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BLACK-FOOTED FERRET (*MUSTELA NIGRIPES*)

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Among the rarest of New Mexico's carnivores, the black-footed ferret (*Mustela nigripes*) is at the center of one of the most compelling wildlife conservation stories in our state and elsewhere. Infrequently observed even before range-wide declines throughout the 20th century and eventual extirpation in the wild in 1987, the species was twice presumed extinct by wildlife biologists. In 1979, it appeared to have been lost after what was then thought to be the last surviving black-footed ferret—a female retrieved from the wild in Mellette County, South Dakota for a captive breeding program—died that year. Two years later, in 1981, another surviving, and indeed the last known, wild population of black-footed ferrets was discovered near Meeteetse, Wyoming. This population has since disappeared, but not before 18 individuals were captured and placed into a captive breeding program. Today, thanks to the dedicated work of numerous wildlife biologists, husbandry experts, and conservation advocates, the species is making a slow and difficult comeback in several western states through the implementation of captive propagation and reintroduction efforts. In 2012, New Mexico became the latest state to attempt the repatriation of the black-footed ferret to its former range, though it remains to be seen whether the species' return to the "Land of Enchantment" succeeds. As later told in this chapter, important challenges continue to confront reintroduction efforts.

The family Mustelidae is comprised of some of the most diverse and specialized carnivores, and within that family the black-footed ferret is more specialized than most (Anderson 1989). A species native to the North American continent, it is a long-bodied, short-legged, and relatively small carnivore but is larger than both the American ermine (*M. erminae*; Chapter 21) and the long-tailed weasel (*Neogale frenata*; Chapter 22). Adults are 480–610 mm (19–24 in) in total length with a 110–140 mm (4–6 in) tail, and weigh 600–1,400 g (1.3–3 lbs); females average 68% of male body weight and 93% of male body length (Anderson et al. 1986). The short, sleek fur is yellowish buff (occasionally whitish) on the upper parts of the body, becoming darker on the middle of the back, and grading to white on the belly and throat, and on much of the face. There are no color morphs. The pelage may become somewhat longer during the cold months of the year, but individuals do not develop the white pelage exhibited during winter by either the American ermine or the long-tailed weasel (Biggins 2000; see Chapters 21 and 22). A blackish mask extends between and encircles the eyes and is most defined in young individuals. The feet, legs, and tip of the tail are black (Clark 1999; Svendsen 2003; Photo 22.1)

Among other mustelids in North

Figure 22.0. (*opposite page*) Photo © David A. Eads.

Photo 22.1. Captive black-footed ferret. Note the long body and short legs, the black feet, legs, and tip of the tail, and the black mask extending between and encircling the eyes, Photograph: © Kimberly Fraser/ US Fish and Wildlife Service.

Photo 22.2. Black-footed ferrets have distinctive black face masks that contrast with surrounding whitish fur on the sides of the head, the muzzle, and the throat. Photograph: © Kimberly Fraser/US Fish and Wildlife Service.

America, the black-footed ferret most closely resembles the long-tailed weasel, which is widespread and fairly common in New Mexico (Chapter 23). Throughout much of the state, the long-tailed weasel, particularly the "bridled" (masked) morph, has a striking black-and-white face mask and, often, a tawny body color similar to that of the black-footed ferret, but lacks the black feet of its close relative (Photo 22.3). Weasels are also considerably smaller (300–350 mm [12–14 in] in total length) and are commonly found in rocky or wooded areas, atypical habitat for black-footed ferrets. Nonetheless, the two species have remarkably convergent color patterns and can be easily mistaken for one another, especially when observed only briefly. This similarity of appearance accounts for the many reports of black-footed ferrets in New Mexico that actually turn out to be sightings of long-tailed weasels.

The black-footed ferret also resembles the domestic ferret, the non-native and popular domesticated form of the European polecat (*Mustela putorius*). Now widely distributed via captive breeding and the pet trade, the domestic ferret occasionally escapes or is released from captivity and, though no breeding population is known to be established anywhere in New Mexico, it has been found on rare occasions in the wild in the state (NMDGF, unpubl. data). The European polecat is comparable in size to the black-footed ferret but usually lacks its distinctive face mask and color pattern. As a result of selective breeding, however, the domestic ferret can exhibit a variety of color patterns and could potentially be mistaken for our native ferret species (Photo 22.4).

Although similar in appearance to the long-tailed weasel, the black-footed ferret is only distantly related to other mustelids in North America and has been assigned to the subgenus *Putorius*, allying it instead with the Old World polecats (Abramov 2000; Wozencraft 2005; and see Chapters 23 and 24 for a discussion of recent taxonomic changes in the genus *Mustela*). Many of the 17 recognized subspecies of the Eurasian steppe polecat (*M. eversmanni*) bear a striking resemblance to the black-footed ferret, and in fact *M. eversmanni* is the black-footed ferret's closest relative, with fossil records suggesting the two species diverged between 0.5 and 2 million years ago (Wisely 2005). Hoffmann and Pattie (1968) considered the steppe polecat and the black-footed ferret to be "ecological equivalents" in that they serve similar functions in

separate biological communities. Biggins et al. (2011) somewhat disagreed by stating that the steppe polecat could not be substituted for the black-footed ferret. Nonetheless, the similarity between the two species led to the use of steppe polecats and steppe polecat–black-footed ferret hybrids as surrogates for *M. nigripes* in early research on the North American species (Biggins et al. 2011).

