HUMAN ALTERATION OF
THE ROLE OF FIRE IN DRY INTERIOR FORESTS

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1. INTRODUCTION

This brief report addresses fire history and fire management issues in dry site Douglas-fir forests in western North America. Such forests are found throughout central British Columbia, and the western States, in the rain shadow east of the coastal mountain ranges. This paper grew out of work carried out in the Cariboo-Chilcotin area in 1992.

Fire once played a major role in the dry climate Douglas-fir forest ecosystems in the Pacific Northwest. Ecologists now understand that frequent light ground fires maintained a sparse understory vegetation layer of fire adapted species and an open lower forest canopy.

There is limited information pertaining to the importance of fire in dry, forested ecosystems in British Columbia. However, a large body of work has been developed in the United States regarding the importance of fire in similar dry climate forests, and the interaction of grasslands, dry climate forests and forest fires.

Ecologists have concluded that fire suppression has caused undesirable ecological modifications to dry climate Douglas-fir forests. The formerly open old growth Douglas-fir forests are now choked with dense Douglas-fir regeneration. We believe that this condition is unnatural, poses a high fire hazard, reduces wildlife habitat values, and may be contributing to forest stress and forest decline by placing too great a demand on limited water resources. We hypothesize that the dense understory may be an important contributing factor in the increase in Douglas-fir bark beetle populations.

We use the term "natural fire" in this report, but the meaning of "natural" is open to interpretation, given the long history of Indigenous human use of the forests of North America. Thus, this section also contains a brief discussion of the meaning of "natural" fires.

2. OLD GROWTH DOUGLAS-FIR FORESTS - A FIRE DEPENDENT COMMUNITY?

We believe that low intensity ground fires once played a major role in Cariboo-Chilcotin Douglas-fir forest ecosystems. We will explain the basis for this conclusion in this section of the report.

During our field examinations we noted the distinct two tiered structure of many of the of old growth Douglas-fir forests in the study area.

Most of these forests are composed of large, very old trees (200+ years), which form an upper canopy layer, surrounded by dense thickets of young (< 50 years) regeneration and saplings. We felt it was odd that very few trees were present in the 50 to 200 year age classes, especially in light of the dense population of trees younger than 50 years. What had prevented earlier regeneration, which obviously occurred in large numbers in this forest type, from reaching the juvenile tree stage beyond 50 years?

We noted several old, fire scarred Douglas-fir in our field surveys. We cut a sample wedge from one of these trees and examined it at a later date. Based on the methodology laid out by Arno and Sneck (1977), we determined that our sample tree showed scars from a history of repeated fires.

Figure 1: Typical pronounced fire scar from repeated light burns on dry site Larch tree in East Kootenay area of B.C.

Marion Parker, a dendrochronologist in Vancouver, has examined this sample and verified that these scars show a history of repeated fires. While one tree section does not constitute a full analysis of fire patterns, we believe that this sample is sound evidence that repeated fires occurred in the study area in the past. Mr. Parker also has advised us that his previous work has shown that repeated low intensity fires occur in lodgepole pine forests in the Cariboo-Chilcotin, and that he believes that the study area would also be affected by such an ecological regime (Parker 1991).

Douglas-fir is well adapted to survive moderate intensity fires. Older Douglas-fir trees have thick, corky bark which provides insulation from heat, and protects the sensitive inner bark from damage. Old Douglas-fir trees also commonly have branch free lower boles. Thus, the tree's foliage is held well above the flames of a ground fire, and is unlikely to ignite causing a crown fire or to suffer significant damage. This growth habitat may well be an adaptation to repeated fires. In any event, Douglas-fir is a logical species to thrive in fire dominated central British Columbia ecosystems.

We reviewed available literature and research reports for further information. The general ecological reports pertaining to the Cariboo-Chilcotin area note that fire played a role in the forest ecology of this area, but provide few specifics. However, a review of literature published by researchers in Montana and Arizona provided a wealth of supporting information. Much of their work has been carried out in old growth ponderosa pine and western larch forests. While neither ponderosa pine and western larch grow in the sub-boreal climate of the study area, we believe that the ecological niche occupied by large, old growth trees of these species is very similar to the niche occupied by large, old growth Douglas- fir in the Chilcotin.

