Predictions of Climate-induced Boreal Forest Change and the Current State of Change

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Abstract: For about three decades, there have been many predictions of the potential ecological response in boreal regions to the currently warmer conditions. In essence, a widespread, naturally occurring experiment has been conducted over time. In this paper, we describe previously modeled predictions of ecological change in boreal Alaska, Canada and Russia, and then we investigate potential evidence of current climate-induced change. For instance, ecological models have suggested that warming will induce the northern and upslope migration of the treeline and an alteration in the current mosaic structure of boreal forests. We present evidence of the migration of keystone ecosystems in the upland and lowland treeline of mountainous regions across southern Siberia. Ecological models have also predicted a moisture-stress-related dieback in white spruce trees in Alaska, and current investigations show that as temperatures increase, white spruce tree growth is declining. Additionally, it was suggested that increases in infestation and wildfire disturbance would be catalysts that precipitate the alteration of the current mosaic forest composition. In Siberia, five of the last seven years have resulted in extreme fire seasons, and extreme fire years have also been more frequent in both Alaska and Canada. In addition, Alaska has experienced extreme and geographically expansive multi-year outbreaks of the spruce beetle, which had been previously limited by the cold, moist environment. We suggest that there is substantial evidence throughout the circumboreal region to conclude that the biosphere within the boreal terrestrial environment has already responded to the transient effects of climate change. Additionally, temperature increases and warming-induced change are progressing faster than had been predicted in some regions, suggesting a potential non-linear rapid response to changes in climate, as opposed to the predicted slow linear response to climate change.