EFFICACY OF SCENT DOGS IN DETECTING BLACK-FOOTED FERRETS (*MUSTELA NIGRIPES*) AT A REINTRODUCTION SITE IN SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

EFFICACY OF SCENT DOGS IN DETECTING BLACK-FOOTED FERRETS (*MUSTELA NIGRIPES*) AT A REINTRODUCTION SITE IN SOUTH DAKOTA

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The nocturnal and fossorial lifestyle of endangered black-footed ferrets (*Mustela nigripes*) has made studying them difficult for biologists. Due to the nocturnal nature of black-footed ferrets, a limited number of monitoring techniques are available for use by site managers. Initial ferret surveys at the Meeteetse, Wyoming site indicated that spotlighting, snow tracking and radio tracking techniques were the best methods for monitoring the species (Clark 1986). Today, nine black-footed ferret reintroduction sites exist in North America ranging from central Montana and north-central South Dakota to northern Mexico. A variety of Federal, State, and Tribal entities currently monitor and manage ferret reintroduction sites.

Specially trained detection dogs were tested on their ability to detect presence or absence of ferrets. Training and testing of the dogs was broken up into three progressive sessions: Pilot Study A, Pilot Study B, and Final Field Test. Pilot Study A tested four specially trained dogs on their ability to detect above ground black-footed ferret scat. Two of the four dogs were then tested on their ability to accurately and efficiently detect presence/absence of black-footed ferrets at the Conata Basin reintroduction site in

southwest South Dakota. In Pilot Study B the dogs were trained on live ferret scent in ferret habitat and then tested. The Final Field Test was an evaluation of the method after the dogs were adequately trained to detect ferrets in their natural environment, and after handlers were acclimated to working the dogs in those areas. Field tests with scent dogs to detect black-footed ferrets in the wild had never been done before, thus training trials (primarily Pilot Study A and B) prior to the Final Field Test were necessary.

Pilot Study A was conducted near Whitehall, Montana from August 18-20, 2003 to determine the ability of four specially trained search dogs to detect black-footed ferret scat above ground prior to field testing them at the Conata Basin reintroduction site. Only Dogs 1 and 2 were used in Pilot Study B training trials and the Final Field Test at the Conata Basin reintroduction site. From September 15 – 28, 2003 the two dogs were exposed to live ferrets, live prairie dogs, prairie dog towns with no ferret scent, and multiple ferret scents planted on prairie dog towns. The Final Field Test was conducted from October16 – 29, 2003. Eleven prairie dog towns averaging 27 ha (ranging from 9 – 38 ha) were selected for each dog-and-handler team to search. In addition, two larger prairie dog towns (100 ha) were also searched. Five of the selected test towns had no record of ferret presence and eight test towns had resident ferrets inhabiting them.

Mean correct positive identification of test towns with ferret presence during Final Field Test for first-time searches of test towns by both dogs combined was 81% (n = 16). Mean correct identification of test towns without ferret presence was 90% (n=10). No false positive alerts (alert given when there is no ferret presence) were recorded for either dog during the Final Field Test. False negative (no alert given where ferrets are present) rate was 13%. No significant difference ($p = 0.409$) in detection rates between dogs was found.

Detection dogs are difficult to estimate cost for simply because of the variability in dog ability. Currently, contracting a trained handler and dog team can cost approximately $400 a day (four hour day). The average search rate for Dog 1 and Dog 2 during the Final Field Test was 21 ha/hr, so an estimated cost for one dog to work four hours is $4.76/ha. Spotlight surveys are the best method available for determining which individuals are in a population as well as population estimates; however, using detection dogs may be a useful alternative method to supplement spotlight surveys and to determine dispersal. Detection dogs may also prove useful for locating ferret “hot spots” within a complex, or to investigate reported ferret sightings.

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Chapter 1. Literature Review

Black-footed Ferrets

Black-footed ferrets (*Mustela nigripes*), hereafter referred to as ferrets, are one of the rarest mammals in North America (Cahalane 1954, Clark 1997). The U.S. Fish and Wildlife Service listed the species under the Endangered Species Act (ESA) in 1967 (P.L. 97-304). Ferrets are buff in color with the exception of a black mask and feet. Males weigh from 900 to 1,800 grams (2-4 pounds); the females are slightly smaller. A slender, tubular body shape enables ferret movements in prairie dog (*Cynomys spp.*) burrow systems (Miller et al. 1996). Prairie dogs comprise approximately 90% of the ferret's diet (Sheets 1970, Campbell et al. 1987). Ferrets also rely on prairie dog burrow systems for shelter and rearing young. The ferret's obligatory lifestyle has contributed to its near extinction. These members of the weasel family, once believed to be extinct, have experienced population collapses mimicking that of the prairie dog population dynamics (Miller et al. 1996). Thus, efforts to eradicate prairie dogs have had negative effects on ferrets.

Saving black-footed ferrets from extinction has been one of the biggest challenges biologists have faced (Clark 1997). Part of the challenge stems from the ferret's nocturnal and fossorial lifestyle. Diseases such as plague (*Yersinia pestis*) and canine distemper (*Morbilivirus*) combined with a lack of suitable habitat (prairie dog complexes) have proven to have detrimental effects on wild populations of ferrets. Additionally, few general biology studies were conducted on ferrets until the species was already at risk of becoming extinct.

Hillman (1968) and Sheets (1970) conducted some of the first studies of ferrets in the wild, which proved to be the foundation for future ferret research. Hillman (1968) studied black-footed ferrets in black-tailed prairie dog (*Cynomys ludovicianus*) towns in south-central South Dakota and collected information on ferret activity, the time the animals spend above ground, and food habits. Following Hillman's research, Sheets (1970) examined scats excavated from prairie dog burrows and determined that over 90 percent of the ferret's diet was comprised of prairie dogs.

Some of the last surviving ferrets from the Mellete County, South Dakota, population studied by Hillman (1968) and Sheets (1970) were captured and brought into captivity. The last of the captive ferrets died in 1979, and the ferret was thought to be extinct. However, in 1981, a local taxidermist near Meeteetse, Wyoming, determined that a local rancher's dog had killed a ferret. The announcement attracted wildlife biologists to Meeteetse, Wyoming, to search for what many believe was the last remaining wild population of ferrets. Wildlife biologists found 61 ferrets while conducting surveys in 1982 (Miller et al. 1996). The ferret population remained fairly stable until a dramatic decline occurred in 1985, at which time researchers began taking ferrets out of the wild and putting them into captivity. The primary reason for the population's decline was an outbreak of canine distemper (*Morbilivirus*) coupled with an outbreak of plague (*Yersinia pestis*). Shortly after bringing the first animals into captivity, the rest of the wild ferret population collapsed, and efforts were made to bring any and all remaining animals into captivity (Clark 1997). Because decisions regarding the fate of the ferret had to be made quickly, managers made decisions on a trial and error basis.

The short time between finding the last wild population of ferrets and bringing them into captivity did not allow biologists to establish adequate protocols for husbandry and propagation. Despite observations in the wild (Hillman 1968, Sheets 1970), little was known about the general biology of ferrets, thus adaptive management techniques were used. Adaptive management scenarios have been a large part of the decision process that dictates the propagation, management, and reintroduction programs for ferrets. Even today, management of the species from every aspect is on a trial and error basis.

Today, nine ferret reintroduction sites exist in North America ranging from central Montana and north-central South Dakota to northern Mexico (Figure 1). All of the reintroduction sites coincide with the current range of prairie dogs, and all occur on existing prairie dog town complexes. The first reintroduction of ferrets into the wild occurred in Wyoming in 1991. The reintroduction was less successful than anticipated, due in part to a lack of knowledge of how to prepare captive ferrets for release into the wild (Clark 1997). Pre-conditioning of ferrets in quasi-natural and natural burrow systems proved to be critical for successful reintroduction efforts. However, disease and a lack of suitable habitat are still obstacles to the recovery efforts for the species. Currently, the Conata Basin site in western South Dakota is the only reintroduction site

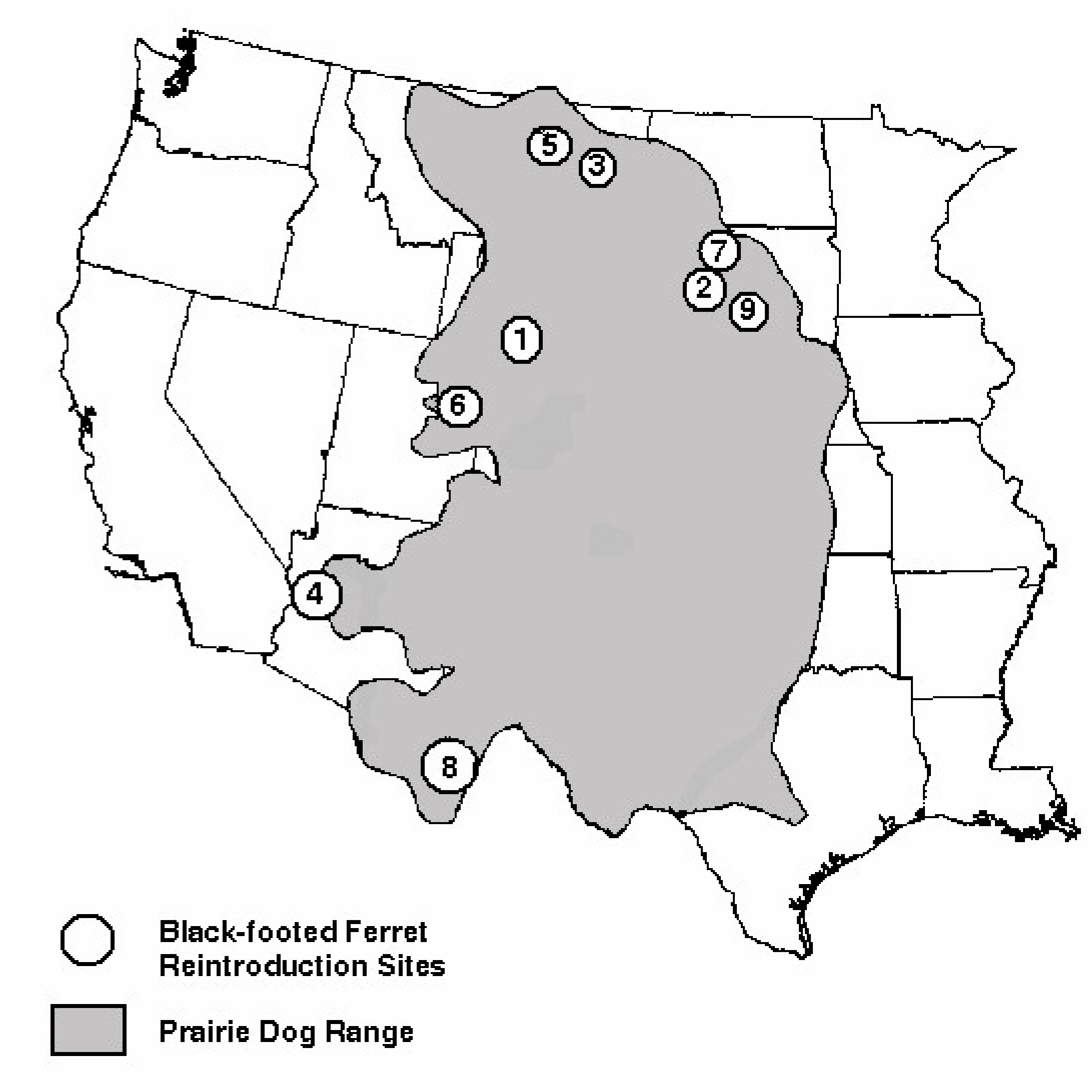

Figure 1. Nine Black-footed ferret reintroduction sites exist in North America; sites are numbered in order of site initiation (Number two is Conata Basin). Shaded area is the historical geographic distribution of prairie dogs (*Cynomys spp*.)

that appears to have a sustainable population of ferrets. The reintroduction site encompasses a 5,983-ha (14,785-ac) plague-free black-tailed prairie dog town complex that has been viable habitat for ferrets thus far (Perry 2004).

