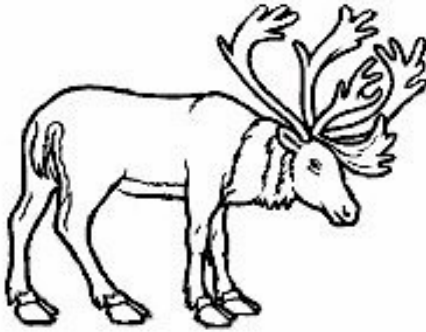


Mountain Caribou Compendium



This
Compendium
is an on-going
project, aimed
at improving
access to
information
about

British Columbia's Mountain Caribou.

The Compendium is a joint project of:

- City of Revelstoke through the Revelstoke Caribou Recovery Committee
- Columbia Mountains Institute of Applied Ecology
- Natural Resources Information Network (FORREX)
- Revelstoke Community Forest Corporation
- Revelstoke Forest Workers Society

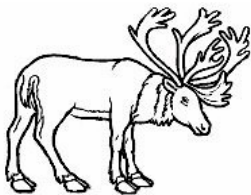
Begun in June 2003

Most recent update August 2008

Mountain Caribou Compendium

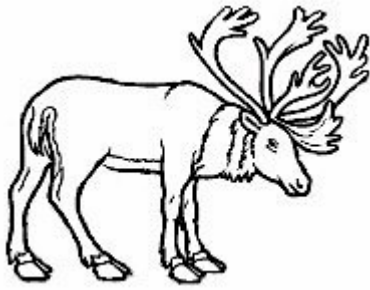
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***This information can be downloaded as a
Microsoft Word document
at www.cmiae.org***

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Mountain Caribou Compendium

1. ABOUT THE MOUNTAIN CARIBOU COMPENDIUM

The southern populations of woodland caribou, known locally as “mountain caribou,” are listed as a threatened species. Virtually all of the world’s 1800 mountain caribou live in southeastern British Columbia. The Mountain Caribou Compendium is an initiative to improve the accessibility of research results and other information related to the mountain caribou herds of southeastern British Columbia.

The Compendium consists of three parts: a print version and two on-line versions:

- Print copies of research reports are housed at the Columbia Mountains Institute of Applied Ecology in Revelstoke, Second Floor, 200 Campbell Avenue (non-circulating collection).
- Digital copies of abstracts are available for downloading as MS Word files at the web site of the Columbia Mountains Institute (www.cmiae.org look in the *Resources* section). Links to some publications are available at this web site.

2. USING THE PRINTED VERSION OF THE MOUNTAIN CARIBOU COMPENDIUM

The printed version of the Mountain Caribou Compendium is housed at the Columbia Mountains Institute of Applied Ecology, located at 200 Campbell Avenue (second floor). Office hours are not regular; call 250-837-9311 or office@cmiae.org to be sure the office is open.

The print version of the Mountain Compendium is for reference only and cannot be removed from the office. The materials are not available through inter-library loans.

To find an article on the library shelf:

This binder contains all the abstracts from the documents that are contained in the Mountain Caribou Compendium. The abstracts are sorted by topic. Simply browse the

abstracts in the topic that you are interested in and locate the number of the article. Go to the boxes on the library shelf and find the article with the corresponding number.

Abstracts are categorized under the following headings:

- Census Reports and Population Descriptions
- Disturbance
- Ecology
- Forestry
- Historical Accounts
- Hydro-Electric Development
- Lichen
- Management Plans
- Predation

3. ON-LINE VERSIONS OF THE MOUNTAIN CARIBOU COMPENDIUM

On-line versions of the Compendium include the abstracts for each document, sources for documents, a hyperlink to the complete document when available, and give the number of the item as it appears on the library shelf.

Visit the Columbia Mountains Institute web site at www.cmiae.org and look in the section called *Resources*, then choose *Mountain Caribou Compendium*. Download either of the two types of MS Word files that are offered, and use your keywords with MS Word's search function to find articles of interest.

4. SUPPORTING AGENCIES FOR THE MOUNTAIN CARIBOU COMPENDIUM

In early 2003 the Revelstoke Forest Workers Society in Revelstoke compiled a list of all research reports and other documents relevant to the management of the threatened local mountain caribou populations. The Columbia Mountains Institute of Applied Ecology became host for the project, with a commitment to maintain the collection of print materials and make the information available over the internet. The Columbia Mountains Institute will be responsible for the long term upkeep for the Compendium. Early financial support for the project comes from the City of Revelstoke's "Revelstoke Caribou Recovery Committee" and the Revelstoke Community Forest Corporation.

5. QUESTIONS ABOUT THE MOUNTAIN CARIBOU COMPENDIUM?

If you have any questions about using the Mountain Caribou Compendium, please contact:

Columbia Mountains Institute of Applied Ecology
PO Box 2568, Revelstoke, British Columbia V0E 2S0
Phone: 250-837-9311 Email: office@cmiae.org
Web site: www.cmiae.org

6. CENSUS REPORTS AND POPULATION DESCRIPTIONS

Habitat Use and Movements of Two Ecotypes of Translocated Caribou in Idaho and British Columbia

Author(s): C.D. Warren, J.M. Peek, G.L. Servheen, P. Zagers

Date: 01-Apr-96

Source:

Number on Library Shelf: 9

Two woodland caribou (*Rangifer tarandus caribou*) ecotypes, mountain and northern, were translocated to the southern Selkirk Mountains in northern Idaho (U.S.A) to augment a remnant subpopulation. The translocation resulted in an additional subpopulation that used the general area of the release site. The mountain ecotype stock exhibited patterns of movement and habitat use similar to those of the resident subpopulation. The northern ecotype stock exhibited more variable habitat use, especially in the first year after translocation. Dispersal of the northern stock was not as extensive as that of the mountain stock. Fourteen of 22 caribou from the northern stock and 6 of 18 caribou from the mountain stock died during the 3-year period after the release. Our results suggest that when donor subpopulations must be used that do not closely compare with resident subpopulations extinct or extant, larger numbers of individuals may be needed to establish a self-sustaining population.

Fuzzy structure and spatial dynamics of a declining woodland caribou population

Author(s): James A. Schaefer, A. M. Veitch, F.H. Harrington, W.K. Brown, J.B.

Theberge, S.N. Luttich

Date: 01-Dec-00

Source: *Oecologia* (2001) 126:507–514

Number on Library Shelf: 11

<http://www.trentu.ca/~jschaefer/Schaefer2001Oecologia.pdf>

Examining both spatial and temporal variation can provide insights into population limiting factors. We investigated the relative spatial and temporal changes in range use and mortality within the Red Wine Mountains caribou herd, a population that declined by approximately 75% from the 1980s to the 1990s. To extract the spatial structure of the population, we applied fuzzy cluster analysis, a method which assigns graded group membership, to space use of radio-tracked adult females, and compared these results to a hard classification based on sums-of-squares agglomerative clustering. Both approaches revealed four subpopulations. Based on the subpopulation assignments, we apportioned the number of animals, radio-days, calving events and mortalities across subpopulations before and after the decline. The results indicated that, as the herd declined, subpopulations were disproportionately affected. In general, subpopulations with the greatest range overlap with migratory caribou from the George

River herd experienced comparative reductions in activity and increased mortality. The subpopulation with the least overlap exhibited the converse pattern. The infra-population imbalances were more pronounced when herd clustering was employed. Our results reiterate that refugia from other ungulates may be important in the persistence of taiga-dwelling caribou. We propose that changes across time and space are valuable assays of localized demographic change, especially where individuals exhibit spatial hyperdispersion and site fidelity.

A Census Technique For Monitoring Woodland Caribou

Author(s): Wayne L. Wakkinen

Date: 19-Jun-95

Source: Journal of Applied Ecology

Volume 37 Issue 4 Page 589 - August 2000

Number on Library Shelf: 44

We attempted to develop a model to quantify factors affecting visibility of woodland caribou and provide statistically valid population estimates. Our design consisted of a 2-stage sampling effort: a "pre-census" fixed wing flight to determine caribou distribution and a "census" flight using a helicopter to count and classify individuals. Radio-marked caribou were used to quantify conditions of non-detection. We detected 100% of the groups with at least 1 radio-marked caribou during the fixed-wing flights (n=27). Eighty-three percent (23 of 27) of these groups were detected during the helicopter census. The conditional probability of detecting a group during the census was) 0.81 at the 90% confidence level. The minimum population size was determined to be 47, 47, 51 and 45 in 1991-1994. Modeling the detection factors had limited value for the highly successful technique described here. The 2-stage method has applications in wildlife census work where animals are unpredictably grouped within a large geographic area.

Mountain Caribou Censuses in the North Columbia Mountains

Author(s): Bruce McLellan, John Flaa, John Woods

Date: 25-Mar-03

Source: 759-766 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp

Number on Library Shelf: 68

http://www.cbfishwildlife.org/reports/teaser.php?report_id=56

Woodland caribou (*Rangifer tarandus caribou*) in southeastern British Columbia feed on arboreal lichen during the winter that are most abundant on old trees and thus have been identified as an old-growth dependent species (B.C. Ministry of Environment 1989). Clear-cut harvesting of mature forests has been perceived as being

incompatible with maintaining winter habitat for caribou. The relationship between the amount of clearcutting plus other forms of human intrusion into caribou habitat and actual numbers of caribou is unknown. To develop an understanding of this relationship, the number of caribou must be known and we must have the ability to track their numbers as the condition of their habitat changes. The primary purpose of this report is to present information on a caribou census conducted in March 1994. It is hoped that this census can be used as a benchmark for future censuses. In addition, we summarized caribou censuses conducted in this area in 1993, and others conducted in the past by the B.C. Hydro Mica and Revelstoke Compensation Programs (MCRP) and by Ministry of Environment, Lands and Parks (MOELP).

Population Censuses Of Caribou In The Columbia Forest District-DRAFT

Author(s): Bruce McLellan, Janis Hooge, John Flaa

Date: 30-Apr-02

Source:

Number on Library Shelf: 80

This document reports on a study conducted in the Columbia Forest District in which mountain caribou were radiocollared in attempts to identify and monitor the population.

Status Of The Selkirk Mountain Caribou

Author(s): David J. Freddy, Albert W. Erikson

Date: 01-Aug-72

Source:

Number on Library Shelf: 101

http://www.cmiae.org/_PDF/reference101.pdf

5.2 MB (scanned)

The Selkirk Mountain caribou (*Rangifer tarandus montanus*) are the only naturally remaining caribou in the contiguous United States, being found in the Selkirk Mountains on northern Idaho, northeastern Washington and southern British Columbia, Canada. Observations indicate there is a minimum of 35 caribou in the herd. These animals are divided into at least three small groups and occupy a somewhat discontinuous range. The animals wintered in the subalpine fir-Engelmann spruce forest in areas of moderate relief between the elevations of 1,380 m and 2,160 m. Arboreal lichens of the genus *Alectoria* range comprised the main winter food. Ecological damage to already limited winter range could seriously jeopardize the size and distribution of this herd. Special land classification, logging restrictions, forest fire control and continued protected status for these animals are essential management considerations.

Caribou and Moose Habitat Inventory and Habitat Management Guidelines in the Columbia River Drainage near Revelstoke, BC

Author(s): Keith Simpson, John P. Kelsall, Chris Clement

Date: 01-Aug-88

Source:

Number on Library Shelf: 102

The report deals with moose and caribou and their habitat in timber supply areas near Revelstoke, B.C. As a result of wildlife studies near Revelstoke and accelerating development in the area, the Ministry of Environment and Parks identified a need to inventory critical habitats for moose and caribou and to develop management guidelines, which will ensure the maintenance of wildlife populations in the area.

Development of a preliminary habitat assessment and planning tool for mountain caribou in southeast British Columbia

Author(s): Clayton D. Apps, Trevor Kinley

Date: 01-Jan-98

Source: Prepared for FRBC, Report #MR270

Number on Library Shelf: 106

<http://www.for.gov.bc.ca/hfd/library/frbc1997/FRBC1997MR270.pdf>

The Purcell Mountains of southeast British Columbia support a population of mountain caribou near the southernmost extension of their range. This ecotype is dependent upon late-successional forests, largely because such stands provide arboreal lichen for winter forage. Recent provincial forest practices legislation and land-use planning initiatives have provided the impetus for developing an interim caribou habitat assessment model for use as a planning tool. We applied the HIS (habitat suitability index) model developed for a nearby population as a testable hypothesis of caribou habitat selection in the southern Purcells. In a study area of about 6000km², 512 radiolocations were obtained for 22 animals from 1993 through 1995. Seasonal selectivity was assessed for the following model variables: elevation, slope, habitat type/current cover type, over story size class, canopy closure, and age of dominant over story. Caribou were most selective for stand age, which the model also defined as the greatest determinant of habitat suitability. However, we did not judge overall model output to be an adequate predictor of habitat selection by southern Purcell caribou. Seasonal ratings for each variable were therefore modified to better reflect selection patterns by animals in this study, and subjectively adjusted to ensure that potentially limiting habitat types were rated highly. An evaluation of the adjusted model established its efficacy as an interim decision-support tool. Selection analyses of spatial habitat distribution levels indicated a preference by caribou for landscapes with at least 40% suitable habitat per 250 ha and per 5000 ha. From this, it is apparent that suitable habitat is highly fragmented in this study area.

Caribou in British Columbia: A 1996 status report

Author(s): Douglas C. Heard, Kathryn L. Vagt

Date: 01-Jan-98

Source: Rangifer, special issue #10: 117-123

Number on Library Shelf: 107

Caribou (*Rangifer tarandus*) in British Columbia are classified into mountain, northern and boreal ecotypes based on behavioural and ecological characteristics. We recognized 12 mountain caribou herds, 27 northern caribou herds, and an area occupied by low density boreal caribou dispersed in the boreal forests of the northeast portion of the province. Abundance estimates were usually based on attempts at total counts made from the air. Trends were based on repeated population estimates or the difference between recruitment and mortality rates for each herd. In 1996 there were approximately 18 000 caribou in British Columbia; 2300 mountain and 15 600 northern and boreal. These estimates suggest a slight increase in the numbers of both ecotypes over the last 18 years. Fifteen percent of the herds were reportedly increasing, 10% were decreasing, 31% were stable, but for 44% of the herds the trend was unknown. Historically caribou were found throughout 8 of the 14 biogeoclimatic zones in B.C. Caribou are now rarely found in the Sub-Boreal Spruce zone, likely due to an increase in predation from wolves that increased in response to increasing moose numbers. Ranges of several herds in the Englemann Spruce-Subalpine Fir and Alpine Tundra zones of south-eastern British Columbia are also reduced relative to historic conditions, probably because of habitat loss, habitat fragmentation, predation and hunting. Forest harvesting represents the greatest threat to caribou habitat and current research focuses on the mitigation of forest harvesting impacts.

Mountain Habitat Use And Population Characteristics For The Central Selkirk Caribou Inventory Project

Author(s): Dennis Hamilton, Steven F. Wilson, Graham Smith

Date: 31-Mar-00

Source:

Number on Library Shelf: 112

This project was designed to provide the population and habitat inventory data necessary to effectively integrate the needs of mountain caribou with forest landscape planning and operational management.

Caribou Research And Management In British Columbia-Proceedings of Workshop

Author(s): BC Ministry of Forests, BC Ministry of Environment

Date: 07-Nov-85

Source: Proceedings of a workshop. BC Ministry of Forests, Research Branch, WHR-27, Victoria, BC

Number on Library Shelf: 113

Proceedings of a workshop in Kamloops, 1985.

Caribou Censuses in the Kinbasket Lake and Duncan River Areas

Author(s): John Flaa

Date: 17-Jun-95

Source: Study done for Columbia Basin Fish and Wildlife Compensation Program.

Number on Library Shelf: 119

To order a copy: http://www.cbfishwildlife.org/reports/teaser.php?report_id=57

This report outlines the results of caribou censuses for the Kinbasket Lake area, completed in 1995.

Robson Valley Caribou Population Review

Author(s): Eliot Terry

Date: 01-May-95

Source: Ministry of Environment, Lands and Parks, Prince George

Number on Library Shelf: 122

The purpose of this report is to compile available information on woodland caribou in the Robson Valley and provide a review of population distribution, seasonal movements and monitoring needs.

Updated COSEWIC Status Report on "Forest-Dwelling" Woodland Caribou

Author(s): Donald C. Thomas, David R. Gray

Date: 01-Aug-01

Source: Prepared for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2002.

Number on Library Shelf: 124

This document is an in-depth summary on the status of woodland caribou.

Selkirk Mountains Woodland Caribou Herd Augmentation in Washington

Author(s): Audet, Suzanne; Allen, Harriet

Date: January 1996

Source:

Number on Library Shelf: 126

<http://wdfw.wa.gov/wlm/research/caribou/caribpub.htm>

The Selkirk Mountain woodland caribou (*Rangifer tarandus caribou*) is listed by the U.S. Fish and Wildlife Service as an endangered species in the United States. It is also designated as an endangered species in Washington by the Washington Department of Fish and Wildlife. The recovery plan for the caribou (USFWS, original 1985; revised 1994) includes a task to establish caribou in the western portion of the Selkirk Ecosystem in Washington. Transplants to the western portion of the ecosystem are needed to achieve better distribution, greater abundance, and to enhance the probability of caribou recovery.

The augmentation project entails capturing caribou in separate, but genetically similar subpopulations in British Columbia, transporting the animals to Washington, releasing them into the wild, and monitoring the results. Previous herd augmentation efforts for the southern Selkirk caribou population involved transplanting caribou from healthy populations in British Columbia to the Ball Creek area of Idaho. A total of 60 caribou were transplanted: 24 in 1987; 24 in 1988; and 12 in 1990. Information and experience gained in the Idaho effort will be used to increase the chances for success of the Washington project.

Three potential sources for transplant animals in British Columbia will be considered: Revelstoke, Blue River/Wells Gray Park, and Prince George. British Columbia officials will determine the number and sources of transplant animals. The target number of animals for the first year will be 20-24 animals, with a sex ratio of 1 male: 4-5 females. Preferred age composition is males 3 years or younger, calves, yearlings, and adult females. Old-aged females or animals in poor condition will be excluded. Methods will follow those used in the Idaho augmentation effort, which experienced very low mortality

rates. Animals will be captured in March, using net guns from helicopters. They will be held for tuberculosis and brucellosis testing and then transported to the release site in Washington.

Four potential release sites on the Sullivan Lake Ranger District of the Colville National Forest were evaluated. One site, Molybdenite Ridge was eliminated from consideration. Potential release sites, in order of preference are: Pass Creek, Mankato Mountain, and upper Sullivan Creek. All are within the Caribou Habitat Area, are currently managed as caribou habitat under the Colville National Forest Plan (U.S. Forest Service 1988), and will require no change in management to accommodate the augmentation effort. The final site selection will depend upon weather conditions and road access at the time of release.

Preliminary work (administrative, habitat mapping, caribou feeding trials) has been conducted during 1995 to facilitate the augmentation project. Pending funding approval, the first transplant will take place in March 1996. Caribou recovery is an interagency and international effort requiring public support and involvement. Law enforcement needs are identified in the augmentation plan and will emphasize prevention of accidental or intentional shooting. Information/Education needs are also addressed in the plan. Some of the information/ education efforts used during the Idaho augmentation effort, such as the "Adopt a Caribou" program, will be used in the Washington project.

Moose Population Monitoring in the Lake Revelstoke valley. 2002-2003

Author(s): Poole, K, and Serrouya, R.

Date: March 2003

Source:

Number on Library Shelf: 127

Moose (*Alces alces andersoni*) numbers north of Revelstoke in the northern Columbia Mountains of British Columbia appear to have increased substantially over the past 2 decades. This has led to mounting conflicts with forestry interests, and concern has been raised about the impact of a moose supported and apparently increasing wolf (*Canis lupus*) population on a sympatric and declining mountain caribou (*Rangifer tarandus caribou*) herd. To provide a current estimate of moose numbers in this area and strengthen background data for management decisions, we conducted a stratified random block aerial survey 14–28 January 2003. The primary objectives were to estimate moose density (absolute abundance) and composition within the study area. A secondary objective was to estimate moose numbers and distribution along the Illecillewaet and Tangier rivers northeast of Revelstoke. Finally, we wanted to present methods to monitor relative abundance, and discuss using aerial methods versus a pilot study based on pellet transects.

Comparisons with previous survey data suggest that moose numbers in the study area have more than doubled in the past 9–12 years. Given current harvest rates, hunter

harvest likely could be more than doubled while still maintaining a stable population. Given the importance of Lake Revelstoke moose numbers in the context of wolf/caribou dynamics and forestry concerns, we recommend annual moose population monitoring. We suggest that a stratified random block survey be conducted every 5 years, with annual trend monitoring conducted by either pellet-group transects or aerial surveys of a sample of sample units in high and medium density areas. The former method may be less costly with the use of local volunteers, but will not provide data on age and sex ratios.

Population Status and Mortality of Mountain Caribou in the Southern Purcell Mountains, British Columbia.

Author(s): Trevor Kinley and Clayton Apps

Date: February 1999

Source: Pp. 655-661 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp.

Number on Library Shelf: 134

<http://wlapwww.gov.bc.ca/wld/documents/mc07kinley.pdf>

Population surveys and mortality monitoring for mountain caribou, an ecotype of woodland caribou (*Rangifer tarandus caribou*), were conducted in the southern Purcell Mountains of British Columbia from 1994 to 1998. Results indicated that this subpopulation was declining, with annual growth rates ranging from 0.82 to 0.88. This was a result of low calf recruitment (late-winter ratios of 0.00–0.13 calves per adult) and high adult mortality (mean annual rate = 0.27). Reasons for low recruitment were unknown, but most adult mortality was attributed to predation, particularly by cougars (*Felis concolor*). The difference in mortality rate between sexes was non-significant ($P = 0.14$), but was consistent with increasing bull: cow ratios observed during the study. The southern portion of the study area had more recent cutblocks and fires (i.e., forests <40 years), greater road density, and more fragmentation than the northern portion. Caribou mortality was also significantly greater in the south than the north ($P = 0.03$). This mortality may have been partly due to post-logging changes in the distribution of ungulates favouring edges and early-seral forests, and the predators that were attracted to these ungulates. If current trends continue, the southern Purcell caribou herd will be extirpated within a decade. To address this problem, we recommend that (1) this subpopulation be augmented with animals from other mountain caribou herds; (2) relationships between predation and patterns of forest harvesting be investigated, with harvesting either deferred in some areas or designed to minimize enhancement of other ungulates' forage; and (3) limiting predation on caribou by reducing the number of cougars and alternate prey be investigated.

Population Characteristics of the Lake Revelstoke Caribou

Author(s): John Flaa and Bruce McLellan

Date: February 1999

Source: Pp. 639-642 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp

Number on Library Shelf: 136

<http://wlapwww.gov.bc.ca/wld/documents/mc03flaa.pdf>

The Lake Revelstoke caribou are the southernmost contiguous mountain caribou population in British Columbia. Population characteristics of the herd were examined during 1981–85, with 13 radio-collared caribou, and 1992–98, with 47 radio-collared caribou. During several late-winter censuses, sightability of marked animals was 92% and the proportion seen was a function of the height of snow. Our best estimate of the population size was 375 animals (95% CI 337–413). Cause of death of 31 radio-collared animals included accidents (42%), predation (29%), and poor condition (10%). Deaths due to avalanches (accidents) were the single leading cause at 23%. Survival of radio-collared caribou averaged 84% since 1992. Progesterone levels in 29 female caribou indicated that 83% were pregnant. There was an average of 28 calves/100 adults during 1981–84, and 18 calves/100 adults during 1994–97. Survival rates of adult caribou and the ratio of calves per 100 adults indicate that the population was stable.

Mountain Caribou Habitat Use in the Salmon Arm Forest District: 2000-2002, Preliminary Report #1

Author(s): Kelsey Furk
Bruce McLellan

Date: March 2003

Source: Produced under contract to:

Okanagan Innovative Forestry Society, 4280 Highway 6, Lumby, BC V0E 2G7
gadick@riverside.bc.ca

Number on Library Shelf: 140

http://www.cmiae.org/_PDF/reference140.pdf

The Okanagan Shuswap Land and Resource Management (OSLRMP) area contains part of three caribou populations identified by Simpson et. al (1997). These are the Wells Gray South, Revelstoke and Monashee populations. In 2001 (OSLRMP) established a Caribou Resource Management Zone (RMZ) with associated connectivity corridors in the Okanagan TSA. The OSLRMP specifies management guidelines for Caribou in this RMZ.

The Okanagan Innovative Forestry Society (OIFS) contracted a caribou study in response to the OSLRMP call for further caribou habitat information. This report documents progress of the study over the first two years of a seven-year project. The OIFS Forestry Plan (2001) identifies five main objectives for this project:

- Identifying opportunities to supply suitable caribou habitat attributes through forest management activities.
- Investigating caribou populations, including predation and mortality; and
- Link monitoring from this project to ongoing caribou research projects in the Columbia and Clearwater Forest Districts.

