SNOW AVALANCHE PATH ECOLOGY: EXAMPLES FROM THE SAN JUAN MOUNTAINS, COLORADO

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ABSTRACT:

We evaluated landscape ecology approaches to characterize snow avalanche paths based on patterns of plant species composition and evidence of disturbance. Historical records of avalanche incidents, patterns in the annual growth layers of woody plants, and distributions of plant species can be used to quantify and map the frequency and magnitude of snow slide events. Near Silverton, Colorado, a series of snow storms in January of 2005 resulted in many avalanche paths running full track at 30 and 100 year return frequency. Many avalanches cut fresh trimlines, widening their tracks by uprooting, stripping, and breaking mature trees. Powerful avalanches deposited massive piles of snow, rocks, and woody debris in their runout zones. We used cross-section discs and cores of representative downed trees to detect dendro-ecological signals of past snow avalanche disturbance. Avalanche signals included impact scars from the moving snow and associated wind blast, relative width of annual growth rings, and development of reaction wood in response to tilting. Initial measurements of plant diversity and disturbance along the elevation gradient of an avalanche path near Silverton indicate that avalanche activity influences patterns of forest cover, contributes to the high local plant species diversity, and provides opportunities for new seedling establishment.

KEYWORDS:
snow avalanche path vegetation, plant species diversity, tree-ring analyses, disturbance ecology

1. INTRODUCTION

An avalanche path refers to an area where a mass of snow moves rapidly down a mountain slope, including the starting zone where unstable snow releases, the track that is impacted by the moving snow and powder blast, and the runout zone where snow and debris is deposited. Snow avalanche disturbances can reduce the density of trees and other vegetation where they occur, resulting in linear patterns of open vegetation within otherwise forested mountain terrain (Johnson 1987). Areas of frequent avalanche activity often appear as vertical swaths of open vegetation down steep mountain slopes, characterized by a different type or age of the dominant vegetation, or a lack of vegetation (Butler 2001, Walsh et al., 2004, Tanaka et al., 2008).

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Below treeline, forest vegetation can shelter avalanche-prone slopes, slowing the redistribution of snow due to wind and shading the snow surface from solar radiation. Intact forest vegetation can influence the formation of cohesive slabs and potentially prevent the initiation of snow slides. However, many avalanches occur high above treeline in steep alpine terrain. Once a snow slide is initiated, the mass of moving snow can mobilize anything in its path.

Vegetation and tree-ring analyses in avalanche path starting zones, tracks, and runouts can be used to improve the dating of past avalanches and estimate the frequency and intensity of snow slide events for specific avalanche path locations (Burrows and Burrows 1977, Jenkins and Hebertson 2004).

2. STUDY AREA AND METHODS

Near Silverton, in the San Juan Mountains of southwestern Colorado, a series of snow storms in January of 2005 resulted in many avalanche paths running full track at 30 and 100 year return frequency (Logan and Williams 2005). Many avalanches cut fresh trimlines, widening their tracks by uprooting, stripping, and breaking mature trees. Powerful avalanches deposited massive piles of snow, rocks, and woody debris in their runout zones.

We conducted an initial evaluation of landscape ecology approaches to characterize avalanche paths based on patterns of plant species composition and evidence of disturbance. Combined with historical records of avalanche incidents, patterns in the annual growth layers of woody plants and distributions of plant species can be used to quantify and map the frequency and magnitude of snow slide events.

We sampled cross-section discs of representative downed trees and increment cores of damaged trees to detect dendro-ecological signals of past snow avalanche disturbance. Avalanche signals recorded in woody plant tissue included direct impact scars from the moving snow and associated wind blast, development of reaction wood in response to tilting, and variation in the relative width of annual growth rings.

Forest monitoring vegetation plots (circular 7.3m radius plots with three 1m2 subplots), were also sampled to assess patterns of plant species diversity and map evidence of disturbance on the elevation gradient of an example avalanche path near Silverton, Colorado (Atkins 2001).

3. PRELIMINARY RESULTS

Documented observations of avalanche events provide the most reliable information, but historic records are often incomplete or strongly influenced by patterns of human activity in an area (Carrara 1979, Armstrong and Armstrong 2006). Aside from reported avalanche observations, impact scars and characteristic damage to woody plants from the moving snow and associated wind blast provide the most direct evidence of snow slide activity. We also found that multiple indirect signals of dendro-ecological disturbance can be used in combination to estimate the local geography of past snow avalanches. These can include the ages of trees in reforested tracks, relative width of annual growth rings, development of reaction wood in response to tilting, and evidence of physiological stress such as the presence of traumatic resin ducts.

Avalanche disturbances create unique habitats for plants and animals in subalpine areas worldwide, but at the same time avalanches can pose major threats to humans (Rixen et al, 2007). Our preliminary measurements of plant diversity along the elevation gradient of an avalanche path near Silverton support this observed pattern of relatively high plant species diversity in avalanche path terrain. Our observations also indicate that snow avalanches interact with multiple disturbance processes to influence patterns of landscape vegetation and forest cover, and can provide opportunities for both native and non-native plant species seedling establishment.

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