Monitoring

A variety of Federal, State, and Tribal entities currently monitor and manage ferret reintroduction sites. Because of the nocturnal nature of ferrets, a limited number of monitoring techniques are available for use by site managers. In order to understand some of the constraints of monitoring ferrets, one must understand how previous methods have been used and modified, and what some of their limitations are. Initial ferret surveys at the Meeteetse, Wyoming, prairie dog complex indicated that spotlighting, snow tracking and radio tracking techniques were the best methods for monitoring the species (Clark 1986). Henderson et al. (1969) listed two ways to search for ferrets: (1) Locate the animal itself and (2) Find signs of the animal by walking in prairie dog towns in search of sign such as scats, ferret skulls, trenches, diggings, and covered or “plugged” prairie dog holes. Several prairie dog burrow entrances covered with dirt is a typical sign of ferret presence. Sites where sign was found were subsequently surveyed using spotlighting techniques. This combination of searches for sign followed by spotlighting was very time consuming and fairly inaccurate because some ferret sign can be easily confused with sign of other mammals inhabiting prairie dog towns [e.g., long-tailed weasels (*Mustela frenata*), badgers (*Taxidea taxus*), and prairie dogs (*Cynomys spp.*)], and searchers must be trained to accurately identify ferret sign prior to searching.

Although monitoring ferret populations by spotlighting and snow tracking is still the preferred method, other monitoring methods have been tried as well. These methods include: scent stations (Hammer and Anderson 1985), video cameras triggered by an infrared sensor (Hinckley and Crawford 1973), night vision goggles and scopes, (Martin and Schroeder 1980), and the use of scent detection dogs (Southwest Research Institute 1979). These methods either did not work, or the application of the method for use in the field was not fully developed, as was the case with scent detection dogs. Each method has an optimal time of year when it provides the most information (Richardson et al. 1985) (Figure 2).

Telemetry

Radio telemetry results have provided valuable knowledge of the biology of ferrets. Information such as time spent above ground, peak activity times, and seasonal fluctuation in the activity of ferrets was determined at Meeteetse, Wyoming, prairie dog towns in 1981 and 1982 by Biggins et al. (1986). Behaviors similar to those observed by Hillman (1968) in South Dakota were quantified. Data collected at Meeteetse gave researchers a starting point for developing more efficient monitoring techniques. Biggins et al. (1986) determined that ferret activity peaked during the summer months, primarily July and August, and daily activity peaked between the hours of 2:00 AM and sunrise. Telemetry-based findings enabled refinement of spotlighting efforts to search during times when the likelihood of seeing a ferret was greatest.

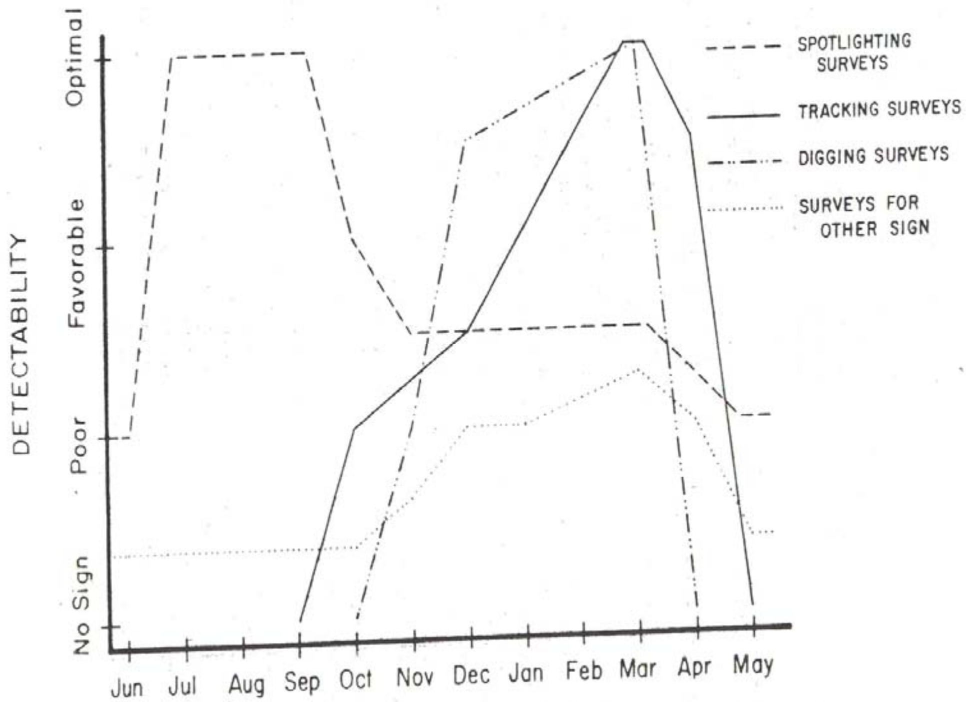

Figure 2. Detectability of ferrets and their sign by month in Meetetsee, Wyoming, using various search methods. Tracks and diggings of ferrets are the most common sign. Other sign include ferret scat and skulls (Richardson et al. 1985).

Spotlighting

Henderson et al. (1969) first described the method of spotlighting ferrets in South Dakota using different types of spotlights mounted atop a vehicle, and determined that the most effective light was a 100-watt aircraft landing light. Since 1969, more advanced spotlights have become available, and now most spotlighting is done with a 1,000,000 candle-power or stronger light beam. Marinari (1992) suggested shining the spotlight over the same area more than once to detect ferrets that may momentarily look away from the light.

Although a variety of colored spotlight filters are available, a red filter has been the only type used for conducting some litter surveys, or for studying ferret behavior for extended periods of time; however, the distance eye-shine can be seen is reduced. Red spotlight filters were noted as being useful for reducing the brightness of a plain white light and thus reducing annoyance to the animal (Campbell et al. 1985). With a plain white light, eye-shine is a brilliant green and can be seen at distances up to 182 m (Henderson et al. 1969). Today, most ferret monitoring is done using spotlights with no filters.

After extensive spotlighting at Meeteetse, Clark et al. (1984) refined spotlighting techniques for optimum ferret sightings by making searches more efficient. Instead of driving to a point and shining the light for 15 minutes (Henderson et al. 1969), observers now survey an area by driving randomly and continuously around a specified area. Along with spotlighting, methods for general ferret searching were also described, similar to what Hillman (1968) described earlier. Campbell et al. (1985) described spotlighting methods for both vehicle and backpack use and found that in a given area, a minimum of three consecutive nights of searching must be done in order to detect 80% of the population on approximately 150 ha (371 ac) of a prairie dog town. Forrest et al. (1988) found that 82% of the actual ferret population on the Meeteetse prairie dog complex could be detected with four nights of searching 150 ha with spotlights.

An experienced observer can easily detect the bright green eye-shine of a ferret while driving. Typically, once an eye-shine is seen, the observer drives to the burrow and places an identification device over the burrow entrance and then leaves the area. All ferrets that originate from a captive breeding program are implanted with a passive integrated transponder (PIT) tag prior to release, and efforts are made to tag any wild born animals on most reintroduction sites. The identification device is used to detect a PIT tag as the ferret passes through, so that the ferret can be identified by number.

One limitation to monitoring reintroduction sites such as Conata Basin is finding the manpower and money to survey all of the areas (Prairie dog town complexes cover more than 5,000 ha.) where ferrets could potentially disperse. The optimal seasonal period for conducting spotlight surveys was determined by Clark et al. (1986) to be from 5 July to 30 August; however, the 1985 guidelines established by the U.S. Fish and Wildlife Service recommend a survey period from June 15 to October 31 (Schroeder 1985). More widely practiced is a spotlight period from late July to November. Variations may exist due to differences in individual site characteristics and the purpose of the survey.

Snow-tracking

Snow-tracking is a valuable tool used on some sites during winter months when ferrets are less active and more sporadic in their above ground activities (Biggins et al. 1986). Snow-tracking is mainly used for determining ferret presence on a site, but it can be used to some degree to identify individuals and estimate population size. Snow-tracking requires snow cover on the ground. In more southerly areas such as Mexico, the absence of snow cover may preclude the use of snow-tracking surveys. Clark et al. (1984) and Richardson et al. (1985) described weather conditions needed for conducting snow-tracking to include fresh snowfall during the previous night and low wind speeds. Surveys should be conducted approximately one hour after sunrise so that ferret tracks are not covered up by prairie dog activities. Snow-tracking surveys can be conducted either by walking, snowmobiling, or motorcycling transects spaced about 50 m apart. Richardson et al. (1984) estimated that each person walking transects on a town could be expected to cover about 15-25 ha/hr. Currently, most snow-tracking is done while driving four-wheel drive vehicles along transects as described above. Such surveys should be conducted on at least three different occasions and with ten days or more between surveys.

SCENT DOGS

Domestic dogs have been used as a research tool in a variety of wildlife management projects ranging from bird flush counts (Gutzwiller 1990) to locating rare species such as San Joaquin kit fox (*Vulpes macrotis mutica*) (Smith et al. 2001). Zwickel (1980) outlined a number of scenarios in which dogs contributed immensely to several monitoring or management methods used on wildlife ranging from chipmunks (*Tamius spp.*) to seals (*Otariidae spp.*). The training of wildlife detection dogs is based on the same methods used to train dogs to detect drugs, other contraband, or even human remains. Regardless of what a dog is searching for, the same basic foundation of search behavior must be established prior to training the dog to a particular scent. Another aspect of using dogs to detect ferret scent is knowledge of how and when to search an area. Syrotuck (1972) reported a number of considerations in regard to weather conditions, how to approach the area to be searched, and dog training.

The orientation of a search is highly dependent on wind direction and activity (e.g. swirling) as well as topography of the area. Shivik (2002) describes the negative effect that high wind variability has on a dog's ability to detect scent. Searchers must also take into consideration the characteristics of the search site. For example, creeks or streams as well as vegetation type influence the way a scent can be detected. The position of the sun can play a role in the way scent disperses. When the sun is at a high angle to the ground surface, scent will be very hard to detect. Syrotuck (1972) also described the role of humidity and temperature in conducting searches. In particular, humid air and cool temperatures hold scent better than hot dry air.

