Post-fire Monitoring of Coast Live Oaks (*Quercus agrifolia*) Burned in the 1993 Old Topanga Fire[1]

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Abstract

The intensity of the 1993 Old Topanga Fire raised many concerns about the recovery and response of the coast live oak trees (*Quercus agrifolia*) and their understory vegetation. Preliminary information on the status of the trees 6 months post-fire has been previously reported. This report provides follow up assessment of the condition of the 90 trees in the original study and assesses the recovery of their understory vegetation over the 8 years since the burn. This long-term study documenting the recovery of coast live oak communities in three different locations (open riparian, ridgeline and valley riparian) illustrates the recovery potential under various conditions and burn frequency histories.

Introduction

In November 1993, the Old Topanga Fire, Los Angeles County, California burned fast and furiously for 3 days under Santa Ana wind conditions, leaving behind acres of scorched hillsides and great concern about the survival rates of the affected coast live oak (*Quercus agrifolia*) trees. Initiated in January 1994, this study followed the recovery of both the oaks and their understory vegetation over time. Preliminary results were reported in Keeley and Scott (1995).

Three locations were selected for monitoring, each representing a subset of the terrain covered by oaks in the burned area. Thirty trees in Red Rock Canyon (valley riparian), Tuna Canyon (ridgeline) and Cold Creek Valley Preserve (open riparian), respectively, were selected and mapped. Selection of groves was random, based primarily on accessibility. All 90 trees experienced approximately equally high fire intensity based on the presence of white ash residue at all sites, in some places inches thick.

Summary of Site Characteristics and Fire History

Red Rock Canyon

The stream bed of this relatively steep, narrow, northeast trending canyon follows the 335 m contour as it cuts through beds of Sespe sandstones and conglomerates. Last burned in the November 1943 Woodland Hills Fire, the mature

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stand of riparian oaks and sycamores was surrounded by northern mixed chaparral and grasslands with a closed canopy of up to 6 m. Dead material in the surrounding chaparral was estimated to have exceeded 50 percent (Pierpont 1994).

The oak trees line the banks of the intermittent streambed. Eleven oaks were totally burned, leaving nothing standing but charred trunks and scaffold branches. No green leaves remained on any of the trees, although some trunks were less charred.

Tuna Canyon (Bel-Mar Property)

Located on an exposed sandstone ridgeline at an elevation of 425 m, this cluster of oaks bisects the fire road and has a history of frequent fires. Part of a prescribed burn in 1988, the site was previously affected by wildfires in 1938, 1942 and 1970. The oak trees form a mature grove surrounded by annual grasses, disturbed soils and slopes covered with mixed coastal sage and chaparral. The crush and burn technique used in the prescribed burn lessened the fuel load in the area surrounding the study site, so accumulated dead material was not as abundant as that in the other two sites.

These trees received the least amount of canopy damage, but 5 oaks on the edge of the fire road, including one sapling, were completely burned. Most of the trees retained some green leaves among the crisped burned leaves.

Cold Creek Valley Preserve

The more open northeast trending riparian corridor lies at approximately the 335 m contour. The sandstone/alluvial/clay based soils support a mixed riparian community surrounded by meadows of native chaparral and introduced annuals. Last burned in the 1943 Woodland Hills Fire, the accumulation of dead chaparral material surrounding the grove was significant.

Due to the closed canopy condition at this site, there was less understory vegetation. The trees are located immediately adjacent to a perennial stream. A total of five oaks were totally burned, while the canopies of the other trees retained some green leaves amid those that burned.

Methodology

Tree conditions were observed one week following the burn in November 1993, January and April 1994, June 1996, June 1998, and June 2001. Vigor and health condition ratings were based on a system modified from the International Society of Arboriculture standard condition evaluation for landscape trees, which includes evaluation of canopy (percent cover), foliage (burned, crisped, new flush, etc.), trunk (diameter at breast height, amount bark burned, scarring, etc.), root crown condition, and overall vigor. Tree vigor was rated as dead (1) to excellent health (5). Additional notes were made concerning composition of understory vegetation, including species present and percent cover of native vs. non-native species within the driplines. Density of understory vegetation was estimated by visual review of each quadrant within the area under the canopy dripline and extending approximately 5 feet outside the edge. Trees were classed by size (range from <25 cm to >125 cm diameter at breast height). Photographs were taken from specified locations to document conditions. *(fig. 1)*

1994 Red Rock Canyon 2001

1994 Tuna Canyon 2001

1994 Cold Creek Valley Preserve 2001

Figure 1—Photographs of burned coast live oaks in 1994 and 2001.

Results

Since initial observations were documented in January 1994, overall tree survival remains high. Of the 21 oaks severely burned in 1993, only 4 have died. All of the others have recovered. Overall survival of oaks that were severely burned at these three sites is 96 percent. Proximity to the fire front is the only common variable among dead trees.

