How Best to Maintain Ecosystem Services in a Vulnerable Forest?

Modeling Outcomes of Climate Change Mitigation vs. Adaptation

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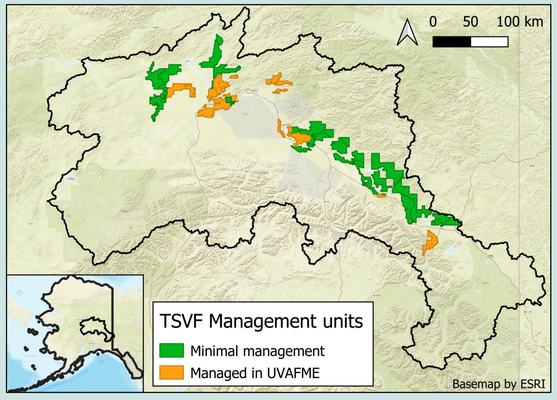
Background

Climate change is driving rapid and persistent shifts in boreal forest composition and productivity. These changes will impact ecosystem services and natural resources which nearby communities depend on. Climate-adaptive forest management shows promise in many regions, but its effectiveness should be reexamined for remote boreal forests.

Significance

The Tanana Valley State Forest (TVSF) management plan is being revised for the first time since 2001. By collaborating with stakeholders and modeling outcomes of their anticipated policies, we can provide a robust scientific basis for recommendations in the next management plan.



Study area: Tanana Valley State Forest in Interior Alaska. Some forest units are managed more intensely than others.

Research Highlights

- Climate change drives rapid forest composition shifts which reduce carbon sequestration and high-quality timber, while increasing early-seral habitat.
- Black spruce stands are extensive and highly flammable when they have high fuel volume. Shearblading is the most effective treatment for reducing fuel loading at these sites.

Conclusions

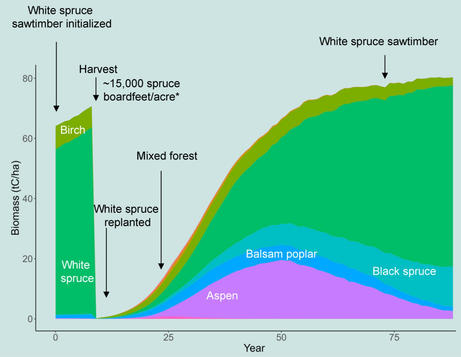
- Climate change has wide-ranging and severe impacts on ecosystem services and natural resources in TVSF.
  - These trends accelerate after 2060 and are amplified under higher-emissions scenarios.
- Climate change mitigation is a more effective strategy than adaptative management based on conventional techniques.
- At local scales, fuel treatments may reduce fire risk.

Broader implications

- By iteratively testing scenarios and sharing results, we were able to provide actionable knowledge to TVSF stakeholders. This work may be continued by modeling impacts of novel and drastic management actions.
- We demonstrate the vulnerability of communities in the boreal zone to climate change.

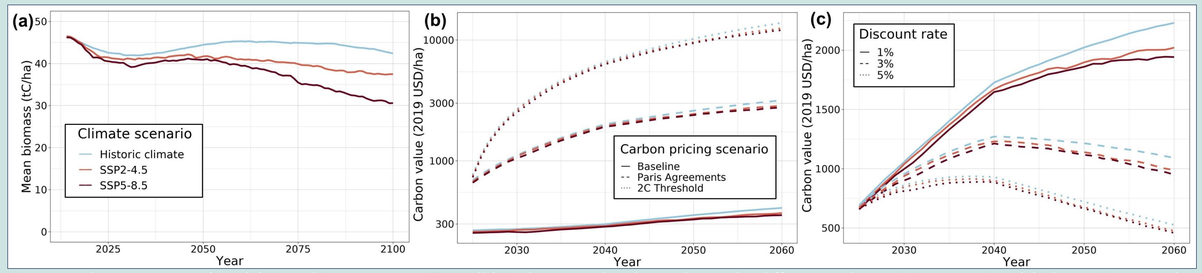
Methods

- We updated the University of Virginia Forest Model Enhanced (UVAFME) to initialize over 15,000 sites and dynamically manage forest units.
- We elicited probable management scenarios from TVSF stakeholders
- We compared model outcomes under different climate (historic, shared socioeconomic pathways [SSP] 2 & 5) and management (counterfactual, business-as-usual, adaptive) scenarios.

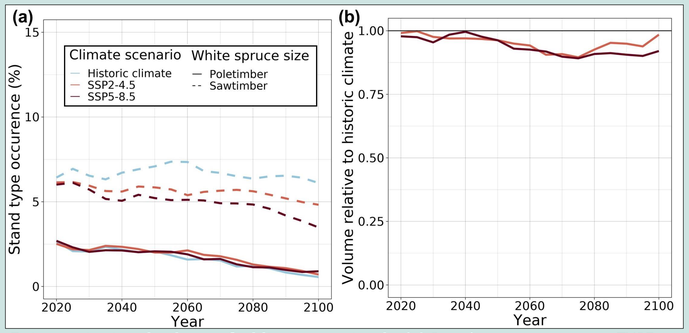


Management in UVAFME: a time series of biomass by species for a white spruce sawtimber site which is harvested and replanted. This is run under a historic climate scenario.

