Southern Interior
Forest Extension
& Research Partnership

MOOSE, MULE DEER AND CARIBOO: *SHARING CURRENT KNOWLEDGE*

File Report 99-5

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Acknowledgements

The workshop and this report are the result of a collaborative effort by many individuals. The organizing committee's longstanding goal to hold a workshop with a wide variety of participants from different technical and non-technical backgrounds provided the opportunity to share information on moose, mule deer and caribou. This goal was adapted for changing circumstances through the planning process, but it remained constant.

The speakers, facilitators and recorders presented information, lead the break-out groups and recorded the discussions. Many of the speakers and facilitators also provided helpful comments on the draft versions of this report. These people are:

Harold Armleder	Ministry of Forests, Research	Organizing committee, speaker
Karen Campbell	Weldwood, Williams Lake	Organizing committee, facilitator
Rick Dawson	Ministry of Forests, Research	Speaker
Ken Day	UBC Alex Fraser Research Forest	Organizing committee, facilitator
Gary Ducommun	Cariboo Tribal Council	Organizing committee, speaker
Ardene Gilbert	Ministry of Forests, Cariboo region	Recorder
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Ken MacKenzie	Weldwood, 100 Mile House	Facilitator
Jane Perry	Southern Interior Forest Extension and Research Partnership	Organizing committee, facilitator, report editor
Heather Rolston	Contractor	Workshop support, recorder
Michaela Waterhouse	Ministry of Forests, Research	Speaker
Jean William	Williams Lake Indian Band	Speaker
Randy Wright	Ministry of Environment, Lands and Parks	Speaker
John Youds	Ministry of Environment, Lands and Parks	Organizing committee, speaker
Jim Young	Ministry of Environment, Lands and Parks	Speaker

The participants were key to the workshop's success. The organizing committee thanks everyone for their participation and the information they contributed to the workshop.

Executive Summary

This technical summary is produced from a one-day workshop held in Williams Lake in March 1999 with 85 participants from government, forest industry companies, First Nations, consulting and other agencies. Presentations, publications and posters on the biology and management of moose, mule deer and caribou gave participants the most current available information. Ungulate management in relation to timber harvesting, access management, public recreation and forest practices was presented and discussed. Information on mule deer biology and management is generally considered more extensive than for moose and caribou, demonstrating some primary information gaps.

Break-out groups gave participants an opportunity to ask questions of ungulate specialists, discuss issues, and suggest follow-up work to improve the sharing of scientific, traditional and experiential knowledge. Recommendations included the need for field trips to continue the information exchange, use of e-mail and updated web sites, improving availability of capability and forest development maps, testing and monitoring new forest practices to integrate timber harvesting with habitat requirements, and the continuation of this kind of information exchange among a wide range of participants. The Southern Interior Forest Extension and Research Partnership is regarded as the most suitable agency to co-ordinate and lead this follow-up.

Introduction

The workshop, *Moose, Mule Deer and Caribou: Sharing Current Knowledge*, was held in Williams Lake on March 23, 1999 at the Cariboo Chilcotin Community Skills Centre. The workshop was sponsored by government, industry, academia, First Nations, the Southern Interior Forest Extension and Research Partnership and Forest Renewal BC. The workshop's purpose was to provide an opportunity for the sharing of scientific, experiential and traditional knowledge among participants on these three important ungulate species in the Cariboo-Chilcotin.

The day's format was divided into morning presentations on the biology and management of moose, mule deer and caribou followed by perspectives from a First Nations speaker on ungulate management. Afternoon break-out groups allowed participants to meet for two hours and more intensively discuss one species and outline recommended future action for sharing information and knowledge. The workshop agenda is included in Appendix 1. The workshop participants (Appendix 2) included 70 audience members and 15 speakers, break-out group facilitators and recorders.

This technical summary includes the general topics or specific information discussed in the break-out groups with answers to questions or other follow-up information provided. Additional information from the morning speakers is included where available. Since the workshop was designed to identify extension needs for ungulate species, recommended action is summarized as useful direction from a comprehensive group of representatives involved in natural resource management. A summary of the written workshop evaluations is found at the end of the report.

The technical material covered demonstrates the breadth of questions and issues among the participants. Readers are encouraged to contact listed references sources or technical specialists for further information.

Technical Summaries for Ungulate Species

The following summaries are based on the recorders' notes from the afternoon break-out groups. In some cases, the presentation notes from the morning speakers are a more useful information source. Most of the questions asked by the participants and the issues discussed as a group related to management of each species, with some additional discussion of forest practices. There were only a few questions about the biology of any of the three species in the break-out groups.

Moose

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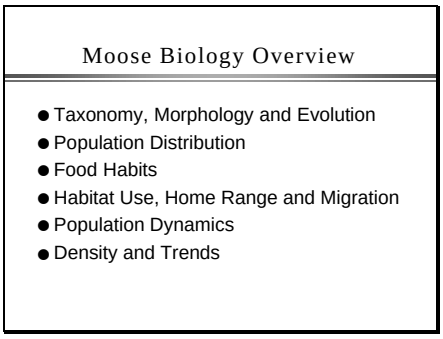
Resource specialists	John Youds 398-4530	Ministry of Environment, Lands and Parks
	Randy Wright 398-4530	Ministry of Environment, Lands and Parks

Biology

Refer to the presentation notes by John Youds for an outline on moose biology, which begins on the following page.

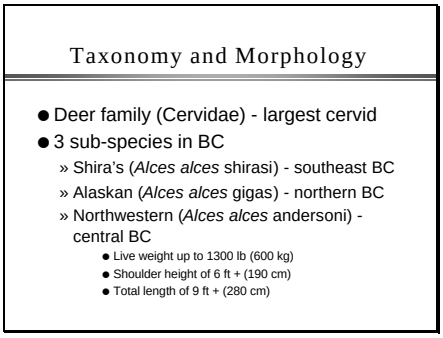
Moose Biology

Slide 1



- The moose is the largest living species of deer -- it is very unique and specialized and unlike any other deer.
- To understand moose biology and ecology, we have to appreciate where they evolved.
- The North American moose evolved in the northern boreal forests of Eurasia beginning about 2 million years ago, under the sometimes harsh climatic conditions of forest-tundra and boreal forest.
- All North American moose have originated from Siberia, entering North America about 10,000 to 70,000 years before present via the Bering Strait land bridge (multiple invasions are likely to have happened).
- Compared to other mammal fauna that invaded North America, the moose is a relatively late arrival.

Slide 2



- Moose have developed adaptations to survive in winters of cold and snow and to take maximum advantage of climates with short summers and abundant woody vegetation.
- Adaptations to environments of snow and cold:
- Large body size -- largest of all living deer -- lower volume to surface area ratio (retain body heat better).
- Long legs, high chest height -- leg bone lengths allow for easy movement through deep snow.
- Dark coloration -- absorb solar radiation better.
- Highly insulative winter coat -- comfortable at -20° C -- lower critical temperature not known.
- Adaptations to short summers and abundant woody vegetation:
- Modified 4-chamber stomach -- smaller rumen, shorter intestine than other deer species -- adapted to eat low quality foods in high quantities that pass through the digestive system quickly -- not an efficient digester of grasses -- browsing specialist.

- Elongated snouts, prehensile lips, long tongues -- allow moose to select the highest quality plant parts (newest growth)
- High weight gain in summer -- adapted to maximize weight gain in short summer season -- need to metabolize 25 to 45 lbs. of forage/day.

Slide 3

Population Distribution

- Limiting factors are food, cover and temperature
- Stressed by winter temperatures >5° C.
- Lower critical temperature unknown, unaffected at - 40° C.
- Snow depths limiting - winter use primarily below 4500 ft
- Coastal populations very limited

- The adaptations that moose have evolved to survive in boreal forests also come with biological constraints that limit the population distribution. Some of these ecological constraints include:
- Thermoregulation -- moose are heat stressed beginning at -5C. in winter and 14C. in summer -- as a result they require forest cover and aquatic environments to help regulate body temperature (ie. boreal forest conditions)
- Snow depths over 90 cm are limiting -- moose need to move to lower elevations or use areas with snow depths less than 90 cm.
- Need for high food intake -- because of their large body size, moose must consume large quantities of food to meet their energetic needs. As a result, moose need to choose feeding areas that permit high rates of intake of woody vegetation. Moose also need to occur at relatively low densities in order to support their energetic requirements
- Moose have only recently expanded their range into central BC during the past 100 years. Moose presently occur throughout the interior part of the region in suitable habitats -- winter use is primarily below 4500 ft due to limiting snow depths at higher elevations.
- There are few moose on the coast and this is likely related to the heat stress limitation (i.e., winter temperatures over 5° C) that limits the southern distribution of moose in North America.

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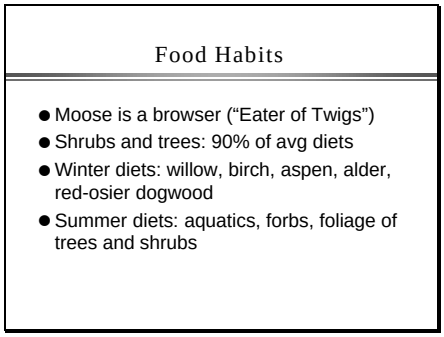

- The common North American name, moose, is derived from a native Algonkian name which means “eater of twigs.”
- The native name was very appropriate, as moose are browsing specialists with 90% of average diets being shrubs and trees.
- Diets are variable dependent on shrub and tree species available.
- Moose require a high food intake and generally occur in areas that have high levels of browse biomass (150-500 kg/ha).
- In winter feeding areas, heavy browsing can occur on preferred shrub species such as willow.
- Moose select the highest quality plant parts, eating the branch tips of newest growth (bark and buds on these parts are highest quality--relatively).
- Bark stripping is sometimes seen, particularly on alder and aspen in late winter.

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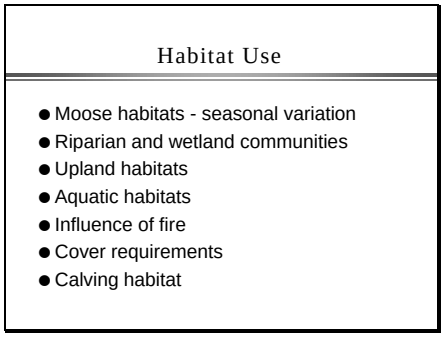
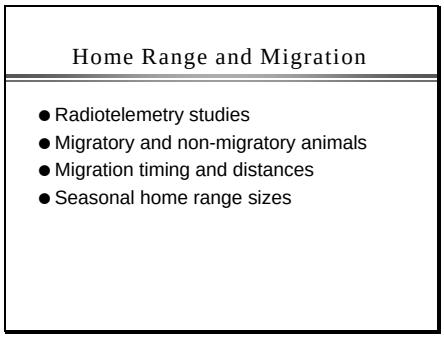


- There is seasonal variation in habitat requirements -- access to forage is a key feature of seasonal habitat selection. Wetland, riparian and floodplain habitats are important throughout the year, but particularly in winter.
- Early winter habitat needs to have a combination of abundant shrub forage and adjacent cover (for predator avoidance and thermal cover) --wetlands and associated spruce forest are recognized as key winter habitats. As well, burns and cutovers can also be important winter habitats during peak shrub production years (avg. 15 - 20 years). Deciduous or mixed deciduous forest stands can also receive a high level of winter use -- particularly on SW aspects in river valleys.
- In deep snowfall areas, moose winter use is concentrated below 3500 ft in valley bottoms -- riparian willow habitats and adjacent forest cover are very important in these areas.
- In late winter, moose use forest cover more extensively, shifting habitat use from open habitats to forest stands -- this is related to thermal stress and (in some areas) snow depth.