The New Mexico Game and Fish Department and the U. S. Fish and Wildlife Service cosponsored the first ferret detection dog test project in the late 1970's (Southwest Research Institute 1979). For the initial test project, four dogs were trained at the Southwest Research Institute to detect ferret scent. In controlled laboratory settings, the dogs could accurately discriminate ferret scent nearly 100% of the time. However, when the same four dogs were tested on actual prairie dog towns where ferret scent was planted, only two of the four dogs performed satisfactorily. The two dogs that did not perform well alerted falsely, lost interest in searching, and became easily distracted (presumably by prairie dog activity). The two dogs that passed the field trials were later used by the U.S. Fish and Wildlife Service to search for remnant populations of ferrets in South Dakota, Wyoming, New Mexico and Montana, but no ferrets were found.

Evans (1981) and Winter (1981), two of the primary dog handlers, described the dogs as having great potential, but explained that some of their limitations for properly training the dogs were due to the rare status of the ferret at the time of the trials and the poor health of the dogs. Martin and Schroeder (1980) listed similar problems with dogs that included the dogs being trained to search on a leash [a problem in sagebrush (*Artemisia spp.*) or tall, dense vegetation areas] and dog disobedience or health problems. Despite the potential usefulness of the dogs in searching for ferrets, they were sold in 1982.

In a summary report of the dog project, Max Schroeder (1982), the Black-footed Ferret Project Director at the time, stated, “It’s too bad the timing for training, funding and finding of living ferrets did not mesh. Perhaps, after we learn a bit more about black-footed ferrets someone should take another run at using dogs to locate this species.” In 2000 the Animal Plant Health Inspection Service (APHIS) sent out a request for partners to train and test dogs to detect the presence of ferrets on prairie dog towns. Due in part to the lack of funding, the project was never started.

There are many challenges involved in conducting such a project, and many factors involving scent detectability that are still unknown. Little is known about how below ground scent is available above ground. Above ground weather conditions are important to the way the scent is distributed, but the below ground conditions, and the structure of the burrow system in which the scent is laid play critical roles in how, if at all, the scent is brought above ground. The earliest work involving the use of ferret fecal material in a burrow system was done by Sheets (1970), when he excavated 18 burrow systems in Mellette County in South Dakota. Sheets found from 3-39 (averaging 11.7) pieces of scat in seven excavated burrows. Based on the potential amount of scat in a burrow system occupied by a ferret and the fact that burrow systems are constructed in a manner that facilitates air circulation (Cincotta 1989), I hypothesized that enough ferret scat scent would be brought above ground to be detected by dogs. Also, the dogs may locate ferret scat deposited above ground. Clark et al. (1986) found 75 potential ferret scats near burrow entrances while observing wild ferrets near Meeteetse, Wyoming over a three-year period.

Today, the availability of optimal training materials is one advantage in training dogs to detect ferrets. Ferret scat and scent can be obtained from several captive or wild individuals instead of from just two captive ferrets and a siberian polecat (*Mustela eversmanni*), as was the case with the dogs trained at the Southwest Research Institute (1979). Currently, dogs can be trained and tested on actual ferret reintroduction sites in addition to prairie dog towns planted with ferret scent. In 2001, a scent detection dog (Rio) was trained to find black-footed ferret scat and was used in trials at a reintroduction site on the Charles M. Russell National Wildlife Refuge in Montana. Results of these trials showed promise (Matchett and Smith 2001).

Chapter 2. Evaluation of Scent Dogs

INTRODUCTION

When monitoring protocols are developed for a ferret reintroduction site, many things are taken into consideration, including budget limitations, personnel requirements, equipment costs, site access, and what information is needed from the monitoring. As ferrets become self-sustaining at reintroduction sites, the need for less intense and less invasive monitoring tools becomes greater. Detection dogs may provide an alternative and supplementary method for determining presence or absence of ferrets.

There are two potential applications of using detection dogs to determine ferret presence or absence. The first and most promising would be to determine dispersal of ferrets onto smaller satellite towns on a reintroduction area, especially during fall when kits generally disperse to new areas. The second potential use would be for detection dogs to identify “hot spots,” areas where ferret density is highest, so that spotlighting efforts could be concentrated in those areas.

The objectives of this project were: (1) to determine the efficacy of specially trained detection dogs in their ability to determine the presence or absence of ferrets on a reintroduction site and (2) to determine the potential application of using detection dogs for monitoring reintroduced populations of ferrets.

Study Areas

Pilot Study A Site

The first pilot study for using dogs to detect black-footed ferrets was conducted in Jefferson County, in southwestern Montana on a site 4 km (2.5 miles) northwest of Whitehall, MT, on land owned by the U.S. Bureau of Land Management (Figure 3). Elevation at the site is 1,326 m (4,351 ft) above sea level and the area is semi-arid and is characterized by short grass and rolling hills. Average annual temperature is 5.8°C and average daily temperature ranges from a minimum of – 1.2°C in winter to a maximum of 17.7°C in summer. Rainfall averages 29.23 cm per year with most of the precipitation occurring in May and June (www.weather.com/weather/climatology/monthly/59759). No prairie dogs were present on this site.

Pilot B Site and Final Field Test Site

The Conata Basin black-footed ferret reintroduction site is located in the Buffalo Gap National Grasslands near Wall, South Dakota (Figure 4). These grasslands encompass approximately 242,814 ha (600,000 ac) in the semi-arid portion of southwestern South Dakota (USDA Forest Service 1995). Average temperatures in the area range from a minimum –4.6°C in the winter to a maximum 25.5°C in the summer. Average annual precipitation is 39.9 cm, most of which comes as rain during the growing season (Severson and Plumb 1998). Badlands formations characterize the Conata Basin area. The soils of the area are primarily comprised of clay. Vegetation is dominated by blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), western

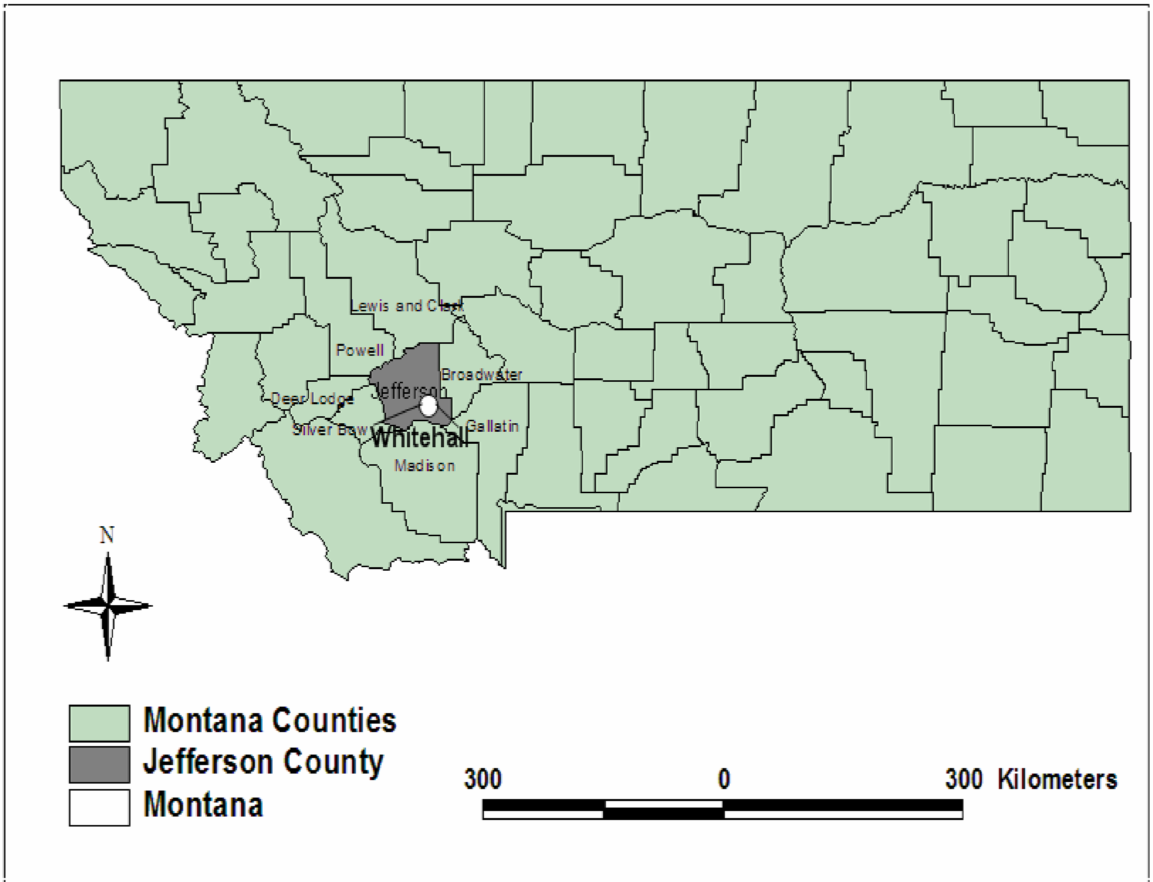

Figure 3. Pilot Study A was conducted in Jefferson County, Montana, near Whitehall where twenty-four test trials were conducted on Bureau of Land Management (BLM) land from August 18-20, 2003 to evaluate above ground detection rates of planted ferret scat by detection dogs.

