Mountain Goats in the Kicking Horse Canyon, Trans Canada Highway

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Executive summary

Upgrades to portions of the Trans Canada Highway (TCH; Highway 1) are being conducted which will include reconstruction of two bridges and their approaches in the Kicking Horse Canyon east of Golden, B.C. Improvements and upgrades to this section of the TCH are required to improve the efficiency and safety of vehicular travel. The objectives of this study were to identify potential impacts to mountain goat (*Oreamnos americanus*) use of and access to the bluffs adjacent to the two bridges; to assess these impacts; and to recommend potential mitigation required to bridge and approach design and construction that will minimize impacts to the goats. Bluffs adjacent to these bridges were reported to contain mineral licks, which are seasonally of high importance to resident goat populations. In addition, we present recommendations for revegetation of surplus material disposal sites for forage values of various recommended species.

The existing alignment of the TCH crosses from the north side of the canyon to the south side at the Yoho Bridge (5-Mile Bridge; segment 990, km 9.5). The highway recrosses back to the north side 4.6 km further up the canyon at the Park Bridge (10-Mile Bridge; segment 990, km 14.1). Bridge design options are still being finalized. For the Yoho Bridge these will generally involve straightening/aligning the bridge and approaches, adding two lanes to the road and bridge, and raising the bridge deck up to 11 m above existing grade at the western end and 9 m above grade at the eastern end. A retaining wall and avalanche and rock stabilization fencing are required adjacent to the western approach. Slope removal at the bluffs adjacent to the eastern approach to the Yoho Bridge will be limited to the lowest portions of the talus slope, although an access road is proposed for east of the lower portion of the bluffs to facilitate rock blasting and removal. Construction activities are scheduled for 1 May 2001 to 1 August 2002, with no construction during the winter period.

Two broad design options are currently being considered for the Park Bridge reconstruction. Both involve a divided four-lane highway and bridges. Options 5/5A involve separate bridges spaced at approximately 30 m on the west side, and would require removal of extensive amounts of the slope and forests adjacent to the western approach, and two lanes being placed significantly higher up the slope. An access road is proposed with Options 5/5A around the back of the Park Bridge bluffs, although details on road placement are currently unclear. Option 5B, currently the preferred option, proposes a two-lane bridge/viaduct stretching over about 1,100 m in length, with the other two lanes and crossing more or less on the existing grade. This option would entail considerably less blasting and removal of rock in the slopes adjacent to the west abutment and no access road above the bluffs. With any option avalanche fencing will be required across the slope at the top of the bluffs west of the main Park Bridge bluffs.

We reviewed existing literature on mountain goat use of mineral licks and the impact of disturbance on goats. Between late May and mid-July 2000 we conducted three 8-9 day observation sessions at the bridges to document goat use of the bluffs adjacent to these sites. We mapped trails into the bluffs, areas of concentrated mineral lick use, and bedding sites. We also reviewed road and harvest mortality data, conducted interviews with residents and local wildlife officials, and obtained information from other wildlife researchers with experience in the area.

Mountain goat numbers in the East Kootenay in general appear to have declined in the past 10 years, with a more noticeable drop in the past 3-4 years. Goat populations are found on

both sides of the Kicking Horse Canyon, but there is little evidence of significant movement across the river. Hunting harvests of goats within the study area have declined over the past 10-15 years. Only one goat has been recorded in road mortality data from the past 20 years along the 26-km stretch of highway between Golden and Yoho National Park.

Use of these low-elevation bluffs begins primarily in late May and peak use appears to extend into early July. Billies appear to use the bluffs earlier than nannies and kids. While there are numerous tracks, trails, and beds throughout the bluffs on the north side of the canyon above the western approach to the Yoho Bridge, there is no obvious mineral lick and little documented use of the area by mountain goats. Extensive use of the area by Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) was evident. Five main goat trails access the upper sections of the Yoho Bridge South bluffs above the eastern approach to the Yoho Bridge. During 66 hours of observation over 26 days we saw at most one goat at any one time. We observed feeding and bedding activities at these bluffs, but no licking behaviour associated with a mineral lick.

Mountain goat use of the Park Bridge bluffs adjacent to the western approach to the Park Bridge was minimal during the first observation session (three goats observed on the last day), but extensive during the second session (up to a daily maximum of 12 goats, including nannies with kids); no goats were observed during the third observation session in July which coincided with unseasonably cool, wet weather. We observed extensive licking of a dark rock band (a fine-grained limestone with interbeds of mudstone) centred in the middle of the bluffs, and observed extensive bedding and some feeding. Numerous trails access the upper and middle sections of the bluffs, including a large number from the upper and middle right (west).

Reconstruction of the Yoho and Park bridges has the potential to impacts mountain goats using the low-elevation rocky bluffs adjacent to these bridges. We considered two broad types of potential impacts: short-term impacts during construction of the bridges and approaches, and permanent impacts caused by changes to the bluffs or access to them. Because of the importance of the mineral lick at the Park Bridge bluffs and the higher number of goats using this site, including a number of nannies with kids, we consider potential impacts to the Park Bridge bluffs to be of greater concern than at the Yoho Bridge bluffs. However, even though no mineral licks were identified at the Yoho Bridge bluffs and nannies with kids were not observed, the Yoho Bridge South bluffs appears to be an important and regularly used low-elevation site for goats. Sheep extensively use the bluffs and flats adjacent to the western approach to the bridge.

The following main concerns are discussed, and options for mitigating impacts are provided:

Yoho Bridge

- Construction activities that produce irregular and loud concussive noises, especially those in close proximity to the bluffs and helicopter activities, will discourage goats from using the bluffs. Construction activities that produce these noises should be minimized during the period of greatest use, between late May and late July, but especially between early June and mid-July.
- The access road proposed for east of the Yoho Bridge South bluffs should not be extended to the bluffs themselves, and should be limited in height to a level below the lower third of the bluffs. Construction and use of this access road within 500 m of the bluffs should be minimized during the period from late May to mid-July. As currently

planned the placement of the road should avoid major access trails to the bluffs; any changes in alignment and positioning will require further site investigation prior to placement. The road should be gated to eliminate non-construction related access, and should be decommissioned and deactivated immediately upon completion of construction.

- Goats have been known to resume use of an area abandoned during disturbance after the disturbance factors were removed. Since permanent changes to the Yoho Bridge bluffs on both sides of the canyon will be relatively minor and concentrated on the lower edges of the slopes, we suspect that normal goat use of these bluffs will resume once construction activities are completed.

Park Bridge

- Options 5/5A may cause a significant reduction in goat use of the Park Bridge mineral lick by altering access routes to the bluffs, removing much of the ridgeline and screen of trees currently in place on the western edge of the bluffs between the bluffs and the TCH, and by placing two lanes of traffic much higher up on the slope and closer to the bluffs.
- Option 5B should produce far fewer long-term impacts to the integrity of the bluffs containing the mineral lick and to access routes to the bluffs, as well as less disturbance to the goats during construction and no requirement for an access road, and therefore is our preferred option.
- Construction should minimize irregular and loud concussive noises in close proximity to the bluffs, including helicopter activity and vehicle use of the access road, during the period of greatest use. This appears to occur between late May and late July, with a likely concentration of use between early June and early-July. Additional monitoring of the Park Bridge bluffs should be conducted between May and August of the next 2 years to clarify the timing and extent of use of the bluffs by goats.
- Efforts should be made to retain the triangle of trees and the ridgeline that currently buffer the Park Bridge bluffs from the TCH near the western approach to the bridge. These areas contain major access routes into the bluffs; removal of this screen will likely result in reduced use of the bluffs.
- An access road along the top of the slope adjacent to the Park Bridge bluffs (as proposed in Options 5/5A) would in all likelihood have a significant impact on goat use of the these bluffs, and could cause goats to abandon the bluffs. If possible, construction of an access/tote road on or near the top of the Park Bridge bluffs should be avoided. In the event that such an access road is required, then its construction should avoid the period from late May to mid-July, and use of the road during this period should be minimized. Routing of the access road should avoid major game trails to the bluffs, and would require further site investigation for optimum placement. The road should be gated to eliminate non-construction related access, and should be decommissioned and deactivated immediately upon completion of construction.
- At the Park Bridge bluffs, it may be possible to mitigate the disturbances associated with construction by establishing a temporary artificial mineral lick southwest of the main bluffs that goats can access during construction. Site placement would require additional

field reconnaissance, but should be at least 500 m from construction activities or the access road, and not in direct line of sight.

The proposed waste rock disposal site south of the Brake Check is primarily comprised of mature or old age stands of Douglas-fir fir (*Pseudotsuga menziesii*), and hybrid white spruce (*Picea glauca* x *engelmannii*) with scattered sub-alpine fir (*Abies lasiocarpa*), and a predominant moss base. Game trails were evident throughout the area, and elk (*Cervus elaphus*) tracks and pellets were relatively abundant. The site is the western extent of valley bottom habitat within the Kicking Horse Valley west of Yoho National Park, and thus tends to act as a funnel for wildlife moving in an east-west direction through the valley.

We suggest that a 50-m setback from the high water mark of the Kicking Horse River should be observed to maximize the value of the area to wildlife, maintain the integrity of the riparian zone, and facilitate movement of animals through this riverside corridor. All trees should be removed from the site, and non-merchantable trees and root balls should be stockpiled. All topsoil (with the existing ground and shrub layer) and fine-grained mineral soil should be removed and stockpiled. The pile of waste rock should contoured to low (<25%), irregular slopes to provide a variety of microsites and minimize erosion, and should be covered with a layer of fines to minimize leaching of the soil and moisture loss. Stockpiled topsoil, non-merchantable trees and root balls should be spread over the site to provide some vegetation structure and a source of nutrients (from decaying wood), to help to stabilize the soil on the site, and to initiate re-establishment of ground and shrub cover.

A combination of indigenous and non-native grasses, legumes, and shrubs should be used to re-establish vegetation at the disposal site, to maximize erosion control and encourage ground cover. Grass species that are relatively drought tolerant and may be appropriate for this application include Canada bluegrass (*Poa compressa*), Crested wheatgrass (*Agropyron cristatum*), and red fescue (*Festuca rubra*), all of which are considered moderate to good forage species for ungulates. Legumes that could be included are alfalfa (*Medicago sativa*) and alsike clover (*Trifolium pratense*), both of which are highly rated as spring forage for ungulates and bears. Willow (*Salix* spp.) and cottonwood (*Populus balsamifera*) are of high value to elk and deer (*Odocoileus* spp.), and could be planted using established suckering techniques. Redstem ceanothus (*Ceanothus sanguineus*) is also a preferred food for ungulates, and may be planted using suckering. Douglas-fir tree may be planted in appropriate microsites to provide cover and forage.

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Introduction

The British Columbia Ministry of Transportation and Highways (MoTH) is upgrading portions of the Trans Canada Highway (TCH; Highway 1) in the central and eastern portions of the province through their Cache Creek to Rockies Program (CCRP). An integral part of this upgrade is reconstruction of two bridges and their approaches in the Kicking Horse Canyon east of Golden, B.C., between the town and the western boundary of Yoho National Park. Wildlife monitoring conducted in the area under the auspices of MoTH (Demarchi and Searing 1997) and BC Environment, Lands and Parks (MELP; D. Martin, Habitat Section, Cranbrook) have identified mountain goats (*Oreamnos americanus*) as a species of concern within the canyon that may be impacted by this development. Mineral licks frequented by mountain goats have been identified in the cliffs and rocky bluffs adjacent to both bridge sites (Demarchi and Searing 1997). There is concern whether construction activities and changes to the bluffs will impact goats using the sites.

The objectives of this study were to identify and assess potential impacts to mountain goat use of and access to the bluffs adjacent to the bridges containing the mineral licks, and to recommend potential mitigation to bridge and approach design and construction that will minimize impacts to the goats. We determined the extent of use and consequent habitat value of these sites to mountain goats, and attempted to clarify the demographics of mountain goats using the area. We report on field observations conducted between late May and mid-July 2000. Finally, we provide recommendations for revegetation of surplus material disposal sites for forage values of various recommended species.

Study area

The Kicking Horse Canyon contains the Kicking Horse River, which flows in a west-northwest or west direction from within Yoho National Park to its confluence with the Columbia River near Golden. The river has high volume and a steep gradient, falling 260 m during its 26-km decent from the Park to Golden. Within the area of concern adjacent to the two bridges, the canyon is steep, with little or no riparian area along its banks; cliffs, bluffs or forested slopes rise up over 1,000 m. The lower portions of the valleys are within the Interior Douglas Fir biogeoclimatic zone. Predominant trees in the vicinity of the bluffs include Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), and hybrid white spruce (*Picea glauca* x *engelmannii*), with lodgepole pine (*Pinus contorta*) and aspen (*Populus tremuloides*) on drier sites. Other ungulates found within the lower Kicking Horse Valley are white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*; most abundant closer to Golden), low numbers of elk (*Cervus elaphus*; most abundant closer to Yoho National Park), moose (*Alces alces;* very low numbers in most areas), and Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*; a group of 20-30 animals reside on the north side of the TCH, generally within 10 km of Golden). Further descriptions of the general study area and wildlife are provided in Demarchi and Searing (1997).

Cliffs or rocky bluffs (steep areas dissected by broken cliffs and steep sections of forests) are found throughout much of this canyon section. Talus slopes of broken rock or coarse gravel

are often found at the bottom of cliff faces. Cliffs and bluffs on both sides of the river are separated from open alpine areas by forested terrain interspersed with areas of cliffs and bluffs.

