ABSTRACT

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Climate change may produce novel climate-fire-vegetation relationships in Greater Yellowstone during the 21st Century

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Ecologists increasingly recognize that climate-induced increases in fire activity may catalyze rapid ecological change and contribute to regime shifts. However, the magnitude, timing and spatial patterns of anticipated changes are not well resolved at regional scales. Here, I synthesize recent studies of climate change, fire regimes, and vegetation in Greater Yellowstone (Wyoming, USA), a large, wildland landscape dominated by conifer forests and characterized by infrequent, high-severity fire. Greater Yellowstone is projected to become much hotter and drier with ongoing climate change, and recent studies suggest a novel fire regime is possible by the mid 21st Century. Large fires (> 200 ha) are anticipated to occur much more frequently than in the past 5,000 to 10,000 yrs. Years without large fires are expected to become rare with continued warming, and fire rotation is projected to shorten to < 30 yrs from the historical 100–300 yrs. Anticipating vegetation shifts in Greater Yellowstone under such novel climate-fire regimes is complex, but forest resilience could be compromised through at least three mechanisms. First, increased fire frequency could reduce postfire tree regeneration if fires recur before seed supply is replenished in developing stands; and reduce carbon storage if legacy wood from previous fires is combusted in the subsequent fire. Second, the occurrence of fire soon after a prior disturbance (e.g., bark beetle outbreak) could reduce postfire tree regeneration (and thus subsequent carbon recovery) if prefire seed supply was reduced. Third, warmer and drier conditions in the years after fire could depress postfire tree seedling establishment and subsequent carbon recovery, even with an abundant seed source. Modeling studies and field evidence following recent fires provide initial support for these mechanisms. Continued warming could completely transform fire regimes in Greater Yellowstone by the mid-21st Century, with profound consequences for many species and ecosystem services.