Fire Management Technical Session

Effects of fire on forest ecology: fire and biodiversity

Presented to:

Canadian Institute of Forestry
Annual Meeting 1992
September 24, 1992
Vancouver, B.C.

John Parminter, Fire Ecologist
Protection Branch, Ministry of Forests
31 Bastion Square, Victoria
British Columbia V8W 3E7

FIRE AND BIODIVERSITY

Biodiversity

Biodiversity is short for biological diversity and refers to the diversity of life. It is defined as the totality of genes, species and ecosystems in a region. Thus there are three levels involved:

- genetic diversity - the variation of genes within a species,
- species diversity - the number and abundance of species within a region, and
- ecosystem diversity - the type, number and distribution of ecosystems.

Canada, and British Columbia in particular, each have a wide variety of ecosystems, habitat types and landscapes. Complex patterns of ecosystems have evolved and a variety of ecological processes operate due to the interrelationships of geology, physiography, climate, natural and human disturbances and the biota.

Within this naturally variable environment, many of the current resource management concerns relate to the loss of biodiversity. This loss is caused, in the main, by:

- habitat fragmentation or destruction,
- introduction of exotic species to new habitats,
- over-exploitation of plant and animal species,
- extinctions of populations or entire species,
- environmental pollution and degradation, and
- ecologically inappropriate resource management.

Conservation of biodiversity may be accomplished by protecting genetic resources, species, ecosystems and habitats from fragmentation, loss, interference and extinction. But habitat protection alone will not necessarily guarantee conservation of biodiversity. We must also understand the natural processes that have been and are at work and allow them to continue to operate where and when feasible.

Biodiversity and fire

The characteristics of our natural forested landscapes are determined by a variety of disturbance processes - primarily wildfire, windthrow, insects and diseases as well as geomorphic activity such as landslides and debris or snow avalanches.

Since many grassland and forested ecosystems are influenced by wildfires, it follows that fire is a major determinant of the different levels of biodiversity. Fire acts as an agent of natural selection in that it selects for or against particular plants and animals, both within the species level, between species, at the ecosystem level and on the landscape.

Natural forests and wildfire

Fires can occur within the soil profile, or affect surface fuels and vegetation or consume the tree crowns. Thus we have ground, surface and crown fires, singly or in combination. The intensity of each fire varies with the amount of available fuel and its arrangement. Fire size is determined by those factors plus topography and fire weather.

Whether the fire's lifetime is short or long, there are nearly always variations in fire behaviour and effects. The most important aspect is scale. Inside the perimeter of a single fire there will be a range of effects - from unburned, lightly burned, or moderately burned, to severely burned fuels, vegetation, and organic soil layers.

In general, post-fire vegetation succession is dependent on the nature of the pre-fire vegetation and its state of development, the season of the burn, fire behaviour, fire intensity, the depth to which the fire burns the soil organic layer, fire size, off-site vegetation, physical site characteristics and post-fire environmental conditions.

Ecosystems can be classified into four groups with respect to the role of fire:

1) Fire independent ecosystems

These are environments which are virtually free from fire. The plant species possess no adaptations to fire and when fire occurs the effects are dramatic and long-lasting. Recovery is slow.

2) Fire dependent ecosystems

Fire is common and fuel conditions are conducive to fire spread. The plant species are adapted to fire and require it for their survival. Post-fire recovery is immediate and fire exclusion is unnatural.

3) Fire initiated ecosystems

Fire is infrequent and catastrophic - it simultaneously terminates and initiates long-lived species. These types are common in temperate and boreal regions and include some pioneer species which are light-demanding, require mineral soil seedbeds for germination, and minimum competition for survival. These die out and are replaced by other species if the fire-free interval is too long. Initial revegetation is rapid but the post-fire recovery period can be lengthy - up to hundreds of years.

4) Fire maintained ecosystems

Fire is frequent (annually to decadal), usually as surface fires, intensity is light, and crown fires are uncommon. Fire serves to decrease fuel build-ups and control plant succession, often keeping out invading species. Fire favours the faster-growing trees with high branches and thick bark, the fire susceptible species are selected out. The exclusion of fire from these types leads to fuel build-ups and vegetative change as fire-susceptible species become more abundant and woody species invade grasslands.

At the stand and landscape levels the fire regime is the important factor. It is defined by the type, intensity, size and return interval (or frequency) of fire. Individual fire regimes range from no natural fire, to surface fires of varying intensities and frequencies, to crown fires and surface fires in combination of varying intensities and frequencies.

Man-made forests and prescribed fire

The natural historic role of fire in influencing the distribution and development of vegetation types can be used as an indication of the degree to which man and his activities have or haven't altered the historic scenario. Man can influence the historical fire regime by:

1) increasing the frequency of fire - by prescribed burning or a function of more fires being ignited by human activity,

2) maintaining the frequency of fire - through a program of prescribed burning or absolute non-interference, allowing nature to continue with the established regime, or

3) decreasing the frequency of fire - a product of fire exclusion brought about intentionally by suppressing fires and managing fuels or as a by-product of altering fuel loadings and continuity.

During the first few decades of forest harvesting on the B.C. coast, fire was regarded as an appropriate tool to remove excess slash loads and abate the fire hazard. With hindsight, such burning could be considered as controlled, or semi-controlled, and not prescribed in the modern sense.

