2020 Project Summaries
Boreal Ecosystem Recovery & Assessment
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Remote Sensing Team: Drone Photogrammetry Can Measure Height of Establishment-aged Seedlings

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Project Summary
Regeneration success on seismic lines is assessed through surveys that measure the abundance and distribution of seedlings exceeding a specified minimum height. We tested the utility of drone-based image point clouds (DIPC) for estimating height of conifer seedlings growing along seismic lines. We compared three different pixel sizes(0.35 cm, 0.75 cm, and 3 cm), two phenological states (leaf-on and leaf-off), and three ground determination methods in three Kirby BERA sites showing various degrees of natural regeneration. The best result (RMSE=24 cm, %RMSE= 39%, Bias= - 11 cm; R^2=0.63) was achieved for seedlings > 30 cm with the finest resolution dataset (GSD = 0.35 cm) in leaf-off conditions, using a method that estimated ground elevation from the DIPC itself. For seedlings ≤30 cm, the R^2 was nil and the best %RMSE was 73%. In a scenario where the estimated heights are used to determine whether a detected seedling enters a stocking survey, an omission counting error would be created if the estimated height is lower than the required height but the true height is above it, or vice versa for a commission error. The impact of height estimation errors on counting errors seems low for seedlings > 30 cm regardless of the GSD: 8% omission and 6% commission for the result showing the lowest impact at 0.35 GSD, and 12% and a 7% respectively for the 3 cm GSD.

Management Implications and Lessons Learned
The lack of relationship between predicted and observed height for seedlings ≤30 cm indicates it is not possible to estimate their height using DIPC for the survival assessment (2-5 years after treatment). For the establishment survey (8-10 years after treatment), reliability increases with seedling height providing the GSD is finer than ½ cm, to a point where for seedlings of 2 m mean height the relative RMSE should be below 10%, although this estimate may not be extrapolatable to lines with mounding, where the mound microtopography may hamper height estimation. Luckily, height estimation errors seem to lead to few counting errors even for the coarser 3 cm GSD. Furthermore, omission and commission errors would cancel each other. This means that height estimation may not be a limiting factor for automated establishment surveys from manned aircraft (seedling detection, which was not addressed in this study, is a more likely factor). However, any program trying to assess height growth using digital aerial photogrammetry will likely require drones, as the required millimetric GSD can only be achieved from those platforms.

Publication(s)
Estimation of individual conifer seedling height in regenerating linear disturbances using drone-based image point clouds (in preparation for spring 2020 submission)