Rocky Mountain Bighorn Sheep Habitat and Population Assessment for the East Kootenay Trench

HCTF Project File #: 99/04B/08
Year-end Progress Report

Irene Teske photo

Fiscal Year: 1998-99

Year: 3 of 5 Years

East Kootenay Wildlife Association

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Executive Summary:

The first goal of the project was to describe fall to spring habitat preference with reference to ecosystem mapping categories, and based on this and range evaluations, to determine whether preferred habitat has adequate quality, quantity, and distribution to support current or higher bighorn sheep populations in the 4 study areas: Mount Broadwood/Wigwam Flats, Bull River, East Columbia Lake, and Premier Ridge. If preferred habitat does not met these criteria, then the second goal was to develop a plan for protecting and enhancing the most limiting habitat elements at each of the 4 areas.

Data collected from radiocollared bighorn sheep at Bull River and East Columbia Lake in 1997 and 1998 (n=1,480 radio locations) were used to determine habitat preference by bighorn sheep. Douglas fir biogeoclimatic zones were selected at both winter ranges. At the site series level, bluebunch wheatgrass types were selected at both sites, although selected types differed between sites. At East Columbia Lake, a pasture sage/bluebunch wheatgrass was most strongly selected while at Bull River, antelope brush/bluebunch wheatgrass types were strongly selected. In addition, the cultivated field type at Bull River was also selected. That type was not available at East Columbia Lake. Different structural stages were selected at the 2 sites. At East Columbia Lake, the herb/grass stage was most strongly selected while at Bull River, the low shrub stage was preferred.

Radio telemetry data from 1997 and 1998 delineated bighorn sheep winter ranges for the Bull River/Power Plant and East Columbia Lake units, while Bill Warktentin of MOELP Wildlife Branch and Mario Rocca of EKWA assisted with the delineation of winter ranges at Mount Broadwood/ Wigwam Flats and Premier Ridge. Transects and production cages were located in the 4 study areas through air photo interpretation of the delineated winter range and site inspections. Range assessment methodology was revised from the original terms of reference to reflect current thinking and procedures within B.C. Ministry of Forests. The new methodology incorporates existing exclosures if they are in range currently occupied by sheep, and additional sampling in the form of transects and production cages to assess the species composition, and abundance of preferred forage in selected polygons on the 4 sheep ranges. Nineteen transects and 40 production cages were placed in 1998. An additional 18 transects will be established in conjunction with production cages at Premier Ridge and Mount Broadwood in 1999.

Analysis of the 1998 range work from the Mount Broadwood/Wigwam study area suggested that the results of the habitat selection analysis at Bull River would not be applicable to the area as planned in the original terms of reference. We recommended that additional radio telemetry work be conducted in the Mount Broadwood/Wigwam study area to determine habitat selection by sheep living there. Ten bighorn ewes were radio collared in January 1999 and radiotracking has been conducted through the winter. These data will be used to conduct a habitat selection analysis and the placement of range transects in the Mount Broadwood/Wigwam study area will be assessed based on those habitat selection results.

1.0 Background

Rocky Mountain bighorn sheep populations in the East Kootenay Subregion of southeastern British Columbia have declined during this century. The herds, which numbered about 4,000 in the 1920's, decreased to 2,100 in 1981. Epizootic die-offs at 18- to 24-year intervals have reduced the bighorn sheep population by 25% to 50% and full recovery has not occurred between these outbreaks. The last epizootic occurred over 17 months in 1981 to 1983 and further reduced the bighorn population in the subregion to 1,550. Populations have recovered since 1983, but again they have not recovered to previous levels. In addition, forage availability for ungulates including bighorn sheep has declined in the area because of forest encroachment on existing grassland and grass shrubland at a rate of 0.5% to 2.0% annually.

Humans and their developments negatively impact bighorn sheep and their habitat in the East Kootenay Subregion. On-going forest encroachment, the expansion of human developments onto critical bighorn winter range, competition with other ungulates—both wild and domestic, the resulting loss of fitness within individual bighorn populations, and predation are possible causes for the documented declines. However, specific causes for population changes and/or changes in habitat use within individual populations may be different for distinct metapopulations. The need for a scientifically-credible database on bighorns and their habitats in the East Kootenay Subregion is great.

2.0 Objectives:

1. To determine the patterns of habitat use on each of fall, winter, and spring range, with reference to the vegetative and terrain characteristics of the types of ecosystem map polygons selected by sheep.

2. To determine the range characteristics, quality, and trends in habitats that are seasonally selected by marked sheep, with emphasis on preferred plant species.

3. Based on #1 and #2 above, to determine if present populations of sheep and other ungulates are degrading or likely to degrade range quality in the habitat types used. If so, range condition and availability will be assumed to be a limiting factor in the sheep population. Alternatively, if preferred habitats are determined to be capable of supporting larger populations, it will be assumed that range condition is not limiting the sheep population, and that the use of some areas may be limited by barriers to movement, harassment, behavioral competition, or predation.

4. To assess the need and possibilities for improving the quality, quantity, or distribution of habitat through enhancement or, alternatively, to determine whether further investigation is required regarding parasitism, disease, predation, harassment, or other factors that may be limiting sheep populations or contributing to increased risk of die-off.

3.0 Location:

Bighorn sheep fall through spring ranges within bioterrain mapping units at Bull River, East Kootenay Lake, Mount Broadwood/Wigwam Creek, and Premier Ridge, in the East Kootenay Subregion (Fig. 1).

