FIRE EFFECTS ON SEED BANKS AND VEGETATION IN THE EASTERN MOJAVE DESERT: IMPLICATIONS FOR POST-FIRE MANAGEMENT

Matthew L. Brooks
Julie V. Draper
U.S. Geological Survey
Western Ecological Research Center
Las Vegas Field Station
Henderson, NV USA

INTRODUCTION

Limited information is currently available on the short-term effects of fire on soil seed banks and vegetation in the Mojave Desert. This information is critical for determining if postfire seedings are potentially beneficial, or even necessary, in this ecosystem. Of all the management tools, aerial seeding is potentially the most cost-effective over large areas because it requires the least amount of lead time. There are clearly many questions associated with this technology, but the more immediate question is whether seeding treatments are necessary in the first place. This question hinges on understanding the short-term effects of fire on the abundance and species composition of soil seed banks and germinated plants immediately following the 70,736 acre Hackberry Fire Complex which occurred at the Mojave National Preserve in the eastern Mojave Desert during late June 2005. Support for this project was provided by the Joint Fire Science Program (project #06-1-2-02).

METHODS

Six sites in the Hackberry Fire Complex were used as replicate sampling blocks, each containing one burned and one unburned experimental unit with 5 non-overlapping sampling units randomly established inside each. This randomized blocks study design consists of 6 blocks X 2 fire treatments X 5 sampling units = 60 total sampling plots. Sampling plots were set up in October 2005 and consisted of a 5 x 30m FMH brush belt transect (USDI National Park Service 2003), overlaid with a 20 x 50m modified Whittaker plot (Stohlgren et al. 1995). Burn severity measurements were collected on the brush belt transects, following FMH protocols (USDI National Park Service 2003). Four 6cm diameter x 3cm deep (volume = 85cm^3) soil samples were collected at each corner of the brush belt transect for determination of seed bank density and species richness and composited into a single soil sample. A ½ cup (111cm^3) portion was grown in a greenhouse during winter 2005-06 following methods adapted from Brenchley and Warington (1939) and modified by Young and Evans (1975). Seed bank density and species richness were measured by counting the number of germinated seedlings for each species.

Above-ground density, cover, and species richness of herbaceous and woody plants were measured during the phenological peak for annual plants in April and early May, 2006, following National Park Service FMH protocols (USDI National Park Service 2003). Spatially nested modified-Whittaker plots were used to measure plant species richness at 1, 10, 100, and 1,000m^2 scales. We focus specifically on the results of the seed bank and herbaceous plant sampling.

Data was analyzed as a randomized blocks analysis of variance (ANOVA) statistical model. The predictor variable was fire (burned, unburned). The response variables included seed bank density by groups of plants (non-native, native), above-ground vegetation density by groups, and species diversity of the seed bank and above-ground vegetation. The data was log transformed since it was not normally distributed and analyzed with SAS Proc GLIMMIX.

RESULTS AND DISCUSSION

Seed banks

Total seed bank density was significantly lower in burned (2,494 seeds/m^2) than unburned (12,460 seeds/m^2) areas ($P<0.0001$)(Fig. 1). This translates into a seed bank depletion (mortality) rate of 80%. Recent aerial seedings of postfire landscapes in the Mojave Desert have ranged from 140 seeds/m^2 (13 seeds/ft^2)(Christiana Lund, BLM, pers. comm.) to 646 seeds/m^2 (60 seeds/ft^2) (Karen Prentice, BLM, pers. comm.), and postfire drill seedings are typically applied at a rate of 323 seeds/m^2 (30 seeds/ft^2)(Karen Prentice pers. comm.). If these seeding rates were applied after the Hackberry Fire Complex, they would have only reduced the depletion rate of the seed bank to 79% if 140 seeds/m^2 were added, or 75% if 646 seeds/m^2 were added. To completely ameliorate seed bank depletion rates (to a 0% net loss), 9,966 seeds/m^2 (926 seeds/ft^2) would have to have been added, an increase of 1,543% over the highest aerial seeding rates typically used.

Non-native seed densities (dominated by *Erodium cicutarium*) were significantly lower in burned (345 seeds/m^2) than unburned (5,667 seeds/m^2) areas ($P<0.0001$)(Fig. 1) (94% depletion rate). Native seed densities were also significantly lower in burned (2,012 seeds/m^2) than unburned (6,701 seeds/m^2) areas ($P=0.0020$)(70% depletion rate). Seed bank species richness per 483cm^2 soil sample was significantly lower where burned (3 species) than unburned (6 species) ($P<0.0001$).

Above-ground herbaceous plants

Total herbaceous plant density was significantly lower in burned (107 plants/m^2) than unburned (329 plants/m^2) areas ($P<0.0001$)(Fig. 2). Non-native density was lower in burned (62 plants/m^2) than unburned (156 plants/m^2) areas ($P<0.0001$). Similarly, native density was lower where burned (45 plants/m^2) than unburned (174 plants/m^2) ($P<0.0001$). Thus, plant densities were reduced 67% during the first postfire spring, and these reductions were similar for native and non-native species. Species richness of herbaceous plants was also significantly lower in burned than unburned areas at 1m^2 (7 species vs. 10 species), 10m^2 (14 vs. 16), 100m^2 (27 vs. 30), and 1,000m^2 (40 vs. 45) spatial scales.