Trunk diameter growth at the three sites is also quite remarkable, given the extent of initial canopy loss. *Table 1* summarizes the change in size class at each location. Many of the single trunk and multi-trunk trees showed consistent increase in diameter, with few remaining in the same size class since the fire. The majority of trees at all sites had recovered around 80 percent of their lost canopy by June 2001. Canopy recovery was lowest at Red Rock, where temperatures are typically colder and sunlight exposure is limited by the steep canyon walls. Canopy structure was notably normal, with predominately terminal bud flushing growth and limited epicormic sprouting. Immediately post-fire, canopy structure was more dominated by epicormic sprouting, with less terminal bud growth. Basal sprouting was minimal at all locations.

Table 1—*Size distribution of surviving oaks.*[1]

	DBH class (cm)								
Site	<25	25-50	51-75	>75	25-50	51-75	76-100	101-125	>125
1994									
Red Rock	2	11	3	1	1	2	4	3	3
Tuna Canyon	6	11	2	0	0	3	2	2	3
Cold Creek	3	1	8	2	2	1	3	2	8
Total # trees	11	23	13	3	3	6	9	7	14
2001									
Red Rock	3	7	5	1	1	1	2	4	4
Tuna Canyon	3	11	2	4	2	2	3	2	2
Cold Creek	2	3	3	5	1	0	1	4	9
Total # trees	8	21	10	10	4	3	6	10	15

[1] Some trees had multiple stems. Values listed are sums for all stems.

Using the International Society of Arboriculture (ISA) evaluation of tree condition, the vigor of the burned oaks was assessed in 1996 and again in 2001. Overall, tree condition appears to have continued improving. Few trees have declined or even remained the same *(table 2)*. (Vigor rating scale: 1=dead, 2=declining, 3=stable, 4=good, 5=excellent).

Table 2—*Average vigor of surviving oaks.*[1]

	DBH class (cm)								
Site	<25	25-50	51-75	>75	25-50	51-75	76-100	101-125	>125
1996									
Red Rock	3.5	2.5	3	4	3	3	3	3	3
Tuna Canyon	3.5	3	4	0	4	3.5	3	3	3
Cold Creek	3	3	4	3	3	2	3	3	3.5
2001									
Red Rock	4	4	3.5	4.5	5	3	3.5	3.5	4.5
Tuna Canyon	4.5	4	4.5	0	4.5	4	4	4	4
Cold Creek	3	4	4	4	4	0	3	4.5	4.5

[1] Values are based on a rating scale of 1-5, where 1=dead and 5=excellent.

Understory vegetation has remained consistent since the initial post-fire flush. During the spring of 1994, numerous “fire following” annuals sprouted along with most native species. Species like fire hearts (*Dicentra ochraleuca*), yellow fire hearts (*Dicentra chrysantha*), fire poppy *(Papaver californicum*), wind poppy (*Stylomecon heterophylla*), and large-flowered *Phacelia* (*Phacelia grandiflora*) were only seen the first spring after the fire. Over time, the “fire followers” disappeared and were replaced by more aggressive native and non-native species.

Displacement of natives by invasive exotics has occurred, primarily along the perimeter of the groves. Invasive exotics are most prevalent in Red Rock, where there is a high degree of disturbance from a trail and fire road immediately adjacent to the trees. Invasives are also quite dominant around the perimeter of the grove at Tuna Canyon, also related to high disturbance levels. The less disturbed and more closed canopy found at Cold Creek is not conducive to invasive annuals, and the dominant vegetation in the understory remains native. The most aggressive invasives are grasses (*Avena fatua, Bromus* sp., *Cynodon dactylon*, *Festuca* sp., *Hordeum murinum,* etc.) and mustard (*Brassica nigra*), followed by a variety of thistles (*Centaurea melitensis, Salsola iberica*, etc.).

The most dominant native understory plants included snowberry (*Symphoricarpos mollis*), clarkia (*Clarkia deflexa*, *C. unguiculata*), giant ryegrass (*Elymus condensatus, E. glaucus*), poison oak (*Toxicodendron diversilobum*), phacelias *(Phacelia* sp.), buckwheats (*Eriogonum* sp.), sagebrush (*Artemesia californica*), mugwort (*Artemesia douglasiana*), canyon sunflower (*Venegazia carpesioides*), and sages (*Salvia* sp.). Numerous oak seedlings were found in the understory, although few exceeded 10 cm in height. Seedling density at Cold Creek was particularly high, although recruitment of saplings (greater than 10 cm tall) has been low in general, and confined to the edges of groves where there is more light. *Table 3* summarizes the differences in understory composition between the sites. All of these sites were excluded from post-fire aerial seeding with annual ryegrass.

