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Can volunteers train their pet dogs to detect a novel odor in a controlled environment in under 12 weeks?

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Highlights:

- Volunteers and their pet dogs were trained to detect a novel odour in a controlled environment in 12 weeks.
- Dog-handler teams were assessed in Week 8 on scent board searches and in room searches both with and without training equipment present. Teams were reassessed in Week 12 on odour-present, odour-absent and distractor odour board searches and odour-present and odour-absent room searches.
- All teams that completed the Week 12 assessment activities scored a minimum of 75% correct responses in odour-present trials.
- Teams were re-assessed after a 14 week period without maintenance training and no significant differences were found between Week 12 search time, proportion of correct alerts, or false alert rate.
- A fully developed volunteer-based model may be an effective, economical and scalable way to train and deploy conservation detection dogs.

Can volunteers train their pet dogs to detect a novel odor in a controlled environment in under 12 weeks?

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Abstract

Conservation Detection Dogs (CDDs) are trained to locate biological material from plants and animals relevant to conservation efforts. CDDs can be more effective and more economical than other survey methods, yet financial costs associated with training and maintaining CDDs, while meeting their welfare needs, can prohibit their use. It takes a great deal of time and effort to train operational CDDs, but an important foundational skill is being able to detect a target odor in controlled conditions. In this study we developed and evaluated a program in which community volunteers trained their own companion dog in such a task. Following an initial assessment, 19 dog-handler teams were selected to work with two professional CDD trainers in a 12-week training program. Teams were assessed in Weeks 8 and 12 in scent board and room search activities. Seventeen teams completed the full program and located the target odor in a minimum of 75% of all search trials in which the odor was present. Search performance was re-assessed in 11 teams after a 14-week period without maintenance training, with no significant reduction in performance being found in search time, proportion of correct responses or number of false alerts. These results suggest that companion dogs can be successfully trained to locate a target odor in controlled conditions in 12 weeks and that this skill is retained for at least several months. While this is a far cry from what might be expected of a fully operational CDD, it is an important first step in demonstrating that a volunteer training model may provide one way to help address financial limitations and welfare implications that can be associated with professional CDDs, while engaging community members in important and sustainable conservation work.

Keywords: Conservation detection dog, Scent detection, Detection performance, Olfaction, Conservation, Novel odor.

Introduction

The use of conservation detection dogs (CDDs), trained to detect targets relevant to conservation efforts, is growing in popularity (Beebe et al., 2017). Evidence suggests that CDDs can be more effective and, in some cases, more economical, than other survey methods, such as camera traps or hair snares, in detecting the presence/absence and relative abundance of plants and wildlife in a non-invasive way (Jenkins et al., 1963; Arnett, 2006; Goodwin et al., 2010; Harrison, 2006; Dematteo et al., 2009). Despite their relative cost-effectiveness, the actual cost of training and maintaining CDD dogs and professional handlers remains prohibitive, costing tens to hundreds of thousands of dollars depending on the project requirements (Orkin et al., 2016). This can make them an unrealistic option for many stakeholders, from small community groups through to large not-for-profit organisations.

Such costs can also threaten the sustainability of emerging or successful programs that rely on just one or two dogs. In addition, dogs involved in seasonal deployment can be left without work for long periods, during which they must be housed and cared for. This is a costly exercise with potential welfare implications for dogs typically selected because of their high energy and strong motivation to work (Beebe et al., 2016; Jamieson et al., 2017). These dogs may cope poorly if housed in a kennel environment for any length of time without considerable physical and mental stimulation.

In Australia, as in many other countries, volunteer-based environmental groups provide much of the workforce for community-based conservation projects, from clearing and replacing invasive or introduced plant species with native ones, to identifying and surveying endangered species (Ryan et al., 2001). While smaller volunteer groups are unlikely to be able to afford access to professionally trained CDDs, the activities undertaken by these groups align well with those of CDD deployment, in that they frequently require detection of difficult-to-detect biological targets. This raises the question of whether an alternative model for provision of CDDs, incorporating community volunteers and their pet dogs, may be worth examining.

Dog ownership is extremely popular and dog owners have a strong tradition of engaging in a wide range of activities with their dog, including dog obedience or agility competitions, but also many volunteer activities, such as visiting nursing homes or schools (Delta Society, 2019) or training to engage in search and rescue activities in emergency situations (SADA, 2019). Of particular interest are the popular sports of canine scent tracking and trailing activities and the emerging K9 Nose Work® sports (K9 Nose Work, 2018). Originating in tracking and substance detection training, these sports involve pet dogs training and competing to follow scent tracks or detect various hidden target odors. These sports have grown in popularity amongst pet dog owners who are looking to engage with their dog in an activity that promotes mental and physical stimulation (K9 Nose Work, 2018; Johnson, 2003).

Applying similar principles, a pilot program operating in the Australian state of Victoria trained and deployed seven volunteer pet dog-handler teams to detect scats of the endangered tiger quoll (*Dasyurus maculatus*), (Conservation Ecology Centre, 2017). One of these dogs was also trained and deployed to detect long-nosed potoroo (*Potorous tridactylus*) scats (Conservation Ecology Centre, 2017). This program provides some indication that volunteers can be trained to work with their pet dogs on conservation programs. However, it has not been formally evaluated and it is not known how successful the program is, whether it is scalable or sustainable, or whether only specific types of dogs or owners are suitable for this role. Indeed, we could find only one study which has examined volunteer CDD team performance. Browne et al. (2015) recruited 20 volunteer dog-handlers with variable experience in competitive obedience scent discrimination exercises and trained their dogs to identify various types of tuatara lizard (*Sphenodon Punctatus*) and gecko (*Naultinus manukanus* and *Hoplodactylus granulatus*) odors. The dogs then engaged in a match-to-sample task in which they mouthed a cloth infused with either lizard or gecko skin/scat odor before retrieving a randomly located and identically-scented cloth from a line-up of seven other neutral or non-target scented cloths (Browne et al., 2015). This study demonstrated that volunteers can adapt previously learned scent-based activities to detect a specific animal's scent. However, because the dogs were searching a defined row of visually salient items, it is unclear how these search skills translate into a broader search context in which salient visual search cues are not as evident.

Even though volunteer CDD teams could represent a considerable cost savings compared to professional CDDs, training volunteers does have associated time and financial costs. Some level of volunteer attrition during training and operational deployment phases is almost certain (Stukas et al., 2014), and poorly developed requisite skills may mean that training needs to begin at a very simple level and proceed far more slowly than would be necessary for professionals. Furthermore, dogs participating in a volunteer CDD program would presumably resume their regular pet dog lifestyle in periods of non-deployment, yet be expected to display a high level of performance during scheduled deployment activities. Therefore, ongoing maintenance training is a necessary consideration.

There are financial costs associated with providing professional maintenance training/guidance to volunteer CDD teams, and very little research exploring the retention rates of search performance in dogs who are not undergoing maintenance training. Williams and Johnston (2002) trained four dogs to detect multiple odors and tested each dog's performance on a recently learned odor after an average period of 8 days without maintenance training (Williams and Johnston, 2002). If dogs made no errors in a detection assessment after this period, a new target odor was introduced for them to detect, if errors were made, a refresher training session was conducted. All four dogs retained detection performance and progressed through multiple detection assessments until they learned 10 odors in total, and the number of refresher sessions required did not increase but did decrease in two cases (Williams and Johnston, 2002). This indicates an average of 8 days without training does not greatly influence detection performance in controlled conditions. Besides this, we could find no peer reviewed information regarding how well detection performance is retained after an extended training break, although beagles trained to perform a simple obedience task were found to have unimpaired retention of the task after a four week period without training (Demant et al., 2011). While performing obedience tasks and using olfaction to search for targets may not be similar in nature, it is possible that these learned behaviors have similar retention rates. Therefore, pet dogs who have been trained to use olfaction to detect a particular odor may be able to do so even after an extended break from training.

