Translocating prairie dogs: a review

Joe C. Truett, Jo Ann L. D. Dullum, Marc R. Matchett, Edward Owens, and David Seery

Abstract Prairie dogs (*Cynomys* spp.) have declined greatly in abundance during the past century, and this warrants efforts to restore populations. Restoration often requires translocating animals to previously occupied areas. Workers should follow standard protocols for animal handling and care. Translocation involves selecting source populations and release sites, capturing and transporting animals, preparing release sites with attendant soft-release infrastructure, and monitoring and managing animals. Source populations should be free of plague and genetically appropriate for the translocation strategy. Release sites ideally have physical or historical evidence of previous occupancy, but also may be selected based on soils, slope, and vegetation. Capture, transport, and release of animals must comply with federal, state, and local regulations. Animals have been commonly captured with live traps, by flooding their burrows, or by using a specially adapted vacuum truck; those captured in plague-prone areas are treated to control fleas. Captives usually are hauled to release sites in covered pickup truck beds or trailers. High-quality release sites have short vegetation (<12 cm tall) and pre-existing burrows; sites without these qualities may need modification. Retention baskets or fenced enclosures, sometimes combined with artificial underground nest chambers, have been used to reduce dispersal and predation. Control of predators may be needed prior to or following release. Post-release monitoring to detect and remedy potential problems such as dispersal and predation is recommended, and providing a food subsidy may reduce dispersal and elevate survival.

Key words capture, *Cynomys,* prairie dog, release, restoration, translocation, transport

All 5 species of prairie dog (*Cynomys* spp.) have disappeared over large portions of their former ranges (Miller et al. 1994). The Mexican prairie dog (*C. mexicanus*) currently is listed as endangered (Mellink and Madrigal 1993) and the Utah prairie dog (*C. parvidens*) as threatened (Ackers 1992). The National Wildlife Federation (1998) recently introduced a petition to list the black-tailed prairie dog *(C. ludovicianus)* as threatened. Conservation of prairie dogs has high priority among grasslands management issues (Miller et al. 1994). Past efforts to conserve prairie dogs have relied partly on translocating animals to supplement small populations or to restore extirpated ones (United States Fish and Wildlife Service 1991, McDonald 1993, Robinette et al. 1995). Translocations undoubtedly will continue to play an important role in recovery of prairie dog populations.

Reports of translocations usually have involved Utah prairie dogs (e.g., Jacquart et al. 1986, McDonald 1993) or black-tailed prairie dogs (e.g., Truett and Savage 1998). Utah prairie dogs represent the subgenus Leucocrossuromys, which also includes white-tailed *(C. leucurus)* and Gunnison's (*C. gunnisoni*) prairie dogs. The black-tailed prairie dog is closely allied with the Mexican prairie dog in the subgenus Cynomys (Hall 1981). Behavioral and ecological differences exist between the subgenera

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(Tileston and Lechleitner 1966, Campbell and Clark 1981). Because a member of each subgenus has been translocated, we expect existing information to apply reasonably well to all 5 species.

Groups of Utah and black-tailed prairie dogs translocated to sites without pre-existing burrows typically have exhibited survival rates of 0–40% during the few months following release (Lewis et al. 1979; Jacquart et al. 1986; Dullum and Durbian 1997*a*,*b*). Dispersal, predation, poor habitat quality, and sometimes other factors have contributed to losses of translocated animals. The purpose of this review is to compile what has been learned about translocating prairie dogs as a basis for experimenting with alternative methodologies and improving the success of future translocation efforts.

General handling and care of prairie dogs

Standardized procedures for acquiring, transporting, holding, quarantining, and euthanizing prairie dogs should be observed during translocation operations. The United States Fish and Wildlife Service protocols for using prairie dogs in black-footed ferret (*Mustela nigripes*) recovery programs (Marinari and Williams 1998) are applicable.

For capture, these authors recommend wire-mesh traps deployed in prairie dog colonies believed to be free of sylvatic plague on the basis of carnivore or small-mammal seroprevalence assessments, flea sampling, or prairie dog activity surveys. To protect handlers against plague, carbaryl, permethrin, or another appropriate pulicide (Barnes 1993) should be applied routinely to kill fleas on captured animals before the animals are handled (Coffeen and Pederson 1993). Unweaned juveniles or lactating females should not be translocated but released immediately (Marinari and Williams 1998). During trapping and subsequent transplant to release sites, animals must be protected from extreme temperatures and adverse weather conditions.