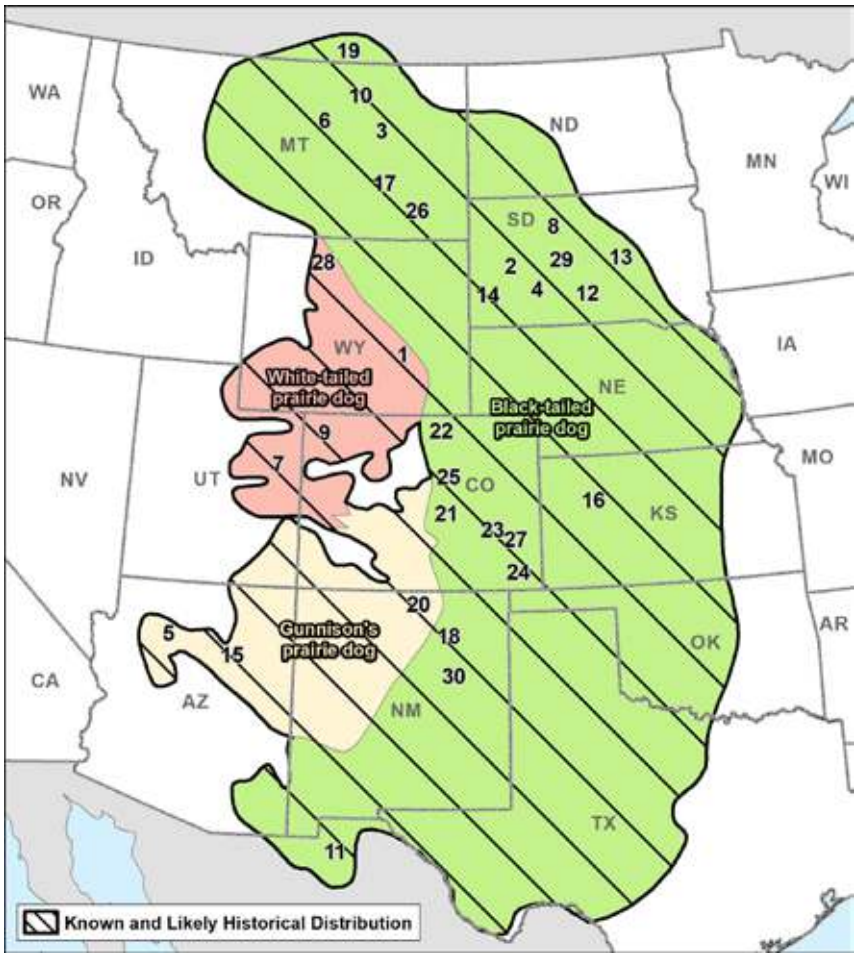
Despite the species' formerly extensive range, morphological variation might have been lacking among historical populations of *M. nigripes*, to the point that no subspecies have been described (Hillman and Clark 1980; Wozencraft 2005). Genetic differentiation existed between historical Great Plains and Wyoming metapopulations, with restricted gene flow even before the black-footed ferret's decline in the 20th century (Wisely 2005). The loss of the Great Plains core population and population bottlenecks elsewhere were later reflected in a remarkable lack of genetic diversity in the Meeteetse, Wyoming population and may account for the failure of the first captive breeding efforts from 1976–1978 using animals from the Mellette County, South Dakota population (Biggins and Schroeder 1988; O'Brien et al. 1989). All black-footed ferrets that are known to exist today are descended from seven of the 18 individuals captured at Meeteetse during 1985–1987 (Garell et al. 1998). Consequently, both captive and reintroduced populations of black-footed ferret exhibit significantly less genetic variation than existed a mere hundred years ago. Nonetheless, the loss of approximately 90% of the species' genetic diversity has not up to this point manifested itself in reduced fecundity or physiological abnormalities common in inbred populations of other mammals (Wisely 2005). Some morphological differences exist between captive and wild-born black-footed ferrets (e.g., ferrets raised in captivity are smaller and shaped differently than wild ferrets), but reintroduced populations acquire the morphology of ancestral populations, suggesting that these differences are due to environmental rather than genetic factors (Wisely et al. 2002, 2005).

Photo 22.3. Long-tailed weasel (*Neogale frenata*) at the Rio Grande Nature Center in Albuquerque on 30 March 2008. All long-tailed weasels—not just the "bridled" (masked) form represented in this photograph—can readily be mistaken for black-footed ferrets. Photograph: © James N. Stuart.

Photo 22.4. The domestic ferret (*Mustela putorius furo*) is the domesticated form of the European polecat (*Mustela putorius*), a species found in much of the western Palaearctic. Various pelage colors are recognized in the domestic ferret, including sable. Sable domestic ferrets that escape into the wild can be mistaken for black-footed ferrets. Photograph: © Travis Livieri/Prairie Wildlife Research.

DISTRIBUTION

The black-footed ferret is exclusively a North American species. Its range once extended from southern Saskatchewan and Alberta in Canada



Map 22.1. Black-footed ferret (*Mustela nigripes*) historical distribution (known and likely) as the cumulative distribution of the white-tailed prairie dog (*Cynomys leucurus*), Gunnison's prairie dog (*C. gunnisoni*), and black-tailed prairie dog (*C. ludovicianus*). Reintroduction sites (with year of first release; * = still active in fall 2018): (1) Shirley Basin, WY (1991)*; (2) Badland NP, SD (1994)*; (3) UL Bend NWR, MT (1994)*; (4) Conata Basin, SD (1996)*; (5) Aubrey Valley, AZ (1996)*; (6) Ft. Belknap Reservation, MT (1997)*; (7) Coyote Basin, UT (1999)*; (8) Cheyenne River Reservation, SD (2000); (9) Wolf Creek, CO (2001); (10) BLM 40-Complex, MT (2001); (11) Janos, Mexico (2001); (12) Rosebud Reservation, SD (2004); (13) Lower Brule Reservation, SD (2006)*; (14) Wind Cave NP, SD (2007)*; (15) Espee Ranch, AZ (2007); (16) Logan County, KS (2007)*; (17) Northern Cheyenne Reservation, MT (2008); (18) Vermejo Park Ranch #1, NM (2008); (19) Grasslands NP, SK, Canada (2009); (20) Vermejo Park Ranch #2, NM (2012); (21) Walker Ranch, CO (2013); (22) Soapstone Complex, CO (2014)*; (23) North Holly Complex, CO (2014); (24) Liberty Complex, CO (2014); (25) Rocky Mountain Arsenal NWR, CO (2015)*; (26) Crow Indian Reservation, MT (2015)*; (27) South Holly Complex (CO (2015); (28) Meeteetse, WY (2016)*; (29) Bad River Ranch, SD (2017); (30) Wagon Mound (Moore) Ranch, NM (2018)*. Adapted from US Fish and Wildlife Service 2019, with updates provided by J. Hughes (Black-footed Ferret Reintroduction Program).

