Fraser, R.H., T.C. Lantz, L. Olthof, S.V. Kokelj, and R.A. Sims. 2014. Warming-induced shrub expansion and lichen decline in the Western Canadian Arctic. Ecosystems 17(7): 1151-1168.

Abstract

Strong evidence for a pan-Arctic expansion of upright shrubs comes from analysis of satellite imagery, historical photographs, vegetation plots, and growth rings. However, there are still uncertainties related to local-scale patterns of shrub growth, resulting interactions among vegetation functional groups, and the relative roles of disturbance and climate as drivers of observed change. Here, we present evidence that widespread and rapid shrub expansion and lichen declines over a 15,000 km^2 area of the western Canadian Arctic have been driven by regional increases in temperature. Using 30 m resolution Landsat satellite imagery and high resolution repeat color-infrared aerial photographs, we show that 85% of the land surface has a positive 1985–2011 trend ($P < 0.05$) in NDVI, making this one of the most intensely greening regions in the Arctic. Strong positive trends (>0.03 NDVI/decade) occurred consistently across all landscape positions and most vegetation types. Comparison of 208, 1:2,000 scale vertical air photo pairs from 1980 and 2013 clearly shows that this greening was driven by increased canopy cover of erect dwarf and tall shrubs, with declines in terricolous lichen cover. Disturbances caused by wildfires, exploratory gas wells, and drained lakes all produced strong, yet localized increases in NDVI due to shrub growth. Our analysis also shows that a 4°C winter temperature increase over the past 30 years, leading to warmer soils and enhanced nutrient mineralization provides the best explanation for observed vegetation change. These observations thus provide early corroboration for modeling studies predicting large-scale vegetation shifts in low-Arctic ecosystems from climate change.