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RESEARCH ARTICLE

Pocket Gophers and the Invasion and Restoration of Native Bunchgrass Communities

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Abstract

More than 7 million hectares of California native plant communities are now dominated by exotic annual species, a biological invasion that has made native bunchgrass ecosystems in this region one of the most endangered ecosystems in North America. Many land use and environmental factors have contributed to the conversion of bunchgrass areas to annual grassland, but the role of gopher disturbance remains understudied. Here I report observational evidence that suggests gopher foraging is nonrandomly concentrated in the open spaces between clumps of bunchgrass and as a result may inhibit the

recruitment of bunchgrass into these areas. Understanding patterns of direct gopher impact and coincident soil disturbance in bunchgrass versus annual grassland is important for successful restoration of bunchgrass habitats. While the prospect of excluding gophers is daunting, even short-term reductions in gopher populations would help to promote a restored community structure with a mature native bunchgrass and annual forb association.

Key words: bunchgrass, gopher, native, belowground, invasive, exotic, community structure, plant, herbivore, *Thomomys*, *Nassella*, annual, perennial.

Introduction

More than 7 million hectares (17%) of California are now dominated by exotic annual grasses and forbs, predominately from the Mediterranean Basin (Huenneke 1989; Hamilton 1997). Many factors are thought to have promoted the invasion of native California grasslands by exotic annual plants, including extended periods of drought, land clearing, and grazing, due to direct consumption of plants, soil compaction, and changes in nutrient cycling (Stromberg & Griffin 1996; Dyer & Rice 1997; Hamilton et al. 2002; Reever-Morghen & Rice 2005). In native California grassland communities, bunchgrasses are important elements of community structure and some research finds that establishing large bunchgrasses increases resistance to invasion by exotic annuals (Corbin & D'Antonio 2004; Reever-Morghen & Rice 2005). However, once bunchgrass communities become heavily invaded by exotic annuals, they are generally difficult to restore making bunchgrass habitats among the most endangered ecosystems in North America (Noss et al. 1995; but see Seabloom et al. 2003; DiVittorio et al. 2007).

Studies of the restoration and maintenance of bunchgrass areas note regular spacing between individuals and low mortality of mature bunchgrasses, but high seedling mortality and low recruitment (e.g., Dyer & Rice 1999; Hamilton

et al. 2002; Corbin & D'Antonio 2004). Bunchgrasses that manage to survive the period of high initial mortality may grow for more than 100 years and reach basal areas of up to 700 cm² (Hamilton 1997). The high mortality that young bunchgrasses suffer has been attributed to diffuse inter- and intraspecific competition for light during the spring growing season and for water during dry summers (Dyer & Rice 1999). Here I examine the possibility that underground patterns of gopher foraging may be a previously undocumented factor in bunchgrass spacing and low recruitment.

Pocket gophers (*Thomomys* spp., Geomyidae) are keystone eco-engineers in California grasslands, affecting soil geomorphology and hydrology, nutrient cycling, and plant succession (Grinnell 1923; Howard & Childs 1959; Reichman & Seabloom 2002). Gophers have existed in California plant communities for at least 4.6 million years (J. Damuth 2002, University of California Santa Barbara, CA, USA personal communication) and their evolution coincides with the Pliocene expansion of grassland in western North America (Raven & Axelrod 1998). At large scales, gopher behavior has community level impacts, contributing to the persistence of an early successional state in grasslands (Huntly & Inouye 1988; Seabloom & Richards 2003). In fact, gophers facilitate weedy annuals by providing germination sites on mounds (burrow tailings of loose soil) (Hobbs & Mooney 1991; Kotanen 1997; Schiffman 2007) and gopher foraging can directly reduce the recruitment of dominant perennials (e.g., oak trees) (Borchert et al. 1989). What is less appreciated about pocket gophers and the displacement of native bunchgrass habitats is that the

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