- In summer, there is also high use of forest stands, as moose become more nocturnal, make less use of cutovers, use north aspects more, increase use of aquatic habitats and move to higher elevations (if migratory).

Slide 6



- 2 moose telemetry studies have been completed in the Cariboo Region (Young 1989, Baker 1990).
- Most moose populations contain migratory and non-migratory animals -- theoretically, the migratory segment of most populations should be larger because migratory cows should have better fecundity (related to higher quality summer diet) -- however some populations are totally non-migratory because they live in isolated habitats or are located at large distances from high elevation habitats.
- Both regional telemetry studies demonstrated migratory animals were most common in these areas (Cariboo River, Anahim Lake)-- however, preliminary telemetry investigations in the Lac La Hache area have indicated no major migratory movements for moose in this area.
- Migration distances are variable from 10 to 90 km (generally shorter distances in non-mountainous terrain).
- Seasonal home range sizes are variable -- winter: 5 to 50 sq. km (5-10 more typical) -- summer: 5 to 50 sq. km.

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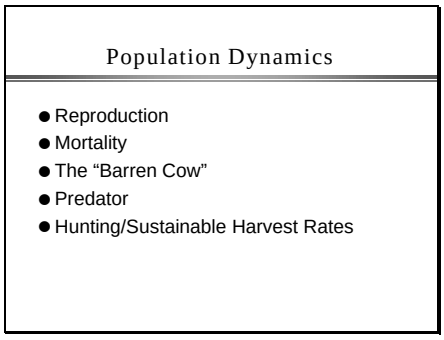

- Moose population dynamics are very much influenced by nutritional energetics -- moose populations are adapted to exploit early seral habitats created through disturbance.
- Reproduction is highly influenced by the nutritional status of cows -- twinning rates vary from 10 to 70% dependent on nutritional plane of cows (regional avg. estimate is 18%) -- age of first reproduction is also variable dependent on nutritional status.
- Most adult cows produce calves (80 to 90%)-- ‘barren cows’ are a result of either neonatal predation (up to 70% of moose calves born each year are killed by bears or wolves) or yearling and 2 yr. old cows that are not sexually mature.

- Moose can live up to 20 years -- most mortality is related to predation and harvest, though other factors such as climate, disease and accidents can be important too.
- Predation can limit the growth of moose populations -- predation effects are often seen in low cow:calf ratios (less than 30 calves/100 cows) -- wolves and bears are the main predators.
- The potential for hunting to initiate a population decline increases with harvest -- the total sustainable harvest is 0 to 10% annually dependent on the level of predation and population growth rate.

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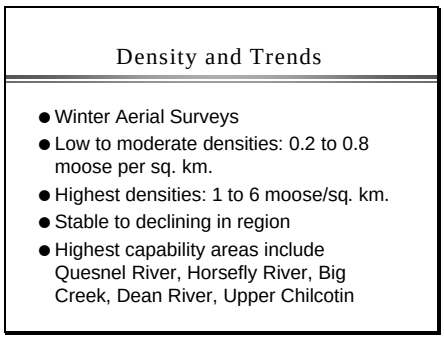

- Overhunting can deplete moose populations in local areas -- this was seen in North America in the 18th and 19th centuries, when moose numbers became scarce in eastern N.A. due to overuse -- the implementation of hunting seasons and harvest regulations in the 20th century has resulted in successful recovery of most N.A. populations.
- Harvesting cow moose has a direct negative impact on the reproductive capacity of a population and needs to be carefully regulated.
- Winter aerial surveys are conducted regionally to monitor trends of populations -- the current regional population estimate is 20,000 to 25,000 moose.
- The current trend of the population varies across the region but overall is considered to be stable to declining -- changes in hunting regulations have been recently introduced to address this population trend.
- In order to maintain moose populations into the future, seasonal habitat requirements need to be addressed through habitat management practices and population impacts need to regulated as best as possible.

Management

Management of Moose in the Cariboo Chilcotin
Presentation by Randy Wright, Ministry of Environment, Lands and Parks

The Role Of Habitat Management

- One of the roles of the Habitat Management Manager is to maintain the diversity and abundance of native species and their habitats.
- In the Cariboo Region, the responsibility of Habitat Management for moose is mainly conducted by a Forest Ecosystem Specialist employed by MELP, who deals directly with the forest harvesting companies and the Ministry of Forests on forest development planning and other activities associated with land development.
- One of the intended results of habitat management is habitat that brings about desired moose population characteristics such as abundance, distribution and condition in a specified period of time.
- The implicit assumption of habitat management is that moose population levels can be increased through the creation, maintenance or other manipulation of high quality habitat.

Objectives for Moose Habitat Management

- The scale or extent to which moose habitat is managed is an important consideration. The habitat manager must ask him/herself if moose habitat should be manipulated everywhere and all the time. The reality of today's world is that moose habitat is being altered daily, both positively and negatively.
- Short term management objectives, such as over a period of 10-20 years, could deal with habitat attributes at the stand level. Management under the short term may include protecting the forest buffer around this wetland where information shows importance for wintering or calving habitat. Short-term management objectives may not, however, adequately address all the attributes required for moose in the surrounding area over the long term.
- A long term habitat management objective would include a longer period of time and a much broader area. Forest development and moose habitat management could be applied across a large landscape unit, and would account for several moose habitat attributes such as those relating to migration, wintering and calving habitats. The broader the area that is managed, the more likely habitat attributes important to moose are achieved over the annual life cycle of a moose.
- Currently, both a short and long term habitat management approach is being applied in the Cariboo Region. To adequately address habitat management issues for moose on either a short or long term basis, information is required on habitat use characteristics of moose in the various biogeoclimatic zones. Unfortunately, due to the differences in habitats, habitat use and movements demonstrated by moose in these biogeoclimatic zones, habitat management recommendations may not always accommodate a moose's needs.

Individual Components of Moose Habitat

- The most important individual components related to a moose's selection of habitat include aspects of thermal cover, forage availability and security cover.

- Due to the wide variety in biogeoclimatic zones in the Cariboo region, there is a significant amount of variability in habitats. One of the key challenges is maintaining forage and cover characteristics on this diversity of moose ranges. In the various biogeoclimatic zones, moose habitat preferences are governed by site productivity, forage availability and during the winter months, snow depth The selected habitats must also provide suitable security and thermal cover.
- An example of the variability in moose habitat use patterns in the various parts of the region can demonstrated by comparing moose habitat selection in an area such as the Horsefly River vs. Dash Creek, which is situated in the west Chilcotin. Riparian areas, valley bottoms and south-facing slopes at lower elevations provide key wintering habitats for moose in wetter mountainous zones such as those located in the Quesnel Lake and Horsefly River areas. In comparison, wetlands and wetland complexes are particularly important for moose in areas such as Dash Creek where upland forests provide poor foraging habitats. A cutover area can provide foraging habitats in more productive upland sites, provided that sufficient forest cover is retained adjacent to these areas. Deciduous and mixedwood stands also provide foraging areas for moose.
- In the Central and Southern Interior of BC, moose utilization of various habitats for cover and foraging is poorly understood. We do know, however, that all moose require coniferous forests in all seasons for shelter from unfavourable weather or environmental conditions such as cold, wind, snow and heat, as well as escape from predation.
- Use by moose of the coniferous forest has been documented in three habitat use research studies conducted in the Southern and Central Interior. A study conducted in the Kamloops area from February 1996 to January 1998 showed use of coniferous forests occurred in all seasons ranging from 31-49% use per season. Mixed coniferous/deciduous forest was also selected during all seasons ranging from 26-41% use per season.

  A 1986 study on moose habitat use in the Anahim Lake area showed that during the winter, moose used spruce wetlands and spruce forests more frequently than expected. It was also determined moose concentrated within 100 m of the forest/wetland edge and virtually did not use areas greater than 200 m from the edge. The combination of food and cover in areas of spruce and edge were likely the main factors determining use of these habitats by wintering moose.

  In the Quesnel Highland winter habitat moose study, moose selected old growth spruce and shrub habitats in riparian flood plains at lower elevations during the winter months.

  The selection of various habitat types in the different biogeoclimatic zones demonstrates the importance of the coniferous forest to moose and the complexity involved in managing these habitats, especially for the critical period of winter when snow depth limits forage availability and moose movement.
- Information on habitats used for calving is also limited. Calving habitat can be described as requiring these characteristics: secluded shelter, available browse and close proximity to water.
- Also, isolated stands of timber in bogs or clearcuts or on islands or peninsulas are preferred sites. Cows will select these types of sites to avoid detection of calves during and immediately following birth. The Kamloops study found that pregnant cows retreated to calving sites predominantly represented in spruce/sedge meadows and riparian willow habitats. During the course of the study, 64% of calf sightings occurred in spruce/sedge meadows and 14% in riparian willow patches.
- Although there is limited information on some aspects of managing moose habitat, there are mechanisms available to protect and enhance habitats.

"Doing the Job"

- Information relevant to moose habitat management is always being pursued. In the Cariboo Region, a substantial amount of information has been collected over the years on the locations of important moose areas, especially winter ranges. This type of information is normally obtained through aerial inventory work and is used in forest development planning exercises. The Patenaude Lake area is normally surveyed annually. This mixed coniferous/deciduous habitat on a south-facing slope is of high value to moose wintering in the Horsefly River watershed.
- Moose habitat suitability mapping has been completed for the Cariboo Region. This mapping outlines a geographical area's suitability to support moose. This wetlands suitability rating for moose will be partially based on forage and cover attributes, moose observed during surveys, and snow depth in relation to elevation. Most of the suitability mapping is done for the winter period, which is the most critical period in the annual life cycle of a moose. Suitability mapping is used in most forest development planning processes and other land based developments.
- One of the most effective ways to obtain information on the habitat use patterns of moose is by radio collaring several animals and monitoring their movements over an extended period of time. These are usually very expensive projects to conduct. A standard radio collar for a moose costs approximately $400-500 and GPS collars cost approximately $10,000.
- There are currently several forest development processes and planning documents that aid the habitat manager in addressing management of moose habitat . Some of these include the Forest Practices Code, and one of its components, the Riparian Management Area Guidebook, which considers protecting riparian habitat. A riparian zone may have several habitat attributes required for moose over its annual life cycle. Landscape Unit Planning and Forest Ecosystem Networks are tools available to achieve moose habitat management on a broad scale.
- The Cariboo Chilcotin Land Use Plan also addresses the issue of moose habitat management by recognizing that additional buffering may be required adjacent to key wetlands or riparian habitats, particularly on the Chilcotin Plateau. There is limited information available on the distance which moose utilize in upland habitats bordering wetlands or riparian areas. The uplands adjacent to these areas provide important cover requirements for moose and determining an acceptable distance for which forest harvesting can occur needs to be obtained.
- In an attempt to obtain this type of information, Riverside Forest Products and MELP have embarked on a cooperative project which includes classifying wetlands and developing criteria to access a wetland importance to moose. In addition, Riverside Forest Products, MOF and MELP are working together to gather moose use information in the uplands adjacent to wetlands in the Spokin Lake area. A series of track transects have been established in a variety of upland forest types and track information is collected after a fresh snowfall.
- Habitat enhancement can be an effective tool for creating foraging areas for moose. In order for moose to utilize any enhanced forage resource, other critical habitat characteristics must be considered. Some of these features include security cover adjacent to foraging sites, and contiguous coniferous stands bordering enhanced sites to allow for unrestricted travel and adequate security and thermal cover. Depending on the site, forest harvesting can have positive effects by increasing secondary production of plant biomass and increases in the abundance of forage plants for moose. The negative impacts from forest harvesting result from the removal of forest cover, which serves many important functions for moose throughout the annual life cycle. Using suitable planning, harvesting and silvicultural

practices, forestry operations can be a valuable tool to the achieve cover, security and foraging requirements for moose throughout the Cariboo Region.

