

**PRELIMINARY ECOLOGICAL & CONSERVATION ASSESSMENT
MALLORY RIDGE PROTECTED AREA PROPOSAL,
NEAR GARDOM LAKE, BC**



*An estimated 200-300 year old Ponderosa pine
"Mother Tree" on a Mallory Ridge bear trail.*

Submitted to Tom and Eleanor Marshall, Deep Creek, BC

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Amber Peters, BSc & Wayne McCrory, RPBio

(Mapping by Baden Cross, Applied Conservation GIS)

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Conservation parks are identified to protect natural areas that have significant natural values and to provide low-key outdoor experiences that are compatible with the natural environment. They may contain sensitive or threatened ecosystems. They protect key green spaces that are important to the natural character of the area. Three such areas (Mallory Ridge, Waby Lake and Kernaghan Lakes) have been identified....CSRD Area D Parks Plan, 2008

EXECUTIVE SUMMARY

This report represents a preliminary independent ecological and conservation assessment of the proposed 255-hectare Mallory Ridge protected area near Enderby, BC. The study was commissioned and funded by Tom and Eleanor Marshall of Deep Creek, BC. Recommendations are provided.

The area was recognized as an important conservation area and proposed for protection as a regional park by residents of Gardom Lake in 2000 and then in 2008 as a Conservation Park by the Columbia Shuswap Regional District (CSRD). However, no protection ensued.

The study area is on unceded “crown” land in the contemporary consultation areas of several bands of the Secwepemc and Syilx Nations. It is respectfully acknowledged that the project area is specifically within the unceded core traditional territory of the Splitsin te Secwepemc. It is further acknowledged that other bands of the Secwepemc and/or Syilx Nations may identify that the project area is within their specific core territories. This largely intact forested study area includes a large portion of the Gardom Lake watershed and portions of the watersheds above Glenmary and upper Mallory Roads. A 19 ha portion of a tenured BC woodlot is located within the southern portion of the proposed protected area.

The proposal area also contains a 12 kilometer network of locally significant trails for a variety of outdoor wilderness experiences. An access road for a powerline just inside the east proposal boundary is used by off-road vehicles (ORVs) for recreation.

The study included field assessments on April 23, May 3 and 4, 2022. Besides surveys for wildlife (including bats) as well as amphibian and reptile habitats and their use, a background review was done on potential species at risk and other ecological features. A GIS spatial analysis was done of potential mature forest recruitment values for provincial old-growth retention. A separate and independent hydrological study commissioned by the clients is also summarized. While it was beyond the scope of our study to include cultural/heritage and ecological/wildlife values by First Nations researchers, we feel this would be important and should be done.

Overall, we found that the Mallory Ridge protection study area is a biodiverse and isolated “island” landscape with locally significant wildlife values and provincially significant species at risk values.

From a landscape perspective, Mallory Ridge is situated in the transition zone between BC’s dry interior bioregion and the interior wet belt and is known to be particularly biodiverse. The largely

forested Douglas fir (*Pseudotsuga menziesii*)-leading and western red cedar (*Thuja plicata*)-leading mixed forest along with wetlands, meadows and rock slides provides a good mix of habitats for a variety of species.

Significant breeding activity of the yellow-listed pacific tree frog (*Pseudacris regilla*) and yellow-listed long-toed salamander (*Ambystoma macrodactylum*) was documented in three wetlands on Mallory Ridge as well as in wetlands downslope from the proposal towards Gardom Lake. Although western toads (*Anaxyrus boreas*), including gravid females, have been documented by residents downslope of the proposal area, none were observed during a survey in May of Gardom Lake and adjacent wetlands – which appeared to us to have breeding potential.

Three species of reptiles were documented within the proposal area including northwestern alligator lizard (*Elgaria coerulea principis*), terrestrial garter snake (*Thamnophis elegans*) and common garter snake (*Thamnophis sirtalis*). The northern rubber boa (*Charina bottae*) has been reported.

We also documented use of the wetlands in the proposal area by bats, although audio recordings from EMT surveys are still being analyzed. The use of forested habitats and understory by black bear (*Ursus americanus*), moose (*Alces alces*) and deer (*Odocoileus spp.*) were documented. Locals report a few confirmed grizzly bear (*Ursus arctos*) sightings in the proposal area, including a mother and two cubs in August 2022, and we identified a number of potential grizzly bear plant root/corm foods and berry-producing shrubs. DNA analysis of bear hair collected from an old-growth bear rubbing/mark tree in the proposal area was inconclusive as to species.

Numerous species at risk would be expected to potentially be found or confirmed in the study area including 151 provincially and/or federally-listed animal species at risk and 23 provincially and/or federally-listed plant species at risk.

A GIS spatial analysis showed that the majority (~85%) of the forest in the study is in the mature age classes (5-8), mostly Douglas fir with an average age of 115 years. Forest structural features that would be important to a variety of animal species were found to be common such as tree cavities and downed trees. The GIS spatial analyst considered the proposal to be significant as old growth recruitment forest identified as highest risk in need of protection by the provincial old growth Technical Advisory Panel. The Mallory Ridge forest is thus provincially significant in terms of its old-growth recruitment value under the province's old-growth strategy.

There are currently no provincial Old Growth Management Areas within the Mallory Ridge study area. However, we found that the proposal is under serious threat from a clearcut logging plan by Tolko Industries Ltd. of some ~74 hectares, including new logging roads. Approximately 42 hectares of proposed logging are within the sensitive Gardom Lake watershed. It must also be kept in mind that if first-pass clearcut logging is allowed to proceed other logging passes will likely occur and impacts on any surviving wildlife and biodiversity will be incremental.

A preliminary hydrological assessment for our clients concluded that Tolko's proposed logging has a moderate to high potential that forest harvest may impact low flows, peak flows, timing of peak flows, and the overall water availability along Mallory Ridge. While the hydrological study focussed on potential mitigation of these impacts on domestic water supplies, we believe that

such hydrological changes would also have a negative impact on water-dependent reptile and amphibian species.

If planned logging goes ahead, it is our professional opinion that significant habitat fragmentation and loss of biodiversity values of this small island of diverse habitats, remnant of an ancient transition ecosystem, will be the outcome. This will include a loss of forest security habitat for wildlife that could also lead to a local increase in human-bear conflicts and reduced values to ungulates. The mature forest old growth recruitment value we identified will be seriously compromised. The potential use of wildlife tree patches (WTPs) or old growth management areas (OGMAs) within the planned logging matrix will not be sufficient to protect wildlife and biodiversity values. An independent hydrological study for the clients identified important potential disruptions to the sensitive hydrological regime of the Mallory Ridge area that could have a negative downstream influence and in our opinion impact wetland breeding habitats for amphibians.

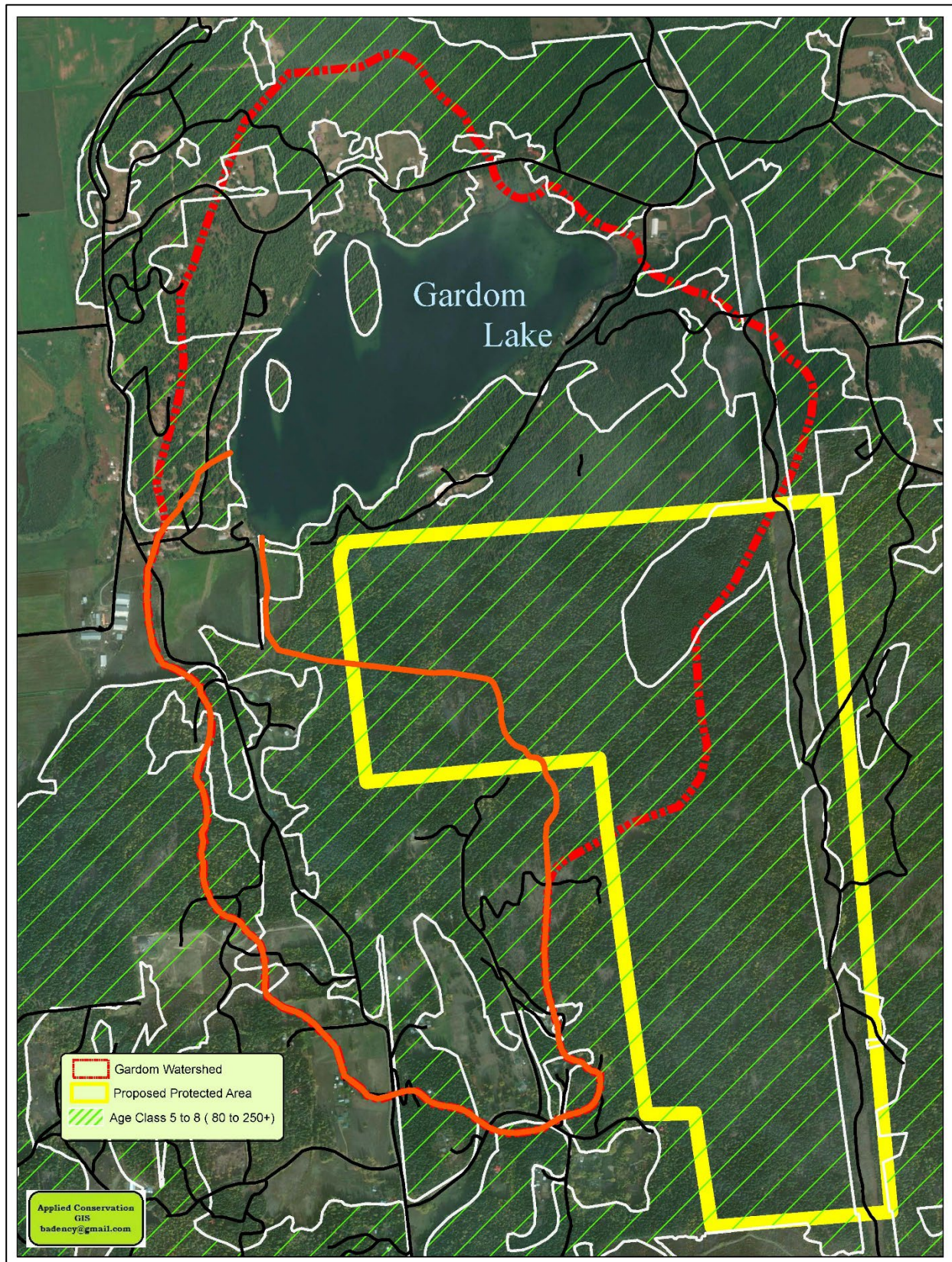
We also estimated that the planned logging would remove approximately 40% of the proposal area's forested trail system that is important to residents of three surrounding communities.

An additional concern is a recent study that found that clearcut logging followed by reforestation creates fuel conditions that contribute to wildfires being easier to ignite and harder to control. This, combined with the increasing wildfire conditions already besetting the province from global warming would make the surrounding communities even more at risk from wildfires.

We conducted a regional conservation analysis that found overall landscape protection of the region is well below provincial goals for protection and targets recommended by scientists to protect biodiversity over the long-term.

Based on our ecological and conservation assessment we strongly recommend that the Mallory Ridge proposal area not be subject to logging and that the clients and community pursue protective status. More specifically, we recommend the following:

1. As a priority, the proponents work closely with First Nations especially the local Splatshin First Nation government to document Indigenous ecological, traditional food, and cultural/heritage values and that includes recognition of First Nations Indigenous laws and customs as a key element to creating a foundation for including Indigenous knowledge in possible collaborative protection.
2. Consider additional research to further document biodiversity including species at risk values of the proposed protected area.
3. A range of protection options should be considered in consultation and collaborative management with First Nations including a Class A provincial park or conservancy, an Indigenous Protected and Conserved Area (IPCA), CSRD regional/conservation park, or other suitable protective mechanisms. A coordinator should be considered to assist the community proponents in achieving protection.



255-hectare Mallory Ridge proposed protected area (yellow) comprised of age classes 5-8 mature forest that is candidential for old-growth recruitment.

*Right: A black bear standing against this old-growth ponderosa pine (*Pinus ponderosa*) rub/mark tree. Night image May 18, 2022 on Stealth Cam trail camera that was set up by volunteers. The tree is heavily marked by bear claws and has been estimated at 200-300 years old. A bear day bed was found next to the tree.*



*Left: Yellow glacier lily (*Erythronium gradiflorum*) and western spring beauty (*Claytonia* spp.) (a.k.a. wild potato) are two important grizzly bear corm (underground part) foods found in fair abundance on Mallory Ridge. The corms are also well-known Indigenous plant foods.*



Left to right: a long-toed salamander, a string of salamander eggs and a juvenile pacific tree frog in the study area during breeding season; May 4, 2022. (Photos by Amber Peters).



