# Evaluating relationships between seedling establishment and microtopography at the Forest-Tundra Ecotone using terrestrial lidar

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ABoVE
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## Introduction

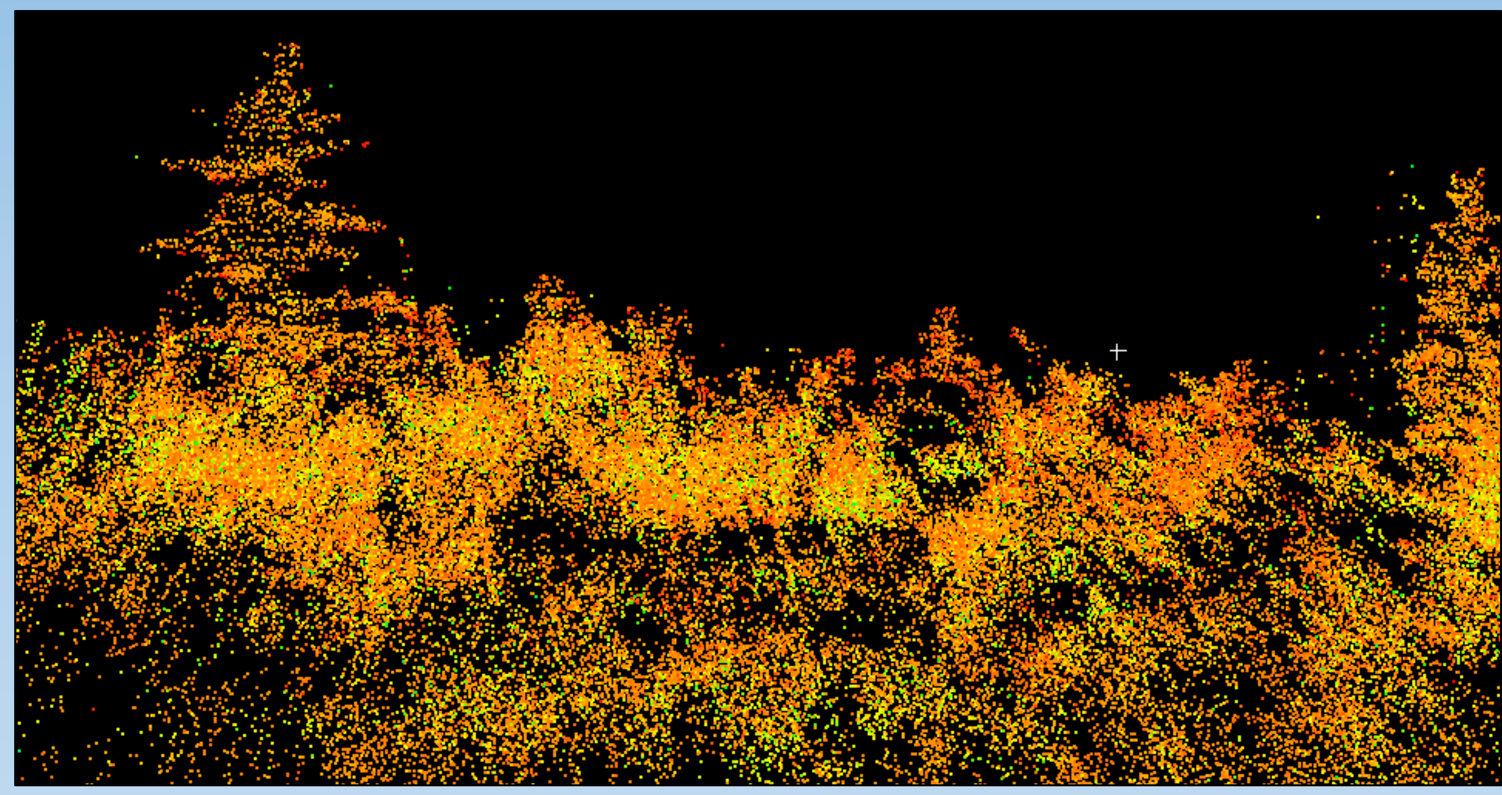
- Examining seedling establishment is critical to improve understanding of the relationships between biophysical structure and ecological function at the forest-tundra ecotone (**FTE**).
- Assessing seedling establishment of individual trees is necessary for scaling up to landscape-level vegetation structural change.
- As the frontier of tree survival, the FTE is the optimal system to determine thresholds of abiotic growth conditions for tree survival.
- We hypothesize that microtopographic metrics affect the physical growth environment and hence seedling establishment (i.e., presence and absence of seedlings).
- **Goal: *Assess relationships between microtopography and successful seedling establishment***

