Fire Severity and Vegetation Age Class Effects on Post-fire Chaparral Seed Banks

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ABSTRACT

The Santa Ana wind-driven Esperanza fire burned through the North Mountain Experimental Area (NMEA) and vicinity in 2006, including all or parts of 10 previous fires. Images of the fire's progression were taken using Riverside Fire Lab's airborne FireMapper thermal-imaging system, providing an instantaneous estimate fire front temperature and intensity. These images, combined with historic aerial photos, fire occurrence maps, existing fuels and resource data, and post-fire imagery, provided an opportunity to investigate relationships between chaparral age class, fire severity, and vegetation response. Points within the fire perimeter were selected in a stratified-random manner across image fire intensity classes. Fire severity was categorized on the ground at each point based on fuel consumption and stump basal diameter. Soil seed bank samples were collected at 15 locations from around each point at two depths (0-2.5 and 2.5-5 cm) to characterize plant community regeneration potential. Soil samples were spread on sterile potting medium in flats and germinated in an unheated greenhouse during winter-early summer 2008. Prefire vegetation age ranged from 3 to over 130 years since the last fire, with most samples collected from sites that burned 30 years or more previously. More than 80 taxa germinated from the samples, mostly native species typically found after fire in chaparral ecosystems. Seedling numbers ranged from 13 to over 1,000 produced from each 0.27 m^2 area sample. Non-native grass seedlings (mainly red brome, *Bromus rubens* ssp. *madritensis*; cheatgrass, *B. tectorum*; and foxtail fescue, *Vulpia myuros*) emerged most often in younger samples, but some were found in the oldest samples as well. Despite the presence within the NMEA of long-term fuel breaks, which were dominated by non-native grasses and burned lightly if at all during the Esperanza fire, few seed bank samples contained substantial numbers of non-native seeds. Samples were dominated by herbaceous fire followers such as *Phacelia brachyloba* and *Camissonia* species. Seeds of the dominant shrub, chamise, germinated from most age classes.

Fig. 1 – Burned patch against backdrop of unburned area, NMEA.

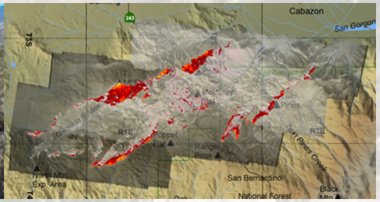

Fig. 2 – FireMapper image of Esperanza fire actively burning areas.

BACKGROUND

The Santa Ana wind-driven Esperanza fire of 2006 burned 16,137 ha of the North Mountain Experimental Area (NMEA) and adjoining lands in the San Jacinto Mountain foothills, CA, including areas burned in 10 previous fires. Some areas within the mapped fire perimeter were skipped by the fire or lightly burned (Fig. 1), despite fierce winds on the day the fire started. Multiple images of the fire's progression were taken using the Forest Service's airborne FireMapper thermal-imaging system (Fig. 2). Existing fuels data and historic NMEA maps plus the new fire images provided a unique opportunity to investigate relationships between vegetation history and fire behavior and severity to address the vegetation patch mosaic debate that rages among southern California fire ecologists (Keeley and Fotheringham 2001, Minnich 2001, Moritz et al. 2004). In this part of the study, we investigated whether soil seed banks differed among different stand ages and burn severities.

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HYPOTHESES

- Older stands (>50 years) burned more intensely, resulting in lower seed densities compared to young and mid-aged stands.
- Young stands (<=10 years) contain more seeds of non-native herbaceous species and fewer native shrub seeds.

Fig. 3 – Collecting seed bank soil samples.

Fig. 4 – Germination flats in greenhouse.

FIELD METHODS

- High resolution thermal imagery of active fire behavior collected by aircraft-based FireMapper® on 6 percent of total burned area (Fig. 2).
- Post-processing of image files classified pixels into 19 classes corresponding to ground surface temperatures.
- Classes grouped into low, moderate, and high fire intensity.
- Ninety points randomly selected, distributed among image-based intensity classes, for ground-truthing of fire intensity/severity.
- Additional 60 points outside image areas also had fire severity evaluated.
- Pre-fire vegetation age determined from historic fire maps.
- Soil samples collected 8-10 months after the fire at 65 of planned fire severity points for seed bank determination (Fig. 3).
- Fifteen samples collected around each point, using 7.6 cm diameter tube, at 0-2.5 and 2.5-5 cm depths; samples combined for each depth at each point (=0.27 m^2).

GREENHOUSE METHODS

- Soil samples spread over sterile potting soil in flats in unheated greenhouse (cooled to 24 C during day) (Fig. 4).
- Germinating seedlings identified, counted, and pulled.
- Unknowns numbered and samples grown out for identification during flowering.
- Germinations counted for 6.5 months (February—mid-July 2008).

