harvest replanting.
- Protect or enhance whitebark pine and limber pine-leading stands, minimizing unintended harvest in mixed stands.
- Maintain forest structure including coarse woody debris (downed logs, stumps, litter) and/or piles of CWD and sufficient overhead vegetation (shrubs, saplings, mature trees) to provide cover and foraging opportunities for American marten, their primary prey and other species.[105]
- Retain and support huckleberry patches:
    - Avoid damaging rootstock by harvesting with good snow cover and/or using equipment with low ground pressure; avoid cable harvesting and mechanical site preparation.
    - Retain some live residual trees to provide partial shade, especially on drier sites (up to 30% Crown Closure), and manage to the lower end of density ranges in stocking standards for reforestation.

  - During silviculture operations, avoid brushing of Vaccinium, Shepherdia, or other berry producing shrubs. Do not apply herbicides or use scarification as a site prep. Technique.
  - Spring prescribed burning should be considered a viable stewardship practice for post-harvest sites with a high abundance of huckleberries. Where practical, consider lightly burning the block (in spring) but avoid high slash loads and hot burns which kill rhizomes.
  - Maintain security cover (forested cover minimum >3 m tall and 2 x sight distance measured as the disappearing distance of a bear) adjacent to high elevation huckleberry patches.
  - Avoid creating new roads within 150 of field-confirmed, mapped huckleberry patches (Proctor mapping).
- Create no-harvest buffer areas around known wallows and mineral licks; and avoid activity in the area during critical use periods (September–November for wallows; May-November for mineral licks).
- Avoid using pesticides, including insecticides, herbicides and rodenticides, except where required for the treatment and control of invasive plants.

10.5 Climate Change Habitat Refugia

Significance / Importance to Corridors and Connectivity: Climate change presents several threats and challenges to the CLEC species and ecosystems (see 9.9). There are distinct differences based on elevation and subareas within the CLEC.[106] Predicted changes include, but are not limited to, increased wildfire frequency and intensity, increased storms and severe weather events, floods, hotter and drier summers, decreased precipitation as snow, and complete loss of glaciers.

Two ecosystem level changes are Climatic Moisture Index and Vapour Pressure Deficit. Utzig describes Climatic Moisture Index (CMI) as “an indicator of available moisture based on the difference between annual precipitation and annual potential evapotranspiration.” Current predictions suggest the Rocky Mountain Trench ecosystems will likely change from marginal savannas to drought prone grasslands. Only the Purcell Mountains and higher elevations of the Rockies are predicted to remain in a closed canopy forest condition.

According to Utzig, Vapour Pressure Deficit (VPD) is “the difference between the amount of moisture the atmosphere is capable of holding or saturation vapour pressure, and the actual amount of moisture in the atmosphere.”[107] As VPD rises, plants increasingly struggle to retain water because evapotranspiration from leaves increases concurrently with atmospheric evaporation. Thus, the drier the air, the more evaporation occurs. If a plant cannot keep up with the demands of evaporation, it shuts down photosynthesis, regardless of how much moisture is in the ground. Lack of photosynthesis limits tree growth. Drying trees and plants with drying soils is fodder for intense wildfire, which releases more carbon into the atmosphere, which of course feeds climate change, which causes more evaporation. Predicted increases in VPD portend more stressed forests leading to decreased productivity and vigor and increased susceptibility to insect attacks and disease. Ultimately, more dead trees increase the fuel for catastrophic wildfire which releases more CO_2 into the atmosphere further adding to climate change and the cycle continues.

As temperatures go up, places that hold water are going to be important in the CLEC. Riparian areas, wetlands, and headwater streams help keep connectivity within a corridor. If these ecosystems are damaged or dry out, the opportunity for species movement is threatened.

Primary Threats:

Increased catastrophic wildfire; increased insect attack; increased storms and severe weather; higher temperatures; seasonal precipitation changes

Key Actions to Reduce Threats and Support Landscape Connectivity:
Greg Utzig's climate report for the CLEC includes several recommendations.[108] Following are selected actions from that report that are specific to the CLEC area. See the report for a full suite of climate-related recommendations and discussion.

- Expand the area and rate of trench ecosystem restoration activities, consistent with creating firesmart resilient communities throughout the lower elevations of the assessment area, especially those areas projected to shift to bioclimates with increased moisture stress and more frequent wildfire regimes, including:
  - remove forest in-growth and ladder fuels;
  - reduce stand densities (to reduce risk of crown fires and build resilience to drought and forest pests);
  - protect large fire-resistant trees (ponderosa pine, Douglas-fir and western larch);
  - re-introduce low intensity fire by making cultural and prescribed burning a primary ecosystem management tool.
- Conserve wetlands, ponds, ephemeral streams and seepage areas:
  - inventory and monitor of changes in water levels;
  - classify according to vulnerability to climate change;
  - ensure water sources are not interrupted by disturbance activities;
  - explore opportunities for protection and enhancement of water levels.
- Protect and enhance riparian areas along streams and rivers, wetlands and lakes .
  - minimize disturbance to riparian areas, restore native vegetation, and minimize upstream disturbances that may increase peak flows and/or reduce low flows;
  - carefully plan timber harvesting and wildfire fuel treatments to prioritize and protect riparian zones along water courses, ponds and wetlands (including consideration of fuel breaks along stream channels where appropriate to ensure riparian zones do not become fire corridors).
- Minimize salvage harvesting operations.
  - where wildfire salvage operations are undertaken, ensure that they follow biodiversity conservation best management practices (e.g., Larson et al. 2022[109], BC MoF 2023[110]);
  - salvage operations should avoid all live tree removal;
  - limit salvage operations to no more than 25% of the burned area (e.g. Thorn et al. 2020[111]).
- Given the potential for expansion of ICH bioclimates and possible arrival of Coastal Hemlock bioclimates in the CLEC subarea (Figure 15), protect and conserve all existing areas of ICH in the CLEC to provide potential seed sources for appropriate species.
- Monitor and manage insect outbreaks where possible utilizing environmentally acceptable methods.
- Manage grazing to reduce wildfire hazards, protect riparian areas and maintain resilient community structure of grassland communities.
- Protect and enhance deciduous trees and stands, particularly trembling aspen, cottonwood and paper birch.
- Control invasive plants, especially during ecosystem restoration activities and salvage operations.

- Further habitat inventory and monitoring to increase understanding of focal species utilization of the corridor, including the identification of seasonal locations, migration routes, and where appropriate, to identify potential range shift linkages necessitated by climate change.
- Further assess key mountain passes within the corridor including those offering connectivity across the Continental Divide, by including habitat inventory and topographic analysis to set priorities for conservation.
- Protect old growth forests to maintain genotypes that have survived the previous warm dry period early in the last century. Researching species and genotypes not present in the area (which may be better adapted to projected climates) and consider trials with suitable genotypes and species potentially leading to assisted migration.

10.6 Access Management

To enhance the connectivity function of the proposed Columbia Lake Ecological Corridor, it is very important to consider increases to secure areas of high habitat (defined as > 500m from an open road). A corridor as large as the CLEC is designed to function as a landscape and not as a short distance linear hallway, where animals move through in an all-in-one movement. Rather they require higher quality habitat sufficient to reproduce and live within and across the corridor over time. This is exactly what Rowland et al. (2018)[112] and Proctor et al. (2023)[113] support for elk and grizzly bears respectively: *the combination of habitat quality and security that meets this requirement*. For the CLEC to function effectively, large mammals such as grizzly bears and elk, require suitable habitat to multi-generational movements in order to sustain viable healthy populations of these focal species.

In the larger CLEC beyond the CCA, access management is important for maintaining connectivity. In considering roads in relation to the habitat requirements of grizzly bears and elk, both species have rigorous, peer-reviewed support for the conclusion that it is a *combination of high quality habitat <u>and</u> habitat security (i.e. further from open roads)* that provides the necessary conditions for them to thrive.[114, 115] They both have literature that suggest road densities at a maximum of 0.6 km / km^2 is beneficial for their reproduction and survival.[116, 117, 118]

Grizzly bear natal dispersal and connectivity occur slowly and can be multi-generational and for females is not over great distances (10-14 km).[119, 120] This suggests that grizzly bears (especially females) will have to spend some of their seasonal habitat use within these corridors, especially ones like the larger park to park CLEC. Consistent with these ideas, Proctor et al. (2015)[121] predicted and validated grizzly bear corridors as being a combination of the best available habitat with the least amount of human disturbance.

Frair et al. (2008)[122] found that road densities < 0.5 km/km^2 yield the highest probability of elk occurrence in hunted regions, and the negative effect on elk likely extends to 700m out from the road. Besides managing human access, they suggested that separating roads from foraging areas may maintain elk in areas with higher road densities and contribute to landscape connectivity. From the standpoint of the CLEC, we suspect that higher quality habitat with more security (i.e. lower road densities) will facilitate increased habitat permeability for both seasonal migration and natal dispersal movements. Thus, the specific areas within the larger CLEC that we recommend be considered for access management are areas where elk and grizzly bear habitat models suggest they both overlap and have a locally high road density (Figure 16). These areas have often been logged, and we recommend that many of the smaller roads within these sections be managed for human access, including closures and rehabilitation. It is open roads that deliver people, the displace or kill these species.

It is possible that only a portion of the elk using the CLEC area migrate between seasons. Poole et al. (2024)[123], found that roughly 50% of the elk herd in the Elkford/Sparwood BC area migrated to higher elevation seasonally. Resident elk, who did not migrate, had a significantly high human-caused mortality rate, and showed signs of nutritional stress. They recommended enhancing high-elevation summer range. Considering results from Rowland et al. (2018)[124,] and Friar et al. 2008,[125] these enhancements might be most beneficial to elk if they occur in areas of low road densities.

Throughout the East Kootenays, elk are migrating seasonally much less than they used to.[126, 127] Causal mechanisms for this change are not fully understood but thought to be a combination of habitat change, summer forage availability in the Trench (hay fields), predation, human disturbance and barriers (high fences and highways). These patterns are consistent with ungulate populations elsewhere.[128]

Brennan et al.[129] pointed out that there are likely several types of movement behaviours for seasonal migration and dispersal among elk and other ungulate species: slower movements that also entail foraging and better suited through higher quality habitat, and faster movements that may occur through lower quality habitats. We also suggest that elk connectivity may be considered at several scales: migration between seasonal habitats, (winter and summer) and then the larger scale movements of natal dispersal between adjacent populations or mountain ranges in the CLEC. Both types of connectivity movements likely occur within the CLEC and between the Purcells-Rockies areas that the CLEC connects.

With these ideas in mind, one of our recommendations emanates from the Forestry Best Management Practices and its associated sub sub-categories with this proposal.

“Avoid road/trail development in intact road-free areas; strategically place essential roads and implement motorized access management in ungulate, Grizzly Bear and Wolverine areas”

This recommendation is designed to provide higher quality habitats that facilitate slower movement behaviour such as foraging[130] and to support healthy populations of our focal species that contribute to broader connectivity between mountain ranges.

11. Connecting to the Future

Because nature needs to move, our vision for the Columbia Lake Ecological Corridor is a landscape where all wildlife can find passage between patches of high-quality habitat and contribute to viable populations and fully functioning ecosystems across ʔamakʔis Ktunaxa and beyond. In the spirit of the Ktunaxa stewardship tenet of *yaqał hankatiłiłki na ʔamak* (our people care for the land, the land cares for our people), we seek the opportunity to maintain and enhance this existing diverse landscape for the benefit of all.

Future land use decisions should ask, “*How does this action affect connectivity?*” as a primary question. As Aldo Leopold so eloquently stated, “A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise.”[131] This does not mean an end to using the land or an infringement on property rights. It highlights the need for a land ethic that reflects the outsized importance of the CLEC to many species and ecosystems. This ethic is reflected in the Ktunaxa stewardship philosophy that humans are part of the land and through the spirit of *ʔaknumuȼtiȼiȼ* ensure that we take care of the land, its beings and its resources.

As stated above, a significant attribute of the CLEC is that much of the area is currently being managed in a manner that supports ecological connectivity. Actions that support connectivity are much easier and less expensive to undertake than restoring degraded lands and waters. We therefore call on all governing bodies and decision-makers to ensure future stewardship of the CLEC is prioritized.

Nałmuqȼin recognized the unique significance of *kinq̓uq̓anki* as the animals fought off Yawuʔnik̓. Today we would be wise to follow that guidance and work to ensure the CLEC's future is as important and valuable as its past.

Tables

Table 1: Species with large movements that are particularly influenced by corridor function

Species	Movement	Details	Corridor	Reference
Grizzly Bear	Wide ranging	Seasonal movements for food and shelter	Can be any direction, will move from Purcells to Rockies or vice-versa	Proctor et al. (2023)[132]
Badger	Wide ranging	Males especially move widely in search of females	Mostly N-S but will travel to upper elevations	Kinley and Newhouse (2008)[133] Newhouse (2006)[134]
Bighorn Sheep	Seasonal Migration	Transitional ranges follow traditional movement routes between seasonal ranges	East side only; occasional dispersal between herds	Dibb (2007)[135] Kinley (2007)[136] Davidson (1994)[137]
Elk	Seasonal Migration	Historically migrated to high elevation summer ranges; much less common now	Avoid roads, following traditional routes	Mulligan (2021)[138] Poole et al. (2024)[139]

Table 2: Classification and area of Protected Areas, Other Effective Area-based Conservation Measures (OECM) and Wildlife Habitat Areas with Conditional Harvest General Wildlife Measures within the Columbia Lake Ecological Corridor (CLEC) and Critical Connectivity Area (CCA).

Corridor Classification	**Land Designation**	**Area km^2**	**Area %**	**Corridor comparison for percentage**
CCA		*596*	*13.4%*	*of total CLEC*
Protected	Ecological Reserve	0.5	0.1%	of CCA
	Fee Simple Private Land	81.0	13.6%	of CCA
	Provincial Park	5.3	0.9%	of CCA
	Wildlife Management Area	69.0	11.6%	of CCA
	Total Protected	*155.8*	*26.1%*	*of CCA*
OECM	No Harvest WHA	0.6	0.1%	of CCA
	Total Protected + OECM	*156.4*	*26.2%*	*of CCA*
Other	Conditional Harvest WHA	4.0	0.7%	of CCA
CLEC (Outside CCA)		*3838*	*89.2%*	*of total CLEC*
Protected	Provincial Park	22.6	0.6%	of CLEC outside CCA
OECM	No Harvest WHA	30.1	0.8%	of CLEC outside CCA
	Total Protected + OECM	*52.7*	*1.4%*	*of CLEC outside CCA*
Other	Conditional Harvest WHA	445.8	11.6%	of CLEC outside CCA
CLEC (Total)		*4434*		
Protected	Protected	178.4	4.0%	of total CLEC
OECM	No Harvest WHA	30.7	0.7%	of total CLEC
	Total Protected + OECM	*209.1*	*4.7%*	*of total CLEC*
Other	Conditional Harvest WHA	449.8	10.1%	of total CLEC

Table 3: Land use designations within the Columbia Lake Ecological Corridor. Ther combined non-overlapping total area encompasses 89% of the CLEC. The existing land use designations that govern management activities very likely meet the needs of ecological connectivity. Legally mandated activities are indicated with an asterisk (*) and total percentage of the entire CLEC is listed in parentheses.

Designations within the Critical Connectivity Area focused on the valley bottom:	
*Provincial Parks	0.1%
*Wildlife Management Areas	1.7%
*Land Trust protected lands	2.9%
*Community Watershed	2.0%

Designations within the larger Columbia Lake Ecological Corridor related to activities within the backcountry regulating primarily forestry, recreation, and hunting:	
*Wildlife Habitat Areas	10.8%
WHA No harvest	0.7%
WHA Conditional harvest	10.1%
*Access Management Areas	43%
Vehicle closure	10%
Vehicle hunting closure	33%
CANFOR High Conservation Value Areas, managed and monitored through their Forest Stewardship Certification process	35%
HCVA reserve (no timber harvest or roads)	
HCVA managed (conditional timber harvest)	
*Old Growth	13%
OGMAs (non-legal)	7%
Forests > 250 & 400 years	6%
*Ungulate Winter Range (Elk, Deer, Moose)	
Conditional harvest	19%
*Mountain Caribou Winter Range (no timber harvest)	7%
*Mountain Goat Winter Range	39%
No timber harvest	14%
Conditional harvest	25%
*Big Horn Sheep Winter Range	5%
No timber harvest	1%
Conditional harvest	4%
Total non-overlapping proportion of the CLEC:	**89%**

Figures

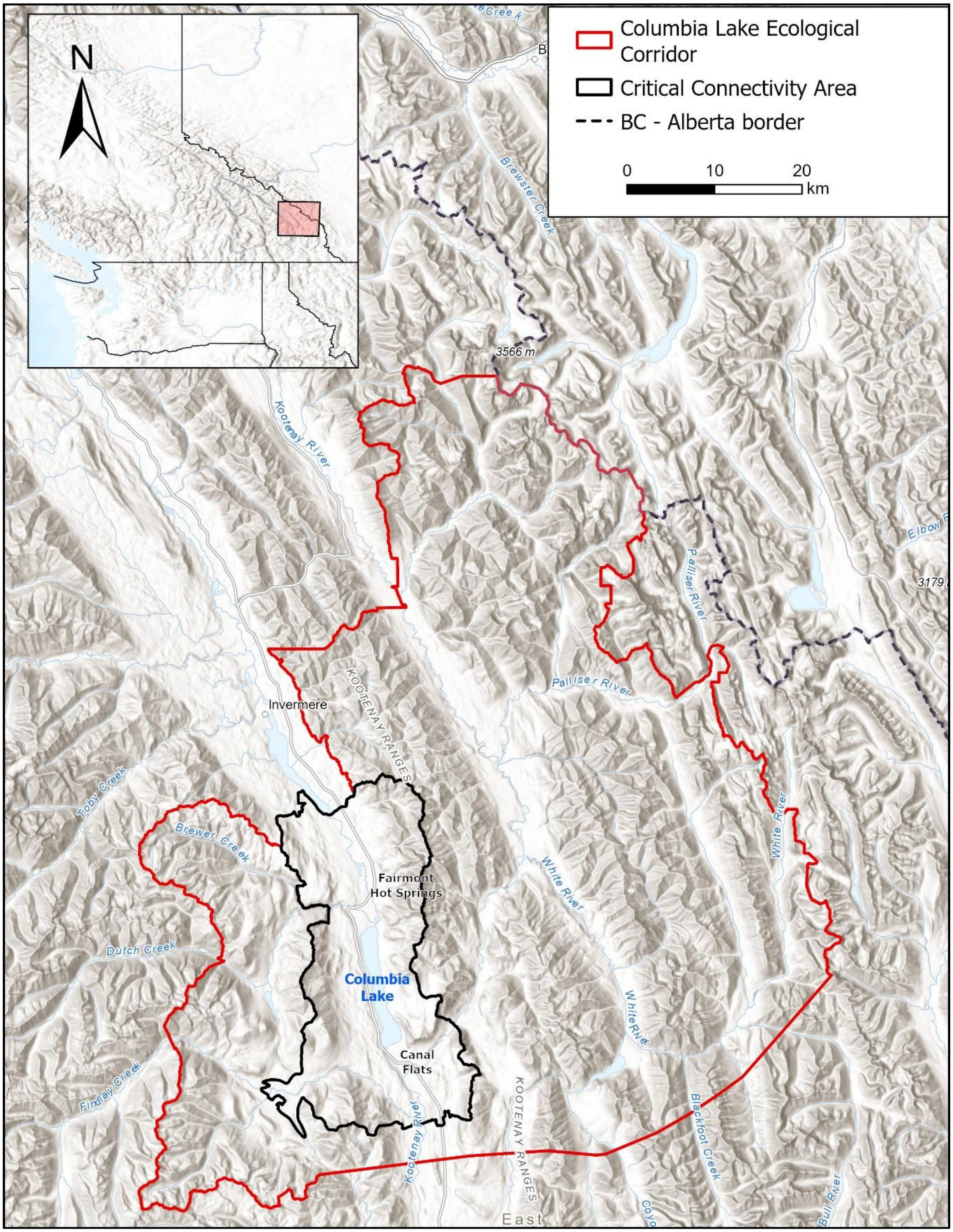


Figure 1: Overview and location of Columbia Lake Ecological Corridor (red) and Critical Connectivity Area (black).