Cages used to transport animals or hold them in quarantine should be sheltered and large enough to allow for postural adjustment (Marinari and Williams 1998). Segregation of overtly aggressive adults (usually males) should be done as the need becomes apparent. Holding 20–30 animals of mixed sexes and ages in single cages usually results in little apparent intraspecific strife even when the animals come from several different coteries (extended-family groups; J. C. Truett, unpublished data). Fresh water and food (laboratory rodent chow or low-sodium cattle cake) should be provided *ad libitum* (Marinari and Williams 1998). All caged animals should be visually examined daily for signs of injury or disease. Bedding material should not be used in cages. Wire mesh on cage bottoms should be <2.5 cm × 2.5 cm to prevent small prairie dogs from getting their hind feet caught in mesh openings (J. C. Truett, unpublished data).

To guard against introducing plague into release areas, animals potentially infected with plague should be held in quarantine at least 14 days. Cages in quarantine facilities should be suspended by wires or chains 0.5–1.0 m off the ground and separated from adjacent cages ≥60 cm. New animals must not be added to cages or adjacent cages during the quarantine period. Prairie dogs that die within the 14-day period should be necropsied and tested for plague, and the remaining animals in the cage and adjacent cages held an additional 14 days if plague is diagnosed (Marinari and Williams 1998).

Animals requiring euthanization because of injuries, need for necropsy, or other reasons should be killed humanely and without leaving chemical residues (Marinari and Williams 1998). Carbon dioxide asphyxiation and cervical dislocation performed by trained personnel are acceptable methods. Animals that become sick during translocation should be euthanized and, along with animals dying inexplicably, submitted to a veterinary pathologist for necropsy. Testing for plague is the primary objective, but determining other causes of sickness or death is highly desirable.

Plague in humans is readily treatable in the early stages and usually is contracted from other than prairie dogs or their fleas (Barnes 1993). However, to guard against potentially dangerous delay in diagnosis and treatment, those who will handle prairie dogs should establish contact with a physician who has had previous experience with plague cases. They should inform the physician of the work situation and follow his or her advice about how best to prevent exposure to plague and how to respond to the onset of plague-like symptoms.

Selection of source populations

Planning translocations requires selecting one or more source populations from which to obtain animals. Three items to be considered in making such selections are disease risks, genetics of the populations, and legal and political constraints.

Disease risks

Sylvatic plague, caused by the bacterium *Yersinia pestis*, probably is the most important threat to prairie dog populations (Barnes 1993, Cully 1993). It typically kills most or all animals in colonies it infects (Cully 1993, 1997; Cully et al. 1997). It can be introduced unintentionally if translocated animals harbor infected fleas. Risks of importing plague during translocations can be minimized by evaluating source populations and areas for presence of plague.

In plague-prone areas, a standard reconnaissance procedure entails collecting carnivores, usually coyotes (*Canis latrans*), and evaluating their blood for plague antibodies (Williams et al. 1992). However, such a strategy does not indicate whether plague is present in prairie dogs, and direct ways of evaluating source populations for occurrence of plague also are advisable. Visual counts (Severson and Plumb 1998), repeated under similar conditions, will usually enable one to assess whether populations are rapidly and unexplainably declining, which, along with plague-positive prairie dog carcasses (Williams et al. 1992), can signal presence of plague. In high-risk situations, quarantine of animals for 14 days prior to their release may be appropriate (Marinari and Williams 1998).

Genetics considerations

Genetic variability among prairie dog populations, a potentially important consideration when selecting a translocation source, may be evaluated based on morphometric and electrophoretic criteria. Two species, black-tailed and Gunnison's prairie dogs, historically were separated by morphometric criteria into 2 subspecies each; the 3 other species were considered monomorphic (Hall 1981). Morphometric (Hansen 1977, Chesser 1983*a*) and electrophoretic (Chesser 1983*b*) studies of black-tailed prairie dogs suggest substantial variability among populations, sometimes even within the same geographic region, but these studies reject the subspecific geography described historically for this species. Studies of Utah prairie dogs have shown little genetic variation among the populations studied (Chesser 1984).

