# THE SEASONAL EFFECTS ON MULE DEER HABITAT FROM LARGE AND SMALL SCALE LOGGING OPERATIONS


## ABSTRACT

Thermal retention and canopy cover is currently regarded as the most important attributes for mule deer survival rates in the winter months and in creating successful winter ranges. Mule deer winter ranges have specialised retention objectives that are specific to each area and can vary from region to region. These current strategies ignore other seasonal ranges or attributes such as year round forage opportunities and large scale managed stands with high levels of biodiversity. This paper will bring to light the effects of both large and small scale logging operations on mule deer habitat, and the importance that both operations have on creating productive mule deer population levels. From this analysis, suggestions for potential silviculture enhancements will be made on how to improve young regenerated Lodgepole pine stands in regards to creating better summer forage opportunities; while still maintaining suitable winter range areas for protection in high snow years. Pre-commercial thinning will be the main enhancement focused on in this paper and how it can provide varying levels of year round attributes that will be vital to mule deer success rates. These silviculture enhancements will not only improve mule deer habitat but will also create more productive timber stands and higher levels of biodiversity.



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# Introduction

## 1.1 Main Objectives

The focus of this essay will analysis the comparison of effects on *Odocoileus hemionus* (mule deer) seasonal range habitats and success rates in the interior of British Columbia from large and small scale logging operations. I will be analyzing the economical and operational costs as well as the varying silvicultural techniques available for enhancing growing stock in newly harvested blocks. Finally I will extrapolate away from the conventional focus on the Interior Douglas fir biogeoclimatic zone and identify new timber types suitable for increasing mule deer over wintering success. I will also present the benefits of summer forage and the linkage to success rates from increased calorie gains.

## 1.2 History of Focus Area

The main regions of focus in this essay will incorporate the southern interior of BC up to the central interior plateau. These areas consists of three major BEC zones which are the Montane Spruce at higher elevations, moving lower in elevation to the Interior Douglas fir and finally there are pockets of Bunch grass zones. The main leading tree species of the area are *Pseudotsuga menziesii* (Douglas fir), *Pinus contorta* (Lodgepole pine), *Picea glauca* (white spruce), *Betula papyrifera* (Paper birch) and *Populus tremuloides* (Trembling aspen). The climate varies in these regions slightly but is relatively consistence across the interior, precipitation comes as snow and rain with the snowpack being a vital part of the riparian system. Most of the precipitation falls in the winter and spring/early summer months, which gives rise to the semi-arid climate at lower elevations in the height of summer. Temperatures can plummet to as low as minus thirty degrees Celsius and rise well into the forties come midsummer. These varying conditions of weather and snow levels forces mule deer to have seasonal

movements and survival dependence on certain attributes of timber stands.

# Mule Deer Habitat

## 2.1 Cover

Habitat requirements for mule deer consist of a variety of attributes such as overhead cover, sheltered corridors, south facing slopes and open ranges. Overhead cover becomes essential in the winter months which can reduce snow levels as well as provide cover from predators and provide added thermal heat. These areas of protection allow deer to shelter themselves from times of bad weather and provide adequate bedding areas with little chance of disturbance. Sheltered corridors are important for connecting feeding areas to bedding or shelter areas as well as providing cover to conceal movement from predators including humans. South facing slopes are vital for cold weather days and areas that on average receive high levels of snow, mule deer need these areas to act as a refuge in colder weather to help regulate body temperature. These areas also receive more sunlight which decrease snow level and may provide areas of forage in the later winter months before snow levels decrease. Open ranges are important for providing browsing areas and access to varying food sources during the summer forage months. Large harvested cut blocks often replace lower level open ranges that have been inhabited by farmers or urbanized. They also can provide relief from insects and high summer temperatures as these areas often have more wind movement.

## 2.2 Nutrition and Food Requirements

Mule Deer are browsers who primarily feed on tree buds, new shoots, grasses and some woody debris. In the spring and summer months they prefer to feed on plants such as Pine grass, wild strawberries and fireweed, they also graze on new shoots produced by young trees or bushes. Although slightly detrimental to planting stockings, clear cuts that have been regenerated with planted trees can be highly beneficial to herds in the early months of spring and summer. In the winter months, mule deer shift their diet to bigger shrubs such as sage brush and snowbush, their reliance on foliage from Douglas fir branches becomes more prominent as snow levels rise as well.