Training volunteers and their companion dogs to work as operational CDDs is an ambitious undertaking, comprised of many small steps. The aim in this study was to commence this process by determining whether a 12-week program is sufficient to teach novice volunteers and their pet dogs, with varying levels of training experience, to detect a novel odor indoors, under controlled conditions. We hypothesised that they would be able to do this with at least 75% correct responses upon completion of the training program. A secondary aim was to see if performance was retained after an extended break from training.

Method

Participants

The research was conducted in the regional Victorian town of Bendigo, which has a population of approximately 150,000 people (Australian Bureau of Statistics, 2017). Participants were recruited primarily from this community, although some travelled considerable distances to take part in the study (see Table 1). Dogs were required to be between one and nine years of age. Twenty-three handlers (owners) expressed interest in the study and were invited to attend a screening day with their pet dog. One failed to attend. After screening, another two were excluded from the study on the basis that their dog showed insufficient motivation to engage in an initial training session. One more was redirected elsewhere because the dog/handler team was already advanced in scent detection work.

Nineteen dog-handler pairs (details in Table 1) commenced a 12-week scent detection training program. Some had prior scent training experience, but no dog had previous experience with myrrh, the target scent used in this study. Two participants withdrew before program completion. One was a strict vegan who found it impossible to handle the meat used for training. The second simply stopped attending and was unable to be contacted. Seventeen teams completed the training program and participated in Week 12 search performance assessments.

During the course of an extended (14 week) break following the Week 12 assessments, three teams withdrew from further participation due to major life changes unrelated to program participation (e.g. pregnancy, relocation interstate).

Eleven of the 14 teams remaining in the project were re-assessed after the 14-week break (Week 26), during which no maintenance training was provided. Ideally, all 14 teams would have been reassessed at this time, but three were unable to attend the assessment session (held during the holiday season). We believe that the 11 teams available for reassessment were broadly representative of the entire cohort and could find no systematic differences in prior performances between those who attended and those who did not. In fact, all three of the unavailable teams re-joined the project for the second training stage not reported in this paper, and they proceeded as successfully as every other team.

Table 1

Dog-Handler Team Demographic Information

Dog-Handler team	Owner-Reported Dog Breed	Dog Sex	Dog Age (years)	Handler Gender	Handler Age (years)	Handler's dog training experience level*	Dog's scent work experience level**	Average days training at home per week†
1	Rhodesian ridgeback	Intact male	5.5	M	38	9	2	-
2	Australian kelpie	Intact male	5.4	F	57	9	10	2.5
3	Miniature poodle	Neutered female	2.4	F	59	5	2	2.3
4	Samoyed	Neutered female	1.9	F	33	7	7	3.6
5	Rough collie	Neutered male	6.25	F	62	8	10	2.8
6	Cocker spaniel x toy poodle	Neutered male	1.75	F	28	5	2	1.6
7	Weimaraner	Intact	4.58	M	53	9	10	-

		male						
8	Labrador x kelpie	Neutered male	3	F	30	5	0	-
9	Cavoodle	Neutered male	1.5	F	49	5	0	1.9
10	Australian cattle dog	Neutered female	7	F	64	5	0	2.4
11	Border collie	Neutered female	4.5	M	67	9	10	3.4
12	Border collie	Intact male	1.33	F	50	8	2	2
13	Whippet, greyhound, Staffordshire bull terrier mix	Neutered male	5.5	F	30	8	7	2.3
14	Border collie	Neutered female	3.5	F	24	5	0	1.3
15	Border collie	Neutered female	8.33	F	66	9	3	2
16	Labrador	Neutered male	2.42	F	36	8	0	-
17	Finnish Lapphund	Intact male	3.17	F	27	9	5	-
18	Bull terrier x kelpie	Neutered female	3.92	F	24	2	1	-
19	Border collie	Intact female	1.67	F	23	8	0	-

*Handler dog training experience scores were obtained from a 10-item self-report scale asking participants to “Please slide the bar to indicate your overall level of dog training experience”. Only the anchor points at each end of the scale and at the mid-point were labelled (1 = “No experience”, 5 = “Some experience”, 10 = “Extremely experienced”).
**Dog scent work experience scores were similarly obtained through a 10-item scale asking participants to “Please slide the bar to rate how familiar your dog is with Scent detection / Nosework”. Only the anchor points at each end of the scale and at the mid-point were labelled (1 = “Not at all familiar”, 5 = “Somewhat familiar”, 10 = “Extremely familiar”).
†Data on home training sessions was based on handler reports. This could not be extracted for seven teams that did not complete/return their training logbook. These cases are denoted by a ‘-‘.

Materials

An online self-report questionnaire (Appendix A) was used to collect demographic information about participants and their dogs, including sex/gender, age, breed, how long they had owned their dog, and information on their level of scent-related dog training and general dog training experience. The questionnaire also collected information about participants’ previous volunteering experience, including the broad field they had volunteered in (e.g. health, education, environment), how many hours they had volunteered in an average week and how long this was maintained. This volunteering information will be reported in a later publication.

Myrrh essential oil (Leonardi Laboratories®) was used as the target odor. Approximately 0.025ml - 0.05ml of myrrh oil was absorbed onto the fibrous end of a cotton tip (Black & Gold® and Swisspers®). Myrrh was presented either on a cotton tip alone that was secured to the floor using transparent tape, or on a tip contained in one of 10 Polyvinyl Chloride (PVC) ‘scent pots’. Scent pots consisted of a 90mm PVC and steel mosquito mesh barrier pipe fitting (Rain Harvesting®) stacked atop two 90mm PVC push-on storm cap pipe fittings (Holman®). The lower end caps of 10 scent pots were screwed to a 1000mm x 90mm x 19mm length of timber (i.e. scent board) in a row (See *Figure 1*), which together formed an economical and portable variant on a long-established and commonly used scent detection training aid (Becker et al., 1962). Only one of the 10 scent pots was designated to contain myrrh, termed the target pot. Both the upper mesh fitting and the middle PVC fitting components of the target pot were marked with a small “‘m” with a permanent marker, while non-target pot components were marked with a small “~”. This ensured no confusion between target and non-target pots during training while also ensuring all pots smelled the same apart from myrrh odor.

Figure 1. Scent board complete with scent pots and a detached pot with the mesh barrier PVC fitting removed (right). The location of the single target pot containing up to two myrrh-infused cotton tips was changed between each training trial. One tip was used for assessment trials.

A myrrh-infused cotton tip was placed on the middle PVC fitting of the target pot so that it sat under the mesh barrier of the upper fitting. This allowed dogs to smell the odor without touching or mouthing the cotton tip, which could contaminate the odor and hinder training. Mesh fittings also greatly reduced visibility of the cotton tip in the scent pot, which was useful in encouraging dogs to use olfaction, rather than vision, in the training activities. This was further useful in that handlers' ability to cue their dogs to the location of the odor was greatly reduced if not eliminated. In training exercises, the "m" was sometimes visible to the handlers, which could have led to them cueing their dogs to the correct location. However, in assessment board searches, a new symbol was used to denote the target odor pot and this was orientated in a way that made it highly unlikely that handlers could have visually identified the target pot and cued their dogs to its location. Non-infused cotton tips were placed in some non-target pots to ensure dogs were training to detect the odor of myrrh essential oil only, not myrrh essential oil and cotton tips.