Background to proposed bridge reconstruction

The Kicking Horse Canyon contains two of the main transportation systems in Canada, the TCH and the Canadian Pacific Railway (CPR) mainline. Annual average daily traffic volumes are approximately 5,000 vehicles (non-trucks), 1,000 trucks, and 30 trains per day, with increases in vehicle traffic during the summer period to about 10,000 per day (A. Izett, MoTH, Victoria, personal communication). In addition, about 20,000 rafters travel the river each summer.

The existing alignment of the TCH crosses from the north side of the canyon to the south side at the Yoho Bridge (5-Mile Bridge; segment 990, km 9.5). The highway recrosses back to the north side 4.6 km further up the canyon at the Park Bridge (10-Mile Bridge; segment 990, km 14.1). Existing approaches onto these bridges are narrow with relatively sharp curves, resulting in reduced traffic speed and higher than normal accident rates. Improvements and upgrades are required to this section of the TCH to improve the efficiency and safety of vehicular travel.

Bridge design for the Yoho Bridge reconstruction is currently underway. This will involve straightening/aligning the bridge and approaches, adding two lanes to the road and bridge, and raising the bridge deck up to 11 m above existing grade at the western end and 9 m above grade at the eastern end (Appendix 1). Options for a steel bridge (with steel girders) and a concrete bridge alignment (with concrete piers) are currently being considered. Both options include west abutments shifted closer to the river than the existing alignment, and eastern abutments that are closer to the river or the same as existing. The western approach to the bridge will include a 45-54 m long retaining wall up to 10 m in height leading up to the west abutment with the bridge. Avalanche and rock catchment adjacent to the western approach will be provided by construction of a ditch and wall/rock catch fence system paralleling the highway. Both bridge alignments are longer and have a higher, more open profile than the existing bridge, thus the resultant bridge should provide more area under the bridge itself than exists with the current alignment. Significant portions of the bank will only be removed east of the Yoho Bridge South bluffs near the first existing uphill corner.

The proposed bridge and approach construction schedule for the Yoho Bridge involves work between 1 May 2001 and 1 December 2002, with construction activities suspended during winter (15 November 2001 to 1 April 2002; Tim Blackburn, Urban Systems Ltd., Kelowna, letter of 23 June 2000). An access road will be constructed east of the Yoho Bridge South bluffs to facilitate rock blasting and removal (T. Blackburn, personal communication). Rock blasting and pile installation, the two activities likely to produce "irregular and loud concussive noise", are tentatively scheduled to occur intermittently between 15 June and 15 November 2001, and 1 April and 1 August 2002. Limited helicopter work will be required in the initial phases of construction. Rock scaling will be required adjacent to both approaches to the bridge.

Conceptual bridge and approach design for the Park Bridge is currently down to two main alignments options (5/5A and 5B) with option 5B currently the preferred option (R. Taylor, personal communication, and drawings from ND Lea Consultants Ltd.; Appendix 1). For both

alignments, the bridge and roadway would be widened to four lanes, and the highway and bridge would be divided. For Options 5/5A, the alignments would be split with separate bridges spaced approximately 30 m apart on the west side. These options would involve two lanes being placed up to 35 m higher on the uphill slope and 45 m over from and east of the existing alignment. Extensive amounts of the slope and forests up to 70 m from the existing alignment on the uphill slope would be removed. Options 5/5A requires an access road around the back of the Park Bridge bluff. Option 5B proposes a two-lane bridge/viaduct stretching over about 1,100 m in length, with the other two lanes and crossing on more or less the existing grade. This option would entail considerably less blasting and rock removal in the slopes adjacent to the existing western abutment, and does not require construction of an access road to the top of the bluffs.

All options will require avalanche fencing 1.0-1.5 m high across the slope to the west of the main Park Bridge bluffs. The fencing would involve approximately 50-m sections placed in discontinuous offset rows at the top of the bluffs, running from approximately 200 to about 400 m west of the bluffs.

Construction scheduling and activities for the Park Bridge are not presently known. Construction activities, such as blasting and pile installation, will be required. Duration of activities will be similar or longer than that required for the Yoho Bridge and approaches. Helicopter lifts and rock scaling will be conducted at various points during construction (R. Taylor, personal communication).

Highway reconstruction east of the Park Bridge will produce large amounts of surplus material. Current plans are for construction of a surplus material disposal site in the valley bottom adjacent to the Kicking Horse River, south of the Brake Check at the top of the 10-Mile Hill. The surplus material, which will be primarily comprised of rock of an alkaline nature, will be moved to the site using a conveyor system. Preliminary estimates are to deposit 500,000 – 800,000 m^3 of material over a 12 ha area (A. Izett, personal communication). If placed in a rectangle on a 12-ha site, this would produce pile of material 4-6.5 m high.

Methods

Literature review

We obtained background material on mountain goats within the study area from MoTH and Acres International Ltd., and reviewed and compiled pertinent information on goats in the project area and relevant biology by examining published and unpublished literature. We contacted MELP in Cranbrook and Golden, MoTH staff in Golden, members of the Golden Rod and Gun Club, the outfitter responsible for the area, and wildlife researchers familiar with the area. Harvest statistics for the area were obtained from MELP, and road mortality data were obtained from the MoTH Wildlife Accident Reporting System (WARS).

Field program

We conducted a field program between 25 May and 12 July 2000 that consisted of three 8 to 9-day sessions of observations. Observations focused on the bluffs adjacent to the south side of the Yoho Bridge (eastern approach) and adjacent to the south side of the Park Bridge (western approach), although observations were made of the bluffs on the north side of the canyon at the Yoho Bridge (adjacent to the western approach) and at other bluffs between Golden and the Park

Bridge. Bluffs at the Yoho and Park bridges were observed using binoculars and spotting scopes from a suitable vantage point, primarily along the highway; at the Park Bridge we used a side road off the Glenogle Forestry Road (access from the Brake Check at the top of the hill). We conducted observations during 1-5 – hour sessions, generally during morning and late afternoon/evening to coincide with predicted periods of peak activity of mountain goats (Singer 1978, Singer and Doherty 1985, Pedevillano and Wright 1987). We systematically alternated observation efforts between bridges from day to day. We used one observer, except during 16-19 June when two observers watched bluffs at each bridge simultaneously. During observations we recorded the number, age and sex class (Smith 1988, Stevens and Houston 1989) of goats using the sites where possible, duration of visit, activity (licking, feeding, bedded, traveling), behaviour (alertness, hesitation, erect tail posture), influence of traffic or visitors, and access routes to and from the bluffs. Sightings of sheep at the bridges were also recorded. We explored the bluffs and adjacent forested habitats of all bluffs where possible, to document goat sign (trails, tracks, pellets, hair, bedding sites, etc.) on and adjacent to the bluffs. Geotechnical crews conducted limited seismic activity at the Yoho Bridge during the spring, but their activity only overlapped with our observation periods on 1 June and we were not allowed to monitor the bluff at that time.

Literature Review

Mountain goat populations in the area

B.C. is the geographic heart of North American mountain goat range and contains the largest number of goats of any jurisdiction. Mountain goats in the region typically follow a cycle that includes use of high elevation alpine areas during early summer, a drop in elevation in fall concurrent with the first snows of the season, and use of cliff habitats near or below treeline during winter. Goats typically use lower elevation sites during spring to access early green-up of vegetation, and move up in elevation following the emergence of new vegetation after snowmelt. Kids are born in isolated areas in early June, and within a couple of weeks nannies and kids group together to form larger nursery groups. Males spend most of their time alone or in small bachelor groups; the rut generally occurs during November.

Goat densities are difficult to estimate, but relative densities on the distribution map provided by Shackleton (1999) suggest that mountain goats on both sides of the Kicking Horse Canyon are in the moderate to plentiful range. Although there is only anecdotal evidence, most persons knowledgeable with mountain goat populations in the East Kootenay and Golden area suggested that goat numbers have decreased substantially over the past 10 years, with the greatest decline over the past 3-4 years (L. Ingham, N. Jesse, B. Klassen, B. Warkentin, personal communications). This decline is impossible to quantify, and suggested causes are numerous and varied. Possible causes offered by observers included increased harvest as a result of increased hunter access, weather (notably severe winters), increased predation, and stress caused by increased helicopter activity (primarily heli-skiing and heli-hiking) in goat range. Weather has been cited as a major influence on goat numbers in the Rocky Mountain chain, with severe winters contributing to poor kid production and/or survival (Vogel et al. 1995). The winter of 1996-97 was one of the most severe on record, and one rafting guide we spoke to suggested that

it was after this winter that she noticed significant declines in the number of goats seen during rafting trips along the Kicking Horse River within the study area. However, in contrast to other ungulates, goat populations have been noted to show limited growth despite light or no harvest and apparent good range conditions, and are a bit of an enigma in the wildlife management world (Vogel et al. 1995).

An estimate of the number of goats in the Kicking Horse River drainage has not been conducted. In mid-July 1996, Demarchi and Searing (1997) counted 216 goats on the mountains that form the western reaches of the Kicking Horse Valley. This count was the result of a single helicopter flight covering open areas above treeline, but also on exposed bluffs below treeline. Goats were observed on both sides of the Kicking Horse River (133 south of the river in the Beaverfoot; 83 north of the river mostly around Mt. Hunter and Porcupine Peak). Most goats were counted in the alpine, and only one goat (an adult) was observed near the bridges in question during the survey (above the north side of the Yoho Bridge area). Sightability of goats within broken cliff and forested habitats typical of the study area is notoriously poor, thus it is likely that the goat population in the area during the survey was substantially greater.

Demarchi and Searing (1997) observed goat trails down to the river near the south side of the Yoho Bridge. In addition to goats at the bluffs adjacent to bridges, they also observed goats at lower elevations on the north side of the valley between the two bridges, mostly near Glenogle Creek. However, Demarchi and Searing (1997) found no evidence to suggest that goats crossed the river. The authors concluded that the raging torrent of spring and early summer freshet was an effective barrier to movement across the river, and that they were therefore dealing with at least two discreet subpopulations. Other persons knowledgeable with these goat populations agreed that movement by goats across the Kicking Horse River is a rare occurrence (N. Jesse, B. Klassen, personal communications).

Thirty-four kids were observed during the July 1996 flight, 16% of the total goat numbers. This figure is on the low side of the percent of kids observed in other populations in B.C. during summer/early fall surveys (range 15-25%; McCrory 1979, Hebert and Woods 1984, Cichowski et al. 1994, Demarchi et al. 1997, Poole et al. 2000). However, direct comparisons among surveys may not be valid because kid estimates vary with survey techniques and time of year (Festa-Bianchet et al. 1994). In addition, the winter of 1995-96 was one of the harshest for ungulates in the East Kootenay during the previous 20 years (Demarchi and Searing 1997), which may have negatively influenced kid production and survival.

Demarchi and Searing (1997) observed goats almost daily during late spring and early summer 1996 near both north and south sides of the Yoho Bridge and the south side of the Park Bridge. Most observation efforts were directed at the Yoho Bridge area, and comparatively little at the Park Bridge area (M. Demarchi, personal communication). Relatively few goats were observed on the north side of the Yoho Bridge, and the number of goats observed on any given day on the south side of the Yoho Bridge and at the Park Bridge only once exceeded two animals; in late June four nannies and a kid were observed at the Park Bridge bluffs (M. Demarchi, personal communication). Most of these animals seen during 1996 were either observed licking the ground (Park Bridge), or were suspected in being in those areas for that purpose. Residents of Golden have regularly observed goats in the vicinity of the bluffs adjacent to the Park Bridge, and less frequently at the bluffs adjacent to Yoho Bridge, as well as other bluffs within the study area (N. Jesse, B. Klassen, personal communications). These observations typically occurred from spring (end of May) through summer (late July and early

August), but also during October and November, when a few goats have been harvested from the bluffs adjacent to the Park Bridge.

Mortality of mountain goats

Data on road-killed wildlife from the WARS database (WARS 2000) between 1990 and 1998 indicate that comparatively few animals were killed in the sections of the highway surrounding the two bridges. The database recorded an average of 7.6 wildlife killed each year between Golden and the Yoho National Park boundary, two-thirds of which were deer. The highest numbers of animals were killed within the first seven km of the Golden town site (79% of the 26-km section total), well west of the Yoho Bridge. No mountain goats were recorded as killed during this period, although Demarchi and Searing (1997) recorded a mortality of one goat when examining WARS data from 1978 to 1995. Even given the standard correction factor of 5:1 applied to the WARS database to account for underreporting, fatal injuries, etc. (A. Buckingham, MoTH, 1997, personal communication, in Demarchi and Searing 1997), it appears that the TCH is not a significant source of mortality of mountain goats, and that mortality of any wildlife is relatively low in the vicinity of the bridges.

Mountain goats can be harvested on both sides of the Kicking Horse River. Harvest quotas are allocated to outfitters, and are available to residents on a Limited Entry Hunting (LEH) lottery basis. The hunting zones adjacent to the Kicking Horse Canyon are 4-35 B on the south side of the canyon (currently 33 LEH tags available) and 4-36 A on the north side (36 tags available). The hunting season currently runs from 10 September to 30 November, and is open for any sex and age goat (although hunters are requested to select males). The overall harvest within the two zones appears to have declined over the last 10-15 years, and the proportion of females in the harvest has fluctuated widely, and perhaps increased in the past five years (Fig. 1).