southward through the Great Plains and Intermontane Basins of the west-central United States to Trans-Pecos Texas (Clark 1989; Map 22.1). The species may also have occurred as far south as northern Chihuahua, Mexico (Miller et al. 1996), though evidence for this is lacking (Findley et al. 1975; Wozencraft 2005). *M. nigripes* appears to be a fairly recent species, the result of immigration of an ancestral form from Asia sometime between 1 and 2 million years ago, followed by diversification in North America (Wisely 2005). The earliest confirmed record of a black-footed ferret in North America, found in Cathedral Cave, Nevada is approximately 750,000–850,000 years old (Owen et al. 2000).

The historical distribution of the black-footed ferret coincides spatially with the combined geographic ranges of the black-tailed (*Cynomys ludovicianus*), Gunnison's (*C. gunnisoni*), and white-tailed (*C. leucurus*) prairie dogs, semi-fossorial colonial ground squirrels that have also experienced significant declines in abundance and distribution over the last century (Anderson et al. 1986; Biggins 2006; Map 22.1; see under "Habitat Associations," below). Prairie dogs are keystone species with which many other taxa have a close ecological relationship, including the black-footed ferret (Kotliar et al. 2006). They are also often viewed by humans as agricultural pests that destroy and consume vegetation; consequently, prairie dogs are frequently destroyed for the sake of livestock grazing in particular. Carr (1986) describes the attempted eradication of the prairie dog as "one of the most diligent vertebrate pest control exercises in history."

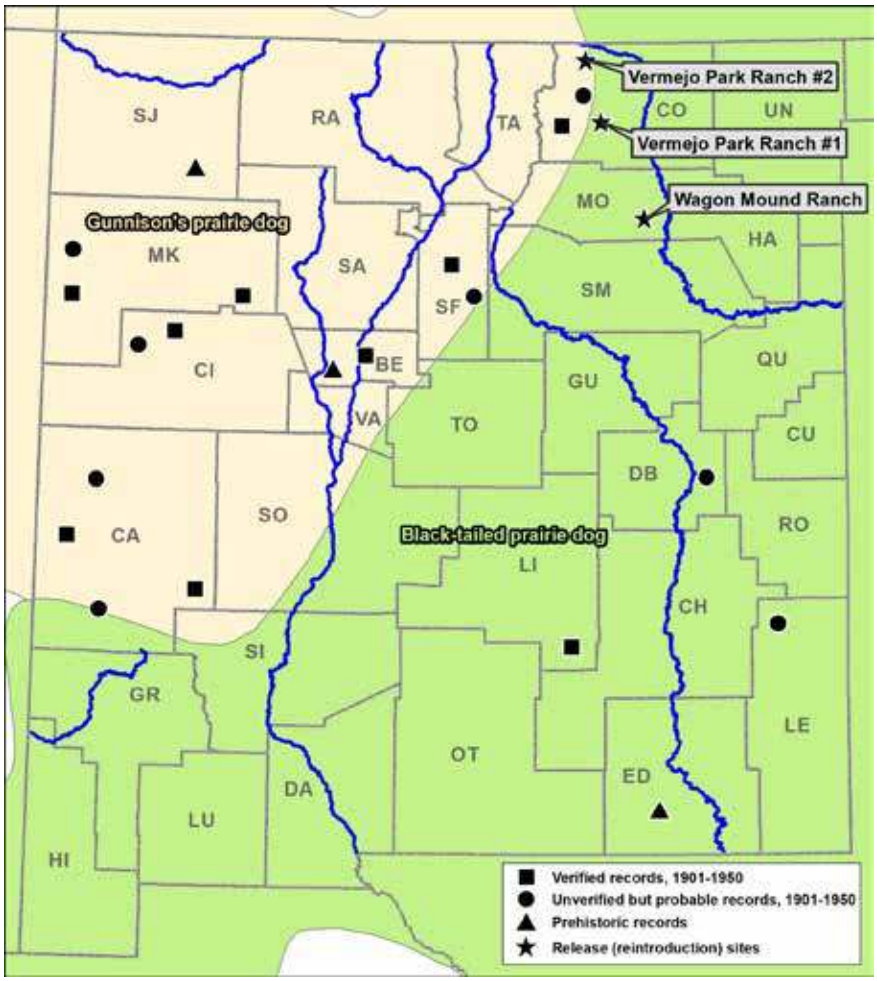
No natural populations of black-footed ferrets are known to persist within the species' historical range, and most populations in the wild were likely extirpated by the 1950s (Lockhart et al. 2006). The proximal causes for the demise and near extinction of the species can be directly attributed to the historical and ongoing widespread eradication of prairie dogs through poisoning; the conversion of native grasslands to cropland; and sylvatic plague (*Yersinia pestis*), a disease threat to both ferrets and prairie dogs (USFWS 2013a). Today, sylvatic plague and limited suitable habitat are considered to be the primary obstacles to the recovery of the black-footed ferret (Jachowski and Lockhart 2009).

