Equisetum arvense along a permafrost thaw and canopy cover gradient

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Introduction

- *Equisetum arvense* (field horsetail) is native to Alaska and has been on the planet since the carboniferous period 300 million years ago (Cannon, 1968). *E. arvense* represents a plant species well suited to survive rapid changes in climate.
- Horsetail is an important food source to a variety of animals including: moose, sheep, caribou and bears (Morgan, 2009).
- Increasing temperatures due to climate change has rapidly increased the thawing of permafrost in the interior of Alaska (Rosamond, 2019), and the effects of the thaw on the phenotypic traits of E. arvense can shed light on how this species is responding to the current changes in climate.

Questions

Question 1: Do horsetail growth traits differ in fen, transition and forest sites?

Question 2: Does changes in canopy cover and thawing depth explain variation in horsetail traits?

Methods

- We selected three sites along a transect with a gradient of permafrost thaw and canopy cover conditions (fen, transition, forest) at Bonanza Creek Experimental Forest (64.70250 N, -148.31326 W).
- At each site we established a 10 m transect and sampled a 30cm x 30cm quadrat every 2 m for a total of 5 plots per transect, and 15 plots in total
- The height, number of whorls and branch length were measured for 2 horsetail plants from each plot and then averaged.
- The % canopy cover, % plant cover, depth of thaw layer, and GLOBE soil temperature and landcover were measured for each plot.

Figure 5: *Equisetum arvense* (Field horsetail). Arrow pointing to a whorl.

Figure 1: Laying down the transect at the fen site.

Figure 2: Obtaining *Equisetum* samples from transition site.

Figure 3: The forest site.

Figure 4: Obtaining the soil temperature at the forest site.

Figure 6: Estimating canopy cover.

Results

Q1: Do horsetail growth traits differ in fen, transition and forest sites?

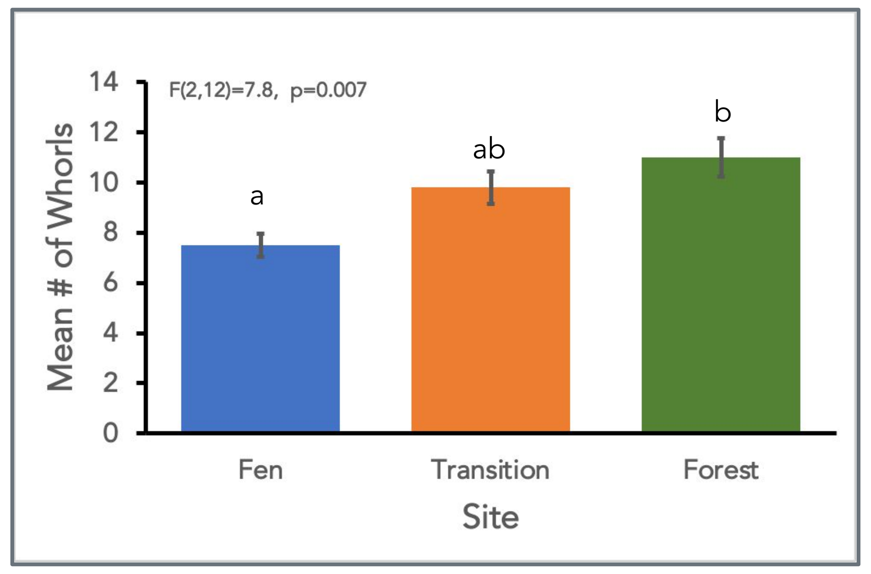

Figure 7: Mean number of branch whorls on *E. arvense* plants (±S.E.) in fen, transition and forest sites. Significant differences between sites is indicated by different letters.

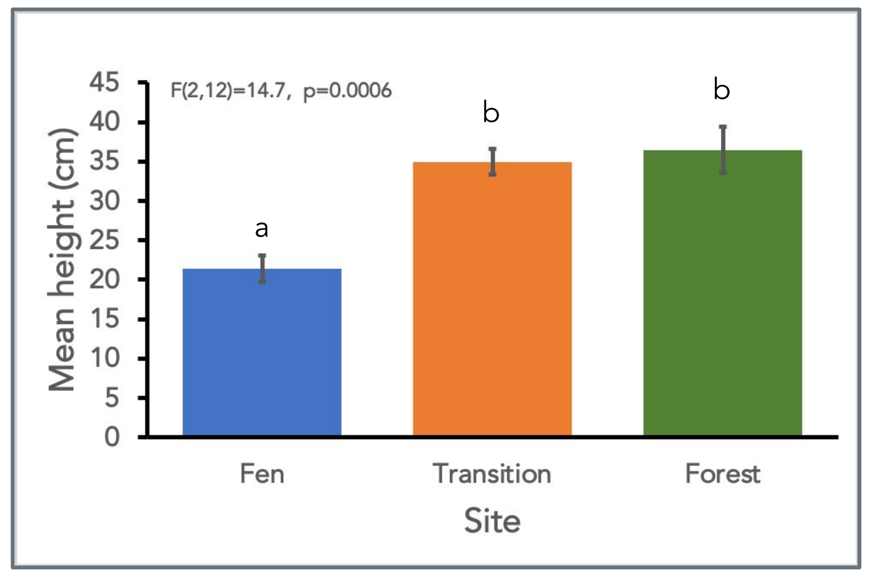

Figure 8: Mean *E. arvense* height (±S.E.) in fen, transition and forest sites. Significant differences between sites is indicated by different letters.