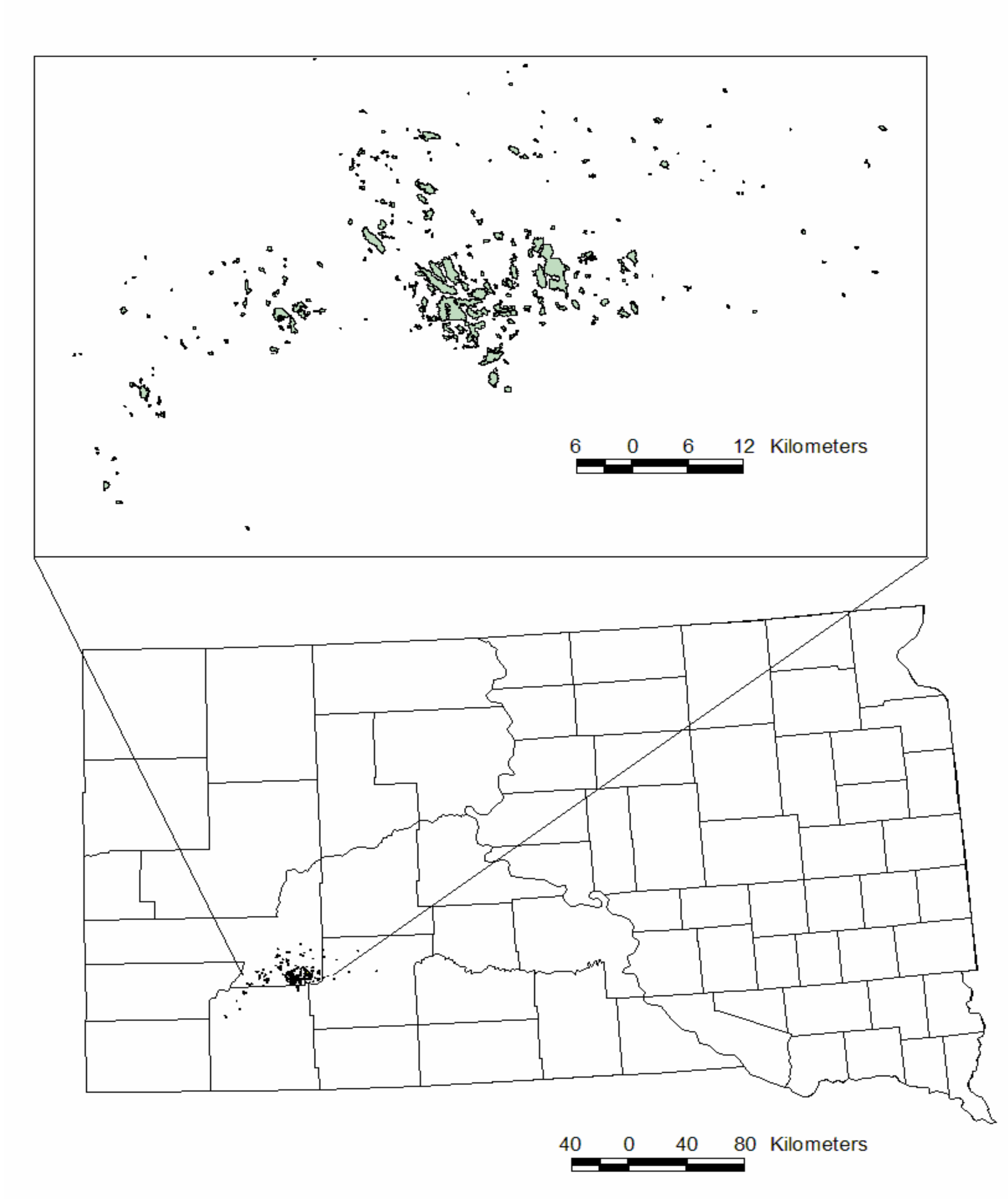

Figure 4. Pilot Study B and Final Field Test site where detection dogs were tested September 16, 2003 through October 29, 2003 at the Conata Basin black-footed ferret reintroduction site, located in southwest South Dakota.

wheatgrass (*Agropyron smithii*), sedges (*Carex spp*.), red three-awn (*Aristida purpurea*), scarlet globemallow (*Sphaeralcea coccinea*), wooly Indian wheat (*Plantago patagonica*) and plains prickly pear (*Opuntia polyacantha*) (MacCracken et al. 1985).

The Conata Basin ferret reintroduction site is bordered by Badlands National Park to the west, east and north. The U. S. Forest Service currently manages the grasslands by allotting grazing permits to local ranchers. Cattle have grazed on the grasslands since 1900 (MacCracken et al. 1985). The Buffalo Gap National Grasslands is split into two districts, the Wall Ranger District and the Fall River District. This study was conducted entirely within the Wall Ranger District, which lies within parts of Shannon, Jackson, and Pennington counties.

Black-tailed prairie dogs currently inhabit 5,983 ha (14,785 ac) within the 31,565 ha (78,000 ac) reintroduction area (Perry 2004). Prairie dog density was approximately 30 prairie dogs per ha (12 prairie dogs per ac) on the core complex where ferrets were reintroduced (Perry 2004). Ferrets were released in the Conata Basin site from 1996 through 1999. Conata Basin is the most successful black-footed ferret reintroduction site, both in terms of establishing a self-sustaining population, and the subsequent production of wild-born young. Ferret litter production in the wild at Conata Basin has exceeded expectations, and recent surveys have documented the ferret population at 263 ferrets (Perry 2004). Ferret kits have been translocated from Conata Basin to the Cheyenne River Sioux Tribe’s reintroduction site in north central South Dakota. The Conata Basin complex is protected from prairie dog shooting, but it is still open to grazing practices. Ferret monitoring is intensive on the site, with field crews annually conducting spotlight surveys from late July until February (as weather and budget permit) and snow tracking surveys are conducted when conditions allow.

METHODS

Testing the detection dogs was divided into three progressive sessions, Pilot Study A, Pilot Study B, and Final Field Test. Pilot Study A was a test of the dogs' ability to detect above ground ferret scat. The next step was to train and test the dogs at the Conata Basin reintroduction site. This step was divided into Pilot Study B, where the dogs were trained on live ferret scent and tested, and the Final Field Test. The Final Field Test was an evaluation of the method after the dogs were adequately trained to detect ferrets in their natural environment, and handlers were acclimated to working the dogs in those areas. Because field tests with scent dogs to detect black-footed ferrets in the wild had never been done before, training trials prior to the Final Field Test were necessary.

Prior to the pilot studies, the dogs were required to successfully complete a certification trial that guaranteed that the dogs were effective at detecting ferret scat planted above ground (For complete certification criteria see Appendix A). Pilot Study B and the Final Field Test occurred during September and October 2003 at the Conata Basin reintroduction site. Lower temperatures in fall optimize dog stamina and performance. Also, because juvenile ferrets disperse into new areas during fall and overall ferret activity is at a peak (Biggins et al. 1986), there is more ferret scent deposited above ground.

Dog Training

Dog training and search protocols for this study were developed by dog handlers from Working Dogs for Conservation, Bozeman, MT using a combination of training protocols used by narcotics, search and rescue, and cadaver dog trainers (Appendix B). Although training and search protocols were modified slightly during the course of this study, approaches of the two dog-and-handler teams were consistent throughout the study. While at Conata Basin, when a dog handler felt there was a problem with a dog, either in ambiguous alerts given by the dog or an apparent lack of interest in the target scent, additional training exercises were incorporated into the session. However, if it became apparent that a dog was not benefiting from training exercises, then that particular dog would not participate in those training exercises.

One obstacle in training dogs to detect ferret presence on prairie dog towns is the fact that the dogs for this study were trained on ferret scat; however, ferrets are documented to defecate primarily below ground (Hillman 1968, Sheets 1970). During Pilot Study B at Conata Basin, both dogs were exposed to a live black-footed ferret and its scent for the first time. We put a live ferret in one holding tube and placed it at random with three other tubes in the line-up, one with a live prairie dog, one with a prairie dog scented article, and one blank tube. Both dogs avoided the prairie dog tubes, and were unsure of the ferret tube at first. Each dog was rewarded when the correct tube was approached, reinforcing the connection between ferret scat and live ferret. In later sessions, ferret scat and the live ferret in the holding tube were alternately put in the line-up to reinforce the idea of both scents representing a reward for the dog.

By presenting the dog with both types of scent material and rewarding the dog for detecting both, a connection between scat and actual ferret scent was thought to have been made by the dog so that they recognize “ferret”, not just ferret scat. This result appeared to have been achieved by a detection dog (Rio) while doing some preliminary tests to find ferrets on the Charles M. Russell National Wildlife Refuge ferret reintroduction site in 2001. When Rio was worked in an area where live ferrets had recently been, he gave strong positive indications even though he had never been exposed to live ferrets (Matchett and Smith 2001).

Pilot Study A

Pilot Study A was conducted from August 18-20, 2003 to determine the accuracy of specially trained search dogs in detecting ferret scat above ground prior to field testing the dogs at the Conata Basin reintroduction site. The pilot study was conducted in Montana because of convenience, disease concerns (potential flea transfer from plague areas into non-plague areas) and minimal travel time for the dogs. Also, we did not want to expose the dogs to rattlesnakes (*Crotalis viridis*) and various non-target scents during the initial training/testing session. Testing the dogs on above ground scat gave measurable and accurate false positive (when a dog indicates there is ferret scat presence where there is none) and false negative (when a dog fails to indicate ferret scat presence where there is ferret scat presence) rates. Pilot Study A served as a chance to ensure that training was progressing as scheduled, and allowed time to make minor adjustments in data collection, methodology, dog behavior, or other logistical issues.

Four teams of one dog plus one handler participated in Pilot Study A. Dog 1 (German Shepherd female) and Dog 2 (Black Labrador Retriever male) had previous experience in conducting wildlife searches. Dog 3 (German Shepherd male) and Dog 4 (German Shepherd female) had never conducted wildlife detection searches. Each team randomly searched 6 of the 12 plots independently of one another. Dogs 1 and 3 had the same handler, so plots were assigned randomly with the restriction that dogs 1 and 3 were assigned to different plots so the same handler would not search the same plot twice. Each team searched three plots the first day and three plots the second day. At least one plot per day per team contained planted scat. Each handler determined optimal search patterns for each plot based on weather data collected immediately prior to a search (primarily wind direction). Weather conditions were recorded at the beginning and end of each plot search. Temperature, relative humidity, barometric pressure, wind speed and direction and cloud cover were recorded. Dog handlers were not allowed to share any information (e.g., scat locations, etc.) until all trials had been completed on day two. Teams were allowed to conduct searches at the same time, but not in the same plot or in directly adjacent plots.

Twelve 50 m x 50 m plots were used for the trials. A colored flag was positioned in the middle of each plot to aid the handlers in keeping dogs on evenly spaced transect lines. Spacing between plots was $\geq$ 100 m to minimize aerial scent transfer from one plot to another. Plot search time was recorded, however no time limits were imposed on the handlers. Spacing between transects averaged approximately 7.6 m. Dogs 1 and 2 worked plots with narrow ($\leq$ 7 m), evenly spaced transect width pattern, while Dog 4 worked plots with a more uneven and more widely ($\geq$ 10 m) spaced transect pattern. Dog 3 worked a pattern similar to Dogs 1 and 2. Dog behavior and handler confidence in dog alerts were also recorded.

Ferret scats (from captive animals fed a prairie dog diet) from both males and females were placed randomly on the ground in six randomly selected plots and six plots were left blank. Scat was kept in a sealed glass jar until placement on each designated plot. Using latex gloves to avoid scent contamination, I placed scat samples approximately 1 m from numbered flags; the flags were placed near grass patches or other natural features that would conceal the scat from the handler's view. Flags without scat planted nearby were also placed randomly throughout each plot. Placed scats were of realistic size (approximately 2.5 cm long). Scat was placed in the plots the day prior to the first search day to ensure an adequate amount of residual scent for the dogs to detect. Scat samples were left in the same position for two days during the testing session. On the first morning of searching, the scat appeared to be much drier than when it was planted, but on the second morning, after heavy dew, the scat was moistened and may have been easier for the dogs to detect. I did not account for this easier detection due to the fact that each dog had the same opportunity to search a sample of the plots on either day. In addition, while searching on the reintroduction site, the dogs were exposed to a variety of search conditions using optimal and less than optimal scent articles, all of which provided additional information to the study. All planted scat was collected on the last day of the searches.

Pilot Study B –Training and Testing

Before the dogs were brought to Conata Basin, dog handlers were responsible for following the disease protocol approved by the USFWS Ferret Conservation Center veterinarian Dr. Julie Kreeger (Appendix C). This step was taken to minimize the risk of disease transfer to the reintroduction site. Domestic dogs can spread diseases such as plague and canine distemper, which are lethal to ferrets.

Dogs 1 and 2 were used in Pilot Study B training trials conducted from September 15 – 28, 2003. Dog 3 from Pilot Study A was a novice search dog and was deemed not ready for Pilot Study B by the dog handler. Dog 4 was not used in Pilot Study B and the Final Field Test because the handler was not able to be present during Pilot Study B and the Final Field Test. Prior to the dog-and-handler teams arriving at Conata Basin, eleven prairie dog towns ranging from 8-40 ha (20-100 ac) in area were chosen as test sites for Pilot Study B and the Final Field Test (Table 1). However, during the course of Pilot Study B I determined that more time was needed for training, which allowed for only six of the eleven test towns to be searched. A majority of the training that occurred during Pilot Study B was done after initial searches of test towns revealed that more training was necessary. Initial searches were analyzed separately from those searches of test towns occurring after one week of intensive training. Therefore, the last four searches of test towns during Pilot Study B were analyzed with the searches conducted during the Final Field Test.