Implications of genetic variability for translocations are not always clear. In New Mexico, for example, where populations of both the historically delineated subspecies of black-tailed prairie dog still exist, and where several genetically distinct populations exist according to Chesser's (1983*a*,*b*) analyses, the Department of Game and Fish discourages long-distance translocations (G. Schmitt, New Mexico Department of Game and Fish, personal communication) that might homogenize populations. On the other hand, the Utah Division of Wildlife Resources encourages mixing of disjunct populations of Utah prairie dogs so as to reduce inbreeding (McDonald 1993). Some states have policies governing the transport of animals across political borders (see below), but to our knowledge none has written protocols to regulate translocations based on population genetics.

Legal and political constraints

Translocations from source populations to release sites must comply with government regulations. Until very recently, prairie dogs almost universally were considered pests in states where they occur (Mulhern and Knowles 1997), and partly for this reason, regulatory barriers to their transport into or within states may exist. For example, New Mexico requires quarantine and strong justification for importing prairie dogs (V. Lopez, New Mexico Department of Game and Fish, personal communication), and proposals to reintroduce black-tailed prairie dogs into Arizona, where they historically were extirpated, have been hindered by political opposition (W. Van Pelt, Arizona Game and Fish Department, personal communication). In some areas, intrastate translocations require permits or are prohibited; for example, county commissioners in Colorado must approve importation of prairie dogs into their respective counties (K. Kinney, Colorado Division of Wildlife, personal communication).

Selection of release sites

Translocated prairie dogs have been released at sites with and without existing populations. Releases at unoccupied sites (e.g., Player and Urness 1982, Jacquart et al. 1986, Truett and Savage 1998) probably have been most common, but follow-up releases to augment small populations that already have established burrows have been applied in some translocations of Utah prairie dogs (Jacquart et al. 1986, Ackers 1992) . We primarily address releases at unoccupied sites.

The best practical indicator of suitable habitat quality at potential release sites is visible evidence of previous occupancy by prairie dogs (Jacquart et al. 1986, Ackers 1992, Truett and Savage 1998).

Recently abandoned burrows indicate presence of suitable vegetation and soils; they also offer released animals immediate protection from predators (Jacquart et al. 1986, McDonald 1993) and dampen dispersal (Jacquart et al. 1986). Colonies eliminated by plague can be successfully repopulated within a few months if burrows are treated with an effective pulicide (D. Seery, unpublished data). Long-abandoned burrows may have few or no visible openings (Jacquart et al. 1986, Truett and Savage 1998) and thus are less suitable than recently occupied burrows, but prairie dogs are adept at locating even old, plugged burrow systems (Jacquart et al. 1986).

Another indicator of potentially suitable habitat is historical evidence that prairie dogs existed at sites. Records of federal eradication programs or interviews with individuals who distributed toxicants may help in delineating locations of long-extinct colonies (Oakes 2000).

Without visible or historical evidence that prairie dogs previously occupied a site, edaphic, topographic, and vegetative criteria derived from measures at known colony locations may be used to estimate site suitability. United States Fish and Wildlife Service (1991) and Coffeen and Pederson (1993) provide such criteria for selecting transplant sites for Utah prairie dogs, and Reading and Matchett (1997) provide criteria for black-tailed prairie dogs. In general, both species require sites with deep and well-drained soils of sandy loam to loam clay texture. Both species avoid shallow and sandy soils. Black-tailed prairie dogs prefer slopes <6% (Reading and Matchett 1997); such small slopes have not been suggested as a requirement for Utah prairie dogs (Coffeen and Pederson 1993) or other species. Black-tailed (Hoogland 1995) and Mexican (Mellink and Madrigal 1993) prairie dog colonies typically have vegetation low enough for good horizontal visibility by the animals (~12 cm or lower); taller plants can be tolerated only if spaced widely. Utah prairie dogs likewise benefit from low-stature vegetation (Player and Urness 1982, McDonald 1993). Black-tailed prairie dogs differ from Utah, white-tailed, and Gunnison's prairie dogs in that, once established, they extensively clip the vegetation to help maintain its low stature (Tileston and Lechleitner 1966, Hoogland 1995).

Remote sensing may help to delineate suitable transplant sites. Both color-infrared (CIR) and black-and-white aerial photography are cost-effective tools to delineate existing prairie dog colonies (Schenbeck and Myhre 1986). Color-infrared photography also can help analysts delineate potential habitat (Dalsted et al. 1981, Schenbeck and Myhre 1986).