Identifying the caribou habitat requirements in the ICH and ESSF zones;
Examining the relationship between forest management activities and relative caribou habitat use in the ICH and ESSF zones.

Caribou research projects in the Columbia and Clearwater Forest districts have also identified caribou movements in the Salmon Arm Forest District. Data from all three studies will be combined to complete the objectives of this study.

Caribou Site Seasonal Home Ranges in the North Thompson Watershed of British Columbia 1996-98

Author(s): Garth Mowat and Kim Poole

Date: March 1999

Source: Ministry of Environment Lands and Parks Kamloops BC

Number on Library Shelf: 147

http://www.cmiaae.org/_PDF/reference147.pdf

Caribou range size followed predictable patterns. Home range sizes were relatively restricted in summer and late winter while caribou moved much further in early winter and spring. Caribou seek out patchy resources during these 2 later periods and this searching appears to effect home range size. During early winter caribou seek wind fallen trees and branches, and during spring caribou seek out early green-up areas which are patchily distributed through the landscape and of limited size (and therefore quickly exploited). These analyses show clearly that the calving strategy of this group of caribou is to move to a higher elevation area (Mowat et al. 1998) before parturition and remain there for 3-4 weeks before resuming significant movements. Figure 5 shows several potential calving areas, 2 of which were used by 2 different caribou (upper Lempriere creek and upper Mrytle creek) These results are similar to those of Mowat et al. (1998) except that the early spring movements were smaller in 1996 and 1997 than during 1998. Summer home ranges were also somewhat smaller in this study but this was largely caused by caribou 36 which had a summer home range of only 3 km² in 1998. Perhaps this animal was dead or lost its collar. Mowat et al. (1998) suggested that season cut-off dates be selected by examining the behaviour of individuals; this is likely to result in a more accurate picture of seasonal movements.

Robson Valley Caribou Surveys

Author(s): March 2001

Date: Dale Seip

Source: Robson Valley Forest District, Enhanced Forestry Management Pilot Project

Number on Library Shelf: 150

<http://www.firthehollin.com/efmpps/research/caribou2001.pdf>

Prior to the start of this project in March 2000, there had not been a complete population survey of caribou in the Robson Valley so it was unclear how many caribou lived there. The habitat management zones were based on historic observations, habitat characteristics, and a limited amount of telemetry data. It was not clear if those areas were currently being used by caribou in winter. Additional information on winter distribution was required to more clearly define important winter habitat areas. The purpose of this project is to conduct winter surveys of mountain caribou distribution in the Robson Valley to determine how many caribou there are,

COSEWIC Assessment and Update Status Report on the Woodland Caribou

Author(s): D.C. Thomas and D.R. Gray

Date: 2002

Source: Committee on the Status of Endangered Wildlife in Canada, Ottawa

Number on Library Shelf: 152

http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_woodland_caribou_e.pdf

Woodland caribou (*Rangifer tarandus caribou*) are medium-sized (100-250 kg) members of the deer family. The taxonomy (classification) and systematics (evolutionary history) of caribou in Canada are uncertain. Based on mitochondrial DNA, caribou in North America evolved from two founding groups (clades) that differentiated in isolation during the last (Wisconsinan) glaciation. The southern clade supposedly evolved south of the continental ice sheet, whereas the northern clade was in a glacial refugium in Alaska and adjacent Arctic Canada. Populations that contained unique southern gene types were the Pukaskwa local population in Ontario and two in Newfoundland. In contrast, exclusively northern types occurred in four Yukon populations and in some forest-tundra and tundra ecotypes of barren-ground caribou (*R. t. groenlandicus*) in northern Canada. Most woodland caribou populations in the mountains of southern British Columbia (B.C.) and Alberta and in the boreal forest and taiga across Canada are mixtures of the two types. Some 'mixed' populations in the taiga exhibit two phenotypes and behave like the forest-tundra ecotype of barren-ground caribou.

2004 Population census of mountain caribou in the Columbia Forest District

Author(s): Janis Hooge, Bruce McLellan, John Flaa

Date: 2004

Source:

Number on Library Shelf: 155

http://www.cmiae.org/_PDF/reference155.pdf

Mountain caribou in the Columbia Forest District were studied using radio telemetry from 1992 to 1999. Censuses conducted in 1994, 1995, 1996, and 1997 indicated a relatively stable population of between 290 to 373 animals. In 2002, census efforts were coordinated throughout the range of mountain caribou in British Columbia and resulted in a population estimate of 211 animals for the Revelstoke area, or a decline to 64% of the 1997 estimate. A downward trend occurred in most mountain caribou subpopulations in southern B.C. However, because there were only 5 radio collared animals remaining in the Revelstoke area in 2002, the sightability of the population (proportion of the total population actually observed) could not be well estimated, resulting in a wide confidence interval of 176-269 animals. The decline was confirmed during the 2004 census, with a population estimate of 176. The 90% confidence interval for the 2004 census was 167-210 animals, based on sighting 14 of the 15 radiocollars available.

2004 Population Census for the Central Selkirk Mountain Caribou

Author(s): Dennis Hamilton

Date: April 10, 2004

Source: Prepared for Pope & Talbot Ltd. Slocan Forest Products, Meadow Creek Cedar Company, Canadian Mountain Holidays

Number on Library Shelf: 166

http://www.cmiae.org/_PDF/reference166.pdf

Central Selkirk mountain caribou population estimates have declined in every census year since surveys began in 1996. The 1996 census flight observed 211 animals where 12 of 14 radio-collared caribou were spotted. The 2002 census, in which 96 caribou were spotted and 6 of 9 radio-collared animals were sighted, resulted in a population estimate of 131 caribou in the study area. The 2002 result was the first year in which a population trend could be established statistically.

A total of 70 animals, including 13 calves, were spotted during helicopter census flights completed in March 2004. Following the census flights, a supplemental fixed wing survey of the peripheral of the study area was conducted, but no caribou were observed. There was only one radio-collar still active in the study area at the time of the 2004 census; consequently, no measure of sightability (ratio of marked animals seen to

known number of marked animals) was calculated. A total count for all census years and population estimates in years where mark-resight data were available are presented.

Due to recent population trend, it is recommended that a population census be conducted every year for the next few years. As mountain caribou are relatively easy to census, weather and climatic conditions permitting, no additional caribou collaring is needed at this time.

Forestry, backcountry recreation and mountain caribou recovery require a coordinated effort if current population trend for the Central Selkirk mountain caribou is to be reversed.

Population dynamics of the endangered mountain ecotype of woodland caribou (*Rangifer tarandus caribou*) in British Columbia, Canada

Authors: Heiko Wittmer, Bruce McLellan, Dale Seip, James Young, Trevor Kinley, Glen Watts, Dennis Hamilton

Date: 2005

Source: Canadian Journal of Zoology **83: 407-418**

Number on library shelf: 174

http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjz&volume=83&calyLang=eng&articleFile=z05-034.pdf

Abstract: We used census results and radiotelemetry locations of >380 collared individuals sampled over the entire distribution of the endangered mountain ecotype of woodland caribou (*Rangifer tarandus caribou* (Gmelin, 1788)) in British Columbia, Canada, to delineate population structure and document the size and trend of the identified populations. We also describe the spatial pattern of decline and the causes and timing of adult mortality and provide estimates of vital rates necessary to develop a population viability analysis. Our results indicate that the abundance of mountain caribou in British Columbia is declining. We found adult female annual survival rates below annual survival rates commonly reported for large ungulates. The major proximate cause of population decline appears to be predation on adult caribou. Spatial patterns of population dynamics revealed a continuous range contraction and an increasing fragmentation of mountain caribou into smaller, isolated subpopulations. The population fragmentation process predominantly occurs at the outer boundaries of the current distribution. Our results indicate that recovery strategies for mountain caribou should be directed at factors contributing to the fragmentation and isolation of mountain caribou populations as well as management strategies aimed at increasing adult survival.

Comment arising from a paper by Wittmer et al.: hypothesis testing for top-down and bottom-up effects in woodland caribou population dynamics.

Authors: Glen S. Brown, Lynn Landriault, Darren J.H. Sleep, Frank F. Mallory

Date: August 2007

Source: Oecologia DOI 10.1007/s00442-007-0855-3

Number on library shelf: 181

http://www.cmiae.org/_PDF/reference181.pdf

Conservation strategies for populations of woodland caribou *Rangifer tarandus caribou* frequently emphasize the importance of predator–prey relationships and the availability of lichen-rich late seral forests, yet the importance of summer diet and forage availability to woodland caribou survival is poorly understood. In a recent article, Wittmer et al. (*Can J Zool* 83:407–418, 2005b) concluded that woodland caribou in British Columbia were declining as a consequence of increased predation that was facilitated by habitat alteration. Their conclusion is consistent with the findings of other authors who have suggested that predation is the most important proximal factor limiting woodland caribou populations (Bergerud and Elliot in *Can J Zool* 64:1515–1529, 1986; Edmonds in *Can J Zool* 66:817–826, 1988; Rettie and Messier in *Can J Zool* 76:251–259, 1998; Hayes et al. in *Wildl Monogr* 152:1–35, 2003). Wittmer et al. (*Can J Zool* 83:407–418, 2005b) presented three alternative, contrasting hypotheses for caribou decline that differed in terms of predicted differences in instantaneous rates of increase, pregnancy rates, causes of mortality, and seasonal vulnerability to mortality (Table 1, p 258). These authors rejected the hypotheses that food or an interaction between food and predation was responsible for observed declines in caribou populations; however, the use of pregnancy rate, mortality season, and cause of mortality to contrast the alternative hypotheses is problematic. We argue here that the data employed in their study were insufficient to properly evaluate a predation-sensitive foraging hypothesis for caribou decline. Empirical data on seasonal forage availability and quality and plane of nutrition of caribou would be required to test the competing hypotheses. We suggest that methodological limitations in studies of woodland caribou population dynamics prohibit proper evaluation of the mechanism of caribou population declines and fail to elucidate potential interactions between top-down and bottom-up effects on populations.

2005 Population Census of Mountain Caribou in the Central Selkirk Mountains of Southeastern British Columbia

Authors: Dennis Hamilton, Steve Wilson

Date: April 18, 2005

Source: Prepared for Canadian Forest Products, Pope and Talbot Ltd. Canadian Mountain Holidays, Mount Revelstoke and Glacier National Parks.

Number on Library Shelf: 169

http://www.cmiae.org/_PDF/reference169.pdf

This census is part of the ongoing monitoring of the Central Selkirk subpopulation.

7. DISTURBANCE

Implications of Snowmobiling on Mountain Caribou Annual Report: Year One

Author(s): Bruce McLellan, Janis Hooge

Date: 31-Dec-01

Source:

Number on Library Shelf: 5

This report focuses on the potential for conflict between mountain caribou and winter recreationalists in British Columbia.

Impacts of Backcountry Recreation Activities on Mountain Caribou-Management Concerns, Interim Management Guidelines and Research Needs

Author(s): K. Simpson, E. Terry

Date: 22-Nov-99

Source: BC Ministry of Water, Land and Air Protection

Number on Library Shelf: 18

<http://wlapwww.gov.bc.ca/wld/documents/techpub/wr99.pdf>

The primary objectives of this report include documentation of the management concerns for each mountain caribou sub-population and development of interim management guidelines. Research recommendations designed to test various working hypotheses within an adaptive management framework are also present.

Snowmobile Activity and Glucocorticoid Stress Responses in Wolves and Elk

Author(s): Scott Creel, Jennifer E. Fox, Amanda Hardy, Jennifer Sands, Jennifer Sands, Bob Garrott, Rolf O. Peterson

Date: 19-Dec-00

Source: Conservation Biology, Pages 809-814 Volume 16 #3 June 2003

Number on Library Shelf: 69

<http://www.montana.edu/wwwbi/staff/creel/snomoGC.pdf>

The effect of human activities on animal populations is widely debated, particularly since a recent decision by US Department of the Interior to ban snowmobiles from national parks. Immunoassays of fecal glucocorticoid stress levels provide a sensitive and noninvasive method of measuring the physiological stress responses of wildlife to disturbances. We tested for associations between snowmobile activity and glucocorticoid levels in an elk (*Cervus elaphus*) population in Yellowstone National Park

and wolf (*Canis lupus*) populations in Yellowstone, Voyageurs, and Isle Royale national parks. For wolves, comparisons among populations and years showed that fecal glucocorticoid levels were higher in areas and times of heavy snowmobile use. For elk, day-to-day variation in fecal glucocorticoid levels paralleled variation in the number of snowmobiles after we controlled for the effects of weather and age. Also for elk, glucocorticoid concentrations were higher in response to snowmobiles than to wheeled vehicles after we controlled for the effects of age, weather, and number of vehicles. Despite these stress responses, there was no evidence that current levels of snowmobile activity are affecting the population dynamics of either species in these locations.

Distribution Of Caribou And Wolves In Relation To Linear Corridors

Author(s): Adam R. C. James, A. Kari Stuart-Smith

Date: 01-Jan-00

Source: Journal of Wildlife Management 64(1): 154-159.

Number on Library Shelf: 70

Linear corridors (roads, trails, seismic lines, and pipeline corridors) have been hypothesized to increase human harvest and predation of woodland caribou (*Rangifer tarandus*). We tested the hypothesis that linear corridors affect caribou and wolf activities by examining the distribution of 2,616 telemetry locations of caribou, 27 caribou mortality sites, 592 telemetry locations of wolves (*Canis lupus*), and 76 sites where wolves preyed on large ungulates relative to linear corridors in caribou range and well-drained sites in northeastern Alberta. Of the 98 radiocollared caribou, 35 were significantly further than random from corridors and only 3 were significantly closer. The mean difference between caribou and random locations (106 m) was significantly different from zero. Within caribou range, wolf locations were closer (134 m) than random to linear corridors. Wolf predation sites were not significantly closer to corridors than were wolf locations or random points. Caribou mortalities attributed to wolf predation were closer (316 m) to linear corridors than were live locations from all caribou, indicating that caribou that are closer to linear corridors are at higher risk of depredation. Each caribou mortality attributed to wolf predation was closer to a corridor than their telemetry locations while alive (mean difference = 204 m). Caribou mortalities caused by humans were 174 m closer to corridors than all alive caribou locations, however this difference was not significant. Increased industrial activity in caribou range could have a significant effect on caribou population dynamics by increasing predation. The development of new corridors within caribou habitat should be minimized and existing corridors should be made unsuitable as travel routes to reduce the impacts of industrial development on caribou populations.

Fecal Measurement of Stress Responses to Snowmobiles in Moose (*Alces alces*)

Author(s): Martha Tomeo

Date: 01-Apr-00

Source: Master's Thesis. University of Alaska Anchorage, Anchorage, Alaska. .

Number on Library Shelf: 71

The impacts of winter recreation snowmobile use on moose (*Alces alces gigas*) in Alaska were investigated in 1999. Snowmobiles have historically been common modes of transport in northern regions, but their popularity as a recreational pastime has increased dramatically in recent years. The impacts of snowmobiles on wildlife are not well understood at present, yet snowmobile activity is rapidly expanding into wilderness areas. The impact of snowmobile activity as a physiological stressor on moose was studied non-invasively by measuring and comparing glucocorticoid levels in moose fecal samples collected from areas with and without recreational snowmobile use.

Additionally, moose fecal samples were collected in three urban sites to provide a comparison of stress levels in different areas of human activity. I radioimmunoassays were preformed to measure metabolized excreted glucocorticoid levels. Mean glucocorticoid concentrations were lower in an area without snowmobile use (51.52 ng/g) than in an area with snowmobile use (58.18 ng/g) ($F = 12.187$, $p < 0.01$). Urban moose had higher glucocorticoid levels (77.84 ng/g, 103.34 ng/g, 167.24 ng/g) than moose in other areas ($F = 267.661$, $p < 0.001$). Assay group was found to be a significant independent actor in the analysis of glucocorticoid levels. The presence of snowmobile activity may be sufficiently stressful to elevate glucocorticoid levels in moose, and amplify the challenges to survival posed by the natural winter environment.

South Selkirk Cougar Ecology And Predation Project, 1998-99 Progress Report

Author(s): Ross Clarke

Date: 15-May-99

Source: Prepared for Columbia Basin Fish and Wildlife Compensation Program, Nelson BC

Number on Library Shelf: 72

<http://www.cbfishwildlife.org/reports/pdfs/cougar99.pdf>

In 1998, the Columbia Basin Fish & Wildlife Compensation Program (CBFWCP) in partnership with the Columbia Basin Trust (CBT), and BC Environment (BCE) initiated a cougar ecology and predation study in the South Selkirk Mountains (SSM) south of Nelson, BC (Woods 1998). Caribou in the SSM had a high rate of mortality during the 7 summers of 1995 to 1997. Mule deer in the same study area also had significant losses to cougars in 1997. In order to reduce or reverse the losses of caribou and mule deer to cougar predation it was determined that there was the need to gather information on the South Selkirk cougar population, prey selection, habitat use, and general ecology. A parallel effort to determine cougar ecology and management

requirements are currently underway in the SSM portion of Washington State and Idaho (Katnik 1998). This progress report represents the first 5 months of field activity up to March 31, 1999 and summarizes field priorities for 1999-00. Initial results will be presented at the end of the next fiscal at which point we will have 16 months of data. Funding for one year of this project was funded by the CBT. Funding in year two will be provided by the CBFWCP and the Habitat Conservation Trust Fund (HCTF).

The Effects of Snowmobiling on Winter Range Use of Mountain Caribou (*Rangifer tarandus caribou*)

Author(s): Keith Simpson

Date: 01-Jul-85

Source:

Number on Library Shelf: 73

http://www.cmiae.org/_PDF/reference73.pdf

2.66 MB (scanned)

Aerial observations of caribou winter range areas showed that caribou avoided areas where there was extensive recreational snowmobiling. Experimental disturbance of caribou, using one or two machines, showed that human scent and large groups moving rapidly around an area were the main causes of avoidance by caribou. Caribou could tolerate low levels of snowmobile use. Recommendations included reducing snowmobile use by access and group size restrictions and posting information signs informing snowmobilers to avoid areas where there were caribou or tracks.

Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta

Author(s): Simon J. Dyer, Jack P. O'Neill, Shawn M. Wasel, Stan Boutin

Date: 01-Jan-02

Source:

Number on Library Shelf: 79

Linear developments such as roads, seismic lines, and pipeline rights-of-way are common anthropogenic features in the boreal forest of Alberta. These features may act as barriers to the movement of threatened woodland caribou (*Rangifer tarandus caribou*). Thirty-six woodland caribou were captured and fitted with global positioning system collars. These collared caribou yielded 43 415 locations during the 12-month study period. We compared rates of crossing roads and seismic lines with rates at which caribou crossed simulated roads and seismic lines using ArcInfo GIS. Seismic lines were not barriers to caribou movements, whereas roads with moderate vehicle traffic acted as semipermeable barriers to caribou movements. The greatest barrier effects were evident during late winter, when caribou crossed actual roads 6 times less

frequently than simulated road networks. Semipermeable barrier effects may exacerbate functional habitat loss demonstrated through avoidance behavior. This novel approach represents an important development in the burgeoning field of road ecology and has great potential for use in validating animal-movement models.

Caribou reactions to provocation by snowmachines in Newfoundland

Author(s): S. P. Mahoney, K. Mawhinney, C. McCarthy, Doug Anions, S. Taylor

Date: 01-Jan-01

Source: Rangifer. Volume 21 -2001. Page 35

Number on Library Shelf: 90

Caribou in Gros Morne National Park reacted to provocation by snowmachine with significant differences in their responses between years. Upon exposure to snowmachines, caribou were displaced 60 to 237 m from their initial locations. Groups with calves allowed the snowmachines to approach more closely before responding (5 to 600m) than adult-only groups (30-1300 m), and their overall flight distances were less. Time spent in locomotion and overall reaction time were greater for animals engaged in the most sedentary activities (eg. Standing $x = 239$ s and $x = 262$ s, and lying $x = 166$ s and $x = 273$ s) than for animals already engaged in more dynamic activities such as walking ($x = 118$ s and $x = 133$ s), running ($x = 74$ s and $x = 63$ s) and feeding ($x = 118$ s and $x = 133$ s). Annual differences in the response of adult-only groups were not due to differences in the sex ratio of these groups, but may be related to annual variation in winter weather conditions.

Calving Success of Woodland Caribou Exposed to Low-Level Jet Fighter Overflights

Author(s): Fred H. Harrington, Alasdair M. Veitch

Date: 01-Sep-92

Source: Arctic, 45 (3): 213-218.

Number on Library Shelf: 91

Effects on woodland caribou (*Rangifer tarandus caribou*) of low-level military jet training at Canadian Forces Base-Goose Bay (Labrador) were studied during the 1986-1988 training seasons. Calf survival was periodically monitored during 1987 and 1988 in a sample of 15 females wearing satellite-tracked radiocollars. During 1987, each female's exposure to low-level overflights was experimentally manipulated on a daily basis. In 1988, daily exposure was determined by analyzing jet flight tracks following the low-level flying season. Calf survival was monitored by survey flights every 3-4 weeks. A calf survival index, the number of survey periods (maximum = 4) that a cow was accompanied by a calf, was negatively correlated with the female's exposure to low-level jet overflights during the calving and immediate post-calving period and again during the period of insect harassment during the summer. No significant relationship

between calf survival and exposure to low-level flying was seen during the pre-calving period, during the late post-calving period prior to insect harassment, and during fall. In view of the continued depression of population growth in the woodland caribou population within the low-level training area, jets should avoid overflying woodland caribou calving range at least during the last week of May and the first three weeks of June.

Responses of woodland caribou to winter ecotourism in the Charlevoix Biosphere Reserve, Canada

Author(s): Mario Duchesne, Steve D. Cote, Cyrille Barrette
Date: 01-Jan-00
Source: Biological Conservation. 96:311-317
Number on Library Shelf: 92

We assessed the impact of ecotourist visits during winter on woodland caribou *Rangifer tarandus caribou* time budgets in the Charlevoix Biosphere Reserve, Canada. We compared the behaviour of caribou during and after ecotourist visits with their behaviour during days without visits. In the presence of ecotourists, caribou increased time spent vigilant and standing, mostly at the expense of time resting and foraging. After visits, caribou tended to rest more than during control days. Caribou reduced the amount of time spent foraging during ecotourist visits as the number of observers increased. The impact of ecotourists appeared to decrease as winter progressed. Visits were short ($x=39.3$ min) and caribou never left their winter quarters because of human presence. However, caribou abandoned their wintering area twice in response to wolf presence. Although winter is a difficult period of the year for caribou, our results suggest that with proper precautions caribou in Charlevoix can tolerate ecotourist visits.

A GIS Approach To Resolve Wildlife/Forestry/Heliskiing Conflicts, Case Studies In The Tangier And Carnes Watershed

Author(s): Sandra J. Brown, William A. Thompson, Andrew Kliskey, Carmen Heaver, Laurie Cooper, Ilian Vertinsky, Hans Schreier
Date: 15-Mar-94
Source:
Number on Library Shelf: 94

This document looks at how Geographic Information Systems can be linked to models of caribou habitat suitability, forest growth and forest economics. This d can provide the capability to address land use conflicts in a spatial and temporal context.

Summer Use of a Highway Crossing by Mountain Caribou

Author(s): Donald R. Johnson, Michael C. Todd

Date: 15-Jun-77

Source: Can. Field-Nat. 91: 312–314

Number on Library Shelf: 114

Caribou use of a highway crossing point near Kootenay Pass, British Columbia was monitored with a time-lapse camera during the summer months when highway traffic was heaviest. Caribou approached the crossing on at least 11 occasions throughout the daylight hours, including times of peak traffic flow. The number of approaches declined as the season progressed. Additional approaches undoubtedly occurred during the daylight hours, but these were not recorded by the camera, and during periods of darkness when the camera was inoperative. We conclude that mountain caribou have become habituated to the presence of highway and road traffic and that they continue to use a traditional travel movement route despite man-caused harassment and mortality.

Short-Term Impacts of Low-Level Jet Fighter Training on Caribou in Labrador

Author(s): Fred H. Harrington, Alasdair M. Veitch

Date: 31-Dec-91

Source: Arctic 44:318-327.

