

Effects of Soil Nutrients and Fire on Seedling Establishment of Native Prairie Species

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Baskett Slough National Wildlife Refuge, Oregon, USA



Prescribed burn in native prairie, Willamette Valley, Oregon, USA



Field assistant counting seedlings in native Willamette Valley prairie

INTRODUCTION:

Historically, the Willamette Valley of Oregon was a vast landscape of prairies and oak savannahs, which was maintained by the annual burns by the Kalapaya Native Americans to enhance hunting, food gathering and travel. Today, because less than 1% of the original native prairies remain, they are considered among the rarest of the ecosystems in the United States and are in critical need of conservation.

Seed regeneration is a crucial step for increasing the abundance of these native herbaceous species, but little is known about the conditions that promote seedling establishment. Fire may be an important factor because of its historical role in maintaining the prairie landscape. Prescribed burning is a favored tool to control woody encroachment into native prairies and thus, understanding the role of fire in seedling establishment is particularly important for land managers.

In this study, we investigated the effect of fire on soil nutrients and the subsequent effects on seedling establishment for seven target native species in a native prairie remnant at Bastkett Slough National Wildlife Refuge in the Willamette Valley, Oregon, USA.

We gratefully acknowledge the support of the United States Fish and Wildlife Service, who provided financial support and also conducted the prescribed burns.

OBJECTIVE ONE

Determine the relationship between seedling establishment rates of native species and soil concentration of soil phosphate, nitrate, and ammonium.

METHODS: In study one, seeds of seven native prairie species were sowed in a remnant native prairie in the fall and seedlings counted the following spring in an unreplicated study in which half of the plots of the remnant native prairie were burned in the fall before seed sowing and half were left unburned. Soil samples were collected at each plots about time of sowing and again 30 days and 270 days later. Concentrations of soil phosphate nitrate ammonium, and were measured. Seedling establishment rates were compared to an integrated measure of each of the soil nutrients over the three sampling dates.

RESULTS: Seedling establishment rates were not significantly correlated with soil nitrate of ammonium. Phosphate was significantly correlated with seedling establishment rates but the direction and strength of the relationship depended on the species, with three species showing positive relationships and three species showing negative relationships (Figure 1).

