Black-Footed Ferret Field Operations Manual

June 15, 2016

U.S. Fish and Wildlife Service
Black-footed Ferret Recovery Program

Guidance and Coordination Regarding Permit Provisions

Purpose of this Black-footed Ferret Field Operations Manual (BFFFOM)

This document provides guidance to parties holding current U.S. Fish and Wildlife Service (Service) permits to work with black-footed ferrets (Mustela nigripes; hereafter, BFF) during field operations involving reintroduction and management efforts. The BFFFOM and ongoing consultations with the Service are intended to address specific coordination needs between the Service BFF Recovery Program and permit holders, but both of these efforts remain subject to more general permit revisions.

Acknowledgements

This document was drafted by Travis Livieri (Prairie Wildlife Research) at the contract request of the Service based on his extensive knowledge and experience with black-footed ferret management. The content of the final document (provided as of June 15, 2016 but likely to be periodically revised) is solely a product of the Service's BFF Recovery program for which no other parties are responsible. The BFFFOM benefited greatly from review and contributions from many partners actively involved in BFF recovery. Photographs are credited. The cover photo was by Travis Livieri.

Coordination with the Service

At the present time the primary Service contact for all BFF field-related activities is John Hughes; questions regarding techniques and procedures described in the BFFFOM, permit requirements, and general BFF management and recovery activities should be directed to Mr. Hughes at john_hughes@fws.gov or (970) 897-2730 x229 (office) or (970) 305-1158 (mobile).

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Approved USFWS Black-footed Ferret Recovery Coordinator

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Chapter 1
Evaluating a Potential Black-Footed Ferret Release Site

This section discusses techniques for monitoring the distribution, size and density of prairie dog colonies within a black-footed ferret (*Mustela nigripes*) reintroduction site. Techniques for monitoring prairie dogs (*Cynomys* spp.) at a county, regional, statewide or range-wide scale are available and recommended by McDonald et al. (2011). Habitat quality is related to the success of a black-footed ferret reintroduction; thus, measures of prairie dog colony distribution, size and density are important factors when evaluating a site. Prior to administrative procedures to establish a site (e.g., Safe Harbor Agreement, Section 10(a)(1)(A) permit, Section 10(j) non-essential experimental designation) and submitting a black-footed ferret allocation request to the U.S. Fish and Wildlife Service (hereafter, Service), site managers should evaluate the potential release site(s) by mapping the colony boundaries and estimating prairie dog densities within the colonies. Colony distribution, size and density should be used to calculate a Ferret Family Rating (FFR; Biggins et al. 1993, 2006a) that allows for an objective comparison of habitat quality with other sites. The summary for evaluating black-footed ferret habitat, adapted from Biggins et al. (2006a), is:

1. Map and estimate the size of prairie dog colonies using Global Positioning Systems (GPS) and Geographic Information Systems (GIS).
2. Circumscribe the prairie dog colony complex and calculate the percentage occupied by prairie dog colonies.
3. Estimate prairie dog densities on colonies by using burrow density strip transects or visual counts.
4. Calculate Ferret Family Ratings for the complex.

Mapping and Estimating the Sizes of Prairie Dog Colonies

The first question that is often asked about a potential black-footed ferret reintroduction site is “how many acres of prairie dogs are at the site?” Some agencies map prairie dog colonies on a regular basis and those data may be available to provide a recent estimate or a starting point of where to look for prairie dog colonies. Remote sensing techniques have been used to map and estimate black-tailed prairie dog (*Cynomys ludovicianus*) colonies (Dalsted et al. 1981, Schenbeck and Myhre 1986, Sidle et al. 2002) and readily accessible tools like Google Earth (http://www.google.com/intl/en/earth/) can be used to initially estimate size and location of prairie dog colonies (Figures 1-3). Results from remote sensing techniques can guide ground mapping efforts. Remote sensing images generally cannot be used to determine if a prairie dog colony is active or inactive (e.g., prairie dogs removed by plague or poisoning) because burrows may continue to appear active for quite some time after prairie dogs become absent (Sidle et al. 2012). White-tailed prairie dog (*Cynomys leucurus*) and Gunnison’s prairie dog (*Cynomys gunnisoni*) colonies often have prominent shrubs and ant hills that obscure or mimic burrow mounds, necessitating ground-truthing. Use of remote sensing technologies for the purposes of evaluating

Figure 1. Google Earth imagery with black-tailed prairie dog colony in Colorado estimated (white line) using burrows (white stipples).

Figure 2. Google Earth imagery with white-tailed prairie dog colony in Wyoming estimated (white line) using burrows (light colored patches).

prairie dog colonies for black-footed ferret reintroduction should be considered a rudimentary initial step in the overall evaluation process. For instance, use of remotely sensed images, such as Google Earth, are very useful in initially identifying areas that may be occupied by prairie dogs and provide a rough approximation of how many acres of potential habitat are available. Use caution when interpreting such images and consider the quality and age of the images, which may vary between areas and even within an area. Black-tailed prairie dog colonies are usually more apparent on remotely-sensed images than white-tailed or Gunnison's prairie dogs. Aircraft can also be used to readily locate prairie dog colonies which can guide ground mapping efforts. Unmanned aerial vehicles (UAVs or drones) may provide a tool to map prairie dog colonies and burrows but extensive testing will need to be completed to assess the accuracy and precision of those estimates.

Figure 3. Google Earth imagery with Gunnison's prairie dog colony in New Mexico estimated (white line) using burrows (white stipples).

Mapping colonies on the ground using GPS. It is preferred that prairie dog colony boundaries are mapped using GPS to provide a higher degree of accuracy than remotely sensed images. Mapping can occur from a truck, all-terrain vehicle (ATV) or on foot, with the objective of tracing the colony edges. For the purposes of black-footed ferret recovery, a prairie dog colony is defined as an aggregation of actively occupied prairie dog burrows $\geq$20 burrows per hectare and $\geq$5 hectares in size ($\geq$8 burrows per acre and $\geq$2 acres in size; Biggins et al. 1993). It is often helpful to conduct reconnaissance prior to mapping to detect any places where difficulties may arise while mapping (e.g., if and where to cross a drainage).

The boundary of the prairie dog colony should be mapped as the outermost active burrow entrances/openings using a GPS unit. Active burrows typically are not overgrown with vegetation, have well-traveled burrow opening entrances and fresh prairie dog scat with 1 meter of the burrow mound. A survey-grade (e.g., Trimble) or consumer-grade (e.g., Garmin) GPS unit can be used to generate polygons, lines or tracks to record the colony edges. Black-tailed prairie dog colonies typically have an apparent vegetation clip line, where the taller vegetation would represent areas not normally used by prairie dogs. Mappers should primarily use the outermost active burrows as a guide for the colony perimeter but the clip line can aid in defining the perimeter (Biggins et al. 2006b). Outlying burrows that do not appear to be obviously connected to the colony should be ignored because their inclusion could also include significant area that is not colony. White-tailed and Gunnison's prairie dog colonies usually will not have an apparent vegetation clip line and mappers must rely exclusively on the outermost burrows. While mapping, try to exclude areas that are not prairie dog habitat (e.g., stock dams, stream beds, rock outcrops, shrubbery stands), but if such non-habitat areas are completely surrounded by the colony then map it separately later as an exclusion. During wet years, there may be situations in large colonies where low-lying areas are abandoned by prairie dogs creating "patchiness" within the colony boundary. After mapping the colony perimeter, it may be useful to then map the empty patches within the interior of the colony and later clipping those out when post-processing the data. GPS data should be imported into a GIS environment for post-processing, correction of errors, removal of non-habitat and calculation of colony area. Mapping should be conducted prior to density estimation and ideally occur during the same time period on an annual basis (i.e., June – August each year).

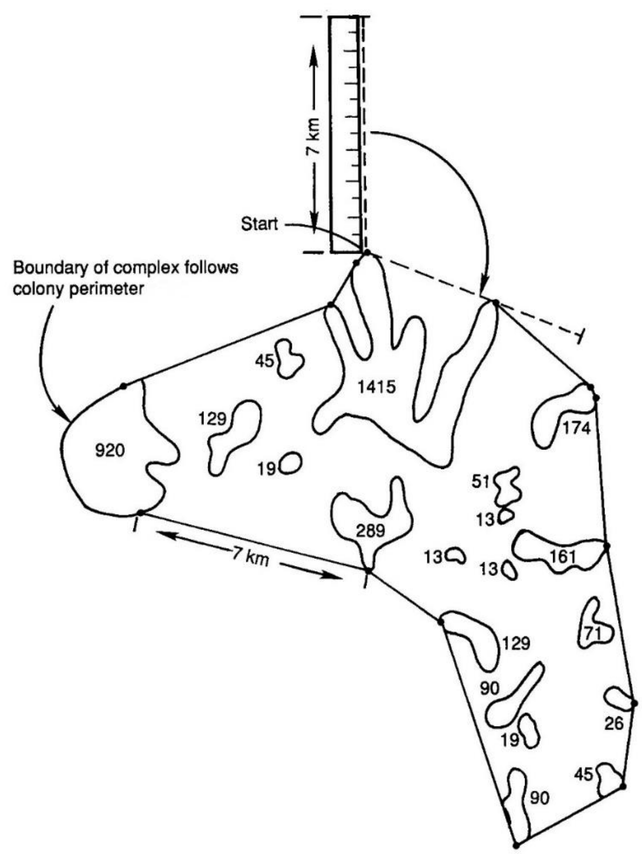

Figure 4. The concept of circumscribing a 7-km prairie dog complex (from Biggins et al. 1993).

Circumscribing the Prairie Dog Colony Complex

A prairie dog colony complex represents the basic management unit of black-footed ferret recovery and is defined as a group of prairie dog colonies distributed so that black-footed ferrets can migrate among them commonly and frequently (Forrest et al. 1985). A prairie dog colony subcomplex is a smaller unit within a larger complex. The inter-colony distances of 7-km and 1.5-km are used to determine which colonies are included in a complex and subcomplex, respectively, based upon recorded black-footed ferret movements (Biggins et al. 1993, 2006a). The process is described in detail by Biggins et al. (1993, 2006a) and utilizes a 7-km or 1.5-km segment to pivot around the colonies (Figure 4). After the colonies are mapped with a GPS and imported into a GIS, the colonies included within a complex can be determined rather quickly by buffering all colonies from the edge by distances of 3.5 km and 0.75 km (Figure 5). The circumscription method described by Biggins et al. (1993; Figure 4) can be used to create a polygon in GIS and calculate the percentage of the complex occupied by prairie dog colonies by subtracting the sum of the area of all prairie dog colonies from the area of the complex polygon (Figure 6). Percentage of the complex occupied by prairie dog colonies provides a relative measure of colony spatial spread.

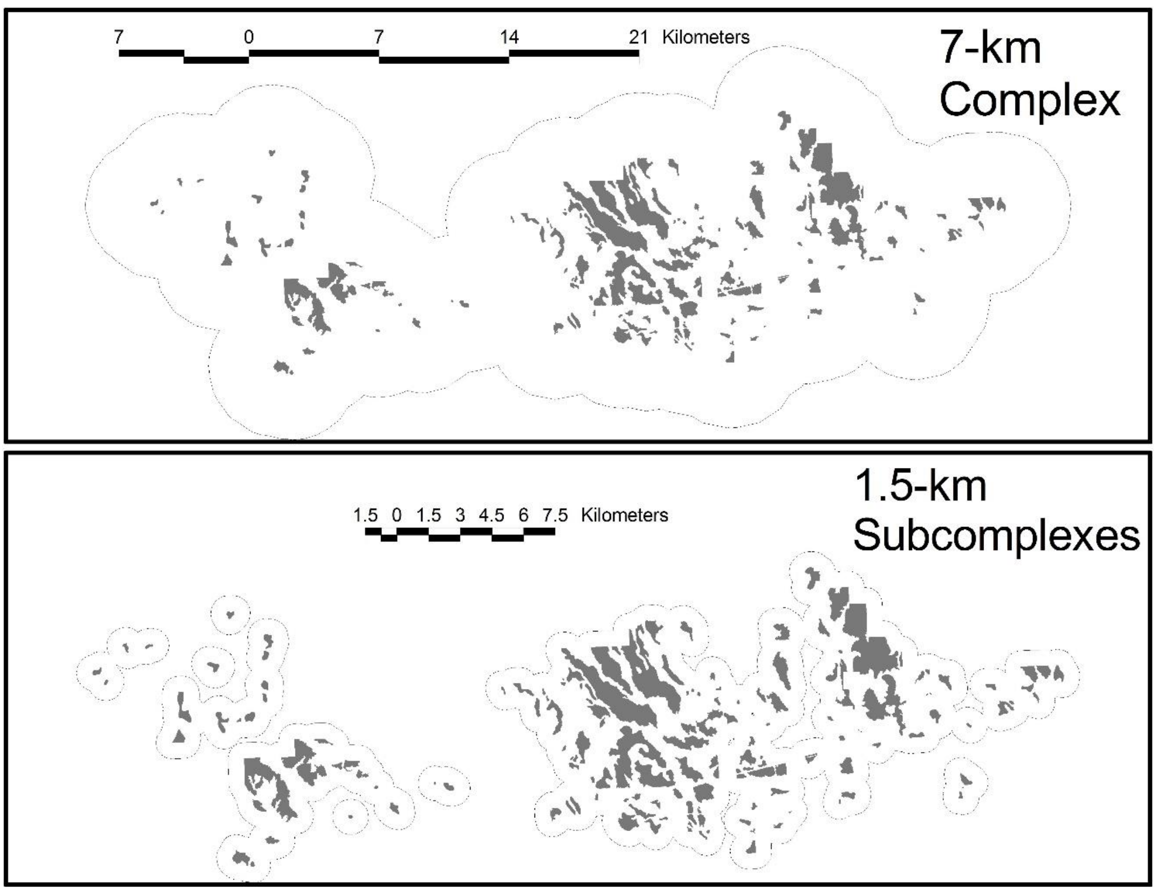

Figure 5. Examples of prairie dog colonies buffered in a GIS by 3.5 km and 0.75 km to circumscribe a 7-km complex and 1.5-km subcomplexes.

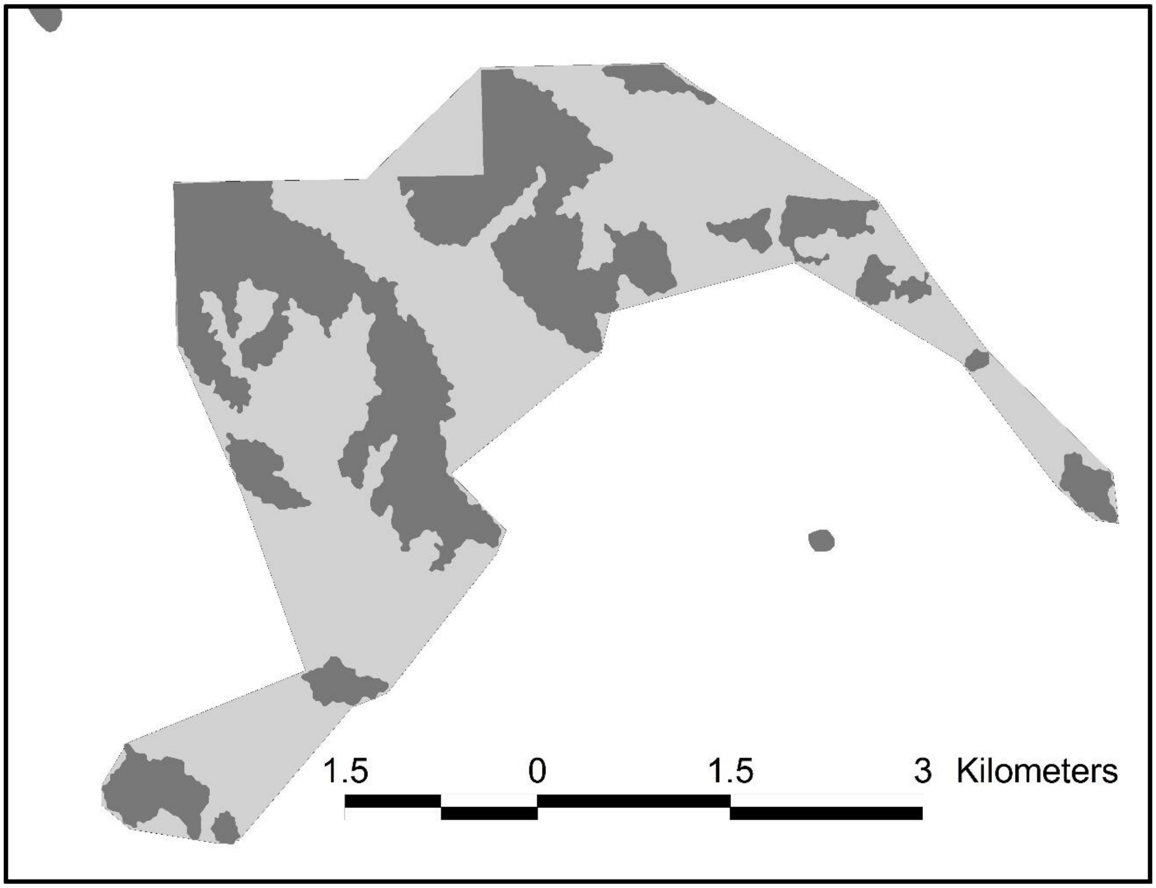

Figure 6. Example of a circumscribed 1.5-km subcomplex using GIS to create a polygon with segments ≤1.5-km. The dark areas are prairie dog colonies and the lighter area is the 1.5-km subcomplex. This can be used to calculate the percentage of the subcomplex occupied by prairie dogs. In this case 37.6% of the subcomplex is occupied by prairie dog colonies (592.3 ha of prairie dog colony within 1,574.8 ha subcomplex).