Number on Library Shelf: 123

The short-term impacts on caribou (*Rangifer tarandus*) of low-level jet fighter training activity at Canadian Forces Base Goose Bay (Labrador) were investigated during the 1986-88 training seasons (April-October). Visual observations of low-level (30 m agl) jet overpasses indicated an initial startle response but otherwise brief overt reaction by woodland caribou on late winter alpine tundra habitat. Between 1986-1988 daily effects of jet overflights were monitored on 10 caribou equipped with satellite tracked radio collars. Which provided daily indices of activity and movement. Half the animals were exposed to jet overflights: the other 5 caribou were avoided during training exercises and therefore served as control animals. In 1988 the control caribou were from a population had never been overflown. Level of exposure to low-level flying within the exposed population did not significantly affect daily activity levels or distance traveled, although comparison with the unexposed population did suggest potential effects. The results indicate that significant impacts of low-level overflights can be minimized through a program of avoidance.

Snowmobile – Mountain Caribou Interactions: A Summary of Perceptions and an Analysis of Trends in Caribou Distribution

Author(s): Trevor Kinley

Date: May 2003

Source: Prepared for: BC Ministry of Water, Land and Air Protection, Victoria.

Number on Library Shelf: 128

Mountain caribou and snowmobilers share much of the same terrain in late winter within the Interior Wet Belt of east-central and southeastern British Columbia, northern Idaho and northeastern Washington. The rarity of mountain caribou and the expansion in both numbers and extent of snowmobiles have led to concerns that snowmobile activity may have negative effects on caribou, such as physiological impacts, increased exposure to dangerous terrain, and range abandonment. This report examines 2 types of information, with the goal of increasing our knowledge on the potential relationships between snowmobiling and caribou. It (1) summarizes the observations of a sample of snowmobilers, wildlife managers and others with experiences relevant to the topic, and (2) examines late-winter census data in relation to mapping of snowmobile use areas, to determine whether there has been any decrease over time in the proportion of censused caribou groups occurring within snowmobile use areas.

Revelstoke Snowmobile Strategy

Author(s):

Date: October 2002

Source: City of Revelstoke web site

Number on Library Shelf: 142

http://www.cmiae.org/_PDF/reference142.pdf

The Revelstoke and Area Community Development Strategic Action Plan contains an objective of promoting and expanding existing tourism activities. A high priority was given to exploring opportunities and constraints related to snowmobile tourism. In April, 2001, the City of Revelstoke formed a Steering Committee to work with the Revelstoke Snowmobile Club and the Revelstoke Snowmobile Society to prepare a Revelstoke Snowmobile Tourism Management Strategy. The Steering Committee was given the task of developing an Action Plan and making recommendations regarding management of the Snowmobile Industry in our community.

Cumulative Effects of Habitat Change and Backcountry Recreation on Mountain Caribou in the Central Selkirk Mountains

Author(s): Steven Wilson and Dennis Hamilton

Date: March 2003

Source: Prepared for BC Ministry of Water, Land and Air Protection, Pope and Talbot Ltd, and Canadian Mountain Holidays.
Number on Library Shelf: 157

http://www.cmiae.org/_PDF/reference157.pdf

We used a cumulative effects analysis to examine the effects of logging and/or burning and commercial backcountry ski use on mountain caribou habitat and habitat use in the Central Selkirk Mountains. We used forest inventory databases to infer logging and/or burning activity in caribou range during each decade 1960-2000. Skier-runs were summarized by month-year within zones defined by Canadian Mountain Holidays (CMH) for their Galena and Kootenay tenure areas. We also examined snowmobile use by interviewing users in Nakusp and Trout Lake. Areas and linear features (i.e., logging roads) used by snowmobilers were mapped and classified according to estimated use. This project represented one of the first attempts to address the effects of mechanized backcountry recreation (particularly heli-sking) on caribou habitat use. The results should be considered preliminary and similar hypotheses should be tested in other areas. Management actions to address habitat loss and to reduce encounters by recreationalists should continue while data from other areas are examined.

The Effects of Human-related Harassment on Caribou

Author(s): Lara Webster

Date: August 1997

Source: Prepared for Jim Young, Senior Wildlife Biologist, Ministry of Environment, Williams Lake

Number on Library Shelf: 164

<http://srmwww.gov.bc.ca/car/resinv/wldinv/inventory/caribou/mtncar/harass/impacts.pdf>

Behavioural Response of Woodland Caribou (*Rangifer tarandus caribou*) to Snowmobile Disturbance in an Alpine Environment

Authors: Todd Powell, Thomas Jung, Marco Festa-Bianchet

Date: September 2004

Source : MSc Thesis Faculté des Sciences, Université de Sherbrooke

Number on Library Shelf: 177

http://www.cmiae.org/_PDF/reference177.pdf

Abstract: Recreational activities on caribou winter range are increasingly of concern, yet little data exist to guide management policies. We experimentally tested the effect of snowmobile activity on woodland caribou (*Rangifer tarandus caribou*) behaviour in the Coast Mountains, Yukon, Canada. Snowmobile activity may change woodland caribou foraging behaviour, cause habitat abandonment, or increase access for wolves that use snowmobile trails. Snowmobile speed, group size or approach angle did not affect caribou reaction. Groups of mature males allowed closer approach by snowmobiles than did maternal groups (containing cows, calves and yearlings) (mean 189 (± 21 SE) metres vs. 289 (± 28 SE) metres). For those groups that ran from the approaching snowmobile, initial flight distances did not differ between male (mean 227 (± 43 SE) metres) and maternal (mean 282 (± 30 SE) metres) groups. Maternal groups were twice as likely to run from an approaching snowmobile than male groups, and spent more time moving and being vigilant after disturbance. As male group size increased, flight distance decreased. This was not the case for maternal groups. Following disturbance, maternal groups spent more time running (mean 117 (± 36 SE) seconds) than did male groups (mean 20 (± 6 SE) seconds). We estimated that a single response to disturbance by a female caribou increases daily energy expenditure by 1.2%. Neither sex showed any evidence of either habituation or sensitization, over a single day or over the season. When snowmobiles were not present, time spent feeding, resting, vigilant and moving did not differ for either sex between areas that did and did not experience snowmobile use. Wolves frequently used snowmobile trails, possibly leading to increased predation on caribou. We recommend a distance of 500 metres or more between snowmobilers and caribou, informing snowmobilers about caribou ecology, and stemming the proliferation of snowmobile trails in caribou winter range.

Motorized backcountry recreation and stress response in mountain caribou (*Rangifer tarandus caribou*)

Author: Nicola L. Freeman,

Date: April 2008

Source: MSc. thesis, University of British Columbia

Number on library shelf: 182

As of August 27, 2008, this thesis was not yet available from the UBC library. Please contact Nicola directly for a copy, at:

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Abstract

Mountain caribou (*Rangifer tarandus caribou*) are endangered in British Columbia and motorized backcountry recreation has been identified as a potential threat to their persistence. My objective was to test if fecal glucocorticoids (GCs), indicative of physiological effects of ecological stress in wildlife, could be used as a non-invasive tool to quantify stress response in free-ranging caribou exposed to motorized recreation.

I validated an enzyme-linked immunosorbent assay (ELISA) to measure concentration of fecal GCs for *R. tarandus* using an adrenocorticotrophic hormone (ACTH) challenge experiment on captive reindeer exposed to extreme variation in winter weather. Female reindeer expressed elevated fecal GCs 9-11 hrs after ACTH injection. Males showed no detectable increase, perhaps due to underdosing. Fecal GCs varied markedly in both sexes in response to natural variation in weather. Overall, my results indicated fecal assays can be used to track biologically meaningful changes in adrenal activity in *R. tarandus*.

I investigated the effects of motorized recreation on stress hormone production by measuring GCs in feces of mountain caribou exposed to snowmobile and heli-ski activity. Concentrations of fecal GCs in snowmobile and heli-ski areas were higher than those measured from caribou in areas where motorized recreation was not allowed. Caribou sampled up to 4 km, 8 km and 10 km distant from snowmobile activity showed elevated fecal GCs when compared to those sampled further away from snowmobile activity areas. Other variables with a significant effect on fecal GCs included reproductive state, snow, aspect, minimum ambient temperature, and daily temperature range. My study indicates that measurement of fecal GCs provides a useful, non-invasive approach in the evaluation of physiological effects of environment, reproductive state, and human-induced stressors on free-ranging mountain caribou. Although research on many species indicates that chronically elevated GCs carry a variety of

physiological costs, more study is needed to know whether GCs can be used as an index of human impact on population health or trend.

8. ECOLOGY

Scale-Dependent Habitat Selection By Mountain Caribou, Columbia Mountains, British Columbia

Author(s): Clayton D. Apps, Bruce N. McLellan, Trevor A. Kinley, John Flaa

Date: 01/01/2001

Source: [Journal of Wildlife Management. 65:65-77.](#)

Number on Library Shelf: 1

Mountain caribou, an endangered ecotype of woodland caribou (*Rangifer tarandus caribou*) are associated with late-successional forests, and protecting their habitat conflicts with timber extraction. Our objectives were to describe seasonal, scale-dependent caribou-habitat relationships and to provide a means for their integration with forest planning. Between 1992 and 1999, 60 caribou were radio-located 3,775 times in the north Columbia Mountains of British Columbia. We analyzed caribou selection for multiple forest overstory and terrain attributes across 4 nested spatial scales, comparing successively smaller and closer paired landscapes (used and random). Seasonal habitat selection varied with scale for most attributes. During early winter, caribou preferred broad landscapes of low elevation, gentle terrain, high productivity, high canopy cover, and old and young forests of species indicative of a relatively mild, dry climate. Finer-scale preferences were for old western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) stands, high canopy closure, high productivity, and southern aspects. During late winter, caribou preferred broad landscapes of high elevation, northern aspects, and old Englemann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) stands. Overstory preferences were similar at fine scales, coupled with low canopy closure and productivity, high elevations, and gentle terrain. During spring, caribou preferred broad landscapes of young and old closed canopy cedar, hemlock, and spruce forests of high productivity and low elevations. Preferences were similar at finer scales but included gentle slopes. Summer preferences included closed canopy, old spruce and subalpine fir forests of high productivity across scales, north and east aspects at broad scales, and gentle terrain at fine scales. Of the variables considered, linear combinations of subsets could explain and predict seasonal habitat selection across scales ($P < 0.001$). Our results confirm the close association of mountain caribou with old-growth forests, and describe relationships that can be accounted for in spatially explicit habitat-timber supply forecast models.

Winter habitat ecology of mountain caribou in relation to forest management

Author(s): Bruce N. McLellan, Glen S. Watts, Eliot Terry

Date: 01-Jan-00

Source: J. Appl. Ecol. 37:589-602.

Number on Library Shelf: 2

During winter, mountain caribou *Rangifer tarandus caribou* live in late successional and old-growth coniferous forests, where they feed almost exclusively on arboreal lichens. Because some of these forests are also valuable to the forest industry, caribou ecology and forest management remains a central conservation issue in British Columbia. To improve our understanding of caribou habitat use in relation to forest management, we investigated the winter habitat selection patterns of mountain caribou at a range of spatial scales between 1988 and 1993 in the northern Cariboo Mountains, British Columbia.

Hierarchical habitat selection by woodland caribou: its relationship to limiting factors

Author(s): W. James Rettie, Francois Messier

Date: 29-Nov-99

Source: *Ecography* 23: 466-478.

Number on Library Shelf: 12

Habitat selection is a hierarchical process that may yield various patterns depending on the scales of investigation. We employed satellite radio-telemetry to examine patterns of habitat selection by female woodland caribou in central Saskatchewan at both coarse (seasonal ranges) and fine (daily area) scales. At each scale, we converted spatial data describing compositions of available and used habitat to standardised resource selection indices and examined them with multivariate analyses of variance. Seasonal ranges generally showed more preferential inclusion of peatlands and black spruce dominated stands relative to recently disturbed stands and early seral stage forests. In all populations, caribou preferred peatlands and black spruce forests to all other habitat types at the daily area scale. In general, these patterns may reveal the avoidance of wolves, the primary factor limiting caribou throughout the boreal forest. In three populations where seasonal ranges showed the selective inclusion of either young jack pine stands or clearcuts along with peatlands and black spruce forests, we found a relative avoidance of the clearcuts and young jack pine stands at the daily area scale. As all caribou populations in the area are thought to be relics of a once more continuous distribution, the seasonal range selection by animals in disturbed areas may better describe historic rather than current habitat selection. We found inter-annual variation in selection at the coarser spatial scale in one population, and inter-seasonal variation in selection at the finer spatial scale in three populations, indicating that the relative grains of the spatial and temporal scales coincide. We were better able to explain the seasonal variations in finer scale selection by considering available forage, a factor less likely than predation to limit woodland caribou populations. The data agree with the theory that the spatial and temporal hierarchy of habitat selection reflects the hierarchy of factors potentially limiting individual fitness.

Mountain Caribou Calf Production And Survival, And Calving And Summer Habitat Use In West-Central Alberta

Author(s): E. Janet Edmonds, Kirby G. Smith

Date: 01-Jan-91

Source:

Number on Library Shelf: 17

A study of mountain caribou (*Rangifer tarandus caribou*) was conducted from 1987 through 1989 to obtain information on calf survival, calving and summer habitat, timing of spring migration and distances moved to calving areas. In addition, the effect of winter severity and snowfall on calf survival based on data collected since 1981 was assessed. Observations of a sample of radio-collared adult female caribou provided detailed data on calf production, timing of movement to calving sites, calving habitat, fidelity to calving sites and timing of mortality of calves. In years when winters were severe or snowfall was high through April and May, radio-collared females did not move as far from their winter range to calve and calved at lower elevations, than years when winters were of average or above average severity and springs were relatively snow free. Correspondingly, low percentage calves in fall/early winter composition counts were associated with a previous severe winter or late spring. Calving habitat was variable, though located primarily above 1600 m, and calving sites were widely dispersed. Dispersal to higher elevation calving sites was considered to be an antipredator strategy that was disrupted when snow cover on the winter range extended late into the spring. Over nine years of monitoring, the mean percentage calves in fall/early winter composition counts was 14 and four years of low calf survival negated five years of average or above average calf survival.

Inland Rain Forest

Author(s): Michael Morris

Date: 01-May-99

Source: Mount Revelstoke and Glacier National Parks

Number on Library Shelf: 19

<http://www.cmiaae.org/Resources/old-growth-inland-info-sheet.php>

This information sheet published by Parks Canada defines and discusses the Inland Rain Forest.

Early-Winter Habitat Of Woodland Caribou, Selkirk Mountains, British Columbia

Author(s): Eric M. Rominger, John L. Oldemeyer, David J. Spalding

Date: 07-Jul-88

Source: J. Wildl. Manage. 53(1):238-242.

Number on Library Shelf: 25

<http://wdfw.wa.gov/archives/pdf/94026205.pdf>

We monitored early-winter habitat use by woodland caribou (*Rangifer tarandus caribou*) in the southern Selkirk Mountains, British Columbia, during November-December 1985-86. We compared biological and physical attributes of random locations within known early-winter caribou range to actual caribou use sites. Univariate and descriptive discriminant analysis indicated significant (P less than or equal to 0.05) separation of several habitat variables between random use sites and sites used by caribou. We observed caribou in old-growth stands with moderate slopes (less than 30 degrees); greater density of recently windthrown, lichen-bearing trees; higher elevations; and less canopy-cover and total tree basal area than measured at random plots. Because the Selkirk caribou use Englemann spruce (*Picea engelmanni*)-subalpine fir (*Abies lasiocarpa*) and western red cedar (*Thuja plicata*)-western hemlock (*Tsuga heterophylla*) communities, we recommend maintenance of old-growth timber in these habitat types.

Preliminary Habitat Suitability Assessment for Mountain Caribou in the Southern Purcell Mountains of B.C.

Author(s): Clayton Apps, Trevor Kinley

Date: 01-Aug-95

Source: Prepared for BC Environment, Cranbrook and East Kootenay Environmental Society, Kimberley

Number on Library Shelf: 27

This document includes: A validation assessment of a mountain caribou Habitat Suitability Index (HSI) model, based on observed habitat use by caribou in the southern Purcell Mountains; an analysis of the relationship between habitat use by caribou and habitat distribution over the surrounding landscape; and associated recommendations for managing mountain caribou habitat in the southern Purcell Mountains.

Habitat Use and Population Status of Woodland Caribou in the Quesnel Highlands, British Columbia

Author(s): Dale R. Seip

Date: 01-Apr-92

Source: Canadian Journal of Zoology. 70:1494-1503

Number on Library Shelf: 28

This document describes a project that was conducted to determine the seasonal habitat requirements and population status of woodland caribou in the Quesnel Highlands, British Columbia.

Comparison of GPS and VHF Collars for use in the Central Selkirks Caribou Project

Author(s): Trevor Kinley
Date: 15-Dec-98
Source:
Number on Library Shelf: 30

The purpose of this report is to briefly summarize the advantages and drawbacks of the two systems, particularly in relation to their potential use for the Central Selkirks caribou project.

A Habitat Suitability Index for the Mountain Caribou

Author(s): T.M. Gaines
Date: 01-Sep-98
Source:
Number on Library Shelf: 31

This document describes a project aimed at developing a habitat suitability index for the mountain caribou which could be applied within the SIMFOR modeling.

Early-winter diet of woodland caribou in relation to snow accumulation, Selkirk Mountains, British Columbia, Canada

Author(s): Eric M. Rominger, John L. Oldemeyer
Date: 15-Aug-89
Source:
Number on Library Shelf: 32

http://www.cmiae.org/_PDF/reference32.pdf

1.46 MB (scanned)

Woodland caribou (*Rangifer tarandus caribou*) in the southern Selkirk Mountains of British Columbia shift from a diet of primarily vascular taxa during snow-free months to an arboreal lichen – conifer diet during late winter. We present evidence that caribou diets, during the early-winter transition period, are influenced by snow accumulation rates. Caribou shift to an arboreal lichen – conifer diet earlier during winters of rapid snow accumulation and forage extensively on myrtle boxwood (*Pachistima myrsinites*),

an evergreen shrub, and other vascular plants during years of slower snow accumulation. The role of coniferous forage in early-winter food habits is examined. Forest management strategies can be developed to provide habitat that will enable caribou to forage in response to varying snow accumulation rates.

4th North American Caribou Workshop St. John's Newfoundland October 31-November 3, 1989 Proceedings

Author(s): Newfoundland and Labrador Wildlife Division

Date: 01-Feb-91

Source:

Number on Library Shelf: 33

Proceedings of a mountain caribou workshop.

Ecology of Woodland Caribou in Wells Gray Provincial Park-Wildlife Bulletin No. B-68

Author(s): Dale R. Seip

Date: 01-Mar-90

Source:

Number on Library Shelf: 34

http://www.savethegoat.ca/robson_caribou.htm

The purpose of this project was to gather information for the development of a management plan for caribou in Wells Gray Provincial Park, including information on seasonal movements and habitat use, population parameters and the status of caribou.

Characteristics of Early-Winter Caribou Feeding Sites in the Southern Purcell Mountains, British Columbia

Author(s): Trevor A. Kinley

Date: 22-Mar-03

Source:

Number on Library Shelf: 35

<http://srmwww.gov.bc.ca/kor/wld/reports/htmlfiles/Purcari001/Purcari001.html>

Mountain caribou are an ecotype of woodland caribou (*Rangifer tarandus caribou*) inhabiting the high-snowfall region of southeastern British Columbia and northern Idaho. Their rarity and reliance on old forests of potentially high timber value necessitates careful management based on knowledge of habitat requirements. Habitat selection

has been modeled at broader spatial scales for the southern Purcell Mountains subpopulation, but patterns of forage site selection were not known. We therefore snow-trailed caribou in the southern Purcells to determine foraging patterns during the potentially limiting early-winter period. When snow was less than or equal to 51 cm deep, caribou fed on grouseberry (*Vaccinium scoparium*) and the terrestrial lichen *Cladonia* in addition to the arboreal hair lichen *Bryoria*. When snow was greater or equal to 62 cm deep, they used exclusively arboreal lichen. In both periods, caribou ate arboreal lichen from essentially every downed tree or branch encountered and fed with a higher intensity at downed trees than standing trees. During the low-snow period, caribou fed at fewer trees but used those with greater lichen abundance and fed more intensively at each, relative to the deep-snow period. In comparison to trees on the foraging path where caribou did not feed, those at which arboreal lichen was foraged intensively were of larger diameter, had greater lichen abundance, and were more likely to be subalpine fir (*Abies lasiocarpa*), or Engelmann spruce (*Picea engelmannii*) and less likely to be whitebark pine (*Pinus albicaulis*), lodgepole pine (*P. contorta*) or alpine larch (*Larix lyalli*). The shift in habitat use between the low-snow and deep-snow periods was consistent with a shift recognized for mountain caribou between the early-winter and late-winter seasons, but occurred at a much earlier date than previously reported. This may have been due to the very rapid snow accumulation during the study period.

Caribou Site Level Habitat Selection and Home Range Patterns in the North Thompson Watershed of British Columbia

Author(s): Garth Mowat, Trevor Kinley, Susan Pendray

Date: 26-Mar-98

Source:

Number on Library Shelf: 36

Seventeen caribou were equipped with VHF radiocollars and eight caribou were equipped with GPS collars in 1996 or early 1997. VHF collars were monitored approximately monthly and GPS collars were set to take fixes at either two or three hour intervals. Between 3 and 18 locations were captured for individuals with VHF collars, and GPS collars generated between 250 and 800 locations per caribou. These data were compared to digital forest cover, elevation, and biogeoclimatic data. We also snow-tracked caribou in early winter 1997 and measured feeding site and forest attributes at selected forage sites and random locations on caribou trails. We found that caribou spent most of their time in the alpine tundra during the calving and summer period; caribou used the ESSF zone to a lesser extent during this time. Caribou made trips to the ICH through the early winter, though they spent a majority of their time in the ESSF zone during that season. Caribou spent virtually all their time in the ESSF zone during late winter and spring, although in late winter of 1997, which was a heavy snowfall year, caribou used lower elevations within the ESSF. Few movement routes across major low-elevation valleys were located, but there does not appear to be a significant route across the upper Blue River valley between summer and early winter.

During early winter caribou foraged in mature stands of all aspects in slopes less than 80%. They browsed lichen from standing and downed trees in the ESSF, while in the ICH they ate lichen on downed trees and browsed on shrubs and herbs. Caribou also foraged along forest edges, where they primarily fed on lichen on fallen branches and trees. Generally caribou selected lichen forage sites that had more lichen available than random sites. They did not select one size or species over another though foraging stands consisted largely of mature trees (mean age = 112 years, mean tree dbh = 26 cm).

Critical Habitats of Caribou in the Mountains of Southern British Columbia

Author(s): Keith Simpson, Keith Herbert, Guy Woods

Date: 31-Feb-87

Source:

Number on Library Shelf: 37

<http://wdfw.wa.gov/archives/pdf/94026205.pdf>

Using radio location data, we identified habitats used by mountain caribou during each season. We also collected data to assess the relative hardship experience by caribou in the early- and late-winter periods. Information on seasonal changes in caribou mobility and food availability was necessary in determining critical habitats. We have proposed an expansion of the currently accepted designations of critical habitat for mountain caribou and discuss the aspect important to management.

Managing forests for caribou in southern British Columbia

Author(s): Susan K. Stevenson

Date: 01-Oct-94

Source:

Number on Library Shelf: 38

http://www.cmiaa.org/_PDF/reference38.pdf

966 KB (scanned)

This article describes the management approach that is being developed in B.C., regarding woodland caribou, and discusses its applicability to other areas

Habitat Use By Woodland Caribou In The Selkirk Mountains

Author(s): Gregg Servheen, L. Jack Lyon

Date: 01-Jan-89

Source: J. Wildl. Manage. 53(l):230-237

Number on Library Shelf: 40

http://www.cmiaa.org/_PDF/reference40.pdf

9.5 MB (scanned)

A small herd of woodland caribou (*Rangifer tarandus caribou*) in the southern Selkirk Mountains of British Columbia and Idaho are the only caribou in the United States outside of Alaska. We initiated studies to determine caribou habitat use in 6 time periods (seasons) and to develop standards for the protection of habitat essential for recovery of this endangered herd. We described habitats for each season by measurements of basal area, tree density, canopy cover, understory cover, lichen abundance, slope, aspect, elevation, and timber stand type. These parameters and the habitat components they described were then related to environmental variables, caribou behavior patterns and physiological requirements of caribou in each season. Snow cover and firmness, isolation of females during calving, and summer and winter forage requirements are discussed as they relate to use of habitat components. Recommendations for habitat management identify those components essential for recovery of caribou in the Selkirk Mountains.

Foods Of Caribou In Wells Gray Park, British Columbia

Author(s): R. Yorke Edwards, Ralph W. Ritcey

Date: 01-Jan-60

Source: Can. Field-Nat. 74:3-7

Number on Library Shelf: 42

This document reports on a study that was conducted to determine those species of plants selected by caribou from the profusion of species available to them.

Mountain Caribou

Author(s): Doug Leighton

Date: 01-Mar-92

Source: BC Outdoors magazine

Number on Library Shelf: 43

This item is an article on mountain caribou from the BC Outdoors magazine.

