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Fire history and fire management implications in the Yukon Flats National Wildlife Refuge, interior Alaska

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ABSTRACT

We conducted this investigation in response to criticisms that the current Alaska Interagency Fire Management Plans are allowing too much of the landscape in interior Alaska to burn annually. To address this issue, we analyzed fire history patterns within the Yukon Flats National Wildlife Refuge, interior Alaska. We dated 40 fires on 27 landscape points within the refuge boundaries using standard dendrochorological methods. Fire return intervals based on tree ring data ranged from 37 to 166 years (mean = 90 $\pm$ 32 years; N = 38) over the 250 year time frame covered by this study. We found no significant differences in the frequency of fire occurence over time. There was no evidence to suggest that changes in fire management policy have significantly altered the fire regime in the Yukon Flats area. However, the lack of significant differences over time may be due in part to the relatively short time period that fires were actively suppressed in Alaska. The full suppression era (1939–1984) may have been too short to significantly alter the fire regime in all areas of interior Alaska.

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1. Introduction

Wildfires have long been known to play an important role in the development of black spruce (*Picea mariana*), white spruce (*Picea glauca*), and mixed spruce-hardwood (*Betula-Populus* spp.) forests in interior Alaska (Lutz, 1956; Viereck, 1973, 1983; Foote, 1983). Yet, between 1939 and 1984 federal policy for interior Alaska mandated that all wildfires be suppressed whenever possible (Gabriel and Tande, 1983; Norum et al., 1983; Vanderlinden, 1996; Roessler, 1998). While this policy was in force, fire suppression organizations intended to limit the occurrence and growth of all wildfires. However, all wildfires were neither actively suppressed nor controlled; some wildfires escaped notice while others were not attacked due to a lack of suppression resources (Norum et al., 1983).

From 1982 through 1984 a series of 13 interagency fire management plans were implemented (Vanderlinden, 1996; Roessler, 1998). Combined into the current Alaska Interagency Fire Management Plan (AIFMP) in 1998, these plans effectively altered and prioritized fire suppression responses across the landscape. Since this change in policy, the total area burned annually in Alaska has increased. For example, two of the three largest fire years on record for Alaska occurred in 2004 and 2005 with 707 fires burning approximately 2.7 million hectares in 2004 and 625 fires burning approximately 1.8 million hectares in 2005 (Rogers, 2005). In contrast, during the latter period of active fire suppression (1964–1984) approximately 246,000 hectares were burned annually by wildfire (Hess et al., 2001).

The main impetus for the AIFMP was to reduce fire suppression costs (Haggstrom, 1994; Roessler, 1998), however there is some debate as to the ecological desirability of the corresponding increase in wildfire activity (Roessler, 1998). Critics of the current fire management policies argue that too much land is burning in these large fires within a single fire season. They feel that some areas in Alaska are burning more frequently and more contiguously than sound ecosystem management policies necessitate. To many, the crux of the problem with the current AIFMP is that it is based on economic realities rather than on a scientific management decision matrix (Roessler, 1998). However, supporters of the present AIFMP argue that the current level of fire in the landscape is natural and provides an essential ecosystem process (DeWilde and Chapin, 2006); any subsequent planning or further study is unnecessary (Roessler, 1998).

The social and economic effects of past and present fire suppression policies have been discussed elsewhere (Natcher, 2004; DeWilde and Chapin, 2006). However, an evaluation of the influences of fire suppression policies on fire frequencies over time

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was lacking. Our study was conducted to investigate potential changes in fire frequency over time and to provide more basic fire history information for interior Alaska. Information on where, when, and how often fires occurred in the past is necessary to evaluate the efficacy of the present AIFMP in a historical context. Specifically, we compiled fire histories on a range of forest types within the Yukon Flats National Wildlife Refuge (YFNWR). Our objectives are to identify the years when fires occurred, the stand ages when fires occurred, and the time intervals between successive fires over a range of past and current fire suppression policies in the YFNWR.

2. Background

2.1. Fire history in interior Alaska

Detailed information on fire history in interior Alaska is lacking. The fire regime of the boreal forest is characterized by stand-replacing fires (Johnson, 1992), which do not leave trees with records of multiple fires as occur in other forest types (Dieterich and Swetnam, 1984). Moreover, the few existing fire history studies in Alaska may have limited application to interior white and black spruce forests. For example, Alaskan fire history studies based entirely on documentary fire records (Barney, 1969; Gabriel and Tande, 1983; Kasischke et al., 2002) tend to be limited by multiple missing records, the possibly inaccurate and/or incomplete reporting of fires, and the relatively short time period covered by historical records (1950 to present). Fire history studies based on charcoal and pollen analysis have provided much needed temporal depth to the fire record in Alaska (Lynch et al., 2003, 2004; Anderson et al., 2006; Berg and Anderson, 2006), but these studies tend to lack annual precision. Fire history studies based on tree rings where individual fires can be dated precisely exist (Mann et al., 1995; DeVolder, 1999; Mann and Plug, 1999; Fastie et al., 2003). However, these studies tend to be located near large settlements (Fastie et al., 2003), in a more maritime climate such as the Kenai Peninsula (DeVolder, 1999), and/or lacked spatial extent (Mann et al., 1995; Mann and Plug, 1999; Fastie et al., 2003). Yarie (1981) provided information on fire occurrence in interior Alaska forests. However, the lack of fire scar evidence to precisely date fires, and the exclusive use of standing age distributions to estimate fire return intervals in Yarie's study may have resulted in inaccurate estimates of fire history (Huggard and Arsenault, 1999).