Break-out Group Topics

- Cover for thermal regulation and predator protection in relation to wetland buffer widths and Riparian Management Areas.
- Stresses to moose: predation, low calf survival, deep snow, lack of cover beside wetlands, disease, ticks and poor nutrition.
- Habitat capability mapping.
- Limited entry hunting, predator management and access regulation.
- Traditional knowledge – A 92-year-old elder at Sugar Cane doesn't remember eating moose as a child. The meat sources were elk and caribou.

Answers to Remaining Break-out Group Questions

1. Moose migration – how extensive is it? If moose don't migrate they will need abundant marshes/wetlands, forage, etc.
   The population is composed of migratory and non-migratory animals. In some areas, migration is quite extensive and in other areas, such as Lac la Hache, it is not.
2. Is there a sub-species of moose in the Cariboo Chilcotin with some animals much larger than others? Or is this a reflection of age and/or nutrition?
   The northwestern moose (Alces alces andersoni) is the sub-species that occurs in the Cariboo. Hybridization between sub-species where they overlap is possible. However, most differences in size are attributable to age, sex, nutrition and individual variation.

3. Is there a range where bulls winter? Do they winter with the cow and calf? Usually bulls are at higher elevations.
   Bulls and cows are typically found on the same winter range area, but mature bulls may occur in smaller groups and less frequently with females than do younger bulls. A small proportion of bulls sometimes winter at higher elevations (>4500 ft.) than is typical of the majority of moose, usually in specialized microhabitats that offer forage and reduced snow depths.

4. What are average mortality rates and the ratio of bull/cow mortality?
   Mortality rates have not been studied in the Cariboo. Typically, calf mortality rates are 30-80%, and dependent on predation levels.

5. What is the number of moose used for sustenance by First Nations? We need to consider the total harvest for accurate harvest figures.
   Sustenance use by First Nations is not currently well documented, although there are some exceptions. Moose are an important food source for most First Nations communities.

6. Are cougar and wolves formidable predators of moose on both winter and summer ranges?
   Overall, wolves are the most significant predators of moose on winter and summer ranges.

Mule Deer

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Resource specialists	Rick Dawson 398-4404	Ministry of Forests Research

Michaela Waterhouse Ministry of Forests Research
398-4405

The break-out group discussion can be grouped into three main issues:

Need for best management guidance
- Basal area guidance
- Practices for mule deer winter range (MDWR) in the wetbelt
- Alternative approaches
- Improvement cutting

Peripheral topics
- Re-introduction of fire
- Effects of climate change
- Co-habitation by mule deer and white-tailed deer

Processes
- Revisit MDWR boundaries
- Difference between capability and suitability of MDWR
- AAC impacts
- Use local knowledge

Biology

- What do mule deer eat?
  Refer to mule deer publications, such as MOF Cariboo Region Research Extension Note #10, and Research Note No. 113 published by the Ministry of Forests Research Program in 1994 entitled, "Winter food habits of mule deer in the central interior of British Columbia." In the Cariboo Region, Douglas-fir litterfall is the major winter diet item, especially during the deepest snow periods of the winter. Other significant forage items include arboreal lichen and various shrubs including saskatoon and Oregon grape.

Management

Comparing crown closure and basal area

- Basal area is a better management tool in the Interior Douglas-fir (IDF) zone.
  Basal area refers to the cross-sectional area of trees, measured at 1.3 m from the ground, in a forest stand. It is commonly used by foresters to describe the size and density of trees which will be maintained on a given site to meet management objectives. Cariboo Region Research Extension Note #25 describes a basal area approach to managing mule deer winter range habitat in the IDF.
- Need different harvesting options in the wet-belt.
  Research work to develop forest management techniques appropriate for the wetbelt has been initiated and is described in MOF Research Extension Note #23 entitled "Silvicultural systems for Douglas-fir stands on very deep snowfall mule deer winter ranges." The pilot study was designed to explore the effectiveness of openings of various size, orientation and shape that could be used in conjunction with group selection, patch cut or clearcut silvicultural systems to regenerate Douglas-fir stands on mule deer winter ranges.
- Best management guides are drafted for the IDF which covers approximately 75% of the winter range habitat identified for special management in the Cariboo Chilcotin Land Use Plan.
  Numerous questions were raised in the break-out group on how to apply this in the Sub-Boreal Spruce (SBS) and Interior Cedar Hemlock (ICH) zones on even-aged, mixed-species stands. Over time, best management guides will also be drafted for these ecosystems. As a general principle, the intent is to manage for uneven-aged Douglas-fir dominated forest on all winter ranges. Uneven-aged forests can be thought of as a mosaic of small even-age patches. In order to adapt forest structure to the ecological conditions, the size of the patches will

increase from very small in the drybelt forests to slightly larger in the SBS zone and slightly larger again in the ICH zone.

White-tailed deer

- White-tailed deer are found in the Kootenays and Peace areas with very small numbers in the Cariboo. They are not considered a threat to mule deer at this time given their low numbers.
- Where the ranges of mule deer and white-tailed deer overlap, they tend to use different habitats. White-tailed deer use riparian habitats and tend to yard up (pack together). One species of deer would probably not exclude the other. They also have different food habits.

Habitat changes since European contact

- There has probably always been very high numbers of large, old trees.
- Now a higher density of small trees due to suppression of wildfires.
- Dense stands increase mortality of large trees due to moisture competition and reduced tree vigour that can encourage bark beetle infestation. When these large trees die, they are not replaced because the smaller trees are not able to release in growth due to the high stand density. Stands with a high density of small trees are also more susceptible to the spread of high intensity forest fires which burn in the forest canopy as opposed to low intensity forest fires which move along the forest floor.

Re-definition of mule deer winter range (MDWR) boundaries

- MDWR originally defined by common knowledge of known use by mule deer.
- Boundaries produced through tree species, slope, aspect and topography.
- Mapped ranges include stands currently considered unsuitable.
- Distinguish between capability and suitability.
  - *Capability is the potential to produce a given set of habitat characteristics.*
  - *Suitability is the current condition of the MDWR habitat in relation to its capability.*
- Should management goals be connected with former conditions with natural conditions or existing conditions?
- Use local knowledge.
- Boundaries are currently entrenched through process.
- Evaluate the whole MDWR before developing plans.
  It is important to understand the habitat condition of the whole winter range before prescribing a forestry treatment for an individual stand. The better the overall condition of the winter range, the more flexibility may be available for treatment of individual stands. Also, evaluation of the whole winter range will help to identify specific areas where extreme care is required in managing habitat values.
- Some winter ranges not included in Cariboo Chilcotin Land Use Plan (CCLUP).

Local knowledge to gauge winter range value

- Consider value of adjacent ranges.
- Forest licensee biologists are involved in MDWR management.

Impact of MDWR on allowable annual cut (AAC)

- The current AAC calculation for woodlots is based on 20% removal every 50 years in the Williams Lake district, giving a 250 year rotation. (This is only an interim method for calculating AAC on MDWR because the model uses an approach for even-aged stands.)
- One woodlot in Quesnel on MDWR saw an 89% reduction in AAC.
- Maximum basal area removal – Required basal area established in MOF Research Extension Note #25.

- Calculating AAC for this type of management is difficult, particularly given limited growth and yield data.

Forest Practices

Harvesting MDWR in wet subzones

- Larger gaps created. eg. Viewland Mountain beside Horsefly Lake
- Trial of group selection or patch cuts
- Still only 20% of stand volume harvested at one time.
- Patch sizes in IDF of 1-6 trees, maximum 30m diameter openings. In the Interior Cedar Hemlock zone, currently experimenting with a range of patch sizes from .25 to 2.0 ha.
- In subzones wetter than the IDF (eg. Sub-Boreal Spruce), will probably need larger openings.
- Variable by slope and aspect – opening size may change in response to this.

Long-term nature of management

- Covered in MOF Cariboo Region, Research Extension Note #25, *Structural Definitions for Management of Mule Deer Winter Range Habitat in the Interior Douglas-fir Zone*.
- Managing to a target stand structure suitable for MDWR, based on classical selection management and a J curve (defines target number of stems by class of tree size).
- In the IDF, at the stand level we manage for minimum residual basal areas depending on cover objectives with a specified component greater than 40 cm. These measures replace the use of managing by crown closure.
- Need funding for mapping which is required to produce winter range plans.

Improvement cutting for mule deer winter range

- Consider harvesting to improve stand structure.
  While commercial thinning will usually have negative short-term effects on stand attributes for mule deer, it can help to develop improved stand structure for mule deer habitat in the long-term. Therefore, some level of commercial thinning should be encouraged on mule deer winter ranges, such as of trees 20-35 cm dbh, while retaining all trees 40 cm dbh and over. The extent of thinning treatments on a winter range over time should be based on the current habitat conditions over the whole winter range and should try to balance the differing short and long-term effects.

Silvicultural systems for MDWR

- Stands in different subzones have different capabilities for deer and for tree growth.
- Approaches needed for SBS.
- Manage to meet a long-term vision for the stand. Need to remember the stand structure goal: to provide forest stands of large, wide-crowned Douglas-fir.
- Consider other silvicultural approaches, such as group selection, irregular shelterwood.
- Patch sizes should vary by typical winter snow depth. Research needed in mule deer ecology and silviculture to determine optimum patch sizes.

Role of other partial cutting approaches

- Clearcutting on winter ranges ended in mid 1980's.
- Animals move in response to weather, seasons.
- Transition to managing entire ecosystems.
- Some examples are Merv Wilkinson's work on Vancouver Island, Silva Forest Foundation.

Patch cutting in even-aged MDWR

- Areas without substantial crown closure are not available for use by mule deer because of deep snow and little litterfall forage.
- At Viewland Mountain (beside Horsefly Lake) in the ICH zone, MOF Research has established a trial examining the use of patches to regenerate Douglas-fir, preserve visual quality from the lake and address Armillaria root rot while maintaining habitat values near pre-harvest levels. See MOF Cariboo Region Research Extension Note #23.

Information Gaps and Research Needs

- Different measures of habitat quality.
- Impacts of global warming on winter range, silvics, forest health, and many other biological processes and management attributes.
- Determine the compatibility of MDWR management practices with other species. (ie. Does managing for deer help other species?)
- Role of fire as a disturbance agent and use of fire by ranchers.
- Response to thinning and management guidelines for best commercial thinning practices.
- Test ideas on the land – demonstration areas in place to show implementation.
- Growth & yield needs more data.
- Predator/prey relationships including cougar as predators.
- Impacts of urbanization and conflicts.
- Implications to AAC, woodlots and all other tenures of managing for MDWR.
- Continue MDWR research in wetbelt.
- Broader range of silvicultural tools to address particular stand conditions.

Process

- Interim measures/strategy given lack of funding for mapping.
- Investment of licensees in MDWR plans – in the field.
- More data on all winter ranges.
- Bigger working groups/study team for winter range plan development.
- Regular (eg .annual) meetings to provide input to strategy committee.
- Early input to planning process.

Caribou

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Resource specialists	Harold Armleder 398-4406	Ministry of Forests, Research
	Jim Young 398-4530	Ministry of Environment, Lands and Parks

Biology and Management

Three presentations follow on caribou biology and management:

Caribou Biology and Management Presentation

Presentation by Jim Young, Ministry of Environment, Lands and Parks

This presentation will talk about caribou in general, then about caribou in the eastern part of the Cariboo, then in the western part of the region, followed by a list of identified management issues.