The modular design of the scent board allowed individual scent pots to be easily attached/detached. Having fewer pots (1, 2, then 3 and so on) in the early training stages assisted in focusing dogs' attention to the target pots and familiarising them to the presentation of the target odor. Additional, non-target pots were added in subsequent training stages, building complexity into the training exercises. Two clean target pots were often used interchangeably during training classes of four to five dog-handler teams and, here, pot locations and pots were changed between trials. Occasionally, saliva would be deposited on the target pot from inadvertent contact with the dog's mouth and nose. When this happened the researchers would wipe the saliva along the tops of several other non-target pots on the board. Dogs were also frequently presented with clean target pots during training sessions. Given this, we believe the dogs learned that the presence of saliva or another dog's odor was not a reliable indicator of target odor position, or part of the 'scent picture' dogs were learning to identify. Rather, dogs learned that myrrh was the target odor alone and not myrrh and saliva, even though sometimes these were presented together during training.

Participants were provided with their own scent board, a scent kit consisting of an airtight container to house a tin containing myrrh cotton tips, tweezers and gloves and asked to conduct brief training sessions at home for approximately 10 minutes every second or third day. They were also given a training logbook to record and briefly describe these home training sessions.

Canine agility equipment including a low wooden platform, a raised plank, a large hoop and small traffic cones were used as obstacles in room searches to make the latter stages of training more complex.

Strips of boiled beef cut to the approximate dimensions of a little finger were used as the main food reward. These were used as they are high-value for most dogs and can be held in the palm of the hand and gradually fed out so that dogs can bite off several fingernail-sized pieces when being rewarded. Some handlers preferred to substitute beef with kangaroo strips, sliced hotdogs or commercially available, strip shaped dog treats. One handler attempted to switch from beef strips to carrot slices but found they did not sufficiently motivate the dog. This participant subsequently withdrew from the study. Tennis balls and squeaky balls were also used by some handlers to motivate dogs who found play and toys to be rewarding. These were used in conjunction with food rewards to reinforce desirable behaviors.

Procedure

Approaches to training odor detection and discrimination tasks in laboratory conditions have evolved for several decades, from early studies involving problem boxes and scented air currents (Becker et al., 1957), to more recent training methodologies involving classical conditioning (Hall et al., 2014) and automated training apparatuses (Edwards, 2019). We chose to employ training methods used by professional CDD groups that emphasise dog and handler/trainer cooperation rather than alternative methods. All training employed positive reinforcement methods and training techniques similar to those described in previous research (Johnen et al., 2013; Braun, 2013; Hurt and Smith, 2009). Clicker training methods were not used and nor were physical corrections or aversive training methods.

Dog-handler teams were divided into groups of four to five, depending on availability to attend weekly training sessions at certain times. Each group then undertook a 12-week training program consisting of nine weekly, 2-hour training classes, plus three, 2-day workshops, to which all teams were invited. All activities took place in a controlled indoor setting, to reduce environmental influences such as fluctuations in wind, temperature, humidity and visual and auditory distractions. The training program and methodology was developed and delivered by two professional CDD trainers. One delivered the weekly training sessions. The other delivered the weekend workshops, assisted by the first trainer. After initial demonstrations, all dog owners were guided by professional trainers to train and handle their own dog. Training followed the same basic plan but was modified as necessary to suit each dog/handler team. Some teams progressed more quickly than others.

Stage one: Novel odor introduction

The program began with introduction of a novel odor (myrrh) with two myrrh-infused cotton tips presented in a scent pot. Kneeling down in front of a dog, a trainer held the scent pot in front of them in one hand and held a food reward in the other hand (i.e. beef strips which were slowly fed out, allowing dogs to pull small cubes off the end) so that the food was inaccessible and both hands were approximately shoulder width apart. Being inquisitive, dogs often initially investigated the hand containing the food reward. Due to it being inaccessible, they then investigated the target scent pot with their nose. Every time they did this, the trainer would move their hand with the food to the scent pot and deliver a food reward to the dog at the source of the odor (i.e., inside the outer rim of the pot) before resetting their hands to the original position.

From this starting point, trainers employed basic operant conditioning principles to shape each dog's behavior through positive reinforcement of desirable behaviors and ignoring undesirable behaviors. Using these shaping principles, trainers gradually changed the reward criteria so that dogs were required to place their nose in the scent pot containing myrrh in order to obtain a food reward. To build an association between the odor and a reward quickly and efficiently, dogs were rewarded at the source of the odor, (i.e. the food held inside the rim of the scent pot) and were consistently rewarded every time their nose was in the scent pot, via a continuous reinforcement schedule. After between five and 10 repetitions, dogs received a break of up to 15 minutes resting in a crate or car so that they did not fatigue too quickly, maintained their motivation to engage with the training and had a chance to consolidate their learning. This was done throughout all training stages. Upon resumption of training, trainers repeated the last activity before introducing a new component.

Stage two: Introducing the scent board

In the next stage, the target scent pot containing myrrh was placed on the floor and dogs were rewarded for placing their nose in it before two non-target scent pots were placed next to the target scent pot in the next trial. Here, dogs typically investigated all three pots initially, but were immediately rewarded only when they placed their nose in the target pot. The exercise was then repeated with the three scent pots attached to the scent board. Over successive trials, all 10 scent pots were gradually attached to the scent board in the exercise and dogs spent progressively less time investigating any pots other than the target pot.

Stage three: Shaping alert behavior

Once dogs were consistently alerting to the target pot on the scent board, trainers gradually shaped the dogs' alert behavior, the behavior through which each dog communicates to their handler that they have located a target. Trainers aimed for dogs to assume a drop position and repeatedly nose the location of the odor as dogs' alert behavior. This was done by holding the food reward in the scent pot when dogs had made a correct selection but making it inaccessible. In an attempt to attain the reward, dogs often assumed a play bow or 'drop' position, immediately after which they were given the food reward at the source of the odor. Verbal praise was also frequently given. Two dogs offered other, easily recognisable alert behaviors involving standing over an odor and staring at their handler and these were adopted as their alert behavior. From then on, dogs were only rewarded while performing their alert behavior at the source of the odor. This was the case until the context in which the odor was presented was changed, as in the next training step.

Stage four: Searching independently of the scent board

Once dogs were reliably alerting to the location of the target odor amongst 10 pots on the scent board (termed ‘full board’), trainers then worked to teach the dogs to search for and alert to the odor independently of the scent board. This was done by conducting several, regular full board searches in which the mesh fitting was removed from the target pot, exposing the uncovered scented cotton tip to the dogs. This familiarised dogs with alerting to the odor without the mesh fitting. As some dogs tried to lick the cotton tip, it was secured to the scent pot using transparent sticky tape to prevent it from being accidentally ingested. Next, the target scent pot was removed from the full scent board and the remaining pots arranged so that the resulting ‘gap’ was located at the end of the board. The scented cotton tip was then taped to the floor at the immediate end of the board next to this gap. Handlers then instructed their dogs to search the scent board and dogs were immediately rewarded when their nose approached the location of the scented tip, regardless of whether they displayed their alert behavior. The distance from the tip that dogs were rewarded for investigating and the alert behavior they offered was gradually shaped until dogs were required to indicate the precise location of the cotton tip with their regular alert behavior in order to receive a food reward. Similarly, the distance between the scent board and the cotton tip was gradually increased over successive trials until the dogs were able to quickly move away from a scent board containing no odor and search a progressively larger area for the odor. To allow trainers to quickly relocate the target odor during training while minimising odor residue, paper towel was tightly packed into small PVC or steel pipes (approximately 100mm long x 20mm wide) and a small amount of myrrh oil dropped into both ends, which were left uncapped. Both cotton tips and pipes were used as training tools, but pipes were not used during assessment activities.

