ABSTRACT

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Changing fire regimes and resilience of lodgepole pine forests in Yellowstone

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Background/questions/methods

Novel fire regimes have the potential to erode forest resilience (ability to tolerate disturbance without shifting to a new forest state) in fire-prone forested landscapes. In Greater Yellowstone (Wyoming, USA), lodgepole pine (*Pinus contorta* var. *latifolia*) forests have been highly resilient to large stand-replacing fires that historically burned at 100 to 300-yr intervals. However, fire-return intervals (FRI) are projected to decline substantially by mid-century as climate warms, increasing the likelihood that forests will re-burn before recovering fully from previous fire. During summer 2016, large high-severity fires in Greater Yellowstone re-burned >18,000 ha of young lodgepole pine forests that regenerated after wildfires in 1988 and 2000. We studied these recent short-interval (16 and 28-yr FRI) stand-replacing fires and asked whether short-interval fires were associated with increased burn severity (e.g., tree mortality, charred surface cover), decreased initial postfire conifer regeneration, and reduced woody carbon storage. During summer 2017, we sampled 0.25-ha plots in short-interval fires (n=18 plots) and in nearby young forests that had not re-burned (n=9 plots). We hypothesized that short-interval fires would reduce forest resilience because burns would be of higher severity, and postfire conifer regeneration and carbon storage would both be substantially reduced.

Results/conclusions

Similar to long-interval fires in Yellowstone, short-interval fires were stand-replacing and created a mosaic of burn severities. However, the range of burn severities was greater than we have observed previously across a range of FRI; in some plots, pre-fire biomass (e.g., live lodgepole pines and downed coarse wood) was completely combusted. Postfire tree seedling density in re-burns declined with increasing burn severity and was 72-99% lower than regeneration after the previous (long-interval) fire. Although tree seedlings were recorded in all re-burned stands, our data indicate conversion from high-density (>70,000 stems/ha) to sparse (<1000 stems/ha) forest where short-interval fires were of extremely high burn severity and far from unburned forest. Postfire coarse wood abundance also declined sharply with increasing fire severity, indicating substantial reductions in carbon stocks. Postfire recovery of carbon stocks has historically taken about 100 years in these forests. However, re-burns caused additional carbon loss, and sparse tree regeneration will likely slow subsequent rates of postfire carbon accretion. Short-interval fire alone was insufficient to catalyze a transition to non-forest, but more extreme and variable burn severity plus slower forest recovery could erode resilience of lodgepole pine forests in Greater Yellowstone.