Mountain Caribou in 21st Century Ecosystems

October 16–18, 2002
Revelstoke, British Columbia
Canada

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Table of Contents

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- John Woods, Conference Chair, Mount Revelstoke and Glacier National Parks
- Del Williams, Field trip co-ordinator, Revelstoke Community Forest Corporation
- Dave Butler, Canadian Mountain Holidays
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- Jackie Morris, Columbia Mountains Institute
- Bruce McLellan, British Columbia Ministry of Forests
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- Guy Woods, British Columbia Ministry of Water, Land and Air Protection

Thanks are also due to the volunteers at the conference, who assisted in keeping the event running smoothly:

- Ian Adams, Corvus Communications
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- Nora Manners, North Columbia Environmental Society

And, of course, we want to thank the conference participants, who travelled from as far away as Finland, Pond Inlet, and New Hampshire to attend the conference.

Introduction

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.

Conference Overview

The three-day *Mountain Caribou in 21st Century Ecosystems* conference consisted of two days of presentations and a field trip on October 18th. At the end of each day of presentations, the speakers gathered at the front of the room for a question and answer period, and a panel discussion. No record was kept of the comments during the panel discussion.

Over 180 people attended the conference and the field trip was fully subscribed at 80 people.

On the evening of October 16th, Dale Seip of the British Columbia Ministry of Forests presented "Mountain Caribou in British Columbia – A Threatened Future." This presentation was open to the public as well as conference participants. About 80 people attended the talk.

The conference was held at the Revelstoke Community Centre, 600 Campbell Avenue in Revelstoke, British Columbia.

Summaries of Presentations

The summaries that follow were provided by the authors who presented at the conference. Some presenters did not submit a summary. Contact information is provided for all presenters, along with the invitation to contact the presenters directly for more details about their projects.

List of Conference Participants

To protect the privacy of the people on our conference participant list, we have not included contact information for participants in this document. If you wish assistance in locating an individual, please contact the CMI office.

About the Columbia Mountains Institute of Applied Ecology

The Columbia Mountains Institute of Applied Ecology (CMI) is a non-profit society established in 1996 to promote, facilitate, and support co-operative interdisciplinary research centred on the Columbia Mountains of southeastern British Columbia. The CMI seeks to facilitate collaboration among researchers, conduct research, and communicate knowledge on the Columbia Mountains ecosystems to the public, educators, and decision-makers. A volunteer Board of Directors manages the Institute. CMI's membership is comprised of government agencies, community agencies, academic institutions, private businesses, and members of the public.

Conference Agenda

Day One: Wednesday, October 16

08:30 **Opening Remarks**, by John Woods, Mount Revelstoke and Glacier National Parks, Conference Chair
Welcome from the City of Revelstoke, by Mayor Gail Bernacki

08:45 **Biology of Mountain Caribou**, by Bruce McLellan, British Columbia Ministry of Forests

09:15 **Southern Mountain Woodland Caribou: A National Perspective**, by Don Thomas, Thomas Wildlife Services.

10:15 *Refreshment break*

10:30 **A Strategy for the Recovery of Mountain Caribou in British Columbia,** by Ian Hatter, British Columbia Ministry of Water, Land and Air Protection

11:15 **Sticks, Carrots, and Caribou: Legal Processes Influencing Activities in Caribou Habitat in British Columbia**, by Jenny Feick, British Columbia Ministry of Water Land, and Air Protection, and David Fraser, British Columbia Ministry of Water Land and Air Protection

11:45 **US Southern Selkirks Mountain Caribou Herd**, by Jon Almack, Washington Department of Fish and Game

12:15 *Lunch*

13:30 **Opening Remarks** by Rachel Holt, Veridian Ecological Consulting, afternoon Chair

13:35 **Application of Central Selkirks Mountain Caribou Inventory Results into a Landscape Unit Planning Strategy for TFL 23**, by Dennis Hamilton, Nanuq Consulting, and Cameron Leitch, Pope and Talbot Inc.

14:00 **Southern Purcells Caribou: Status and Action**, by Trevor Kinley, Sylvan Consulting Ltd.

14:30 **Caribou Management: A Precautionary Approach?** by Greg Utzig, Kutenai Nature Investigations Ltd.

15:00 *Refreshment Break*

15:30 **Caribou Response to Linear Developments in a West-Central Alberta Landscape**, by Paula Bentham, Golder Associates and University of Alberta

16:00 **Panel Discussion:** Mountain Caribou Recovery: How Do We Get There? Moderator Guy Woods, Ministry of Water, Land and Air Protection

17:00 *Social*

Evening Presenter

Open to the community, 20:00 pm at the Revelstoke Community Centre:

"Mountain Caribou in British Columbia – A Threatened Future"

Dale Seip, Wildlife Habitat Ecologist, Ministry of Forests, Prince George Forest Region

Day Two: Thursday, October 17

08:30 **Opening Remarks** by Dave Butler, Canadian Mountain Holidays, morning Chair
08:35 **Working with the Caribou Forestry Guidelines: Putting It on the Ground**, by Del Williams, Revelstoke Community Forest Corporation
09:00 **A 21st Century Approach to Forest Management for Mountain Caribou**, by Harold Armleder, British Columbia Ministry of Forests
09:30 **Recruiting Caribou Habitats Using Silvicultural Treatments,** by Colene Wood, British Columbia Ministry of Water, Land and Air Protection.

10:00 *Refreshment Break*

10:30 **Partial Cutting and Forage Lichens: New Results**, by Susan Stevenson, Silvifauna Research and Darwyn Coxson, University of Northern British Columbia.
11:00 **Retention Systems Silviculture in Caribou Habitat**, by Wes Bieber, Weyerhaeuser Company
11:30 **Hair Lichens, Snowpack Variation and the Fate of the Mountain Caribou: The LSC Hypothesis,** by Trevor Goward, Enlichened Consulting Ltd.

12:00 *Lunch*

13:00 **Opening Remarks** by Cindy Pearce, Mountain Labyrinths Consulting, afternoon Chair
13:05 **Recreation and Caribou: What Do We Know About the Affects of Recreation on Caribou?** by Bruce McLellan, British Columbia Ministry of Forests
13:30 **Snowmobiles and Caribou:** by Tom Dickson, Revelstoke Snowmobile Club, and Pat Whiteway, British Columbia Snowmobile Federation.
14:10 **A Retrospective GIS Analysis of Spatial Interactions between Mountain Caribou and Helicopter Skiing**, by Steven Wilson, EcoLogic Research, and Dennis Hamilton, Nanuq Consulting
14:40 **Does Human Activity Affect Woodland Caribou in Jasper National Park?** by George Mercer, Jasper National Park

15:10 *Refreshment Break*

15:30 **Designing Credible Field Studies on the Effect of Human Disturbance on Mountain Caribou**, by Steven Wilson, EcoLogic Research
16:00 **Tracking the Prolific Past: An Historical Overview of Caribou Abundance in the Columbia Mountains**, by Eileen Delehanty Pearkes, writer and independent researcher
16:30 **Panel Discussion:** Mountain Caribou Recovery: What are the priorities, actions, and partnerships we need to be working on? Moderator Dennis Hamilton, Nanuq Consulting

Day Three: Friday, October 18

Field Trip

The full-day field trip went north of Revelstoke into caribou range and explored the themes of: forest management practices for caribou; the relationship between serial stages and predation; and the relationship between access, recreation, and disturbance.

(See field trip description on page 51 at the end of the presentation summaries.)

Presentation Summaries

1. Biology of Mountain Caribou

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All caribou in North America can be divided into two groups: 1) forest-dwelling sedentary caribou that disperse during calving, and 2) forest-tundra migratory caribou that concentrate during calving. The forest-dwelling sedentary caribou can further be divided into those that forage on both arboreal and terrestrial lichens and live in areas with relatively shallow snow and those that live in areas with deep snowpacks and forage almost exclusively on arboreal lichens during mid to late winter. In British Columbia, these caribou living in mountainous, deep-snow areas have been called mountain caribou. The distribution and abundance of mountain caribou has been declining over the past century and their status is of growing concern.

Because mountain caribou feed almost exclusively on arboreal lichens and these lichens are most abundant on older trees, there has been a long-standing management conflict over forest practices that reduce the amount of old forests. This conflict has received great attention and has resulted in a variety of forest management plans across several spatial scales. As populations continue to decline, concern has been also directed at other activities in caribou habitat and in particular winter recreation. However, in most areas predation is the major limiting factor causing population declines. It appears that the wet-belt ecosystem that supported larger numbers of mountain caribou in the past is gradually being transformed to a younger ecosystem that contains greater numbers of other prey species and their predators, which, in combination with a great variety of human activities, is causing caribou numbers to decline.

For more information on the general biology of mountain caribou, visit the Columbia Mountains Institute of Applied Ecology web site, www.cmiae.org and look in the "National Park Feature Articles" section.

2. Southern Mountain Woodland Caribou: A National Perspective

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Don discussed how mountain caribou in British Columbia fit into the larger picture of woodland caribou (*Rangifer tarandus caribou*) in North America. Information comes from a draft status report on forest-dwelling woodland caribou that he updated from late 2000 to September 2002.

The report was commissioned by the *Committee on the Status of Wildlife in Canada* (COSEWIC) (http://www.cosewic.gc.ca). Don discussed mountain caribou in relation to other caribou populations under the headings: taxonomy and terminology, COSEWIC National Ecological Areas/populations, caribou ecotypes, caribou genetics, distribution, range, numbers, trend in numbers, concerns/threats, and risk designations. Some highlights are listed here.

In 1994, COSEWIC divided Canada into eight National Ecological Areas (NEAs). The eight COSEWIC NEAs were an amalgamation of 15 ecozones established in 1986. Separate risk designations can be applied to populations in COSEWIC NEAs provided that they are genetically and geographically distinct and nationally significant. That provision was critical to conservation of caribou in Canada. It was realized that countrywide risk designations were untenable for wide-ranging species. With exclusion of forest-tundra caribou, almost all forest-dwelling caribou occur in the Newfoundland, Northern Mountain, and Boreal populations. The status of those COSEWIC populations is best assessed through a numerical compilation of the demographics of local populations within them.

Another method of dividing caribou into units for conservation and management is use of ecotypes. Ecotype designations across Canada include eaters of terrestrial lichens and eaters of arboreal lichen eaters in British Columbia (Northern and Mountain), Mountain and Boreal in Alberta, Boreal and Forest-Tundra in Ontario, and sedentary and migratory in Quebec. However, woodland caribou do not seem to fit into any one system of ecotype classification. Nevertheless, ecotypes are useful conceptually to facilitate discussions of caribou ecology and in planning such activities as forest prescriptions.

Analysis of mitochondrial DNA indicated that woodland caribou in North America were derived from two clades that evolved in isolation during the second half of the Wisconsinan glaciation. Many caribou populations in North America apparently are mixtures of the two clades. Specifically, the four local populations in the Southern Mountain population that were examined (Selkirk, Southern Purcells, Cariboo Mountains, and Jasper) were predominantly from the northern clade that gave rise to barren-ground (*R. t. granti, R. t. groenlandicus*) and Peary caribou (*R. t. pearyi*) in Alaska and Canada. All tested populations (four) in the Northern Mountain population in Yukon were "pure" northern clade. The results make current caribou taxonomy problematic and justify use of COSEWIC NEA/populations. Whereas caribou in the Cordilleran Mountains of western North America are predominantly of northern origin, those in the Boreal NEA to the east are entirely or predominantly of southern origin. Further DNA results should clarify boundaries of pure and mixed populations.

The distribution of woodland caribou has shrunk considerably over the past 150 years. Perhaps the greatest retraction is by caribou in COSEWIC's Southern Mountain population in southern British Columbia. Range reduction there is undoubtedly greater than the 40% estimate for all of British Columbia. Current range sizes of local populations reflect that range reduction. For example, 10%, 33%, and 63% of local populations in the Southern Mountains population are in ranges smaller than 1000 km^2, 2000 km^2, and 5000 km^2, respectively. Corresponding percentages for mountain caribou are 15, 23, and 54. A similar situation exists in the Boreal population.

The Southern Mountain population in British Columbia /Alberta contains about 7200 caribou or 3.9% of forest-dwelling caribou in North America. Mountain caribou in British Columbia comprise only 1% of forest-dwelling caribou in North America and 26% of the Southern Mountain population. About 78% of forest-dwelling caribou occur in the Newfoundland and Northern Mountain populations.

A major concern is that 46%, 54%, and 77% of local populations of mountain caribou in British Columbia contain fewer than 50, 100, and 250 individuals, respectively. Corresponding numbers for the Southern Mountain population are 27%, 37%, and 70%.

From 1997 to 2002, the downward trend for the Southern Mountain population in British Columbia averaged 2.46%/year. It appears to have the greatest rate of decline of all caribou in Canada. In 2002, trends in numbers for 30 local populations are 12 decreasing, 13 about stable, and 5 unknown. Corresponding numbers for mountain caribou in British Columbia are 6, 6, and 1. A similar situation prevails in the Boreal population where, unfortunately, trends are unknown for a majority of local populations. By contrast, in Newfoundland, most local populations are increasing in number or are stable. The population increased to 100 000 from 25 600 in 22 years. The Northern Mountain population has a near balance of increasing and decreasing local populations.

The concerns for local populations in COSEWIC's Southern Mountain population are predation, access/disturbance, developments including forestry, available habitat, fragmentation/isolation, low numbers, fire, and unregulated hunting. By contrast, unregulated hunting is the greatest concern in the Northern Mountain population. Major concerns in the Boreal population are predation, fire, range fragmentation, and access/disturbance. Predation and access/disturbance are predominant concerns in Newfoundland.

Because of scale, national designations encompass large ecological areas and therefore must strike a balance among a range of risk to individual local populations. In May 2000, COSEWIC designated the Southern Mountain population *threatened*.

This comparison of mountain caribou with other populations of forest-dwelling caribou in North America suggests that conservation of the ecotype will require a high degree of monitoring, ecological knowledge, cooperative management, and a favourable political, economic, and physical climate.

3. A Strategy for the Recovery of Mountain Caribou in British Columbia

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The following is the Executive Summary taken from "A Strategy for the Recovery of Mountain Caribou in British Columbia." The full document is available as a downloadable PDF file at: http://wlapwww.gov.bc.ca/wld/documents/mtcaribou_rcvrystrat02.pdf

The "Strategy for Recovery of Mountain Caribou in British Columbia" 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. It is intended to complement a National Recovery Strategy for Woodland Caribou. The national strategy will include, but is not limited to, Mountain Caribou. Both the National Recovery Strategy and the Strategy for Recovery of Mountain Caribou in British Columbia establish the need and priority for development of local population-specific Recovery Action Plans for Woodland Caribou.

Section I provides the introduction and background information. The British Columbia Conservation Data Centre (CDC) placed the Mountain Caribou on the provincial Red List in 2000. The CDC Red List includes species that are candidates for legal status as provincially Threatened or Endangered. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated caribou in the Southern Mountains National Ecological Area (SMNEA), including all Mountain Caribou, on their Threatened list in May 2000 and reaffirmed this designation in May 2002. The COSEWIC designation includes species that are candidates for formal national Threatened status under the new federal Species at Risk Act (SARA). A small, transboundary population of Mountain Caribou in the South Selkirks was officially designated as Endangered in the United States in 1984. Thus, British Columbia has provincial, national, and international responsibilities for maintaining Mountain Caribou.