Table 3—*Comparison of native vs. non-native understory coverage, 2001.*

Site	Avg. pct. cover native	Avg. pct. cover non-native
Red Rock	62	38
Tuna Canyon	60	40
Cold Creek	86	14

Discussion

Post-fire survival of coast live oaks is enhanced by their thick bark and ability to regenerate lost canopy quickly following a burn (Plumb 1980). Basal sprouting was minimal (only one tree), which contrasts with results found by Pavlik (1991) and Paysen (1993). They both noted significant basal sprouting following topkill of smaller saplings and mature trees, as well as increased mortality in seedlings under 15 cm tall. Tietje and others (2001) found that topkilled coast live oak saplings consistently exhibited basal resprouting following damage in a prescribed burn. Basal sprouting was uncommon at our sites, with only one topkilled sapling responding with basal sprouts.

The majority of the oaks in the study had recovered over 80 percent canopy density within 2 years of the fire. Sprouting initially occurred both epicormically from scaffold branches and trunks, and also in a more standard pattern from terminal buds. As the years passed and the canopy spread, terminal branching took over, reducing the number of epicormic sprouts remaining. In some cases, the epicormic sprouts grew into stout branches, replacing burned scaffold branches that had fallen from the tree.

As the canopy regenerated, diameter of the trunks increased. The majority of the trees have grown substantially since the fire. Nutrient availability increases following a high intensity burn (Boerner 1988). This surge of nutrients not only supports the recovery of the trees, but also the peak of understory species richness immediately post fire. Numerous native "fire following" species were noted in the spring of 1994, followed by a decline in number of native species over the years as non-natives re-colonized. In spring 2001, species diversity is still fairly high, but reflects a higher number of invasive exotics replacing the native fire-followers. Invasive exotics were able to exploit the post-fire vegetation disturbance, resulting in higher percent cover along the perimeter of groves, especially when adjacent to continually disturbed trails and fire roads. Within the center of the oak groves, native plants are dominant.

The alteration of fire frequencies due to suppression policies over the past 100 years are considered to be responsible for the shift of landscape-level mosaics of plant communities (Callaway 1993). Low-intensity fires were a standard management tool of many California Native Americans, selecting for and encouraging growth of plants and animals needed for food, shelter and clothing. Changes in fire suppression and brush clearance policy over time has significantly altered the fuel loads, especially in chaparral–oak woodland mosaics along the urban-wildland interface (Franklin 1995).

Keeley and others (1999) compared the burn frequency and fire size in chaparral communities since 1910, finding that intervals between burns is related more to ignition sources and weather factors than to age or accumulation of fuels. Thus, Santa Ana wind conditions increase the possibility of crown fires regardless of the age of surrounding chaparral fuels, and are significantly more damaging to the trees than a cooler, non-wind driven understory burn. In the Santa Ana driven 1993 Old Topanga Fire, crown fires did occur at the Red Rock and Cold Creek sites, both of which also had 50 years of accumulated dead fuels in the surrounding chaparral and understory communities. Charred skeletons were all that remained of several trees in each location. Due to a prescribed burn following brush crushing at the Tuna Canyon site, overall fuel loads were reduced adjacent to the trees. Even though the flame lengths were significantly greater as the fire rushed up the slope, fewer trees were completely burned and canopy damage was less immediately following the fire. This finding appears consistent with the recommendation of Keeley and others (1999) to focus intensive management at strategic locations along the urban-wildland interface, rather than attempt large scale fuel modification. This strategy would limit the extent of ecological disturbance conducive to the spread of invasive exotics, while still providing necessary protection to structures and significant oak stands located at the interface zone.

Summary

Post-fire recovery of coast live oaks burned in the 1993 Old Topanga Fire was excellent, with 96 percent of the trees surviving after 8 years, most with over 80 percent canopy cover. The age of the surrounding chaparral vegetation influenced the extent of crown fires, but not overall tree survival. Canopy recovery initially was dominated by epicormic sprouts from the scaffold branches, giving way over time to a more normal pattern of terminal bud growth. Fear of excessive tree mortality due to high understory fuel loads was unfounded. Tree mortality was related more to location in relation to fire intensity and flame length, than to size. Basal sprouting was minimal, with canopy recovery generated instead from charred scaffold branches and terminal buds. Immediate post-fire understory diversity was high due to the appearance of "fire following" annuals. Percent cover of natives is higher than non-natives at all sites, but due to the invasion of exotic weeds, species diversity remains higher in the more disturbed locations along the edges of groves than in the native dominated understory of the closed oak canopy. Oaks thus demonstrated once again their ability to withstand the assault of wind driven wildfires.

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