Boreal Ecosystem Recovery & Assessment
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Remote Sensing Team: Deep-Learning Algorithms Show Promise for Detecting Conifer Seedlings

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Project Summary

Monitoring tree regeneration in forest areas disturbed by resource extraction is a requirement for sustainably managing the boreal forest of Alberta, Canada. Drones have the potential to decrease the cost of field surveys drastically, but produce large quantities of data that will require specialized processing techniques. In this study, we explored the possibility of using convolutional neural networks (CNNs) on this data for automatically detecting conifer seedlings along recovering seismic lines: a common legacy footprint from oil and gas exploration. We assessed three different CNN architectures, of which faster region-CNN (R-CNN) performed best (mean average precision 81%). We also evaluated the effects of training-set size, season, seedling size, and spatial resolution on the detection performance. Our results indicate that drone imagery analyzed by artificial intelligence can be used to detect conifer seedlings in regenerating sites with high accuracy, which increases with the size in pixels of the seedlings. By using a pre-trained network, the size of the training dataset can be reduced to a couple hundred seedlings without any significant loss of accuracy. Furthermore, we show that combining data from different seasons yields the best results. The proposed method is a first step towards automated monitoring of forest restoration/regeneration.

Management Implications and Lessons Learned

This was the world-first application of artificial intelligence to conifer seedling detection. More research is needed to bring this technology to operational status.

Publication(s)

Fromm, M. (2018): Semisupervized Object Detection in UAV Images. Master's thesis, LMU Munich Department of Computing Science.

Fromm, M., Schubert, M., Castilla, G., Linke, J. and McDermid, G., 2019. Automated Detection of Conifer Seedlings in Drone Imagery Using Convolutional Neural Networks. *Remote Sensing*, 11(21), p.2585.