

## Advances in fire history research and their application for ecosystem management and conservation

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Paleoecology is a valuable tool for understanding the long-term ecosystem dynamics that underlie present environmental conditions. Fire is an important form of disturbance in most terrestrial ecosystems, and increased levels of biomass burning in many parts of the world have raised concerns about the role of fire in transforming vegetation composition, extent, and function in the future. Sedimentary charcoal records can help inform this discussion by providing fire-history information that spans a range of temporal and spatial scales. At a regional to continental scale, climate emerges as the strong driver of past biomass burning, with warmer periods being associated with higher fire activity. In many regions, humans have also significantly altered natural fire regimes through (1) igniting fires in places where fires were naturally rare, (2) lengthening the fire season through deliberate burning, (3) manipulating fuels through land-use activities, and (4) suppressing or eliminating natural fires. Human impacts are often greatest where fires are naturally infrequent. In New Zealand, for example, the arrival of people c. 700 years ago was associated with large-scale burning; deliberate fires destroyed about 40% of the native forests within decades and resulted in a fundamental transformation of many watersheds. In the European Alps, significant anthropogenic burning has occurred since the middle Holocene, and millennia of land use have altered both the vegetation and natural disturbance regimes. In contrast, in the US Rocky Mountains, past fire activity is largely driven by climate, and pre-European human influences are primarily local in scale. The implications of the past for the future will vary among these three regions: In the western U.S., increased temperatures will increase fire activity and likely shift ecosystems beyond the historical range of variability. In Europe, landscapes that have been long altered by people may be somewhat insensitive to climate-driven changes in fire occurrence. In New Zealand, future climate and land-use conditions will likely increase fire and help maintain current open landscapes at the expense of forest. In each example, knowledge of past fire variability can help guide appropriate management and conservation strategies.