Odor-adsorptive clothing, environmental factors, and search-dog ability

John A. Shivik

Abstract Trained domestic dogs are noted for their use in finding and identifying people, wildlife, and spoor. Given the importance of scent-dog use, it is unfortunate that the limits of their capabilities remain unidentified. I measured the ability of 7 search dogs to find a person wearing scent-adsorbing clothing in order to investigate both the dogs' abilities and the effectiveness of the garments. Scent-adsorbing clothing, which manufacturers claim prevents game from detecting human odors, is primarily marketed to hunters and may be useful for wildlife professionals attempting to surreptitiously monitor wild animals. Based on 42 trials (21 treatment and 21 control), I concluded that scent-adsorbing suits had little effect on dog capability. However, environmental factors such as wind variability negatively correlated with dogs' ability to find subjects quickly. This information suggests that odor-adsorbing suits may not keep animals from detecting humans through olfaction and thus may provide little benefit to wildlife observers. Scientists and dog handlers should understand the influence of weather conditions, especially wind variability, on research or search operations.

Key words domestic dog, scent, scent-adsorbing suit, search dog

Wildlife biologists have increasingly incorporated domestic dogs into their studies (Gutzwiller 1990, Castelli and Sleggs 2000, Connelly et al. 2000, Miller et al. 2001). Dogs have been reported to be 4 times better at finding fox scats than human searchers (Smith et al. 2001) and have exhibited a 100% correct species identification rate. Other dogs have been trained to find cryptic galliform broods and bird carcasses (Zwickel 1980, Homan et al. 2001) and neonatal deer (D. J. Freddy, Colorado Division of Wildlife, personal communication).

Trained dogs also have been noted for finding and identifying people, although little scientific study that rigorously examines scent-dog capability exists (Brisbin et al. 2000). Dogs are commonly thought to be capable of amazing behaviors; however, the limitations of this "almost mythological ability of scenting dogs" must be better defined (Brisbin et al. 2000:1093). Some impressive abilities of trained dogs have been described. For example,

dogs correctly identified and tracked individuals who crossed a field contaminated with scent from the individual's identical twin and other family members (Kalmus 1955, Sommerville et al. 1990, Schoon and deBruin 1994, Settle et al. 1994).

The reliability of dogs to correctly follow a track is disputable, however (MacKenzie and Schultz 1987), and contradictory results due to variable methodology and dog ability have led to conflicting viewpoints on qualifications of dogs for scent tasks (Brisbin and Austad 1991, 1993; Sommerville et al. 1993; Schoon 1996). Because human life frequently depends upon the performance of these animals (American Rescue Dog Association 1991), it is important to scientifically investigate their capabilities.

Using trained scent dogs in scientific procedures has two important aspects. First, the abilities and limitations of dogs can be measured experimentally, thus allowing future handlers and researchers to

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understand the proper application of dogs for wildlife research. Second, trained scenting dogs can be used as models to allow experimental understanding of the capabilities of nonhuman species for detecting human scent. For example, scent trails may influence predation events on monitored animals (Donalty and Henke 2001), and in some instances there is a need to minimize scent left by researchers that could bias experimental results. Trained dogs can be used to test the effectiveness of systems that purportedly mask or capture human scent.