Estimating Densities of Prairie Dogs

The objective of estimating prairie dog densities described here is for the purposes of estimating the total population of prairie dogs to calculate a Ferret Family Rating for comparison with other sites. The methods recommended to accomplish these objectives may not be suitable for other objectives (e.g., prairie dog research). Three methods are commonly used to estimate densities of prairie dogs at black-footed ferret reintroduction sites; capture-mark-recapture (CMR), visual counts, and burrow counts (Biggins et al. 2006b). CMR methodology may provide the most accurate estimate of prairie dog density but is also the most labor-intensive and costly, hence we do not recommend CMR for estimating prairie dog densities for the purposes of black-footed ferret reintroduction. However, if there are other objectives that require the use of CMR then CMR data may be helpful in evaluating a site. For more information on CMR methods with prairie dogs see Fagerstone and Biggins 1986, Menkens and Anderson 1993, and Magle et al. 2007.

Visual counts. Visual counts of prairie dogs to estimate densities generally entail directly counting the number of prairie dogs observed within a plot of known size using binoculars and from an elevated vantage point (Figures 7, 8). Pin flags, stakes and other visible objects can be used to delineate the plot boundaries. Plots are counted during times of known high prairie dog activity (morning and late afternoon) and repeatedly counted over several consecutive days (recommended 3 or more days) under similar weather conditions. The maximum count per plot is then used as the single value for each plot to estimate the prairie dog density. Sizes of plots are typically 4 hectares but can vary depending on objectives and local conditions (e.g., topography). Counts can be conducted from a corner, edge or center of a plot. For detailed methodology see Fagerstone and Biggins 1986, Menkens et al. 1990, and Severson and Plumb 1998.

Figure 7. Visual counting of black-tailed prairie dogs from an elevated platform in South Dakota. Photo by Travis Livieri.

Figure 8. Visual counting of black-tailed prairie dogs from the bed of a pickup truck in Kansas. Photo by Travis Livieri.

Visual counts provide a direct index because the prairie dogs are being counted, whereas burrow counts (see below) are an indirect index to prairie dog densities. Drawbacks of visual counts include limited area that can be effectively counted and extrinsic influences that reduce prairie dog activity, including weather, presence of predators, humans or vehicles. Visual counts are more difficult to incorporate into FFR. For a discussion on the relative merits of visual counts and burrow counts see Biggins et al. (2006b).

Burrow density strip transects. Prairie dog density can also be estimated by counting burrows as an index to prairie dog density. Strip transects can be used to sample prairie dog burrows on colonies (Figures 9, 10) and have several advantages over visual counts. First, burrow counts are less affected by weather, human, or animal activity. Second, burrow counts are easier to employ over a large area compared to visual counts. Detailed methods for burrow counts using strip transects are described in Biggins et al. (1993, 2006a) and further suggestions are provided here:

- Construct a 3-meter pole, using PVC conduit, with telescoping pieces that fit inside each other and held together by clevis pins. The 3-meter pole can be attached to a backpack, if transecting on foot, or to the front rack of an ATV (Figures 11, 12).
- A GPS unit can be used to measure distance and maintain straight, unbiased lines. Transects can be pre-determined on a GIS and uploaded into a GPS for use in the field. Transects in the cardinal directions (N-S, E-W) can be kept straight and unbiased by keeping a constant coordinate for each transect (e.g., if transecting N-S then keep the Easting coordinate constant per transect).
- Wider transect spacing will reduce transecting effort but also reduce the proportion of the area transected; thus density estimates will tend to have increased variability. Include transect spacing and % of the colony/complex sampled when reporting results.
- If possible, use a GPS to map the transect lines and the burrows within each transect. These data can be used to create a density grid map.

Other activities, such as dusting prairie dog burrows (see Chapter 2), may require counting of burrows and those data can be used to estimate or calculate burrow densities (see Griebel 2014 for an example) and map prairie dog colonies (Eads et al. 2011a, 2011b).

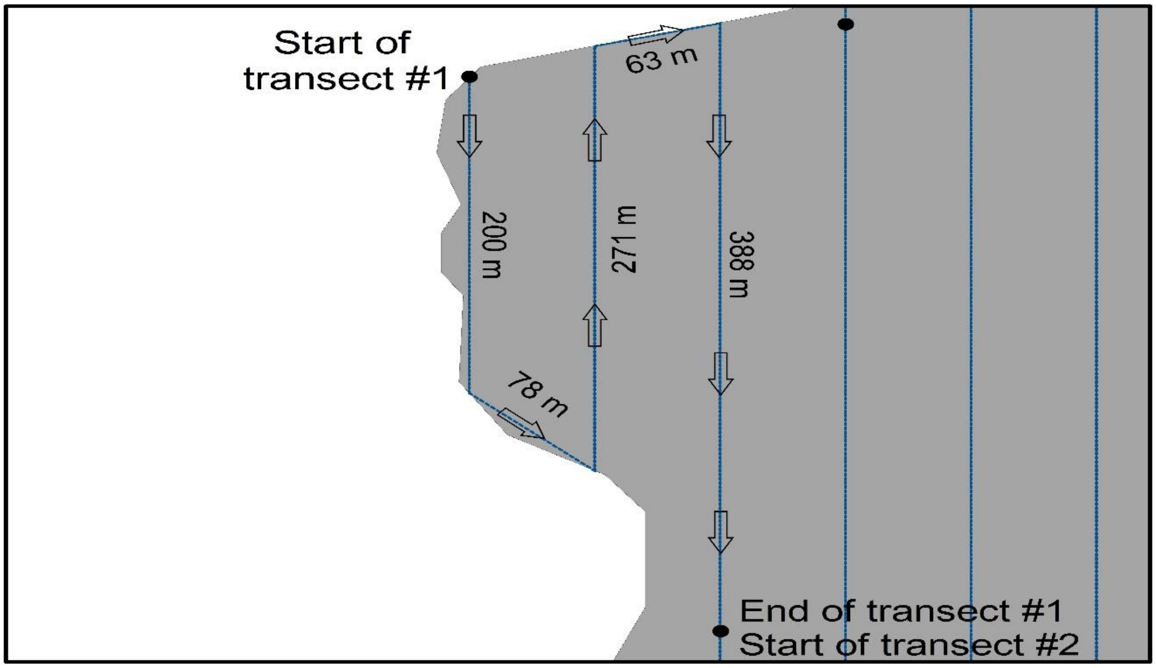

Figure 9. Example of how to use burrow strip transects. Transects can be continued during the spacing move (Biggins et al. 1993) but observers must ensure transects are still completely within the colony during the spacing move. In the above example all segment lengths add up to 1,000 m and transects are spaced 60 m apart.

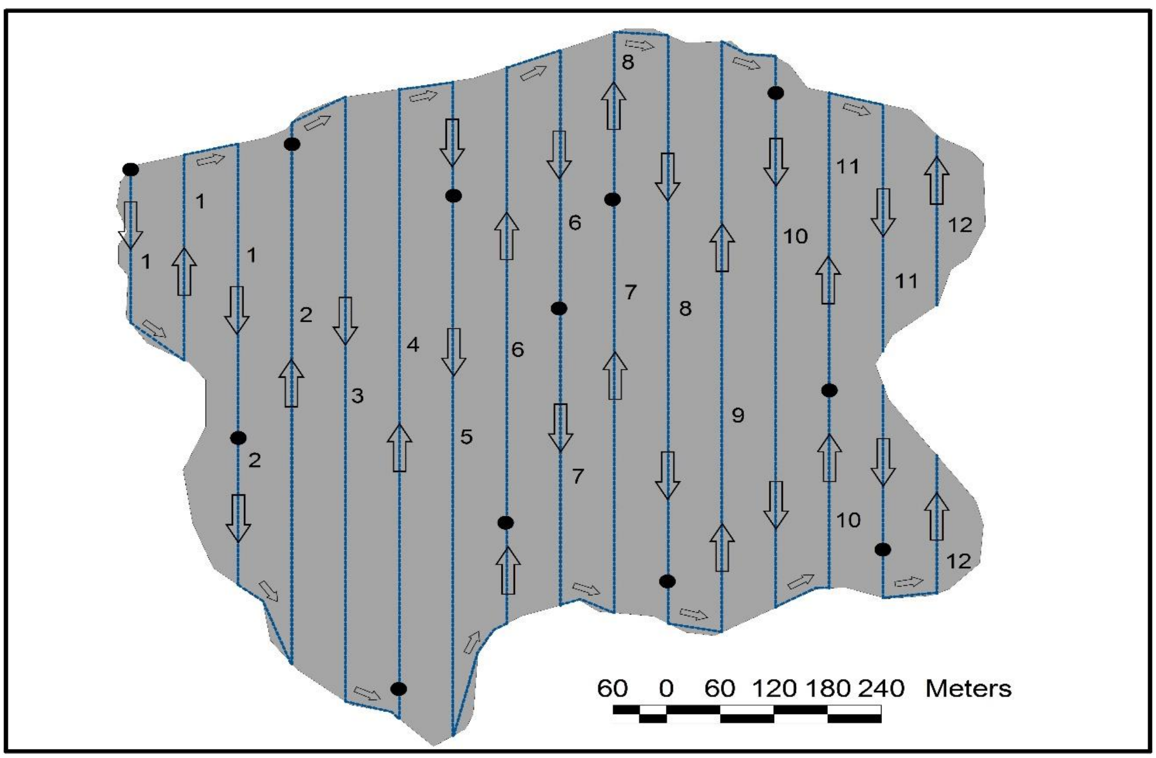

Figure 10. Example of burrow strip transects on a prairie dog colony. The colony is 62.9 ha (155.4 acres) and required 12 transects to sample at 5% (60 m spacing between transects). Each transect is 1,000 m long with the exception of the 12^{th} transect (528 m).

Figure 11. Burrow strip transect conducted on foot with a GPS unit in Colorado. Photo by Travis Livieri.

Figure 12. Burrow strip transecting from an ATV with a GPS unit in Colorado. Photo by Travis Livieri.

Calculating a Ferret Family Rating

Follow the detailed instructions of Biggins et al. (1993, 2006a) to calculate a Ferret Family Rating for prairie dog complexes and subcomplexes. If the estimated prairie dog density on a colony is ≥18 prairie dogs/ha then refer to the territoriality adjustments in Biggins et al. (2006a). The FFR is a relative number used to compare the suitability of prairie dog complexes for black-footed ferret reintroduction. Do not interpret the FFR as an absolute measure of how many ferrets can be expected to occupy a given complex. In some cases, personnel may elect to release more ferrets than suggested by the FFR, allowing ferrets to behaviorally determine habitat carrying capacity, which is often less than the FFR but can exceed the FFR in some cases. When reporting the results of mapping, prairie dog densities and FFRs to the Service it is suggested to include a summary spreadsheet of prairie dog colony area, estimated density, and FFR calculations. The Service can provide a template spreadsheet if needed.

Minimum Standards for Evaluating a Release Site

- Map prairie dog colonies on the ground with GPS units.
- Estimate prairie dog densities using burrow strip transects (preferred) or visual counts.
- Use prairie dog colony sizes and estimated prairie dog densities to calculate a Ferret Family Rating and report these numbers to the Service.

Chapter 2
Monitoring and Managing Black-Footed Ferret Habitat

This section includes information about ongoing or periodic site management methods to be employed after the initial evaluation of a release site. All black-footed ferret reintroduction sites, regardless of when ferrets will be or have been released on them, should have a habitat monitoring and management plan that will contribute to persistence of black-footed ferrets on those sites.

Monitoring of Prairie Dogs at a Black-footed Ferret Recovery Site

After the initial assessment of a prairie dog complex (Chapter 1) site managers do not need to routinely map or estimate densities of prairie dogs annually. The Service recommends mapping and density estimation every 2-3 years unless stochastic events such as drought or plague may be influencing colony acreage and densities. Site managers should, at a minimum, make a qualitative visual assessment of the colony acreage and density on an annual basis and advise the Service (e.g., numbers of acres increased over last year and densities decreased). At times the Service may need accurate measures of ferret-occupied colony sizes and densities for Endangered Species Act (ESA) review and will advise site managers if and when such data are needed.

Shooting Prairie Dogs

Prairie dog shooting should not be allowed on a black-footed ferret reintroduction site. The Service recognizes that shooting is regulated by individual states, tribes, and landowners. However, prairie dog shooting negatively impacts prairie dog populations (Reeve and Vosburgh 2006, Pauli and Buskirk 2007a) and thus decreases the quality of black-footed ferret habitat. Shooting also results in lead fragments in prairie dog carcasses and an increased probability of lead poisoning in prairie dog scavengers, including ferrets (Pauli and Buskirk 2007b). If shooting does occur near a ferret reintroduction site then non-toxic ammunition should be used. Shooting mortality of ferrets has not been documented but is possible. If shooting does occur on a site then seasonal closures may reduce the severity of negative impacts. Several factors influence the persistence and health of prairie dog populations, including: forage availability, precipitation, plague, predation, shooting and poisoning. Of these factors, site managers can directly regulate both shooting and poisoning; therefore these tools should only be used cautiously and sparingly, if at all.

Poisoning and Toxicant Use

Use of toxicants is typically not permitted within active reintroduction sites, but may be conducted within areas adjacent to reintroduction sites. Use of toxicants within reintroduction sites is not recommended by the Service. In those cases in which a toxicant must be used, the safest toxicant in terms of secondary poisoning effects on ferrets is zinc phosphide (Hill and Carpenter 1982, Matschke et al. 1992). Other poisons such as aluminum phosphide, chlorophacinone and diphacinone are not recommended for use in areas where black-footed ferrets are known to be present due to their known secondary poisoning impacts (Witmer et al. 2016). Similar to shooting, poisoning can be regulated by site managers and should only be used cautiously and sparingly, if at all. Contact the Service prior to any poisoning activities on a reintroduction site.

Disease Surveillance

Canine distemper. Black-footed ferrets are very susceptible to canine distemper virus (CDV) and management of this disease is important for black-footed ferret recovery. CDV is a morbillivirus in the family Paramyxoviridae and exists worldwide in carnivores, including domestic dogs (Deem et al. 2000). CDV exists naturally in wild carnivores and is likely present within some carnivores at all black-footed ferret reintroduction sites. Monitoring of CDV, for the purposes of black-footed ferret recovery, can be accomplished through serology of other carnivores in the area (see **Carnivore serology** below) but is not a high priority. Currently, managing CDV in the wild is not possible; however, we can manage CDV from human sources. Anyone working with black-footed ferrets should be aware of CDV and how it may be inadvertently transported by humans. CDV is primarily transmitted by respiratory aerosol, direct contact and fomites (inanimate objects including, but not limited to, clothing and equipment). Ask field workers and survey participants, prior to any field work with black-footed ferrets, if they have come into contact with any stray carnivores (including unvaccinated domestic dogs or recently vaccinated dogs) or potentially have been exposed to CDV. Use Nolvasan® (chlorhexidine diacetate) solution to disinfect any fomites that potentially came into contact with CDV and pay close attention to the soles of footwear. There is only one CDV vaccine approved for use in black-footed ferrets (PureVax® Ferret Distemper by Merial). Other canine distemper vaccines, while safe for domestic ferrets (*Mustela putorius furo*), may be fatal for black-footed ferrets. **A modified-live virus CDV vaccine should not be used with black-footed ferrets. Consult with the Service prior to any vaccinations of black-footed ferrets.**

Sylvatic plague. Sylvatic plague is a non-native disease, caused by the bacterium *Yersinia pestis,* transmitted primarily by fleas, and fatal to prairie dogs and black-footed ferrets. Much of our current knowledge about plague is reviewed by Abbott and Rocke (2012) and it is recommended that site managers review this document.

Management of plague at reintroduction sites is a high priority for the Service and at present several tools are available. Plague exists across the western half of North America and has affected most, if not all, reintroduction sites. It may be safe to assume for all prairie dog complexes that plague is present in the greater ecosystem at some level. While chronic, enzootic plague (between outbreaks) is difficult to detect in the absence of intensive trapping efforts (Biggins et al. 2010, Matchett et al. 2010), several tools are available to determine if plague is present in an area at an epizootic (outbreak) level. If a complex of prairie dogs is experiencing a plague epizootic then immediate measures must be taken if the area is to be preserved for black-footed ferret reintroduction; thus determining the status of plague in an area is very important. We recommend using several tools simultaneously to gather evidence for determining if epizootic plague is present; windshield surveys, submitting carcasses for testing, carnivore serology and burrow swabbing for fleas.

Windshield surveys. The first tool, windshield surveys, is simply visiting prairie dog colonies and looking for the presence/absence of prairie dogs and burrow activity. Colonies should be visited during daylight hours when prairie dogs are typically active and weather/season minimally affect activity (e.g., not hibernating or inclement weather).

Use binoculars and spotting scopes to visually detect prairie dogs. Use a GPS or map to keep track of the survey route. Also inspect prairie dog burrows for signs of activity. Inactive burrows may have vegetation growing on the mound, partially collapsed entrances, crusted soils, and a lack of fresh prairie dog scat. Active burrows typically are not overgrown with vegetation, have well-traveled burrow opening entrances and fresh prairie dog scat within 1 meter of the burrow mound. If prairie dogs are absent and more inactive burrows are found than expected then plague should be suspected. Follow-up visits should be made at similar times and conditions to verify or refute any initial observations of decreased prairie dog numbers and activity. Windshield surveys alone are not enough to confirm the presence of a plague epizootic. Surveys should be conducted at regular intervals and detailed notes kept because the effects of plague may be absent during one survey, but readily apparent during the next.

Collecting a carcass for disease testing. Carcasses of prairie dogs and other small mammals may be useful for surveillance of plague and other diseases. If any dead wildlife are encountered in the field (Figure 13) and the observer can safely collect the carcass, then strict protocols should be followed to collect and submit the carcass for disease testing.

