Conifer phytobiomes within consortia: effects of vegetation neighborhood, soil properties, and anthropogenic change on seedling performance

Laura Super, Clara Barnes, Yipeng Chen, Rob Guy

Department of Forest and Conservation Sciences, Faculty of Forestry, University of British Columbia

INTRODUCTION

- Plant seeding performance, given anthropogenic change, will be impacted by various simultaneous factors, and more research is needed on factors affecting each plant, its environment, and associated organisms, i.e. the phytobiome [1].
- This research asks how tree seedling performance varies with vegetation cover, harvest type, experiment simulated warming, and experiment simulated nitrogen deposition. Microbiome data are also forthcoming.
- Preliminary analyses of soil fertility were performed; more results will be soon.

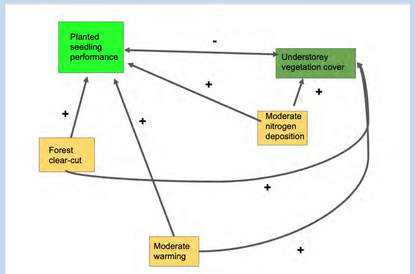

Figure 1. Hypothesized relationships, with positive meaning an increase, and negative meaning a decrease, e.g., in plant performance.

METHODS

- Research was conducted at UBC's Malcolm Knapp Research Forest (2016-2021). The main field experiment had 12 plots, with 25 subplots (or consortia) per plot randomized with simulated nitrogen deposition (none, 10 kg per ha per year) and/or simulated warming (none, passive open-top chamber).
- Each subplot had three planted conifers (Douglas-fir, western red cedar, western hemlock), with performance measures (height, biomass or estimated biomass, etc.), soil properties (pH, organic matter content, etc.), and vegetation (cover, etc.) after three growing seasons of treatment.
- Shoot volume, which can be collected without destructive harvest, was used for analysis, with the sum of all seedlings per subplot (V = ¼ height cone based on root collar diameter + ¼ height cone based on basal shoot diameter + ½ height cone based on midpoint diameter of shoot; essentially three cones added together)

Fig. 2. Example clear-cut plot. There were six clear-cut plots with 25 subplots per plot.

Fig. 3. Example forest edge plot. There were six forest edge plots with 25 subplots per plot.

RESULTS

- Preliminary data suggest that warming and nitrogen impacts are context and species-dependent and consortia of phytobiomes co-vary with shrub cover in and soil properties in complex ways.
- Height was collected for all subplots and showed similar but slightly different trends than biomass. Biomass was collected for six subplots, so for this analysis those six subplots were used; biomass related to and correlates well with ($r^2 > 0.85$) shoot volume as a proxy, rather than height here ($r^2 < 0.7$).

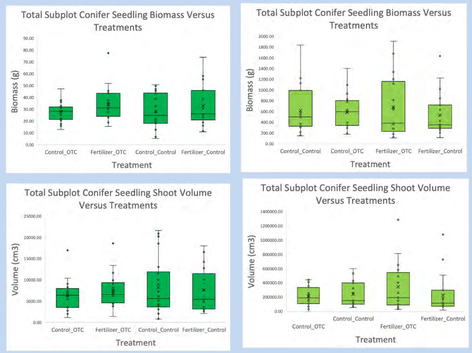

Fig. 4. Conifer seedling performance in forests (dark green) and clear-cuts (light green) subplots.

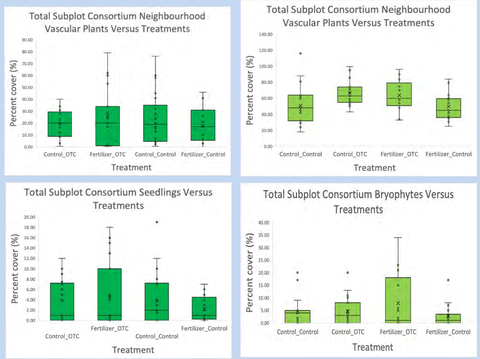

Fig. 5. Vascular plant vegetation and bryophytes in consortium neighborhood of subplots in forests (dark green) and clear-cuts (light green)

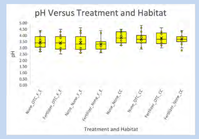

Fig. 6. Soil pH for both clear-cuts (CC) and forests (F_E)

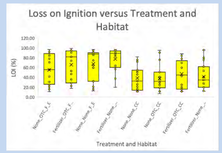

Fig. 7. Soil loss on ignition (LOI), (more LOI, means more organic matter) for both clear-cuts (CC) and forests (F_E)

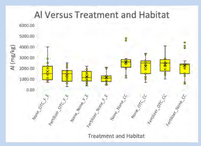

Fig. 8. Aluminum for both clear-cuts (CC) and forests (F_E)

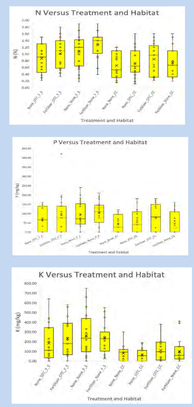

Fig. 9. N, P, K for both clear-cuts (CC) and forests (F_E)

DISCUSSION

- The biomass and shoot volume were similar in response but different than height, and shoot volume (and estimated biomass) and height can be explored with the 12 plots.
- Mixed-effects models can tease apart the relationship between the different factors. These models are in process.
- Clear-cuts were different from forests with respect to plants and their consortia, which is likely due to light and also the legacy of the broader habitat.

FUTURE DIRECTIONS

- Soil data are currently being analyzed in relation to the plants (conifer performance, neighborhood vegetation) as well as the experimental treatments.
- Shoot, root and soil microbiome data are forthcoming. These can be compared to soil data with ordination and mixed-effects modelling.
- There is a smaller study in plots to examine the shoot and soil microbiome through time (in control plots, no open-top chambers) in forests versus clear-cuts.

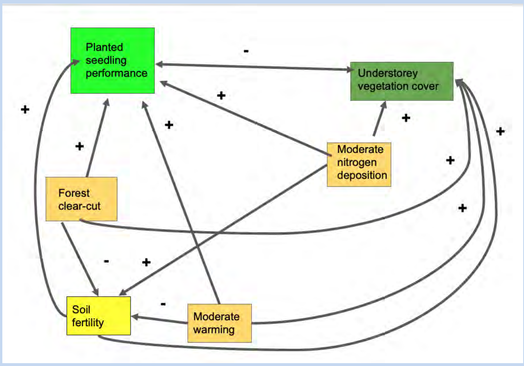

Fig. 10. Hypothesized relationships, with positive meaning an increase, and negative meaning a decrease in plant performance. Soil fertility impacts are expected to be more complex given interactions with other factors.

REFERENCES

- [1] Leach, J. E., Triplett, L. R., Argueso, C. T., & Trivedi, P. (2017). Communication in the phytobiome. *Cell*, *169*(4), 587-596.

NSERC CRSNG