### 2.3 Migration Routes

British Columbia's varying seasons and topography can make seasonal movements for mule deer vital to survival and healthy population levels. These routes provide strategic corridors from higher elevation summer ranges to lower elevation winter ranges. They also can connect varying browsing areas such as deciduous areas to young coniferous stands or to sheltered fawning grounds.

## Legislative Requirements

### 3.1 Ministry of Environment Standards

All mule deer winter ranges must be managed to the UWR standards according to the Ministry of Environments' online standards[1]. These standards depict objectives for silvicutlure, harvesting and management operations within IDF mule deer winter ranges. These standards vary for different regions and are specific for those certain areas within the boundaries. There is allowance to harvest fire or insect damaged trees as well as danger trees outside of the standards.

## Large Scale Logging Operations

### 4.1 Economics

The economics involved with logging operations are primarily based on the volume that you harvest from the land base. Production rate and market log prices do play a role in cost, but generally the more timber you harvest the lower your operation costs are. Most operation base their cost on an hourly rate per cubic meter. The following examples are some aspects that will be cheaper than small scale operations. The Mobilisation (Mob) and Demobilisation (Demob) of equipment will be lower because the machines will working for extended periods of time on large scale operations and harvesting large volumes. Landings will be accessible from a larger area and skidding distances can be reduced because of the lower costs of implementing numerous landings within the block. Road construction and maintenance costs will also be reduced especially if the road will be an extension of a main line or used for second pass operations. Layout costs will vary slightly depending on the company and the

[1] http://www.env.gov.bc.ca/wld/frpa/uwr/approved_uwr.html

personnel but all production costs will be reduced with the increase in size of the logging block and reduced amount of boundary constraints. Many intensive silviculture practices available for large scale logging blocks are expensive in the short term but can provide economic gains in the long run that will compensate the short term losses. These blocks also require less intensive forest planning given the lowered amount of environmental requirements and compliance.

## 4.2 Silviculture Options

### 4.2.1 Ecotones

Large scale logging can create and change a forests serial stage complexity and create numerous ecotones within the harvesting block. An example of a new ecotone created by logging disturbances would be a riparian management buffer adjacent to an open cut-block. Over time large shrubs, bushes and young tree saplings will begin to grow, creating new understory qualities and complexities. These ecotones create biodiversity across the land base and help to reduce the spread of disease as well as introduce new attributes that promote a healthy multilayered forest scenario.

### 4.2.2 Species Selection and Reforestation

Species selection is determined utilizing in a detailed silviculture plan with objectives to replace the species that is currently on the land base and maintain forest health. The selection is based on numerous factors including site index, moisture regime and soil nutrient levels. Companies that harvest timber off the land base are required to oversee the replanting of the harvested blocks and insure that the new crop will meet the provincial's minimum stocking standards. With large cut blocks, it is important to have information that represents the majority of the timber across the block and include areas that may require different stoked species. Complication in choosing the correct species can emerge after the timber has been removed such as frost damage from cold sinking air or failed regeneration on extreme dry sites. Failure to meet this standard can be devastating to a company's reputation and profits, costing thousands of dollars in reprimanding fees to fix failed regenerated trees and potential future contract cancelations.

### 4.2.3 Light Availability

Light levels in large new cut-blocks are usually high and of little implication to the new growing stocks. Adjacent timber edges, wildlife tree patches and leave trees can pose some shading issues which need to be taken into account given the amount of shade covering those areas during the day. Planting trees that have a higher shade tolerance can be a simple solution to these problems if they are appropriate for the site given soil nutrient and moisture regime levels. Over shadowing by larger fast growing shrubs and plants can cause stress on the growth rates of Lodgepole pine and Douglas fir as light availability becomes limited over time. Although this is more common in coastal regions these competitors can effectively out compete slower growing trees and shade them out causing high amounts of stress on the saplings, leaving them vulnerable to other diseases. It is important in these large stands to also be aware of the proximity of planted trees to natural regenerated trees and how over time they may impede each other.