Small prairie dog towns were chosen so that a distinction between areas searched could be made easily. Small towns, often called satellite towns, occur along the

Table 1. Eleven prairie dog towns ("Test Towns") used to test the efficacy of ferret detection dogs. Ferret status, the subcomplex it belongs to, and area are given for each test town.

Test Town	Subcomplex	Ferret Presence Y/N	Hectares (acres)
1	Heck Table	Y	27 ha (67 ac)
2	Heck Table	Y	27 ha (67 ac)
3	Heck Table	Y	29 ha (73 ac)
4	Heck Table	Y	30 ha (73 ac)
5	Sage Creek	Y	13 ha (31 ac)
6	Agate	Y	33 ha (81 ac)
7	Agate	Y	38 ha (94 ac)
8	N/A	N	31 ha (76 ac)
9	N/A	N	31 ha (76 ac)
10	N/A	N	31 ha (77 ac)
11	N/A	N	8 ha (21 ac)

periphery of larger towns, and were chosen to simulate testing the method in areas where it is most likely to be applied by reintroduction site managers (Figure 5). Also, smaller prairie dog towns typically have fewer ferrets on them, thereby providing the dogs a more discrete scent area in which to work.

The towns designated as having no ferrets were separated from the ferret release area by a wall of badlands formations and other landscape features that would make dispersal to these areas by ferrets during the trials highly improbable. Spotlight surveys were conducted within two weeks of the dog search trials. Presence or absence of ferrets on the test towns was determined by spotlight surveys on all 11 test towns. Spotlight surveys were conducted for a minimum of three consecutive nights. Spotlighting followed the protocol outlined by the USFWS (1989). Roof-mounted spotlights were used when possible; otherwise a 2-million candlepower handheld spotlight was used.

To estimate the dogs' ability to identify the scent that live ferrets produce in their natural environment, some acclimation training was done upon the dogs' arrival at Conata Basin. First, the dogs were taken to a prairie dog town outside of the test area and worked on a small area (approximately 100 m x100 m) where ferret scent had been planted. Scent articles used for training purposes included ferret scat, urine soaked bedding material, and towels used as ferret nest material. All scent articles were handled using latex gloves to avoid contamination. Next the dogs were taken to a ferret "hot spot" where three ferret litters were found the previous week. Each dog was worked separately in a 24-ha (60 ac) plot. Transects were spaced approximately 65-70 m apart.

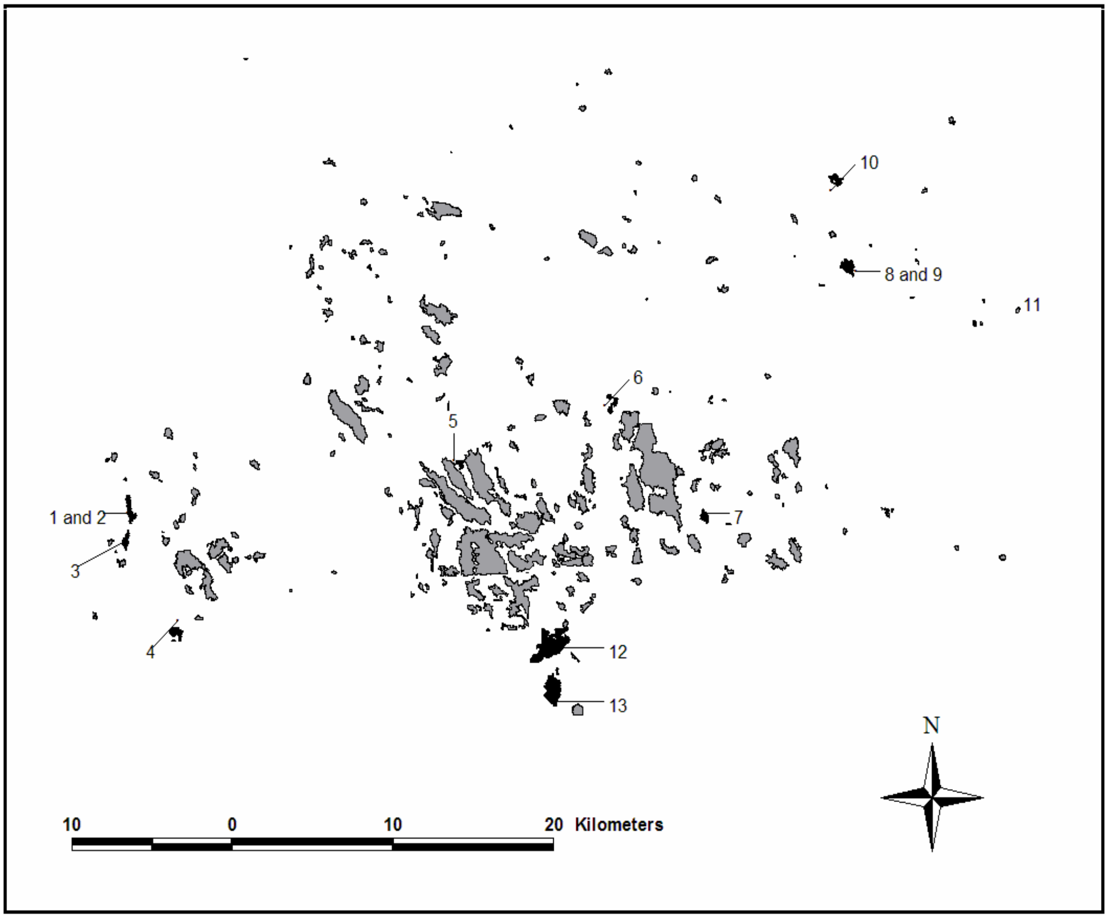

Figure 5. Distribution of prairie dog test towns used for the Final Field Test at the Conata Basin black-footed ferret reintroduction site. Pilot Study B and Final Field Test towns are shaded in black and labeled 1-11. Test Towns 12 and 13 were only searched during the Final Field Test.

Each dog displayed multiple alerts, some of which were in overlapping areas, and some alerts were given where reflectors marking prior ferret sightings had been left out by spotlight crews. At this point, the dog handlers believed that the dogs were detecting ferret scent within the prairie dog burrows. The dogs were then taken to the test towns to begin the field-testing portion of Pilot Study B.

Each team was randomly assigned to the order in which they would search the Pilot Study B test towns. Each town was assigned a number, and that number along with the size of the town (so handlers could determine transect spacing width) was the only information given to the dog handlers. Teams worked separately from each other, and were not allowed to discuss any aspects of the trials until the end of the study. To optimize efficiency of searching the test towns, if two teams drew the same town to search on a day, the search order for that day would be adjusted to prevent overlap. Teams could work the same town on the same day, but not at the same time, and the second team to work the area was not allowed to watch the working team. Handlers were given no information on ferret presence/absence or location in relation to the test town.

Each handler determined the search orientation and pattern for each town on the basis of wind direction. Search orientation was most commonly worked perpendicular to the wind and searches began on the down wind edge of each town enabling the dogs the most opportunity to detect scent (Figure 6). Shifts in wind direction occurred with varying frequency and were sometimes compensated for during a search by rotating the transect pattern.

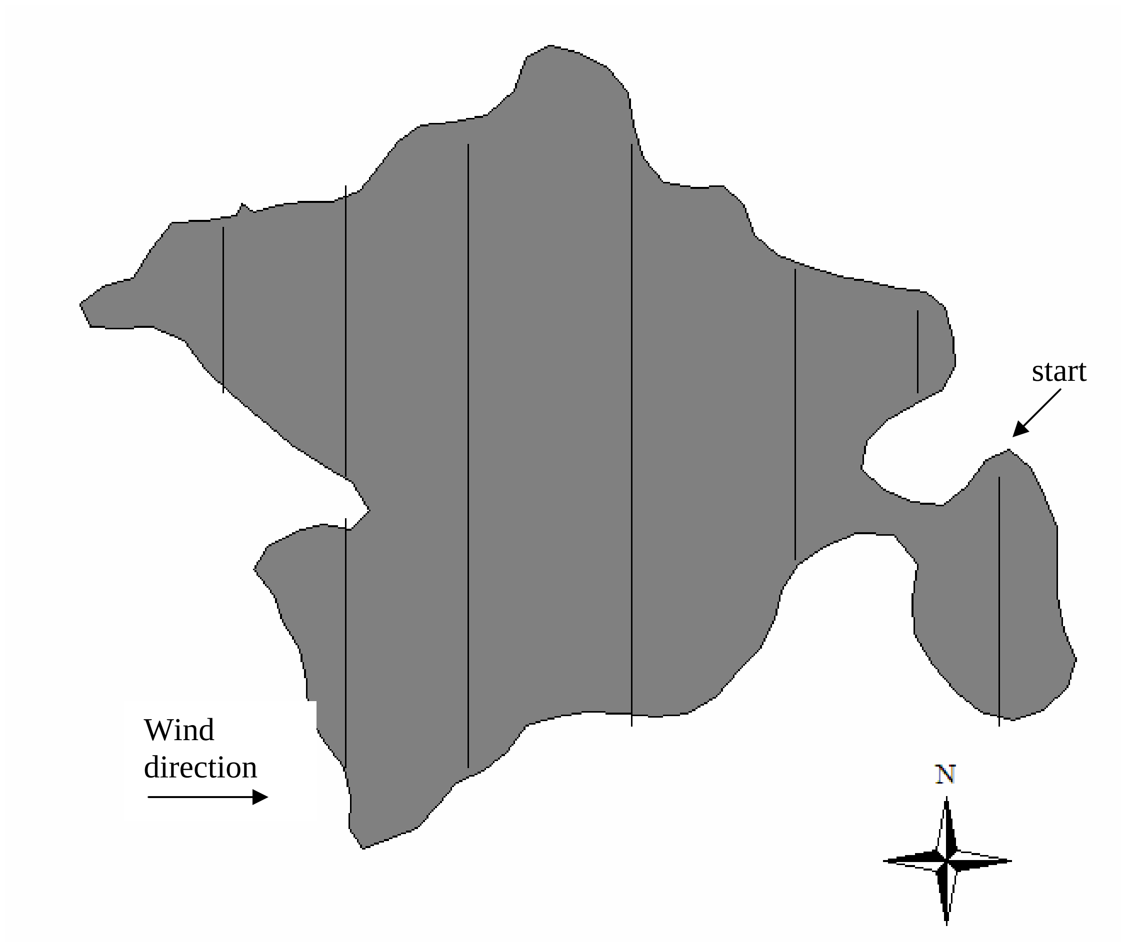

Figure 6. Typical detection dog search pattern of a prairie dog test town during Pilot Study B and the Final Field Test using a transect spacing of ~110m on a 27-ha prairie dog town.

A recorder followed each dog-and-handler team during searches and was responsible for collecting weather data, marking locations where the dogs alerted using a Global Positioning System (GPS), taking notes on dog behavior leading up to an alert, and recording and collecting any ferret sign present in the area (e.g. scat, trenching, tracks, plugged burrows, etc.). Presence of cactus, cattle, and anything that made searching difficult or distracting for the dogs was also recorded.

