What is fire ecology?

Fire ecology is a branch of ecology that focuses on the origins of wildland fire and it's relationship to the environment, both living and non-living, in which it occurs. A wildland fire is defined as any fire that is burning in a natural environment (see www.nifc.gov/fireinfo/glossary.html for additional definitions). Fire ecologists recognize that fire is a natural process, and that it often operates as an integral part of the ecosystem in which it occurs. The main factors that are addressed in fire ecology are fire dependence and adaptation of plants and animals, fire history, fire regime and fire effects on ecosystems.

Fire dependence

In the 1930's, researchers in the southern United States argued against the negative perspective that has surrounded fire, with the belief that all fire is bad. It was realized that the devastating picture painted by huge-scale fires produced fear in the minds of the public (and in politicians and scientists alike), and that this generated detrimental results in response to any wildland fires. These researchers recognized that there are species of plants that rely upon the effects of fire to make the environment more hospitable for regeneration and growth. Fire in these environments prepares the soil for seeding by creating an open seedbed, making nutrients more available for uptake and often killing plants that are invading into the habitat and competing with native species.

Fire history

Fire history is the study of with how often fires have occurred in a given geographical area. Through recorded history, we can see into the recent past, but trees are our source of information on fires in the distant past. Trees record their history through a system of growth rings that develop on the trees each year. When a fire goes through an area, the growth rings of that particular tree may be scarred. On live trees this is called a fire scar. Fire scars can also be seen on dead trees. Tree origin dates (calculated from the total number of rings) can also tell when fires occurred, in that fires gave way for these new trees to develop. The study of growth rings is called dendrochronology. Utilizing dendrochronology, we can determine when fires have occurred in the past, and sometimes determine their intensity and direction as well as other information about the weather patterns in that era.

Fire regime

Fire regime refers to the patterns of fire that occur over long periods of time, and the immediate effects of fire in the ecosystem in which it occurs. There are many ways to define a fire regime. Fire regime is a function of the frequency of fire occurrence, fire intensity and the amount of fuel consumed. The frequency is determined largely by the ecosystem characteristics, the duration and character of the weather (whether the season is drier or wetter than normal, etc.) and ignition sources. The intensity of a fire is determined by the quantity of fuel available, the fuel's combustion rates and existing weather conditions. Interactions between frequency and intensity are influenced by wind, topography and fire history. There are many other factors that can come into play when talking of fire regimes, though this simple definition will work for most cases.

Fire Effects

Fire effects refers to the immediate and more long-range effect of fire on all living and non-living organisms in the system. For example, fire can have a range of immediate effects on soils, vegetation, water/watersheds, and infrastructure, to name a few. One of the overall benefits of wildland fire is that it is a catalyst for enhancing an ecosystem's ability to sustain nutrient and water cycles and promote biological diversity. Wildland fires burning in their natural regimes reinitiate succession of vegetation communities. They foster new plant growth, which in turn, supports diverse wildlife habitats.

Definitions taken from: www.pacificbio.org/Projects/Fire2001/fire_ecology.htm

Fire Suppression/Exclusion Practices

A substantial amount of attention has been paid to the development of dense stockings of small trees in some forests, and the contribution of fuel loading to current fire severity in those areas. Although this may be true of some drier vegetation ecosystems, this observation does not apply well to the pinyon-juniper woodland types or many of the high-elevation forests that dominate much of the western Rockies. Nor does it apply to non-forested areas.

Much of the discussion of overstocking of the forests have focused on fire suppression policies over the last century as the dominant factor contributing to the overstocking. However, in most areas, wildfire suppression practices have been only one of many contributing factors that have resulted in fire exclusion. For example, the development of communities and road systems associated with logging, mining, grazing, and recreation practices have all contributed to the change of vegetation composition, amount, and distribution across the landscape. As a result, fire has been excluded in many areas where it historically played an important role in the evolution of the landscape.

The ecological effects of practices that have excluded wildfire vary with vegetation type. In addition, the frequency of fire historically varies considerably depending upon the type of vegetation in a given ecosystem. Therefore, there is no single way to characterize the effect of fire-exclusion practices on vegetation composition and structure varies considerably (Smith and Fischer, 1997).

Fuel Types in Colorado

Fire played a major role in shaping the composition, structure, and function of the vegetation types throughout Colorado - particularly those of the Ponderosa pine, pinyon juniper woodland, mountain shrublands, and sagebrush grasslands at lower elevations in Colorado (Covington et al., 1994; Romme et al., 1994; Crane, 1982) and the high-elevation subalpine forests, which are composed mainly of subalpine fir, Engelmann spruce, Douglas fir, lodgepole pine, and aspen in the central mountains in Colorado. However, the ecological changes brought about by traditional land management practices that have resulted in the exclusion of fire have greatly altered conditions in many of the plant communities and greatly affected many species occurring in Colorado (Uncompahgre Field Office Fire Management Plan Environmental Assessment 1999, White River Fire Use Fire Management Plan).

These changes have moved vegetation conditions in areas with heavy human use away from their pre-European-settlement range of natural variation for community structure, fire frequency, and fire size (Covington et al., 1994; Romme et al., 1994). Post-settlement changes include increased density of trees, invasion of trees into formerly shrub or grass dominated areas, increased abundance of saplings and pole-sized trees, decreased abundance of large trees, increased fuel accumulations in the form of litter and fine woody debris, dominance of older age shrubs, and decreased abundance of native bunchgrasses and forbs.

