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Sustainability of culturally important teepee poles on Mescalero Apache Tribal Lands: Characteristics and climate change effects

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ABSTRACT

Integrating traditional ecological knowledge (TEK) with western science and modeling tools can enhance not only the delivery of culturally important species, but also community support and overall effectiveness of management. This paper presents a case study of co-producing usable science integrating TEK on a culturally important species with a modeling tool, Climate-Forest Vegetation Simulator (C-FVS). The Mescalero Apache tribe (southwestern USA) conduct a coming of age ceremony for young women who follow a traditional way of life. In order to conduct this ceremony, tall, thin teepee poles made from Douglas-fir trees are needed. Douglas-fir trees capable of producing teepee poles are a culturally important resource for the Mescalero Apache tribe. We interacted with medicine people, tribal members, and forest managers to gain insight on characteristics of teepee pole stands. We established thirty, 400 m^2 circular plots with nested 100 m^2 regeneration plots in teepee pole producing stands to characterize composition, structure, age, growth rates, and fuels. Teepee pole producing stands occupy an elevation range from 2012 to 2561 m, slopes of 3–43%, and aspects from NW to NE. The stands consist of dense, relatively old trees dominated by Douglas-fir, with other species of trees usually present as a minor component. Douglas-firs in teepee pole producing stands averaged 1255 ± 99 trees per ha (TPH), basal area 31.7 ± 1.5 m^2/ha, and 18.5 ± 0.5 cm quadratic mean diameters (QMD). Douglas-fir trees in teepee pole producing stands were most commonly 75–100 years old with diameters at breast height (DBH) ranging from 5.1 to 25.4 cm. In order to assess future trajectories of teepee pole stands, we applied C-FVS which incorporates the effects of climate change scenarios over the next 100 years. We compared three standard scenarios ranging from moderate to severe climate change: Representative Concentration Pathways (RCP) 4.5, 6.0, and 8.5. Simulated future forests at the current plot locations even under the most mild climate change scenario (RCP 4.5) did not contain Douglas-fir after a century of modeling. Complete forest mortality was predicted under RCP 6.0 and RCP 8.5. Comparing bioclimatic niche modeling of Douglas-fir with downscaled future climate scenarios indicated that the species would have to be planted at least 305 m higher to maintain 21st century viability under RCP 4.5 and 6.0, or at least 610 m higher under RCP 8.0. The characterization of current teepee pole producing stands and simulations of future effects of climate change provide useful information to the Mescalero Apache Tribe to support management decisions on how they would like to preserve this cultural important resource.

1. Introduction

Forests provide a wide variety of ecosystem services, including plants and animals supporting livelihoods and cultural traditions, but are under threat from loss of resilience with increasing temperature and decreasing precipitation (McDowell et al., 2016). Native American communities are particularly vulnerable to changing forest conditions as their values and identifies are linked to the natural landscape (Voggesser et al., 2013). Traditional ecological knowledge (TEK) is a cumulative body of knowledge, practice, and belief about the relationships among living beings and with their environment (Berkes et al., 2000) and guides the selection, management, and uses of culturally important species. TEK is often in the form of qualitative descriptions passed on through oral and experiential cultural transmissions, which make it challenging to incorporate into forest inventory and planning efforts (Hummel and Lake, 2015). Thus, ensuring sustainable access to culturally important resources may require developing unique climate adaptation strategies (Voggesser et al., 2013) by

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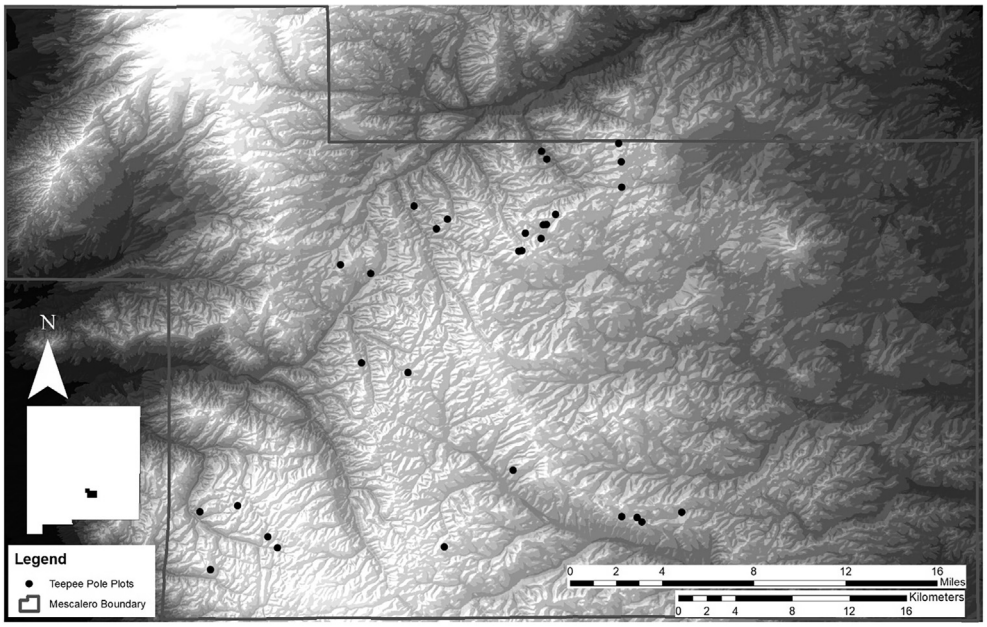