- Even carcasses that appear to be scavenged or when the cause of death is assumed (predation) can be important. Carcasses can be collected in the field and placed in a cooler or freezer upon return to the office.
- Use disposable gloves and an inverted bag technique (i.e. turn a bag inside-out, put your hand inside the bag and use the inside-out bag to pick up the carcass before folding the bag right-side in over the carcass and then use a second bag to double-bag the carcass). Tape the bags closed.
- Label the sample with date, location, GPS coordinates, county, state, collector, species, and any relevant notes. Veterinary diagnostic laboratories cannot accept unlabeled carcasses.
- If the carcass will be submitted for necropsy the same day then transport the carcass in a cooler with ice-packs. If it is unknown when necropsy will take place or if it will be >24 hours then place the double bagged carcass in a specimen/evidence freezer. **Never place a carcass in a cooler or freezer containing human food.**
- Contact the Service immediately for instructions on where to submit a carcass.
- Be careful of contacting the specimen or fluids with your skin. Inspect your skin and clothing for any fleas that may have left the carcass. Many human cases of plague occur when a human contacts a carcass. If anyone who came into contact with the carcass feels ill then seek immediate medical attention and inform the attending physician of the potential for plague.

Figure 13. Spotted ground squirrel (*Spermophilus spilosoma*) found on a black-tailed prairie dog colony during burrow counts in Colorado. Photo by Steve Forrest.

Carnivore serology. Several carnivore species, including coyotes (*Canis latrans*) and badgers (*Taxidea taxus*), that are common in the prairie dog ecosystem are at least partially resistant to plague and often develop protective titers toward the disease. These titers can be detected in freshly collected blood with a Nobuto strip (Wolff and Hudson 1974). When handling any dead animal or fluid follow the safety guidelines presented above. In some cases there may already be predator collection conducted in the area for other reasons and serology data may be readily available through state agencies or the U.S. Department of Agriculture – Wildlife Services. An animal with a positive titer for plague indicates that it was exposed to the disease previously; however, it cannot be determined when the animal was exposed and whether or not it can serve as a source of infection. A lateral flow test for field use will soon be available for trained personnel to rapidly determine plague exposure from blood or serum (Abbott et al. 2014). In addition to windshield surveys of prairie dogs, sero-surveillance of carnivores is one of the most efficient methods for monitoring epizootic plague in an area (Gage et al. 1994). Prevalence of plague in local carnivores is a useful indicator of relative plague activity. For instance, if plague seroprevalence in carnivores collected from a particular county increased from 12% to 85% in a 2 year period then a plague epizootic may have occurred in the area. Badgers might serve as ideal “sentinels” when using carnivore sero-surveillance because they can easily excavate prairie dog burrows and quickly locate prairie dog carcasses.

Swabbing burrows. Fleas can be collected directly from prairie dog burrows with a swab and submitted for plague testing (Figure 14; Ubico et al. 1988). This approach is highly useful during ongoing outbreaks; as hosts die from plague, fleas jump from the carcasses and seek burrow openings in pursuit of living hosts, thereby providing field biologists with increased opportunities to collect and test fleas. Prairie dog fleas rarely feed on humans, but even rare instances of biting can lead to fatal plague cases. Extra caution should be taken when swabbing burrows for fleas by wearing long sleeves, light colored clothing, sealing pant and sleeve cuffs and wearing insect repellent (Figure 14).

When using burrow swabbing for plague surveillance, it may prove useful to sample particular types of burrow openings. For instance, fleas tend to be most abundant in burrows recently used by prairie dogs (e.g. with relatively fresh scat) and in tunnels connected to “dome” and “crater” burrow mounds (D. Eads, unpubl. data). Use a plumbers snake with a 12”x12” piece of white flannel cloth attached. Push the flannel cloth as deep as possible into the selected burrow and move it in/out to simulate movement by a prairie dog. After the maximum depth is reached, pull the swab upward through the burrow tunnel at a moderate pace. Remove the flannel cloth and immediately place into a large, clear plastic bag with a sliding lock, flattening the cloth so it can be inspected for fleas. Regardless of flea presence or absence, label the sealed bag with date, time, location and collector. Store the bags in a cool, dry place and freeze when possible to kill all ectoparasites.

Later, under controlled conditions, remove dead fleas, ticks, and other invertebrates from a swab and place into a vial with alcohol. Next, pour out any remaining contents of the Ziploc bag onto a sheet of white paper and inspect the material for additional fleas or invertebrates. Store the remaining specimens with those collected from the swab and label the associated vial with the date, time, and location of initial field sampling. Machine wash swabs between use to remove mud and any missed fleas or parasites. Several different methods are available to test fleas for plague. Site managers should contact the Service to find out where to submit fleas for plague testing.

Figure 14. Swabbing a black-tailed prairie dog burrows for fleas in South Dakota. Ideally this person would have worn a light-colored top with taped cuffs. Photo by Dan Licht.

Disease Management

Dusting burrows. Insecticides have been applied to prairie dog burrows to kill fleas since the 1970’s. Several different chemicals have been applied to prairie dog burrows or prairie dogs themselves to slow or halt plague, including but not limited to: carbaryl (Barnes et al. 1972), permethrin (Beard et al. 1992), deltamethrin (Seery et al.

2003, Biggins et al. 2010, Matchett et al. 2010), and imidacloprid (Jachowski et al. 2011). These insecticides usually come in dust form and are applied to burrows using specialized mechanical dusters (Figure 15). Imidacloprid baits have also been tested with limited effectiveness (Jachowski et al. 2011) and are not recommended.

Currently, the most effective chemical to kill fleas in prairie dog burrows is deltamethrin in a waterproof formulation (trade name DeltaDust), manufactured by Bayer Science Corporation), which is water resistant and can provide several months of protection. The objective for dusting prairie dog burrows is to coat the inside of the burrow, on all surfaces, from the mouth of the burrow to the furthest depth that can be reached. Adult fleas can be found at the burrow mouth and, more typically, in the nest chamber of a burrow system (Sheets et al. 1971) along with larvae and eggs. DeltaDust is usually applied to prairie dog burrows in the warmer months (May – October) of the year. Typically crews will use mechanical dusters to apply 4-6 grams of dust into each prairie dog burrow on the target colony. Several mechanical dusters are available that can be used from an ATV or on foot (see Chapter 5). Each duster unit should be calibrated on a daily basis prior to use and then monitored to ensure that 4-6 grams is applied to each burrow opening. Calibration can be done by holding a small plastic bag over the end of the wand and weighing on a portable digital scale. During application, count the number of seconds it takes to apply 4-6 grams and err on the high side (i.e., more grams of dust rather than fewer).

Organization and crew size are key factors in an efficient dusting operation. One person should be designated as the flagger, responsible for laying out lines of pin flags to form lanes that the dusters sequentially complete. Lanes should be wide enough for the dusters, usually on ATV, to swerve from side to side while moving forward. If the lane is too wide or the crew size is small then too much time is spent in side-to-side movement and progress will be slow. A duster should try to determine and match the angle of a burrow while approaching (e.g., the technician in Figure 15 was able to insert the dusting wand deeply into the burrow). Insert the wand deeply into the burrow and begin dusting. Slowly move the wand in a circular fashion while dusting to coat all surfaces and pull back towards the burrow mouth, leaving a small amount of extra dust on the burrow mound. The extra dust on the burrow mound will make it apparent to other dusters that this burrow was dusted. One flagger and duster can be expected to complete dusting on approximately 2.4 – 5.1 acres per hour depending upon burrow densities (Griebel 2014). A crew of 4-6 dusters and one flagger is ideal. All burrows, regardless of activity, should be dusted and counted. At the end of the work day the area dusted should be mapped with a GPS unit. Keep records on how many acres and burrows were dusted, when they were dusted, and how much dust was used. File an annual report with the Service (see Griebel 2014 for an example). Recent evidence suggests that repeated annual applications of deltamethrin may cause flea populations to develop resistance to the chemical; thus, dusting burrows should be done judiciously (Boyer et al. 2014, D. Biggins and D. Eads, personal communication).

Figure 15. Application of DeltaDust (active ingredient deltamethrin) insecticide to a black-tailed prairie dog burrow in Montana using a Technicide duster. Photo by Travis Livieri.

Figure 16. DeltaDust (active ingredient deltamethrin) applied to a black-tailed prairie dog burrow in Montana. Photo by Travis Livieri.

Other diseases and microorganisms of concern. Other diseases and microorganisms may affect prairie dog and ferret health but at this time little to no information is available. Localized outbreaks of Rocky Mountain spotted fever can occur in prairie dogs (K.L. Gage, CDC, personal communication). Tularemia is known to affect prairie dogs (Petersen et al. 2004) and can be lethal but outbreaks appear to be localized (Long et al. 2006). Black-footed ferrets do develop antibodies when exposed to tularemia, but fatalities have not been documented (R. Sanytmire, personal communication). Wisely et al. (2008) found an unidentified filarial species in wild ferrets but it did not appear to negatively affect them. Other diseases and microorganisms that may affect prairie dogs and black-footed ferrets include, but are not limited to: Aleutian's disease virus, rabies, toxoplasmosis, leptospirosis, bartonella, cryptosporidium, and coccidiosis. While most of these diseases and microorganisms cannot be controlled, site managers should be aware of them and be observant of diseases that may be affecting other local wildlife (e.g. rabies in skunks, tularemia in rabbits, canine distemper in dogs). Many diseases are spread by ticks and fleas; thus obtaining a sample of ectoparasites from local wildlife may inform site managers about the prevalence of other vector-borne diseases in the area. A highly recommended disease resource for personnel in the field is Kreeger et al. (2011).

Preventing inadvertent transmission of disease. Preventing the transmission of disease by humans within and among black-footed ferret reintroduction sites is essential. If equipment, such as traps, are shared between ferret sites then they should be disinfected with Nolvasan® (chlorhexidine diacetate). Plague can remain virulent in soil for more than 40 weeks (Ayyadurai et al. 2008); thus, disinfecting equipment that comes in contact with soil should be a high priority for site managers. If vehicles are moving between recovery sites then they should be washed with high-pressure hose equipment before travel, with particular attention given to the underbody to remove clods of soil that may have accumulated. Travel trailers may harbor rodents that should be removed prior to moving to another recovery site.

Minimum Standards for Monitoring and Managing Black-footed Ferret Habitat

- Map prairie dog colonies and estimate densities at a black-footed ferret reintroduction site every 2-3 years; more frequent surveys may be required if plague erupts in epizootic form.
- Conduct annual qualitative assessment of prairie dog colonies in years without mapping, including windshield surveys, for possible plague epizootics. Keep in mind that the absence of plague epizootics does not prove absence of plague; enzootic plague can affect prairie dogs and ferrets between epizootics.
- Clean and disinfect equipment and vehicles that moves between sites.
- Inform the Service of any changes in habitat.

Chapter 3
Obtaining and Releasing Black-Footed Ferrets

The U.S. Fish & Wildlife Service allocates black-footed ferrets to a release site through an application and ranking process. Requests for applications are solicited by the Service early in the calendar year to the Black-Footed Ferret Recovery Implementation Team (BFFRIT) and interested partners. Applications use a standardized format and are usually due by March 15th. The Service evaluates proposals through a ranking process (Jachowski and Lockhart 2009) and makes a preliminary decision by late spring. Ferrets are generally available for release in the late summer and fall months (August-November). The Service will make arrangements with site managers for a release date and try to accommodate requests for particular dates. Typically, ferrets are transported to the site by the Service to arrive in the afternoon for a release before or during sunset (Figure 17). A release can be a small private affair or a large public event (Figure 18); however, the most important goal of any release is to set the ferrets free in a safe and efficient manner.

Figure 17. A black-footed ferret in a pet carrier ready for release. Photo by Travis Livieri.

Figure 18. A black-footed ferret release in Grasslands National Park, Saskatchewan, Canada. Approximately 200 people attended the public release. Photo by Ashley Wruth.

Where and When to Release

Prior to a release, site managers should select release sites (i.e., specific burrows) on the designated prairie dog colonies and map the sites on a GPS. Generally, the preferred release sites are those areas with high prairie dog densities and absent resident ferrets, although consideration should also be given to potential predation on newly released ferrets. Predation has been a primary cause of loss for released ferrets (Biggins et al. 2006c). It is difficult to predict the preferred locations of most predators at particular times, but it is good idea to avoid selecting release locations near potential perch sites for raptors. For example, cottonwood trees near ferret release sites were associated with high rates of great-horned owl (*Bubo virginianus*) predation on released ferrets (Poessel et al. 2011). Also, there is preliminary evidence illustrating that an abundance of rabbits (*Sylvilagus* spp. primarily, but also *Lepus* spp.) may result in high predation rates on ferrets (Eads et al. 2015). Rabbits are a preferred prey of coyotes, which in turn are the primary cause of mortality for released ferrets (Biggins et al. 1998 1999, 2006c, 2011a). Ferret release sites where rabbits are abundant may thus have relatively high rates of incidental contact between coyotes and ferrets.

Placing reflective markers and flags at the intended release sites is recommended so participants can easily find the release sites during daylight or at night as well as a pre-loaded GPS with the selected sites. Release sites should be spaced no less than 932 ft (284 m) apart and consideration should be given to area per ferret released and the sex ratio at release. A typical release density (i.e., number of acres per ferret) varies with habitat quality and with better habitats the release density could be as high as 20 acres/ferret (8 ha/ferret) and lower quality would call for a lower density such as 75 acres/ferret (30 ha/ferret). It is not uncommon for the Service to allocate more males than females because males tend to have a lower post-release survival rate than females. Site managers should release several males and females on each colony with the expectation that some will not survive.

Ferrets do not need to be released on every available colony; it is better to release many ferrets on a few colonies rather than a few ferrets on many colonies. The goal is to maximize survival and reproduction in the first year and if the ferrets are released too far away from one another there may be a lack of one sex available during breeding season. Releases in subsequent years can occur on other unoccupied colonies or they may be colonized by the wild-born individuals. The Service may allocate an adult female with one or several of her kits in which case it is acceptable to release them as a group. Adult males should always be released alone. Every release location should be recorded with a GPS unit so that each ferret has a release coordinate; those locations, with the associated animal identification numbers, should be provided to the Service.

Black-footed ferrets have been released during both daylight hours (usually late afternoon) and at night. Radio-tagged ferrets released during day in Montana exhibited greater post-release movements than those released at night (D.E. Biggins, personal communication). Movements aboveground are dangerous for ferrets, but such movements during day are expected to be especially hazardous. A multi-state assessment of day and night releases of ferrets gave somewhat unclear results with regard to short-term survival rates (D.E. Biggins, personal communication). The choice of release timing may not be clear, but be especially cautious about deviating from the more traditional releases during darkness at sites where large diurnal birds of prey tend to be abundant.

Release Day Operations

On the release day site managers should meet with participants and staff before the release to discuss instructions, as well as release and safety protocols. Designate an experienced release leader who organizes all communications and on-site decisions. Assign team leaders if there are a large number of participants or teams of people simultaneously releasing ferrets. Use two-way radios for communication in the field and have all team leaders report back to the release leader. Clearly communicate with the media, if present, when there will be opportunities for photos/video. If the release is a public event then it can work well if a few ferrets are released with the public present, allowing for photographs/video and media interviews while the majority of the ferrets are being released by the site partners and staff. Try to avoid a large group of people slowly moving to multiple release sites which will slow down the release process. Do not let anyone linger after the release because it may inhibit or disrupt the ferret's movements.

Releasing a black-footed may require some coaxing to get a ferret to leave the carrier. Typically the carrier is filled with shredded paper, a short length of black tubing and a piece of prairie dog meat. Place the carrier on the ground with the door facing an open prairie dog burrow (Figure 19). Ensure that any bystanders are to the rear or sides of the carrier because if the ferret can see people while looking out from the carrier the ferret may be reluctant to leave. Try to match the carrier with the angle of the burrow so that the ferret can easily see the burrow entrance. Ferrets typically do not immediately dart out from the carrier right away; thus, some gentle coaxing may be necessary. If the ferret is in the black tube, gently and carefully reach into the carrier with a gloved hand and firmly grasp the tube. With the ferret in the tube, remove it from the carrier and place the tube in the burrow entrance opening. The ferret will likely vocalize sharply and loudly. Back away from the burrow and allow the ferret to leave the tube. The ferret may enter the burrow that was selected or run across the prairie. If the ferret enters a burrow then remove the prairie dog meat from the carrier and throw it down into the burrow for the ferret. Do not leave the prairie dog meat aboveground where it could attract potential predators. Vacate the area immediately and allow no one to remain. Pick up any paper, reflectors or flags that were placed earlier and use a GPS to record the location, time and animal number. **After the release, count and check all carriers to ensure that they are empty and no ferrets were missed.**

Figure 19. A black-footed ferret release on Soapstone Prairie in Colorado. Photo by Ann Marie Gage.

Managing Photography of Black-footed Ferrets

Participants in black-footed ferret releases and subsequent surveys may want to photograph ferrets and it is the responsibility of the site managers and survey coordinators to ensure ferret safety. During a release the site manager should have full control of all participants and not allow interference with the release or ferret movements. During nighttime surveys flash photography should be kept to a minimum. If a flash is used, then it should be in conjunction with a spotlight to minimize temporary blindness in an animal. Photographers should not be allowed to disturb or modify a ferret-occupied burrow. When possible, photographers should use a zoom lens to maintain a comfortable distance from the ferret. Under Section 3 of the Endangered Species Act it is illegal to harass or pursue an endangered species; thus, site managers and survey coordinators should discuss photography issues with participants. Spotlighting of black-footed ferrets can be considered "pursuit" and illegal without a permit; thus, nighttime photography should be limited to coordinated surveys and releases rather than independent efforts by individual photographers. The welfare of black-footed ferrets is always the highest priority in any photography situation.

Minimum Standards for a Black-footed Ferret Release

- Release ferrets at least 932 feet (284 m) apart, with preference to release many ferrets in few colonies (instead of releasing few ferrets to many colonies).
- Release ferrets at a density of no greater than 20 acres/ferret (8 ha/ferret) on high quality habitat and no less 75 acres/ferret (30 ha/ferret) on lower quality habitats.
- Use a GPS to record all release locations, time and animal numbers and provide this information to the Service.
- After the release, count and check all carriers to ensure that they are empty and no ferrets were missed.

