Weed Identification in Wild Blueberry Fields Using Convolutional Neural Networks

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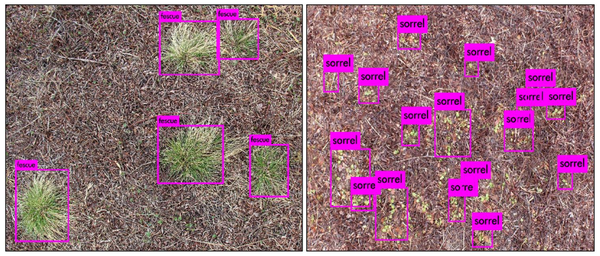
Introduction

- The wild blueberry (*Vaccinium angustifolium* Ait.) is a perennial crop native to northeastern North America.
- Weeds, including hair fescue (*Festuca filiformis* Pourr.) and sheep sorrel (*Rumex acetosella* L.) limit wild blueberry yield.
- Herbicides needed for effective management of weeds varies by species.
- Convolutional Neural Networks (CNNs) provide accurate, real-time image identification.



Hair fescue (L) and sheep sorrel (R) detected by the YOLOv3-Tiny CNN.

- Selectively applying herbicides from a smart sprayer using a CNN would reduce input costs.
- A smartphone app which provides field-specific information using CNNs will improve accessibility to updates in best management practices.

Objectives

- Train a CNN to identify hair fescue and sheep sorrel.
- Perform an in-field evaluation of the CNN with three different cameras.
- Determine the viability of adapting CNNs for use in wild blueberry production.

Methods

- 8902 images containing hair fescue and/or sheep sorrel were collected during April and May 2019 from 58 wild blueberry fields.
- Six different cameras were used for image collection.

Map of image collection sites.

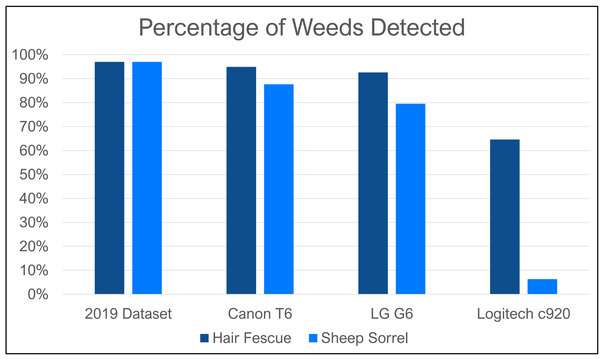
- The YOLOv3-Tiny CNN was trained to detect hair fescue and sheep sorrel using 3780 and 960 images at 1280x720 resolution.
- The trained CNN was used to process new images taken from sampling locations in three fields during May 2020.
- Three cameras were used: a Canon Rebel T6 DSLR, an LG G6 smartphone, a Logitech c920 web camera.

Image capture at randomly-selected locations in a wild blueberry field.

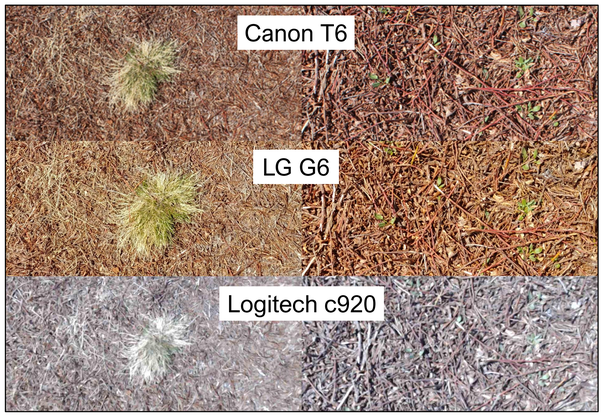
- The percentage of images from each camera in which the CNN could detect weeds was calculated.

Results

- The YOLOv3-Tiny CNN detected hair fescue in 96.7% of images and sheep sorrel in 97.0% of images in the May 2019 dataset.
- Hair fescue was detected in 94.9% of Canon T6 images, 92.6% of LG G6 images, and 64.6% of Logitech c920 images.
- Sheep sorrel was detected in 87.7% of Canon T6 images, 79.5% of LG G6 images and 6.3% of Logitech c920 images.



- Poor quality images from the Logitech c920 probably caused the significant reduction in accuracy.



Comparison of image quality from the three cameras.

- Image collection sites were less controlled during 2019. The images used for training and evaluating the CNN contained weeds that were likely easier on-average to see than during the 2020 testing.
- Future training datasets should be captured in a more controlled manner.

Conclusions

- CNNs can accurately identify weed species in wild blueberry fields.
- Image quality significantly impacts the accuracy of CNNs.
- CNNs could be used in a smart sprayer to selectively apply herbicide.
- A smartphone app relying on CNNs could be used to scout fields and provide site-specific information to growers.

Further Reading

Hennessy, P. J., Esau, T. J., Schumann, A. W., Farooque, A. A., Zaman, Q. U., & Corscadden, K. W. (2021). *Evaluation of Cameras and Image Distance for CNN-Based Weed Detection in Wild Blueberry.* Smart Agricultural Technology, 2(100030). https://doi.org/10.1016/j.atech.2021.100030

Hennessy, P. J., Esau, T. J., Farooque, A. A., Schumann, A. W., Zaman, Q. U., & Corscadden, K. W. *Hair Fescue and Sheep Sorrel Identification Using Deep Learning in Wild Blueberry Production.* Remote Sensing, 13(5), 943. https://doi.org/10.3390/rs13050943

Acknowledgements

This work was funded by the Natural Sciences and Engineering Research Council of Canada Discovery Grants Program (RGPIN-06295-2019). Additional funding for this research was provided by Mitacs through the Mitacs Accelerate Program (IT23150), the Wild Blueberry Producers Association of Nova Scotia, Doug Bragg Enterprises, Ltd, and New Brunswick Canadian Agricultural Partnership (CAP). The authors would like to thank the wild blueberry growers in Nova Scotia for use of their fields during image collection. Also, the authors acknowledge the efforts of the agricultural mechanized systems and precision agriculture research teams at Dalhousie University's Faculty of Agriculture.

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NSERC CRSNG · Mitacs · Wild Blueberry Producers Association of Nova Scotia · DBE Doug Bragg Enterprises · New Nouveau Brunswick · Canadian Agricultural Partnership