Determining the feasibility of training a dog to detect *Hieracium* species

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Summary *Hieracium* species, commonly known as hawkweeds, have been high on the radar for Australian land managers for many years now with large-scale eradication programs in place to manage infestations in Victoria, New South Wales and Tasmania. The programs rely on surveillance undertaken by humans, which is resource intensive and can be physically exhausting to the volunteers and contractors involved.

In an effort to determine if the Victorian eradication program could improve surveillance confidence and efficiency, to help fast track the eradication program, the use of a hawkweed detection dog is being investigated. If successful, the dog may not only cover ground faster than humans, but it may also be able to achieve a higher level of confidence in detection rates than humans.

Initial results have shown that it is possible to train a dog to detect hawkweed rosettes, stolons and rhizomes.

Keywords Hawkweed, detection dog, surveillance, eradication, State prohibited weeds.

INTRODUCTION

Hawkweeds are members of the daisy family (Asteraceae). They are native to Europe and widely regarded as an extremely invasive environmental and agricultural weed around the world (Brinkley and Bomford 2002, Cipriotti *et al.* 2010, Day and Buckley 2011). The detrimental effects of hawkweeds (*Hieracium* spp.) is seen in countries such as New Zealand (Jesson *et al.* 2000), and South America (Southern Patagonia) (Cipriotti *et al.* 2010), where it has become a significant environmental and agricultural problem. Australia is now starting to see first-hand the influence hawkweeds have on the natural environment (Cousens *et al.* 2012), with small infestations present in Victoria, Tasmania and New South Wales. With predictions estimating losses to agricultural systems in the order of $AUD48 million (Brinkley and Bomford 2002), hawkweed could be detrimental to Australia's environmental and agricultural systems if left unmanaged.

Hawkweed's allelopathic ability (Saggar *et al.* 1999) allows it to outcompete native ground covers, eventually forming a monoculture at the infestation site. They do this by converting soil mineral nitrogen (N) to organic forms, subsequently reducing net N mineralisation, making it difficult for other ground covers to survive (Scott *et al.* 2001). Further to this a single plant is able to produce viable seed within 14 days of the bud forming, and up to 40,000 seeds m^{-2} can be produced in a flowering season when the infestation is thick (National Heritage Trust 2003). Viable seed can be produced both sexually and asexually (Tucker *et al.* 2003), and hawkweeds can also spread through the formation of stolons (Winkler and Stöcklin 2002).

It is for these reasons that hawkweeds have been classified as State prohibited weeds in Victoria under the *Catchment and Land Protection Act 1994,* and have been the focus of comprehensive eradication programs at the two largest naturalised infestations in Victoria's high country at Mount Buller and Falls Creek. A small infestation of orange hawkweed (*Hieracium aurantiacum* L.) is present at Mount Buller, whereas Falls Creek has a much larger infestation, and also has infestations of mouse-ear hawkweed (*Hieracium pilosella* L.) and king devil hawkweed (*Hieracium praealtum* Vill. ex Gochnat).

After intense surveillance, monitoring and treatment over many years the eradication programs have made significant progress towards eradicating the infestations by preventing their spread and reducing the number of active sites. Although progress has been made, the programs are extremely resource intensive with around 2600 hours spent each summer searching for hawkweed plants in rough and hilly landscapes often thickly covered with alpine vegetation. As dedicated as both the contractors and volunteers are, their job will always be demanding, often searching for a single rosette just centimetres across in this challenging terrain.

Furthermore, the highest confidence interval that the eradication program can achieve through human surveillance is 80% (Hauser *et al.* 2012). Hauser *et al.* (2012) found that this can be achieved if hawkweed flowers are present and 5.5 hrs is spent searching in a one hectare area of grassland. In the same study it was also found that if no flowers are present, 43 hours of searching is required to achieve an 80% confidence interval in a one hectare area of grassland. This demonstrates the difficulties the eradication program faces in developing confidence in surveillance and ultimately eradicating the infestations. Compounding this, the vegetation varies from grassland to thick forest, which further reduces the confidence interval that can be achieved without spending excessive hours searching each grid. Using current surveillance practices and confidence intervals we may never be able to reach 100% confidence that every plant has been found, especially as the infestations reduce in size to single plants over large areas of rough terrain.