Section II, Evaluation of Conservation Status, first identifies factors contributing to vulnerability and Threatened status, then examines the role of Mountain Caribou in the ecosystem and interactions with humans. Historically, Mountain Caribou were apparently more widely distributed and abundant than today. One estimate is that Mountain Caribou have been extirpated from 43% of their historic British Columbia range. British Columbia currently has an estimated 1900 Mountain Caribou distributed in 13 local populations that collectively form a metapopulation. Widespread habitat alteration, past over-hunting, and increased predation are believed to have contributed to the disappearance of Mountain Caribou from portions of their historic range in British Columbia. Today, the primary threat to Mountain Caribou appears to be fragmentation of their habitat. Associated with this fragmentation are potential reductions in available winter food supply, increased human access and associated disturbance, and alteration of predator-prey relationships. For these reasons, forest practices are currently considered to be

the greatest habitat management concern. Increasing interest in mechanized backcountry recreation poses a more recent potential threat to caribou.

General considerations for recovery under Section II outline a conservation ranking for local populations, and present a conservation approach that employs the metapopulation concept, the precautionary principle, adaptive management, and ecosystem management principles. The most effective means to satisfactorily resolve conflicts between management of habitat for Mountain Caribou and competing land uses is to use existing information and conservation principles over the short term, employ adaptive management over the longer term, and ensure full participation of all relevant stakeholders in the decision-making process.

The Recovery Goals and Objectives under Section III identify three goals and associated objectives to advance the recovery of Mountain Caribou:

1. A metapopulation of 2500–3000 caribou distributed throughout their current range in British Columbia
2. Enhancement of identified local populations
3. Public support for the recovery of Mountain Caribou and their habitats.

Goal 3 recognizes that integrated resource management and public interest and involvement are key to recovery.

In Section III, Provincial Recovery Actions describes 20 recovery actions. For each one, the status of the issue, the recovery action proposed, and some possible concerns with implementing the action are identified.

Section IV, Recovery Strategy Implementation, identifies three general principles for realizing the recovery goals and objectives. These include ensuring that recovery actions will be science-based, that recovery will be based on shared stewardship, and that recovery will be based on financial capacity. It is recognized that maintaining Mountain Caribou and their habitat in perpetuity throughout their range will require the cooperation of government agencies, the forest industry, commercial recreation operators, local communities, First Nations, and non-government organizations (NGOs). An implementation schedule is provided, which identifies the priority of each recovery action, possible co-operators, target date for completion, and required funding. The schedule should be used in the regular monitoring of all provincial recovery actions and as a basis for the funding of recovery measures. The schedule should also be reviewed on an annual basis to evaluate progress and to update activities according to changing circumstances.

A major purpose of the Strategy for Recovery is to outline an approach that will lead to down-listing of Woodland Caribou from their Threatened status under COSEWIC for the SMNEA and down-listing by the CDC. Implementing the provincial recovery actions will require an estimated $3.5 million over five years. The recovery strategy should be reviewed and updated after five years (2007) to determine whether progress towards the goals and objectives has been achieved, to review and prioritize provincial actions as needed, and to update the strategy document with new information.

4. Sticks, Carrots, and Caribou: Legal Processes Influencing Activities in Caribou Habitat in British Columbia

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Increased public demand for the protection of biodiversity, including species at risk, has resulted in a complicated working environment of changing laws, procedures, market forces, trade sanctions, and boycotts. This presentation provided an overview of some of these programs, including: the National Accord for the Protection of Species at Risk; British Columbia's current tools for protection of species at risk, particularly Mountain Caribou; and some of the National and international programs and policies that serve as incentives in recovery planning for species such as Mountain Caribou.

For more information please visit these web sites, which were referenced during the presentation.

Topic	Web Site
British Columbia Ministry of Water, Land and Air Protection, Biodiversity Branch	http://wlapwww.gov.bc.ca/wld
Accord for the Protection of Species at Risk	www.speciesatrisk.gc.ca/sar/strategy/accord_e.htm
"New Era" document quote "Environmental management based on sound science"	www.gov.bc.ca/prem/popt/letters/ne_elp.htm
British Columbia Ministry of Water, Land and Air Protection Mission, which is also the ESD Goal in the WLAP Service Plan	www.gov.bc.ca/prem/popt/corereview/srv_pln/wlap/wlap.pdf
"Identify, protect and restore species at risk and their habitat"	www.gov.bc.ca/prem/popt/corereview/srv_pln/wlap/wlap.pdf (noted as the first ESD Objective in the Service Plan)
British Columbia Wildlife Act	http://www.qp.gov.bc.ca/statreg/stat/W/96488_01.htm
Forest Practices Code of BC Act	http://www.for.gov.bc.ca/code/
Convention on International Trade in Endangered Species of Wild Fauna and Flora	www.cites.ec.gc.ca

US General Accounting Office	http://www.gao.gov
Conserving Borderline Species: A Partnership between the United States and Canada	http://www.speciesatrisk.gc.ca/species/sar/publications
North American Agreement on Environmental Co-operation	www.cec.org/home
Pelly Amendment	http://laws.fws.gov/lawsdigest/fishpro.html
Forest Stewardship Council	www.fscoax.org/principal.htm
Canadian Standards Association	www.csa-international.org
"New Era" commitment – eco-labelling British Columbia forest products	http://www.bcliberals.com/files/12_Environment.pdf

5. US Southern Selkirks Mountain Caribou Herd

Jon Almack, Washington Department of Fish and Game
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No summary was provided. Please contact Jon for information about the US southern Selkirk herd of mountain caribou.

6. Application of Central Selkirks Mountain Caribou Inventory Results into a Landscape Unit Planning Strategy for TFL 23

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The Central Selkirks sub-population of mountain caribou (*Rangifer tarandus*) is a conservation concern, and habitat management for the species could have considerable economic consequences for the region. In 1996, Forest Renewal British Columbia, in cooperation with local forest companies and the Ministry of Environment, Lands and Parks, initiated a four-year

inventory study of the Central Selkirks sub-population. The study collected caribou population and life history data, and generated models of stand- and landscape-scale resource selection.

The inventory study also identified knowledge gaps regarding the ability of some of these experimental models to adequately describe habitat attributes selected by caribou. In response and in accordance with Resource Inventory Committee standards, a mountain caribou species-habitat model (species account and ratings table) was developed for the Tree Farm Licence #23 (TFL 23) portion of the Central Selkirks. Project personnel generated ratings for all site series and structural stages present on the project area. Field-based habitat suitability ratings were conducted at 49 early-winter caribou telemetry locations and were compared to suitability ratings in the ratings table. Ratings were applied to the Arrow Predictive Ecosystem Map (PEM), using structural stages derived from forest age, in order to map mountain caribou habitat capability and suitability within TFL 23. Final suitability maps were tested for goodness-of-fit with existing caribou telemetry point locations. Caribou selected higher-rated habitats and avoided lower-rated habitats in all seasons. This project presents the first integration of wildlife-habitat ratings with the Arrow PEM where goodness-of-fit was tested with extensive animal use data.

In conjunction with on-going mountain caribou inventory, Pope and Talbot Inc., the ministries of Forests and Water, Land and Air Protection, and caribou project staff initiated a landscape unit planning pilot project within the Trout, Fish, and Halfway landscape units of TFL 23. The purposes of the pilot project were:

- To explore opportunities to integrate strategic planning direction into landscape unit planning
- To identify opportunities for spatial landscape design that meet strategic targets, while emphasizing caribou management and minimizing timber impacts
- To identify monitoring indicators to support implementation of the resulting landscape unit plan
- To provide recommendations regarding policy implications resulting from the landscape unit planning pilot project approach.

The TFL 23 pilot project landscape unit planning strategy includes:

- Criteria for identification and mapping of management emphasis zones:
  - Caribou connectivity zone
  - Interim deferral zone
  - Caribou management emphasis zone
  - Integrated management zone
- Office and field assessment standards and procedures for conducting field and stand level assessments
- Harvesting and silviculture management strategies with emphasis on caribou habitat and habitat elements
- Monitoring and adaptive management strategy
- District agreement on landscape unit implementation strategy
- Development of a landscape unit planning strategy with the regional caribou committee.

A number of recommendations are also suggested:

The *Biodiversity Guidebook* (1995) recommends a range of small to medium/large (up to 250 ha) similarly aged forest patches on the landscape for both NDT1 and NDT2; however, it also cautions against reliance on small patches that would lead to excessive forest fragmentation. The guidebook and Operation Planning Regulations (OPRs) allow district manager discretion for smaller (OPR 21 (3) (a)) and larger (OPR 21 (3) (b)) cutblock sizes. It is recommended that this discretion be applied in association with the alternative scenario management approach outlined in the guidebook.

Amend the HLPO regional connectivity corridor to coincide more with the known seasonal migration and movement patterns of caribou within the Fish and Halfway landscape units (submitted).

A multi-season commercial and non-commercial Access Planning strategy should be initiated, developed and implemented within the range of mountain caribou in the Central Selkirks.

Recent census data suggest that the Central Selkirks caribou population is in decline. Information presented in this report and available elsewhere should be used to conduct a formal cumulative effects assessment in order to hypothesize reasons for the recent decline. In addition, annual population censuses should be conducted to monitor population trend.

A PEM-based mountain caribou species-habitat model (species account and habitat ratings table) and 1:20,000 capability and suitability habitat mapping have recently been completed for the TFL 23 portion of the Central Selkirks mountain caribou area. This standardized approach (Resource Inventory Committee 1999) accommodates ecosystem-based habitat assessments and should be considered for application in future analysis and assessments.

In cooperation with and with funding support from Meadow Creek Cedar, Slocan Forest Products, and Arrow and Kootenay Lake Small Business Enterprise Programs, the TFL 23 landscape unit planning strategy is currently being expanded to encompass the remaining landscape units within the distribution of mountain caribou in the Central Selkirks.

7. Southern Purcells Caribou: Status and Action

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Mountain caribou historically occurred throughout most or all of the Purcell Mountains. However, the current distribution includes only:

- Occasional sightings of animals at the extreme north end of the range (possibly part of the Central Rockies subpopulation)
- A small resident group east of the Duncan River (part of the Central Selkirks subpopulation)
- Periodic sightings in the central Purcells, which may be residents of the Central Selkirks or Southern Purcells subpopulations, or possibly residents of a small, as-yet undefined subpopulation
- The Southern Purcells subpopulation, occurring from the Skookumchuck drainage to Highway 3 and as far west as Kootenay Lake, which is currently estimated at 20 animals.

Modern subpopulation designations probably do not match historic distribution and movement patterns, but prior to the mid 1800s there were probably several hundred caribou within the modern range of the Southern Purcells herd. Early impacts to caribou population likely began with the era of prospecting in the late 1800s. During this time, increased numbers of people began living for extended periods in the mountains, often shooting caribou for food and starting wildfires to expose minerals for prospecting. Over the past century, there has been progressively less meat-hunting and greater fire suppression. However, that period has also seen the progression of forest harvesting into core caribou habitat at higher elevations, and the establishment or re-establishment of a major alternate prey species (elk) and expansion of several other species (white-tailed deer and moose) within the Purcells.

Caribou research within the southern Purcells began in 1993. The highest late-winter count was 78 animals, in 1995, although projections of numbers within areas missed in the 1993 census suggest a population of about 90 in 1993. The most recent population estimate is 20, based on a 2002 survey in which 19 animals were either seen or otherwise known to be present (collared). There was a preponderance of bulls, but two calves were present. This compares to a count of 18 in 2000, suggesting that the subpopulation has recently stabilized at a very low level. Periodic sightings of one to six animals within the central portion of the Purcell Mountains immediately north of the study area have been made through the fall of 2002. Other research outcomes include the development of models that indicate the distribution of habitat within the southern Purcells, and clarification of seasonal foraging habits.

During the 1990s, the Southern Purcells population declined at about 24% annually. Among collared animals dying of known causes, predation was the major source. This was particularly due to cougars (six of nine known-cause predation events) but also included bears (two) and wolverine (one). Other sources of death were shooting, a fall into a tree well, and a vehicle

collision (one each). It appears that predation occurred primarily within fragmented landscapes, not in undisturbed landscapes. This is consistent with theories that the creation of early-seral foraging areas for other ungulates in what was formerly old-forest caribou habitat shifts the distribution of those species sufficiently to attract predators that opportunistically kill caribou. Predation also occurred at a time when there was a major increase in cougar numbers.

Winter backcountry recreation, particularly non-commercial snowmobiling, is extensive in the Purcells, but the population effect (if any) that this has had is unknown.

Current actions taken to maintain and allow recovery of caribou in the southern Purcells are as follows:

1. Through the Kootenay-Boundary Land Use Plan, special management areas were established for caribou, with guidelines requiring retention of old-growth forest. These guidelines and the areas in which they apply are under review, but current proposals would see Core Habitat, Supporting Habitat, and Population Recovery zones established, in which there would be a mix of retention, partial-cutting, and conventional harvest (of pine-leading stands), along with the designation of corridors for intra-herd and meta-population connectivity, with an emphasis on long sight lines and lack of impediments to movement. In addition to protecting key habitat areas, this management scheme offers the possibility of allowing early-seral habitats, which may currently be attracting a prey base close to caribou, to succeed to stages that are far less attractive to other ungulates.

2. Using the number of problem cougar kills, accidental trapping kills, and roadkills as an index of the cougar population, it appears that cougar populations rose rapidly in the 1990s but have since dropped equally dramatically. The introduction of a cougar harvest quota in the late 1980s appears to have led to a major population increase, with regional non-hunting kills rising from about three annually in the 1970s and 1980s to 54 in 1997/1998. Liberalized quotas and possibly also a temporarily reduced prey base have apparently been responsible for the recent downward trend in cougar numbers, with only seven non-hunting kills reported in 2001/2002. The recent stabilization of caribou in the South Purcells matches that of the South Selkirks, where cougar predation was also a major factor.

3. A recreation management strategy is being developed this winter for the portion of the southern Purcells within the Cranbrook Forest District. When this initiative was undertaken in the east half of the district, winter recreation designations included motorized, motorized with restrictions, and non-motorized. The high profile of caribou in the west half of the district and the success of the initiative elsewhere suggest that appropriate management designations are likely to be made for caribou habitat.

A national recovery strategy for woodland caribou in the Southern Mountains National Ecological Area has been prepared, and a Recovery Action Group is currently being established for the Southern Purcells and Southern Selkirk subpopulations collectively. Any actions taken as a result of recovery planning would likely be coordinated through local land-use planning processes.

A proposal to translocate 120 caribou to the southern Purcells and southern Selkirks from the Itcha-Ilgachuz herd over the next six years is being developed. Public consultation is under way. If the plan is approved, translocations to the southern Purcells could begin in late winter of 2003. The infusion of new animals is expected to initiate recovery by providing a large base of breeding adults and reducing concerns about inbreeding within the existing animals.

8. Caribou Management: A Precautionary Approach?

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Introduction

I was asked to present this paper to provide an "environmentalist" or "conservation-based" view of caribou management. This presentation is not intended as a "scientific paper," but rather as a non-technical review of caribou management, as I see it. I want to say up front, I am not a wildlife biologist and do not claim to have special expertise regarding caribou management. My background is in forest soils, forest ecology, and resource management. However, I have worked with biologists evaluating ecosystem management, habitat modelling, and risk assessment. I have lived and worked in the Kootenays for most of the last 30 years, and therefore my comments will focus mainly on the caribou populations in this region: Southern Selkirks, Southern Purcells, Central Selkirks, Monashees, Revelstoke, and Central Rockies.

Where are we?

The present status of the southeastern British Columbia populations of Mountain Caribou is generally dismal (see Table 1). The British Columbia Conservation Data Centre (CDC) has placed the southern ecotype of Woodland Caribou (i.e., Mountain Caribou) on the *Red List*. This means that scientists in British Columbia have determined that the southern population of caribou is "very susceptible to extinction."