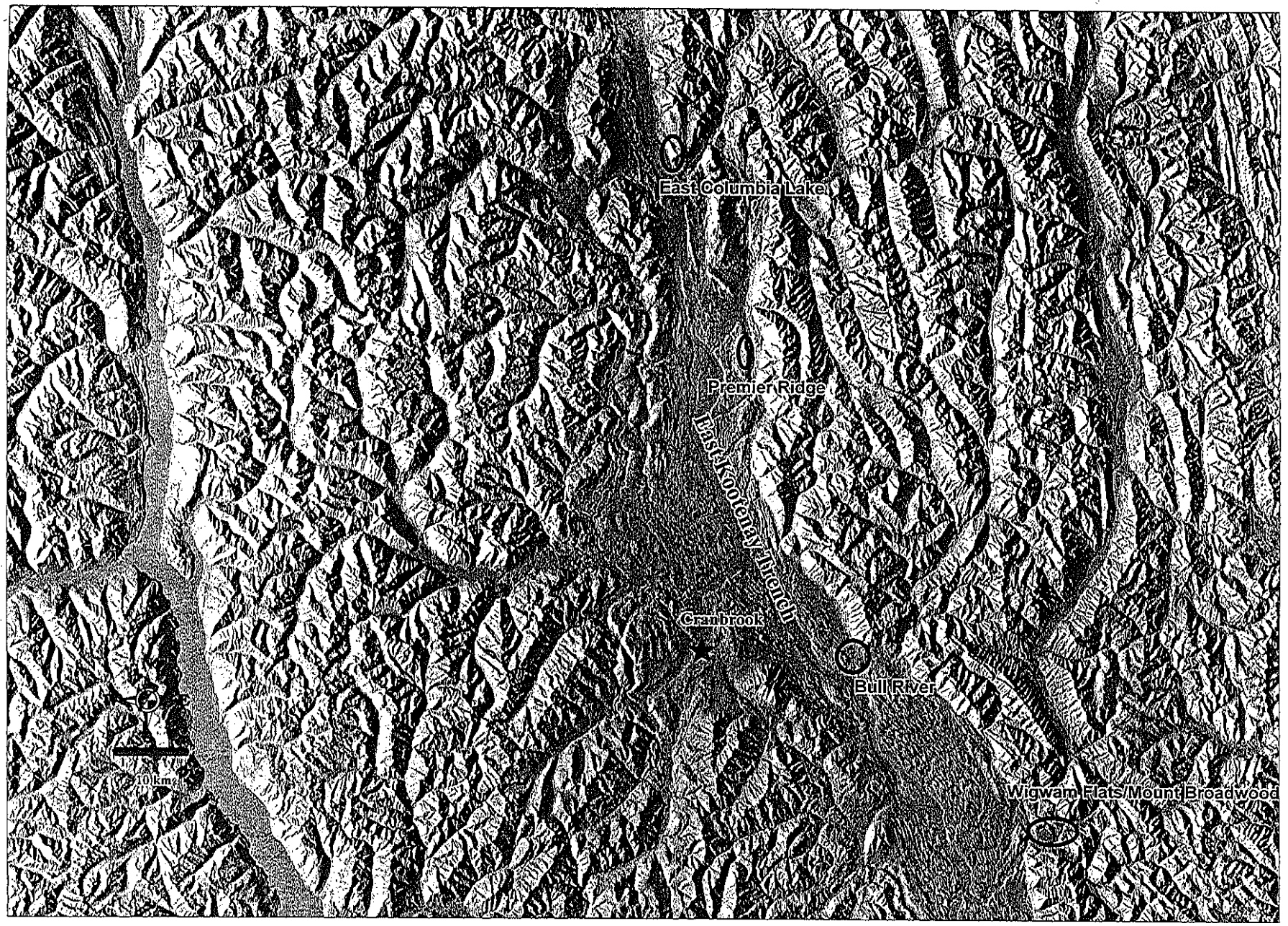


Figure 1. Locations of the 4 study areas of the Rocky Mountain Bighorn Sheep Habitat and Population Assessment for the East Kootenay Trench Project.

4.0 Technical Details (Methods)

Radio Telemetry

Capture

Bighorn sheep in the East Columbia Lake and Bull River study areas were radiocollared in January and February 1997. Bighorn sheep in the Wigwam/Mt. Broadwood study area were radiocollared in January 1999 as recommended in the mid-year HCTF progress report (EKWA 1998). Only bighorn ewes were radiocollared. Standard measurements were taken and blood was drawn for later analysis.

Radio Telemetry on Winter Range

Radiocollared sheep at Bull River, East Columbia Lake, and Wigwam/Mt. Broadwood were radiotracked on the ground on a regular basis during the period that radiocollared sheep are off their summer range. Radiolocations were determined by homing in on the radio signal of individual sheep until they were visually located. If an individual could not be located visually, possibly because the cover type she was in was too dense, then the bioterrain unit polygon that she was in and her approximate location within the polygon was determined by triangulating from less than 500m. A ground radio telemetry form was filled out for each radio location. Ground radio telemetry was conducted 5 days/week when radiocollared sheep were their winter ranges at Bull River and East Columbia Lake in 1997 and 1998. In winter 1999, collared sheep at Mount Broadwood/Wigwam were located about 3 times per week on the ground while radiocollared sheep at the 2 original sites were radiolocated once per month either aerially or from the ground.

Data collected for each ground radio telemetry location include:

- Date and time
- Bighorn sheep number
- Radio frequency
- Group size
- Presence of other marked sheep, ear tag numbers
- Activity
- Location: General descriptor and UTM grid reference
- Elevation
- Slope
- Aspect
- Cover type

Aerial radio telemetry (off winter range)

During the non-winter months or when collared sheep were off their winter ranges during the winter, aerial telemetry was used to locate them. Bull River and East Columbia Lake ewes were located approximately once per month to monitor mortality and to generally locate summer range.

Habitat Selection Analysis

Habitat selection was analyzed for radiocollared sheep on the Bull River/Power Plant and East Columbia Lake Bioterrain Units. Habitat use was determined by the frequency of polygon use (number of radio locations) by radiocollared sheep. Not all radio telemetry locations collected between fall and spring fell within these mapping units and were therefore not included in the analysis. Habitat availability was determined by the frequency of polygon types in a randomly-generated set of locations within the bioterrain mapping areas. Univariate and multivariate regression analyses were carried out to determine significant relationships (Sokal and Rohlf 1981, $p<0.05$). Since winter severity could affect habitat selection, each winter's data for each bioterrain mapping area were analyzed separately.

Range Assessment

The methods used for range assessment were altered from the original terms of reference. Instead of using paired 15 m x 30 m macroplots, 1 fenced and 1 open to grazing, as in previous studies (Demarchi 1967; Stelfox et al. 1985; Davidson 1991), 30 m transects were used to characterize the various vegetation community types. Fifteen x 30 m macroplots were not used due to concerns expressed by the Ministry of Forests. Such exclosures are now considered too small to properly evaluate range use since they result in "edge effects" within the entire exclosure. Therefore, there was opposition to building new exclosures of this size. It was agreed that if an existing 15 m x 30 m exclosure was in key bighorn sheep winter range, and if it was in good repair, an attempt would be made to relocate the existing transects within and outside the exclosure and follow previous methodology. It was also agreed that exclosures that meet the current specifications (minimum of 1 ha) could be built if the proposed location also was of use in the Ministry of Forests Rangeland Reference Area Program (RRAP). In such cases, Don Gayton, the current head of the program, would undertake the construction and future maintenance costs of the exclosure.

At a meeting including representatives of Arc Wildlife Services, Biota Consultants, the Ministry of Forests and the Wildlife Branch of the Ministry of Environment, Lands and Parks (MOELP), all parties agreed that data collected from 1 exclosure site would not likely represent all of the plant community types within the ecosystem units selected by the radio-collared sheep. Although mapped at 1:20,000, individual polygons within the bioterrain mapping units still contained several different plant communities. Therefore, a new methodology was proposed. Transects would be placed within each plant community type in key bighorn sheep winter habitat to assess species composition, and an accompanying series of forage production cages would be established for fall and spring clipping to determine forage availability prior to and after winter use (production/ utilization).

Macroplots

Use of exclosures in the 4 study areas was determined by Biota Consultants in consultation with Mr. Gayton. The two existing exclosures in the Bull River study area were deemed unsuitable for use on this project since they were in areas not currently used by bighorn sheep. However, a contrast in vegetation was noted along a fence line between very heavily grazing public land (Whitetail Pasture) and virtually ungrazed

range on private land. Livestock graze the public land and bighorn sheep graze both sides of the fence. Mr. Gayton obtained permission from the land owners (the Armstrongs) to use their land for comparative plots in the assessment/monitoring component of this project rather than building an exclosure. Five 60 m transects were established parallel to the fence on each side (one set on public land, one set on private land). The transect establishment followed the Range Reference Area Baseline Vegetation Monitoring Procedures - Nelson Forest Region (1998). The transects were established at 13 m, 19 m, 25 m, 29 m and 35 m from the fence. The zero point was located on the west side of a bird house for swallows at the base of the metal post. The transects were read from east to west. The 10 sampling locations along each transect were predetermined in the guidelines. Sampling was conducted using a $0.1 m^2$ Daubenmire frame placed on the right hand side (up-slope side) of the tape, looking down the tape.

In the Columbia Lake study area, the existing exclosure below the radio tower was in an appropriate location with respect to our objectives, but the vegetation community in which it was located was not large enough to allow expansion of the exclosure to 1 ha. Unfortunately, the wire on the east side of the exclosure had been cut some time in the past, allowing grazing to take place inside the exclosure. EKWA volunteers repaired the wire in July, 1998. The 5 50 ft transects were relocated within the exclosure but the original transects outside the exclosure could not be found. To the west of the exclosure, the vegetation community and site parameters were most similar to the macroplot inside the exclosure, therefore 5 new transects were established there to represent the paired macroplot. We later learned that the original transects were on a flat area to the east of the exclosure. An area fitting this description was scraped clear of snow to establish temporary corrals for bighorn sheep capture. It is possible that any pegs were destroyed in the process.

The existing exclosure on Wigwam Flats at the Mount Broadwood study area was also suitable for use on this project. Mr. Gayton proposed to rebuild the fence surrounding this exclosure in exchange for obtaining the data collected at this site during the study. He decided against expanding the exclosure to 1 ha. The 5 50 ft transects were relocated within the exclosure and most of the original transects outside the exclosure were found. They were remarked as best as possible.