An intermediate training step was used for several dogs that were reluctant to search away from the scent board, whereby several non-target scent pots were detached from the board and scattered around a room in which the cotton tip was placed. This visual cue encouraged dogs to search further from the board until they detected the target odor. However, due to the possibility that some dogs would develop a reliance on these visual cues to search areas, this was not used extensively. The final stages of training involved dogs searching otherwise empty rooms in which both scented and unscented cotton tips were taped to the floor. Dogs then progressed to searching rooms containing various obstacles, such as canine agility equipment and furniture, in which scented tips were hidden on floors, walls and obstacles.

In training and assessment activities, both myrrh-infused and unscented cotton tips were secured to the floor using transparent tape. Due to the visual appearance of the floor in the laboratory where this research was conducted (See Figure 1) these tips were highly camouflaged and difficult to locate visually. To avoid cross contamination of the target odor, cotton tips were always handled with gloves and tweezers and locations where myrrh was taped to the floor were cleaned with disinfectant wipes (Strike®) when tips were moved. Trainers ensured to handle each scent pot equally so that all pots were as identical in smell as possible, except for the presence of a myrrh infused cotton tip. As training and assessments took place in the same rooms for all teams, dogs were frequently searching the same rooms after one another. In the same way we believe dogs learned to ignore other dog odors as cues in training board searches, target odor locations were also moved between area searches so that dogs did not learn to associate strong concentrations of dog odor in a room with target scent location. During latter training and assessment stages, trainers wiped their hands on areas of floors and walls and used disinfectant wipes on areas that did not contain myrrh to ensure dogs were not cued to the location of the target odor by other odors dogs may have associated with the presence of myrrh. Furthermore, all scent pots were washed with running hot water after each training session to clean off saliva and food residue. Myrrh pots were washed last to prevent cross contamination.

Dog-handler teams were provided with training equipment and were encouraged to practise training activities at home and record these in a log book. Dog-handler team progress was assessed at Week 8 and Week 12 of the program.

Scent detection assessments

General assessment methodology

Individual dog-handler teams were assigned their own, thoroughly cleaned, scent board and pots for all assessments to reduce influences of their own or other dogs' scent on equipment. These scent boards were selected from a pool of five training boards, not from among those the dogs had been trained on at home. Target pot mesh fittings were washed after a maximum of two board search trials before that team conducted the next board search and an unscented cotton tip was placed at random in two of the non-target pots during searches involving pots. All 10 scent pots were used in board search and pot search activities, meaning the probability of dogs alerting to the target pot by chance was 10%. Handlers were blind to the location of the target odor in all search trials and the order and pseudorandomised location of the target in each odor-present search was the same for all teams' search trials. During training, dogs were occasionally observed directly returning to the location of the target pot in the previous trial. To ensure dogs were finding the target odor via olfaction and not location memory, target pot locations were pseudorandomised. That is, they were positioned randomly, with the exception that the same position was never used in two consecutive trials. To reduce the potential for handlers to cue their dogs to the target odor location, target scent pots were marked with a small symbol which had not been used in training and was similar in appearance to that used to denote non-target pots. Furthermore, scent pots were mounted on the scent board in such a way that handlers could not easily see the symbols written on them. As all odors were presented either in scent pots, which are close to the floor, or taped directly to the floor, and handlers were standing during searches, it is highly unlikely that handlers could have smelled the location of the myrrh and cued their dog to it. Myrrh-infused tip locations in room search activities were thoroughly cleaned with disposable wipes between trials. When placing scented tips, experimenters ensured to touch multiple surfaces in order to distribute their own odor around the room so as not to cue dogs to areas where the target odor was placed.

Handlers initiated a search by giving their dog a “search” cue. Trials concluded after the time limit had elapsed (60 seconds for all board searches and 120 seconds for all room searches), or when the handler believed their dog was alerting to the source of the odor (the scent pot or tip), usually through displaying their alert behavior, which handlers communicated to the experimenter by declaring “found”. An experimenter who arranged the scent board and pot configuration for each trial stood facing the scent pots in a stationary position against a wall approximately 3m from the scent board and stared directly at the scent board during board search trials and the centre of the room during room search trials. Upon a handler declaring “found” the experimenter would respond with either “correct” or “incorrect” based on the position of the dog’s nose in relation to the scent pots at the time of the handler declaring found, allowing the handler to reward the dog or ignore incorrect (false) alerts accordingly. Scent pot trials were scored as correct if the dog was alerting to the correct location of the myrrh when the owner declared “found”. False alerts (alerting to a pot not containing myrrh) resulted in the trial being scored as incorrect. Room search trials were scored as correct if the dog was alerting to the location of the myrrh at the time of the handler declaring “found” and incorrect if they were not. Odor-absent search trials were scored as correct in two ways; when handlers did not declare an odor to be found within the time limit (i.e., no alert), or when handlers declared that there was no odor present within the time limit. These odor-absent trials were scored as incorrect if handlers did declare that their dogs had found odor. While it is possible that the experimenter being present may have unconsciously cued the team to the correct location during a search, this is unlikely as dogs were consistently focused on the scent pots or floor during room searches and handlers were consistently focused on watching their dog, rather than the experimenter.

Week 8 interim assessments

Dog-handler performance was evaluated in interim assessments at Week 8, over three different search activities. Here, teams conducted five single-blind search trials of a 10-pot scent board in which one pot contained a cotton tip infused with myrrh essential oil and the other nine pots contained either unscented tips or nothing.

Search trials began with the dog in a heel position next to the handler standing 4m from the scent board in a 6m x 8m room. False alerts were scored as incorrect and the handler was shown the correct location of the myrrh, turning the trial into a training exercise. Trials that exceeded the maximum time limit of 60 seconds were terminated and scored as incorrect.

Teams then conducted three search trials of a 4m x 4.2m room in which a target scent pot was placed among nine unscented pots scattered within a 2m x 3m area. Searches commenced as teams entered the room and trials that exceeded the maximum time limit of 120 seconds were terminated and scored as incorrect.

The third search activity required teams to conduct three 4m x 4.2m room search trials in which one myrrh-infused cotton tip and two unscented cotton tips were taped to the floor in pseudorandomised locations in an otherwise empty room. While tips were placed directly on the floor, they closely matched the colour and patterning of the linoleum in the room and were difficult to locate visually (See Figure 2). Indeed, dogs were generally observed to be exploring the room via smell and not visually searching for and investigating one tip after another. Trials that exceeded the maximum time limit of 120 seconds were terminated and scored as incorrect.

Figure 2. Cotton tip taped to the floor during the room search activities. Tip locations were cleaned with disposable disinfectant wipes after being removed.

Week 12 assessments

Week 12 assessments consisted of six search activities, with search trials following the same methodology as in Week 8 except that false alerts were ignored and the trial continued until the team alerted to the correct location of the myrrh or the time limit elapsed. However, false alerts resulted in the trial being scored as incorrect. Teams completed five scent board search trials and repeated one 4m x 4.2m room search activity from the Week 8 assessments. Teams also completed two search trials of a 3.6m x 4.2m room in which one myrrh-infused cotton tip and two blank tips, separate from the scent pots, were taped to the floor amongst various canine agility obstacles. To ensure dogs were alerting to myrrh and not simply the presence of a distinct odor, teams also conducted two 'distractor board' searches in which a novel odor (frankincense then kunzea essential oil) was present in one of the nine non-myrrh scented pots. To measure false positive alert rates in the absence of myrrh, teams also conducted a blank (odor-absent) 4m x 4.2m room search and an odor-absent board search during which myrrh was not presented, yet unscented cotton tips were present. As odor-absent search activities had not been conducted in training to this point, handlers were unaware that some trials did not have odor present.

Post training break (Week 26) assessments

To investigate the retention of search performance over time in the absence of maintenance training, 11 dog-handler teams repeated the Week 12 assessments after a period of approximately 14 weeks. Handlers were instructed to not do any training during this time, although compliance with this instruction was not determined. The order of the Week 26 blank room and obstacle room search assessment activities was changed from Week 12 to reduce possible practise effects.