I recently used dogs to investigate the effectiveness of scent-adsorbing clothing (i.e., an overgarment lined with activated charcoal) advertised as being capable of concealing human odors from wildlife species. From a wildlife research perspective, if the suit was found effective, it would be of assistance in behavioral observations of species whose behavior may be altered by the presence of human odor. I used trained search and rescue dogs to test whether scent-adsorbing clothing could effectively prevent canids from detecting human odor. Simultaneously, I measured other factors that could influence search-dog ability in order to elucidate factors that limit the capabilities of trained dogs.
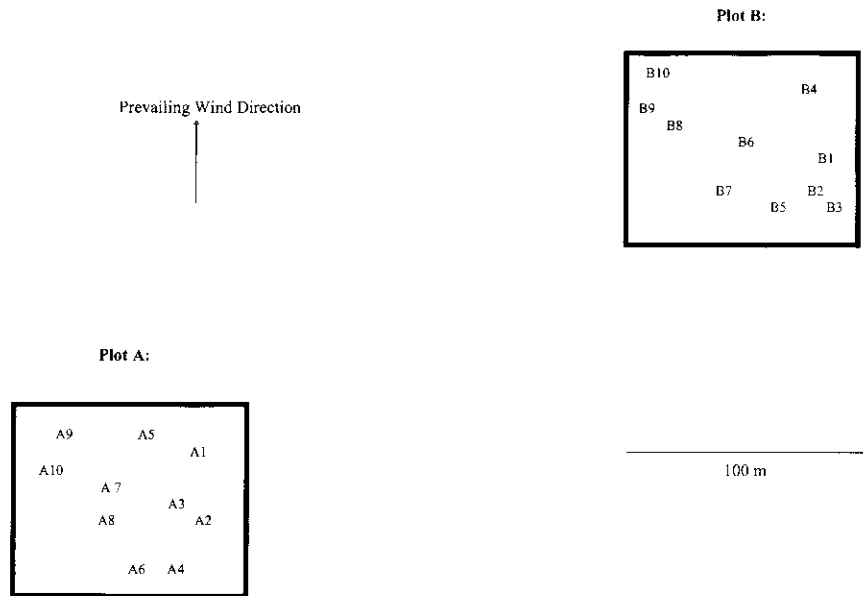

Figure 1. Spatial layout of plots used to examine scent-adsorbing suits and scent-dog ability at the National Wildlife Research Center, Fort Collins, Colorado. The same cardboard box was placed at a station (indicated by number on plot A or B) during each of 21 days during January–April, 2001. Within plot, the subject's location in each trial was determined using a random number table and treatment order and plot by coin-toss.

Methods

Study plots and subjects

I established 2 100 × 100-m study plots on the grounds of the National Wildlife Research Center, Fort Collins, Colorado (Figure 1). Each plot contained 10 randomly dispersed stations. Hikers and commuters had access to the area outside of trial times, but access was minimal (I observed 2–3 people passing through the area per day) and on a path that did not bisect study plots. Within 2 hr prior to each trial, I or an assistant placed a 53 × 61 × 122-cm cardboard box at each station and prohibited nonparticipant access to the area. I collected boxes between trials and stored them indoors. I randomly assigned treatment (subject wearing pants, jacket, gloves, breath mask, and a hood of Scent-Lok® clothing [Cabela's, Sydney, Nebr.]; Figure 2) (in this paper, the use of commercial product names is for identification only, not as an endorsement of the products by the author or the United States Department of Agriculture) or control (subject in normal clothes) to each plot during each trial. The subject was randomly assigned a station to occupy. Subjects donned appropriate clothing before being driven to their assigned station, where they crawled directly into the box from the passenger seat of a truck. After placing the subject, I drove through the plot area, visiting all boxes to control for possible effects of ground disturbance while placing a subject.

Search procedure

Subjects waited in the box for 10 minutes before handlers were instructed to begin their search. Trained search dogs (of various pure breeds, mixed breeds, and ages) and handlers were provided by Search and Rescue Dogs of Colorado. Dogs took the subject's scent from a scent article given to the

Figure 2. A subject wears an odor-adsorptive suit that was tested using 7 search-trained dogs at the National Wildlife Research Center.

Figure 3. Handler presents the subject's scent to a trained search dog in the examination of scent-adsorbing suits and scenting-dog ability.

handler (Figure 3). Scent articles were clean cotton cloths previously autoclaved (30-minute sterilization at 132°C) and sealed in zip-closing bags. For scenting, I gave a clean cloth to the subject, who handled and rubbed the cloth for 1 minute and replaced it in its plastic bag. I allowed each handler and dog 10 minutes to search the plot. Handlers were given explicit instructions not to search from box to box (they were not allowed to approach and inspect the boxes) but to follow a normal search procedure, using a fine grid pattern and working from the leeward side of the plot. I instructed handlers to note when the dogs indicated detection of the subject and to indicate which box contained the subject based on dog behavior. Handlers had no knowledge of treatment or control condition or subject location. They were told that a subject might or might not be present in one of the boxes, although no trials were run without a subject.