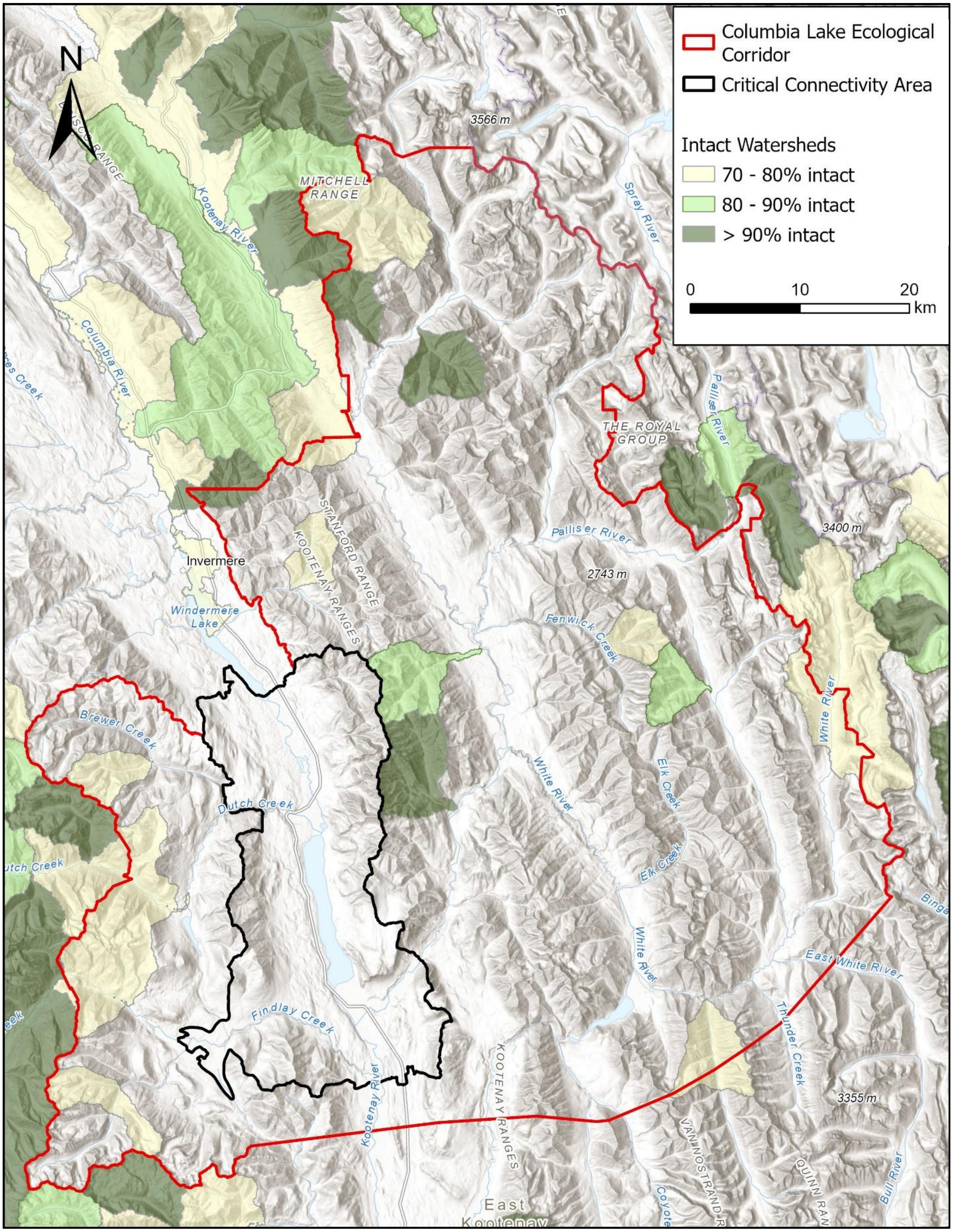


Figure 2: Watersheds considered 70% intact, or more in the broader Columbia Lake Ecological Corridor area. Source: BC Old Growth Advisory Panel[140]

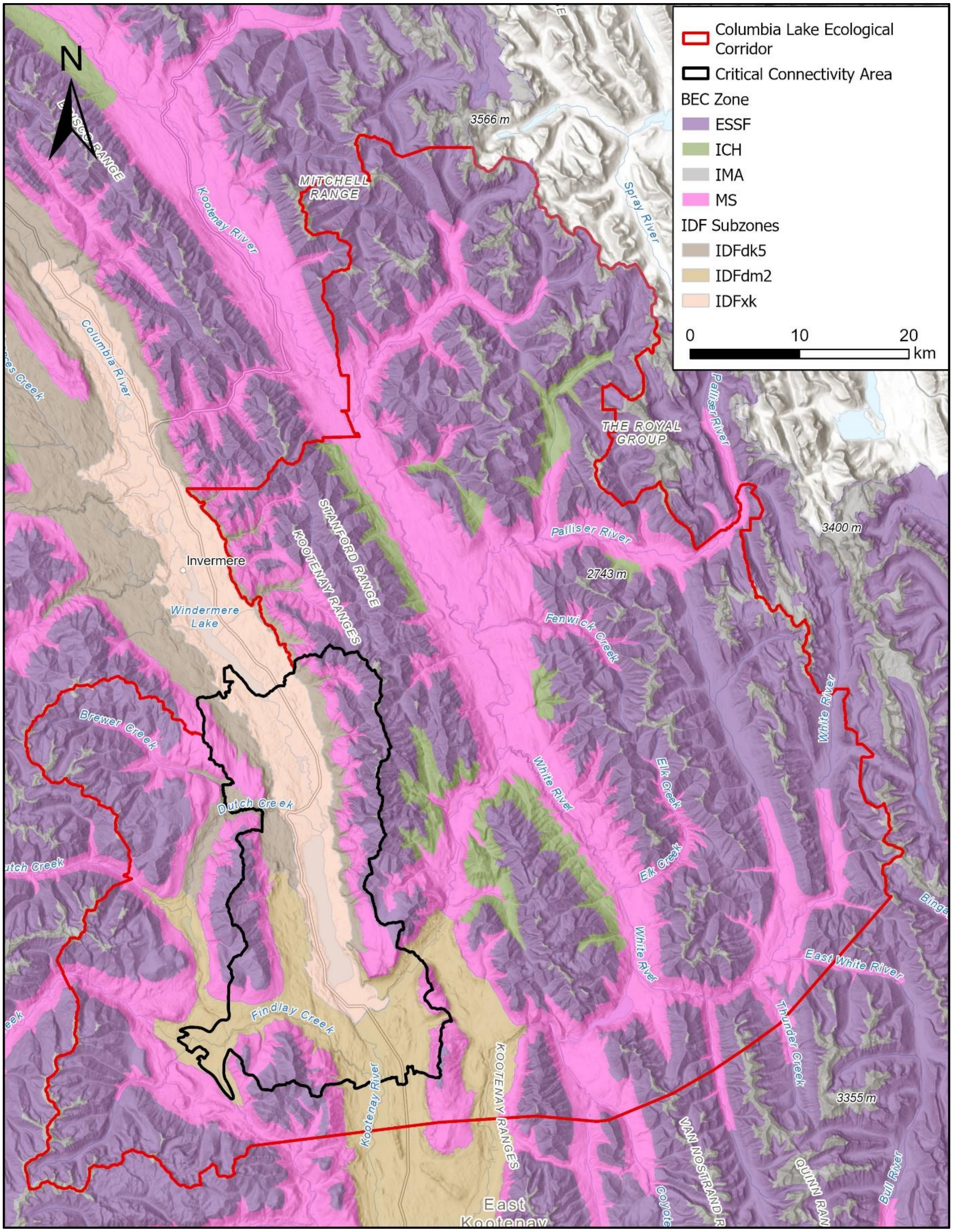


Figure 3: Biogeoclimatic (BEC) Zones in relation to the extent of full Columbia Lake Ecological Corridor (red line) and Critical Connectivity Area (black line). The majority of ESSF is in the ESSFdk subzone transitioning to woodland and parkland variants at upper elevations.

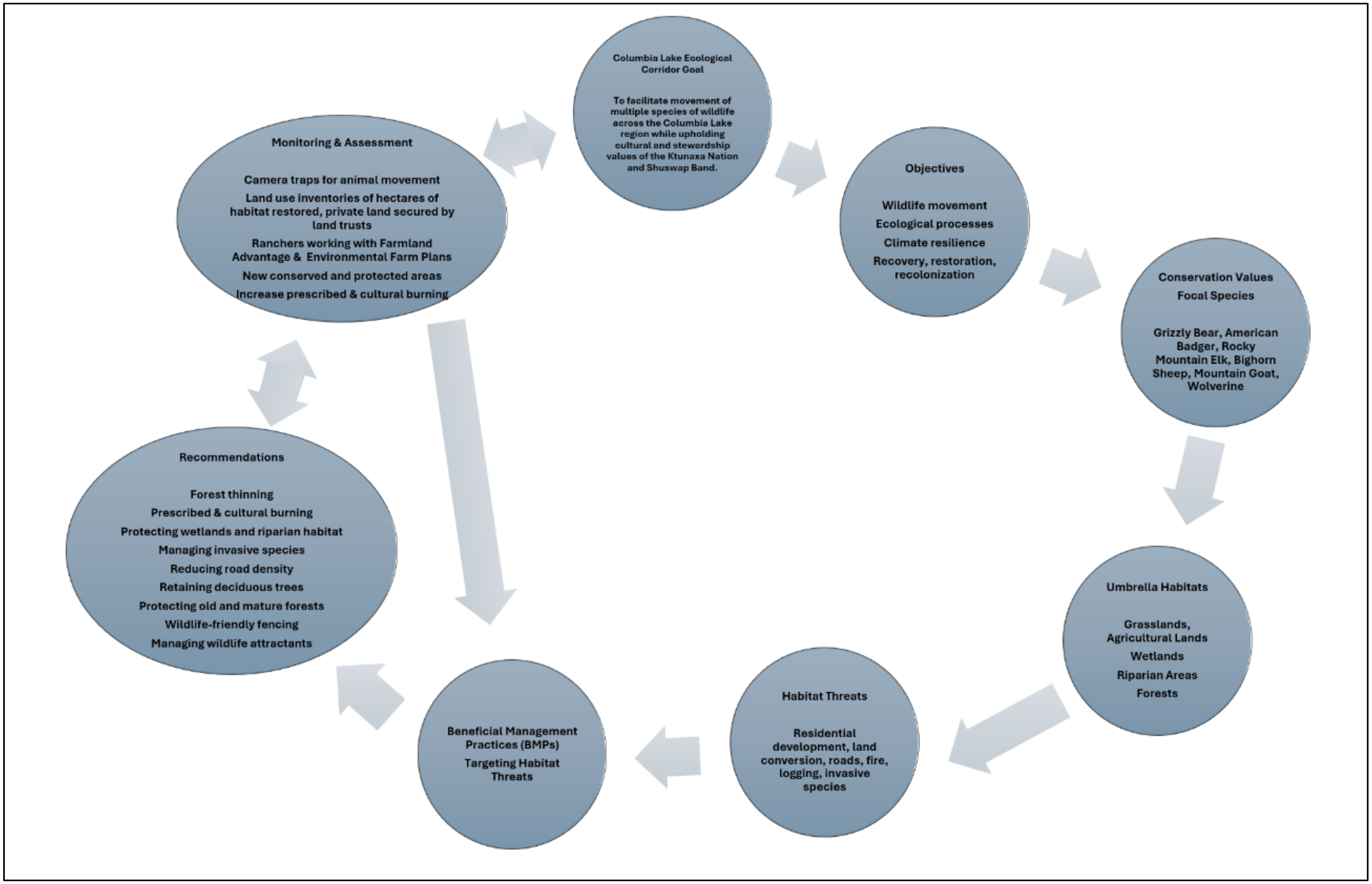


Figure 4: Flow diagram of approach to stewarding conservation values in the Columbia Lake Ecological Corridor.

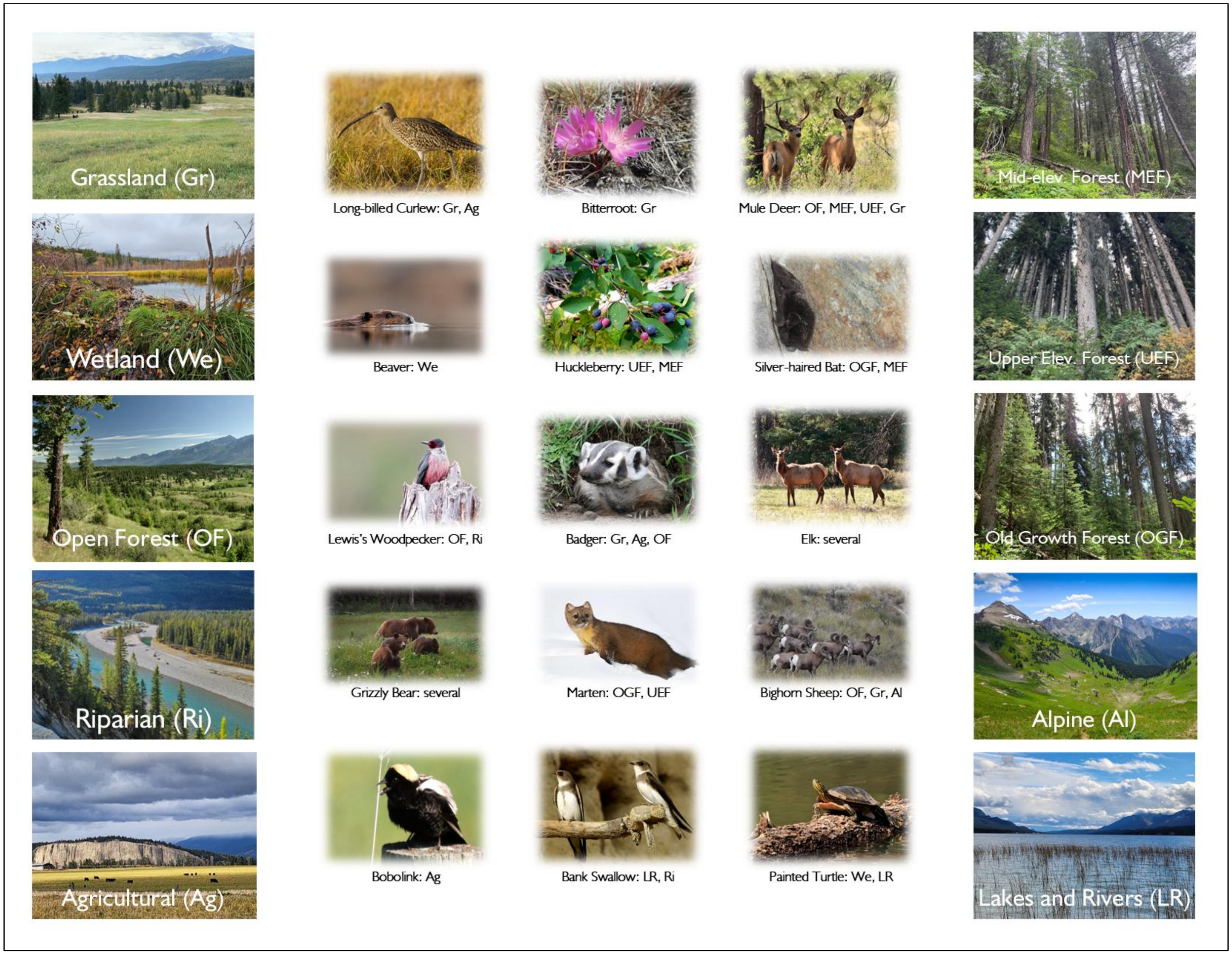


Figure 5: Coarse habitat types and example focal species. Photo credits: Marcy Mahr: Agricultural, Lakes & Rivers; Michael Proctor: Grassland, Grizzly Bear; Bighorn Sheep; Kari Stuart-Smith: Mid-elevation Forst, Upper Elevation Forest, Old Growth Forest, Alpine; Richard Klafki: Badger; Cori Lausen: Silver-haired Bat; Jose Sousa: Bank Swallow; Kyle Tansley: Beaver; Odd Runefalch: Long-billed Curlew; US National Park Service: American Marten; Ian Adams: Wetland, Open Forest, Riparian, Bobolink, Bitterroot, Huckleberry, Mule Deer, Elk, Painted Turtle

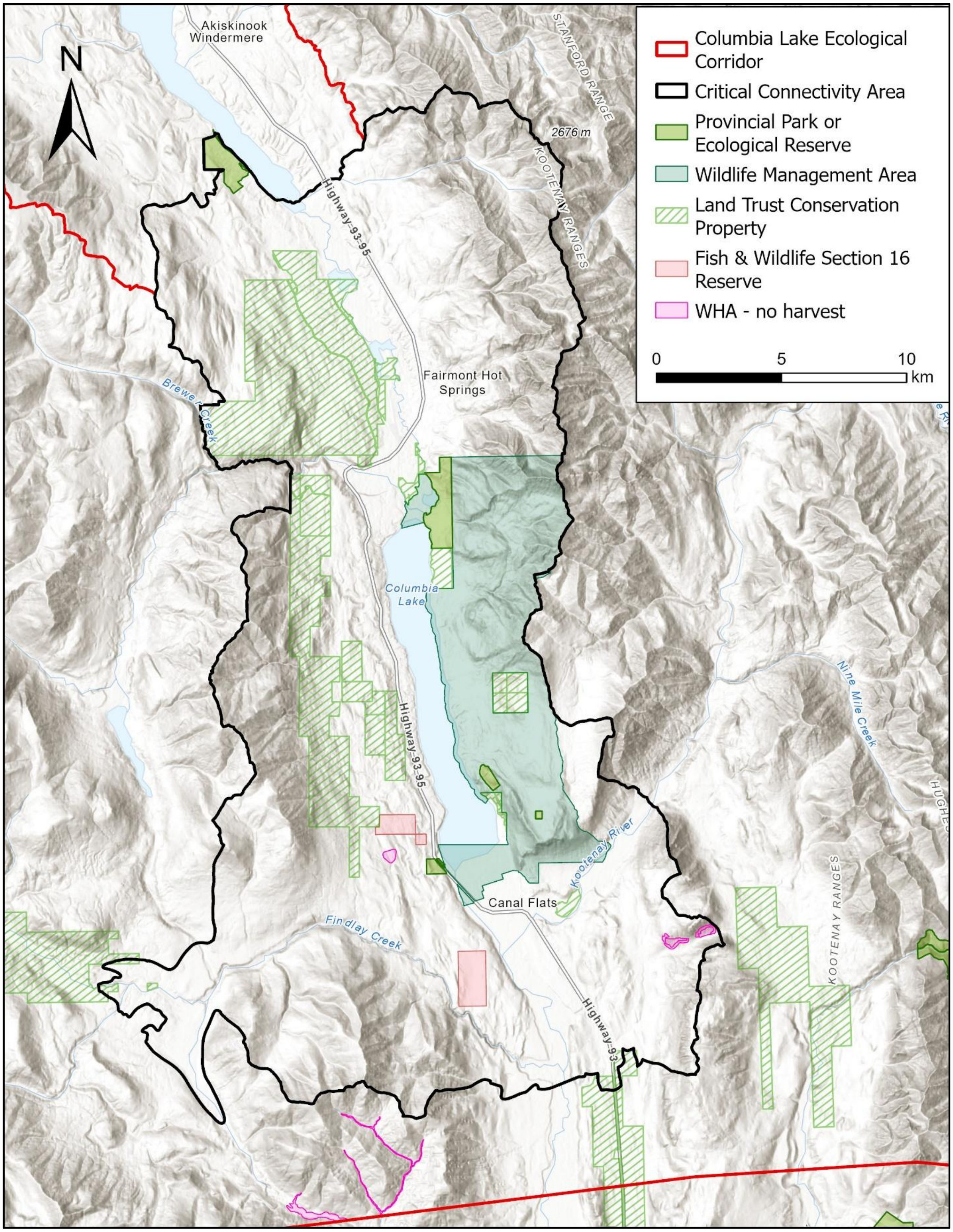


Figure 6: Protected areas within Critical Connectivity Area of the Columbia Lake Ecological Corridor.

