Object Detection with Convolutional Neural Networks for Real-Time Weed Identification in Wild Blueberry Fields

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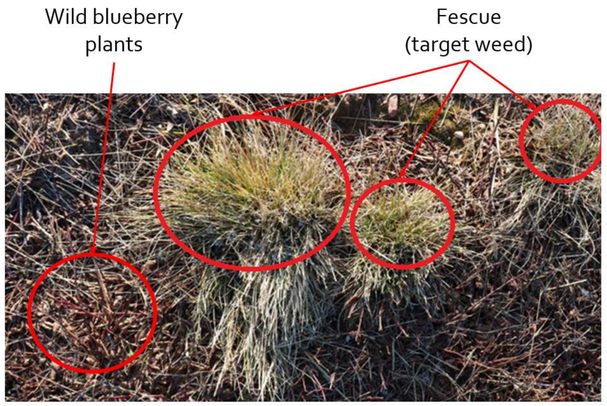
Introduction

- The wild blueberry (*Vaccinium angustifolium* Ait.) is a perennial plant native to northeast North America
- The bulk price of wild blueberries in NS decreased from \$0.48 kg^{-1} to \$0.09 kg^{-1} from 2007 to 2017
- Weeds, including fescue (*Festuca filiformis* Pourr.), limit wild blueberry yield by competing with blueberries for nutrients and clogging up harvesters
- Herbicides are applied evenly across wild blueberry fields; fescue had a field uniformity of 23% in 2018
- Reducing input costs for wild blueberry growers is necessary for ensuring financial sustainability of the wild blueberry industry
- Convolutional Neural Networks (CNNs) have been used for accurate, real-time image identification
- Real-time identification of fescue would allow for spot-application of herbicide instead of a uniform coating, reducing input costs

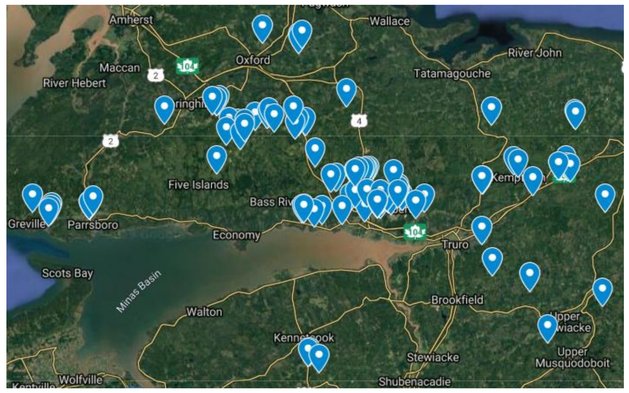


Objectives

- Train an object detection convolutional neural network which can correctly identify fescue plants
- Determine the minimum number of training images required to develop a CNN for fescue detection
- Evaluate the effectiveness of two different CNN models for fescue detection

Methods

- 1200 images were collected in April and May 2019 across northern NS

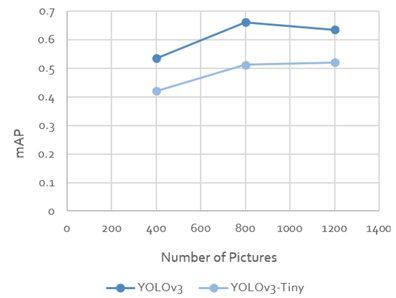


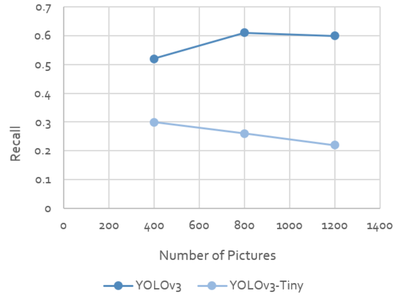
- Sites were selected for maximum variability in field conditions

- 75% of the images were used for training the CNN, while 25% were reserved for validating the model
- Fescue plants were labeled using a custom-built graphics program
- Two neural networks based on the Darknet framework were tested (YOLOv3 and YOLOv3-tiny)
- Networks were evaluated on their ability to detect fescue plants in the validation image set

Results

- The greatest mean average precision (mAP, 66.2%) was achieved using the YOLOv3 network with 800 images
- The greatest recall (61%) was achieved using the YOLOv3 network with 800 images
- YOLOv3 had greater mAP and recall across all datasets than YOLOv3-tiny
- The greatest precision (86%) was achieved using the YOLOv3-tiny network with 1200 images





Discussion and Conclusions

- Dataset sizes of 800 images and 1200 images yielded similar identification performance
- YOLOv3 was better at detecting fescue plants than YOLOv3-tiny for all dataset sizes
- A secondary training dataset may improve performance of the neural networks
- These models require additional training prior to use for spot-application of herbicides

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