This ranking is based on an assessment of the following factors (CDC 2002):

- Estimated number of existing occurrences
- Viability of these occurrences
- Trend in population size, number of occurrences, or geographic distribution
- Overall estimated population size
- Geographic distribution (range)
- Number of occurrences adequately protected *and* managed
- Actual or potential threats facing the species or its habitat.

At a national level, species at risk are evaluated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This committee is composed of representatives from each provincial and territorial government wildlife agency, four federal agencies, three non-governmental scientists, and the co-chairs of the species specialist and the Aboriginal Traditional Knowledge subcommittees. Based on criteria adapted from the World Conservation Union, COSEWIC has designated the Woodland Caribou within the Southern Mountains National Ecological Area as *threatened* (COSEWIC 2002). The area includes Mountain Caribou. This designation is defined as: those "species likely to become *endangered* if limiting factors are not reversed" (*endangered* being those species that face imminent extirpation or extinction). COSEWIC had designated the Woodland Caribou as a species of "special concern" in 1984; however, the Southern Mountain caribou population was up-listed to *threatened* in 2000, while the Northern population was down-listed to *not at risk* between 2000 and 2002; in 2002 it was subsequently up-listed to *special concern* again.

The primary factors cited for the CDC and COSEWIC designations include:

- Declining populations
- Reduced range and population isolation
- Habitat loss and fragmentation
- Increased predation losses linked to habitat alteration and increased populations of other ungulates
- Forest harvesting, access development, and commercial recreation uses, which are continuing to degrade habitat
- Lack of knowledge regarding specific habitat relationships.

Table 1. Summary of population trends for caribou populations in southeastern British Columbia (see also Figure 1)

Population	Population Estimates*		Present Trend and Historical Context
	Pre–1850	2002	
South Selkirks	100s ??	35	Stable – severely reduced
South Purcells	100s ??	20	Stable – severely reduced
Central Selkirks	100s – 1,000s ??	130	Down – substantially reduced
Monashees	100s ??	10	Down – severely reduced
Revelstoke	100s – 1,000s ??	225	Down – reduced
Central Rockies	100s ??	20	Down – severely reduced
Central and Northern Purcells, Northern Idaho and Washington	100s ??	Rare occurrences	Essentially extirpated
Okanagan Highlands, Valhalla Mountains, Southern Monashees, Yahk, Southern Rockies	100s ??	0	Extirpated

*2002 population estimates and trends from BC MWLAP 2002

How did we get here?

Based on archaeological evidence, woodland caribou have been present in southeastern British Columbia since deglaciation, roughly 10 000 years ago (MacDonald 1996). The archaeological record shows that caribou followed the retreating ice sheets into southeastern British Columbia from glacial refugia in the United States, along the Pacific Coast and potentially other locations. The range may have contracted somewhat during the hypsothermal (warmer period that occurred about 5000 years ago). However, caribou numbers likely recovered during a slightly cooler and wetter climatic period known as the Little Ice Age that had commenced in about 1500 AD.

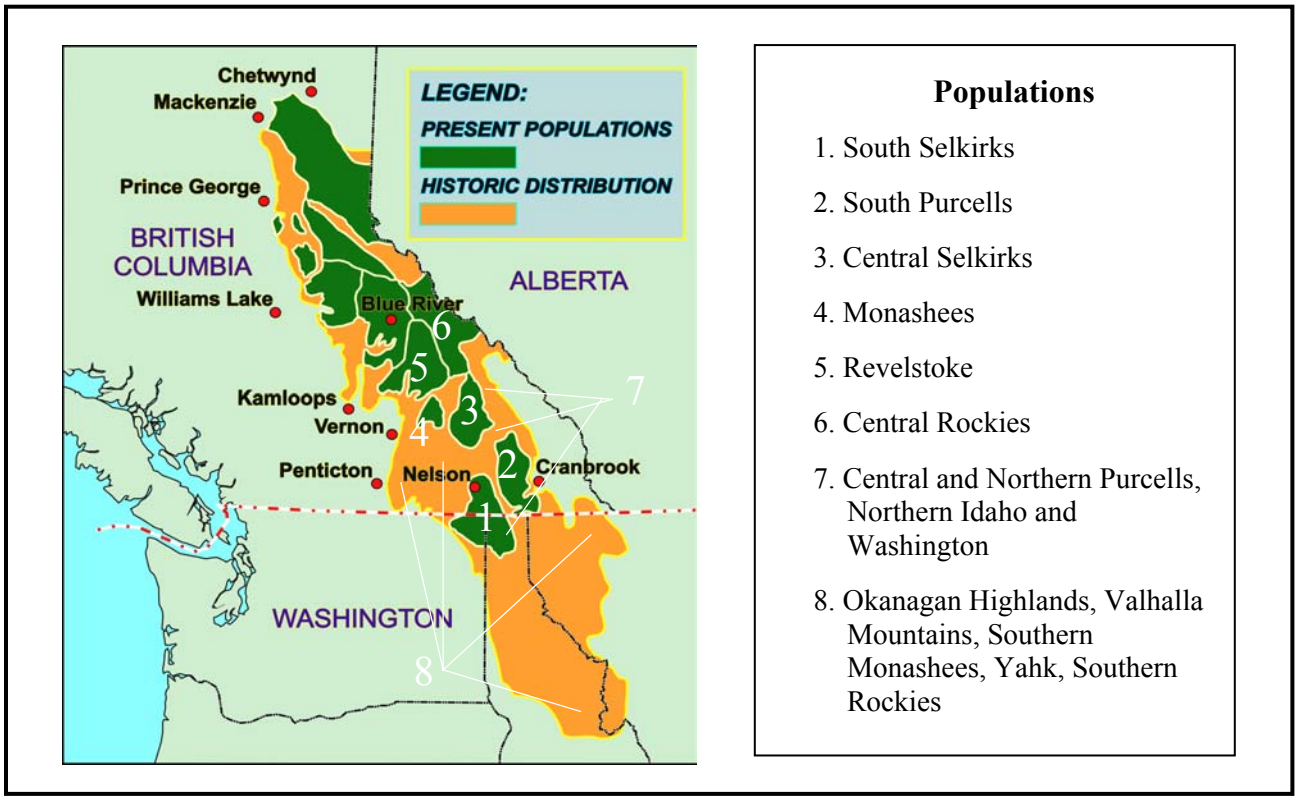


Figure 1. Present and historic populations in southeastern British Columbia and adjacent US

Historical records confirm caribou existing in the late 1800s as far southwest as the Okanagan Highlands in the vicinity of Greybeck Mountain and into the upper Granby and Kettle River valleys. In the Selkirks and Purcells, mountain caribou ranged as far south as the Snake River valley in Idaho. There were also reports of mountain caribou as far east as Missoula, Montana, and into northwestern Wyoming in the 1870s (MacDonald 1996; Spalding 2000). In general, it is believed that caribou occurred only sporadically on the east side of the Rocky Mountain Trench south of the Kicking Horse River; however, there are records of their presence east of the Flathead River in northern Montana (Trevor Kinley, personal communication.).

Early historical accounts show that Ktunaxa, Shuswap, and Lakes First Nations peoples throughout the Kootenays and adjacent US used caribou as a source of meat and hides

(MacDonald 1996; Spalding 2000). In general, however, caribou use seemed to be secondary to use of deer, elk, goats, salmon, and bison for First Nations in southeastern British Columbia. In contrast, further to the north, caribou increased in importance to the Shuswap and Chilcotin peoples. Interestingly, early explorers' and fur traders' comments regarding caribou tend to indicate their relatively early abundance and relative ease of hunting (Spalding 2000).

Prior to the 1850s, the influx of Europeans had minimal impact on Mountain Caribou. In the Kootenay/Columbia fur trading records, caribou occur very rarely. The first real encroachment was the placer mining booms beginning in the US portion of the Columbia Basin and the Fraser River area of British Columbia in the 1850s, and the Cariboo gold rush and the Wildhorse River area developments in the 1860s. These were then followed by the hard rock mining booms in the 1890s that brought new settlers and towns such as Revelstoke, Ainsworth, Nelson, Sandon, and Trout Lake. Mining exploration and associated development resulted in a significant increase in fires and habitat destruction, combined with heavy hunting pressure to supply meat to hungry miners and railroad workers (MacDonald 1996).

Settlement and industrial development was paralleled by the construction of major east-west railways in the 1890s - the Great Northern in Idaho and Montana, and the southern CPR route through Crowsnest Pass and along the Kootenay River and the northern CPR route through Rogers Pass. These were followed by north-south rail lines such as like the Fort Sheppard Railway in the southern Selkirks, the CPR in the Arrow Lakes valley, the Kaslo-Slocan and the Lardeau-Trout Lake line. The rail lines fragmented habitat, resulting in significant fires, further habitat destruction, and increased hunter access. In addition to the industrial and subsistence hunting by new settlers, the railroads and sternwheelers brought in tourists and big-game hunters. Historical records show hunters killing 25 caribou near the Pend d'Orielle River in the winter of 1888/89 and Teddy Roosevelt shooting a bull caribou northwest of Creston in 1888 (MacDonald 1996).

Historical accounts tell of the ease of shooting caribou. One writer commenting on First Nations hunting remarked: "They were easy to kill, being so gentle and stupid that the hunter could go right up to them and discharge his arrows without their taking flight. Even after the Indians had firearms the animals would not take flight at the sound of a gun. They even congregate around the Indian camps." He also commented, "The Tobacco Plains and Libby bands often joined the Bonner's Ferry and Creston folk on the caribou grounds somewhere between Tobacco Plains and Yakt. Often enough caribou were found around home to obviate the necessity of travel." Another commented, "They were just like shooting cows" (MacDonald 1996).

Beginning in the 1890s, and continuing on until the early to mid 1900s, forest harvesting and agriculture expanded into almost all the major valley bottoms across the Kootenays, further fragmenting habitat and dividing a formerly continuous southern population of Mountain Caribou into semi-isolated sub-populations. The increased human population also resulted in increasing hunting pressure. Simultaneous to the expansion in human population increase was a parallel increase in other ungulates, namely deer, elk, and moose. The expansion of these populations was likely tied to the dramatic increase in early seral-stage habitat resulting from human-caused increases in fire frequency.

Until the 1930s, timber harvesting was generally limited to lower elevations and species such as Douglas fir, larch, cedar, and white and yellow pine; that is, areas of less importance to Mountain Caribou populations in the Kootenays. Up to this time, the impacts of forest harvesting were indirect in the form of limiting connectivity and loss of habitat from runaway logging slash fires that spread into mid- and upper-elevation habitats, especially in the South Selkirks and the Boundary area. However, by the mid 1930s, markets were beginning to develop for hemlock, spruce, and subalpine fir. Following the Sloan Commission in 1945, forest harvesting in the interior of British Columbia began to grow dramatically, increasing from about 10% of the provincial harvest to about 50% of the total today. The combined provincial harvest of hemlock, spruce and subalpine fir (species most associated with caribou habitat) more than tripled from about 11.4 million m^3 (39% of the cut) in 1955 to approximately 39 million m^3 (55% of the cut) by 1976 (MacDonald 1996).

Loss of habitat during that period was aggravated by increased fragmentation, hunting pressure, and harassment resulting from a huge increase in road access. In recent years this has been further aggravated by commercial recreation developments in the backcountry and unregulated motorized recreation in prime caribou habitat, principally by snowmobiles and ATVs. Roads and motorized recreation trails have also provided increased predation opportunities in traditionally unfragmented caribou habitat. Figure 2 provides a summary of estimated population trends and causal factors.

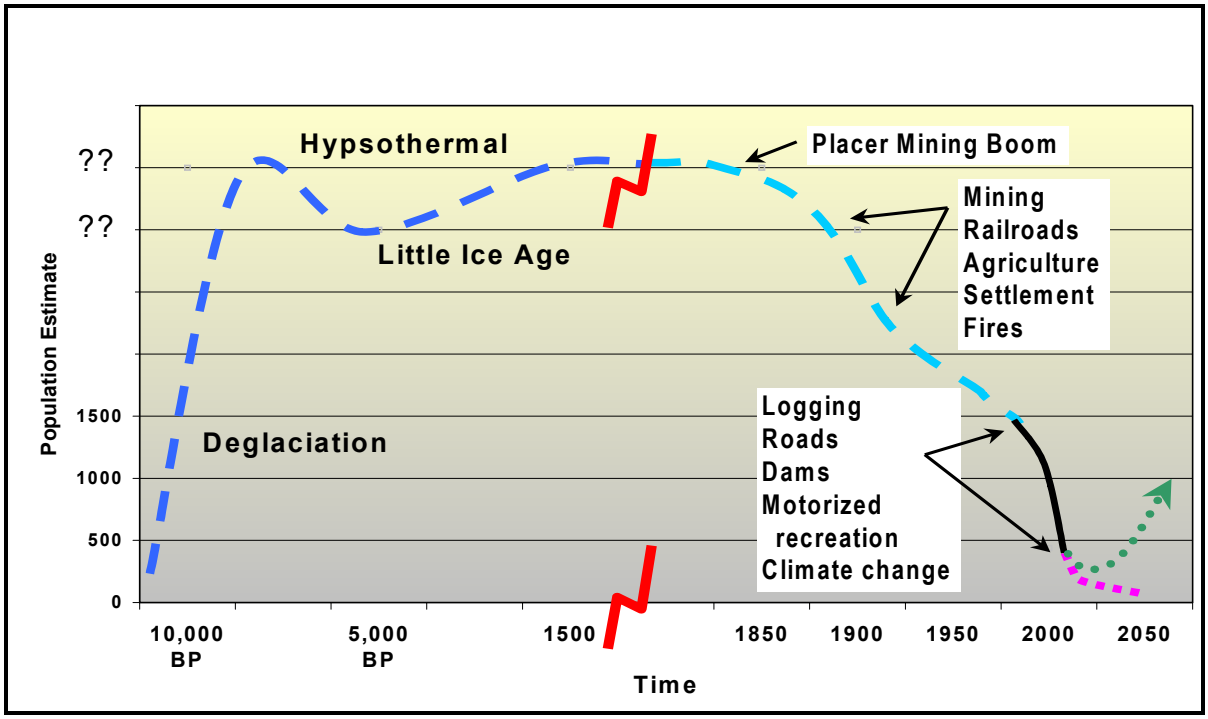


Figure 2. Estimated changes in southeastern British Columbia caribou populations since glaciation (dashed lines) and recent population census results (black solid line). Note time scale break after 1500.

What are we doing now?

The potential impacts of human-caused habitat destruction were recognized as early as the beginning of the 20th century, when many people commented on the reductions in caribou hunting opportunities due to loss of forest cover due to fires and logging. Problems with caribou hunting management were recognized as early as 1918, when a two-year hunting closure was implemented to rebuild caribou populations (Spalding 2000). Things began to change further in the 1970s, with the recognition that caribou did not respond to human development the same way that other ungulates do. Hunting quotas were reduced and a 1979 caribou management plan recognized the following problems (BC Environment 1997):

- Logging is destroying some winter ranges
- Some herds are reduced because of past overharvest, habitat destruction, or both
- Inventory is incomplete
- Predation may be limiting some populations
- New access roads, coupled with resource extraction operations, are making many populations vulnerable to overhunting (legal and illegal)
- Some habitats are not occupied, critical habitats are not well known or defined, and habitat rotation and migration are not completely understood
- The importance of behaviour and herd structure needs further study.

