Convolutional Neural Network Web Application for Aiding Field Management in Wild Blueberry

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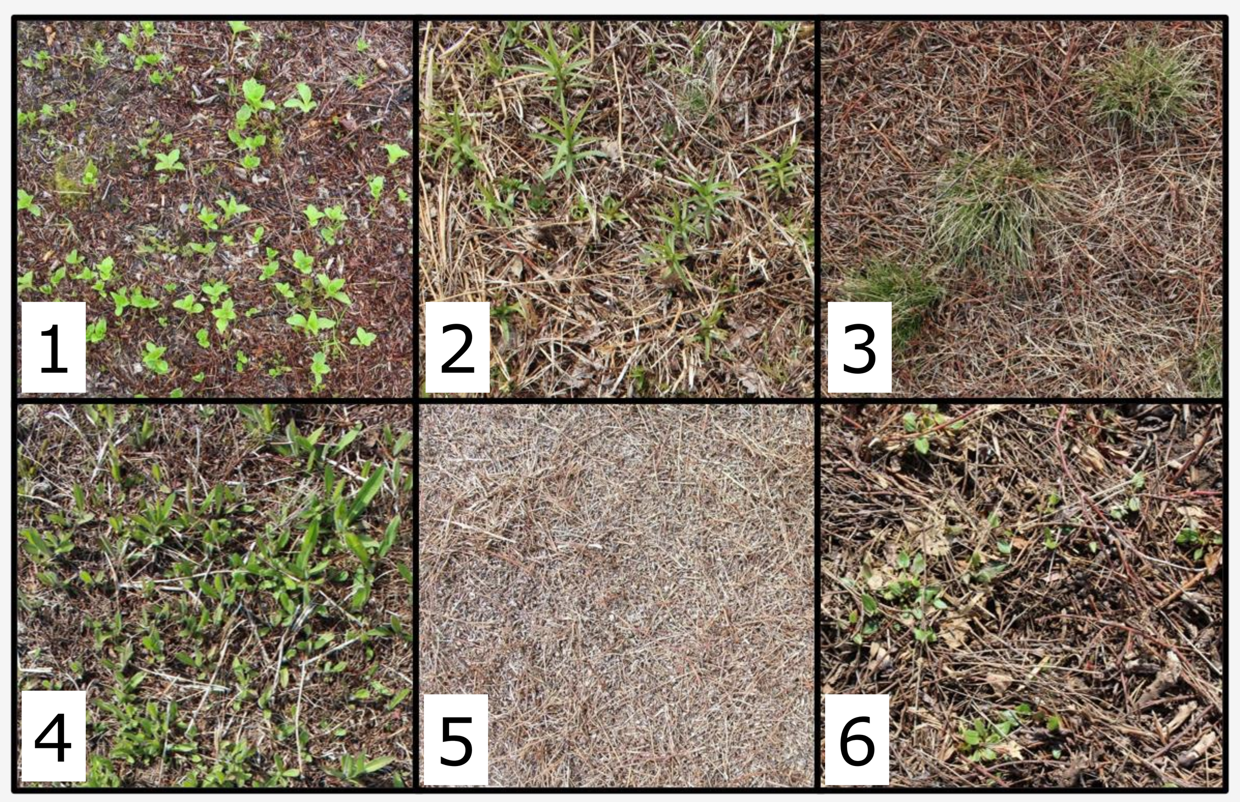
Introduction

- The wild blueberry (*Vaccinium angustifolium* Ait.) is a perennial crop native to northeastern North America.
- Weeds, including bunchberry (*Cornus canadesis* L.), goldenrod (*Solidago* spp.), hair fescue (*Festuca filiformis* Pourr.), hawkweed (*Hieracium* spp.), and sheep sorrel (*Rumex acetosella* L.) limit wild blueberry yield.



1) bunchberry, 2) goldenrod, 3) hair fescue, 4) hawkweed, 5) bare field (no weeds), 6) sheep sorrel.

- Herbicides needed for effective management of weeds varies by species.
- Updates for best management practices are traditionally communicated to growers through biannual meetings, email dispatches, and a telephone hotline.
- Convolutional Neural Networks (CNNs) provide accurate, real-time image identification.
- A web-based application which provides field-specific information using CNNs will improve accessibility to updates in management practices.