### 4.2.4 Nutrient Availability

Nutrient availability and productivity is subject to many different factors that can determine whether the site is poor, medium or rich. To begin with different minerals levels within the soil have varying degrees of effect on tree regeneration success. Higher levels of Nitrogen, Sulphur and Boron in the soil have been proven to increase growth rate and success rates, however these minerals are often the limiting factors in interior Lodgepole pine and Douglas fir timber stands. Moisture regimes across the block is the next factor that plays a large role in regeneration success, Lodgepole pine and Douglas Fir do not require high levels of moisture within the site which makes them well adapted to the hot dry climate of the interior of BC. Both species do have a maximum moisture deficiency level in which they can handle but it is when higher levels of moisture are present that success rates of pine and Douglas fir's begin to fall. The final factor that can impede proper regeneration is competition between species and neighboring trees. Shrub and plant species such as *Alnus tenuifolia* (Alder), *Rosa acicularis* (Prickle Rose), *Chamerion angustifolium* (Fireweed) and *vaccinium* species can take up valuable nutrients and water that cause growth rates to reduce and reduce future market values of the trees. Planting trees too close together can have the same

effect as competing shrubs, as trees grow outward and root bases widen they will begin to compete for the same resources, casing stress on each other and diminishing the success rate of stand.

# Small Scale Logging

## 5.1 Economics

Small scale logging is more expensive then large scale logging primarily because you are harvesting less timber over the same time period from a given area. The Mobilization and Demobilization costs will be more expensive due to the fact that the same equipment needs to be trucked in, but the machines will be working for a shorter time period. With costs driven up, production is essential to keep operating hours to a minimum. Road construction costs are often very high for small scale logging operations so linking up to mainlines and extending skidding distances are often better options then building new road for small volumes of logs. Creating landings are costly as well so one or two landings often serve the entire harvesting operation, this means longer skid distances especially in group or single tree selection operations. The layout and development costs will also be set higher due to the amount of extra field hours needed to address boundary location and create manageable access points for machinery. Often small logging operations are conducted with the intent to incorporate a higher level plan such as mule deer winter range management, so it is essential that any industrial operation create as minimal of disturbance as possible. These higher level constraints complicate planning operations and opportunities for linking up access to future neighboring stands, all of which can decrease costs in the long term but raise them in the short term. Higher level silviculture objectives become more realistic in these smaller blocks because of the substantially smaller treatment areas reduce the cost of application to the harvested area. By applying these enhanced silviculture techniques to the land base companies can improve productivity and enhance forest health providing greater value to the trees and improving biodiversity in a multi-aged forest.

## 5.2 Ecotones

Small scale logging operations often operate in single ecotones such as a dry fir

ridge or a small stand of mature timber. Harvesting of these areas will alter the ecotones progression, setting it back in its serial stage development to a mixed Lodgepole Pine and Douglas fir stand for example. The benefit of targeting these ecotones and managing them correctly, is it allows foresters to isolate certain unique areas and create a multi layered forest that is both productive for timber values and non-timber values.

## 5.3 Species Selection

Selecting the right species in small scale logging operations such as small clear-cuts and patch cuts is highly based on surrounding growing conditions such as light and nutrient availability and moisture regimes. In operations such as group selection and single tree selection, regeneration of planted trees may not be physically necessary or cost effective. Neighboring mature trees can provide the necessary seed source for natural regeneration, or it may be effective to slowly thin out the stand to decrease competition between neighbors and transition the stand to a climactic serial stage level.

## 5.4 Light Availability

In small scale logging operations light availability to new growing stock can be a very limiting factor for growth, especially the smaller your operation becomes. Neighboring timber edges and trees can cast large shade windows which may impede many potential species from being successful in the shade. Small clearcuts may be able to host some shade intolerant tree species such as Lodgepole pine near the middle of the block but for the majority of patch cuts and group selections, trees with intermediate to high shade tolerant characteristics will have the highest success rates.

## 5.5 Nutrient Availability

Due to the fact that small patch cuts and group selection cuts are usually located on xeric(dry) sites that have shallow humus forms and low soil nutrient levels; creates high levels of competition between new growing stocks and standing timber. Small cutblock’s nutrient levels will also be low given the same characteristics as above but now the competition for resources will shift. Regenerated trees will compete between pioneer shrubs and grass species that thrive on dry exposed soils. The poor nutrient availability of these sites present the opportunity to incorporate some enhanced silviculture objectives, such as fertilization and thinning of non-timber species. The

relatively small areas in need of treatment can make it cost effective in terms of revenue from improved higher grades of fibre and decreased rotation ages.