Various recommendations were made in 1979, including: identifying and protecting critical caribou habitat, implementing guidelines to control development that destroyed habitat, hunting regulations, and predator reduction. Although we have implemented some habitat reserves and habitat management guidelines since 1979 (BC MWLAP 2002), we have also significantly increased access into core caribou habitat and continued to fragment and destroy habitat through forest harvesting. Even though habitat retention guidelines have been implemented, they are likely insufficient in extent and not appropriately spatially located to be effective in providing low-risk habitat for Mountain Caribou (i.e., insufficient large continuous block of old and mature forest). The continued fragmentation of old and mature forests has favoured increased populations of other ungulates in areas previously dominated by Mountain Caribou, and likely contributed to a net increase in predator losses. Although we have experimented with predator control in a few isolated locations, we have not confronted the root causes of increased predation. On the positive side, we have slowly eliminated hunting in many areas since 1979.

In the 23 years since those recommendations were made, Mountain Caribou populations in southeastern British Columbia have continued to fall at a precipitous rate (see Table 1 and Figure 2), likely demonstrating the direct and indirect impacts of continued habitat alteration. Another thing we have certainly done since 1979 is to study the problem—as the numerous papers at this conference show. And we have continued to increase our outputs of pollution into the atmosphere to the point that we have added a new threat to caribou—climate change. The question that must be seriously considered at this time is, "In another 20 years, will we be looking back at the caribou recovery strategy released today and making the same comments?" Will we be following the upward line or the downward line at the right edge of Figure 2?

Who are the players, what are they doing, and what are our responsibilities?

In resource management there are generally three main groups of players:

- Stakeholders—development proponents (e.g., forest industry, commercial recreation interests, mining) and non-governmental organizations (NGOs) e.g., environmental groups, hunter groups, snowmobile clubs)
- Decision-makers—district, regional, and provincial resource managers, private land managers, and, ultimately, the elected provincial and federal representatives
- Technical specialists—research scientists and professional practitioners who advise decision-makers of potential outcomes of the various options before them.

The stakeholders are doing what stakeholders do—attempting to influence the decision-makers of the merits of their case, to maintain or increase their "piece of the pie". The forest industry has been generally meeting minimum legal requirements for caribou management on the ground, while actively working to undermine environmental protection in general and caribou management specifically (e.g., ILMA 2001 and MSRM 2002). Motorized commercial and non-commercial recreation interests have been steadily expanding their operations into caribou habitat and attempting to minimize management restrictions wherever possible.

Environmentalists have been raising caribou management as an issue while lobbying government for more effective forest management regulations. They have also been pushing market campaigns and forest certification to put pressure on the forest industry. Hunters have been surprisingly quiet on the issue of Mountain Caribou although they have actively promoted the high populations of other ungulates. Given the state of caribou populations in southeastern British Columbia, caribou advocates seem to be on the losing side at this time.

It will likely surprise many to hear me say that I feel the political decision-makers do not seem to be at fault in this case, at least at a policy level. The federal government has signed on to the 1992 Convention on Biodiversity and is presently working on endangered species legislation. Unfortunately, they have little jurisdiction regarding habitat management. Provincial policies and objectives on maintenance of biodiversity and ecosystem integrity are clear. The 1996 Action Plan for the Ministry of the Environment (MELP 1996) included the following two principles:

- Environmental equity: All species—human, animal, and plant—have an intrinsic right to a healthy environment and this right extends beyond the present generation to future generations. No segment of these populations should bear disproportionately high adverse effects.
- Precautionary principle: The onus of proof should be on parties who undertake actions that could cause serious or irreversible environmental damage, to prove beyond a reasonable doubt that no damage will be caused.

Even the Forest Practices Code (FPC 1996) legislation included reference to forest stewardship and conserving biodiversity in the preamble:

> WHEREAS British Columbians desire sustainable use of the forests they hold in trust for future generations; AND WHEREAS sustainable use includes
>
> (a) Managing forests to meet present needs without compromising the needs of future generations,
> (b) Providing stewardship of forests based on an ethic of respect for the land,
> (c) Balancing economic, productive, spiritual, ecological and recreational values of forests to meet the economic, social and cultural needs of peoples and communities, including First Nations,
> (d) Conserving biological diversity, soil, water, fish, wildlife, scenic diversity and other forest resources, and
> (e) Restoring damaged ecologies;
>
> THEREFORE HER MAJESTY, by and with the advice and consent of the Legislative Assembly of the Province of British Columbia, enacts as follows …

Some might suggest that these principles no longer apply since the elimination of MELP; however, Goal 2 of the newly created MWLAP is:

> Environmental Stewardship—Maintain and restore the natural diversity of ecosystems, and fish and wildlife species and their habitats.
>
> - Species at Risk—Identify, protect and restore species at risk and their habitat.
> - Wildlife and Wild Fish—Manage and protect fish, wildlife and their habitat.

Thus, if government has provided managers with a mandate to maintain these caribou populations in a healthy state, why are populations continuing to decline? Why are management decisions continuing to allow development to proceed that is clearly detrimental to the survival of Mountain Caribou? Maybe we should look at the role of the third group—the technical advisors.

What about the responsibilities of the technical advisors—many of us here in the room? The role of scientists and professional practitioners in decision-making generally involves providing decision-makers with a range of options for achieving specific objectives or goals (in this case, perpetuation of Mountain Caribou). Each option should include information regarding the potential costs and benefits of the option, the risks involved, and the relative reliability of the information. The technical advisors must ensure that the decision-maker is fully aware of each of these aspects of the options. The role of the decision-maker is to choose an option that best reflects his/her mandate, *and* honestly report the implications of the selected option (e.g., Everest et al. 1997).

We cannot blame the decision-makers for poor decisions if we are not performing our role. And even if decision-makers are not using our information properly we still have an obligation to ensure that the public interest is protected. One way to see what we should be doing is to examine the Codes of Ethics for the two professional groups most directly involved in management of caribou and caribou habitat—Professional Foresters and Professional Biologists.

Registered Professional Foresters—Standards of Professional Practice and Guidelines for Interpretation (selected excerpts, ABCPF 2002)

Stewardship Standard
Professional foresters demonstrate stewardship by balancing present and future values against the capacity of the land to provide for those values (the word "land" is not limited to soil but is used in its broadest possible sense to include, without limitation: soil, water, plants, animals, air, and the processes upon which they depend).

Guideline

Stewardship is the care of natural resources, taking into consideration the values of the landowners and society. Stewardship includes the application of an ecological understanding at the stand, forest and landscape levels, and is based upon an ethical responsibility to the land and the place of people in the natural world… Stewardship recognizes complex biotic systems, competing interests and values, and obligations to future generations. Stewardship requires the forester to constantly evaluate specific or more narrow decisions in light of impacts on the whole range of forest resources and values on a temporal and spatial scale ...

Registered Professional Foresters—Code of Ethics and Guidelines for Interpretation (selected excerpts, ABCPF 1993)

Guideline 2
To advocate and practice good stewardship of forest land based on sound ecological principles to sustain its ability to provide those values that have been assigned by society; stewardship is the management of forest land to provide for specified values while considering all forest resources. Stewardship requires management decisions that balance many social values. "Ecological principles" mean the natural processes that govern the development of an ecosystem and its response to disturbance. "Society" means public of British Columbia as represented by Government. Members advocate and practice forestry to meet the goals of society based on sound science, valid experience, responsible economics, and rational planning.

Guideline 4
Where a member believes that a practice is detrimental to good stewardship … members should make every effort to discuss the consequences of implementing such a practice with the responsible individual(s) … If the matter is subsequently not resolved, the member must inform (RPF) Council immediately.

Guideline 16
To inform the client or employer of any action planned or undertaken by the client or employer that a member believes is detrimental to good stewardship of forest land … It is a member's duty to advise the client or employer of the consequences of this action …

Professional Biologists—Code of Ethics and Explanatory Notes (selected excerpts, APBBC 2000)

(A) Relations with the Public

i. The Professional Biologist who becomes aware of any undertaking that is profoundly detrimental to the sound management and conservation of biological resources will accept responsibility to advise a responsible party; if after reasonable effort no remedy is achieved and the issue warrants, s/he will inform this Association in writing of the particulars.

This section establishes an obligation to proactively report or act to forestall severely damaging actions ... The section is intended to apply to undertakings with serious consequences, such as actions that …threaten biological diversity, impact upon endangered species … Section A (i) overrides the requirement for confidentiality between the biologist and employer or client.

ii. The Professional Biologist ... will be objective and honest in all estimates, reports, testimony, and other matters, and will identify any limitations in data or concepts… In the field of environmental impact assessment, it may be especially important to clarify that absence of data does not imply the absence of impact.

iii. When presenting any statement, criticisms, or arguments on behalf of a client or employer, the Professional Biologist will clearly indicate on whose behalf they are being made … The member is responsible for identifying any inadequacies in data associated with decisions, conclusions, or recommendations for a specific project. S/he should oppose the use and release of selective, biased, or inaccurate information …

(B) Relations with Employers and Clients

iv. The Professional Biologist will advise the employer or client of any adverse consequences to be expected if his/her professional judgment is overruled, and will advise of alternative courses of action.

Given the state of mountain caribou populations in southeastern British Columbia, and the numerous scientific papers pointing out the causes of the population declines, I would suggest that there clearly are "undertakings that are profoundly detrimental to the sound management and conservation of biological resources" and actions "detrimental to good stewardship of forest land." But have there been any complaints to the associations by Professional Biologists or Foresters? None that I am aware of.

Admittedly, politicians and some decision-makers like to be "all things to all people," and in this case suggest that we can maintain caribou and increase forest harvesting in caribou habitat. However, in this "new era" of results-based management and professional reliance, there is a

clear need for professionals to act in a responsible manner (as required by their codes of ethics). Professionals must ensure that managers are fully aware of the implications of their decisions.

Professionals must speak out where habitat reserves and management measures are inadequate to fulfil their intended objectives. We must not allow environmental management in this province to slip into a paradigm "where systemic distortions will form the cultural bases for defining what is reasonable, what is responsible, and what is realistic … (where) science becomes the opiate of the people, (where) it reassures people that all is well, and anyone who disagrees is not qualified" (Bella 1992). I would argue that the extirpation and/or extinction of Mountain Caribou are not reasonable.

What might an application of the precautionary approach principle to mountain caribou management look like?

The precautionary principle was first enunciated in Germany in 1976. As then defined, it stated that in addition to environmental restoration and crisis intervention, a precautionary approach to environmental policy was necessary to fully protect the environment. In various forms a similar approach has been incorporated into numerous treaties and declarations, including the 1992 Convention on Biological Diversity, the 1992 Climate Change Convention and the 1992 Rio de Janeiro Declaration on Environment and Development.

In general most discussions of the precautionary approach or principle include the following components (e.g., VanderZwaag 1999 and FSC-BC 2002):

- Managers do not undertake any actions where there is significant risk of serious or irreversible harm (actions that may lead to irreversible changes to ecosystem function and resilience).
- Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation.
- The onus is on the proponent or manager to prove that the proposed action will not result in serious or irreversible harm.
- When previously unanticipated threats to ecosystem integrity are identified or knowledge of ecosystem processes increases, the manager takes timely, efficient, and effective corrective actions.
- The manager remains mindful of the needs of future generations.

Although there are some varying opinions on when and where a "precautionary approach" should be applied, and to what level of precaution, almost everyone would agree that it would be appropriate in the case of a red-listed species. With that in mind, the following are proposed as possible components of a precautionary approach to Mountain Caribou management:

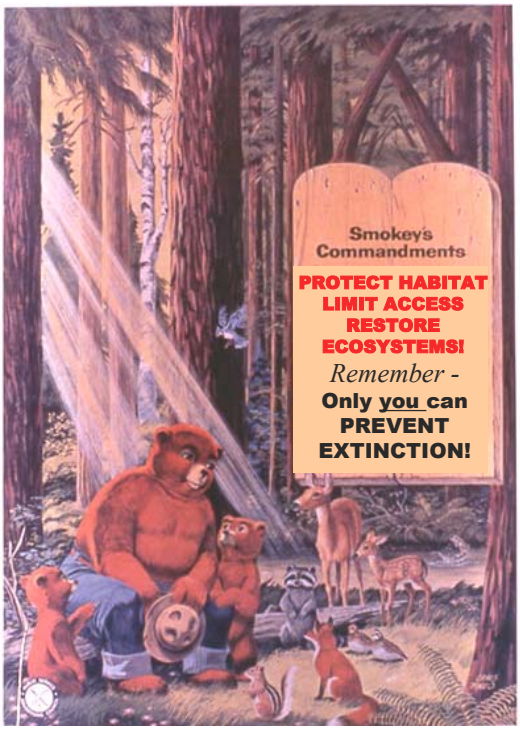
- Stop all habitat alteration in core caribou habitat for caribou populations in decline, or having less than 250 individuals—unless it can be clearly demonstrated that NO

detrimental impacts to caribou habitat will result (i.e., eliminate forest harvesting and road construction).

- Restrict all experimentation with caribou habitat alteration (i.e., silvicultural trials) to non-core habitat areas of caribou populations that have at least 250 animals and have been stable of increasing for at least five years.
- Immediately develop and implement access management strategies in core habitat areas for all caribou populations in decline, or having less than 250 individuals, including road closures and restrictions on commercial and non-commercial motorized recreation (i.e. helicopters, snowmobiles, ATVs, etc.).
- To enhance the ability of caribou to separate themselves from other ungulates, undertake ecosystem restoration measures to minimize deer, elk, and moose habitat within and adjacent to core caribou habitat areas (especially at high elevations) and use hunting regulations to reduce deer, elk and moose populations in caribou areas where appropriate.
- Undertake ecosystem restoration measures to increase habitat suitability in core caribou habitat areas degraded by past management activities (e.g., silvicultural treatments and road rehabilitation).
- Assess predator risks and implement predator control programs where appropriate (i.e., predation is linked to high mortality rates and predator populations are not at risk).
- Where populations have been reduced to fewer than 50 individuals and are not increasing, sufficient habitat is available, and effective habitat protection and access management measures are being implemented, assess the potential for population augmentation by transplantation, and implement where appropriate.
- Manage caribou hunting regulations in a precautionary manner, and undertake a hunter education program to minimize accidental kills and increase hunter awareness regarding caribou management issues.

My closing comment is to suggest that conference participants compare this set of suggestions with the elements in the government recovery strategy, and decide for themselves whether the Mountain Caribou recovery strategy presented today is a precautionary approach, whether that strategy is consistent with scientific information available today, and whether it is likely to meet its goal of "a viable metapopulation of 2500–3000 Mountain Caribou distributed throughout their current range in British Columbia"? Or, will Mountain Caribou go the way of the Dodo? the Passenger Pigeon?

Only you can decide …



Poster adapted from USDA Forest Service fire prevention poster (1959).

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9. Caribou Response to Linear Developments in a West-Central Alberta Landscape

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Resource expansion into previously undeveloped areas requires increases in access, which may have detrimental effects for some wildlife species. Paula studied the response of migratory mountain caribou to linear landscape features, including streams, roads, and seismic exploration lines, in the foothills along the eastern slopes of the Canadian Rocky Mountains in west-central Alberta. Data from GPS telemetry collars during the two winters 1998–2000 were compared to a base map of linear features in a GIS, using distance buffers and compositional analysis. Caribou locations were distributed non-randomly around streams and roads, with preference increasing with distance from these linear features. This pattern of avoidance was also significant at a fine-scale, including only caribou that were in the vicinity of 0.5 km of linear features. Paula did not detect a significant avoidance or preference by caribou for seismic lines in either winter. This study adds evidence that caribou avoid linear landscape features in forested landscapes. The exact mechanism is not known, but may relate to the presence of natural predators or human disturbance on these corridors. The lack of response from seismic lines in the study area could possibly be due to differences in mountain caribou ecology from other regions, low statistical power in the study design, or the success in mitigation measures to reduce impacts. From these results, Paula highlighted approaches to reduce effects of linear features as prescribed by current operating guidelines for industrial activity on caribou ranges in Alberta.