We also noted similarities between the forest problems encountered by excluding fire, the ecological patterns, the ecological processes, and the climatic regimes described in the research areas and the conditions we have observed in the Chilcotin forests. These similarities lead us to conclude that the U.S. research findings are transferable (at a theoretical level) to the old growth Douglas-fir forests of the Cariboo-Chilcotin.

2.1 THE ECOLOGICAL ROLE OF FIRE IN DRY CLIMATE OLD GROWTH FORESTS

The importance of fire in dry climate forest ecosystems has been understood for many years. Jepson (1923) noted that "The Sierra Nevadan forest, as the white man found it, was clearly the result of periodic or irregular firing over many thousands of years". Harold Weaver of the USDA Forest Service began a campaign in 1943 to show that:

> *... complete prevention of forest fires in the ponderosa pine region of the Pacific Slope has certain undesirable ecological effects. ....Conditions are already deplorable and are becoming increasingly serious over large areas. (Journal of Forestry, 1943)*

Weaver noted problems such as stand stagnation due to overstocking and unnaturally high fire hazards due to very dense, unhealthy stands being willfully created and maintained. He also noted that increasing pine beetle populations were causing epidemics in areas where beetles had not previously been a significant problem. He believed that the increase in beetle populations were due to lack of vigor in the forest, caused by tree stress from increased competition for water from the dense understory (Weaver 1943).

The early work of these ecologists and foresters was largely ignored. Various authors attribute this to the success of the "Smokey the Bear" mindset, in which all fires were bad and any loss of timber to fire was both unacceptable and an indication of poor management. The fire control bias is now being challenged by modern researchers, many of whom acknowledge a debt to Weaver and the other pioneers.

Habek (1990) made the following comments regarding an old growth ponderosa pine - larch forest in the Patee Canyon in Montana.

> *The oldest fire scar found in Patee Canyon dates to 1557, over 430 years ago, with numerous fires occurring between the mid 1500s and 1900. Specifically, 51 distinct fire dates were identified between 1557 and 1918, yielding an average canyon fire interval of 7.1 years. After 1900, fires were effectively reduced in number and size.*
>
> *The potential climax dominant, Douglas-fir, has invaded the open, old-growth forests during the fire exclusion era. In some of the plots, invading ponderosa pine reproduction is mixed with the Douglas-fir. Often canyon sites dominated by invading pine are currently subject to mortality caused by mountain pine beetle. Douglas-firs have become heavily infested with western spruce budworm and dwarf mistletoe throughout Patee Canyon. The levels of these infestations may be the consequence of changes associated with modern fire suppression.*
>
> *Patee Canyon's remnant old-growth pines and larch now exist in an extremely high fire hazard due to the present of densely stocked Douglas-fir saplings and pole sized trees, which today would support high intensity fires. ...The understory Douglas-fir have the potential to serve as fuel ladders which would conduct a present-day fire into the crowns of the surviving old-growth trees, probably ending their lives.*

Harrington and Sackett (1990) describe the relationship between ponderosa pine old growth forests, forest fires and forest fire suppression as follows:

> *The ponderosa pine (Pinus ponderosa Laws.) forests of the Southwest have gone through extensive structural and compositional changes in the last century. Numerous references document the open, park-like appearance of historic ponderosa pine stands, where herbaceous vegetation was vigorous and abundant. Fires were a regular feature of these forests, burning the light surface fuels at intervals usually averaging less than 10 years and as often as every 2 years. The frequency of these fires resulted from the continuity of grass and pine needle fuels, the high incidence of lightning, and the warm, dry weather common to the Southwest. Light surface fuels built up sufficiently with the rapid resprouting of grasses and the annual pine needle cast. Large, woody fuels, which fall infrequently, rarely accumulated over extensive areas. When single or small groups of trees fell, they were generally consumed by subsequent fires, creating a mineral soil seedbed and reducing grass competition in microsites, favoring ponderosa pine seedling establishment. These circumstances created an uneven-aged stand structure composed of small, relatively even-aged groups.*

> *...The changes that have taken place primarily within the last century have created several undesirable conditions in the ponderosa pine forests of the Southwest. The extreme fuel hazard is probably most apparent. The combination of heavy forest floor fuel loadings and dense sapling thickets coupled with the normally dry climate and frequent lightning- and human-caused ignition potential result in a severe wildfire threat. Additionally, trees of all sizes have generally poor vigor and reduced growth rates. This condition is likely due to the reduced availability of soil moisture caused by intense competition and by moisture retention in the thick forest floor. The thick forest floor also indicates that soil nutrients, especially nitrogen, may be limiting because they are bound in unavailable forms.*

Figure 2: A remnant savannah forest in East Kootenay Region of B.C. Significant infilling of small stems due to fire suppression is occurring, but the original ecological character of the area can still be seen in the photograph.