All caribou in British Columbia belong to the same subspecies, known as woodland caribou. Woodland caribou occur right across North America throughout the boreal forest. There are about 16,500 caribou in BC, which are divided into three ecotypes based primarily on different habitat use characteristics.

- About 700 boreal caribou in northeast BC live in muskeg areas.
- About 2500 mountain caribou in southeast BC live in the Interior wetbelt.
- The northern ecotype makes up the remaining numbers.

Mountain caribou live in a deep snow environment where their primary winter forage is arboreal lichens. The northern ecotype live in a shallow snow environment where they forage on terrestrial (ground) lichens during the winter.

Most of our knowledge of caribou has been obtained through radio collaring female caribou from both the eastern and western populations. Radio telemetry provides us with information regarding:

- Animal movements
- Home range size
- Habitat use information
- Mortality rates
- Population estimates

There are 13 sub-populations in the province ranging from Prince George to the U.S. border. The Cariboo-Chilcotin region has portions of three of these sub-populations.

- The Bowron block is a small part of the North Cariboo Mountains sub-population that extends to Prince George.
- The Barkerville block overlaps with Barkerville sub-population.
- The Wells Gray North sub-population has been divided into three inventory blocks.

Sub-Population	Inventory Block	Population
Wells Gray North	Horsefly	50
	Junction	60
	Stevenson	70
Barkerville	Barkerville	40
North Cariboo Mtns.	Bowron	30
	Total	250

Mountain caribou calve in early June and spend the rest of the summer in high elevation old growth spruce-balsam stands. They use the calving strategy of getting to high elevations and spreading out from each other. They are usually at the snow line and at very low densities. This makes them hard to find for predators and separates them from moose and deer, which are usually at lower elevations.

Caribou summer throughout the Quesnel Highland from Two Sisters Mountain in the north, Cariboo Mountain to the west, throughout the Quesnel Lake area, and as far south as Boss and Deception Mountains. Some move into Wells Gray Park for the summer.

Although early winter snow pushes some of the caribou to valley bottoms, usually by January the snow crusts up and caribou can walk on top of it with ease. Caribou hooves are the size of those of a moose but their body weight is only half as much. As in the summer, during late winter caribou can be found in high elevation, old spruce-balsam forests on gentle slopes.

Individual animals have home ranges that are several hundred square km in size. For example, one female has been monitored for five years and her home range is over 800 km^2. In some years, caribou summer and winter in the same areas. As well, Quesnel Lake is not a barrier to movement – caribou will swim across.

Attributes of High Elevation Forests Suitable for Caribou

- Heavy arboreal lichen loads on the spruce and subalpine fir
- Fairly open to allow caribou to observe predators
- Not commonly used by moose and deer, so there are fewer predators than at lower elevations.

Caribou are found in old forests 80-90% of the time. This is important because most spruce stands are being managed on a 120-year rotation. Without special management, these old stands would disappear.

During winter, the bulk of the mountain caribou diet is made of arboreal lichens. They forage on standing trees or blowdown as well.

In the western portion of the Cariboo-Chilcotin region, there are three different herds (based on calving areas):

- Itcha-Ilgachuz Mountains
- Rainbow Mountains (about 100-150 caribou)
- Charlotte Alplands (about 50 caribou were transported by capture/helicopter from the Itcha-Ilgachuz in the mid to late 1980's and this herd appears to have remained fairly stable over the last 10 or so years).

The Itcha-Ilgachuz herd remained fairly stable from the mid 1980's to the mid 1990's but has appeared to increase in the last few years. Record numbers were counted in the MELP June survey: over 2100 animals including over 1000 cows and almost 600 calves.

Caribou in the west use the calving strategy of moving to high elevations and spacing themselves away. They calve in the alpine on open ridges where they have a good view of potential predators and are well spaced from other ungulates and their predators, usually found at lower elevations.

While the cows are calving, the bulls and yearlings at low elevations feed on lush green forage. About 85% of summer locations are in protected areas, either in Itcha-Ilgachuz or Tweedsmuir Parks.

During the winter, about 80% of caribou locations have been in old pine stands at mid elevations. They crater for ground lichens, and if the snow becomes too deep or the snow surface too crusty, they feed on arboreal lichens. Northeast and south of the Itcha Mountains:

- These stands provide an abundance of terrestrial lichens.
- Stands are open enough that caribou can see approaching predators.

- Caribou are spatially separated from moose and wolves, which are generally found at lower elevations.

Winter use by caribou:

- 80-90% of stands are older than 80 years
- Equal use of stands 80-140 years old and stands older than 140 years.

The Cariboo Chilcotin Land Use Plan uses 80 years as the age at which stands will be harvested in conventional harvest areas, and 140 years as the age that terrestrial lichen sites will be grown to.

Caribou are found occasionally in clearcuts, mostly in the spring or fall.

Timber Harvesting Concerns

- Clearcuts can remove the valuable lichen forage base, reducing the amount of winter habitat available to the caribou.
- Logging can enhance habitat for moose and deer, attracting more of these ungulate species with their associated predators to caribou range.
- Winter logging can provide packed trails that improve the mobility of wolves.
- Logging roads can provide access for poachers.
- Logging can improve access for winter recreationalists such as snowmobilers. Caribou appear to avoid heavily used snowmobile areas, reducing the effectiveness of the habitat.

Main Management Issues for Caribou

- Maintain suitable winter habitat for caribou.
- Protect calving areas from disturbance.
- Maintain habitat in large patches so that caribou can spread out and live at low densities to avoid predation.
- Manage access to minimize poaching and harassment of animals.
- Manage habitat in a way that does not attract other ungulates to the caribou range.

Break-out Group Topics

- Caribou populations
- Forest fragmentation
- Caribou food sources, terrestrial (ground-based) and arboreal (tree) lichens
- Predation on calves
- Forest practices including visual patterns of harvesting and cutting cycles
- Group selection system
- Mapping
- Planning

Information Gaps and Research Needs

- Progress reports of telemetry findings and other research for non-logging causes of declines in caribou populations (eg. Horsefly block), such as access, predation and nutrition.

A MANAGEMENT STRATEGY FOR MOUNTAIN CARIBOU —THE CARIBOO REGION EXAMPLE

Harold Armleder, Jim Young and John Youds

Presented at *Species and Habitats at Risk* Conference, Kamloops, February 1999

Abstract: We describe how research and monitoring were applied, within higher level plan direction, to craft an integrated management strategy for mountain caribou. Nine years of radio-telemetry on 75 animals with over 4000 relocations has defined the range and habitat selection patterns for this population. Timber harvesting trials since 1990 have tested variations of the selection silvicultural system. The Cariboo-Chilcotin Land Use Plan has established the size of the area that can be managed for mountain caribou and defined the level of acceptable impact on the timber resource. These inputs were used to develop an initial strategy which zones caribou habitat and describes management in those zones. Recommendations for forest management systems, access, and predation management are part of the strategy.
Key words: *Rangifer tarandus caribou,* mountain caribou, forest management, logging, silvicultural systems, access management, predation, land-use planning, British Columbia

BACKGROUND

The mountain caribou (*Rangifer tarandus caribou*) within the Cariboo Forest Region (Wells Gray North, Barkerville and a portion of the North Cariboo Mountains sub-populations) comprise about 300 animals and represent 12% of the provincial mountain caribou population. The importance of these caribou has been provincially recognized (Simpson et al. 1997). In 1980 the Ministry of Environment, Lands and Parks delineated high elevation caribou habitat and subsequently negotiated a 20 year timber harvesting deferral over much of the original area of concern. The mid 1980's brought an increase in population surveys and the first radio-telemetry research which established basic habitat use patterns (Seip 1992a).

Mountain caribou require old forest habitat to obtain the arboreal lichen they need for winter food (Stevenson et al. 1994). Clearcutting removes the entire arboreal lichen food resource whereas the new forest will take 100-150 years before arboreal lichens are abundant enough to be suitable forage for caribou (Armleder and Stevenson 1994). Consequently, researchers in the Ministry of Forests began to investigate integrated timber management solutions starting in 1989. In 1990 a pilot block was harvested using several partial cutting treatments. Because arboreal lichen is such a vital winter food, research was also started on measuring lichen growth rates and biomass changes in various treatments. This was followed in 1992-3 by the establishment of a major multi-disciplinary replicated silvicultural systems trial.

Starting in 1993 the Ministry of Environment, Lands and Parks initiated an intensive radio-telemetry project continuously involving 20-25 caribou relocated 2-4 times per month (>4000 relocations as of January 1999). In addition, wolves from three packs were monitored using radio-telemetry. Trailing research was also conducted to explore caribou habitat use at the stand level. To meet the anticipated data needs arising from the end of the timber harvesting deferral a major terrestrial ecosystem mapping project covering all the mountain caribou range was completed.

CARIBOO-CHILCOTIN LAND USE PLAN

While the research was ongoing, regional land-use planning was initiated with a plan delivered in 1995. The Cariboo-Chilcotin Land-Use Plan (CCLUP) recognized that mountain caribou in the eastern part of the region are of provincial significance and are a species at risk. Maintaining habitat values for mountain caribou was identified as an overriding objective within the plan. To address this objective the CCLUP mandated the production of a caribou strategy which would

provide recommendations on how habitat and other factors impacting caribou could be managed. An initial strategy was produced in 1996 with an update delivered in 1998. The final mandated strategy is due in 2000. The CCLUP recognized the value of ongoing research and therefore deferred the full implementation of the plan for caribou habitat until the year 2000. The entire caribou strategy process involved consultations with the forest industry and the conservation council as well as government agencies. This integrated management approach has led to smoother strategy implementation.

In this paper we will review the current strategy (Caribou Strategy Committee. 1998. Caribou strategy update. Ministry of Environment, Lands and Parks, Williams Lake, B. C.) and reference the role played by research, monitoring and higher level direction to the development of the strategy.

ZONING OF HABITAT

Input from the CCLUP resulted in the adoption of the principle of zoning the habitat of caribou. The CCLUP (Province of British Columbia 1995) specified that 65% of the productive forest land within the deferral area would be zoned 'no harvest' and the remaining 35% as 'modified harvest'. The Caribou Strategy Committee utilized the following criteria to delineate the location of 'modified' harvest areas for mountain caribou (Fig. 1):

1. Areas of lower caribou use (using data from radio-telemetry studies).
2. Areas of lower suitability for caribou (from terrestrial ecosystem mapping).
3. Areas of lower human accessibility since development will create access concerns.
4. Large areas (typically 1 000s ha) to complement large 'no harvest' areas. Additionally, large areas offer a full range of elevation, slope, aspect and timber types for forest companies to access.
5. Areas peripheral to the range and therefore of less value to caribou.

Interestingly, the deferral drawn in 1980 was quite accurate in identifying high elevation caribou habitat when considered in the light of over 4000 radio-telemetry re-locations. Exceptions occurred mostly with the Barkerville sub-population and are being addressed through possible trades of less valuable areas within the deferral for more recently identified habitat areas outside the deferral. The overriding constraint is that the impact to timber extraction can be no greater than the CCLUP modelled. This unfortunately limits what can be done to protect areas used as low elevation early winter range in the Interior Cedar-Hemlock (ICH) zone.

TIMBER HARVESTING STRATEGY

All recommended approaches were designed to be fully compatible with the impacts to timber modelled in the CCLUP (Integration Committee. 1998. Integration Report. Cariboo Mid-Coast Interagency Management Committee, Williams Lake, B. C.). A threefold approach for managing the habitat of mountain caribou is recommended.