10. Working with the Caribou Forestry Guidelines: Putting It on the Ground

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Del reviewed the work involved in taking caribou habitat guidelines and actually translating them to a series of on-the-ground mature forest retention areas. He described the innovative forest management practices undertaken by the Revelstoke Community Forest Corporation to minimize caribou habitat impacts.

11. A 21st Century Approach to Forest Management for Mountain Caribou

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This paper reports on the approach taken in the Cariboo region to address the needs of mountain caribou. The strategy is very much the product of a group of dedicated researchers, managers, foresters, and biologists (from the ministries of Forests, Sustainable Resource Management, and Water, Land and Air Protection) working closely with forest companies and conservation groups to find innovative yet workable solutions.

Mountain caribou are an ecotype of woodland caribou (*Rangifer tarandus caribou*) that feed mainly on arboreal lichens (*Bryoria* spp. and *Alectoria sarmentosa)* during winter. Consequently, the habitat requirements of caribou are incompatible with clearcutting—the common silvicultural system within their range. To survive, mountain caribou need to be able to spread out over large areas of suitable habitat, where it is difficult for predators to find them. Suitable winter habitat has characteristics of old forest, including abundant arboreal lichens.

Research on partial cutting to maintain caribou habitat has been ongoing in the Cariboo region since 1990 when a pilot trial was harvested to explore the possibilities of the partial cutting approach. A group selection silvicultural system was developed with the objective of maintaining the forest structure needed to retain arboreal lichens in the stand in perpetuity and therefore continually provide caribou habitat. This group selection system was the focus of a replicated trial harvested in 1992–93 with a 33% removal level. Three treatments, differing only in opening sizes (0.03, 0.13, 1.0 ha), were tested. A description of the project can be found at: http://www.pfc.cfs.nrcan.gc.ca/ecology/ferns/quesnel/index_e.html .

The results, now almost 10 years post-harvest, are encouraging. Windthrow in the residual stand is minimal. No significant difference in lichen biomass occurred among the treatments. Also, there was no difference in lichen biomass when comparing the uncut control to the residual trees in all treatments. Therefore, lichens are growing in the partially cut stands, and increased wind-scouring on the remaining trees is not occurring. Natural regeneration is successful but depends on a sufficient cone crop—a sporadic occurrence in high-elevation forests. Planted spruce and subalpine fir survives and shows adequate growth in all but the smallest openings at the highest elevations. Re-measurement of this replicated trial will continue over the long term. Some results can be found at: www.for.gov.bc.ca/cariboo/research/index.htm .

Meanwhile, the Cariboo Chilcotin Land Use Plan (CCLUP), released in 1994, identified that the maintenance of mountain caribou habitat was an overriding objective. The CCLUP designated 53 509 ha of "modified harvesting" and 86 836 ha of "no harvesting" to meet the needs of mountain caribou. In 2000, a Mountain Caribou Strategy was completed for the Cariboo region. This document geographically designated the "modified" and "no harvest" areas within caribou habitat. Drawing on the ongoing research, it also defined "modified" harvesting as a selection

silvicultural system with 33% removal at an 80-year cutting cycle. Although group selection was the preferred approach, it also made room for single-tree selection on appropriate sites and strip selection on steeper slopes. The full strategy is available at: http://wlapwww.gov.bc.ca/car/env_stewardship/wildlife/reports/cari_2000_rpt/cari_main.htm .

The process did not end with the release of the strategy because further steps were necessary to ensure successful operational implementation. A large adaptive management trial is being established at Mount Tom in the Quesnel Forest District to address caribou response, silvicultural options, and operational issues that could not be addressed at the scale of the replicated research trial. The logging started in March 2001 and will continue for at least four years to develop approximately 1400 ha of high-elevation forest. To date, 282 ha have been logged with two different logging methods applying group selection with openings ranging from 0.1 to 1.0 ha in area. Several 3 ha patches are also included to compare tree growth in a clearcut environment to that in the group selection system. A 2000 ha control will be left unharvested for at least 10 years after the logging is finished. This will allow a detailed examination to be made of caribou response using radio-telemetry.

The Mountain Caribou Strategy provided a framework for the development of a predator management strategy. The strategy recommended two main components:

- A modified regional moose management strategy within and adjacent to caribou range to reduce the primary prey of wolves
- A wolf management program within caribou range to reduce predation pressure on caribou.

To address the first recommendation, the number of limited-entry harvesting permits for moose within the general caribou area has been increased from 267 to 390 annually. The objective is to keep moose numbers at approximately historic levels with the knowledge that reduction in predators will increase both caribou and moose survival.

Additionally, a wolf management strategy was produced and approved at the ministerial level by the Ministry of Water, Land and Air Protection. This plan includes sterilization of dominant animals and removal of some of the subdominant wolves in packs that are preying on caribou. Currently, year two of a five-year plan to implement the strategy is under way. Packs that prey on caribou are being identified and some sterilisation has occurred.

The development of an access management strategy was a recommendation of the Mountain Caribou Strategy and work has proceeded on several topics. After consultations with interest groups, options for zoning snowmobile use within caribou range were produced and have been presented to decision-makers. In the meantime, a major increase in heli-skiing has been approved for the heart of the caribou range, further complicating the access issue. Perhaps the greatest challenge to maintaining mountain caribou in this region lies in finding effective and socially acceptable solutions to motorized recreation in caribou habitat.

The following are members of the CCLUP Mountain Caribou Strategy Committee: Harold Armleder, Chris Bauditz, Mike Lloyd, and Michael Pelchat of the Ministry of Forests; Michael

Folkema and Robin Hoffos of the Ministry of Sustainable Resource Management; and John Youds and Jim Young of the Ministry of Water, Land and Air Protection. Additional contributors to the supporting research include: Teresa Newsome, Ordell Steen and Michaela Waterhouse of the Ministry of Forests; and Pat Dielman, Nicola Freeman, Lara Roorda and Randy Wright of the Ministry of Water, Land and Air Protection.

12. Recruiting Caribou Habitats Using Silvicultural Treatments

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Introduction

Silviculture treatments applied to managed stands have the potential to accelerate the development of habitat attributes preferred by mountain caribou, including abundance of arboreal lichens and understory falsebox, and open stand structure with some large trees providing good sight lines and snow interception. The report, *Recruiting Caribou Habitat Using Silviculture Treatments*, by Lauren Waters, RPF, and Rhonda Delong, M.Sc., 2001, http://www.for.gov.bc.ca/cpp/fia/surveys.htm provides such direction.

The report specifically:

- Identifies desired attributes of caribou habitat
- Proposes guidelines for ranking and priorizing stands for caribou habitat recruitment
- Suggests specific silviculture treatments to recruit caribou habitat in young forests and maintain caribou habitat in old-growth forests
- Proposes using an adaptive management framework for monitoring, refining guidelines, and improving prescriptions for recruiting caribou habitat.

In 2002, the Ministry of Water, Land and Air Protection contracted Manning, Cooper and Associates to compile the existing guidelines and best management practices for recruiting habitat using silviculture, for a variety of species including caribou. The work is in draft and will be reviewed later this year before being posted on the Ministry website. Electronic copies are available from Colene Wood, and if you are interested in being part of the review please let Colene know.

The objective of this presentation is to highlight the recommendations of Lauren and Rhonda's report and the Manning, Cooper and Associates draft guidelines, and put these works into the current context of developing Sustainable Forest Management Plans and operational trials.

Sustainable Forest Management Plans

Sustainable Forest Management Plans (SFMPs) are planning documents that lay the foundation for achieving sustainable forest management by setting goals, indicators, and targets for a defined forest area. While there is no legislated mandate for SFMPs, and no government approval process, SFMPs fit well within the current forest legislation framework and will be compatible with the "Results Based Code." The SFMPs are expected to form the basis for investment under the Forest Investment Account (FIA). Information on SFMPs related to the FIA can be found at: http://www.for.gov.bc.ca/hfp/pubssfmp.htm .

An SFMP must be consistent with legally established land-use objectives (higher-level plans). SFMPs can also address or incorporate the objectives of other resource plans that are not legally binding. Development of an SFMP, or components of an SFMP, may qualify as an activity that can be funded under the FIA in 2002/03. Commencing April 2003, a licensee will need to be a signatory to an existing SFMP or be actively participating in the development of an SFMP in order to receive FIA funding. (Note: this initial expectation is under review.) Planning documents, such as Silviculture Strategies or Pest Management Plans, can be incorporated or referred to in an SFMP.

The intent is for licensees operating in a management unit (TSA or TFL) to cooperatively develop an SFMP. To a certain extent this is happening across the province; however, time is needed to get full coverage and develop effective tactical plans.

The development of SFMPs provides an excellent opportunity for licensees operating in mountain caribou habitat to plan operational trials and activities to test the recommendations and guidelines in the two reports mentioned above.

Recognizing that management cannot create old-growth forests, Lauren outlined the general management objectives for recruiting caribou habitat:

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

The SFMP needs to specify management objectives, and propose how to measure progress towards sustainable forest management. Management objectives and silvicultural strategies for caribou winter habitat can be taken from the Minister's Advisory Plan (1999) and other planning documents. However, for the purpose of justifying FIA investments, silviculture treatments need a rationale specific to species recovery and timber harvesting. Information from the Timber Supply Analysis and Recovery Action Plans may support such a rationale.

Lauren and Rhonda's work also outlines how to prescribe specific stand-level management objectives, and assess forests to determine which stands within the landscape need silviculture treatment to encourage growth and to put them on a trajectory towards old growth sooner than without treatment. Their recommendations are very specific as to the need for operational trials and an adaptive management approach.

Operational Trials

The Mountain Caribou in Managed Forests program began in 1988 to question if forest stands can be managed, through alternative silvicultural systems and habitat enhancement techniques, to sustain both timber harvest and caribou habitat in the long term. The program has yielded an excellent report, which is recommended reading for all land use managers operating in caribou habitat, "Mountain Caribou in Managed Forests: Recommendations for Managers – Second Edition" (Stevenson et al. 2001). Much of the findings from research can now be applied at the operational level, to move us forward in managing caribou habitat.

In addition to this report, Lauren noted several innovative operational trials set up in Blue River by Weyerhaeuser in the Clearwater Forest District, which has timber types and terrain similar to the Revelstoke TSA. Some of the recommendations include:

- High-elevation ESSF cluster planting—minimum inter-tree spacing should be reduced to 1 m to take advantage of raised microsites and to avoid overhead debris and brushy areas. Gaps up to 5 m between tree groupings will be permitted.
- Retention (depending on site conditions, varies from 40% to 20–80 sph)—these stems will be left scattered or in clumps throughout the block where operationally feasible to provide thermal cover and a source of lichen recruitment for caribou. These trees will also function as perching and nesting trees and a source for future snags and coarse woody debris.

This year, a number of trials are being conducted in the Cariboo Region, in partnerships between licensees and the Ministry of Forests. Ken Soneff, Research Program, in the Cariboo Region can be contacted for further information.

The Manning, Cooper and Associates report, "Silviculture Guidelines and Practices for Maintaining or Recruiting Key Habitat Objectives," 2002, proposes best management practices for pre- and post-harvesting activities, and various silviculture regimes to meet specific management objectives. These proposed practices should form the basis for any operational trials, in order to build upon existing knowledge and effectively invest in discovering better ways to manage caribou habitat. *(The section on mountain caribou appears as Appendix One in this document.)*

The FIA is a source of funds for both research and operational trials. The FIA Research Program (under Forestry Innovation Investment Program [FIIP] and managed by Forintek) has strict criteria and a formal review process to determine eligibility and selection of projects. Under the FIA Land-base Investment Program (LBIP), PriceWaterhouseCoopers approves licensee-proposed operational trials that develop, assess, or refine existing or new practices, techniques, tools, standards, and best management practices, subject to adherence to:

- Research protocols if an applied/operational research project is planned, located at http://www.for.gov.bc.ca/cpp/rmp/guidelines/200203/Protocols.pdf
- Adaptive management standards if adaptive management techniques are being used, from the publications *Statistical Methods for Adaptive Management Studies* and *An Introductory Guide to Adaptive Management for Project Leaders*, located at http://www.for.gov.bc.ca/hfp/amhome/am_publications.htm .

There is a "grey area" where research and operational trials meld, and licensees may not be certain to which program they should apply. The Ministry of Forests will be clarifying the differences, in order to avoid duplication and disappointment. In general, an operational trial should be considered: 1) when research becomes adaptive management; 2) when a licensee is testing different standards; or 3) when a licensee is testing different forest practices. In either case, FIA funding can be guaranteed for only one year; however, the need for work in subsequent years contributes to the prioritization of future projects.

When designing operational trials, the FIA criteria should be understood in order to capitalize on the funding source while meeting research and management objectives:

- Eligibility—based on the work plan
- Status of trial site—can be on a licensee-obligated block as long as the trial is small enough not to be a substitute for the obligation
- Local scope—if provincial in scope, the Research Program is more applicable
- Activity standards—established activity standards will apply unless the licensee is testing different standards
- Partnerships—academic and ministries partnerships are encouraged
- Extension—a necessary component of every trial.

The licensee must do homework, and ensure that they are not unnecessarily duplicating other trials. On the other hand, if other similar trials exist, the licensee needs to follow the same or similar methodologies and contribute to the larger collection of data and information. In all cases, the results must be publicly accessible.

Summary

We do not totally understand how to manage habitat for mountain caribou. Cooperation, adaptive management, and sharing of information are necessary to contribute to the species recovery and to continue harvesting timber. The Forest Investment Account provides funds to develop Sustainable Forest Management Plans and conduct operational trials, which should build on the existing available knowledge. Check web sites, get together in your management units and beyond, and plan activities that can be monitored and assessed.

Colene Wood provided an excerpt from the draft "Silviculture Guidelines and Practices for Maintaining or Recruiting Key Habitat Objectives" (2002), which deals with mountain caribou. It appears as Appendix One in this document.

13. Partial Cutting and Forage Lichens: New Results

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The use of selection silvicultural systems has been proposed as a possible means to harvest timber while maintaining habitat for mountain caribou. When a stand is partially cut, the arboreal forage lichens on the felled trees are lost from the system. But what happens to the lichens on the remaining trees?

We have studied the short-term impacts of partial cutting on biomass, growth rates, and litterfall rates of forage lichens at Pinkerton Mountain in the wet cold Engelmann Spruce–Subalpine Fir Zone (ESSFwc3) east of Prince George, British Columbia. The silvicultural systems trial includes a group selection area in which trees were removed in discrete groups with a mean size of 0.25 ha, a single-tree selection area in which trees were removed across a range of diameter classes, and an adjacent unlogged area. The level of volume removal was 30% in both selection prescriptions.

Two years after partial cutting, lichen retention on residual trees in the group selection and single-tree selection units was similar to that in the unlogged area. There appeared to be a small post-harvest pulse of litterfall, but it was restricted to the single-tree selection area, and was largely masked by natural variation in litterfall among years. Deposition patterns of lichen litterfall suggest that lichen establishment on regeneration will be enhanced within about 12 m of the nearest large tree. Lichen growth rates were as high in the single-tree selection area as in the unlogged control area. In the group selection area, growth rates were reduced along the edges of openings, but we would not expect to see reduced growth in the interior of the residual stand. Our research findings suggest that low-volume partial cutting can meet short-term management goals for the retention of forage lichens in ESSF forests.