Mineral licks

Mineral licks are important elements in the ecology of most ungulates, including mountain goats. Sodium (Na), and perhaps other trace elements, appear to be critical for proper growth and physiological maintenance. Hebert and Cowan (1971) suggested that mountain goats use mineral licks to compensate for sodium deficiency. Dormaar and Walker (1996) suggested that magnesium, manganese, iron and copper may also draw animals to specific sites. Use of licks during spring and early summer may be in response to nutritional demands of reproduction, growth and maintenance, especially overwinter weight loss and mineral depletion (Robbins 1983). Use of licks by goats may be driven by both increased loss of minerals (a result of a switch in diet to lush new growth with resulting softer pellets) and increased demand (Hebert and Cowan 1971).

The available literature suggests that there is a great deal of individual variation among goats in the number of lick visits, timing and duration of visits, and distance traveled to licks. While prevalent in most goat populations, use of mineral licks by goats is not universal (Varley 1994). Alkaline rock types having relatively high sodium content may be abundantly dispersed throughout an area, thus goats may be able to obtain their mineral requirements without moving

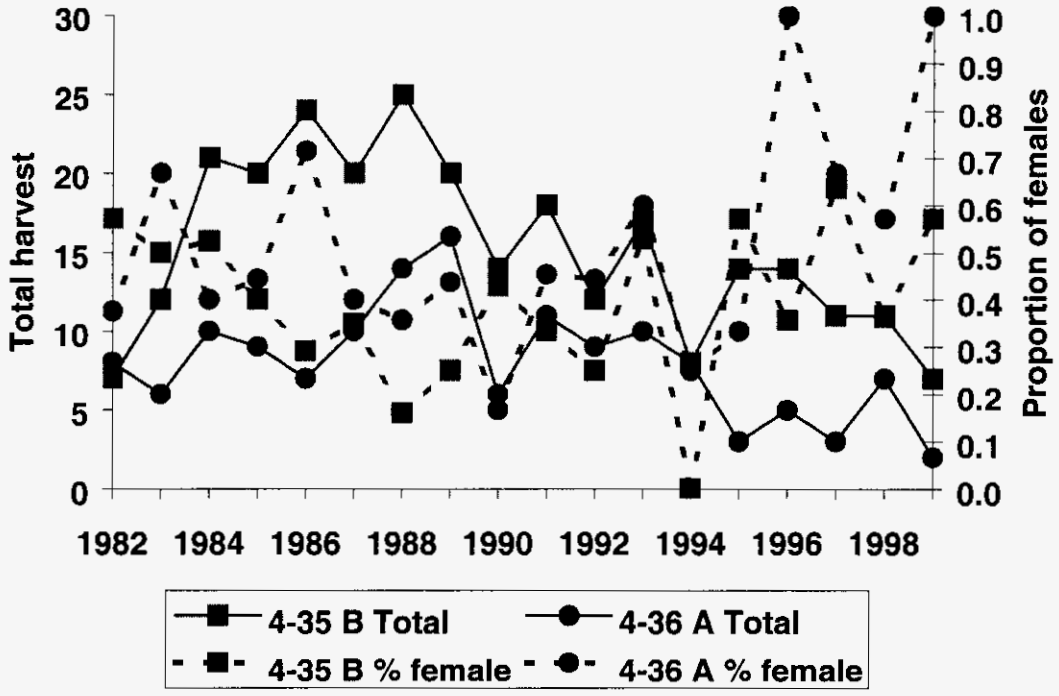

Figure 1. Annual mountain goat harvest and the proportion of females in the harvest for management zones 4-35 B (south of the Kicking Horse Canyon) and 4-36 A (north of the canyon).

to highly concentrated sites. Licks are generally located at low-elevation sites, but licks at high-elevation sites, often in silt areas near edges of glaciers, glacier moraines, caves, limestone outcrops and shale cliffs with white encrustations, have also been reported (Hebert and Cowan 1971, McCrory 1979, Poole 1999). Licks may be generalized as being of three types: dry earth exposures, muck licks, and rock face licks, and are often associated with groundwater discharge (Dormaar and Walker 1996). Goats have also been known to use artificial licks where gravel mixed with road salt has been deposited (McCrory 1979).

In the Rocky Mountain Trench goats typically prefer dry earth licks, but on occasion use mineral springs (Herbert and Cowan 1971). Hebert and Cowan (1971) found that mineral licks frequented by goats were composed of a dry brownish to whitish clay and a varying amount of sand and gravel. Within each lick some areas were preferred more than others, generally those that contained a large proportion of moist brown clay, usually among the roots of Douglas-fir trees, and in the B horizon of the soil profile. In one case a new lick was discovered by goats as a result of logging operations, with higher sodium concentrations than preferred sites of the primary lick. Vegetation did not account for enough of a difference in sodium content among sites [the summer diet of mountain goats in the Rocky Mountain Trench is primarily grasses and to a lesser extent browse (Hebert and Cowan 1971)], thus it is the soil and/or rock that attracts goats to the site. Hebert and Cowan (1971) coined the terms primary and secondary licks, based on degree of use by goats.

Mineral lick use by mountain goats is highest during spring and early summer (Hebert and Cowan 1971, Singer 1978, Singer and Doherty 1985). However, use of mineral licks outside of this peak period has been identified. In the Rocky Mountain Trench, Hebert and Cowan (1971) found use over about a 70-day period from late May through early August for both sexes. Goats used a lick in Montana from 15 April to 15 September, with the peak occurring in late June and early July (Singer 1978). Lemke (1999) observed use of mineral licks between mid-May and mid-July in the Cayoosh Range in western B.C.

Males make use of the licks earlier than females. Hebert and Cowan (1971) observed that use by males began in April and peaked at the end of May, and use by females began in early June after birthing, and peaked at the end of June and early July. Singer (1978) found that use of licks by males peaked in May and June, and use by females increased through June and July.

Reports on the frequency of use of licks by goats are somewhat equivocal, and have been described as one trip of several days to three weeks annually (Hebert and Cowan 1971), to multiple trips (3-14 annually) throughout the spring to mid-summer (Singer and Doherty 1985, Hopkins et al. 1992). Frequency of visits to a lick did not differ between sexes (Singer and Doherty 1985). Goats have been observed to spend only a few hours at the lick where there is limited escape terrain nearby (Hopkins et al. 1992). Movements to licks of up to 10-24 km have been reported, often on traditional trails through coniferous forests far from escape terrain (Hebert and Cowan 1971, Singer 1978, Hopkins et al. 1992). Use of licks appears to be affected by elevation, receding snowpack, spring vegetation and weather; there is little use in stormy weather. Hebert (1967) observed more lick visits immediately after a storm had cleared, and Singer and Doherty (1985) suggested that the probability of movement to a lick was highest on a clear day, and when more than seven days had elapsed since the last visit. Relative use of licks in one study differed among years (Hopkins et al. 1992).

Use of licks throughout the day has been described as largely crepuscular, with more night use (Pedevillano and Wright 1987). Singer (1978) found that goats used a lick located adjacent to a viewing area off a highway primarily at night, arriving in the evening and departing at dawn. Licks appear to be avoided when it is hot (Pedevillano and Wright 1987). Peak movements by goats were observed from 07:00-10:00 and 15:00-20:00 hrs (Singer and Doherty 1985). At Caw Ridge in western Alberta, movement by goats peaked in the early morning, at midday (12:00-13:00 hrs) and in late afternoon, and feeding activity tended to decrease in late morning and increase in late afternoon (after 18:00 hrs; Romeo and Lovari 1996).

Mineral licks in the Kicking Horse Canyon

During their study of wildlife movements in the Kicking Horse Valley, Demarchi and Searing (1997) "commonly observed" goats during late spring and early summer on or near rocky outcrops from just west of the Yoho Bridge to just east of the Park Bridge, and assumed that the goats were on these rocky outcrops seeking exposed rock and mineral soils to obtain trace elements. Based on the presence of goats on these low elevation bluffs, the authors assumed they had found four low elevation licks; the two at the Yoho Bridge (one adjacent to each approach), one adjacent to the south side (western approach) of the Park Bridge, and one on the south side of the valley (opposite the TCH) between Golden and Yoho Bridge. Demarchi and Searing (1997:49) also obliquely suggested that there may be a lick on the north side of the

valley between the two bridges (near the rafting pullout). No other licks in the area were identified in this report. Within the valley the only other lick we are aware of is a "large salt lick" reported to be at the main fork of Hunter Creek, 1.5 km up the creek from the Kicking horse River, approximately 5 km east of the Park Bridge (Harvey Research Ltd. 1994).

Residents familiar with the area confirm that mountain goats have always used the rocky outcrop at the Park Bridge as a mineral lick (N. Jesse, B. Klassen, personal communications). Up to 23 goats have been observed simultaneously using the Park Bridge bluffs (B. Klassen, personal communication). However, although goats have been occasionally observed in low numbers in the cliffs and rocky outcrops adjacent to the Yoho Bridge, it is less clear to these observers whether these sites are actually used as mineral licks. One resident suggested that goats were more often observed in the bluffs west of Yoho Bridge than at the bluffs adjacent to the bridge (N. Jesse, personal communication).

Review of mountain goats and disturbance

Mountain goats are especially sensitive to certain types of disturbance. Close-flying aircraft, especially helicopters, have been shown to cause extreme flight behaviour in goats, with a positive correlation between stress-response and proximity of the disturbance (Foster and Rahs 1983, Côté 1996). In one study the reaction by goats was greatest when the disturbance was above the animals and when the goats were exposed and away from escape terrain (Foster and Rahs 1983). In addition to short-term behavioural responses and increased energy expenditure, goats reacted to sustained disturbance by altering daily feeding patterns (increasing nocturnal feeding) and abandoning traditional range to use sub-standard areas (Foster and Rahs 1983). One study found that once a disturbance that caused abandonment of a cliff complex was removed, the goats reoccupied the area within two weeks (Foster and Rahs 1983).

Another study found a negative correlation between energy exploration activities (mostly seismic lines with extensive helicopter support) and declining adult female numbers, kid production, and productivity (Joslin 1986). However, this study found only a correlation, not cause and effect, but the author did discuss (and essentially eliminated) other potential factors to cause the population declines.

Goats have been shown to habituate to disturbances that are localized, continuous, highly predictable, and non-threatening. The reaction of mountain goats to noise appears to vary with the familiarity of the auditory stimulus (Brandborg 1955, Penner 1988). Penner (1988) suggested that goats could become habituated to regular disturbance and potentially averse stimuli if negative associations are avoided. Sudden, unpredictable stimuli will cause a reaction in goats (Pedevillano and Wright 1987, Penner 1988). Stimuli within line of sight appeared to elicit a stronger response than most types of noise alone (Penner 1988). There appears to be individual variation in goats' reactions to disturbance (Pedevillano and Wright 1987). Females appeared especially sensitive and responsive to disturbance during the kidding and post-kidding periods (Penner 1988).

Goats can habituate to highway traffic, although some animals altered their behaviour and activity patterns in response to traffic volumes (Singer 1978, Pedevillano and Wright 1987). Traffic noise, especially downshifting trucks (even up to one km away), caused goats to respond in some areas (Singer 1978). The success of highway crossings has been negatively correlated with increased human presence on the highway, including traffic and visitors to a viewing

pullout (Singer 1978, Pedevillano and Wright 1987). Goats have habituated to using mineral licks adjacent to high traffic areas in the States (Singer 1978, Pedevillano and Wright 1987) and in Kootenay National Park, B.C. (K. Poole, personal observations).

Results

Observations of goats in the Kicking Horse Canyon

A total of 171:45 hr was spent observing the bluffs along the Kicking Horse Canyon during session 1 (46:35 hr; 25 May – 1 June), session 2 (68:45 hr; 15-23 June), and session 3 (56:35 hr; 4-12 July) (Appendix 2). Almost 66 hours were spent observing the Yoho Bridge bluffs on the south side, and 96 hours on the Park Bridge bluffs; an additional four hours were spent observing the Yoho Bridge bluffs on the north side and five hours on the Glenogle bluffs on the north side during session 1.