1. Park and 'No Harvest' Areas

These areas provide a core habitat that will have little or no road access (very limited salvage harvesting in 'no harvest' is permitted according to the CCLUP Integration Report). This provides caribou not only with suitable space (habitat) in which to meet their needs but also a large area essentially free of harvest and harassment by humans (provided the use of snowmobiles and ATVs, and other activities are adequately controlled). Since logging will not create more early seral habitat (or very little as in the CCLUP Integration Report), moose will not be enhanced which will help protect caribou from additional predation pressures caused by increased wolf numbers. These areas provide a perpetual supply of large, contiguous suitable habitat so that caribou can space out at low densities and avoid predators and harassment (Seip and Cichowski 1996).

2. 'Modified Harvest' Areas

These areas will be managed to maintain caribou habitat continuously through time and space and will emulate natural disturbance patterns. Harvesting approaches are designed to discourage the enhancement of moose habitat.

'Modified Harvesting' Approach on Arboreal Lichen Sites Less Than 45% Slope.--
Mature and old stands with a slope of less than 45% are most heavily used by caribou (Fig. 2) and therefore should be managed to maintain habitat value continuously through time and space. This should be accomplished in the following manner:

1. Maximize the size of cutblocks as allowed in this Natural Disturbance Type (NDT) in the Forest Practices Code (FPC) Biodiversity Guidebook. This will serve to spatially concentrate harvesting activity.
2. Harvest by applying 33% volume removal group selection with an 80 year cutting cycle. This approach is supported by 8 years of experimental research which, although not completed, shows encouraging preliminary results for forest management and for caribou.
3. Harvest openings should be 2-3 tree-lengths wide and up to 3-4 tree-lengths long. Where windthrow and windscouring of lichens are not concerns the openings could be somewhat longer. Openings should be less than 1 ha in size.

This management approach is not without risks for caribou because we estimate that stands managed in this way will, in time, have about half of the available lichen biomass of an uncut old forest (Caribou Strategy Committee. 1996. Caribou Strategy Report, B. C. Ministry of Environment, Lands, and Parks, Williams Lake, B. C.). Evidence suggests that caribou will still use stands with these biomass levels. Additionally, immediate post-harvest lichen growth rates are up to 15% lower than an uncut old forest (Fig. 3). In spite of these concerns, we feel this approach has the best chance of success in the integrated management environment in which it is recommended.

'Modified Harvesting' Approach on Arboreal Lichen Sites Greater Than 45% Slope.--
Stands with a slope of more than 45% are used less by caribou and are more difficult to harvest with a group selection system. High-lead or helicopter logging could be used to implement the logging prescription on these slopes but the value of doing so is reduced since caribou make less use of steep slopes than slopes less than 45% (Fig. 2). Therefore, clearcutting with reserves on slopes greater than 45% is acceptable. To allow for some caribou use and stay within the impact modelled in the integration report (i.e., 100% of the stand is available for harvest in a 240 year period), 50% of each cutblock should be clearcut every 120 years. This will result in half of each stand being 120-240 years of age at all times, thereby providing some lichen bearing habitat. This approach acknowledges that 50% of each stand will not be suitable habitat for caribou through substantial periods of the rotation. The harvesting should be applied in the following manner:

1. Maximize the size of cutblocks as allowed in this NDT in the FPC Biodiversity Guidebook.
2. Harvest using clearcutting with 50% of the cutblock in reserves.
3. Keep the clearcut parts of the block as narrow as possible within the limits of logistics.
4. Plan the cutblock is such a way so that the 50% reserve area can be logically accessed for logging in 120 years.

3. Early Winter Range Outside the CCLUP Caribou Area

Some caribou use mature stands in the ICH during the early winter when these lower elevations have less snow than the Engelmann spruce - Subalpine fir (ESSF) zone. Later in the winter, as the density of snow increases, they move up in elevation into the ESSF zone. These early winter

range areas should be managed to emulate the natural disturbance pattern and structure to the extent allowed in the FPC Biodiversity Guidebook and landscape unit emphasis.

Radio-telemetry data shows that there are a few specific areas that are especially heavily used as early winter habitat in the ICH zone (Fig. 4). We recommend that these heavily used areas should overlap with the old seral areas of the biodiversity strategy. If harvesting must take place we recommend the group selection system. Unfortunately, there is no CCLUP provision for extended rotations for caribou in the ICH zone because early winter range in the ICH is a part of mountain caribou range in the Cariboo Forest Region that the CCLUP has zoned as 'conventional' harvest with regard to caribou.

Adaptive Management
The recommended harvesting approaches reflect the best current strategy given higher level plan direction, knowledge of caribou needs, ecology of arboreal forage lichens, silviculture of Engelmann spruce and subalpine fir, and logistics of timber harvesting. Many long-term questions remain to be answered and research installations will continue to be monitored. Some questions can only be answered at other scales of investigation. For example, how would caribou respond to landscape level development using 'modified' harvesting approaches? To address this and related questions a major adaptive management trial is being planned in the Mount Tom area of the Quesnel Forest District which will involve full development of about 1700 ha while approximately 2300 ha will remain as an uncut control. Pre-treatment radio-telemetry data shows substantial caribou use in the area and radio-telemetry will be expanded by monitoring more animals in the post-treatment period. Timber harvesting on this trial is scheduled to begin later this year.

ACCESS
Two access issues are of special concern to caribou—roads and off-road motorized recreation. To address road access we recommend aggregating timber harvesting in specific landscape units over short time periods followed by road deactivation and not accessing the area again for twenty years. Access control points are recommended for each drainage. Also, by developing caribou habitat on an even timber flow basis it will prevent massive harvesting throughout the range of these animals in any single time period.

Our radio-telemetry data has shown that caribou do not use highly suitable habitat when intensive snowmobiling activity occurs in high elevation areas. A strategy is being developed to protect caribou from the negative impacts of snowmobiling by zoning caribou range into three categories of use: (1) unrestricted access, (2) careful access (with rules to minimize the impact on caribou), and (3) no motorized access. This type of technical input is being provided to sub-regional planning tables to incorporate into higher level direction. This topic remains a hotly debated issue among user groups.

PREDATION
Wolf predation can dramatically reduce caribou populations in areas where the wolf population is sustained by other prey species (Seip 1992b). This has occurred with mountain caribou in the Cariboo Region. During the 1980s population levels decreased substantially; however, during the past 10 years the caribou population has been stable with enough recruitment to offset mortality. Legal hunting has been closed for mountain caribou in the Cariboo Region to eliminate that source of mortality. The timber harvesting approaches for slopes <45% were designed not to enhance moose habitat in an effort to limit prey species abundance for wolves and thereby control predation on caribou. We recommend minimizing the number of snow-ploughed roads in caribou winter range to not enhance mobility of wolves. Also, the Ministry of Environment, Lands and Parks is proposing to manage moose populations in mountain caribou range to levels which will not increase wolf numbers above present levels.

Recent data collected on two wolf packs in the range of mountain caribou in the region indicate an elevational separation from caribou during most of the year (fig. 5). During the caribou decline in the 1980's there was more elevational overlap between the two species (Seip 1992). Monitoring of caribou and wolf populations will continue. If current measures are inadequate for maintaining viable caribou numbers then other options will be explored.

OUTSTANDING ISSUES

To successfully maintain caribou, we need to manage a whole package of issues, not separately, but in concert within mountain caribou range. These issues include: forest management systems (within and outside deferrals), hunting (legal and illegal), predation, and access. The strategy has addressed all of these issues but decision makers still need to accept the whole package. While questions remain about all these issues, major unresolved areas of concern include: (1) the inability to adequately address early winter range in the ICH (outside of the deferral) while forest development is targeting these areas in the short-term, and (2) the lack of an accepted snowmobile access plan. Sub-regional planning must keep pace with these issues and make appropriate decisions before key habitats are lost.

ACKNOWLEDGEMENTS

The strategy was developed by the Caribou Strategy Committee whose members also include Mike Folkema, Robin Hoffos, Heather Knezevich, Mike Lloyd and Mike Pelchat. Much of the strategy was developed from the results of research and monitoring conducted by many people including Michaela Waterhouse, Lara Roorda, Dale Seip, Teresa Newsome, Stephen Walker, Larry Davis and Wade Beaulieu. Michaela Waterhouse reviewed an earlier version of the manuscript.

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Fig. 1. Zonation of mountain caribou habitat within the deferral area in the Cariboo Forest Region (1998), British Columbia (35% of the productive forest is zoned 'modified harvest' whereas 65% is zoned 'no harvest' within the deferral area).

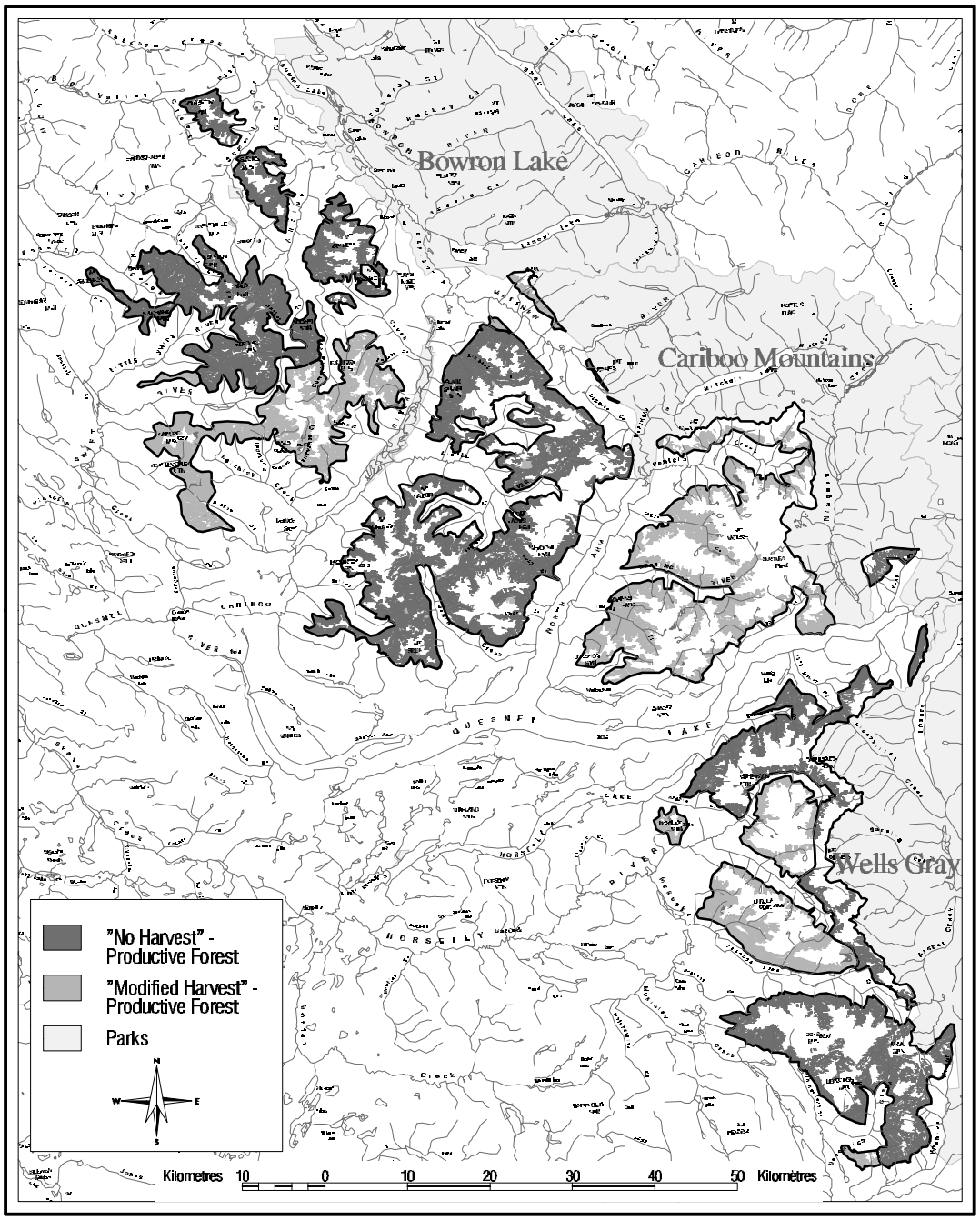


Fig. 2. Cumulative frequency distribution of slope use by radio-telemetry equipped mountain caribou for all seasons combined in the Cariboo Region (1993-1998), British Columbia.