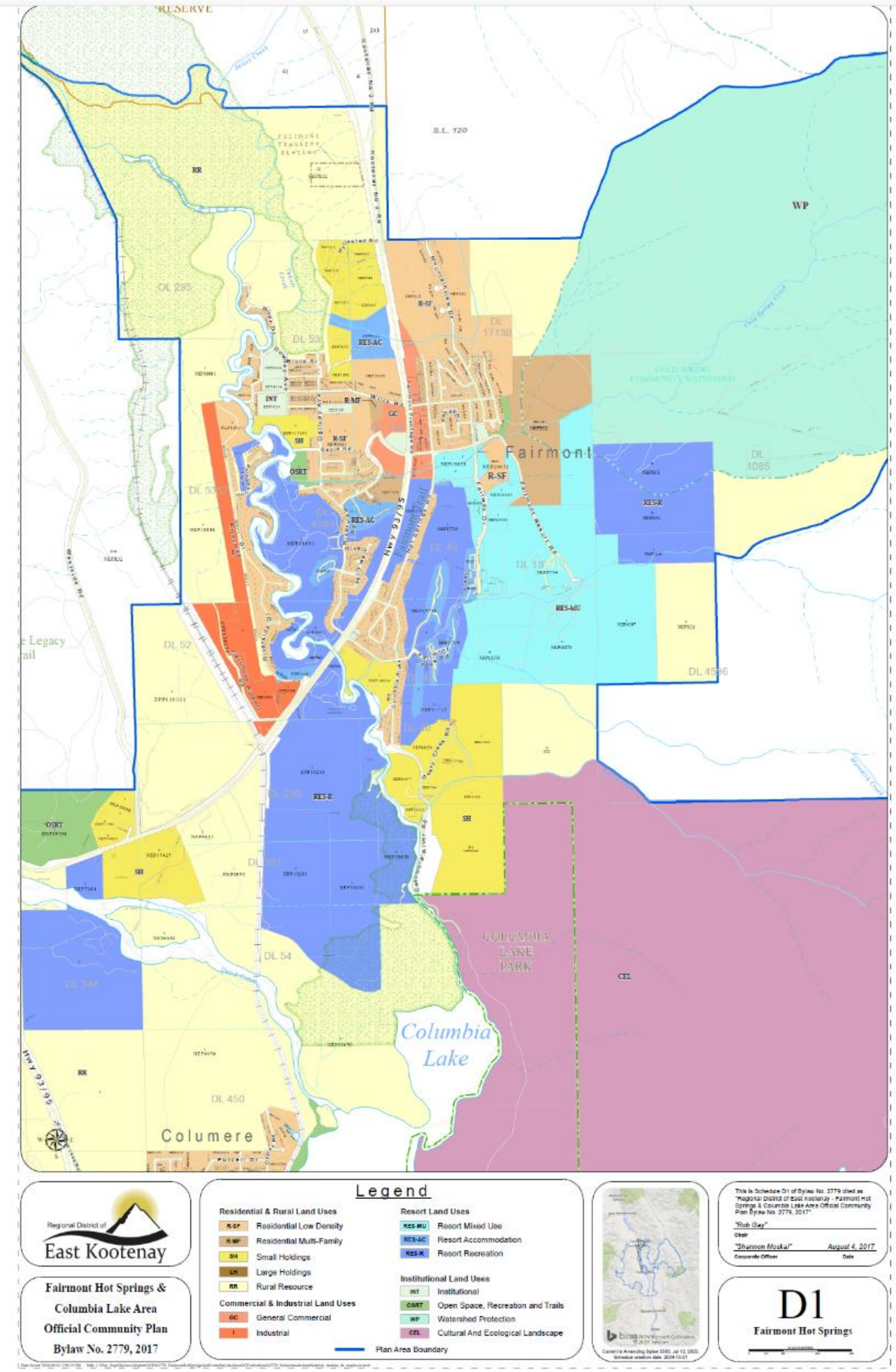


Figure 7: Land Use planning at Fairmont. Source: RDEK bylaw number 2779, Fairmont Hot Springs & Columbia Lake Area Official Community Plan.[141]

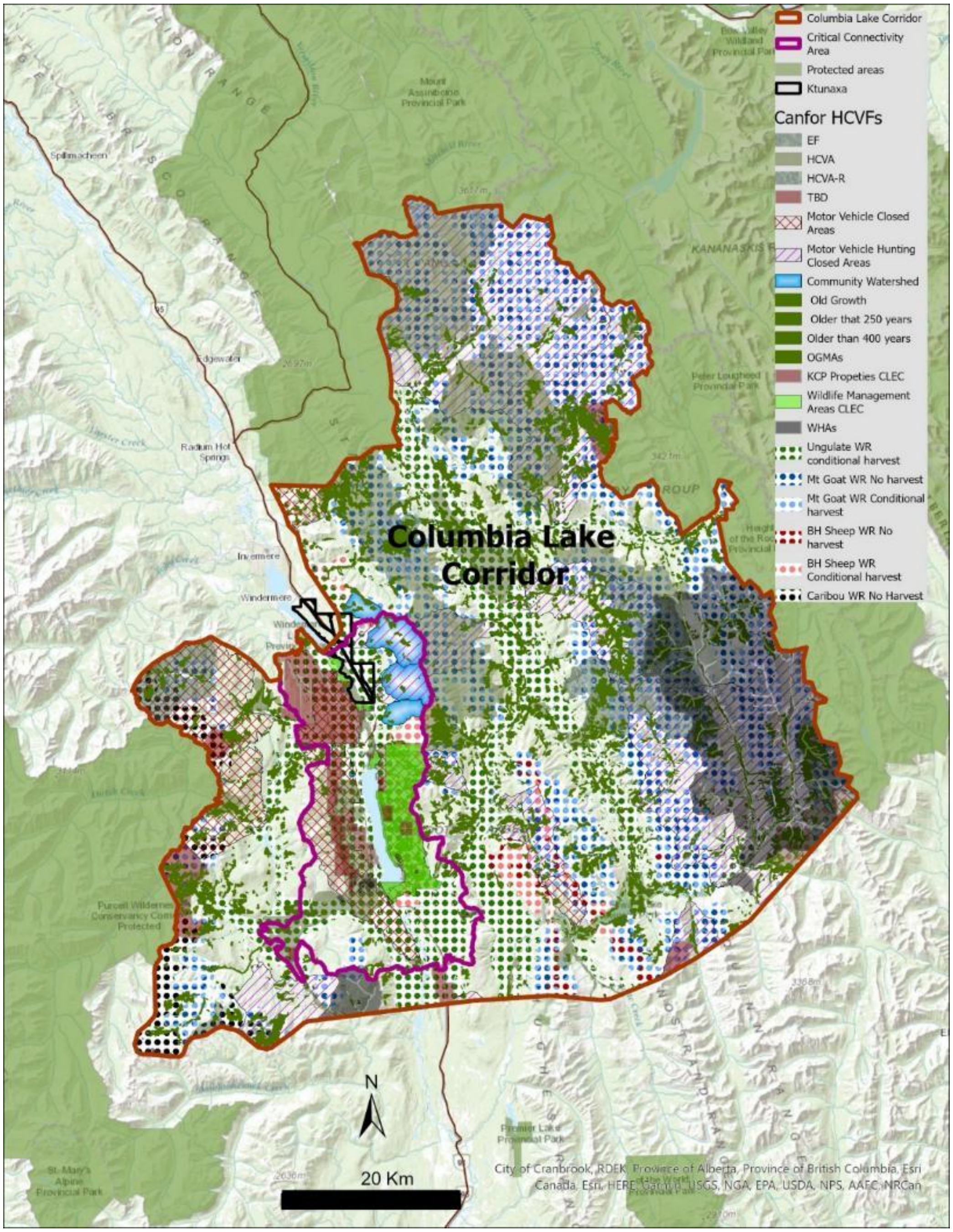


Figure 8: The suite of land use designations within the Columbia Lake Ecological Corridor. The combined non-overlapping total area encompasses 89% of the CLEC. The existing land use designations and regulations that govern management practices very likely meet the needs of ecological connectivity.

We believe this suite of existing mechanisms can, and currently does, reach the objective of managing this landscape for ecological connectivity. Conservation designations include Provincial Parks, Wildlife Management Areas, Wildlife Habitat Areas, land trust properties, a Community Watershed, Access Management Areas, Canfor High Conservation Value Forests, Ungulate (elk, deer, moose) winter range, Big Horn Sheep winter range, Mountain Goat winter range, and old growth forests.

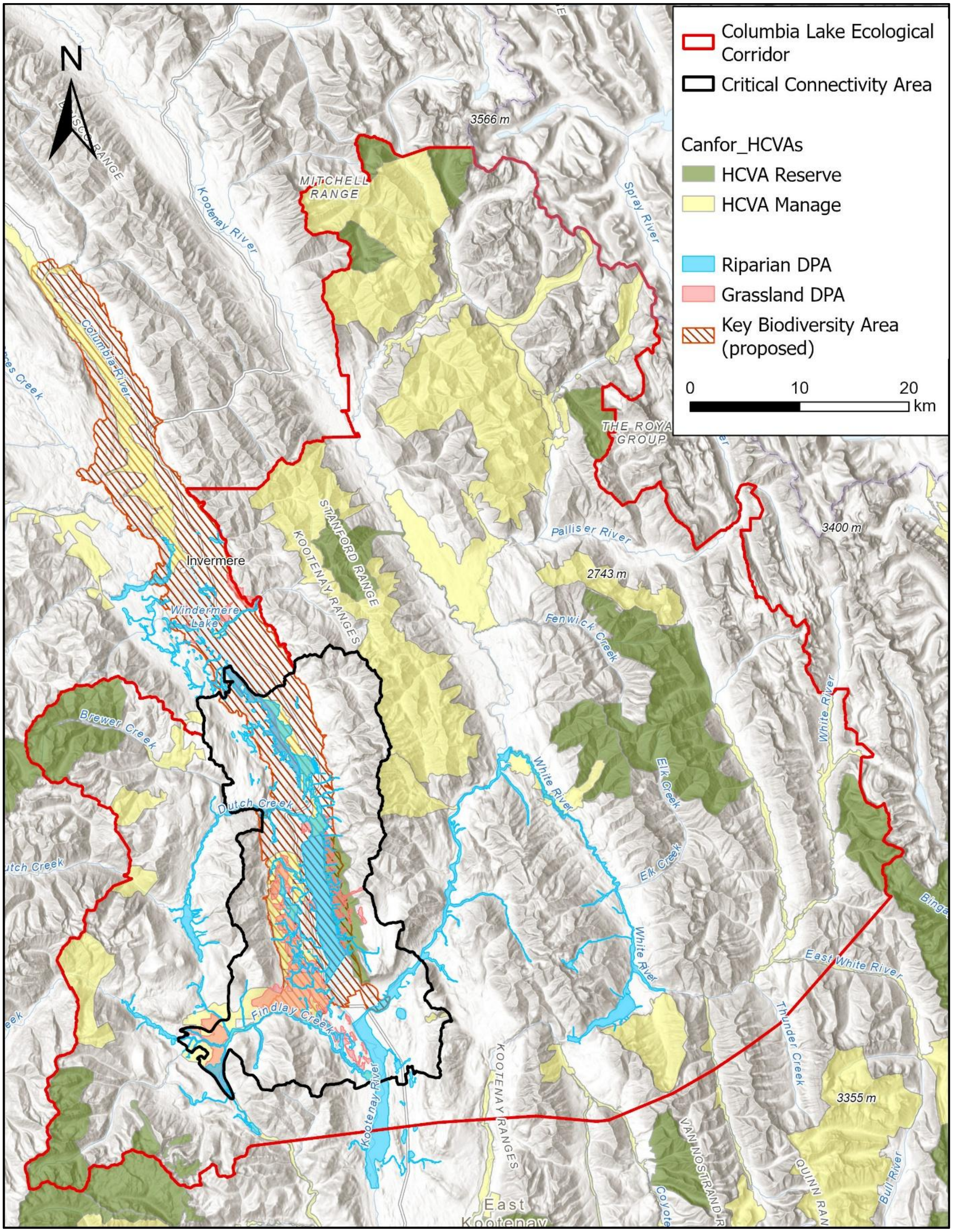


Figure 9: Land designations that potentially support connectivity including Development Permit Areas (DPAs) and High Conservation Value Areas (HCVA) under Canfor's Forest Stewardship Council's Certification that allow some harvest (HCVA-Manage) or do not allow harvest (HCVA-Reserve).

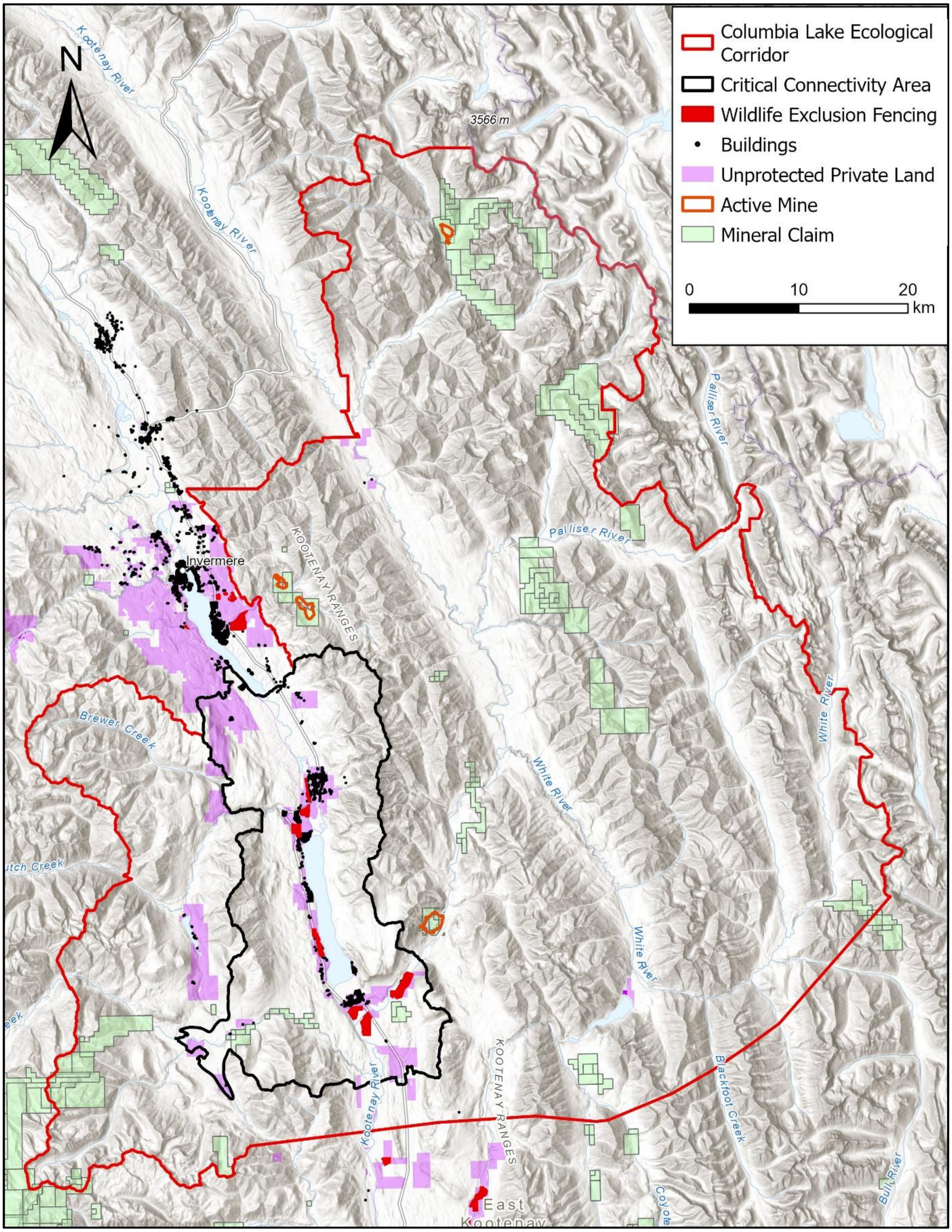


Figure 10: Spatialized potential threats or impediments to connectivity in the Columbia Lake Ecological Corridor.

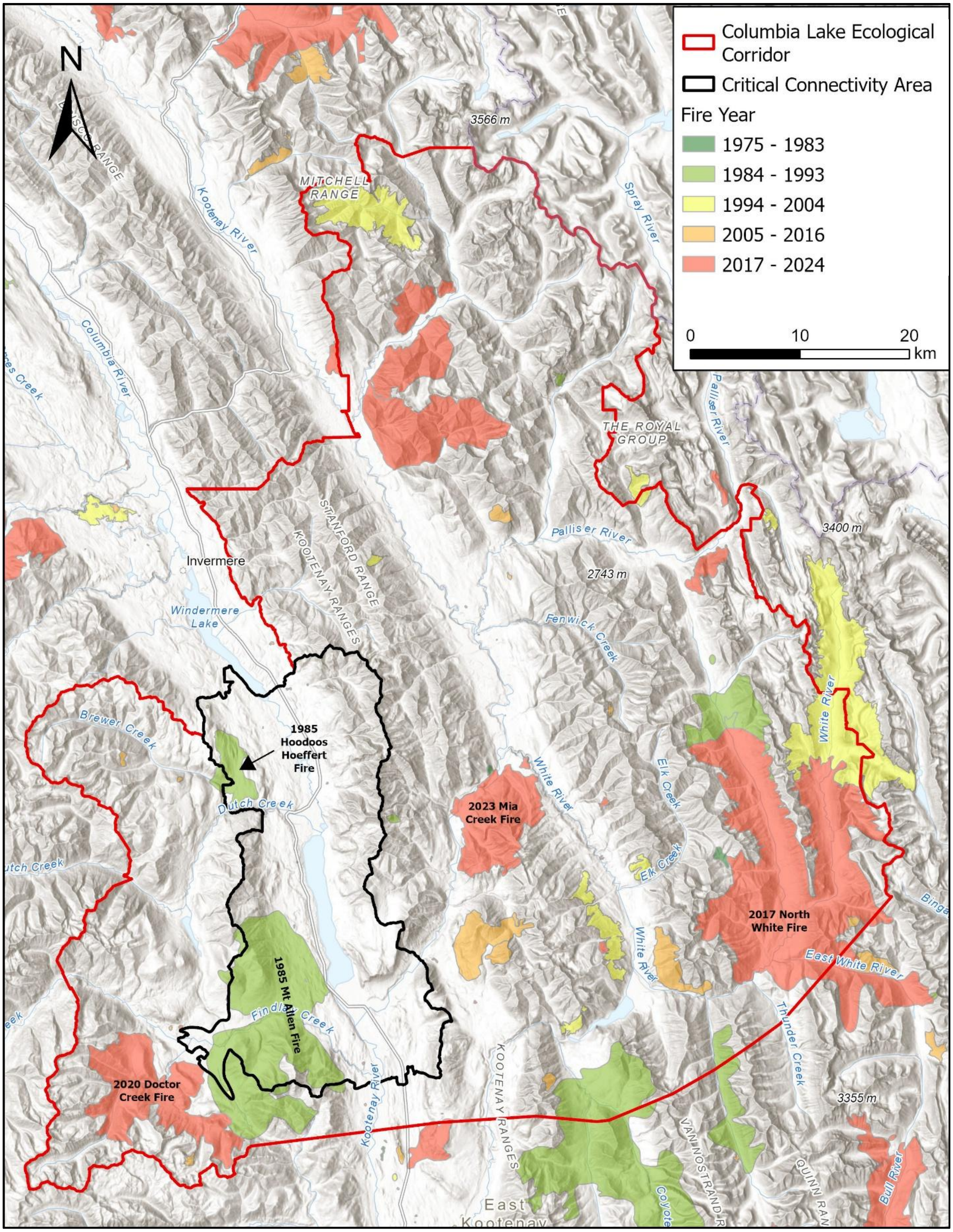


Figure 11: Wildfire from 1975 through 2024. Source: BC government.