Vegetation change may have severely degraded the quality of habitat at historically occupied sites. Woody plants (McDonald 1993) or tall grasses (Osborn and Allan 1949) may dominate sites that once were short-stature grassland. Remedial actions to remove shrubs or reduce height of shrubs or grasses may be required to render such habitats suitable for prairie dogs (Player and Urness 1982, Truett and Savage 1998).

Landowner aversion to prairie dogs may render sites near or on private lands unsuitable as release sites. Site-selection criteria for releases of Utah prairie dogs (United States Fish and Wildlife Service 1991) call for a 1.6-km distance or a structural barrier between release sites and private land. In some cases where prairie dogs have been translocated to private ranches in New Mexico, even more extreme distances and barriers have been used to prevent dispersal of black-tailed prairie dogs to neighboring ranches (J. C. Truett, unpublished data.).

The distance of a potential release site from existing prairie dog colonies is important when translocations are designed to help build colony complexes. Maximum distances between colonies may be determined by estimated dispersal distances of prairie dogs (Knowles 1985) or black-footed ferrets (Bevers et al. 1997).

Capture and transport

Capture

Three methods have been used to capture prairie dogs: live trapping, flooding of burrows, and using a vacuum truck. Live trapping probably is the most commonly applied method, and Marinari and Williams (1998) judged it to be the most humane of the conventional capture methods.

Details of successful live trapping are offered by numerous investigators (e.g., Coffeen and Pederson 1993, McDonald 1993, Hoogland 1995). Single- or double-door wire mesh traps, often Tomahawk or Havahart brand, are used commonly. Prebaiting for several days or more with traps in place but wired open increases trapping success. Bait choices include horse sweet-feed mix, peanut butter, rolled oats, and other attractants (Coffeen and Pederson 1993; Robinette et al. 1995; D. Seery, unpublished data), but in terms of trapping success, bait type may be less important than prebaiting. Live trapping should be conducted in the absence of large herbivores if possible because cattle may trip doors of traps and remove flagging, horses may damage traps by pawing, and bison may crush traps by wallowing on them (M. R. Matchett, unpublished data; J. C. Truett, unpublished data).

Flooding for capture entails filling burrows with water, usually with a detergent added, and noosing the animals or catching them by hand when they emerge (McDonald 1993; D. Seery, unpublished data). It requires a copious water source and thus often is unsuitable for remote areas. Private citizens' groups often use this method to capture and remove prairie dogs from areas slated for urban development (D. Seery, unpublished data; K. Kinney, Colorado Division of Wildlife, personal communication). Some agencies initially tried flushing but abandoned it in favor of live trapping because of its logistics requirements and suspected role in the drowning of prairie dogs (McDonald 1993).

An individual from Cortez, Colorado, has for several years used a modified street-sweeper truck to capture prairie dogs (G. Balfour, Cortez, Colorado, personal communication). Using a 10-cm flexible hose running from the vacuum chamber of the truck into burrows (Figure 1), 2 operators under appropriate conditions can capture 100 or more animals/day. Rate of capture is much greater in summer than in winter.

In all prairie dog species, capture and translocation of coterie members as coherent units probably minimizes stress and post-release dispersal. Strong social bonds exist among coterie members of black-tailed prairie dogs (Hoogland 1995), and the spatial sorting and intensification of social signaling that occur upon release of animals at a site (Truett and Savage 1998) suggest attempts to reestablish coterie unity. Disruption of social units of Utah prairie dogs may be less important (Ackers 1992).

The best mix of sexes and ages of animals for translocations may vary with location, time of year, and species. Jacquart et al. (1986) found that juvenile and adult female Utah prairie dogs released in May and June exhibited lesser survival than males, apparently because cold, wet weather depleted the energy reserves of the former. Juvenile black-tailed prairie dogs dispersed less commonly than adults when 70 animals of mixed sexes and ages were released in early summer at a site in southern New Mexico (J. C. Truett, unpublished data).

Immediate treatment of captured animals to control fleas is conventional practice in regions known to harbor plague. Before transport of animals, workers commonly dust them with a nonpersistent pesticide such as carbaryl (Coffeen and Pederson 1993, Marinari and Williams 1998) or a more persistent one such as permethrin (Durbian et al. 1997).