Interim Scale-Dependent Habitat Modeling for Mountain Caribou in the Thompson River Watershed, British Columbia

Author(s): Clayton Apps, Trevor Kinley

Date: 01-Jul-99

Source:

Number on Library Shelf: 45

This document outlines management recommendations that are apparent as a result of the univariate results of the habitat modeling in the Thompson River Watershed.

Habitat Suitability for Mountain Caribou in the Southern Purcell Mountains of BC- A Preliminary Adjustment of the Idaho Panhandle HIS Model

Author(s): Clayton Apps, Trevor Kinley

Date: 01-Mar-95

Source:

Number on Library Shelf: 46

This document describes an analysis of habitat selection by southern Purcell mountain caribou over a period of approximately 3 years. Research is ongoing, and because the data is pool is still somewhat limited, this analysis should be considered preliminary. For this assessment, we have taken an approach which is felt will best integrate results to date into landscape level habitat planning with caribou as a management objective.

Habitats Used by Mountain Caribou in the North Columbia Mountains, 1993-94; Year 2 Preliminary Report #2

Author(s): Bruce McLellan, John Flaa, Mike Super

Date: 01-Jan-94

Source:

Number on Library Shelf: 61

Woodland caribou (*Rangifer tarandus caribou*) in southeastern British Columbia feed on arboreal lichen during winter. Because arboreal lichen is most abundant on old trees, these caribou have been identified as old-growth dependent (B.C. Ministry of Environment 1989). Clear-cut harvesting of mature forests is perceived to be incompatible with maintaining winter habitat for caribou. Knowing the relative value of various habitats to the caribou population both within and among seasons and understanding why these habitats are important is critical when integrating caribou requirements in an area managed primarily for timber production. An early step towards gaining this knowledge is to determine which habitats caribou prefer to use during each season.

Caribou Site Level Habitat Selection in the North Thompson Watershed of British Columbia Year 2, 1998-99

Author(s): Garth Mowat, David Stanley

Date: 08-Mar-99

Source:

Number on Library Shelf: 62

We studied mountain caribou habitat selection in the North Thompson valley of British Columbia. We were interested to measure site level forage choice during mid-winter in order to help with select cut prescriptions on logging blocks in caribou winter range. We followed caribou tracks in the snow order to measure site level forage choice. We measured the size, age, species, vigor, and lichen abundance and species composition on standing and downed forage trees, and an equal number of random trees in the forage stands. All recent downed trees and branches appear to be foraged when first discovered. Downed trees tended to be older and more decadent than standing trees, but not larger. Caribou exploited windfall along habitat edges such as roadways and the borders of swamps and logged blocks, though one edge habitat type was always unlogged mature forest. Caribou foraged on trees > 10m tall which had high lichen loads. These trees were 10% larger (at dbh above snow) and 29% older than random trees. Very few trees < 10m tall were selected though they were common in the forage stands we studied (40% of all trees > 2m). Select or partial cutting in mature ESSF stands will only retain caribou lichen foraging opportunities if mature trees > 10m tall are preserved. It is difficult to define the number of these large trees required to maintain reasonable foraging efficiency for caribou, canopy closure must not be substantially reduced or travel costs due to higher snow depths may discourage use. We found caribou made low elevation crossings of the Blue River and upper Mad River in January very close to crossings observed in previous years. We suggest these areas be protected as travel corridors.

Habitat Use And Seasonal Movements By Woodland Caribou In East Central British Columbia

Author(s): Eliot Terry

Date: 01-May-93

Source:

Number on Library Shelf: 63

In 1988 the Ministry of Environment, Lands and Parks initiated the Mountain Caribou and Managed Forests Program in response to forestry conflicts related to high elevation timber harvesting in mountain caribou winter range. This report provides information from the radio-telemetry component of the program (1988-1991) designed to determine seasonal movements and habitat use patterns of mountain caribou east of Prince George, BC.

Mountain Caribou Backtracking Final Report

Author(s): David Pehl, Sean Bennett

Date: 01-Mar-00

Source:

Number on Library Shelf: 64

Provincial declines in abundance and distribution of Mountain Caribou (*Rangifer tarandus caribou*) have prompted studies directed toward specific habitat requirements for this subspecies. Determining site level habitat selection is necessary to ensure proper management of habitat requirements for mountain caribou at the landscape level. In the third year of this site level forage selection project, data was collected in late-winter from January 25th through February 18th. Habitat surveyed included all biogeoclimatic subzones from the Interior Cedar-Hemlock (ICH) subzone upward in elevation to the lower elevation of the Alpine Tundra (AT). Identification of forage sites and plot data was determined by using the same methodology from previous years. Trees that had obvious forage indications were measured and recorded and then, if possible, a paired site with similar characteristics and within the same stand containing no recent forage activity was measured for the same variables. Caribou foraged on a variety of trees that ranged in height from approximately 6-30m and that were predominately from the A2 strata canopy layer. Although large mature trees were common to most forage stands smaller regressed A3 or B1 layer trees were often the selected forage sites. Forage trees often had both common arboreal lichen species (*Alectoria* spp and *Bryoria* spp) with *Bryoria* commonly being the dominant species. Caribou forage sites occurred in a wide variety of habitat types including habitat edges along roads, natural openings or alpine, clearcut or selectively harvested areas, and undisturbed mature forests.

Developing a Habitat Suitability Model for Mountain Caribou in the North Columbia Mountains, Preliminary Report #4

Author(s): Bruce McLellan, John Flaa, Mike Super

Date: 25-Mar-03

Source: Ministry of Forests, Revelstoke, BC 23 pp

Number on Library Shelf: 66

For over 2 years representatives of various interest groups negotiated land-use plans over a large proportion of British Columbia in a process that is generally referred to as the Commission on Resources and Environment or CORE. Complete consensus among sector representatives was not attained in all areas, but based on CORE negotiations the government of B.C. produced the West Kootenay-Boundary Land-Use Plan in March, 1995. This plan highlights the challenge in the Revelstoke Forest District of "ensuring the long-term viability of the internationally important woodland caribou

(*Rangifer tarandus caribou*) population while maintaining a viable forest industry". The government accepted the plan submitted by the citizens of Revelstoke that identified 14 of 31 polygons in the Forest District as having both high timber and caribou values and thus require enhanced management.

Population Characteristics Of Lake Revelstoke Caribou

Author(s): John P. Flaa, Bruce McLellan

Date: 25-Mar-03

Source: Pp. 639-642 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp

Number on Library Shelf: 67

<http://wlapwww.gov.bc.ca/wld/documents/mc03flaa.pdf>

The Lake Revelstoke caribou are the southernmost contiguous mountain caribou population in British Columbia. Population characteristics of the herd were examined during 1981–85, with 13 radio-collared caribou, and 1992–98, with 47 radio-collared caribou. During several late-winter censuses, sightability of marked animals was 92% and the proportion seen was a function of the height of snow. Our best estimate of the population size was 375 animals (95% CI 337–413). Cause of death of 31 radio-collared animals included accidents (42%), predation (29%), and poor condition (10%). Deaths due to avalanches (accidents) were the single leading cause at 23%. Survival of radio-collared caribou averaged 84% since 1992. Progesterone levels in 29 female caribou indicated that 83% were pregnant. There was an average of 28 calves/100 adults during 1981–84, and 18 calves/100 adults during 1994–97. Survival rates of adult caribou and the ratio of calves per 100 adults indicate that the population was stable.

Global Positioning System (GPS) and the Mountain Caribou Critical Habitat Project

Author(s): Alan Norquay

Date: 27-Aug-98

Source:

Number on Library Shelf: 77

This brief document looks at how GPS technology could be applied to the Mountain Caribou Habitat Project.

Foraging and movement paths of female reindeer: insights from fractal analysis, correlated random walks, and Levy flights.

Author(s): Anders Marell, John P. Ball, Annika Hofgaard

Date: 01-Jan-02

Source: Can. J. Zool./Rev. Can. Zool. 80(5): 854-865 (2002)

Number on Library Shelf: 78

http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_abst_e?cjz_z02-061_80_ns_nf_cjz5-02

Food-plant and foraging-site selection by semi-domesticated female reindeer (*Rangifer tarandus tarandus* L.) was studied to shed light on the searching and foraging behavior of this herbivore. The aims of the study were (i) to determine the role of food biomass and (or) plant nitrogen content in feeding-site selection and (ii) to analyse the extent to which movement patterns of reindeer are related to availability of food resources using several models of searching behavior (fractal analysis, correlated random walks, and Levy flights). The study was conducted in summer 1999 in a mountainous area of northern Sweden. Reindeer selected different plant communities during the period and changed search patterns in the late summer. We found that reindeer selected feeding sites with higher green biomass of *Betula* spp. and *Salix* spp. However, there was no sharp threshold for foraging as suggested by some models. Contrary to qualitative predictions of optimal-foraging theory, we found no selection of feeding sites on the basis of nitrogen content of food. The changed search pattern in late summer and the discrepancy between reindeer foraging paths and a correlated random walk model suggests that reindeer were responding to their environment by changing their searching behaviour.

Mountain Caribou Habitat Use, Movements, And Factors Associated With GPS Location Bias In The Robson Valley, British Columbia

Author(s): Clayton Apps, Trevor Kinley

Date: 07-Apr-00

Source: Prepared for Columbia Basin Fish and Wildlife Compensation Program

Number on Library Shelf: 84

www.cbfishwildlife.org/reports/pdfs/caribou00.pdf

This document analyzes data collected from GPS collars deployed on 6 mountain caribou near the Robson Valley, British Columbia, during 1996 and 1997.

Caribou in British Columbia

Author(s): Kenneth N. Child

Date: 26-Mar-03

Source:

Number on Library Shelf: 86

An information sheet on mountain caribou in British Columbia.

Central Selkirk Caribou Project-Annual Report

Author(s): Dennis Hamilton, Brenda Herbison

Date: 01-Sep-97

Source: Prepared for Forest Renewal BC

Number on Library Shelf: 87

<http://www.for.gov.bc.ca/hfd/library/frbc1999/FRBC1999MR164.pdf>

A report outlining the results of third year of a four year project.

Mountain Caribou Take To The Trees

Author(s): Janice Wormworth

Date: 01-Dec-98

Source: Beautiful British Columbia 40:4 (1998): 30-35.

Number on Library Shelf: 88

An article on mountain caribou from the Beautiful British Columbia Magazine: Winter 1998

Identifying Mountain Caribou Sign In The Field

Author(s): Jasper Carlton

Date: unknown

Source:

Number on Library Shelf: 89

This document provides a detailed description of mountain caribou sign.

Late Winter Foraging Ecology Of Woodland Caribou

Author(s): Eric Moore Rominger

Date: 01-May-95

Source: Rominger, E.M. 1995. Late Winter Foraging Ecology of Woodland Caribou. Ph.D. Dissertation, Washington State University, Pullman. 68 pp.

Number on Library Shelf: 96

To better understand late winter foraging ecology of woodland caribou (*Rangifer tarandus caribou*) in the arboreal lichen feeding niche, bottle-raised caribou were used in laboratory and field trials. Variables with the greatest influence on intake rate differed between laboratory and field trials. Bite size was the most important variable in laboratory trials; bite rate was the most important in field trials. During late winter field trials, caribou foraged on lichen primarily on standing subalpine fir (*Abies lasiocarpa*) and dead trees. Bite size, bite rate, bite intake, tree resident time, and amount of lichen eaten/tree were included in a general linear model with tree species, tree size class, and tree lichen class as the independent variables. All variables, except bite size, increased significantly with an increase in tree lichen class. Compared to theoretical maximums, intake rate was low on all lichen class trees (range 1.4-2.1g/min). Caribou would have to forage 14-21 hours to meet predicted daily requirements. Tree resident time and time between trees varied inversely with tree density. In cafeteria style preference trials using the 2 primarily arboreal lichen genera, caribou strongly preferred *Bryoria* spp. (92%) compared to *Alectoria sarmentosa* (8%). Apparent dry matter digestibility of this diet was 82%. Data from late winter field trials were used to test recent functional response models relative to optimality and mechanisms. Observed patch resident time, amount of lichen eaten/patch, lichen intake rate, and bite rate of caribou were significantly lower than model predictions. I conclude that short temporal frame foraging trials with fasted ungulates do not accurately reflect foraging ecology under field conditions, and that caribou do not forage "optimally" as defined by current models, and that multiple tests of models will be required to integrate foraging theory and management.

Mountain Caribou And Their Forage In The Selkirk Mountains Of British Columbia

Author(s): Dr. John Harling, Dr. Joan Snyder

Date: 06-Jun-75

Source:

Number on Library Shelf: 103

A report presented to the International Caribou Steering Committee, June 6, 1975.
Spokane, Washington.

Ecosystem management and the conservation of caribou habitat in British Columbia

Author(s): Dale R. Seip

Date: 01-Jan-98

Source: *Rangifer*. Special Issue #10

Number on Library Shelf: 104

Woodland caribou (*Rangifer tarandus caribou*) in British Columbia inhabit a wide variety of forest ecosystems. Numerous research projects have provided information that has

been used to develop caribou habitat management recommendations for different areas. Recently, the province has implemented guidelines to protect biodiversity that are based on an ecosystem management strategy of mimicking natural forest conditions. There is a great deal of similarity between caribou management recommendations and biodiversity recommendations within different forest types. In mountain caribou habitat, both approaches recommend maintaining a landscape dominated by old and mature forests, uneven-aged management, small cutblocks, and maintaining mature forest connectivity. In northern caribou habitat, both approaches recommend maintaining some older stands on the landscape (but less than for mountain caribou), even-aged management, and a mosaic of large harvest units and leave areas. The ecosystem management recommendations provide a useful foundation for caribou habitat conservation. More detailed information on caribou and other management objectives can then be used to fine-tune those recommendations.

The Ecology And Status Of Mountain Caribou And Caribou Range In Central British Columbia

Author(s): Michael Irwin Bloomfield

Date: 01-Mar-79

Source: MSc thesis 318 pp.

Number on Library Shelf: 109

A thesis submitted to the faculty of graduate studies and research in partial fulfillment of the requirements for the degree of Master of Science in wildlife productivity and management.

Movements And Habitat Of Caribou In The Mountains Of Southern British Columbia

Author(s): Keith Simpson, Guy Woods

Date: 01-May-87

Source:

Number on Library Shelf: 110

This document summarizes the results of a BC Hydro Compensation fund project. As a result of the reservoir flooding the funds were provided for the project for research on mountain caribou in the area north of Revelstoke, B.C.

Mountain Caribou (brochure)

Author(s): Trevor Kinley

Date: 1999

Source: B.C. Minist. Environ., Lands and Parks, Wildl. Branch. 6pp.

Number on Library Shelf: 118

<http://wlapwww.gov.bc.ca/wld/documents/caribou.pdf>

Mechanisms underlying the decline of mountain caribou (*Rangifer tarandus*) in British Columbia

Author(s): Heiko Uwe Wittmer

Date: March 2004

Source: PhD Thesis, University of British Columbia

Number on Library Shelf: 132

http://www.cmiae.org/_PDF/reference132.pdf

The distribution and abundance of mountain caribou (*Rangifer tarandus caribou*) in British Columbia has declined. High predation rates as a consequence of forest management and associated changes to the relative abundances of alternate ungulate prey species have been proposed to cause the population declines. A direct link between changes in the forest age structure and declining caribou population trends, however, is lacking. Understanding the underlying mechanism of the population decline is necessary to develop recovery strategies aimed at maintaining a viable mountain caribou population. I synthesized demographic and radio-telemetry data from separate studies initiated over the entire distribution of mountain caribou between 1984 and 2002. My primary goal was to use a comparative approach among identified subpopulations to distinguish between three potential repercussions of forest management (food regulation, predation-sensitive foraging, and predation) that might explain the observed declining population trends. I used information on caribou density per area of forests >140 years within subpopulation ranges and cause of mortality to differentiate between the potential repercussions. Predation was the primary cause of caribou mortality over the entire distribution of mountain caribou. In addition, I found increasingly negative rates of increase as caribou density per area of forests >140 years declined (i.e. inverse density dependence). Both results were consistent with the hypothesis that the decline of mountain caribou is caused by high predation rates. I then quantified the influence of demographic parameters on sub=population trends and identified environmental factors correlated with variation in these demographic parameters among subpopulations. My results indicated that differences in subpopulation trends were best explained by differences in female adult survival rates. Female adult survival rates were negatively associated with increasing amounts of young forest stands and thus high proportions of suitable habitat for alternate prey species. Thus, my data supports the mechanistic link between the amount of habitat characteristics suitable for alternate ungulates and decreased survival of adult female

caribou. Finally, I carried out a population viability analysis for mountain caribou. My results indicate that mountain caribou are likely declining to extinction over the majority of their distribution within <100 years.

Multivariate Habitat Modeling for Mountain Caribou in the Columbia Mountains, British Columbia

Author(s): Clayton Apps

Date: February 1999

Source: P 653 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 1; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC.

Number on Library Shelf: 162

<http://wlapwww.gov.bc.ca/wld/documents/mc06apps2.qxd.pdf>

Central Selkirk Mountain Caribou Habitat Model

Author(s): Dennis Hamilton, Steven Wilson

Date: March 31, 2003

Source: Prepared for Slocan Forest Products, Meadow Creek Cedar Company, BC Timber Sales Branch of MoF, BC Ministry of Water, Land and Air Protection.

Number on Library Shelf: 165

http://www.cmiae.org/_PDF/reference165.pdf

Mountain caribou are a species at risk in British Columbia and the Central Selkirk herd experienced a significant population decline during 1996-2002. We conducted Resource Inventory Standards Committee (RISC)-approved ground sampling and capability-suitability modelling to map caribou habitat throughout the range of the Central Selkirk mountain caribou herd.

We collected data at 91 plots within the Central Selkirk Mountains study area, outside of TFL 23. Many of these plots were in the ICHwk1 biogeoclimatic subzone variant where few plots had previously been sampled to RISC standards. In addition, many of the plots were within the area of the Kootenay Lake predictive ecosystem map (PEM), where no RISC-standard plot work had previously been conducted.

We developed 4 seasonal suitability and capability models and accompanying maps that illustrated the value of ecosystem units for caribou. We also tested the goodness-of-fit of the models with respect to telemetry point data collected during inventory projects in the Central Selkirk Mountains. We found that habitats rated high were used more than expected, based on their availability within the study area, for each of the 4

seasons. Similarly, habitats rated low were used less than expected and moderate habitats were used in proportion to their availability.

We also developed a zonation strategy based on the results of this and previous projects. The zonation attempted to maximize the benefit to caribou habitat of mature and old forest guidelines in the Kootenay Boundary Higher Level Plan by spatially stratifying the range of the Central Selkirk mountain caribou herd into areas within which different forest practices are recommended. The zonation strategy requires a timber supply, economic impact and trade-off analysis before it is adopted.

Mountain Caribou – On The Edge

Author(s): Mount Revelstoke and Glacier National Parks, Knowledge Network

Date: 2002

Source: Mount Revelstoke and Glacier National Parks

Number on Library Shelf: 168

<http://www.cmiae.org/Resources/mountain-caribou-film.php>

This 90-second film from Parks Canada highlights issues related to dwindling populations of southern BC's Mountain Caribou.

Density, ages, and growth rates in old-growth and young-growth forests in coastal Oregon

Author(s): John C. Tappeiner, David Huffman, David Marshall, Thomas A. Spies, John D. Bailey

Date: 31-Jan-97

Source: Canadian Journal of Forest Research 27:638- 648.

Number on Library Shelf: 6

http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfr&volume=27&calyLang=eng&articleFile=x97-015.pdf

We studied the ages and diameter growth rates of trees in former Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) old-growth stands on 10 sites and compared them with young-growth stands (50-70 years old, regenerated after timber harvest) in the Coast Range of western Oregon. The diameters and diameter growth rates for the first 100 years of trees in the old-growth stands were significantly greater than those in the young-growth stands. Growth rates in the old stands were comparable with those from long-term studies of young stands in which density is about 100-120 trees/ha; often young-growth stand density is well over 500 trees/ha. Ages of large trees in the old stands ranged from 100 to 420 years; ages in young stands varied only by about 4-

10 years. Apparently, regeneration of old-growth stands on these sites occurred over a prolonged period, and trees grew at low density with little self-thinning; in contrast, after timber harvest, young stands may develop with high density of trees with similar ages and considerable self-thinning. The results suggest that thinning may be needed in dense young stands where the management objective is to speed the development of old-growth characteristics.

Dynamics of an old-growth, fire-initiated subalpine forest in southern interior British Columbia: tree size, age and spatial structure

Author(s): Joseph A. Antos, Roberta Parish

Date: 31-Jan-02

Source: Canadian Journal of Forest Research November 2002, vol. 32, no. 11, pp. 1935-1946(12)

Number on Library Shelf: 7

http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfr&volume=32&calyLang=eng&articleFile=x02-132.pdf

We used dendrochronological analysis of over 2000 trees in four 50 x 50 m plots to reconstruct the history and dynamics of a 330-year-old, fire-initiated spruce-fir forest. All lodgepole pine (*Pinus contorta* Dougl. ex Loud.), half of the canopy Englemann spruce (*Picea engelmannii* Parry ex Englem.), but less than 10% of the canopy subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) dated from the first 50 years of stand development. Tree-ring patterns of individual surviving trees showed no evidence of disturbance during the first 200 years after stand initiation; subsequently, episodes of disturbance are indicated by periods of release in understory fir. Although many fir owe their canopy position to release after disturbance, few canopy fir in the current stand established in response to either the stand-initiating event or subsequent partial disturbances. A seedling bank of long-lived fir appears critical to the dynamics of this forest. In contrast, establishment of almost all canopy spruce can be related to disturbance. This stand, although fire initiated, was structured primarily by a combination of partial disturbances and autogenic processes. We suspect that most old, fire-initiated stands in many forest regions are similarly structured and emphasize that the contribution of partial disturbances and autogenic processes should be fully assessed when examining their dynamics or managing such forests.

Ecological Characteristics of Inland Rainforests

Author(s): Andre Arsenault, Trevor Goward

Date: 01-Feb-99

Source:

Number on Library Shelf: 8

<http://wetbelt.unbc.ca/docs/inland-rainforests.pdf>

Within the northern hemisphere a major proportion of the world's rain forests at temperate latitudes occur along the west coast of North America. Fronting the Pacific Ocean, and centered in British Columbia at 43 degrees N to 61 degrees N (see also Alaback 1991), these coastal rain forests are characterized by a highly oceanic climate, with heavy precipitation, high overall humidity, moderate temperatures, and relatively infrequent thunderstorm activity (Agee 1993). Related to the above, they are also characterized by a low incidence of wildfire (Agee 1993, Arsenault 1995), a preponderance of old-growth forests, a biomass virtually unequalled in other terrestrial ecosystems (Waring and Franklin 1979), and a rich epiphytic nonvascular flora. Outside of British Columbia, the coastal rain forests narrow southward into Oregon, and northward into southeast Alaska.

Winter distribution of woodland caribou in relation to clear-cut logging in west-central Alberta

Author(s): Kirby G. Smith, E.J. Ficht, D. Hobson and T.C. Sorenson, David Hervieux

Date: 01-Jan-00

Source: Can. J. Zool. 78: 1433–1440 (2000)

Number on Library Shelf: 10

http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjz&volume=78&calyLang=eng&articleFile=z00-094.pdf

The responses of a herd of migratory woodland caribou (*Rangifer tarandus caribou*) to timber harvesting that fragmented about 11% of their winter range in west-central Alberta were examined in this study. From 1981 to 1996, 45 caribou were radio-collared and monitored during the initiation and completion of first-pass timber harvest (50% removal). Variables examined were home-range size, daily movement rates and distance to the nearest cutblock for radio-collared individuals. Daily movement rates and individual winter range sizes decreased as timber harvesting progressed. Caribou avoided using frequently fragmented areas by an average of 1.2 km. If fragmentation of the winter range continues through timber harvesting and other industrial activities, the "spacing out" antipredator strategy used by caribou may be compromised. Based on these findings, timber-harvesting strategies are recommended that (i) ensure an

adequate area of useable habitat to support the current population, (ii) minimize the amount of fragmented area, and (iii) in the short term avoid presently defined core use areas.