Moir and Diterich (1988) and van Wagtendonk (1983) have described similar dynamics in ponderosa pine ecosystems. Arno (1983) noted that while the return fire interval in ponderosa pine forests was 5 to 25 years, the return fire interval in higher elevation Douglas-fir forests, which grow in cooler climates, was 25 to 60 years.

Bancroft et al (1983) described the effects of sixty years of fire suppression in Sequoia National Park:

> *Fire suppression resulted in an unnatural accumulation of fuel, particularly in the sequoia and mixed conifer forests; this accumulation reached a point at which the forest was threatened by fires of higher intensity than those to which it was adapted. The removal of fire also increased the density of fire tolerant species such as white fir. The fire regime appeared to be changing from low to high intensity and from short to long return.*
>
> *Severe wildfires in the Sierra Nevada in 1955 and 1960 demonstrated the potential of these dangerous fuels.*

Van Wagtendonk (1983) describes the following ecological processes in "mixed coniferous" forests. These forests, as defined by the author, include Douglas-fir, grand fir and ponderosa pine in the Intermountain area of the northwest United States. The author describes natural fire processes first:

> *Periodic fires eliminate most of the shade tolerant understory that develops between fires favoring the more fire tolerant pines. Local variations in fire intensity create openings in the forest, which would become regenerated ...based on the ability of each species to grow under various levels of sunlight, litter depth, and fire intensity.*
>
> *The effects of fire suppression in mixed conifer forests have been an increase in fuel accumulation and a shift in composition toward shade tolerant species. These changes have increased the potential for a high intensity crown fire, not only by providing more available energy but also by creating pathways for flames to reach the overstory canopies. Such crown fires usually exceed the capacity of suppression forces.*

Fire also served as a natural stand density control. Previous authors have alluded to this function. Harrington and Sackett (1990) note that:

> *Thinning by fire was a natural process in ponderosa pine before settlement. The degree of thinning is dependent on the quantity of fuel on the ground. The more dense the thicket, the more fuel, and the more intense the fire; thus resembling a self regulating feedback mechanism governed essentially by stand density.*

Van Wagtendonk (1983) also noted that:

> *The small accumulations of needles underneath the young pines do not carry a fire and thus protect them (the trees) until they are able to survive. Subsequent fires remove any small trees underneath the large trees.*

Natural fire patterns in dry climate forests also maintain wildlife habitat and wildlife populations. A study of white-tailed deer in Montana showed that the deer population was largely controlled by the abundance of and the access to paired habitats of open, dry climate, old growth forests and moist, luxuriant riparian zone forests. Old growth forests were valuable for hiding and thermal cover, but most importantly because the natural openings and open understory in the old growth forests contained accessible, nutritious forage plants in winter (Mundinger et al 1982). Other studies have documented similar effects for mule deer in various locations (Schoen et al 1981, Hanley et al 1989, Armleder et al 1986). Forage plants in large openings (e.g. clearcuts) are often buried by winter snow, and inaccessible to deer and other ungulates. Old growth trees intercept much of the winter snow fall, resulting in a variable snow pack within the forest, which provides accessible forage plants. Reducing the availability of, access to or quality of either of these habitats would be expected to negatively impact deer populations. Fire suppression has, as noted, altered the ground cover in old growth forests from a grass/shrub community (high forage values) to a coniferous regeneration community (low forage values). Freedman and Habek interpreted these results as follows:

> *Before the introduction of effective fire suppression in western Montana in the 1930's, recurrent wildfires maintained much of the lower forest zones in a complex, mosaic pattern of developmental stages of succession. ..Fires (maintained) mosaics of young and mature seral types, fires thinned the forests and produced gaps in the canopies. Fire's influence is likely to have been repetitive and predicable, leading to a degree of stability in range habitat components. ..Long term stability in deer numbers is geared toward the effective exploitation of a relatively stable physical habitat maintained, in this case, by periodic fire disturbances.*

Fire suppression has lead to the homogenization or simplification of the formerly varied deer habitat, and decreased its usefulness and productivity for deer. This, coupled with the effects of clearcut logging, has lead to a situation where "it may not be possible to ..maintain and improve habitat for white-tailed deer" (Mundinger 1984).