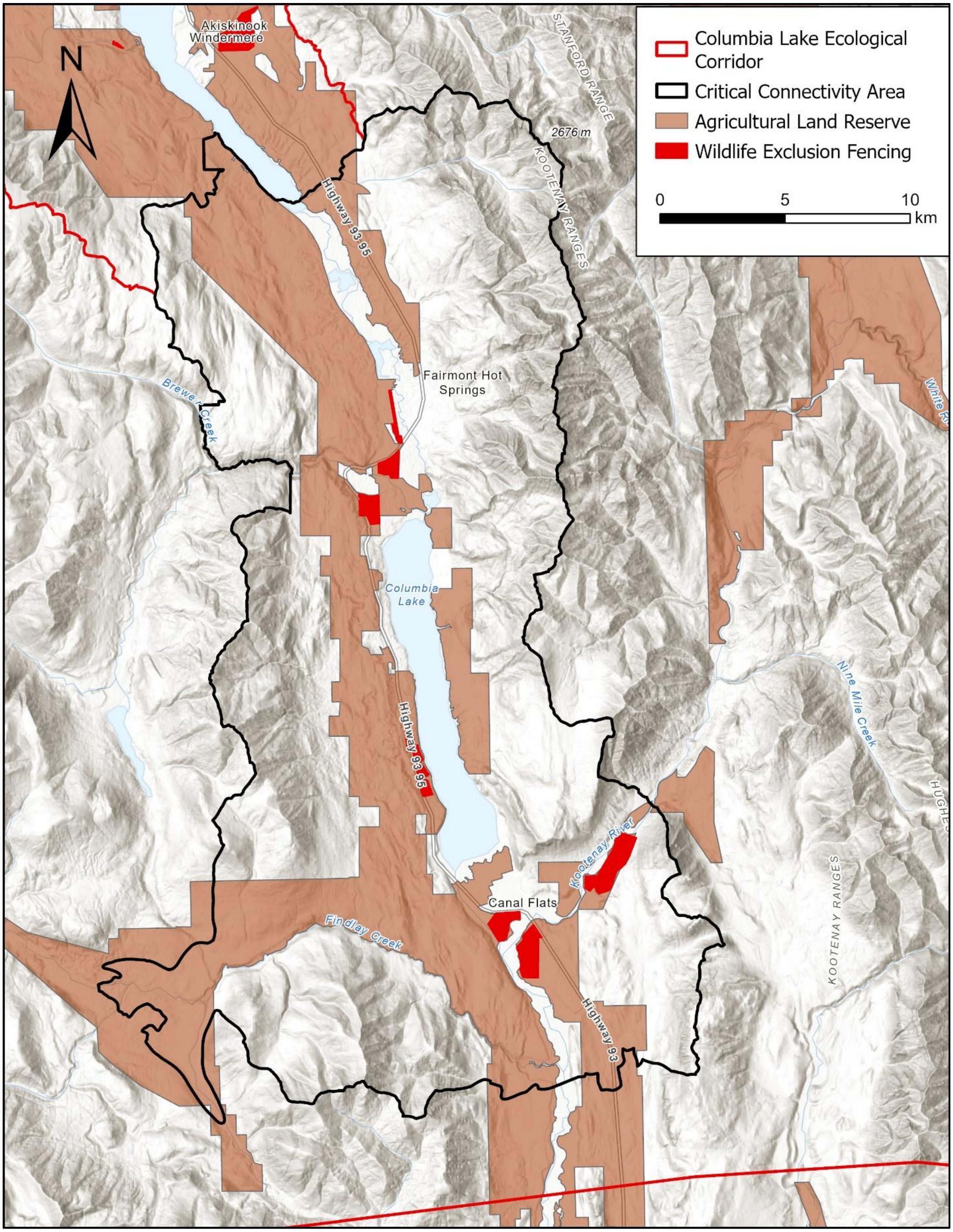


Figure 12: Lands (brown) in the Agricultural Land Reserve (ALR) within and near the Columbia Lake Critical Connectivity Area (black line). Red areas are within 8-foot-high fencing to exclude wildlife.

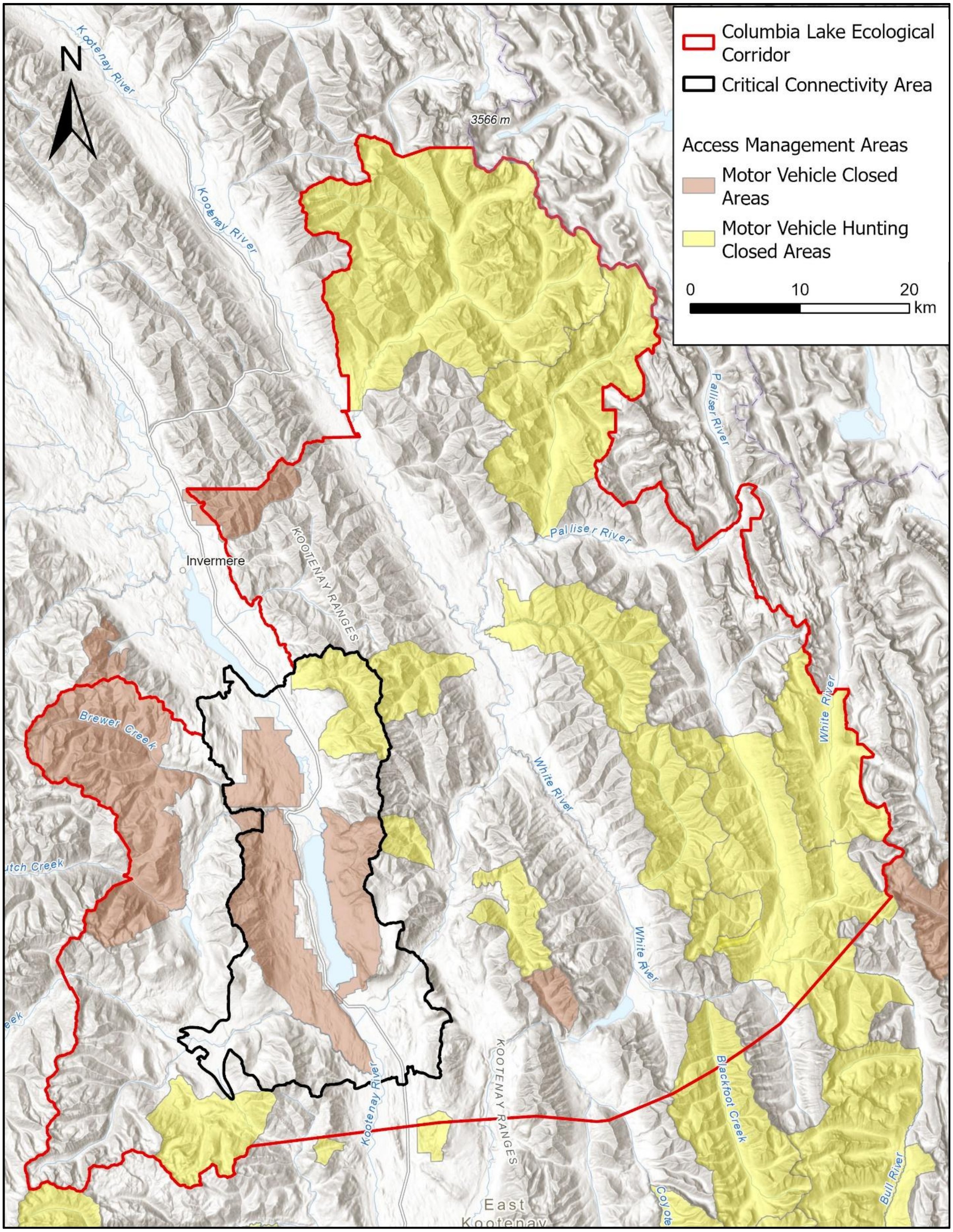


Figure 13: Motor Vehicle Closure Areas (orange) and Motor Vehicle Hunting Closure Areas (yellow) in and adjacent to the Columbia Lake Ecological Corridor and Critical Connectivity Area (black).

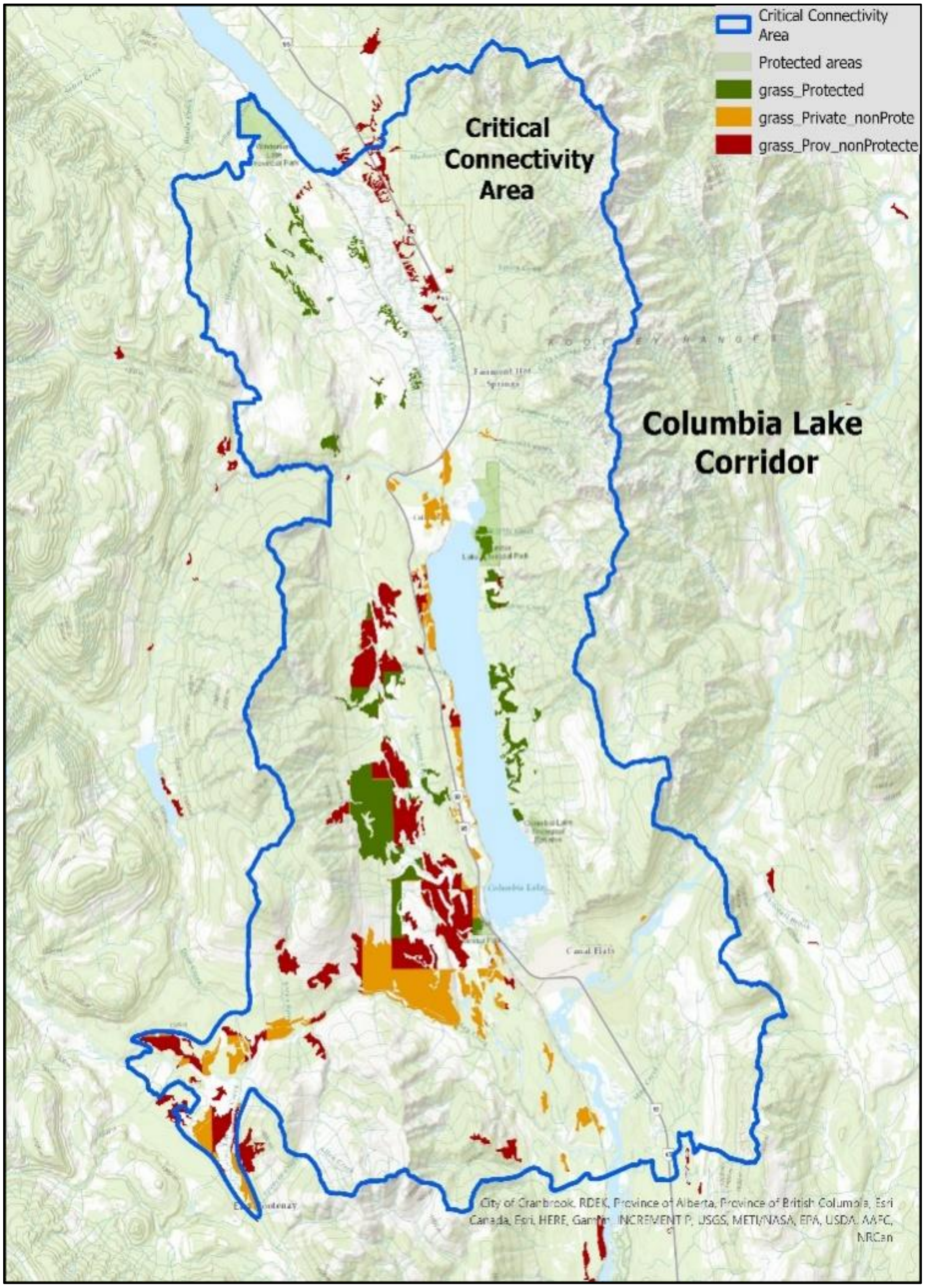


Figure 14: Grassland habitats in the Critical Connectivity Area of the Columbia Lake Ecological Corridor partitioned by protected lands (conservation property, WMA or Provincial Park), provincial lands (non-protected) and private lands (non-protected).

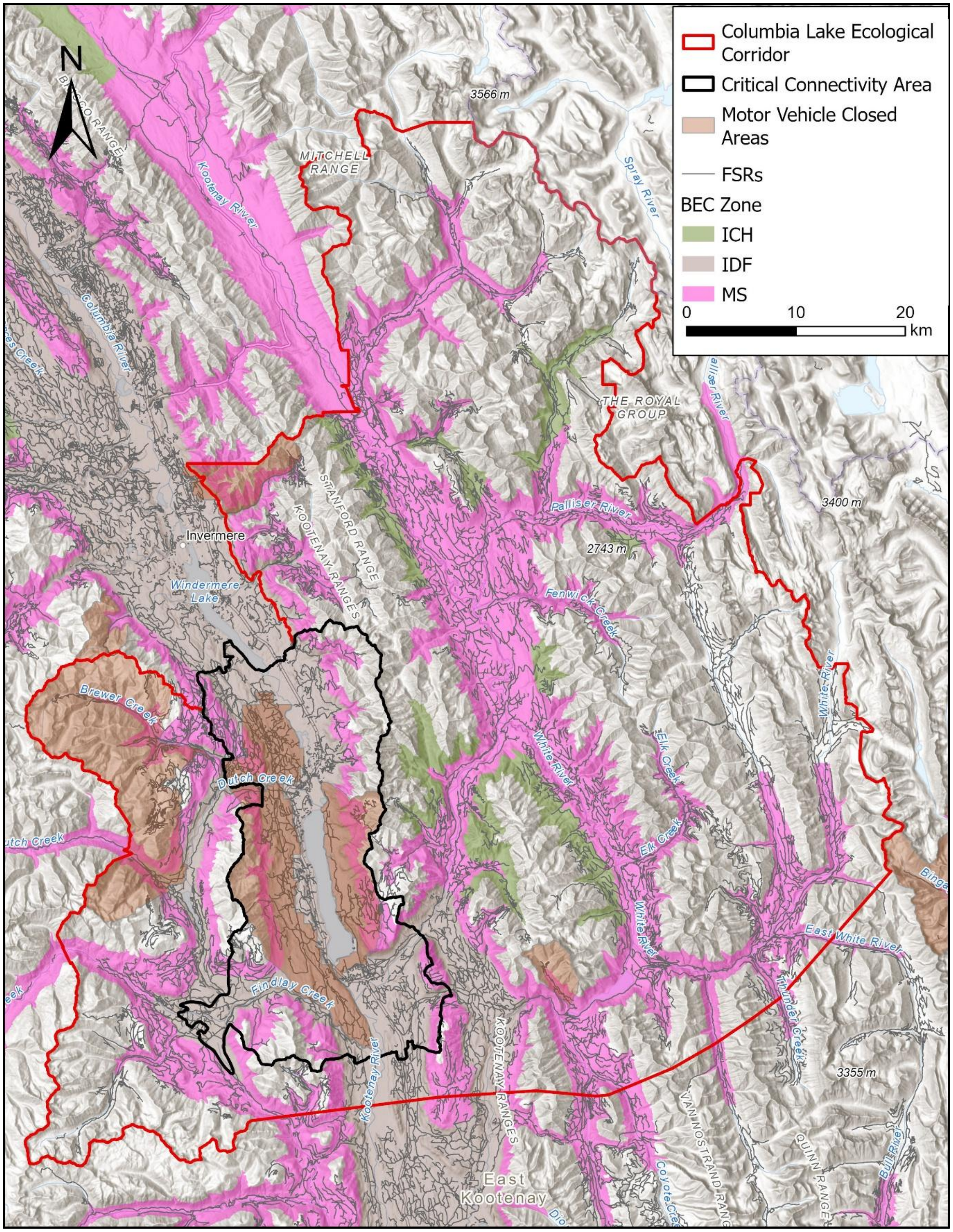


Figure 15: Extent of Interior Douglas-fir (IDF), Montane Spruce (MS) and Interior Cedar Hemlock (ICH) Biogeoclimatic zones in the CLEC (red line) and Critical Connectivity Area (black line). Note that not all Forest Service Roads (FSRs) depicted are necessarily available to motorized traffic. Roads in Access Management Areas are mostly closed (primary road is often open but no secondary spur roads).

