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Contributions of Seed Bank and Vegetative Propagules to Vegetation Composition on Prairie Dog Colonies in Western South Dakota

Emily R. Helms

South Dakota State University

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Author: Emily R Helms

Faculty Sponsors: Dr. Lan Xu, Dr. Jack L. Butler

Department: Natural Resource Management

ABSTRACT

Characterizing the contributions of the seed bank and vegetative propagules will enhance our understanding of community resiliency associated with prairie dog disturbances. Our objective was to determine the effects of ecological condition (EC) and distance from burrows on the soil seed bank and vegetative propagules. Based on species composition of the extant vegetation, two prairie dog colonies were selected on the Buffalo Gap National Grasslands in western South Dakota. Within each colony, two prairie dog burrows were randomly selected at each of three sample points located about 150m apart. Two soil cores were taken at 0.5m, 1.0m, and 1.5m distances from the center of each burrow. Cores used to evaluate the seed bank were sifted and spread within standard seed flats, while cores used to determine vegetative propagules were placed intact into plastic pots. Both were maintained in a greenhouse for daily monitoring. A total 450 seedlings representing 16 species emerged from the low EC seed flats while 550 seedlings comprising 24 species emerged from the high EC seed flats. Sixty-two percent of the low EC and 67% of the high EC species emerged from the seed flats were annuals. On the low EC colony, 43 shoots generated from vegetative propagules representing 7 species, two of which were also found in the seed flats. On the high EC colony, 431 shoots sprouted from vegetative propagules representing 5 species, 3 of which were not present in the seed flats. Fourteen percent of the low EC and 80% of the high EC species emerged as vegetative propagules were perennial native grasses. Distance from burrows had no impact on species richness within

each EC. Both colonies demonstrated considerable revegetation potential but differed with respect to relative contributions from the soil seed bank and vegetative propagules.

INTRODUCTION

Prairie dogs and prairie dog colonies are very important components of native grasslands where they contribute substantially to ecosystem biodiversity as well as providing habitat and serving as a food source for several threatened, endangered, and sensitive species. Prairie dogs are deemed as a keystone species and ecosystem engineers (Vannimwegen, et. al., 2008). Predators and arthropods are more abundant in areas surrounding prairie dog towns when compared with non-prairie dog colonized areas (Vannimwegen, et. al., 2008). The most endangered mammal in North America, the black-footed ferret, use prairie dogs as their sole food source. Other organisms such as burrowing owls, non-game grassland birds, reptiles, and insects all call a prairie dog burrow home. Continuously clipping, foraging and burrowing, prairie dogs has physically altered their habitat.

However, managing prairie dogs as keystone species is often considered incongruent with managing grasslands for livestock production. Because both prairie dogs and cattle prefer graminoids (Uresk, 1984) and cattle use the same landscapes and forage as prairie dogs. These two species seem to compete for available forage. A general inability exists in developing adaptive management plans that simultaneously manage public grasslands for black-footed ferret habitat and livestock production in South Dakota. Much of this ability can be directly attributed to the lack of understanding of the factors controlling vegetation dynamics involved in correctly managing these important communities (Miller, et. al., 2007).

Areas inhabited by prairie dogs are subject to continuous and intense disturbance by grazing and burrowing that alters vegetation composition and structure compared to the surrounding uninhabited areas. Vegetation resilience following these disturbances comes from two primary sources: seeds (seed bank) and vegetative propagules (bud bank) (Harper, 1977). Distinguishing the different contributions (seed bank *vs.* bud bank) may be especially important to communities often subjected to multiple levels of disturbance, such as with prairie dogs. Because the existing vegetation on prairie dog colonies is generally well adapted to a wide variety of disturbance, the on-site bud bank may greatly facilitate the process, although this has not been evaluated. In comparison, the soil seed bank often contains a mix of seeds representing both extant species and migrant. Because seeds germinating as migrants are not adapted to the often extreme conditions associated with prairie dog colonies, their contribution to vegetation dynamics may be limited, although this has also not been tested.

The objective of this study was to gain greater insight into vegetation dynamics after prairie dog removal by evaluating the ecological conditions (the extant vegetation) and disturbance intensity (i.e. distance from burrows) on soil seed bank and vegetative propaguels.

