Effects of climate change and fire on forests in southwest Yukon Territory, Canada

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Introduction

In the Yukon Territory, mean annual temperature has risen between 1 and 3°C in the latter half of the 20th century, with some regions warming more than others. We have modelled the effects of temperature and precipitation changes due to global warming on tree phenology and fire regimes in the southwest Yukon Territory of Canada.

Questions

- How will species in a cold boreal forest respond to climate change?
- What are the impacts of climate change and fire on forest composition and structure?

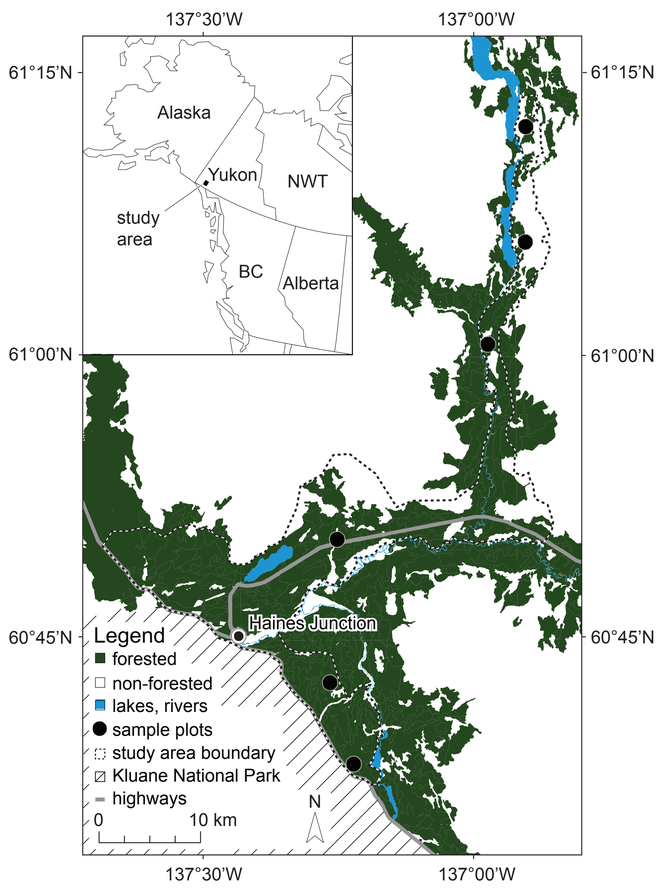

Figure 1. We modelled the dynamics of 53,000 hectares of cold boreal forest in southwestern Yukon, near Haines Junction and Kluane National Park.

Methods

Forest inventory geospatial data along with supplemental information in the form of stand age structures and soil properties from 90 plots in 6 locations were used to parameterize the TACA (Tree and Climate Assessment; Nitschke and Innes 2008) and LANDIS-II (Scheller et al. 2007) models. Weather data were from 3 meteorological stations in the study area.

TACA is a mechanistic species distribution model which analyses the response of trees in their regeneration niche to climate-driven phenological and biophysical attributes. It was applied to predict forest cover in the study area over 200 years under the influence of current climate and high climate change.

LANDIS-II, a spatially explicit forest landscape model, was used to simulate current climate and high climate change conditions, fires of different extents and severities, and forest succession over the same period.