Chapter 4
Black-Footed Ferret Population Monitoring and Estimation Techniques

In this chapter we will discuss several monitoring techniques, how to employ them in the field and how to utilize the resulting data collected to estimate the population size, demography and distribution of black-footed ferrets. This chapter is intended to supplement and reinforce Biggins et al. (2006d). Clark et al. (1984a) also provide excellent background material regarding searches for black-footed ferrets. For a discussion on the need for standardized monitoring, objectives, techniques and recommendations see Biggins et al. (2006d). For a brief physical description of black-footed ferrets see Appendix 1.

Monitoring Objectives

The primary objectives for a black-footed ferret monitoring program are to estimate the population size, demography and distribution of ferrets to determine a site's status, progress and contribution towards site-specific and national recovery goals. Secondary but related objectives, such as research, may use many of the same techniques described here. The Service recognizes that individual ferret reintroduction sites may have different objectives annually based upon budgets, resources, needs, landowner tolerance and other factors. Ideally the Service desires an annual Summer/Fall population estimate for each site but, when population-level information is not available, data such as presence, population index or trend can be valuable. Sites should consult with the Service on an annual basis regarding monitoring objectives and appropriate methodology. The Service will need population size, demographic and distribution estimates periodically for recovery purposes (e.g., 5-year review, recovery plan revision) and will inform sites no less than 1 year in advance of the need for these data.

Spotlighting

Background. Spotlighting is the primary and most versatile method used to locate black-footed ferrets (Hillman 1968, Fortenbery 1972, Henderson et al. 1974, Campbell et al. 1985, Schroeder 1985, Biggins et al. 2006d, Grenier et al. 2009, Livieri 2011). In use since 1964, spotlighting has been used to locate ferrets occupying black-tailed, white-tailed and Gunnison's prairie dog colonies across North America. Spotlighting for ferrets is very efficient compared to surveys for similar-sized carnivores with a latency to first ferret detection of 5.7 hours (SD = 3.9 hours) at some sites (Grenier et al. 2009). The premise of spotlighting is to use a high-powered spotlight to detect the eyeshine of ferrets that are above ground. Many nocturnal mammals, such as ferrets, have a tapetum lucidum, a membrane in the rear of the eye that reflects light back to the retina. The tapetum helps these animals see in low-light conditions by gathering more of the ambient light (e.g., moonlight, starlight) and making it available to the eye. The eyeshine produced by the tapetum can be different colors in different animals (Table 1). Black-footed ferret eyeshine appears emerald green to most observers (Figure 20) although other animals do have green eyeshine.

Table 1. Eyeshine color of animals commonly seen during spotlighting surveys for black-footed ferrets.

Common name	**Scientific name**	**Eyeshine color**
Black-footed ferret	*Mustela nigripes*	Emerald green
American badger	*Taxidea taxus*	Green, orange or white
Swift fox	*Vulpes velox*	Green or blue-green
Coyote	*Canis latrans*	Green or white
Long-tailed weasel	*Mustela frenata*	Green
Bobcat	*Felis rufus*	Green or orange
Pronghorn	*Antilocapra americana*	Green
Deer	*Odocoileus* spp.	Green
Bison	*Bison bison*	Green or white
Domestic cattle	*Bos taurus*	Green or white
Domestic sheep	*Ovis aries*	Green
Cottontail	*Sylvilagus* spp.	Dull red
Jackrabbit	*Lepus* spp.	Dull red

Figure 20. Black-footed ferret eyeshine illuminated by a spotlight. Photo by Keith Crowley (upper left), others by Travis Livieri.

Observers can use behavior, orbital (eye) size and inter-orbital distance to differentiate between various species. Black-footed ferret eyeshine is close to the ground and typically does not move very much. Ferret eyeshine undulates with their bounding gait when they do run. Long-tailed weasels have smaller eyes than ferrets and move at a more rapid pace, usually with more erratic movement. Badgers also are low to the ground but the eyeshine may not be quite as bright, does not undulate when they run and the inter-orbital distance is greater than ferrets. Swift fox may crouch close to the ground, remaining motionless until they suddenly move away. Fox eyeshine tends to remain stable and parallel to the ground as they run. Coyote eyeshine is noticeably higher off the ground than eyeshine from a ferret. Typically, a coyote will look briefly at the light, run a short distance and then look back at the light again, with relatively level eyeshine staying at a constant height above ground. Often the body of the coyote is visible as well. Occasionally some invertebrates, such as wolf spiders (*Hogna carolinensis*), will have reflective eyeshine.

How to spotlight. Typically the method of transporting the spotlight (vehicle, ATV, or on-foot) will be determined by topography, size of the area to be surveyed, accessibility, and the rules and policies set forth by the landowners and managers. Spotlighting from a vehicle may be the most efficient method for surveying a prairie dog colony for ferrets (Figure 21) although surveys from an ATV or on-foot can be quite effective.

From a vehicle. For areas that allow full vehicle access (i.e., no travel restrictions) try to establish a grid pattern to consistently survey the colony whereby the entire plot area can be surveyed approximately once per hour. In most areas, a vehicle with inexperienced observers can effectively survey 640 acres (259 hectares) per hour and experienced observers up to 1,000 acres (405 hectares) per hour (Figure 22). Topography and vegetation can affect vehicle speeds. Vehicle speeds of approximately 4-7 miles per hour will provide adequate coverage of the colony. Black-footed ferret eyeshine can reliably be detected up to 186 yards (170 meters) away by most observers (Hillman 1968, Clark et al. 1984a, Marinari 1992, Livieri et al. 2015).

Figure 21. Spotlighting from a vehicle in South Dakota. Photo by Travis Livieri.

Utilizing a grid pattern to survey the plot provides for even and thorough coverage. Starting on one end of the colony a vehicle can utilize directional transects (e.g., north-south, east-west) spaced no more than 400 yards (366 meters) apart (see

Figure 23 for an example). After completing one circuit through the plot the vehicle should then switch directions if possible (e.g., if the first circuit was north-south then switch to east-west for the second circuit). If a grid pattern is not possible because of topography, fences or colony shape then try to establish a route with occasional reversals throughout the night (e.g., drive the route in the opposite direction, continuous path; Figure 23). Using a GPS unit with a track log can help surveyors to see where they have (and have not) been on the colony.

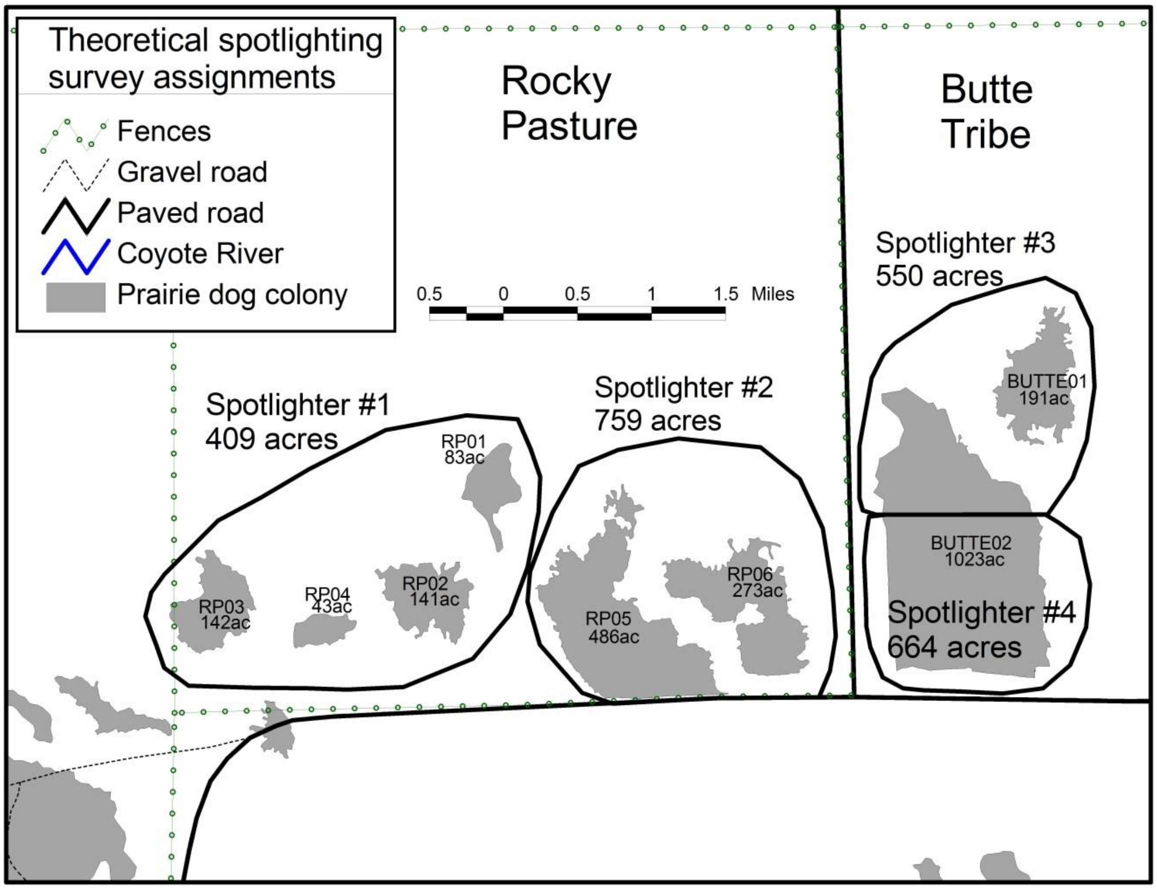

Figure 22. Theoretical spotlighting assignments for a fictional complex of prairie dog colonies.

Areas that allow restricted access for vehicles (e.g., restricted to roads only) may need to use on-foot surveys to supplement coverage in areas that cannot be effectively surveyed by vehicle. In such cases it may be efficient to pair a vehicle surveyor with an on-foot surveyor.

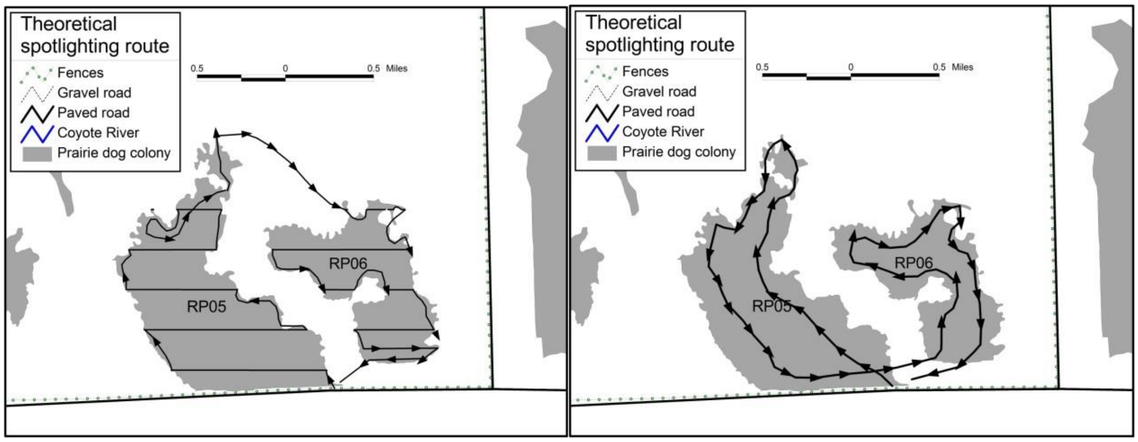

Figure 23. Theoretical spotlighting routes utilizing a grid transect (left) or continuous path (right) with transects spaced approximately 400 yards (366 meters) apart.

From an ATV/UTV. Spotlighting for black-footed ferrets from an ATV offers the opportunity to survey areas (or portions thereof) that may be inaccessible to vehicles and reduce the impact on colonies with fragile soils or vegetation. A handheld spotlight powered by the ATV battery is most often used. If using a UTV with a roll bar then a roof-mounted spotlight can be attached to a piece of plywood, attached to the roll bars with u-bolts, and powered by the UTV battery or an extra battery in the storage bed. Survey methods are the same as those from a vehicle.

On foot. On areas (or parts of areas) that have restricted access for vehicles (e.g., restricted to roads only) on-foot surveys may be most appropriate (Figure 24). Spotlighting for black-footed ferrets on foot can be physically demanding, although recent advances in lightweight batteries have made it easier for participants. On-foot surveys require more participants to survey the same area as vehicles and also more coordination to recharge batteries on a daily basis. In most areas surveyors can be expected to effectively cover 200-300 acres (81-121 hectares) of colony while spotlighting on foot. Care should be taken to avoid real or perceived hazards including, but not limited to, rattlesnakes, cactus or large openings to prairie dog burrows. Non-target wildlife and domestic animals should be left undisturbed when possible.

Equipment to use. Biologists in the ferret program have used many different types and brands of spotlights over the past 50 years. One particular brand, Lightforce, is the preferred choice for the majority of biologists (see Chapter 5). When spotlighting from a vehicle with only hand-held spotlights it is most effective to have two observers per vehicle to effectively encompass a full 180° view of the front and sides of the vehicle. Roof-top magnet mount and permanent spotlights (see Chapter 5) usually allow one person to cover a full 180° view, although extra observers (with hand-held spotlights) can be helpful. Some observers use two roof-top magnet mounts per vehicle. Powering spotlights in a vehicle with the in-cab 12-volt power supply can sometimes lead to blown fuses or overheating of cords. If possible, connect the power directly to the vehicle or ATV battery. An in-line fuse for the spotlight power cord is recommended.

Figure 24. Spotlighting on foot in Saskatchewan, Canada. Photo by Travis Livieri.

Frame backpacks work well for on foot spotlighting and can be loaded with sufficient equipment. Lightweight battery packs (see Chapter 5) fit well inside backpacks and spotlighters should carry an extra battery (it can be cached somewhere on the survey colony until needed). Every spotlighter/team should have a GPS and radio for communication (see Chapter 5). Ferret locations should be marked with a reflective post or flag for easy identification from a distance. Red driveway marker reflectors work very well and reflective "mailbox" stickers can be used to give each reflector a unique number. Other equipment including readers, traps and trapping accessories are described below.

When to spotlight. Spotlight surveys during different times of the year can produce varying data and results. Site managers often have limited resources to conduct spotlight surveys and should prioritize surveys to gather the most important data on black-footed ferrets at that site.

30 days post-release. A standard of ferret recovery is a spotlighting session 30 days after release to assess survival of released animals to one month. Conducting surveys at 30 days post-release allows comparison with previous studies of survival and movement (Biggins et al. 1998, 1999, 2006c, 2011a), and can provide an early warning of forthcoming problems.

Spring breeding surveys. Spotlight surveys conducted in the late winter and early spring months (March-April) are generally considered breeding surveys. These can provide an estimate of the adult population size at breeding and project an estimated number of litters for the summer. Males tend to be very active and are readily identifiable as they mobilize in search of females and in territorial defense. Females can be less conspicuous and often remain below ground. Breeding surveys are not required by the Service and anesthesia of ferrets during breeding season requires Service approval. Snow and moisture at some sites can make breeding surveys difficult to accomplish. Spring surveys may be useful in areas where tall vegetation creates sightability issues during other times of the year because snow and winter-grazing may reduce vegetation height.

Summer litter surveys. Black-footed ferret kits are generally large enough to come above ground in mid-July; however, some late litters have been observed in the wild in which kits were not above ground until late August or early September. Surveys for litters provides data on reproduction and potential recruitment. If litter counts are of interest, care should be taken to ensure that each mother ferret can hunt and care for her kits with limited disturbance while, if possible, observers collect desired data.

Summer/Fall population surveys. Late summer and fall (August-October) is typically the optimal time to assess black-footed ferret population size. Kits can still be dependent on dams (adult female parents) in August, allowing for litter counts to assess productivity, although adult males tend to be less visible (Biggins et al. 2006d, Eads et al. 2012b). In September-October the kits become more independent of their dams as they reach adult size and begin to disperse from their natal home range. Capturing kits for passive integrated transponder (PIT) tagging becomes easier in the fall and adult males tend to become more visible. Summer/Fall surveys may be difficult on Gunnison's and white-tailed prairie dog colonies if robust vegetative growth occurred during the growing season because neither species actively clips tall vegetation. **Annual Summer/Fall population surveys are the highest priority for the Service as they provide an estimate of reproductive success in combination with a relatively standardized estimate of the minimum number of ferrets alive (MNA, Krebs 1966) in a given population.**

Winter surveys. Winter surveys (November-February) can also be productive but typically are at higher risk for inclement weather and colder temperatures may preclude trapping activities. Black-footed ferrets are active throughout the winter and can be quite active in cold weather (Henderson et al. 1974, Richardson et al. 1987). Winter spotlight surveys combined with snow-tracking can add data on over-winter population size, recruitment and habitat use.

Survey timing. Although black-footed ferrets are active on most nights and throughout the year, surveys near the full moon can be slightly more productive than new moon periods (Eads et al. 2012b). While surveys should be targeted for full moon periods, there is still significant value in spotlighting during other moon phases (Biggins et al. 2011b, Eads et al. 2012b). Black-footed ferrets can be active at any time throughout the night and occasionally during daylight hours. During the summer months it is usually possible to survey the entire evening when sunset occurs near 2100 hours and sunrise at 0500 hours. When the nights are longer it is often impractical to survey the entire night; thus, a portion of the night must be selected for surveying. During the summer and fall months black-footed ferrets are generally most active and detected between 0100 and 0300 hours although ferrets can be detected at any time throughout the night (Eads et al. 2012b). It is not unusual for some ferrets to be active near sunset for an hour and then less active prior to midnight. Also, it is not unusual for ferrets to be active near sunrise and into the early daylight hours (Eads et al. 2010). The highest priority for surveys should be a period that encompasses the 0100 to 0400 time period (Biggins et al. 1986). While ferrets are occasionally active during daylight hours there is very little utility in daylight surveys.

Organizing surveys. Successful spotlight surveys are the result of good organization prior to, during and after surveys. Spotlighting dates should be selected several months in advance if possible and participants notified of the dates. Surveys should be conducted for a minimum of 3 consecutive nights in an area because not all ferrets are usually detected in a given night. Optimally, surveys should be conducted for 4-5 consecutive nights in an area to maximize the probability of detecting all of the ferrets that may be present (Biggins et al. 2006d).

