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Source: Rangeland Ecology & Management, 67(3):285-291. 2014.
Published By: Society for Range Management
DOI: http://dx.doi.org/10.2111/REM-D-12-00147.1
URL: http://www.bioone.org/doi/full/10.2111/REM-D-12-00147.1

Rangeland Ecol Manage 67:285–291 | May 2014 | DOI: 10.2111/REM-D-12-00147.1

Impact of Cultivation Legacies on Rehabilitation Seedings and Native Species Re-Establishment in Great Basin Shrublands

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Abstract

Little is known about how cultivation legacies affect the outcome of rehabilitation seedings in the Great Basin, even though both frequently co-occur on the same lands. Similarly, there is little known about how these legacies affect native species re-establishment into these seedings. We examined these legacy effects by comparing areas historically cultivated and seeded to adjacent areas that were seeded but never cultivated, for density of seeded crested wheatgrass (*Agropyron cristatum* [L.] Gaertn.) and native perennial grasses, vegetation cover, and ground cover. At half of the sites, historically cultivated areas had lower crested wheatgrass density ($P < 0.05$), and only one site had a higher density of crested wheatgrass ($P < 0.05$). Likewise, the native shrub Wyoming big sagebrush (*Artemisia tridentata* Nutt. subsp. *wyomingensis* Beetle & Young) had lower cover ($P < 0.05$) in historically cultivated areas at half the sites. Sandberg bluegrass (*Poa secunda* J. Presl.) density was consistently lower in historically cultivated areas relative to those seeded-only. At sites where black greasewood (*Sarcobatus vermiculatus* [Hook.] Torr.) and bottlebrush squirreltail (*Elymus elymoides* [Raf.] Swezey) were encountered, there was either no difference or a higher density and cover within historically cultivated areas ($P < 0.05$). Likewise, cover of exotic forbs, especially halogeton (*Halogeton glomeratus* [M. Bieb.] C. A. Mey.), was either not different or higher in historically cultivated areas ($P < 0.05$). Bare ground was greater in historically cultivated areas at three sites ($P < 0.05$). These results suggest that cultivation legacies can affect seeding success and re-establishment of native vegetation, and therefore should not be overlooked when selecting research sites or planning land treatments that include seeding and or management to achieve greater native species diversity.

Key Words: crested wheatgrass, exarable fields, land-use legacies, old fields, sagebrush, site history

INTRODUCTION

Despite calls over the last decade for more research into ecological consequences of historical land use, the link between land use and the outcome of restoration efforts remains one of the most poorly investigated topics in the field of restoration ecology (Kettle et al. 2000; Wu and Hobbs 2002; Brudvig 2011). Historical cultivation represents the most extensive and drastic of human land uses because, in comparison to the natural disturbance regimes (e.g., fire) under which ecosystems evolve, the disturbances associated with cultivation (e.g., plowing) are newly introduced to the ecosystem (McIntyre and Hobbs 1999). Therefore, cultivation can degrade both biotic and abiotic properties with ecological consequences (known as "legacies") that last for decades to millennia (Foster et al. 2003; Cramer et al. 2008). Biotic degradation can alter the assembly of recolonizing native species and thus community assembly (Foster et al. 2003; Cramer et al. 2008). On the other hand, abiotic degradation can alter soil structure, chemistry, and water movement, and ultimately the performance of colonizing species (Cramer et al. 2008). Plowing mixes soils, which can destroy soil structure, increase erosion potential and organic carbon and nutrient loss, and alter soil chemistry (e.g., pH and salinity), leaving a fundamentally altered abiotic habitat in old fields (McLauchlan 2006; Standish et al. 2006).

Research on cultivation legacies from former wheat-growing regions of Australia, Canada, and the United States reveal that community assembly can be altered for over half a century (Rickard and Sauer 1982; Dormaar and Smoliak 1985; Standish et al. 2007). Species dispersal mode and life history traits are important biotic determinants of these changes (Dyer 2010). For example, wind-dispersed species are sometimes the few native plants to consistently re-establish in old fields (Standish et al. 2006; Morris et al. 2011). Furthermore, because cultivation removes entire plants, species that primarily reproduce vegetatively are less likely to occupy old fields (Dyer 2010; Morris et al. 2011). Consequently, comparisons of vegetation abundance between old fields that have undergone secondary succession and native sites that have never been cultivated indicate that old fields contain lower shrub and forb cover and higher cover of early seral and exotic invasive plants (Rickard and Sauer 1982; Dormaar and Smoliak 1985; Standish et al. 2007). When exotic invasive grasses gain dominance in old fields, secondary succession is stalled for decades (Cramer et al. 2008). For example, the invasive annual grass cheatgrass (*Bromus tectorum* L.) has replaced the native perennial bunch grasses on old fields where it persists for over

This research was funded by the USDA Agricultural Research Service Area-wide Ecologically Based Invasive Plant Management project.

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Manuscript received 27 September 2012; manuscript accepted 12 February 2014.