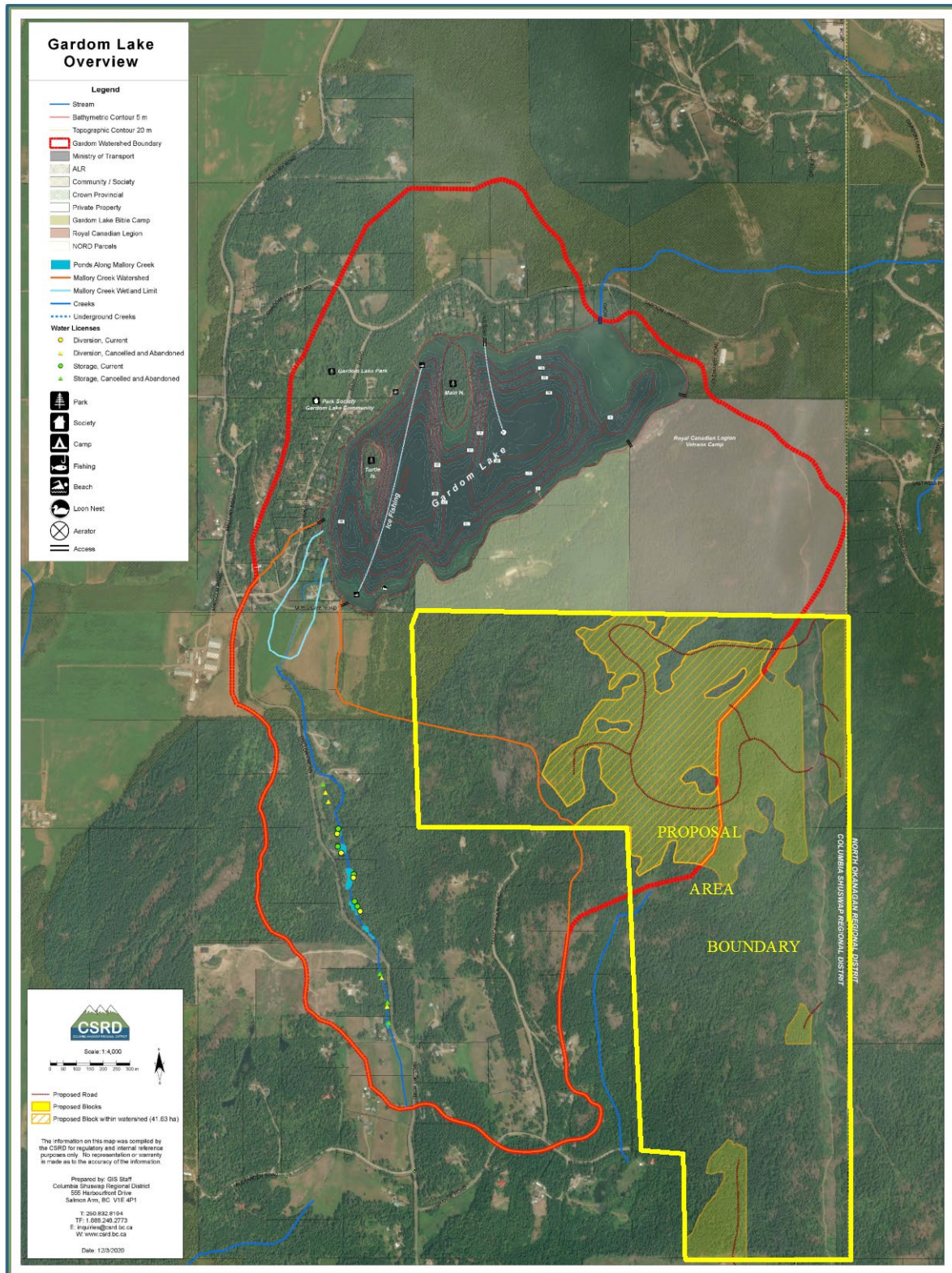
*Left: A female moose and calves. Right: A Violet-green swallow (*Tachycineta thalassina*); one of many migratory bird species that inhabit the proposal area. (Photos: Community Photographers)*



An open-water, cattail-dominated wetland on Mallory Ridge; one of multiple sites of confirmed pacific tree frog and long-toed salamander breeding. (Photo by Amber Peters).



At the height of land on the scenic bluffs of Mallory Ridge, local residents enjoy the vista towards Gardom Lake and its riparian area. The proposal area is of high recreational value for local residents who use a network of non-motorized and low-key hiking trails. (Photo: Community Photographers).



Showing large cumulative areas of proposed clearcuts (shaded yellow) within proposal area (yellow boundary) of this “island” biodiversity hot spot. Base map from CSRD who added the proposed Tolko cut blocks at the request of the client. Proposal Area overlay by Baden Cross.

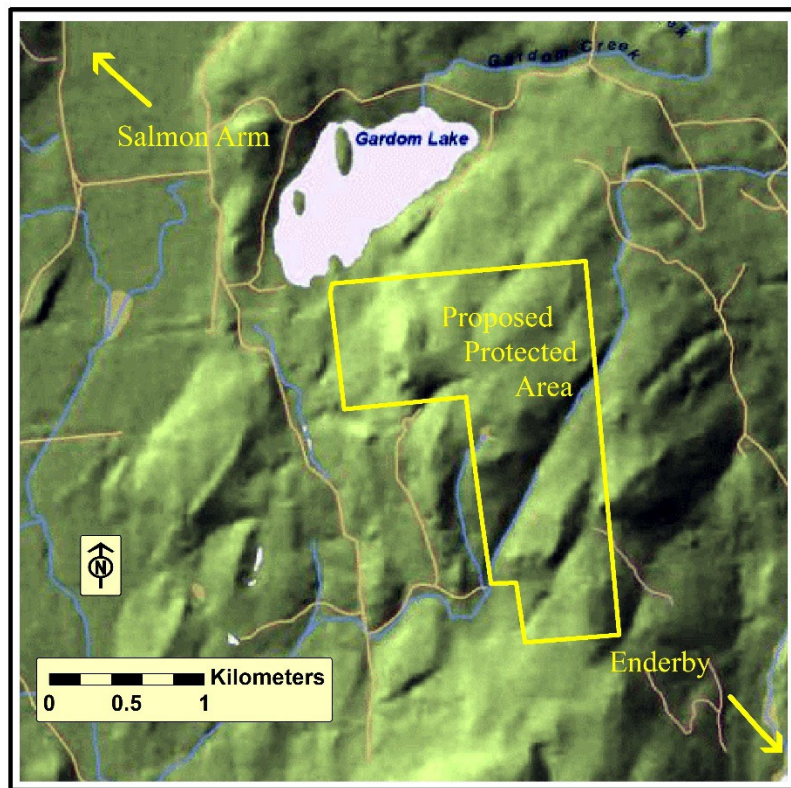
1.0 INTRODUCTION

After several preliminary scoping sessions of background material by RPBio. Wayne McCrory with the clients in 2021 followed by a field reconnaissance of Mallory Ridge on April 26, 2022, this study was commissioned and funded by Tom and Eleanor Marshall of Deep Creek, BC. Amber Peters, BIT (Biologist in Training) did the two days of follow up field surveys and a review and assemblage of background information. The goal was to do a preliminary ecological and conservation assessment of the Mallory Ridge proposed protected area and based on our findings make relevant recommendations.

This report is owned by Tom and Eleanor Marshall. The authors used due diligence and fact checking in assembling this report and are not responsible for any errors in information from outside sources. In some instances, the authors have had to rely on professional opinion.

2.0 THE STUDY AREA

The Mallory Ridge proposed protected area is approximately 255 hectares of crown land surrounded by private land on the northern, eastern and western borders. It is a largely forested ecosystem between Enderby and Salmon Arm in the traditional territory of the Secwepemc and



The proposed protected area of Mallory Ridge (yellow).

Syilx First Nations in an area known as Deep Creek.

Mallory Ridge is southeast of the residential and recreational area of Gardom Lake. The study area is in the Columbia Shuswap Regional District (CSRD) of British Columbia's Thompson Nicola region. Here the dry southern interior meets BC's interior wet belt creating a diversity of wildlife habitats. The height of land reaches approximately 750m elevation.

The forest of the proposal area is dominated by maturing interior Douglas fir as a leading species, with some western red cedar-leading forest and a diversity of mixed secondary species associated with BC's dry and wet interior bioregions.

A large portion of Mallory Ridge includes the upland watershed of Gardom Lake. This habitat has long been observed by local residents as important wildlife habitat and a wildlife corridor to Gardom Lake. At Gardom Lake significant stewardship initiatives include water quality monitoring in partnership with the BC Ministry of Environment and the BC Lake Stewardship Society, invasive species management, northern painted turtle nesting habitat enhancement, wetland construction and tree swallow (*Tachycineta bicolor*) nesting box installation. The latter has been undertaken by volunteer residents, including the “Friends of Gardom Lake” and the Gardom Lake Stewardship Society. Conservation work has gone on for three decades.

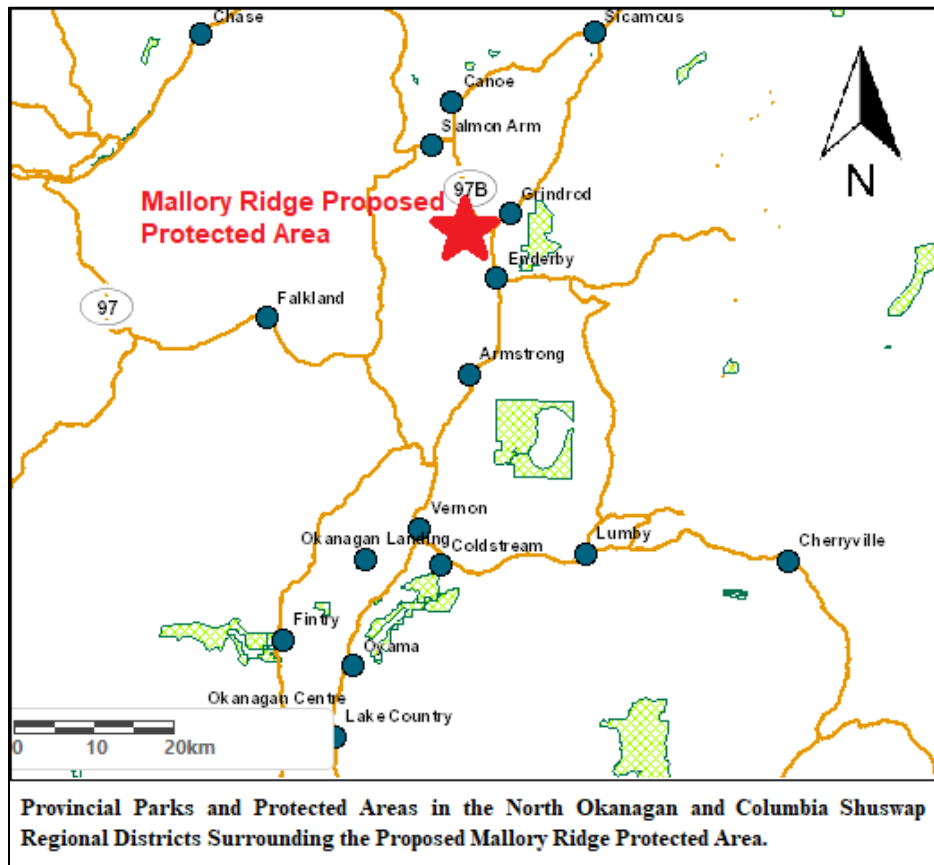
Right: Volunteers with the Gardom Lake Stewardship Society conduct water quality monitoring (GLSS 2022).

A significant portion of the water reaching the Lake is from groundwater flow from Mallory Ridge (Lapp & MacDonald 2022). Maintaining water quality and water flow in the summer is dependent on retaining fully functioning adjacent forest habitats in the watershed.

Local residents and recreationists from surrounding communities have maintained a 12 kilometer network of respectful-use trails within the Mallory Ridge proposal area, used for wildlife viewing, hiking, horseback riding, cross-country skiing, photography, nature appreciation and snowshoeing. Some of the trails are thought to be old skid roads from selection logging that occurred in the 1940s-50s. A power line right of way runs north to south just inside the eastern proposal boundary and is utilized by off road vehicles (ORVs).



Left: locals utilize the existing trail network for self-propelled enjoyment of nature. (Photo by Community Photographers).



Left: The region has only a small amount of the land base under various protective status. First Nations Indigenous Protected and Conserved Areas (IPCAs) or candidates have not been included in this map.

3.0 METHODS AND APPROACH

3.1 General wildlife assessment

Habitat assessment involved hiking along the existing Mallory Ridge trail network and off-trail areas and documenting general wildlife habitat features and wildlife sign including ungulate scat and browsing activity. Ground truthing and photo-documentation also took place including of wetland, forest types, ground cover and other habitat parameters.