The previously-built exclosure in the Premier Ridge study area was not in key bighorn sheep winter habitat. A 1 ha exclosure that is part of the RRAP is located at the base of Premier Ridge. Mr. Gayton offered to share the data collected from this site with Biota Consultants. Mr. Gayton did not feel that building any new exclosures within the identified bighorn sheep winter habitat of the four study areas would meet the objectives of the RRAP.

It appears that different-sized microplots were used along the transects during previous sampling in the study areas. Davidson (1991) indicates that he used 0.5 m^2 microplots in 1987, while 0.25 m^2 microplots were used in 1984, and 0.1 m^2 plots were used in 1966. Poulton and Tisdale (1961) recommended a 1 ft x 2 ft plot (30 cm x 60 cm) or 0.18 m^2. Mr. Davidson recalled, however, that his microplots were 0.5 m x 0.5 m, which equals 0.25 m^2. For our assessments, a 0.25 m^2 plot frame was used within the existing paired macroplots (inside and outside the exclosures), as specified in the Terms of Reference.

Transects

The following methodology has been established by the Ministry of Forests (District Level) for the establishment and reading of the transects, and was followed in our study:

- A transect will be placed in the most representative part of the polygon.
- Transects located on slopes will be established parallel to slope contours.
- A transect will be 30 m long with 15 microplots (20 cm x 50 cm in size) placed at 2 m intervals along the right hand side of the transect to sample graminoids and forbs. At each transect, two 10 m x 10 m macroplots will be used to record the shrub cover (<2.5 m in height). These macroplots will be at either end of the transect and straddle it equally on both sides. One 20 m x 20 m macroplot located at the centre of the 30 m transect and straddling it will be used to estimate the canopy cover of trees and tall shrubs (>3 m in height). Trees and shrubs will be recorded only once in the average per cent cover column to the nearest 5 per cent cover.
- A minimum of 2 transects per distinct community type is required.
- Cover estimates for all other species will be recorded to the nearest percent between 1 and 15 percent, and to the nearest 5 percent between 20 and 100 percent. Cover estimates will be recorded at each microplot on the range inventory form. The plant species (trees, shrubs, graminoids and forbs) will be recorded using a seven letter code composed of the first four letters of the genus and first three letters of the species. If the species is unknown it will be marked on the plot sheet (with an unique code), collected and later identified. If possible all plants should have a species name. All other components of the vegetation inventory data sheet must be completed.

Radio telemetry data from the previous 2 winters were used to delineate bighorn sheep winter ranges for the Bull River and Columbia Lake study areas, and Bill Warkentin and Anna Fontana of MOELP, Wildlife Branch and Mario Rocca of EKWA assisted with the delineation of winter ranges at Mount Broadwood and Premier Ridge study areas. Transect locations in the 4 study areas were determined based on the habitat selection analysis, air photo interpretation and site examinations in the field. During July 1998, transects were established and macroplots were re-assessed. Locations were marked on colour copies of the air photos and the position noted with a hand held Global Positioning System (GPS). Due to the delay in the start of the summer field program caused by the reassessment of the methodology, and the fact that the optimum period for vegetation assessment ended in mid-July, it was not possible to complete the assessment of plant species composition of all of the vegetation communities within the four study areas. This should be completed in 1999.

Biomass Production

Ministry of Forests in Invermere agreed to supply production cages for the term of the project (Darrell Smith, pers. comm.). In August, 1998, these cages were placed in association with the transects to exclude grazing. An area of 1 m^2 was clipped within and outside each exclosure, in September 1998. In addition, a 1 m^2 area within each cage was clipped to determine forage production prior to winter. The cage was then relocated onto ungrazed vegetation. Further clippings will be done in April 1999 and the following fall and spring for the next 2 years to determine forage availability prior to and after winter use. This is a deviation from the schedule proposed in the original Request for Proposal,

which suggested clippings in May, July, September and November. Since the study areas will not be used by livestock or by significant numbers of wildlife species in summer, it is probably not necessary to do clippings in the summer. However, if this changes, production/utilization clips should be done to evaluate the per cent of forage available and its utilization at various time intervals.

Data Analysis

Microplot data from each transect was entered into a spreadsheet and averaged over the transect to provide the average cover of each plant species. Normally, these data would be subjected to ordination and cluster analysis to assist in the identification of vegetation community types. The final allocation of a site to a specific community type would be subjective and based on the researcher's field observations. Since there were not many transects in each study area, only a subjective analysis was conducted at this early stage of the project. Transects were grouped into separate community types based on plant species composition and dominance, and aspect and slope of the site.

5.0 Results:

Project activities since spring 1998 have involved completion of the radio tracking on fall through spring ranges at Bull River and East Columbia Lake, mapping all radio telemetry data collected since the project's initiation, habitat selection analysis, and initiation of range work based on the habitat selection analysis. In addition, 10 bighorn sheep in the Wigwam/Mt. Broadwood study area were radiocollared and subsequently radiotracked 3 days per week. Each of these activities is discussed in detail below.

Bighorn Sheep Radio Telemetry

In summer 1998, radio telemetry of bighorn sheep has been carried out on an opportunistic basis. Radio collared sheep were located when radio telemetry flights for other projects were scheduled to allow for cost sharing. As a result, flights have been conducted monthly at Bull River and no radio locations were collected to date for sheep at East Columbia Lake. Table 1 summarizes radio location data collected to date on the project by month and year. Currently, there are 9 radio collared sheep alive at Bull River and 9 at East Columbia Lake.

Bighorn sheep use of the Bull River and East Columbia Lake study areas has varied spatially (Figs. 2, 3). The 95% adaptive kernel (ADK) home range of radiocollared sheep wintering in the study areas was substantially smaller in 1997 than in 1998, even when differences in sampling periods were taken into account. However, the 50% ADK home ranges for 1997 and 1998 overlapped in each study indicating the fidelity of radiocollared sheep to their core winter ranges. Although reasons for the differences in home range use between years are not known for certain, winter severity was greater in 1997 than in 1998, and that reason alone could account for the differences between years.

Bighorn Sheep Mortality

Six mortalities have been documented to date. Three were likely the result of avalanches, 1 mortality was probably caused by drowning, 1 was a result of cougar predation and 1 was of unknown natural causes that were not predation-related. An additional

