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The anthropogenic imprint on temperate and boreal forest age structure and carbon turnover

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The sweeping transformation of the biosphere by humans over the last millennia leaves only limited windows into its natural state. Much of the forests that dominated temperate and southern boreal regions have been lost and those that remain typically bear a strong imprint of harvest activity. Here, we ask how would the dynamics, structure and function of temperate and boreal forests differ in the absence of harvest? We focused our analysis on the human-induced shift in forest disturbance dynamics and its resultant effects on forest age structure and carbon cycling. We constructed an empirical model of natural disturbance probability as a function of community traits and climate, based on observed disturbance rate and form across 77 protected forest landscapes distributed across three continents. Coupling this to a dynamic vegetation model, we generate estimates of stand-replacing disturbance return intervals and calculate the forest age structure that results. We compare this to best estimates of current age structures based on (a) past land-use change and management and (b) forest inventory observations. Modern forests are typically much younger than those under natural disturbance only, with 43% less old-growth stands. This results in a 33% reduction in vegetation carbon turnover time across temperate forests and a 14% reduction for boreal forests. Understanding the state and dynamics of forests in the absence of harvest provides context for making decisions related to global conservation and climate change mitigation efforts, especially related to nature-based solutions.