Prescribed Burning Effects in Central California Chaparral

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Dense growth of chaparral shrubs (many with flammable compounds in the foliage), accumulation of fuels, and summer drought result in inevitable, periodic fires in California chaparral vegetation. Historically, fires were started by lightning and occurred in the summer and early fall (the dry or warm season) when shrubs are dormant.

The use of prescribed burning has become a widespread management practice in California chaparral vegetation. Prescribed burning is defined as "the application of fire to wildland fuels under such conditions of weather, fuels and topography that specific objectives are accomplished safely" (Green 1981). Prescribed burns (1) create a mosaic of different vegetative age classes in chaparral and build resistance to rapid fire spread, (2) decrease fire control costs and the damage from wildfires, and (3) facilitate the integration of all wildland resources (Biswell 1979).

An active program of prescribed burning was initiated for public lands administered by the Bureau of Land Management in central California in 1979. In the Bakersfield District's Hollister Resource Area, prescribed burns have been undertaken for range improvement, fuel hazard reduction, watershed improvement, and wildlife habitat improvement. An important overall objective has been to re-introduce fire as a natural process in chaparral communities and to maintain chaparral species diversity.

Range improvement burns are usually conducted in the warm season and characteristically involve intensive preparation such as fireline construction and sometimes pretreatment such as chaining or crushing the brush. These burns also require a large commitment of manpower and equipment.

Hazard reduction and watershed improvement burns are frequently conducted in the cool season (late fall, winter, or early spring) with no fireline construction and a minimum number of personnel. These fires burn large acreages of south slopes in a mosaic pattern to break up fuel continuity, reduce potential for catastrophic wildfires and preserve watershed stability. North slopes are usually too moist and shaded to burn in the cool season.

Wildlife habitat improvement burns are usually conducted in the cool season with the objective of creating small mosaics of many different age classes. About 10 percent of the area is burned on an average of every two to three years instead of burning a larger acreage at one time as would be done in other types of burns. Habitat improvement burns create increased edge and habitat diversity, which in turn enhances wildlife species diversity.

All burns are conducted in close cooperation with the California Department of Forestry and adjacent land owners. In addition, wildlife habitat improvement burns are implemented in coordination with the Department of Fish and Game. Most prescribed burns in this area are accomplished by the use of a helitorch.

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Typical Post-fire Effects in Chaparral Communities

Vegetation

Chaparral species growth and development begin immediately after a fire. In sprouting species, fire destroys the apical parts of the plant and the plant sprouts from roots, underground stems and lignotubers (Sweeney 1968). The season in which the burn occurred, fire intensity, and site conditions influence sprouting species survival after fire (Biswell 1979).

Nonsprouting shrubs (obligate seeders) suffer complete mortality after fire. These species and fire-following herbaceous plants germinate after a fire from long-lived seeds stored in the soil. Seeds germinating after a fire need time to develop root systems before the cessation of rains to survive the dry summer. Middle to late spring burns could result in very high obligate seeder mortality.

Shrub seedlings often germinate mid-March to mid-April depending on the weather. Most seedlings are eliminated in the first year due to summer drought and competition with annual plants which germinated after the fall rains. Some shrub seedlings may germinate the second year after fire but usually few new seedlings germinate after the first winter (Biswell 1979).

Post-fire succession can be described in three stages: (1) a high cover of native herbaceous vegetation the first post-fire year with subshrub and shrub seedlings and sprouts, (2) a high mortality of shrub and subshrub seedlings the second post-fire year with decreased native and increased nonnative herbaceous plants, and (3) a growth of the remaining sprouts and seedlings while herbaceous vegetation gradually decreases as the shrubs become larger. After eight to ten years, a relatively mature chaparral cover with little understory has developed (Hanes 1977).

Soils and Water

The effects of burning on soils is directly related to the duration and intensity of the fire as well as on-site soil characteristics. High temperatures, such as those induced by wildfire, can cause significant changes in surface soil properties, particularly organic matter content, water repellancy and microbial populations. Prescribed fires at lower overall intensities can, however minimize these effects.