14. Retention Systems Silviculture in Caribou Habitat

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Preface

At this time, in the Kamloops TSA, harvest guidelines included in Appendix 10 of the Kamloops Land and Resource Management Plan (KLRMP) do not include the use of the Retention Silviculture System. I am presently working with John Surgenor of the Ministry of Water, Land and Air Protection to explore a new approach to harvest guidelines in mountain caribou habitat. I propose the addition of the Retention Silviculture System as a tool to achieve timber and caribou objectives. We are a technical subcommittee to the KLRMP Caribou Committee. We will present an amended Appendix 10 to this committee who will in turn review, suggest revision, and submit to the KLRMP for endorsement.

To date, the only purposeful retention harvests have been done in McRae Creek, in an area zoned as early winter caribou habitat. Examples of 10%, 15%, 20%, 40%, and 60% retentions are located in the lower ESSF. Significant analysis has been done in old Intermediate Utilization areas, age class 3–6 stands that originated from wildfire and in early partial cuts of 50–60% retention (1992+).

What is a retention silviculture system?

As defined in the Operational Planning Regulation (*Forest Practices Code for British Columbia Act*):

"Retention system" means a silvicultural system that is designed:

- To retain individual trees or groups of trees to maintain structural diversity over the area of the cutblock for at least one rotation
- To leave more than half the total area of the cutblock within one tree height from the base of a tree or group of trees, whether or not the tree or group of trees is inside the cutblock.

This is a fairly clear stand prescription. However, in order to implement this system the following strategic guidance is required:

- The land base needs to be zoned such that objectives can be set. In the case of the North Thompson, a Caribou Habitat Resource Emphasis Zone exists in the KLRMP with habitats subdivided into Late Winter, Early Winter, and Corridors. Given new information from GPS and VHF collaring in the last five years, we are determining new

zones. New strategies for Late Winter and Early Winter zones include maintain and recruit habitat.
- Retention strategies (targets) for achieving objectives need to be established for each strategy within each zone.

Why consider this silviculture system for harvest in caribou habitat?

The existing guidelines are not achieving objectives:

- The third and sometimes second pass of an individual selection system likely will not be there when harvest is scheduled. This is due to the decadence of the existing stand and insect and disease agents working in these areas.
- Harvest of the second and third passes in a group selection scenario will erode rather than maintain caribou habitat. In the end, a patchwork of even-aged densely planted trees will likely be avoided by caribou.
- Individual tree selection removals are not taking enough volume to influence the immigration of *Bryoria* down to the lower 4.5 m of the stem (not enough ventilation).
- Permanent access is being developed to facilitate three-entry harvest. This is expensive and defeats caribou access management objectives.
- Reforestation objectives are not being met. Short regeneration delays preclude a natural regeneration regime. Yet in older examples of selection harvest, natural regeneration is being chosen over planted trees that are exhibiting poor form and vigour. We are experiencing significant frost and cold air damage in group selection areas at high elevation. Furthermore, we have observed spruce budworm parachuting out of the overstory to feast on new seedlings.

Hypothesis that Variable Retention will obtain results:

- We have better knowledge on which to base retention objectives. Backtracking efforts and GPS/VHF collar data analysis have improved our understanding of habitat attributes to manage for in late and early winter areas. We have a better understanding of the ecology of *Bryoria* lichen, the main food source for caribou during these periods, through Trevor Goward's work.
- Managing to a retention objective is a better guarantee of achieving the desired result than managing with a percent reduction. For example, 33% reductions have resulted in basal area retentions of between 18 and 33 m^2. These are entirely different residual results.
- Variable retention can better mimic natural disturbance patterns.
- It can effectively meet access management objectives with temporary roads.
- It can eliminate costly post-harvest silviculture activities to modify regenerated stands to meet caribou objectives.

15. Hair Lichens, Snowpack Variation and the Fate of the Mountain Caribou: The LSC Hypothesis

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British Columbia's mountain caribou are behaviourally adapted to survival in regions of heavy snow. In winter, when ground forage is buried out of reach, these animals subsist on a diet of tree-dwelling hair lichens. Caribou forage for hair lichens, especially *Bryoria*, in three contexts: 1) as litterfall; 2) in the crowns of recently windthrown trees; and 3) on the lower branches of standing trees. Litterfall and windthrown trees are especially important to caribou in their early winter habitats, often at lower elevations. The main winter range, however, is in the subalpine, and here they rely much more heavily on hair lichens growing on the branches of standing trees.

Bryoria biomass is heaviest in old-growth forests, where these lichens increase in abundance with increasing distance from the ground. Three vertical zones of abundance can be recognized:

- Zone A, in which *Bryoria* is virtually absent, is restricted to the basal portions of the canopy, its upper boundary (the "A/B threshold") corresponding with the depth of the winter snowpack.
- Zone B is located directly above Zone A, and supports *Bryoria* at quite variable loadings, both spatially and temporally. The upward transition to Zone C is signalled by an abrupt increase in *Bryoria* abundance.
- Zone C is the zone of maximum *Bryoria* accumulation, especially on defoliated branches. Litterfall from Zone C contributes significantly to *Bryoria* biomass in Zone B, in part accounting for the highly variable *Bryoria* loadings characteristic of this zone.

Bryoria is unable to withstand prolonged burial by snow. Winters with exceptionally deep snowpacks cause upward shifts in the A/B threshold as buried *Bryoria* dies off. Thereafter, especially at subalpine elevations, the lower *Bryoria* trimline is likely to be situated well out of reach of caribou in early winter.

This can be predicted to delay the migration of caribou from their early winter habitat to their main winter range, because caribou are capable of foraging efficiently in subalpine forests only once deepening snows provide a feeding platform within about 1.5 – 2 m of the A/B threshold (or A/C in highly exposed sites).

Once elevated, an A/B threshold is slow to readjust downwards to its original position, requiring perhaps a decade or more. During this period, caribou can be predicted to spend more time than usual in their early-winter ranges, particularly in years when snowpacks are slow to build. Such years are probably highly stressful for caribou. Firstly, because these animals, effectively trapped at lower elevations, are at higher-than-average risk of encountering predators (owing to greater concentrations of other ungulates). Secondly, because as old-growth forests continue to

be replaced by clearcuts, the likelihood of locating *Bryoria*-rich windthrown trees must also decline. Cratering for falsebox and other forbs of course provides some nourishment (less, however, in clearcuts than in forest settings), though the question needs to be raised whether the increasing lack of availability of hair lichens at lower elevations could result in food shortages for these animals.

The above Lichen-Snow-Caribou (LSC) hypothesis could provide a plausible explanation for the well-known tendency of caribou to perform annual vertical migrations much more pronounced in areas of heavy snows than in less snowy regions. It also suggests a framework against which to examine historic fluctuations in population size. In principle, caribou herds in areas of heavy snow ought to experience rapid episodic declines, followed by more gradual increases. Such declines, moreover, would be expected during the decade following a year of exceptionally deep snowpacks. Caribou populations in drier areas should be more stable.

To the extent that the LSC hypothesis is eventually validated, resource managers would do well to heed the warning implicit in it: low elevation old-growth forests may be crucial, at least in regions of heavy snow, to the long-term survival of mountain caribou. If so, then recent declines in the Revelstoke and Central Selkirk subpopulations could be simply an inevitable downward adjustment to existing conditions brought on by clearcut logging at the landscape scale.

16. Recreation and Caribou: What Do We Know About the Effects of Recreation on Caribou?

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Very little is known about the effects of recreation on mountain caribou. Not only is this topic difficult to quantify, it has been looked at only twice and for short periods of time. Where snowmobile use has increased gradually and snowmobiles are, due to topography or regulation, limited to a portion of the late winter caribou habitat, individual caribou appear to have habituated to snowmobile use and show little immediate response. These animals are the ones most often observed by snowmobilers. There is some indication that other animals have been displaced from areas where snowmobile use rapidly increased over the past decade and where their use is less limited across the late-winter habitat.

17. Snowmobiles and Caribou: Perspectives from the Revelstoke Snowmobile Club and British Columbia Snowmobile Federation

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For information on the Revelstoke Snowmobile Club and information on area closures due to caribou, visit http://www.sledrevelstoke.com and look in the "Wildlife Issues" section.

For information about the British Columbia Snowmobile Federation and snowmobiling in British Columbia, visit: http://www.snowmobilebc.ca .

18. A Retrospective GIS Analysis of Spatial Interactions between Mountain Caribou and Helicopter Skiing

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Recreation-related impacts on mountain caribou are often cited but rarely studied. Helicopters used in commercial backcountry ski operations are considered by some to be a significant source of harassment during a critical season for caribou. As a result, we are currently conducting a retrospective analysis of the spatial interactions between mountain caribou and helicopter skiing.

Our study area is comprised of two commercial recreation tenures held by Canadian Mountain Holidays (CMH) located within the range of the Central Selkirk mountain caribou herd in the West Kootenay region of British Columbia. The tenures cover approximately 2000 km^2 within which CMH uses established ski runs. Records have been maintained for several years regarding the intensity of use of different runs.

The Central Selkirk mountain caribou herd has been the focus of inventory work for 10 years. During that time, approximately 2000 radio telemetry locations have been collected on 40

collared caribou. In addition, caribou habitat has been mapped within the range of the herd using both expert-based and resource selection function approaches.

The purpose of our study is to examine the interaction between caribou and heli-skiing habitat use during 1992–2002. Because this interaction is occurring on a multiple-use landscape, we are using a retrospective cumulative effects approach that also considers other resource uses such as industrial forestry and snowmobiling.

The principal questions being asked in our study are:

- To what extent is caribou and heli-skiing habitat use coincident?
- Do caribou avoid areas that are used for heli-skiing?
- Is there evidence that caribou have abandoned previously occupied range in areas used for heli-skiing?
- How can CMH improve their operating practices in caribou habitat?

We are conducting both a quantitative and qualitative analysis. The quantitative analysis involves the calculation of resource selection functions for both early and late winter seasons, explicitly incorporating the intensity of heli-skiing activity as a factor. In addition, we are also examining evidence for changes in range use by individual caribou and by the herd (based on fixed kernel individual and composite seasonal home ranges) in relation to heli-skiing activity. The qualitative analysis involves a series of spatial overlays that illustrate the coincidence of heli-skiing and other resource uses with caribou and caribou habitat, by season and year. The overlays will highlight any geographic areas of management concern where the coincidence of landscape uses in areas important for caribou might warrant special management.

The strength of this approach is that it leverages existing information to spatially illustrate, and statistically analyze, the interaction between caribou and human-related activities on a landscape. The approach is necessarily correlative, and is limited by the availability of data; however, it can quickly highlight areas of management concern, and can control statistically for the independent effects of different landscape uses on caribou.

19. Does Human Activity Affect Woodland Caribou in Jasper National Park?

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Within the Rocky Mountain national parks, woodland caribou are close to extirpation in Banff National Park but continue to occupy northern and southern Jasper National Park. Aerial surveys on herds in southern Jasper indicate that this population has declined from approximately 500 animals in the 1960s to just over 100 animals in 2000. Moreover, a recent population viability analysis suggested that the South Jasper herds might be extirpated within the next 40 years, based on conservative population parameters. Unlike other declining caribou populations, this population has declined in the absence of resource extraction and other

extensive landscape changes. Recreational activity has therefore been suggested as a possible cause for this decline. Human activity may directly displace caribou from preferred habitat, however literature supporting this hypothesis is weak. Alternatively, ploughed winter roads and packed trails may indirectly affect caribou by providing wolves with easy access to them.

Over the next four years we will experimentally test the effects of recreational activity on caribou in the Maligne Valley of southern Jasper. We plan to place GPS collars on 10 caribou and four wolves in each of the next four winters. We also plan to close the Maligne Valley to vehicle and skier traffic in the latter two years. We will then examine changes in caribou response to road and trails pre- and post-closure. Preliminary data analysis for two radio-collared caribou (2001) suggests that these caribou avoided the Maligne Road and human-use trails. Results of this study will be used to develop human use management strategies for caribou wintering areas in Jasper National Park.

20. Designing Credible Field Studies on the Effect of Human Disturbance on Mountain Caribou

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With the increase in front- and backcountry traffic associated with ecotourism and other "non-consumptive" wildlife uses has come an increase in concern about the effects of disturbance on wildlife populations. Disturbance responses of species such as mountain caribou can be stratified into three categories that correspond to different spatial and temporal scales:

- Short-term, acute: responses that are immediate and obvious, but are short in duration. These include both behavioural and physiological responses.
- Medium-term, chronic: responses that are slow to develop or dissipate, such as changes in habitat use or range abandonment.
- Long-term, demographic: responses related to population declines that are typically difficult to detect and reverse, and are often associated with other factors such as habitat quality, disease, and/or predation.

Many studies have examined the short-term behavioural and/or physiological (e.g., heart rate) responses of ungulates to disturbance. Most studies on wild species have focussed on deer and sheep. Of these, many have involved captive populations. Caribou have been the focus of some longitudinal studies. A significant issue in the design of these studies is that the disturbance history of animals is unknown. In addition, these studies rarely involve marked animals, leading to pseudoreplication issues. Where marked animals are involved, sensitization to human-related disturbances is a key concern.

Individual animals vary in their behavioural response to disturbance, and physiological measures have correlated poorly with observable behaviours. Casually linking these short-term responses

to longer-term effects is difficult. As a result, defensible benchmarks and thresholds associated with acceptable levels of disturbance are unlikely to be outcomes of these studies.

Few studies have causally linked disturbance events to habitat use. There are opportunities to conduct such studies on caribou herds in British Columbia, where good data exist on current and past distributions of mountain caribou. These studies are limited by available data, particular those related to non-commercial backcountry activities. These studies should be done in a cumulative effects context that accommodates other landscape uses that might be correlated with disturbance events. Studies demonstrating avoidance of areas affected by disturbances, or medium- to long-term changes in range use by mountain caribou in response to disturbance (where other factors are controlled statistically), can provide convincing evidence that populations are being adversely affected.

Establishing the long-term, demographic consequences of disturbance events is difficult because of the long time scales required to detect population changes, and confounding factors that influence population dynamics.

Given the challenges of designing studies to determine the effects of disturbance on mountain caribou, management is likely to remain based on acceptable management risks rather than on scientifically defensible benchmarks and thresholds.

21. Tracking the Prolific Past: An Historical Overview of Caribou Abundance in the Columbia Mountains

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In *Life is a Miracle*, American essayist and conservationist Wendell Berry asserts that "We can begin ... only where our history has so far brought us …" He argues strongly for the role history can play in the formation of what he calls "locality"; in other words, a cultural attachment to and respect for our natural habitats. Locality, Berry believes, is enhanced by deep, multi-generational knowledge. This knowledge includes how things *were* as well as how they *are*.

So, with that in mind, let us consider this mammal that interests us all, this large-footed creature of docile and communal nature. What is its history in relation to the human culture of the Southern Interior Mountain eco-region? The number of people gathered at this conference suggests that the caribou is a species of considerable value. Has it always been so? How much of our current understanding and valuing of caribou is informed by history?

Originally, my interest in past landscapes grew out of the task of researching and writing a book about the Columbia Mountain region's First People, the Arrow Lakes Indians, or Sinixt. But before too long, I had moved beyond the scope of aboriginal history. I became fascinated with any and all references to this interior wet-belt ecosystem as it once was: its animals, plants, pre-

dam waterways and weather. I began to ferret out journals and diaries of obscure trade fort managers, travelling botanists, missionaries, and adventurers, always searching to understand more about how this landscape functioned prior to industrial use of natural resources.

Scientists usually work in the here and now, making accurate, first-hand observation their sharpest tool. Decisions about habitat protection or enhancement, about herd augmentation or predation are not formed by focusing on the past. Instead, they are formed by gathering today's evidence, studying the numbers and then suggesting hypotheses. The work of a scientist is distinct from that of an historian. Historians work with information passed down from often vague and sometimes unreliable sources. They work more conceptually, and with more qualitative information. Fact, for an historian, is a difficult beast to stalk; forming a hypothesis is a tricky business.

