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Tree-ring history of Swiss needle cast impact on Douglas-fir growth in western Oregon: Correlations with climatic variables

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Abstract

The fungal pathogen, *Phaeocryptopus gaumannii*, occurs wherever Douglas-fir is found but disease damage is believed to be limited to the Coast Range and is of no concern outside the coastal fog zone (Shaw et al., 2011). However, knowledge remains limited on the history and spatial distribution of Swiss Needle Cast (SNC) impacts in the Pacific Northwest. We reconstructed the history of SNC impacts on mature Douglas-fir trees based on tree ringwidth chronologies from the west slope of the Coast Range to the high Cascades of Oregon. Our findings show that SNC impacts on growth occur wherever Douglas-fir is found in western Oregon and is not limited to the coastal fog zone. The spatiotemporal patterns of growth impact from SNC disease were synchronous across the region, displayed periodicities of 25-30 years, strongly correlated with winter and summer temperatures and summer precipitation, and matched the patterns of enriched cellulosic stable carbon isotope indicative of physiological stress. While winter and summer temperature and summer precipitation influenced pathogen dynamics at all sites, the primary climatic factor of these three limiting factors varied spatially by location, topography, and elevation. In the 20th century, SNC impacts at low- to mid-elevations were least severe during the warm phase of the Pacific Decadal Oscillation (PDO, 1924-1945) and most severe in 1984-1986, following the cool phase of the PDO (1945-1977). At high elevations on the west slope of the Cascade Mountains, SNC impacts were the greatest in the 1990s and 2000s due to warmer winter temperatures associated with climate change. Warmer winters will likely continue to increase SNC severity at higher elevation, north along the coast from northern Oregon to British Columbia, and inland sites where current winter temperatures limit fungal growth. Surprisingly, tree-ring records of ancient Douglas-fir logs dated > 65,000 radioactive years B.P. from Eddyville, OR displayed the same 7- and 30-year periodicities of SNC impact as found in modern day coastal Douglas-fir tree-ring records. Our findings indicate that SNC is a significant forest

health problem that has persisted for as long as its host and will likely continue to be an ecologically important biotic factor in the future.