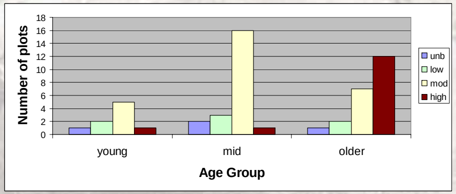
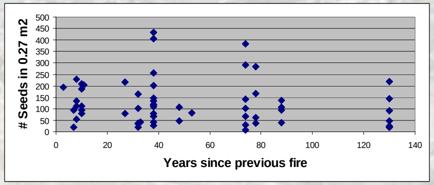


Fig. 5 – Number of plots in each age group classified as unburned, low, moderate, or high burn severity from which seed bank samples were collected. Young=10 yrs or less since previous fire; Older=50 years or greater. Fire severity was not recorded in 8 plots. A greater proportion of older plots experienced high burn severity.

RESULTS

Aerially-derived fire intensity class did not correlate well with ground characterizations of fire severity (Weise and Riggan 2007). All references to fire severity hereafter are based on ground measurements (used in Figs. 5, 7).

Fig. 6 – Number of seeds at 0-2.5 cm depth in 0.27 m^2 sample by pre-fire stand age. Number of seeds was not significantly correlated with stand age (R^2=0.02, p=0.32). Results for 2.5-5 cm depth were similar. The oldest stands had been fire-free for at least 130 years (limit of record).



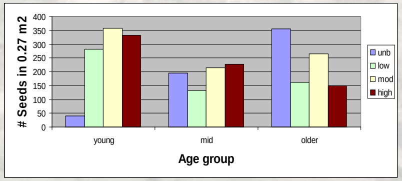


Fig. 7 – Mean number of seedlings germinated by age group and fire severity (soil depths combined). Older and mid-age samples tended to have fewer germinants than young-age samples, but variability was extremely high: 13 (older-high) to over 1,000 (young-moderate) seedlings per sample.

Table 1 – Major invasive non-native species found in soil samples. The predominant non-native annuals found in our area occurred in less than half of the soil samples: 69% of plots from young stands, 42% of mid-age, and 30% of older stands. All of the mid and older age plots with exotics were located near roads or fuel breaks. Densities were low.

Major Non-native Species	# plots
Bromus madritensis ssp. *rubens*	18
Bromus tectorum	9
Hirschfeldia incana	8
Erodium cicutarium	9
Erodium moschatum	6
Vulpia myuros	17

Chamise	Young	Mid	Older
Mean±stdv	9.6±8.6	2.8±2.4	14.3±19.4
n	7	10	13
% of plots	53.8	41.7	56.5

Table 2 – Number of chamise (*Adenostoma fasciculata*) seedlings per 0.27 m^2 sample by age class. Chamise was the dominant pre-fire shrub on most plots. All the young plots with seedlings were at least 8 years since last fire.

Discussion and Management Implications

Our samples were collected after first post-fire year growth had started; thus, the seedlings we counted could have been from seeds remaining from the pre-fire seed bank OR the result of post-fire reproduction. However, the first winter post-fire was extremely dry, and very low cover was produced (Fig. 3). Still, fire-followers such as *Phacelia brachyloba* were plentiful the first year after fire and in the seed bank samples we collected (58/65 plots). Contrary to our hypothesis, seed bank density was not significantly lower in stands of older age pre-fire. As predicted, non-native annuals occurred more often in samples from young vegetation (<=10 years since previous fire), but even older-age samples from near disturbed areas contained invasive seeds. Obligate-seeder shrub species were absent from all our samples – either all seeds available had already germinated, or conditions in the greenhouse were not appropriate. The vast majority of seedlings produced from our samples were native herbs, suggesting that burned chaparral of all ages has the potential to produce substantial first-year herbaceous cover after fire given adequate rainfall.

References Cited

Keeley, J.E., and C.J. Fotheringham. 2001. Historic fire regime in southern California. Conservation Biology 15: 1536-1548.

Minnich, R.A. 2001. An integrated model of two fire regimes. Conservation Biology 15: 1549-1553.

Moritz, M.A, J.E Keeley, E.A Johnson, and A.A Schaffner. 2004. Testing a basic assumption of shrubland fire management: How important is fuel age? Frontiers in Ecology and Environment 2: 67-72.

Weise, D.R., and P.J. Riggan. 2007. Correlation between remotely sensed fire intensity and fuel consumption in California chaparral – a case study. Poster presentation P1.5. 7th Symposium on Fire and Forest Meteorology, Oct. 22-25, 2007, Bar Harbor, Maine. http://ams.confex.com/ams/pdfpapers/126871.pdf