3.2 Grizzly and black bear assessment

A preliminary bear habitat assessment involved documenting bear sign and food items that could be identified along the existing trail network and in habitats adjoining the trail network including wildflower meadows. This included identification of potential grizzly bear root/corm foods such as glacier lily and western spring beauty since residents reported a grizzly bear in the vicinity some years ago. General bear food density was estimated based on previous studies and Herrero (pers. comm.). Local grizzly bear sightings were also documented in 2022.

Several samples of guard hairs were collected from a large old-growth tree using tweezers. The tree had bear scratches and was identified as bear rub/mark tree. Hair was placed in a paper envelope and mailed to Wildlife Genetics International in Nelson BC for determination if the

hair was deposited by a black bear or grizzly bear. Volunteers installed a trail camera at the same rub/mark tree. The Stealth Cam trail camera was only temporarily active in the spring of 2022. We do not have the camera model or settings information.

3.3 Amphibian assessment

Daytime amphibian breeding assessments of wetland habitats included visual presence/absence surveys and dip-netting for amphibian eggs and larvae in constructed and natural wetlands on and downslope of Mallory Ridge. A portion of each wetland shoreline was surveyed in a limited timeframe where accessible on foot. Dip-netting involved making a long sweep through the shoreline vegetation and bottom substrate every approximately two meters. A visual search for eggs was also conducted by lifting and sifting by hand through shoreline aquatic vegetation along accessible wetland shoreline areas.

Local residents were also interviewed and their residential wetlands and terrestrial habitats downslope of Mallory Ridge were partially assessed for amphibian breeding and habitation.

A daytime shoreline canoe survey of Gardom Lake was also conducted to assess western toad habitat values and potential breeding/egg deposit sites, in particular for the western toad since Mallory Ridge could be a potential upland rearing and hibernation habitat for the at risk species.

Pacific tree frog nighttime call surveys were conducted at wetlands. This involved sitting at the shore of each open-water wetland for 5-10 minutes in the dark and assigning a pacific tree frog call index for each breeding site as follows:

Call Index

- 0 No calls heard
- 1 Individual calls can be counted with time between calls
- 2 Some calls overlapping but individuals are still distinguishable
- 3 Constant chorus. Impossible to count individuals

Opportunistic observations of adult amphibians were also recorded.

3.4 Reptile assessment

A talus slope habitat was visually surveyed for reptile presence in a time-constrained search. Rocks were lifted to increase the potential of visual encounters in suspect habitat areas. The survey was conducted during clear weather in the hotter part of the day to increase the likelihood of encounters during spring emergence. Other opportunistic observations of reptiles were also recorded in the study area.

3.5 Nighttime bat acoustic surveys

Acoustic sampling for bats was conducted using an Echo Meter Touch 2 (EMT 2 Pro) recorder manufactured by Wildlife Acoustics. The EMT consists of an ultrasonic microphone plugged into a smart phone or tablet so the user can see the sonogram of the echolocation calls and also see AutoID results. The EMT Pro records the calls and location of recordings for future analysis. Analysis of the digital acoustic files will be done using Kaleidoscope Pro Version 3.1.8.

Wildlife Acoustics provides the following disclaimer regarding their software:

Automatic identification (AutoID) is not perfect and will result in false positive and false negative errors. Never rely solely on the output of this software to make land management decisions. The AutoID is intended only as a suggestion to facilitate analysis, not to replace human expert vetting.

Limited resources mean that only suspect call sequences of bat species that are very rare or out of ecological context for the study area will be manually examined. This is currently underway and results once completed will be provided to the clients.

3.6 Forest type, age class, structural features assessment and old growth recruitment forest analysis

We assessed forest structural features for wildlife such as downed trees, tree cavities for bird nesting, and other aspects.

Baden Cross of Applied Conservation GIS completed a spatial analysis and mapping of forest types and age class, site index, species composition and watershed boundaries using provincial VRI data and provincial watershed boundary data. He then assessed the results to see if the mature forest (age classes 5-8) in the spatial analysis might qualify as old-growth recruitment forest under the current provincial program.

3.7 Threats

Potential threats to the proposal area were obtained in initial interviews with the clients. The outline of proposed logging plans and a map were obtained including the number of proposed cut blocks, size and locations.

3.8 Conservation assessment

Any previous conservation proposals of the study area as well as regional district plans and provincial land use plans and provincial protection policies were reviewed. The efficacy of logging mitigation guidelines such as old growth management areas (OGMAs) and wildlife tree patches (WTPs) under the province's 2002 Forest and Range Practices Act (FRPA) was also reviewed. We also applied the province's old growth study and old growth policies under 3.6 on forests.

3.8 Climate change considerations

Given the current escalation of wildfire, flooding and other weather-related events in the province that are partially attributed to global warming, relevant research was reviewed with respect to climate change and applied to the issue of proposed logging versus proposed protection of Mallory Ridge.

4.0 RESULTS & DISCUSSION

Habitat and species surveys of the proposal study area and Gardom Lake were conducted on April 23, May 3 and 4, 2022. Background research was done over the late spring and early summer and then the report was undertaken. The clients were sent an earlier draft to review.

4.1 General wildlife, wildlife habitat and species at risk values

The meeting of wet and dry bioregions in the proposal area leads to a flourishing of diverse plant communities within the forests with added biodiversity from a number of wetlands, semi-open meadows, rock bluffs and talus slopes. As a result a significant diversity of local and migratory wildlife species and confirmed or hypothetical species at risk occur (Appendix A, B & C). There are several cattail (*Typha latifolia*)-dominated, open-water wetlands as well as open wildflower meadows where a diversity of Indigenous plant foods have been documented by local biologists and naturalists.

A total of 151 provincially and/or federally-listed animal species are expected to occur or have already been confirmed in the study area including 41 provincially red listed species, 91 blue and 13 yellow listed species as well as six that have no provincial status but are endangered, threatened or of special concern federally (Appendix A).

*Right: A yellow-listed great grey owl (*Strix nebulosa*) in the proposal area. (Photo by Community Photographers).*



A total of 23 provincially and/or federally-listed plant species at risk are expected to occur or have already been confirmed in the study area including six red, 16 blue and one yellow listed species (Appendix B). At least 13 tree and 83 flowering plant species have been confirmed by a local biologist and naturalists. (Appendix C). We are waiting for confirmation of other species at risk that have been documented to date.

Overall, the proposal area has a low-moderate habitat value for ungulates and black and grizzly bears but because it is an isolated “island” refugium, critically functions as a movement corridor and security habitat in an area surrounded by intensive residential and land developments (It has higher values for a host of confirmed species and hypothetical species at risk as we will itemize).

Moose and deer scat and tracks were noted throughout the recreation/wildlife trail network as was some browsing on willow species (*Salix spp.*) on trails and around two open-water wetlands, suggesting the wetlands are important ungulate spring and summer foraging areas. Elk (*Cervus canadensis*) have been known to inhabit the area but have declined dramatically in recent years.

The proposal area was also identified within the range of fisher (*Martes pennanti*) habitat in the Okanagan-Shuswap Land and Resource Management Plan (LRMP). Though data for fisher are very limited this southern extent of their range has most likely contracted since 2001. However, retention of forests with features such as tree hollows that create suitable habitat for umbrella

species like fisher is becoming increasingly important to the preservation of biodiverse systems in British Columbia (Aubry et al. 2012).



Left: Meadows such as this create habitat diversity in the proposal. Right: A coyote in the proposal area. . (Photos by Community Photographers).

4.2 Bears

Black bears have been well known to utilize the proposal area. Signs of black bear digging in decaying wood and cambium feeding on various tree species were found in the proposal area. At least one bear rub tree and day bed were confirmed. Based on a variety of bear plant foods assessed, the proposal area was rated to have a low-moderate feeding potential and a high security value for a small number of black bears and grizzly bears.

The habitat potential for grizzly bears includes small semi-open meadows at higher elevations with glacier lily, western spring beauty and biscuitroot (*Lomatium spp.*) whose underground plant parts are dug by grizzly bears as part of their diet. There had been a few confirmed sightings on Mallory Ridge over the years and more recently there was a regular now gone presumably from old age. This one was coming down from Mallory Ridge and Mt Ida and fed often in the corn fields (Tom Marshall, pers. comm.). A mother grizzly bear and two cubs have also been sighted in the proposal area along the power line right of way in August of 2022.

Right: Bear biologist Wayne McCrory observes bear markings and hair on a large ponderosa pine mother tree. It is unknown for how many generations this tree may have been used for scent marking. (Photo by Eleanor Marshall).



Hair samples that resembled grizzly bear guard hairs were sent to the Wildlife Genetics International lab in Nelson, BC, which showed the sample to be inconclusive in terms of species type, likely due to having been exposed to the elements.

Right: One example of multiple documentations of cambium feeding observed along a bear trail on Mallory Ridge. (Photo by Amber Peters).



Residents of Gardom Lake have had some issues with bear conflicts on adjacent agricultural and residential lands in the past which at one point resulted in conservation officers trapping and exterminating a bear.

Julia Helland, WildSafe community coordinator for two CSRD electoral areas adjacent to Mallory Ridge and Gardom Lake, reported that 2021 was an “active year.” Ninety-one wildlife conflict reports were made to the B.C. Conservation Officer Service in adjacent electoral areas, including 38 calls for black bears and five for grizzly bears (Eagle Valley News 2021).

One of our significant concerns with logging development of the remaining wildlands in the corridor of Gardom Lake and Mallory Ridge is a likely increase in human-bear conflict due to extensive loss of security habitat. According to the BC Ministry of Environment (2020):

“Development can impact bears directly by increasing the frequency of bear and human conflict, leading to higher mortality, and indirectly by reducing habitat availability due to human-caused disturbance and avoidance by bears.”

Grizzly bears are listed as a species of ‘Special Concern’ under federal legislation and ranked as S3? (Vulnerable Uncertain) provincially. Of the 55 grizzly bear population units (GBPUs) in BC, the Columbia Shuswap GBPU whose range partially overlays Mallory Ridge is one of 15 with a high threat rating, largely due to human development. The population unit is highly isolated from other GBPU’s, reducing its ability to maintain genetic diversity and bounce back from population declines (Environmental Reporting BC. 2020).

4.3 Amphibians

On May 3 by Amber Peters found significant amphibian breeding in three wetlands on Mallory Ridge. These wetlands are structurally diverse with various shoreline depths, fallen logs and branches along the shorelines, emergent and submerged vegetation and decaying leaf litter. They would provide ideal breeding habitat for a number of amphibians that likely utilize the surrounding mixed species and age-class forest as terrestrial and hibernation habitats.

Preliminary visual and dip-net surveys found significant breeding of long-toed salamander and pacific tree frog. Eggs were visually confirmed in the three wetlands as were two adult long-toed salamanders and seven adult tree frogs. A call index of 3 (constant chorus. Impossible to count

individuals) was assigned to three wetlands in the study area during tree frog nighttime call surveys. The amplitude of breeding calls confirmed significantly more tree frogs than were visually observed during the limited day survey. This is also likely true for other amphibian species considering the limited timeframe allocated to visual surveys.

Significant pacific tree frog and long-toed salamander breeding were also confirmed through visual and call surveys in wetlands downslope of the proposal, as was long-toed salamander use of terrestrial habitat below the home of a residential property at the base of Mallory Ridge on May 4.

Western toads, including gravid adult females, have been confirmed downslope of Mallory Ridge in previous years and in the proposal area by residents. They likely utilize the proposed protected area as a terrestrial and hibernation habitat. The shoreline of Gardom Lake was found to be largely cattail-dominated with fallen logs and some shallow, sandy shoreline areas that may be suitable breeding habitats for western toad. Daytime shoreline surveys of the lake and several wetlands downslope of the proposal area on May 4 were not able to confirm western toad breeding (adults and egg masses). However, it is possible that breeding may occur in any of the upper or lower elevation wetlands within or downslope of the proposal area. The structurally diverse upland habitats of Mallory Ridge, which include features such as small mammal dens, decaying trees and talus rock slopes, may contain hibernacula for western toad.

Further study is needed to confirm use of these habitats by western toad as well as by great basin spadefoot toad (*Spea intermontana*) and other at-risk species expected in the proposal area.

Right: A western toad basking on a residential property below Mallory Ridge. (Photo by Community Photographers).



Western toads are yellow listed in BC and have experienced significant declines, largely due to the loss of habitats that contain suitable hibernacula (Province of British Columbia 2022). Their migratory lifecycle provides annual sustenance to a wide variety of other species, including invertebrates, birds, snakes, mammals and frogs that predate on their various life stages in aquatic and terrestrial habitats. The annual migration of toadlets (metamorphs) from lakes and ponds contributes to nutrient cycling as the majority of young distribute across relatively vast landscapes with a low rate of survival.

