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Topographic Context of the Burn Edge Influences Postfire Recruitment of Arid Land Shrubs☆

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ABSTRACT

Although fire is becoming frequent in arid lands throughout the world, little is known about the recruitment pattern of many arid land shrub species after fire. We explored topographic and edaphic correlates of postfire recruitment for four shrub species 6 years following wildfire in central Nevada, United States. We hypothesized that the spatial pattern of shrub recruitment varies with fire-related species traits according to the topographic position of the burn edge, which correlated with postfire seed sources. Where the burn edge fell on a ridge, the frequency of the colonizing shrub, *Artemisia tridentata* ssp. *vaseyana,* decreased with distance from the burn edge, whereas the frequency of facultative resprouting species was independent or increased with distance. Where the burn edge fell behind a ridge, there were fewer shrubs overall and a greater proportion of resprouting species. Most individuals of resprouting species were adults, suggesting immediate, fire-stimulated recruitment. Interactions among topographic position and distance from the burn edge influence the recruitment patterns of shrub species and have implications for the postfire species assemblage that are predictable on the basis of fire-related plant traits. We demonstrate how the topographic position of the burn edge influences postfire recovery trajectories of the shrub community.

Changes in climate and anthropogenic disturbances have resulted in the alteration of many fire regimes (Brooks et al., 2004; Pausas, 2004). Understanding how vegetation responds to changing fire regimes is important for predicting the distribution of ecosystems (Pausas, 1999). Due to overgrazing, plant invasion, and other pressures resulting in an altered fire regime, the sagebrush steppe of the Great Basin of the United States has become one of the most threatened ecosystems in North America (Noss et al., 1995). Many species of conservation concern depend on a resilient and unfragmented sagebrush ecosystem, including the Greater Sage-Grouse, a sagebrush-obligate bird species that is threatened as a result of habitat loss (Wisdom et al., 2011). An improved understanding of the various influences on the rate and trajectory of sagebrush ecosystem recovery from fire is critical for guiding landscape-level restoration efforts (Chambers et al., 2014).

Adaptations of shrub species to fire regimes are well studied for fire-prone environments (Keeley et al., 2011). Obligate seeding species escape fire with seed burial, and colonizers reestablish into burned areas via wind-borne seeds (Keeley and Zedler, 1978; Ooi et al., 2007). Resprouters regrow from belowground organs following fire (James, 1984). Fire can lead to greater relative cover of resprouting species versus seeding species, as observed in Australia (Clarke, 2002), South America (Galíndez et al., 2009), southern California (Keeley and Zedler, 1978), and Spain (Ojeda et al., 1996). However, fires that result in patches of seed-producing individuals may favor the dominance of colonizing species, which are capable of more rapid growth than resprouting species that must allocate more resources into storage organs (Pausas et al., 2004).

In less fire-prone environments such as pinyon-juniper woodlands and sagebrush steppe, we have a more limited understanding of how native shrub species respond to fire. Functional traits related to postfire survival and establishment provide a framework for exploring this question. We examined the spatial patterns of establishment for four common Great Basin shrub species of varying fire-related responses in central Nevada, United States. Species were classified into functional groups on the basis of resprouting capability and propagule persistence (Pausas et al., 2004). This division resulted in four fire-related functional groups: facultative resprouters, which resprout and survive via seed; obligate resprouters, which resprout but do not survive via seed; obligate seeders, which do not resprout but persist via seed; and colonizers, which do not persist following fire and must arrive onsite from neighboring populations. We hypothesized that proximity to seed source,

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topography, and fire-related functional traits interact to influence the spatial patterns of postfire shrub establishment. Shrubs outside the burn edge provide a seed source, suggesting that the frequency of colonizer shrubs decreases with increasing distance from the burn edge. We predicted that this decrease will be most apparent where the burn edge fell on the ridge, because the ridge itself can effectively block seed dispersal where the burn extends beyond the ridge. Resprouting species were predicted to show no effect of distance from the burn edge as