In New Mexico, the black-footed ferret was formerly found within the combined geographic ranges of black-tailed and Gunnison's prairie dogs, which encompassed most of the state (Hubbard and Schmitt 1984; Map 22.2). Prehistoric evidence of the species' occurrence in the state during the late Pleistocene has been found in Eddy and Bernalillo counties (see Chapter 1), while the charred remains of black-footed ferrets dating back to 2,000–3,000 BP were discovered in Atlatl Cave in San Juan County (Hubbard and Schmitt 1984). According to Hubbard and Schmitt's (1984) review of the species in New Mexico, those are the only confirmed records of occurrence predating the 20th century in the state (but see below). Specimens and reliable observations from New Mexico nonetheless suggest that the species formerly ranged statewide except for the highest elevations and possibly the southwestern corner south of the Mogollon Plateau (Schmitt 1982; Hubbard and Schmitt 1984; Map 22.2 and Table 22.1). Findley et al. (1975) listed six specimens that had been preserved from New Mexico, most of them from McKinley and Cibola (formerly western Valencia) counties in the western part of the state, and one each from Santa Fe and Chaves counties. Perhaps not surprisingly, most ferret specimens and reliable observations in New Mexico were obtained during the 1920s when a federally sponsored program to eradicate prairie dogs and predators was underway (Hubbard and Schmitt 1984; Anderson et al. 1986). A specimen obtained in 1929 from near Agua Fria in what is now Cibola County, at about 2,400 m (8,000 feet) in elevation, was secured in a Gunnison's prairie dog colony that was being eradicated

with carbon bisulphide gas (Aldous 1940; Hooper 1941). Hubbard and Schmitt's (1984) review identified both verified records based on preserved museum specimens and numerous observation records of varying reliability. Nine preserved specimens are available from 1915 to 1934 whereas no verified specimens have been collected since that time (see Map 22.2 and Table 22.1). Anderson et al. (1986) listed ten extant specimens collected in New Mexico that included both the nine mentioned by Hubbard and Schmitt (1984) and an additional individual identified through a mandible collected in Roswell, Chaves County by Vernon Bailey in 1899. The most recent observations that Hubbard and Schmitt (1984) considered "probable" were of single animals sighted during daytime at Valle Grande, Sandoval County in May 1970 and another near Angel Fire, Colfax County in September 1981; both of these observations were in areas occupied by Gunnison's prairie

Table 22.1. Confirmed and highly probable black-footed records from New Mexico, in chronological order (adapted from Hubbard and Schmitt 1984).

Record (Number)	Date	Sex	Location	Collector
Confirmed (1)	18 March 1915	Male	Catron County; Centerfire Basin	J. Stokley Ligon
Confirmed (1)	1 May 1918	Male	McKinley County; 10 mi NE of Mt. Taylor	J. Stokley Ligon
Confirmed (1)	15 October 1918	Male	Cibola County; 2 mi N. of Bluewater	C. P. Musgrave
Confirmed (1)	22 November 1918	Female	Catron County; Garcia Ranch, 75 mi SW of Magdalena	J. S. Felkner
Confirmed (1)	14 November 1925	Male	Bernalillo County; Albuquerque, 12th St.	J. Stokley Ligon
Highly probable (1)	Summer 1928		DeBaca County; Ben Hall Ranch, SE of Ft. Sumner	Homer Pickens
Confirmed (1)	10 July 1929; killed 28 December 1929	Female	Colfax County, Moreno Valley, Agua Fria area	Shaler E. Aldous
Confirmed (1)	7 1929	Female	Lincoln County; 3 mi S of Picacho	Wharton Huber
Confirmed (1)	31 August 1930	Male	Santa Fe County; 8 mi SW of Santa Fe, near Arroyo Hondo	Theodore E. White
Highly probable (2)	Autumn(?) 1930	Unknown	Colfax County; Vermejo Park Ranch near Castle Rock	Elliot Barker
Highly probable (2)	1931	Unknown	Catron County; 10 mi S., 1.5 mi W. of Quemado	T. J. Lyon
Confirmed (1)	30 October 1934	Unknown	McKinley County; Gallup	M. E. Musgrave
Highly probable (6–8)	1934	Unknown	Chaves and Lea counties; Milnesand-Caprock area	Charles Walter
Highly probable (1)	Autumn(?) 1940	Unknown	Santa Fe County; E. side of Hwy 285 between Lamy and Hwy 85	Howard Campbell
Highly probable (1)	1940	Unknown	McKinley County; between Window Rock, AZ and Mexican Springs	William E. Fair
Highly probable	1941	Unknown	Cibola County; Ramah area	Arnold Bayne
Highly probable	1942	Unknown	McKinley County; Gallup area	Arnold Bayne



Map 22.2. Black-footed ferret historical records and reintroduction sites in New Mexico, relative to the distribution of Gunnison's prairie dogs (*Cynonys gunnisoni*) and black-tailed prairie dogs (*C. ludovicianus*). Note the preponderance of New Mexico ferret records in association with Gunnison's prairie dog.

dogs. No reliable reports of black-footed ferrets have been obtained in New Mexico in recent decades and, despite Hubbard and Schmitt's (1984) optimistic contention that the "species still likely occurs here," it seems more likely that the ferret had been extirpated from the state by the time of their 1984 review.

Although no natural black-footed ferret populations apparently persist today in New Mexico, experimental reintroductions took place at Vermejo Park Ranch in Colfax County and, most recently, also at Wagon Mound Ranch in Mora County. The details of these reintroductions are discussed below under "Status and Management."

HABITAT ASSOCIATIONS

Historically, populations of the black-footed ferret were coexistent with and dependent upon colonies of black-tailed, Gunnison's, and white-tailed prairie dogs (Anderson et al. 1986; Biggins 2006). Two other prairie dog species occur in North America, the Utah (*C. parvidens*) and Mexican (*C. mexicanus*) prairie dogs, but black-footed

ferrets were in contrast never documented anywhere within their ranges (Lockhart et al. 2006). Such is the ecological dependency on black-tailed, Gunnison's, and white-tailed prairie dogs that though dispersing black-footed ferrets are reported in other habitats, no breeding populations have ever been documented anywhere but on colonies of one of those three sciurid rodents (Linder et al. 1972; Forrest et a1.1985). Therefore, much of our understanding of habitat use by *M. nigripes* can be deduced or inferred from historical and current habitat use by prairie dogs.