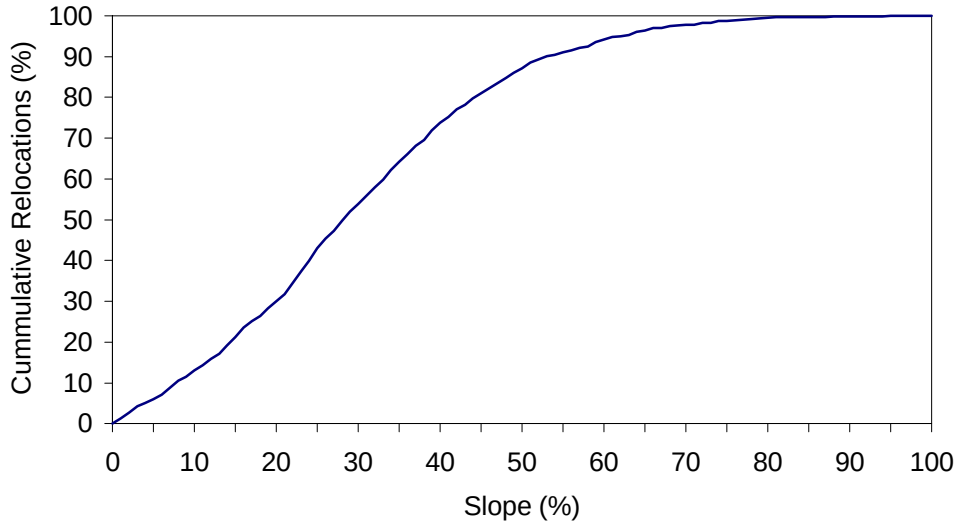


Fig. 3. Annual growth rates and 95% confidence intervals of *Bryoria glabra/fuscescens* in 3 replicates of group selection treatments and controls in the Engelmann Spruce - Subalpine fir zone of the Cariboo Region (1994), British Columbia. Small openings are 0.03 ha, medium openings are 0.13 ha, and large openings are 1.0 ha, controls are uncut. All treatments involved 30% volume removal.

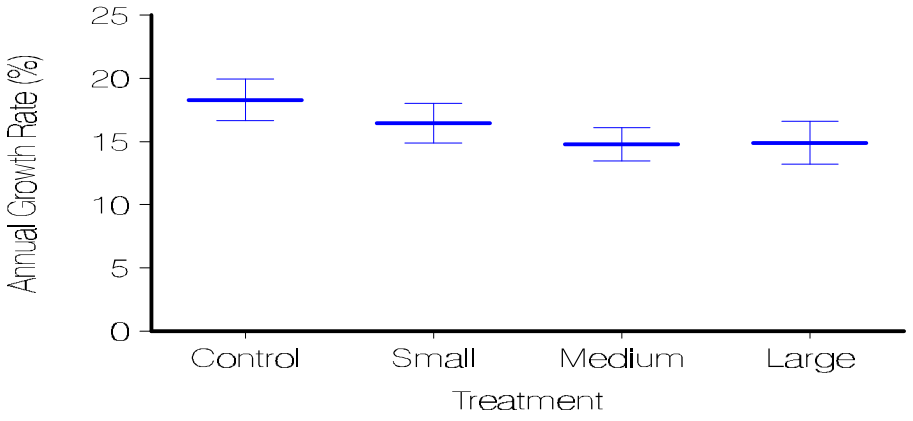


Fig. 4. Early winter radio-telemetry relocations (1984-1998) showing areas of use outside of the deferral areas for which the Cariboo-Chilcotin Land-Use Plan has not made provision.

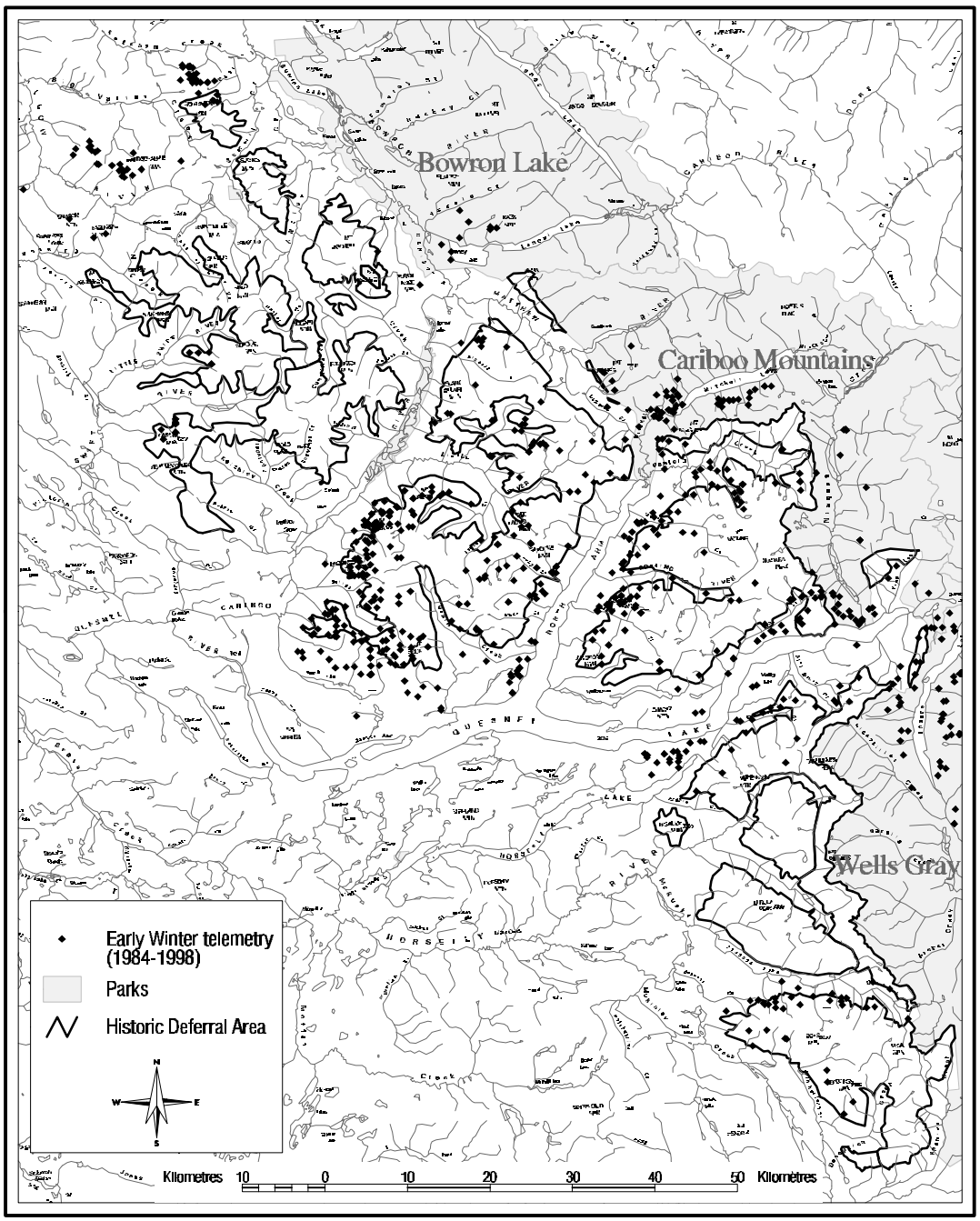
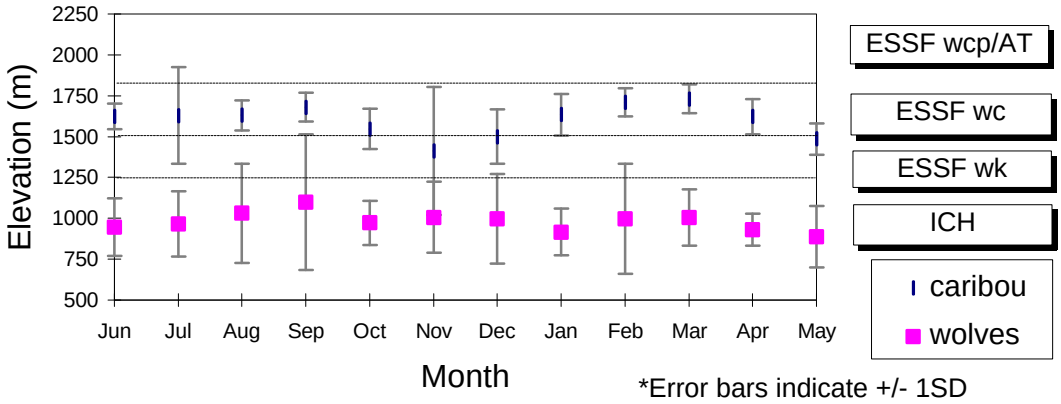


Fig. 5. Mean monthly elevations used by radio-telemetry equipped wolves and mountain caribou in the Cariboo Region (1993-1998), British Columbia.



Extension Needs

The following extension needs were identified by participants in the break-out groups.

General

- Require opportunities to view capability map in relation to management aspects.
- Available maps of existing logging, mining and other extractions would be helpful especially if overlaid with the telemetry maps.
- Would like a written summary of the presentations from the morning sessions.
  The presentations on the biology and management of moose and caribou are included in the workshop report, along with two associated presentations on caribou management.
- Would like a summary of the notes taken by recorders during break-out sessions.
  Where possible, the issues discussed and questions/answers have been compiled into the workshop report.
- Videotape presentations to help reach a larger group of people including more of the public.
  Recommendation for future workshops.
- Advertise available publications.
  See list in Appendix 3 with related websites.
- Provide access to a regularly updated website with better links to related websites.
- Use e-mail, electronic bulletin boards and the Internet to distribute information.
- Continue to communicate new research and continue extension of past research.
- Communicate types of harvesting being tested and the correlation with results on ungulate species.
- Make raw data from ungulate-related research more widely available.
  There is some concern over the value of releasing data without technical analysis and interpretation.
- Produce management handbooks for moose and caribou similar to the mule deer management handbook (Armleder, Dawson and Thomson, 1986).
- Future workshops should invite presenters with ungulate expertise from other regions. Continue with presentations from researchers and First Nations and maintain a broad audience of participants.
- Field trips for the biology and management of the three ungulates would be helpful.
- Need to monitor environmental pollution in ungulate species since so many First Nations people depend on wild meat in their diet.
- Informal local sessions like this workshop.

Moose

- Address the information gap for moose.
- Road restrictions need to be explained in the Hunting Regulations so that the public better understands their purpose.
- MOF and MELP should lead public education to ATV and snowmobile users regarding hunting and access limitations.

Mule Deer

- Summarize and distribute information on regeneration success using different systems and methods.
- Continue monitoring population and habitat to maintain ongoing data for assessment.

Caribou

- Produce maps with caribou use, past and planned timber harvesting, and other resource values.
- Offer to make a presentation to snowmobile clubs in the Cariboo about caribou habitat needs and the importance of access restrictions.
- Foster appreciation of how the regional caribou populations relate to British Columbia and the world.