Prior to surveys, determine how many nights are needed to adequately survey an area. Calculate the size of each spotlight area and the number of hours/nights needed to accumulate a minimum of 3 minutes per acre (8 minutes per hectare) to help determine how many nights are needed to adequately survey an area. For example, if the survey area is 600 acres (243 hectares) and a cumulative minimum of 3 minutes per acre (8 minutes per hectare) is desired then a minimum of 30 hours of spotlighting will be required (600 acres x 3 minutes = 1,800 minutes = 30 hours). If surveys last for 8 hours each night then at least 4 nights of surveys (8 hours per night x 4 nights = 32 cumulative spotlighting hours) will be needed to survey the area. A minimum of 3 survey nights for a cumulative effort of 3 minutes per acre (8 minutes per hectare) are recommended based upon spotlighting data reported in Biggins et al. (2006d Figures 1-2).

Prior to surveys check and repair all equipment, prepare maps and data sheets (see Appendix for examples), and contact local authorities and landowners. On the first night of surveys hold a meeting with all participants and review the objectives, procedures and safety concerns (Figure 25). Brief videos of ferret activity, eyeshine and procedures can be helpful to show survey participants before entering the field. If necessary use a sign out sheet of equipment for items assigned to participants (e.g., spotlights, GPS unit, radio, ring readers, traps, etc.; see Biggins et al. 2006d).

Provide a map to each participant with their individual survey areas highlighted. Maps should include colony boundary, topography, fences and roads. Print the map on the opposite side of the data sheet; ask participants to mark ferret locations on their map as they complete their survey. Also, review the data sheet with participants to ensure that data are collected in the desired manner (e.g., UTM coordinates rather than lat/long, datum, notations) and provide a completed sample data sheet as a guide. Use two-way radios or cell phones (where coverage is adequate) for communication and make sure that all participants can communicate. Periodically throughout the evening check in with participants and provide updates on ferret detections and other useful information. Be alert to inclement weather and plan accordingly. If there is a high probability of inclement weather (e.g., heavy rain, lightning, snow) during the survey then it may be prudent to cancel.

Figure 25. Demonstrating proper equipment usage to spotlight survey participants in Wyoming. Photo by Travis Livieri.

As morning approaches use the radio to inform participants of the survey ending time and a meeting point before retiring for the day. Each morning collect data sheets from participants and quickly review them for any omissions and errors. Gather equipment that needs to be charged (e.g., spotlight batteries, radios) or repaired before the next evening. Speak with participants to understand challenges that may impede spotlight surveys (e.g. topography, equipment or other factors). Also ask participants regularly about their ferret detections (e.g., were they close to each other in time and/or space? Do you think it could be a litter? Was there more than one animal? How many do you think have not been captured or identified yet? Are there any areas that are not being covered very well?). Crew leaders should not leave the field in the morning until all personnel, PIT tag readers, and traps (if trapping) are accounted for, and completed datasheets have been returned. After all surveys are finished and compiled, the data should be collated and summarized into a report (see Livieri 2015 for an example).

Spotlighting tips and recommendations

General

- Aim the spotlight beam so that the top half of the beam falls above the horizon and the bottom half below.
- Use binoculars to help verify eyeshine and identify the species found.
- When a ferret is detected move directly towards the ferret and try to keep the spotlight focused upon the burrow the ferret occupies. Keep your eyes on the target.
- If the ferret submerges into a burrow before you can identify the exact burrow then stop and wait. The ferret may re-emerge. If the ferret does not re-emerge

and you still are not sure which burrow it is in then use a flashlight to look down into the closest burrows. Often the ferret will be in one of the burrows and looking at you.

- Use high visibility reflector posts to mark ferret-occupied burrows, readers and traps. Red works best and is highly visible from long distances. Wrap a strip of red reflective tape around the post so it can be seen from all directions.
- When placing a reflector push it firmly into the ground at least 6 inches. Wind and other animals can knock over a reflector if it is not securely inserted into the ground. Place the reflector a few feet from the burrow and not directly into the burrow mound.
- Use a numbering system to uniquely identify each ferret location (e.g., a reflective number sticker on each reflector). This will aid in data management and also ensure that captured ferrets are returned to their capture burrow.
- Utilize hills and high points to scan the surrounding areas.
- Try to take breaks at different times of each survey night (e.g., break at 0030 on night 1, break at 0130 on night 2, etc.).
- Be prepared and bring extra equipment and supplies (e.g., spotlight bulbs, batteries, flashlights, pencils, fuses). Also, bring tools to make repairs in the field, including (when possible) those relating to the spotlight, but also the vehicle including coolant, a tool box, tow strap, shovel, flat tire sealant, and 12-volt vehicle tire air compressor.
- Assign individuals to specific areas for the duration of the surveys. Do not assign multiple individuals to one large area (e.g., three vehicles/participants are responsible for surveying one 2,000 acre colony). Partition the colony into logical areas and assign each vehicle/participant to an area.
- Try to enlist participants who can survey the entire period rather than just one night; observers become increasingly efficient with experience. For this reason, pair up inexperienced participants with experienced surveyors.

From a vehicle/ATV

- Cross drainages and ditches carefully. Exit the vehicle/ATV and investigate any drainages in question prior to crossing. Use reflectors, preferably of a different color, to mark preferred crossings or hazards. Often crossing shallow drainages at an angle (rather than perpendicular) will make it easier.
- Beware of hazards that could damage tires or vehicles/ATVs (e.g., cactus, greasewood, barbed wire)

On foot

- Occasionally stop and look behind you. Ferrets may emerge from the burrow after you have walked through an area.
- Step carefully and purposefully before placing weight on a foot while walking on a prairie dog colony. The objective is to keep your eyes focused on the horizon and if that becomes too difficult or unsafe then take a few steps, stop and scan, take a few steps, etc.

Identifying Black-Footed Ferrets

Using PIT tag readers. The Service implants passive integrated transponder (PIT) tags, manufactured by AVID Identification Systems (Norco, CA), into all black-footed ferrets prior to release (Fagerstone and Johns 1987, Gibbons and Andrews 2004; Figure 26). One PIT tag is inserted in the neck area and will typically last for the life of the animal. Reintroduction sites should purchase and use AVID PIT tags and readers to ensure compatibility (see Chapter 5). PIT tags do not have batteries or any moving parts and a reader must get within 4 inches of the tag to obtain a reading. AVID does manufacture a ring reader that is designed to fit over a prairie dog burrow and read the PIT tag when a ferret passes through the ring (Figure 27). Readers that are powered by a single 9-volt battery can be expected to last less than an hour thus it is recommended to use a longer life battery system (See Chapter 5 for modifications to a reader).

Figure 26. Passive integrated transponder (PIT) tag manufactured by AVID. Photo by Travis Livieri.

After identifying a ferret-occupied burrow place the reader behind the angle of the burrow so that it cannot be seen by the ferret while in the burrow (see Figure 27). Use a test PIT tag to ensure the reader is working properly. Place a small amount of grass in the burrow (i.e. a grass plug) that will help in determining if a ferret passed through the ring (Figure 28). Firmly place the ring in the burrow opening so that it minimally obstructs the opening and does not move or tilt. After the reader and ring are set, test them again with a test PIT tag. Upon returning, check the grass plug to see if it has moved. If the grass plug has moved, then the ferret passed through the ring. Check the reader and if it still reads "LOOKING" then, without moving or changing the reader set up, pass a test PIT tag through the ring to ensure that it is working properly. If the reader scans the test PIT tag correctly then it can be assumed the ferret did not have a PIT tag (i.e., unchipped and wild-born) or the PIT tag in a tagged ferret is malfunctioning).

In colder weather the liquid crystal display (LCD) on the reader may freeze and appear blank. If the LCD is frozen, then place a warm hand over the LCD screen for one minute and it should appear again. Most AVID PIT tag readers are designed to read only one PIT tag at a time and if power is lost then any reading will be lost as well. A reader

Figure 27. Setting a ring reader in South Dakota. Photo by Diane Hargreaves.


Figure 28. A shallow grass plug in a prairie dog burrow with a ring reader. If a ferret passes through the reader then the grass will be obviously moved and can help determine if the ferret does not have a PIT tag. Photo by Travis Livieri.

equipped with long-life batteries can be left through the day and even up to several days. If a reader is to be left during the day it is recommended that it be inconspicuous so that it is not overly attractive to predators, livestock or people. Readers can be placed inside a sturdy box, small cooler, or Tupperware type enclosure to protect it from the elements (Figure 29). Chemical hand-warmers can be placed inside the box with the reader during cold weather to prolong battery life. Red reflective tape can be useful for locating readers at night.

Figure 29. Black-footed ferret passing through a ring reader in Saskatchewan, Canada. The reader is configured for long-term field deployment with a sturdy case and batteries that can last for 2 weeks. Photo by Travis Livieri.

Other marking methods. PIT tags and dye-marking are the only approved methods to mark black-footed ferrets. Dye-marks can use common hair dye for humans and black colors work the best. Most commercially available hair dye products contain p-phenylenediamine (1,4 phenylene diamine) which can be toxic if repeatedly ingested over time. Dye marks on ferrets must be in locations they cannot easily groom (i.e., neck) and not on other body parts (e.g., rib cage), yet remain visible to observers from a distance (Figure 30). Hair dye, when used properly, can last up to several months. Mix hair dye at the moment of use and not beforehand. If a more temporary mark is desired that only lasts 1-3 days, then a permanent marker can be used. For instructions on applying dye marks to a black-footed ferret see "**Vaccinating black-footed ferrets"** ferrets below. Ear tags, tattoos, freeze branding and toe clipping are not acceptable methods of marking ferrets.

Figure 30. Black-footed ferrets with dye-marks on neck. “X” pattern (upper left) is highly visible from most viewpoints. A red “W” mark on a ferret in Wyoming (upper right) provided a unique mark for that individual as part of a capture-mark-recapture study (Grenier et al. 2009). A black stripe on the side of the neck can be seen from several directions and these dye marks are at least 1 month old (bottom left, bottom right). Photos by Travis Livieri.

Capturing/Trapping Black-footed Ferrets

Capturing black-footed ferrets should be undertaken only after serious thought and consideration for the reason(s) why ferrets should be captured. There is considerable risk to ferrets in any trapping efforts including, but not limited to: stress, hypothermia, hyperthermia, injury, disruption of movements, and vulnerability to predators. Trap mortality of black-footed ferrets is rare but does occur. Site managers should first ask if ferrets need to be captured to meet the objectives and data needs for that site. Black-footed ferrets should only be trapped for the following reasons:

- To anesthetize the black-footed ferret for PIT tag insertion, determination of sex, vaccination, and sampling (only under Service and appropriate state permits).
- To determine sex, reproductive status, and vaccinate a black-footed ferret in a trap with immediate release at the capture location.
- To translocate a black-footed ferret to a new area (only under Service and appropriate state permits).

Prior to surveys inspect all traps and ensure they are working properly. See Figure 55 for a schematic of a Service-approved trap design for black-footed ferrets. Use a cloth wrap (e.g., canvas, burlap, wool) and if the weather is cooler (below 40° F or 4° C) use an insulating layer. If the temperature with wind chill factor is below 0° F (-18° C), then trapping should not be considered unless the trap is monitored continuously (e.g., with telemetry) and immediate attention is given to any captured animal. To set and place a trap, insert your hand, palm up, into the round portion of the trap and push the door up to the top. Use your index finger to find the dog (trigger) and pull it towards you until it is under the door. Rest the door on the dog (trigger). Use your thumb to push the dog (trigger) back to the edge of the door for a light-triggered set. Firmly push the entrance round end of the trap into the prairie dog burrow (Figure 31). The trap should not bounce or fall out of the burrow. Look down into the trap to ensure that the trap is still set and in the proper direction; the treadle (trip pan) near the rear of the trap should be on the bottom. Make sure the rear door (square) is locked and secured with a clip.

Figure 31. Black-footed ferret trap with canvas wrap set in South Dakota. The red reflector has a unique number on the other side for ferret safety and proper data management. Photo by Travis Livieri.

The burrow that a ferret is located in may be connected to other burrows (Biggins 2012) and several options exist to increase your trapping success in this situation. First, is to simply ignore the extra burrow opening(s). Set the trap, place a reflector, mark it in a GPS and leave the area quickly. Often this can be effective by minimizing the time spent around the burrow. Second, is to set more traps on burrow openings that are suspected to be connected. Lastly, use an object to block potentially connected burrows. Objects can be pieces of a wooden fence post, large plastic cups, or anything else that can block a burrow and easily be removed (by the trapper, not the ferret). Plugging burrows by kicking or shoveling soil into them is not recommended because the obstruction cannot be removed quickly and may cause extra stress and energy expenditure by a ferret. Burrows can be connected up to, or exceeding, 18 meters (60 feet) away but observers should focus on just a few within the immediate vicinity. Always record the number of traps and plugs set in a location to aid in removing traps and plugs after a capture or in the morning if a ferret is not captured.

Traps should be checked at least once per hour. When checking traps, look all the way down into the bottom of the trap; some trapped ferrets will hide at the bottom. If there is no ferret in the trap, then confirm that the trap is still set.

After a ferret is trapped, remove the trap from the burrow and place it on the ground. If you are spotlighting from a vehicle, then use the headlights of the vehicle, if possible, and utilize that generous light source to your advantage. Unwrap the trap and, if the ferret is going to be anesthetized, prepare to move it into a black tube for transport (Figure 32). If the ferret is going to be vaccinated in the trap then do not move it into a black tube yet (see "**Vaccinating black-footed ferrets**" below). To move the ferret from trap to tube, remove one door from the black tube and place it nearby on the ground. Remove the clip from the end of the trap and open the door while quickly placing the open end of the black tube against the open end of the trap. Use the free tube door to coax the ferret into the tube. If the ferret does not move from the trap into the tube, then use a paper or plastic bag and crinkle it above the ferret (Figure 32). It is useful to keep a plastic bag in your back pocket. **DO NOT BLOW ON THE FERRET.** After the ferret is in the tube, close and secure both doors and label the black tube with the trap/reflector number and the trapper's name. This procedure should be accomplished as close to the capture location as possible in the rare event the ferret accidentally escapes during the transfer into a tube.

Figure 32. Using a plastic bag to make crinkling noise to coax a black-footed ferret from a trap into a black tube in South Dakota. Photo by Dennes Barrett.

When transporting a ferret in a black tube, place the ferret in a secure and quiet spot (e.g., in the back seat of a vehicle, under your arm if on foot). Maintain a comfortable temperature (approximately room temperature) and minimize loud noises. Do not allow the black tube to roll around. When giving the black tube with a ferret to another person (i.e., anesthesia personnel) make sure the tube is clearly labeled with the trap/reflector number and the trapper's name; duct tape and permanent black markers are highly useful for this purpose. Remove all traps and plugs in the morning (reflectors can remain) so that nothing remains during the day. Count the traps and mark them off on your data sheet to ensure that all traps are picked up before the night's survey ends.

Black-footed ferret anesthesia. Anesthesia of black-footed ferrets can only be conducted under permit from the Service and appropriate state agencies. Isoflurane is the only anesthetic drug permitted for anesthesia of ferrets unless written authorization is obtained from the Service. Black-footed ferrets should only be anesthetized by Service-trained personnel or a licensed Doctor of Veterinary Medicine (DVM). The only reasons to anesthetize a ferret are for PIT tag insertion, determination of sex, vaccination, sampling and preparation for translocation. Please refer to the **Black-Footed Ferret Field Anesthesia Manual** for more information.

Determining sex/age of black-footed ferrets. Black-footed ferrets are sexually dimorphic with males typically larger than females (Santymire et al. 2012). However, the most reliable way to determine the sex of a black-footed ferret is to inspect markings in the belly-groin region (Figure 33). Females have a long, thin, black medial line on the ventral surface that extends caudally (to the rear) from mid-belly to the vulva and anus. The line is continuous. Male black-footed ferrets also have a black ventral line that begins mid-belly and extends caudally (to the rear) but widens and ends near the penis sheath opening. The line between the penis and anus is very light, if at all present, and testes are not always apparent.

Determining sex of a ferret in a trap can be difficult. Hold the trap above your head and use a flashlight to look for the ventral line on the ferret (Figure 34). The ferret may move in the trap or remain in a position that makes the line unclear. Gently turn the trap and the ferret should move to provide a better view. Often the line on a male looks even wider and sometimes the testicles are apparent. If there are any doubts regarding the sex of an animal then take pictures for later inspection by someone with more experience.

Determining the age of a conscious black-footed ferret is also difficult. The best way to determine age is using tooth measurements or gum-line recession (Santymire et al. 2012); however, this can only be done under anesthesia. If a female has nipples that are apparent and have been recently lactating, then she is an adult. Male testes are not as definitive, unfortunately, but body size relative to the time of year may help in distinguishing between a juvenile and adult. If the captured ferret will be anesthetized, then leave it to the anesthesia team to determine sex/age. If the ferret is not being anesthetized and will be immediately released, then it is recommended to weigh the ferret as an additional piece of evidence for age/sex.

Weighing. A ferret can be weighed in a trap using a hanging scale. Weigh the entire trap with the ferret in it and record the total weight (ferret weight + trap weight = total weight). After the ferret is removed from the trap then weigh the trap, using the same scale and trap. Subtract the trap weight from the total weight to obtain the ferret's weight (total weight – trap weight = ferret weight).

Figure 33. Ventral medial lines of black-footed ferrets to determine sex. The long thin line of the female accompanied with apparently suckled nipples (upper left) makes determination of an adult female easy. The descended testes of a male are apparent in adult males (bottom left) and less apparent on juvenile males (bottom right) however that can change rapidly for juveniles and may not be the most reliable method to determine age.