The number of goats seen at the two main bluffs (Yoho Bridge South and Park Bridge) varied between bridge sites and between sessions (Fig. 2). The maximum number of goats observed at Yoho Bridge South at any one time was one animal; a nanny and a billy (likely the same individuals) were observed on separate occasions during most of the first observation

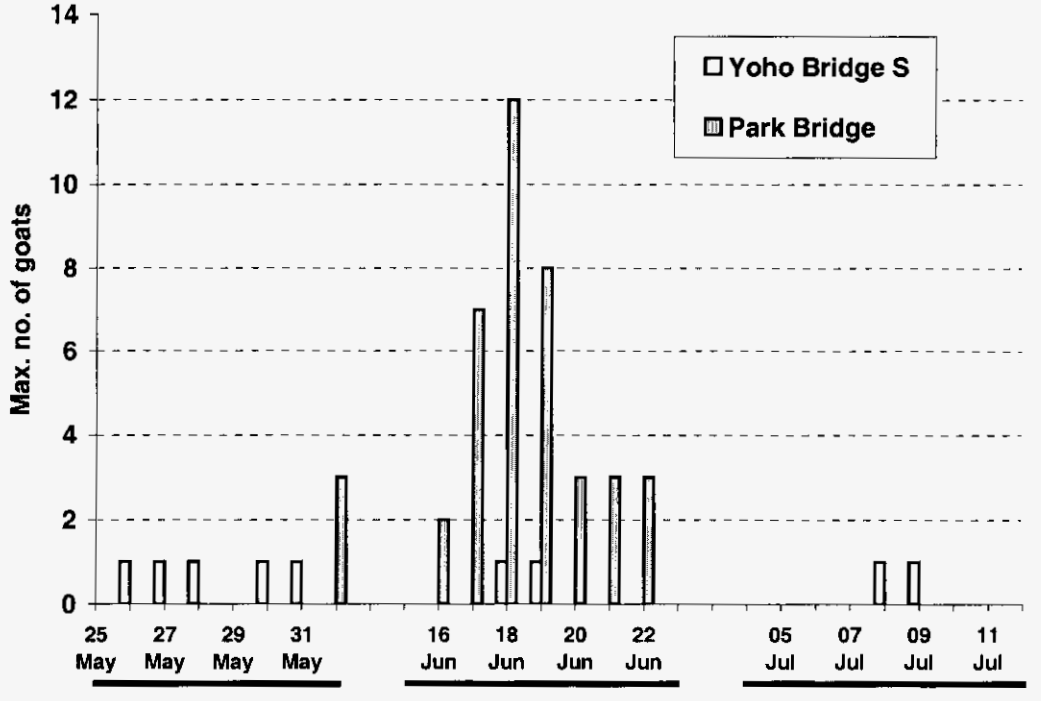

Figure 2. Maximum number of mountain goats observed at the Yoho Bridge South and Park Bridge bluffs during three 8 to 9-day observation periods, May-July 2000. Heavy lines below dates on x-axis indicate observation periods.

session, and a billy was seen during two days in each of the second and third sessions. No goats were observed at the Park Bridge bluffs during the first session until the final day, when three billies showed up. Numbers of goats at the Park Bridge bluffs peaked during the second session, with most animals comprised of nannies and kids. A maximum of four kids was observed on the bluffs during the second session. No goats were observed at the Park Bridge Bluffs during the third session. In addition, one adult goat was observed on the Glenogle bluffs and one was observed high above the Yoho Bridge N bluffs during the first session. We observed a group of 11 sheep (eight ewes and three lambs) at the Yoho Bridge N bluffs and along the TCH at the western approach to the bridge, and we regularly saw and had reported to us groups of ewes and lambs and a group of rams near the Dart Creek pullout and along the Blackwall Bluffs.

Goats were observed feeding on a variety of vegetation, including grazing on grasses and browsing on willow (*Salix* spp.), redstem ceanothus (*Ceanothus sanguineus*), juniper (*Juniperus* spp.), Douglas-fir, and trembling aspen.

Many of the goats, especially some of the adult billies, appeared to be shedding heavily, and a few appeared to have essentially no hair left on their shoulders and necks. Goats were often observed scratching or wallowing. One tick (likely the winter tick; *Dermacentor albipictus*) was found on each of two large clumps of hair above the Park Bridge bluffs, and may have been the cause of the irritation and hair loss.

Yoho Bridge bluffs

North side: Observations and a partial reconnaissance of the bluffs on the north side of the canyon above the western approach to the Yoho Bridge (Fig. 3) suggest that while there are numerous tracks, trails, beds and evidence of browsing throughout the bluffs, there is no obvious mineral lick. Extensive use of the area by sheep was evident, and sheep appear to contribute the greatest amount of ungulate sign in the area. Even though we did not spend extensive periods of time observing these bluffs, we did scan them for ungulates several times daily, thus it is unlikely that we missed a significant number of goats using these bluffs.

South side: All goats observed at the Yoho Bridge South bluffs were observed feeding and bedded, but never licking. Bedding sites were generally high on the bluffs (Fig. 4), and feeding often took place relatively low on the bluffs in the bottom of the talus slopes where regenerating conifers and deciduous trees were growing (Fig. 5). We explored the Yoho Bridge south side bluffs above the eastern approach on 17 June. There appears to be about five main access trails into the bluffs, two from upper left (east) and three from right (west), with the two upper left and one upper right being the heaviest used (Fig. 4). None of the access trails appeared to be heavily used or well worn. Fresh goat droppings were observed on the upper right and middle top trails, and bedding sites were observed at two locations near the top of the bluffs.

Goat tracks were observed on both the pullout on the west approach to Yoho Bridge and under the east approach to the bridge (where we also saw a goat on 19 June). These trails appear to head to the river, or at least to under the bridge, where the goats may be accessing salt residues left over from winter road maintenance.

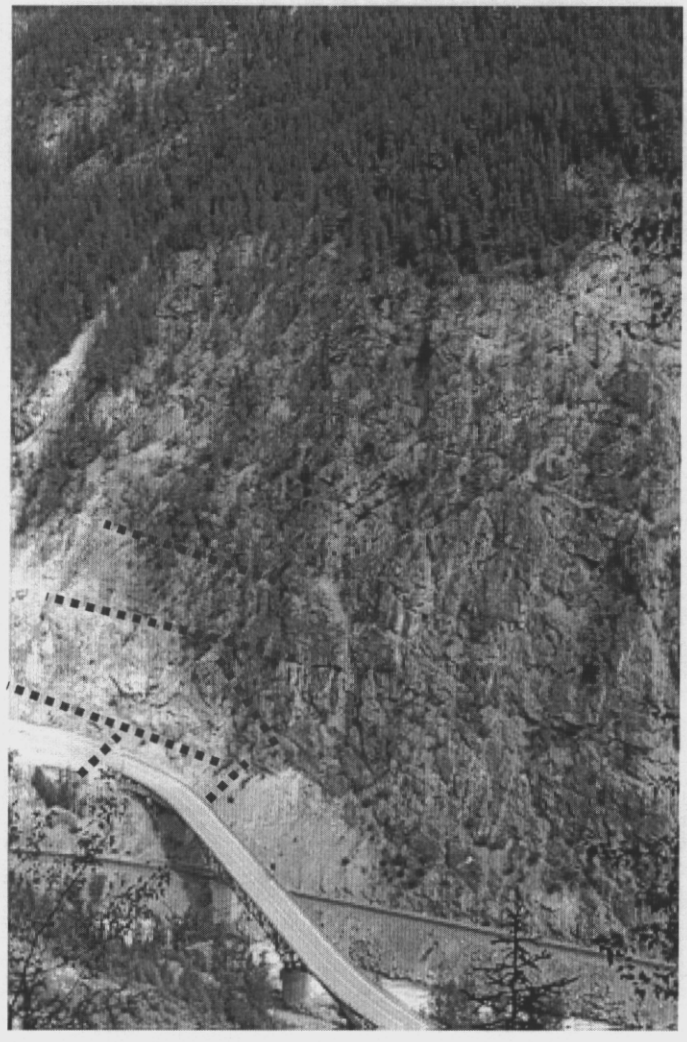

Figure 3. Bluffs on the north side of the Yoho Bridge, Kicking Horse Canyon. The lone goat seen in this area was bedded east (right) of the upper edge of the photo. The red dashed lines denote observed movement paths of sheep (ewes and lambs).

Park Bridge bluff

At the Park Bridge bluffs activities by mountain goats included extensive licking of the rock face, bedding, and some feeding. Goat use of the Park Bridge bluffs was concentrated in the middle and upper half of the bluffs (Fig. 6). The main lick areas appear to be in and off the draws running up and down in the middle of the bluffs. A few smaller licks were evident on the east side of the face near some fir trees. The animals appear to be licking the rock face, as opposed to eating soil, when obtaining minerals. The rock band most heavily used for licking is a dark band of folded rock, identified as a fine-grained limestone with interbeds of mudstone located along a thrust fault (B. Poole, personal communication). The rock had a perceptible salty taste. Minimum time the goats were observed continually licking the rock ranged from 20-160 minutes.

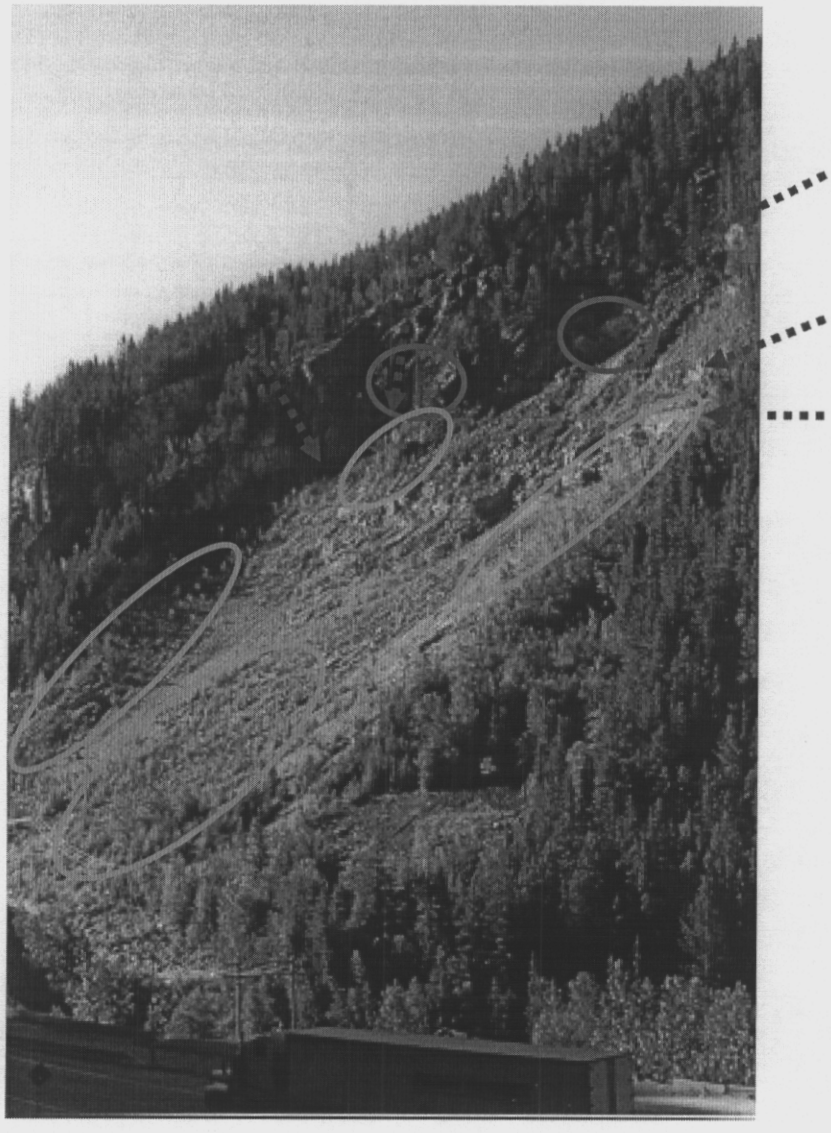

Figure 4. Bluffs on the south side of the Yoho Bridge, Kicking Horse Canyon. Red dashed lines and arrows denote locations of main access trails to the bluffs. Blue ovals denote observed bedding areas. Green ovals denote main feeding areas, and included vegetated areas above the eastern approach (off the bottom left side of the photo).

The area around the Park Bridge bluffs was climbed on 28 May and 18 June. Main access routes on and off the bluffs were from the middle and upper left of the bluff (east side), the two angling draws from the upper right (west), and through the upper third of the triangle of trees to the right (west; Fig. 6). Some trails through the triangle of trees extended around to the

Figure 5. Mountain goat (nanny) feeding on the lower portion of the Yoho Bridge South bluffs.

west-facing slopes overlooking the TCH. Trails also cut down to the TCH through the triangle of trees. There were extensive trails, pellets, and goat sign along the top of the bluffs within the trees. Major access trails into the bluff area were along the treed ridge to the southeast, and through the top of the partially open bluffs southwest of the main Park Bridge bluffs, above the TCH. Bedding sites were varied, but the goats appear to prefer the upper angled draw and a grassy patch in the upper centre of the bluffs (Fig. 6). Goats were also observed bedding in the trees above the bluffs, the upper left area of the bluffs, and 300-400 m southwest of the bluffs.

Observations of goats and our two reconnaissance climbs confirmed that use of the bluffs is seasonal. During the first observation session little use of the bluffs was observed, and no fresh goat sign was found on 28 May. During the second session we observed widespread use of the bluffs by goats, and on 18 June found extensive goat sign, including hair and pellets. No goats were observed using the bluffs during the third session.

For the most part the goats did not appear to be overly alert or disturbed while on the bluffs. However, during some periods the goats appeared more alert than normal; the cause of this alertness was not established. Most animals did not appear to be overly concerned by the traffic on the TCH, and we were unable to detect any obvious differences in alertness between sexes.