I reactivated the suit between trials using a hot-air clothes drier as directed by the manufacturer, then stored it in a plastic bag. The suit was not handled directly but was encased in a storage bag and picked up without contacting the fabric. I used the same boxes for all trials, but no 2 trials occurred within 24 hrs of each other. Although boxes probably retained residual scent from replacement by my assistants or myself, boxes were not handled by a subject before a trial, in order to avoid contamination with the subject's scent. I tested each dog twice per day (once on each plot with random assignment of treatment or control) on three occasions from 5 January through 4 April, 2001 during daylight hours (0830-1700), using a different subject (two female and one male) on each day. Concealing subjects in the box prevented handlers from knowing the treatment during and after the test. I did not give handlers information about treatments and trial results until after the study's conclusion.

Detection of the subject was defined as the moment when a dog became alerted to airborne scent, turned, and ran directly toward a box (Figure 4). Distance to detection was the distance from where the dog detected the subject to the subject location. Time to find was the time from the beginning of the trial to when the handler indicated that the dog had found the subject.
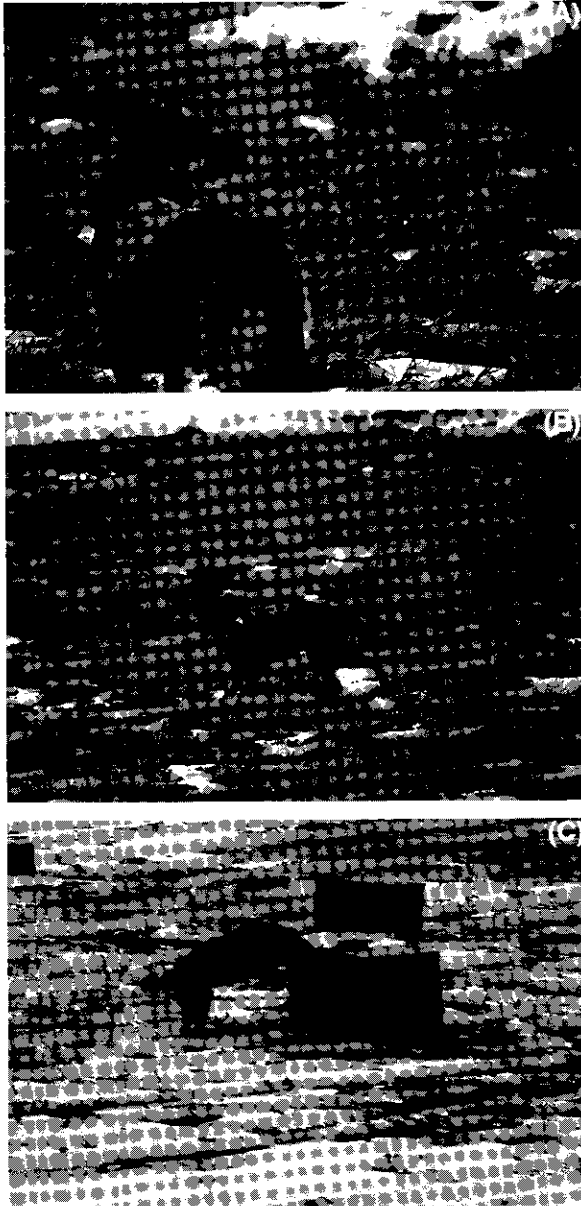

Figure 4. Behaviors of a trained search dog finding a subject. A dog that detected the scent of a human (A) typically paused, lifted its nose, and turned into the wind. Then it would run into the wind (B), narrowing the focus of the search until (C) it enthusiastically indicated the subject's location.