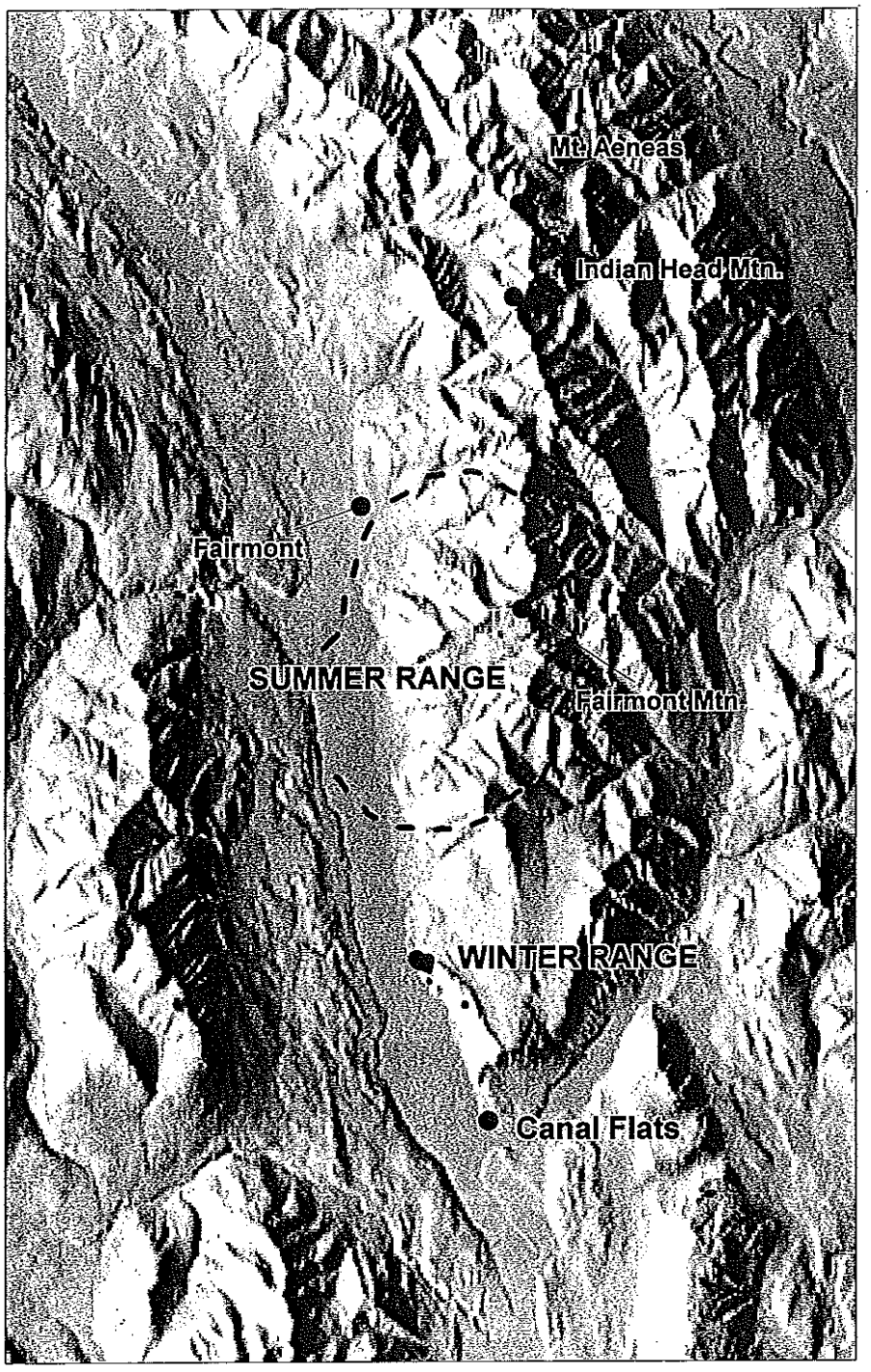


Figure 2. Cumulative summer and winter home ranges of 11 radiocollared bighorn ewes during 1997 and 1998 in the East Columbia Lake study area.

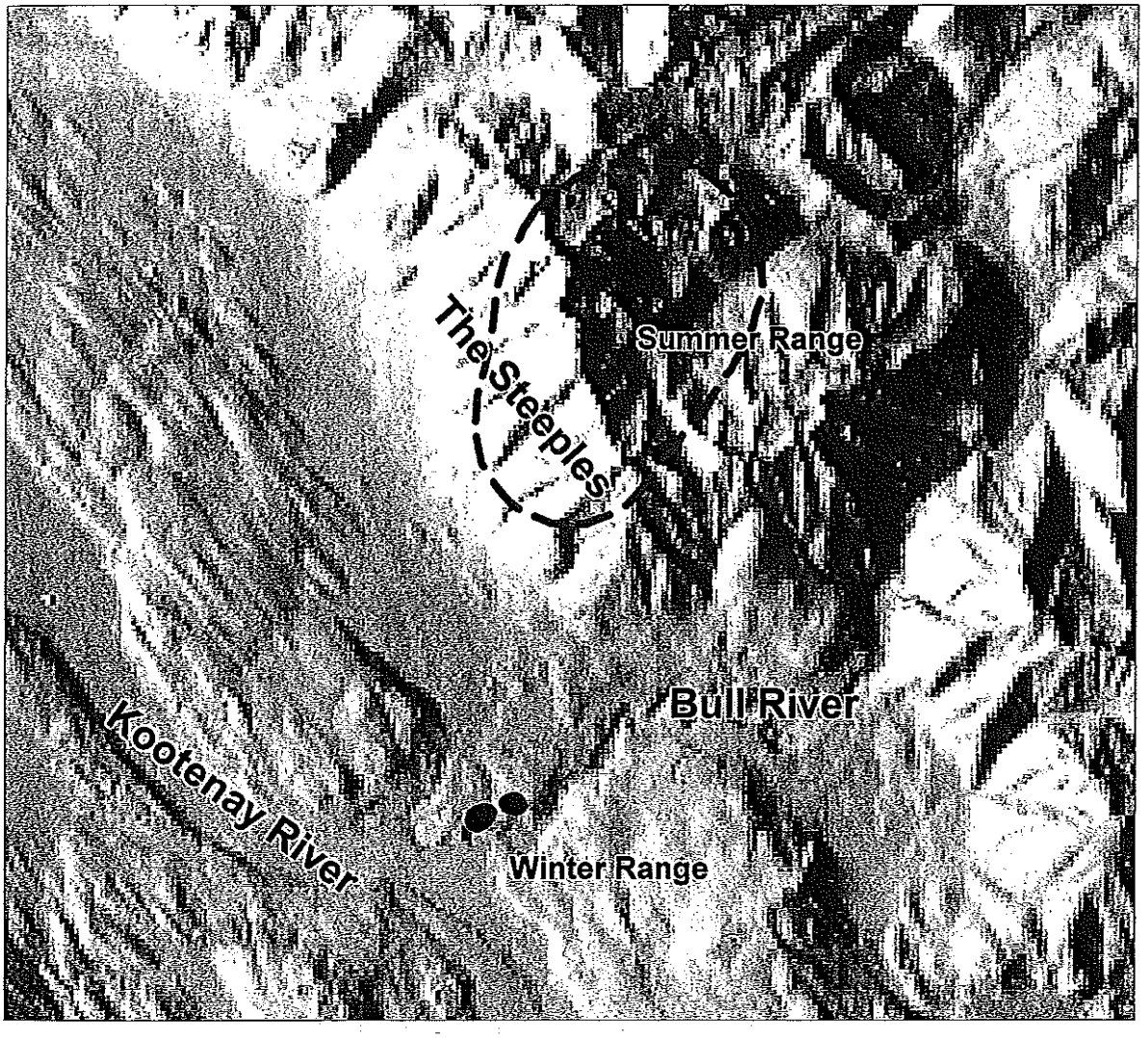


Figure 3. Cumulative summer and winter home ranges of 12 radiocollared bighorn ewes during 1997 and 1998 in the Bull River study area.

radiocollared ewe from Bull River probably died in upper Dibble Creek in winter 1999. However, her collar has not yet been retrieved because of hazardous snow conditions in the immediate vicinity.

Table 1. Number of radio locations collected per month at Bull River and East Columbia Lake between February 1997 and August 1998.

Year	Month	Bull River	Columbia Lake	Wigwam/Mt Broadwood
1997	February	0	67	
	March	80	91	
	April	99	86	
	May	88	88	
	June	9	10	
	July	18	17	
	August	9	8	
	September	9	8	
	October	9	8	
	November	14	0	
	December	14	8	
1998	January	77	88	
	February	106	58	
	March	102	70	
	April	85	80	
	May	17	12	
	June	9	9	
	July	9	0	
	August	9	0	
	September	9	0	
	October	9	9	
	November	9	0	
	December	16	7	
1999	January	7	5	25
	February	9	7	77
	March	5	11	66
TOTAL		827	747	168

Bioterrain Mapping

Bioterrain mapping of the bighorn sheep winter ranges was required to conduct the detailed habitat selection analysis as outlined in this project's terms of reference and was to be competed by other contractors.

Bull River/Power Plant Unit

Bioterrain mapping of the Bull River/Power Plant Unit was completed by Ketcheson et al. (1996). The habitat selection analysis conducted for this project was the first time the bioterrain map was used. The first iteration of the habitat selection analysis indicated that sheep were selecting for structural stage 0 or bare earth. When the extent of bare earth in the unit was mapped it became apparent that there were problems with the database, since a large portion of the study area appeared to be structural stage 0. However, checks of the original database indicated that it was not in error (G. Kernaghan, pers. comm.). The problem was eventually traced to an error in a macro used to transcribe data from MS Excel to ArcInfo used by MOELP.