Vaccinating black-footed ferrets. Black-footed ferrets can be vaccinated in a trap, without anesthesia, by Service-trained personnel. First, remove the trap with the ferret from the burrow and place it on the ground (if spotlighting on foot) or bring it into the vehicle and place it on the seat. Turn off all lights and noise with the exception of your headlamp. Carefully unwrap the trap and use a handheld AVID MiniTracker to scan for a PIT tag microchip. The metal of the trap can interfere with the reader, but if the reader is placed as close as possible to the ferret and the area that contains the PIT tag, then it may be read. Tilt the trap, if necessary, to get the shoulders of the ferret near the side of the trap and gently work the reader directly on the trap. If there is no reading, then it may have a PIT tag that was unable to be read through the trap or it may be unchipped. After vaccination, dye marking, and weighing, the ferret should be transferred to a black tube and the reader used again to confirm if the ferret does or does not have a PIT tag.

Prepare the vaccine syringe. When the ferret has stopped moving and the arch of the back is near the top of the trap, gently reach through a square of the trap mesh with your thumb and index finger to grasp the ferret's hair. Pull up and gain a grip on the skin. Pull the skin gently, but firmly, through the trap square (Figure 35). The ferret may struggle slightly, but if you maintain a firm grip, keep quiet and the area dark, then the ferret should quickly calm down. Carefully insert the needle into the skin, making sure not to poke through the other side, and inject the proper amount of vaccine. The needle does not need to go very deep to deliver vaccine. Let go of the skin. If you see any drops or moisture on the ferret's back then the injection went through both sides of the skin and you will have to try again.

Figure 34. An adult female black-footed ferret is apparent by the long thin medial line that continues from the belly to vulva and adult status is confirmed by the presence of nipples that appear suckled (upper left). Holding a trap above your head in good lighting will aid in determining sex/age of a ferret (upper right). An adult male has a wider ventral line that extends only from the belly to the penis and a scrotum/testes are usually apparent (lower left). A male kit has a scrotum/testes that are less apparent than an adult male (lower right). Photos by Travis Livieri.

If a dye mark is desired to visually determine whether or not a ferret has received a vaccination, then mix up dye in an empty syringe or suitable vial; black generally works best. Use a cotton swab to mix the dye. Slowly stand the trap up on end. Wait for the ferret to get into a comfortable position and slowly use the cotton swab to apply hair dye to the front or sides of the neck (Figure 36). Start gently and progressively work the dye into the hair and down to the skin. If the ferret becomes agitated or bites at the cotton swab, then stop for a moment before trying again. Quiet, dark and calm conditions will help calm the ferret. The most effective dye marks are on the ventral neck or sides of the neck using black hair dye. Dye should be mixed only for immediate use and not mixed beforehand. If hair dye is not available or a more temporary mark is desired, then a permanent marker (e.g., Sharpie) can be used. The objective is to create an apparently unnatural mark on the ferret that can be easily observed; thus, it does not have to be perfect as long as it is distinguishable.

Figure 35. Vaccinating a black-footed ferret in a trap. A portion of a ferret's skin can be pulled through the trap for injecting vaccine. Quiet, dark and calm conditions (such as the cab of a pickup) keeps the ferret calm. Photo by Travis Livieri.

Figure 36. Applying a dye mark to the neck of a captured black-footed ferret after vaccination in the trap. Photo by Travis Livieri.

Obtaining samples from conscious black-footed ferrets. Several different types of samples can be obtained from a conscious black-footed ferret in a trap. Feces and ectoparasites (e.g., ticks, fleas) can be collected without a permit from the Service. Feces are occasionally deposited by a ferret in a trap, typically on the inside of the trap door. Ectoparasites can be removed with tweezers but should be done with great caution to prevent injury to the ferret. Hair can be plucked with forceps or fingers but hair collection requires a permit from the Service.

Release considerations. Ferrets should always be released at the burrow of capture or an adjacent burrow. Ferrets can be released directly from a trap by pointing the square end of the trap at the burrow and opening the back door. Use a plastic or paper bag to coax the ferret out of the trap (Figure 32). When releasing a ferret from a pet carrier after anesthesia the ferret will be fully awake but may move cautiously and reluctantly as it leaves the carrier and crawls down into the burrow. Point the carrier directly at the burrow (Figure 37) without any people or vehicles in the direct sight of the ferret. Open the carrier door and, if possible, reach in and grab the towel or pad that is inside and pull it out. This will agitate the ferret and make the release easier. Tilt the carrier towards the burrow and the ferret will slide towards it. The ferret will likely pause for a moment and then crawl into the burrow.

Figure 37. Releasing a black-footed ferret from pet carrier into the capture burrow after anesthesia in South Dakota. Photo by Travis Livieri.

Transporting black-footed ferrets over long distances. Ferrets cannot be moved to new sites or new locations within a site without prior approval from the Service. When transporting black-footed ferrets over a long distance (i.e., away from one reintroduction site to another site) use a pet carrier. Fill the pet carrier with shredded paper and a short length of black tube (Figure 17). Place a small portion (~80g) of moist prairie dog meat, from a quarantined source, in the carrier with the ferret. Clearly label each carrier with the ferret identification number and sex. Place the carriers in a van or in the cab of a pickup. Do not allow excess sunlight to reach the carriers and potentially cause the carrier to heat up. Tape newspaper or some other material to the vehicle windows to block sunlight but avoid window coverage that might impair driving safety. Maintain a cool temperature in the vehicle (room temperature or less) and keep noise to a minimum. It is a good idea to use an indoor/outdoor thermometer to monitor the temperatures at the driver and at the ferrets; because while it may be cool where the driver sits it may be warm where the ferrets are placed. If possible have a passenger/second driver to help with any situations that may arise. Bring along an empty black tube, welding gloves, duct tape and a flashlight to help find and recapture any possible escapees. Communicate clearly with the receiving site regarding the estimated time of arrival.

Keeping black-footed ferrets overnight. If the transportation of black-footed ferrets requires an overnight stay, then ferrets can be brought into a motel room or left in the vehicle, depending upon the weather conditions. If temperatures are cool (less than 60° F) and the ferrets can be securely left in the vehicle, then leave a window open very slightly to allow air flow. Check on the ferrets periodically throughout the night and monitor the temperature. If the ferrets are brought into a motel room, drape a small towel over the door of the carrier to avoid stressing the ferrets. The towel should be positioned so that the ferret cannot pull it into the carrier. Place the carriers on the floor and spaced a few feet apart. Be mindful of the heat or air conditioning in the room and do not place a carrier directly in front of the heating/cooling vent. Avoid loud noises.

Population Assessment and Data Management

Spotlighting data sheets should be inspected for errors, omissions and illegible writing. Make corrections as soon as possible, hopefully during spotlight surveys while the participant is still present. On the bottom of each data sheet summarize the # of hours surveyed, # of acres surveyed, # of ferret locations and # of identified ferrets. Enter the summary data for each night into a spreadsheet or database (see Appendix 4 for an example). In a separate spreadsheet or database enter each individual ferret location and the associated information (see Appendix 4 for an example). Use a GIS to plot the locations and confirm that locations are within the correct survey plot and visually look for any potential errors. After data is screened and entered into a spreadsheet or database the population size can be estimated.

The size of a black-footed ferret population can be estimated in several ways including number of unique captures (NUC), minimum number alive (MNA), capture-mark-recapture (CMR), and number of litters (Forrest et al. 1988, Grenier et al. 2009). NUC is the number of individual black-footed ferrets that were captured and identified over a certain time period. Only individuals captured and identified by PIT tag are included in NUC and this is a conservative estimate of the population. MNA uses the NUC and incorporates some of the uncaptured and unidentified black-footed ferret locations. For instance, if a ferret is found on an outlying colony and is not captured or identified, and there is little probability that it is a previously identified ferret, then it can be considered a verified unknown and added to the NUC. See Figure 4 in Biggins et al. (2006d) for guidance on timing and distance between sightings to determine if two sightings may be two different individuals. CMR estimates can provide an accurate population estimate with variance; however, this method requires a significant amount of data (Grenier et al. 2009) and should not be attempted on populations with less than 100 individuals. Population sizes should be estimated and reported for discrete periods of time with the highest priority given to Summer/Fall population surveys. The period can be as little as a few days or several months, but should not extend through an entire year as it makes it difficult to determine the number of breeding adults (Summer/Fall population surveys and litter surveys likely provide the most accurate estimate of breeding adults). The Service uses the number of breeding adults at a site as part of the down-listing and de-listing criteria (U.S. Fish and Wildlife Service 2013).

Data should be kept in organized spreadsheets or databases that utilize a consistent format so that compilation across years can be accomplished easily. Annual reports are very helpful in summarizing data; otherwise data may be forgotten or lost if it is not curated. Personnel changes at a site can also cause a significant loss of data. Periodic reports, such as a 5-year review, for a site can be very helpful in preserving data that is useful to ferret recovery. See National Park Service (1998) and Livieri et al. (2015) for examples of 5-year summary reports.

Snow-tracking Black-footed Ferrets

Black-footed ferrets typically use a locomotive pattern known as “bounding” as they run between burrows and leave a distinctive track in the snow (Figure 38). Snow-tracking provides a non-invasive technique to collect data that may supplement spotlighting in northern climates. This technique should not be relied upon as a sole method of estimating population size, but as opportunistic data that may direct future spotlighting efforts (Richardson et al. 1985). Any uncertainty of ferret presence on specific colonies may be confirmed through snow-tracking but documentation of their absence is not reliable by snow-tracking alone. Prior to any snow-tracking activities the site biologist should develop a communication and safety plan, prepare equipment, and prioritize prairie dog colonies for surveys.

Snow conditions. Biologists should observe weather forecasts for upcoming potential opportunities to snow-track ferrets and put observers on standby. The key factors to evaluating good snow conditions for tracking ferrets are snow depth, wind, temperature and timing. Black-footed ferret tracks can be observed in snow depths as little as 1” (2.5 cm) under the proper conditions and deep snows usually do not affect ferret movement, but can affect human accessibility to prairie dog colonies. The best snow conditions occur when a few inches of low-moisture snow falls before midnight, winds are low (<5 mph), and temperatures remain below freezing. If it continues to snow throughout the night, winds persist or the ground does not freeze, then there is little chance that snow-tracking will be effective, although tracking conditions may be ideal on the second day. If biologists live near the area to be snow-tracked, they can create their own tracks in the snow on the night before and if the tracks are still crisp and visible the next morning then conditions may be favorable.

Figure 38. Typical two-print tracks of a black-footed ferret moving between black-tailed prairie dog burrows in Kansas. All tracks in the photo were made by a black-footed ferret. Photo by Travis Livieri.

Bright, sunlit days usually provide the best contrast to detect snow tracks as slight shadows, created by the tracks, are observable on a blanket of snow. While tracking during the day, weather can quickly deteriorate snow conditions; thus, biologists should be aware of the ephemeral nature of snow conditions. Good snow-tracking conditions can be very short-lived and sometimes last less than one hour as temperatures rise, winds increase or prairie dogs become more active. It is not unusual for the wind speeds to increase during daylight hours and, when tracking on black-tailed prairie dog colonies or white-tailed colonies in the early spring, prairie dogs can become quite active in sunny conditions and quickly obscure ferret tracks. Several recent winters in northern climates have seen very little snow and it would not be unusual for a winter to have zero favorable snow-tracking days.

Areas to snow-track. The ephemeral and unpredictable nature of good snow-tracking conditions should lead to a prioritization of colonies to be tracked in a rotating fashion so that the highest priority colonies are some of the first to be surveyed. Snow-tracking data is best used in detecting if ferrets are present on a colony that presence/absence of ferrets is uncertain. Snow-tracking can confirm presence of ferrets but cannot confirm absence on a prairie dog colony.

On the morning of snow-tracking, the biologists and observers should first go to a prairie dog colony that is known to be occupied by black-footed ferrets and quickly search for a set of ferret tracks and assess the track quality given the snow conditions. If ferret tracks are not found on colonies that are known to contain ferrets, then it is unlikely that ferret tracks on colonies of unknown occupation will be found. After ferret tracks are confirmed and observers get a chance to develop a search image, then they should immediately proceed to high priority colonies of unknown ferret occupation and begin searching.

Snow-tracking methods. The site biologist should be aware of weather conditions for the day which may help in estimating how long snow conditions may persist. If snow-tracking on foot, then it is recommended to have teams of two or more surveyors. If snow-tracking from a vehicle, then two observers per vehicle are not necessary but may help. Observers should be equipped with sunglasses, binoculars, camera, yardstick, GPS unit and radio or cell phone communication capabilities. Vehicles should be 4-wheel drive and include a shovel, tow strap and handyman jack. Start surveys immediately upon entering the colony and use a transect system to work across the entire colony at 164-410 ft (50-125 m) between transects. If tracking by vehicle, then observers can move quite quickly through a prairie dog colony but speeds should not exceed 15 mph. Be wary of hazards hidden by snow and drifts. Observers should use the track log function on a GPS or similar method to later determine what areas were surveyed. Continue tracking until snow conditions deteriorate or there are no more colonies left to survey.

Identifying black-footed ferret tracks. Tracks of several other species are commonly observed in snow on prairie dog colonies including coyotes, swift fox, badgers, rabbits and pronghorn. Use a reference book or field guide (Forrest 1988) to learn about the tracks of wildlife that may be present in the area. When a snow track is observed the first characteristic to determine is the track pattern (alternating, two-print or four-print). An alternating track is a left-right, parallel row offset pattern produced by humans and animals such as coyotes, fox, badgers and ungulates as they walk or trot (Figure 39). Black-footed ferrets mostly produce two-print tracks as they bound between prairie dog burrows (Figure 38) and their back feet land where their front feet were. Ferrets also leave four-print tracks when they walk, often after a length of two-print bounding. Prairie dogs and rabbits also leave four-print tracks but track sizes are differently sized or spaced than ferrets (Figure 40).

Black-footed ferret two-print tracks are 2-4” wide (5-10 cm) and 3-5” long (7.5-12.5 cm; Richardson et al. 1987, Forrest 1988, T. Livieri unpubl. data). A single foot track is 1-1.5” wide (2.5-3.8 cm) by 1.5-3” long (3.8-7.6 cm). The inter-stridal distance between two-print tracks is approximately 8-30” (20-76 cm) with an average of 20” (51 cm; Figure 41). The dimensions of tracks are diagnostic and discriminate between ferrets and long-tailed weasels (see Forrest 1988), which also leave a two-print track, but may be confused with mink in situations proximate to large, open bodies of water. In the latter case, mink tracks can always be backtracked to water.

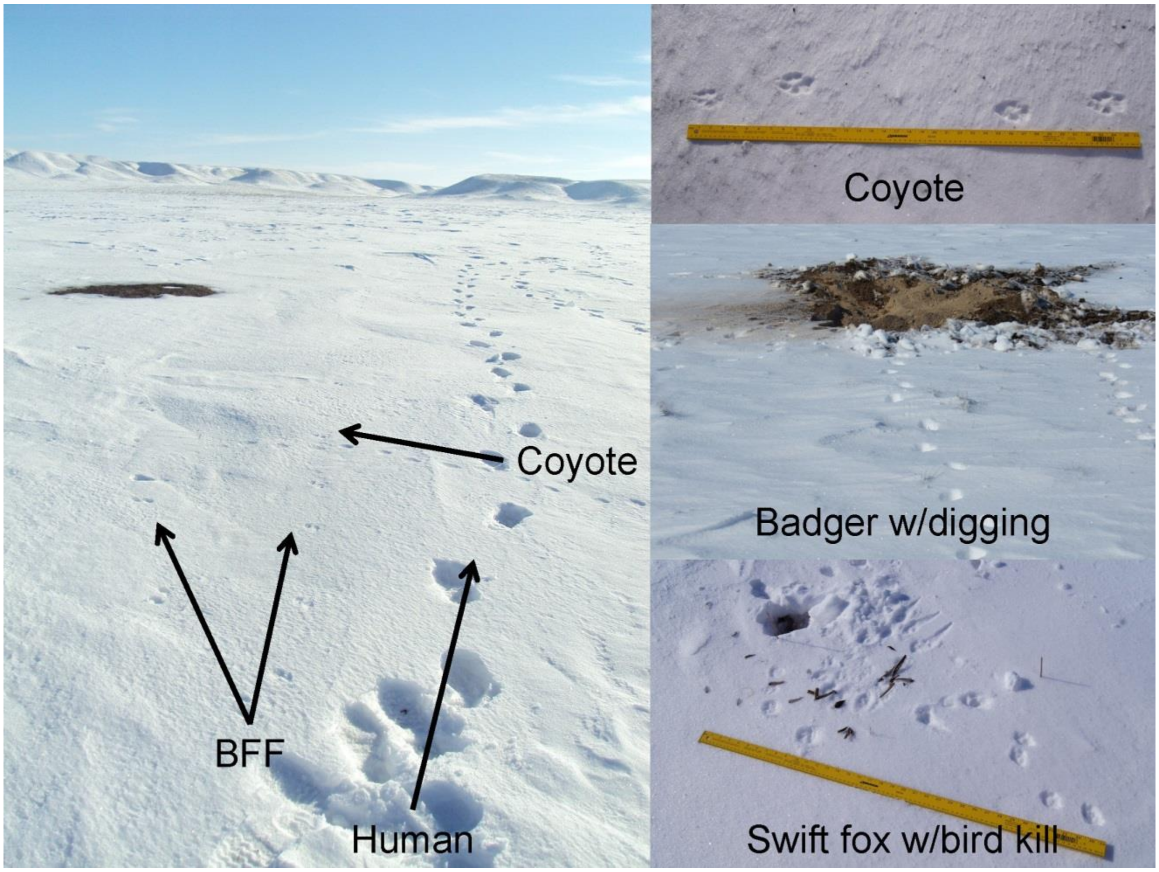

Figure 39. Snow tracks of coyotes, humans and black-footed ferrets on a black-tailed prairie dog colony in Saskatchewan, Canada (left), coyote tracks (upper right), badger tracks with digging (middle right) and swift fox tracks with bird kill (lower right) on a black-tailed prairie dog colony in Kansas. All photos by Travis Livieri.