Threats to western toad were evaluated in 2012 by the Provincial Western Toad Working Group (2014), resulting in an overall threat rating of High-Medium. Declines observed in southern B.C. have resulted in an overall documented provincial decline of 10-30% (Provincial Western Toad Working Group 2014).

Amphibian populations globally have experienced detrimental declines, extirpations and extinction. The International Union for the Conservation of Nature (IUCN) found that 41% of all amphibian species assessed are currently threatened with extinction; more than any other

vertebrate group (2022). Because of their sensitivity to environmental pollution and other causes of decline, they are considered indicator species for the health of their ecosystems, and efforts to protect amphibians and their role in the ecosystems they inhabit have become more important in BC and globally. Protection of remaining populations is essential to maintaining healthy ecosystems.

4.4 Reptiles

A limited timeframe of 30 minutes was allocated to assessing a talus slope habitat on Mallory Ridge for potential reptile activity during the spring emergence season. A very cool, wet spring meant that detection probability may have been reduced. Efforts were focused on assessing the large talus rock slope habitat during the mid-afternoon (the warmest part of the day) on a clear day on May 3. In 30 minutes a northwestern alligator lizard and terrestrial garter snake were observed in the rocky slope. The talus habitat is structurally diverse with partial southern sun exposure, forest habitat at the mossy foothill of the slope, various rock sizes and overhanging rocks with cavernous openings. It is expected to potentially host a significant diversity of species which may include bats and western toads.

On May 3 & 4 one adult and one juvenile common garter snake and an additional terrestrial garter snake were documented in the proposal area. Significant use of Gardom Lake by painted turtles was also documented, as well as some use of wetlands downslope of Mallory Ridge including on residential property.



Right: Blue-listed painted turtles basking on Gardom Lake where community volunteers including the Gardom Lake Stewardship Society and private landowners have implemented nesting habitat enhancement by developing dedicated nesting sites where the turtles can nest without risk of traffic mortality to adults and young. (Photo by Amber Peters).



A terrestrial garter snake found near the power line right of way. May 3, 2022. (Photo by Amber Peters).

Northern rubber boa (*Charina bottae*) have also been confirmed in the proposal area, though the extent of their use of the area and nesting site locations are not currently known.

4.5 Nighttime bat acoustic surveys

Bat acoustic surveys occurred on nights of May 3 and 4. This was at the very start of the bat emergence season so the likelihood of significant findings for this preliminary

study may be relatively low compared to the more active warmer season. Several calls were collected on a clear night on May 3 at two open-water wetlands on Mallory Ridge as well as in an open, tall-grass field in the location of an old barn structure that may be utilized by bats at the base of Mallory Ridge. Recording efficacy on May 4 was limited by changing weather including periods of rain when bats seemed to be less active. Audio recordings from EMT surveys are currently being analyzed and will be included in an updated report or addendum.

4.6 Assessment of forest structural features for wildlife and GIS analysis of old growth recruitment forest value

A preliminary assessment of habitat values confirmed mixed-stand, mostly Douglas fir-leading forests that are developing old growth features important to many wildlife species and biodiversity. At risk plant communities and ungulate and bear foods populate some of the understory of these mixed forests. A partial list of flowering vascular plants confirmed in the proposal area can be found in Appendix C.

A GIS spatial analysis revealed that aging mature forests (age classes 5-8) in the proposal (with increasing carbon storage and sequestration capacity) include 249 hectares of forest with interior Douglas fir as a leading species and seven hectares of forest with western red cedar as a leading species. Western red cedar is a secondary species in 146 hectares of forest. Other species occurring as secondary in parts of the proposal area are ponderosa pine (*Pinus ponderosa*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), lodgepole pine (*Pinus contorta*), western larch (*Larix occidentalis*), western hemlock (*Tsuga heterophylla*), white pine (*Pinus strobus*), rocky mountain juniper (*Juniperus scopulorum*), Douglas maple (*Acer glabrum* var. *douglasii*), grand fir (*Abies grandis*) and Engelmann spruce (*Picea engelmannii*).

Forest structural features important to a variety of animal species were found to be common. These structures included sloughing tree bark, fallen and decaying logs, exposed root wads, standing dead tree snags, small, hollow cavities in standing and fallen trees and roots and variations in canopy cover.

Left: Loose, sloughing bark provides roosting habitat for bats.

Right: A fallen tree has created a small, natural wetland below its roots. These habitats are often home to amphibians, can provide roosting habitat for bats, and create unique microhabitat conditions that can host rare plant growth (Photos by Amber Peters).





Above: Tree pathogens (e.g., fungi, mistletoe) are essential for creating the old growth structures used for resting, reproduction and hibernation by many bird and mammal species (Photos: Amber Peters).

A small number of old growth trees that survived previous wildfires and the small amount of early selection logging occur in the proposal, including the previously mentioned old growth ponderosa pine tree used by bears as a mark/rub tree that is on the report cover. We considered these of particular importance as “mother trees”. According to forest ecologist Dr. Suzanne Simard these large, highly connected trees are important for the flow of information and resources in a forest; contributing to forest resiliency, adaptability and recovery (The Mother Tree Project 2022).

Right: A large cottonwood mother tree (Photo by Amber Peters).

A detailed GIS analysis revealed that the majority (~85%) of the forest is candidate old growth “recruitment” forest (age class 5-8) identified as “highest risk” in need of protection by the provincial old growth Technical Advisory Panel. The average age of the leading interior Douglas fir forest is 115 years and the western red cedar-leading forest is 95 years. With an average height class of four (28.5 – 34.7 m) and site index 18 (close to the benchmark ‘20’ as to define good growing sites), we concluded that these forests are locally significant in terms of recommended protection for future BC old growth recruitment defined by the provincial Technical Advisory Panel.

4.7 The Logging Threat

Mallory Ridge was formerly a candidate for a regional district conservation area but protection never occurred.

Recently, local residents were surprised to learn that Tolko Industries Ltd. has proposed roading and logging of four cut blocks in the proposal amounting to ~74 hectares, 41.63 ha of which are in the Gardom Lake watershed.



We estimated that logging would remove approximately 40% of the proposal area's forested trail system (~4.6 km of self-propelling trails) maintained by residents of three surrounding communities. Residents are also seriously concerned about how clearcut logging and roading in areas of their hiking trail network will impact and reduce their enjoyment. Research published in the journal *Nature Communications* suggests the economic value of protected areas to communities' mental health is an order of magnitude greater than the global value of protected area tourism (Buckley et al. 2019).

While we did not carry out a detailed environmental impact assessment of Tolko's logging plans, we submit that if the logging goes ahead, it will seriously erode the current ecological integrity of this high value biodiverse and small island ecosystem. We identified that a significant loss of intact forested security cover for wildlife and potentially increased motorized access from new logging roads would likely negatively impact wildlife. Additionally, fragmentation by logging and loss of security habitat may also lead to a local increase in human-bear conflicts. The loss of this significant portion of the remaining forested crown land on Mallory Ridge also has the potential to seriously reduce its value as old growth recruitment forest and lead to loss of old forest structures that are likely being utilized by species at risk.

While we cannot speak for First Nations, the anticipated logging impacts to wildlife habitats and vegetation communities important as potential traditional food gathering areas would also be a major concern.

Provincially legal protection measures, such as Old Growth Management Areas (OGMAs), Wildlife Tree Patches (WTPs), and small reserves for Identified Wildlife are generally used in forestry cut block planning and practices in BC under the 2002 Forest and Range Practices Act (FRPA). A mix of these will likely be applied by Tolko Industries to their proposed logging plan on Mallory Ridge in order to attempt to mitigate impacts to wildlife and other values and address residents' concerns.

However, it is our professional opinion from previous field research elsewhere and a former review of the scientific literature on the impacts of logging on wildlife and species at risk that these provincial stop-gap measures will be insufficient to protect the range of biodiversity (and recreational) values we identified in the proposal area. For one thing, the province has never conducted long range studies and to monitor if such "legal" measures are truly protecting the wildlife and biodiversity values they claim to protect. Secondly, recent research showed that small patch reserves such as OGMAs create a loss of Interior forest conditions in the adjacent older forests, including a loss of old forest-dependent species up to 100 meters from the edge of adjoining roads and clearcuts (Gorley and Merkel 2020). On the Sunshine Coast, an independent biological review of the Elphinstone forest proposed protected area concluded that the provincial legal protection measures used in logging plans would be too minimal and insufficient to protect the Elphinstone's high biodiversity values including numerous macrofungal (mushroom) communities (McCrary 2015). We feel the same would apply to the Mallory Ridge protected area proposal.

Additionally, a preliminary and confidential hydrological assessment done for our clients by MacHydro (2022) raised some important concerns related to Tolko's logging plans. The report is referred to here with permission from our clients. The report concluded that the proposed forest harvest by Tolko has a moderate to high potential to impact low flows, peak flows, timing of peak flows, and the overall water availability along Mallory Ridge. While the hydrologists' main focus was on the potential impact to domestic water licences within the study area, and although

it makes recommendations for mitigating these potential impacts, we submit that any potential impacts to hydrology and the possible amplification of existing debris and silt torrents into downslope waterbodies could threaten and compromise the habitat of blue-listed painted turtles at Gardom Lake and at-risk breeding amphibians in the proposal area.

A significant concern is that the success of long-term stewardship initiatives that support the use of Gardom Lake by northern painted turtle and other at-risk species will be detrimentally impacted by the disturbance and loss of a significant portion of its treed upslope watershed.

Clearcutting the forests surrounding our communities can seriously impact our watersheds, putting us at greater risk of droughts and wildfire, dirtying drinking water and increasing flood risk (Khanal & Parajuli 2013; US Forest Service 2000).



Left: This photo shows an alluvial fan in “Cheryl’s Pond” on private land adjacent to clearcut logging that took place in 2016 just south of the Mallory Ridge protected area proposal. The fan was observed to increase in size over several years and was attributed to turbid runoff from the adjacent logging. The photo was taken in 2021 by Eleanor Marshall.

4.8 Conservation assessment

The conservation goal of the 2001 LRMP was to increase protected areas from 2.9% of the Okanagan - Shuswap land base (a 2,449,164 hectare plan area) to 7.9%. One of the goals of the LRMP was to protect biodiversity, by preserving “rare plants, rare plant communities, rare

wildlife and other rare elements, including the habitat features they depend on”. The 7.9% LRMP protection goal was considerably short of the target of the 1992 BC Protected Areas Strategy, which was to protect 12% of the province's land base by the year 2000; although the 12% was not based on any sound conservation science.

Although protection progress was made with the Okanagan-Shuswap LRMP, the small number of new parks protected is a far cry from the 12% goal set for the province and recommended 44-

50% that conservation scientists internationally agree is necessary to preserve wide ranging species and associated biodiversity.

Mallory Ridge was recognized as an important conservation area and proposed for protection as a regional park by residents of Gardom Lake in 2000 and again as a Conservation Park by the CSRD in 2008. It is unfortunate, given that Mallory Ridge was once proposed as a regional conservation park, that it was not considered in the LRMP for Goal 2 protected status. Its wildlife and conservation values still warrant strong government considerations for full protection in collaboration with First Nations. Logging should not be allowed to proceed.

4.9 Climate Change Considerations

The United Nations “Red Alert” issued on global warming after the release of the International Panel on Climate Change (IPCC) report (2021), combined with the record BC heat waves and severe wildfires have accelerated the necessity to protect these older-aged forests in the province. According to the report (p. 345): “*Deforestation has contributed about one third of the total warming in hot extremes in some mid-latitude regions since pre-industrial times.*”

A 2021 IPCC report echoed a statement made in 2018 by 40 scientists from five countries that forests are currently the only proven means of removing and storing atmospheric CO₂ at a scale that can meaningfully contribute to achieving carbon balance. Forests remove about 28% of the carbon put into the atmosphere by humans. Cutting them not only loses their removal of carbon from the air, but also releases the carbon they have stored for decades into the atmosphere (Climate and Land Use Alliance 2018).

Just the logging and slash-burning practices of BC forestry alone produce higher gross carbon emissions than any other sector in BC (Pojar 2019). There is also increasing evidence that clearcut logging, followed by reforestation, creates fuel conditions that contribute to fires being easier to light and harder to control (Broadland 2021).

5.0 RECOMMENDATIONS

1. Overall the recreational and watershed values of the Mallory Ridge protected proposal to surrounding communities and its low-moderate wildlife values, high biodiversity values and mature forest old growth recruitment values make it a worthy candidate for protection. The Mallory Ridge mature forests with remaining mother trees should be allowed to reach their old growth potential to preserve biodiversity and contribute to carbon sequestration and community resilience in the face of increasing global warming impacts on the environment and communities. Additionally if clearcut logging and reforestation are allowed on Mallory Ridge, research shows this could increase the risk of a wildfire to surrounding communities.