Searches on test towns were conducted on September 17 and 19, 2003. On the 19^{th}, Dog 1 gave multiple alerts on a no-ferret town. At this point we determined that the dogs required more training, so blind searches of test towns were halted. From September 20 – 25, 2003, the dogs were worked on practice towns to validate their ability to detect ferret scent and to work non-ferret areas without giving false alerts. Dog reinforcement training of ferret scent was repeated in similar fashion to that described earlier with the use of tubes, one with a live ferret, one with a live black-tailed prairie dog or prairie dog nest material, and one with no scent items. Reinforcement training was done off of prairie dog towns, to minimize the number of non-target scents in the area. Another training exercise used to ensure that the dogs were not alerting to non-target scent was to take the dogs to a blank prairie dog town (one with no ferrets) and if the dogs gave an alert, the handlers corrected the dogs. During the course of the training exercises, we were able to eliminate the possibility that the dogs were alerting on burrowing owls (*Athene cunicularia*), other weasels (*Mustela spp.*), badger (*Taxidea taxus*), or rattlesnakes. In addition, blank towns were used for planting ferret-scented articles for the dogs to find. During these searches, however, the dogs were required to search a larger area and the handler was aware of the location of planted articles.

We also conducted practice situations where handlers were blind to the planted scat locations; however, handlers were not allowed to falsely reward the dog in these situations. After both dogs correctly determined a prairie dog town planted with ferret scent and a known blank town, training exercises stopped and the blind searches of the test towns resumed. On September 26th, both dogs completed searching two more test towns for a total of six test towns searched blindly in Pilot Study B.

Final Field Test

The Final Field Test was conducted from October16 – 29, 2003. As in Pilot Study B, each dog was given a day to acclimate to their surroundings prior to the field tests. During the acclimation day, Dogs 1 and 2 were taken to prairie dog towns that were not part of the study and were not within the ferret reintroduction area. The dogs were worked on small areas (< 2 ha) within the practice prairie dog towns where scat samples were planted. These practice trials reinforced previous training done in Pilot Study B.

I tested whether the dogs were able to identify live ferrets by working the dogs in an area where, through spotlighting, we were able to locate a ferret. Once a ferret was located, we blocked the burrow entrance where the ferret was seen along with all surrounding burrows until approximately 30 minutes before sunrise, and then removed the blocks and allowed the dogs to work through the area. Both dogs gave a strong alert on the burrow where the ferret was located. This exercise was conducted twice for Dog 2. On the second trial, two ferrets were blocked in burrow systems with wooden fence post ends approximately 200 m apart and the dog was asked to work the area, and again the dog indicated on the burrows where the animals were located.

The same eleven prairie dog towns that were designated as test towns in Pilot Study B were used in the Final Field Test. In addition, two larger prairie dog towns (100 ha) were searched at the end of the study and coincided with spotlight surveys conducted by the Forest Service. Neither of the prairie dog towns had ever been surveyed for black-footed ferrets. The total number of prairie dog towns searched by each dog during the Final Field Test was thirteen. Each team completed searching an average of two test towns per day. Due to unexpectedly high temperatures in October (>20°C), searches were occasionally limited to working one test town per dog per day. The dogs were given two days rest during the Final Field Test.

Although the main objective of this study was to evaluate the efficacy of dogs in detecting the presence or absence of ferrets, detailed accounts of each alert were recorded along with aspects of the dogs' behavior such as, willingness to work, whether an indication was strong or weak, and behavior leading up to an alert. Also, any ferret sign present in the area, such as plugged burrows (Prairie dogs will cover a burrow entrance with dirt after a predator enters.), trenching, or scat, was recorded and if possible, the scat was collected. The handlers used detailed accounts of each alert as a reference to determine if dogs had any change in search behavior during the course of the study.

DATA ANALYSIS

Data were analyzed to determine percent of plots or test towns identified correctly by each dog and percentage of false positives and false negatives. The duration of the searches each day were not sufficient to test the influence of weather on search success, so weather data were not included in the analysis. Pilot Study A provided an estimate of above ground scent detection accuracy, and how often the dogs might indicate falsely. Data from Pilot Study B were split and analyzed separately. The searches of test towns conducted prior to the week of intensive training were analyzed separately from the searches of test towns conducted after training. The latter were combined with the Final Field Test results to provide a larger data set.

RESULTS

Pilot Study A

Weather conditions during Pilot Study A were fairly consistent between days. Temperatures ranged as high as 25° C (78° F) and as low as 15°C (60°F) during searches, with the average temperature at 68.9°F. Humidity was highest during the first searches on both days at 58.4% and 65.6%, respectively, and then dropped to lows of 27.9% and 31.4%. Wind was variable, but overall light. Maximum wind speed recorded for all of the searches was 2 m/sec (4.7 mph); many of the 24 searches were conducted with little (1-2 mph) to no wind at all. Barometric pressure remained steady at 25.2 inches Hg over all search times.

Scent detection dogs correctly determined presence/absence of above ground ferret scat on 83% of the 24 Pilot Study A trials (Table 2). Mean correct identification of plots containing scat was 84% (SE = 33) for four dogs. Mean correct identification of plots not containing scat was 83% (SE = 67). Correct positive rates were based on each dog's ability to detect presence or absence of scat on a given plot. Dog 2 indicated falsely on two of the "absence" plots (these plots were adjacent to one another). It appeared that the dog was alerting on either fox (*Vulpes spp.*) or coyote (*Canis latrans*) scat. The handler noted under field conditions that she would have ignored the dog's alert and continued with the search due to the fact that it was obviously not the target scent (ferret scat). However, since ferret scent is primarily underground and visual inspection is not an option, we wanted to determine detection rates based solely on dog performance without handler interpretation so the alerts were counted as false positives. Dogs 3 and 4 each had one false negative observation.

Pilot Study B

Mean correct positive rate for detection of test towns with ferrets present during the first part of Pilot Study B was 100% (Table 3). Only one test town with no ferrets present was searched, and Dog 1 falsely indicated presence. This test town was the first no-ferret town searched by Dog 1 and the first no-ferret town searched at Conata Basin. Both dogs correctly indicated presence on the test towns with ferrets.

Table 2. Detection of black-footed ferret scat by four trained dogs of plots for Pilot Study A conducted near Whitehall, Montana from August 18-20, 2003. Dog 1 and 2 searched six plots and Dog 3 and 4 searched six different plots yielding 24 trials. Plots either had black-footed ferret scat planted on them, or were left blank. Columns in bold represent the correct response for the type of test town being searched.

	Planted Scat Plots n=6			Blank Plots n=6		
	Indicated Presence	No Indication	Uncertain	Indicated Presence	**No Indication**	Uncertain
Dog 1	**3 (100%)**	0	0	0	**3 (100%)**	0
Dog 2	**3 (100%)**	0	0	2 (67%)	**1 (33%)**	0
Dog 3	**2 (67%)**	1 (33%)	0	0	**3 (100%)**	0
Dog 4	**2 (67%)**	1 (33%)	0	0	**3 (100%)**	0

Table 3. Search results from six test towns by Dog 1 and Dog 2 during Pilot Study B conducted at the Conata Basin black-footed ferret reintroduction site from September 15-19, 2003. Dogs 1 and 2 were blind tested on six prairie dog towns, five had resident ferret them, and one had no record of ferret presence. Columns in bold represent the correct response for the type of test town being searched.

	Ferrets Present n=5			No Ferrets Present n=1		
	Indicated Presence	No Indication	Uncertain	Indicated Presence	**No Indication**	Uncertain
Dog 1	**2 (100%)**	0	0	1 (100%)	**0**	0
Dog 2	**3 (100%)**	0	0	0	**0**	0

Final Field Test

During 26 searches of thirteen test towns conducted by two dog-and-handler teams, 22 (84.6%) were correctly identified as ferret or no-ferret, two (7.7%) were incorrectly identified, and two searches (7.7%) were declared uncertain by the dog handlers (Table 4 and Figure 7). The handlers determined uncertain identifications when the dog's alert was unclear, or the handler felt the dog was not working well. Chi-square tests revealed that differences between dogs in their ability to correctly identify presence or absence were not significant (p = 0.409). Mean correct positive rate for test towns with ferrets was 81% (SE = 13) and correct positive rate for test towns without ferrets was 90% (SE = 20). Dog 2 had two false negative alerts recorded on two different test towns. Two towns during these searches were categorized as uncertain, one on a ferret town and one on a no ferret town.

Dog 1 found two scats that appeared to be ferret scat on two different towns. Both scats were found on towns with resident ferrets in areas where spotlight crews had seen ferrets two weeks earlier. One of the scats was found in a pile of what appeared to be nest material that was extracted from the inside of the burrow, something which Clark et al. (1986) had documented ferrets doing and which I have personally seen them do on several occasions. The other scat was found in an area where the dog-and-handler team and recorder documented seeing a ferret. During the second searches on eight of the test towns conducted by Dog 1 and Dog 2 mean correct positive detection on test towns with resident ferrets was 75% (SE = 50). Searches of test towns with no resident ferrets yielded a mean of 88% correct (SE = 25) (Table 5).

Table 4. Identification of test towns during first visit searches by Dogs 1 and 2 during the Final Field Test at Conata Basin black-footed ferret reintroduction site. Twenty-six trials using two dogs on 13 test towns were conducted on September 26, 2003 and from October 16-29, 2003. Whether or not indications were given was recorded for the first time searches, eight with resident ferrets and five with no record of ferret presence. Ferret presence or absence was documented by spotlight surveys. Uncertain was recorded on towns where either the dog gave ambiguous alerts, or the handler did not feel the dog was working well. Columns in bold represent the correct response for the type of test town searched.