Population dynamics of the endangered mountain ecotype of woodland caribou (*Rangifer tarandus caribou*) in British Columbia, Canada

Authors: Heiko Wittmer, Bruce McLellan, Dale Seip, James Young, Trevor Kinley, Glen Watts, Dennis Hamilton

Date: 2005

Source: Canadian Journal of Zoology **83**: 407-418

Number on library shelf: 174

http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjz&volume=83&calyLang=eng&articleFile=z05-034.pdf

Abstract: We used census results and radiotelemetry locations of >380 collared individuals sampled over the entire distribution of the endangered mountain ecotype of woodland caribou (*Rangifer tarandus caribou* (Gmelin, 1788)) in British Columbia, Canada, to delineate population structure and document the size and trend of the identified populations. We also describe the spatial pattern of decline and the causes and timing of adult mortality and provide estimates of vital rates necessary to develop a population viability analysis. Our results indicate that the abundance of mountain caribou in British Columbia is declining. We found adult female annual survival rates below annual survival rates commonly reported for large ungulates. The major proximate cause of population decline appears to be predation on adult caribou. Spatial patterns of population dynamics revealed a continuous range contraction and an increasing fragmentation of mountain caribou into smaller, isolated subpopulations. The population fragmentation process predominantly occurs at the outer boundaries of the current distribution. Our results indicate that recovery strategies for mountain caribou should be directed at factors contributing to the fragmentation and isolation of mountain caribou populations as well as management strategies aimed at increasing adult survival.

Ecological interactions among caribou, moose, and wolves: Literature review

Authors: Thomas Chowns, Cormack Gates

Date: December 2004

Source: National Council for Air and Stream Improvement, Inc. (NCASI). 2004.

Technical Bulletin No. 0893. Research Triangle Park, NC:

Number on Library Shelf: 175

<http://www.ncasi.org/Publications/Detail.aspx?id=2697>

Woodland caribou populations are declining in many areas of Canada and there is concern that the decline may be associated with timber harvesting. Caribou, moose, and wolves share a long evolutionary history and their relationships may become altered by large-scale landscape disturbance. This technical bulletin presents a review of scientific literature pertaining to the hypothesis that increases in moose and wolf populations after timber harvesting have adverse effects on caribou. Specifically, large-scale habitat changes that have allowed moose populations to increase and thereby sustain higher wolf numbers presumably have resulted in excessive predation on caribou, apparently resulting in caribou population declines.

Differentiation of caribou by ecotype rather than phenotype has advantages for conservation purposes. The “forest-dwelling” ecotype of woodland caribou often move across extensive areas at low densities, and populations have been difficult to define and monitor. Woodland caribou and moose often partition habitats on the landscape, such that caribou tend to graze mostly lichens and occupy nutrient-poor forest types, while moose browse vascular plant species such as willows, which are associated with more productive environments. The relatively high reproductive potential of moose enables their populations to respond rapidly to a superabundance of forage produced after forest fires or logging. Carrying capacities for caribou increase more slowly and are likely to decline suddenly after such disturbances.

Some caribou populations experience the effects of multiple predators such as grizzly bears, black bears, cougars, coyotes, wolverines, lynx, eagles, and humans. The predation rate is determined by the predator’s functional and numerical responses to changes in prey density. Some of the most viable caribou populations are those that employ anti-predator strategies which reduce encounter rates with wolves at calving time. These include migrating away from wolf denning habitat, seeking refuge on islands, bogs, and shorelines, and parturient females dispersing away from caribou concentrations.

Food selection by wolves is influenced by profitability relative to energetic costs of travel, especially in snow, and dangers in attacking large prey. If primary prey become less abundant, it may be more profitable for wolves to switch to another prey species. Critical thresholds in predator and prey densities affect population dynamics. In some areas, woodland caribou populations are too low to sustain wolves without alternate prey such as moose. Caribou appear in decline or may be eliminated in areas where wolves exceed critical densities. On the other hand, caribou populations have been known to change by several orders of magnitude, especially where herds are migratory and alternate prey for wolves are low in numbers or lacking. Several factors such as age, nutritional state, season, disease, parasites, and genetic load are capable of affecting caribou vulnerability to predation. The very young and the very old are usually the most heavily preyed upon.

Recent changes in ungulate and carnivore distributions may be influenced by climate change and human activities. Measures implemented to conserve woodland caribou

populations include hunting restrictions, reintroductions, predator control, parks and protected areas, and national and provincial recovery strategies.

Caribou habitat and commercial forest overlap in some regions and the effects of forestry on caribou vary according to the ecological setting. Roads and seismic-exploration trails may allow greater penetration of wolves into areas occupied by caribou, and vehicular traffic may displace caribou into closer proximity to moose and wolves. The design of forest harvest pattern may significantly affect predator-prey relationships. A mosaic of small cutovers across extensive areas or cutting upland sites in close proximity to fen/bog habitat may be undesirable for caribou management. Silvicultural activities that are compatible with lichen retention and discourage moose browse production are expected to be the most beneficial for caribou. Although fire control may conserve caribou habitat in the short term, fire is an integral part of the boreal forest and this animal is adapted to a fire environment. Further research and management needs have been recommended.

Quantifying forest stand and landscape attributes that influence mountain caribou habitat fragmentation

Authors: Robert Serrouya, Doug Lewis, Bruce McLellan, Gary Pavan, and Clayton Apps
Date: May 2006

Source: Columbia Mountains Institute of Applied Ecology; funded by World Wildlife Fund and the Endangered Species Recovery Fund (project # ESR7114)
Number on Library Shelf: 179

http://www.cmiae.org/_PDF/reference179.pdf

Mountain caribou telemetry studies have shown either high use or preference of old forests. However, the relatively coarse scale of VHF telemetry precluded the investigation of fine-scale factors that may influence the paths selected by mountain caribou for movement and foraging. In this study, we followed caribou paths in snow in areas where forest harvesting occurs to examine how caribou interact within a matrix of young, mid-seral, and old forests. Specifically, we asked: 1) How are caribou paths influenced by the matrix of old and young stands; 2) How do caribou make use of forest-cutblock edges?; 3) Do caribou select partial cuts of the type used in Englemann spruce-subalpine fir (ESSF) plateau forests? These questions were addressed by comparing used and available habitats at 2 spatial scales – buffers of 100 and 1000 m from the caribou path.

Relative to what was available, caribou selected areas closer to the forest-clearcut edge, regardless of whether the trail was in old forests or in clearcuts. Caribou were likely responding to windthrow and lichen litterfall, which is more common at edges. The attraction to edges was not apparent if there was residual structure in the cutblocks (i.e. partial cuts). Caribou avoided clearcuts, selected old forests at 1 scale, and tended to use partial cuts more than available at the larger scale, although this difference was not significant indicating an inconsistent level of use. Caribou strongly selected roads, likely

for ease of movement. Although the magnitude of this effect was large in both ESSF and Interior Cedar-Hemlock (ICH) forests, the difference was only significant in ESSF forests.

Multivariate models included distance to edge variables, road density, amount of clearcut and old forests. Clearcuts were avoided, old forests selected, as were edges and higher road density. The abundance of partial cuts did not factor in any of the top multivariate models. Overall, partial cuts appeared to be an improvement over clearcut harvest systems because of the increased Bryoria growth documented in these stands. The preference of roads and edges needs to be interpreted in the context of larger-scale studies that show decreased chance of caribou persistence when these features are prominent on the landscape.

9. FORESTRY

Recruiting Caribou Habitat Using Silviculture Treatments

Author(s): Lauren Waters, RPF, Rhonda Delong, MSc

Date: 04-Jun-01

Source:

Number on Library Shelf: 13

<http://srmwww.gov.bc.ca/frco/programs/efp/chreport.doc>

Integrating mountain caribou (*Rangifer tarandus caribou*) management and timber management is important in the Revelstoke area because a significant proportion of the allowable annual cut is harvested from old-growth forests, which are critical for caribou habitat. This has heightened the interest in applying forest management strategies that can maintain or simulate old-growth attributes on which the caribou rely. Silviculture treatments applied to managed stands have the potential to accelerate the development of habitat attributes preferred by mountain caribou, including abundance of arboreal lichen and understory falsebox, and open stand structure with some large trees providing good sight lines and snow interception.

The Minister of Forests Advisory Committee (MAC) land use plan for the Revelstoke TSA requires 40% retention in mature and old-growth forests within areas with high value caribou habitat. In response to this requirement, the following goals and management objectives for caribou habitat recruitment using silviculture treatments are proposed:

Overall goals:

1. Maintain and supplement the 40% retention target for mature and old forests in caribou management areas (as laid out in the MAC plan) over time to ensure a sustainable supply of suitable habitat for the future.
2. Increase use of later seral stage (i.e. younger than mature) forests by mountain caribou for forage and cover in the Revelstoke TSA.

Management objectives:

1. Mimic attributes of mature and old-growth forests in later seral stage forests favorable to caribou using silviculture techniques (i.e., create open forests with large trees and complex structure).
2. Accelerate the development of suitable connective habitat for caribou in managed forests to facilitate movement between foraging habitats and predator avoidance.
3. Increase the amount of available lichen for caribou in later seral stage forests.

The purpose of this report is to provide guidance and ecological justification for managers and silviculture foresters to plan, prescribe, implement and monitor silviculture treatments, to meet caribou habitat requirements and timber harvesting objectives. The report specifically:

- a) identifies desired attributes of caribou habitat;
- b) proposes guidelines for ranking and prioritizing stands for caribou habitat recruitment
- c) suggests specific silviculture treatments to recruit caribou habitat in young forests and maintain caribou habitat in old-growth forests; and
- d) proposes using an adaptive management framework for monitoring, refining guidelines and improving prescriptions for recruiting caribou habitat.

Mountain Caribou In Managed Forests-Recommendations For Managers (second Edition)

Author(s): Susan Stevenson, Harold Armleder, Michael Jull, David King, Bruce McLellan, Darwyn Coxson

Date: March 2003

Source: Wildlife Report R-26

Number on Library Shelf: 16

http://wlapwww.gov.bc.ca/wld/documents/techpub/r26_mtcaribou.pdf

Mountain Caribou, an ecotype of woodland caribou (*Rangifer tarandus caribou*), inhabit mature forests and alpine areas in southeastern and east-central British Columbia. During winter, the caribou feed mainly on the arboreal lichens *Bryoria* spp. and *Alectoria sarmentosa*, which are most abundant on old trees. For more than 25 years, forest harvesting has been a management concern in Mountain Caribou ranges in the Engelmann Spruce-Subalpine Fir (ESSF) and Interior Cedar—Hemlock (ICH) biogeoclimatic zones. As the pressure on the timber supply increases, the demand for information on forest harvesting in caribou habitat also increases. This report focuses on winter ranges because it is there that direct conflicts with forestry activities are most severe.

Post Augmentation Caribou Movements

Author(s): Wayne Wakkinen
Date: 24-Mar-03
Source:
Number on Library Shelf: 39

This document looks at post-release movements of woodland caribou to aid in the evaluation of transplant sites in the Washington portion of the Selkirk Mountains.

A Comparison of Mountain Caribou Winter Habitat Characteristics and Partial-Cut Blocks in the Southern Selkirk Mountains

Author(s): B. McLellan, E Terry
Date: 23-Nov-98
Source:
Number on Library Shelf: 47

http://www.cmiaae.org/_PDF/reference47.pdf
1.9 MB (scanned)

This report compares winter habitat characteristics of mountain caribou foraging areas to characteristics of selectively logged cut-blocks (i.e. partial-cuts) located in the southern Selkirk Mountains. Habitat characteristics of caribou foraging areas are described using data from two caribou herds including the Revelstoke Herd in the north Columbia Mountains, and The Yellowhead Herd east of Prince George situated in the north Cariboo Mountains. Experimental partial-cut blocks near Salmo, B.C. were used to determine how well habitat attributes in selectively logged stands (managed stands) maintain winter habitat characteristics in these two study areas.

Selection silvicultural systems in mountain caribou habitat: Logging and learning at Pinkerton Mountain

Author(s): Susan K. Stevenson, Mike Jull, Darwyn S. Coxson
Date: 01-May-99
Source: UNBC Forest Research Note PG #19
Number on Library Shelf: 52

<http://wetbelt.unbc.ca/docs/Pinkerton%20research%20note%20pg-19.pdf>

To make informed decisions about what silvicultural systems to use to meet resource objectives, managers need to know the implications of their decisions for a variety of resource values. In the long term, the stand structural information we have collected at

Pinkerton Mountain before and after harvesting will become the baseline for continued monitoring of a variety of stand dynamics processes, and continued reporting of our results to managers.

Integrating Mountain Caribou Requirements and Forest Management in the Interior Cedar Hemlock, Post-Harvesting Windthrow Rates

Author(s): Harold J. Quesnel, Lauren Waters

Date: 01-Mar-00

Source: BC Ministry of Forests Extension Note 054

Number on Library Shelf: 53

<http://www.for.gov.bc.ca/rsi/research/nextnotes/En054.htm>

Alternative harvesting systems in old growth are being evaluated in the Revelstoke area. Integrating mountain caribou (*Rangifer tarandus caribou*) and timber management is important because a significant proportion of the annual allowable cut will be harvested from old-growth habitat critical for caribou in the Revelstoke area. Alternative silviculture systems that maintain caribou habitat while allowing access to merchantable timber are preferred in caribou management areas.

Windthrow or Clearcut-What's the Difference?

Author(s): Karen Price, Jim Pojar, Audrey Roburn, Lori Brewer, Nola Poirier

Date: 01-Jan-98

Source: Northwest Science 72(Special Issue No.2): 30-32

Number on Library Shelf: 55

This paper focuses on two questions: (1) Do mature stands initiated by blowdown contain more structure than mature stands initiated by clearcutting? (2) Do blowdown-initiated stands support different species than logged stands? More specifically, we asked whether stands initiated by blowdown were more similar to old growth, and predicted that blowdown sites would contain greater structural legacy (more large trees and snags, abundant coarse woody debris) and would have greater heterogeneity (in canopy gaps, microtopography, tree spacing and size).

Integrating Mountain Caribou Requirements And Forest Management In The Interior Cedar Hemlock-Lichen Retrospective and Dispersal Study, Final Report

Author(s): Harold J. Quesnel, Lauren Waters

Date: 01-Mar-00

Source: BC Ministry of Forests Extension Note 054

Number on Library Shelf: 56

<http://www.for.gov.bc.ca/rsi/research/nextnotes/En054.htm>

Alternative harvesting systems in old growth are being evaluated in the Revelstoke area. Integrating mountain caribou (*Rangifer tarandus caibou*) and timber management is important because a significant proportion of the annual allowable cut will be harvested from old-growth habitat critical for caribou in the Revelstoke area. Alternative silviculture systems that maintain caribou habitat while allowing access to merchantable timber are preferred in caribou management areas.

Intergrating Mountain Caribou Requirements And Forest Management In The Interior Wet-Belt Near Revelstoke, British Columbia-Lichen Retrospective and Dispersal Studies, Progress Report

Author(s): Harold J. Quesnel, Lauren Waters

Date: 01-Mar-99

Source:

Number on Library Shelf: 57

Alternative harvesting systems in old growth are being evaluated in the Revelstoke area. Integrating mountain caribou (*Rangifer tarandus caibou*) and timber management is important because a significant proportion of the annual allowable cut will be harvested from old-growth habitat critical for caribou in the Revelstoke area. Alternative silviculture systems that maintain caribou habitat while allowing access to merchantable timber are preferred in caribou management areas.

Integrating Mountain Caribou Requirements and Forest Management in Wet Belt Ecosystems, Final Report Summary

Author(s): Bruce McLellan

Date: 31-Mar-2000

Source: Forest Renewal BC Report

#MR 39

Number on Library Shelf: 65

<http://www.for.gov.bc.ca/HFD/library/FRBC2000/FRBC2000MR39.pdf>

Mountain Caribou, a red listed or endangered ecotype of woodland caribou (*Rangifer tarandus caribou*), are associated with late-successional forests, and managing for mountain caribou habitat requires explicit consideration over regional, to landscape, stand, and single tree spatial scales. During this FRBC funded study, 48 caribou were radiolocated 4186 times in the north Columbia Mountains of British Columbia. We analyzed caribou selection for multiple forest overstory and terrain attributes across 4 nested spatial scales, comparing successively smaller and closer paired used and

random landscapes. To complete our multi-scale approach to understanding habitat selection, we also investigate selection at the stand, path chosen by caribou, and foraging site scale. Our population analysis included three detailed censuses and re-analyses of all previous censuses. We investigated the sites of 37 caribou that died. To further understand the relationship among wolves and caribou, 2 wolf packs were also radiocollared. We also investigated the feasibility of 1-2 ha patch cuts in old ICH forests. In these cuts we monitored lichen dispersal and blowdown. Our research was directly incorporated into the Columbia District's land use plan by participating in the Minister's Advisory Committee and Kootenay Boundary Land Use Planning Processes. Our results and methodology has also been used throughout the Nelson Forest Region and parts of the Kamloops Forest Region and contributed to the report "Mountain Caribou in Managed Forests: Recommendations for Managers- Second Edition". We hosted a 2 day workshop on partial cutting in caribou habitat and participated in many field trips with MOELP, MOF, and licensees. Two scientific papers are in press, another has been submitted, and drafts of several are being prepared. This report is only a summary of several more complete papers. The reader is asked to read the complete reports, and not to rely on this summary.

Integrating Mountain Caribou Requirements and Forest Management in the Interior Cedar Hemlock

Author(s): Harold J. Quesnel, Lauren Waters

Date: 01-Mar-02

Source: BC Ministry of Forests Extension Note 54

Number on Library Shelf: 83

<http://www.for.gov.bc.ca/rsi/research/nextnotes/En054.htm>

Alternative harvesting systems in old growth are being evaluated in the Revelstoke area. Integrating mountain caribou (*Rangifer tarandus caribou*) and timber management is important because a significant proportion of the annual allowable cut will be harvested from old-growth habitat critical for caribou in the Revelstoke area. Alternative silviculture systems that maintain caribou habitat while allowing access to merchantable timber are preferred in caribou management areas.

Managing second-growth forests as caribou habitat

Author(s): Susan K. Stevenson

Date: 31-Jan-90

Source: Rangifer Special Issue (3): 139

Number on Library Shelf: 105

Habitat management for woodland caribou (*Rangifer tarandus caribou*) in southeastern British Columbia has generally focussed on protecting old-growth forests from logging. As that strategy becomes more difficult to maintain, biologists are beginning to explore

opportunities to manage second-growth stands to provide arboreal lichens and other habitat resources important to caribou. Special harvesting and stand management practices are being developed and formulated into strategies for maintaining caribou populations in managed forests.

Review of forestry practices in caribou habitat in southeastern British Columbia, Canada

Author(s): Susan K. Stevenson

Date: 01-Jan-86

Source: Rangifer. Special Issue #1: 289.

Number on Library Shelf: 108

Woodland caribou (*Rangifer tarandus caribou*) in southeastern British Columbia feed mainly on arboreal lichens in the winter. Some modified forestry practices that have been used or proposed for caribou ranges are reviewed. Partial cutting results in the retention of some forage lichens. Partial cutting and small patch harvesting may improve lichen growth on the remaining trees. Retention of advanced regeneration and some residual trees may improve lichen growth in the remaining stand. Extension of the rotation age increases the amount of harvestable forest useful to caribou at any one time. Progressive cutting minimizes road access to caribou ranges, and may be combined with partial cutting. Most forestry practices intended to maintain lichen production will result in increased human activity in caribou ranges, unless road access is controlled. The management strategy selected depends on site conditions and on the relative importance assigned to the impact of habitat alteration and human activity on caribou.

Case Study: Patch Cutting in Old-Growth Forests to Maintain Caribou Habitat. 1997-1999 Research Results

Author(s): Lauren Waters, RPF, Harry Quesnel

Date: 01-Jan-99

Source: BC Ministry of Forests Extension Note 029

Number on Library Shelf: 116

<http://www.for.gov.bc.ca/rsi/research/nextnotes/rs029.htm>

This Extension Note reports on the results of post-harvest monitoring of regeneration, coarse woody debris, windthrow, and lichen.

Case Study: Patch Cutting in Old-Growth to Maintain Early Winter Caribou Habitat

Author(s): Lauren Waters

Date: 01-Nov-96

Source: BC Ministry of Forests Extension Note 029

Number on Library Shelf: 117

<http://www.for.gov.bc.ca/rsi/research/nextnotes/rs029.htm>

This Extension Note reports on the results of post-harvest monitoring of regeneration, coarse woody debris, windthrow, and lichen.

Integrating Mountain Caribou And Forestry-The Revelstoke Caribou Project

Author(s): Bruce McLellan, John Flaa

Date: 01-Jan-93

Source: E.P. 1161. Annual Report Year One. Ministry of Forests, Revelstoke, BC

Number on Library Shelf: 120

Annual report on the Revelstoke Caribou Project, for 1992-1993 (Year One).

Alternative Silviculture Systems

Author(s): Susan K. Stevenson

Date: 01-Mar-93

Source:

Number on Library Shelf: 121

This document reports on the Lucille Mountain project that was initiated in 1989 with the following objectives:

1. To ensure that caribou habitat values are accommodated in all aspects of the Lucille Mountain project: planning, implementation, monitoring, education, and demonstration.
2. To monitor the response of the following caribou habitat values to the management activities: abundance of available forage lichens, lichen growth rates, and microclimate of the lower canopy where forage lichens grow.
3. To ensure that project results are considered in subsequent development of management strategies.

10. HISTORICAL ACCOUNTS

The Early History of Woodland Caribou in British Columbia

Author(s): David Spalding

Date: March 2000

Source: BC Ministry of Water, Land and Air Protection

Number on Library Shelf: 26

<http://wlapwww.gov.bc.ca/wld/documents/techpub/b100.pdf>

Woodland Caribou (*Rangifer tarandus caribou*) have ranged throughout the mountains of British Columbia for approximately 10,000 years, arriving quickly behind the retreating ice of the last ice age. Today their numbers and distribution are reduced, even from early historical times. There are three distinct groups, or ecotypes: the northern ecotype (relying heavily on terrestrial lichens for food), the mountain ecotype (feeding more on arboreal lichens than their northern counterpart) and the boreal ecotype, few in number and restricted to the lowlands of the extreme north-east of the province. Northern caribou are found in the Northern Boreal Mountain, Boreal Plains, Sub-boreal Interior, Central Interior and Coast and Mountain ecoprovinces. Their numbers and distribution in the Northern Boreal Mountains probably changed little over historical times, at least until about 1970; elsewhere, however, northern caribou have experienced a decline in numbers and a reduction in distribution. Mountain Caribou are found in the Southern Interior and Southern Interior Mountains ecoprovinces, and in the south-east portion of the Subboreal Interior and on the eastern edge of the Central Interior ecoprovinces. The decline in Mountain Caribou numbers and distribution has been more pronounced than in the northern ecotype, particularly in the Okanagan and throughout the Kootenays. Boreal Caribou have probably changed little in number or distribution during historical times. The initial series of declines in Caribou numbers began around the turn of the century in the extreme south-east of the province and ended in the early 1940s in the Cariboo. The evidence suggests a combination of over-hunting, often in combination with wolf predation, caused these initial reductions. Following control of hunter harvest and wolf numbers, Caribou began to increase slowly. However, by the 1950s and 1960s, habitat degradation and habitat loss were of growing importance and Caribou never increased to pre-decline levels. Dawson's Caribou (*Rangifer tarandus dawsoni*) arrived early on the Queen Charlotte Islands, probably 9–10,000 years ago, either by crossing on a land bridge or swimming a narrow channel. A slowly changing climate, particularly during the last 2000 years, created an environment unsuitable for Caribou and that sub-species is now extinct.

Caribou and Human Agency in the North Columbia Mountains: Towards the Environmental History of a Species

Author(s): Graham A. MacDonald

Date: 01-Jan-96

Source:

Number on Library Shelf: 60

The study reviews the literature relevant to Mountain caribou (*Rangifer tarandus caribou*) and seeks to assess the historical nature of the presence in the species in the Columbia Mountains. Sponsored by Mount Revelstoke-Glacier National Park, the study area has been conceived at the level of the known range of the animal, stretching from Northern Idaho to about Prince George on the north. The Columbia Mountains, consisting of the Selkirks, Purcells and Monashee ranges, represents the geographic unit of the study, with the Columbia trench and the western face of the Rockies defining an eastern limit.

Caribou of the central Selkirks: Questioning historic records for clues to recovery

Author: Brenda Herbison

Date: June 15, 2005

Number on Library Shelf: 172

This is a record of a presentation to North Kootenay Recovery Implementation Group. The presentation was funded by the Columbia Basin Trust's Environmental Initiatives fund. PowerPoint presentation with speaking notes are available as an PDF file at:

http://www.cmiae.org/_PDF/reference172.pdf

11. HYDRO-ELECTRIC DEVELOPMENT

Summary of Terrestrial Biology Program Revelstoke Project, 2nd Annual Report-1978

Author(s): Richard L. Bonar
Date: 01-Jan-78
Source:
Number on Library Shelf: 15

This report summarizes progress on terrestrial biology programs undertaken during 1978-79 for the Revelstoke Hydroelectric Project by the Project Wildlife Biologist. These studies have as main objectives inventory of wildlife resources and assessment of Project impact on wildlife populations. Most studies are now underway. Preliminary findings as presented in this report are subject to revision and should not be considered as final data.