Transport

Workers often transport prairie dogs in pickup truck beds or horse trailers (Coffeen and Pederson 1993; M. R. Matchett, unpublished data; J. C. Truett, unpublished data). In warm weather, care must be taken to prevent overheating, and in cold weather animals wet from rain or snow should be dried or kept warm to prevent hypothermia. Well-ventilated camper shells or trailers that block the sun, rain, and wind are appropriate protection. Hauling animals at night is recommended if overheating from direct sun or high daytime temperatures are a potential problem. Feeding fresh vegetables in transit helps offset stress; carrots, small-end-down and wedged through the tops of wire-mesh traps or cages, offer a relatively sanitary way of feeding animals in transit.

Figure 1. Vacuum truck capturing prairie dogs from burrows near Denver, Colorado. The senior author's observations of this truck in operation suggest that prairie dog mortality rates from this capture method probably are roughly comparable to those from other methods.

Site preparation and soft-release options

Release sites normally are prepared well in advance of animal captures. Commonly, site preparation includes treatment to reduce height of tall vegetation and, where burrows in good condition are absent, installation of soft-release devices to reduce dispersal and enhance survival. Appropriate methodologies will vary with circumstances, budgets, and expectations about loss rates.

Vegetation height

Regardless of the release strategy anticipated, sites where dominant plants are taller than ~12 cm should be treated to reduce vegetation height. Potential treatments include mowing, grazing, burning, "rotobeating," "railing," and applying herbicides (Player and Urness 1982, Truett and Savage 1998). Almost all ungrazed or lightly grazed sites except those dominated by blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), and other short-grass species will require treatment, as will sites where shrubs severely restrict visibility at prairie dog height.

Sites with pre-existing burrows

Sites with unoccupied burrow systems in good condition usually require little preparation other than control of tall vegetation, and in such cases soft-release devices may be unnecessary. Animals hard-released directly into pre-existing burrow openings appear to disperse at lesser rates and survive better than those released in the absence of natural burrow systems, often even when soft-release techniques are used in the latter (Ackers 1992, Robinette et al. 1995, Dullum and Durbian 1997*a*).

Starter burrows and retention baskets

"Starter burrows," 7-13 cm in diameter and augered at angles of ~45° into the ground, have been used alone or in combination with welded-wire or hardware-cloth "retention baskets" to discourage dispersal of released animals and offer them temporary protection from predators. The rate of dispersal of one small group of black-tailed prairie dogs from starter burrows was 100% when retention baskets were not used (D. Seery, unpublished data). Retention baskets with holes in the bottoms placed directly over starter-burrow entrances delayed escape of released Utah and black-tailed prairie dogs for a few hours to a few days (Jacquart et al. 1986; Dullum and Durbian 1997*a*; D. Seery, unpublished data) and apparently reduced dispersal tendencies (Lewis et al. 1979; Jacquart et al. 1986; D. Seery, unpublished data). But even when retention baskets were used, >60% of Utah (Jacquart et al. 1986) and black-tailed (Lewis et al. 1979) prairie dogs usually disappeared from the immediate area within a few weeks. Rarely were starter burrows themselves used as activity centers by black-tailed (M. R. Matchett, unpublished data) or Utah (Jacquart et al. 1986) prairie dogs for more than a few days after the prairie dogs escaped from retention baskets.

Acclimation cages

During 1998-2000, the Turner Endangered Species Fund tested, in New Mexico and South Dakota, a soft-release method whereby translocated black-tailed prairie dogs were held 5-15 days in escape-proof acclimation cages (J. C. Truett, unpublished data). The cages consisted of nest chambers buried 0.4-1.0 m below ground level and connected to above-ground retention baskets (Figure 2) by