The available 20th-century distribution records from New Mexico suggest that the black-footed ferret used diverse biotic communities (prairie grasslands, semi-desert grasslands and shrublands, and montane meadows), provided that one of the species of prairie dogs indigenous to the state was present to provide both food and burrow systems for shelter (Hubbard and Schmitt 1984). The most widespread of the *Cynomys* species in North America, the black-tailed prairie dog, occupies both shortgrass prairie and desert grasslands of the xeric Southwest and the more mesic mixed-grass prairie of the Great Plains (Map 22.1). A few populations of black-tailed prairie dogs have also been reported in tall-grass prairie, where vegetation height can impair the ability of prairie dogs to scan for predators or communicate visually. Thus, occupied tall-grass prairie sites require substantial vegetation height reduction (e.g., heavy grazing) for the species to persist. The US Fish and Wildlife Service (2009) estimated that black-tailed prairie dogs once occupied 32–42 million ha (80–104 million acres) in North America (USFWS 2009), encompassing 83% of the black-footed ferret rangewide locality records (Anderson et al. 1986); and that their distribution in North America had been reduced by 2009 to 404,685–809,371 ha (1–2 million acres). In New Mexico, the black-tailed prairie dog was formerly abundant in the eastern and southern portions of the state (Hubbard and Schmidt 1984; Oakes 2000; Map 22.2) and occupied 2,687,000–3,622,000 ha (6–8.95 million acres) (Bailey 1931; USFWS 2009). In comparison with estimates of the black-tailed prairie dog's historical distribution in our state, the New Mexico Department of Game and Fish calculated in 2010 that the species now occupies only about 16,592 ha (41,000 acres) in New Mexico, mostly as small colonies on the eastern plains. Only about 11% (one of nine) of the confirmed black-footed ferret records in New Mexico and 29% (two of seven) of the "highly probable" records as defined by Hubbard and Schmitt (1984) originated on black-tailed prairie dog colonies (see Map 22.2 and Table 22.1).

The Gunnison's prairie dog largely replaces the black-tailed prairie dog in distribution from central New Mexico westward into central and northern Arizona, and northward into southeastern Utah and southwestern Colorado (Map 22.1). *C. gunnisoni* occupies more diverse vegetation types than the black-tailed prairie dog, ranging from alluvial river valleys and shrub-dominated plains to plateau grasslands and mountain meadows, up to around 3,660 meters (12,000 feet) in elevation (see Maps 22.1 and 22.2). Compared to black-tailed prairie dogs, Gunnison's prairie dogs are more tolerant of not being able to scan their surroundings for predators, as evidenced by the fact that they often occur in shrub-steppe vegetation communities (Hoogland 1995). Gunnison's prairie dogs historically occupied approximately 9.7 million ha (24 million acres) (USFWS 2008), with colonies of this prairie dog species associated with 5.8% of all rangewide ferret locality records (Anderson et al. 1986). The US Fish and Wildlife Service (USFWS 2008) estimated rangewide occupancy of the black-footed ferret on Gunnison's prairie dog colonies to be between 136,000–200,000 ha (340,000–500,000 acres). In New Mexico, black-footed ferret specimens collected on Gunnison's prairie dog colonies represent 89% (8 of 9) of the confirmed records and 61% (5 of 7) of the "highly probable" records (Hubbard

and Schmitt, 1984; See Map 22.2 and Table 22.1). Approximately 4.1–7.3 million ha (10–18 million acres) of potentially suitable habitat for Gunnison's prairie dogs occur in New Mexico, based on two predictive models (Seglund et al. 2006; Neville and Johnson 2007). However, based on survey data from 2010, the actual occupied acreage in New Mexico is probably substantially less, perhaps only 720,340–1,294,994 ha (1.78–3.2 million acres) (NMDGF, unpubl. data). The difference between occupied and suitable land cover may be due in part to the predictive models overestimating the amount of suitable habitat in the state, or else it may reflect the history of regional decline of Gunnison's prairie dog colonies.

The white-tailed prairie dog, which has habitat requirements similar to those of Gunnison's prairie dogs, does not occur in New Mexico. This species of prairie dog, which was associated with the last known natural population of black-footed ferrets in Wyoming, is found in northwestern Colorado, northeastern Utah, central and western Wyoming, and southern Montana (see Map 22.2). White-tailed prairie dogs historically occupied 17–20 million ha (43–51 million acres) (Pauli et al. 2006) with colonies of this prairie dog species associated with 11.2% of rangewide locality records for black-footed ferrets (Anderson et al. 1986). The current rangewide distribution of white-tailed prairie dog is only approximately 340,000 ha (840,158 acres) (Pauli et al. 2006).

All species of prairie dog dig extensive burrow systems and occur in colonies of varying size and density. Merriam (1902) and Bailey (1905) both mentioned a colony of black-tailed prairie dogs in the mixed-grass prairie of Texas estimated to be 400 km (248 miles) long and 160–240 km (100–150 miles) wide, thus perhaps covering as many as 9.6 million ha (23.7 million acres). In general, black-tailed prairie dogs are more social and tend to live at higher densities than the other two species (Hoogland 1995). Colonies of black-tailed prairie dogs also tend to be more conspicuous in the open prairie landscapes where they occur, as they have the unique habit of clipping vegetation on and around the colony and maintaining a distinct mound around many burrow openings. As expected, wild-born black-footed ferrets show a strong preference for large prairie dog colonies and portions of prairie dog colonies that persist at high population and burrow densities (Biggins et al. 1985, 1993; Eads 2009). However, a study of captive-born ferrets released into a black-tailed prairie dog colony in northeastern New Mexico (see under "Status and Management") indicated no measurable preference for areas with high burrow densities, perhaps because the ferrets were born in captivity and, consequently, were relatively naive (Chipault et al. 2012).