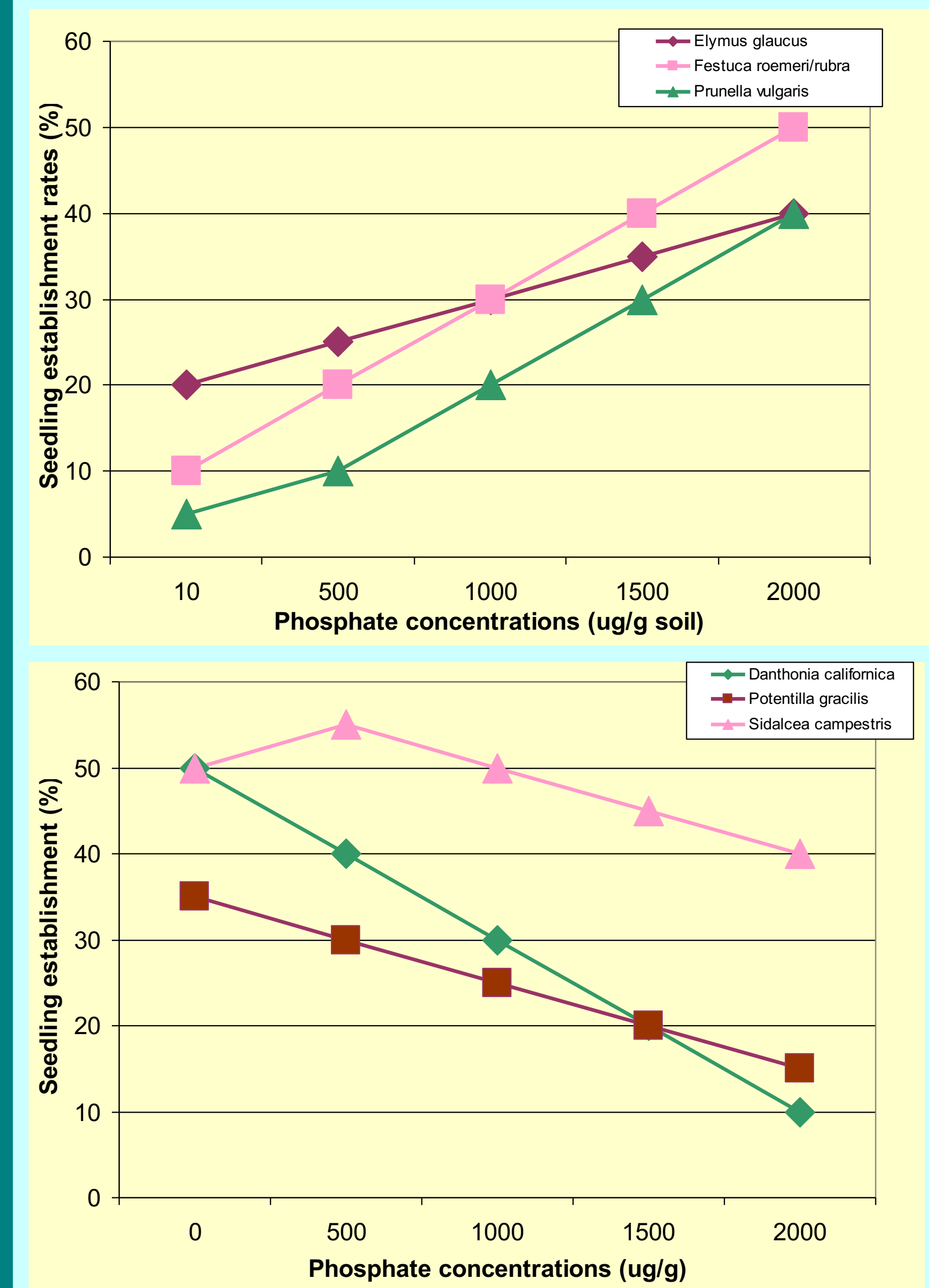


Figure 1: Correlation of average seedling establishment for native prairie species with average soil nutrient concentrations integrated over 3 collection dates (fall, spring, summer).

OBJECTIVE TWO

Determine the effect of fire on the soil concentrations of phosphate, nitrate, ammonium.

METHODS: In study two, soil samples were collected from replicated plots within two management treatments, burned and unburned, 7, 30 and 270 days after the fall burn. Concentration of soil phosphate, nitrate, and ammonium measured and integrated into a single measure over the three sampling dates.

RESULTS: Soil phosphate increased significantly in the burned plots compared to the unburned plots ($P \leq 0.0001$), soil ammonium decreased significantly in the burned plots ($P \leq 0.1$), and soil nitrate showed no significant differences between the burned and unburned plots (Figure 2).