Objectives

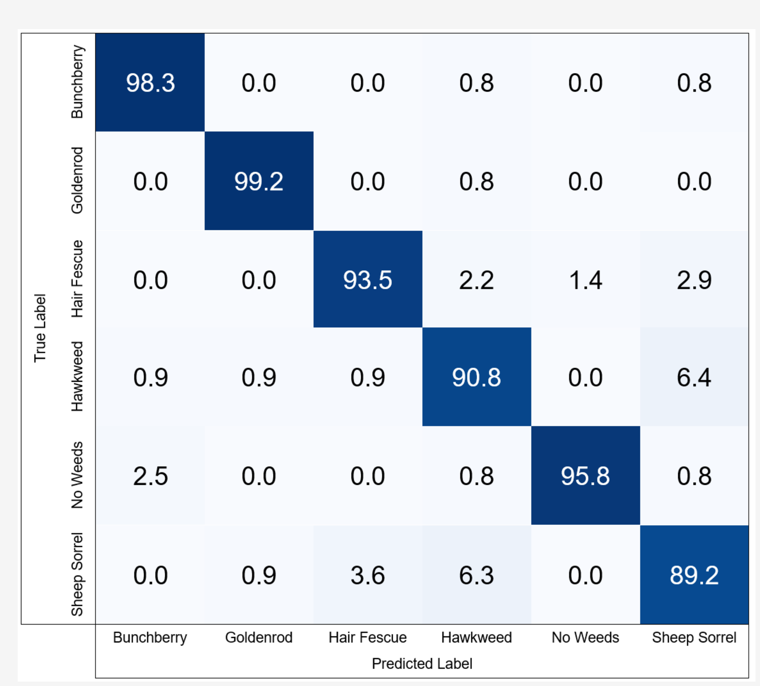
- Train and evaluate the MobileNet and EfficientNet-B0 CNNs for correctly classifying five weed species and bare field.
- Develop a web application which uses a CNN to classify pictures uploaded by users.

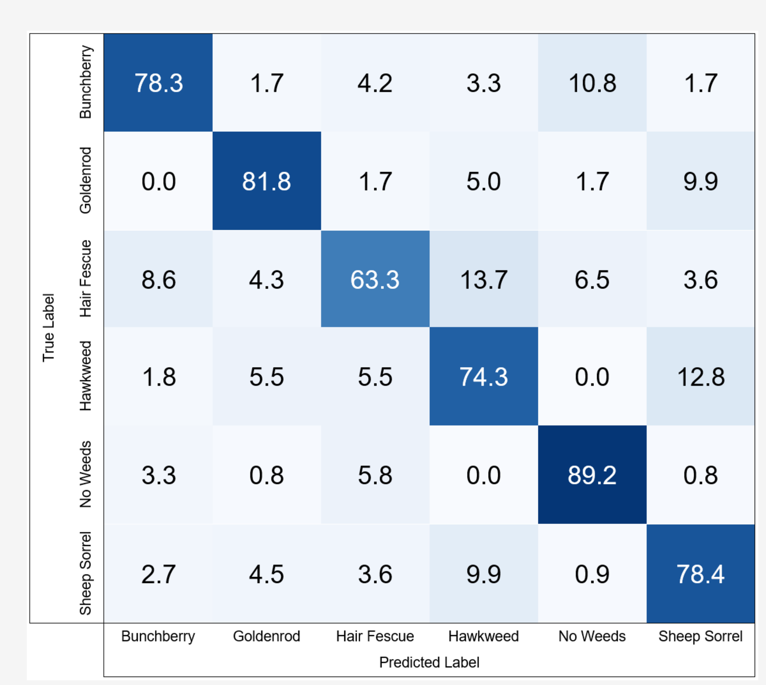
Materials & Methods

- More than 15000 images were collected in April, May, and June 2019 and 2020 in northern and central Nova Scotia.
- Images were sorted by the most prevalent weed shown in the frame if more than one species was present.
- 800 images of each target weed and 800 images of bare field with no weeds were selected for use with the CNNs.
- 70% of the images (4080) were used for training the CNNs, while 30% (720) were reserved for validating them.
- Google Colab was used to train MobileNet and EfficientNet-B0 using TensorFlow and Keras.
- Both networks were trained twice. First with all layers unfrozen, and second with only the first half of the layers unfrozen.
- A web application was written in JavaScript using the ReactJS framework for users to upload their images for classification.
- MobileNet was converted from Keras to TensorFlow.JS for processing in the users' web browser.

Results & Discussion

- EfficientNet-B0 (93.5%) produced a greater overall accuracy on the validation dataset than MobileNet (77.2%) after two training cycles.