While many present-day populations of prairie dogs in North America appear to be extensive enough to support self-sustaining populations of black-footed ferrets, most of them are routinely decimated by sylvatic plague (see under "Life History").

LIFE HISTORY

Until recently, *M. nigripes* was one of the least-studied carnivores in North America. The species was known to many Native American tribes, which used ferret parts during rituals, and the species was mentioned by early fur trappers (Henderson et al. 1969; Clark 1975). However, it was not formally described and named, by John James Audubon and John Bachman, until 1851 (Clark 1986), and the ferret was rarely mentioned again in the scientific literature for the remainder of the century (Casey et al. 1986). It actually took the discovery of the last wild black-footed ferret population in 1981 and the ferret's designation as an Endangered species to prompt the initiation of numerous life history studies, which have been conducted in association with captive breeding and reintroduction programs. As a result, the life history of the black-footed ferret is now better understood in many respects than that of many other, more

common mustelids. Several research volumes have been published that focus on various aspects of the species' biology and review the extensive literature, including those by Wood (1986), Clark (1989), Oldemeyer et al. (1993), Miller et al. (1996), Roelle et al. (2006), and Blake (2011). Relatively little research on black-footed ferrets has been conducted in New Mexico, though, given that habitat requirements appear to be consistent rangewide, much of what has been learned elsewhere is likely relevant to New Mexico.

Photo 22.5. An adult female black-footed ferret (*Mustela nigripes*) carrying her prey, a juvenile black-tailed prairie dog (*Cynomys ludovicianus*), in the Conata Basin, South Dakota, July 2009. Photograph: © David Eads.

Photos 22.6a and b. Captive black-footed ferrets photographed learning to hunt live prey at the National Black-footed Ferret Conservation Center in Colorado. Prairie dogs account for about 90% of the black-footed ferret's diet. Photographs: © Mike Lockhart/US Fish and Wildlife Service.

Diet and Foraging

M. nigripes is an apparent obligate associate of prairie dogs (Richardson et al. 1987; Biggins et al. 1993), as these colonial rodents and their burrows provide the ferret with its main prey and den sites, respectively (Sheets et al. 1972; Richardson et al. 1987). At Meeteetse, Wyoming and Mallette County, South Dakota, prairie dogs accounted for about 90% of the black-footed ferret's diet (Sheets et al. 1972; Campbell et al. 1987). And Bailey (1931:326), one of the first biologists to report on black-footed ferrets in New Mexico, offered these comments –somewhat disparagingly— about the species:

> These big weasels are almost invariably associated with prairie-dog towns, where they live among the burrows and feed on the prairie dogs, going down the burrows and capturing the occupants at will. Had they not been very scarce they would long since have exhausted their favorite food supply. High living on easily obtained fat prairie dogs seems to be the only explanation of their scarcity, as they are vicious little animals with few enemies.

Although black-footed ferrets today are highly dependent on prairie dogs, Owen et al. (2000) noted that 42% of fossil remains of the species are not associated with prairie dog remains and suggested that the close relationship between these animals may be a secondary effect of the colonization of the North American grasslands by black-footed ferrets within the last 800,000 years.

As is true for many other mustelids, a black-footed ferret's energy requirements are relatively high, but comparable to the predicted energy needs of mammals of similar body mass (Harrington et al. 2003). A ferret's metabolic rate requires 1,200 kJ or less per day (Harrington et al. 2005), and one black-tailed prairie dog alone can provide 4,000–5,000 kJ of energy (Powell et al. 1985). On the other hand, the ferret is not an

obligate hibernator, nor does it store large quantities of fat, so it must forage year-round. Biggins et al. (1993) estimated that a population of 763 prairie dogs are needed for one "ferret family" (i.e., one adult female, her young, and 0.5 male; male home territories typically encompass that of 2 female home territories) to survive one year, and that on average a single black-footed ferret kills and consumes 109 prairie dogs every year.

Biggins et al. (2011) and Eads et al. (2011) found that black-footed ferrets move the most during brightly moonlit nights and were most active during the hours after midnight. This nocturnal activity pattern differs from that of coyotes (*Canis latrans*) and might be a means to avoid contact with this and other predators, including diurnal raptors. In most instances, ferret predation on prairie dogs occurs in burrows at night and, consequently, is rarely observed. However, one of us (D. Long) and Vargas and Anderson (1998) have had the opportunity to witness and document multiple predation events in preconditioning pens (enclosures used to prepare captive-born ferrets for release to the wild; see under "Status and Management"), which seem to follow a similar pattern. Ferrets held in the preconditioning pens in New Mexico were observed attacking prairie dogs both above ground and in burrows. If the attack was initiated above ground, the ferret always attempted to drag the prairie dog into a burrow or artificial burrow tube to complete the kill. Never in the hundreds of predatory encounters observed in the New Mexico pens was a ferret observed to kill an adult prairie dog above ground (D. Long, pers. obs.). In most aboveground attacks that were successful, an experienced ferret would attack and bite onto the head or neck of the prairie dog, which would result in the prairie dog "balling up," thus making the task of dragging, or sometimes carrying, it into the burrow easier for the ferret. Occasionally, the initial attack resulted in the ferret biting onto a part of the prairie dog other than the head or neck. Such cases often resulted in the prairie dog then defending itself and biting the ferret, which likely explains why ferrets were frequently observed aborting a predatory effort if unable to secure a firm bite on the head or neck in the opening seconds of an encounter. Once a prairie dog was pulled inside the burrow, however, the ferret would often readjust its bite (if necessary) onto the head or neck and then quickly moved its grip to the throat where it "chewed" at the area around the esophagus, resulting in hemorrhaging and visible contusions. During this final phase of the attack, a ferret would also frequently wrap itself around the prairie dog and brace its body against the side of the burrow, thus limiting its victim's ability to continue the struggle and presumably reducing the potential for injury to the ferret. Most of these predatory encounters resulted in the death of the prairie dog within a couple of minutes, though attacks sometimes lasted for four or more minutes, depending in part on the amount of prior hunting experience the ferret had. Such is the physical exertion involved that ferrets have been observed panting for prolonged periods after attacks (Vargas and Anderson 1998), and large prairie dogs, particularly adult males, are very difficult, even often impossible, for many ferrets to kill (D. Long, pers. obs.). And more energy may need to be spent in the wild, some female ferrets having been observed to carry a dead prairie dog from a burrow where the kill occurred to her maternal den site to feed her young (Hillman 1968).