This recommendation for protection should not be surprising since its local conservation values for protection were previously recognized some decades ago by the CSRD.

2. We highly recommend that protection include the entire 255-hectare crown land portion of Mallory Ridge as a protected area and not just a portion such as that which might represent a compromise to allow logging. A host of proposal options is available ranging from regional to

provincial protection (Class A Park or Conservancy) as well as an Indigenous Protected and Conserved Area (IPCA). Protection options should be coordinated with Indigenous interests and stewardship if possible.

3. As part of the spirit and intent of the BC government's 2019 *Declaration on the Rights of Indigenous Peoples Act*, as a priority the proponents are strongly recommended to work closely with First Nations especially the local Słatsin First Nations to document Indigenous ecological, traditional food, and cultural/heritage values and that includes recognition of First Nations Indigenous laws and customs as a key element to creating a foundation for the sharing of Indigenous knowledge and possible collaborative protection.

4. Additional study might be pursued, depending on funding and community interest, to further document biodiversity including species at risk values of the proposed protected area.

5. Serious consideration should be given to the option of the proponents hiring a part time experienced outreach coordinator to liaise with the Indigenous governments, local community, media, government agencies and others.

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Appendix A – Provincially or federally-listed animals confirmed or that may occur at Gardom Lake/Mallory Ridge

The following table was compiled through the BC Species and Ecosystem Explorer using a custom polygon surrounding the immediate vicinity of Gardom Lake and the proposed Mallory Ridge protected area. Search Criteria: Animals with BC Conservation Status: Red (Extirpated, Endangered, or Threatened), Blue (Special Concern) or Yellow (Not at Risk), or COSEWIC Status: Endangered, Threatened, Special Concern, Not at Risk, or Data Deficient.

Some of these species may have since been extirpated. Stemming the tide of further extirpation will require greater habitat protection.

Table 1: Provincially or federally-listed animals confirmed or that may occur at Gardom Lake or in the Mallory Ridge proposed protected area.

Scientific Name	English Name	BC List	Provincial	COSEWIC
<i>Cicindela parowana</i>	Dark Saltflat Tiger Beetle	Red	S1 (2015)	E
<i>Dryobates albolarvatus</i>	White-headed Woodpecker	Red	S1 (2015)	E
<i>Falco mexicanus</i>	Prairie Falcon	Red	S1 (2018)	NAR
<i>Lithobates pipiens</i>	Northern Leopard Frog	Red	S1 (2016)	E
<i>Nycticorax nycticorax</i>	Black-crowned Night-heron	Red	S1 (2015)	
<i>Rangifer tarandus</i> pop. 1	Caribou (Southern Mountain Population)	Red	S1 (2017)	E
<i>Satyrrium behrii</i>	Behr's Hairstreak	Red	S1 (2020)	E
<i>Satyrrium semiluna</i>	Half-moon Hairstreak	Red	S1 (2020)	E
<i>Eremobates</i> sp. 1		Red	S1? (2016)	
<i>Eremobates</i> sp. 2		Red	S1? (2016)	
<i>Hemerotrecha</i> sp. 1		Red	S1? (2016)	
<i>Danaus plexippus</i>	Monarch	Red	S1?B (2020)	E
<i>Aechmophorus clarkii</i>	Clark's Grebe	Red	S1B (2015)	
<i>Ammodramus savannarum</i>	Grasshopper Sparrow	Red	S1B (2018)	
<i>Athene cunicularia</i>	Burrowing Owl	Red	S1B (2020)	E
<i>Limosa haemastica</i>	Hudsonian Godwit	Red	S1B (2020)	T
<i>Oreoscoptes montanus</i>	Sage Thrasher	Red	S1B (2015)	E
<i>Pelecanus erythrorhynchos</i>	American White Pelican	Red	S1B (2015)	NAR
<i>Sterna forsteri</i>	Forster's Tern	Red	S1B (2015)	DD
<i>Aechmophorus occidentalis</i>	Western Grebe	Red	S1B,S2N (2015)	SC
<i>Apodemia mormo</i>	Mormon Metalmark	Red	S1S2 (2020)	E

<i>Sorex preblei</i>	Preble's Shrew	Red	S1S2 (2015)	
<i>Acipenser transmontanus</i>	White Sturgeon	No Status	S2 (2018)	E/T
<i>Ambystoma mavortium</i>	Western Tiger Salamander	Red	S2 (2016)	E
<i>Chlosyne hoffmanni</i>	Hoffman's Checkerspot	Red	S2 (2020)	
<i>Gonidea angulata</i>	Rocky Mountain Ridged Mussel	Red	S2 (2014)	E
<i>Hypsiglena chlorophaea</i>	Desert Nightsnake	Red	S2 (2018)	E
<i>Polites sabuleti</i>	Sandhill Skipper	Red	S2 (2020)	
<i>Rhinichthys umatilla</i>	Umatilla Dace	Red	S2 (2019)	T
<i>Speyeria mormonia erinna</i>	Mormon Fritillary, <i>erinna</i> subspecies	Red	S2 (2021)	
<i>Stylurus olivaceus</i>	Olive Clubtail	Red	S2 (2015)	E
<i>Taxidea taxus</i>	American Badger	Red	S2 (2015)	E
<i>Eremobates scaber</i>		Red	S2? (2016)	
<i>Falco peregrinus anatum</i>	Peregrine Falcon, <i>anatum</i> subspecies	Red	S2? (2011)	NAR
<i>Tyto alba</i>	Barn Owl	Red	S2? (2015)	T
<i>Bartramia longicauda</i>	Upland Sandpiper	Red	S2B (2015)	
<i>Buteo swainsoni</i>	Swainson's Hawk	Red	S2B (2015)	
<i>Icteria virens</i>	Yellow-breasted Chat	Red	S2B (2018)	E
<i>Aeshna constricta</i>	Lance-tipped Darner	Blue	S2S3 (2015)	
<i>Argia vivida</i>	Vivid Dancer	Blue	S2S3 (2015)	SC
<i>Callophrys affinis</i>	Immaculate Green Hairstreak	Blue	S2S3 (2020)	
<i>Coluber constrictor</i>	North American Racer	Blue	S2S3 (2018)	T
<i>Crotalus oreganus</i>	Western Rattlesnake	Blue	S2S3 (2018)	T
<i>Galba obrussa</i>	Golden Fossaria	Blue	S2S3 (2015)	
<i>Magnipelta mycophaga</i>	Magnum Mantleslug	Blue	S2S3 (2015)	SC
<i>Myotis ciliolabrum</i>	Western Small-footed Myotis	Blue	S2S3 (2015)	
<i>Phanogomphus graslinellus</i>	Pronghorn Clubtail	Blue	S2S3 (2015)	
<i>Promenetus umbilicatellus</i>	Umbilicate Sprite	Blue	S2S3 (2015)	
<i>Sphaerium occidentale</i>	Herrington Fingernailclam	Blue	S2S3 (2015)	

<i>Stagnicola apicina</i>	Abbreviate Pondsnaill	Blue	S2S3 (2015)	
<i>Synaptomys borealis artemisiae</i>	Northern Bog Lemming, <i>artemisiae</i> subspecies	Blue	S2S3 (2006)	
<i>Tympanuchus phasianellus columbianus</i>	Sharp-tailed Grouse, <i>columbianus</i> subspecies	Blue	S2S3 (2005)	
<i>Larus californicus</i>	California Gull	Blue	S2S3B (2015)	
<i>Limnodromus griseus</i>	Short-billed Dowitcher	Blue	S2S3B (2015)	
<i>Melanerpes lewis</i>	Lewis's Woodpecker	Blue	S2S3B (2015)	T
<i>Recurvirostra americana</i>	American Avocet	Blue	S2S3B (2015)	
<i>Spizella breweri breweri</i>	Brewer's Sparrow, <i>breweri</i> subspecies	Blue	S2S3B (2018)	
<i>Cicindela hirticollis</i>	Hairy-necked Tiger Beetle	Blue	S2S4 (2017)	
<i>Chrysemys picta</i>	Northern Painted Turtle	No Status	S3 (2018)	E/SC
<i>Cottus hubbsi</i>	Columbia Sculpin	Blue	S3 (2019)	SC
<i>Cupido comyntas</i>	Eastern Tailed Blue	Blue	S3 (2020)	
<i>Enallagma clausum</i>	Alkali Bluet	Blue	S3 (2015)	
<i>Epargyreus clarus</i>	Silver-spotted Skipper	Blue	S3 (2020)	
<i>Falco peregrinus</i>	Peregrine Falcon	No Status	S3 (2015)	SC
<i>Gulo gulo</i>	Wolverine	No Status	S3 (2015)	SC
<i>Gulo gulo luscus</i>	Wolverine, <i>luscus</i> subspecies	Blue	S3 (2010)	SC
<i>Hemphillia camelus</i>	Pale Jumping-slug	Blue	S3 (2015)	
<i>Libellula pulchella</i>	Twelve-spotted Skimmer	Blue	S3 (2015)	
<i>Lycaena nivalis</i>	Lilac-bordered Copper	Blue	S3 (2020)	
<i>Macromia magnifica</i>	Western River Cruiser	Blue	S3 (2015)	
<i>Megascops kennicottii macfarlanei</i>	Western Screech-Owl, <i>macfarlanei</i> subspecies	Blue	S3 (2017)	T
<i>Myotis thysanodes</i>	Fringed Myotis	Blue	S3 (2015)	DD
<i>Ophiogomphus occidentis</i>	Sinuous Snaketail	Blue	S3 (2015)	
<i>Oreamnos americanus</i>	Mountain Goat	Blue	S3 (2015)	
<i>Perognathus parvus</i>	Columbia Plateau Pocket Mouse	Blue	S3 (2015)	
<i>Pholisora catullus</i>	Common Sootywing	Blue	S3 (2020)	

<i>Pituophis catenifer deserticola</i>	Gopher Snake, <i>deserticola</i> subspecies	Blue	S3 (2018)	T
<i>Polites sonora</i>	Sonora Skipper	Blue	S3 (2020)	NAR
<i>Pyrgus communis</i>	Checkered Skipper	Blue	S3 (2020)	
<i>Reithrodontomys megalotis</i>	Western Harvest Mouse	Blue	S3 (2015)	E
<i>Satyrium californica</i>	California Hairstreak	Blue	S3 (2020)	
<i>Spea intermontana</i>	Great Basin Spadefoot	Blue	S3 (2018)	T
<i>Sylvilagus nuttallii</i>	Nuttall's Cottontail	Blue	S3 (2015)	SC
<i>Ardea herodias herodias</i>	Great Blue Heron, <i>herodias</i> subspecies	Blue	S3? (2017)	
<i>Catherpes mexicanus</i>	Canyon Wren	Blue	S3? (2015)	NAR
<i>Chrysemys picta</i> pop. 2	Northern Painted Turtle - Intermountain - Rocky Mountain Population	Blue	S3? (2018)	SC
<i>Eremophila alpestris merrilli</i>	Horned Lark, <i>merrilli</i> subspecies	Blue	S3? (2017)	
<i>Ovis canadensis</i>	Bighorn Sheep	Blue	S3? (2015)	
<i>Ursus arctos</i>	Grizzly Bear	Blue	S3? (2015)	SC
<i>Buteo platypterus</i>	Broad-winged Hawk	Blue	S3?B (2015)	
<i>Dolichonyx oryzivorus</i>	Bobolink	Blue	S3B (2015)	SC
<i>Empidonax wrightii</i>	Gray Flycatcher	Blue	S3B (2015)	NAR
<i>Hydroprogne caspia</i>	Caspian Tern	Blue	S3B (2015)	NAR
<i>Numenius americanus</i>	Long-billed Curlew	Blue	S3B (2018)	SC
<i>Podiceps nigricollis</i>	Eared Grebe	Blue	S3B (2015)	
<i>Psiloscopus flammeolus</i>	Flammulated Owl	Blue	S3B (2015)	SC
<i>Sphyrapicus thyroideus</i>	Williamson's Sapsucker	Blue	S3B (2020)	E
<i>Botaurus lentiginosus</i>	American Bittern	Blue	S3B, SNRN (2015)	
<i>Asio flammeus</i>	Short-eared Owl	Blue	S3B, S2N (2015)	T
<i>Melanitta perspicillata</i>	Surf Scoter	Blue	S3B, S4N (2015)	
<i>Branta bernicla</i>	Brant	Blue	S3M (2015)	
<i>Buteo lagopus</i>	Rough-legged Hawk	Blue	S3N (2015)	NAR
<i>Cygnus columbianus</i>	Tundra Swan	Blue	S3N (2015)	
<i>Accipiter gentilis atricapillus</i>	Northern Goshawk, <i>atricapillus</i> subspecies	Blue	S3S4 (2017)	NAR
<i>Argia emma</i>	Emma's Dancer	Blue	S3S4 (2015)	
<i>Corynorhinus townsendii</i>	Townsend's Big-eared Bat	Blue	S3S4 (2015)	
<i>Erythemis collocata</i>	Western Pondhawk	Blue	S3S4 (2015)	