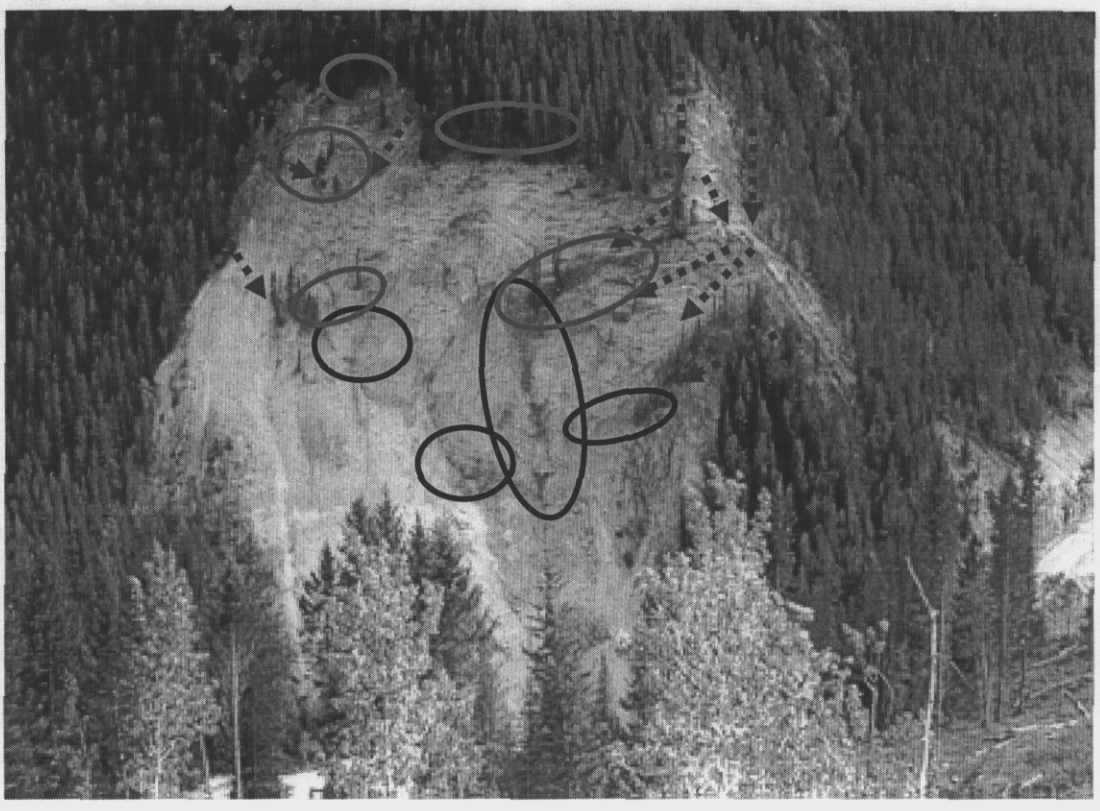

Figure 6. Park Bridge bluffs on the south side of the Kicking Horse Canyon. Black ovals denote main areas of mineral lick activity; blue ovals denote main bedding areas. Red dashed lines and arrows denote locations of main access trails to the bluffs.

Discussion

Mountain goats residing within the Kicking Horse valley and surrounding ranges use the cliffs and bluffs in the Kicking Horse Canyon on a seasonal basis. For a number of reasons, it is difficult to estimate the number of individual goats or proportion of the population using the canyon: goat population estimates for the valley are unknown, identification of unmarked individuals is difficult, the surrounding forest makes a complete census impossible, night use of the open bluffs may be extensive, and our observation sessions were samples, not continuous. Various age and sex cohorts of goats make use of low-elevation sites at different periods of the year, thus we cannot assume to have sampled the entire period of use.

Our observations generally supported local knowledge of these sites. Use of these low-elevation bluffs begins primarily in late May and peak use may extend through June and into early July. Our observations suggest that billies use the bluffs earlier than nannies and kids.

We suspect that the bluffs on either side of the canyon at the Yoho Bridge do not contain mineral licks. Despite 66 hours of observations over 26 days during the period when greatest use

of mineral licks by goats is expected, we saw at most one goat, and never observed any behaviour suggesting that mineral rock or soil was being ingested. Residents familiar with the goats and the bluffs support these observations (N. Jesse, B. Klassen, personal communications). This is not to suggest that the Yoho Bridge bluffs are not important to the area goat population; low-elevation bluffs provide escape terrain to animals seeking early forage and green-up prior to movement to summer alpine habitats and during winter (i.e., Gilbert and Raedeke 1992, Poole 1999). While perhaps not as "critical" to population health and maintenance as mineral licks, low-elevation cliffs are still seasonally important. The Yoho Bridge North bluffs are of importance to sheep frequenting the area, primarily during non-winter periods. These bluffs may also be of minor importance to goats as low-elevation winter range, but no-one familiar with the area reported observing more than the occasional goat here during winter, and Demarchi and Searing (1997) did not observe goats at these sites during mid-winter aerial surveys.

The Park Bridge bluffs appear to contain a source of minerals that is an attractant to goats in the area, including nannies with 2-3 week old kids. The dark band of rock found within the bluffs likely contains the elevated levels of minerals the goats are seeking. The relative importance of this lick to the goat population on the south side of the valley is unknown but is likely high. Only one other lick has been identified within the region (Harvey Research Ltd. 1994), although identification of licks in forested habitats or at high elevation is difficult.

Our preliminary observations suggest that use of the Park Bridge bluffs is highest in June, consistent with the literature and local observations that lick use occurs primarily between late May and early August, with a peak in June and early July. We observed no use of the Park Bridge bluffs during our third observation session; however, cool and wet weather during this session may have affected use of these sites during this session. Timing and intensity of use of mineral licks and low elevation bluffs may vary from year to year depending upon weather, snow melt, and spring phenology. Thus, caution must be used in attempting to extrapolate the timing and intensity of use observed during 2000 to other years.

Goat tracks and goats have been observed leading to the river at both bridge sites. However, there is no evidence to suggest that goats regularly cross the river, at least during periods of high water flow. During spring flood it is unlikely that most goats attempting to cross the river within the canyon would survive. However, goats are passable swimmers and well-known dispersers (Vogel et al. 1995), thus we would expect some individuals would successfully cross the river over time, probably during low water flow.

Mitigation options and recommendations

The proposed realignment of the Yoho and Park bridges on the TCH within the Kicking Horse Canyon has the potential to impact mountain goats using the low-elevation rocky bluffs adjacent to these bridges. Two broad types of impacts to the goats can be considered: short-term impacts during construction of the bridges and approaches, and permanent impacts caused by physical alterations to the bluffs or changes to the access to and from the bluffs. Because of the importance of the mineral lick at the Park Bridge bluffs and the higher number of goats using this site, including a number of nannies with kids, we consider potential impacts to the Park Bridge bluffs to be of greater concern than at the Yoho Bridge bluffs. However, even though no mineral lick was identified at the Yoho Bridge bluffs and nannies with kids were not observed,

the Yoho Bridge South bluff appears to be an important and regularly used low-elevation site for goats.

Following is a preliminary list of concerns regarding these sites, with recommendations to avoid or mitigate impacts to the goats. Limited research has been conducted on the short-term or long-term reactions of mountain goats to various types of disturbance, thus although we can make educated predictions on the impact that construction activities and permanent changes to the sites will have; they are predictions only, backed by limited empirical data.

Construction

1. Construction activities that produce irregular and loud concussive noises will likely discourage goats from using the bluffs. The degree to which goats are deterred from using the bluffs will vary positively with the proximity of the activity.

Goats can habituate to disturbances that are localized, continuous, highly predictable, and non-threatening. However, given the nature, pattern and proximity of the blasting, it is unlikely that the goats will be able to habituate to the proposed rock blasting, pile installation, helicopter activity and road construction and use associated with the bridge and approach reconstruction. At the Yoho Bridge, pile installation is tentatively scheduled to occur between 15 June – 15 November 2001, and 1 April – 1 August 2002, and rock blasting and removal to occur between 15 May – 15 September 2001. Helicopter activity will occur sporadically during construction (primarily during the initial phases), and an access road may be constructed close to the lower east side of the bluffs. Given the possible rock removal and pile installation required in the Park Bridge area, the frequency and duration of these activities at that bridge will likely be greater.

Goats have been shown to react differently to disturbances placed at varying distances from the animals. Disturbances at distances <100 m caused moderate to severe flight reactions in 68% of groups, while disturbances 100-400 m distance elicited these reactions in 52% of goat groups (Foster and Rahs 1983). Given the proximity of the bridges and approaches to the bluffs, we can expect that any goats on or adjacent to these bluffs will in all likelihood react negatively to disturbances emanating from below or adjacent to the bluffs. Construction of access roads near or adjacent to the top of bluffs used by goats and vehicular activity on these roads will in all likelihood cause at least temporary abandonment of the adjacent sites. Because of the irregular nature of the disturbance and the proximity of the disturbance to the bluffs, we do not expect that the goats will be able to habituate to the louder, irregular construction noises (i.e., blasting, pile driving) or irregular helicopter or vehicular activity (on access roads). Nannies with kids tend to be especially nervous of potential disturbances, thus the goats at the Park Bridge bluffs may be impacted to a greater extent in June and early July than elsewhere or at other times of the year.

Although goat use of mineral licks tends to be greatest in early morning and later in the afternoon and evening, restrictions on blasting activities or helicopter use during these periods of the day will likely not successfully mitigate potential disturbance to these goats. Goats using these low-elevation bluffs generally bed in the nearby forest, adjacent to this escape terrain, and thus would likely still be disturbed enough to avoid the sites.

Recommendations

Impacts to goats using the bluffs adjacent to the bridges would be minimized if construction activities that produced loud and irregular noises do not occur within the main window of greatest use. We believe that the primary use by goats of the bluffs adjacent to the bridges is between late May and mid-July. We acknowledge that such constraints on construction activities will in all likelihood not be feasible without greatly lengthening the construction window and vastly increasing the project costs. We therefore suggest the following for each bridge:

Yoho Bridge

a) Activities that produce unfamiliar and sudden loud noises should be minimized during the period of greatest use of these bluffs, generally from early June through to mid-July. As a corollary, construction activities should be concentrated during the periods of the year when goats do not appear to frequent the bluffs, from August through to May.

b) Goat use of the bluffs may be impacted less if blasting activities and helicopter flights are conducted during concentrated periods of time, rather than conducted irregularly over a longer time period. This is especially relevant to the Yoho Bridge South bluffs.

c) Construction and use of the proposed access/tote road up to the lower eastern portion of the Yoho Bridge South bluffs should be minimized during the period from late May to mid-July. The placement of the road should avoid major access trails to the bluffs, and should preferably not access the main bluffs themselves. The access road may require further site investigation prior to placement. The road should be gated to eliminate non-construction related access.

Park Bridge

d) As with the Yoho Bridge bluffs, activities at the Park Bridge bluffs that produce unfamiliar and sudden loud noises should be minimized during the period of greatest use of these bluffs, generally from early June through to mid-July.

e) Given the importance of mineral licks to the goats, the importance of nanny and kid groups to the population, and sensitivity of nannies to disturbance, blasting activities, helicopter use, and any vehicle traffic on access roads adjacent to the Park Bridge bluffs should be minimized or curtailed from early June until early July.

f) With the start of reconstruction of the Park Bridge at least 2 years off, we suggest that additional monitoring be conducted during spring 2001 and 2002 to further clarify the seasonal pattern of use of these bluffs. A proposed pattern of 2 hours of observation of the bluffs every 2 days (alternating morning and evening periods) from mid-May to early August would serve to clarify the current timing and extent of use. This work could be conducted on contract to a Golden resident, perhaps utilizing the Golden Rod and Gun Club.

g) Goat use of the bluffs may be impacted less if blasting activities and helicopter flights are conducted during concentrated periods of time, rather than conducted irregularly over a longer time period.

h) An access road along the top of the slope adjacent to the Park Bridge bluffs (as would be required in Options 5/5A) would in all likelihood have a significant impact on goat use of the these bluffs, and could cause goats to abandon the bluffs. If possible, construction of an access/tote road on or near the top of the Park Bridge bluffs should be avoided. If this road is unavoidable, then its construction should not occur during the period from late May to mid-July, and use of the road during this period should be minimized. Routing of the access road should avoid major access trails to the bluffs, and would require further site investigation for optimum placement. The road should be gated to eliminate non-construction related access.

i) At the Park Bridge it may be feasible to develop a temporary artificial mineral lick southwest of the main bluffs that goats can access during construction. Road salt tilled into the soil has been successfully used to create mineral licks that attract ungulates. The artificial lick would need to be placed in or adjacent to escape terrain (bluffs), and near existing access trails into the area (so that goats will readily discover the new lick), and may provide the goats with their spring/early summer mineral requirements during the period when construction activities render the Park Bridge bluffs unfavourable for use. Site placement would require additional field reconnaissance, but should be not in direct line of sight and at least 500 m from construction activities.

There is a real risk that any construction activities adjacent to the bluffs, especially the Park Bridge bluffs, may cause abandonment of these sites until construction activities are completed. The centre of the Park Bridge bluffs frequented by goats is less than 150 m from the west bridge abutment where a great deal of construction activity will be focussed. Significant construction will occur in the lower portions of the Yoho Bridge South bluffs, within 150 m of the top of the bluffs. It is unknown whether these distances are great enough such that goats will use these bluffs to any degree during construction.

Impacts of bridge and roadway alignments

2. The proposed design options for the Yoho Bridge and its approaches should have little long-term impact on goat use of the adjacent bluffs.

The proposed changes to the Yoho Bridge and its western approach should have little long-term impact on use of the adjacent bluffs on the north side of the canyon by goats or sheep. Most of the construction along the western approach will entail building out the downhill embankments using a retaining wall, not cutting into the uphill slopes. Little use of these bluffs by goats has been detected, and if there is a mineral lick located within 200 m of the western approach to the bridge, it is of relatively low importance to the local goat population. Sheep, primarily ewes and lambs, appear to use this area to a greater degree than goats. Wildlife passage opportunities should be enhanced from having a bridge with a higher profile and longer span, encouraging access to the river via under the bridge, rather than across the approach.

Avalanche and rock fences on the north side bluffs should be placed to avoid major ungulate trails (primarily sheep), and should be discontinuous to avoid eliminating passage through the area.

We suggest that the proposed changes to the eastern approach to the Yoho Bridge will have limited impact on goat use of the adjacent bluffs on the south side of the canyon. It appears that although these bluffs are used and important to at least a few goats, the bluffs do not contain a mineral lick. Goats may use these bluffs to obtain early vegetation green-up, and we did observe two goats feeding in the lower portion of the bluff. All of the main access trails into the bluffs are located off the edges of the upper half of the bluffs, which should be well above the proposed construction activity concentrated within 30-40 m of the existing alignment. If goat use of this bluff is reduced during construction, it is likely that given the minimal impacts to the bluffs, the animals will resume use once construction activities are completed.

