

Introduction

About 42 percent or 170,000 km² of California is forest and woodland, 56,000 km² of which occurs in the Sierra Nevada (Davis and Stoms 1996). Along the Sierra's western slope, four main forest types occur along an elevation gradient: ponderosa pine (1,100-1,600 m), white fir-mixed conifer (1,500-2,300 m), red fir (2,100-2,900 m) and lodgepole pine (2,600-3,800 m) (Barbour 1988, Kuchler 1964, Raven and Axelrod 1978, Rundel and others 1977). Since European arrival, productive and accessible forests such as mixed conifer and ponderosa pine have been the focal areas for timber harvesting and fire suppression efforts. The alteration in the mean fire return interval from historical to current conditions has been estimated as a change from 15 to 644 years (McKelvey and Busse 1996). The ecosystem dynamics of most Sierra forest communities, with the possible exception of giant sequoia (*Sequoiadendron giganteum*) forests, is still poorly understood. Given the importance of Sierra forests for water production, biodiversity and recreation, a better understanding of the impacts of management activities on ecosystem structure and function is sorely needed.

In 1996 the Sierra Nevada Ecosystem Project (SNEP) published an assessment of current conditions and a suggestion of research priorities to address several critical concerns for the future of the Sierra Nevada ecosystem. One of these findings focused on the role of fire and mechanical thinning in forest restoration. Thinning has been proposed as a means of reducing fuel loads before an area is prescribe-burned, or as a surrogate for restoring a forest's structure and composition to historic conditions when prescribed fire cannot be used because of the presence of houses, air quality restrictions, etc. Although thinning may produce a stand structure and composition that copies the results of burning, it may have significantly different effects on many ecosystem processes. According to SNEP (1996, p. 4-5):

Although silvicultural treatments can mimic the effects of fire on structural patterns of woody vegetation, virtually no data exist on the ability to mimic ecological functions of natural fire. Silvicultural treatments can create patterns of woody vegetation that appear similar to those that fire would create, but the consequence for nutrient cycling, hydrology, seed scarification, nonwoody vegetation response, plant diversity, disease and insect infestation, and genetic diversity are mostly unknown.

To compare the effects of different levels of thinning and burning on mixed-conifer ecosystems, an experiment was initiated in 1998 at the Teakettle Experimental Forest (Appendix A). As a precursor to this experiment, extensive analysis of vegetation conditions at Teakettle was made to map and identify different forest communities and intensively analyze mixed-conifer conditions to appropriately size and locate permanent plots for thinning and burning treatments.

Although Teakettle has been briefly described in previous reports (Berg 1990, Keeler-Wolf 1990), we provide additional historical information, a comprehensive vegetation map based on systematic sampling, quantitative analysis of the mixed-conifer and red fir portions of the forest, and data from ongoing research in Teakettle's mixed-conifer areas. This intensive analysis of forest vegetation at Teakettle was needed to establish plots with replicated structure and composition, and to understand the appropriate scale and pattern for designing field sampling (North and Oakley 2003). We also studied the structure, composition and patch pattern of the trees, shrubs and herbs of these two forest types from intensive mapping and field sampling. The mixed-conifer forest type in particular demands spatially-explicit, intensive measurements to understand its inherent heterogeneity. Confusion about the pattern of structural organization in mixed conifer has generated uncertainty about how to scale management activities, inventory the amount and distribution of remaining old growth, and evaluate restoration efforts (USDA 2001). Mixed-conifer forests are complex, with a high tree and shrub diversity for a western coniferous forest, and a structure that is both horizontally (ranging