Analysis

A repeated measures analysis of variance (ANOVA) was used to compare time to find subjects by type of clothing worn. Because moment of detection was not always obvious, I compared mean distance to detection of each dog for each treatment using a t-test. This counteracted difficulties of empty cells in repeated measures ANOVA, and I avoided pseudo-replication by using the dog as the sample unit.

I also collected data to identify and measure possible influences of weather variables on scent-dog ability. Environmental variables measured at the time of the trial were temperature (°C), relative humidity (%), wind speed (mph), atmospheric pressure (mm Hg), circular standard deviation of wind direction (σ_c, calculated from wind data 5 and 10 minutes before, during, and 5 and 10 minutes after each trial; Zar 1984), and percent cloud cover. I performed analyses by calculating all possible multiple regressions of environmental factors as predictors of the time it took dogs to find the subject. I used AIC model selection procedures (Burnham and Anderson 1998) to rank and list the top 3 descriptive models.

Results

I ran 42 trials using 7 search and rescue dogs. Dogs found subjects within allotted time in all but 1 trial. Dogs found the suited subject in 95% of trials ($n = 21$) and found the plain-clothes subject in 100% of trials ($n = 21$, $\chi^2_1 = 1.024$, $P = 0.311$). Furthermore, handlers never misidentified the container in which the subject was hidden. Repeated measures ANOVA indicated that mean time to find subjects wearing a scent-adsorbing suit (3.4 min) did not statistically differ from those wearing normal clothing (2.7 min; $F_{1,4} = 2.7, P = 0.175$). Of the 6 dogs showing clear and obvious alerts when detecting subjects from a distance, there was little difference (10.9 m) between detection distance for suit-wearing subjects ($\bar{x} = 29.3$ m) versus those not wearing the suit ($\bar{x} = 40.2$ m, $t_{10} = 1.28, P = 0.227$).

In the regression analyses of environmental variables, the top explanatory models always included σ_c, the only term that did not have a confidence interval that included zero; σ_c was positively correlated with time it took dogs to find subjects, as were atmospheric pressure and relative humidity (Table 1).

Table 1. Best-fit inferential models evaluating environmental variables influencing scent-dog ability, as measured by time to find the subject hidden in a 100 × 100-m field. Each model is a linear combination of listed parameters equaling the time to find the subject.[a]

Model	Model parameters (95% CI)	ΔAIC	P
1	Pressure (−1.319, 8.628), σ_c (0.006, 0.078)	0.00	0.02
2	Humidity (−0.017, 0.073), Pressure (−0.690, 9.448), σ_c (0.011, 0.084)	0.23	0.02
3	σ_c (0.008, 0.081)	0.31	0.02

[a] Pressure was atmospheric pressure, humidity was percent relative humidity, and σ_c was the circular deviation of the wind direction during the trial.

Discussion

In this experiment, scent-adsorbing clothing did not prevent search dogs from finding hidden subjects. In one trial, the subject was wearing an odor-adsorbing suit and the dog did not find him in the allotted time, but I do not believe the outcome was related to the suit. Wind direction was particularly variable during the trial, and the dog also showed some indication of sickness and "nervousness" (vomiting) immediately before the trial, which may have affected its performance. Furthermore, this dog had no difficulty finding the subject in subsequent trials ($n = 5$).

Scent-adsorbing clothing is primarily sold to hunters, who want to prevent game species from sensing human odor. I did not do a scientific review of the product to determine accuracy of the manufacturer's claims. However, I suspect that other mammals may detect human odors in a manner similar to dogs, and suggest that suits would provide little, if any assistance for observing game species surreptitiously. The suits are probably not worth the cost ($200) to researchers or managers who want to approach canids undetected.