METHODS

Two prairie dog colonies on a Loamy ecological site were chosen on the Buffalo Gap National Grasslands in western South Dakota. These two colonies were about 5 km apart. Based on vegetation composition of the extant vegetation, one colony was classified as low ecological condition (Low EC) while the other was classified as high ecological condition (High EC).

Within each colony, two prairie dog burrows were randomly selected at each of three sample points located about 150 m apart. Two soil cores were taken at 0.5m, 1.0m, and 1.5m distance from the center of each burrow. One core was used to evaluate the seed bank while the other was used to examine for vegetative propagules. Cores used to evaluate the seed bank were sifted and spread within standard seed flats on top of an inch of MiracleGro potting soil. The soil cores used to determine vegetative propagules were placed intact into 15cm diameter plastic pots. Space around the soil cores was filled in with MiracleGro potting soil as well.

The soil cores and seed flats were maintained in a greenhouse with 16 hours light/8 hours dark photoperiod cycle at a temperature of 24 ± 3ºC. The samples were misted and monitored daily. Plants were identified as they emerged, counted, and then removed. Unidentifiable plants were allowed to grow until identification could be made.

After two months, soil cores were broken apart to determine whether the plants emerged from seeds or vegetative perennating structures.

Sørensen similarity indices were calculated based on abundance to assess similarity between colonies, within colonies different distances from the burrow. One way analysis of variance was used to test the difference mean species richness among distances within each ecological condition.

RESULTS

Seed Bank

A total **450** seedlings representing **16** species emerged from the low EC seed flats, while **550** seedlings comprising **24** species emerged from high EC seed flats (Fig.1). The majority of the species that emerged from both ecological conditions consisted of native, annual forbs (Fig. 1). The high EC had more diverse for all functional groups.

The seed bank was dominated by annual species seedlings on both colonies and approximately the same on each site: Low EC (**86%**), high EC (**82%**). On the low EC, **80%** of seed bank was dominated by *Verbena bracteata* (58%), *Hedeoma drummondii* (12%), *and Plantago patagonica* (9%). In contrast, on the high EC, **64%** of seed bank was dominated by *Bromus tectorum* (24%), *Vulpia octoflora* (23%), *and Hedeoma drummondii* (17%) (Fig. 2).

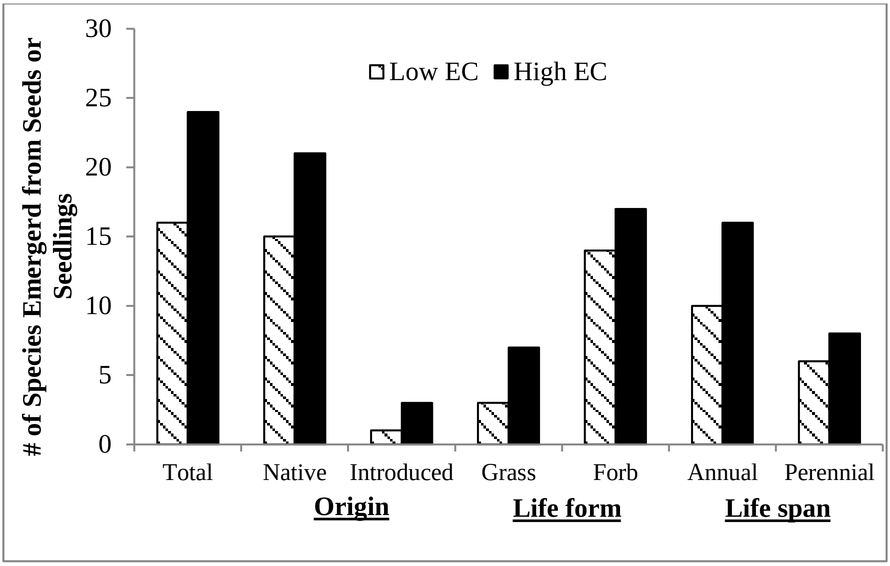

Figure 1 Number of species emerged from seeds on high and low ecological conditions at different functional groups