The need to improve surveillance efficiencies and confidence intervals to achieve eradication, triggered the investigation into the use of a dog trained in the olfactory detection of hawkweeds. An acute sense of smell and the ability to traverse landscapes at a much quicker pace than humans, makes dogs an ideal candidate to efficiently detect hawkweed whilst also potentially achieving a very high confidence level (Cablk and Heaton 2006, Johnen *et al.* 2013).

HAWKWEED DETECTION DOG

The Victorian Department of Environment and Primary Industries have commenced a trial to investigate the ability of a dog to detect hawkweed with a professional detection dog trainer. The trainer supplied his own working detection dog 'Missy' for the trial. Missy is a two-year-old English springer spaniel. Missy has previously worked on fox, rabbit and hare detection, and has a proven ability to be an effective detection dog in these areas.

Training commenced with Missy mid-2013, using specimens of orange, king-devil and mouse-ear hawkweed, along with common native and introduced species found in the Victorian high country. It was not known if a dog would be able to discriminate the scent of hawkweed, and so the trial was broken into two stages.

The first stage of training was to determine if a dog could associate the scent of hawkweed rosettes with the positive reward of a ball, and if so, could it discriminate the scent of hawkweed rosettes (target species) from the other species (non-target species).

Scent association training was conducted by placing the target species into a removable compartment on a scent board that also contained 9 other empty compartments. After being instructed to search, Missy was rewarded when she placed her nose into the target species compartment. Repeated training saw Missy develop a positive association of hawkweed to the reward. Scent discrimination training was then conducted by placing the target species in a compartment and setting non-target species in the remaining compartments. During each training session the compartments were moved around the board to challenge Missy's olfactory senses and enhance her scent discrimination. Missy was instructed to search and then rewarded when she located the target. This was repeated until Missy could identify the target species correctly with no misidentifications.

On successful completion of the first stage, Missy progressed to stage two of training where she was introduced to detecting the target species in open landscapes. Plants were placed in sealed buckets with small holes drilled in the lid to ensure the target species and non-targets species were not released during transport and training. The holes released enough hawkweed scent for the dog to detect (Syrotuck 2000). Control buckets were also placed out for training. These were either left empty or contained a non-target species. The locations of the buckets were marked with a flag on a 90 cm piece of dowel to ensure they would not be lost in tall vegetation.

The results of this first stage demonstrated that after several weeks of training in varying landscapes ranging from backyards, parks, bush lands and grasslands, a dog is able to detect the target with no false positives or false negatives. The dog's behaviour also indicated that it was able to first detect the target species scent from distances up to 20 meters away.

The success of the hawkweed rosette trials prompted testing a dog's ability to detect stolons and rhizomes. If successful, this would increase the period in which surveillance could take place in the field. It would also improve the confidence of finding hawkweed, as even if no rosettes were present, hawkweed could still be located.

Given Missy showed strong scent association and discrimination to rosettes at the first stage of training, it was thought unnecessary to conduct this phase for stolons and rhizomes. Missy was therefore introduced to stolons and rhizomes using the same method as the stage two open field training for rosettes.

Training commenced for stolon and rhizomes in December 2013. The initial results are very positive, indicating that Missy can also detect these plant parts. Training will continue over the winter months of 2014 to ensure that all hawkweed stolons, rhizomes and rosettes can be detected by Missy to a high detection rate. After this has been achieved, a detection experiment is planned in early 2015, in Victoria's high country. This will provide an indication of the confidence intervals we can achieve in hawkweed surveillance using a detection dog and also highlight any efficiencies.

After conducting this detection experiment we will be able to directly compare the findings of Hauser *et al.* (2012), who also conducted a detection experiment on the ability of humans to locate hawkweed in varying landscapes in the Victorian high country.

CONCLUSION

The initial findings of the trial have proven to be extremely promising, suggesting that a dog can be trained to detect hawkweed. With continued training throughout the year and results of the detection experiment known, we hope to determine whether a dog can be efficient and cost effective in finding hawkweed in the field.

The trial will help inform managers of the Victorian eradication programs on the benefits and limitations of using a detection dog as part of hawkweed eradication. If successful, it may be possible to more efficiently find hawkweed to a higher level of confidence and vastly accelerate the eradication of hawkweed in Victoria, while potentially offering detection benefits to other hawkweed affected states in Australia.

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