These citations set out the ecological patterns and processes of natural fire patterns in dry climate forests. The authors describe the effects and benefits of frequent light intensity burns in dry climate/dry site forests, and document the negative effects of fire suppression. The conclusion supported by this body of work is that absolute fire suppression in dry climate forest ecosystems has been a serious error. The detrimental effects noted by Weaver in 1943 are now much worse, and more evident. The proposed solution is to re-introduce fire to these ecosystems, although this is known to be an expensive and difficult undertaking, which has significant risks.

It is important to note that no authors or researchers are advocating a "hands off" approach that would simply let any and all forest fires burn unchecked. What is being proposed is a careful and cautious reintroduction of controlled fire, planned and ignited by forest managers. The intense fuel build up (the legacy of fire suppression policies) makes any other course too dangerous, with too great a risk of explosive fires which kill the vast majority of trees in the forest, rather than starting the process of restoring ecological balance.

2.2 FIRE SUPPRESSION AND PRAIRIE ECOSYSTEMS

Fire suppression has also been found to have detrimental effects on grassland ecosystems. Prairie grassland ecosystems have evolved with average fire return intervals of less than a decade. Fires control encroachment by woody vegetation, maintain vegetation communities, maintain habitat diversity and renew valuable forage species (Kruse and Higgins 1990).

Land managers discovered the ecological importance of fire in prairie ecosystems in the 1940's. At that time, the University of Wisconsin Arboretum was attempting to restore a severely degraded prairie ecosystem. The researchers found that attempts to restore the prairie without fire failed, while experimental prescribed burning led to improved plant health and diversity (Jordan et al 1987, Sperry 1990).

Annas and Coupe (1979) have noted that the upper elevation prairies in the Interior Douglas-fir zone may well be maintained over the long term by fire. Fire suppression is expected to lead to tree encroachment on the grasslands.

A complex interaction between the season of burning and the intensity of burning determines the positive effects and/or the negative impacts on specific parts of the prairie vegetation community (Steuter et al 1990). Burns which are too frequent, too intense or incorrectly timed may cause harm to prairie ecosystems. Desirable plant species may be killed, animals may be killed or injured, and nesting habitat and browse availability may be reduced (Steuter et al 1990, Kruse and Higgins 1990). However, carefully planned and monitored fires which burn a portion of an area at any given time can be expected to have a variety of positive effects. These include:

1. Favoring the growth and establishment of native prairie grasses, at the expense of invasive, non-native plants and tree species (Harty et al 1991).
2. Maintaining a mosaic pattern of varied cover types and habitat resources in the grassland landscape.
3. Restoring the health and productivity of grazing resources (Steuter et al 1990).
4. Maintaining a natural balance in insect, bird and animal communities. Prairie fauna evolved with frequent fires; some species depend on burned areas for their habitat (Kruse and Higgins 1990). Fire suppression favors those species which inhabit unburned areas, at the expense of those dependent on various ages of burned sites.

2.3 "NATURAL" FIRES?

The term "natural fire" has been used frequently in this report, and is used in the fire ecology literature. However, as most authors acknowledge, this term is misleading and discriminatory as it disregards the effects of the original inhabitants of this continent upon the ecosystem. A more thorough, and accurate, term would be "fires ignited by lightning and/or Indigenous people". However, for the sake of brevity, authors have largely used the term "natural".

Revealing words on the importance of indigenous peoples in "natural" fires are provided by Thomas Bonnicksen, who has been working to restore functioning, fire dependent ecosystems for 20 years. His comments were directed to a review of the Yellowstone Park fires of 1989:

> *The "let burn" policy of relying primarily on lightning fires to manage vegetation, which led to the Yellowstone wildfire disaster and which is based on the "natural regulation" philosophy, is founded on a false premise--that national park and wilderness areas were pristine or untouched by humans when they were set aside. They were not pristine. By the time European explorers arrived, much of the vegetation and wildlife in park and wilderness areas was profoundly altered due to thousands of years of management and use by aboriginal people. Aboriginal fires interacted with lightning fires to create and maintain vegetation in a mosaic pattern that supported an abundant variety of wildlife and contained wildfires within limited areas. After years of vegetation change due to unnatural fire suppression, lightning fires alone cannot be expected to restore this vegetation mosaic to its natural scale and diversity. . . .*
>
> *. . . The answer is to go back to the basics and approximate what happened before we arrived on the scene and began changing vegetation and wildlife to suit our European fantasies and prejudices. We must restore vegetation mosaics that are similar in scale and diversity to the ones that existed in each park and wilderness area prior to our intervention. Once an approximation of the original scale and diversity of vegetation types is restored in the mosaics, these patterns can then be easily maintained as an ever changing kaleidoscope of biotic communities at relatively low cost. Before we arrived on the scene, the natural dynamic vegetation mosaic that resulted from the interaction of aboriginal and lightning fires worked for thousands of years to produce safe and attractive forests and grasslands with a wide variety of wildlife, and could work for thousands of years into the future to produce the same benefits for us and our children.*

2.4 CONCLUSION

Prior to organized fire suppression activities, frequent, low intensity fires in the dry Douglas-fir ecosystem maintained open, multi-aged forests with little understory. Fire adapted plants, such as deciduous shrubs and grasses, dominated the lower vegetation layers. Trees germinated in open areas between fires, but most young stems did not survive the repeated fires. Natural feedback loops, involving stand density and fire intensity, controlled the number of trees per hectare and resulted in open forest canopy dominated by large old growth Douglas-fir. This stocking control helped to maintain healthy, vigorous forests.

Fire suppression has altered this pattern. Dense understory tree layers now occur in these dry climate forests. These understory layers cause a hazard of explosive, uncontrollable fire, and likely lead to general forest decline and stagnation. Increased competition for limited soil water supplies is likely leading to forest stress, and fostering bark beetle outbreaks. The sorry state of old growth Douglas-fir forests in the Cariboo-Chilcotin is well known. We believe that the observed problems are a result of ecosystem modification, largely attributable to fire suppression.

We conclude that controlled fires should be carefully reintroduced to these ecosystems. But, allowing these forests to burn in their current condition would likely produce a catastrophic fire, and kill the majority of the trees. Historically, regular low-intensity ground fires that cleaned the understory were the natural pattern. However, with the existing dense understory of young trees, uncontrolled fire may kill all of the trees, including the large overstory once maintained by ground fires. Fire must be reintroduced carefully to minimize damage to existing stands, although it is not possible to re-introduce fire without some adverse impacts.

3. RE-INTRODUCTION OF FIRE

3.1 RE-INTRODUCTION OF FIRE TO OLD GROWTH DOUGLAS-FIR FORESTS

As discussed above, fire once played a major role in dry climate, old growth Douglas-fir forest ecosystems. We conclude that controlled, low intensity fire should be reintroduced to these ecosystems. However, allowing these forests to simply burn in their current condition would not be a desirable approach. The dense understory of young trees which has regenerated in the absence of fire will cause a forest fire which is too hot and too severe, and which would likely kill all of the trees, including the large overstory trees which are very ecologically valuable and irreplaceable in human timeframes. Regular ground fires that reduced fuel accumulations in the understory were the natural pattern, not hot crown fires which killed substantial numbers of large trees. Fire must be reintroduced to this ecosystem carefully.

A sizable body of research and practical experience pertaining to reintroducing fire to fire dominated ecosystems has been developed in the United States over the last few decades. This experience provides information on successful methods used to reintroduce fire following decades of fire suppression, and the ecological effects of reintroduced fire. However, as Harrington and Sackett caution:

> *One fire seldom corrects problems associated with 100 years of fire exclusion.*

Reintroducing fire to old growth forests following fire suppression is not without risks, and the possibility of damage to the very forest such a program is trying to maintain. On some sites, as many as 35% of the old growth trees which survived pre-settlement fires have been killed by initial burns (Harrington and Sackett 1990). Possible reasons for this mortality include:

1. Some of the trees were likely severely stressed from previous ecological changes (fire suppression) and were insufficiently resilient to withstand further stress.