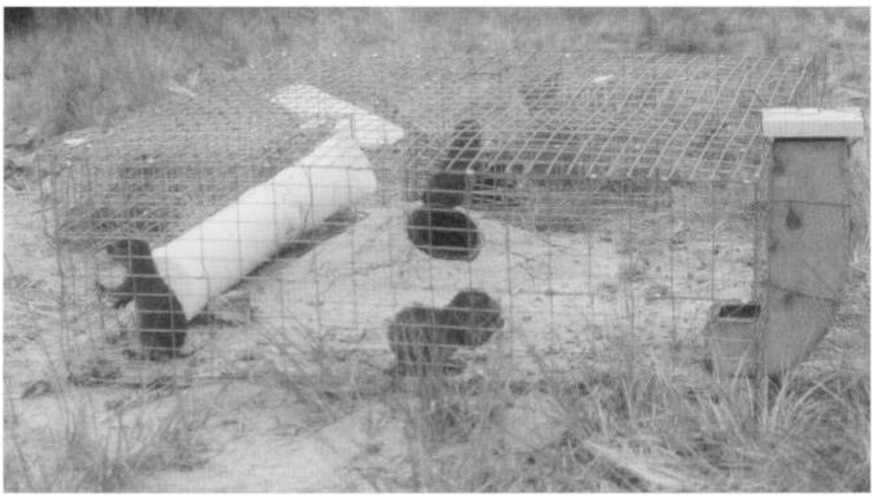

Figure 2. Retention cage to acclimate translocated prairie dogs to release site. This cage is connected to a subsurface nest box by a flexible sewer pipe, the entrance to which appears in the cage center. These juvenile black-tailed prairie dogs ate food (from dispenser at right) and drank water (from plastic pipe drinker at left) the first day of their introduction to the cage.

10-cm (4-in) flexible drain pipe. Dry food and water were provided *ad libitum* in the retention baskets. Workers released the animals by removing the retention baskets. Most of the animals continued using the nest chambers (for several months to a year in some cases) as activity centers while they excavated new burrows nearby. Except for occasional predation by badgers (*Taxidea taxus*) or coyotes, 40–50% of the animals released typically remained alive at release sites after 1 to 2 months. Twenty-five new colonies were established in this manner; all that survived >1 year produced young.

Fenced enclosures

Fenced enclosures have been used with varying levels of success. The more successful enclosures had ground-level barriers to discourage prairie dogs from digging under fences.

Lewis et al. (1979) attempted to prevent dispersal by black-tailed prairie dogs released in Oklahoma by erecting a 0.9-m-high chicken-wire fence of 2.5-cm mesh around a large enclosure. These workers anchored the bottom 6 cm of the fence to the ground as an inside apron and left the top 0.3 m unattached. Later they extended the inside apron with additional wire and partially covered it with soil. Some prairie dogs bypassed the fence despite these adjustments, usually by crawling between the apron and the ground.

On historic, degraded black-tailed prairie dog colony sites in New Mexico, Truett and Savage (1998) built 4 enclosures, each ~0.4 ha in size, of 0.9-m-wide, 2.5-cm mesh chicken wire. The top one-third of the perimeter fences remained unattached and leaned inward. An interior apron of the same kind of wire had the inner half of its width buried as a U-shaped loop in a 10-cm-wide by 25-cm-deep trench (Figure 3). Electrical wires paralleled the fences 10 cm above the ground inside (to repel prairie dogs) and outside (to repel badgers). Apparently no prairie dogs escaped during the first few months except through fence apertures intentionally made or via pre-existing prairie dog tunnels beneath the fence footing. Observers found no sign that badgers had been inside or attempted to enter during the 1 to 2 years the fences remained in place, although badger excavations and tracks were observed immediately outside some of the fences during this period.

Dullum and Durbian (1997*a,b*) released black-tailed prairie dogs into 2 types of enclosures: 1) a 3 × 3-m pen constructed of 1.2-m-high fences of fiberglass greenhouse panels with a 0.5-m-wide chicken-wire apron inside and 2) a 10.6 × 10.6-m pen constructed of 0.9-m-wide chicken wire with a 0.3-m-wide chicken-wire apron at bottom on the inside and the fence folded inward at the top. The 5 animals released into the "panel" enclosure escaped within a day, apparently by digging beneath the panels. Most of 16 animals released into the chicken wire enclosure escaped within 2 days, apparently by climbing out at corners.

Figure 3. Construction of chicken-wire apron to prevent prairie dogs from digging under perimeter fence of enclosure. This apron, which will join the bottom of an upright fence attached to the posts, loops down into a narrow trench.

