Research Brief for Forest Managers

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Climate-Driven Changes in Forest Succession

Climate and species interactions influence where individual tree species are capable of establishing and growing. Both of these factors also influence growth rates, which can alter the carbon dynamics in a forest. The higher temperatures and changes in precipitation projected to occur with on-going climate change have the potential to alter species distributions and interactions.

In a study at Joint Base Lewis-McChord (JBLM), Washington we used a landscape simulation model to quantify the effects of projected changes in climate under moderate and high emission scenarios on forest dynamics. We also simulated different management scenarios to determine if management actions altered forest response to changing climate. We simulated a no-action control, prescribed burning, thinning based on JBLM's management plan, and thinning coupled with prescribed burning. In the absence of management, we found relatively small changes in the net ecosystem carbon balance (NECB) under climate projections from the moderate emission scenario (Figure 1A). However, under the high emission scenario, we found a substantial decrease in the amount of carbon sequestered by the forest during the late century period (Figure 1B).

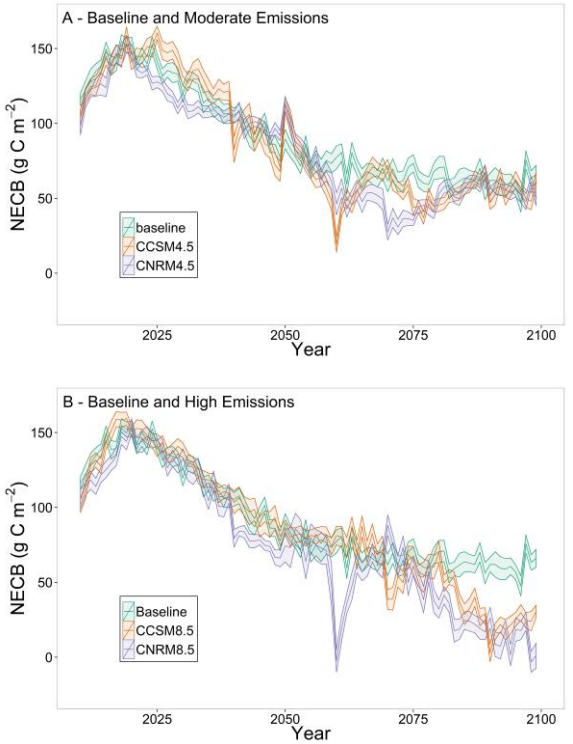

Figure 1: Net Ecosystem Carbon Balance (NECB) for the no management (control) simulations under baseline climate and climate projections from two general circulation models (CCSM and CNRM), driven by moderate (RCP 4.5) and high (RCP 8.5) emission scenarios. Lines are the mean NECB and shading the 95% confidence intervals from 25 replicate simulations.

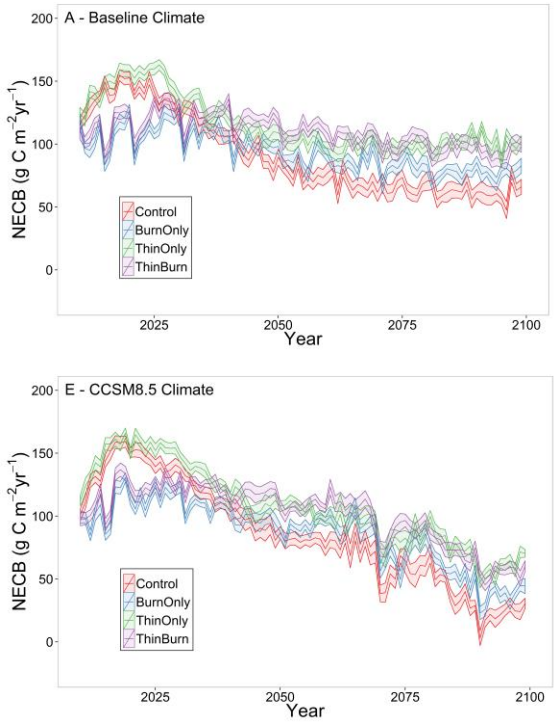

Figure 2: Net Ecosystem Carbon Balance (NECB) of simulated forest management treatments (control, burn-only, thin-only, thin-and-burn) under baseline climate and climate projections from a high emission scenario. Lines are the mean NECB and shading the 95% confidence intervals from 25 replicate simulations.

When we simulated the different management actions under the baseline climate, we found that treatments caused an increase in the amount of carbon sequestered by the forest after 30 years (Figure 2A). Under the high emission scenario, treatments had a similar effect on forest carbon sequestration. However, treatment effects were insufficient to prevent the climate-driven decline in carbon sequestration (Figure 2E).

Projected climate from the high emission scenario also caused a decline in the amount of areas at JBLM that had higher tree species richness. The warmer, drier summers projected under the high emission scenario prevented late-successional species, such as western hemlock and western redcedar, from establishing in many places. This contributed to a landscape-level decline in forest carbon sequestration. Given the range of species-specific responses to climate, a strategy that produces heterogeneous ecological conditions presents the best strategy for a resilient ecosystem.

Management Implications:

- In the short term, thinning and burning treatments in Douglas-fir forest decrease carbon storage.
- In the long-term, however, management treatments can increase the carbon sequestration rate.
- Future climate under the high emission scenario will decrease carbon sequestration and species will respond differently to the warmer, drier conditions.

References:

Laflower, D.M., M.D. Hurteau, G.W. Koch, M.P. North, B.A. Hungate. 2016. Climate-driven changes in forest succession and the influence of management on forest carbon dynamics in the Puget Lowlands of Washington State, USA. Forest Ecology and Management, 362:194-204.

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