# Silviculture Practices for Young Stands

### 6.1 Pre-Commercial Thinning

Pre-commercial thinning is a silviculture technique used mainly on Lodgepole Pine plantations that have been planted on large scale logging operations. An example of this technique is taken from Thomas Sullivan's paper on mammalian use in young Lodgepole pine thinned stands. Which had unthinned stands at >2000 stems/ha, high density at 20000 stems/ha, medium at 1000 stems/ha and low density at 500 stems/ha (Sullivan et al, 2006). Depending on the targeted density of the stand a large amount of variability can be seen between the stands and the varied levels of biodiversity. By increasing the spacing between individual trees it reduces the competition and suppression enacted on one another, the greater (lower the density) the spacing the more productive a stand will be till its threshold. Different densities will promote different attributes within the timber stand, high densities will promote tall skinny trees with lots of small branches and little understory vegetation. This is due to the shade effect caused by a completely closed canopy and high levels of competition between neighbors, theses stands also have very low levels of biodiversity. Wildlife usage in these stands tend to be low as well due to the difficulty of movement through the tight spaces in between trees. Snow level in these stands tend to be fairly low due to the high level of interception of the canopy. These stands have the least amount of thinning applied to the growing stock so naturally they are the least expensive PCT treatment. Medium density stands have much less competition amongst neighboring trees which promotes healthier growth such as reduced amount of branches and clearer stems. Canopies tend to be semi-closed and there is an increased amount of shade intolerant understory which contributes to greater levels of biodiversity and increases the complexity of the timber stands. The thinning in these stands is fairly intensive and reduces almost half of the original stand numbers and thus raises the costs of the silviculture operation. Low density stands has a fairly open canopy with varying levels of trees and understory shrubs, these stands promotes greater amounts of understory growth due to the

increased light availability. Nutrient availability is also at a higher level due to the low levels of competition between neighboring trees, Snow levels are higher in these stand due to the reduced canopy cover and thermal retention is reduced. Biodiversity is at its highest level in low density stands due to the above factors which in turn attract wildlife such as mule deer.

## 6.2 Fertilization

Fertilization is a silviculture option that can greatly improve soil nutrient levels on site that have poor nutrients regimes or shallow soils. By improving nitrogen levels as an example, the overall stand productivity will increase and the susceptibility to infection or disease will decrease. Poor sites can be transformed into medium or rich nutrient sites depending on the intensity of fertilization and the time period of treatment. Fertilization can also promote the growth of other non-timber species that may not have been able to survive on previous poor sites. Fertilization can be a costly operation so generally the smaller the site the better, small scale logging operations in mature Douglas fir stands provide the ideal location for these techniques to be applied.

## 6.3 Biodiversity

Managing with more objectives than timber values can provide a great value to the overall health of a forest and promote sustainability for all aspects of forest environments. Promoting shrub growth in the understory can greatly increase a forest's complexity and elevate stress applied to new growing stocks from ungulate or mammalian foraging. Planting deciduous trees such as Paper birch or Trembling aspen can address areas infected or susceptible to root diseases and help stop the spread to neighboring stands. Having a forest at numerous serial stages is an effective way to reduce the spread of disease or lower the potential for massive insect outbreaks. The Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemic of the last decade is an example of what happens when large amounts of forests are at an even aged level. Promoting the variety of conifer and deciduous species can provide stands with greater inputs back into the ecosystem through soil nutrient rejuvenation from leached nutrients out of leaves and increased available spring forage on new buds. Coniferous can provide over winter thermal cover and available winter forage for ungulate species when

deciduous trees begin to lie dormant and have lose their leaves.