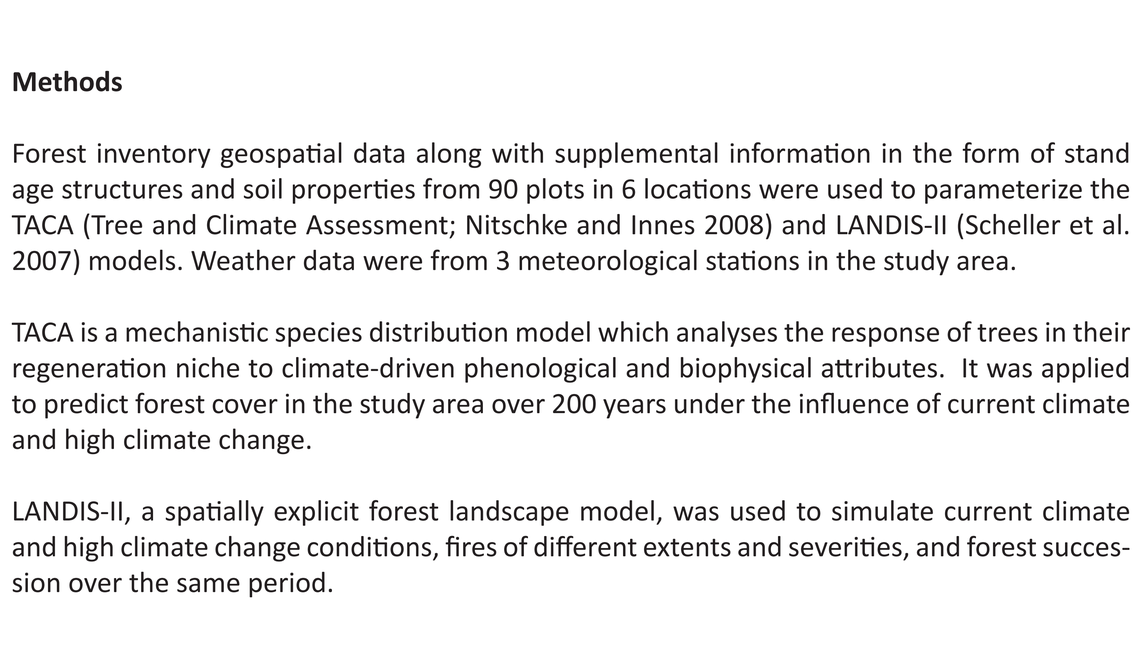

Figure 2. The majority of the forest is dominated by white spruce, trembling aspen or mixed wood [left], which grows on xeric, subxeric or mesic sites [right].

Results

- Effects of climate change on tree establishment vary among species and soil types (Fig. 3).
- White spruce dominates the landscape but decreases with climate change and fire. Abundance of lodgepole pine increases with fire and is enhanced by climate change. Trembling aspen and balsam poplar also increase with fire and climate change (Fig. 4).
- Fire had a greater effect than climate change on the cover of different forest types (Fig. 5) and on landscape structural diversity indicated by seral stages (Fig. 6).

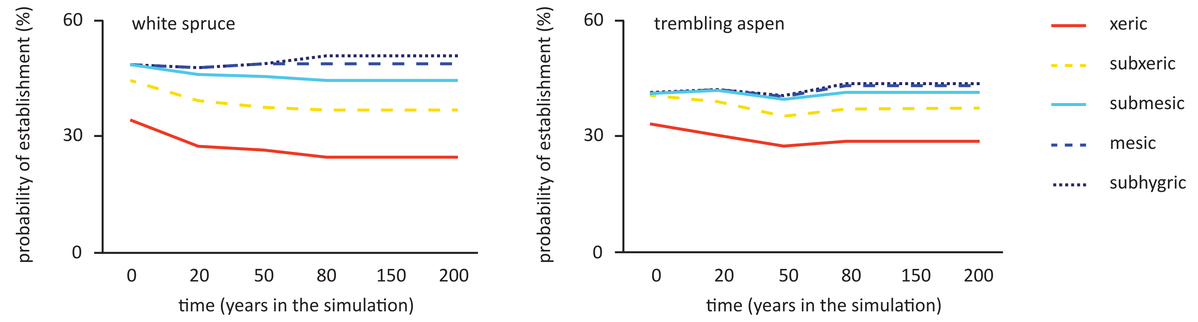

Figure 3. Establishment probabilities for white spruce and trembling aspen vary among soil types over the 200 years modelled using TACA.

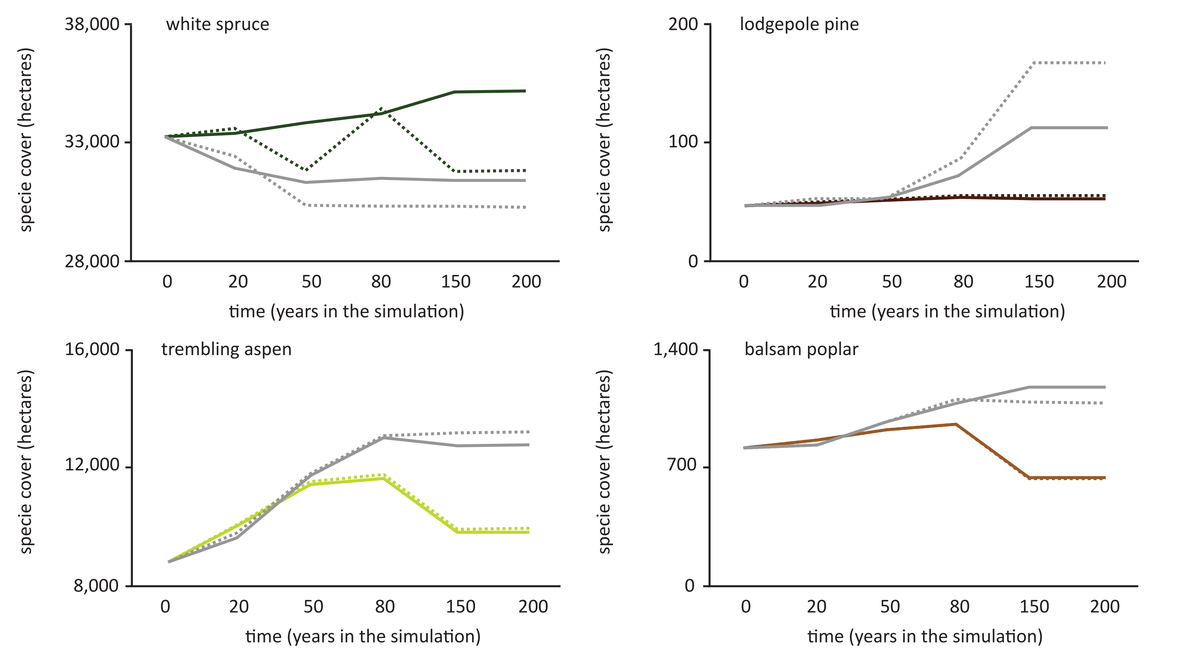

Figure 4. Abundance of 4 tree species over 200 years modelled using LANDIS-II. Four scenarios are: current climate (coloured line), climate change (dotted coloured line), current climate & fire (grey line), climate change & fire (dotted grey line).