<i>Euderma maculatum</i>	Spotted Bat	Blue	S3S4 (2015)	SC
<i>Galba dalli</i>	Dusky Fossaria	Blue	S3S4 (2015)	
<i>Gyraulus crista</i>	Star Gyro	Blue	S3S4 (2015)	
<i>Hesperia nevada</i>	Nevada Skipper	Blue	S3S4 (2020)	
<i>Nannopterum auritum</i>	Double-crested Cormorant	Blue	S3S4 (2015)	NAR
<i>Oncorhynchus clarkii clarkii</i>	Cutthroat Trout, <i>clarkii</i> subspecies	Blue	S3S4 (2004)	
<i>Patagioenas fasciata</i>	Band-tailed Pigeon	Blue	S3S4 (2015)	SC
<i>Plestiodon skiltonianus</i>	Western Skink	Blue	S3S4 (2018)	SC
<i>Pristiloma arcticum</i>	Northern Tightcoil	Blue	S3S4 (2015)	
<i>Salvelinus confluentus</i>	Bull Trout	Blue	S3S4 (2018)	SC
<i>Sphaerium striatinum</i>	Striated Fingernailclam	Blue	S3S4 (2015)	
<i>Stagnicola traski</i>	Widelip Pondsnaill	Blue	S3S4 (2015)	
<i>Aeronautes saxatalis</i>	White-throated Swift	Blue	S3S4B (2015)	
<i>Butorides virescens</i>	Green Heron	Blue	S3S4B (2015)	
<i>Chondestes grammacus</i>	Lark Sparrow	Blue	S3S4B (2015)	
<i>Contopus cooperi</i>	Olive-sided Flycatcher	Blue	S3S4B (2015)	SC
<i>Cypseloides niger</i>	Black Swift	Blue	S3S4B (2021)	E
<i>Euphagus carolinus</i>	Rusty Blackbird	Blue	S3S4B (2015)	SC
<i>Hirundo rustica</i>	Barn Swallow	Blue	S3S4B (2015)	SC
<i>Phalaropus lobatus</i>	Red-necked Phalarope	Blue	S3S4B (2015)	SC
<i>Pluvialis dominica</i>	American Golden-Plover	Blue	S3S4B (2015)	
<i>Falco rusticolus</i>	Gyrfalcon	Blue	S3S4B, SNRN (2015)	NAR
<i>Galba truncatula</i>	Attenuate Fossaria	Blue	S3S5 (2015)	

<i>Physella virginea</i>	Sunset Physa	Blue	S3S5 (2015)	
<i>Calcarius pictus</i>	Smith's Longspur	Blue	S3S5B (2015)	
<i>Anaxyrus boreas</i>	Western Toad	Yellow	S4 (2016)	SC
<i>Aplodontia rufa</i>	Mountain Beaver	Yellow	S4 (2015)	SC
<i>Charina bottae</i>	Northern Rubber Boa	Yellow	S4 (2018)	SC
<i>Megascops kennicottii</i>	Western Screech-Owl	No Status	S4 (2015)	T
<i>Myotis lucifugus</i>	Little Brown Myotis	Yellow	S4 (2015)	E
<i>Chordeiles minor</i>	Common Nighthawk	Yellow	S4B (2015)	SC
<i>Lasionycteris noctivagans</i>	Silver-haired Bat	Yellow	S4S5 (2015)	
<i>Lasiurus cinereus</i>	Hoary Bat	Yellow	S4S5 (2015)	
<i>Myotis californicus</i>	Californian Myotis	Yellow	S4S5 (2015)	
<i>Myotis volans</i>	Long-legged Myotis	Yellow	S4S5 (2015)	
<i>Coccythraustes vespertinus</i>	Evening Grosbeak	Yellow	S5 (2015)	SC
<i>Eptesicus fuscus</i>	Big Brown Bat	Yellow	S5 (2015)	
<i>Myotis yumanensis</i>	Yuma Myotis	Yellow	S5 (2015)	
<i>Myotis evotis</i>	Long-eared Myotis	Yellow	S5? (2015)	
<i>Copablepharon absidum</i>	Columbia Dune Moth	Red	SH (2009)	DD
<i>Sphyrapicus thyroideus thyroideus</i>	Williamson's Sapsucker, <i>thyroideus</i> subspecies	No Status	SNRB (2012)	E
<i>Lepus townsendii</i>	White-tailed Jackrabbit	Red	SX (2015)	
<i>Limnitis archippus</i>	Viceroy	Red	SX (2020)	
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo	Red	SXB (2015)	

Appendix B – Provincially or federally-listed plants confirmed or that may occur at Gardom Lake/Mallory Ridge

The following table was compiled through the BC Species and Ecosystem Explorer using a custom polygon surrounding the immediate vicinity of Gardom Lake and the proposed Mallory Ridge protected area. Search Criteria: Plants with BC Conservation Status: Red (Extirpated, Endangered, or Threatened), Blue (Special Concern) or Yellow (Not at Risk), or COSEWIC Status: Endangered, Threatened, Special Concern, Not at Risk, or Data Deficient

Some of these species may have since been extirpated. Stemming the tide of further extirpation will require greater habitat protection.

Table 2: Provincially or federally-listed confirmed or that may occur at Gardom Lake or in the Mallory Ridge proposed protected area.

Scientific Name	English Name	BC List	Provincial	COSEWIC
<i>Eleocharis atropurpurea</i>	purple spike-rush	Red	S1 (2019)	
<i>Taraxia breviflora</i>	short-flowered evening-primrose	Red	S1 (2019)	
<i>Carex epapillosa</i>	blackened sedge	Red	S1? (2021)	
<i>Olsynium douglasii</i> var. <i>inflatum</i>	satinflower	Red	S1? (2017)	
<i>Sisyrinchium idahoense</i> var. <i>occidentale</i>	Idaho blue-eyed grass	Red	S1S3 (2015)	
<i>Schoenoplectiella saximontana</i>	Rocky Mountain clubrush	Red	S2 (2019)	
<i>Bryoerythrophyllum columbianum</i>	Columbian carpet moss	Blue	S2S3 (2015)	SC
<i>Claytonia cordifolia</i>	heart-leaved springbeauty	Blue	S2S3 (2019)	
<i>Pinus albicaulis</i>	whitebark pine	Blue	S2S3 (2019)	E
<i>Triglochin concinna</i> var. <i>debilis</i>	slender arrow-grass	Blue	S2S3 (2015)	
<i>Utricularia ochroleuca</i>	ochroleucous bladderwort	Blue	S2S3 (2019)	
<i>Acorus americanus</i>	American sweet-flag	Blue	S3 (2019)	
<i>Azolla mexicana</i>	Mexican mosquito fern	Blue	S3 (2019)	T
<i>Crataegus atrovirens</i>	dark-green hawthorn	Blue	S3 (2019)	
<i>Liparis loeselii</i>	yellow widelip orchid	Blue	S3 (2019)	
<i>Marsilea vestita</i>	hairy water-clover	Blue	S3 (2019)	
<i>Pterygoneurum kozlovii</i>	alkaline wing-nerved moss	Blue	S3 (2015)	T
<i>Rhynchospora capillacea</i>	brown beak-rush	Blue	S3 (2019)	

<i>Salix amygdaloides</i>	peach-leaf willow	Blue	S3 (2019)	
<i>Viola sororia</i>	woolly blue violet	Blue	S3 (2019)	
<i>Berula incisa</i>	cut-leaved water-parsnip	Blue	S3? (2019)	
<i>Crataegus okanaganensis</i> var. <i>okanaganensis</i>	Okanagan hawthorn	Blue	S3?	
<i>Potentilla glaucophylla</i> var. <i>perdissecta</i>	diverse-leaved cinquefoil	Yellow	S4S5 (2021)	

Appendix C – Preliminary list of flowering vascular plant species confirmed on Mallory Ridge

This list was developed for the original Mallory Ridge Park Proposal, by retired biologist Tom Crowley and naturalists Mary Lou Tapson-Jones and Margaret Filiatrault in 2000. Updated by Eleanor Marshall in 2022.

Scientific Name	Common Name
<i>Achillea millefolium</i>	Yarrow
<i>Adenocaulon bicolor</i>	Pathfinder
<i>Agoseris</i>	False Dandelion
<i>Allium cernuum</i>	Nodding Onion
<i>Amelanchier alnifolia</i>	Saskatoon, Shadbush, etc.
<i>Androsace occidentalis</i>	Fairy Candelabra
<i>Antennaria</i>	Pussy Toes
<i>Arabis drummondii</i>	Drummond's Rockcress
<i>Arabis holboellii</i>	Holboell's Rockcress
<i>Aralia nudicaulis</i>	Sarsaparilla
<i>Arctistaphylos</i>	Kinnikinic
<i>Arctostaphylos uva-ursi</i>	Vetch species
<i>Arnica cordifolia</i>	Heart Leaved Arnica
<i>Asarum caudatum</i>	Wild Ginger
<i>Aster conspicuus</i>	Showy Aster
<i>Astragalus miser</i>	Balsam Root
<i>Balsamorhiza sagittata</i>	Arrow-Leaved Balsam Root
<i>Berberis</i>	Sticky Laurel
<i>Calamagrotis rubescens</i>	Pine grass
<i>Calypso bulbosa</i>	Fairyslipper
<i>Castilleja minuta</i>	Red Paintbrush
<i>Ceanothus sanguineus</i>	Redstem Ceanothus
<i>Chimaphila umbellata</i>	Pipsissewa
<i>Chrysanthemum leucanthemum</i>	Oxeye Daisy
<i>Claytonia lanceolata</i>	Spring Beauty
<i>Clematis columbiana</i>	Clematis - blue
<i>Clematis ligusticifolia</i>	Clematis - white
<i>Clintonia uniflora</i>	Queen's Cup
<i>Collinsia parviflora</i>	Blue-eyed Mary
<i>Corallorhiza striata</i>	Striped Coralroot
<i>Coralliorhiza trifida</i>	Yellow Coral Root
<i>Cornus canadensis</i>	Bunch Berry

<i>Cornus stolonifera</i>	Red Osier Dogwood
<i>Crataegus douglasii</i>	Hawthorn
<i>Cypridedium calceolus</i>	Yellow Ladyslipper
<i>Cypripedium montanum</i>	Mountain Ladyslipper
<i>Daucus carota</i>	Queen Ann's Lace
<i>Delphinium menzies</i>	Larkspur
<i>Disporum hookeri</i>	Fairy Bells
<i>Dodecatheon</i>	Shooting Star
<i>Epilobium angustifolium</i>	Fireweed
<i>Erigeron</i>	Daisy- like flowers
<i>Erythronium grandiflorum</i>	Glacier Lily
<i>Frageria</i>	Strawberries
<i>Fritillaria lanceolata</i>	Chocolate Lily
<i>Fritillaria pudica</i>	Yellow Bells
<i>Geum triflorum</i>	Three Flowered Avens
<i>Goodyera oblongifolia</i>	Rattlesnake Plantain
<i>Hacklia</i>	False Forget-me-not
<i>Heuchera cylindrica</i>	Alumroot
<i>Hieracium aurantiacum</i>	Orange Hawkweed
<i>Hieracium gracile</i>	Slender Hawkweed
<i>Holodiscus discolor</i>	Ocean Spray
<i>Leucanthemum vulgare</i>	Oxeye Daisy
<i>Lilium columbianum</i>	Tiger Lily
<i>Linnaea borealis</i>	Twinflower
<i>Lithophragma ruderales</i>	Fringecup
<i>Lithophragma bulbifera</i>	Fringecup- early
<i>Lithospermum ruderales</i>	Puccoon or Gromwell
<i>Lomatium dissectum</i>	Fern-leafed desert parsley
<i>Lomatium macrocarpum</i>	Biscuitroot
<i>Lomatium tiernatum</i>	Spring Gold
<i>Lonicera ciliosa</i>	Orange Honeysuckle
<i>Lonicera involucrata</i>	Black Twinberry
<i>Lonicera utahensis</i>	Utah Honeysuckle
<i>Lupinus</i>	Lupine
<i>Lysichiton americanum</i>	Skunk Cabbage
<i>Lycopodium</i>	Ground Cedar and Fir
<i>Mahonia aquilifolium</i>	Oregon Grape
<i>Melilotus alba</i>	White Sweet-clover
<i>Mertensia oblongifolia</i>	Mertensia or Lungwort