Analyses

Given the nature of this study, only limited analysis of the data was possible. As the variables analysed were not normally distributed based on a Kolmogorov-Smirnov test, non-parametric statistics were used for all analyses (Pallant, 2013). Spearman's Rank Order Correlation (rho) coefficients were used to explore whether numerical measures of search performance (i.e. proportion of correct responses and number of false alerts) of teams at week eight and upon completion of the program were associated with handlers' self-reported dog training experience prior to the program. Mann-Whitney U Tests were used to further investigate the relationship between previous training experience of dogs and handlers and whether teams made at least 75% correct responses by Week 8 or Week 12. Spearman's rho correlations were also conducted to explore whether the time participants spent training was related to the self-reported training experience of either handlers or dogs or to search performance upon completion of the program. To determine whether search performance deteriorated after a 14 week break from training, Wilcoxon Signed Rank tests were conducted on the rate of true positive (correct alert) and false positive (false alert) responses made by teams that completed the Week 12 and Week 26 assessments. Survival analysis is a common statistical method used to model time between two events (Lucy et al., 2017). A non-parametric Kaplan-Meier survival analysis was used to determine whether time to first alert was significantly different between the Week 12 and Week 26 responses for both odor-present and odor-absent searches.

Results

Dog-handler team search performance

Seventeen of the 19 commencing dog-handler teams completed the full training program and participated in the Week 8 and Week 12 assessment phases. Eleven teams were tested again after a break of 14 weeks (Week 26). Descriptive statistics for combined dog-handler team search performance in all searches in Week 8, Week 12 and Week 26 are presented in Table 2. Descriptive statistics for the Week 12 searches of the 11 participants who subsequently completed Week 26 assessments are also presented separately to facilitate comparisons.

At Week 8, teams made was 92.68% correct responses overall for scent board searches, 90.20% in pot room searches and 77.08% during standard room search activities. At Week 12, teams correctly located the target in 96.39% of standard board searches, 94.12% of standard room searches and 100% of obstacle room searches. Teams also correctly identified 85.29% of targets presented among novel distractor odors in distraction board searches. Finally, 64.71% of blank board and 70.59% of blank room searches were scored as correct with no false alerts made. After a 14 week break from training (Week 26), participating teams correctly located the target in 94.45% and 100% of the standard board and standard room searches, respectively. They found the target odor in 95.50% of distractor board searches and 81.82% of obstacle room searches, and correctly identified within the time limit that no odor was present in 81.82% of blank room and 72.73% of blank board searches. While alert behaviors varied between dogs, individual dogs' alert behaviors were generally consistent across all three assessment phases. **Table 2**

Results of the Week 8, Week 12 and Week 26 search performance assessments.

Search task	*N* trials per dog	Total correct trials	Total incorrect trials	False alerts	*N* 'time outs'	% correct responses	*N* missing cases	Time	
								Mean	
Results for all dog-handler teams who completed at least 8 weeks of the 12-week training course (*N* = 17)									
Week 8									
Standard board	5	76	6	4	2	92.68	3	12.34	1
Pot room	3	46	5	5	0	90.20	0	17.78	1
Standard room	3	37	14	7	7	72.55	0	41.00	2
Results for all dog-handler teams who completed the 12-week training course (*N* = 17)									
Week 12									
Standard board	5	80	3	2	1	96.39	2	14.62	1
Standard room	1	16	1	1	0	94.12	0	21.06	1
Distractor board	2	29	5	2	3	85.29	0	16.41	1
Obstacle room	2	34	0	0	0	100.00	0	20.85	1
Blank board	1	11	6	6	11	64.71	0	28.83*	1.
Blank room	1	12	5	5	6	70.59	0	57.40*	2.
Results for subset of dog-handler teams who completed the 12-week training course and were available 14 w assessment (*N* = 11)									
Week 12									
Standard board	5	53	1	1	0	98.11	1	12.69	1
Standard room	1	11	0	0	0	100.00	0	25.18	2
Distractor board	2	20	2	1	1	90.91	0	14.76	1
Obstacle room	2	22	0	0	0	100.00	0	23.64	1

Blank board	1	6	5	5	6	54.55	0	31.80*	1
Blank room	1	7	4	4	3	63.64	0	47.50*	6
Week 26									
Standard board	5	52	3	3	0	94.55	0	10.62	[illegible]
Standard room	1	11	0	0	0	100.00	0	15.82	1
Distractor board	2	21	1	0	1	95.45	0	14.24	1
Obstacle room	2	18	2	2	0	81.82	0	30.32	3
Blank board	1	8	3	3	3	72.73	0	29.67*	2
Blank room	1	9	2	2	3	81.82	0	57.50*	4

Notes: Board search time limit was 60 seconds. Room search activities time limit was 120 seconds. During all assessments, trials were scored as incorrect after the first false alert. Odor present trials were scored as correct after a correct alert. Odor absent trials were scored as correct if a handler did not declare their dog to be alerting within the time limit, or if a handler declared a search to contain no odor within the time limit.

* Descriptive statistics on the time to first alert during blank search tasks are calculated using the first false alert in blank trials in which false alerts were made.

A Kaplan-Meier survival analysis revealed no significant difference between time to first alert for the 11 teams in the Week 12 and Week 26 responses for odor present searches χ^2 (1, n = 219) = 0.25, p = 0.62 or odor-absent searches (1, n = 44) = 1.06, p = 0.30. Wilcoxon signed rank test indicated no significant differences in the number of trials scored as correct (true positive) and incorrect (false positive and false negative, or 'timed out') between Week 12 and Week 26 assessments for odor-present searches z = -1.41, p = 0.157 with a medium effect size (r = 0.30) according to Cohen's (1998) criteria, or odor-absent searches z = -0.96, p =0 .33 with a medium effect size (r = 0.21). The same analyses indicated no significant differences in the overall rate of false alerts in odor present searches,

z = -0.82, p = .41 with a small effect size (r = 0.17) or in odor absent searches, z = -0.97, p = .34 with a small effect size (r = 0.21) (Cohen, 1998).

No significant correlations were found at Week 8 between handlers' self-reported dog training experience level and search score r_s = -0.17, n = 17, p = 0.52 or false alert rate, r_s = -0.17, n = 17, p = 0.51, nor for search score in Week 12 r_s = -0.09, n = 17, p = 0.7 or in false alert rates r_s = 0.05 n = 17, p = 0.86. No significant correlations were found between dog's prior scent work experience, as reported by their handlers, and Week 8 overall search assessment score r_s = 0.36, n = 17, p = 0.16 or false alert rate, r_s = -0.42, n = 17, p = 0.09 nor Week 12 score r_s = 0.03, n = 17, p = 0.90 or false alert rate r_s = -0.47, n =17, p = 0.89. Mann-Whitney U tests were conducted to further investigate the relationship between previous experience and time to reach criteria. These revealed no significant difference in handler self-reported experience levels between teams that reached a minimum of 75% correct responses by Week 8 (n = 14) and teams that reached it by Week 12 (n = 3), U = 20.50, z = -0.07, p = 0.95, r = -0.02. Similarly, no significant difference in dog's previous scent work experience was found between teams that reached a minimum of 75% correct responses by Week 8 and teams that reached it by Week 12, U = 20.00, z = -0.13, p = 0.90, r = -0.03.

A correlation between handler experience and average minutes trained at home per week was not significant r_s = 0.38, n = 12, p = 0.23; similarly, dog experience was not significantly correlated with minutes trained per week r_s =0 .21, n = 12, p = 0.51. Furthermore, a correlation between average minutes spent training at home per week and Week 12 score was not significant r_s = 0.04, n = 12, p = 0.90. It is worth noting that these correlational analyses are likely underpowered due to the small sample size.