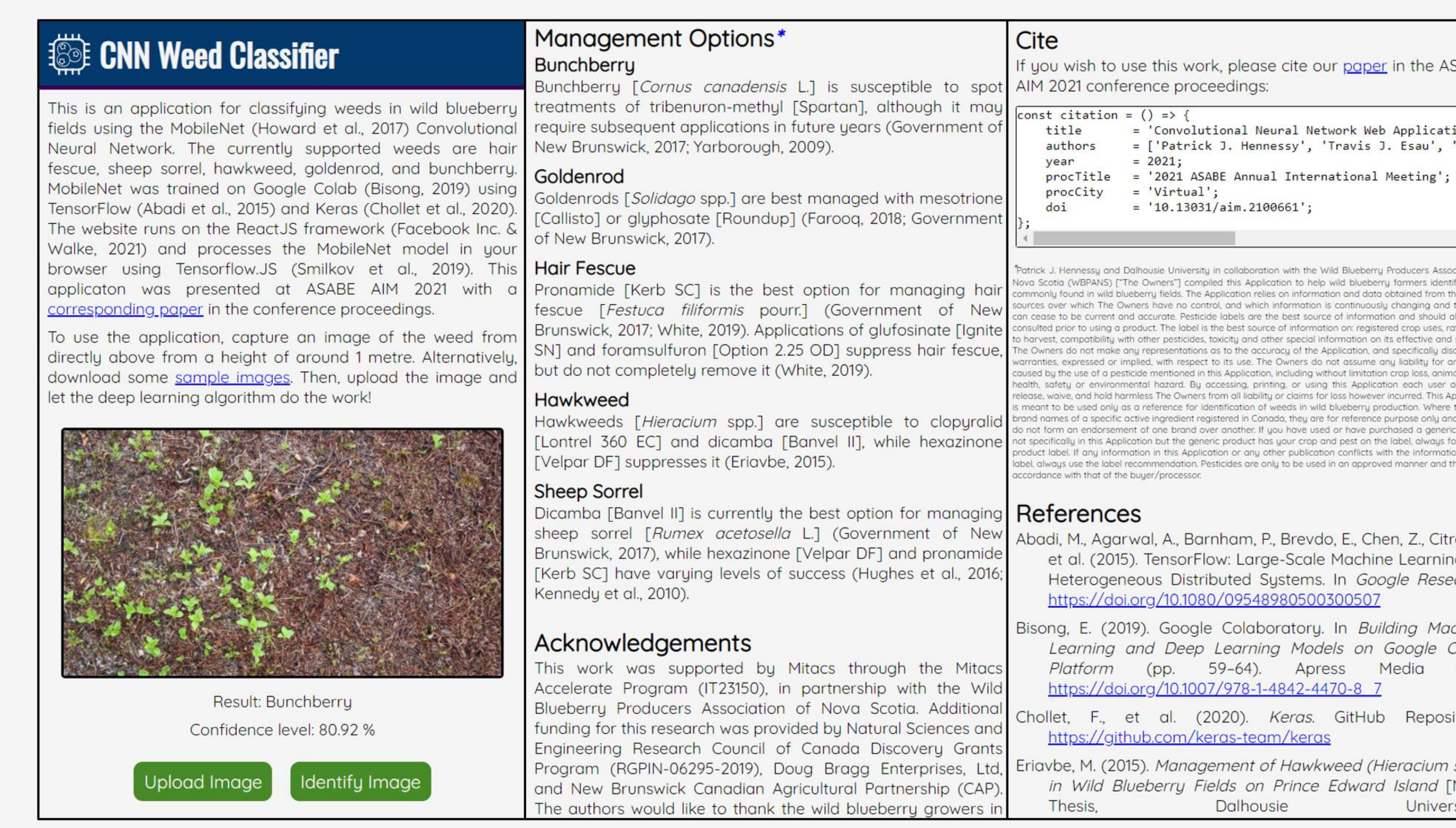




Confusion matrices for classification of validation images using EfficientNet-B0 (left) and MobileNet (right).

The application can be accessed by scanning this QR code, or by visiting https://patrickhennessy-dal.github.io/weed_class_asabe21/

- Accuracy may be improved by using images that contain only one species of weed.
- The rescaling layers used in EfficientNet-B0 are not available in Tensorflow.JS as of the current version (3.6.0).
- Processing images on a backend sever instead of in the users' browser would allow for different CNNs such as EfficientNet-B0 to be used.



Screenshots of the web application.

Conclusions

- This application will help growers use optimal management practices, thus increasing the sustainability of the industry.
- A better dataset and backend processing with EfficientNet-B0 will help improve classification.

Acknowledgements

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