ECOLOGICAL APPLICATIONS
ECOLOGICAL SOCIETY OF AMERICA

Article

Climate and landscape drive the pace and pattern of conifer encroachment into subalpine meadows

Kaitlin C. Lubetkin, Anthony LeRoy Westerling, Lara M. Kueppers

First published: 08 May 2017 | https://doi.org/10.1002/eap.1574 | Cited by: 3

Corresponding Editor: John B. Bradford.

Read the full text > PDF TOOLS SHARE

Abstract

Mountain meadows have high biodiversity and help regulate stream water release following the snowmelt pulse. However, many meadows are experiencing woody plant encroachment, threatening these ecosystem services. While there have been field surveys of individual meadows and remote sensing-based landscape-scale studies of encroachment, what is missing is a broad-scale, ground-based study to understand common regional drivers, especially at high elevations, where land management has often played a less direct role. With this study, we ask: What are the climate and landscape conditions conducive to woody plant encroachment at the landscape scale, and how has historical climate variation affected tree recruitment in subalpine meadows over time? We measured density of encroaching trees across 340 subalpine meadows in the central Sierra Nevada, California, USA, and used generalized additive models (GAMs) to determine the relationship between landscape-scale patterns of encroachment and meadow environmental properties. We determined ages of trees in 30 survey meadows, used observed climate and GAMs to model the relationship between timing of recruitment and climate since the early 1900s, and extrapolated recruitment patterns into the future using downscaled climate scenarios. Encroachment was high among meadows with lodgepole pine (*Pinus contorta* Douglas ex Loudon var. *murrayana* (Balf.) Engelm.) in the immediate vicinity, at lower elevations, with physical conditions favoring strong soil drying, and with maximum temperatures above or below average. Climatic conditions during the year of germination were unimportant, with tree recruitment instead depending on a 3-yr seed production period prior to germination and a 6-yr seedling establishment period following germination. Recruitment was high when the seed production period had high snowpack, and when the seedling establishment period had warm summer maximum temperatures, high summer precipitation, and high snowpack. Applying our temporal model to downscaled output from four global climate models indicated that the average meadow will shift to forest by the end of the 21st century. Sierra Nevada meadow encroachment by conifers is ubiquitous and associated with climate conditions increasingly favorable for tree recruitment, which will lead to substantial changes in subalpine meadows and the ecosystem services they provide.