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Author(s): Bruce A. Roundy, Stuart P. Hardegree, Jeanne C. Chambers, and Alison Whittaker

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# Prediction of Cheatgrass Field Germination Potential Using Wet Thermal Accumulation

Bruce A. Roundy,<sup>1</sup> Stuart P. Hardegree,<sup>2</sup> Jeanne C. Chambers,<sup>3</sup> and Alison Whittaker<sup>4</sup>

Authors are <sup>1</sup>Professor, Wildlife and Wildlands Conservation Program, Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT 84602; <sup>2</sup>Plant Physiologist, USDA Agricultural Research Service, Northwest Watershed Research Center, Boise, ID 83712; <sup>3</sup>Research Ecologist, USDA Forest Service, Rocky Mountain Research Station, Reno, NV 89512; and <sup>4</sup>Wildlife Biologist, Utah Division Wildlife Resources, Ephraim, UT 84627.

## Abstract

Invasion and dominance of weedy species is facilitated or constrained by environmental and ecological factors that affect resource availability during critical life stages. We compared the relative effects of season, annual weather, site, and disturbance on potential cheatgrass (*Bromus tectorum* L.) germination in big sagebrush (*Artemisia tridentata* Nutt.) communities. Soil water status and temperature in the seedbed were measured continuously for 4 years on 9 big sagebrush sites in Nevada and Utah. Field plots at lower-, middle-, and upper-elevation sites were either undisturbed, or were burned, sprayed with herbicide, or both sprayed and burned. Spraying removed perennial herbaceous vegetation, whereas burning removed sagebrush. We used thermal-germination data from laboratory incubation studies of 18 cheatgrass seedlots and field soil moisture and temperature measurements to model and predict potential germination in the field plots for periods when seedbeds were continuously wet (above  $-0.5$ ,  $-1$ , or  $-1.5$  MPa) and across intermittent wet and dry periods. Season had the greatest effect on potential cheatgrass germination, followed by annual weather, and site variables (elevation and location); the effects of disturbance were minimal. Potential germination was predicted for most sites and years in spring, a majority of sites and years in fall, and few sites or years in winter. Even though disturbance has limited effects on potential germination, it can increase cheatgrass invasion and dominance by reducing perennial herbaceous species resource use and allowing increased cheatgrass growth and reproduction.

## Resumen

La invasión y dominancia de las malezas es facilitada o dificultada por factores ambientales y ecológicos que afectan la disponibilidad de recursos durante las etapas críticas del ciclo de vida. Comparamos los efectos relativos de la estación, clima anual, sitio, y disturbio sobre la germinación potencial del “Cheatgrass” (*Bromus tectorum* L.) en comunidades de “Big sagebrush” (*Artemisia tridentata* Nutt.). La temperatura y el estado del agua en el suelo se midieron continuamente en la cama de siembra por cuatros años en 9 sitios de “Big sagebrush” en Nevada y Utah. Las parcelas de campo en los sitios de elevaciones baja, media, y alta recibieron alguno de los siguientes tratamientos: sin disturbio, quemados, asperjados con herbicidas, o quemados y asperjados con herbicidas. La aspersión de herbicida removió la vegetación herbácea perenne, mientras que la quema removió el “Sagebrush.” Usamos datos de temperatura-germinación de estudios de incubación en laboratorio de 18 lotes de semilla de “Cheatgrass” y las mediciones de campo de temperatura y humedad del suelo para modelar y predecir la germinación potencial en las parcelas de campo en periodos cuando las camas de siembra estuvieron continuamente húmedas (arriba de  $-0.5$ ,  $-1$ , o  $-1.5$  MPa) y durante periodos intermitentes secos y húmedos. La estación tuvo el efecto más fuerte sobre la germinación potencial del “Cheatgrass,” seguida por el clima anual y las variables del sitio (elevación y localización); que los efectos del disturbio fueron mínimos. En primavera, la germinación potencial se predijo para la mayoría de los sitios y años, en otoño, para un gran número de sitios y años, y en invierno para pocos sitios y años. A pesar de que el disturbio tuvo efectos limitados sobre la germinación potencial, esta condición puede aumentar la invasión y dominio del “Cheatgrass” al reducir el uso de los recursos por especies herbáceas perennes y permitir un mayor crecimiento y reproducción del “Cheatgrass.”

**Key Words:** big sagebrush, disturbance, fire, Great Basin, heat accumulation, soil temperature, soil water, thermal-germination models, weed invasion

## INTRODUCTION

Cheatgrass (*Bromus tectorum* L.) has spread across the Intermountain West since its introduction in the late 1880s

(Mack 1986). Its current dominance on rangelands once occupied by big sagebrush (*Artemisia tridentata* Nutt.) has decreased ecological values and greatly increased the frequency of catastrophic wildfire in this region (Billings 1990; D’Antonio and Vitousek 1992). Because of their extent and location, Wyoming big sagebrush (*Artemisia tridentata* Nutt. subsp. *wyomingensis* Beetle and Young) communities in the Great Basin are especially susceptible to invasion by cheatgrass and other annual weeds (Wisdom et al. 2005). Higher elevation mountain big sagebrush (*Artemisia tridentata* Nutt. subsp. *Vaseyana* [Rydb.] Beetle) communities are also considered to be at risk to invasion, but are less extensive than Wyoming big sagebrush communities and have exhibited less invasion

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Correspondence: Bruce A. Roundy, Dept of Plant and Wildlife Sciences, Brigham Young University, Provo, UT 84602. Email: bruce\_roundy@byu.edu

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