East Columbia Lake Unit

Manual bioterrain mapping (mylar product) of the East Columbia Lake was completed by Marcoux et al. (1997). However, a digital copy of the map with its associated attribute table was preferable for bighorn sheep habitat selection analysis if it was to be completed on schedule. Since digitizing the hard copy was not scheduled for completion until fall 1998, Arc Wildlife Services Ltd. undertook the task of producing a digital copy of the bioterrain map. The mylar map was drum-digitized and georeferenced, and the polygon attribute table was tied in, allowing the sheep habitat selection procedure to be go ahead.

3.3 Habitat Selection Analysis

Habitat selection was analyzed for radio collared sheep on the Bull River/Power Plant and East Columbia Lake Bioterrain Units. Habitat use was determined by the frequency of polygon use (number of radio locations) by radio collared sheep. Not all radio telemetry locations collected between fall and spring fell within these mapping units and were therefore not included in the analysis. Habitat availability was determined by the frequency of polygon types in a randomly-generated set of locations within the bioterrain mapping areas. Univariate and multivariate regression analyses were carried out to determine significant relationships (Sokal and Rohlf 1981, $p<0.05$). Since winter severity was significantly greater in 1997 and the 95% ADK winter ranges differed between years, habitat selection analysis was conducted for each winter separately for each bioterrain mapping area.

Bull River/Power Plant Bioterrain Mapping Unit

At the broad level of biogeoclimatic zones, there was clear positive selection for the interior douglas fir zone (IDF). There was negative selection for the montane spruce (MS) and Engelmann spruce/subalpine fir (ESSF) zones. No differences between years in the use of biogeoclimatic zones was apparent.

At the site series level, there was strong selection over both years for the antelope brush – bluebunch wheatgrass unit (AW) unit, though selection was significantly stronger during 96/97. There was also positive selection over both years for the cultivated field unit (CF), and this was stronger during 97/98. Multivariate analysis of all variables also suggested that AW and CF together explained much of the variation in sheep habitat selection over both years at Bull River.

At the structural stage level, there was a strong positive relationship with low shrub types (STR_3a) over both years, but more so during 96/97. This variable was positively correlated with AW (Kendall's *Tau-b* = 0.589, $P<0.001$), and influence was shared between both in the multivariate analysis. However, sheep habitat use was more closely associated with antelope brush than low shrub types. Study animals appeared to select against grass/forbs (STR_1), tall shrubs (STR_3b), pole/saplings (STR_4), young forest (STR_5), and to a lesser degree, mature forest stages (STR_6). STR_1 was used less during 97/98, and both STR_2 and STR_5 were used less during 96/97.

Among structural stage modifiers, there was strong negative selection for warm aspects (MOD_W) over both years, with no difference between years. Minor negative selection was also apparent over both years for gentle slopes (MOD_J) and cool north and east-facing aspects (MOD_K).

East Columbia Lake Bioterrain Mapping Unit

At the broad level of biogeoclimatic zones, there was a weak positive selection for IDF during 97/98, more so than 96/97. However, there was a very strong positive selection for undifferentiated IDF over both years, but more so during 96/97. Overall negative selection was strong for MS and moderate for ESSF.

At the site series level, there was very strong positive selection for pasture sage/bluebunch wheatgrass (SW) during both years, though slightly more so during 96/97. Based on univariate analysis, this was by far the most significant site series variable, however, it did not contribute as much in the multivariate model. This suggested that the predominant structural stage or modifier of this site series may explain much of the type's apparent selection. Selection was moderately positive for AW and Rocky Mountain juniper (DJ), with DJ used more during 96/97. AW has a strong positive contribution in multivariate analysis, suggesting that the true importance of this site series was not reflected in univariate analysis due to association with other negative variables (e.g., structural stage). The contribution of DJ was also moderately positive in multivariate analysis. There was also moderate selection for rock outcrop (RO), though more so during 97/98. Selection was moderately negative for juniper/pine grass (LJ) and buffaloberry/grouseberry types (SG), with LJ used slightly less during 96/97.. SG contributed slightly in multivariate analysis. Selection was slightly negative for several types including pine grass/twinflower (DT), with DT used significantly less during 96/97. However, the contribution of DT in multivariate analysis was moderately positive, suggesting that this site series itself may be selected for, but variables with which it was associated (perhaps structural stage) were selected against.

At the level of structural stage, very strong positive selection was apparent for grass/forb types (STR_2) over both years, though it was slightly greater during 96/97. This appeared to be the most important structural stage variable, and its significance was also reflected in multivariate analysis. Positive selection was moderate for non-/sparsely vegetated ground (STR_1), and slight for 20-40 years old pole/sapling stage (STR_4), though STR_4 was used significantly more so during 96/97. STR_4 also has a moderate positive contribution to the multivariate model. Overall selection for mature forest (STR_6) was moderately negative, though this variable was used less during 96/97.

Among structural stage modifiers there was a fairly strong positive selection over both years for warm aspects (MOD_W), though more so during 97/98. This was also reflected in its contribution to the multivariate model. There was slight positive selection for ridged types (MOD_R) in both univariate and multivariate analysis. Negative selection was moderate for cool north and east-facing aspects (MOD_K).

3.4 Range Assessment

Bull River Study Area

Nine transects were established. The majority of transects were placed within the Antelope Brush-Bluebunch Wheatgrass ecosystem unit (AW). One was placed in the Cultivated Field ecosystem unit (CF) on a level terrace.

One production cage was associated with each transect with the exception of 2 of the transects that were positioned on terraces. These had 2 cages each associated with each, placed in areas that differed in the dominant grass species. A 12th cage was placed on public land on the opposite side of the Armstrong's fence.

On examining the transect data, it was determined that 6 vegetation community types were represented by the 9 transects. Some of these may have once been the same type, however due to grazing disturbance and the invasion of non-native weeds and agronomic species, the plant species composition has shifted.

Transect BR01 represented the CF ecosystem unit. It was comprised almost entirely of agronomic, non-native species such as Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*), smooth brome (*Bromus inermis*) and black medick (*Medicago lupulina*), along with non-native weeds such as dandelion (*Taraxacum officinale*), tufted vetch (*Vicia cracca*) and quack grass (*Elymus repens*). This community was located on a flat terrace above the river.

Two terraced sites within the AW ecosystem unit harboured 2 different vegetation communities. The site represented by BR06 was dominated by spreading needlegrass (*Stipa richardsonii*). This community is tentatively named the spreading needlegrass - rough fescue - slender wheatgrass/sulphur cinquefoil - wild bergamot/saskatoon - antelope-brush community type. Sulphur cinquefoil (*Potentilla recta*) is an aggressive non-native weed that has invaded the Bull River study area, becoming a dominant species in many areas. Other common species included in this community were early blue violet (*Viola adunca*), sedge (*Carex* sp.) and Canada bluegrass. The terraced site represented by BR04 was characterised by a mixture of native and non-native species. Canada bluegrass and black medick were dominant. Western wheatgrass (*Elymus smithii*) was the only common native grass, and spike-like goldenrod (*Solidago spathulata*) and tufted phlox (*Phlox caespitosa*) were common native forbs. Sulphur cinquefoil was present but at low cover. This community is tentatively named the Canada bluegrass - western wheatgrass/black medick - tufted phlox/antelope-brush community type.

The remaining 6 sites tended to have southerly aspects and steep slopes (17-32°). BR05 differed from the other five in having needle-and-thread grass (*Stipa comata*) as the dominant grass, along with minor cover of sand dropseed (*Sporobolus cryptandrus*). It was located on the slope above the first terrace above the river. This community has also become highly invaded by non-native agronomic and weed species, such as cheatgrass (*Bromus tectorum*), Canada bluegrass, pale alyssum (*Alyssum alyssoides*), sweet-clover (*Melilotus* sp.), common mullein (*Verbascum thapsus*) and black medick. It was tentatively named needle-and-thread grass - cheatgrass/pale alyssum - sweet-clover/antelope-brush community type. Some of the native forbs present were pasture sage (*Artemesia frigida*), yellow gromwell (*Lithospermum incisum*) and lotus milk-vetch (*Astragalus lotiflorus*).