- Horsetail number of branch whorls and heights significantly differed between site types, but branch length did not.
- The fen site had significantly fewer whorls than the forest site, while the transition site was not different from the fen site or the transition site (Figure 7).
- The fen site had significantly lower E. arvense plant height than the transition and forest sites (Figure 8).

Q2: Does canopy cover and soil thaw depth explain variation in horsetail growth?

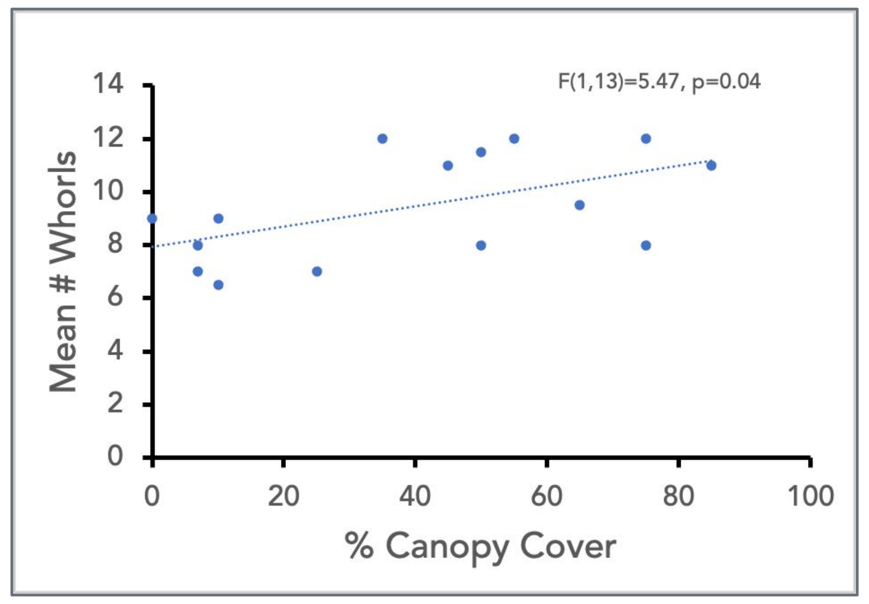

Figure 9: Relationship between mean number of branch whorls and percent canopy cover.

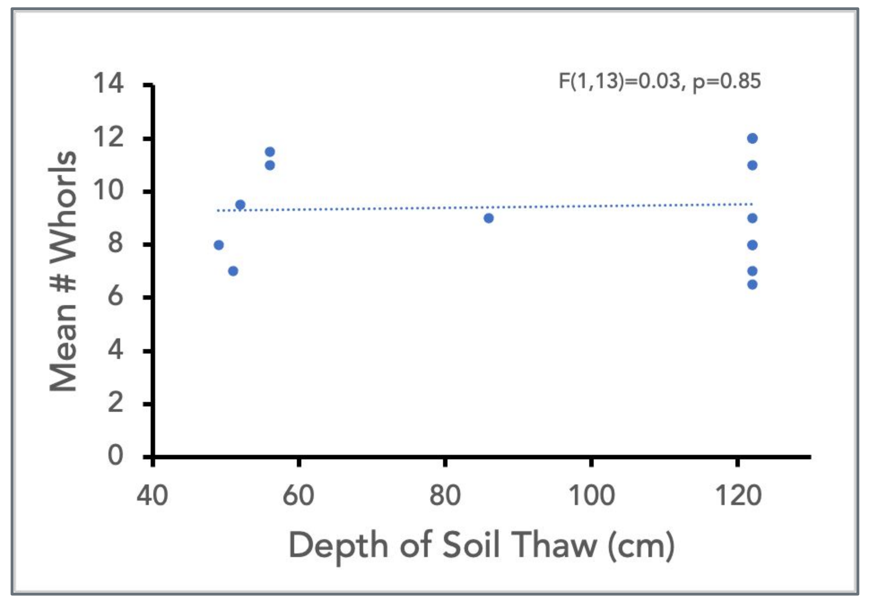

Figure 10: Relationship between mean number of branch whorls and depth of soil thaw. Measurements of 122 cm soil thaw depth represent our maximum measurement ability and does not represent accuracy.