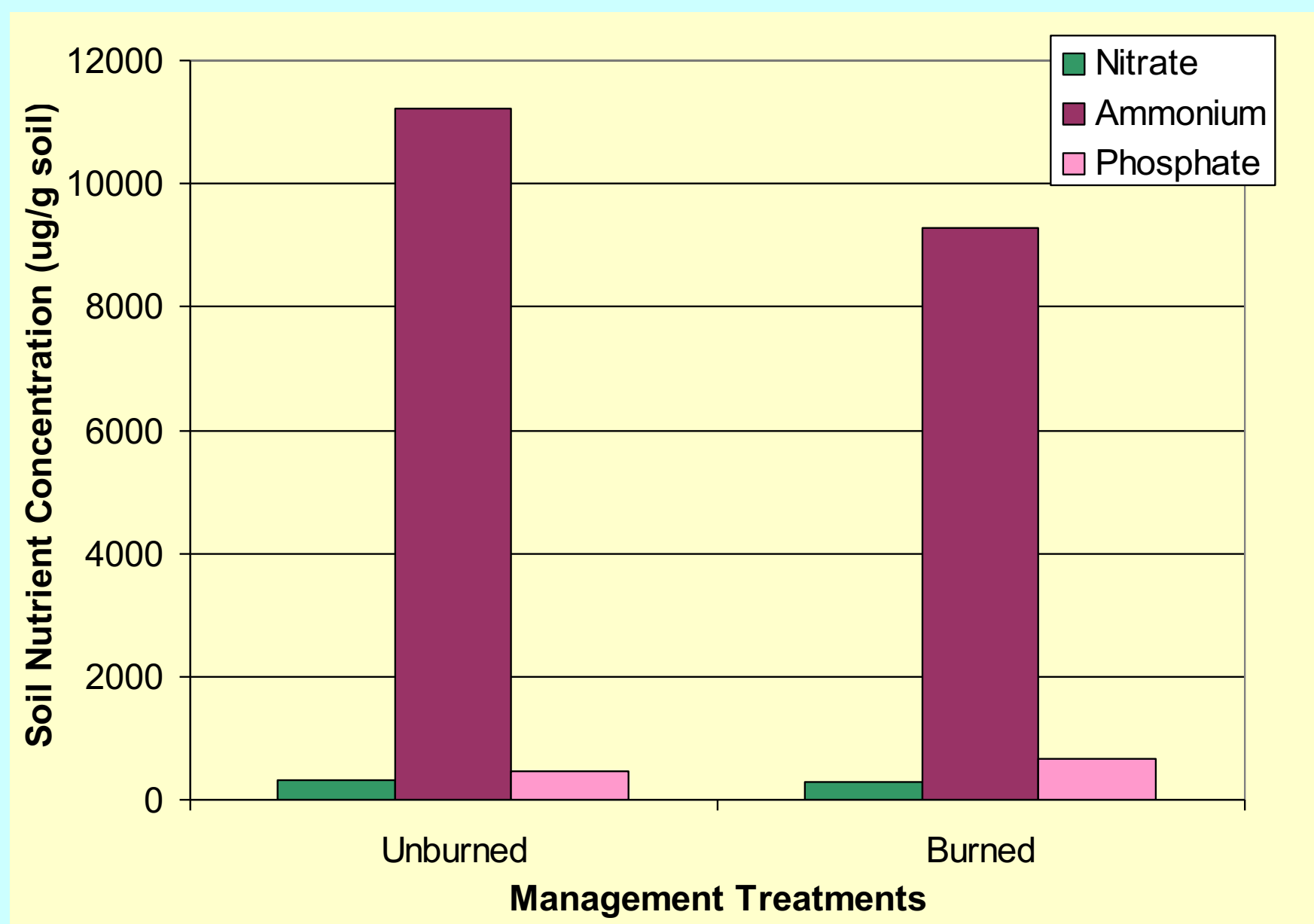


Figure 2: Average soil nutrients concentrations integrated over 3 collection dates (fall, spring, summer) for two conservation management treatments: burned and unburned in a native prairie of the Willamette Valley, Oregon, USA. Asterisks indicate a significant difference in means ** $P \leq 0.0001$; * $P \leq 0.1$.



Showy forb species of native Willamette Valley prairies

OBJECTIVE THREE

Determine the overall effect of fire on seedling establishment rates of target native prairie species.

METHODS: Seeds of seven native species were sowed into the same replicated plots as study two following the fall burn. Seedlings were counted the following spring.

RESULTS: Based on the nutrient patterns observed in objectives one and two, we predicted that species showing a positive correlation with phosphate levels and seedling establishment rates should have increased seedling establishment rates in the experimentally burned plots compared to the unburned plots due to the increased soil phosphate levels. Species with a negative correlation with phosphate levels should have decreased seedling establishment in the burned plots. The results of the experimental burn matched this prediction (Figure 3).

