ORIGINAL ARTICLE

Influence of bioclimatic variables on tree-line conifer distribution in the Greater Yellowstone Ecosystem: implications for species of conservation concern

Anne M. Schrag[1]*, Andrew G. Bunn[2] and Lisa J. Graumlich[1]†

[1]*Big Sky Institute, Montana State University, Bozeman, MT 59717, USA and* [2]*Department of Environmental Sciences, Huxley College of the Environment, Western Washington University, Bellingham, WA 98225, USA*

ABSTRACT

Aim Tree-line conifers are believed to be limited by temperature worldwide, and thus may serve as important indicators of climate change. The purpose of this study was to examine the potential shifts in spatial distribution of three tree-line conifer species in the Greater Yellowstone Ecosystem under three future climate-change scenarios and to assess their potential sensitivity to changes in both temperature and precipitation.

Location This study was performed using data from 275 sites within the boundaries of Yellowstone and Grand Teton national parks, primarily located in Wyoming, USA.

Methods We used data on tree-line conifer presence from the US Forest Service Forest Inventory and Analysis Program. Climatic and edaphic variables were derived from spatially interpolated maps and approximated for each of the sites. We used the random-forest prediction method to build a model of predicted current and future distributions of each of the species under various climate-change scenarios.

Results We had good success in predicting the distribution of tree-line conifer species currently and under future climate scenarios. Temperature and temperature-related variables appeared to be most influential in the distribution of whitebark pine (*Pinus albicaulis*), whereas precipitation and soil variables dominated the models for subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). The model for whitebark pine substantially overpredicted absences (as compared with the other models), which is probably a result of the importance of biological factors in the distribution of this species.

Main conclusions These models demonstrate the complex response of conifer distributions to changing climate scenarios. Whitebark pine is considered a 'keystone' species in the subalpine forests of western North America; however, it is believed to be nearly extinct throughout a substantial portion of its range owing to the combined effects of an introduced pathogen, outbreaks of the native mountain pine beetle (*Dendroctonus ponderosae*), and changing fire regimes. Given predicted changes in climate, it is reasonable to predict an overall decrease in pine-dominated subalpine forests in the Greater Yellowstone Ecosystem. In order to manage these forests effectively with respect to future climate, it may be important to focus attention on monitoring dry mid- and high-elevation forests as harbingers of long-term change.

Keywords

Biophysical variables, climate change, climate variability, Greater Yellowstone Ecosystem, *Pinus albicaulis*, random forest model, species distribution, tree-line conifer distributions.

*Correspondence and present address: Anne M. Schrag, Northern Great Plains Program, World Wildlife Fund, 202 S. Black, Ste. 3, Bozeman, MT 59715, USA.
E-mail: anne.schrag@wwfus.org
†Present address: College of Natural Resources, University of Arizona, Tucson, AZ 85712, USA.

© 2007 The Authors
Journal compilation © 2007 Blackwell Publishing Ltd