Discussion

This study indicates that a 12-week training program can be effective in teaching volunteers and their pet dogs to detect and indicate to a novel odor in controlled conditions. Furthermore, they can do this with a high degree of sensitivity. Combined dog-handler search performance in Week 8 assessments exceeded 75% correct responses in search tasks involving board searches and room searches with myrrh present. By Week 12, this level of performance was also achieved in all odor present searches, supporting our hypothesis that teams would make at least 75% correct responses after 12 weeks of training. The scores for many individual teams were much higher than this. As teams had not yet been exposed to odor-absent searches during training and were unaware that blank searches would be included in the Week 12 assessments, blank board and room trial results represent searches in which both dogs and handlers expected there to be odor present. Handlers expectations have been demonstrated to influence search outcomes (Lit and Crawford, 2006) and it is likely that both dog and handler expectations caused a high number of false alerts in these assessments. As myrrh is a volatile essential oil, it is possible that dogs could have detected it from some distance in the indoor laboratory environment. Therefore, dogs may have been able to smell myrrh during distractor board searches at the same time as the novel, non-target essential oils. A more valuable control to demonstrate the dogs' detection specificity to myrrh rather than any general 'odor' would be to present a non-target oil as a distracter scent in board and room searches where no myrrh was present. We recommend that this be used in future studies to ensure that the level of detection and discrimination the dogs have achieved is more robust that the elemental level demonstrated in this study."

While this study represents only the very beginning stages of training, the results are consistent with our contention that a volunteer-based model could one day provide an effective method of training CDDs.

All teams passed the Week 12 assessments, yet they did not all progress through the program at the same rate, which might largely be explained by differences in dog characteristics or handler characteristics. The comparatively low correct response rate and high standard deviation in Week 8 room search tests illustrate this, with some teams competently conducting room searches after eight weeks of training, while others could not. Conversely, experimenters considered several teams to be competent enough to complete the final assessments around Week 9, while others required the full 12 weeks.

This sample had a degree of variability in dog breed, dog and handler age, scent-specific and general training experience that could be considered representative of community sourced owners and dogs interested in participating in volunteer conservation detection work. Hence, it is not surprising that there was variability within the group. Individual differences in the rate dogs learn odor detection or discrimination are well established (Hall et al., 2013; Hall et al., 2015) and may account for much of the variability in individual dog-handler team's progression. While the current sample did not have sufficient representatives from each dog breed to examine breed differences, past research (Jezierski et al., 2014; Polgar et al., 2016; Hall et al., 2015) suggests differences in scent detection performance or ability between breeds likely exists. Importantly, any differences in performance due to breed, experience, or other individual characteristics that may have existed in the diverse sample of dogs was not substantial enough to prevent any dog that completed the training program from responding to at least 75% of Week 12 controlled assessments correctly.

Handler characteristics were likely just as, if not more, influential on team progress than dog characteristics. Handlers were observed to differ greatly both in their initial training skills and in the degree to which their timing and precision improved throughout the program. While automated training apparati can help alleviate handler influences and achieve true positive and true negative detection rates that approach 100% (Edwards, 2019), the focus of this study was on developing foundational skills for both dogs and handlers that could later be applied to searching in uncontrolled field conditions. Therefore, we placed equal emphasis on the development of handlers' training skills as on dogs' detection skills through handlers training their own dog. Furthermore, while detailed training resources are available for numerous detection applications, such as landmine clearing (GICHD., 2004), we also aimed to provide a detailed description of the initial CDD training methodology we used, which is often lacking in CDD studies. This training method was novel for all participants and home training recommendations were given by trainers that were tailored to each team. Despite this, experimenters observed that handlers who demonstrated an initial understanding of fundamental training principles, such as reward timing and maintaining suitable motivation levels in their dogs, tended to progress through the training stages more quickly. However, this was not reflected in the data we collected: no significant correlations were found between Week 8 or Week 12 search performance outcomes and handlers' dog training experience, or dogs' reported scent work experience. Furthermore, no significant correlations were found between the average time teams spent training each week and Week 12 correct response rate or between either handlers' or dogs' previous training experience and the average time spent training at home each week. However, a medium effect size of r_s =0.38 (Cohen, 1988) between handler's previous experience and average time spent training each week might indicate the presence of some degree of a relationship between these variables, despite this not reaching statistical significance in this sample. Results of Mann-Whitney U Tests also indicated no significant differences in either handler's or dog's previous experience between teams who reached a minimum of 75% correct response rate in odor present searches by Week 8 or by Week 12. However, given that only three teams failed to reach this criteria by Week 8, results of this test should be interpreted with caution. Nevertheless, this suggests that prior experience may be less important in determining handler success than an underlying capacity to learn new skills and work effectively with dogs – a constellation of personal characteristics labelled ‘dogmanship’ by McGreevy et al. (2017). This is also consistent with a survey of 35 CDD handlers in which ‘the ability to read dog body language’ was endorsed as the most important of 16 dog handler traits and characteristics (Jamieson et al., 2018). Future research would benefit from exploring this issue in more depth, although all participating teams, regardless of previous dog or handler experience, met or exceeded criterion on all odor-present assessment trials by Week 12.

Also of note is that search performance was well maintained in the absence of regular maintenance training. No significant differences were found between time to first alert in the 11 teams that were available for re-assessment after a 14-week break from training in either odor-present or odor-absent searches. Furthermore, no significant differences in performance were found for correct response or false alert rate. Despite no significant differences being detected in our analyses, a slight decreasing trend in dog-handler team performance in odor-absent tasks may be present after an extended break. This requires further investigation. While dogs have been shown to competently demonstrate learned obedience tasks after four weeks without training (Demant et al., 2011), there is scant published literature on the retention of trained responses to an odor after a period without maintenance training beyond that of days (Williams and Johnston, 2002). These results are important as they suggest that, once trained, teams of volunteers and their pet CDDs could maintain a high level of search performance over a period of up to several months without maintenance training. By only needing to attend occasional training sessions (e.g., monthly) during non-working periods, volunteer teams could live an otherwise normal companion dog-owner lifestyle in which dog’s care needs are met and they are valued while handlers enjoy the benefits of a companion dog. Teams could then train more regularly just prior to survey deployment periods in order to ensure adequate search performance while working. Such a model removes the need for dogs to be kennelled during non-working periods, alleviating potential welfare issues associated with kennel environments, such as risk of hearing damage and stress (Scheifele, 2012). It also ensures that CDDs have a familiar home waiting for them following retirement.

The cost of purchasing a professionally trained CCD can range from tens to hundreds of thousands of dollars (Orkin et al., 2016). Once dogs have been acquired, additional costs such as engaging or training a handler must also be considered. Of the 19 dog-handler teams that began the training program, 17 participated in Week 12 assessments, which all teams passed. This equates to a success rate of approximately 89%. Another three teams left the program once the initial 12-week training course was completed; with these handlers being impacted by major life events such as pregnancy or moving interstate. Volunteer programs are often adversely impacted by high rates of attrition, but this needs to be balanced by the overall potential for substantial cost savings. In our program, owners remained responsible for all costs associated with caring for and transporting their dogs. Our costs consisted of providing training sessions and equipment to 19 teams, which amounted to less than the approximate cost of purchasing one trained CDD (Orkin et al., 2016) and which produced 14 dog-handler teams that are competent in searching a controlled, experimental setting. While this is far removed from producing teams able to conduct lengthy searches of uncontrolled field environments, it does equip them with a set of specialised skills that form the foundation of fully operational CDD dog-handler team.