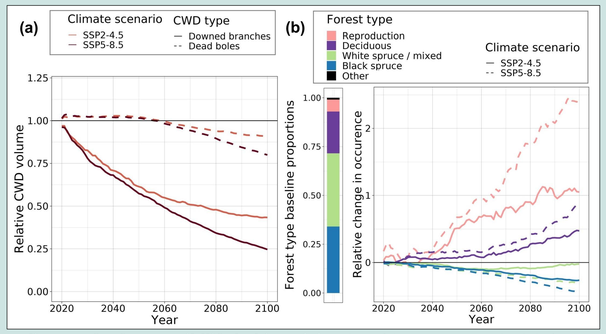
Results



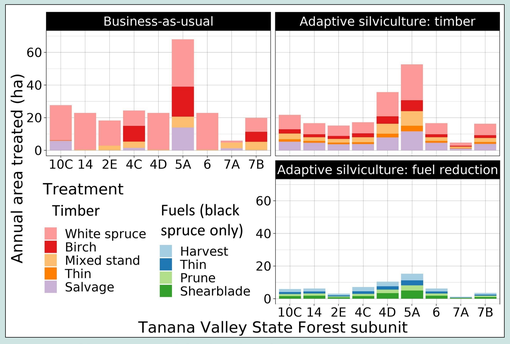
Future carbon sequestration: (a) Mean biomass across TVSF. **(b)** Undiscounted carbon value under different carbon pricing scenarios. **(c)** Alternative annual discount rates applied to carbon prices from the *Paris Agreement* scenario.



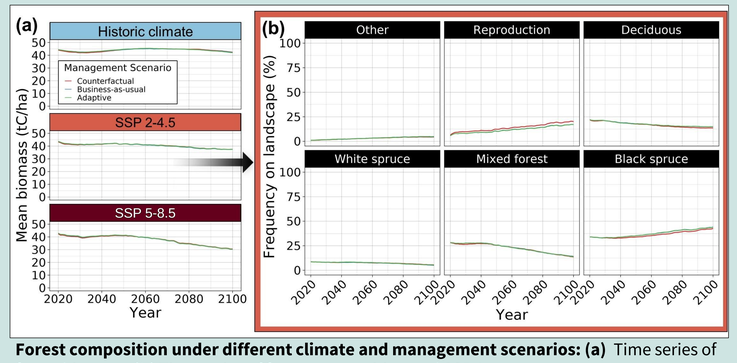
Future extent and volume of white spruce stands: (a) Stand occurrence across TVSF. **(b)** Volume (boardfeet) changes for white spruce stands compared to historic climate scenario. White spruce is the most commercially valuable timber.



Indicators for future wildlife habitat: (a) TVSF-wide coarse woody debris (CWD) volume in weight relative to historic climate scenario. **(b)** Trends in relative occurrence of common forest types compared to 2020 baseline.

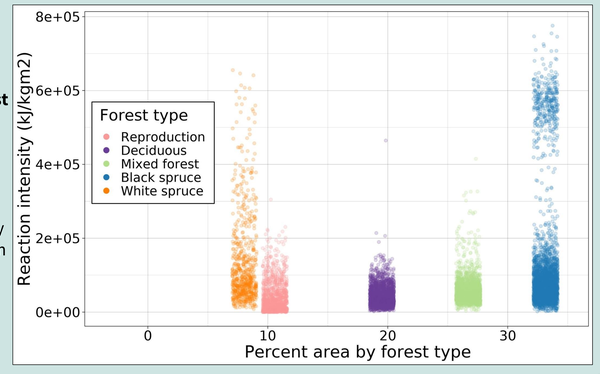


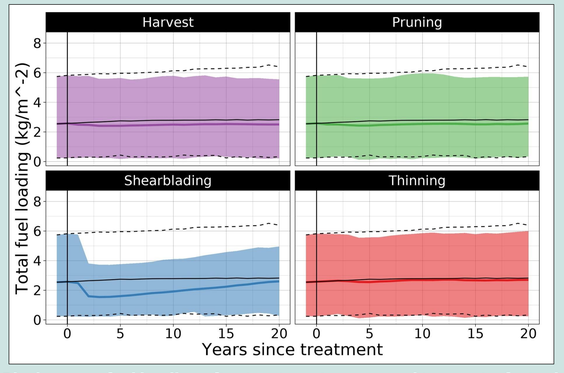
Extent of harvest and fuel reduction treatments



Forest composition under different climate and management scenarios: (a) Time series of forest biomass. **(b)** Time series of forest composition und SSP 2.

Fire intensity and area occupied by dominant forest types. 12% of black spruce fires burn 7x hotter than the other 88%; the highest intensity fires occurred on sites with greater fuel loading.





Black spruce fuel loading after treatments compared to counterfactual.