For obvious reasons, conservation biologists and ecologists have not spent a lot of time bent over history books. But interestingly enough, both the Federal and Provincial governments have recently funded historical studies of mountain caribou. In 1996, Parks Canada published Graham A. MacDonald's *Caribou and Human Agency in the Columbia Mountains, Towards an Environmental History of a Species*. And in the year 2000, the provincial Ministry of Environment, Lands and Parks produced Wildlife Bulletin No. B-100, *The Early History of Woodland Caribou in BC*, written by David Spalding.

This willingness to value historical cultural information as it relates to mountain caribou suggests that the past does indeed have something to offer those who presently work in this field. But what might that be? I'd like to explore the environmental heritage of the mountain caribou as it can be pieced together from various historical and ethnographic sources prior to about 1900. I will divide the information into three phases of time, each one of varying length. After a brief survey of the material, perhaps then we might consider what past knowledge of this creature's place here can offer.

Hunter-Gatherers in a Tangled Forest; 5000 B.P.–1811 A.D.

Imagine an old-growth interior wet-belt forest with white pine, cedar, and hemlock rising up in what has been variously described by early European contact explorers as a landscape "filled with large trees," "impenetrable," and "thickly wooded." Imagine mature groves of these trees, enhanced by a climate of constant disturbance from flood and fire. Imagine rivers teeming with anadromous spawning salmon, lakes filled with Kokanee, bull trout and sturgeon, wetland mammals, bears, deer, raptors, songbirds, and mosquitoes. Imagine sunny floodplains alive with the blooms of tiger lily and steeper slopes thick with huckleberry and wild raspberry. Now picture herds of caribou, many herds, which roamed the higher elevations through the summer and into early autumn, then descended into the lush, narrow valleys as the snow began to accumulate. They followed deepening snow up to the subalpine meadows, to feed on lichen dripping its black wealth from the branches of the trees. Settled in villages along the rivers and lakes and in the forests were human hunter-gatherers; a Neolithic culture without metal, motors, or money as we know it today. They knew the caribou's habits and depended on its presence for their survival.

How long did the caribou co-exist with the hunter-gatherer culture? Archaeologists suggest that human beings arrived in the Columbia Mountains sometime after 5000 BP, probably coming up along the Columbia River from the Kettle Falls region. The descendants of these arrivals are the Sinixt. They and three other First Nations hunted the caribou in the vast Southern Interior Mountain eco-region. The Sinixt hunted primarily in the Monashee, Selkirk, and Purcell Ranges surrounding the Columbia and Kootenay Rivers. The Ktunaxa hunted between Tobacco Plains and Yahk as well as the mountains around Kootenay Lake. The Secwepemc came over from the west along the Inonoaklin Creek drainage, to share Sinixt hunting grounds along Lower Arrow Lake. And the Kalispel hunted caribou in lower Kalispel country, near the present-day Washington/Idaho border.

While all four nations used caribou, ethnographers tell us that caribou was in particular a central aspect of the meat-rich diet of the Sinixt, who lived in the heart of the Upper Columbia watershed. Elder Martin Louie told researchers that caribou were prolific in Arrow Lakes country long ago. He described communal hunts when caribou were driven into the lake, where men in bark canoes would club or shoot them. Louie said that his grandfather participated in these drives in the 19th century; he told his grandson that if the hunters were not careful, the caribou would kick the canoe and then the hunters would be swimming alongside them.

The Sinixt also stalked caribou individually, with bow and arrow. When a hunter returned to the village with fresh kill, the carcass was laid in a central location for all to share in its value. Waste was frowned upon. The hide was tanned and fashioned into clothing, shoes, or blankets, meat was eaten fresh or pounded and dried into jerky, the bones were pulverized for marrow, and the horns were polished for handles or utensils.

Ethnographers James Teit and Verne Ray both recorded more testimony from other Sinixt native elders in the early 20th century that caribou could long ago be hunted in many places in the Columbia Mountains. Elders spoke of caribou in the floodplains around the Arrow Lakes, at the lower end of Trout Lake, in the mountainous area north of the Kootenay River, in the Kokanee Range between the West Arm and the Slocan River, around Nakusp, on the east side of Lower Arrow Lake, at Whatshan Lake, and to the west of the pre-dam Columbia River Narrows.

The Ktunaxa, eastern neighbours of the Sinixt, also considered the caribou to be economically significant. "Yahk" a common place name in northern Montana and southeastern British Columbia, means "caribou" in the Ktunaxa language. According to the ethnographer Harry Turney-High, Ktunaxa elders told him that they considered the caribou to be a sort of "safety-valve" in their food supply, given their wide availability and docility for hunting. As well, the arrival from the west of the Secwepemc people to the Arrow Lakes each fall indicates that the mountains surrounding the Columbia River and the valleys themselves had a wide reputation for being prime caribou habitat.

The Kalispel, living in the South Selkirks, also hunted caribou. Evidently, they did not round up caribou as they did deer, because the caribou would not run from a barking dog. There is evidence that the Kalispel mimicked mating calls to attract the animal.

Though it is impossible to predict precise numbers or herd locations of the caribou in this pre-contact period, the record suggests that the mammal, like the mature forests that formed its primary habitat, was extremely common and may have even been prolific. Caribou appear to have ranged in the highest elevations only in the warmer months. The record suggests that they were more commonly hunted in areas close to or on valley bottoms where permanent village sites were located, and once the salmon had ceased to spawn in early autumn.

The Fur Trade and the End of the Mini-Ice Age: 1811 – 1872

In 1811, the first European entered the densely tangled Columbia Mountains. This was the intrepid explorer David Thompson, searching for a navigable route to the Pacific for trading purposes. The effects of European culture had been felt even before his arrival, in disease passed through inter-tribal trade sometime after 1770. The fur trade period, spanning 1811 – 1870, overlaps with the tail end of the mini ice-age, when temperatures were lower, winters longer, and snow deeper in these mountains. These conditions would not have disadvantaged the caribou and, according to Graham MacDonald's report, may even have enhanced temporarily their populations.

There is no reason to believe that caribou suffered any significant losses from industrial harvest of hides by the fur trade. Across the northwest, trade forts did not generally place value on ungulate hides. For example, the records of commodities traded by the Sinixt at Fort Colville at Kettle Falls, Washington in 1827 list the skins of 281 beaver, 72 marten, 76 muskrat, 15 otter, and 22 deer, as well as 235 pounds of fresh venison, but make no mention of caribou. A fur trade journal of March 1831 from Fort Colville lists 12 "carriboeufs," still a relatively small number by comparison to other animals harvested.

The journals of botanist David Douglas, recorded in April 1827 as he travelled north along the Columbia toward Rocky Mountain House, indicate that caribou continued to be plentiful and important to the First People of the region in the first several decades following European contact. Stopping briefly at a family of Sinixt living along the former Columbia River Narrows near present-day Nakusp to trade for some snowshoes, Douglas noticed that "not fewer than a hundred skins were inside this lodge." The next day, he encountered another village of Sinixt people at Arrowhead near Galena Bay. There, inside a lodge, he found "many skins of Black-tailed, Rein, and Red deer being in their possession." He observed that they seemed to live comfortably and "purchased of them a little dried reindeer-meat and a little black bear."

Later, as surveyors began to explore the region, they, too, noticed signs of the prolific presence of caribou. In 1859, John Sullivan, a member of Palliser's expedition, was helping to forge a trail over the Summit Creek pass near the U.S./Canada border when, at the height of land, he came across what he thought was an Indian trail to help the expedition find its way. But, as he recorded, "our guide informed me that we had been travelling for the last half hour ... upon ... a carriboeuf road. Carriboeufs frequent this part of the country in large numbers, as the woods are traversed by their beaten tracks. They are induced to visit this tract of country in order to feed upon a very large leaf, which grows in great abundance on the moist lands high up in the

mountains." Near to that time, artist and adventurer Paul Kane also recorded seeing caribou along Upper Arrow Lake as he paddled in search of scenes to paint.

By the time the trade centres of Fort Shepherd and Fort Colville had closed, between 1870 and 1872, gold seekers from the U.S. and Canada had already begun to enter the region with the intent to locate and extract minerals. The hunter-gatherers who had co-existed relatively peacefully with the fur trade industry spent less and less time in the valleys around the Columbia and Kootenay Rivers. Their traditional way of life as well as their thousands of years – old relationship with the caribou was increasingly disrupted by settlement pressures. Placer mining of creeks began. Then fires were set on the mountains to burn away timber and expose potential mineral deposits.

These fires, occurring largely between 1880 and 1890, were often left untended and burned out of control, destroying vast sections of timbered hillsides. They must have caused catastrophic loss of habitat for forest mammals, though the direct impact on caribou is not known. Interestingly, a 1905 government forestry map demonstrates that mature forests in unsettled portions of valley bottoms and along major drainages, some of the prime winter habitat for caribou, were not always affected by the burns. In addition, as Spalding has pointed out, since some disturbance was common in the Columbia Mountain ecosystem, caribou may well have been conditioned to adjust more readily to the effects of the fires. Reports of a successful hunt of dozens of caribou along the Pend d'Oreille River in the winter of 1888–9 support this theory.

Clearing and Tilling the Fertile Valleys, 1900 – 1950

The place names "Caribou Creek," "Caribou Point," "Caribou Lake," and "Cariboo Mountains" began to appear on maps around 1900, indicating that even with the new pressures on habitat as farms were tilled and cities built, the mammal continued to be at least a noticeable presence throughout the Columbia Mountains. The Sinixt First People, who, after about 1890, gradually sought refuge on the U.S. Reservation established in 1872, continued to come north across the border into their traditional territory to hunt each autumn, presumably in search of caribou, deer, and bear. Their annual return to traditional hunting grounds sometimes caused conflict with settlers.

In 1895, the *Kootenay Mail* newspaper reported the story of a settler near Beaton Arm named Evan Johnson, who described shooting a caribou that had swum across the arm. The animal was picked up by Sinixt hunters, who later annoyed Johnson when they came to him offering some of the meat for sale.

In 1900, trophy hunter and English aristocrat W.W. Baillie-Grohman reported herds of caribou on the steep slopes around Kootenay Lake. But then in 1907, he suggested that herds around Kootenay Lake had moved north in response to the fires of the 1880s. In 1905, botanist John Macoun recorded that "the caribou ... are also growing scarce, but with a guide who is a sportsman and not afraid of a long walk, good sport can still be had ... We found caribou ... quite easily plentiful on the Gold Range." There were apparently enough caribou still resident north

and just west of Kootenay Lake to organize a limited commercial harvest in the Lardeau Valley in 1917.

At most, however, the historical information from this period suggests sporadic abundance; caribou numbers were definitely in relative decline. This is not surprising, as settlement and agricultural development of valley bottoms continued in earnest. Any management of wildlife resources was still very much on the margin of the colonial government's priorities.

This summary of the pre-historical and early historical period that I have tried to offer paints a picture of a gradual shift from prolific numbers of caribou acting as a primary food source for hunter-gatherers to an animal of more and more marginal presence and significance in the Southern Interior Mountains. This occured as motorized technology, firearms, and extractive efficiency increased. It is not hard to project forward from the Lardeau commercial hunt of 1917 to the present day, when the caribou has become an elusive, almost ghost-like presence and is threatened with extinction. I don't have time to detail the more recent past in this presentation, but I urge you to consult both MacDonald and Spalding for a fascinating look at caribou populations and land use decisions between World War II and the end of the 20th century, when industrial logging moved inland from the coast and hydroelectric projects flooded river valley bottoms in several places.

There is no question to me that the First People of the Southern Interior Mountains valued and respected the caribou enormously: their survival depended on it. The early settlement European culture also appears to have appreciated the mammal for food and sport. But somewhere along the way, in the complex interface between nature and human culture, the tendency to value and prize an important animal developed into a tendency to make decisions that threatened its survival. How exactly that has happened is the subject of history, a history of sparse record, which is, unfortunately, little known or understood.

The relationship between human beings and nature may well be the last frontier in modern ecology. The growing field of ecological restoration reminds us that, like it or not, we are definitely part of any ecosystem where we live. Our actions always make a difference. Certainly this has been my primary lesson as I have surveyed the history of caribou and human culture. And I suppose it is that, in the end, that fascinates me about early landscapes. Somehow, by taking into consideration the vast series of changes that have taken place between that shady, half-forgotten time we call "then" and this urgent, worrisome time we call "now," a span of only 200 years, I have begun to understand how much influence human culture can exert on nature. But I do not say this in dismay. My research has also suggested to me how much potential we have to be part of the solution. Knowledge of our region's environmental heritage can inform land use decisions by expanding our temporal framework, increasing our reverence and humbling our place. It seems to me that the formation of lasting solutions to the caribou problem involves learning the environmental heritage of these Southern Interior Mountains, the eco-home of the caribou as well as ourselves. Then, with any luck, we will be better able to judge past actions in order to forge future solutions.

Field Trip

The Field Trip was co-ordinated by:
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Stop One

Gregson Road, 54 km north of Revelstoke on Highway 23 North.
This site featured Interior Cedar-Hemlock old growth, and group selection logging using 1 ha patches. Bruce McLellan, Trevor Kinley, and Del Williams talked about ungulate/caribou interactions, forest management on the site, and lichens in Interior Cedar-Hemlock forests.

Stop Two

Key Road, 60 km north of Revelstoke, about 2 km up the road
Lauren Waters and Del Williams talked about the commercial thinning and recruiting caribou habitat.

Stop Three

Upper Key Road
The field trip participants split into several groups and then:

- Del Williams spoke on Revelstoke Community Forest Corporation's (RCFC's) forest management (single tree selection, group selection, and contrasting with the clearcut forestry adjacent)
- Buck Corrigan from Canadian Mountain Holidays and Tom Dickson from the Revelstoke Snowmobile Club spoke on their activities in caribou habitat
- Wes Bieber from Weyerhaeuser and Doug Lewis took the group on a walkabout to discuss "variable retention" harvesting and lichens in ESSF forests
- Harold Armleder followed with a description of his use of the group selection method and a bit of a comparison with RCFC's method.

The group returned to Revelstoke at about 4:30 pm.

Appendix One

Silviculture Guidelines and Practices for Maintaining or Recruiting Key Habitat Objectives

This is an excerpt from a draft report prepared by Manning, Cooper and Associates of Victoria, British Columbia (June 2002) for the Biodiversity Branch, British Columbia Ministry of Water, Land and Air Protection, Victoria British Columbia. It has been included here at the request of Colene Wood, Biodiversity Branch, British Columbia Ministry of Water, Land and Air Protection.

Executive Summary

Ten key, broad-level habitat objectives were identified that can be managed (i.e., maintained or recruited) using silviculture treatments (i.e., including appropriate harvesting and retention strategies, post-harvest regeneration and stand tending regimes, and additional habitat restoration practices). These habitat objectives, as follows, were chosen because of their applicability to many forested regions of British Columbia, their frequent inclusion in higher-level management plans and associated operational guidelines and prescriptions, and the general benefit to stand-level biodiversity and ecosystem function they produce. As well, these objectives are specific, achievable and measurable:

- Maintenance and/or recruitment of coarse woody debris (CWD)
- Retention and/or recruitment of wildlife tree patches (WTPs)
- Maintenance and/or recruitment of habitat structure and function in riparian management areas (RMAs)
- Maintenance and/or recruitment of landscape level biodiversity functions/objectives (including seral stage distribution and landscape connectivity / wildlife travel corridors)
- Maintenance and/or recruitment of habitat elements for the general range of primary cavity excavating birds
- Maintenance and/or recruitment of habitat elements for Northern Goshawk reproduction and foraging
- Maintenance and/or recruitment of coastal black-tailed deer and Roosevelt elk winter range
- Maintenance and/or recruitment of mule deer winter range
- Maintenance and/or recruitment of mountain caribou winter range
- Maintenance and/or recruitment of habitat elements for grizzly bear forage and security cover.