2. During the period of fire suppression, deep forest floors[1] may develop in stands which had very shallow forest floors under a frequent fire regime. Over time, forest trees relocate large amounts of their active roots to this layer, which is rich in organic nutrients and moisture. However, this organic soil layer will likely burn, and may smolder for several days, in initial fires. The extensive root killing which results is likely a cause of much of the subsequent tree mortality (Harrington and Sackett 1990).

Two courses of action are open to re-introduce fire to old growth Douglas-fir forests.

1. The forest can be burned as is, using weather conditions as a fire regulator to achieve the goals (understory and fuel reduction) without excessive damage to the remaining overstory. This is inherently risky, as a small mistake can result in extensive damage. If successful, however, this course of action is relatively inexpensive.
2. The forest can be silviculturally treated to reduce fuel loads prior to burning. This option is more expensive, but presents less risk of damage to the remaining forest.

Harrington and Sackett (1990) make the following comments on utilizing fire in untreated stands. Note, however, that these instructions are specific to Ponderosa Pine forests in New Mexico. While they provide useful suggestions of parameters to consider, this should not be interpreted as a cookbook prescription for re-introducing fire to Douglas-fir forests in the Chilcotin. The authors state:

> *In forested sites where fire has been absent for decades, the initial fuel reduction burns should be conducted in fall or early spring when temperatures and humidities are moderate.*
>
> *The following prescription parameters are the primary variables which determine whether a fire will burn successfully, hazardously, or not at all. On sites requiring reduction of natural fuels, maximum daytime air temperatures should be between 50 and 75 F. Below 50 F, moderately dry fuels (9 to 12% moisture) burn poorly and above 80 F extensive overstory crown scorching is likely. minimum relative humidities should not drop below 20% or exceed 40%. Fuels subjected to a series of low humidity days become hazardously dry. Windspeed at flame height should be between 3 and 8 miles per hour. Slope effects can compensate for wind. A fire burning with little or no wind and no effective slope will either not spread well or will cause extensive crown heating, if fuels are dry. Windspeeds greater than 10 miles per hour can result in erratic fire behavior.*

The authors continue to discuss compensating factors and exceptions to the norm. The gist of the citation is that reintroducing fire without pretreatment is a challenging task requiring "very exact estimates." In other words, this approach is, at best, a calculated gamble. Too cool a burn will not accomplish objectives. To hot a burn will injure more of the overstory

[1] The layer of organic materiel which accumulates on top of the mineral soil under a forest canopy.

than is necessary. A slow burn will cause excessive soil heating and root death. A fast burn may escape control, and cause crown scorch.

Pretreatment serves to lower the risks of burning, and widen the window of conditions under which burning will achieve management objectives. Various authors have discussed the use of pre-burn treatments to lessen the damage to desired old growth leave trees and resultant mortality (Moir and Dieterich 1988, Martin et al 1989, Guyette and Cutter 1991). Treatments work by reducing the fuel loading and fuel continuity around desired leave trees in stands before burning. This can be accomplished by cutting back the understory in these stands, and reducing fuel concentrations. The costs of such activity are expected to be high. Cotton and McBride (1987) discussed an "appearance management" program in Sequoia forests in the U.S. which involved raking accumulated litter away from the base of large trees, moving heavy fuels away from the base of the trees, and falling, piling and burning small stems. While initial stand densities and productivity are not noted, the authors indicate that expected costs range from $600 to $1000 dollars per hectare.

A combination of both the above noted methods, tailored to the conditions found in the remaining old growth Douglas-fir forests would likely be appropriate. The relative scarcity of these forests, and the lack of experience with reintroducing fire to this ecosystem, makes burning with no stand preparation unadvisable. The risk of damage to this scarce forest is too high. Full pretreatment may be too expensive, and may be unnecessary. However, the first treatment should include a full treatment in order to determine how much less treatment is safe for the forest. Experiments in small areas with partial stand treatments and burning conditions could be carried out in conjunction with full treatment to develop procedures and parameters which are suitable to the forests in question.