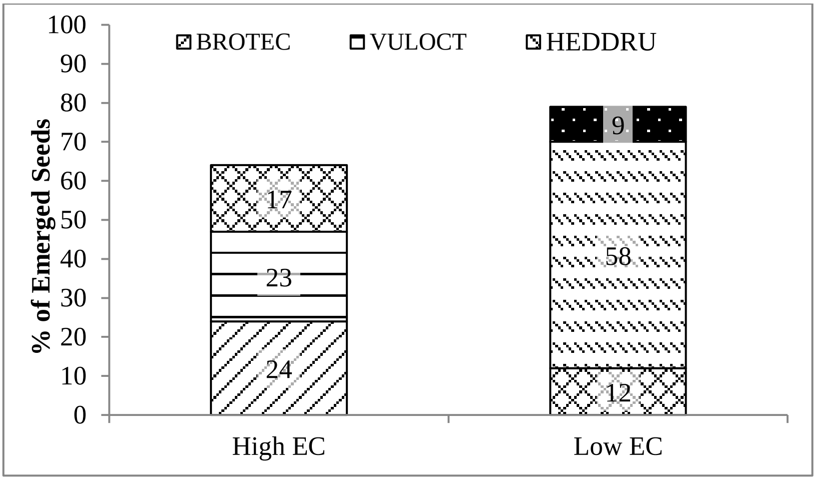

Figure 2 Percentage of Emerged Seeds by Species on High and Low Ecological Condition. BROTEC= ***Bromus tectorum*****, VULOCT=*****Vulpia octoflora*****, HEDDRU=** ***Hedeoma drummundii*****, VERBRA=** ***Verbena bracteata*****, PLAPAT=** ***Plantago patagonica***

Vegetative Propaguales

On the low EC colony, **43** shoots emerged as vegetative propagules representing **7** species (Fig. 3), **2** of which were also found in the seed bank. Among 7 species, 6 species were forbs. Dominant species from vegetative propagules were *Pascopyrum smithii* (**63%**), *Hedeoma drummondii* (**16%**), and *Spharalcea coccinea* (7%). *Hedeoma drummondii* was also found in the seed bank with **12%**.

On the high EC colony, **431** shoots emerged as vegetative propagules representing **5** species, **2** of which were also present in the seed bank. Four of the 5 species were graminoids. Dominant species from vegetative propagules were *Bouteloua gracilis* (**70%**) and *Bouteloua dactyloides* (**20%**), which were also present in seed bank with less than **0.3%**.

Distance from the burrow had no impact on species richness within each EC colony. Species richness ranges from **6** to **7** on low seed flats, and **10** to **12** on high seed flats from distance 0.5m to 1.5m.

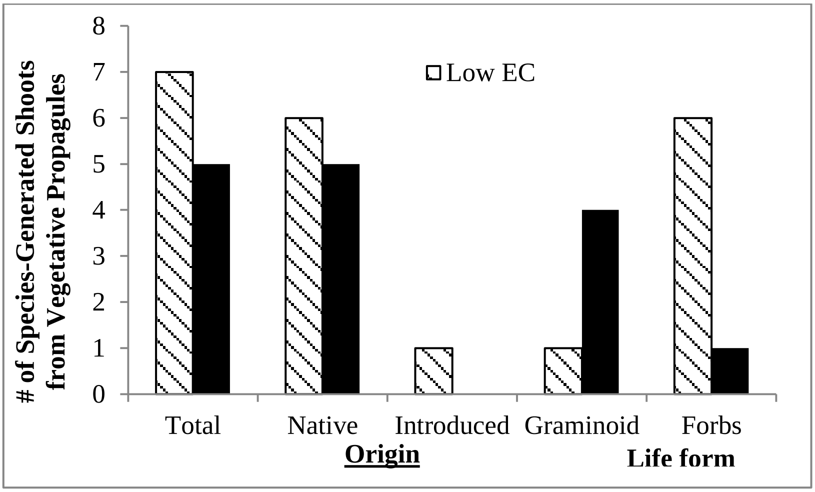

Figure 3 Number of species generated shoots from vegetative propagules at high and low ecological conditions.