Unlike captive individuals, wild ferrets will only rarely attack prairie dogs during daytime when they are above ground and away from their burrows (Clark et al. 1986). Undoubtedly, such attacks can be hazardous for the ferret as the exposure and commotion associated with capturing a prairie dog on the surface increases the ferret's own risk of predation, such as by raptors. In addition, it is common for black-tailed prairie dogs to "mob" and chase away a black-footed

ferret that ventures away from its burrow during the daytime (Livieri et al. 2013).

The black-footed ferret is also an opportunistic carnivore and has been observed attacking, capturing, and consuming small mammal and bird species associated with prairie dog colonies and, occasionally, feeding on carrion (Linder et al. 1972; Clark et al. 1986; Eads 2012; D. Long, pers. obs.). The capture and killing of small rodent species (e.g., Ord's Kangaroo Rat [*Dipodomys ordii*.]) appears to require less skill and effort than that needed to kill a prairie dog. When capturing small rodents, the ferret generally bites the prey on the dorsal part of the neck or back and crushes the animal in its jaws (D. Long, pers. obs.). A ferret captured in New Mexico in 1929 was fed a variety of meats, milk, and bread while in captivity and reportedly was fond of fish (Aldous 1940), though these items certainly would not be found in the diet of wild ferrets.

Reproduction and Social Behavior

Black-footed ferrets become reproductively mature in their first year (Clark 1999). Changes in photoperiod in late winter and spring trigger reproductive activity, and breeding in the wild occurs in March–April (Anderson et al. 1986). In captive black-footed ferrets, the photoperiod is sometimes manipulated to meet management needs and to induce breeding at other times of the year (Branvold et al. 2003). Black-footed ferrets are polygynous (Miller et al. 1988), monoestrous, and induced ovulators (Williams et al. 1992); their breeding and whelping seasons roughly parallel those of prairie dogs. Unlike many mustelids, black-footed ferrets do not have delayed implantation of the fertilized ova, and therefore the gestation period of about 42 days is relatively short for a member of that family (Carpenter and Hillman 1978). Most litters range in size from one to five kits with 3.3 kits and 3.4 kits being the average in the last two wild populations studied (Linder et al. 1972; Forrest et al. 1988), and 3.1 kits being the average in a reintroduced black-footed ferret population at Buffalo Gap National Grasslands, South Dakota (US Forest Service 2000). A group of seven kits was observed with a female ferret (dam) in the Conata Basin, South Dakota (D. A. Eads, Colorado State University, pers. comm.) and in captivity, litters of eight or nine kits have been documented (Branvold et al. 2003). Males (sires) do not appear to assist in raising young (Forrest et al. 1985). Dams are not committed to one den site and will routinely move kits between burrows, either by carrying them or, when they are more mature, leading them in a

Photo 22.7. One-week-old black-footed ferrets. Most litters in the wild consist of one to five kits, whereas in captivity litter size can reach eight or nine. Photograph: © Robyn Bortner/US Fish and Wildlife Service.

Photo 22.8. Black-footed ferret newborn kit. Photograph: © Kimberly Fraser/US Fish and Wildlife Service.

single-file "train" to a new burrow (Hillman 1968; Clark et al. 1986; Paunovich and Forrest 1987). Kits first appear above ground at about 45 days of age (in June–July) (Clark et al. 1986) and begin to participate in hunting forays in August. By September, as the kits are now transitioning from what Biggins et al. (1985) call social and dependent juveniles to solitary and independent individuals, they start to disperse from their natal area (Forrest et al. 1988). Data collected from the Meeteetse, Wyoming population indicated that juvenile mortality is high and the average life span is probably less than one year (Biggins et al. 2006). An individual in the wild rarely lives more than three years (Forrest et al. 1988), though older individuals have been detected, including a six-year-old wild-born adult that was monitored in South Dakota (Eads 2012).

The black-footed ferret is generally a solitary animal except during the reproductive season. Studies by Livieri and Anderson (2012), involving a reintroduced black-footed ferret population on a black-tailed prairie dog colony in South Dakota, indicate that males occupy home ranges of 131.8 ha (325 acres) whereas female home ranges average 64.7 ha (160 acres). Females have been reported to successfully raise a litter of kits on colonies as small as 10 ha (25 acres) (Hillman 1979), and it has been suggested that females may even successfully raise litters on colonies as small as 5 ha (12 acres) (Biggins et al. 2006). Overall, both male and female home ranges are strongly influenced by the species of prairie dog present, colony size, and prairie dog densities (Forrest et al. 1985; Biggins et al. 2006; Jachowski et al. 2010; Livieri and Anderson 2012). The population density of female ferrets may be less than the predicted carrying capacity due to intrasexual (female vs. female) territoriality leading to reduced overlap in home ranges (Livieri and Anderson 2012). The territory of a male ferret typically overlaps the territories of two or more females and may not include any additional area beyond that occupied by the females. The sex ratio in most populations with established home ranges is one male for every two females (Forrest et al. 1988; Livieri and Anderson 2012).

Predation, Interspecific Interactions, and Disease

Based on the similar size of black-footed ferrets and prairie dogs and the strong association that many predators form with prairie dog colonies, it seems reasonable to assume that predators that take prairie dogs are also capable of preying on black-footed ferrets (Biggins 2000). The best information on predators of ferrets is derived from research on the Meeteetse, Wyoming population and more recent studies of the reintroduced Conata Basin, South Dakota population (Miller et al. 1996; Breck et al. 2006). Predation can account for up to 95% of the documented mortalities of newly released, captive-reared, and relatively naïve ferrets at reintroduction sites (Breck et al. 2006). In the last wild population at Meeteetse, Wyoming, an estimated 57% of known ferret mortality could be attributed to predation (Forrest et al. 1988), though the actual percentage was likely much higher (Breck et al. 2006).