	Ferrets Present n=8			No Ferrets Present n=5		
	Indicated Presence	No Indication	Uncertain	**Indicated Presence**	No Indication	Uncertain
Dog 1	**7 (88%)**	0	1 (12%)	**0**	5 (100%)	0
Dog 2	**6 (75%)**	2 (25%)	0	**0**	4 (80%)	1 (20%)

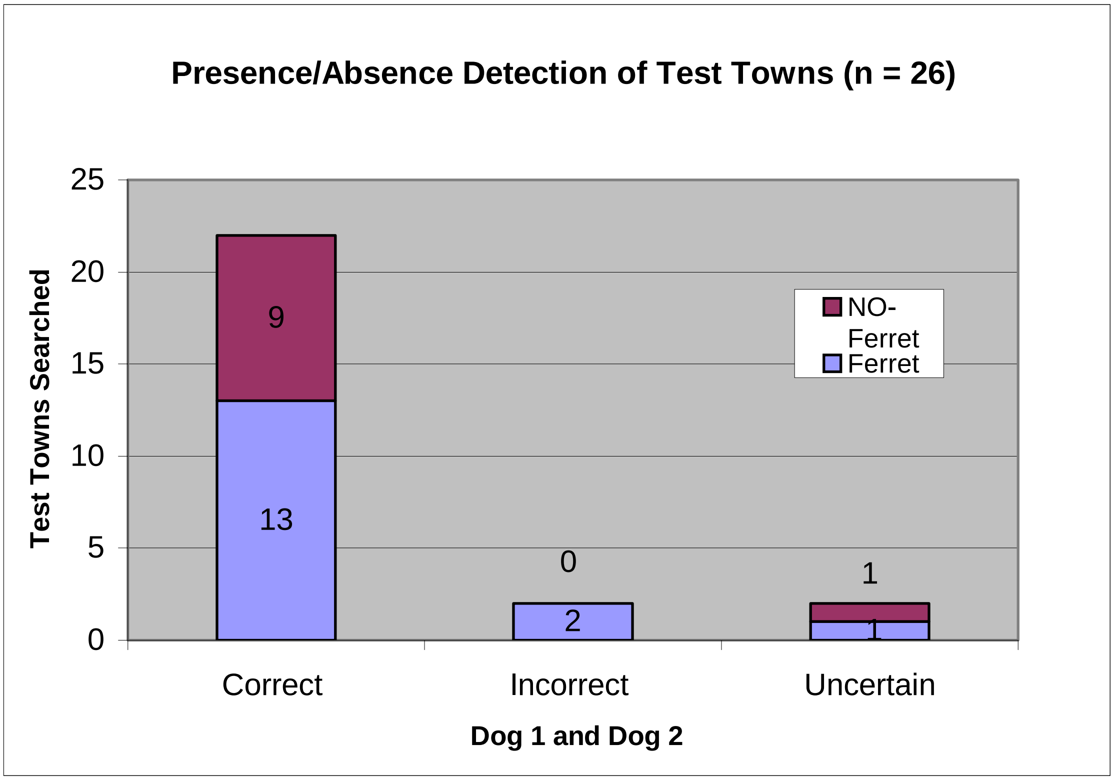

Figure 7. Detection accuracy of detection dogs on ferret and no-ferret towns at the Conata Basin reintroduction site. Correct, incorrect and uncertain determinations were recorded for each town searched during the Final Field Test. Uncertain represents records when either the dog gave an ambiguous alert, or the handler did not feel the dog was working well.

Table 5. Indications recorded for Dogs 1 and 2 during searches of eight test towns visited for a second time by Dog 1 and Dog 2 during the Final Field Test at Conata Basin black-footed ferret reintroduction site from October16-26, 2003. Four of the test towns had resident ferrets inhabiting them and four had no record of ferret presence. Ferret presence or absence was documented by spotlight surveys. Uncertain was recorded on towns where either the dog gave ambiguous alerts, or the handler did not feel the dog was working well. Columns in bold represent the correct response for the type of test town searched.

	Ferrets Present n=4			No Ferrets Present n=4		
	Indicated Presence	No Indication	Uncertain	**Indicated Presence**	No Indication	Uncertain
Dog 1	**4 (100%)**	0	0	**0**	3 (75%)	1 (25%)
Dog 2	**2 (50%)**	2 (50%)	0	**0**	4 (100%)	0

Coverage of test towns searched was figured by multiplying the distance of all transects by 20 m (the distance on either side of the handler that the dog worked). Scent dogs were able to cover an average of 22% (range 18% - 43%) of prairie dog test towns searched. Smaller towns had greater coverage than larger towns. Correct detection rates did not vary by coverage. Average time to detection of presence while spotlighting six of the prairie dog test towns (test towns 1 and 2 combined, 3, 4, 5, 6, 7) with resident ferrets was 240 minutes (15 – 465 minutes). Average search time for the same test towns using detection dogs was 71 minutes (52 – 102 minutes) (Table 6). Mean correct identification of the six test towns by Dog 1 and Dog 2 over the 24 searches (both dogs searched each town twice) was 86% (SE = 25).

COST OF DETECTION DOGS

Costs given will vary by reintroduction site; these estimates are based on detection dogs used on the Conata Basin reintroduction site. As techniques are refined and made more efficient, costs will vary. Currently, contracting a trained dog-and-handler team can cost approximately $400 a day. Depending on the type and intensity of the search, most detection dogs can work approximately four hours a day. I found that scent dogs were able to cover an average of 21 ha/hr. The cost for dogs in this study is$4.76/ha based on each dog working an average of 21 ha/hr at $400/four hour day. An experienced detection dog may be able to search 200 ha (500 ac) in one work day (approximately four hours), as shown by this study, which would lower the cost to

Table 6. Comparison of detection dog search time and time to detection of presence for spotlighting on six test towns during Pilot Study B and the Final Field Test at Conata Basin from September – October 2003.

Test Town	Spotlighting Time to Detection of Presence (minutes)	Average Detection Dog Search Time (minutes)	Percent Correctly Identified as Presence/Absence by Dog 1 and 2 (out of 4)
1 and 2	15	53	88
3	90	66	100
4	300	52	75
5	150	66	75
6	420	102	75
7	465	88	100

2.00/ha. Detection dogs were adequate for covering larger areas with a high level of confidence in their ability to detect ferret presence. The results presented are specific to this study using these dogs in this environment. Using less experienced detection dogs, or less qualified dogs would affect efficiency and accuracy. At another reintroduction site, different results may occur due to different environmental conditions.

Discussion

Method Efficiency

When evaluating methods for monitoring populations of ferrets, different methods will provide results at different levels of accuracy and efficiency. For example, Richardson et al. (1985) set an area coverage rate of 15-25 ha/hr for conducting snow-tracking surveys while walking. Campbell et al. (1985) and Forrest et al. (1988) determined that approximately 80% of a ferret population could be estimated by spotlighting when covering 6.4 ha/hr (based on four eight-hour nights covering 150 ha each night). In this study, scent dogs were able to cover an average of 21 ha/hr, but up to 41 ha/hr when transects were widely spaced. Covering this same area by spotlighting would require at least three nights of effort. Depending on what information is needed, more emphasis may be placed on accuracy or efficiency.

My data suggests that the use of wildlife detection dogs trained specially for determining presence or absence of black-footed ferrets could provide reintroduction site managers with an alternative monitoring tool that is efficient and accurate. Due to the differences in topography, budget constraints, personnel, and ferret population size, each reintroduction site offers different challenges when it comes to monitoring black-footed ferret populations. Reintroduction sites with the following situations would benefit the most from using detection dogs: limited personnel, rough topography, limited access within the reintroduction area, and limited time for monitoring efforts. When more information is needed about the population, such as sex and age ratios, reproduction rates, locations of litters, and what individuals are in the population, spotlight surveys should be used as the monitoring method of choice. A combination of spotlight surveys and detection dogs would provide a thorough and efficient way to survey a reintroduced population of ferrets.

Incorrect Responses

Many of the false alerts can be explained, and in most cases understanding the conditions under which a dog gave an incorrect response may help in interpretation of results. During Pilot Study A, the dogs could pick up the ferret scat scent from 10–12 m while working on a 50 m x 50 m plot, and on some occasions they were called off of a scent because the handlers were trying to keep them on transect and not allow them to work too far ahead in the plot. In two instances in particular, after a dog was instructed to stop following the scent and come back to the transect path, the dog later missed the scent article the dog had been working towards earlier in the search. Not allowing a dog to follow a scent to its source may have caused a few of the planted scat samples to be undetected. Under normal circumstances, this likely would not have happened simply because a handler would not command a dog to stop following a scent during a normal search unless they were sure it was not the target scent. One of the false negative records for a plot searched by Dog 4 was probably due to high temperatures (>25°C) and fatigue from working three plots prior. During the search, the dog was panting heavily, and not working as vigorously as on previous plots. It should be noted, however, that after the handler had ended the search and the team was leaving the plot, the dog alerted on the planted scat. Dog 3 was the youngest of the four dogs and was not as experienced in working in the field for extended periods of time. This lack of experience may explain why the dog did not alert presence on a plot with planted scat.

I believe there is a possibility that Dog 2 was only alerting on live animal scent towards the end of the study. During the second searches of the Final Field Test, Dog 2 had a decrease in the number of alerts given on towns with ferret presence. Also, occasionally, Dog 2 gave weak alerts while generally searching in a distracted manner. The handler opted not to reward these alerts, and may in fact have been failing to reward the dog when it was correct. Additionally, working both dogs in areas where there was recent live ferret scent laid may have reinforced this live animal scent. During one of the last searches, when spotlight crews failed to detect presence on a test town, Dog 2 indicated presence multiple times in a small area. Ferret traps were set on the burrows and surrounding burrows where the dog alerted, and that night a ferret was trapped.

Problems Encountered at Conata Basin

There were several unforeseen problems that occurred while working the dogs at the reintroduction site, including the multiplicity of scents that the dogs had to discriminate among. Also, frequent barking and movement of prairie dogs distracted the dogs. One of the most difficult issues to deal with was the fact that the handlers were not able to investigate what the dog was alerting to because it was below ground. The only way to determine if the dogs were actually alerting on ferret scent would be to excavate the burrow system in search of ferret sign, a process that would be expensive and highly impractical.

Prairie dogs often distracted the detection dogs with their frequent barking and movement when the dogs were in close proximity, sometimes within < 2 m of their burrows. The constant presence of prairie dogs both above and below ground undoubtedly creates a complex scent environment for the dogs to discriminate. Thus, when the dogs are rewarded for alerting on ferret scent, there is prairie dog scent present as well. If a dog alerts on a small amount of ferret scent in an abundance of prairie dog scent, there is a possibility of the dog making a connection between the prairie dog scent and a reward. The confusion of prairie dog scent mixed with ferret scent could be made more clear to the dogs by intermittent training that reinforces the ferret scent and discourages alerting on prairie dog scent. According to Schoon and Haak (2002), dogs acquire more receptors to scents that they are exposed to frequently, which may help them to discriminate scent more easily, even in a complex scent environment.

Rattlesnakes and cactus (*Opuntia spp.*) also proved to be challenging during searches. Rattlesnakes were found basking in the burrow entrances and lying on the burrow mounds. Surprisingly, neither dog acknowledged the presence of any of the snakes we encountered. The dogs would investigate burrows by putting their noses down the burrow without hesitation. Adverse conditioning to rattlesnakes could improve a scent dog's reaction to snakes, but might also compromise their willingness to investigate burrows.

Beds of prickly pear cactus (*Opuntia spp.*) were initially difficult for the dogs to maneuver through, but they quickly learned how to avoid being stuck with spines. The smaller cactus such as pincushions (*Coryphantha spp.*) would be impossible to work among without protective boots for the dogs, simply because these cacti are not as visible as other cacti. If scent detection dogs are used at other reintroduction sites, a period of dog acclimation with sufficient time to detect potential problems should be undertaken prior to any search.

Management Implications

Scent detection dogs provide reintroduction site managers an additional method for monitoring populations of ferrets on reintroduction sites, in particular in areas where dispersal is probable. In determining presence or absence of ferrets, the use of detection dogs may be a better method than spotlighting based not only on efficiency, but accuracy as well. For reintroduction site monitoring programs limited by topographic features and/or access, detection dogs could provide a much more efficient way to cover areas that are presently being covered by backpack spotlighting. Using detection dogs has benefits that may become more important to reintroduction site managers as the need for intensive monitoring lessens.

In addition to less intensive monitoring, the desire for less invasive methods may increase. The effects of spotlighting on ferrets may influence behavior changes in response to the bright light. Campbell et al. (1985) conducted a pilot study to determine the effects of spotlighting on ferret behavior, but due to a small sample size, they could not conclude for certain that spotlighting influences behavior. It was however, suggested that exposure to the light does have an impact on behavior; the data shows that after exposure to the bright light the ferret's activity is reduced, possibly because of temporary "night blindness". Henderson et al. (1969) suggested that ferrets are disturbed by bright white light. However, Hillman (1968) describes ferrets as having little reaction to spotlighting. Impacts of spotlighting are probably minimal, but have not been thoroughly investigated.