Fig. 1. Mescalero Apache Tribal Lands reference map in New Mexico. Mixed-conifer forests are found in the central region of the MATL. Shading indicates elevation from low (dark) to high (light). The highest elevation of the landscape, Sierra Blanca 3652 m, is at the northwest corner of the map.

integrating knowledge from different sources and traditions (Bohensky and Maru, 2011). Integrating TEK with western science and modeling tools can enhance not only the delivery of the target species, but also community support and overall effectiveness of management (Emery et al., 2014; Hummel and Lake, 2015; Costanza et al., 2017).

In south-central New Mexico, USA, the Mescalero Apache Tribe conducts a Coming-of-Age Ceremony for young women who follow a traditional way of life. This 12-day rite of passage ceremony marks the transition from girlhood into womanhood (Mescalero Apache Tribe 2018). As a key religious rite that the tribe observes today, the ceremony also serves a social function of gathering the tribal members who may live far away (Farrer, 1987). The maiden goes through a series of ceremonies led by medicine people to ensure that she lives a prosperous life. The preparation for a ceremony starts with selecting and harvesting trees to construct teepees and arbors, which are built with evergreen poles and oak branches (Farrer, 1987). Teepees are used for storage, cooking and living before, during, and after the ceremony. Each teepee requires 12 evergreen poles (Farrer, 1987). A ceremony can have 3–4 teepees with 1 “big teepee”. One medicine man stated that he conducted an average of nine ceremonies per summer, which would require up to 324–432 teepee poles. Poles are made exclusively from Rocky Mountain Douglas-fir (*Pseudotsuga menziesii var. glauca* (Beissn.) Franco), although conversations with medicine men indicated that other tree species such as aspen (*Populus tremuloides* Michx.) may have been used long ago. Rocky Mountain Douglas-fir can grow up to 35–46 m, reach about 0.9 m DBH, and can be found on cool, dry, interior mountain ranges from New Mexico up into Canada (Hermann and Lavender, 1999). It is smaller than the coastal variety (*Pseudotsuga menziesii* (Mirb.) Franco *var. menziesii*), that can reach 76 m tall and is found from California to British Columbia. Douglas-fir trees in the Southwest are found in warm/dry mixed conifer forests (Romme et al., 2009) which are vulnerable to warming climate and associated disturbances (Allen et al., 2010; Flatley and Fulé, 2016).

The Mescalero Apache Tribal Lands (MATL) are located in the Sacramento Mountain Range of New Mexico. The dominant forest type on MATL is warm/dry mixed conifer. Surface fires burned with sub- to multi-decadal frequency prior to Euro-American settlement (late 1800 s) but fires have been excluded for over a century (A. Azpeleta et al., unpublished manuscript), leading to several large, uncharacteristically severe crownfires in the 20th century (Historical Research Associates, 1981). Management of MATL forests is conducted jointly between the Bureau of Indian Affairs and the Tribe’s Division of Resource Management and Protection. Silvicultural treatments, fuels reduction operations, and prescribed burning are carried out on over 2023 ha annually. Much of the commercial forest area is managed for low-density, crownfire-resistant, efficient wood fiber production featuring Douglas-fir and ponderosa pine (Hoyt et al., 2016). However, an important core objective for Mescalero forest management includes the incorporation of traditional, religious, and cultural forest values. In the specific case of teepee pole production, the incorporation of traditional values creates a paradox for forest management. Contemporary forest management aims to restore and maintain open forests similar to historical conditions, but simultaneously the Mescalero Apache Tribe seeks to sustain patches of high-density Douglas-fir stands for teepee pole production. Recently, people who follow a traditional Mescalero Apache way of life have expressed concerns with silvicultural treatments such as thinning in teepee pole stands, leading the Tribal Council to identify teepee poles as a resource of concern in tribal government resolutions (#13–20) and to seek research on sustaining them for the future.

The study was initiated by a request from the tribe based on the long-term relationship that the researchers built with the tribe during previous research projects and continuous two-way communications to produce actionable science for the tribe, which are the key principles for co-producing usable climate science (Raymond et al, 2010; Meadow et al., 2015). The tribal stakeholders, including tribal and BIA forest managers, medicine men, and tribal members who conduct ceremonies, provided insight into the ecological, cultural, and management issues surrounding teepee pole producing stands. Based on this information, we sampled teepee pole stands across Mescalero’s forested lands with the following objectives: (1) characterize the: morphology (DBH, height, and form) of culturally desired teepee poles, composition, structure, age, growth rates, and fuels of current teepee pole stands; (2) apply forest simulation modeling to forecast teepee pole stand development and sustainability under alternative management and climate scenarios; and (3) provide the data for the tribe to develop plans for future management of this important cultural resource.