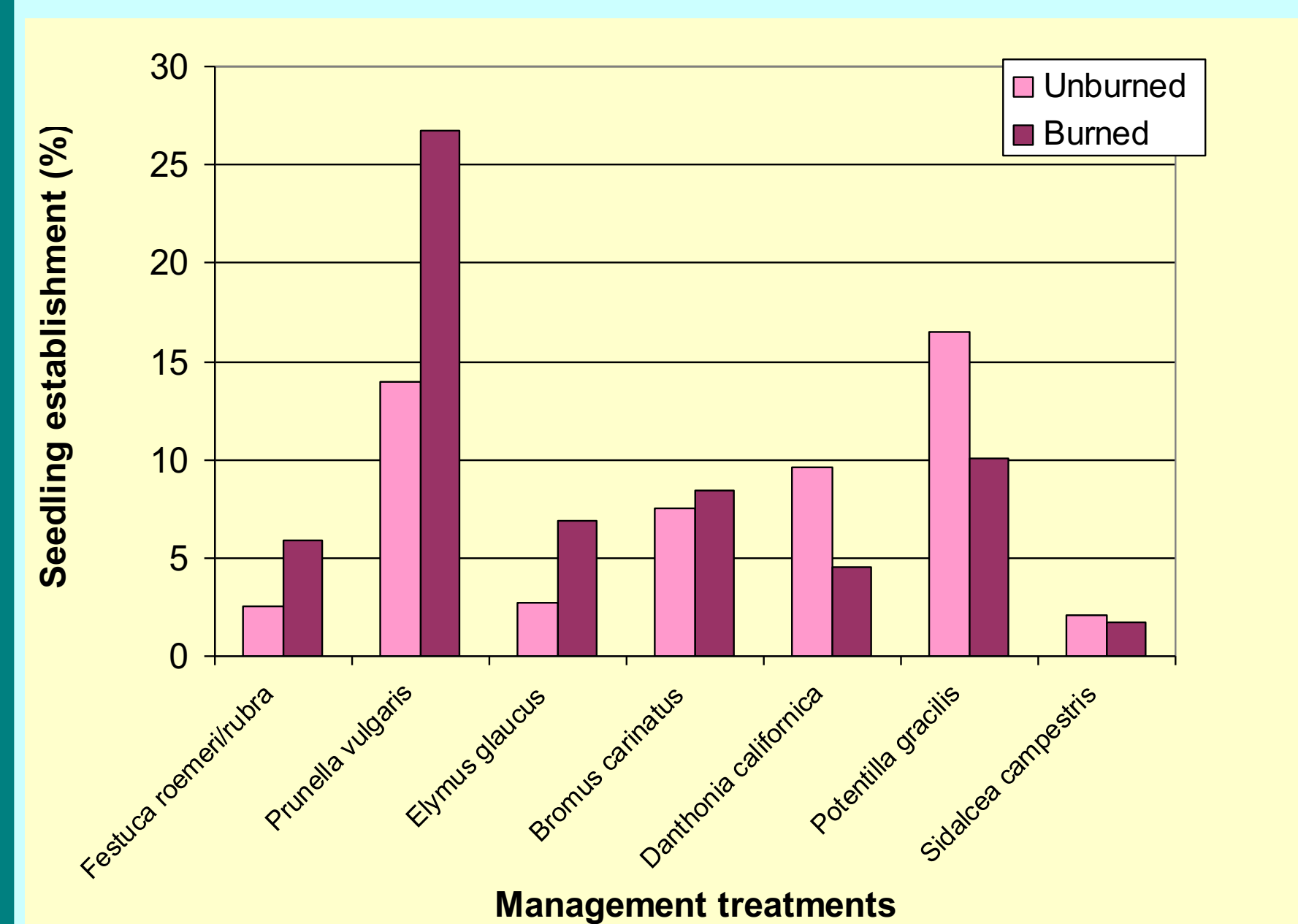


Figure 3: Average seedling establishment rates for 7 native prairie plant species in burned and unburned plots of a native prairie of the Willamette Valley, Oregon, USA. Asterisks indicate a significant different in means (* $P \leq 0.1$)



Machelle Nelson, one of authors, collecting field data at Baskett Slough National Wildlife Refuge