Over the past several decades, at least in British Columbia, forest management has primarily involved clearcutting where appropriate and provision for a new crop through artificial or natural regeneration. Site preparation, when carried out, has involved the use of fire, chemicals and mechanical equipment.

The current use of prescribed fire for site preparation is usually aided by site specific ecological guidelines which describe whether or not fire should be used, and if so what intensity of fire is appropriate. Fire may be applied to the entire cutblock, to windrowed material or just on certain spots.

Management for biodiversity

The historical role of wildfire and the effects of prior prescribed fires on similar sites are taken into account in developing ecological guidelines for prescribed burning. Nevertheless, there are differences between natural fire regimes and those imposed by forest managers. The former may involve infrequent fires which have greater impacts on the soil yet leave many standing snags, much coarse woody debris and some live trees. In a managed forest the effects of prescribed fires on the soil should be less dramatic yet snags, coarse woody debris and live trees are greatly reduced in number and biomass.

With "new forestry" practices, consideration is given to maintaining structural diversity at the stand level and ecologically-based planning at the landscape level. Some of the forest components which are retained are wildlife trees, coarse woody debris, green trees and riparian habitats. However, it may prove difficult to use prescribed fire on sites where some of these components need to be left for the coming rotation.

In the ponderosa pine and interior Douglas-fir types it is easier to develop a forest management strategy which more closely approximates the natural fire regime. In these cases the stands have a history of periodic surface fires which consumed woody fuels, rejuvenated most herb and shrub species while selecting against others, thinned the younger stands and raised the height to live crown.

While this regime of fire maintenance would normally be easy to duplicate in a managed forest, the situation is complicated by several decades of fire exclusion as part of a province-wide policy of fire suppression regardless of the principles of fire ecology.

Many ponderosa pine and interior Douglas-fir stands have filled in with more conifers, resulting in fuel accumulations, increased probability of crown fires instead of surface fires, loss of understorey forage, as well as insect and disease damage. Adjacent grasslands have often been invaded by conifers, especially Douglas-fir, and thus landscape level biodiversity has decreased.

In forests characterised by long return interval crown fires, the adverse ecological effects of fire suppression programs have likely been small. With natural fire return intervals ranging from about 100 to as high as 600 years or more, the influence of a few decades of effective fire suppression will not be apparent at greater than a regional scale.

To counteract the effect of suppression of lightning-caused fires before they might have grown to their expected "natural" size we have had man-caused fires adding to the area burned. Although man-caused fires do not necessarily duplicate lightning-caused fires in terms of place of origin or ignition date, those details may be insignificant to vegetation which is either aided or injured by fire, regardless of the agent of ignition.

The response of existing forests to catastrophic disturbances such as fire and wind varies depending on the herb, shrub and tree species involved and the nature and extent of the disturbance. Usually the vegetation goes through a series of stages after the disturbance and a forest quite similar to the one disturbed or destroyed eventually re-occupies the site. The stages may include a herb-shrub mixture with hardwood trees and young conifers, a hardwood-conifer mixture and eventually a pure coniferous stand or one with a few hardwoods here and there. Some conifer species may decline in abundance and be replaced by others in the long-term absence of further disturbance.

Wildfire frequency and effects determine the landscape patterns from fine scale mosaics of small groups of trees of varying ages to large areas of trees of similar age. The spatial pattern is a product of the typical fire type, size, and shape which have historically influenced the particular landscape in question. Fire prevents total development to old growth forest by maintaining a mix of successional stages.

The usual result is a mosaic of forest types on the landscape with different species mixes, age classes and structure. The oldest ones are commonly referred to as old growth. When disturbance by fire or wind is very frequent, early successional species and types will dominate the landscape. When disturbance is less frequent, the older successional species and types will dominate.

In the long-term, from several hundred to a thousand years, these forest types evolve and change. Continued disturbances such as fire and wind initiate new vegetation succession processes. The landscape mosaic shifts and rearranges itself like the patterns in a kaleidoscope.

A landscape will continue to be diverse as long as disturbances occur and bring change. A diverse landscape is more stable, and at the same time more resilient. Stability arises from the mixture of forest types and age classes - lessening the adverse impact of a single severe disturbance. Resiliency comes from the ability of the landscape to recover from disturbances.

Conclusion

Historically the development of forests from youth to climax was viewed as an inevitable process. The development occurred in spite of repeated disturbances and their impacts. This view has changed in the past two decades and disturbances are now considered to be part of the process of forest and landscape development rather than an external agent of destruction.

Whether the working forest or a wilderness area is involved, information on natural disturbance types as well as their distribution and extent, frequency, and intensity is essential to better understand natural landscape unit size and pattern, degree of fragmentation and level of natural landscape biodiversity.

When fire is a factor in the ecology, its positive and/or negative effects on the plant and animal species present need to be taken into account. At the stand level the specific components which are created or destroyed by fire need to be assessed. At the landscape level we should strive to maintain a mix of vegetation types and seral stages in a variety of sizes and shapes.

In the broad scheme of things fire is no longer an external agent which destroys timber resources but rather an ecological force which influences, for better or worse, biotic resources at the genetic, species, ecosystem and landscape levels. Fire is a major determinant of biodiversity and its inclusion in resource management plans warrants careful consideration, with due attention also being given to the appropriate positive and negative environmental and socio-economic factors.