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REFERENCES

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. Well illustrated to demonstrate key information for planning and operations.

Key Words: Mule deer winter range, Timber harvesting, Interior Douglas-fir, IDF.

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).

Key Words: Mule deer winter range, Timber harvesting, Interior Douglas-fir, IDF.



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.

Key Words: Lichen, Mountain caribou, ESSF.

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.

Key Words: Mountain caribou, Northern caribou, Lichen, ICH, ESSF, MS.

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 through monitoring of 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).

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.

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.

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.



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, maintaining 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, regeneration success, lichen health and abundance, and caribou use. These stand-level factors need to be expanded to a landscape-level basis for application of these alternatives on a large scale in the long term.

Key Words: Mountain caribou, Timber harvesting, Selection systems, Lichen, ESSF.
BC Ministry of Forests. 1999. Clumpy spacing. Juvenile spacing Douglas-fir into clumps to imitate natural stand structure. *Research prog. Ext. 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 achieve desired stand structure attributes for mule deer winter range. Implementation guidelines are included.

Key Words: Interior Douglas-fir, Mule deer winter range, Juvenile spacing, IDF.

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.

Key Words: Mule deer winter range, Timber harvesting, Interior Douglas-fir, IDF.

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 be preferably conducted in fall or winter to create an additional short-term foliage supply.

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.

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*, Research Section, Cariboo Forest Region.

This extension note provides guidance for silviculturists and habitat managers developing uneven-age 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” which is a stand measure commonly used by foresters to describe uneven-aged stands.

Key Words: Interior Douglas-fir, Selection management, mule deer winter range

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.

Key Words: Interior Douglas-fir, Selection management, IDF.

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 m²/ha/decade. For the Knife Creek block, B-level stocking on Langsaetter's curve is calculated at 17.5 m²/ha. Construction and validation of a Gingrich stocking chart are also described.

Key Words: Interior Douglas-fir, Uneven-aged management, IDF.

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 in relation to potential catastrophic fire.

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.

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.

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.



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.

Key Words: Wildlife management, Habitat management, Black-tailed deer, Mule deer, coastal Grizzly bear, Marten, Mountain caribou.

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.

Key Words: Mountain caribou, Silvicultural systems, ICH, ESSF.

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.

Key Words: Snowshoe hare, Mule deer, Coyote, Fox, Moose, Interior Douglas-fir, IDF.



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, with increasing use by hares with increasing strip width; however, without reaching use levels in 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 indiscriminately. The creation of regular trails through deep slash is required to facilitate movement of large animals through spaced areas.

Key Words: Snowshoe hare, Mule deer, Red squirrel, Moose, Interior Douglas-fir, IDF.

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.

Key Words: Lichen, Interior Douglas-fir, Mule deer winter range, IDF.

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.

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.

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.

Key Words: Mule deer winter range, Interior Douglas-fir, IDF.