4.1 SPATIAL AND TEMPORAL COHERENCE OF FOREST FIRE AND DROUGHT PATTERNS IN THE WESTERN UNITED STATES

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1. Introduction

Regional to sub-continental scale forest fire activity in the western United States is highly variable in space and time, but during certain years numerous large fires occur in many places. The great fire years of 1910 and 2000 are examples of years when major forest fires occurred in almost all regions of the western U.S. Conversely, during some years fire activity is low in most or all regions. And during other years fire activity is high in some regions, while low in others (e.g., the year 2001 had very high fire activity in the Pacific Northwest and low fire activity in the Southwest). Synchroneity of fire occurrence patterns at these very broad scales is controlled by climatic patterns (e.g., drought and wet episodes). I have investigated these patterns of fire and climate synchrony across the western United States over the period 1700 to present using a combination of modern (20th century) and paleo (pre-20th century) fire occurrence and climate records.

2. Data Sets and Spatial/Temporal Patterns

I assembled regional networks of crossdated fire-scar chronologies from forest stands in the Southwest (Arizona, New Mexico) and the Sierra Nevada of California. These chronologies extend back at least to AD 1700 (Swetnam and Baisan 1996, Swetnam et al. 2001), and in the case of giant sequoia groves in California back to ca. AD 1 (Swetnam 1993). Other fire historians have compiled networks of fire-scar chronologies in the eastern Cascades, Washington (Everett et al. 2000), and Blue Mountains, Oregon (Heyerdahl et al. 2001). I combined these networks in an assessment of spatial and temporal patterns of fire synchrony in four sub-regions of the western U.S.

An outstanding feature of within-region comparisons of fire-scar chronologies is the high synchroneity of certain fire years. There is also high synchroneity of years when few fires were recorded within regions. (Figure 1). For example, in the year 1748, 41 of 63 Southwestern sites recorded a fire, while in 1749 only one site recorded a fire. Since most of the sampled stands are too distant for fire spread between them, this synchroneity is almost certainly due to regional climatic factors. Direct comparisons with drought reconstructions from tree-rings (Cook et al. 1999) confirms the largest and smallest fire years are highly correlated with dry and wet years, respectively (Swetnam and Baisan 1996, Swetnam and Betancourt 1998, Veblen et al. 2000).

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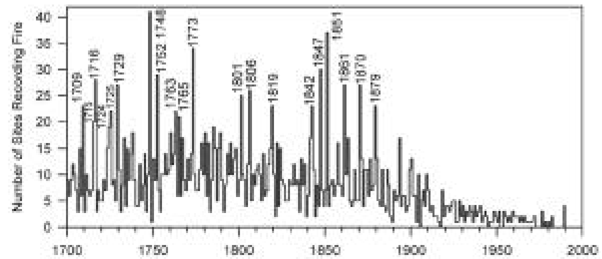

Figure 1. Synchronous fire years across the Southwest are indicated by labeled years in the composite fire-scar chronology from a total of 63 sites.

The fire scar chronologies from ponderosa pine and mixed conifer forests from the western U.S. typically show frequent surface fires until the late 1800s. The decline in recorded fires after this time was due to a combination of forced removal of Native Americans from some areas, introduction of large numbers of livestock, and subsequent organized fire suppression by government agencies (Swetnam and Baisan 1996, Swetnam et al. 2001).

Twentieth century fire occurrence and climate records, including mapped patterns of drought severity, show that regional fire years and drought were often in anti-phase between the Pacific Northwest and Southwest (Figure 2). A western U.S. “dipole” in precipitation patterns has been noted before, and long-term assessments show that the strength and latitudinal position of the switching of dry/wet conditions changes through time (Dettinger et al. 1998, McCabe and Dettinger 1999). The strength and geographic positions of the dipole are probably associated with a combination of ENSO and PDO teleconnections.

Comparisons of synchronous large and small fire years between regional fire-scar networks from the Southwest, Sierra Nevada, and the Pacific Northwest reveal interesting spatial associations that correspond with broad-scale climatic patterns (Figure 3). A common pattern, for example, is an inverse relation between the Southwest and Pacific Northwest in fire activity and in winter rainfall during extreme ENSO events. Other patterns show synchronous fire activity in the Southwest and Sierra Nevada during some drought events, and asynchronous during others (Figure 3).

These findings have a number of important implications for using antecedent and current climatic patterns for allocating fire fighting or prescribed burning resources at continental scales. Comparisons of well-dated, high resolution fire chronologies across scales, from regions to continents, has good potential for revealing important ecosystem responses to global climate patterns (Kitzberger et al. 2001).

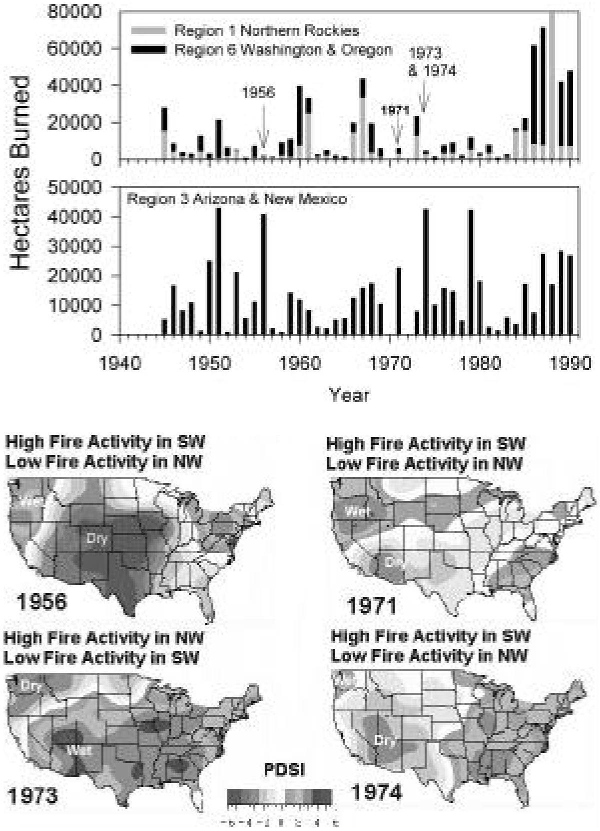

Figure 2. Time series of area burned on National Forest lands in the Northern Rockies, Washington and Oregon, and Arizona and New Mexico (upper graphs). Large and small fire years are sometimes in anti-phase between the Northwest and Southwest. Mapped patterns of summer Palmer drought severity indices (PDSI) generally correspond with these 20th century fire events. Similar spatial associations in the 18th and 19th centuries are evident in PDSI and synchronous fire occurrence events from tree ring reconstructions (as will be shown in the presentation).

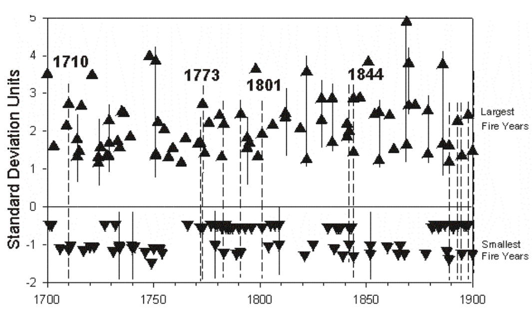

Figure 3. The largest (up arrows) and smallest (down arrows) fire years in the four sub-regions are compared. Regionally synchronous events are indicated with solid lines and asynchrony (large versus small years) are indicated with dashed lines. Note that certain decades have predominantly synchronous or asynchronous events.

3. References

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