Mica Reservoir Region Resource Study-Volume 2 of 2

Author(s): British Columbia Environment And Land Use Committee
Date: 01-Jun-74
Source:
Number on Library Shelf: 21

The Mica Reservoir could provide a significant transportation function for the forest industry, to help reduce the need for an extensive road system.

However, if the cold winter climate will produce a freeze-up condition in the reservoir, followed by a breaking up of the ice due to the falling reservoir level, then it will be rendered useless for transport of men during a period of about four months. The effect of this will be to limit forest areas with only water access, to summer logging only due to the prohibitive expense of maintaining winter camps by helicopter. The result will be pressure from the forest operators for an extended road system around the reservoir as soon as possible.

The Pacific Region Field Services Directorate of the Atmospheric Environment Service (Environment Canada) carried out a study in 1973 to determine the conditions for freezing of the Mica Reservoir. As a result of this study they have predicted that it will normally freeze in winter. The period of ice cover will likely be from early January to mid-April, and the reservoir may remain open about one winter in ten except for shore ice in shallower areas.

The following report on the potential freezing of Mica Reservoir was prepared by Mr. D. Barry Schaefer for the Regional Director, Mr. J. L. Knox and submitted to the Mica Study Group.

Mica Reservoir Region Resource Study-Volume 1 of 2

Author(s): British Columbia Environment And Land Use Committee

Date: 01-Aug-74

Source:

Number on Library Shelf: 22

The Mica Dam was completed in 1973. The region defined for the study is that section of the Rocky Mountain Trench between Valemount and Golden together with its tributary valleys.

The purpose of the study was to determine the resources of the region, to assess restraints on development and to advise the Government on the possible options for their management.

Impacts of a Hydro-Electric Reservoir on Populations of Caribou and Grizzly Bear in Southern British Columbia

Author(s): Keith Simpson, Ralph W. Ritcey

Date: 01-Feb-87

Source:

Number on Library Shelf: 41

The impacts of a hydro-electric reservoir on populations of caribou and grizzly bear were studied north of Revelstoke, BC. Information collected for 3 years prior to flooding was compared with data collected 1984-85. The reservoir did not obstruct the movement of caribou and animals did not attempt crossing during periods when ice conditions were hazardous. Evidence suggested that predator avoidance was the most important determinant of habitats used in spring. The cleared reservoir was an important habitat for caribou in spring because of the abundant food and security from predators it offered. A potential decline in caribou recruitment was noted in 1985 coincident with reservoir flooding. Further data will be required to confirm this decline. Recommendations include clearing some logged areas adjacent to formerly used reservoir habitats and maintaining movement corridors of mature timber between seasonal habitats. Inconclusive evidence suggested that the reservoir was a barrier to movement for grizzlies. Grizzly spring movements were related primarily to good feeding sites. Avalanche paths in side drainages were the principal habitats used. Cleared areas did provide an abundance of food comparable to naturally disturbed habitats. The main impact of reservoir flooding was in shifting the habitat use of bears from relatively secure areas, in the reservoir, to high risk habitats on the highway and

powerline right-of-ways. Mitigative recommendations include reducing the attractiveness of right-of-ways by planting less palatable plants and maintaining spring ranges in tributary valleys by careful development planning. Formats used for recording habitat information and summarized guidelines for identifying important caribou and grizzly spring ranges are given in the appendices.

12. LICHEN

Patterns of bryophyte and lichen diversity in interior and coastal cedar-hemlock forests of British Columbia.

Author(s): Andre Arsenault, Rene J. Belland, Trevor Goward, Steven G. Newmaster, Dale Vitt

Date: 31-Mar-00

Source:

Number on Library Shelf: 3

This project examined the patterns of bryophyte and lichen diversity in cedar-hemlock forests of interior and coastal British Columbia. Our study provides a better understanding of the distribution ecology of bryophytes and lichens, and the relationship between sensitive species and their habitat and offers insight that can be used to minimize the impact of forestry operations on biological diversity.

The Inland Rainforest Formation of Northwestern North America: A Lichenological Perspective

Author(s): Trevor Goward, Toby Spribille

Date: 28-Feb-02

Source:

Number on Library Shelf: 4

Northwestern North America is renowned for its coastal temperate rainforests. Recently there has been a movement to include the inland wetbelt forests of southeastern British Columbia and adjacent Idaho and Montana in the rainforest formation. In this paper we propose a biological circumscription of the inland rainforest formation using oceanic lichens as key discriminators. We recognize a perhumid inland rainforest occurring on the windward slopes of the Columbia and Rocky Mountains between about 51 degrees N and 54 degrees N. The rainforest attributes of other portions of the inland wetbelt are discussed in light of lichenological evidence. Epiphytic lichens are shown to be highly sensitive indicators for the recognition of varying degrees of "rainforestness". An index of rainforestness is proposed.

Observations on the Ecology of the Lichen Genus Bryoria in High Elevation Conifer Forests

Author(s): Trevor Goward

Date: 01-Jan-98

Source:

Number on Library Shelf: 14

The distributional ecology of the tree-dwelling "hair lichens" *Bryoria fremontii* and *B. pseudofuscescens* is examined, based on observations in high elevation conifer forests of inland British Columbia. Seven obvious microscale and mesoscale patterns are reported for one or both of these species (1) a failure to successfully colonize branches occurring below the upper limit of the winter snowpack (2) an occurrence in much lower abundance over the outer, foliated portions of branches than over the inner, defoliated portions of the same branches: (3) a tendency to periodic die-off in the outer, foliated branches, but not the inner, defoliated branches; (4) a development of disproportionately heavier loadings over old, senescent trees than over young, vigorously growing trees of similar size: (5) the ability to colonize all levels of the forest canopy, including the upper crowns of trees: (6) an anomalously higher biomass in young stands growing in exposed sites than in young stands growing in sheltered sites: (7) a development of considerable biomass in poorly illuminated stands that are nevertheless well ventilated. Based on these observations, the main distributional features of these species, and of *Bryoria* as a whole, are assumed to reflect a pronounced sensitivity to prolonged wetting, especially as a result of snowmelt. Other environmental factors are apparently less important at least in the study area.

Is Dispersal Really Limiting To Hair Lichen (Bryoria) Colonization In Young High Elevation Forests?

Author(s): Trevor Goward

Date: 28-Nov-99

Source:

Number on Library Shelf: 48

The purpose of this paper is to examine the relation of wind to hair lichen dispersal in high elevation ESSF forests. In keeping with the importance of hair lichens to the ecology of Mountain Caribou, special emphasis will be placed on those species prominent in the winter diet of these animals.

Epiphytic Lichen Biomass In Managed And Old-Growth Boreal Forests: Effect Of Branch Quality

Author(s): Pers-Anders Esseen, Karl-Erik Renhorn, Roger B. Pettersson

Date: 28-Feb-95

Source: Ecological Applications 6: 228- 238

Number on Library Shelf: 49

To maintain biodiversity in managed forests we must understand the patterns and processes that regulate the occurrence and dynamics of species in undisturbed ecosystems. We compared biomass and species composition of canopy lichens on 180 lower branches of Norway spruce (*Picea abies*) in three pairs of old-growth and managed (selectively logged) stands in northern Sweden (30 branches per stand). The purpose was to evaluate the effect of substrate quality (branch characteristics) on patterns of lichen biomass for two different growth forms (foliose and fruticose). Old-growth stands had six times higher lichen mass per spruce branch, and two times higher expressed as percentage of branch mass, compared to mature stands of managed forest. Lichen mass was strongly related to mass, diameter and age of branches. Fruticose, pendulous species (*Alectoria sarmentosa* and *Bryoria* spp.) were highly sensitive to forest practices. In contrast, type of forests had no significant effect on foliose species. Species number per stand was the same (15 species) in both types of forests, but there were marked differences in the relative abundance of different lichen groups. Results suggest that limited amount of substrate (i.e. small branches) available to lichens, and young branches, providing only a short time for lichen colonization and growth, are important factors limiting epiphytic lichen abundance in managed forests. Conversion of old-growth forests into young, managed stands will lead to a significant reduction in epiphytic lichen mass. This in turn may probably affect nutrient cycling in forests and has negative consequences for animals that utilize canopy lichens as food, shelter or nesting material.

Edge Effects on an Epiphytic Lichen in Fragmented Forests

Author(s): Pers-Anders Esseen, Karl-Erik Renhorn

Date: 13-Feb-98

Source: Conservation Biology 12: 1307-1317

Number on Library Shelf: 50

Increased amount of edge habitat is one of several important consequences of forest fragmentation. Consequently, we must understand the responses of plants and animals to edges to formulate adequate recommendations for conservation and biodiversity. Epiphytic lichens are a well-suited subject for a study of abiotic edge effects because they gain nutrients and water directly from the atmosphere. We present a temporal model of edge effects on lichens based on empirical data for the pendulous, fruticose species *Alectoria sarmentosa*. Ten high-contrast edges of different age between

mature *Picea abies* forest and large clearcuts (10-260 ha) were studied in northwestern Sweden. Abundance of *A. sarmentosa* (mass on 1-m branch sections and maximum thallus length per tree) was estimated in the lower canopy in four 10 X 50 m² plots located 5-100m into the forest. The abundance of *A. sarmentosa* was significantly affected by both distance from the edge and site location. Maximum edge effects extended 25-50m into the forest at moderately exposed sites. The major factor reducing lichen abundance was physical damage by strong wind. Large, pendulous lichens such as *A. sarmentosa* are prone to thallus fragmentation. At older edges lichen abundance had recovered inside the edge (20-30m), probably due to increased growth in response to increased irradiance. Our analysis supports the view that edge effects may be strongly dynamic over time and caused by the interaction of several factors. We conclude that epiphytic lichens have large potential as indicators of forest edge effects.

Arboreal lichen in uncut and partially cut subalpine fir stands in woodland caribou habitat, northern Idaho and southeastern British Columbia

Author(s): Eric M. Rominger, Lydia Allen-Johnson, John L Oldemeyer

Date: 24-May-94

Source:

Number on Library Shelf: 51

To better understand the effects of partial cutting on arboreal lichen biomass production within woodland caribou (*Rangifer tarandus caribou*) habitat, lichen was hand picked from 1228 branches on 307 subalpine fir (*Abies lasiocarpa*) trees in Idaho (ID), and in British Columbia (BC). Lichen biomass from partially cut stands was compared with biomass on trees from adjacent uncut stands at each site. Arboreal lichen biomass did not differ significantly between uncut and partially cut stands. Live branches had more lichen than dead branches. Species composition of arboreal lichen changed in partially cut stands compared with adjacent uncut stands. The ratio of live to dead branches was substantially different within the BC partial cut.

Hotspots of Epiphytic Lichen Diversity in Two Young Managed Forests

Author(s): Peter N. Neitlich, Bruce McCune

Date: 28-May-96

Source: Conservation Biology

Volume 11 Issue 1 Page 172 - February 1997

Number on Library Shelf: 54

Understanding within-stand variation in diversity of epiphytes will provide an improved basis for producing timber while conserving biological diversity. Two 80-ha, 50-year-old managed stands of conifers were surveyed to locate 0.4 ha putative "diversity" plots, the areas appearing most diverse in lichen epiphytes. These plots were generally located

in areas made heterogeneous by canopy gaps, wolf trees (trees with large-diameter lower branches), and old-growth remnant trees. "Matrix" plots, in contrast, were chosen at random from the remaining, more homogenous forest. Diversity plots hosted from 25% to 40% more epiphytic lichen species than matrix plots in both stands. The strongest within-stand gradients in species composition were correlated with species richness ($r=0.79$). In the more structurally diverse stand, diversity and abundance of nitrogen-fixing "cyanolichens" were correlated with percentage of the plot occupied by gaps ($0.5 < r < 0.0$), and alectoroid lichens were correlated with percentage of plot occupied by old-growth remnant trees ($0.5 < r < 0.6$). In the stand with more homogenous structure, percentage of plot under gaps was correlated with regionally common species that were otherwise absent or sparse in the matrix. Protecting gaps, hardwoods, wolf trees, and old-growth remnant trees during thinning of other partial cutting is likely to promote the majority of epiphytic macrolichens in young conifer forests. Because these features are easily recognized on aerial photos and on ground by land managers, it is practical to manage for forest structures that would promote lichen diversity.

Ecology Of Arboreal Lichen And Their Role In Ungulate Ecology, Especially Mountain Caribou Ecology

Author(s): M.L. Beets, D.E. Russell

Date: 01-Jun-76

Source:

Number on Library Shelf: 58

Many authors indicate the importance of lichens as a food source of ungulate species (Baskin, 1970; Kelsall, 1968; Edwards and Ritcey, 1959, Cowan, 1945). The apparent importance in B.C. of arboreal lichens has resulted in the initiation of a few studies of lichen ecology (Ahti, 1962; Edwards, Soos and Ritcey, 1960; Rochelle, in prep.). In conjunction with this research an up-to-date literature review would be advantageous to introduce interested readers to the ecology of lichens, with special reference to arboreal lichens, and to the results of research on ungulate/arboreal lichen interactions. Special attention will be paid to mountain caribou dependence on arboreal lichens.

Lichens of the Coastal Forest Chronosequences

Author(s): Katherine A. Enns

Date: 01-Jan-98

Source: Pages 103-105 in J.A. Trofymow and A. MacKinnon, editors.

Proceedings of a workshop on Structure, Process, and Diversity in Successional Forests of Coastal British Columbia, February 17-19, 1998, Victoria, British Columbia. Northwest Science, Vol. 72 (special issue No. 2).

Number on Library Shelf: 59

<http://www.pfc.forestry.ca/ecology/chrono/sfrw/32enns.pdf>

In 1992, the Canadian Forest Service established the Coastal Forest Chronosequence project in age sequences of coastal temperate rainforests on Southern Vancouver Island. They were established to investigate several key questions about the conversion of old-growth forests to younger seral stages. Old forests are habitat to a variety of species with small home ranges or poor dispersal capability, including lichens. Conversion of large areas may therefore result in the decline of some lichen species. A brief examination of lichens on branches from the chronosequences sampled in 1995 and compare this sample to a more detailed sample series taken from a single chronosequence in 1996.

The LaForme Creek Lichen Enhancement Project: Preliminary Results To Date

Author(s): Cameron Gillies, John Boulanger

Date: 01-Feb-01

Source: Prepared for Columbia Basin Fish and Wildlife Compensation Program

Number on Library Shelf: 74

<http://www.cbfishwildlife.org/reports/pdfs/lichen01.pdf>

Concern about the dependence of mountain caribou (*Rangifer tarandus caribou*) on economically important older Western Red Cedar and Hemlock forests for arboreal lichen in British Columbia initiated the LaForme creek lichen enhancement project. This project was undertaken in the LaForme Creek drainage of the North Columbia Mountains under the auspices of the "Mountain Caribou in Managed Forests" program. The aim was to determine if girdling selected trees in second growth stands increased the quantity of arboreal lichen and lichen litterfall.

Effects of Partial Cutting on Arboreal Lichens Used by Mountain Caribou.

Author(s): Susan Stevenson and Darwyn Coxson

Date: February 1999

Source: Pp. 663-664 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp.

Number on Library Shelf: 135

<http://wlapwww.gov.bc.ca/wld/documents/mc08stevenson.pdf>

About 10 years ago, managers began to experiment with partial cutting rather than clear cutting in mountain caribou habitat. The rationale was to determine whether it was

possible, through use of non-clear cutting silvicultural systems, to harvest timber and also maintain the habitat attributes that are critical to caribou (Stevenson et al. 1994). Much has been learned from those early trials about layout, harvesting practices, and short-term impacts on timber values and caribou habitat attributes (Jull et al. 1996, Cariboo Forest Region 1997, Jull and Stevenson 1999). A new generation of operational partial cutblocks is under way, building on the results of the earlier trials (Waters 1996, Armleder et al. 2000, Stevenson et al. 1999). Recently, the move to improve biodiversity conservation by patterning forest management after the characteristic natural disturbance regime (Province of British Columbia 1995, Voller and Harrison 1998) has given added impetus to the use of partial cutting in the forests of the Interior Cedar–Hemlock and Engelmann Spruce–Subalpine Fir biogeoclimatic zones in southeastern British Columbia. Most mountain caribou range is characterized by a natural disturbance regime in which stand-destroying events are infrequent, and regeneration occurs largely through the death of individual trees or small groups of trees. Single-tree selection and group selection resemble the natural disturbance regime in these stands more than do even-aged silvicultural systems. However, no silvicultural system perfectly imitates nature. Partially cut stands typically differ from natural stands in several ways: more trees are usually removed in a harvest entry than would die naturally; few dead trees are left standing after a harvest entry; and, over time, more and more of the trees are in younger age classes. Partial cutting can affect mountain caribou in a variety of ways. Here we discuss only the effects of partial cutting on the main winter foods of mountain caribou, the arboreal lichens *Bryoria* spp. and *Alectoria sarmentosa*. The most immediate impact is the loss of the arboreal lichens on the trees that are felled for harvest. Sometimes caribou forage on the felled trees, but those lichens are available only briefly. The reduction in lichen biomass exceeds the level associated with merchantable timber removal, because of the additional loss of lichens on dead or dangerous trees that are felled to ensure a safe work environment. The lichens on the remaining trees are exposed to more wind than they were exposed to before cutting. In extreme instances, due to topographic exposure, excessive timber removal, or both, much of the lichen in the residual stand may be blown off. More commonly, increased exposure may result in a pulse of litter fall after harvesting, followed by stabilization. By opening up the canopy of a stand, partial cutting alters the canopy microclimate. We expect that at any given level in the canopy, the microclimate will be slightly windier, drier, and more extreme in temperature in a partially cut stand than in an unharvested stand. These microclimatic changes are likely to affect the physiological activity, growth rates, and fragmentation rates of the lichens in the canopy. So far, our studies of growth rates of lichens in the lower canopy of Engelmann spruce–subalpine fir stands indicate a decline in the growth rate of *A. sarmentosa*, but not necessarily of *Bryoria* spp., after partial cutting. These results suggest that a gradual shift in genus composition will occur, and are consistent with the stratification of epiphyte species in a forest canopy along a moisture gradient described by McCune (1993). As caribou select *Bryoria* spp. over *A. sarmentosa* in feeding trials (Rominger et al. 1996), such a shift in genus composition may not be unfavourable to them. Distances between old trees and many of the young trees will be greater in a partially cut stand than in an unharvested stand. Studies of dispersal of lichen propagules (Stevenson 1988, Dettki 1998) have shown that *Bryoria* spp. disperse effectively over

much greater distances than *A. sarmentosa*. *Bryoria* colonization is likely to exceed background levels throughout the openings in a partial cut, but not necessarily in a clearcut. *A. sarmentosa* may be uncommon on young trees in the interior of openings, especially if it is limited to the lower canopy in the adjacent mature trees. Because of the altered age structure in a partially cut stand, a higher proportion of the substrate available for lichen growth will be young. Young branches support lower biomass of *A. sarmentosa* and *Bryoria* spp. than do old branches, even when the effect of branch size is controlled (Esseen et al. 1996). This may occur in part because *Bryoria* spp. grow more abundantly on the defoliated portions of branches than on the needle-bearing portions, and the defoliated parts constitute a higher proportion of old than young branches (Goward 1998). It seems clear that caribou-forage lichens will still be present in Interior wet-belt stands after partial cutting, that the total amount of available forage will be lower in partially cut stands than in uncut stands, and that the relative proportion of *Bryoria* spp. to *A. sarmentosa* will increase. There are many unanswered questions about the dynamics, magnitude, and functional processes associated with these changes. To address these questions, we are currently investigating the effects of the size and pattern of selection harvest openings on distribution and abundance, physiological functioning, growth and fragmentation, and litterfall rates of arboreal caribou-forage lichens in wet-belt forests east of Prince George.

Inland Old-Growth Rain Forests: Safe Haven for Rare Lichens?

Author(s): Trevor Goward, Andre Arsenault

Date: February 1999

Source: 759-766 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp

Number on Library Shelf: 137

Lichens in which a cyanobacterial partner occurs can be referred to as "cyanolichens". Such species are potentially important contributors to the nitrogen budgets of some conifer forest ecosystems. In the intermontane forests of BC, 31 epiphytic (tree-dwelling) cyanolichens are known to colonize conifers, including 12 species that can be considered rare or infrequent in the province as a whole. In this paper we present a simple key for predicting stand-level epiphytic cyanolichen diversity on conifers. The key is based on several readily mappable environmental factors and is useful at an operational scale. Maximum cyanolichen diversity is shown to occur in lowland old-growth rain forests established over nutrient-rich soils and subject to a rainfall pH above about 5.0. Such stands are generally restricted to the base of hill slopes in the wettest subzones of the Interior Cedar-Hemlock zone, where they not only support one of BC's richest assemblages of rare cyanolichens, but also themselves represent one of the province's rarest and most endangered forest ecosystems. Further work is urgently needed.

The Drip Zone Effect: New Insights into the Distribution of Rare Lichens

Author(s): Andre Arsenault and Trevor Goward

Date: February 1999

Source: Pp. 768-768 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp

Number on Library Shelf: 138

Nearly half of BC's rare tree-dwelling macrolichens have a cyanobacterium as photobiont. Such species can be referred to as epiphytic cyanolichens. As a group, epiphytic cyanolichens have a requirement for nutrient –rich substrates, including the bark of conifers. Viewed from this perspective the copious presence of cyanolichens over the bark of pines, spruces, hemlocks, and other members of the Pinaceae in some portions of northwestern North America would seem anomalous. We propose that this phenomenon must reflect nutrient enrichment from sources extraneous to the trees themselves. Enrichment may derive, for example, from air-borne dust, aerosols associated with the spray zones of waterfalls, or from nutrients present in the soil.

Ecological Characteristics of Inland Rain Forests

Author(s): Andre Arsenault and Trevor Goward

Date: February 1999

Source: Pp. 437-439 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 1; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC.

Number on Library Shelf: 139

In 1999 we initiated a project funded by Forest Renewal BC to compare and contrast inland rain forests with their coastal counterparts. This project had two components: 1) to study similarities and differences in disturbance ecology and forest dynamics and 2) to discern differential patterns of lichen and bryophyte diversity.

On the Vertical Zonation of Hair Lichens (Bryoria) in the Canopies of High Elevation Old growth Conifer Forests

Author(s): Trevor Goward

Date: 2003

Source: The Canadian Field-Naturalist Volume 117, Number 1 (Jan–Mar 2003)

Number on Library Shelf: 141

Three vertical zones of Bryoria abundance are recognized upper- and mid-elevation oldgrowth conifer forests in southern inland British Columbia. Zone A, with virtually no Bryoria, is restricted to the lower trunk and lowermost branches, where its upper boundary (the A/B threshold) corresponds roughly with the maximum settled depth of the winter snowpack. Zone B is located directly above Zone A, and supports Bryoria in variable amounts ranging from negligible to heavy; its upper boundary is defined by an abrupt increase in Bryoria at the B/C threshold. Above this is Zone C: a well ventilated region supporting maximum Bryoria loadings consisting predominantly of the nonsorediate species *B. fremonti*, *B. pseudofuscescens*, and *Nodobryoria oregano*. Bryoria loadings in Zone B benefit from litterfall from Zone C, in the absence of which, Zone B would predominantly support only the sorediate species *B. fuscescens* and *B. glabra*. Winters of exceptionally deep snow cause marked upward shifts in the A/B threshold, presumably resulting in reductions in the early winter availability of Bryoria to mountain caribou. This is expected to prolong early-winter migrations to lower elevations, where caribou depend on lichen-rich old growth forests. The existence of such forests is hypothesized to be integral to the long-term maintenance of healthy caribou populations.

Summary of Lichen Detection Using Remote Sensing Project to January 19, 2000

Author(s): Alan Norquay
Date: January 2000
Source: --
Number on Library Shelf: 146

http://www.cmiae.org/_PDF/reference146.pdf

The purpose of this project is to investigate the use of remote sensing technology to identify forest stands containing arboreal lichen, namely *Alectoria* spp and *Bryoria* spp. As this lichen forms an important component of the diet of mountain caribou, finding locations of particular interest to caribou would aid in forest management practices. To date it has generally been accepted that the lichen grows only on trees of a particular age. However, recent hypotheses have shown this is often erroneous, and they are often found on younger than expected stands, and many times not present on older stands.

Patterns of bryophyte and lichen diversity in interior and coastal cedar-hemlock forests of British Columbia.