Black-footed ferret tracks typically lie between prairie dog burrows and rarely do they pass by a burrow without approach or investigation. Ferrets may then enter a burrow, or at least insert their head, and continue on to the next burrow mound. It is not unusual for a ferret to double back and leave a parallel track in the opposite direction. Some burrow mounds may have ferret tracks radiating out in several directions as the ferret repeatedly moved to and from a single burrow. If there are uncertainties about track identity, then follow them for a distance to look at other characteristics. The overall tracks left by coyotes and fox tend to be very linear and directional through a prairie dog colony with very little, if any, investigation of prairie dog burrows.

Badgers will travel between prairie dog burrows but have an alternating track that appears pigeon-toed. Also, badgers will often excavate a prairie dog burrow and move large quantities of soil (Figure 39; Eads et al. 2013). Rabbit tracks are usually four-print and do not always approach burrows. Prairie dog tracks are also usually four-print and appreciably smaller than ferret tracks. Prairie dog tracks are often burrow-to-burrow with lots of activity near the burrow mound. Black-footed ferret tracks appear to “connect the dots” of prairie dog burrows and an individual ferret can move significant distances in one night. Richardson et al. (1987) measured overall movements of 6.5 - 22,658 ft. (2 - 6,908 m) in one night by ferrets occupying white-tailed prairie dog colonies near

Meeteetse, Wyoming. The nightly activity areas, as determined by a minimum convex polygon of the outermost snow tracks, were 1 - 242 acres (0.4 - 98.1 ha) for ferrets occupying white-tailed prairie dog colonies in Wyoming and similar-sized areas for ferrets occupying black-tailed prairie dog colonies in Kansas and South Dakota (T. Livieri, unpubl. data).

Figure 40. Two-print track pattern made by a black-footed ferret across the center of the photo with black-tailed prairie dog tracks in the upper left. Photo by Travis Livieri.

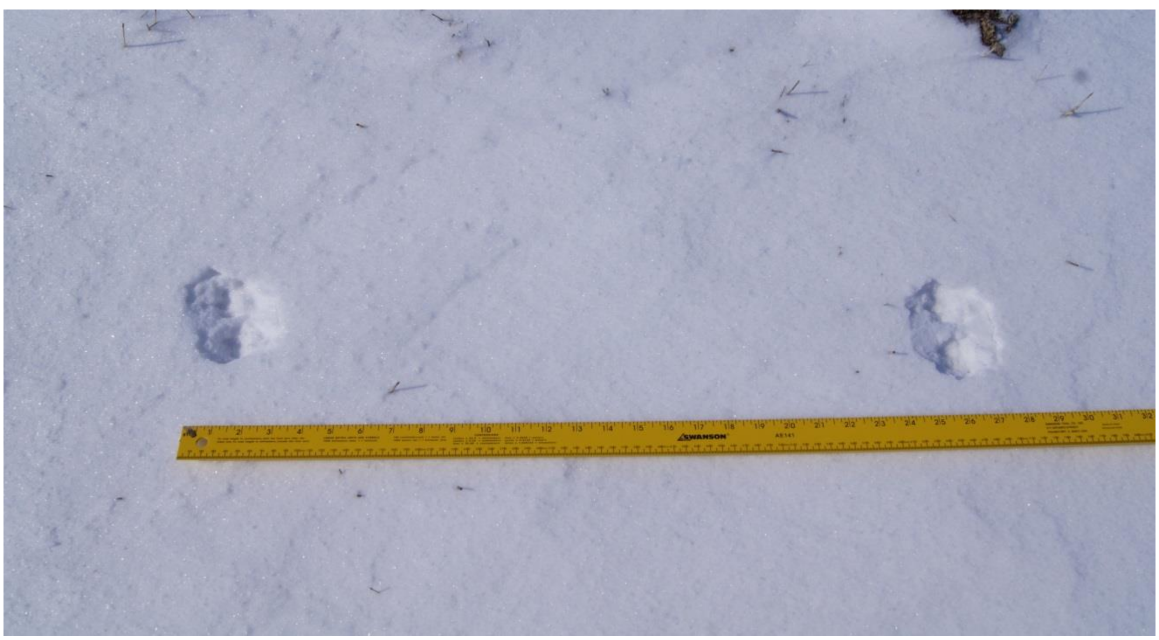

Figure 41. Inter-stridal distance and typical two-print track made by a black-footed ferret while bounding between black-tailed prairie dog burrows in Kansas. Photo by Travis Livieri.

Diggings. Black-footed ferrets will, for reasons not well understood, occasionally excavate a prairie dog burrow in a behavior termed "trenching", although the term can be misleading (Henderson et al. 1974, Clark et al. 1984b, Richardson et al. 1987, Biggins et al. 2012) (Figure 41). Subsurface soil is brought up to the surface and deposited in a linear fashion typically with a furrow in the center. Diggings can be single or multi-lobed, but will almost always appear different than a badger-reamed burrow in which the burrow opening is greatly widened and soil is spread in many directions without any obvious lobes (Figure 39). Ferrets will dig at different times throughout the year, but diggings are most apparent in the snow and can even be spotted from low-flying aircraft (Henderson et al. 1974; Figure 42).

Figure 42. Black-footed ferret diggings in Kansas (upper left, upper right), South Dakota (lower left) and a digging viewed from a low-flying aircraft on a black-tailed prairie dog colony in Montana (lower right; trench is in upper right of photo). Photos by Travis Livieri and Randy Matchett (lower right).

Scent marking. Male black-footed ferrets begin to change hormonally in November as they become more territorial and in the winter months may deposit scent to mark their territory. Scent marking is easiest to find in the snow and scent is often deposited on a small shrub, burrow mound or other object that is, from a ferret's perspective, slightly elevated above the surrounding landscape (Figure 43; Richardson et al. 1987).

Figure 43. Scent marking and urine deposition on a small shrub by a black-footed ferret in Kansas. All tracks in the photo were made by a black-footed ferret. Photo by Travis Livieri.

Data to collect. When black-footed ferret snow tracks are located, observers should note the date, time, snow conditions, GPS location, potential behaviors of the animal, and the survey hours spent on each colony. The track route should be followed and GPS mapped to determine the total extent of the activity area and also to ensure the track is not re-encountered soon thereafter and incorrectly assumed to be a different ferret. Photographs should be taken for later verification of ferret tracks and photos taken with a measuring tool, such as a yardstick, are very helpful. If any doubt exists that the tracks were made by a ferret, then the photos can be examined back at the office or shared with others who may help determine the animal species. A snow-tracking report or memo should be written up soon after the survey ends and GPS data incorporated into a GIS.

Radio Telemetry

Radio telemetry monitoring of black-footed ferrets is difficult and expensive, but can produce essential data that cannot be gained through other methods. Telemetry allows real-time and unbiased monitoring of movements, activity and mortality. In the early years of the ferret recovery program, telemetry was essential in monitoring treatment groups of captive-born released ferrets and led to much of our understanding regarding pre-conditioning and survival (Biggins et al. 1999, 2006c, 2006e, 2011c).

Telemetry is not recommended for standard monitoring of black-footed ferrets and should only be used in special cases where determining fates and mortality sources of ferrets is essential to the future of the reintroduction site. No telemetry is allowed without prior Service approval. Any study designs that propose the use of radio telemetry on black-footed ferrets should be submitted to the Service prior to obtaining funding and should include significant involvement of biologists who are experienced with radio telemetry monitoring of ferrets.

The commitment needed for proper radio telemetry monitoring of black-footed ferrets can be substantial. Base-station triangulation telemetry (Figure 44) is needed to collect adequate data for radio telemetry monitoring to be worth the cost to the site and the risk to the ferrets. Tracking with hand-held antennas or automated systems can supplement base-station triangulation data but do not produce adequate data by themselves. Livieri and Kopcso (1999) used an automated telemetry array to monitor ferrets in South Dakota, but found the range was severely limited and animals were not reliably tracked.

Figure 44. Radio telemetry base station triangulation tracking of black-footed ferrets in Conata Basin, South Dakota. Photo by Travis Livieri.

The most significant challenge for radio telemetry of black-footed ferrets is biological rather than technological. The only effective and safe way to attach a transmitter to a ferret is on a neck collar, but fitting a collar on a ferret is very difficult (Figure 45). It is not unusual for a radio-collared ferret to shed its collar within a few days after release. If a radio-collared ferret loses weight after release, then it will be easier to shed the collar. Conversely, if the radio-collared ferret gains weight, then the collar may become restrictive and lead to neck abrasions. Biggins et al. (2006f) document, in great detail, the process of developing the optimal radio-collar configuration to answer vital questions for the recovery program. Thus, while radio telemetry technology may have improved, the issue of collar fit and retention remains the same. Most radio telemetry studies on black-footed ferrets were 2-4 weeks in duration because of the great labor cost and difficulty in collar retention. Some studies would re-collar animals that shed a collar (which would require spotlighting) and some animals were able to shed a collar 3 times over a few weeks (R. Matchett, personal communication).

Before any serious consideration of using radio-telemetry on black-footed ferrets, site managers should thoroughly read Biggins et al. (2006f) and the studies published using radio-telemetry data. Biggins et al. (2006f) summarized it concisely when they wrote "*…radio telemetry is an expensive and labor-intensive method for monitoring black-footed ferrets and that attaching radio transmitters to ferrets poses risks to the animals. It is essential, therefore, to carefully consider the objectives of a study to ascertain whether other tools would suffice. Justifications for use of radio telemetry on ferrets include unexplained lack of success in establishing a ferret population and tests of hypotheses that have large-scale management implications and require behavioral information. Cost/benefit analyses regarding use of telemetry should include as costs the potential future losses of ferrets if a perceived need for information remains unfulfilled. In some cases, short-term recovery objectives may become subordinate to learning objectives that could advance long-term recovery goals.*"

Figure 45. Attaching a Wildlife Materials SOM190 transmitter with wool/cotton collar to a black-footed ferret anesthetized with ketamine/medetomidine. Photo by Travis Livieri.

Diurnal Surveys

Diurnal surveys for black-footed ferret sign are somewhat limited in their effectiveness, particularly without snow cover. Two signs of black-footed ferrets can aid or confirm presence of ferrets; plugged prairie dog burrows and surface deposits of soil that pulled from burrows, sometimes referred to as "trenching" in the literature, although the term can be misleading (Clark et al. 1984b). Prairie dogs will often plug burrows that are occupied by black-footed ferrets (Hillman 1968, Eads and Biggins 2012; Figure 46); thus, the presence of several freshly plugged burrows in a small area is worth follow up investigation with spotlighting. Ferrets will dig throughout different times of the year and, while soil deposits are easier to find with snow cover, they are present in the summer months and can indicate ferret presence (Clark et al. 1984b, Eads et al. 2012a). Black-footed ferrets are primarily nocturnal but are occasionally observed during daylight hours. Ferrets are sometimes seen during the summer and fall months in the early morning twilight and sunrise hours, prior to prairie dog emergence or in the evening twilight hours after prairie dog submergence. A spotting scope or binoculars can be used to quickly scan a prairie dog colony for above-ground ferrets (T. Livieri, personal observation).

Figure 46. Freshly plugged prairie dog burrow in South Dakota. Photo by Travis Livieri.

Other Techniques

Several other techniques to detect and locate black-footed ferrets have been employed to various degrees. Scent dogs were initially evaluated in the 1970's (Southwest Research Institute 1979, Hanebury and Biggins 2006) but rigorous tests with live black-footed ferrets were not possible. Reindl-Thompson et al. (2006) successfully used scent dogs to locate black-footed ferrets and concluded that scent dogs could supplement spotlighting efforts (Figure 47). The amount of area that could be effectively covered by an experienced dog-handler team in a day was approximately 500 acres (200 ha) under favorable conditions (Reindl 2004). Using scent dogs may increase the risk of plague transmission across prairie dog colonies and to humans because dogs may pick up fleas while sniffing burrows.

Figure 47. Working Dogs for Conservation Foundation using a scent dog to detect black-footed ferrets in South Dakota. Photo by Travis Livieri.

Ferret scat is infrequently found (Hillman 1968, Henderson et al. 1974, Clark et al. 1984a) and may be difficult to distinguish from other species but can be used to supplement other evidence of ferrets. See Sheets et al. (1972) and Clark et al. (1984a) for descriptions of ferret scat. Night vision scopes and thermal infrared sensors have been used experimentally to detect black-footed ferrets, but the limitations of the equipment often requires observers to be within a few hundred feet (i.e., spotlighting range) of a black-footed ferret in order to observe it (Henderson et al. 1974, T. Livieri, personal observation). Scent stations and attractants with track plates were unsuccessfully tried (Clark and Campbell 1983, Hammer and Anderson 1985) but studies concluded that ferrets are not attracted by scents and avoid strange objects. Scent posts could actually have the opposite effect by attracting predators (e.g., coyotes and badgers) to a scent post and thereby repelling ferrets or placing them at increased risk of predation. Use of infrared-triggered cameras to monitor wildlife has increased in recent years and technology has become more cost-efficient. Black-footed ferrets have been captured on remote camera traps at several reintroduction sites, but at a very low rate that would be unlikely to facilitate effective monitoring or population estimation. Video systems have been used to monitor behavior and litter sizes of black-footed ferrets (Jachowski 2007), but may also increase the risk of detection by a predator that investigates a foreign object left out near a known ferret location. New technologies such as unmanned aerial vehicles (drones) carrying various types of remote sensing equipment may prove effective in the future. Table 2 provides a summary of different techniques to monitor black-footed ferrets and the advantages/disadvantages of each approach.

Table 2. Comparison of techniques used to monitor black-footed ferrets and the advantages/disadvantages.

Technique	**Advantages**	**Disadvantages**
Spotlighting (Henderson et al. 1974, Campbell et al. 1985, Biggins et al. 2006d, Eads et al. 2012b)	Accurate locations, can determine demography, behavior	Invasive, physically taxing on participants
Snow tracking (Henderson et al. 1974, Richardson et al. 1985, 1987, Biggins et al. 2006d)	Non-invasive, unbiased data on movements, relatively inexepensive	No identification, subject to unreliable weather, only available in northern climates
Radio telemetry (Biggins et al. 2006f)	Can determine mortality, high quality data on movement and activity	Difficult, expensive, short-term, initially invasive, high level of training
Scent dogs (Reindl 2004, Reindl-Thompson 2006)	Non-invasive, high detection rate	Limited daily search area per dog, no identification, potential disease transmission, requires specially trained dogs and handlers
Scent/track stations (Hammer and Anderson 1985)	Non-invasive	Ferrets not attracted by scents, may draw other predators
Night vision infrared/thermal	Less invasive than some methods	Limited distance view (less than spotlighting)
Camera traps	Easy to deploy	Low capture rate of ferrets, no identification, image analysis is time-intensive

Identifying and Evaluating Alternative Techniques

Biologists have been monitoring black-footed ferrets for more than 50 years, using some of the techniques described above, while always looking for more efficient ways to accomplish the same goal. As a program, BFFRIT needs to evaluate new technologies and re-visit old ones for monitoring ferrets. **To date, spotlighting remains**

the most efficient and effective way to monitor black-footed ferret populations at pragmatic scales.

The Service encourages partners to seek new techniques to monitor black-footed ferrets but adoption of any new techniques by the Service, for recovery purposes, will require extensive testing to demonstrate efficacy equivalent to or greater than spotlighting. New techniques should be tested in the field under typical conditions, without black-footed ferrets, to simulate natural use conditions before any further testing. Any device or substance intended to be placed upon or inside of a black-footed ferret must be thoroughly tested, preferably with a surrogate or model, before any trials on live black-footed ferrets. Any testing on black-footed ferrets requires Service approval. Currently the only devices or substances that are approved for placement on or in a black-footed ferret for monitoring purposes are:

1. 125 kHz passive integrated transponder (PIT) tag microchip (see Chapter 5)
2. Temporary dye-mark (see above)
3. Wildlife Materials SOM-190 transmitter attached to a 100% wool collar with 100% cotton thread for radio telemetry (see Biggins et al. 2006f; **radio telemetry cannot be used without prior Service approval**)

Any consideration of new techniques must account for planning, development, testing, deployment and post-processing costs. Consult with the Service during the initial planning phase to discuss the feasibility of new techniques.

Minimum Standards for Black-footed Ferret Population Monitoring and Estimation

- Site managers should read Biggins et al. (2006d) in addition to this document.
- Annually consult with the Service regarding monitoring objectives for the upcoming year.
- Conduct a 30-day post-release spotlighting effort.
- Spotlight each colony for a minimum of 3 consecutive nights and for a minimum total cumulative effort of 3 minutes per acre (8 minutes per hectare).
- Conduct an annual spotlight survey in the Summer/Fall to assess population size and reproduction if possible.
- Keep detailed records on spotlight and other survey effort and ferret locations.
- Annually file a report with the Service.

Chapter 5
List of Equipment Needed and Suppliers

Biologists have been working in the field with black-footed ferrets and prairie dogs for more than 50 years and have used, tested and evaluated many different types of equipment and suppliers. Below are the preferred equipment and sources for the majority of biologists working with black-footed ferrets.

Spotlights

The most widely used and recommended brand of spotlights for black-footed ferret monitoring produce a focused light beam of 375,000 – 1 million candelas. Many sites use Lightforce Inc. products which can be ordered directly at:
LightForce Performance Lighting
336 Hazen Lane
Orofino, ID 83544
(208) 476-9814
http://lightforce.com/index.php

Figure 48. Lightforce RM240 Blitz driving spotlight that can be mounted on the RC150 or RC225 T-bar grip and mounted on a vehicle. RM240 uses a 100 watt halogen bulb.

Figure 49. RM240 Blitz with RC225 T-bar grip and RCEXT hinge mounted to a 2”x4” and magnetic mounts for easy use on top of a vehicle. The power cord with alligator clips attaches directly to the vehicle battery. Other configurations include mounting to thick foam, rather than wood, to provide flexibility on the curved roof of a vehicle. Some newer vehicles may have an aluminum body making magnet-mounts useless. Photos by Travis Livieri.

Figure 50. RM240 Blitz with RC225 T-bar grip and RCSBC Suction Bar Kit. The suction cups allow easy attachment to any vehicle. A ratchet strap can be used to keep the suction bar in place while surveying. Other configurations include replacing the metal bar with thin wall conduit across the width of the vehicle and mounting a spotlight on each side of the vehicle. Photo by Travis Livieri.