In chaparral, burning of the surface organic matter causes the formation of a water repellant layer on the soil. The thickness and depth of the water repellant layer depends on the intensity of the fire, the soil water content and the soil texture. If surface temperatures are not not, water repellancy may be near the surface. When the soil is heated to higher temperatures, water repellancy is present in the deeper layers but the surface may be wettable (DeBano et al. 1979).

Only a limited amount of information is available on soil erosion following prescribed burning (DeBano and Conrad 1976). Soil erosion after wildfire appears to be a two-phase process. First, soil loss occurs immediately after fire on chaparral slopes by gravity-activated landslides and dry ravel (mass movement of dry soil downslope). The debris then accumulates in drainages and at the bottom of steep slopes. This soil was previously held in place by the roots of woody vegetation. During rainstorms, this debris is transported downstream (DeBano et al 1979). Since prescribed burns usually result in mosaics of burned and unburned vegetation and are usually of a lower fire intensity than most wildfires, soil erosion is expected to be substantially less.

Water yield may increase on burned chaparral watersheds by reducing evapotranspiration. Water yield can be increased by clearing shrubs and trees, but only when evapotranspiration of shrubs and trees exceeds that of herbaceous cover (Turner 1986).

Wildlife

Vertebrate communities that exist prior to fire in mature to decadent chamise chaparral are low in numbers and species diversity. Important game species such as blacktail deer and valley quail are low in density when compared to those in burned brush areas. Biswell et al. (1952) reported the number of deer in unburned overmature chamise as 10–30 per square mile. On controlled brush management burns, deer density increased to between 40 and 100 per square mile. They also found valley quail populations of less than 40 per square mile pre-burn increased to 250 per square mile after a burn.

In northern California, Longhurst (1978) found some 55 species of birds and 25 species of terrestrial mammals inhabited the chaparral ecosystems with varying degrees of dependence. Responses of individual species to chaparral fire were determined by habitat preferences, movement patterns, reproduction, and food habits. Only two species of mammals and three species of birds were found to be especially adapted to extensive stands of mature chaparral. In contrast, 23 mammals and 50 kinds of birds were better adapted to younger aged stands of chaparral and chaparral interspersed with grassy openings.

Lawrence (1966) points out that no species is totally eliminated following fire. There is an increase in predatory birds and mammals and an increase in the density of seed-eating nesting birds but there is little or no increase in the total number of small mammals. Wirtz (1979) mentions that fire may temporarily eliminate some avian species in post-fire seral stages but most chaparral species can quickly reinvade burned areas. Most reptiles survive burns and their density in either burned or unburned chaparral is probably dependent upon available food supply (Howard et al. 1959).

Post-fire Observations

On each prescribed burn site, a post-fire ocular reconnaisance was conducted and photo plots were established. Post-fire plant species occurrence, relative abundance, and dominance as well as information on wildlife use and soil erosion were collected. Burn sites were evaluated for at least the first two post-fire years and periodically thereafter.

Fourteen burns have been evaluated through 1986. All burn areas are steep hillsides with an average slope of 50 percent. Fire intensities varied from low to high. Two sites were burned during the summer and were last burned 10 and 20 years previously. All other areas were burned in the fall, winter, and early spring and had not been burned for 35 years or more. Six burns were conducted during the warm season and eight were conducted during the cool season.

Vegetation

South slope vegetation on all sites was a variation of chamise chaparral, sometimes mixed with soft chaparral species such as California buckwheat and sometimes mixed with buck brush. North slope vegetation consisted of mixed chaparral containing various shrub species or pine-oak woodland containing Coast live and oak and Digger pine. Brush height gradually becomes shorter as one goes further south or east in the Resource Area, possibly due to climate and/or soils.

Herbaceous species succession generally followed the typical post-fire pattern. Even on cool-season burn sites, fire-following herbaceous species were present.

Chamise, the predominant sprouting species on the burn areas, was most affected by fire intensity and physiology of the plant when burned. High fire intensity and/or burning when chamise was growing or flowering resulted in the highest mortality.

The regeneration of obligate seeders (bigberry manzanita and buck brush) was more difficult to determine. The amount of seed present on each area before the fire was unknown. Some areas had little or no living obligate seeders in the pre-burn stand. Most south-facing burned sites had scattered buck brush seedlings while manzanita seedlings were only found on one burn area.