Recommendations

Based on consultations with the dog handlers and general observations noted during all facets of this project, I highly recommend that scent dogs be trained in natural environments similar to those scheduled for searches. Training in a natural environment serves dog handlers two purposes: (1) it affords a chance to observe how a dog reacts to live ferret scent in the natural environment, and (2) it enables handlers to determine the level of distraction prairie dogs and other factors may create for a particular dog. While training in the natural environment, ferret scent should be presented with varying intensities of prairie dog scent. Exposing a dog to varying degrees of ferret scent presented with prairie dog scent closely simulates what a dog will encounter when searching a reintroduction site. Most importantly, dogs used for this type of work must be well-trained and evaluated prior to conducting testing or searching on prairie dog towns.

Timing of searches could influence efficiency and accuracy. If searches are conducted early in the day, the presence of distractions and fresh scent from prairie dogs are lessened. Seasonal timing of searches could also prove critical to efficiency and accuracy of a search. In fall when temperatures are cooler and ferret litters are dispersing, dog stamina would be optimized and more scent would be available to detect.

The use of detection dogs in studying rare or difficult-to-monitor species has many benefits to wildlife biologists. For species that are threatened or endangered, less invasive methods are preferred (Smith et al. 2003). Much information can be obtained about a population simply by identifying presence and, under certain situations, collecting scat. Many species may benefit from the use of less invasive methods, and in some instances, wildlife managers may find the method to be more efficient and economical.

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Appendices

Appendix A. Certification criteria for detection dogs used by Working Dogs for Conservation, Bozeman, Montana.

Working Dogs for Conservation Proficiency Test

Purpose:

1. Establish minimum standards of proficiency of a dog/handler team in the search for wildlife, wildlife feces, or other desirable scent article.
2. Map a dog/handler team's ability to work successfully with varying scent articles, terrain and vegetation cover, and scent article distribution (above/below ground). This will ensure that dog/handler teams will be appropriately matched to scent detection projects.

Intended Use for Proficiency Test:

Working Dogs for Conservation (WDC) will require that each dog/handler team pass the proficiency exam which best represents the search for which WDC has been contracted. There are three variables which are altered to create the most realistic testing scenario: scent article; terrain and vegetation cover; and scent placement (above or below ground). For example: WDC is contracted to locate San Joaquin kit fox scat in the arid, flat bottom valley near Bakersfield, California. WDC would set up an exam with contractor provided kit fox scat, in a flat field with some scrub, and scats would be located above ground. Modified in this manner, this test assures WDC and the contractor that the tested teams are field ready. Additionally, should the actual field conditions vary greatly from the testing scenario, WDC will re-examine teams in a more appropriate scenario. This creates the best opportunity for WDC and the contractor to conduct a successful field search.

Exam standards:

Type and amount of scent material used: Scent article will be of a natural size and in good condition. Testing articles may be from the same source as the training aids, but will not be the same aids used in training. If scent article must be in packaging to maintain structural integrity, then empty packaging will also be located in the testing area. There shall be not less than one and not more than three scent articles in the test area.

Search area: The search area should be no less than 50 meters by 50 meters. The evaluator shall select the size and location of the test area. Multiple teams testing on the same test area must wait 24 hours between teams. If an area is to be reused as a test area there must be 48 hours between use.

Scent article placement: The evaluator will place the aids in an appropriate location, based on the scent article type. If the article should be in a burrow, then the evaluator will dig a minimum of three "blank" burrows as well. Articles in burrows may be placed at a depth which simulates realistic location of scent article. Articles must be placed out a minimum of one hour prior to exam. Evaluator must walk entire testing area, to ensure equal contamination of the test area. Distracters (such as other types of scat, or roadkill) may be in the test area, but should not be excessive.

Time: Time limit will be determined by the evaluator based on size, terrain, and vegetation, but will not exceed one hour. The dog must maintain interest in the search for the duration of the exam.

Evaluation: Teams will either pass or fail. To pass a team must:

1. Locate all of the scent articles: The dog must alert to the article. If the handler sees the article prior to the dog's change of behavior the team should be issued another exam.
2. Alert: The alert must be passive. An aggressive response results in failing the test. The alert must be readable to the evaluator, yet the handler must "call" an alert. If a handler calls a false alert, the team fails the test.
3. Search plan: The handler must choose an appropriate search method and be able to defend the method to the evaluator. The search decisions include, but are not limited to: direction of travel, on or off lead work of the dog, and distance between search lines. The handler must be able to control the dog, and conduct a thorough search, in an energy and time efficient manner. Teams are allowed to research parts of the test area if they can defend their reasoning to the evaluator. Re-searching an entire test area just to "double check" is not acceptable.

Evaluator standards: Evaluators must be canine professionals, familiar with observing search behavior and alerts. WDC handlers may administer exam to other WDC dog/handler teams, or its sub-contractors. Evaluators will not question or otherwise distract dog/handler teams while conducting the search.

Note:
In the event that testing must occur in an area which may contain naturally deposited scent articles (e.g. conducting an exam near the field site where the search project is to be conducted) the team will not be failed for calling a false alert.

This exam is based upon certification and proficiency criteria for cadaver, explosive, and narcotic detection as evaluated by K-9 Specialty Search Associates, National Narcotics Detection Dog Association, and Eastern States Working Dog Association.

Appendix B. Background, Training, and Search Protocol used by Working Dogs for Conservation.

Working Dogs for Conservation

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We (WDC) are an affiliation of wildlife professionals committed to developing and furthering the training and use of canine/human teams for non-invasive scientific inquiry, conservation, and management.
WDC is associated with the Denver Zoological Foundation as a non-profit organization

Background: Increasing concern about the status of rare species and endangered populations has led to development of non-invasive methods for censusing, monitoring and research. Photographic traps, hair snag stations and fecal (scat) collection are examples of non-invasive sampling methods. Most useful may be scat and urine samples, which can be used to determine a species' presence/absence, relative abundance, food habits, parasite loads, habitat use, home range size and utilization. Endocrine extraction from samples can be used to determine the sex and reproductive status of individuals. DNA extraction from scats can identify species, population size, sex ratio, home range, paternity, and kinship.

Use of non-invasive approaches to obtain critical data requires that wildlife and/or their sign (e.g. scat, urine, hair, dens) can be easily located, yet detection can be difficult depending upon a species' range size and habitat types. WDC trains and uses canine/handler teams to differentiate and locate target species and/or their sign. The denning, hibernation and burrowing life history traits of some species make them excellent candidates for location by canine olfaction. Over the past decades, dogs have been trained to successfully detect a variety of wildlife species including seals, fox, turtles, snakes, birds, black-footed ferrets, termites and bears. WDC aims to expand upon these detection endeavors by increasing applications for wildlife detection dogs and quantifying detection and discrimination performance in a scientifically rigorous manner.

WDC's canine/handler teams are trained to locate target wildlife and/or detect and collect their sign for research and conservation projects. We have been involved in the design and implementing of projects, training canine/handler teams, presentations, data analysis and report/manuscript writing. Our sampling has been used for monitoring, mark recapture estimates, physiological analyses, forensics and disease investigations.

Dog selection and training: Dogs are selected based upon their ability and willingness to work. Adequate obedience and training allow dogs to maintain focus when subjected to a variety of stressful, or tempting distractions such as flushed wildlife, busy roadways, observers, baited hair snag and trapping stations, and domestic animals (e.g. livestock/herding dogs). Our dogs are trained and comfortable being transported by car, truck, boat, plane and helicopter. Because dogs pique public curiosity, we require our dogs be well-socialized ambassadors for working dogs.

Using modified narcotic, forensic, and search and rescue techniques, we condition dogs to associate the odor of a target object with a highly prized reward. Initially, dogs are chosen for testing based upon an intense focus on a toy or food that is subsequently used as a reward. The dogs are at least one year old, capable of demonstrating consistent concentration, and have a high degree of body flexibility and agility. Training begins with scent introduction in enclosed scent boxes and proceeds to handler-blind field simulations. The dogs alert to target odors with a passive response and do not contact the sample. Dogs are trained off of non-target scents, and other wildlife. For example, if dogs are trained to locate wolf scats they will not alert on coyote or fox scats. In our kit fox scat searches, the dogs have proven 100% successful at discriminating between kit fox and sympatric red fox and coyote.

Projects:

2003 **-** Black-footed ferret presence/absence detection in collaboration with South Dakota State University, U.S. Fish and Wildlife Service, U.S. Forest Service and the Black-footed Ferret Foundation. Kit fox scat searches in collaboration with University of Washington and Smithsonian Institution. Discrimination scent-testing workshop with Russian based Amur Tiger Scent Dog Monitoring Project and Save the Tiger Fund. Desert tortoise detection (preliminary training and testing) in collaboration with the University of Redlands and the Desert Research Institute. Canine/handler training workshops. Red and grey fox scat searches in collaboration with the United States Geologic Survey.

2002 **-**Forensic search for illegally killed and snow-buried wolves in collaboration with United States Fish and Wildlife Service Law Enforcement, Montana State Fish, Wildlife and Parks. Kit fox natal den searches in collaboration with University of Washington and Smithsonian Institution.

2001 **-** Black-footed ferret presence detection in collaboration with United States Fish and Wildlife Service. Discrimination scent-testing between kit and red fox scats in collaboration with University of Washington, Smithsonian Institution, and Packleader Dog Training. Lynx scat searches in collaboration with United States Forest Service. Expansion of kit fox scat research project in collaboration with University of Washington, Smithsonian Institution, California State University, and Stanislaus'Endangered Species Recovery Program.

2000 – Kit fox scat searches in collaboration with University of Washington and Smithsonian Institution. Discrimination scent-testing between grizzly and black bear scats in collaboration with University of Montana and Packleader Dog Training.

Publications:

Smith, D., K. Ralls, A. Hurt, B. Adams, M. Parker, B. Davenport, MC Smith, JE Maldonado 2002. Detection and accuracy rates of dogs trained to find scats of San Joaquin kit foxes (*Vulpes macrotis mutica)* Animal Conservation (2003) **6**, 339-346

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Appendix C. Disease protocol established by the Black-Footed Ferret Conservation Center to be implemented by Working Dogs for Conservation during Pilot Study B and Final Field Test.

In order to reduce/avoid the spread or transfer of canine distemper and/or plague, all dogs certified to search for black-footed ferrets will be required to follow the disease protocol outlined below.

I. Prior to searching a reintroduction site, every dog will undergo the following:

a. Either have documentation of a current vaccination for canine distemper (non-live vaccine), or be administered the vaccine one month prior to searching a prairie-dog town.
b. Full-body dusting with Carbaryl (Sevin) powder. Powder may be reapplied between towns when more than one town is searched in a day.
c. Health examination by Working Dogs for Conservation (WDC) animal care and use committee veterinarians and/or certified veterinary technologist, Alice Whitelaw (WDC).

II. Both prior and upon completion of each town search, all equipment, including leashes, kennels, and food dishes, etc., will be thoroughly disinfected.