Figure 51. RM240 Blitz with RC225 T-bar grip mounted through the roof of a pickup truck. A 2” hole is required for installation. This configuration is preferred by most biologists. Photo by Diane Hargreaves.

Figure 52. Striker 170 handheld spotlight (left) and 170 Walk Pack (right) kit that includes a battery that is lightweight and well suited for spotlighting on foot. 170 size spotlight uses a 30 or 50 watt bulb.

Figure 53. Striker 170 handheld spotlight attached to BP9SLA Kit Battery Bag powered by 9 amp-hour sealed lead acid battery. This configuration with a 30 watt bulb lasts 4-6 hours of continuous spotlighting. Photo by Travis Livieri.

Traps

Figure 54. A black-footed ferret in a trap. Photo by Travis Livieri.

Available from:
Prairie Wildlife Research
P.O. Box 308
Wellington, CO 80549
(970) 219-1659
Email: tlivieri@prairiewildlife.org
Website: http://www.prairiewildlife.org

Tomahawk Live Trap
PO Box 155
Hazelhurst, WI 54531
1-800-272-8727
Email: trapem@livetrap.com
Website: http://www.livetrap.com

Tru Catch Traps
P.O. Box 816
300 Industrial Street
Belle Fourche, SD 57717
1-800-247-6132
Email: recep@trucatchtraps.com
Website: http://www.trucatchtraps.com/

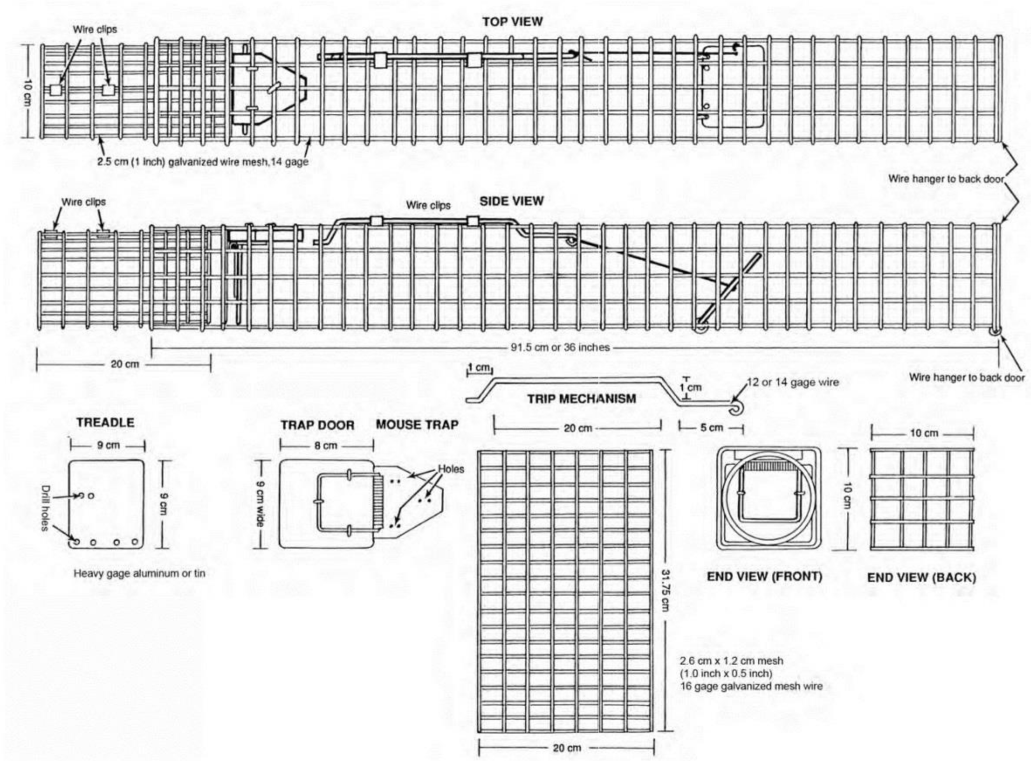

Figure 55. Schematic of a black-footed ferret trap (from Biggins et al. 2006d) based on the design described in Sheets (1972). This is the only trap configuration approved by the Service.

PIT Tag/Microchip/Transponder Readers

The black-footed ferret recovery program uses and recommends AVID brand Passive Integrated Transponder (PIT) tag microchips that operate at 125 kHz. When purchasing PIT tags for use in the field we recommend the AVID Friendchip in the Single-Use Disposable Syringe (SUDS; Figure 56). AVID manufactures hand-held microchip readers that can also be ordered with a ring attached for use at the burrow. Hand-held reader models including MiniTracker 1, 2 and 3 (Figure 57) are compatible with the 125 kHz Friendchip.

Figure 56. FriendChip (125 kHz) PIT tag manufactured by AVID in the Single Use Disposable Syringe (SUDS). Photo by Travis Livieri.

Other PIT tag frequencies and technologies are available from other manufacturers, however there is no guarantee it will be compatible with AVID equipment. All black-footed ferrets that come from the Service have an AVID 125 kHz PIT tag and the Service suggests the continued use of AVID products to maintain continuity and compatibility.

Avid Identification Systems, Inc.
3185 Hamner Ave.
Norco, CA 92860
(951) 371-7505
1-800-336-2843
Email: sales@avidid.com
Website: http://www.avidid.com

Figure 57. AVID Minitracker hand-held PIT tag microchip reader (left) and AVID Industrial Stationary Reader (right).

Figure 58. AVID Minitracker with 6" coil modified for long-term field use. Upper left is the configuration that comes from the manufacturer with a 9-volt (6 AA battery) power pack for longer battery life. Upper right, a military style ammunition box was used for protection from the elements with the ring coil threaded through the front of the box and a 9-volt modified battery pack below (6 D battery) and shown being used in the field (primary picture). This modified 6 D-cell battery configuration provides up to 2 weeks of continuous use in cold conditions.

Transport Tubes

These tubes are designed for the transport of a black-footed ferret from a trap to a mobile anesthesia station. Use 4” perforated drain tile, 3/16” hardboard or plastic for the doors, 1/8” paracord and cotter pins to secure the doors.

Figure 59. Measurements and dimensions for black transport tubes. Photos by Travis Livieri.

Pet Carriers

Animal kennels are used to recover black-footed ferrets after anesthesia and transport back to the capture location. Available at most pet stores or online retail stores.

Figure 60. PetMate animal kennel measuring 24.1" x 16.7" x 14.5". The gray side clips can sometimes come loose and can be secured with a cable zip tie. Photo from website.

Insecticide Dusters

The most widely used mechanical dusters, manufactured by Technicide (Figure 61), are no longer in production and cost more than $2,000 each. The Exacticide, a new type of duster manufactured by Technicide (Figure 62), has been used in the field but reports have been less than ideal. An alternative to Technicide products that may be more cost efficient is a Birchmeier DR-5 mounted to an ATV (Figure 63). This configuration produces a compressed air blast of dust and would need to be calibrated differently than other products, but has been used to dust prairie dog colonies.

Technicide Inc.
1050 Calle Cordillera, Suite 105
San Clemente, CA 92673
Phone: 1-800-950-5866
Email: info@technicide.com

Birchmeier US distributor
ITB Co. Inc.
1688 Nevada Avenue
London KY 40743
Phone: 1800-866-1357
E-Mail: tyler@itbcompany.com
www.itbcompany.com

Figure 61. Techniduster (model shown is discontinued) manufactured by Technicide. Photo by Travis Livieri.

Figure 62. Exacticide duster manufactured by Technicide. Photo from website.

Figure 63. Birchmeier DR-5 powder duster with compressed air valve connected to a 12-volt air pump. Photo by Travis Livieri.

GPS Units

Most black-footed ferret and prairie dog work can be accomplished using standard Garmin GPS units that can be connected to a computer for downloading, such as the eTrex20 (Figure 64). The DNRGarmin software is free (http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html) and can be used to interface with a Garmin GPS and works with several GIS software packages. A GPS unit of this type can obtain <3 meter accuracy using WAAS (Wide Area Augmentation System). If Trimble GPS units are available, then you may be able to achieve <1 meter accuracy, but the cost of Trimble units, software and training may not be efficient for some projects.

Figure 64. Garmin Etrex 20. Photo from website.

Two-Way Radios

Communication in the field is essential and generally FRS/GMRS-type radios (Family Radio Service/General Mobile Radio Service) are underpowered and insufficient. Sites should preferably use UHF or VHF style radios with several watts of power. Consult your agency and local authorities as some uses may require an FCC license.

Figure 65. Motorola On-Site RDV5100 10-Channel VHF Water-Resistant Two-Way Business Radio. Photo from website.

Literature Cited

Included with most citations is a digital object identifier (DOI), a system used to uniquely identify electronic documents. The DOI link will take you to the source journal. Some journal articles may be available for free download at the journal website or through another source (search Google Scholar http://scholar.google.com/). If copies of the citations listed here are not available then please contact the Service.

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Appendix

Appendix 1. Black-footed ferret description, characteristics and behavior.

Figure 66. Adult female black-footed ferret in Conata Basin, South Dakota, August 2004.

Table 3. Body length and weight of wild adult black-footed ferrets in Conata Basin, South Dakota, 2007-2015 (n = 416).

	Adult Female		Adult Male	
	Mean	**Range**	**Mean**	**Range**
Body length (cm)	39.8	37.0-42.5	43.2	41.0-45.5
Tail length (cm)	12.2	10.0-13.5	13.0	11.5-14.5
Total length (cm)	52.0	48.5-55.0	56.2	53.5-59.5
Weight (grams)	732	555-900	1096	830-1325

Pelage: Body color is buff-tan with whitish underbelly, neck and face. Feet and tail-tip black. Face mask black, blending into forehead with a white patch above each eye. Nose black. Fur approximately 1 cm in length. Molt in fall and spring with no noticeable change in color or length.
Dentition: i 3/3, c 1/1, p 3/3, m 1/2
Behavior: Mostly nocturnal but occasionally observed in daylight. Solitary except during breeding season (March-April) and litter rearing (June-September). Found only in prairie dog colonies with very rare exceptions such as dispersal (September-October). Vocalization in wild rarely noticeable to humans and only when agitated. Musky odor, particularly from males, noticeable to humans only when handled. Active throughout all seasons and weather conditions.

Appendix 2. Examples of spotlight survey data forms.

2014 BFF Spotlighting

DATE:________________ **(night you went out)** **NAME:**________________

DATUM: NAD 27 or 83 **SURVEY TIMES:** ________________ **(24-hr time)**

AREA SURVEYED:________________ **Also highlight or circle areas covered during the night on map (see back)**

Time	Ref#	Easting	Northing	Transponder#	Studbook#	Traps	Plugs	Comments
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Appendix 2 (continued). Examples of black-footed ferret spotlight survey forms (from Biggins et al. 2006b).

Black-footed Ferret (BFF) Survey Form

Mark sequential observation numbers on reverse-side map. Flag each location with BFF ID, date, and time for later GPS mapping.

Observer: ______________________ Night of: ______________________
(e.g., 3/19–20/98)

Transportation type: ______________________

Prairie dog colony: (Sketch area searched on map on reverse side.)

Cloud cover: ______________________ Moon phase: ______________________

Snow cover %: ____________ Temp.: ________ Wind speed/direction: ______________

Comments: ____

Start and end time	Map and observation number	Time seen	BFF ID	Transponder number	Location	Time trap set/checked	Predators observed

Total search minutes: ____________

Appendix 3. Example of a completed spotlight survey form.

2014 BFF Spotlighting

DATE: 9/15/14 – 9/16
(night you went out)

NAME: James Smith – Mary Johnson

DATUM: NAD 27 or 83 (83 circled)

SURVEY TIMES: (24-hr time) 2130-0030 0100-0600

AREA SURVEYED: RP05-06 Rocky Pasture **Also highlight or circle areas covered during the night on map (see back)**

Time	Ref#	Easting	Northing	Transponder#	Studbook#	Traps	Plugs	Comments
2218	15B	729076	4850897	054*854*878	12-008 F	1 ✓	2 ✓	3 BFFs in same burrow
				* *				caught one
2348	5Y	729192	4851007	* *		–	–	reader left, did not
				* *				go through grass plug
0036	99C	728862	4850041	* *		2 ✓	–	Couldn't see dye mark
				* *				maybe same BFF as previous
				* *				night at Ref# 70C
0141	66V	729434	4850977	055*586*317	14-002 F	–	–	dye mark observed
				* *				on left neck, reader left
0158	10K	728562	4850802	* *		3 ✓	–	observed trenching
				* *				did not capture
0228	70M	728336	4850872	054*901*283	14-005 M	1 ✓	–	kit vaccinated in trap
				* *				by Dr. Wright
0229	3Q	728341	4850886	* *		1 ✓	–	separate BFF than 70M
				* *				observed at same time
0545	9B	729553	4850805	* *		2 ✓	–	did not catch
				* *				
				* *				
				* *				
				* *				
				* *				

Appendix 4. Example spreadsheet for spotlight summary.

Date	Area Surveyed	Hours	# BFF detections	Acres	Start	Stop	Start	Stop	Personnel	Detection Times				
10/6/2014	AG01 (sec24)	8.5	4	640	2200	630			Amanda Ciurej	233	247	300	400	
10/6/2014	AG01 (sec25,26)	8.5	3	934	2200	630			Ben Matykiewicz	100	120	235		
10/6/2014	AG01 (sec26,27,35)	8.25	4	887	2230	645			CJ Woodard	2315	55	225	424	
10/6/2014	Cwest East	8.5	2	612	2200	630			Randy Griebel	2320	100			
10/6/2014	AG01 (14-23)	6	6	801	2230	430			TL	2249	2302	133	221	402
10/7/2014	AG01 (sec24)	8	8	640	2230	630			Amanda Ciurej	2335	2335	2354	2400	2309
10/7/2014	AG01 (sec25,26)	8.5	1	934	2200	630			Ben Matykiewicz	2300				
10/7/2014	AG01 (sec26,27,35)	8	2	887	2230	630			CJ Woodard	2400	132			
10/7/2014	Cwest East	7	2	612	2200	500			Randy Griebel	2215	200			
10/7/2014	AG01 (14-23)	7.75	8	801	2230	615			TL	2255	2301	2312	2335	2335
10/8/2014	AG01 (sec24)	8	3	640	2230	630			Amanda Ciurej	2245	248	420		
10/8/2014	AG01 (sec25,26)	8.5	2	934	2200	630			Ben Matykiewicz	2400	310			
10/8/2014	AG01 (sec26,27,35)	7.75	0	887	2230	615			CJ Woodard					
10/8/2014	Cwest East	8.5	1	612	200	630			Randy Griebel	100				
10/8/2014	AG01 (14-23)	5.5	1	801	2300	430			TL	427				
10/9/2014	AG01 (sec24)	8	6	640	2230	630			Amanda Ciurej	2335	33	154	248	426
10/9/2014	AG01 (sec25,26)	8.5	1	934	2200	630			Ben Matykiewicz	125				
10/9/2014	AG01 (sec26,27,35)	8	0	887	2230	630			CJ Woodard					
10/9/2014	AG01 (14-23)	5.25	2	801	2230	230	500	615	TL	6	149			
10/10/2014	AG01 (sec24)	8.5	8	640	2200	630			Amanda Ciurej	44	120	154	224	244
10/10/2014	AG01 (14-23)	6.25	3	801	2245	500			TL	15	211	215		
10/13/2014	Prairie Wind east	8	6	712	2300	700			Amanda Ciurej	2353	111	151	244	250

Appendix 5. Example spreadsheet of black-footed ferret spotlight location data.

1	Date	Ref #	Time	Easting (83)	Northing (83)	Transponder	Stud	Sex	Comments	Who	Trap/Chip	Plot
178	10/7/2014	90Z	233	728968	4850941	055*589*354	14-005	Male	trapped at 445am	Amanda Ciurej	Yes	AG
179	10/7/2014	6X	235	727096	4849641				did not trap	Ben Matykiewicz		AG
180	10/7/2014	70M	247	729049	4850603					Amanda Ciurej		AG
181	10/7/2014	10N	300	729682	4850314					Amanda Ciurej		AG
182	10/7/2014	101	400	729470	4850049					Amanda Ciurej		AG
183	10/7/2014	69V	402	728641	4850733					TL		AG
184	10/7/2014	31S	410	728257	4851382	055*589*800	14-001	Male		TL	Yes	AG
185	10/7/2014	9	424	727050	4849696	034*098*514	14-017	Male	saw again on 10/17/14	CJ Woodard	Yes	AG
186	10/7/2014	127	2215	724716	4849711	034*318*026	13-018	Male		Randy Griebel	Yes	SC
187	10/7/2014	NN	2255	728324	4851472	055*339*376	13-006	Female	assumed to be 13-006, dye mark L-R	TL		AG
188	10/7/2014	41T	2300	729147	4849771				did not trap	Ben Matykiewicz		AG
189	10/7/2014	NN	2301	728334	4851319	055*589*800	14-001	Male	assumed to be 14-001, dye mark L-R	TL		AG
190	10/7/2014	NN	2309	729152	4849772					Amanda Ciurej		AG
191	10/7/2014	8B	2312	728113	4850540	055*601*114	14-020	Male	small kit	TL	Yes	AG
192	10/7/2014	5HV	2335	729659	4850328					Amanda Ciurej		AG
193	10/7/2014	7XC	2335	729661	4850343					Amanda Ciurej		AG
194	10/7/2014	134	2335	727328	4850747	034*326*624	14-019	Male	different animal than 5FX	TL	Yes	AG
195	10/7/2014	5FX	2335	727336	4850760					TL		AG
196	10/7/2014	4IT	2354	729661	4850337					Amanda Ciurej		AG
197	10/7/2014	1DW	2355	728305	4851144	055*600*328	14-004	Male		TL	Yes	AG
198	10/7/2014	4FW	2359	727481	4848895	034*048*539	14-018	Male	Recapture	CJ Woodard	Yes	AG
199	10/7/2014	99A	2359	729730	4850080					Amanda Ciurej		AG