BR02, BR07 and BR09 appear to represent the community type for which this ecosystem unit is named, with bluebunch wheatgrass (*Elymus spicata*) and antelope-brush (*Purshia tridentata*) as common or dominant species. It was named the bluebunch wheatgrass - Canada bluegrass - cheatgrass/sulphur cinquefoil/antelope-brush - saskatoon - snowberry community type, and occurred on the slopes above the river. It appeared that the original native vegetation community on these slopes has been greatly modified by the introduction of non-native agronomic and weed species, including Canada bluegrass, cheatgrass, sulphur cinquefoil, common mullein, thyme-leaved sandwort (*Arenaria serpyllifolia*) and black medick, some of which have become dominant or co-dominant

species. Common native species may include pasture sage, wild bergamot (*Monarda fistulosa*), golden aster (*Heterotheca villosa*), common yarrow (*Achillea millefolium*), sleepy catchfly (*Silene antirrhina*) and June grass (*Koeleria macrantha*).

The community type represented by BR03 and BR08 differed slightly from the above type by having lower cover of bluebunch wheatgrass (present but not a dominant grass). It also occurred on the slopes above the river. The original vegetation community appeared to be more highly modified, which is exemplified by the dominance of Canada bluegrass, cheatgrass, sulphur cinquefoil, black medick and common mullein. This community type was named the Canada bluegrass - cheatgrass/sulphur cinquefoil - wild bergamot/snowberry - saskatoon - antelope-brush community type. Common native species may include wild bergamot, common yarrow, rose (*Rosa* spp.) and June grass.

The sites represented by BR02 and BR03 were subjected to a controlled burn in the spring of 1998. We speculate that this might explain why sulphur cinquefoil had a much higher cover than any of the other species at BR02, estimated at 50% overall (35.3% along the transect). Sulphur cinquefoil cover was also very high at the site represented by BR03, estimated at 40% overall (21.3% along the transect). In comparison, the highest cover recorded along the other transects, which were not in burned areas, was 7.5%. Fire was tested as a control treatment of sulphur cinquefoil in Montana (Lesica and Martin 1997), however burning appeared to cause an increase in the density of seedlings and had little effect on the density of juvenile and mature plants. Fall burning resulted in an increase in the density of mature plants as well as seedlings.

The transects of the rangeland reference area, established on either side of the fence between Whitetail Pasture and the Armstrong's property, represented a rare community type dominated by little bluestem (*Schizachyrium scoparium*), needle-and-thread grass, bluebunch wheatgrass and cheatgrass. Little bluestem is a rare grass species in British Columbia. Like BR05, this site was located on the slope above the first terrace above the river. The abundance of cheatgrass as well as sweet-clover and pale alyssum, and the common occurrence of other weeds, indicates that this site has also been disturbed in the past. The non-native species dominated in Whitetail Pasture while the native species dominated on the Armstrong's side of the fence. Common native species included pasture sage, yellow gromwell, sand dropseed and antelope-brush. This community was named the little bluestem - needle-and-thread grass - bluebunch wheatgrass - cheatgrass/sweet-clover - pasture sage/antelope-brush community type.

Columbia Lake Study Area

Eight transects were established, and 1 production cage was associated with each of these transects. The transects were located within the Pasture Sage-Bluebunch Wheatgrass ecosystem unit (SW) on sites of varying slope and predominantly west to southwest aspect. On examining the transect data, it was determined that 6 vegetation community types were represented by the 8 transects.

The needle-and-thread grass/pasture sage - thread-leaved fleabane/common rabbit-brush community type was represented by CL01 and the paired macroplots. Other grass species present may include June grass, bluebunch wheatgrass and western wheatgrass. Common forbs included Columbia bladderpod (*Lesquerella douglasii*), yellow gromwell, pale comandra (*Comandra umbellata*) and wild blue flax (*Linum perenne* spp. *lewisii*). The

macroplot inside the exclosure, which, although the fence was down for an undetermined period of time, has probably been subject to less grazing pressure, had slightly greater grass cover and a greater proportion of June grass than CL01 and the macroplot outside. It also had less forb cover. This community occurred on southwest-facing slopes of 5-12°.

Transect CL02 represented a level area above Columbia Lake and was characterised by the dominance of June grass and co-dominance of needle-and-thread grass and rosy pussytoes (*Antennaria microphylla*). Other common species included common rabbit-brush (*Chrysothamnus nauseosus*), western wheatgrass and pale comandra. Pasture sage, wild blue flax and Columbia bladderpod frequently occurred but generally at low cover. This community was tentatively named June grass - needle-and-thread grass/rosy pussytoes - pale comandra/common rabbit-brush community type.

The bluebunch wheatgrass - needle-and-thread grass/pasture sage/common rabbit-brush community type was represented by CL03 and CL04. These occurred on west-facing slopes of 30° and 7°, respectively. The dominant species are reflected in the community name. June grass was a co-dominant along CL04 and was common along CL03. Other common species included Columbia bladderpod, rosy pussytoes and pale comandra. Sandberg bluegrass (*Poa secunda*), large-fruited desert-parsley (*Lomatium macrocarpum*) and noddingonion (*Allium cernuum*) were frequent along CL04.

The site represented by CL05 was a sparsely vegetated, west-southwest-facing slope of 18°. Of the plant species present, bluebunch wheatgrass and pasture sage had the greatest cover, followed by cheatgrass, needle-and-thread grass, shaggy fleabane (*Erigeron pumilus*) and June grass. This community was tentatively named the bluebunch wheatgrass - cheatgrass/pasture sage - shaggy fleabane community type.

The site represented by CL06 was on a ridge crest. Bluebunch wheat grass was the dominant species, followed by June grass. Other common species included common yarrow, compact selaginella (*Selaginella densa*), long-leaved fleabane (*Erigeron corymbosus*), cut-leaved daisy (*E. compositus*), cut-leaved anemone (*Anemone multifida*) and woolly groundsel (*Senecio canus*). This community was tentatively named the bluebunch wheatgrass - June grass/common yarrow - compact selaginella community type.

The bluebunch wheatgrass/pasture sage/common rabbit-brush community type was represented by CL07 and CL08. It differed from the bluebunch wheatgrass - needle-and-thread grass/pasture sage/common rabbit-brush community type by having low cover of needle-and-thread grass. It was also more sparsely vegetated with a very high cover of exposed rock and soil (over 80%). The slope was steep (22-28°) and southwest- and west-facing. Other common species may include June grass, cheatgrass, Columbia bladderpod, common mullein, Sandberg bluegrass, shaggy fleabane and rosy pussytoes.

Premier Ridge Study Area

Two transects were established in 1998 and 1 production cage was placed in association with each. An additional 6 production cages were placed in other vegetation communities. Transects associated with these cages will be established in 1999. The bioterrain mapping of this area had not been completed at the time of the field survey, therefore the ecosystem units of the transect and cage sites are not known. Transects and cages were placed in areas identified as sheep habitat by Anna Fontana (pers. comm.) and

Bill Warkentin (pers. comm.). On examining the transect data, it was determined that the 2 transects represented 2 different vegetation community types.

Transect PR01 represented a shrubland on a steep (30°), west-facing slope. Bluebunch wheatgrass was the dominant grass species, followed by cheatgrass and Canada bluegrass. June grass and needle-and-thread grass were present. Golden aster, yellow salsify (*Tragopogon dubius*), thyme-leaved sandwort, wavy-leaved thistle (*Cirsium undulatum*) and pale comandra were common forbs. Common snowberry (*Symphoricarpos albus*), prairie rose (*Rosa woodsii*) and saskatoon were the dominant shrubs. Antelope-brush and choke cherry (*Prunus virginiana*) were also common. This community was tentatively named the common snowberry - prairie rose - saskatoon/bluebunch wheatgrass community type.