Author(s): André Arsenault, René J. Belland, Trevor Goward, Steven G. Newmaster, Dale Vitt
Date: 2000

Source: Final report for Forest Renewal British Columbia SCBC# FR-96/97-389,
FRBC#T096048
Number on Library Shelf: 148

http://www.cmiaae.org/_PDF/reference148.pdf

This project examined the patterns of bryophyte and lichen diversity in cedar-hemlock forests of interior and coastal British Columbia. Our study provides a better understanding of the distribution ecology of bryophytes and lichens, and of the relationship between sensitive species and their habitat and offers insight that can be used to minimize the impact of forestry operations on biological diversity. We investigated the patterns of lichen and bryophyte diversity at three scales of ecosystem organization: 1) at a within-stand scale examining microdistributional ecology of species on various substrates; 2) at a meso-scale focussing on differences in species distribution and abundance in forests of different ages; and 3) at broader geographical scales assessing landscape and regional differences in species composition and developing predictive tools for the distribution of cyanolichens. Our work mainly took place in the ICHmw, ICHwk, and ICHvk subzones of the Kamloops Forest Region and in the CWHvm subzone of the Vancouver Forest Region. Our studies on the distribution of cyanolichens on conifers also included information from various regions of the Northern Hemisphere. We found that many factors affect the patterns of bryophyte and lichen diversity in ICH and CWH forests. At a small scale the type and number of microhabitats are an important predictor of the number and type of species present. For example, conifer trees influenced by nearby *Populus* trees often have circumneutral bark pH and are strongly correlated with cyanolichen diversity. Other important habitats for bryophytes and lichens include large rotten logs, and large leaning trees and snags. At the stand level, the number of species of bryophytes and lichens is consistently higher in old-growth forests compared to young forests in both the Interior Cedar-Hemlock Zone and in the Coastal western Hemlock Zone. However, this relationship between species diversity and stand age is complex and will vary for certain groups of species across ecological gradients. For example old cedar-hemlock stands in the inland rainforests located on toe slope positions contain unique assemblages of epiphytic lichens, many of which are rare or infrequent, that are not found on adjacent old-growth forests located on mid-slope positions in the same biogeoclimatic variant. These findings clearly show that ecosystem representation at a finer scale than the biogeoclimatic variant is essential for the designation of old-growth management areas to minimize the loss of biological diversity in managed landscapes. Our data also clearly shows that no single stand management practice will satisfy the requirements of all sensitive lichens and bryophytes. Our detailed comparisons of macrolichen, Calicioid lichen, and bryophyte diversity in old and young unmanaged forests is unparalleled elsewhere in British Columbia and complements work comparing old-growth and young managed forests in other forests of the world. Some of our work is not only contributing to knowledge on the distribution ecology of cyanolichens in British Columbia but is also providing new insights into patterns observed at the scale of the Northern Hemisphere. We have presented our results in many operational forestry meetings, public meetings, provincial and international scientific conferences, peer reviewed Journal and

Proceeding papers. Some of our findings have already assisted the land use planning in the Kamloops Forest Region.

Cyanolichens and conifers: implications for global conservation

Author(s): Trevor Goward and André Arsenault

Date: 2000

Source: For. Snow Landsc. Res. 75, 3: 303–318 (2000)

Number on Library Shelf: 149

http://www.cmiaae.org/_PDF/reference149.pdf

Based on a survey of 935 herbarium specimens collected from British Columbia, the substrate ecology and “lifezone” distribution of 48 species of epiphytic cyanolichens are broadly summarized. Conifers belonging to the Pinaceae provide habitat, in coastal regions, for at least 43 cyanolichen species, 12 of which occur exclusively on conifers. Hardwoods support a similar number of cyanolichens, but provide exclusive habitat for only four species. Cyanolichen diversity on conifer branches is shown to increase along a gradient of increasing summer precipitation. It is suggested that the occurrence of cyanolichens on conifer branches (i.e., the “CC phenomenon”) was formerly well developed in many parts of Europe, but has declined in response to increasing acid precipitation. According to this hypothesis, existing epiphytic lichen assemblages in Europe no longer express their full pre-industrial ecological amplitude. In contrast, conifers in Pacific North America apparently still support “pristine” epiphytic communities; this region should be accorded special emphasis for global cyanolichen conservation. The CC phenomenon may offer a highly sensitive early warning system of broad-scale acidification in eastern North America and other regions where industrial activity is increasing.

Canopy microclimate and arboreal lichen loading in subalpine spruce–fir forest

Author(s): 2001

Date: Jocelyn Campbell and Darwyn S. Coxson

Source: Can. J. Bot. 79: 537–555 (2001)

Number on Library Shelf: 151

http://wetbelt.unbc.ca/docs/campbell_and_coxson_20021.pdf

Hair lichen communities in Engelmann spruce (*Picea engelmannii*) – subalpine fir (*Abies lasiocarpa*) forests of the northern Cariboo Mountains (British Columbia) show distinct vertical zonation. *Alectoria sarmentosa* reaches peak abundance in the lower canopy (over 35 kg/ha) whereas *Bryoria* spp. lichens reach peak abundance in the upper canopy (over 250 kg/ha). These distribution patterns are accentuated by stand

structure with 6 trees growing in clumps retaining significantly higher lichen loading on a per branch basis compared to solitary trees. The vertical zonation of lichen communities is accompanied by distinct trends in canopy microclimate. Snowmelt events account for the largest proportion of observed thallus hydration in both *Alectoria* and *Bryoria*. Although canopy microclimate is surprisingly isothermal during rainfall events, the attenuation of thallus hydration after wetting is typically greater for lower canopy exposures. An important exception to this pattern is seen under midwinter conditions, when solar insolation is insufficient to sustain prolonged lower canopy snowmelt. Our data support the hypothesis that ventilation in upper canopy exposures is a contributing factor in the vertical zonation of *Alectoria* and *Bryoria* communities. Upper canopy *Bryoria* rely more heavily on snowmelt events to sustain thallus hydration, whereas lower canopy *Alectoria* utilize summer rainfall events to a greater extent. We hypothesize that physiological mechanisms, through which these patterns of canopy microclimate influence lichen zonation, may include an intolerance to prolonged wetting by *Bryoria* and higher resaturation respiration costs in *Alectoria*, which would limit it to more mesic canopy exposures. We believe that the observed distribution of canopy lichens ultimately reflects the long-term interaction of both physiological and successional processes (lichen colonization and dispersal) within the canopy.

13. MANAGEMENT PLANS

Toward a Provincial Mountain Caribou Management Strategy for BC: Habitat Requirements and Sub-population Status

Author(s): Keith Simpson, Eliot Terry, Dennis Hamilton

Date: 01-May-96

Source:

Number on Library Shelf: 75

Existing BC Environment policy dictates that mountain caribou populations and their habitat should be managed to maintain existing populations at current levels. Hunting, human disturbance and predation are all recognized as important factors which must be carefully controlled, however, the threats to caribou habitat represent the greatest challenge. Any successful management strategy for mountain caribou must emphasize maintaining their habitat. The long term viability of mountain caribou in the province can only be achieved by establishing an interconnecting mosaic of reserves (both temporary and permanent) and integrated management areas throughout central and south-eastern British Columbia. In some cases, fully protected corridors should be established, while in other cases, an appropriate mix of land management practices should occur. The management strategy includes: definition of caribou herds, sub-populations and broad management areas; definition of key habitats and management requirements; clear definition of compatible management programs; monitoring of population trends to ensure viability of the sub-populations. The successful implementation of caribou management programs, which will certainly impact other resources, will require a plan to resolve the conflicts. The strategy to implement the management plan and resolve conflicts includes: prioritization of sub-populations; identification of criteria to assess socio-economic conflicts for each sub-population; definition of management options for caribou which reduce socio-economic conflicts; and definition of information needs and the research and monitoring programs which will support the strategic objectives above. Mountain caribou sub-populations have been identified and they have been ranked to indicate their relative importance to maintaining a viable population in the province. Closely linked large subpopulations have been given the highest priority. Smaller isolated sub-populations must also be managed, however, maintaining the contiguous core sub-populations is most important. Six linked sub-populations which make up 87% of the total population in B.C. include Hart Ranges, North Cariboo, Wells Gray north, Wells Gray south, Revelstoke and central Selkirs.

Management and Conservation of Mountain Caribou Habitat in the Cariboo Region

Author(s): Forest Practices Board

Date: 01-Mar-02

Source: Forest Practices Board special report
Number on Library Shelf: 76

<http://www.fpb.gov.bc.ca/SPECIAL/investigations/SIR09/SIR09s.htm>

This special investigation is about whether operational plans in an area by caribou in early winter meet the requirements of the Forest Practices Code of British Columbia Act, its regulations and its guidebooks (the Code.)

Components of a Mountain Caribou Conservation Strategy for British Columbia

Author(s): Ian W. Hatter

Date: 01-Jan-00

Source: Pp 631-635 in L.M. Darling, editor. Proceedings of a conference on the biology and management of species and habitats at risk, Kamloops, British Columbia, 15-19 Feb. 1999. Volume 2. British Columbia Ministry of Environment, Lands and Parks, Victoria,

Number on Library Shelf: 81

Mountain caribou (*Rangifer tarandus caribou*, mountain/arboreal-lichen feeding ecotype) are currently Blue-listed in British Columbia. British Columbia currently has an estimated 22,450 mountain caribou, representing about 98% of the world population, distributed in 13 spatially disjunct subpopulations, which comprise a single metapopulation. Habitat fragmentation, reduction in winter food supply, human access and disturbance (including hunting and poaching), and predation have probably contributed to past declines in distribution and abundance. To meet national and international responsibilities for the long-term viability of mountain caribou, a provincial Mountain Caribou Conservation Strategy (MCSS) is being developed. The proposed vision is to 'maintain caribou and their habitat in perpetuity throughout British Columbia's mountain caribou range' and the proposed goals are to: (1) maintain a population of greater or equal to 2500 mountain caribou, distributed throughout their current range in British Columbia; (2) enhance the recovery of threatened subpopulations; (3) provide opportunities for integrated use of caribou habitats, and assess socioeconomic impacts; and (4) provide opportunities for the use and enjoyment of mountain caribou. A proposed conservation approach is outlined. Long-term conservation of the mountain caribou meta-population will require maintenance of caribou core old-growth habitats and protection of habitat linkages between subpopulations. Short-term persistence of several threatened subpopulations may require active participation of the provincial ministries of Environments and Forests, the forest industry, and other stakeholders.

Proposed Habitat Management Guidelines and Habitat Distribution for Mountain Caribou of the South Purcell Subpopulation

Author(s): Trevor Kinley, Greg Utzig

Date: 31-Jul-01

Source: Unpl. Rpt. for BC Land Use Coordination Office. Victoria, BC. 21pp. with Maps and Apps.

Number on Library Shelf: 82

This document outlines proposed revisions to those forest management guidelines and boundaries, and accompanies 1: 50000 mapping of zones and recommended habitat reserves. It is based in part on both the original caribou management area, and revised line work proposed by the Kootenay Regional Caribou Committee.

Revelstoke and Area Land Use Planning Recommendations

Author(s): Revelstoke and Area Land Use Planning Committee

Date: 01-Oct-99

Source:

Number on Library Shelf: 95

<http://www.for.gov.bc.ca/dco/MAC/RLUPR99.pdf>

These land use planning recommendations include mountain caribou into the local land use planning process.

Integrated Management Of Mountain Caribou And Forestry In Southern British Columbia

Author(s): Keith Simpson, John P. Kelsall, Maria Leung

Date: 31-Mar-94

Source:

Number on Library Shelf: 97

This report is a response to a request from the Ministry of Environment, Lands and Parks for the development of draft guidelines for the integrated management of mountain caribou in southern British Columbia. The overall aim will be to provide a starting point for the development of comprehensive mountain caribou/forestry guidelines with the Ministry of Forests.

Toward a Mountain Caribou Management Strategy for British Columbia, Background Report

Author(s): Ministry of Environment, Lands and Parks

Date: 31-Oct-97

Source: M. M. Paquet; 1997; 72 pp.; ISBN 0-7726-3438-6; MoELP, Wildlife Branch; technical;

Number on Library Shelf: 98

The purpose of this background report is to provide information regarding mountain caribou in British Columbia.

Interim Wildlife Guidelines for Commercial Backcountry Recreation in British Columbia Chapter 4 Mammals

Author(s): BC Ministry of Water, Land and Air Protection

Date: May 2002

Source:

Number on Library Shelf: 129

<http://wlapwww.gov.bc.ca/wld/comrec/crecintro.html>

Lists Management Objectives, Impact Mitigation Guidelines and Success indicators for all BC mammals.

Connectivity and Movements of Radio-Collared Caribou

Author(s): Douglas Heard, Glenn Watts

Date: Feb 1999

Source: pp. 637-638 Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp.

Number on Library Shelf: 131

<http://wlapwww.gov.bc.ca/wld/documents/mc02heard.pdf>

Over the long term, mountain caribou (*Rangifer tarandus caribou*) conservation will almost certainly require the maintenance of connectivity among herds, but the characteristics of what constitutes connecting habitat are neither obvious nor easily determined. We felt that GPS (global positioning system) radio-collars might provide the frequency of location data required to detail caribou travel paths, and that those data might provide some indication of what might constitute caribou movement corridors. We

collared 3 adult female caribou from the Yellowhead herd (Heard and Vagt 1998) east of Prince George, B.C. in spring 1996, and 4 caribou from the same herd in early 1997, using Lotek GPS 1000 radio-collars. A variety of technical failures reduced the number of times that the collars attempted to acquire a position from an anticipated 15,000 to only 4,000. Because only about 50% of the attempts were successful, we ended up with only 1,900 useable locations. To distinguish travelling from foraging and other movements, we used a nonlinear, curve-fitting approach on the log of the movement rate frequency data to separate activity bouts (Sibly et al. 1990). We distinguished 3 travelling (i.e. high movement rate) periods in our data set: 1 by caribou CA, and 2 by caribou CB. CA was travelling almost the entire time her collar functioned, which was from 29 March 1996 to 2 May 1996. During that period the collar obtained 138 useable location fixes, even though it was scheduled to do so every hour. CA moved generally east to west when travelling until she came to the eastern edge of the Bowron clearcut, an opening of roughly 7,000 km² that was logged in about 1980. At that point she swung north, generally paralleling the clearcut boundary, but never entering or crossing, even when the opening narrowed near Tumuch Lake. She also appeared to avoid other smaller cutblocks scattered around the periphery of the Bowron clearcut and generally in her path of movement. The absence of any locations in cutblocks was not likely due to a bias in the GPS collar, since collars are more likely to be successful at obtaining a fix in the open than in the forest. CB's collar functioned from 22 April 1997 until 29 June 1998, obtaining 627 useable location fixes, with attempts scheduled every 6 hours. The first travelling period was in late June and July, when she moved in almost a straight line across the clearcut at Tumuch Lake and reversed her direction of movement only when encountering the Yellowhead Highway. If the location data and the highway map are both precise, CB appeared to have crossed the highway before turning around and recrossing, moving back up to higher elevation forests. She remained in the same general area until September, when her movement rate again increased substantially. At that time she descended to the highway, but did not appear to cross before turning around and returning to where she had come from and where she eventually spent the winter. Direct observations of caribou along the highway, and movements of radio-collared caribou that were documented during a previous study, indicated that caribou had on numerous occasions moved across the Yellowhead Highway. Moreover, they appeared to have crossed in, and only in, the same area where CB went but did not continue through. None of the caribou monitored in previous years crossed the clearcut at Tumuch Lake. Because of our small sample size and the variability between animals, we were unable to draw any conclusions about habitat connectivity characteristics from our data. CA appeared to be reluctant to cross the clearcut at Tumuch Lake at the same point where CB crossed, but CB did not cross the Yellowhead Highway on either of 2 occasions, even though many other caribou had done so previously. The large number of locations that GPS collars can provide has the potential to refine and improve our understanding of caribou habitat use, but only after a much larger number of individuals has been monitored.

A Management Strategy for Mountain Caribou: The Cariboo Region Example.

Author(s): Harold Armleder, James Young and John Youds

Date: Feb 1999

Source: Pp. 645-651 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp.

Number on Library Shelf: 133

<http://wlapwww.gov.bc.ca/wld/documents/mc05armleder.pdf>

We describe how research and monitoring were applied, within higher level plan direction, to craft an integrated management strategy for mountain caribou. Nine years of radio-telemetry on 75 animals with >4,000 relocations have defined the range and habitat selection patterns for this population. Timber harvesting trials since 1990 have tested variations of the selection silvicultural system. The Cariboo-Chilcotin Land-Use Plan has established the size of the area that can be managed for mountain caribou and defined the level of acceptable impact on the timber resource. These inputs were used to develop an initial strategy which zones caribou habitat and describes management in those zones. Recommendations for forest management systems, access, and predation management are part of the strategy.

Caribou Habitat Use in the Chelaslie River Migration Corridor and Recommendations for Management

Author(s):

Date:

Source:

Number on Library Shelf: 143

<http://www.for.gov.bc.ca/hfd/pubs/docs/lmh/Lmh37.pdf>

The movements and habitat use of radio-collared caribou within the 80,000 hectare "migration corridor" between Tweedsmuir Park and the primary winter range were examined from spring 1993 through spring 1995. In the relatively mild winter of 1993/94, about half the animals used the study area for most of the winter. When used for wintering, caribou favoured older forest on poor tree growing sites (generally good lichen sites), and wetland/forest mosaics. During spring and fall migration movements, habitat use is less distinct. A management strategy is proposed consisting of: maintaining amounts of mature forest similar to that expected under long-term natural disturbance regimes, directing timber harvest primarily to areas of lower value to caribou, access control, and innovative silvicultural practices.

Ecosystem Management and the Conservation of Caribou Habitat in British Columbia

Author(s): Dale Seip

Date: No date

Source: --

Number on Library Shelf: 144

http://www.cmiae.org/_PDF/reference144.pdf

Woodland caribou (*Rangifer tarandus caribou*) in British Columbia inhabit a wide variety of forest ecosystems. Numerous research projects have provided information that has been used to develop caribou habitat management recommendations for different areas. Recently, the province has implemented guidelines to protect biodiversity that are based on an ecosystem management strategy of mimicking natural forest conditions. There is a great deal of similarity between caribou management recommendations and biodiversity recommendations within different forest types. In mountain caribou habitat, both approaches recommend maintaining a landscape dominated by old and mature forests, uneven-aged management, small cutblocks, and maintaining mature forest connectivity. In northern caribou habitat, both approaches recommend maintaining some older stands on the landscape (but less than for mountain caribou), even-aged management, and a mosaic of large harvest units and leave areas. The ecosystem management recommendations provide a useful foundation for caribou habitat conservation. More detailed information on caribou and other management objectives can then be used to fine-tune those recommendations.

Mountain Caribou in the Harrop Proctor Community Forest Area

Author(s): Kim Poole and Garth Mowat

Date: July 2001

Source: Contract to Harrop Proctor Community Forest Co-operative PO Box 5 Proctor BC V0G 1V0

Number on Library Shelf: 145

http://www.cmiae.org/_PDF/reference145.pdf

The goal of this literature review was to provide Co-op forest managers with the background knowledge to begin to integrate caribou habitat into their forestry planning. Specific objectives were to describe the historic distribution and current distribution and status of the South Selkirk caribou herd, describe seasonal habitats and movements of these animals and caribou from adjacent herds, and provide initial recommendations for management of caribou habitat within the forest tenure area.

Revelstoke and Area Land Use Planning Final Recommendations (“MAC Report” Caribou portion)

Author(s): Revelstoke and Area Minister’s Advisory Committee

Date: October 1999

Source: MAC Report, Pages 44-119

Number on Library Shelf: 153

<http://www.for.gov.bc.ca/dco/MAC/RLUPR99.pdf>

Includes guidelines for management of Mountain Caribou in the Columbia Forest District. Intent of guidelines are:

- To provide the amount and distribution of habitat required to maintain viable populations of the blue-listed mountain caribou in the Revelstoke herd.
- To minimize displacement of mountain caribou resulting from development and recreational activities in critical habitat.

Within the context of the land use plan, mountain caribou are being used as an umbrella species, in that the application of the guidelines, in combination with the biodiversity emphasis option allocation (see Section 3.2) is intended to address the needs of old growth dependent species in those ecosystems, at least until further information about such species allows for more specific management direction to be developed. In this plan, mountain caribou habitat is also seen to contribute to the intermediate biodiversity emphasis objectives.

Lichen Colonization and Gap Structure in Wet-temperate Rainforests of Northern Interior British Columbia.

Author(s): Shelly Benson and Darwyn Coxson

Date: 2002

Source: The Bryologist 105(4), pp. 673-692.

Number on Library Shelf: 154

http://wetbelt.unbc.ca/docs/Benson_and_Coxson_2002.pdf

Abundant canopy lichen communities characterize wet-temperate rainforests on the windward slopes of interior mountain ranges in north-central British Columbia, Canada. Historically, these forests have regenerated through gap-dynamics; however, our knowledge of lichen colonization within gaps is limited. We have now compared lichen biomass on regenerating trees in naturally occurring 1–3 ha gap-disturbances (these gaps presumed to have originated from insect out-breaks in the late 1800’s) with those on regenerating trees of similar age growing in the understory of the surrounding old

growth forest. Only small differences were seen in total lichen biomass on regenerating trees between the two settings, however, analysis of the individual lichen groups (Alectoria, Bryoria, Foliose, and Cyanolichen) revealed striking differences. The Bryoria group was 35% more abundant on gap trees (632 g/tree) and was distributed vertically through a larger proportion of the tree crown. The Cyanolichen functional group was largely absent from gap trees, despite high levels of biomass loading (1,332 kg/ha) in the surrounding old-growth stand. Alectoria and Foliose functional groups did not differ significantly in biomass or distribution between regenerating trees of the two types. Tree size positively affected lichen loading. Total lichen biomass was 38% greater on the larger size class (31–44 cm dbh) regenerating trees, with the Alectoria functional group alone having 45% greater biomass on larger trees. Presence or absence of leaves on branch substrate had no effect on lichen loading. Stand level projections indicate that the old growth forest had 19% more arboreal lichen biomass (2,684 kg/ha) and contained greater lichen species diversity than did the “second-growth” regenerating forest patches. The low cyanolichen biomass in naturally occurring gap openings poses concern for the proposed utility of “new-forestry” type harvesting practices to retain canopy biodiversity using current harvest rotation intervals.

Accounts and Measures for Managing Identified Wildlife (Caribou)

Author(s): Deborah Cichowski, Trevor Kinley and Brian Churchill

Date: BC Ministry of Water, Land and Air Protection

Source: 2004

Number on Library Shelf: 156

http://wlapwww.gov.bc.ca/wld/identified/documents/Mammals/m_caribou.pdf

The Identified Wildlife Management Strategy is an initiative of the Ministry of Water, Land and Air Protection, in partnership with the Ministry of Forests and carried out in consultation with other resource ministries, stakeholders and the public. Two companion documents address the management of Identified Wildlife, and together, comprise the Identified Wildlife Management Strategy (IWMS). The first document, Procedures for Managing Identified Wildlife, describes the procedures for establishing, modifying and rescinding a wildlife habitat area (WHA), and for implementing strategic and landscape level planning recommendations. The second document, Accounts and Measures for Managing Identified Wildlife, summarizes the status, life history, distribution and habitats of Identified Wildlife, and outlines specific guidelines for management of their habitats. These documents are a resource for government planners, foresters and wildlife managers, and for those persons interested in the life histories of Identified Wildlife.

Fire, Terrestrial Lichens, and the Itcha-Ilgachuz Caribou

Author(s): Trevor Goward

Date: February 1999

Source: Pp. 665-669 in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 1; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC.

Number on Library Shelf: 160

<http://wlapwww.gov.bc.ca/wld/documents/mc09goward2.pdf>

This paper presents 11 testable hypotheses pertaining to terrestrial lichens, forest dynamics, and woodland caribou on the Chilcotin Plateau of south-central British Columbia. Based on preliminary studies conducted in the lodgepole pine forests of the Very Dry, Cold subzone of the Sub-boreal Pine–Spruce biogeoclimatic zone (SBPSxc), it is suggested that caribou and terrestrial forage lichens are linked in a positive-feedback continuum dependent in the long term on periodic surface fire. The possibility is raised that fire suppression may adversely affect woodland caribou in this subzone. Further work is required.

Strategic Planning Tools for Mountain Caribou Conservation

Author(s): Clayton Apps Trevor Kinley, Joe Scott, Candace Batycki and John Bergenske

Date:

Source: Research and maps are presented in a poster format

Number on Library Shelf: 163

<http://www.mountaincaribou.org/pubs/poster.pdf>

This is a poster. No print version is available in the Revelstoke Library.

Mountain Caribou in 21st Century Ecosystems

Author(s): Columbia Mountains Institute of Applied Ecology

Date: 18-Oct-02

Source: Columbia Mountains Institute

Number on Library Shelf: 23

http://www.cmiae.org/_PDF/Caribou_2002-summary.pdf

see also http://www.cmiae.org/_PDF/Caribou_2006_summary.pdf for simialr conference hosted by CMI in 2006.