# Results

## 7.1 Effects on Mule Deer Habitat

### 7.1.1 Shelter

Large scale logging has a large short term impact on mule deer shelter as both understory and canopy cover is completely removed from their habitat. In the following few years before tree species reach green up stages (1.3m or 5 years), mule deer cannot use these harvested blocks as areas of refuge. They are forced into neighboring timber stands that may be fragmented from their seasonal foraging grounds or fawning areas. Concentration in these neighboring stands can leave the deer more susceptible to pressure from predators or competition with free range cattle grazing operations. Once green up does occur utilization of these areas becomes more concentrated in spring/summer months when overhead cover is not as important as lateral cover from understory species and food availability. The colder winter months will make large scale harvesting areas inaccessible due to high snow pack and will provide little shelter from the elements. This is what makes mule deer winter ranges a vital part of their success rate over winter, these areas provide the needed thermal and overhead cover that is limited on a timber land base. If compromised or if mule deer have limited access to their winter ranges it can be devastating to their survival success.

In comparison small scale logging has a far less negative impact on shelter for mule deer especially the group and single tree selection operations. These operations have been proven to retain overhead cover while still providing small timber volumes to harvesting operations. Group and single tree selection mainly occurs in mature Douglas fir stands, by only harvesting small volumes the overall canopy cover is not completely lost allowing the trees to still intercept snow and retain thermal heat. Small clear cuts and patch cut operations remove both the understory and overhead cover in the same fashion as large scale logging operations, but they retain more potential surrounding shelter due to the small area of the land base that is harvested. Fragmentation between shelter areas and foraging or fawning areas will be greatly decreased. Harvesting impacts will not compromise suitable shelter areas in both summer and winter while

exposure to predators will also be greatly reduced due to smaller openings and shorter sight lines.

### 7.1.2 Food Availability and Promotion of Summer Forage.

Food availability levels are high in large scale logging blocks during harvest and the following few decades in the future. Debris such as branches and foliage left over from harvested trees provides mule deer with ample amounts of foliage to graze on that otherwise would be out of reach. Once harvesting has been completed the exposed soil allows new pioneer shrubs and grasses to establish which creates more opportunities for foraging on the new shoots and buds. When the block is replanted with new tree saplings they begin to replace the low lying understory overtime. These saplings still provide the deer with high levels of forage opportunities that will insure them with the needed nutrients required for survival through the coming winter. Silvicultural enhancements such as pre-commercial thinning and fertilization can prolong summer forage areas in these new blocks allowing, easier movements within them and a greater variety of food from spring to fall. The increased understory growth and abundance of new conifer shoots allow deer to access numerous different food sources which will increase their calorie intake and thus success rate over winter.

The food availability in small scale logging blocks depends on the operation and the timber stand location. Small scale clear-cuts and patch cuts produce available feed during harvest and post-harvest for decades into the future but at a smaller scale than large scale logging. The foliage debris from timber harvesting provides mule deer with short term food availability opportunities but is limited to the volume of trees that is harvested. As new species converge on the disturbed site it allows mule deer to access new grazing areas that are close to mature timber stands with overhead and thermal cover. Often these small isolated harvested areas provide available feed for fall and winter forage because they are located near or in Mule deer winter ranges. Increasing the siviculture treatments in these areas to promote understory growth and success of regenerated trees can provide the deer with easy access to a reliable food source in the winter months. Young treatment areas can sustain mule deer through their transition into the winter months or when snow levels are high because the short distances too overhead cover reduces calorie loss in deep snow travel. Group selection or single tree

selection harvests provide new short term inputs to food availability from harvested debris but long term inputs tend to be small due to little or no new growing stocks being replanted. The pressure of summer forage in these areas are fairly low because mule deer aren't restricted by snow levels so they often move to larger young regenerated stands where the biodiversity of food is higher and competition for healthy foraging areas is reduced.

### 7.1.3 Fragmentation

Fragmentation is a main issue for large scale logging operations in the years before green up. Non-salvage harvesting operations can clearcut up to 40 hectares for one block and Lodgepole pine salvage operations has no restrictions in size, they can be as big as 125 hectares. These changes to timber stands can impede safe travel for mule deer migrating seasonally or everyday movements. Riparian areas are often left as wildlife reserves in these large blocks which could have provided the deer with their nearest access to a reliable water source. Unfortunately the large amount of open areas surrounding it can expose the deer to increased predation possibilities with little cover areas for refuge. Avoidance of these areas can force the deer to have to adapt to new travel movements or find new water sources that cause increased stress and calorie loss.

Small scale logging operations do not create much fragmentation in comparison to large scale logging because the max size of them are 10 hectares and below. Mule deer can adapt much faster to the disturbance and their natural movements are not as impeded.