This report is intended to be a companion document to the various provincial and regional forest management guidelines that have already been developed for managing selected species and habitats. It provides a useful summary of current knowledge and recommended best management practices for managing the key habitat objectives described above, and is

compatible with existing silviculture standards guidelines (e.g., *Establishment to Free Growing Guidebooks*). Information on habitat restoration practices is also provided.

Acknowledgements

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This report was prepared by Todd Manning, Bill Golding, Jay Baker, Reinhard Muller, John Cooper, Paul Chytyk and Susan Stevenson, for Manning, Cooper and Associates (Victoria, British Columbia).

Mountain Caribou (*Rangifer tarandus caribou*)

1. Key Habitat Objectives
Maintain and or recruit habitat elements for mountain caribou—for forage and security in winter range (**not applicable to northern caribou**). **Landscape Level:** Landscape level management objectives such as connectivity, patch size distribution, and seral stage targets, as well as access management, should be described in higher level plans and sustainable forest management plans. It is important to link higher level plan objectives such as these for a landscape unit or other planning area, with specific practices implemented at the stand level (see Best Management Practices, below). A further discussion of landscape level considerations is found in the Landscape Considerations section of this report. *(please refer to complete report)*

2. Forest Types / BEC Zones
ESSF dk, mm, vc, vv, wc, wk, wm, ICH mk2, mm, mw, vk, wk

3. Best Management Practices and Specific Habitat Objectives for Access Development and Harvesting
Maintain and/or restore forested connectivity corridors to facilitate predator avoidance and movement of caribou between seasonal ranges. Protect caribou from access-related impacts by developing a road/access management plan. Where forest harvesting is planned in mountain caribou winter range, maintain most of the stand in a late-seral condition by using partial cutting techniques with low (< 30%) volume removal and long cutting cycles. For example: 30% volume removal at intervals of 80 years, or 25% removal at intervals of 60 years. **Note**: Harvest cycles of this duration are intended to ensure that the regeneration from the first entry will be of sufficient size to provide travel habitat and have an inner defoliated zone, which is important for lichen forage development Maintain pre-harvest tree species composition. In the ICH and on the ICH/ESSF ecotone, minimize disturbance of soil and vegetation during harvesting and silvicultural activities in order to: Maintain low evergreen shrubs and herbs with persistent green leaves (e.g., falsebox [*Pachystima myrsinites]*, bunchberry [*Cornus Canadensis]*, foamflower [*Tiarella* spp.], and wintergreen [*Pyrola* spp.]) Avoid enhancing shrubs preferred by moose, deer, and elk (e.g., willow [*Salix* spp.], red-osier dogwood [*Cornus stolonifera]*, and Douglas maple [*Acer glabrum])*. Avoid excessive physical obstructions (such as windrowed slash or many downed trees).

4. Best Management Practices and Specific Habitat Objectives Post Harvest

Restoration:
Young or mid-seral stands that are dense or homogeneous may be spaced or thinned to encourage development of a multi-layered structure with heterogeneous spacing.

Regeneration:
Minimize visual obstructions and maintain freedom of movement for caribou by keeping regeneration density low.
Maintain a clumped stand structure where it occurs naturally, and by cluster planting where possible (see Additional Planting Information, section 6 of complete report).

Brushing:
In the ICH and on the ICH/ESSF ecotone, vegetation management should be planned to discourage woody browse species.

Spacing/Thinning/Pruning (or associated practices):
In the ICH and on the **ICH/ESSF ecotone**, manage for a multi-layered stand structure and heterogeneous spacing – some areas should have more open spacing to encourage production of forage lichens, and other areas should have higher canopy closure and dense, wide, long crowns to provide snow interception. Overall, manage for approximately 300 live and 25–30 dead stems/ha (> 19 cm dbh) at age 140 years. To achieve this stand structure:
Conserve some advance regeneration during harvesting.
Plant widely spaced trees, and allow natural regeneration of western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*).
Space trees to encourage variable stem densities and support advance regeneration. Dense thickets of regeneration that interfere with sight distances may be reduced.
Note: Pruning does not significantly affect caribou forage in the ICH, where there are few forage lichens within reach. Pruning can actually be used to improve sight distances in these stands.
In the ESSF, manage for a multi-layered stand with clumped trees separated by gaps. Overall, manage for approximately 300 live and 25–30 dead stems/ha (> 19 cm dbh) at age 140 years. To achieve this stand structure:
In the prescription, reduce acceptable inter-tree spacing to 1 m.
Conserve some advance regeneration during harvesting.
Cluster-plant on naturally raised microsites or on clumped mounds. For example, plant an average of four seedlings per clump and space clumps approximately 5–7 m apart.
Avoid pruning in areas where arboreal lichens on low branches are important forage for ungulates.
Note: It is important to avoid pruning in the ESSF, where caribou eat lichens directly off the lower branches of trees.

Protection (fire, insects, disease, damage):
Mountain caribou are adapted to forests that regenerate through gap-dynamics processes. Caribou winter ranges should be protected from extensive stand-destroying fires.

5. Recommended Silvicultural Regimes	
BEC – Zones ***ESSFdk mm, vc, vv, wc, wk, wm*** ***ICHmk2, mm, mw, vk, wk***	Uneven-aged management with high retention of residuals should be practiced wherever possible. The following silvicultural regimes apply to even-aged stands where recruitment of future caribou habitat is a management objective. Examples would be pre-existing even-aged stands, or harvest blocks within movement corridors that are being managed to provide snow-interception habitat in the future. The use of moderate, rather than low, densities early in stand history discourages browse species and encourages dieback of lower branches, which improves sight distances. Later management should focus on the enhancement and/or recruitment of heterogeneous stem density and inter-tree spacing throughout the stand rotation. The associated standards reflect this goal. Modified standards are provided only for submesic to subhygric sites in an effort to create conditions across a landscape that will contain various free-growing densities (e.g., a bell curve density distribution). Silvicultural Systems that may be applicable for this objective include: Clearcut, Patch Cut, Shelterwood, Retention, Seed Tree, and Selection systems. Harvesting practices should ensure that post harvest debris loading does not create excessive physical obstruction to animal movements. Site preparation treatments should not create excessive physical obstructions (such as windrows) and must preserve retained advance regeneration. On subhygric sites, establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern. On submesic sites, establish plantations in a uniform pattern to encourage earlier crown closure. Do not employ broadcast-brushing techniques such as herbicides. In addition, during brushing and or spacing treatments ensure that variable-density distribution of target crop trees is achieved. Implement juvenile spacing programs as required (maximim density 5000 stems/ha) to ensure that the desired variation in stand densities and inter-tree spacing is achieved. Post-spacing standards can range significantly and it is preferable to obtain a non-uniform spacing throughout an area post-treatment; this will help to ensure that heterogeneous canopy conditions will be present later into stand development (20–60 years).

6. Monitoring Standards – Establishment to Free Growing Seral Stage

Table 1.1 – Stocking Standard Guidelines

Applicable Ecosystem (BEC)			**Stocking Standard Modifiers**									
Zones	**Subzones**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assessment Time Frame**	**Min. Tree Ht.**	**% Tree Over Brush**	**Min Inter-Tree Distance**	**Max Density**	**Survey Method**	**Comments**
ESSF	dk, mm, un, vc, vv, wc, wk, wm	5/A-E	Footnote 2	0.8	Same	Same	Same	Same	1.0 m	Footnote 3	Footnote 4	
ESSF	dk, mm, un, vc, vv, wc, wk, wm	3/A-E	Footnote 2	1.2	Same	Same	Same	Same	2.0 m	Footnote 3	Footnote 4	
ICH	mk2, mm, mw, vk, wk	5/A-E	Footnote 2	0.8	Same	Same	Same	Same	2.0 m	Footnote 3	Footnote 4	
ICH	mk2, mm, mw, vk, wk	3/A-E	Footnote 2	1.2	Same	Same	Same	Same	2.0 m	Footnote 3	Footnote 4	

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within *Establishment to Free Growing Guidebooks*. For example: the stocking standards (well-spaced/ha) for the ESSFwk 05 site as found in the *Establishment to Free Growing Guidebook*, Cariboo Forest Region equals = TSSpa **1200**, MSSpa **700**, MSSp **600**. The equivalent stocking standards (well-spaced/ha) for areas with maintenance and or recruitment of forage supply, stand structure and habitat elements for the mountain caribou winter range objective would be TSSpa **960**, MSSpa **560**, MSSp **480**. TSS - target stocking standard, MSS - minimum stocking standard, pa – preferred and acceptable, and p - preferred.

2. Lodgepole pine (*Pinus contorta*) should be managed as a minor (< 20%) stand component for areas with caribou management objectives.

3. Maximum Density is 5000 stems/ ha for these ecosystems. Post spacing densities should range significantly (1000–3000 stems/ ha) on a given area in an effort to provide varied post free growing inter tree spacing and total density per ha.

4. The survey methodologies used to assess the success of meeting these standards should be consistent with existing methodologies. However, do not stratify areas into contiguous units smaller than 1 ha, or use dispersed stratum methodologies. In general, more plots may be required to prove that obligations are met due directly to the desired variable post-free growing density distribution targeted. The maximum number of plots required will be 1.5 per ha. The statistical requirements for these areas will be consistent with existing methodologies.

6. Monitoring Standards – Establishment to Free Growing Seral Stage (continued)

Table 1.2– Cluster Distribution

Stocking (tress/ha)	Clusters Per ha								Triangular Inter-Cluster Spacing (m)							
	Trees Per Cluster								Trees Per Cluster							
	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
200	25	29	33	40	50	67	100	200	21.5	20.1	18.6	17.0	15.2	13.2	10.7	7.6
250	31	36	42	50	63	83	125	250	19.2	18.0	16.6	15.2	13.6	11.8	9.6	6.8
300	38	43	50	60	75	100	150	300	17.5	16.4	15.2	13.9	12.4	10.7	8.8	6.2
350	44	50	58	70	88	117	175	350	16.2	15.2	14.1	12.8	11.5	9.9	8.1	5.7
400	50	57	67	80	100	133	200	400	15.2	14.2	13.2	12.0	10.7	9.3	7.6	5.4
450	56	64	75	90	113	150	225	450	14.3	13.4	12.4	11.3	10.1	8.8	7.2	5.1
500	63	71	83	100	125	167	250	500	13.6	12.7	11.8	10.7	9.6	8.3	6.8	4.8
550	69	79	92	110	138	183	275	550	13.0	12.1	11.2	10.2	9.2	7.9	6.5	4.6
600	75	86	100	120	150	200	300	600	12.4	11.6	10.7	9.8	8.8	7.6	6.2	4.4
650	81	93	108	130	163	217	325	650	11.9	11.2	10.3	9.4	8.4	7.3	6.0	4.2
700	88	100	117	140	175	233	350	700	11.5	10.7	9.9	9.1	8.1	7.0	5.7	4.1
750	94	107	125	150	188	250	375	750	11.1	10.4	9.6	8.8	7.8	6.8	5.5	3.9
800	100	114	133	160	200	267	400	800	10.7	10.1	9.3	8.5	7.6	6.6	5.4	3.8
850	106	121	142	170	212	283	425	850	10.4	9.8	9.0	8.2	7.4	6.4	5.2	3.7
900	112	129	150	180	225	300	450	900	10.2	9.5	8.8	8.0	7.2	6.2	5.1	3.6
950	119	136	158	190	238	317	475	950	9.9	9.2	8.5	7.8	7.0	6.0	4.9	3.5
1000	125	143	167	200	250	333	500	1000	9.6	9.0	8.3	7.6	6.8	5.9	4.8	3.4

6.0 Monitoring Standards, continued…

Notes: When cluster planting is prescribed, silviculture prescriptions should specify target trees per cluster and target clusters per ha, in addition to the target stocking standard.

Two methods have been developed to determine the prescribed number of clusters per ha.

Final Crop Tree Method

The final crop tree formula is the preferred method of determining the number of clusters. Managers must first determine the number of crop trees desired at rotation. Working backward from the density at final rotation, free growing targets and planting targets should be established based on appropriate mortality factors for the site. The following should be considered when deriving a mortality factor: species selection (e.g., shade-tolerant species show less mortality), availability of suitable microsites (e.g., moisture and nutrient requirements, likelihood of flood events), vegetative competition, and anticipated mortality due to stock handling. Dividing the planting

target stocking by trees per cluster will result in the required number of clusters per ha.

Number of clusters per ha = planting target/ trees per cluster

Target Stocking Method

Managers wishing to use the target stocking method should first consult the stocking standards table to determine the free growing target stocking recommended for the site series. Next, they should establish a mortality factor based on the site series and conditions, as in the final crop tree method, to derive the planting target. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha. The cluster distribution table above can be consulted to help verify the calculated figure.

Number of clusters per ha = planting target/ trees per cluster *(Triangular inter-cluster spacing = The square root of 11547/# of clusters per/ha)*

When cluster planting is implemented, spacing between clusters should be adjusted to reflect site conditions and microsite location. Uniform distribution of clusters over the block is appropriate where site conditions are relatively uniform. However, clusters should be located on appropriate planting sites, taking advantage of natural site features such as elevated hummocks or stumps.

Inter-cluster spacing is measured from the centre of one cluster to the centre of the adjacent ones on a square grid. However, where sites are undulating, clusters should be located on appropriate planting sites to take advantage of natural features such as elevated hummocks or stumps. Inter-cluster distances should be varied in order to optimize microsite selection.

Inter-cluster spacing is recommended to be a minimum of 80% and a maximum of 120% of that required to achieve the desired planting target. This range should result in achieving the overall desired stocking density, within acceptable statistical limits, when a stocking survey is applied across the area.

"Dispersed or non-uniform cluster" uses a mix of cluster densities across the block, and is appropriate for some blocks where microsites suitable for clusters (e.g., elevated hummocks) are not evenly distributed.

For dispersed cluster planting, the minimum inter-tree distance within a cluster is 1 m on suitable microsites. The number of suitable clusters per ha should be estimated from a reliable survey that covers the entire area. The minimum/maximum inter-cluster distances may vary substantially, as long as the overall target density is met.

6. Monitoring Standards – Additional
Establishment (Age 0–4 Year) Phase: N/A. Refer to the Best Management Practices section for management strategies through this portion of stand development. **Juvenile (Age 20–60 Year) Phase:** No specific standards are developed for this point in stand development. Management of younger age classes (e.g., establishment to free growing 0–20 years) is intended to develop suitable stand conditions through this age class. Existing stands within this age class may be managed to create the desired variable inter-tree spacing and total density per ha through late juvenile spacing or commercial harvesting. **Mature (Age 60+ Year) Phase:** No specific standards are applicable for this age class. In general, subsequent partial cutting harvesting strategies should be implemented that are consistent with the best management practices outlined.

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Appendix Two

Snowmobile Activity and Glucocorticoid Stress Responses in Wild Wolves and Elk

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Although noted as a presenter on early versions of the conference agenda, Scott Creel was unable to attend the *Mountain Caribou in 21st Century Ecosystems* conference. He supplied the following citation for a paper on his recent work, published in Conservation Biology:

> Creel, S. Fox, JE, Hardy, A, Sands, J, Garrott, R, and Peterson, R. 2002. Snowmobile activity and glucocorticoid stress responses in wild wolves and elk. Conservation Biology 16:809 – 814

This article is available as a PDF download from Scott's web site. The link is: http://www.montana.edu/wwwbi/staff/creel/snomoGC.pdf .