The cost of training these 14 teams to their current level of performance would have been substantially greater had this program not operated on a volunteer-based model. As participants in a research project approved by university ethics committees, handlers and their dogs are covered by the public liability insurance of La Trobe University. This represents a substantial savings to our program's operational expenses, although it would be an important consideration for any group that plans to train CDD teams without the benefit of university support.

While there are substantial cost savings associated with an operational volunteer-based model, there are additional costs associated with coordinating a larger group of dogs and handlers in the field that might not be encountered by one or two professional CDD teams. One to two trainers/coordinators are valuable on field deployments to provide on ground support to teams, liaise with land managers or research collaborators and coordinate searches. This role may not be necessary in a professional CDD context, or could be fulfilled by a senior handler if CDD teams were working in small groups. While engaging supervising trainers in a volunteer program incurs additional costs, supervisors can coordinate more than one team and in turn, more than one dog at a time. It is typically not possible for one handler, whether volunteer or professional, to search with more than one dog at a time, meaning a greater area overall could be surveyed in a shorter amount of time and at a reduced cost by supervised volunteers than professional teams.

The overall survey capacity of a volunteer group is largely influenced by the availability of volunteers, which is often subject to competing time and financial commitments. The nature of a relatively large pool of motivated volunteers with diverse work, family and recreational commitments maximises the likelihood that at least several teams are available to participate in surveys at a given time.

As rates of species extinction increase internationally (Pimm et al., 2014), so do the costs of monitoring cryptic and endangered species. An enormous amount of on-ground conservation work is already done by volunteers internationally (Ryan et al., 2001) and the economic advantage of volunteer CDD teams could be an important factor in monitoring target species that are difficult to monitor with other methods. The volunteer CDD program training teams to detect Tiger Quoll scat (Conservation Ecology Centre, 2017) employed the same professional training methodology and one of the same trainers as the present study. Although this pilot project was smaller than the present study, our results suggests a volunteer CDD model is not only economical, but the training methodology and structure is scalable and could be conducted by professional trainers elsewhere.

Volunteers in this study have not yet demonstrated that they can take their newly acquired skills and apply them in natural settings. We chose to train indoors initially, as this allowed us to control environmental influences such as weather conditions and visual, olfactory and auditory distractions which can impact a dog's concentration and performance. It also permits manipulation of these factors, allowing their influences to be systematically evaluated in future research. Despite these advantages, it is essential that potential CDD teams be evaluated in the field. An important characteristic of any CDD working outside of a controlled environment is that they are safe around (i.e., do not chase or harass) other animals they may encounter (Jamieson et al., 2017; Cablk and Heaton, 2006; Hurt and Smith, 2009; Beebe et al., 2016). They also need to perform reliably in a range of environmental conditions. However, useful roles for CDD are not limited to surveys conducted in uncontrolled field conditions. Various applications are suited to being conducted in controlled conditions, such as screening water samples from the field for presence of targets (Quaife, 2018) or identifying individuals from collections of scat samples (Kerley and Salkina, 2007). Nonetheless, our next task is to determine the extent to which volunteers can transfer their skills to outdoor field conditions and more biologically relevant targets.

We anticipate that volunteer CDDs may be suited to particular types of survey deployments, where many dogs are required to cover a large area in a short amount of time. A large group of volunteer teams might be especially beneficial during breeding, migration, seeding or similar events, where they can search large areas in a more time- and cost-efficient way than a smaller number of professional CDDs. While fully developed volunteer teams could potentially be trained to the same detection performance as professional teams, less proficient volunteer CDDs could additionally be applied in settings in which existing survey methods are largely ineffective and broad coverage is more important than absolute detection sensitivity. For example, volunteer CDD teams that find even 50% of endangered turtle nests in areas where 90% of unprotected nests are raided by introduced predators (Spencer and Thompson, 2005) would constitute the most effective nest survey tool available, given that no other suitable, large scale detection methods exist. However, it is unlikely that volunteer CDD teams could replace the need for professional working CDDs teams, which often have specific skills such as the ability to work for long periods of time at great distances from where they live. The capacity of volunteers to do this may be restricted by fitness, work, family or other commitments. Indeed, the roles of professional and volunteer CDDs are likely complementary, rather than competitive, in nature.

Conclusion

These findings demonstrate that a diverse group of volunteer companion dog-owner teams can be trained to successfully locate an odor in controlled laboratory conditions in under 12 weeks. We anticipate that, with further field-based training, these dogs and handlers could build on the foundational detection skills learned in this study to search for target odors in outdoor environments. With extensive training, the skills of successful and suitable volunteer teams could potentially be applied to various conservation detection tasks. This may be useful in addressing the financial limitations and potential welfare implications that can be associated with professional CDDs, while also engaging community members in important and sustainable conservation work. It remains to be seen whether the volunteers maintain their engagement over a longer period of time and whether they can work successfully in natural settings, where the handler assumes more responsibility for directing their dog's search behavior. These issues will be addressed in future research.

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Ethical considerations

This research was approved by the La Trobe University Human Ethics Committee (S17-107) and Animal Ethics Committee (AEC17-37).

Conflict of interest

None.

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Appendix A – demographic survey

Please answer the following questions so we can learn more about you.

1. Please enter your full name__________________

2. What is your gender?

   ☐ Male ☐ Female ☐ Other (please write) ________________ ☐ Prefer not to disclose

3. In what year where you born? ________________

4. Please enter your postcode __________________

5. Is English your first language? ☐ Yes ☐ No

6. Please slide the bar to indicate your overall level of dog training experience

No experience					Some experience					Extremely experienced
0	1	2	3	4	5	6	7	8	9	10

7. Which of the following tools do you currently use regularly, or have regularly used in the past while training dogs? (Please select all that apply).

☐ Flat Collar
☐ Halti
☐ Slip chain
☐ Lead
☐ Harness
☐ E-Collar

☐ Clicker
☐ I have not used any tools before
☐ Other (please write) ________________

8. Please slide the bar to indicate your overall level of experience in training dogs on scent based tasks or games, including tracking or trailing.

No experience				Some experience						Extremely experienced
0	1	2	3	4	5	6	7	8	9	10

No experience				Some experience						Extremely experienced
0	1	2	3	4	5	6	7	8	9	10

(If answered above 0 in the previous question): Please list what target scent/s you have trained with____

9. Do you currently volunteer for a program or organisation on a regular basis, either with or without your dog? (e.g. RSPCA, landcare group, sports club, lifeline, etc)?
☐ Yes ☐ No

(If answered yes to the previous question): Which of the following categories best describes the type of work that the program or organisation you volunteer for does in the community? (select all that apply).

☐ Environmental services (e.g friends of a park, landcare group, animal/plant survey, etc.)

☐ Animal based services (e.g. RSPCA, animal shelter, wildlife care, foster care, etc.)

☐ Emergency Services (e.g. state emergency service, ambulance services, CFA, etc.)

☐ Health (e.g hospital auxiliary, health promotion, palliative care group, disease support group, lifeline or support agency, etc.)

☐ Community/welfare services (e.g disability support groups, community support, welfare provider, public advocacy, youth support, meals on wheels, etc.)

☐ Education (e.g. neighbourhood house, adult education support, University of the third age, literacy group, historical society, learning network, etc.)

☐ Sport and recreation (e.g. sports club, sport association, YMCA, scouts, guides, etc.)

For how long have you actively volunteered for this program or organisation? (Note: If you volunteer for more than one program or organisation, please answer this question in relation to the one you give the most of your time to).

☐ Less than a month
☐ 1 – 3 months
☐ 3 – 6 months
☐ 6 – 12 months
☐ 1 – 2 years
☐ 2 – 5 years
☐ 5 – 10 years
☐ 10+ years (please indicate) __________

On average, approximately how many hours would you spend volunteering for this program or organisation in a typical week? (Note: If you volunteer for more than one program or organisation, please answer this question in relation to the one you give the most of your time to).