<i>Monotropa uniflora</i>	Indian Pipe
<i>Orobanche uniflora</i>	Cancer Root
<i>Pachistima myrinites</i>	False Box
<i>Penstemon fruticosus</i>	Shrubby Penstemon
<i>Penstemon rupicola</i>	Rock Penstemon
<i>Petasites frigidus</i>	Coltsfoot
<i>Potentilla gracilis</i>	Cinquefoil
<i>Prunella vulgaris</i>	Heal-all
<i>Prunus emarginta</i>	Bitter Cherry
<i>Prunus virginiana</i>	Choke Cherry
<i>Ranunculus glaberrimus</i>	Sagebrush Buttercup
<i>Ranunculus acris</i>	Tall Buttercup
<i>Ribes lacustre</i>	Swamp Current
<i>Rosa nutkana</i>	Rose hip/Wild Rose
<i>Rubus idaeus</i>	Red Raspberry
<i>Sambucus racemosa</i>	Redberry Elder
<i>Satureja douglasii</i>	Yerba Buena
<i>Saxifrage Intergrifolia</i>	Saxifrage
<i>Senecia</i>	Ragwort - Western
<i>Shepherdia canadensis</i>	Soopolallie
<i>Silene menziesii</i>	Campion - small
<i>Sisyrinchium inflatum</i>	Grass Widow
<i>Smilacina racemosa</i>	False Salomon's Seal
<i>Smilacina stellata</i>	Starflower Solomon's Seal
<i>Solidago canadensis</i>	Golden Rod
<i>Spiraea betulifolia</i>	Birch-leaved Spirea
<i>Spiranthes romanzoffiana</i>	Lady's Tresses
<i>Streptopus amplexifolius</i>	Twisted Stalk
<i>Symphoricarpus alba</i>	Snowberry
<i>Taraxacum officinale</i>	Dandelion
<i>Trifolium pratense</i>	Red Clover
<i>Vaccinium membranaceum</i>	Black Huckleberry
<i>Viburnum trilobum</i>	Highbush Cranberry
<i>Viola adunca</i>	Common Blue Violet
<i>Viola canadensis</i>	Tall White Violet
<i>Viola glabella</i>	Small Yellow or white violet
<i>Viola nephrophylla</i>	Bog Violet
<i>Viola nuttallii</i>	Yellow Prairie Violet
<i>Zigadenus venenosus</i>	Death Camas

Appendix D - Mallory Ridge Hydrologic Assessment funded by Western Canada Environmental Law through their Environmental Dispute Resolution Fund.



August 24, 2022

Tom and Eleanor Marshall
toelmarshall@gmail.com

Mallory Ridge Hydrologic Assessment

Introduction

This memo provides a basic hydrologic assessment of the Mallory Ridge area with a focus on the potential impacts that forest harvesting may have to low flows, peak flows, timing of peak flows, and the overall water availability. We also provide a desktop analysis of the current condition disturbance indicators including road density, Equivalent Clearcut Area (ECA), and a topographic analysis. The memo is in response to concerns raised by community members on both sides of Mallory Ridge and the Gardom Lake Stewardship Society that the logging proposed by Tolko in 2020 (Figure 1) may affect the hydrology along Mallory Ridge, and primarily the three watersheds of interest: Gardom Lake watershed, Ferguson Creek watershed, and Glenmary Creek watershed.

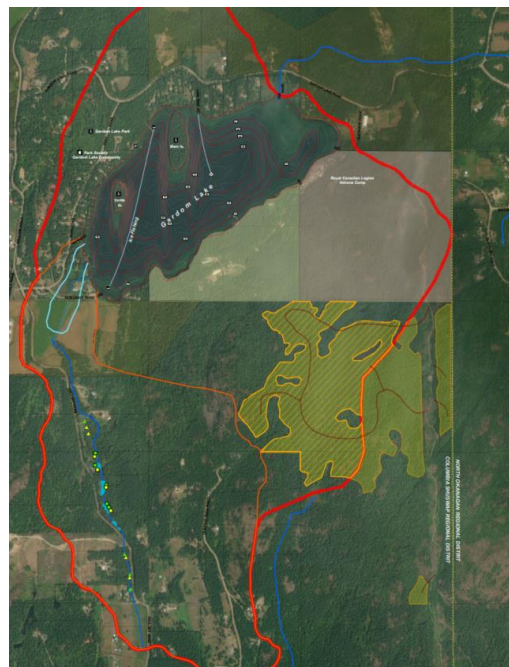


Figure 1. Proposed 2020 Development (Map prepared by the Columbia Shuswap Regional District in 2020).

Assessment Area

Mallory Ridge runs north to south and is the watershed boundary between the Okanagan watershed, part of the Columbia River watershed, and the Thompson River watershed, part of the Fraser River watershed. The slopes at the west edge of Mallory Ridge shed water through the Grange Road Bowl (Ferguson Creek watershed) which joins Deep Creek downstream and enters the north arm of Okanagan Lake. The remainder of the water flows towards the Fraser River through Gardom Lake or east to the Shuswap River. The Ridge is located between Salmon Arm and Enderby, BC and has

average elevation of about 700 m ASL with its highest point being about 850 m. It is the transition zone between the dry southern interior bioregion and the wetter interior region and is within the Interior Cedar Hemlock BEC Zone. The three watersheds of concern are Gardom Lake watershed, which includes Mallory Creek, Ferguson Creek watershed and the Glenmary Creek watershed (Appendix A). Mallory Ridge contains both private and crown land, with some of the private land being cleared, and a BC Hydro mainline runs north to south along the ridge. Several private residences are at the base of Mallory Ridge, with some below relatively steep slopes.

Mallory Ridge is characterized as having complex interaction between surface water and groundwater. Gardom Lake is primarily spring-fed and sensitive to contamination by pollutants and changes in groundwater fluctuations. It has high wildlife values and home to migratory birds, fish and western painted turtles, amphibians and reptiles (GLSS, 2022). Mallory Creek consists of a series of manmade impoundments located on private land upstream of where it enters Gardom Lake. In 2018, a new wetland was established at the mouth of Mallory Creek prior to entering Gardom Lake. Mallory Creek typically runs dry in the later summer. The hydrologic regime of the area is characteristic of a landscape with a seasonal snowpack, with the annual maximum peakflow typically occurring in April. There are no hydrometric gauges within any of the three watersheds or streams along the ridge.

A field reconnaissance along Mallory Ridge took place on June 23 and 24, 2022. Appendix A shows the primarily field sites and Appendix B shows selected photos.

Current Condition Assessment

Channel Conditions

The topography of Mallory Ridge is undulating with numerous natural ponds and wetlands and natural groundwater recharge areas in the upper and middle elevations. The middle and lower elevations within the Gardom Lake watershed and Ferguson Creek watersheds consist of “wet” areas or groundwater discharge zones (Appendix C). Within the gullies and NCD’s, subsurface flow was evident throughout the ridge. Springs were identified along the bench south of Gardom Lake along the Glenmary Road (Appendix C). Ferguson Creek is considered an S6 to NCD, depending on the channel section, and is ephemeral, only flowing during the spring or following major rain events. Sections of the creek flow subsurface and re-emerge at lower elevations along the ridge.

Equivalent Clearcut Area (ECA)

An ECA was calculated for the historical cutblock area as a product of disturbed area (km²) and a hydrologic recovery factor assigned based on tree height (Winkler and Boon, 2015) for each watershed unit. Higher recovery rates are assigned as the tree height increases, which assumes the growing stand hydrologically functions like a mature stand than a recent clearcut. ECA’s were calculated for each watershed and for the watershed area above the H₆₀ elevation, or the snow sensitive zone. For reference, the following ECAs above the H₆₀ line and associated potential of increasing peak flow have been used for watershed assessments:

- <30% ECA above H₆₀ = low potential of increased peak flows
- 30 to 40% ECA above H₆₀ = moderate potential of increased peak flows
- >40% ECA above H₆₀ = high potential of increased peak flows

During the field assessment, recent harvesting was identified on private land within the Gardom Lake watershed above the H₆₀ elevation (field stop; Appendix A). This block was not shown in the most current Provincial database (VRI 2021 or Harvested Areas of BC) and is not part of the ECA calculations

for Gardom Lake watershed. The upper ridge had also been impacted by the drought and heat stress in 2021 as noted with patches of dead cedars. The ECA calculations are current to February 2021 and therefore do not account for any recent private land harvested (Table 1). ECA's have been used to indicate the potential for changes in the watershed hydrologic regime and particularly peak flows, and more recently impacts to low flows.

Table 1. Watershed Area, Current ECA Calculations (February 8, 2021), and Road Density.

Watershed Unit	Area	Total ECA	Elevation H ₆₀	Area Above H ₆₀	ECA above H ₆₀	Road Density
	ha	ha/%	m	ha	ha/%	km/km ²
Gardom Lake	599	35/6*	566	357	9/2*	3.3
Ferguson Creek	284	54/19	691	170	53/31	4.0
Glenmary Creek	223	19/8	593	133	77/12	5.6

* Gardom Lake ECA does not include recent 2021 logging.

The ECA for Gardom Lake watershed does not include the recent 2021 logging, which is above the H₆₀ elevation. Based on the 2021 information, the ECA above the H₆₀ is 2% and considered a *Low* potential. The ECA above the H₆₀ for Ferguson Creek watershed is 31% and is considered a *Moderate* potential. The ECA above the H₆₀ for Glenmary Creek watershed is 12% and is considered a *Low* potential.

Within each of the watersheds, nearly half or over half of the area is privately owned, with only small portions of that land cleared (Table 2). Following the field reconnaissance in June, additional logging occurred on private land within the Gardom Lake watershed (personal communication with Tom and Eleanor Marshall, August 2, 2022). Additional private land could be cleared in the future which would have an impact on the ECA's and potentially the hydrology within each of the watersheds.

Table 2. Private land within each watershed.

Watershed Unit	Area	Private	Cleared	Forested	Non-Forested*
	ha	ha/%	ha/%	ha/%	ha/%
Gardom Lake	599	336/56	29/5	207/35	99/17
Ferguson Creek	284	131/46	4/1	85/30	42/15
Glenmary Creek	223	151/68	15/7	90/40	46/21

* Non-forested includes rock, swamp or non-productive bush. The greater the non-forested area, the less potential change in runoff with forest harvest.

Sources of Sediment

Soils along the ridge are primarily sandy loam and have a potential for soil erosion, with some rock outcrops. Road Density in all three watersheds is considered *high* (Table 1; Lewis et al., 2016). Most of

the roads are at lower elevations connecting the private residences. A few legacy roads exist throughout the ridge at the middle and upper elevations and are overgrown, which would not be a chronic source of sediment. These older roads have altered the drainage patterns so that water now runs along the road surface or ditch line, rather than through natural drainages. Numerous (mostly damaged) culverts were identified along these roads. Erosion and sediment deposition were observed from a new road built to access the 2021 harvested area at the south end of Ferguson Creek watershed, and on private land directly below the harvested area due to upstream creek alterations.

Riparian Conditions

The riparian area along the upper ridge reaches of the streams, ponds, and NCD's were intact and undisturbed and consisted of alders, cedars and other native plants. These riparian areas are considered properly functioning. The riparian areas along Mallory Creek within private land are disturbed, with most of the riparian vegetation removed and are considered not properly functioning.

Runoff Generation Potential

The watershed characteristics impact the runoff generation potential. The distribution of aspects influences the hydrologic response to snowmelt. Watersheds with predominately south and west facing aspects tend to have a quicker runoff response to short-term warm periods compared to those with a wider range of slope aspects. Watersheds with predominately north aspect slopes tend to have slower rise to snowmelt peak flows and slower recession to baseflow due to slower snowmelt and reduced insolation compared to south aspect slopes. The Gardom Lake watershed upper elevation slopes primarily face north to northwest. Ferguson Creek primarily flows south and west with the upper watershed elevation slopes facing south and northwest. Glenmary Creek flows northeast with the upper watershed elevation slopes primarily facing southeast and east. The three watersheds, and other face units along the ridge, are unregulated and considered small. Smaller watersheds generally have greater variability in streamflow characteristics and show a relatively larger impact to land use change than larger watersheds (Pike et al., 2010). Depending on the location of the proposed development, there is a potential that melt runoff could be synchronized between the upper and middle watershed and contribute to increased peak flows and runoff variability.