Recommended Action

Participants recommended the following extension needs as the most significant:

- Provide more **information on ungulate biology**, particularly for moose.
- **Capability and development maps** need to be made more easily available.
- **Videotape future workshop presentations** so that others can benefit from the information.
- Provide a **regularly updated website** with current information on ungulate biology and management. Test other electronic methods to distribute information efficiently.
- Use the **Southern Interior Forest Extension and Research Partnership** to help continue with post-workshop extension needs.
- Summarize and distribute results of different **silvicultural systems** on mule deer winter range.
- Produce **management handbooks** for moose and caribou similar to the mule deer management handbook.
- Increase awareness of **available publications** through websites and help make relevant publications more widely available to those who need them.
- **Future workshops** should invite **speakers from outside the Cariboo-Chilcotin**. Continue with presentations from **researchers and First Nations**.
- **Field trips** to view demonstration areas and research sites would be useful.
- MOF researchers and MELP habitat managers should offer to make **presentations to local snowmobile clubs** about caribou habitat needs and the importance of access restrictions.

Workshop Evaluation Feedback

A two-page evaluation form was included in the workshop folder and 24 evaluations (33%) were returned. Responses were generally positive, with some specific points raised to improve the quality of future events. On a scale of 1 (poor) to 5 (excellent), the average scores for the participants' overall impression of the workshop, the value of the workshop for their work, the quality of the presentations and the value of the break-out groups were 4.0 to 4.2. The suitability of the facilities of the Skills Centre received the highest average score of 4.5. Most of the scores for all five issues were ranked at 4 or 5.

Most of the evaluations ranked the morning presentations as “about right” for time, but some comments reflected the limited time of 15 minutes for each speaker. The two-hour afternoon break-out groups were seen as “about right” by approximately ¾ of the respondents, while the rest found the break-outs too long or too short. The break-out summaries and workshop closing at the final plenary session were regarded as appropriate in length of time.

The participants’ written and verbal comments showed that the presentations were a more useful part of the workshop than was originally perceived. Many felt that the speakers were restricted in the breadth of information they could present in such limited time and that the workshop would have benefited from longer presentations. Some speakers also expressed concern at limiting a broad technical subject to only a 15 minute presentation. In future, technical presentations should be planned for at least 20 minutes, in fairness not only to the audience but to the speakers as well.

The combination of presentations and break-out groups satisfied almost all of the participants. Most respondents who didn’t care for one preferred the other. This combination should be continued for similar events.

Appendix 1

Workshop Agenda

8:00 am	Registration and poster session	
9:00	Workshop introduction	Jane Perry
9:15	Workshop purpose and objectives	Gary Ducommun
9:30	Moose presentations	John Youds (biology) Randy Wright (management)
10:00	Break	
10:15	Mule deer presentations	Michaela Waterhouse (biology) Rick Dawson (management)
10:45	Caribou presentations	Jim Young (biology) Harold Armleder (management)
11:15	First Nations speaker	Jean William
11:45	Questions	
12:00	Lunch	"Info-lunch" to include time to browse posters and publications
1:00 pm	Break-out groups	<u>Moose</u> *Facilitator* – Ken MacKenzie *Resource people* – John Youds, Randy Wright <u>Mule deer</u> *Facilitator* – Ken Day *Resource people* – Michaela Waterhouse, Rick Dawson <u>Caribou</u> *Facilitator* – Karen Campbell *Resource people* – Jim Young, Harold Armleder
3:00	Break	
3:30	Summaries from break-out groups	
4:15	Workshop wrap-up and closing remarks	Jane Perry
4:30	Adjourn	

Appendix 2

List of Participants

Harold Armleder	Ministry of Forests, Cariboo region
Dennis Asher	Ministry of Forests, Quesnel district
Bill Ashman	Ministry of Forests, Horsefly district
Lyle Badger	Ministry of Forests, Quesnel district
Kevin Bedford	DWB Forestry Services Ltd.
Al Bennett	West Fraser Mills, Williams Lake
Wayne Biffert	Williams Lake Sportmen's Association
Randy Billyboy	Tsilhqot'in National Government
Becky Bings	Ministry of Environment, Lands and Parks, Williams Lake
Chris Blake	Quesnel River Watershed Alliance
Todd Burgess	Ministry of Forests, Chilcotin district
Trevor Brown	Tsi Del Del
Karen Campbell	Weldwood of Canada, Williams Lake
Bruce Catton	Wildlife consultant
Larry Davis	DWB Forestry Services Ltd.
Rick Dawson	Ministry of Forests, Cariboo region
Ken Day	UBC Alex Fraser Research Forest
Don Dixon	Cariboo Tribal Council
Gary Ducommun	Cariboo Tribal Council
Chris Elden	Weldwood of Canada, Quesnel
Grant Feldinger	Chiltech Forestry, Alexis Creek
Charyl Flinton	Linkages Communication Services
Mike Folkema	Ministry of Forests, Chilcotin district
Don Gayton	Southern Interior Forest Extension and Research Partnership, Nelson
Ardene Gilbert	Ministry of Forests, Cariboo region
Lloyd Gilbert	Cariboo Tribal Council
Sandy Gilbert	Cariboo Tribal Council
Bert Groenenberg	Carrier-Chilcotin Tribal Coucil
Cris Guppy	Ministry of Environment, Lands and Parks, Quesnel
Eric Hatch	Cariboo Chilcotin Guide Outfitters Association
Victor Hegan	Slocan Forest Products Ltd., Quesnel
Jeff Hendricks	Ministry of Forests, Chilcotin district
Mark Holland	Weldwood of Canada, Williams Lake
Robin Hood	Sherwood Forest Contracting
Jiri Hornburg	Lone Tree Consulting Ltd.
Kerri Howse	Ministry of Forests, Horsefly district
Dave Johnson	Ministry of Forests, Horsefly district
Mildred Kalelest	Cariboo Tribal Council
Rod Krimmer	Woodlot Licencee
Bill Layton	Quesnel Woodlot Association
Darcy Lillico	Ministry of Forests, Williams Lake district
Mike Lloyd	Ministry of Forests, Horsefly district
Dawn Lowe	UBC Alex Fraser Research Forest
Alex Lulua	Tsilhqot'in National Government
John MacKenzie	Acme Cruising, Williams Lake
Ken MacKenzie	Weldwood of Canada, 100 Mile House

Stuart Maitland	Cariboo Chilcotin Guide Outfitters Association
Allan McDonald	Slocan Forest Products Ltd., Quesnel
Graeme McIntosh	West Fraser Timber Co., Williams Lake
Shawn Meisner	Lignum Ltd.
Charlene Mellor	Montane Forest Consultants
Bob Merta	Ministry of Forests, Quesnel district
Frank Miklas	Ministry of Forests, Chilcotin district
Al Moi	Ministry of Forests, Quesnel district
Dave Neads	Cariboo Chilcotin Conservation Society
Nora Nichol	Cariboo Chilcotin Conservation Society
Peter Nicklin	Inland Timber Management
Roger Packham	Ministry of Environment, Lands and Parks, 100 Mile House
Darcy Peel	Ministry of Environment, Lands and Parks, Williams Lake
Jane Perry	Southern Interior Forest Extension and Research Partnership, Williams Lake
Frank Pete	Canim Lake Band
George Pete	Cariboo Tribal Council
Jason Pope	Riverside Forest Products, Williams Lake
Geoff Price	Ministry of Environment, Lands and Parks, Horsefly
Mircea Rau	UBC Alex Fraser Research Forest
Roxanne Robbins	Williams Lake Indian Band
Heather Rolston	Contractor
Guy Scharf	For Fish Consulting
Judy Schellenberg	Schellenberg Forestry Services
Ernie Schmid	Weldwood of Canada, Williams Lake
Tom Sellars	Xatsu'll Treaty/Self-Government
Ken Soneff	Ministry of Forests, Cariboo region
Leo Stump	Tsilhqot'in National Government
Kevin Sytsma	Lignum Ltd.
Phil Therriault	Riverside Forest Products, Williams Lake
Claire Trethewey	UBC Alex Fraser Research Forest
Steve Viszlai	Riverside Forest Products, Williams Lake
Michaela Waterhouse	Ministry of Forests, Cariboo region
Robin Webb	Ministry of Forests, Horsefly district
Jean William	Williams Lake Indian Band
Naomi Wills	West Fraser Mills, Quesnel
Randy Wright	Ministry of Environment, Lands and Parks, Williams Lake
Tom Yacyshen	Ministry of Forests, Williams Lake district
John Youds	Ministry of Environment, Lands and Parks, Williams Lake
Bill Young	Ministry of Forests, Horsefly district
Lisa Young	Ministry of Forests, Horsefly district
Jim Young	Ministry of Environment, Lands and Parks, Williams Lake

Appendix 3

Information Sources

Publications

Armleder, H.M., R.J. Dawson and R.N. Thomson. 1986. Handbook for timber and mule deer management co-ordination on winter ranges in the Cariboo forest region. BC Min. of For. Land Manage. Handb. 13.

This handbook first describes the ecological principles underlying mule deer winter range management. It then provides timber harvesting guidelines designed to maintain important mule deer habitat attributes at the level of individual forest stands and on the winter range as a whole. The handbook is well illustrated to demonstrate key information for planning and operations.

Armleder, H.M. and R.J. Dawson. 1992. Logging on mule deer winter range: An integrated management approach. For. Chron. 68(1):132-137.

The integration of wildlife habitat with timber harvesting is described, providing background and rationale for low-volume partial cutting on mule deer winter range in the Cariboo Forest Region. This publication provides a technical overview to expand on the mule deer winter range handbook (Armleder, Dawson and Thomson, 1986).

Armleder, Harold M., Susan K. Stevenson and Stephen D. Walker. 1992. Estimating the abundance of arboreal forage lichens. BC Min. of For., Land Manage. Handb. Field Guide Insert 7.

This field handbook of photographs assists the user in measuring arboreal lichen (lichen growing on trees) in high elevation spruce-balsam forests. Good quality photographs are provided to estimate the proportions and overall abundance of arboreal lichen for yellow-green (*Alectoria*) and brown, greyish or almost black (*Bryoria*) lichen.

Armleder, Harold M. and Susan K. Stevenson. 1994. Silviculture systems to maintain caribou habitat in managed British Columbia forests. *In* "Innovative Silviculture Systems in Boreal Forests" Symp., Oct. 2-8, Edmonton, AB. *Ed.* Colin Bamsey, Nat. Res. Can., Can. For. Serv.

An overview of research efforts to find suitable silvicultural systems to maintain winter habitat for northern and mountain caribou is outlined. Non-clearcutting systems are being tested to maintain terrestrial (ground) and arboreal (tree) lichens depending on the ecotype of caribou and the biogeoclimatic zone. Group selection with reserves is being tested in the ICH, with single tree selection in the ESSF and clearcutting with reserves in the MS. All of the systems are designed at the research phase to be operationally and economically feasible, meeting site specific and landscape-level considerations.

Armleder, Harold M., Michaela J. Waterhouse, Dagmar G. Keisker and Richard J. Dawson. 1994. Winter habitat use by mule deer in the central interior of British Columbia. Can. J. Zool. 72(10):1721-1725.

Winter habitat use by mule deer was tracked for seven years by monitoring radio-collared animals. Habitat selection was determined by examining characteristics of stands most frequently used to begin formulating mule deer needs over winter and appropriate silvicultural systems to meet required stand characteristics. Mule deer preferred old Douglas-fir stands with moderate or high crown closure, where they benefit from thermal cover, lower snowpack due to snow interception by overlapping tree crowns, and forage availability from foliage broken off by wind. Gentle slopes were also preferred. Managing stand characteristics to retain winter range needs can be achieved through the guidelines in the mule deer handbook (Armleder, Dawson and Thomson, 1986).