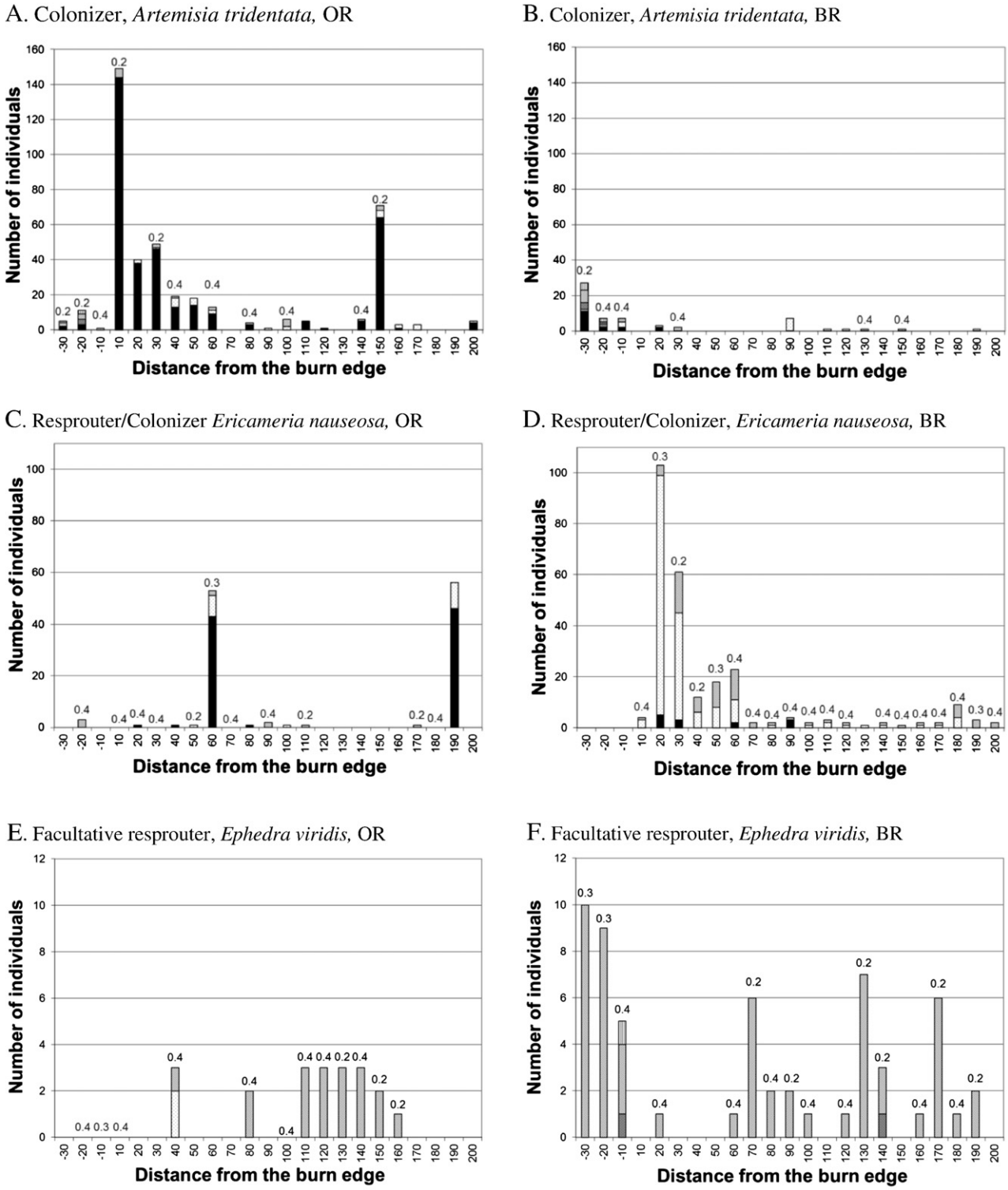

Fig. 1. Stacked bar graphs of total abundance of shrubs by life stage: ■ seedling, □ juvenile, ▩ dead, ▧ adult mature, ▯ adult decadent. Plots where the burn edge was behind the ridge **are** denoted as BR. Plots where the burn edge was on the ridge **are** denoted as OR. Distance from the burn edge is in meters. Abundance of the colonizer species, *A. tridentata* ssp. *vaseyana* on **A,** OR plots and **B,** BR plots. Abundance of resprouter/colonizer *E. nauseosa* on **C,** OR plots and **D,** BR plots. Abundance of facultative resprouter, *E. viridis* on **E,** OR plots and **F,** BR plots. Abundance of facultative resprouter, *P. tridentata* on **G,** OR plots and **H,** BR plots. Seedlings are defined as <5 cm in height. Juvenile shrubs are <15 cm in height. Dead shrubs show no sign of live tissue. Adult mature shrubs have >50% dead tissue and adult mature shrubs have <50% dead tissue. Numbers above the bars indicate the standard error in the number of adult mature individuals of that species by transect, when greater than zero.