Buck brush was often found to be concentrated in hot spots-under piles of brush or under killed sprouting shrubs. Perhaps the remains of the dead shrubs provided a better habitat for the seedlings or protected the seedlings. High temperature or charate (chemicals released from fire-charred shrubs) may have enhanced germination in these spots or the hot fire may have caused increased mortality of other seeds, eliminating competition.

Presumably, obligate seeders germinate immediately after fire if moisture is sufficient. Therefore, fall and summer burns should have the best conditions for obligate seeder survival with the wet season still to come. Seeds of nonsprouters germinating after winter fire would need sufficient moisture to become established before the dry season. If moisture is available, obligate seeders would be at a competitive advantage with no nonnative annual species yet on the site. In fact, established buck brush seedlings were found on five cool-season burn sites and manzanita seedlings were found on one cool season burn site. However, burning in the late spring may be detrimental to obligate seeders because soon after they germinate, the dry season begins. Clearly, more research needs to be done on the response of obligate seeders to cool-season burning.

Soils and Water

Erosion pin transects were established on four burns to record soil movement in different locations and under different burn conditions. All locations exhibited some soil movement. Soil movement could be characterized by soil moving onto the site and covering the erosion pin or soil moving off the site and leaving a portion of the pin exposed. This movement varied from 1/16 of an inch (approximately ten tons per acre) to 5/8 of an inch (approximately fifty tons per acre) for both types of movement. It must be emphasized, however, that the soil movement recorded by the erosion pins is representative only of the location of each transect. Slope and fire intensity within the burn areas are too variable to extend this information to entire burn areas.

In general, most burn sites exhibited very few visible signs of soil erosion. Those that showed signs had varying amounts of rill or gully formation on steeper slopes the first post-fire year.

Increased water yield was observed or reported on at least three burn sites. The increased yield was in the form of increased flows in established springs and appearance of new springs.

Wildlife

Use of burn areas by vertebrate wildlife species was observed directly or indirectly (pellet groups or signs of browsing) in all areas. Avian use of burn areas was conspicuous and immediate in all areas. Raptors were often seen flying or soaring in and out of the smoke on prescribed burns in progress. Quail were seen dusting in the ashes on several burns within hours or days after the burn. Above-average breeding bird diversity was noted during 1986 field observations within the wildlife habitat improvement burn areas. These observations correlate with the increased habitat diversity and amount of edge in these areas.

No direct mortality was observed in any of the burn areas. This contrasts with personal observations on several high intensity wildfires in which one deer and a variety of small mammals suffered direct mortality from the fire.

Deer harvest information has been recorded on two of the study areas. Deer kill increased approximately 160 percent in one area and 320 percent in the other between 1980 and 1985. Changes in deer kill were variable from year to year but, in general, deer kill increased and has held steady for several years after burning.

Harvest data have been used to give overall estimates of deer populations. Smith (1976) estimated that reported deer kill represented approximately five percent of the total population. It can be assumed that the harvest data represent some increase in deer numbers within the burn areas. This increase is probably due to a combination of increased production, increased recruitment from adjacent unburned areas, and increased hunter success (there has also been a corresponding increase in the number of hunter days within each area).

Conclusion

Since 1979, more than 20,000 acres of chaparral have been burned on public lands administered by the Bureau of Land Management in central California. The per acre cost of these burns has ranged from two or three dollars per acre for large, winter hazard reduction burns to about 47 dollars per acre for some wildlife habitat improvement burns requiring mechanical pretreatment.

Since chaparral vegetation has been recognized as requiring fire to rejuvenate itself, fire should function as a natural force in order to perpetuate these communities. Currently, prescribed burning is necessary to reduce hazardous fuel levels to prevent catastrophic wildfires and decrease erosion. Opening up dense brush fields also improves wildlife habitat and increases livestock forage.

Most chaparral areas should be managed to promote species diversity and regeneration of sprouters and obligate seeders in coordination with management goals. Since the season of the burn and intensity of fire affects plant species response, burns can be timed to maximize the desired response.

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