Armleder, H.M., M.J. Waterhouse, R.J. Dawson and K.E. Iverson. 1998. Mule deer response to low-volume partial cutting on winter ranges in central interior British Columbia. Res. Rep. #16, BC Min. of For. Research, Victoria. QP4500012195.

The impact of low-volume removal (20%) single-tree selection harvesting on mule deer winter range was compared with unlogged winter range by counting mule deer tracks in fresh snow. Snow depth ranges were linked with mule deer use to conclude that this single-tree selection system is suitable for maintaining mule deer winter range attributes while allowing for timber extraction.

Armleder, Harold M. and Susan K. Stevenson. 1996. Using alternative silvicultural systems to integrate mountain caribou and timber management in British Columbia. Rangifer, Spec. Issue No. 9, 141-148.

In high elevation Engelmann spruce—subalpine fir forests, the need to maintain arboreal lichens for mountain caribou after timber harvesting led to the testing of single-tree and group selection systems. By removing all trees on a cutblock, clearcutting destroys all lichens growing on tree branches, whereas the retention of mature trees maintains the lichen food source with future inoculation to adjacent harvested areas. Various research initiatives are described with insights to their success as alternatives to clearcutting. Short-term results from these trials are expected to show trends in post-harvesting windthrow, conifer regeneration success, lichen health and abundance, and caribou use. These stand-level factors need to be expanded to a landscape-level basis for long-term application of these alternatives on a large scale.

BC Ministry of Forests. 1999. Clumpy spacing. Juvenile spacing Douglas-fir into clumps to imitate natural stand structure. Research prog. Extension Note #32. Feb.

This extension note presents clumpy spacing as a management practice in drybelt Douglas-fir. By concentrating selected crop trees in clumps with approximately 5 m between clump edges, the spaced stand will more quickly achieve desired stand structure attributes for mule deer winter range than by standard spacing. Implementation guidelines are included.

BC Ministry of Forests. no date. Logging on mule deer winter range. A guide for loggers. Pamphlet.

This pamphlet for loggers presents basic principles for timber harvesting on mule deer winter range using illustrations and simplified text.

Dawson, Richard J., Harold M. Armleder and Michaela J. Waterhouse. 1990. Preferences of mule deer for Douglas-fir foliage from different sized trees. J. Wildl. Manage. 54(3):378-382.

Douglas-fir trees on mule deer winter range were felled to investigate preference of mule deer for consuming foliage from different tree sizes. Mule deer clearly preferred foraging on foliage from trees 40 cm dbh or greater and rarely consumed foliage on trees less than 6 cm dbh. There is a general trend that mule deer prefer foliage from larger trees. Douglas-fir foliage from large trees becomes available to deer when small twigs or whole branches are blown down in high winds or left on the ground as harvesting slash. Harvesting on mule deer winter range should leave clumps of large, old trees and preferably be conducted in fall or winter to create an additional short-term foliage supply.

Dawson, Richard J., and Harold M. Armleder. 1999. Structural definitions for management of mule deer winter range habitat in the interior Douglas-fir zone. Extension Note #25, BC Min. of For. Research, Cariboo Forest Region.

This extension note provides guidance for silviculturists and habitat managers developing uneven-aged stand prescriptions for mule deer winter ranges in the Interior Douglas-fir zone in the Cariboo Forest Region. Stand structure goals for three different mule deer habitat types are provided using basal area, a stand measure commonly used by foresters to describe uneven-aged stands.

Day, Ken. 1996. Interior Douglas-fir and selection management. Directed study rep. (FRST 504), Univ. of BC, Nov. Unpub. doc.

This Masters-level report summarizes the silvics and gap dynamics of uneven-aged drybelt Douglas-fir and the IDF's natural disturbance regimes. The history and principles of selection systems for optimum management of these stands to meet a variety of objectives are covered. Operational factors and management interpretations build on the information provided to help the reader better understand the application of the scientific principles.

Day, Ken. 1997. Stocking standards for uneven-aged interior Douglas-fir. *From* Dry Douglas-fir workshop, Kamloops, BC, April 29-30. Sept. 97. Unpub. doc.

Stand-level management objectives and productive capacity determine stocking in uneven-aged forests. Stocking control is critical for uneven-aged drybelt Douglas-fir management. This paper provides guidance for setting residual growing stock levels through the examination of relationships between basal area growth and stand density from retrospective studies on the UBC Alex Fraser Research Forest. Average periodic basal area increment is estimated at 4.2 m^2/ha/decade. For the Knife Creek block, B-level stocking on Langsaetter's curve is calculated at 17.5 m^2/ha. The construction and validation of a Gingrich stocking chart are also described.

Day, Ken. 1997. Interior Douglas-fir and selection management at the UBC/Alex Fraser research forest. *From* IUFRO Uneven-aged Silviculture Symposium, Corvallis, OR, Sept. 15-19. Unpub. doc.

Uneven-aged management of drybelt Douglas-fir at the Knife Creek block of the UBC Alex Fraser Research Forest is based on meeting management objectives for mule deer winter range and timber production. The application of the mule deer winter range handbook for the setting and testing of stand management objectives through target stand structure, cutting cycle and tree marking is described. Current and desired stand structures are discussed in relation to winter range requirements, forest health, and fuel conditions relative to potential catastrophic fire.

Day, Ken. 1998. Selection management of interior Douglas-fir for mule deer winter range. M.F. thesis, Univ. of BC, May.

This Masters thesis provides an extensive overview of Interior Douglas-fir management to meet mule deer winter range requirements on the Knife Creek block of the UBC Alex Fraser Research Forest. Background information on the silvics and natural disturbance regimes of uneven-aged Douglas-fir, followed by mule deer winter range requirements, lead the reader into technical discussion on forest management, regulation at the stand and forest estate levels, and silviculture prescription considerations. Operational application of the theory presented is followed by a comprehensive list of research and extension needs relating to drybelt fir management.

Eastman, Don S., Colleen Bryden, Marvin Eng, Ron Kowall, Harold Armleder, Eric Lofroth and Susan Stevenson. 1991. Silviculturists and wildlife habitat managers: competitors or cooperators? Trans. 56th N. Am. Wildl. & Nat. Res. Conf.:640-651.

Five case studies are presented to describe attempts to manage stands for feature wildlife species, including mule deer and mountain caribou. Only by maintaining biodiversity can the viability of all species be achieved, however. Successful implementation requires supporting policy, modification of existing practice standards, innovation demonstrated through on-the-ground examples, training and extension, and providing tools for managers to incorporate wildlife habitat requirements into operational forestry and wildlife habitat plans. Cooperation between wildlife biologists and foresters is necessary to minimize conflict, consider public concerns and achieve wildlife habitat objectives.

Stevenson, Susan K., Harold M. Armleder, Michael J. Jull, David G. King, Eliot L. Terry, Glen S. Watts, Bruce N. McLellan and Kenneth N. Child. 1994. Mountain caribou in managed forests: preliminary recommendations for managers. Can.-BC Partn. Agreem. on For. Res. Dev.: FRDA II.

The Mountain Caribou in Managed Forests program was initiated in 1988 to determine if forest stands can be managed to sustain both timber harvesting and mountain caribou habitat over the long term. This scientific report summarizes information for resource managers in landscape- and stand-level planning.

The report focuses on mountain caribou winter range in high elevation mature forests in the ICH and ESSF zones, where caribou rely on arboreal lichens on old trees. Silvicultural systems that limit volume removal to approximately 30% include group and single tree selection. Anticipated research results are expected to help refine current recommendations, but long-term effects of harvesting will not be understood until tested through time. Resource managers will find the illustrations, summary tables and figures helpful for application of the information presented.

Waterhouse, M.J., R.J. Dawson, H.M. Armleder and P. Belliveau. 1988. A preliminary study of the effects of juvenile spacing on wildlife habitat use during winter in the interior Douglas-fir zone of British Columbia. BC Min. For. Res. Rep. 88002-CA.

This report summarizes an early study on the effects of Douglas-fir juvenile spacing on winter habitat use by snowshoe hare, red squirrel, fox, coyote, lynx, mule deer and moose. Spaced and unspaced strips were monitored for animal use by tracking in fresh snow. Snowshoe hares clearly preferred unspaced areas, coyotes/foxes and moose showed no significant preference for spaced or unspaced stands, and mule deer preference was inconsistent. Mule deer and some other species used man-made trails through spaced areas more extensively than non-trails, probably due to less energy consumed to travel on trails. The study's most significant preliminary result is the significant drop in snowshoe hare use of spaced stands, which should be considered in large-scale juvenile spacing programs.

Waterhouse, M.J., R.J. Dawson and H.M. Armleder. 1989. The effects of juvenile spacing on wildlife habitat use during winter in the interior Douglas-fir zone of British Columbia. BC Min. For. Res. Rep. 89003-CA.

This study provides a further year of results to the above report. Snowshoe hare use of spaced stands was found to remain low, but unspaced strips left in spaced blocks received high use by hares and red squirrels, Hare use of unspaced strips increased in wider strips but without reaching use levels in larger unspaced areas. Mule deer and moose use unspaced strips for thermal and security cover. The study also monitored depth of spacing slash and its effect on animal use in relation to movement through slash and snow. Slash management at the time of spacing can help restore habitat more quickly than if slash is allowed to fall more randomly. The creation of regular trails through deep slash is required to facilitate movement of large animals through spaced areas.

Waterhouse, M.J., H.M. Armleder and R.J. Dawson. 1991. Forage litterfall in Douglas-fir forests in the central interior of British Columbia. BC Min. For. Res. Note No. 108.

The winter diet of mule deer relies heavily on arboreal lichen growing on Douglas-fir. Lichen falls with wind, especially when tree crowns rub together. This study found that trees older than 100 years provide the most lichen litterfall for mule deer. The natural clumpy distribution of drybelt Douglas-fir helps to facilitate lichen litterfall and should be maintained through harvesting plans. Uneven-aged stand management through low volume partial cutting helps provide a continuous source of litterfall by maintaining large trees as a lichen source and to further inoculate younger trees.

Waterhouse, M.J., R.J. Dawson and H.M. Armleder. 1991. Chemical composition of Douglas-fir foliage on mule deer winter range. BC Min. For. Res. Rep. 91003-CA.

Douglas-fir foliage provides an important food source for mule deer during the winter. Earlier work by Dawson *et al.* (1990) found that mule deer preferred foliage from larger trees. This study analyzed nutrients in foliage to determine if critical needs for mule deer were met. Foliage mineral levels were compared with known needs and suggested palatability for mule deer. The role of tannins in chemical digestion is also discussed.

Waterhouse, M.J., H.M. Armleder and R.J. Dawson. 1994. Winter food habits of mule deer in the central interior of British Columbia. BC Min. For. Res. Note No. 113.

Mule deer pellet samples were analyzed for plant species and diet quality. Douglas-fir foliage was the most highly ingested food, obtained as litterfall from large, older trees. Management practices, such as harvesting, juvenile spacing and grazing, affect forage availability for mule deer, an important consideration on winter range. Landscape- and stand-level planning must incorporate the maintenance winter food source supplies for mule deer survival. Short- and long-term effects of management practices must also be considered and integrated.

Web Sites

Ministry of Environment, Lands and Parks
www.gov.bc.ca/envparkst.html

Ministry of Forests Research Branch
www.for.gov.bc.ca/research/

Ministry of Forests, Cariboo Forest Region, Research section
* *Extension Notes can be downloaded from this site.*
www.for.gov.bc.ca/cariboo/research/research.htm

Southern Interior Forest Extension and Research Partnership
www.siferp.org

University of British Columbia, Faculty of Forestry research forests
www.forestry.ubc.ca/resfor/resfor.html