Recommendations

a) The western approach to the Yoho Bridge should be constructed such that animals are encouraged to travel under the bridge deck, rather than over the western approach, when accessing the river. Proposed ditching and rock catch fencing above the highway and the retaining wall below the highway should discourage travel across the western approach. Wildlife exclusion fencing adjacent to the highway should be avoided where possible, to reduce animals being trapped on the "wrong" side of the fence.

b) A pullout adjacent to the east side approach should not be constructed because people leaving their vehicles may disturb any goats using the bluffs. Visitors stopping in this area may be encouraged to climb after and disturb goats feeding on the middle and lower portions of the bluffs.

c) The access road, if constructed, should be decommissioned and deactivated immediately upon completion of construction activities.

3. The proposed design options for the Park Bridge and approaches have the potential to negatively affect goat use of and access to the mineral lick located on the adjacent bluffs.

Goats heavily use the north-facing bluffs adjacent to the western approach to the Park Bridge during periods in spring and early summer, with an exposed band of mineral-rich rock being the main attractant. Nannies and kids appear to make use of the bluffs starting in mid-June. Use of these licks may be vital to the ecology of the local populations of goats, and disruption of lick use may have negative impacts for the health of local populations.

Goats were observed accessing the bluffs from both sides. Main access routes were observed on the western side of the bluffs, extending through the triangle of trees and around to the west-facing slopes overlooking the TCH.

Currently there are two main design options for the bluffs. Options 5/5A will result in two separate two-lane highways being constructed, the southern lane which will result in significant portions of the slopes west of main bluffs to be removed, including much of the triangle of trees currently in place on the west side of the bluffs. These options will result in two lanes of highway being moved to within 60-80 m of the mineral lick. Option 5B (the "viaduct"

option), currently the preferred option being considered by engineers, should result in far less slope removal in this area, and fewer permanent impacts to the bluffs.

Recommendations

a) Option 5B is our preferred option for reconstruction of the Park Bridge. This option should produce far fewer long-term impacts than Options 5/5A to the integrity of the bluffs containing the mineral lick, and to goat access routes to the bluffs. This option should also produce fewer disturbances to the goats during construction and during normal highway activity.

b) Options 5/5A will probably cause a significant reduction in use of the Park Bridge mineral lick by altering access routes to the bluffs from the western side, removing much of the ridgeline and screen of trees currently in place on the western edge of the bluffs between the bluffs and the TCH, and by placing two lanes of traffic much higher up on the slope and closer to the bluffs. This option will in all likelihood have a significant impact on the goats and their use of the mineral lick.

c) A triangle of trees and a ridgeline currently buffer the Park Bridge bluffs from the TCH near the western approach to the bridge, such that the main potential disturbances as perceived by the goats currently come from north of the bluffs across the Kicking Horse River. During construction, all effort should be made to retain this stand of trees and as much of the western ridgeline as possible.

d) Major access trails to the bluffs occur on the western side through the upper half of the triangle of trees, and the upper western end of the bluffs. Disturbance to these areas should be minimized. If removed, goats may simply use other access routes into the bluffs, but there is a chance that they may also reduce their use of the bluffs if they perceive that reduced access increases their risk of danger.

e) Upon completion of the construction activity, any access road constructed around the back of the Park Bridge bluffs should be decommissioned and deactivated.

f) As noted by Demarchi and Searing (1997), steep rock-cuts should be avoided near the mineral licks in order to maintain the integrity of those sites.

g) Avalanche fencing currently planned for the top of the bluffs above the TCH west of the main Park Bridge bluffs may impact goat use of the numerous trails running relatively horizontally along that face. To minimize the potential impact of these fences on the goats they should be placed below the main trails along the top of the bluffs, not cut across existing trails, and be adequately staggered/spaced to not produce a barrier to animal movement.

Recommendations for revegetation of surplus material disposal sites

We examined the proposed surplus material disposal site in May 2000. Much of the area is forested, comprised of mature stands of Douglas-fir and white spruce, with scattered sub-alpine fir. There is a predominant moss base, which likely covers a limited depth of organic soils. A portion of the proposed site (perhaps 2-3 ha) is covered with a silt/dirt slide, where 2-4 m high cottonwood (*Populus balsamifera*) and willow are found. Game trails were evident throughout the area, generally running parallel to the river. Elk tracks and pellets were relatively abundant, especially in the area of cottonwood and willow regeneration where there was extensive evidence of browsing, and bones from a deer were observed.

We were presented with a number of considerations and limitations for revegetation options of the proposed surplus material disposal site. Valley bottom and riparian habitat in this area have relatively high wildlife values. The proposed disposal site is the western extent of valley bottom within the Kicking Horse Valley west of Yoho National Park, and thus tends to act as a funnel for wildlife moving in an east-west direction through the valley. To minimize costs, use of off-site topsoil was to be avoided, therefore, vegetation had to be tolerant of relatively low-nutrient conditions. Because of the waste rock base, the site was likely to be well drained in places (depending upon microsite location). We also wanted to avoid, if possible, the use of introducing "weedy" species into the area. Finally, we wanted to maximize the availability of winter forage species for ungulates, primarily elk, within the area. Ungulates tend to use valley bottom habitats to the greatest extent during winter and early spring.

We propose the following be considered for this disposal site. These suggestions are based primarily on Hubbard and Bell (1977), Blower (1982), Harrison (1985), Ziemkiewicz (1985), RRTAC (1989), Ministry of Transportation and Highways (1994), Oil Sands Vegetation Reclamation Committee (1998), and B. MacCallum (personal commuication):

- We suggest that a 50-m setback from the high water mark of the Kicking Horse River should be observed to maximize the value of the area to wildlife, maintain the integrity of the riparian zone, provide a source of seeds for natural revegetation of the disposal site, and facilitate movement of animals through this riverside corridor. The Forest Practices Code requires a 50-m reserve of no development along S1 streams (>50 m wide), such as the Kicking Horse River.

- All trees should be removed from the site. Non-merchantable trees and root balls should be stockpiled. All topsoil (with the existing ground and shrub layer) should be removed and stockpiled. Underlying fine-grained mineral soil should be also stockpiled.

- The surplus material should be shaped to provide no greater than 25% slopes. Irregular shaped edges and irregular contours (hummocky) are preferable to provide a variety of microsites to re-establish vegetation and topographic cover. Because of the nature of the crushed rock that will be deposited, moisture on the site will likely drain rapidly on slopes and hilltops. This will result in a leaching of overlaying soils into the substrate, reducing the soil productivity. A layer of fines should be spread over the waste rock to minimize leaching of soil and loss of moisture.

- Stockpiled topsoil and organic materials should be spread over the contoured waste rock. Stockpiled non-merchantable trees and root balls should be spread over the site to

provide some vegetation structure and a source of nutrients (from decaying wood), and to help to stabilize the soil on the site. Depending upon how long the topsoil was stockpiled, the topsoil and ground/shrub layer mixture should help to re-establish at least some new species of indigenous vegetation on the site.

- While it is preferable to use indigenous species to re-establish plant cover (Ministry of Transportation and Highways 1994), it is exceedingly difficult (and more costly) to successfully seed indigenous ground cover species in disturbed sites (B. MacCallum, personal communication). Given these constraints, shrub species could be used as a focus for re-vegetation and soil stabilization, with a mix of non-native grasses and legumes to provide an additional source of rapid ground cover, soil stabilization, and ungulate forage. Non-native grasses and forbs tend to produce deep roots, providing plant cover and erosion control faster than most indigenous species. If a mix of grasses and legumes is used, there is greater chance that at least some species will become established in the variety of microsites available.

- Grasses and legume could be applied in a mix of seeds. Grass species that are relatively drought tolerant and may be appropriate for this application include Canada bluegrass (*Poa compressa*), Crested wheatgrass (*Agropyron cristatum*), and red fescue (*Festuca rubra*), all of which are considered moderate to good forage species for ungulates. All grasses are nutrient deficiency intolerant, and thus would benefit from initial application with fertilizer and mixture with legumes. Legumes are nutrient deficiency tolerant and tend to enrich nutrient-poor substrates. Legumes that could be included are alfalfa (*Medicago sativa*) and alsike clover (*Trifolium pratense*), both of which are highly rated as spring forage for ungulates and bears.

- Blower (1982) rated key winter forage species for ungulates in B.C. Willow and cottonwood are rated as moderate and high importance to elk, respectively, and could be planted using established suckering techniques in the lower (and more moist) microsites of the area. These species are also rated as moderate forage importance to both species of deer. Redstem ceanothus (*Ceanothus sanguineus*) is also a preferred food for elk and deer, and seedlings of this species have been planted to enhance winter forage for ungulates in the West Kootenay (J. Gwilliam, Columbia Basin Fish and Wildlife Compensation Program, Nelson, personal communication). Douglas maple (*Acer circinatum*) and Saskatoon (*Amelanchier alnifolia*) are highly rated for ungualtes, and may be appropriate species to plant or establish within some microsites.

- Coniferous trees may be planted in appropriate microsites to provide hiding cover and an additional source of forage. Douglas-fir may be the best choice here, because of its high forage value (Blower 1982) and prevalence in the surrounding forest. White spruce has also been used to provide tree cover in reclaimed areas (Hubbard and Bell 1977). Conifer trees should be caged to protect them from browsing by ungulates until they become sufficiently established.

- The acidity of the site will be influenced by the nature of the waste rock substrate, which will in turn influence the species of vegetation that will become established on the site. We suggest that additional research is required to determine the optimum physical layout of the disposal site, site preparation and the plants, shrubs, and tree species that will provide the greatest ground cover and soil stabilization, while maximizing value for

ungulates and other wildlife. Over time, natural revegetation from the surrounding forests should establish native vegetation in the disposal site (Oil Sands Vegetation Reclamation Committee 1998).

Persons contacted

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Literature cited

Blower, D. 1982. Key winter forage plants for B.C. ungulates. Unpublished report, Terrestrial Studies Branch, B.C. Minsitry of Environment, Victoria.

Brandborg, S.M. 1955. Life history and management of the mountain goat in Idaho. Idaho Department of Fish and Game Wildlife Bulletin No. 2.

Chichowski, D.B., D. Haas, and G. Schultze. 1994. A method used for estimating mountain goat numbers in the Babine Mountains Recreation Area, British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council 9:56-64.

Côté, S.D. 1996. Mountain goat responses to helicopter disturbance. Wildlife Society Bulletin 24:681-685.

Demarchi, M.W., and G.F. Searing. 1997. Wildlife tracking project: Golden to west boundary of Yoho National Park. Final report. LGL Limited. Sidney, BC.

Demarchi, M.W., S.R. Johnson, and G.F. Searing. 1997. Mountain goat inventory in the Nisga'a Wildlife Management Area Region A. Unpublished report submitted to BC Environment, Lands and Parks, Smithers.

Dormaar, J.F., and B.D. Walker. 1996. Elemental content of animal licks along the eastern slopes of the Rocky Mountains in southern Alberta, Canada. Canadian Journal of Soil Sciences 76:509-512.

Festa-Bianchet, M., M. Urquhart, and K.G. Smith. 1994. Mountain goat recruitment: kid production and survival to breeding age. Canadian Journal of Zoology 72:22-27.

Foster, B.R., and E.Y. Rahs. 1983. Mountain goat responses to hydroelectric exploration in Northwestern British Columbia. Environmental Management 7:189-197.

Gilbert, B.A., and K.J. Raedeke. 1992. Winter habitat selection of mountain goats in the North Tolt and Mine Creek drainages of the North Central Cascades. Biennial Symposium of the Northern Wild Sheep and Goat Council 8:305-324.

Harrison, G. 1985. Establishment and maintenance of plant cover on disturbances in the National Parks. Pages 192-202 *in* P.F. Ziemkiewicz, editor. Workshop proceedings, revegetation methods for Alberta's mountains & foothills, 30 April – 1 May 1984, Edmonton, Alberta. Alberta Land Conservation & Reclamation Council, Reclamation Research Technical Advisory Committee report #RRTAC 85-1, Edmonton, Alberta.

Harvey Research Ltd. 1994. Wildlife habitat mapping, Trans Canada Highway corridor Golden to Yoho National Park, BC. Prepared for the BC Ministry of Transportation and Highways.

Hebert, D, and I.M. Cowan. 1971. Natural salt licks as a part of the ecology of the mountain goat. Canadian Journal of Zoology 49:605-610.

Hebert, D., and R. Woods. 1984. A preliminary analysis of intensive, unreplicated survey data for mountain goat populations in British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council 4:506-513.

Hopkins, A., J.P. Fitzgerald, A. Chappell, and G. Byrne. 1992. Population dynamics and behavior of mountain goats using Elliot Ridge, Gore Range, Colorado. Biennial Symposium of the Northern Wild Sheep and Goat Council 8:340-356.

Hubbard, W.F., and M.A.M. Bell. 1977. Reclamation of lands disturbed by mining in mountainous and northern areas: a synoptic bibliography and review relevant to British Columbia and adjacent areas. Prepared for B.C. Ministry of Mines and Petroleum, Resources Inspection Branch. Biocon Research Ltd., Victoria, B.C.

Joslin, G.L. 1986. Montana mountain goat investigations, Rocky Mountain Front. Final Report. Montana Department of Fish, Wildlife and Parks, Helena.

Lemke, S.L. 1999. Cayoosh Range mountain goat study results and recommendations. Unpublished report for BC Ministry of Environment, Lands and Parks, Kamloops.