Supplemental food and water

Providing supplemental food and water in retention cages probably decreases stress and dampens post-release dispersal tendencies. Truett and Savage (1998) provided commercial rabbit pellets and water *ad libitum* to animals released inside chicken-wire enclosures, and J. C. Truett (unpublished data) provided cattle cake or commercial breeder rabbit pellets and water to animals held inside retention cages (Figure 2). In both cases, prairie dogs began eating the supplement the first day and daily consumed substantial amounts of food and water thereafter.

Post-release monitoring and management

The period immediately following release of animals unrestrained into a new area is critical to the success of the translocation. During this period the dispersal tendency is strong, particularly if the translocated animals have had little time to acclimate to the new area (Lewis et al. 1979, Jacquart et al. 1986). Also, unless the animals have been released in their exact original family groups (which often is impractical), they face social disorientation (Hoogland 1995). If natural burrow systems in good condition are absent, released animals must spend much energy and weeks to months of time excavating secure burrows (Jacquart et al. 1986, Truett and Savage 1998). These factors predispose the released animals to short-term losses caused by dispersal, predation, and cold temperatures or other weather extremes. They become more resilient to these sources of disturbance as time passes, stress subsides, and burrow systems become better developed (Jacquart et al. 1986).

Monitoring new releases is important to the success of current and subsequent release efforts. Periodic observations can be made from elevated points (Player and Urness 1982). The approach to and intensity of monitoring may vary from daily radiotracking of released animals (Jacquart et al. 1986) to daily counts of animals observed aboveground (Jacquart et al. 1986, Player and Urness 1982) to seasonal censuses (McDonald 1993). Because released animals are most vulnerable to losses early in the release period, efficiency often dictates that monitoring frequency should decline sharply with time after release (e.g., Player and Urness 1982).

Monitoring distribution, abundance, and quality of new burrows gives insight about security of released animals. The number of extensive burrows (i.e., those with large volumes of soil excavated) is more important than total number as an index of security against predation and overwinter temperature extremes (Jacquart et al. 1986).

Monitoring should include reconnaissance for signs of predation or predators. Prairie dog carcasses or remnants thereof may suggest whether a predator, and which predator, was involved. Visible signs of reaming of new burrows commonly is associated with badger predation (McDonald 1993). Once a badger or badgers begin preying on animals at a new release site, the entire contingent of animals is at extreme risk unless the site had preexisting and extensive burrows (Jacquart et al. 1986, Coffeen and Pederson 1993).

If predators are common in release areas, prerelease control of at least mammalian predators may be advisable. Badger control helps protect new colonies of Utah prairie dogs, and control or harassment of other predators has accompanied some releases (Jacquart et al. 1986). Badgers often return after initial predation successes and, unless removed, may ultimately eliminate most or all animals at a release site (Jacquart et al. 1986, McDonald 1993).

Fences enclosing release sites can be constructed to repel predators. Truett and Savage (1998) repelled badgers and coyotes with chicken-wire fencing reinforced with electrical wires. Matchett (1999) surrounded prairie dog colonies in Montana with electric fence netting to temporarily protect black-footed ferrets from mammalian predators; the prairie dogs thereby also were protected. Enclosures (5 to 8 ha) of electrical smooth-wire fencing, similar to those used by Lokemoen et al. (1982), repelled badgers and coyotes (J. C. Truett, unpublished data). Even if fencing is not totally predator-proof, it may reduce mammalian predation sufficiently to allow a colony to establish itself.

Supplemental food provided at release sites probably reduces dispersal and predation. Providing food in pelleted form (commercial guinea pig or rabbit food) or block form (sodium-free cattle cake), along with water, has since 1997 accompanied releases of some black-tailed prairie dogs (J.C. Truett, unpublished data). The prairie dogs readily consumed these foods, both in small retention cages and in larger enclosures. Once released into the wild, the animals repeatedly returned to the food between exploratory forays. Released animals excavated new burrows near food in preference to using sites farther away, which probably reduced vulnerability to predation.

Vegetation management may be needed to promote expansion of newly established colonies. Reducing height of tall vegetation, as recommended previously for colony establishment, probably is the most commonly cited management need (McDonald 1993, Klukas 1998). As colonies grow and the required size of areas that need treating expand, livestock grazing and fire may become more cost-effective than mechanical or chemical methods of vegetation management (Player and Urness 1982, Cable and Timm 1988, Klukas 1998).

Under some circumstances, grazing may over time reduce rather than enhance habitat quality by stimulating increases in woody plant abundance (McDonald 1993).

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