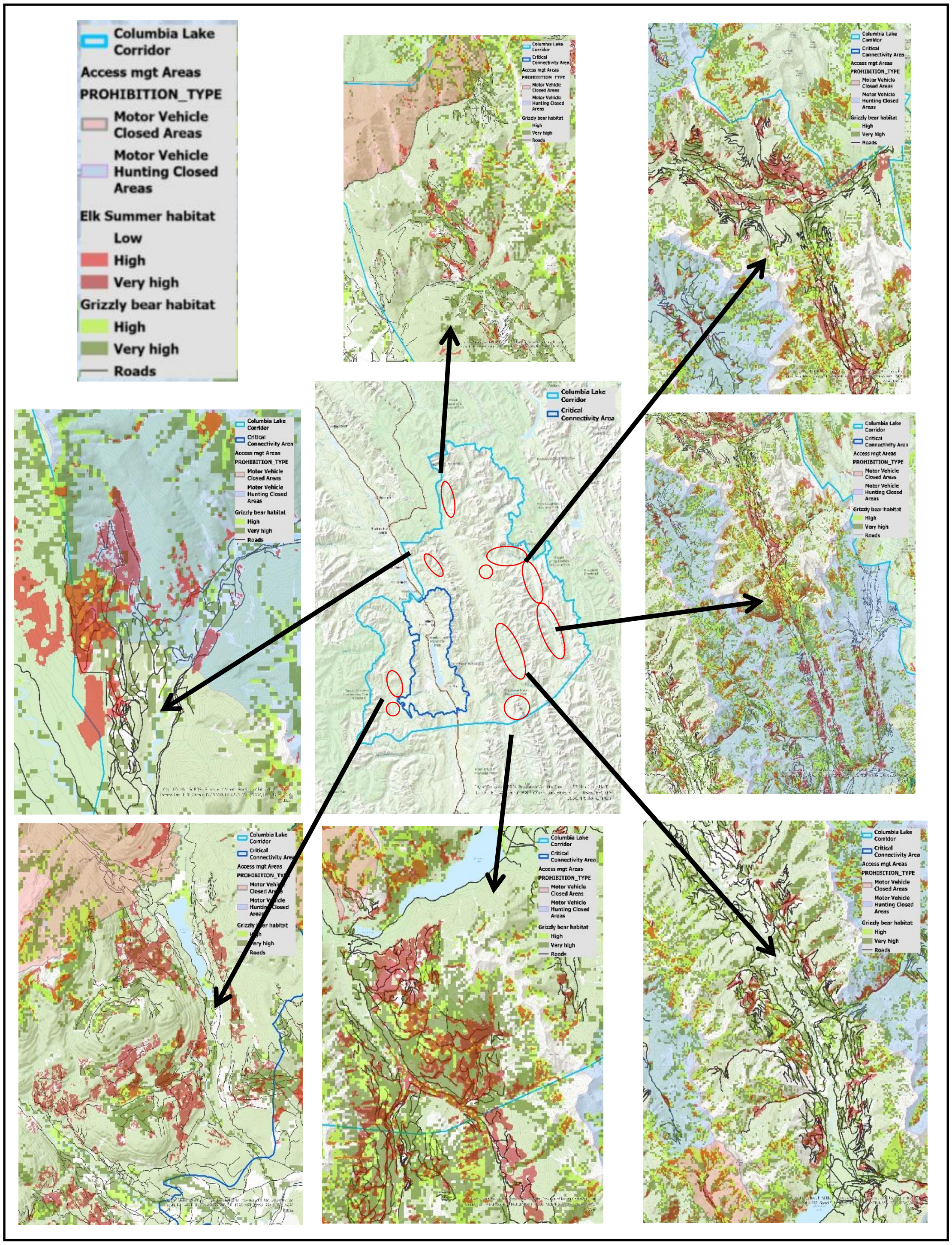


Figure 16: Maps across the Columbia Lake Ecological Corridor depicting several potential areas where access management may benefit elk and grizzly bears. Maps surrounding the central corridor map show small areas with higher quality habitat for both elk and grizzly bears, but that also have a locally high road density. Some degree of access management (e.g., spur roads closed to vehicle traffic) would likely be beneficial to landscape connectivity and to population viability supporting larger scale dispersal movements between the Rocky Mountain and Purcell ranges.

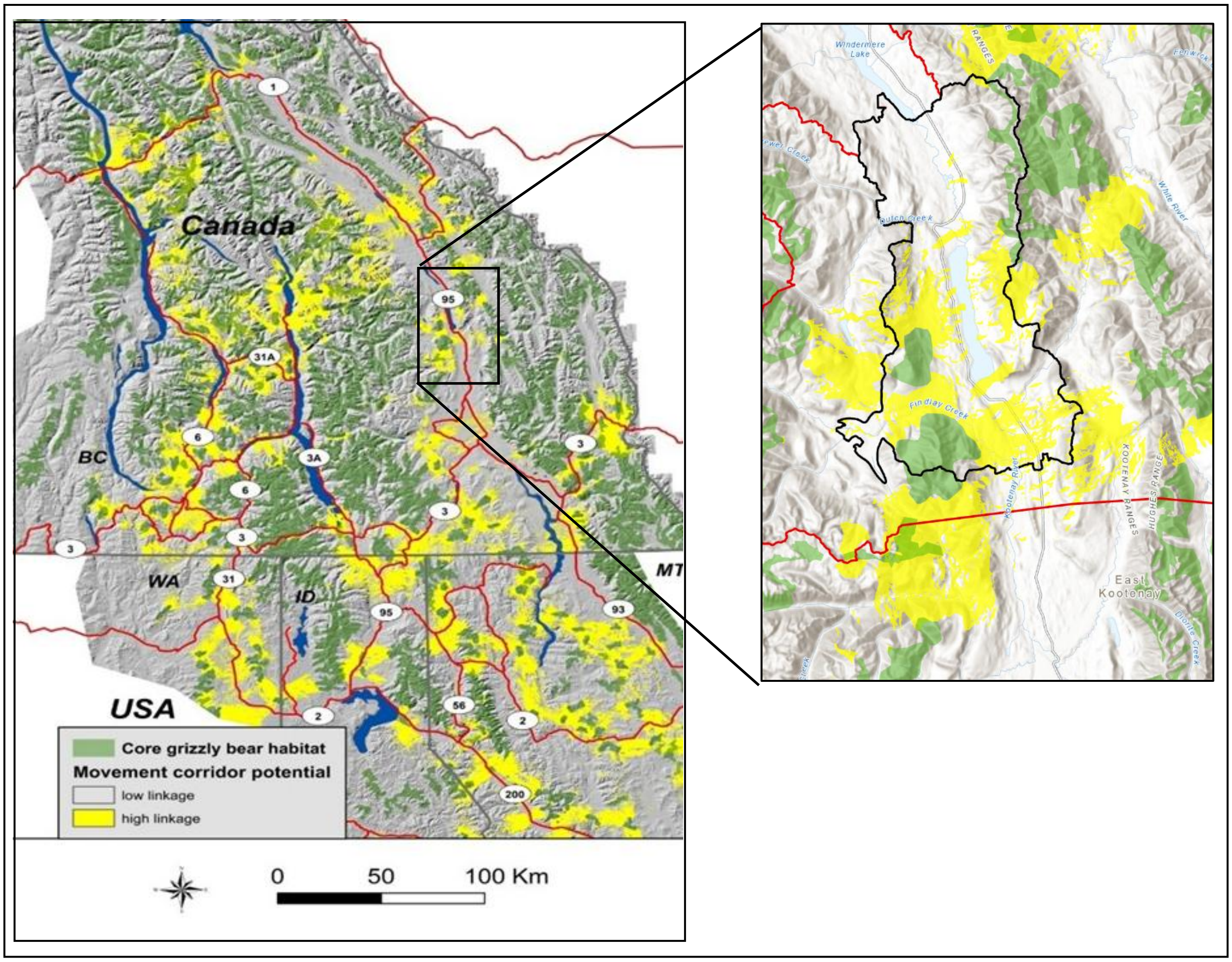
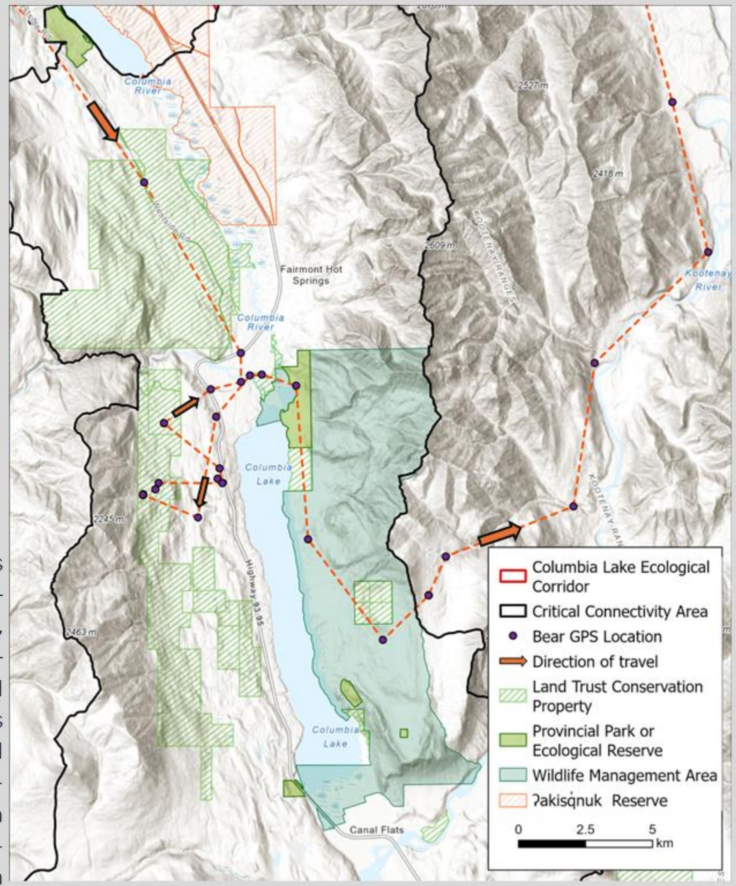


Figure 17: Connectivity corridor potential for grizzly bears derived from GPS telemetry data after Proctor et al. (2015[142]). Yellow polygons are grizzly corridors connecting clusters of high-quality habitat (green polygons), with an inset detail of grizzly corridor habitat in the Columbia Lake Ecological Corridor (inset red line) and Critical Connectivity Area (inset black line).

12. Features

12.1 Drone Bear – Route-finding in a Conservation Corridor

Feature: Drone Bear – Route-finding in a Conservation Corridor



One graphic example of how large mammals can move through the Columbia Lake Corridor exists in a radio collared male grizzly bear, affectionately called "Drone Bear", who traveled from the high country in the Purcell Mountains to the Rocky Mountains. This bear's journey took him across the Purcell Wilderness Conservancy heading east towards Invermere. Near the Rocky Mountain Trench, the bear veered south, perhaps looking for a place to cross he went as far south as the Marion Creek area on the west side of Columbia Lake. He then returned north, expertly dodging residences to cross agricultural land and wetlands on the north end of the lake, including a recently purchased property by The Nature Trust of BC before making his way down the east side of the lake. Here he passed through the provincial park, wildlife management area and NCC's Lot 48 before returning north to find a place to hibernate in Kootenay National Park. The following spring Drone Bear retraced his route crossing the valley again for a short visit in a Columbia Lake Corridor (not shown on map) as he made his way north back to the Purcells through the predicted Spillimacheen – Brisco Corridor north of Radium.

Of 17 collar locations within the Critical Corridor Area, 11 were either on conservation properties or agricultural lands in the Farmland Advantage program and two more were located within metres of such properties. This is a clear example of how wildlife can navigate a complicated landscape to find avoid conflict while finding their way to more preferred habitats.

Sources and Further Reading:

Proctor, M.F., et al., 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. DOI: 10.1002/jwmg.862

Proctor, M.F., et al. 2019. The effects of roads and motorized human access on grizzly bear populations in British Columbia and Alberta, Canada. Ursus 30e2:6-19. DOI: 10.2192/URSUS-D-18-00016.2

Proctor, M.F., et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213. DOI: 10.1002/wmon.1078

12.2 kinq̓uq̓anki Stewardship Project

Feature: kinq́uq́anki Stewardship Project

kwiⱡqⱡi / Bighorn Sheep

ʔa·kuk̓pⱡuⱡaⱡ / juniper

The Ktunaxa Nation has been stewarding these lands since time immemorial. In modern times, the Ktunaxa Nation Council (KNC) and ʔakisq́nuk First Nation (AFN) have brought together the various land managers to steward the east side of Columbia Lake for Ktunaxa values. The project received its name, kinq́uq́anki, from a group of elders. Though the full meaning of this word has been lost, we know it is associated with the east side of Columbia Lake and thought to refer to the placing of boughs on the trail to bless a journey. The east side of Columbia Lake was certainly a place where journeys began for Ktunaxa ʔaqⱡsmaknik (people). There are many stories of Ktunaxa ʔaqⱡsmaknik travelling over the mountains from this area to hunt bison and trade with the ʔaqⱡsmaknik east of the Rockies.

Community engagement identified key stewardship goals for kinq́uq́anki, including improving ungulate habitat, protecting cultural resources, and getting more Ktunaxa ʔaqⱡsmaknik onto the land. Stewardship actions revolve around reducing forest encroachment, bringing fire back to the land, managing recreation and inventorying cultural heritage resources.

Lot 48

Since 2023, KNC and AFN have teamed up with the Nature Conservancy of Canada (NCC) to conduct thinning treatments and a culturally informed prescribed fire on NCC's Lot 48 (above). KNC will track the cultural and ecological impacts of the burn for years to come to inform future work on the east side of Columbia Lake. In turn, this knowledge will inform ongoing stewardship work in the area with BC Parks and the BC Ministry of Water Land and Resource Stewardship.

Juniper Harvest

In the spring of 2025, KNC held a juniper (ʔa·kuk̓pⱡuⱡaⱡ) harvest at Columbia Lake Provincial Park. Ktunaxa ʔaqⱡsmaknik travelled from as far away as yaqan nuʔkiy (Creston) to harvest ʔa·kuk̓pⱡuⱡaⱡ for cultural use and, with the help of Keepers of the Season, make juniper salve right out on the land for medicinal use. It was a great way to be together on the land, and KNC and BC Parks look to continue this as an annual event.

12.3 Ktunaxa Forestry Standards

Feature: Ktunaxa Forestry Standards

ʔamakʔis Ktunaxa, the traditional territory of Ktunaxa people is a large landscape covering a diverse range of ecosystems. Forestry has long been a central part of the region's economy and, while providing economic benefits, it can also negatively impact these ecosystems. Concerned about forest practices that degrade lands and waters and impacts wildlife and their habitats, Ktunaxa have developed guidelines that aim to reduce fragmentation and cumulative impacts on biodiversity. The Ktunaxa Forestry Standards document outlines enhanced objectives, results, strategies and practices for forest and Cultural Conservation Values.

Ktunaxa Nation Council developed Forestry Standards to ensure that more precautionary management of forests consistent with Ktunaxa stewardship responsibility for All Living Things - ʔa·kxam'is q'api qapsin - is applied across ʔamakʔis Ktunaxa.

Following these standards, forestry and harvesting practices must consider broader forest values and the ecosystem services - ʔaqaɬikmiyiʔis - to be sustainable and sufficiently precautionary in terms of improving forest health, buffering sensitive wetlands and riparian areas, providing critical habitat for species at risk, retaining valuable wildlife trees, protecting old and interior forest-dependent wildlife, enhancing connectivity corridors, and managing for carbon storage and climate mitigation and adaptation.

Cultural Conservation Values

A. Culturally Important Sites
B. Culturally Significant and Medicinal Plants
C. Fisheries Values
D. Wetlands and Riparian Areas
E. Water Quality/Quantity
F. Soil Quality/Quantity
G. Old Growth and Veteran Stands and Trees
H. Deciduous/Broadleaf Trees
I. Western White Pine
J. Animal/Plant Species, Communities and Habitats At-Risk
K. Wildlife Habitat and Populations
L. Huckleberries
M. Carnivores and their Habitats
N. Furbearers and their Habitats
O. Ungulates and their Habitats
P. Rock Outcrops
Q. High Elevation Grasslands/Brushlands
R. Moderate Elevation Grasslands/Brushlands

niȼnapku / moose

ɬawiyaɬ / huckleberry

12.4 Good Fire – Bad Fire

Feature: Good Fire, Bad Fire

Upland forests and grasslands around Columbia Lake are naturally adapted to fire, ʔa·kinq̓uku in Ktunaxa, of varying intensities. At lower elevations, historical cultural burning maintained open forest stands and healthy grassland communities with fire return intervals of five to twenty years. This frequent low-intensity fire is a critical component of ecosystem function that maintains habitats for species such as American badger and Lewis's woodpecker. However over the past 150 years, fire suppression has replaced this cycle, leading to fuel buildup and larger, catastrophic wildfire.

At higher elevations, high intensity fires often burn entire valleys and can affect wildlife corridor planning Severe fires drastically alter landscape conditions and impact many species by increasing blowdown which can impede movement and removing forest canopy cover over entire valleys. Riparian and wet areas are often completely lost. Catastrophic wildfire is expected to increase in coming decades as a result of climate change and fuel accumulations. Stewarding for fire-resilient forests will be crucial in the years ahead to sustain a mosaic of forest species and age classes, and retain mature and old growth stands that contribute to functioning wildlife corridors and community safety.

Returning cultural and prescribed fire to the landscape is a critical component to ecosystem function in the Critical Corridor Area of the broader Columbia Lake corridor. Use of fire in the broader corridor is also important for maintaining habitat features such a bighorn sheep transition ranges and mule deer summer range.

Two recent severe wildfires in the CLEC. Left: 2020 Doctor Creek fire shown two years post burn. Right: 2017 North White fire shown eight yeas post burn with a dense forest of young lodgepole pine emerging.

Sources and Further Reading:

Baron, J.N., et al. 2022. A century of transformation: fire regime transitions from 1919 to 2019 in southeastern British Columbia, Canada. Landscape Ecology. 37:2707-2727. DOI: 10.1007/s10980-022-01506-9

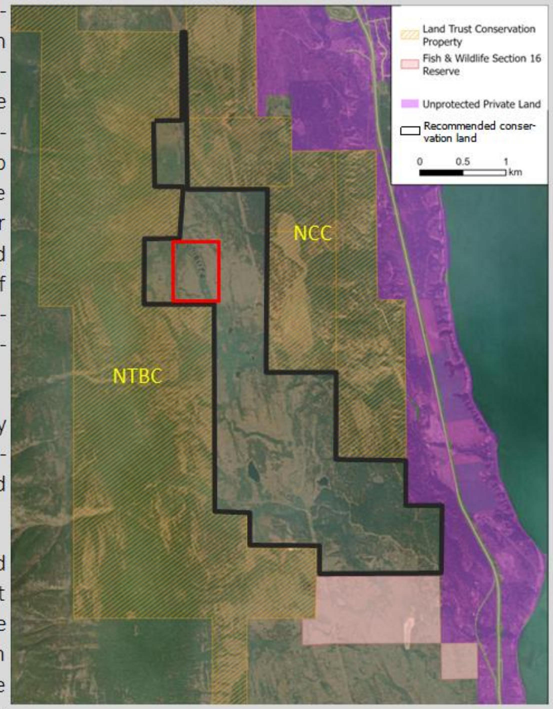
Greene, G.A. 2021. Fire Resilient Ecosystems: Fire Exclusion and Selective Harvesting Degrade Dry Forests in British Columbia. Dissertation. University of British Columbia, Vancouver, BC. https://open.library.ubc.ca/soa/cIRcle/collections/ubctheses/24/items/1.0398455

Hessburg, P.F. et al. 2019. Climate, Environment, and Disturbance History Govern Resilience of Western North American Forests. Front. Ecol. Evol. 7. DOI: 10.3389/fevo.2019.00239

13. Case Studies

13.1 Marion Creek Beavers and the Four Amigos

Case Study: Marion Creek Beavers and the Four Amigos



Over the past several decades, water flows have been significantly altered to provide irrigation for agricultural on the Marion Bench uplands on the west side of Columbia Lake. These modifications combined with drier conditions under climate change have increased the vulnerability of this landscape to drought. According to field research by the Columbia Wetlands Stewardship Partners, wetlands west of Columbia Lake have greater moisture deficit than the upland benchlands further north and a higher potential for wetlands vulnerable to climate change. They found 24 active beaver dams are maintaining a connected series of ponds in the upper reaches of Marion Creek and holding approximately 33,447 m^3 of water on the landscape (red inset and pictured below, left).

These beaver ponds on the upper bench (red inset), are especially important for maintaining open water and wetland habitat, moderating water temperature for westslope cutthroat trout, and providing a dependable source of water downstream.