Bancroft et al (1985) and Seveson and Rinne (1990) both address the issue of landscape pattern and reintroduced fire. Both articles conclude that land managers should aim to create a diverse mosaic of fire dates and intensities, rather than applying a uniform treatment to entire stands. They believe that fire dependent forests were subject to a range of fire intensities, which moved across the landscape in random patterns, influenced by biological events. These natural patterns can best be initiated by repeated treatments over small areas. As Harvey et al (1980) note:

> *The implication of this pattern for management is that fire as a tool probably should not be applied evenly in a short period of time throughout a large area. Prescription fires should be applied in a patchy manner thus coming closest to re-establishing the primitive mixed conifer forest. The overall long term goal should be the establishment of conditions that would allow natural processes to operate uninterrupted in the ecosystem.*

The isolated nature of many of the remaining old growth stands may be a negative feature with regard to landscape ecology, but isolation does have positive benefits in a plan to reintroduce fire. Treatments and fires in one part of the forest can easily be confined to that forest area, without the expense or ecologically negative impact of fireguards or other suppression activities.

We are not, as is clear from the above discussion of methods and treatments, advocating a return to completely "natural" fire patterns, or a "let burn" approach to fire management.

The historical pattern of forest fires in western North America is quite likely related past use by native peoples. Nor are we under the illusion that the forests can be held in stasis, without change, by any management regime. Landscape ecology explicitly expects and plans for alterations and disturbances in the ecosystems within a landscape. Also, paleoecologists[2] tell us that current vegetation communities and patterns are transient, shifting phenomenon. The forest vegetation types which we intrinsically recognize as "old growth fir" and "lodgepole pine forest" are relatively recent assemblages, that have been changing over thousands of years, and will likely continue to change (Brubaker 1988). The goals of the proposed restoration ecology measures (re-introducing fire) are to return natural ecosystem processes to the landscape in the study area. That these natural processes can only be re-introduced under a regime of intensive human management and intervention is a measure of how greatly altered and disturbed these ecosystems are at the present time.

In summary, re-introducing fire to the old growth Douglas-fir forest in the Cariboo-Chilcotin, and other ecologically similar parts of British Columbia, is a practical and achievable goal. Such a program is relatively untried in Canada, but is certainly not unprecedented in North America. We believe that this ecosystem is dependent on low intensity fires, and that many of the current forest health problems are attributable to the ecological disruption brought about by fire suppression. Experience in other jurisdictions indicates that various silvicultural treatments will be required to reduce the density and fuel continuity of the existing understory, and to lower the risk of damage to leave trees. These potential treatments include hand cutting and piling of dense understory, and reduction of soil litter levels around large old growth trees.

3.2 REINTRODUCTION OF FIRE TO PRAIRIE ECOSYSTEM

The concepts and guidelines set out in the above discussion of re-introduction of fire to dry climate, old growth forest ecosystems also generally apply to re-introduction of fire to prairie ecosystems.

The scientific literature provides solid support for the concept that prairie ecosystems evolved with frequent fires, and in fact require sporadic burning for ecological health. However, as noted above, just "lighting it up" is not a sound approach. Uncontrolled, and unplanned, fire can have detrimental effects on prairie ecosystems. Most prairie areas in British Columbia occupy mere fragment of a complete landscape. A poorly planned or escaped fire could do a great deal of damage to this small area of prairie by homogenizing the area, instead of maintaining or increasing diversity. Diverse habitats must be maintained, as many of the species resident on the prairie have no alternative location to move to if the entire grassland area is burned.

As with forests, a management plan which identifies priority areas for burning, and proposes pre-burn conditions and proposed timing for burning is required before a match is

[2] Ecologists who study the ecology of past landscapes, often in prehistoric times.

struck. Initial trials should be deliberately kept small, in order to assess effects of the fire, and to improve the ability of land managers to predict the effect of prairie fires.

Kruse and Higgins (1990) provide an applicable summary:

> *The optimum timing and frequency of prescribed burns is still being researched. Controlled burning is an efficient tool in wildlife management, but indiscriminate annual burning reduced the quality and quantity of waterfowl nesting cover. Native grasslands should be burned 2 out of 5 years. Land managers who burn in the spring should consider partial burns if they are concerned about nesting birds. Partial burns have less impact on total vegetation changes but can result in higher recruitment rates than complete burns. Annual fall burning would be harmful to wildlife because of the lack of residual nesting cover, and it is suggested that to enhance waterfowl production burning should be conducted every other year at most.*
>
> *Fire creates vegetative diversity and therefore enhances wildlife habitat. Optimum benefits occur where fire creates a mosaic pattern of burned and unburned vegetation that provides new growth of nutritional forages, seasonal habitats, and maintenance of vegetation in early stages of succession.*

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