Dogs did detect, on average, subjects not wearing the suits from a longer (but statistically insignificant) distance. This may be evidence of suit effectiveness or perhaps an effect of wearing more layers of clean clothing (for which I did not control). In practical application, however, trials were fairly brief, and the suit was recharged before every trial. Therefore, scent should not have had time to build up or "leak" from the suit during the 20 minutes subjects wore the clothing. If a large effect was not detected under the conditions I measured, it is unlikely the suit would be noticeably effective under more realistic and lengthy field trials. An alternative hypothesis for future testing, however, would be that handling the suit while putting it on left enough scent to allow dogs to detect odors left on the outside of the clothing. This question is of general interest because I believe it is possible to construct and don a completely sealed suit that would render humans imperceptible to canids. However, for practical use of the clothing, a person must handle it to put it on and walk or be transported to a place of concealment. That the dogs detected humans wearing the suit indicated that the system failed to prevent the detection of human odor, whether the mechanism was in the handling of the suit or the suit's inability to trap all odor.

Analyses of environmental variables elucidating the relationship between search-dog capability and wind variability provided useful data that heretofore were primarily anecdotal knowledge among dog handlers. Excellent discussions of scent composition and dispersion exist in webpages (e.g., www.impulse.net/~mlynch/pod_k9.html) and in popular literature (e.g., Pearsall and Verbruggen 1982), but peer-reviewed analyses of scent-dog capabilities relative to environmental conditions are rare in the literature. Scientists studying sensory capabilities of wildlife must be aware of effects of such phenomena. Search-dog handlers also must be aware of how weather factors limit the probability of detecting a lost subject. Mechanistically, I believe that highly variable wind mixes air and disperses scent so that dogs cannot detect subjects, or wind shifts increase the chances dogs are never directly leeward of the odor source. The model selection process suggested that relative humidity and atmospheric pressure also were correlated with time it took to find subjects, although the effects of these factors were not as strong. Higher atmospheric pressure should decrease volatility of odor molecules, making detection more difficult.

The mechanism behind the inverse relationship between humidity and dog capability is more difficult to explain. One would expect that higher relative humidity in Colorado's dry climate (mean relative humidity during trials was 43.1%, range = 7.6-99.8%) would assist bacterial decomposition of scent rafts, presumably producing odors that dogs can detect (Syrotuck 1972). However, the opposite influence was indicated. There were no cross-

correlated variables to explain the observation. Either dogs were more fatigued in higher humidity, high humidity saturated the air and reduced availability of scent (Pearsall and Verbruggen 1982), some unaccounted-for effect influenced observations, or the result was spurious. The latter is most likely, given that the confidence interval on the estimate bracketed zero.
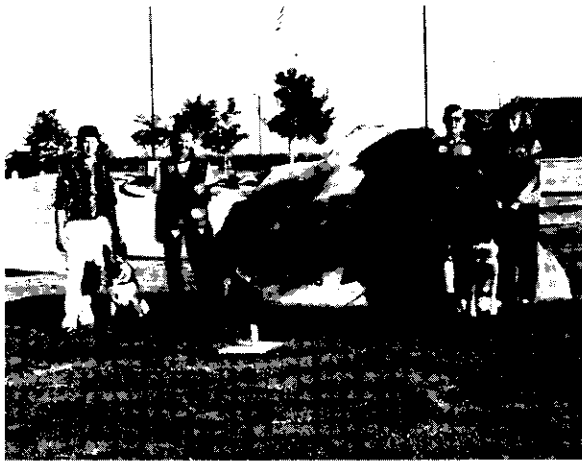
The usefulness of trained scenting dogs is unquestioned; for example, they are used by law-enforcement personnel, search and rescue teams, and wildlife researchers. But scenting dogs have limitations that may be overcome by proper animal behavior research and training. Scientists should not limit studies only to those identifying the bounds of dogs' apparent ability (e.g., success rates of various trained animals as determined in this study) but must also identify intrinsic and extrinsic variables impinging upon scent-dog ability (such as the weather factors discussed in this paper). Properly gathered information should be used to improve training regimes and thus the capability and reliability of dogs and handlers that perform important roles. The goal of scent-dog research should be to ensure that scent-dog training is a rigorous scientific endeavor and not only an anecdotally informed art.

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