☐ Less than 30 minutes	☐ 5 – 10 hours
☐ 30 minutes – 1 hour	☐ 10 – 20 hours
☐ 2 – 5 hours	☐ 20 + hours (please indicate)_________

10. Have you regularly volunteered for a program or organisation <u>in the past,</u> either with or without your dog? (e.g. RSPCA, landcare group, sports club, lifeline, etc).
    ☐ Yes ☐ No

(If answered yes to the previous question): Which of the following categories best describes the type of work that the program or organisation you volunteered for does in the community? (select all that apply).

☐ Environmental services (e.g friends of a park, landcare group, animal/plant survey, etc.)

☐ Animal based services (e.g. RSPCA, animal shelter, wildlife care, foster care, etc.)

☐ Emergency Services (e.g. state emergency service, ambulance services, CFA, etc.)

☐ Health (e.g hospital auxiliary, health promotion, palliative care group, disease support group, lifeline or support agency, etc.)

☐ Community/welfare services (e.g disability support groups, community support, welfare provider, public advocacy, youth support, meals on wheels, etc.)

☐ Education (e.g. neighbourhood house, adult education support, University of the third age, literacy group, historical society, learning network, etc.)

☐ Sport and recreation (e.g. sports club, sport association, YMCA, scouts, guides, etc.)

For how long did you actively volunteer for this program or organisation? (Note: If you volunteered for more than one program or organisation, please answer this question in relation to the one you gave the most of your time to).

☐ Less than a month	☐ 1 – 2 years
☐ 1 – 3 months	☐ 2 – 5 years
☐ 3 – 6 months	☐ 5 – 10 years
☐ 6 – 12 months	☐ 10+ years (please indicate) __________

On average, approximately how many hours would you spend volunteering for this program or organisation in a typical week? (Note: If you volunteered for more than one program or organisation, please answer this question in relation to the one you give the most of your time to).

☐ Less than 30 minutes	☐ 5 – 10 hours

☐ 30 minutes – 1 hour
☐ 2 – 5 hours
☐ 10 – 20 hours
☐ 20 + hours (please indicate)_________

Please answer the following questions so we can learn a little more about the dog you will be working with during this project

11. What is your dog's name? ___________________

12. How old is your dog? _____Years Months ______________

13. What is your dog's sex? ☐ Male ☐ Female

14. Is your dog desexed?

    ☐ Yes, my dog is desexed ☐ No, my dog is sexually intact ☐ Not sure

15. Is your dog a purebred or a mixed breed?

    ☐ Purebreed ☐ Mixed breed ☐ Not sure

16. What breed/s? _______________________________________

17. Where did you get your dog from?

    ☐ Breeder

    ☐ Private rescue organisation

    ☐ RSPCA/Animal Shelter

    ☐ Friend/family member

    ☐ Pet shop

    ☐ Private sale

    ☐ Other (please write):_____________

18. How long have you had this dog?: Years ______ Months_________________

19. Has your dog received all of the vaccinations appropriate for its age and do you have the associated documentation to confirm this? (We will need to check this before you can start training in our facility).

    ☐ Yes ☐ No ☐ Not sure
    Comments____

20. How many dogs in total are there in your household? ___________________________

21. Who is the dogs primary caregiver?___________________________________

22. Does your dog suffer from any physical or psychological health conditions, injuries or complaints that might hinder their ability to participate in a physically engaging training program that requires a good level of fitness?

☐ No ☐ Yes (Please list) ____

23. Is your dog currently on medication or receiving treatment for these or other complaints?
☐ No ☐ Yes (Please describe e.g. "antibiotics for ear infection") ____

24. Please slide the bar to indicate how much your dog prefers each of the following rewards.

	Least preferred reward										Most preferred reward
Food (e.g. Treats)	0	1	2	3	4	5	6	7	8	9	10
Play (e.g. Toys)	0	1	2	3	4	5	6	7	8	9	10
Physical praise (e.g. Patting)	0	1	2	3	4	5	6	7	8	9	10
Physical praise (e.g. Patting)	0	1	2	3	4	5	6	7	8	9	10
Other (please write)	0	1	2	3	4	5	6	7	8	9	10

25. How likely is it that your dog would respond in the following ways if they encountered another dog while walking ON lead with you?

	Highly unlikely					Neither unlikely or likely					Highly likely
Completely ignore the other dog	0	1	2	3	4	5	6	7	8	9	10
Look at the other dog and continue walking	0	1	2	3	4	5	6	7	8	9	10
Try to evade the dog	0	1	2	3	4	5	6	7	8	9	10
Try to approach the dog	0	1	2	3	4	5	6	7	8	9	10
Bark at the other dog	0	1	2	3	4	5	6	7	8	9	10
Try to attack the other dog	0	1	2	3	4	5	6	7	8	9	10
I do not know	0	1	2	3	4	5	6	7	8	9	10

what my dog would do in this situation											
Other (please indicate) ____________ ____________	0	1	2	3	4	5	6	7	8	9	10

26. How likely is it that your dog would respond in the following ways if they encountered another animal (e.g. rabbit, kangaroo, bird, etc) while walking OFF lead with you?

	Highly unlikely					Neither unlikely or likely					Highly likely
Completely ignore the other animal	0	1	2	3	4	5	6	7	8	9	10
Look at the animal but continue walking	0	1	2	3	4	5	6	7	8	9	10
Try to evade the animal	0	1	2	3	4	5	6	7	8	9	10
Approach the animal but promptly return if called	0	1	2	3	4	5	6	7	8	9	10
Approach the animal but not promptly return if called	0	1	2	3	4	5	6	7	8	9	10
Chase the animal but promptly return if called	0	1	2	3	4	5	6	7	8	9	10
Chase the animal but not promptly return if called	0	1	2	3	4	5	6	7	8	9	10
My dog would likely attack the animal	0	1	2	3	4	5	6	7	8	9	10
I do not know what my dog would do in this situation	0	1	2	3	4	5	6	7	8	9	10
Other (please indicate)	0	1	2	3	4	5	6	7	8	9	10

____________ ____________	

27. a) Please slide the bar to indicate how familiar <u>your dog</u> is with the following sports

	Not at all familiar					Somewhat familiar					Extremely familiar
Dog agility	0	1	2	3	4	5	6	7	8	9	10
Competition obedience	0	1	2	3	4	5	6	7	8	9	10
Tricks training	0	1	2	3	4	5	6	7	8	9	10
Tracking	0	1	2	3	4	5	6	7	8	9	10

(If tracking rating is greater than 0) Please list what scent/s your dog has worked with: ____________________________________

Nosework / scent detection	0	1	2	3	4	5	6	7	8	9	10

(If Nosework/scent detection rating is greater than 0) Please list what scent/s your dog has worked with: ____________________________________

28. Please slide the bar to rate your dog's ability to perform the following behaviors on command.

	Never					Sometimes					Always
Nose touch/ Target an object	0	1	2	3	4	5	6	7	8	9	10
Nose touch/ Target a hand	0	1	2	3	4	5	6	7	8	9	10
Go settle on a mat or bed	0	1	2	3	4	5	6	7	8	9	10
Lie down	0	1	2	3	4	5	6	7	8	9	10
Fetch a ball or toy	0	1	2	3	4	5	6	7	8	9	10
Shake paws	0	1	2	3	4	5	6	7	8	9	10
Sit	0	1	2	3	4	5	6	7	8	9	10
Walk on loose lead	0	1	2	3	4	5	6	7	8	9	10
Come when called	0	1	2	3	4	5	6	7	8	9	10
Spin in a circle	0	1	2	3	4	5	6	7	8	9	10