Potential Forest Harvesting Impacts to Water Availability and Water Quality

Forest harvesting can change the streamflow regime by altering hydrologic processes that drive runoff generation and thus, the amount of water delivered to the stream (Green and Alila, 2012). The hydrologic changes that result from forest harvest are primarily related to forest canopy loss. Forest cover directly influences the amount of precipitation that is partitioned between interception storage in the canopy and net precipitation that reaches the forest floor. The change in hydrologic processes following harvest, particularly snowmelt energy, will be amplified or mitigated by watershed characteristics such as elevation range, slope gradient, aspect distribution, amount of alpine area, canopy closure and drainage density (Green & Alila, 2012). Runoff generated for streamflow is controlled by the amount of storage and partitioning of flow paths within the subsurface (Smith et al., 2014; Spencer et al., 2019). In addition, changes in runoff generation potential with forest harvest will depend on the synchronicity of runoff from varied slope gradients, aspects and elevation. The greater variation in slope and aspect within the watershed, the more desynchronized runoff generation. Desynchronization of runoff timing can minimize the frequency and magnitude of floods, while the synchronization of runoff timing can conversely increase peak flows (Green and Alila, 2012;

Ellis et al., 2013). For example, clearcut harvest at upper elevations of the watershed can lead to earlier snowmelt and synchronize melt runoff, which can advance the timing of spring high flows and lead to lower summer flows in June and July (Winkler et al., 2015). Hydrologic simulations have shown that an advanced spring freshet could result in lower summer streamflow because groundwater discharge to streams becomes depleted in the summer due to early drainage of shallow aquifers adjacent to streams (Huntington & Niswonger, 2012).

Another mechanism that could influence the response of summer streamflow to forest harvest relates to changes in evapotranspiration (Goeking & Tarboton, 2020). The immediate reduction of interception loss of rainfall and transpiration following harvest could result in higher soil moisture and summer-autumn baseflow; however, the effect is likely transient as interception loss and transpiration will increase with forest regeneration (Goeking & Tarboton, 2020; Moore et al., 2020). As the forest recovers, the increase often experienced with summer baseflow (low flow) slowly returns to pre-harvest conditions; as the forest regeneration intensifies, it can increase evapotranspiration and decrease soil moisture, and the magnitude of the baseflow decline can continue up to 50% below pre-harvest conditions (Coble et al., 2020; Segura et al., 2020). The retention of riparian buffers, along with other current harvest practices, may limit low flow increases; however, there is limited research to know if the buffers will relieve low flow declines (Coble et al., 2020).

Near-surface groundwater can be adversely affected as well following forest harvest due to the construction of forest road networks along hillsides. The construction of these roads creates a compact, relatively impervious surface which can alter the flow of near-surface groundwater, and funnel it along the hillslope. This redistribution of water could result in localized areas with an anomalously high-water table and increase landslide risk and surface rilling.

Forest disturbance can increase the amount of sediment generated and delivered to streams (Gomi et al., 2005). New pathways of sediment delivery to the stream are created by redirection of flow by roads and the drainage systems, especially during large rainfall events (Wemple et al., 2001). Forest roads can be significant sediment sources (Luce and Wemple, 2001). Sediment production from roads can vary by soil texture and road material (Luce and Black, 1999) and depends on how frequently the road is used (Reid and Dunne, 1984). Roads can also influence gully initiation, i.e., overland flow from roads is discharged onto hillslopes, which can directly deliver sediment to streams through the connection of forest road drainage (Croke and Hairsine, 2006). A long-term paired watershed study in Oregon used to separate the effects of increased sediment supply and increased runoff on sediment transport following harvest found streamflow increases alone produced modest increases in sediment transport rates (twice as much as non-harvested), but changes in sediment supply following harvest have a much larger influence on the sediment transport regime (twenty-fold; Safeeq et al., 2020). In addition, two adjacent watersheds, one harvested with roads (WS3) and one harvested without roads (WS1) found that WS3 produced four times more erosion as WS1 over the same period, which highlights the effects of road disturbance, sediment generation and delivery to streams (Safeeq et al., 2020).

To reduce sediment delivery from forest roads, best management practices (BMPs) are implemented in contemporary forest harvest practices such as water bars to slow overland flow, drainage control, riparian reserves and road removal. Recent studies in watersheds that properly implemented BMPs were effective at reducing overland sediment delivery. For example, suspended sediment sampled from a stream in Oregon found sediment sources were primarily from in-channel processes rather than external sources (Rachels et al., 2020). There was also negligible effect of contemporary forest harvest practices on suspended sediment from road crossings in Oregon and SW Alberta (Arismendi et

al., 2017; Corrigan, 2017). However, a more recent review on forest harvest and sediment yields argues that most BMPs only address direct mechanisms that could cause a change in sediment yield after harvest (McEachran et al., 2021). Indirect effects of forest harvest on sediment are those that increase in- and near-stream erosion due to increased flows (McEachran et al., 2021). The post-harvest shift in hydrologic processes due to reduced watershed evapotranspiration can deliver more water to the stream via subsurface and surface pathways (Buttle, 2011). Indirect sediment effects depend on climate, watershed size, geology and physiographic watershed characteristics, vegetation cover type and stream geomorphic characteristics (e.g., stability, bank material, floodplain storage; McEachran et al., 2021).

Elements at Risk

Mallory Ridge is home to a diverse range of wildlife, aquatic life, including the western Painted turtles (a blue listed species), vegetation, residential developments and recreation. Residences within the three watersheds, and along the base of Mallory Ridge, primarily obtain their drinking water from groundwater wells (Appendix C). Surface water licences on Mallory Creek, Ferguson Creek and the Glenmary Creek also support domestic drinking water, irrigation and other purposes. Gardom Lake supports surface water licences for domestic drinking water, irrigation, camp and industrial purposes. Forest harvesting has been shown to impact low flows and groundwater levels in the near and longer term, which may negatively impact these water resources. The private residences at the base of Mallory Ridge may also be susceptible to an increase in peak flows and sediment, and potentially debris flows as a result of forest development.

Conclusions and Recommendations

At the time of writing this memo, Tolko was re-evaluating their proposed 2020 harvest blocks. Due to the elements at risk, we recommend that caution be taken if development were to proceed. There is a moderate to high potential that forest harvest may impact low flows, peak flows, timing of peak flows, and the overall water availability along Mallory Ridge. If forest harvest were to proceed the following recommendations are aimed at providing mitigation relative to potential runoff changes, water availability, and implications of changes in water quality as a function of this proposed development:

- The ECA's calculated for Gardom Lake watershed do not include the 2021 or 2022 private land harvested. This calculation, along with the other watershed ECA's, should be updated with the most recent information.
- The impacts of climate change be considered once the proposed harvest blocks are available.
- The upper elevations along Mallory Ridge are highly sensitive to forest harvest because it is mostly intact, other than some private logging.
- Proposed harvesting on crown lands would primarily be located at the upper elevations along Mallory Ridge (Appendix A). Depending on the placement of blocks there is a potential to synchronize runoff generation and increase peak flows. There is also a potential that the development may impact low flows and groundwater levels. Proposed block placement and size must consider slope and aspect and the potential impacts to downstream water licence holders and residential developments.
- Ensure drainage structures, particularly at crossings are inspected and maintained to minimize the potential for damage because of the increased runoff.
- Implement BMPs to reduce sediment production and delivery to streams and along roads (e.g., water bars to slow overland flow and drainage control).

- The highest standards should be implemented for riparian areas. Machine free zones, with maintenance of riparian understory should be implemented on all streams, including S6 and NCDs.
- MacHydro review Tolko's proposed forest harvest plans and update the ECA calculations and potential impacts to the hydrology along Mallory Ridge.

Closing and Limitations

MacHydro prepared this document at the request of Tom and Eleanor Marshall. The material in it reflects the professional judgment of MacHydro staff and considers the information available to MacHydro at the time of document preparation. This assessment did not consider climate change and is not intended to inform forest management decisions due to the limited analysis. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. MacHydro accepts no responsibility for damages, if any, suffered by any third party because of decisions made or actions based on this document.

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We trust the above satisfies your requirements. Please contact us should you have any questions or comments.

Sincerely,



Suzan Lapp, Ph.D., P.Geo.
Hydrologist



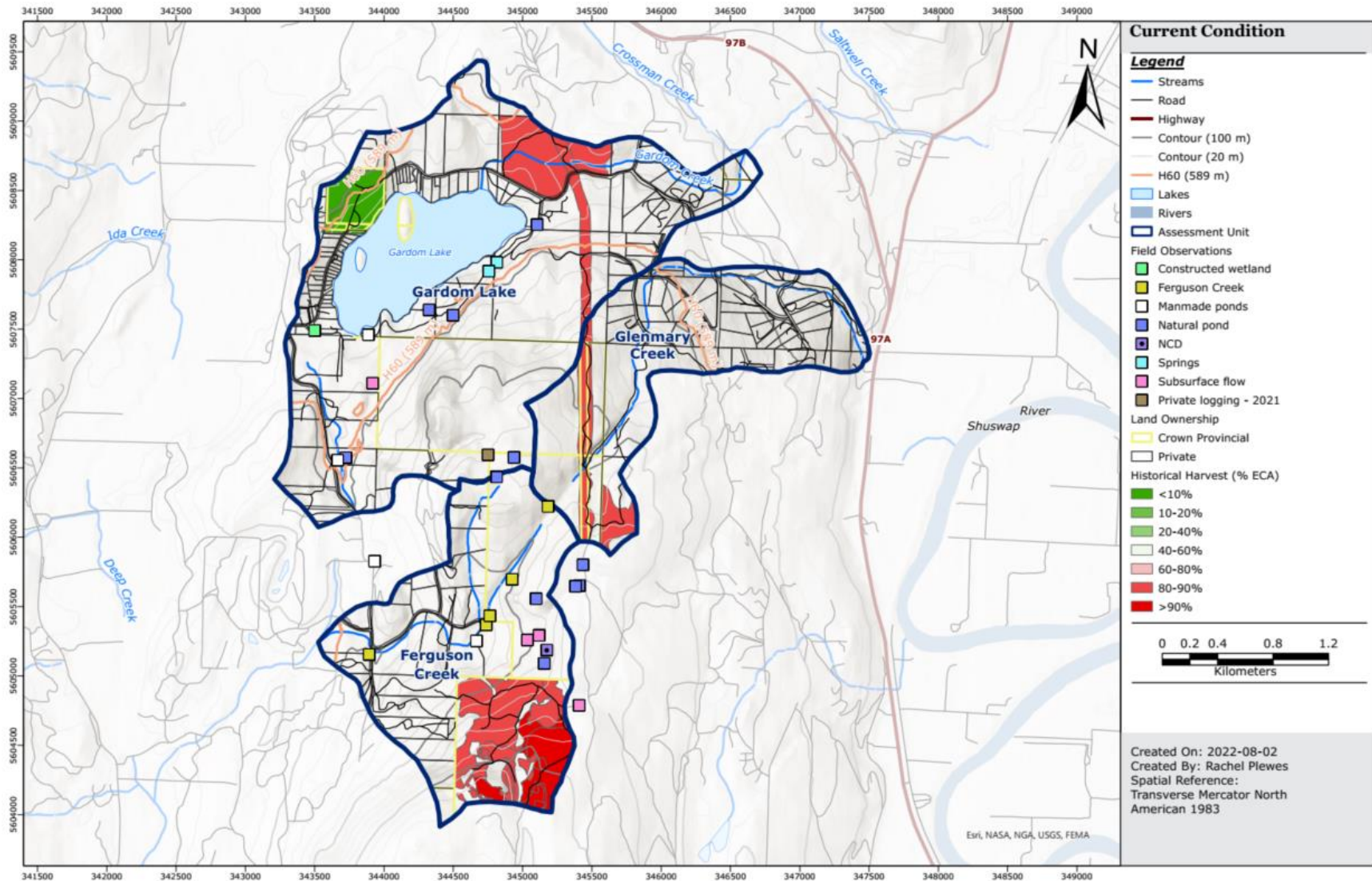
Ryan MacDonald Ph.D., P.Ag.
Hydrologist

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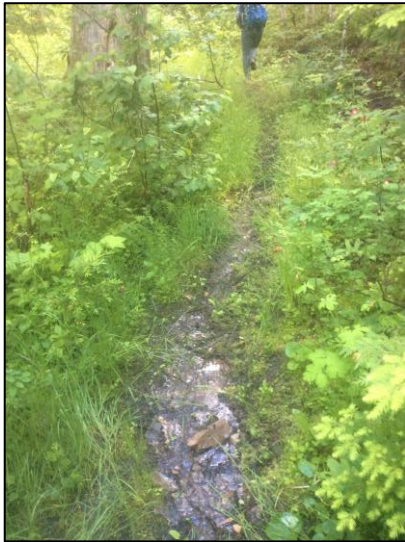
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Appendix A – Current Condition Map and Select Field Stops



Appendix B – Select Field Site Photos

Ferguson Creek: Upper elevation – S6



Ferguson Creek: Middle elevation – NCD



Natural upland Ponds – Gardom Lake watershed



Natural upland Ponds – Gardom Lake watershed



Manmade Impoundment – Mallory Creek



Sediment delivery from Ferguson Creek watershed logging



Appendix C – Water Licence Types and Locations