Figure 1. Sampling was conducted in the Brooks Range, AK (circa 68.0° N, 149.7 ° W).

Figure 2. FTE “seedlings”. These 45 cm “seedlings” are approximately 35 years old.

## Sampling methods

- Terrestrial laser scanning (TLS) data (>1 point $cm^{-2}$) was acquired at four ~17m radius plots at the FTE in the Brooks Range, AK
- Spruce (*Picea* spp.) seedlings were identified in-situ and coordinates were extracted from the TLS data
- Coordinates for no-seedling points were randomly generated in R (R Core Team, 2016)
- Based on Greaves et al. (2016)[1] ground finding algorithm, TLS data was classified into ground and vegetation returns
- Topographic metrics were calculated for each seedling coordinate within a variable search radius



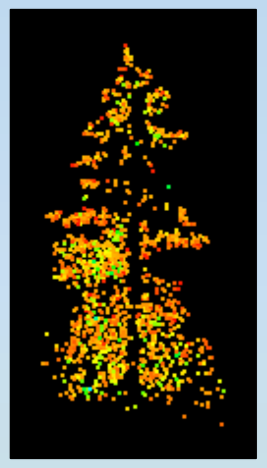


Figure 3a. Georegistered terrestrial laser scanner (TLS) point cloud of spruce “seedlings” <2m tall amongst *Betula* sp. (dwarf birch) and *Alnus* sp. (alder) shrubs from TLS scans. A Leica C10 instrument was used for all scans, and each plot was scanned from 4-5 scan positions.
Figure 3b. Profile of individual spruce “seedling” from TLS scans.

## Analytical methods

- Initial microtopographic metrics measured within 1 m radius of all seedling coordinates:

  **Ground roughness** (standard deviation of the z-value of all ground points)

  **Average aspect** of a DTM interpolated from ground points
- Logistic regression model using a binary dependent variable (seedling presence) was used with two covariates (bolded above)