Pinyon pine and juniper woodlands are widespread at the lower elevations, particularly on the Western Slope of Colorado. Juniper-dominated woodlands tend to include open savannas of scattered trees without a significant shrub component, except in areas where big sagebrush has become dominant as a consequence of grazing. Woodland communities have expanded considerably over the course of the century, and now dominate many sites (2001 Report on the Conditions of Colorado's Forests). Average fire intervals vary considerably in pinyon-juniper woodlands, with some historically ranging from 200-400 years (Romme year??). Pinyon pine and juniper do not usually survive a high intensity fire. The rate of stand recovery after a fire depends on the season, availability of seed from adjacent surviving trees, post fire precipitation, competition from other plants, and the amount of area burned.

Ponderosa pine is generally the dominant lower elevation species in Colorado's montane zone, particularly at elevations from 5,800 to 9,800 feet. However, through a century of fire exclusion, shade-tolerant Douglas fir has increasingly encroached on ponderosa pine stands, changing the fire characteristics and fire regime (2001 Report on the Condition of Colorado's Forests). In low-elevation ponderosa pine and dry

Douglas fir forests, average fire intervals have historically ranged from 5 to 20 years, and low to medium intensity fires were common (Arno 1980, Smith and Fisher 1997). Fire exclusion has been fairly effective in reducing the number of fire cycles that these low elevation dry coniferous forests have experienced over the last century. Fire exclusion leads to more intense fires in these areas when fires do occur. When fire occurs in these mixed forests, the understory Douglas-fir tend to carry fire in ladder fashion into the pine crowns, making the fire much more likely to reach unnatural, stand replacement proportions (2001 Report on the Condition of Colorado's Forests).

Colorado's high-elevation subalpine forests are composed mainly of subalpine fir, Engelmann spruce and Douglas fir, lodgepole pine, aspen, and high-elevation sagebrush. These forests are situated at higher elevations, which are considerably wetter and colder than the dry forests. Subalpine forests typically burn rather infrequently, though often at a much higher intensity than do dry forests. Fire intervals in high-elevation forests are difficult to determine with certainty since fires generally kill, rather than scar, the species that survive at these altitudes. However, studies have shown that historic fire-return intervals in subalpine forests range from 50 to 300 years (Arno 1980, Smith and Fisher 1997, Agee 1990, Agee 1993).

In many cases, historic fire-return intervals for subalpine forests are longer than the period of time in which the current fire exclusion practices have been in effect. Fire exclusion due to wildfire-suppression activities has not yet measurably altered the structure and composition of the subalpine forests since they have, in general, not missed sizable fire cycles like the dry forests have. (Smith and Fisher 1997). It can be assumed, though, that historic fire suppression practices have resulted in some loss of mosaic patterning and diversity of age classes, which has allowed larger, more contiguous areas which can carry a stand replacement fire.

Lodgepole pine in most prevelant in the montane and subalpine forests of Colorado's northern Rocky Mountains. Studies have shown fire-free intervals in lodgepole pine to vary between 150-300 years. On unproductive sites, however, intervals of 400-600 years may be more typical (White River Fire Use Fire Management Plan). Some of the conifer species present in sub-alpine forests are killed by moderate-intensity fire (Bradley, et al. 1992). In contrast, lodgepole pine often reproduces prolifically following wildfire (Agee 1993). Lodgepole pine is intolerant of shade and thrives in the aftermath of fire. Many lodgepole produce serotinous cones, which open in response to extreme heat and release an abundance of seeds. These long-lived cones may remain viable for decades, waiting for a fire to release their seeds. Natural lodgpole regeneration in open, sunny areas often produces very dense stand of 20,000 or more trees per acres. (2001 Report on the Condition of Colorado's Forests).

Fire intervals in high-elevation sagebrush, alpine grasslands and aspen are shorter than coniferous forest, and range from 30 to 100 years (White River Fire Use Fire Management Plan).

Fires also burn in US Forest Service Inventoried Roadless Areas and designated Wilderness Areas. Many of the forests in these areas have not been severely altered from their historic fire regimes, and are difficult to access due to steep, rugged topography.

Why prescribed fire?

Fuels treatments of some sort – whether they be mechanical or prescribed burning or a combination of treatment types - are the most effective form of fuel management in these areas where the effects of fire exclusion and the potential for severe wildfire are greatest

But the presence of additional social, political, and ecological management concerns, such as human occupation, threatened and endangered species, cultural/heritage resources, and habitat concerns, make fire use management in these areas more difficult. Fire use is still an option, but often requires much more restrictive management constraints.

Advantages/Disadvantages of Fire

Disadvantages: Fire can cause soil damage, especially through combustion in the litter layer and organic material in the soil. This organic material helps to protect the soil from erosion. When organic material is removed by an essentially intense fire, erosion can occur. Heat from intense fires can also cause soil particles to become hydrophobic. Rainwater then tends to run off the soil rather than to infiltrate through the soil. This can also contribute to erosion. In actuality, the negative effects of fires on soils are often exaggerated, and many fairly intense fires in western United States forests cause little soil damage. There is also the potential for alien plants to become established after fire in previously uninfested areas.

The ashes that remain after a fire can add nutrients often locked in older vegetation to the soil for trees and other vegetation. Fires can also provide a way for controlling insect pests by killing off the older or diseased trees and leaving the younger, healthier trees. In addition to all of the above-mentioned benefits, burned trees provide habitat for nesting birds, homes for mammals and a nutrient base for new plants. When these trees decay, they return even more nutrients to the soil.