In 2000, the arboreal-lichen feeding caribou of British Columbia's southeastern mountains were "red-listed" by the British Columbia Conservation Data Centre and

designated as “threatened” by the federal Committee on the Status of Endangered Wildlife in Canada. These high-profile designations underscored the need to understand why population declines were occurring, and what could be done to reverse them.

Mountain caribou face a variety of challenges within their historic range. Factors such as past over-hunting, changes in forest structure and age, disturbances within their preferred habitat, climatic variability, and the changing abundance and distribution of their predators, could all be playing a role. It follows that solutions to the decline will be complex and will require the imagination and resolve of all users sharing mountain caribou range.

To encourage better communication between researchers and the various individuals and organizations that use mountain caribou range, the Columbia Mountains Institute of Applied Ecology held a conference in Revelstoke, British Columbia in October 2002. Thanks to the diverse background of our steering committee, we assembled and presented an agenda that we hope has furthered understanding of both the issues and the science surrounding the decline of mountain caribou populations.

A Strategy for the Recovery of Mountain Caribou in British Columbia

Author(s): The Mountain Caribou Technical Advisory Committee

Date: 01-Sep-02

Source:

Number on Library Shelf: 24

http://wlapwww.gov.bc.ca/wld/documents/mtcaribou_rcvrystrat02.pdf

The Strategy for Recovery of Mountain Caribou is a document for planning recovery actions for the Mountain Caribou, an arboreal lichen-winter feeding ecotype of the Woodland Caribou (*Rangifer tarandus caribou*) found primarily in southeastern British Columbia. The national strategy will include, but is not limited to, Mountain Caribou. The national strategy is the first part of a two-part National Recovery Plan for Woodland Caribou; the local population specific Recovery Action Plans is the second part.

Woodland Caribou in the Thompson-Nicola Resource Region

Author(s): Ministry of Environment

Date: 01-Jun-81

Source:

Number on Library Shelf: 85

This report discusses the status and management objectives for woodland caribou in the east-central portion of the province.

Recent Augmentation of Mountain Caribou to the Southern Selkirk Mountains of Northeastern Washington, Northern Idaho, and Southern British Columbia

Author(s): Jon Almack

Date: February 1999

Source: P 643. in L.M. Darling, ed. 2000. Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 1; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC.

Number on Library Shelf: 161

<http://wlapwww.gov.bc.ca/wld/documents/mc04almack.pdf>

Over a 3-year period, we transplanted 43 radio-marked mountain caribou from central British Columbia to the southern Selkirk Mountains of Washington, Idaho, and British Columbia. We have monitored these animals to determine initial movements from release site, seasonal movements, habitat use, recruitment, and cause of mortality. Five caribou have emigrated from the Selkirk Mountains recovery zone; 2 returned to the area, 3 died within weeks of leaving. Other movements and habitat use are still being analyzed and will be completed in time for presentation at the conference. We have observed calf production each year, but survival of this cohort is unknown. Twenty-six radio-collared caribou have died: 4 were killed by cougars, 1 by grizzly bears, 1 from accidental fall, 2 from poaching, and 18 from unknown causes. Monitoring of this population will likely continue for at least 2 more years. We also have initiated a cougar study in cooperation with the United States Fish and Wildlife Service, United States Forest Service, and British Columbia Wildlife Branch to determine the effects of predation on the survival of this endangered caribou population.

CMH Wildlife Operating Procedures (Winter)

Author(s): Dave Butler, Director, Land Resources for Canadian Mountain Holidays

Date: January 1, 2004

Source: Canadian Mountain Holidays

Number on Library Shelf: 167

<http://www.canadianmountainholidays.com/pdf/WildlifeOperatingProcedures.pdf>

Canadian Mountain Holidays has developed these operating practices to minimize the potential direct and indirect impacts of their activities on wildlife.

Mountain Caribou Consultation Document

Author: Species at Risk Coordination Office, Ministry of Environment Released by SARCO, Mark Zacharias

Date: October 18, 2005

Number on Library Shelf: 178

http://ilmbwww.gov.bc.ca/ilmb/pdfs/mountain_caribou_consultation_document_20051025.pdf

Includes recovery options for mountain caribou, situational analysis, information on specific herds, maps.

Staring at Extinction: Mountain Caribou in British Columbia, An Analysis of Planned logging in B.C.'s Inland Temperate Rainforest

Authors: Devon Page, Joe Scott, Candace Batycki

Date: May 2005

Source: Mountain Caribou Project

Number on Library Shelf: 173

<http://www.mountaincaribou.org/report.html>

We quantified the existing threats and present new information regarding the caribou recovery process. Through this report we intend to hold government and industry responsible for the ongoing cumulative impacts to mountain caribou habitat, and challenge them to make the necessary changes to avoid the extinction of this Canadian icon and the unravelling of the unique inland rainforest ecosystem.

Socioeconomic Baseline Analysis for the Kootenay Caribou Recovery Action Plans, Final Report

Authors: Economic Growth Solutions

Date: March 2005

Source: Prepared for B.C. Ministry of Water, Land and Air Protection

Number on Library Shelf: 176

http://www.cmiae.org/_PDF/reference176.pdf

B.C.'s Mountain Caribou: Last Chance for Conservation? (Special Report)

Author: Forest Practices Board

Date: September 29, 2004

Source: Forest Practices Board Special Report FPB/SR/22

Number on Library Shelf: 171

<http://www.fpb.gov.bc.ca/news/releases/2004/29-09.htm>

This internet address leads to the news release for the report, and has links to the full report and backgrounders.

14. PREDATION

Mortality patterns in a subpopulation of endangered mountain caribou.

Author(s): Trevor A. Kinley, Clayton D. Apps

Date: 01-Jan-01

Source:

Number on Library Shelf: 20

Mountain caribou are an endangered ecotype of woodland caribou (*Rangifer tarandus caribou*) occurring in the high-snowfall region of southeast British Columbia. They occur in a series of small subpopulations, some of which are declining. We conducted population surveys and mortality monitoring for mountain caribou in the southern Purcell Mountains of British Columbia from 1994 to 2000. The subpopulation declined, with annual growth rates of 0.62 to 0.88. This was because of low calf recruitment (mean late winter ratio=0.05) and high adult mortality (mean annual rate=0.24). Reasons for low recruitment were unknown, but most known-cause adult mortality was from predation, particularly by cougars (*Puma concolor*). Mortality was higher for females than males ($P=0.03$). The southern portion of the study area had a greater proportion of forests less than or equal to 40 years, a higher road density, and was more fragmented than the northern portion. Caribou mortality also was higher in the south than the north ($P=0.03$). This may have been due in part to post-disturbance changes in the distribution of ungulates favoring edges and early seral forests and the predators that were attracted to these ungulates. If current trends continue, the southern Purcell caribou herd will almost certainly be extirpated within a decade. We recommend augmenting this subpopulation, conducting research into relationships between predation and patterns of forest harvesting and reasons for low calf recruitment, and limiting predation by reducing numbers of cougars and alternate prey.

Predation and caribou populations

Author(s): Dale R. Seip

Date: 01-Jan-91

Source: Proceedings of the Fifth North American Caribou Workshop.
Yellowknife, Northwest Territories, Canada, 19-21 March 1991.

Heard, D. and Williams, M. (eds) .1991. 170pp.

Special Issue 7:46

Number on Library Shelf: 29

Predation, especially wolf (*Canis lupus*) predation, limits many North American caribou (*Rangifer tarandus*) populations below the density that food resources could sustain. The impact of predation depends on the parameters for the functional and numerical response of the wolves, relative to the potential annual increment of the caribou population. Differences in predator-avoidance strategies largely explain the major

differences in caribou densities that occur naturally in North America. Caribou migrations that spatially separate caribou from wolves allow relatively high densities of caribou to survive. Non-migratory caribou that live in areas where wolf populations are sustained by alternate prey can be eliminated by wolf predation.

A Review of Wolf-Caribou Relationships and Conservation Implications in Canada

Author(s): D.C. Thomas

Date: 27-Aug-92

Source: In: Carbyn, L. N.; Fritts, S. H., and Seip, D. R., eds. Ecology and conservation of wolves in a changing world ; 1992 Aug 25-1992 Aug 27; Edmonton, Alberta. Edmonton, Alberta: Canadian Circumpolar Institute; 1995: 261-607.

Number on Library Shelf: 93

This document discusses some strategies that can be used to conserve wolf and caribou populations in changing environments.

Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia

Author(s): Dale R. Seip

Date: 12-Feb-92

Source: Canadian Journal of Zoology 70:1494-1503

Number on Library Shelf: 99

http://www.cmiae.org/_PDF/reference99.pdf

2.6 MB (scanned)

Caribou (*Rangifer tarandus caribou*), wolves (*Canis lupus*), and moose (*Alces alces*) were radio-collared and monitored in two areas of southeastern British Columbia to determine predator- prey interactions. Throughout the year, wolves and moose used similar areas and habitats, and moose were the primary prey of wolves. In winter most caribou used high-elevation habitats and were spatially separated from wolves and moose living in valley bottoms. In summer, caribou, wolves, and moose at Quesnel Lake used similar areas and habitats, whereas in Wells Gray Park most caribou migrated to rugged, mountainous areas, which kept them spatially separated from wolves and moose. The Quesnel Lake caribou population had a high adult mortality rate (29%/year), wolf predation being the major cause. Calf survival to October was low (2.5/100 adult females) when wolves were present and uncontrolled in the area, but was significantly greater (39/100 adult females) when wolves were reduced or absent. The Quesnel Lake caribou population was found to be declining by about 25%/year, and wolf predation appeared to be the major limiting factor. Caribou in Wells Gray Park had a low adult mortality rate (8%/year) and comparatively high calf survival to October (37/100 adult females). The Wells Gray caribou population was found to be slowly

increasing, apparently because its migratory behavior kept it separated from wolves and moose throughout the year, resulting in low wolf predation on the caribou.

Antipredator tactics of calving caribou: dispersion in mountains

Author(s): A. T. Bergerud, H. E. Butler, D. R. Miller,
Date: 01-Jan-84
Source: Canadian Journal of Zoology. 62:1566-1575
Number on Library Shelf: 100

A study of mountain caribou (*Rangifer tarandus caribou*) was conducted from 1987 through 1989 to obtain information on calf survival, calving and summer habitat, timing of spring migration and distances moved to calving areas. In addition, the effect of winter severity and snowfall on calf survival based on data collected since 1981 was assessed. Observations of a sample of radio-collared adult female caribou provided detailed data on calf production, timing of movement to calving sites, calving habitat, fidelity to calving sites and timing of mortality of calves. In years when winters were severe or snowfall was high through April and May, radio-collared females did not move as far from their winter range to calve and calved at lower elevations, than years when winters were of average or above average severity and springs were relatively snow free. Correspondingly, low percentage calves in fall/early winter composition counts were associated with a previous severe winter or late spring. Calving habitat was variable, though located primarily above 1600 m, and calving sites were widely dispersed. Dispersal to higher elevation calving sites was considered to be an antipredator strategy that was disrupted when snow cover on the winter range extended late into the spring. Over nine years of monitoring, the mean percentage calves in fall/early winter composition counts was 14 and four years of low calf survival negated five years of average or above average calf survival.

The Influence Of Wolves On The Ecology Of Mountain Caribou

Author(s): Bradley Armstrong Allison
Date: 01-May-98
Source: Thesis, 40 pp. Label:M-862 The University of British Columbia
Number on Library Shelf: 111

The wolf (*Canis lupus*)/mountain caribou (*Rangifer tarandus caribou*) spatial separation model (Seip 1992a) was examined in highland and mountainous area of east central and southeastern British Columbia to determine the influence of wolves on mountain caribou ecology. Three key elements investigated were: the importance of wolf predation as a mountain caribou mortality factor, the elevational relationship of mountain caribou, wolves, and moose (*Alces alces*) and the seasonal dietary importance of moose to wolves. Mountain caribou mortality data from the Columbia Mountains and Quesnel Lake supported the hypothesis that wolf predation is greater in

highland than in mountainous areas. Wolf predation was the main mortality factor of caribou in the highlands around Quesnel Lake, but was a minor factor in the other three study areas. Wolf predation at Quesnel Lake occurred primarily during summer/fall at low elevations. Mountain caribou, wolf and moose radio-telemetry data suggested that wolves in both highland and mountainous areas are more closely associated with moose than caribou throughout the year. Caribou in highland areas appeared as adept as those in rugged mountains at spacing elevationally away from wolves during all seasons. Significant elevational overlap between wolves and caribou occurred only in the rugged Columbia Mountains, and then, only during summer/fall. Wolf scats from the Columbia Mountains indicated that mountain caribou were of lesser dietary importance than moose to wolves throughout the year. Moose, particularly in winter, were the main diet item of wolves. Beaver was an important dietary item of wolves during summer/fall. Elevational separation appears inadequate in explaining the variation in wolf predation on mountain caribou in the highland and mountainous study areas.

Factors influencing the dispersion and fragmentation of endangered mountain caribou populations

Author(s): Clayton D. Apps, Bruce N. McLellan

Date: 2006

Source: Biological Conservation 130 (2006) pages 84-87

Number on Library Shelf: 125

Mountain caribou, an ecotype of woodland caribou, are endangered due to the loss and fragmentation of old forests on which they depend. However, a wider array of natural and human factors may limit caribou persistence and isolate populations, and understanding these may help to stop or reverse population declines by forecasting risk and targeting core habitat areas and key linkages for protection, enhancement, or restoration. Across most of the historic range of mountain caribou, we conducted a bi-level analysis to evaluate factors related to the persistence of, and landscape occupancy within, remaining subpopulations. We used caribou location data from 235 radio-collared animals across 13 subpopulations to derive a landscape occupancy index, while accounting for inherent sampling biases. We analyzed this index against 33 landscape variables of forest overstory, land cover, terrain, climate, and human influence. At the metapopulation level, the persistence of subpopulations relative to historic range was explained by the extent of wet and very wet climatic conditions, the distribution of both old (>140 yr) forests, particularly of cedar and hemlock composition, and alpine areas. Other important factors were remoteness from human presence, low road density, and little motorized access. At the subpopulation level, the relative intensity of caribou landscape occupancy within subpopulation bounds was explained by the distribution of old cedar/hemlock and spruce/subalpine fir forests and the lack of deciduous forests. Other factors impeding population contiguity were icefields, non-forested alpine, hydro reservoirs, extensive road networks, and primary highway routes. Model outputs at both levels were combined to predict the potential for mountain caribou population persistence, isolation, and restoration. We combined this output with

the original occupancy index to gauge the potential vulnerability of caribou to extirpation within landscapes known to have recently supported animals. We discuss implications as they pertain to range-wide caribou population connectivity and conservation.

Wolverine Ecology and Habitat Use in the North Columbia Mountains: Progress Report

Author(s): John Krebs, David Lewis

Date: Feb 1999

Source: Proc. Conf. on the Biology and Manage. Species and Habitats at Risk, Kamloops, B.C., 15-19 Feb., 1999. Vol. 2; B.C. Minist. Environ., Lands and Parks, Victoria, BC, and Univ. College of the Cariboo, Kamloops, BC. 520pp.
Number on Library Shelf: 130

<http://wlapwww.gov.bc.ca/wld/documents/ca08krebs.pdf>

We are currently completing a multi-year project investigating demography and habitat use of a harvested population of wolverine (*Gulo gulo*) in a 7,000 km² area within the Kootenay region of British Columbia. The study area contains 10 registered trap lines, 2 national parks, a major transportation corridor, 2 hydroelectric reservoirs, and active logging areas and supports a substantial helicopter skiing industry. Wolverine are considered vulnerable by the British Columbia Wildlife Branch; consequently, vital rate data are important for evaluating management/conservation options. A total of 39 (14 F 25 M) adult and subadult wolverine have been captured over 3,700 trap nights using log-box traps baited with available road-killed wildlife. Population estimates for the core 4,000 km² study area based on 4 years of live-trapping data are 25.6 (95% CI: 15.6-55.3) and 24.0 (95% CI: 14.7-44.3) for 1996 and 1997 respectively. Six of 11 mortalities detected during the study to date have been human caused. Annual survival rate was estimated to be .77 (95% CI: 0.66-0.88) for all age and sex categories combined. Reproductive data are being gathered through radio-telemetry and follow-up ground investigations of breeding females after den abandonment. Three 2-kit litters have been produced in 14 adult female reproductive seasons. Four of these juveniles have been captured and implanted with radio transmitters. Natal den sites have been in the Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zone, and associated with woody debris and/or large boulder talus in undeveloped drainages. Home ranges of males (mean = 1,005 km²) were significantly larger than those of females (mean = 310 km²). At the study area scale, the distribution of wolverine use is highly clumped in 4 distinct utilization peaks. The 2 largest utilization peaks occur within Glacier and Mount Revelstoke National Parks, disproportionate to their land base within the study area. The focus for the remainder of the project is on the monitoring of existing females and kits, and identification and characterization of natal dens in spring 1999. A population census using motion-sensitive cameras will be conducted March-April 1999. Final report and management recommendations will be completed in 2000-01.

Revelstoke Mountain Caribou Recovery: An Independent Review of Predator-Prey-Habitat Interactions

Author(s): Francois Messier, Doug Heard, and Stan Boutin

Date: March 2004

Source: Submitted to Revelstoke Caribou Recovery Committee

Number on Library Shelf: 158

http://www.cmiae.org/_PDF/reference158.pdf

The mandate of this panel was:

- To improve collective understanding of the complex predator-prey-habitat interactions that affect mortality of mountain caribou herds within the Revelstoke and Central Rockies area.
- To provide advice regarding prioritized research activities that should be initiated to conserve mountain caribou herds within a context of adaptive management.
- To propose mitigation actions that could be implemented in order to foster recovery of caribou populations in the Revelstoke area.

Wolves, Bears, and their Prey in Alaska: Biological and Social Changes in Alaska

Author(s):

Date: 1997

Source: National Academies Press, Washington DC

Number on Library Shelf: 159

<http://books.nap.edu/books/0309064058/html/index.html>

This book assesses Alaskan wolf and bear management programs from scientific and economic perspectives. Relevant factors that should be taken into account when evaluating the utility of such programs are identified. The assessment includes a review of current scientific knowledge about the dynamics and management of large mammalian predator-prey relationships and human harvest of wildlife in northern ecosystems, and an evaluation of the extent to which existing research and management data allow prediction of the outcome of wolf management or control programs and grizzly bear management programs. Included is an evaluation of available economic studies and methodologies for estimating the costs and benefits of predator control programs in Alaska.

Ecological interactions among caribou, moose, and wolves: Literature review

Authors: Thomas Chowns, Cormack Gates

Date: December 2004

Source: National Council for Air and Stream Improvement, Inc. (NCASI). 2004.

Technical Bulletin No. 0893. Research Triangle Park, NC:

Number on Library Shelf: 175

<http://www.ncasi.org/Publications/Detail.aspx?id=2697>

Woodland caribou populations are declining in many areas of Canada and there is concern that the decline may be associated with timber harvesting. Caribou, moose, and wolves share a long evolutionary history and their relationships may become altered by large-scale landscape disturbance. This technical bulletin presents a review of scientific literature pertaining to the hypothesis that increases in moose and wolf populations after timber harvesting have adverse effects on caribou. Specifically, large-scale habitat changes that have allowed moose populations to increase and thereby sustain higher wolf numbers presumably have resulted in excessive predation on caribou, apparently resulting in caribou population declines.

Differentiation of caribou by ecotype rather than phenotype has advantages for conservation purposes. The "forest-dwelling" ecotype of woodland caribou often move across extensive areas at low densities, and populations have been difficult to define and monitor. Woodland caribou and moose often partition habitats on the landscape, such that caribou tend to graze mostly lichens and occupy nutrient-poor forest types, while moose browse vascular plant species such as willows, which are associated with more productive environments. The relatively high reproductive potential of moose enables their populations to respond rapidly to a superabundance of forage produced after forest fires or logging. Carrying capacities for caribou increase more slowly and are likely to decline suddenly after such disturbances.

Some caribou populations experience the effects of multiple predators such as grizzly bears, black bears, cougars, coyotes, wolverines, lynx, eagles, and humans. The predation rate is determined by the predator's functional and numerical responses to changes in prey density. Some of the most viable caribou populations are those that employ anti-predator strategies which reduce encounter rates with wolves at calving time. These include migrating away from wolf denning habitat, seeking refuge on islands, bogs, and shorelines, and parturient females dispersing away from caribou concentrations.

Food selection by wolves is influenced by profitability relative to energetic costs of travel, especially in snow, and dangers in attacking large prey. If primary prey become less abundant, it may be more profitable for wolves to switch to another prey species. Critical thresholds in predator and prey densities affect population dynamics. In some areas, woodland caribou populations are too low to sustain wolves without alternate prey such as moose. Caribou appear in decline or may be eliminated in areas where

wolves exceed critical densities. On the other hand, caribou populations have been known to change by several orders of magnitude, especially where herds are migratory and alternate prey for wolves are low in numbers or lacking. Several factors such as age, nutritional state, season, disease, parasites, and genetic load are capable of affecting caribou vulnerability to predation. The very young and the very old are usually the most heavily preyed upon.

Recent changes in ungulate and carnivore distributions may be influenced by climate change and human activities. Measures implemented to conserve woodland caribou populations include hunting restrictions, reintroductions, predator control, parks and protected areas, and national and provincial recovery strategies.

Caribou habitat and commercial forest overlap in some regions and the effects of forestry on caribou vary according to the ecological setting. Roads and seismic-exploration trails may allow greater penetration of wolves into areas occupied by caribou, and vehicular traffic may displace caribou into closer proximity to moose and wolves. The design of forest harvest pattern may significantly affect predator-prey relationships. A mosaic of small cutovers across extensive areas or cutting upland sites in close proximity to fen/bog habitat may be undesirable for caribou management. Silvicultural activities that are compatible with lichen retention and discourage moose browse production are expected to be the most beneficial for caribou. Although fire control may conserve caribou habitat in the short term, fire is an integral part of the boreal forest and this animal is adapted to a fire environment. Further research and management needs have been recommended.

Relating predation mortality to broad-scale habitat selection

Authors: Philip McLoughlin, Jesse Dunsford and Stan Boutin

Date: 2005

Sources: Journal of Animal Ecology 2005, **74**, 701-707

Number on Library Shelf

Summary:

1. Few studies have related metrics of fitness to broad-scale, multivariate patterns of resource selection.
2. Our objective was to relate long-term predation-mortality patterns for adult woodland caribou [*Rangifer tarandus caribou* (Banfield)] from Alberta, Canada (1991–2002), with patterns of multivariate habitat selection.
3. We first compared probabilities of radio-tracked caribou dying ($n = 55$) from predation in habitats within the home range, controlling for habitat availability, with that expected from habitat selection probabilities for the same animals during life. We then compared survival rates of caribou ($n = 141$) possessing dissimilar patterns of habitat selection using a Cox proportional hazards regression model.
4. Patterns in habitat-specific predation mortality differed significantly from expected given probabilities of habitat selection during life ($P < 0.0001$). Cox regression indicated

that mortality rates of caribou due to predation were affected significantly by and can be predicted from patterns of selection ($P = 0.02$).

5. Our results strongly suggest that uplands (primarily mixed deciduous and coniferous forest) present caribou with higher than expected levels of predation risk, and that caribou can avoid predation by maximizing selection of peat lands (open, conifer dominated bogs and fens).

6. Approaches presented in this study may be useful for ecologists interested in assessing the influence of mortality factors on broad-scale, multivariate resource selection. Linking metrics of fitness to multivariate resource selection will enable us to ask questions of evolutionary ecology once restricted to only the finest ecological scales.

Ecological interactions of mountain caribou, wolves, and moose in the north Columbia Mountains, British Columbia

Author: Shannon A. Stotyn

Date: Spring 2008

Source: Master's thesis, University of Alberta, Edmonton

Number on library shelf: 180

http://www.cmiae.org/_PDF/reference180.pdf

The Southern Mountain population of mountain caribou (*Rangifer tarandus caribou*) is threatened in Canada, with predation the proximate cause of these declines. To reduce predation risk, caribou isolate themselves from predators and other prey species. I examined the spatial partitioning of mountain caribou, moose (*Alces alces*), and wolves (*Canis lupus*), and mortality sources of caribou in the north Columbia Mountains, British Columbia (2003 – 2006). Spatial separation between caribou and wolves was highest in late winter and lowest in spring and calving season. Engelmann spruce/subalpine fir forests, alpine areas, and old forests (> 140 yrs) were important variables that separated these species. The main predator of adult caribou was bears, with wolf predation increasing in importance after 2000. Wolf diet was comprised of moose (91 – 99%) with small relative proportions of caribou, deer, and beaver. This information will provide critical information for effective wildlife management and planning caribou recovery strategies.