Transect PR02 represented a grassland on a steep (31°), southwest-facing slope. Bluebunch wheatgrass was the dominant grass species and June grass was common. Cheatgrass and Canada bluegrass were also present. Spreading dogbane (*Apocynum androsaemifolium*), golden aster and wavy-leaved thistle were common forbs. Antelope-brush was the dominant shrub, followed by saskatoon and prairie rose. This community was tentatively named the bluebunch wheatgrass/spreading dogbane/antelope-brush community type.

According to the Terms of Reference, the results of the habitat analysis for Columbia Lake were to be extrapolated to the other northern study area, which is now Premier Ridge. However, based on preliminary vegetation analysis and reconnaissance, it would appear that the Bull River study area is more comparable vegetatively to the Premier Ridge study area.

Mount Broadwood/Wigwam Study Area

Twelve cages were placed, but no transects have been established to date. This will take place in 1999. The bioterrain mapping of this area had not been completed at the time of the field survey. Therefore, the ecosystem units of the cage sites are not known. Cages were placed in areas identified as sheep habitat by Anna Fontana (pers. comm.) and Bill Warkentin (pers. comm.).

The species composition of the vegetation communities observed in the Mt. Broadwood study area did not appear to match the AW ecosystem unit, suggesting that extrapolation of habitat preferences from the Bull River study area may be inappropriate. No antelope-brush was noted in the bighorn sheep winter range and dominant grasses varied from non-native species such as Canada bluegrass and smooth brome, to native species such as bluebunch wheatgrass, timber oatgrass (*Danthonia intermedia*) and rough fescue (*Festuca campestris*). Many forb and shrub species were noted that did not occur at Bull River.

There was marked invasion by non-native species, especially toward the western portion of the study area. This included agronomic species as well as weedy species such as sulphur cinquefoil, common St. John's-wort (*Hypericum perforatum*) and spotted knapweed (*Centaurea maculosa*). Areas dominated by non-native grasses and legumes could be considered comparable to the CF ecosystem unit of the Bull River study area. Due to the presence of so many weedy and non-native species, disturbance in this area should be kept to a minimum to avoid further invasion into native plant communities.

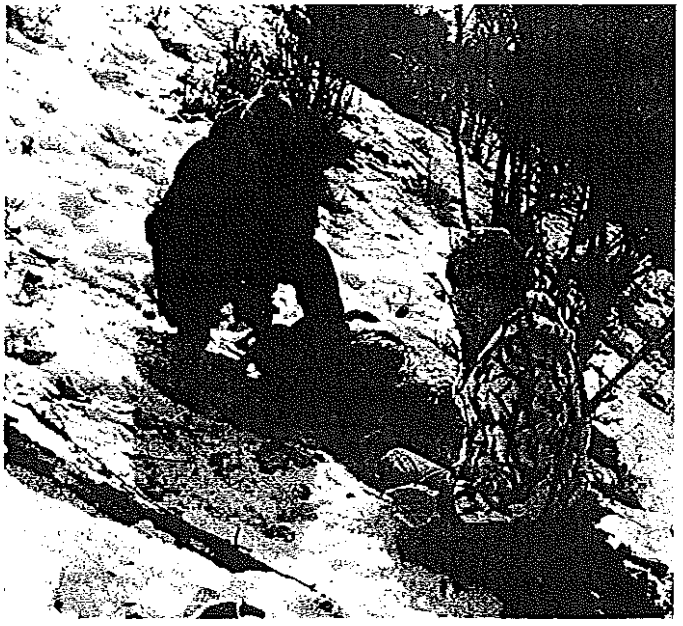
The existing exclosure was located in fescue grassland on the edge of the terrace above the Wigwam River. This community was tentatively named the rough fescue/wild bergamot-field pussytoes/birch-leaved spiraea - choke cherry/Douglas fir community type. Rough fescue was the dominant species within the exclosure. There were also several young Douglas fir trees (*Pseudotsuga menziesii*). Choke cherry, common juniper (*Juniperus communis*) and prickly rose (*Rosa acicularis*) were common shrubs. Field pussytoes (*Antennaria neglecta*), wild bergamot, large-fruited desert-parsley and tufted phlox were common forbs. June grass was also common but at much lower cover than rough fescue. Field chickweed (*Cerastium arvense*), nodding onion, common harebell (*Campanula rotundifolia*) and woolly groundsel frequently occurred but at low cover.

Vegetative cover was not as great outside the exclosure and grass cover was comparatively less, no doubt due to grazing pressure. Rough fescue was still the dominant grass, but bluebunch wheatgrass and June grass were more common than inside the exclosure. Idaho fescue (*Festuca idahoensis*), Canada bluegrass and Sandberg bluegrass frequently occurred but at low cover. Wild bergamot was the dominant species outside the exclosure. Tufted phlox, woolly groundsel, field chickweed, common yarrow and diffuse fleabane (*Erigeron divergens*) also were common. Rosy pussytoes, field pussytoes, yellow rattle (*Rhinanthus minor*), large-fruited desert-parsley, common harebell, spike-like goldenrod and yellow salsify frequently occurred but at low cover. Birch-leaved spiraea (*Spiraea betulifolia*), prickly rose and choke cherry were the most common shrubs.

6.0 Public Reaction:

n/a

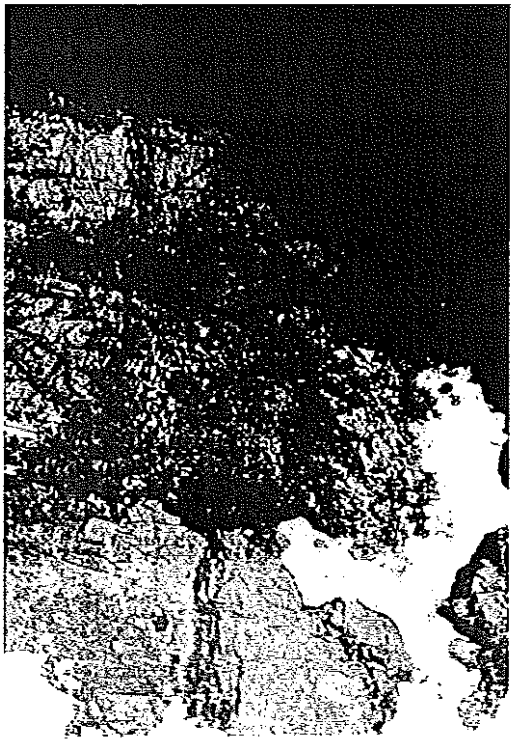
7.0 Photographic Record: (photos by Irene Teske and Brian Fantuz)



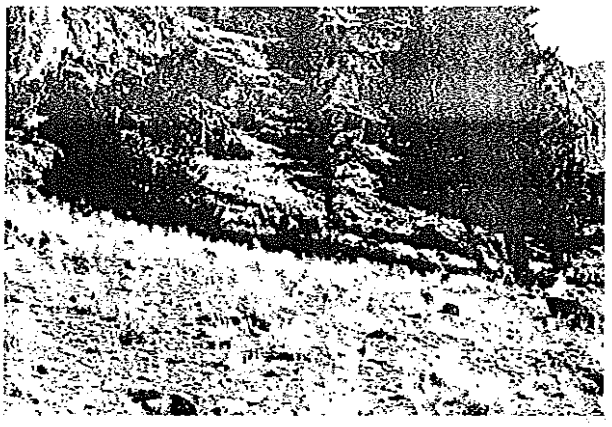
Ian Ross and Mario Rocca radiocollar a ewe, Wigwam Flats, January 1999.

Bighorn ewe mortality in avalanche slope habitat, Dibble Creek.

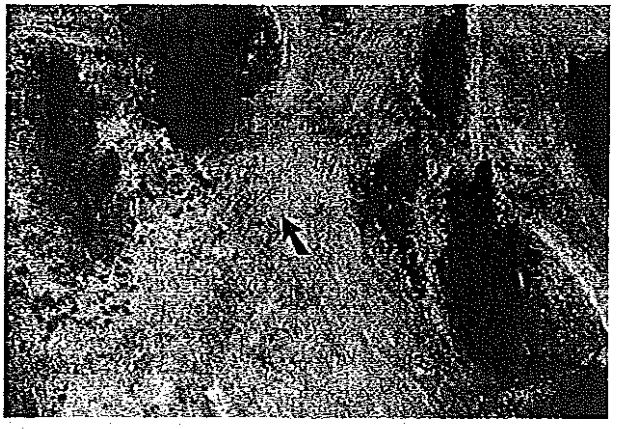
Radiocollared bighorn ewe in the Mount Broadwood-Wigwam study area.