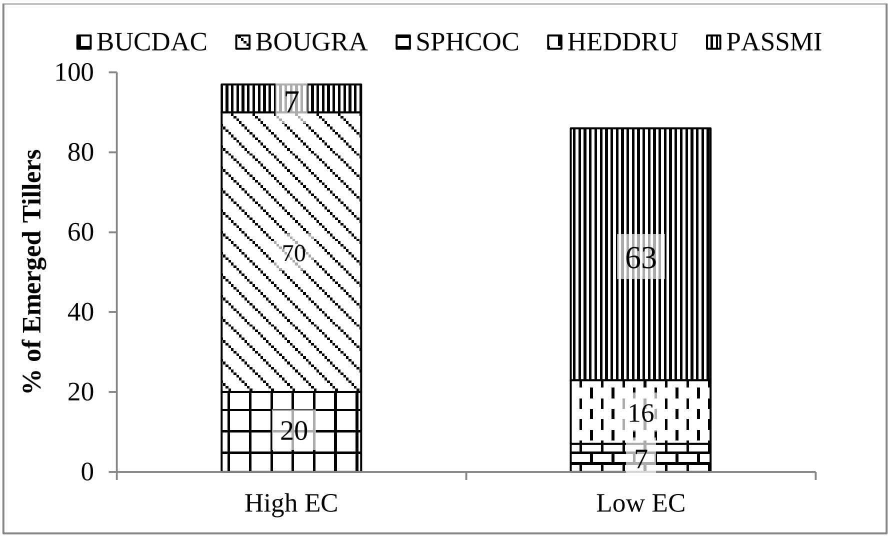

Figure 4 Percentage of Emerged Tillers by Species from High and Low Ecological Conditions. BUCDAC= Buchloe dactyloides, BOUGRA= Bouteloua gracilis, SPHCOC= Spharalcea coccinea, HEDDRU= Hedeoma drummondii, PASSMI= Pascopyrum smithii

Similarity

Between low EC and high EC colonies seed bank species composition and abundance were distinctive (Sørensen Similarity Index=0.26), which was also reflected at each distance level (Fig. 5) even though they were dominated by native and forbs. Within the colonies, high EC tended to be more similar in species composition and abundance among the distance compared to low EC (Fig. 5).

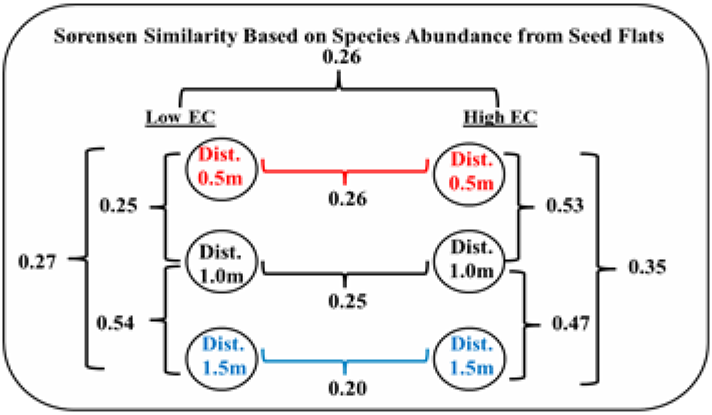

Figure 5 Sorensen similarity indices based on species abundance from seed flats

Sørensen Similarity was determined between each distance from the burrow. On the Low EC, there was a 25% similarity between the 0.5m distance and the 1.0m distance and a similarity of 54% between the 1.0m distance and the 1.5m distance. Between the 0.5m distance and the 1.5m distance, there was a similarity of 27%. On the High EC, there was a similarity of 53% between the 0.5m distance and 1.0m distance. Between the 1.0m and 1.5m distance on the High EC, there was a 47% similarity. Between the 0.5m distance and the 1.0m distance, there was a similarity of 35%.

Across ecological conditions, there was a similarity of 26% between species abundance found at the 0.5m seed flats, a 25% similarity between 1.0m seed flats, and a 20% similarity between 1.5m seed flats.

DISCUSSION AND CONCLUSIONS

Our results showed a significant revegetation potential with a considerable amount of seeds and vegetative propagules emerging from both ecological conditions. The high EC colony shows a higher revegetation potential as there is a higher abundance and greater species composition, particularly more sprouting from vegetative propagules when compared with the low EC colony.

Results from this study are concurrent with other studies that have found on perennial mixed-grass and shortgrasses prairie that annual forbs occurrence increases on prairie dog towns (Winter, et. al., 2002; Fahnestock, et. al., 2003). This reflected on presence of the abundant *Verbena bracteata, Dyssodia papposa,* and *Plantago patigonica* in the seed bank. There was difference between proportion species composition and abundance between low EC and high EC. On the low EC colony, seed bank was dominated by annual forbs (67%), while on the high EC colony, 47% of seed bank was dominated by annual grasses such as *Bromus tectorum* and *Vulpia octoflora*.