## Preliminary results

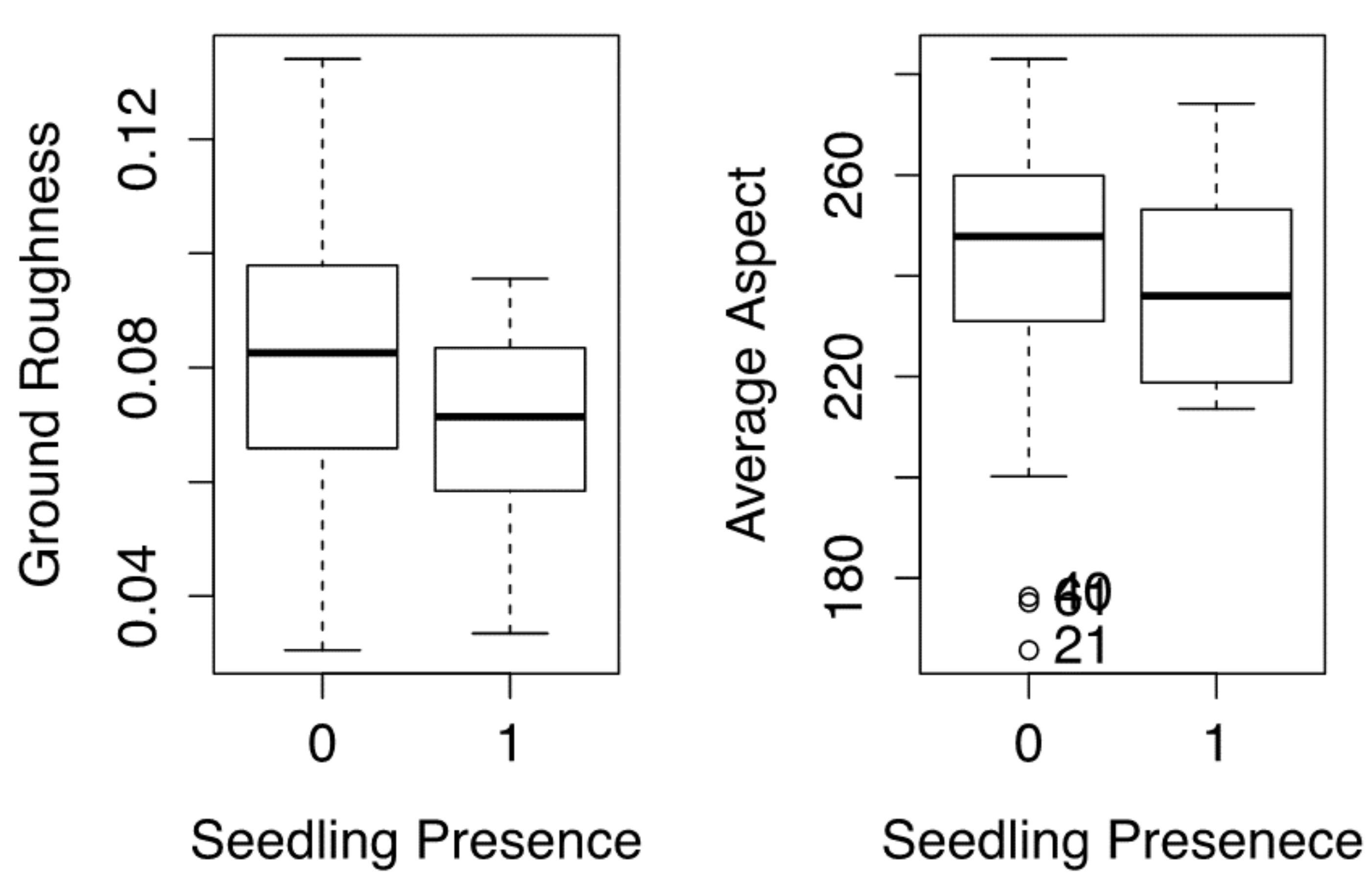



Figure 4. Neither covariate exhibited a significant difference ($p > 0.05$) with respect to seedling presence or absence (0/1). Data are from only one of four plots.

## Future directions

- Extend analysis to all four plots after locating seedling coordinates within point clouds
- Incorporate canopy-derived metrics:
  - Canopy-roughness
  - Wind-shelter
  - Snow-shelter
  - Wetness
- Determine optimal search radius from coordinates for calculating metrics
- Improve sampling methods for seedling = absent coordinates (account for spatial autocorrelation and ensure appropriately spaced from seedling = present coordinates)
- Thin out point cloud to reduce bias of areas of more concentrated sampling (since trees were targeted over no-tree areas)
- Determine how to best account for sampling error (uncertainty of identifying every seedling in point clouds)

Figure 5. Coregistered images from Leica C10 lidar instrument of plot adjacent to northern treeline. Immature *Picea* sp. (spruce) trees are labeled among *Betula* sp. (dwarf birch) and *Alnus* sp. (alder) shrubs from TLS scans. Mature trees at the edge of treeline are visible in the background and a Spectralon® panel for gauging reflectance values of the TLS returns is visible to the right.

## Acknowledgements

[1]Greaves, H.E., Vierling, L.A., Eitel, J.U.H., Boelman, N.T., Magney, T.S.*, Prager, C.M., Griffin, K.L. 2016. High-resolution mapping of aboveground shrub biomass in Arctic tundra using lidar and imagery. Remote Sensing of Environment, 184, 361-373.
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