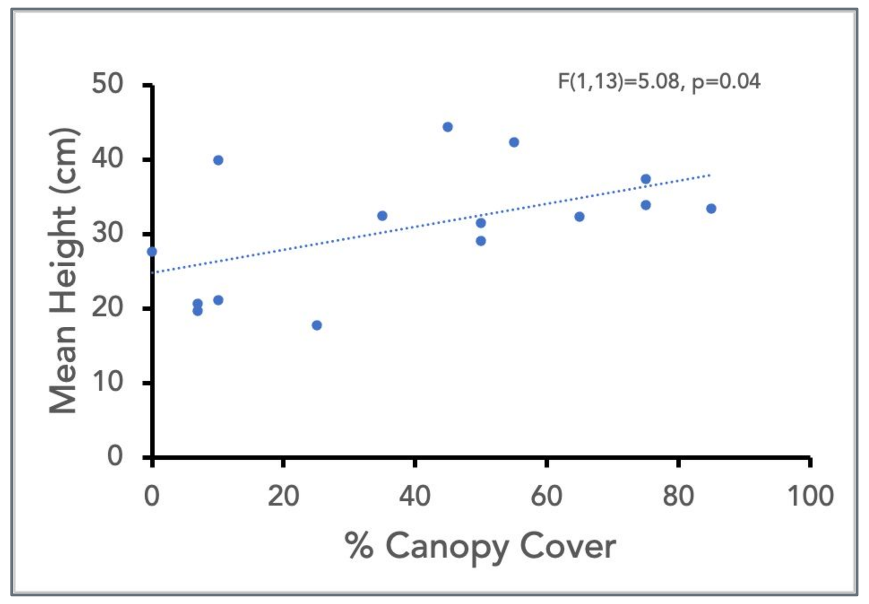

Figure 11: Relationship between mean *E. arvense* plant height and percent canopy cover.

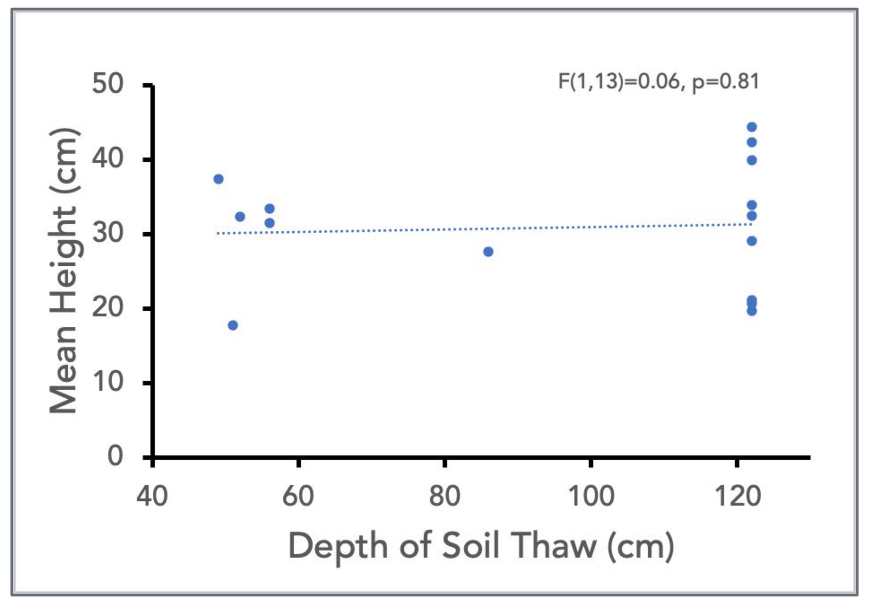

Figure 12: Mean Height vs Thaw Depth, Measurements of 122 cm represents a max measure ability and does not represent accuracy.

- Canopy cover significantly influenced both the number of branch whorls and the heights of *E. arvense* (Figure 9 & 11).
- Depth of the soil thaw did not have a significant relationship to the number of whorls or the plant height of *E. arvense* along our transect (Figures 10 & 12)

Discussion

- Height and number of whorls of *Equisetum arvense* was reduced in the fen site (Fig. 7 & 8) and this result was best explained by the change in canopy cover. suggesting that the ideal environmental conditions for this species of horsetail is forested areas because of the high canopy cover it provides.
- As the climate warms, thaws permafrost and creates wetland conditions, canopy cover decreases. This is due to stress on trees like retaining excess water, impacting root stability, and causing erosion (Howard, 2014).
- Although we did not find evidence that thaw depth is correlated to horsetail height, this might have been due to our equipment limitation preventing us from digging deep enough to asses thaw depth. The variables we collected that are highly correlated with thaw depth (organic layer depth, soil temperature, and soil moisture) did not explain variation in the plant traits, suggesting that the changes in canopy cover are more important.
- Soil nutrient levels may also be important (Labun et al. 2012, thought we did not have the ability to test this.

Further Directions

- It would be interesting to explore how different species of horsetail perform within the fen, transition area and forest. We also found *E. scirpoides* and *E. fluviatile* in or near our sites.
- Continue research studies and to further explore the fen to obtain accurate measurement of the thawing permafrost depth by using a tool that would allow for the measure of thawing depth beyond 122cm.
- Furthermore, it would be beneficial to replicate this study and include more transects for a larger sample size.
- An assessment quantifying the variety of *Equisetum* species in each site would provide us with a better understanding of what growth forms and traits are more advantageous for each site.

Figure 13: Collecting data from the transition site.

Figure 14: Placing transect flags at the fen site.

Citations

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