The relative contributions of the seed and bud bank to each colony generally reflected the ecological condition of each colony, which is a product of the management and environmental history of each colony. On the high EC colony, the vegetative propaguls (bud bank) (**431** shoots emerged from vegetative propagules) was much higher than low EC colony's bud bank (only **43** shoots generated from vegetative propagules). In addition, the species compositions on these vegetative propaguels were different, there was more native perennial forbs like *Spharalcea coccinea* and *Hedeoma drummondii* on the low EC colony compared to more native perennial grasses such as *Bouteloua gracilis* (**70%**) and *Bouteloua dactyloides* (**20%**) on the high EC.

Although few species emerged from the seed bank could be considered typical of undisturbed mixed-grass prairie vegetation, the number and composition of seedlings suggest that, with the removal of the major disturbance factors (prairie dogs, livestock), colonies have the potential to quickly re-vegetate. The high percentage (44%) emergence of shoots from the bud bank on the high EC colony suggest that vegetation recovery may proceed faster and persist longer than recovery on the low EC colony (only 9% emergence of shoot from the bud bank). More management may be needed in order to reach a climax state equal to a historic climax plant community for that site.

LIMITATIONS

The main limitations to this study were greenhouse space and time. Due to these limitations, the samples size was limited to 3 replications and two months duration. Future study should have more replications, long duration, and different distance regimes from the center of the burrows in order to fully quantify the soil seed bank and vegetative propagule numbers.

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APPENDIX

Table 2 List of all the species found in soil cores, soil flats, or both.

Scientific Name	Common name	Origin[1]	Life span[2]	Life form[3]	Found
Amaranthus albus	tumbling mustard	I	A	F	Both
Androsace occidentalis	western rockjasmine	N	A	F	Both
Bouteloua gracilis	blue grama	N	P	G	Both
Bromus japonicus	Japanese brome	I	A	G	Both
Bromus tectorum	downy brome	I	A	G	Both
Buchloe dactyloides	buffalograss	N	P	G	Both
Carex spp	Sedge	N	P	G	Both
Chamaesyce glyptosperma	sandmat	N	A	F	Both
Cirsium arvense	Canada thistle	I	P	F	Cores
Conyza canadensis	horseweed	N	A	F	Both
Conyza ramosissima	dwarf horseweed	N	A	F	Both
Cryptantha minima	little cryptantha	N	A	F	Both
Descurainia pinnata	western tansymustard	N	A	F	Flats
Draba reptans	Carolina draba	N	A	F	Both
Dyssodia papposa	fetid marigold	N	A	F	Both
Gaura coccinea	scarlet gaura	N	P	F	Cores
Hedeoma drummondii	Drummond's false pennyroyal	N	P	F	Both
Hedeoma hispida	rough false pennyroyal	N	A	F	Cores
Hordeum pusillum	little barley	N	A	G	Cores
Lepidium densiflorum	common pepperweed	N	A	F	Both

Logfia arvensis	field cottonrose	I	A	F	Both
Medicago lupulina	black medic	I	A	F	Cores
Nassella viridula	green needlegrass	N	P	G	Cores
Oxalis dillenii	slender yellow woodsorrel	N	P	F	Flats
Pascopyrum smithii	western wheatgrass	N	P	G	Both
Picradeniopsis oppositifolia	oppositeleaf bahia	N	P	F	Cores
Plantago patagonica	wolly plantain	N	A	F	Cores
Pseudognaphalium viscosum	clammy cudweed	N	A	F	Both
Schedonnardus paniculatus	tumblegrass	N	P	G	Flats
Silene antirrhina	catchfly	N	A	F	Flats
Spharalcea coccinea	scarlet globemallow	N	P	F	Flats
Triodanis leptocarpa	slimpod venus' looking glass	N	A	F	Cores
Triodanis perfoliata	clasping venus' looking glass	N	A	F	Both
Verbena bracteata	prostrate vervain	N	P	F	Both
Veronica peregrina	neckweed (purslane speedwell)	N	A	F	Flats
Vulpia octoflora	sixweeks fescue	N	A	G	Both

[1]Origin: I= Introduced, N=Native; [2]Life span: A=Annual, P=Perennial; [3]Life Form: F=Forb, G=Graminoid/Grass