2.2. Wildfire and climate relationships in Alaska

Variation in the amount of area burned annually in boreal forest ecosystems may be related to climate variability (Skinner et al., 1999; Hess et al., 2001; Duffy et al., 2005). Wildfire statistics for Canada have been used to relate annual increases in area burned to circulation anomalies that create above normal temperature and below normal precipitation conditions during the fire season (Skinner et al., 1999, 2002). For Alaska, large wildfire years (defined by increased area burned) have been positively correlated with the El Niño Southern Oscillation (ENSO; Hess et al., 2001). El Niño events may be conducive to wildfire as temperatures tend to be warmer than average and precipitation levels are below average (Hess et al., 2001). Duffy et al. (2005) provide additional evidence linking annual area burned in Alaska to global circulation patterns. Positive phases of the East Pacific teleconnection were related to surface high-pressure systems that block westerly flows causing warmer temperatures, lower precipitation, and above average area burned (Duffy et al. 2005). Duffy et al. (2005) also found connections between the Pacific Decadal Oscillation (PDO) and annual area burned in Alaska. The cool phase of the PDO potentially influences winter and summer precipitation levels creating conditions conducive to fire ignition and spread but the mechanisms for these connections are unclear (Duffy et al., 2005). In our study, we investigate potential relationships between fire occurrence and the El Niño Southern Oscillation to clarify the influences of climate versus fire suppression policies.

2.3. The Alaska Interagency Fire Management Plan (AIFMP)

The AIFMP prioritizes fire suppression responses based on the proximity of urbanized areas, presence of private property, presence of high-value natural resources, and the economic and ecological consequences of fire suppression (Roessler, 1998). The AIFMP places all lands in Alaska into one of four broad wildfire response categories: critical, full, modified, and limited. All wildfires are aggressively suppressed on lands designated as warranting critical and full suppression. Wildfires on lands designated as modified are attacked early in the fire season, but after a predetermined date, usually July 10 for interior Alaska, they are commonly monitored. Fires on limited lands are monitored and allowed to burn unchecked as long as life and property are not threatened. As of 1996, approximately 65% of the fire-prone acreage on state and federal lands in Alaska was in the limited action suppression category (Vanderlinden, 1996).

3. Study area

3.1. Physiography

The Yukon Flats National Wildlife Refuge is located in northeast interior Alaska (Fig. 1). The refuge is approximately 4.5 million hectares in area with boundaries that extend 192 km from north to south (67 30′N to 65 45′N) and 352 km east to west (142–150° W). Enclosed within the refuge boundaries are portions of four topographic regions: the Yukon Flats (the largest interior basin in Alaska) which comprises most of the central portion of the refuge; the Kokrine-Hodzana Highlands in the refuge's northwestern portion; the Yukon-Tanana Uplands that make up its southern portion; and the Porcupine Plateau in the eastern portion of the refuge (Selkregg, 1976).

3.2. Climate and vegetation

Climate within the Yukon Flats National Wildlife Refuge is classified as continental (Gallant et al., 1995). Winters are cold with daily temperatures averaging from −34 to −24 °C (Gallant et al., 1995). Summers are warm (although below freezing temperatures may occur during any month) with daily high temperatures averaging around 22 °C. Total precipitation averages 16.7 cm annually at Fort Yukon (located centrally within the refuge boundary) with most of the precipitation that falls as rain occurring in July (2.4 cm) and August (3.1 cm). Summer precipitation often falls episodically in thunderstorms and rain showers which results in very localized rainfall patterns. Snow covers the ground from October to May and the average snowfall each winter is approximately 1.1 m.

Vegetation patterns are quite diverse within the Yukon Flats National Wildlife refuge. Conifer, broadleaf, and mixed species forests form a heterogeneous patchwork of multiple-aged forests that occupy individual sites depending on soil characteristics and wildfire disturbance events (Gallant et al., 1995; Viereck, 1973; Foote, 1983). White spruce (*P. glauca*) commonly dominate well-drained conifer forests, while black spruce (*P. mariana*) are more dominant in poorly-drained, cooler forested areas (Gallant et al., 1995). Aspens (*Populus tremuloides*) tend to dominate broadleaf