Bull River ewes on the east side of the Steeples, July 1997.



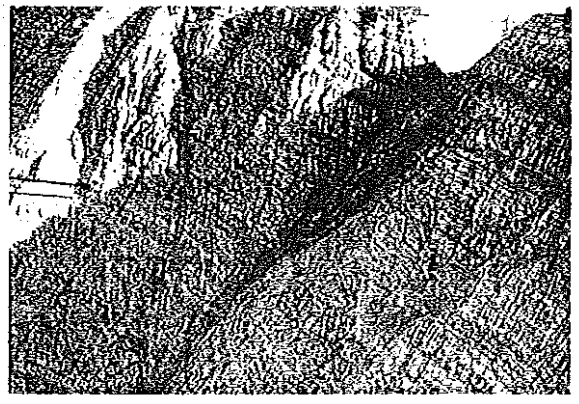
Ewes on winter range north of Canal Flats, East Columbia Lake.



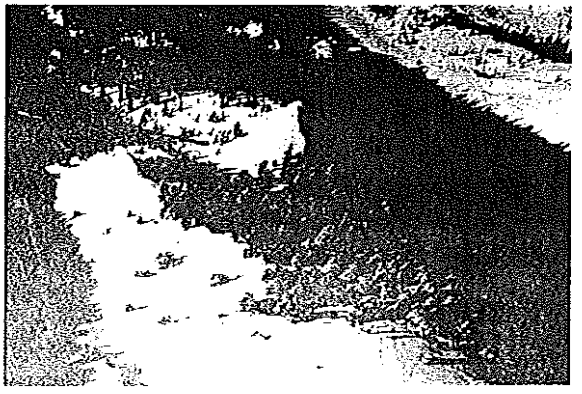
Columbia Lake ewes on the ski hill at Fairmont, late May 1997.

Bull River ewes in shrub habitat on the lower slopes of the Steeples, late May 1997.

Ewes north of the water tower, East Columbia Lake winter range, March 1998



General location of Bull River ewe #10 on the Steeples, August 1997.



Columbia Lake ewe #6 in Tatley Creek, January 1998.

Habitat Conservation Trust Fund - Project Financial Report

Period: **01-Apr-98** **31-Mar-99**
Project Name: Rocky Mountain Bighorn Sheep Habitat and Population Assessment for the East Kootenay Trench
Reporting Period: 1 April 1998- 31 March 1999

Section A
Actual Project Funding Sources

	Habitat Conservation Trust Fund			Total Project		
	Cash	In-kind	Total	Cash	In-kind	Total
Habitat Conservation Trust Fund	$60,000.00					$60,000.00
Federal Government						$0.00
Provincial Government						$0.00
Columbia Basin F&W Compensation Fund				$22,500.00		$22,500.00
Wild Sheep Society of B.C.				$10,000.00		$10,000.00
East Kootenay Wildlife Assoc.				$5,000.00		$5,000.00
Total Project Funding-Total Section A	$60,000.00			$37,500.00	$0.00	$97,500.00

Section B
Actual Project Expenditures

	Habitat Conservation Trust Fund			Total Project		
	Cash	In-kind	Total	Cash	In-kind	Total
Administration fee	$3,000.00		$3,000.00	$3,000.00		$3,000.00
Salaries			$0.00			$0.00
Contracts	$36,683.76		$36,683.76	$64,665.45		$64,665.45
Travel	$13,236.88		$13,236.88	$13,259.45		$13,259.45
Equipment Purchases			$0.00			$0.00
Equipment/Vehicle rentals	$3,427.33		$3,427.33	$3,306.95		$3,306.95
Materials and Supplies	$3,513.30		$3,513.30	$3,514.80		$3,514.80
Miscellaneous	$138.73		$138.73	$235.04		$235.04
Total Project Expenditures-Total Section B	$60,000.00	$0.00	$60,000.00	$87,981.69	$0.00	$87,981.69

Total Section A-Total Section B=PROJECT BALANCE (+/-)	**$0.00**	**$9,518.31**

9.0 Contractor Performance

Arc Wildlife Services Ltd. has been the principle contractor of this contract and has worked closely with myself and the East Kootenay Wildlife Assoc. to ensure that all aspects of the project are understood from budgeting to administration. They have also worked closely with the B.C. Ministry of the Environment and other funding agencies to ensure that all objectives are being met. I would rate their performance in all aspects of their responsibilities as excellent and am confident that they are delivering the product we had asked for.

Several subcontractors have been involved in the project to date. Irene Teske, our radio tracking technician, has conducted most of the radio tracking since the end of the first year and has acquitted herself admirably in what can only be considered less than ideal radiotracking terrain. Clayton Apps, Aspen Consulting conducted the habitat selection analysis in a timely fashion. Nortek Inc encountered problems with the production of the East Columbia Lake digital bioterrain map, which they could not resolve quickly. However, Jack Wierzchowski of Geomar Consultants worked quickly with Clayton to straighten out the georeferencing problems so that the habitat selection analysis for that study area was not held up. Finally, Brian and Anne Weerstra of Biota Consultants have worked closely with Arc Wildlife and B.C. Forestry and Wildlife to develop a new protocol for the range assessment. The initial success of the first summer's range work is due entirely to their diligence.

All contractors will continue their involvement with the project in 1999 providing consistency in data collection and analysis.

10.0 Recommendations and Future Work

Recommendations regarding bighorn sheep habitat and population enhancement will be made at the end of the project's 5th year. However, the following items will be dealt with in 1999.

- Coordination of research and management of bighorns in the East Kootenay region is needed. The recent workshop sponsored by HCTF and B.C. MOELP (17-18 April at Blue Lake Centre) was successful in focussing the attention of researchers and managers on the need for regional coordination. The review of bighorn sheep management priorities in the East Kootenays currently being conducted by MOE Cranbrook should be finished as soon as possible and circulated for comment among all interested parties, in particular to resource extraction interests in the Trench and the Elk Valley (i.e., forestry, mining, agriculture) who were not present at the workshop.

- Lamb natality and survival are not currently being monitored systematically in any of the 4 study areas, yet knowledge of these population parameters is needed to better understand potential problems with these populations. We recommend that lamb natality immediately post-lambing be determined for radiocollared ewes at each of the 3 study sites with radiocollared individuals.

- Digital bioterrain mapping has not been completed at the Premier Ridge study area. Bioterrain mapping of the area would greatly facilitate range work that we are conducting on the study area as part of this project. Bioterrain mapping at the site should be finished as soon as possible to be of greatest benefit to this project.

- The assessment of plant species composition of all of the vegetation communities within the 4 study areas should be completed during the summer of 1999. We will attempt to locate additional transects in the Bull River and Columbia Lake study areas to obtain at least 2 representative samples of each vegetation community type. This would involve establishing at least 4 additional transects at Bull River and three additional transects at Columbia Lake. In some cases, it may be difficult to find a homogeneous area within the community that is large enough to accommodate a 30 m transect.

- If not already present, transects will be established in the vicinity of the production cages that were placed in the Premier Ridge and Mt. Broadwood study areas. This will total 6 additional transects at Premier Ridge and 12 transects at Mt. Broadwood. Further transects will be established if it is clear that not all vegetation communities have been sampled at least twice. In the Mt. Broadwood study area, additional transects may be located if the results of the habitat selection analysis indicate other areas as being key winter habitat.

- The 2 transects in the areas where controlled burning took place at Bull River in 1998 should be re-read to monitor the progression in plant species composition and cover. It will be important to note whether the sulphur cinquefoil colonies remain as numerous and vigorous as they were following the burns.

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12.0 Personal Communications

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