McCrory, W.P. 1979. An inventory of the mountain goats of Glacier and Mount Revelstoke National Parks, British Columbia. Parks Canada, Western Region, Glacier National Park, Revelstoke, B.C.

Ministry of Transportation and Highways. 1995. Reclamation and environmental protection handbook for sand, gravel, and quarry operations in British Columbia. Properties Branch, Gravel Management Division, Victoria.

Oil Sands Vegetation Reclamation Committee. 1998. Guidelines for reclamation to forest vegetation in the Athabasca Oil Sands region. Alberta Environmental Protection, Oil Sands Vegetation Reclamation Committee, Edmonton, Alberta.

Pedevillano, C., and R.G. Wright. 1987. The influence of visitors on mountain goat activities in Glacier Nation Park. Biological Conservation 39:1-11.

Penner, D.F. 1988. Behavioral response and habituation of mountain goats in relation to petroleum exploration at Pinto Creek, Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council 6:141-158.

Poole, K.G. 1999. Low elevation forest use by mountain goats in the Robson Valley Forest District, British Columbia, year 2. Unpublished report submitted to Fish and Wildlife Branch, B.C. Ministry of Environment, Lands and Parks, Prince George.

Poole, K.G., D.C. Heard, and G.S. Watts. 2000. Mountain goat inventory in the Robson Valley, British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council. In press.

RRTAC. 1989. Manual of plant species suitability for reclamation in Alberta. Second edition. Alberta Land Conservation and reclamation Council, Reclamation Research Technical Advisory Committee report #89-4, Edmonton, Alberta.

Robbins, C.T. 1983. Wildlife feeding and nutrition. Academic Press, Toronto.

Romeo, G., and S. Lovari. 1996. Summer activity rhythms of the mountain goat *Oreamnos americanus* (de Blainville, 1816). Mammalia 60:496-499.

Shackleton, D. 1999. Hoofed mammals of British Columbia. The Mammals of British Columbia,Volume 3, Royal British Columbia Museum. UBC Press, Vancouver.

Singer, F.J. 1978. Behavior of mountain goats in relation to U.S. Highway 2, Glacier National Park, Montana. Journal of Wildlife Management 42:591-597.

Singer, F.J., and J.L. Doherty. 1985. Movements and habitat use in an unhunted population of mountain goats, *Oreamnos americanus*. Canadian Field-Naturalist 99:205-217.

Smith, B.L. 1988. Criteria for determining age and sex of American mountain goats in the field. Journal of Mammalogy 69:395-402.

Stevens, V., and D.B. Houston. 1989. Reliability of age determination of mountain goats. Wildlife Society Bulletin 17:72-74.

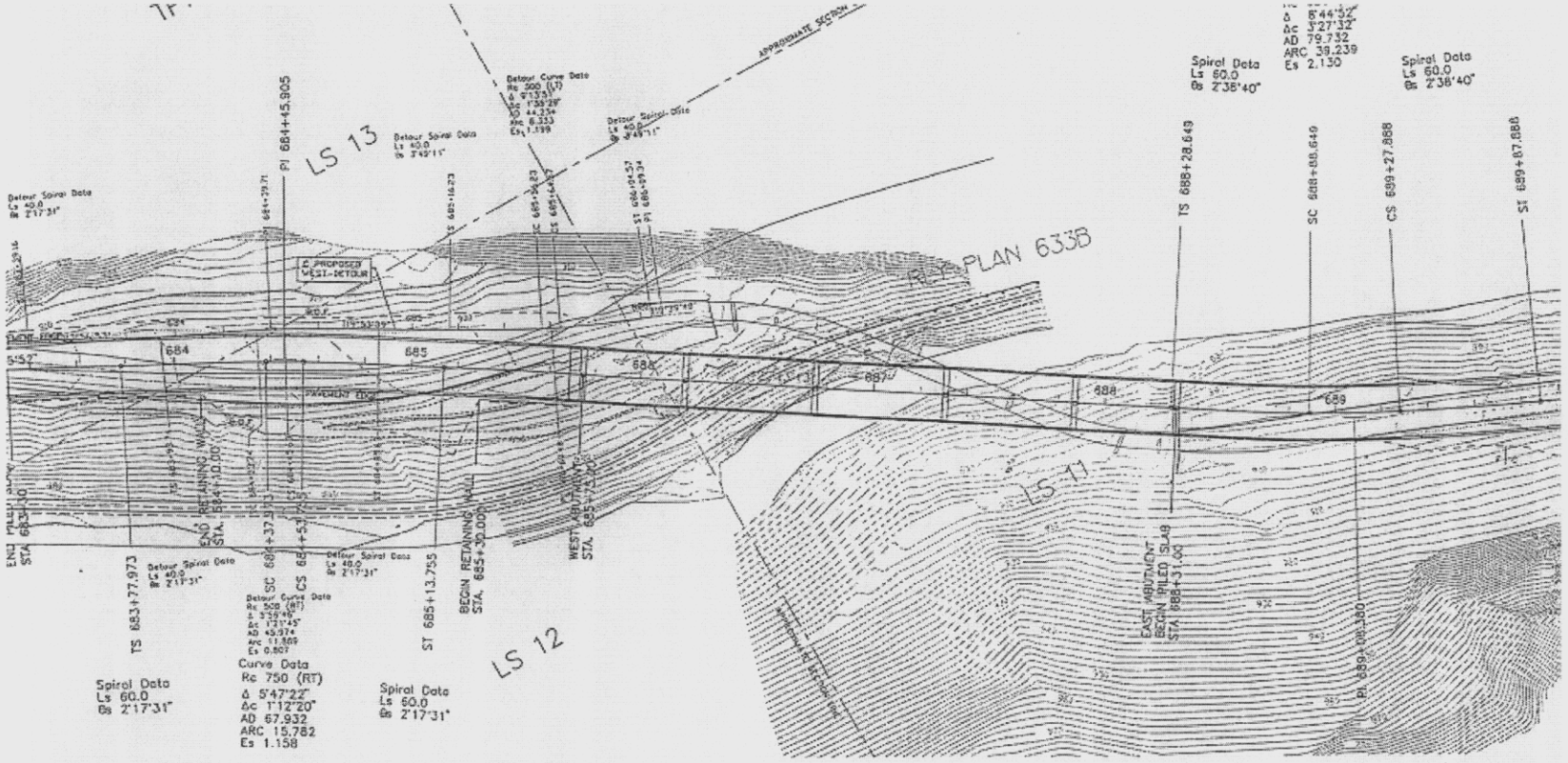
Varley, N.C. 1994. Summer-fall habitat use and fall diets of mountain goats and bighorn sheep in the Absaroka Range, Montana. Biennial Symposium of the Northern Wild Sheep and Goat Council 9:131-138.

Vogel, C.A., E.D. Ables, and J.M. Scott. 1995. Review and analysis of North American mountain goat (*Oreamnos americanus*) literature with emphasis on population dynamics. Unpublished report, University of Idaho, Moscow.

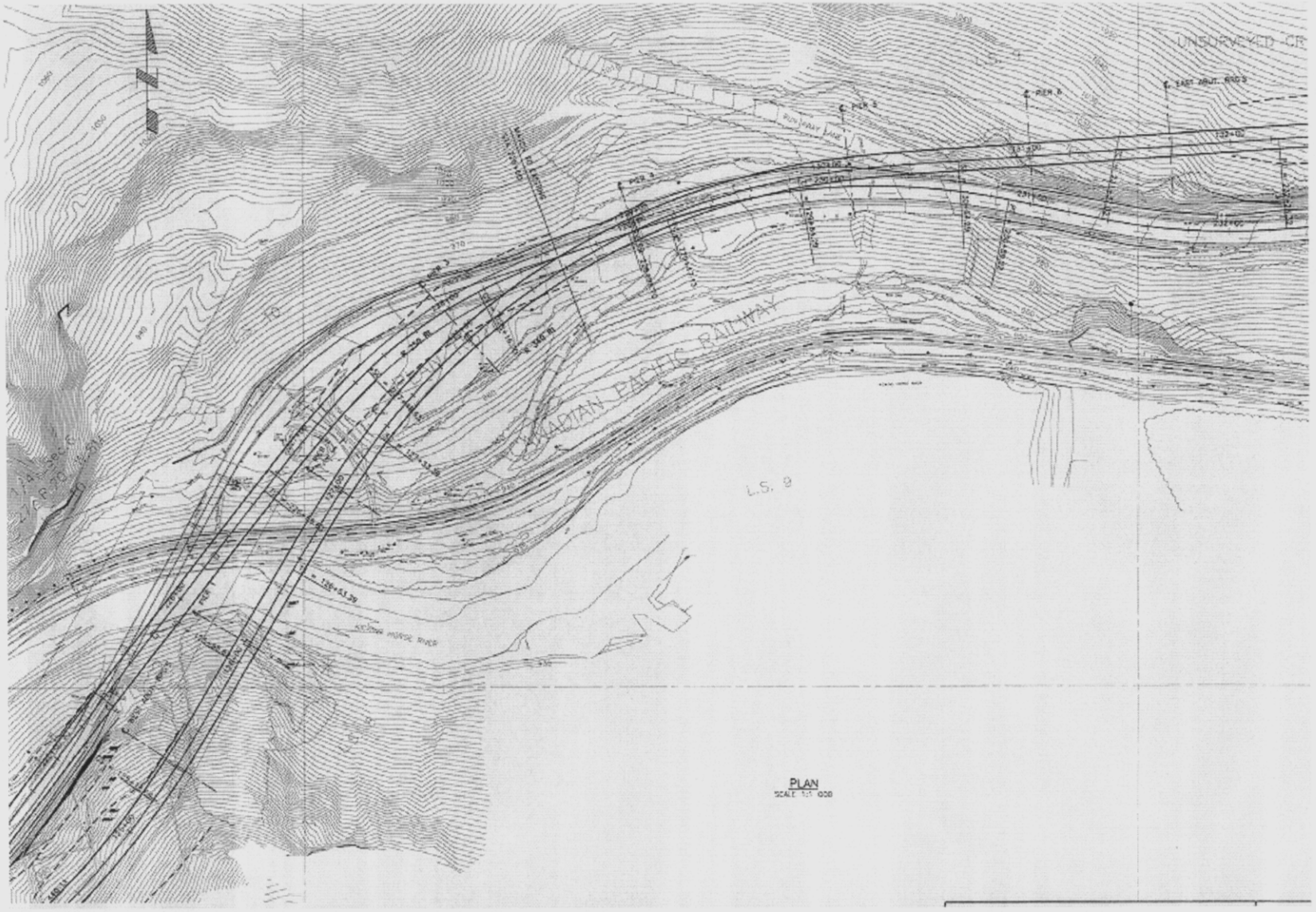
WARS. 2000. Wildlife accident reporting system. B.C. Ministry of Transportation and Highways, Victoria.

Ziemkiewicz, P.F. 1985. Revegetation of oil & gas disturbances, seed mixes, fertilizers and application methods. Pages 90-100 *in* P.F. Ziemkiewicz, editor. Workshop proceedings, revegetation methods for Alberta's mountains & foothills, 30 April – 1 May 1984, Edmonton, Alberta. Alberta Land Conservation & Reclamation Council, Reclamation Research Technical Advisory Committee report #RRTAC 85-1, Edmonton, Alberta.

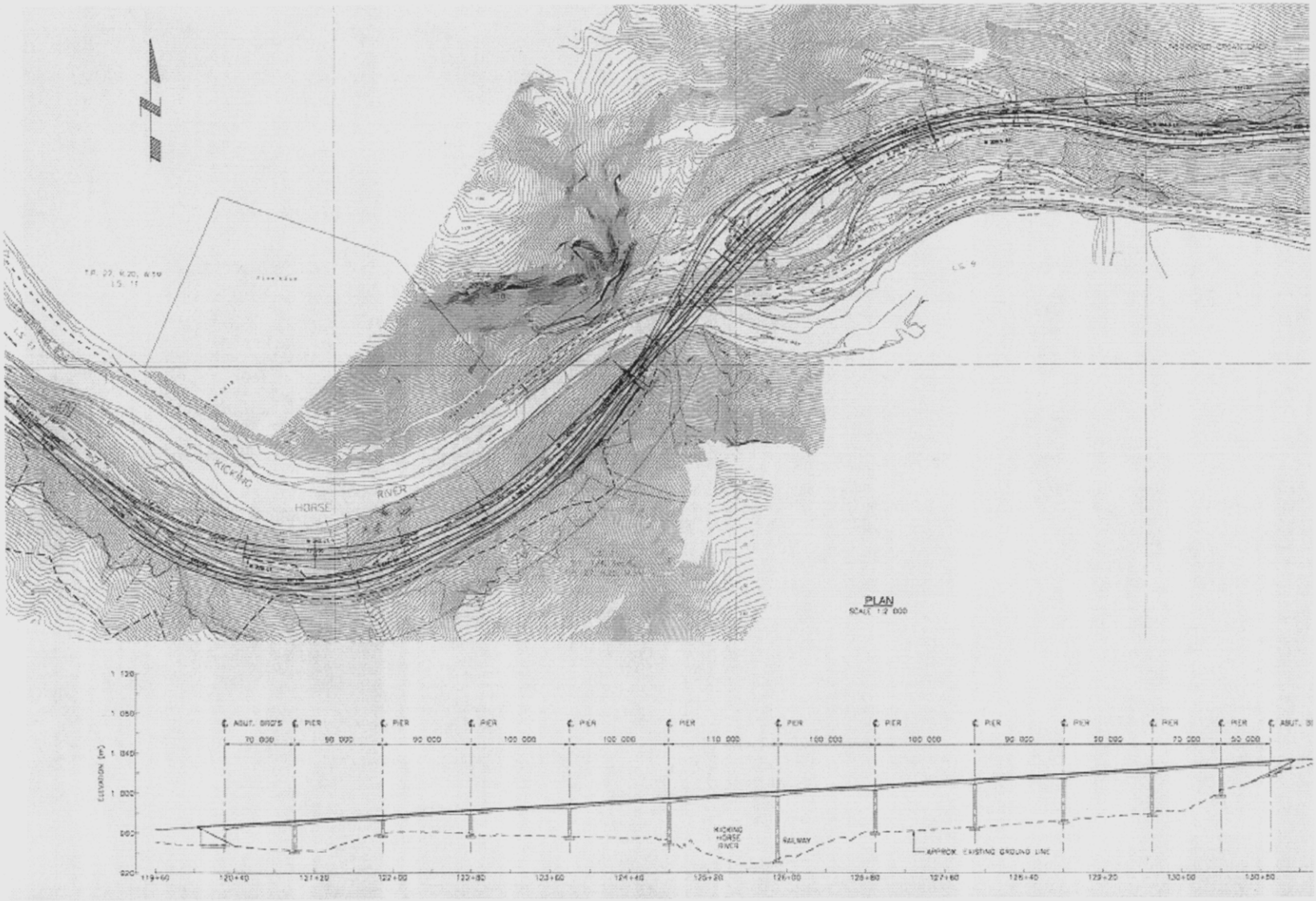
Appendix 1. Drawings of bridge designs for the Yoho and Park bridges, Kicking Horse Canyon.