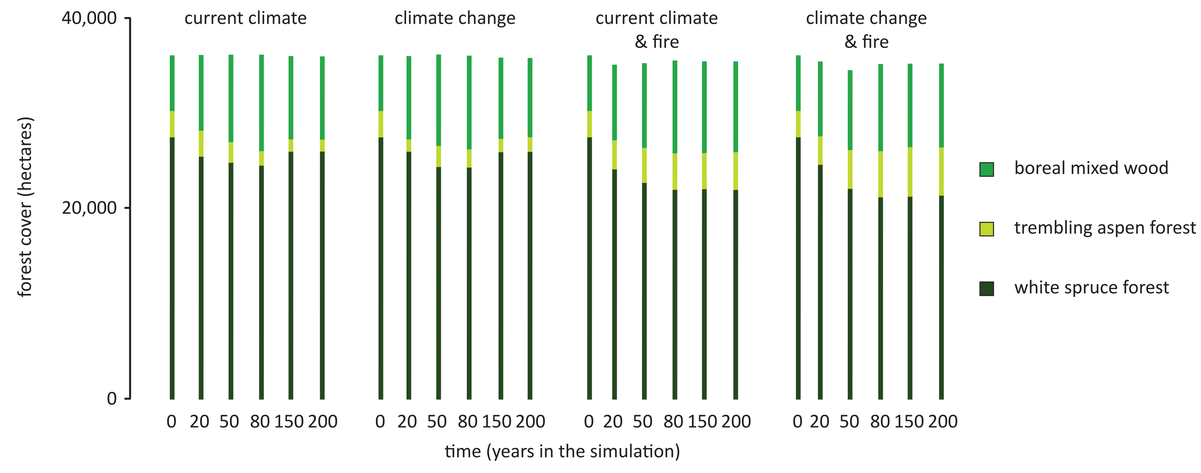

Figure 5. Abundance of the 3 dominant forest types over 200 years modelled using LANDIS-II. Scenarios are: current climate, climate change, current climate & fire, climate change & fire.

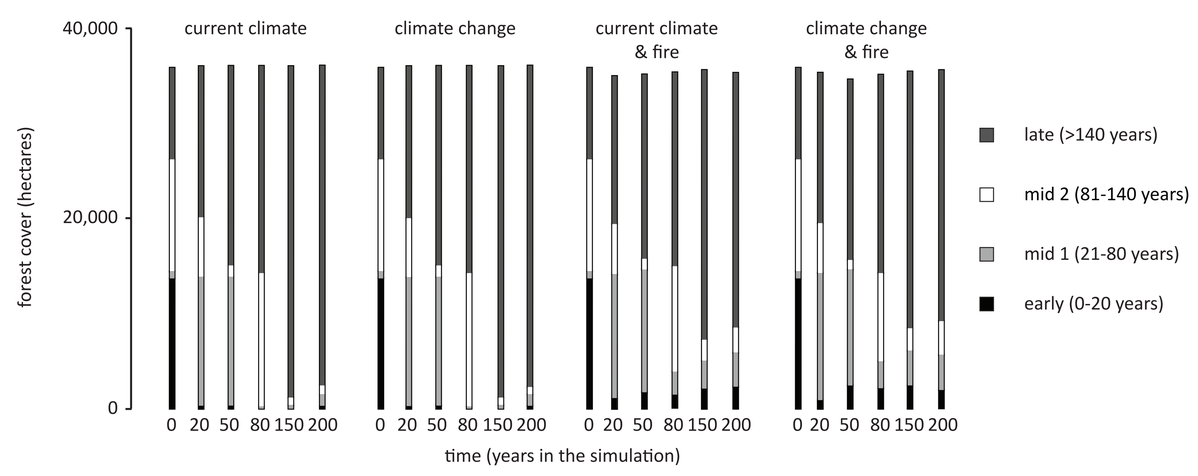

Figure 6. Abundance of 4 seral stages over 200 years modelled using LANDIS-II. Scenarios are: current climate, climate change, current climate & fire, climate change & fire.

Conclusion

- White spruce will remain the dominant tree species; however, the relative abundance of lodgepole pine, trembling aspen and balsam poplar will increase, under the influence of climate change and fire over the next 200 years.
- Fire is an important driver of landscape compositional and structural diversity.

Scheller et al. (2007) Design, development, and application of LANDIS-II, a spatial landscape simulation model with flexible temporal and spatial resolution. Ecol. Model. 201, 409–419.
Nitschke C.R., Innes J.L. (2008) A tree and climate assessment tool for modelling ecosystem response to climate change. Ecol. Model. 210, 263–277.

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