### 7.1.4 Road access and Hunting Pressure

Logging roads are part of both large and small scale logging operations and can cause small levels of disturbance in the surrounding environments. Roads create hard edges that are permanent for extended periods of time. These roads provide hunters with access into a variety of areas and often hunters use the roads to cover lots of different ground, while searching for harvestable mule deer. The hunting season for mule deer correlates to the deer's mating season (the rut), when the deer are the most active in searching for a mate. As fall turns into winter most of the foliage dies off of the deciduous trees and this can create a reduced amount of cover in large cut blocks,

which can make mule deer easily visible as the search for food or mates. Large cut blocks allow hunters long sight lines and the ability to spot deer without spooking them. The high level of pressure in these areas can force mule deer to seek cover in thick timber stands or smaller blocks that receive less pressure. Small scale cut blocks often have more temporary roads which help reduce hunting pressures and allow mule deer refuge from areas that may be more accessible to hunters. These areas also tend to have reduced sight lines and provide more lateral cover to conceal movements. These areas become more vital at hiding deer and providing forage areas as snow levels drive them to lower elevation and higher concentrations.

## Discussion

After analysis and comparison of the effects of large and small scale logging operations on mule deer seasonal habitats in the interior of British Columbia; I have concluded that large scale logging operations are vital to creating and maintaining a healthy mule deer population. Firstly large scale harvested blocks are essential for summer forage months, providing ample amounts of diverse plant species for mule deer to build up their fat reserves for the coming winter. It is important to manage these areas with the same diligence and direction as winter ranges by utilising medium or high intensity PCT operations and promoting understory growth. By providing these managed areas, mule deer can have large areas to feed and acquire the proper nutrients needed to promote healthy growth and winter survival. Mule deer forage heavily once the mating season begins and bucks spar for mates, which requires numerous replenishments of reserves. These areas must be managed to provide available feed from summer to late fall. Without these summer forages areas mule deer stand a greatly decreased chance of surviving the winter no matter how well their winter ranges are at providing thermal and overhead cover. The closer the proximity of large scale operations are to mule deer winter ranges, the more important they will become to providing proper habitat. The deer will access these areas first in the spring as snow levels begin to melt and travel becomes easier, and will forage later in the fall at these areas as the snow level increases at higher elevations. It is also important that managers be aware of fragmentation and road access to hunters. By reducing long cut block edges and providing wildlife corridors to adjacent standing timber it can help to

mitigate fragmentation between seasonal ranges. Reducing hunting pressure through road deactivations or closers to motor vehicles can help alleviate this issue and provide deer with areas of refuge in which to concentrate on foraging and mating.

Due to government regulation, small scale logging is best utilized within transitional winter ranges and in mule deer winter ranges, primarily mature IDF stands. The small levels of harvest can provide limited forage areas in regenerated blocks while thermal and overhead cover are not compromised and close by. The small harvested blocks also create natural wildlife corridors between the surrounding stands as well as create higher levels of biodiversity due to increased understory growth. This improved understory growth and enhanced regeneration of new trees can provide a reliable food source through the winter when forage from fallen branches becomes sparse. Road access and skid trail placement has become restricted in these areas by government policy so disturbance from operational traffic and hunters has become greatly reduced.

## Conclusion

In conclusion I believe that large scale logging operations can be more beneficial in the long run then small scale logging operations and just as important as well managed mule deer winter ranges. By providing enhanced blocks in both summer and winter ranges, forest managers can create a dynamic land base in which mule deer have increased access to year round food and cover. I believe summer forage has been overlooked as a prominent factor in determining mule deer success rates over winter and it is obvious that increased productivity within stands lead to better food availability and thus healthier mule deer entering the winter months. Thermal cover is still vital to their survival but it will become irrelevant if deer have restricted areas to feed or are solely reliant on fallen debris in the winter months. I believe managers need to broaden their focus outside of managing IDF winter ranges and identify that enhanced summer forage ranges may be the key factor in creating successful IDF winter ranges. By utilizing medium to high PCT operations in large scale Lodgepole pine cut-blocks, managers can create higher quality market value timber while still creating a diverse and productive environment for mule deer summer and winter ranges.

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