Yoho Bridge



Park Bridge, Options 5/5A



Park Bridge, Option 5B

Appendix 2. Mountain goat observations in the Kicking Horse Canyon, 25 May – 12 July 2000.

Date	Location	Time (hr)	Obs. time (hr)	Obs.[1]	Weather	Goats present	Comments
	Session 1						
25 May	Yoho Bridge S	08:30 – 08:40	0:10	AW	Clear	1 billy	Bedded at top of bluff
	Park Bridge	17:30 – 20:30	3:00	AW	Clear		
26 May	Park Bridge	08:00 – 11:30	3:30	AW	Overcast		
	Yoho Bridge S	11:45 – 12:00	0:15	AW	Overcast		
	Glenogle Bluffs	17:00 – 19:00	2:00	AW	Stormy	1 adult billy	Feeding
	Yoho Bridge S	19:00 – 20:30	1:30	AW	Clearing	1 adult billy	Feeding at top of bluff
27 May	Park Bridge	07:00 – 07:30	0:30	AW	Broken cloud		
	Yoho Bridge S	07:45 – 09:45	2:00	AW	Broken cloud		
	Glenogle Bluffs	09:45 – 10:00	0:15	AW	Overcast	1 adult billy	Feeding
	Km 7.5	13:30 – 14:00	0:30	AW	Rainy, overcast	1 adult billy	Feeding, rubbing
	Yoho Bridge S	14:00 – 14:30	0:30	AW	Rainy, overcast	1 adult nanny	Feeding, <100 m from highway; alert at trucks passing
	Glenogle Bluffs	14:30 – 15:00	0:30	AW	Rainy, overcast	1 adult billy	Bedded
	Park Bridge	15:00 – 18:00	3:00	AW	Rainy, overcast		
28 May	Park Bridge	08:00 – 11:00	3:00	AW	Rainy, overcast		
	Glenogle Bluffs	11:00 – 11:30	0:30	AW	Overcast, clearing	1 adult billy	Bedded
	Yoho Bridge S	13:00 – 14:00	1:00	AW	Partly cloudy	1 adult nanny	Feeding (*Salix*) 100 m above highway
	Yoho Bridge S	21:00 – 22:00	1:00	AW	Clear	1 adult goat	Feeding at top of bluffs
	Glenogle Bluffs	22:00 – 22:30	0:30	AW	Clear	1 adult billy	Feeding
29 May	Yoho Bridge S	08:00 – 10:00	2:00	AW	Overcast		
	Yoho Bridge N	10:30 – 11:00	0:30	AW	Overcast		

	Glenogle Bluffs	10:30 – 11:00	0:30	AW	Overcast	1 adult billy	Bedded, scratching, low on bluffs
	Park Bridge	11:00 – 11:30	0:30	AW	Overcast, clearing		
	Park Bridge	19:00 – 22:00	3:00	AW	Broken clouds		
30 May	Park Bridge	06:00 – 09:30	3:30	AW	Partly cloudy		
	Yoho Bridge S	09:45 – 10:15	0:30	AW	Overcast	1 adult, 500 m west	Bedded in forests/bluffs
	Yoho Bridge S	20:00 – 22:30	2:30	AW	Overcast		
31 May	Yoho Bridge S	06:00 – 07:45	1:45	AW	Clear		
	Glenogle Bluffs	08:00 – 09:00	1:00	AW	Clear	1 adult billy	Bedded
	Park Bridge	09:20 – 10:30	1:10	AW	Clear		
	Yoho Bridge S	10:30 – 11:00	0:30	AW	Clear	1 adult billy, 500 m west	Feeding in forests/bluffs
	Yoho Bridge N	20:00 – 22:30	2:30	AW	Clear	1 adult goat 5 ewes, 3 lambs	Bedded high on bluffs Feeding high on bluffs
1 June	Park Bridge	08:00 – 11:00	3:00	AW	Clear	3 adult billies	Feeding, some bedding, upper half of bluffs
	Session 2						
15 June	Yoho Bridge S	16:15 – 16:30	0:15	KP	Partly clear		
	Park Bridge	16:40 – 19:10	2:30	KP	Mostly cloudy, wind	5 adults, 1 km SW	Bedded, feeding; black bear nearby
	Yoho Bridge S	19:20 – 19:45	0:25	KP	Mostly cloudy, wind		
16 June	Yoho Bridge S	07:45 – 09:00 09:40 – 11:00	1:15 1:20	KP	Clear		
	Park Bridge	08:15 – 09:30 09:55 – 10:50	1:15 0:55	AW	Clear	2 nannies, 1 kid	Licking rock (middle center of bluff), then bedded on SW ridge
	Yoho Bridge S	16:15 – 20:00	3:45	AW	Cloudy to clear		
	Park Bridge	16:20 – 19:50	3:30	KP	Cloudy to clear	2 adult billies 6 adults, 1 kid to	2 adult billies licking the rock, bedded; groups of 7 1 km SW,

						SW	bedded
17 June	Yoho Bridge S	07:35 – 10:35	3:00	AW	Mainly clear	8 ewes, 3 lambs	Crossed through west approach and pullout
	Park Bridge	07:45 – 11:15	3:30	KP	Mainly clear	2 nannies, 1 kid, 2 billies 1 nanny, 1 kid 4 adults to SW	Licking, bedded, on upper left of bluff; alert; move to upper right Arrive 10:35 from west edge, licking Bedded 1 km SW
	Yoho Bridge S	16:00 – 20:10	4:10	KP	Overcast	1 adult goat 400 m to west 4 ewes	Glimpse of goat in trees; heading east Crossed highway at west approach
	Park Bridge	17:00 – 20:00	3:00	AW	Overcast	4 nannies, 2 kids	Feeding and licking; arrived from east, licked lower center draws, moved through the top of tree triangle
18 June	Yoho Bridge S	07:35 – 11:00	3:25	KP	Overcast, light rain	1 adult billy 250 m to west of top of bluff	Bedded, feeding, scratching
	Park Bridge	07:40 – 11:00	3:20	AW	Overcast	7 nannies, 4 kids, 1 yearling	Licking, primarily central draws; bedded middle upper and near top
	Yoho Bridge S	17:30 – 18:30	1:00	AW	Partly clear	1 adult billy	Feeding from eastern edge down to above highway
	Park Bridge	17:30 – 18:40	1:10	KP	Partly clear	3 nannies, 2 kids, 1 billy, 1 adult	Licking, bedded
19 June	Yoho Bridge S	07:40 – 11:10	3:30	AW	Partly clear	1 adult billy	Bedded at top of bluff, wallowing, scratching, feeding to under bridge
	Park Bridge	07:30 – 10:50	3:20	KP	Partly clear	1 nanny, 1 kid on bluffs 4 adults, 2 kids on southwest ridge	Licking, bedded, on east central portion of bluffs Bedded about 300 m from bluffs
	Yoho Bridge S	19:00 – 19:20	0:20	AW	Overcast	1 adult billy	Feeding in middle left (east) regen.
	Park Bridge	19:30 – 22:00	2:30	AW	Overcast	2 nannies, 1 kid, 1	Licking (yearling), moving above

						yearling	bluff (nannies and kid)
20 June	Park Bridge	09:30 – 12:30	3:00	AW	Overcast	1 adult billy	Bedded on southeast ridge
	Yoho Bridge S	18:30 – 19:00	0:30	AW	Overcast		
	Park Bridge	19:10 – 21:30	2:20	AW	Overcast	1 nanny, 1 kid, 1 billy	Nanny and kid bedded, scratching, wallowing; billy licking, then all moved off bluff to west
21 June	Park Bridge	07:40 – 09:30	1:50	AW	Partly clear	2 nannies, 1 kid	Feeding, bedded, licking; upper west side of bluff
	Yoho Bridge S	09:40 – 11:00	1:20	AW	Partly clear		
	Park Bridge	18:45 – 22:00	3:15	AW	Clear	2 nannies, 1 kid	Feeding; upper east part of bluffs
22 June	Park Bridge	08:30 – 10:00	1:30	AW	Overcast	2 nannies, 1 kid	Feeding on southwest ridge west of main bluffs; possible lick
	Yoho Bridge S	10:20 – 11:45	1:25	AW	Overcast		
	Yoho Bridge S	17:40 – 18:30	0:50	AW	Partly cloudy		
	Park Bridge	18:40 – 21:00	2:20	AW	Partly cloudy		
23 June	Park Bridge	07:15 – 9:45	2:30	AW	Partly cloudy		
	Yoho Bridge S	10:00 – 10:30	0:30	AW	Partly cloudy		
	Session 3						
4 July	Park Bridge	18:30 – 20:30	2:00	AW	Cold, light rain		
	Yoho Bridge S	20:35 – 21:00	0:25	AW	Cold, heavy rain		
5 July	Yoho Bridge S	07:15 – 09:00	1:45	AW	Overcast, light rain		
	Park Bridge	09:10 – 11:00	1:50	AW	Mostly cloudy	1 adult (billy?)	Feeding, bedded 500 m west of bluffs
	Park Bridge	18:00 – 19:30	1:30	AW	Mostly cloudy	1 adult (billy?)	Feeding 500 m west of bluffs
	Yoho Bridge S	19:40 – 21:10	1:30	AW	Mostly cloudy		
6 July	Yoho Bridge S	07:30 – 09:15	1:45	AW	Clear		
	Park Bridge	09:25 – 11:15	1:50	AW	Clear		

	Park Bridge	18:30 – 20:30	2:00	AW	Partly cloudy		
	Yoho Bridge S	20:40 – 21:45	1:05	AW	Partly cloudy		
7 July	Park Bridge	08:00 – 11:00	3:00	AW	Overcast		
	Yoho Bridge S	11:10 – 11:45	0:35	AW	Overcast		
	Yoho Bridge S	18:00 – 18:30	0:30	AW	Overcast		
	Yoho Bridge N	18:30 – 19:30	1:00	AW	Overcast	1 ewe, 2 lambs	Cross highway at west approach
	Park Bridge	19:40 – 21:00	1:20	AW	Overcast	1 adult (billy?)	Feeding 500 m west of bluffs
8 July	Park Bridge	09:00 – 11:15	2:15	AW	Mainly clear		
	Yoho Bridge S	11:30 – 12:30	1:00	AW	Mainly clear		
	Park Bridge	18:30 – 20:30	2:00	AW	Overcast		
	Yoho Bridge S	20:40 – 21:45	1:05	AW	Overcast	1 adult billy	Feeding on east side of bluffs
9 July	Park Bridge	08:00 – 10:00	2:00	AW	Overcast, cool		
	Yoho Bridge S	10:10 – 12:00	1:50	AW	Overcast, cool	1 adult billy	Feeding on west edge of bluffs
	Park Bridge	17:45 – 19:00	1:15	AW	Overcast		
	Yoho Bridge S	19:00 – 20:50	1:50	AW	Mostly cloudy		
10 July	Park Bridge	08:00 – 10:30	2:30	AW	Rain, fog		
	Yoho Bridge S	10:45 – 12:15	1:30	AW	Overcast, fog		
	Yoho Bridge S	17:45 – 20:00	4:15	AW	Overcast, cool		
	Park Bridge	20:15 – 21:30	1:15	AW	Overcast, cool		
11 July	Yoho Bridge S	08:10 – 10:30	2:20	AW	Overcast, cool		
	Park Bridge	10:45 – 12:15	1:30	AW	Mostly cloudy		
	Yoho Bridge S	17:10 – 18:30	1:20	AW	Partly cloudy, warm	2 ewes, 3 lambs	Bedded on pullout on west approach
	Park Bridge	18:45 – 20:45	2:00	AW	Partly cloudy, warm		
12 July	Park Bridge	06:45 – 09:00	2:15	AW	Partly cloudy		
	Yoho Bridge S	09:10 – 10:30	2:20	AW	Partly cloudy		

[1] AW = Andrew Walker; KP = Kim Poole