This beaver-maintained wetland complex is in an area surrounded by conservation lands owned and managed by The Nature Trust of BC to the west and the Nature Conservancy of Canada to the east. In all, over 2800 ha of private land is conserved between Findlay and Dutch Creeks. Yet, the beavers ponds themselves are located on unprotected public land that largely has no zoning by the Regional District, outlined here in black. The area, known as the *Three Amigos* to the Ecosystem Restoration Program, has been the focus of ER planning. However, more action and including First Nations as the fourth amigo is needed.

Beyond these ponds, the area supports a mosaic of grassland, open forests and wetlands. The beaver ponds and wetlands hold water, slowly releasing it into the Marion Creek system, providing resilience to climate change. We recommend the provincial government manage the area outlined in black alongside ʔakisq̓nuk FN and both land trusts in a manner that maintains landscape-level hydrology and habitat. Options include expanding the Section 16 Reserve notation nearby be expanded to include the lands between the NTBC and NCC parcels or designating it as a Wildlife Management Area.

Marion Creek beaver ʔa·ḱaq̓ⱡaʔhaⱡ / wetland complex

sina / beaver

Sources and Further Reading:

Green, K.C. and C.J. Westbrook. 2009. Changes in riparian area structure, channel hydraulics, and sediment yield following loss of beaver dams. BC Journal of Ecosystems and Management 10:68–79. DOI: 10.22230/jem.2009v10n1a412

Levens, C., R. Haubrich and S. Bayley. 2025. Kootenay Connect: 6CW Columbia Wetlands: Wetlands West of Columbia Lake. Year 6. Report to Environment and Climate Change Canada and Columbia Basin Trust. Available here

13.2 Navigating Development and Yawuʔnik̓'s Ribs

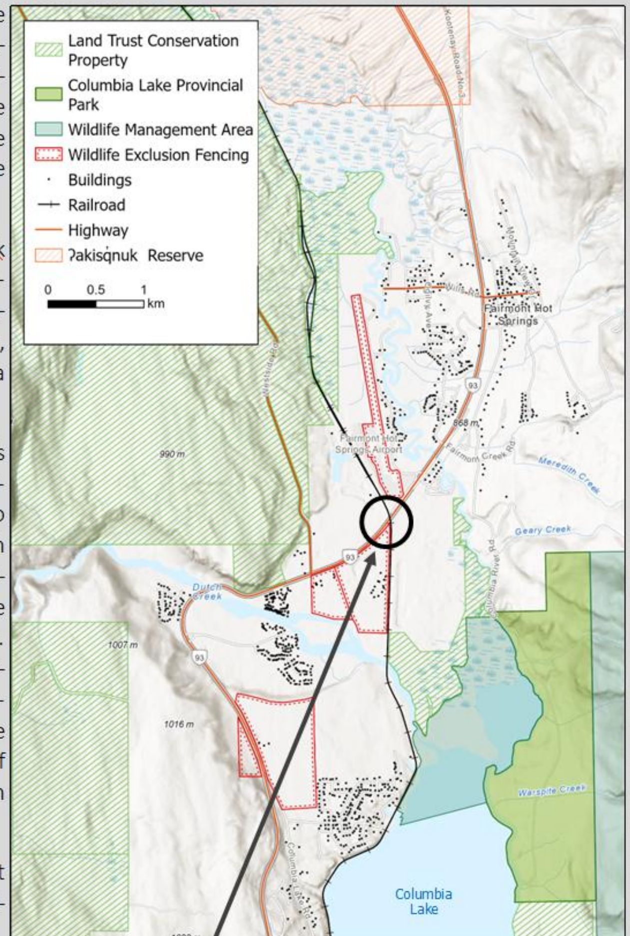
Case Study: Navigating Development and Yawuʔnik̓'s Ribs

The north end of Columbia Lake is a pinch point for wildlife movement and presents a significant challenge to connectivity in the Columbia Lake Ecological Corridor. Development and infrastructure combine with natural features, like the Hoodoos or Yawuʔnik̓'s ribs (see Prologue) which rise some 200 m above Columbia Lake, to complicate wildlife movement, funneling it to any available passage.

From the north end of Columbia Lake, through to ʔakisq̓nuk First Nation Reserve lands, the landscape has limited permeability (see Feature: Drone Bear). Housing developments, a busy two-lane highway, an airport, golf course, and eight-foot-high wildlife fencing, all combine to create a challenging matrix for wildlife to navigate.

One area that may provide enhancement opportunities is the railway underpass below Highway 93/95 (pictured below and circled in map). Lying in a pinch-point between two high-fenced areas, the underpass avoids the highway with only the railway as a direct threat. Also supporting connectivity through this pinch point is a mix of public and private lands that are managed for conservation to some degree. They include Columbia Lake Provincial Park, East Side Columbia Lake Wildlife Management Area, land trust conservation lands and agricultural lands. These parcels facilitate wildlife passage through what is otherwise a labyrinth of connectivity barriers such as fencing, roads and human buildings and activity.

Maintaining opportunities for connectivity in pinch point areas such as this is a crucial step to maintain overall corridor function in the Columbia Lake landscape.



Sources and Further Reading:

Ktunaxa Creation Story: https://www.ktunaxa.org/who-we-are/creation-story/

13.3 Why Did the Badger Cross the Road?

Case Study: Why Did the Badger Cross the Road?

The main threat to badgers in British Columbia is road mortality. An effective ecological corridor requires individual animals to be able to safely cross roads and, for badgers, this has been a serious problem.

Work in the Upper Columbia Valley is documenting opportunities for badgers to safely pass *under* the often busy Highway 93/95 that bisects the Columbia Lake Ecological Corridor.

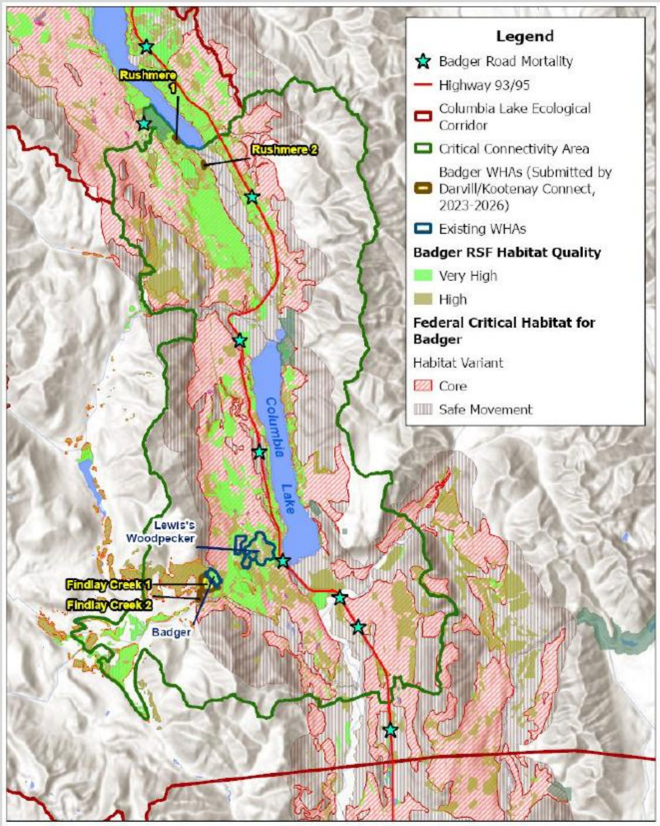
Following successful reintroduction to the Upper Columbia in 2000s, badgers are again particularly active in the grasslands and open forests on the west side of Columbia Lake. However, males in particular have large home ranges and likely cross the highway frequently, leaving them at risk of being killed by vehicles. Badger road mortality (stars on map) is high throughout the Upper Columbia Valley. Although most mortality occurs on Highway 93/95, badgers are at risk on all roads.

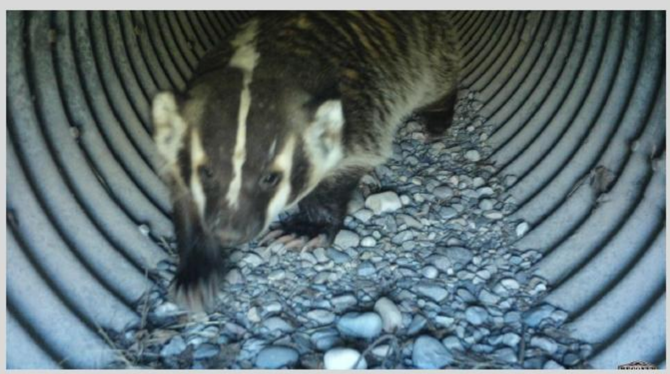
Luckily, badgers do not hesitate to make use of road underpasses, including culverts, provided they are kept open. Kootenay Connect has sponsored recent work in the area to check that culverts remain usable by badgers and other species by having entrances clear of debris. Wildlife cameras "caught" a badger (photo lower right) in one culvert near Columbia Lake in June 2025.

While many culverts are in place along highway in the Columbia Lake Corridor, more are always welcome. BC government is working to install more culverts at construction sites when opportunities arise.

Maintaining existing crossing structures and installing new ones wherever possible is considered an essential action for the recovery of this species at risk.

Why do badgers cross roads? Mostly to find food and /or mates. We can help them do it safely!





naɫmiɫ / badger

Sources and Further Reading:

BC Ministry of Water, Land and Resource Stewardship. 2025. Best Management Practices for Badgers - Road Culvert Maintenance. Available: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/best-management-practices/badgerculverts_bmp2025.pdf

British Columbia Badger Recovery Team. 2016. Recovery plan for American Badger (*Taxidea taxus*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, B.C. 36 pp.

Kinley, T.A. and N.J. Newhouse. 2009. Badger Roadkill Risk in Relation to the Presence of Culverts and Jersey Barriers, Northwest Science 83:148-153. DOI: 10.3955/046.083.0206

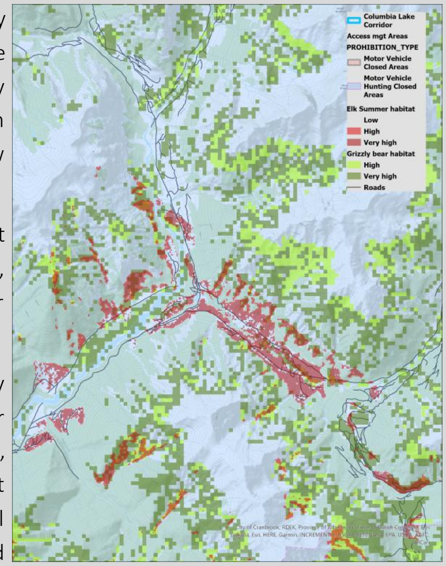
13.4 Access affects Elk and Grizzly Bear Habitat Quality

Case Study: Access affects Elk and Grizzly Bear Habitat Quality

For access management, we consider the habitat requirements of grizzly bears and elk. Both species have rigorous peer-reviewed support for the conclusion that a combination of higher quality habitat and habitat security (being further from open roads) provide the necessary conditions for them to thrive. Both have literature that recommend road densities remain below 0.5 to 0.6 km/km^2 to benefit reproduction and survival.

Grizzly bear corridors have been shown to be a combination of the best available habitat with the least amount of human disturbance. Similarly, separating roads from foraging areas may maintain elk in areas with higher road densities and contribute to landscape connectivity.

From the standpoint of the CLEC, higher quality habitat with more security (lower road densities) should facilitate increased habitat permeability for both elk and grizzly bear seasonal migration and larger dispersal events, including park-to-park across the entire corridor. Thus, we recommend that areas with high value elk and/or grizzly bear habitats and also high local road density be considered for access management options, such as road deactivation or vehicle closures. Examples of two different conditions in the CLEC are shown in the maps to the right.

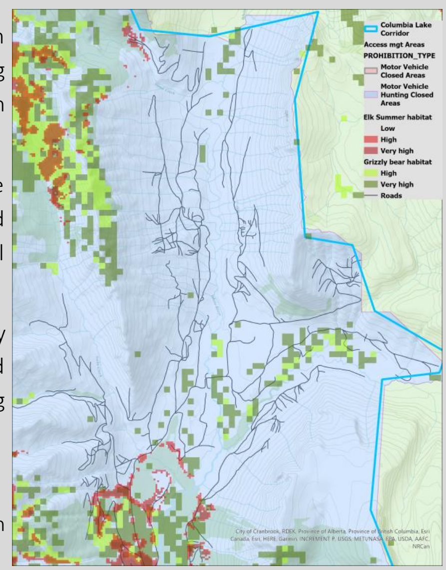


High Elk and Grizzly Bear habitat, low road density

Elk migratory behaviour has declined throughout the East Kootenays, with non-migratory elk suffering higher human-caused mortality, and showing signs of nutritional stress. Enhancing high-elevation summer range has been recommended to help restore migratory behaviour.

While there are numerous Access Management Areas and Hunting Vehicle Closure Areas throughout the CLEC, enforcement needs to be increased and new areas considered. We also strongly recommend avoiding road and trail development in intact road-free areas.

Implementation of access management BMPs will not only enhance grizzly bear and elk connectivity, but also likely improve habitat security, and therefore landscape connectivity, for other wide-ranging species including wolverine, mountain goat, moose, and lynx.



Low Elk and Grizzly Bear habitat, high road density

Sources and Further Reading:

Friar, J.L., et al. 2008. Thresholds in landscape connectivity and mortality risks in response to growing road networks. J Appl Ecol 45:1504-1512. DOI: 10.1111/j.1365-2664.2008.01526.x

Mulligan, K.L. 2021. Long-term changes in migratory patterns of elk (*Cervus canadensis*) in the southern Rocky Mountain Trench of British Columbia, Canada. MSc Thesis, University of Alberta. Edmonton, AB.

Poole, K.G., et al. 2024. Migration, movements, and survival in a partially migratory elk (Cervus canadensis) population. Conserv Sci Pract 6:13128. DOI: 10.1111/csp2.13128

Proctor, M.F., et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildl Monog. 213. DOI: 10.1002/wmon.1078.

Rowland, M.M., et. al. 2018. Modeling elk nutrition and habitat use in western Oregon and Washington. Wildl Monog.199. https://DOI: 10.1002/wmon.1033

Appendix 1: Focal Species

Focal species of conservation value

Species	Scientific Name	Ktunaxa Name	COSEWIC	SARA	BC CDC	Habitat type
MAMMALS						
American Badger	*Taxidea taxus* pop. 2	naɬmiṫ	Endangered	Schedule 1, Endangered	Red	grassland, pastures, open forests
Canadian Beaver	*Castor canadensis*	sina				wetland riparian
American Marten	*Martes americana*	naqsaq				low-mid elevation forests
American Mink	*Neovison vison*	ʔinuya				wetland riparian
Big Brown Bat	*Eptesicus fuscus*	ʔa·kɬuṁ (all bats)				Various
Grizzly Bear	*Ursus arctos*	kɬawɬa	Special Concern	Schedule 1, Special Concern	Blue	Various
Grey Wolf	*Canis lupus*	ka·kin				Various
Little Brown Myotis	*Myotis lucifugus*	ʔa·kɬuṁ (all bats)	Endangered	Schedule 1, Endangered	Blue	Low elevation old growth, near water (buildings & concrete bridges)
Silver-haired Bat	*Lasionycteris noctivagans*	ʔa·kɬuṁ (all bats)	Endangered			Low elevation old growth near water
Hoary Bat	*Lasiurus cinereus*	ʔa·kɬuṁ (all bats)	Endangered		Blue	Low elevation old growth near water
Townsend's Big-eared Bat	*Corynorhinus townsendii*	ʔa·kɬuṁ (all bats)			Blue	low elevation rocky terrain (buildings)
Moose	*Alces alces*	niȼnapku				wetland riparian
Mountain Goat	*Oreamnos americana*	kyanukxu			Blue	high elevation rocky bluffs, mineral licks
Mule Deer	*Odocoileus hemonius*	ȼupqa				Various
Muskrat	*Ondatra zibethicus*	hanq̓u				wetland riparian
Porcupine	*Erethizon dorsatum*	niɬksaq̓				Various
Rocky Mountain Bighorn Sheep	*Ovis canadensis canadensis*	kwiɬqɬi			Blue	Low mid elevation open, sub-alpine & alpine
Rocky Mountain Elk	*Cervus elaphus*	kiɬq̓aɬɬi				grassland & various
Canada Lynx	*Lynx canadensis*	q̓uq̓ni				Second growth forest
White-tailed Deer	*Odocoileus virginianus*	kamnuqɬuqat or ȼupqa				Various
Wolverine	*Gulo gulo*	ʔaȼ̓pu	Special Concern	Schedule 1, Special Concern	Blue	high elevation open forests

Species	Scientific Name	Ktunaxa Name	COSEWIC	SARA	BC CDC	Habitat type
BIRDS						
American Bittern	*Botaurus lentiginosus*	kałqułq̓axał (long-legged water bird)			Blue	wetland riparian, grassland, shrubs
Bank Swallow	*Riparia riparia*	kyatłanana	Threatened	Schedule 1, Threatened		Silt bluffs near water
Barn Swallow	*Hirundo rustica*	kyatłanana	Special Concern	Schedule 1, Threatened		low elevation open areas, wetland riparian
Bobolink	*Dolichonyx oryzivorus*		Special Concern	Schedule 1, Threatened	Red	grassland, hayfield
Clark's Nutcracker	*Nucifraga columbiana*					high elevation open sub alpine; Various in winter
Common Nighthawk	*Chordeiles minor*	p̓iq̓	Special Concern	Schedule 1, Special Concern	Blue	low elevation
Flammulated Owl	*Psiloscops flammeolus*	kupi (small owl)	Special Concern	Schedule 1, Special Concern	Blue	mature Douglas fir & ponderosa pine forests
Great Blue Heron, *herodias* ssp.	*Ardea herodias herodias*	waq̓a			Blue	wetland riparian, forest nesting
Lewis's Woodpecker	*Melanerpes lewis*	kaȼkaȼ (small woodpecker)	Threatened	Schedule 1, Threatened	Blue	open ponderosa pine forest, cottonwood riparian
Long-billed Curlew	*Numenius americanus*	kƚ̓anuqłuk	Threatened	Schedule 1, Special Concern		grassland, wetlands
Northern Goshawk, *atricapillus* ssp	*Accipiter atricapillus atricapillus*	k̓it̓ikika (generic hawk)	Not At Risk		Blue	mature to old growth mid-elevation forests
Olive-sided Flycatcher	*Contopus cooperi*		Special Concern	Schedule 1, Special Concern		higher forest edges, near streams
AMPHIBIANS & REPTILES						
Western Toad	*Anaxyrus boreas*	ku·ku	Special Concern	Schedule 1, Special Concern		Breeds ponds and lakes, adults in various forests
Western Painted Turtle	*Chrysemys picta* pop. 2	kaxax	Special Concern	Schedule 1, Special Concern	Blue	wetlands gravel nest sites

Species	Scientific Name	Ktunaxa Name	COSEWIC	SARA	BC CDC	Habitat type
FISH						
Bull Trout, Pacific populations	*Salvelinus confluentus* pop. 26	tuhuɫ	Not At Risk		Blue	cold water lakes & streams
Burbot	*Lota lota*	ʔa·q̓uɫam				cold water lakes & streams
Westslope Cutthroat Trout	*Oncorhynchus clarkii lewisi*	qustit̕	Special Concern	Schedule 1, Special Concern	Blue	cold water streams
PLANTS						
Whitebark Pine	*Pinus albicaulis*	q̓anɫat̕ana	Endangered	Schedule 1, Endangered	Blue	higher elevations
Limber Pine	*Pinus flexilis*		Endangered		Blue	lower elevation open forests
Bitterroot	*Lewisia rediviva*	naqamȼu				grasslands
Balsamroot	*Balsamorhiza sagittata*	xaɫ				open dry slopes
Black Elderberry	*Sambucus racemosa* var. *melanocarpa*	yuk Bush = yukwuʔk				open
Huckleberry/ vaccinium	*Vaccinium membranaceum*	ɫawiyaɫ, bush = a·kwukaʔis ɫawiyaɫ				mid higher elevation open
Red-stem Ceanothus (buckbrush)	*Ceanothus sanguineus*	kakyaxapwuʔk				lower elevation open forests
Snowbrush	*Ceanothus velutinus*					mid higher elevation open
Rose spp	*Rosa* spp.	q̓uɫwa				Various
Saskatoon	*Amelanchier alnifolia*	sq̓umu				open dry slopes
Wapato (Broadleaf Arrowhead)	*Sagittaria latifolia*	ʔawisi				wetland riparian
Rocky Mountain Juniper	Juniperus scopulorum	ʔa·kuk̓pɫuɫaɫ				open dry forests
Meadow Death Camas	*Toxicoscordion venenosum*	nupqasaquɫ				open dry forests

Appendix 2: Wide ranging species as Indicators of Connectivity

Wide-ranging species, such as grizzly bears, have large home ranges, and their conservation requires protecting large, connected areas. Recent research has revealed significant and extensive population level fragmentation grizzly bears in the Kootenay region. Proctor et al. (2012)[143] found that major highways accompanied by human settlement were fragmenting grizzly populations, including the settled Upper Columbia Valley that contains Highway 93/95. Proctor et al. (2015)[144] used extensive grizzly bear GPS telemetry data to predict habitat quality and potential connectivity habitat throughout the region (Figure 17). They found high quality connectivity habitat for grizzly bears at the north and south ends of Columbia Lake (Figure 17). Recent evidence suggests at least male grizzly bears still cross the valley (M. Proctor, pers. comm, see Drone Bear – Route-finding in a Conservation Corridor).