SUMMARY AND CONCLUSIONS

These first year results indicate that the Hackberry Fire Complex of June 2005 had the immediate effects of reducing soil seed bank and herbaceous plant density and diversity during the first postfire fall (October 2005) and spring (April-May 2006) respectively. Typical postfire seeding rates for the Mojave Desert would not have resulted in appreciable increases in seed bank densities if they had been applied after this fire, although our data do not allow us to that these differences would have not have been ecologically significant. The broader implications of these results will be better known after we evaluate results from postfire years 2 and 3.

LITERATURE CITED

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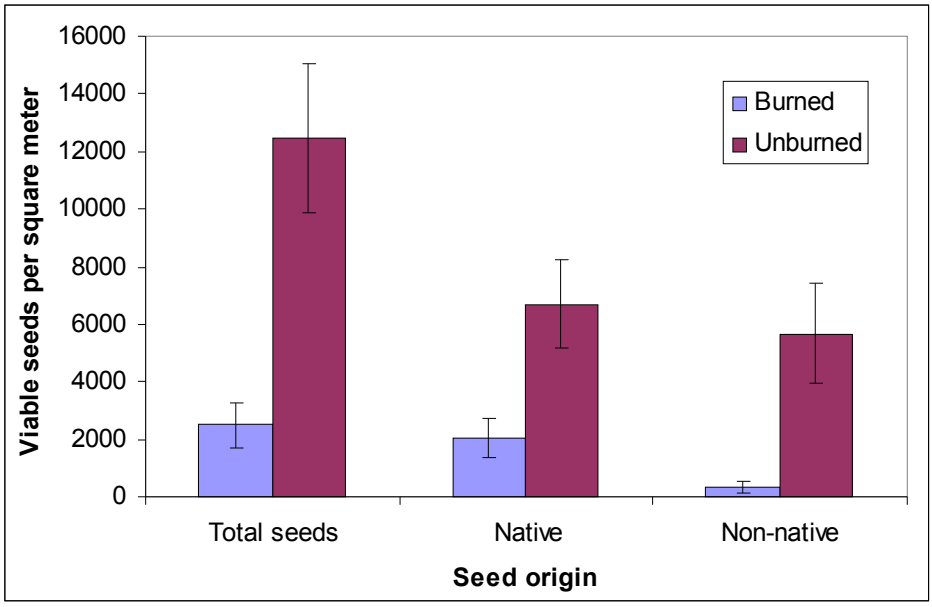

Fig. 1. Density of viable seeds in the seed bank during October 2005 following the June 2005 Hackberry Fire Complex (+/-1 SE, n=6).

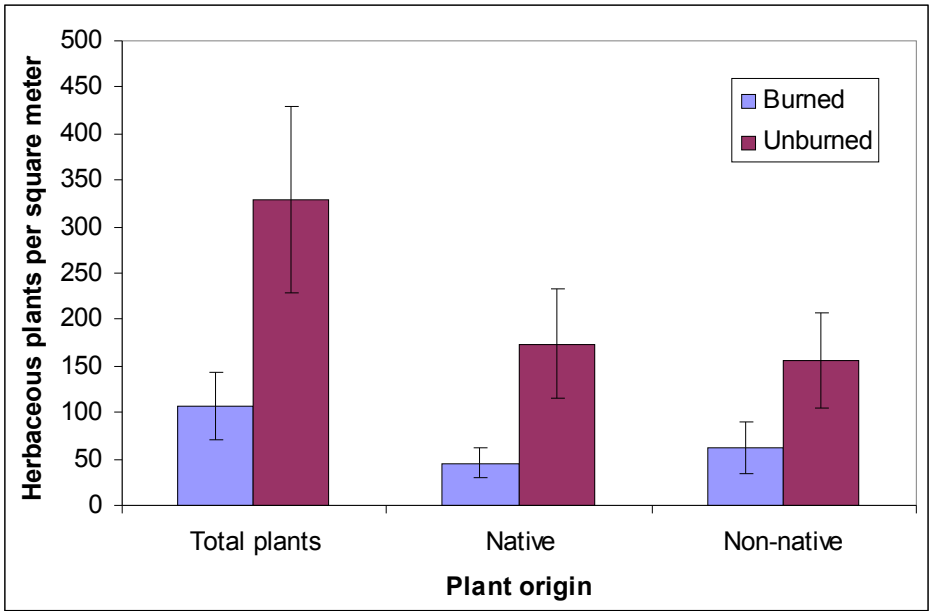

Fig. 2. Herbaceous plant density during April-May 2006 following the June 2005 Hackberry Fire Complex (+/-1SE, n=6).