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# Seedling Establishment and Survival on Restored Campsites in Subalpine Forest

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## Abstract

This study experimented with common restoration techniques (scarification, soil amendments, mulch, and seeding) on six closed wilderness campsites in subalpine forests in Oregon. Effectiveness in encouraging seedling establishment, growth, and survival was assessed every year for the first 7 years following treatment. Closure and restoration of the campsites increased the density of plants established from seed. Despite an original density of virtually zero, mean density of perennial plants was 55 plants/m<sup>2</sup> 7 years after closure. All the treatments, with the exception of the biodegradable mulch mat, increased plant density. Seven years after treatment, seeding had increased plant density 5-fold, whereas scarification and soil amendments (organic matter, compost, and soil inoculum) had each increased

density 3-fold. The organic and compost amendments also had the positive benefit of increasing growth rates and shortening the time-to-reproductive maturity. Results suggest that restoration of the herbaceous cover on these campsites can occur rapidly using the techniques employed. All but one of the species we seeded established in substantial quantities and survived at densities exceeding their density in the naturally sparse herbaceous cover on these sites. Thirty-six perennial species volunteered on these sites. The remaining challenge is reestablishment of the shrub species that comprise much of the ground cover in these forests. These species seldom establish from seed.

**Key words:** compost, recreation impacts, scarification, seeding, soil amendments.

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## Introduction

Ecological restoration of recreation impact in high-elevation-protected areas has received little attention. This is unfortunate because recreation can damage vegetation and soil on campgrounds and other nodes of concentrated use, compromising preservation goals of protected areas. Protected area managers attempt to close and restore damaged recreation sites, often with little success (Moritsch & Muir 1993). Restoration of impacts can be unusually challenging, given the remoteness of sites, unfavorable growing conditions (e.g., short growing seasons, shallow soils), and high standards for success (restoration of natural conditions).

Although there has been substantial research on effectiveness of such restoration treatments as seeding, soil amendments, and mulches, little of this research has been conducted in subalpine ecosystems or on damaged recreation sites. Success with seeding of native species, particularly grasses, has been reported in alpine ecosystems (Chambers et al. 1988; Smyth 1997). Mulching has been found to increase seeding success at high elevations (Petersen et al. 2004). Seedling growth has been reported to be greater on organic topsoil than on mineral soil (Chambers et al. 1990), leading to recommendations that

organic amendments be used in alpine restoration (Chambers 1997). However, students of high elevation restoration consistently note that seedling establishment and survival vary greatly with disturbance characteristics and species life history, making it difficult to extrapolate results from one situation to another (Urbanska & Schütz 1986; Chambers et al. 1990).

Given the paucity of restoration research in subalpine ecosystems and on recreation sites, this study experimented with restoration treatments on long-disturbed campsites in subalpine forests. It was conducted in a designated Wilderness, where management objectives stress preservation of natural conditions and minimal manipulation. Consequently, commonly recommended treatments compatible with these objectives were selected. Specifically, the effectiveness of seeding; improving the physical, biological, and chemical properties of soils (through scarification and amendments of organic matter, compost, and soil inoculum); and ameliorating microclimatic conditions (through application of a biodegradable mulch mat) were assessed over a 7-year period.

## Methods

### Study Sites

The study was conducted on six campsites in the Eagle Cap Wilderness, Wallowa Mountains, northeastern Oregon. These campsites have been highly disturbed for a long time, probably more than 50 years. Compared to adjacent

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