Because grizzly bears are wide-ranging animals and we have an abundance of data on them, they are used here as an example of how ecological corridor planning can benefit wildlife. Although large scale definitive fragmentation and corridor data do not exist for other species to the extent they do for grizzly bears, research suggests human disturbance in several forms (e.g., highways, agriculture, human settlement) also inhibits elk movements[145, 146] and Mountain Goat gene flow, risking isolation.[147, 148]

Grizzly Bears and Biodiversity

The umbrella species concept has been popular in ecology for decades,[149, 150] though not without critics. It holds that maintaining habitat requirements of wide-ranging species that need large territories, diverse habitat types, food resources, and travel routes, innumerable other species including plants, amphibians, and smaller mammals are also indirectly protected.

Within the Canadian Rockies, grizzly bears have been shown to be the best umbrella found for predicting carnivore species richness within a multi-species assessment.[151] In the Columbia Lake Corridor, grizzly bears are a reasonable umbrella species for various components of conservation, particularly connectivity.

Research on grizzlies in the Kootenays has demonstrated their wide year-round needs include many different seasonal habitat types from low to mid to high elevations, including connectivity habitat.[152, 153] Grizzly bears are also known to require a functioning meta-population (interconnected subpopulations) across the trans-border region to survive on the fragmented landscape.[154, 155, 156, 157, 158, 159] These data support the idea that our region needs to contain a sufficient proportion of connected wildlife habitat to maintain our otherwise abundant yet declining biodiversity. Thus, strategically focusing conservation efforts on functioning wildlife corridors helps maintain an entire ecosystem.

While the Columbia Lake Ecological Corridor is experiencing levels of human disturbance that are inhibiting wildlife movement, the valley bottom is not a complete barrier to movements and is functioning to some degree as an ecological corridor. This is an opportune time to establish an Ecological Corridor across the valley, before human disturbance further restricts and possibly eliminates wildlife movements.

Appendix 3: Columbia Lake Ecological Corridor Partners

Existing Partners:

Government

- Indigenous
  - ʔakisq̓nuk First Nation
  - Ktunaxa Nation Council
- Provincial
  - Ministry of Water, Land & Resource Stewardship
  - Ministry of Forests
  - Ministry of Environment and Parks
  - Ministry of Agriculture and Food
  - Ministry of Transportation and Transit
- Federal
  - Parks Canada

Interest Groups and Organizations

- Kootenay Connect Society
- Nature Conservancy of Canada

Potential Partners:

Government

- Indigenous
  - Shuswap Band
- Municipal / Regional
  - Regional District of East Kootenay (Area F)
  - Village of Canal Flats
- Provincial
  - Ministry of Forests
  - Ministry of Agriculture and Food
  - Ministry of Transportation and Transit
- Federal
  - Environment and Climate Change Canada (Canadian Wildlife Service)

Interest Groups and Organizations

- BC Nature
- Canal Flats Wilderness Club
- Columbia Lake Stewardship Society
- Columbia Wetlands Stewardship Partners
- East Kootenay Wildlife Association
- Farmland Advantage
- Fish & Wildlife Compensation Program
- Kootenay Conservation Program
- Lake Windermere District Rod and Gun Club
- Summit Trail Makers Society
- The Nature Trust of British Columbia
- Wildsight
- Windermere & District Farmers Institute
- Wings Over the Rockies Nature Festival

Industry

- Canfor
- BC Timber Sales
- CertainTeed – Saint Gobain
- Canadian Pacific Kansas City Railroad

Appendix 4: Acronyms

ALR	Agricultural Land Reserve
BMP	Beneficial Management Practices or Best Management Practices
CCA	Critical Connectivity Area
CLEC	Columbia Lake Ecological Corridor
DPA	Development Permit Area
ESCL	East Side Columbia Lake
ESCLWMA	East Side Columbia Lake Wildlife Management Area
FSC	Forest Stewardship Council
GAR	Government Action Regulation orders
HCVA-M	High Conservation Value Area - Management
HCVA-R	High Conservation Value Area - Reserve
IPCA	Indigenous Protected and Conserved Area
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
KNC	Ktunaxa Nation Council
MWLRS	Ministry of Water, Land and Resource Stewardship
RDEK	Regional District of East Kootenay
WHA	Wildlife Habitat Area
WMA	Wildlife Management Area

Appendix 5: Beneficial Management Practices

Appended as separate files

- Grasslands
- Agriculture
- Riparian Areas
- Wetlands
- Forests
- Wild Berries

14. References

[1] Ktunaxa Nation Council. 2025. Creation Story. Website: https://www.ktunaxa.org/history/ [Accessed July, 2026].

[2] Stralberg, D., Carroll, C., and Nielsen, S.E. 2020. Toward a climate-informed North American protected areas network: Incorporating climate-change refugia and corridors in conservation planning. Conservation Letters. e12712. https://doi.org/10.1111/conl.12712

[3] Maxwell, S.L. et al. 2020. Area-based conservation in the twenty-first century. Nature 586(7828):217-227. https://doi.org/10.1038/s41586-020-2773-z

[4] Brodie et al. 2025. A well-connected Earth: The science and conservation of organismal movement. Science 388:eadn2225. https://doi.org/10.1126/science.adn2225

[5] Hilty et al. 2020. Guidelines for conserving connectivity through ecological networks and corridors. Best Practice Protected Area Guidelines Series No. 30. International Union for Conservation of Nature (IUCN), Gland, Switzerland. Available: https://portals.iucn.org/library/sites/library/files/documents/PAG-030-En.pdf

[6] Bennett, A.F. 2003. Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland and Cambridge, UK. xiv + 254 pp. https://portals.iucn.org/library/efiles/documents/fr-021.pdf

[7] Hilty et al. 2020. *Op. cit.*

[8] Buxton, R.T. et al. 2021. Key information needs to move from knowledge to action for biodiversity conservation in Canada. Biological Conservation. 256:108983. https://doi.org/10.1016/j.biocon.2021.108983

[9] Parks Canada. 2025. Criteria for Ecological Corridors. Website: https://parks.canada.ca/nature/science/conservation/corridors-ecologiques-ecological-corridors/criteres-criteria [Accessed February 15, 2025].

[10] Keeley, A.T.H., Beier, P., Creech, T., Jones, K., Jongman, R.H.G., Stonecipher G. and Tabor, G.M. 2019. Thirty years of connectivity conservation planning: an assessment of factors influencing plan implementation. Environmental Research Letters. 14:103001. https://doi.org.10.1088/1748-9326/ab3234

[11] Conservation Corridor. 2025. Connectivity in National Policies: Costa Rica. Website: https://conservationcorridor.org/digests/2023/11/ecological-connectivity-in-national-policies-costa-rica/ [Accessed December 16, 2025].

[12] Florida Wildlife Corridor Foundation. 2025. About the Corridor. Website: https://floridawildlifecorridor.org/about/about-the-corridor/ [Accessed December 16, 2025].

[13] Key Biodiversity Areas Canada Secretariat. 2025. Key Biodiversity Areas: Canada's critical places for nature. Website: https://kbacanada.org/ [Accessed November 18, 2025]. See also Global KBA site: https://www.keybiodiversityareas.org/

[14] UNESCO. 2025. Man and the Biosphere Programme. United Nations Educational, Scientific and Cultural Organization. Website: https://www.unesco.org/en/mab [Accessed November 18, 2025].

[15] BirdLife International. 2025. Important Bird and Biodiversity Areas (IBAs). Website: https://datazone.birdlife.org/about-our-science/ibas [Accessed November 18, 2025].

[16] Proctor, M.F., and M.H. Mahr. 2023. Kootenay Connect: Riparian Wildlife Corridors for Climate Change, Year 4 Summary Report. Kootenay Connect, Kaslo, BC. xxii + 253pp.

[17] Proctor, M.F. et al. 2012. Population fragmentation and interecosystem movements of grizzly bears in Western Canada and the Northern United States. Wildlife Monographs 180. https://doi.org/10.1002/wmon.6

[18] Kootenay Inter-Agency Management Committee. 1997. Kootenay/Boundary Land Use Plan Implementation Strategy. Government of British Columbia. Available: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/kootenayboundary-region/kootenayboundary-rlup/kootenayboundary_rlup_implementation_strategy.pdf

[19] Adams, I. and Robinson, M. 2009. Habitat Linkages for Species at Risk in the Upper Columbia Valley, BC: Background Information. Report to Columbia Wetland Stewardship Partners. Interior Reforestation. Cranbrook, BC.

[20] Adams, I. 2010. Connecting the Upper Columbia Valley II: Identifying Critical Areas for Species at Risk Habitat Linkages. Report to Columbia Wetland Stewardship Partners. Interior Reforestation. Cranbrook, BC.

[21] Adams, I. 2011. Connecting the Upper Columbia Valley III: Habitat Criteria and Conditions. Report to Columbia Wetland Stewardship Partners. Interior Reforestation. Cranbrook, BC.

[22] Proctor, M.F. et al. 2012. Population fragmentation and interecosystem movements of grizzly bears in Western Canada and the Northern United States. Wildlife Monographs 180. https://doi.org/10.1002/wmon.6

[23] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[24] Proctor, M.F. et al. 2018. Resource Roads and Grizzly Bears in British Columbia, and Alberta. Canadian Grizzly Bear Management Series, Resource Road Management. Trans-border Grizzly Bear Project. Kaslo, BC. Canada http://transbordergrizzlybearproject.ca/research/publications.html

[25] Kinley, T.A., Whittington, J., Dibb, A and Newhouse, N.J. 2013. Badger Resource Selection in the Rocky Mountain Trench of British Columbia. Journal of Ecosystems and Management 14(3):1–22. https://doi.org/10.22230/jem.2013v14n3a566

[26] Mulligan, K.L. 2021. Long-term changes in migratory patterns of elk (*Cervus canadensis*) in the southern Rocky Mountain Trench of British Columbia, Canada. Master's Thesis, University of Alberta.

[27] McRoberts, J and Millspaugh. J. 2020. A Current Review of Elk Conservation and Management in the Kootenay Region of British Columbia. Report the BC Ministry of Forests, Lands and Natural Resource Operations. Cranbrook, BC

[28] Kinley, T.A. 2007. Introduction and Animal Monitoring results. In T.A. Kinley, ed. Rocky Mountain Bighorn Sheep Habitat and Population Assessment for the East Kootenay Trench. Report to East Kootenay Wildlife Association. Canal Flats, BC.

[29] Poole, K.G, Bachmann, K.D. and Teske, I.E. 2010. Mineral lick use by GPS radio-collared Mountain Goats in Southeastern British Columbia. Western North American Naturalist. 70:208-217. https://scholarsarchive.byu.edu/wnan/vol70/iss2/7

[30] Sawaya, M.A., Clevenger, A.P. and Schwartz, M.K. 2019. Demographic fragmentation of a protected wolverine population bisected by a major transportation corridor. Biological Conservation. 236:616-625. https://doi.org/10.1016/j.biocon.2019.06.030

[31] Utzig, G. 2025. The Columbia Lake Corridor and Climate Disruption, A Basic Assessment. Kutenai Nature Investigations, Nelson, BC. Report to Kootenay Connect.

[32] Utzig. G. 2025. *Ibid.*

[33] Lees, J. and W. Clutterbuck. 1888. *B.C. 1887: A Ramble in British Columbia*. Longmans, Green and Co. London, UK. Available: https://open.library.ubc.ca/collections/bcbooks/items/1.0222211

[34] Lees, J. and W. Clutterbuck. 1888. *Ibid.*

[35] Cannings, S. and Cannings R.J. 1999. *Geology of British Columbia: A Journey Through Time*. Greystone Books. Vancouver, BC.

[36] Ryder, J.M. 1981. Biophysical Resources of the East Kootenay Area: Terrain. APD Bulletin 7. BC Ministry of Environment.

[37] Green, K.C. and C.J. Westbrook. 2009. Changes in riparian area structure, channel hydraulics, and sediment yield following loss of beaver dams. BC Journal of Ecosystems and Management 10:68–79. https://doi.org/10.22230/jem.2009v10n1a412

[38] Westbrook, C.J., D.J. Cooper, and B.W. Baker. 2006. Beaver dams and overbank floods influence groundwater-surface water interactions of a Rocky Mountain riparian area. Water Resources Research 42:W06404. https://doi.org/10.1029/2005WR004560

[39] Regional District of East Kootenay. 2017. Fairmont Hot Springs & Columbia Lake Area Official Community Plan, Bylaw No.2779, 2017. Regional District of East Kootenay. Cranbrook, BC. Available: https://www.rdek.bc.ca/bylaws/ocp_zoning_landuse/ocp/fairmontocp/

[40] Regional District of East Kootenay. 2019. Lake Windermere Official Community Plan Bylaw No. 2929, 2019. Regional District of East Kootenay. Cranbrook, BC. Available: https://www.rdek.bc.ca/bylaws/ocp_zoning_landuse/ocp/lakewindermereocp/

[41] Hatter, I. and J. Feick. 2026. Columbia Lake Ecological Reserve. Warden Reports and other materials. https://ecoreserves.bc.ca/portfolio/020-columbia-lake/ [Accessed June 10, 2026].

[42] Feick, J. and I. Hatter. 2026. Mount Sabine Ecological Reserve. Warden Reports and other materials. https://ecoreserves.bc.ca/portfolio/019-mount-sabine/ [Accessed June 10, 2026].

[43] KBA Canada Coalition. 2021. A National Standard for the Identification of Key Biodiversity Areas in Canada v. 1.0. Wildlife Conservation Society Canada and Key Biodiversity Area Canada Coalition, Toronto, ON Canada. https://kbacanada.org/wp-content/uploads/2022/07/National-KBA-Standard.pdf

[44] IUCN. 2016. A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition. Gland, Switzerland: IUCN.

[45] International Union for Conservation of Nature (IUCN). 2022. *Threats Classification Scheme, v 3.3*. International Union for Conservation of Nature. https://www.iucnredlist.org/resources/threat-classification-scheme

[46] Rocky Mountain Trench Ecosystem Restoration Program. 2013. Blueprint for Action: Progress and Learnings 1997-2013. Rocky Mountain Trench Ecosystem Restoration Program, Cranbrook, BC.

[47] Proctor, M.F., et al. 2019. The effects of roads and motorized human access on grizzly bear populations in British Columbia and Alberta, Canada. Ursus 30e2:6–19. https://doi.org/10.2192/URSUS-D-18-00016.2

[48] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[49] Rowland, M.M., et. al. 2018. Modeling elk nutrition and habitat use in western Oregon and Washington. Wildlife Monograph199. https://doi.org/10.1002/wmon.1033

[50] Ktunaxa Nation Council. 2022. Ktunaxa Forestry Standards Document for Forestry within ʔamakʔis Ktunaxa. December 2022 draft. Ktunaxa Nation Council, Cranbrook, BC.

[51] British Columbia Badger Recovery Team. 2016. Recovery plan for American Badger (*Taxidea taxus*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, B.C. 36 pp.

[52] Proctor, M.F., et al. 2019. The effects of roads and motorized human access on grizzly bear populations in British Columbia and Alberta, Canada. Ursus 30e2:6–19. https://doi.org/10.2192/URSUS-D-18-00016.2

[53] Lamb, C.T. et al. 2018. Effects of habitat quality and access management on the density of a recovering grizzly bear population. Journal of Applied Ecology 55:1406–1417. https://doi.org/10.1111/1365-2664.13056

[54] Government of British Columbia. 2024. Motor Vehicle Prohibition Regulation. Last amended September 17, 2024. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/18_2024

[55] Government of British Columbia. 2024. *Ibid.*

[56] Kinley, T.A. and N.J. Newhouse. 2009. Badger Roadkill Risk in Relation to the Presence of Culverts and Jersey Barriers. Northwest Science. 83:148-153. https://doi.org/10.3955/046.083.0206

[57] B.C. Ministry of Environment. 2017. Management plan for the Painted Turtle – Intermountain– Rocky Mountain Population (*Chrysemys picta* pop. 2) in British Columbia. B.C. Ministry of Environment, Victoria, BC. 31 pp. Available: https://ecprccsarstacct.z9.web.core.windows.net/files/SARAFiles/legacy/plans/Mp-WtnPaintedTurtleIntermtnRockyMtnPop-v00-2018Oct-Eng.pdf

[58] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[59] Mulligan, K.L. 2021. Long-term changes in migratory patterns of elk (*Cervus canadensis*) in the southern Rocky Mountain Trench of British Columbia, Canada. MSc thesis. University of Alberta, Edmonton, AB.

[60] Bellard, C., C. Bernery, and C. Leclerc. 2021. Looming extinctions due to invasive species: irreversible loss of ecological strategy and evolutionary history. Global Change Biology, 27: 4967–4979. https://doi.org/10.1111/gcb.15771

[61] Tamburello, N. and Lit, M.A. 2023. Multiple impacts of invasive species on species at risk: a case study in British Columbia, Canada. Facets. 8:1-13. https://doi.org/10.1139/facets-2022-0234

[62] East Kootenay Invasive Species Council. 2025. Invasive species. Webpage: https://www.ekisc.com/invasive-species [Accessed August 2025].

[63] Canadian Food Inspection Agency. 2024. Notice to Industry – Update on Zoning for Whirling Disease – British Columbia and Columbia River Watershed. Website: https://inspection.canada.ca/en/animal-health/aquatic-animals/diseases/reportable-diseases/whirling-disease/update-zoning-whirling-disease [Accessed August 2025].

[64] Rocky Mountain Trench Ecosystem Restoration Program. 2013. Blueprint for Action: Progress and Learnings 1997-2013. Rocky Mountain Trench Ecosystem Restoration Program, Cranbrook, BC.

[65] Barbero, R., J.T. Abatzoglou, N.K. Larkin, C A. Kolden and B. Stocks. 2015. Climate change presents increased potential for very large fires in the contiguous United States. International Journal of Wildland Fire. 24:892–899. http://dx.doi.org/10.1071/WF15083

[66] Green, G.A. 2021. Fire-resilient ecosystems: fire exclusion and selective harvesting degrade dry forests in British Columbia. Dissertation. University of British Columbia, Vancouver, BC.

[67] Utzig, G. 2025. The Columbia Lake Corridor and Climate Disruption, A Basic Assessment. Kutenai Nature Investigations, Nelson, BC. Report to Kootenay Connect.

[68] Utzig, G. 2025. *Ibid.*

[69] Scholtz, R. and Twidwell, D., 2022. The last continuous grasslands on Earth: Identification and conservation importance. Conservation Science and Practice, 4(3), p.e626. DOI: https://doi.org/10.1111/csp2.626

[70] Delesalle, B.P., B.J. Coupe, B.M. Wikeem, S.J. Wikeem. 2009. Grasslands Monitoring Manual for British Columbia: A Tool for Ranchers. Grasslands Conservation Council of British Columbia (reprint 2019). Available: https://bcgrasslands.org/wp-content/uploads/2019/05/2019reprint_bc_grassland_monitoring_manual_for_bc.pdf

[71] Rocky Mountain Trench Ecosystem Restoration Program. 2013. Blueprint for Action: Progress and Learnings 1997-2013. Rocky Mountain Trench Ecosystem Restoration Program, Cranbrook, BC.

[72] Forest Practices Board. 2016. Restoring and Maintaining Rangelands in the East Kootenay - Special Report FPB/SR/53. Available: https://www.bcfpb.ca/wp-content/uploads/2016/12/SR53-Rangeland-East-Kootenay.pdf

[73] Bennett, A.F., 2003. Linkages in the landscape: the role of corridors and connectivity in wildlife conservation (No. 1). IUCN. Available: https://portals.iucn.org/library/efiles/documents/fr-021.pdf

[74] Bennett, A.F., 2003. *Ibid.*

[75] Hindmarch S., J. Elliott, R. Weir, S. Lee, and F. Maisonneuve. 2025. Anticoagulant rodenticide exposure in endangered American badgers (Taxidea taxus) and fishers (Pekania pennanti) from British Columbia, Canada, 1998 to 2018. Environmental Pollution. 375: https://doi.org/10.1016/j.envpol.2025.126278

[76] Rocky Mountain Trench Ecosystem Restoration Committee. 2014. Ecosystem Restoration Best Management Practices for Planning, Layout, Harvesting, Silviculture and Reclamation of Open Range and Open Forest Blocks. Cranbrook, BC.

[77] BC Ministry of Water, Land and Resource Stewardship. 2025. Best Management Practices for Badgers - Road Culvert Maintenance. Available: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/best-management-practices/badgerculverts_bmp2025.pdf

[78] Campbell D.L.M., J. Ouzman, D. Mowat, J.M. Lea, C. Lee and R.S. Llewellyn. 2020. Virtual Fencing Technology Excludes Beef Cattle from an Environmentally Sensitive Area. *Animals*. 10(6):1069. https://doi.org/10.3390/ani10061069

[79] Scallion, M. and K. Titchener. 2023. Trail development guidelines to minimize disturbance to and conflict with large carnivores. Outdoor Recreation Council of BC. 26 pp. Available: https://static1.squarespace.com/static/6169b9b7f9862761042c7c05/t/646282cf3d2b9e714b75cbab/1684177627976/TrailDevelopmentGuidelines_ORCBC.pdf

[80] B.C. Ministry of Environment. 2006. Wildlife Guidelines for Backcountry Tourism/Commercial Recreation in British Columbia. 53 pp. Available: https://www.env.gov.bc.ca/wld/twg/documents/wildlife_guidelines_recreation_may06_v2.pdf

[81] BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development. 2021. Kootenay Region Bighorn Sheep Management Plan. Available: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/wildlife-wildlife-habitat/sheep/kootenay_bighorn_sheep_management_plan.pdf

[82] Scallion, M. and K. Titchener. 2023. Trail development guidelines to minimize disturbance to and conflict with large carnivores. Outdoor Recreation Council of BC. 26 pp. Available: https://static1.squarespace.com/static/6169b9b7f9862761042c7c05/t/646282cf3d2b9e714b75cbab/1684177627976/TrailDevelopmentGuidelines_ORCBC.pdf

[83] Ambrose, N., G. Ehlert, K. Spicer-Rawe. 2009. Riparian Health Assessment for Lakes, Sloughs, and Wetlands - Field Workbook Second Edition. Lethbridge, Alberta. Cows and Fish program. 96 pgs. Available: https://cowsandfish.org/wp-content/uploads/LakesandWetlandsRHAWorkbook2009.pdf

[84] MacDonald Hydrology Consultants Ltd. (2024) Vulnerability Assessment of the Bench Wetlands in the Upper Columbia River Basin. Prepared for the Columbia Wetlands Stewardship Partners. (March 2024). Available: https://kootenayconservation.ca/wp-content/uploads/2024/07/Vulnerability-Assessment-of-the-Bench-Wetlands-in-the-Upper-Columbia-River-Basin-18Mar2024.pdf

[85] Klein C. et al. 2009. Incorporating ecological and evolutionary processes into continental-scale conservation. Ecological Applications. 19:206-217. https://doi.org/10.1890/07-1684.1

[86] Kinley, T.A., and N.J. Newhouse. 1997. Relationship of riparian reserve zone width to bird density and diversity in southeast British Columbia. Northwest Science 71:75–86. https://hdl.handle.net/2376/1245

[87] Hauer, F.R. et al. 2016. Gravel-bed river floodplains are the ecological nexus of glaciated mountain landscapes. Science Advances 2 (6):e1600026. https://doi.org/10.1126/sciadv.1600026

[88] McDaniel, J., 2015. Fire, fuels, and streams: the effects and effectiveness of riparian treatments. Fire Science Digest (21). Available: https://www.nwfirescience.org/sites/default/files/publications/FSDigest21.pdf

[89] Lausen, C.L., D.W. Nagorsen, R.M. Brigham and J. Hobbs. 2022. Bats of British Columbia. 2nd Edition. Royal BC Museum, Victoria, BC.

[90] Government of British Columbia. 2014. Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia - A companion document to Develop with Care. Available: https://www.env.gov.bc.ca/wld/documents/bmp/HerptileBMP_complete.pdf

[91] Wetland Stewardship Partnership. 2010. Wetlands in British Columbia: A Primer for Local Governments. Wetland Stewardship Partnership. 19 p. Available: https://bc-wetlands.ca/wp-content/uploads/2016/11/wetlandprimer_wsp_2010.pdf

[92] Government of British Columbia. 2014. Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia - A companion document to Develop with Care. Available: https://www.env.gov.bc.ca/wld/documents/bmp/HerptileBMP_complete.pdf

[93] Government of B.C. 2014. Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia- Factsheet #11: Great Blue Heron. Available: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/best-management-practices/develop-with-care/fact-sheet-11-herons.pdf

[94] Lausen, C.L., D.W. Nagorsen, R.M. Brigham and J. Hobbs. 2022. Bats of British Columbia. 2nd Edition. Royal BC Museum, Victoria, BC.

[95] Government of British Columbia. 2014. Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia - A companion document to Develop with Care. Available: https://www.env.gov.bc.ca/wld/documents/bmp/HerptileBMP_complete.pdf

[96] Wetland Stewardship Partnership. 2010. Wetlands in British Columbia: A Primer for Local Governments. Wetland Stewardship Partnership. 19 p. Available: https://bc-wetlands.ca/wp-content/uploads/2016/11/wetlandprimer_wsp_2010.pdf

[97] Wetland Stewardship Partnership. 2010. Wetlands in British Columbia: A Primer for Local Governments. Wetland Stewardship Partnership. 19 p. Available: https://bc-wetlands.ca/wp-content/uploads/2016/11/wetlandprimer_wsp_2010.pdf

[98] Natural Resources Canada. 2025. Forest Carbon. Website: https://natural-resources.canada.ca/climate-change/forest-carbon [Accessed November 24, 2025].

[99] Whitebark Pine Ecosystem Foundation of Canada. 2025. Whitebark Pine Matters: Pines in peril. Website: https://whitebarkpine.ca/about/why-does-whitebark-pine-matter/ [Accessed November 19, 2025]

[100] Green, G.A. 2021. Fire-resilient ecosystems: fire exclusion and selective harvesting degrade dry forests in British Columbia. Dissertation. University of British Columbia, Vancouver, BC.

[101] Pfeifer, M., et al. 2017. Creation of forest edges has a global impact on forest vertebrates. Nature 551:187–191. https://doi.org/10.1038/nature24457

[102] Ktunaxa Nation Council. 2022. Ktunaxa Forestry Standards Document for Forestry within ʔamakʔis Ktunaxa. December 2022 draft. Ktunaxa Nation Council, Cranbrook, BC.

[103] Rocky Mountain Trench Ecosystem Restoration Committee. 2014. Ecosystem Restoration Best Management Practices for Planning, Layout, Harvesting, Silviculture and Reclamation of Open Range and Open Forest Blocks. Cranbrook, BC.

[104] BC Ministry of Forests. 2023. Post-Natural Disturbance Forest Restoration Guidance: Landscape Level Wildfire Recovery. BC Min. of Forests. Victoria, BC. 30pp. Available: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-andindustry/forestry/post_natural_disturbance_wildfire_guide.pdf [Accessed November 17 2025]

[105] Hatler F., Blood, D.A., and A.M.M. Beal. 2003. Furbearer Management Guidelines - Marten (*Martes americana*). https://www2.gov.bc.ca/assets/gov/sports-recreation-arts-and-culture/outdoor-recreation/fishing-and-hunting/hunting/trapping/marten.pdf

[106] Utzig, G. 2025. The Columbia Lake Corridor and Climate Disruption, A Basic Assessment. Kutenai Nature Investigations, Nelson, BC. Report to Kootenay Connect.

[107] Utzig, G. 2025. *Ibid.*

[108] Utzig, G. 2025. *Ibid.*

[109] Larson, A.J. et al. 2022. Tamm Review: Ecological principles to guide post-fire forest landscape management in the Inland Pacific and Northern Rocky Mountain regions. Forest Ecology and Management, 504:119680. https://doi.org/10.1016/j.foreco.2021.119680

[110] BC Ministry of Forests. 2023. Post-Natural Disturbance Forest Restoration Guidance: Landscape Level Wildfire Recovery. BC Min. of Forests. Victoria, BC. 30pp. Available: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-andindustry/forestry/post_natural_disturbance_wildfire_guide.pdf [Accessed November 17 2025]

[111] Thorn, S. et al. 2020. Estimating retention benchmarks for salvage logging to protect biodiversity. Nature Communications 11(1):4762. https://doi.org/10.1038/s41467-020-18612-4

[112] Rowland, M.M., et. al. 2018. Modeling elk nutrition and habitat use in western Oregon and Washington. Wildlife Monograph199. https://doi.org/10.1002/wmon.1033

[113] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[114] Rowland, M.M. et al. 2018. Modeling elk nutrition and habitat use in western Oregon and Washington. Wildlife Monograph199. https://doi.org/10.1002/wmon.1033.

[115] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[116] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[117] Friar, J.L., et al. 2008. Thresholds in landscape connectivity and mortality risks in response to growing road networks. Journal of Applied Ecology 45:1504-1512. DOI: 10.1111/j.1365-2664.2008.01526.x

[118] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[119] McLellan, B. N., and F. Hovey. 2001. Natal dispersal of grizzly bears. Canadian Journal of Zoology 79:838-844.

[120] Proctor, M.F., B.N. McLellan, C. Strobeck, and R. Barclay. 2004. Gender specific dispersal distances for grizzly bears analysis revealed by genetic analysis. Canadian Journal of Zoology 82:1108-1118.

[121] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[122] Friar, J.L., et al. 2008. Thresholds in landscape connectivity and mortality risks in response to growing road networks. Journal of Applied Ecology 45:1504-1512. DOI: 10.1111/j.1365-2664.2008.01526.x

[123] Poole, K.G., C.T. Lamb, S. Metcalf, and L. Amos 2024. Migration, movements, and survival in a partially migratory elk (*Cervus canadensis*) population. Conservation Science and Practice 6:13128. https://doi.org/10.1111/csp2.13128

[124] Rowland, M.M., et. al. 2018. Modeling elk nutrition and habitat use in western Oregon and Washington. Wildlife Monograph199. https://doi.org/10.1002/wmon.1033

[125] Friar, J.L., et al. 2008. Thresholds in landscape connectivity and mortality risks in response to growing road networks. Journal of Applied Ecology 45:1504-1512. DOI: 10.1111/j.1365-2664.2008.01526.x

[126] Mulligan, K.L. 2021. Long-term changes in migratory patterns of elk (*Cervus canadensis*) in the southern Rocky Mountain Trench of British Columbia, Canada. Master's Thesis, University of Alberta.

[127] McRoberts, J and Millspaugh. J. 2020. A Current Review of Elk Conservation and Management in the Kootenay Region of British Columbia. Report the BC Ministry of Forests, Lands and Natural Resource Operations. Cranbrook, BC

[128] Bolger, D.T., W.D. Newmark, T.A. Morrison, and D. F. Doak, 2008. The need for integrative approaches to understand and conserve migratory ungulates. Ecology Letters, 11, 63–77.

[129] Brennan, A., et al. 2018. Examining speed versus selection in connectivity models using elk as an example. Landscape Ecology 33:955-968.

[130] Brennan A. et al. 2018. *Ibid.*

[131] Leopold, A. 1949. *A Sand County Almanac.* Oxford University Press.

[132] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[133] Kinley, T.A. and N.J. Newhouse. 2008. Ecology and Translocation-Aided Recovery of an Endangered Badger Population. Journal of Wildlife Management. 72:113-122 https://doi.org/10.2193/2006-406

[134] Newhouse, N.J. 2006. East Kootenay Badger Project Summary: June 1996 – June 2006. Report to Fish & Wildlife Compensation Program, Columbia Basin and Parks Canada. Invermere, BC.

[135] Dibb, A.D. 2007. Spatial Analysis of Bighorn Sheep Movement in the Radium Hot Springs Area, British Columbia: Modelling and Management. MSc thesis. University of Calgary, Calgary, AB.

[136] Kinley, T.A. 2007. Introduction and Animal Monitoring results. In T.A. Kinley, ed. Rocky Mountain Bighorn Sheep Habitat and Population Assessment for the East Kootenay Trench. Report to East Kootenay Wildlife Association. Canal Flats, BC.

[137] Davidson, P.W. 1994 East Kootenay Bighorn Sheep enhancement project: Completion report. Unpublished report prepared for B.C. Ministry of Environment. Cranbrook, British Columbia. 183 pp.

[138] Mulligan, K.L. 2021. Long-term changes in migratory patterns of elk (*Cervus canadensis*) in the southern Rocky Mountain Trench of British Columbia, Canada. MSc thesis. University of Alberta, Edmonton, AB.

[139] Poole, K.G., C.T. Lamb, S. Metcalf, and L. Amos 2024. Migration, movements, and survival in a partially migratory elk (*Cervus canadensis*) population. Conservation Science and Practice 6:13128. https://doi.org/10.1111/csp2.13128

[140] BC Old Growth Advisory Panel. 2024. Old growth information, analysis and technical advisory panel report. Available: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/old-growth-forests/information-and-analysis. [Accessed February 2025]

[141] Regional District of East Kootenay. 2017. Fairmont Hot Springs & Columbia Lake Area Official Community Plan, Bylaw No.2779, 2017. Regional District of East Kootenay. Cranbrook, BC. Available: https://www.rdek.bc.ca/bylaws/ocp_zoning_landuse/ocp/fairmontocp/

[142] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[143] Proctor, M.F. et al. 2012. Population fragmentation and interecosystem movements of grizzly bears in Western Canada and the Northern United States. Wildlife Monographs 180. https://doi.org/10.1002/wmon.6

[144] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[145] Hebblewhite, M., et al. 2006. Is the migratory behaviour of montane elk herds in peril? The case of Alberta's Ya Ha Tinda elk herd. Wildlife Society Bulletin, 34, 1280–1294 https://doi.org/10.2193/0091-7648(2006)34[1280:ITMBOM]2.0.CO;2

[146] Poole, K.G., C.T. Lamb, S. Metcalf, and L. Amos 2024. Migration, movements, and survival in a partially migratory elk (*Cervus canadensis*) population. Conservation Science and Practice 6:13128. https://doi.org/10.1111/csp2.13128

[147] Parks, L.C., D.O. Wallin, S.A. Cushman and B.H. McRae. 2015. Landscape-level analysis of mountain goat population connectivity in Washington and southern British Columbia. Conservation Genetics. 16:1195–1207. https://doi.org/10.1007/s10592-015-0732-2

[148] Shirk., A.J., D.O. Wallin, A.A. Cushman, C.G. Rice, and K.I. Warheit. 2010. Inferring landscape effects on gene flow: a model selection framework. Molecular Ecology 19:3603-3619. https://doi.org/10.1111/j.1365-294X.2010.04745.x

[149] Wilcox, B.A. 1984. In situ conservation of genetic resources: determinants of minimum area requirements. pp. 639-647 in J.A. Miller, R.K. Miller (Eds.), *National Parks, Conservation and Development: The Role of Protected Areas in Sustaining Society*, Smithsonian Institution Press, Washington, D.C.

[150] Noss, R.F., H.B. Quigley, M.G. Hornocker, and T. Merrill. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. Conservation Biology 10:949-963. https://doi.org/10.1046/j.1523-1739.1996.10040949.x

[151] Steenweg, R., et al. 2022. Testing umbrella species and food-web properties of large carnivores in the Rocky Mountains. Biological Conservation. 109888 https://doi.org/10.1016/j.biocon.2022.109888

[152] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[153] McLellan, B.F. and F.W. Hovey. 1995. The diet of grizzly bears in the Flathead River drainage of southeastern British Columbia. Canadian Journal of Zoology. 73:704–712. https://doi.org/10.1139/z95-082

[154] Proctor, M.F. et al. 2023. Berries and Bullets: influence of food and mortality risk on grizzly bear in British Columbia. Wildlife Monographs. 213 https://doi.org/10.1002/wmon.1078

[155] Proctor, M.F. et al. 2019. The effects of roads and motorized human access on grizzly bear populations in British Columbia and Alberta, Canada. Ursus 30e2:6–19. https://doi.org/10.2192/URSUS-D-18-00016.2

[156] Proctor, M.F. et al. 2018. Resource Roads and Grizzly Bears in British Columbia, and Alberta. Canadian Grizzly Bear Management Series, Resource Road Management. Trans-border Grizzly Bear Project. Kaslo, BC. Canada http://transbordergrizzlybearproject.ca/research/publications.html

[157] Proctor, M.F. et al. 2015. Grizzly bear connectivity mapping in the Canada–US transborder region. Journal of Wildlife Management 79:554–55. https://doi.org/10.1002/jwmg.862

[158] Proctor, M.F. et al. 2012. Population fragmentation and interecosystem movements of grizzly bears in Western Canada and the Northern United States. Wildlife Monographs 180. https://doi.org/10.1002/wmon.6

[159] Proctor, M.F., B.N. McLellan, C. Strobeck, and R. Barclay. 2005. Genetic analysis reveals demographic fragmentation of grizzly bears yielding vulnerably small populations. Proceedings of the Royal Society, London 272:2409-2416. https://doi.org/10.1098/rspb.2005.3246