Coyotes appear to be the most important predator of black-footed ferrets, accounting for about 60% of documented predation events and up to 95% of the mortality of captive-bred, reintroduced individuals (Biggins et al. 2006). American badgers (*Taxidea taxus*) and raptors including great horned owls (*Bubo virginianus*) account for a smaller portion of ferret mortality, though Breck et al. (2006) noted that great horned owls in particular can develop a "search image" for black-footed ferrets on reintroduction sites, resulting in substantial losses of newly released animals. If unconfirmed predation events are included, coyotes may nonetheless account for 80–90% of predation events (Breck et al. 2006). A coyote is far less likely to immediately consume a ferret that it has killed and instead may bury it (Miller

Photo 22.9. Ring-reader in place at prairie dog burrow. The reader is used to detect the individual passive integrated transponder (PIT)-tag number of a reintroduced ferret after it has been observed at a burrow during nighttime spotlighting surveys. This monitoring technique allows researchers to track survivorship of ferrets on a reintroduction site. Each PIT tag is a small radio transponder that contains its own specific code. Photograph: © James N. Stuart.

et al. 1996; Biggins 2000). Predation by coyotes on other carnivore species is common and presumably benefits the coyote by removing competition (Biggins et al. 2011).

Known causes of human related black-footed ferret mortality include vehicle impacts, shooting, trapping, and poisoning (Cahalane 1954; Hanebury and Biggins 2005). In New Mexico, Hubbard and Schmitt (1984) documented instances of human-caused mortalities of ferrets through trapping and prairie dog poisoning. The black-footed ferret is also vulnerable to bacterial and viral diseases. Around 1900, the invasive disease commonly referred to as the plague—sylvatic plague when it occurs in wild animals—or the "black death," made its entry into North America, likely aboard a trading ship traveling from Asia and docking in San Francisco (Biggins and Kosoy 2001). The disease, which is caused by the bacterium *Yersinia pestis* and relies on fleas for transmission, quickly spread among the native mammal communities on the West Coast and began to progress eastward. By the 1940s, the plague had been reported in New Mexico and 15 other western states (Barnes 1993). For unknown reasons, but possibly environmental conditions related to humidity and temperature, the plague made a stop at the 101st Meridian for 70 years and only in 2008 did it push eastward beyond what was formerly referred to as the "plague line." With this last intrusion, the plague now largely encompasses the entire historical range of prairie dogs and black-footed ferrets. In New Mexico and elsewhere in the West, important reservoir species for the sylvatic plague may include mammals with high resistance to the disease such as certain species of voles (*Microtus* spp.), deer mice (*Peromyscus maniculatus*), kangaroo rats (*Dipodomys* spp.), and possibly many carnivores (Antolin et al. 2002).

Prairie dogs are highly vulnerable to plague, and mortality within a colony is typically very high during epizootic (outbreak) events (Antolin et al. 2002). However, a small number (less than 1%) of prairie dogs in a colony will sometimes survive the disease and are capable of repopulating the site over time (Cully 1997; D. Long, pers. obs.). As for the black-footed ferrets, they are often unable to survive major plague events since those individuals that do not succumb to the disease either starve or are forced to abandon the stricken colony (Cully 1993). Even for ferrets that do survive epizootic events, the disease can continue to pose a significant threat during so-called enzootic periods, when plague remains present in the environment without any noticeable prairie dog die-off. During enzootic periods, black-footed ferret survival is indeed significantly reduced (Matchett et al. 2010). The disease has been and remains a major impediment in the re-establishment of black-footed ferrets in the wild (Lockhart et al. 2006), and its ubiquity throughout the historical range of prairie dogs and black-footed ferrets alike often requires "heavy-handed" management to

protect populations of both animals (see under "Status and Management").

Canine distemper, another highly virulent disease found in black-footed ferrets, was in part responsible for the loss of the last known wild populations in South Dakota and Wyoming (Carpenter et al. 1976; Forrest et al. 1988). Of the nine ferrets brought into captivity from the South Dakota population, four were inadvertently killed after vaccination with a modified live canine distemper virus (the vaccine had proven safe in European polecats but was lethal in black-footed ferrets). The first six black-footed ferrets removed from the wild at Meeteetse, Wyoming apparently were already infected with the virus and succumbed to the disease while in captivity (Lockhart et al. 2006).

STATUS AND MANAGEMENT

Historical Population Status

Not only are black-footed ferrets fossorial, nocturnal, and secretive by nature, they were never of economic importance as a furbearer. Consequently, very few records of occurrence exist, making it difficult to assess the historical abundance of the species throughout its range. Based on pre-settlement accounts of large prairie dog colonies measured in miles (see below), population estimates from the last two recorded wild ferret populations, and the availability of ferret specimens from throughout its historical range, the species might have once been common, if not abundant, in at least portions of its distribution. However, there is no consensus on this. Some authors have suggested that ferrets were probably common (Linder et al. 1972; Choate et al. 1982; Hubbard and Schmitt 1984; Anderson et al. 1986), whereas others have argued they were likely scarce (Bailey 1931; Cahalane 1954). Paleontological evidence, historical records, and studies of the last two wild populations before extirpation suggest to us that black-footed ferret densities were not uniform throughout the species' range. Perhaps ferrets were locally common, but, like many carnivores, they may also have persisted at relatively low densities throughout much of the species' historical range, due to territoriality and, in some cases, variable abundance of prey.

Estimates of historical and contemporary rangewide prairie dog occupation and, consequently, black-footed ferret populations are imprecise and oftentimes controversial (see Hubbard and Schmitt 1984). Early explorers and naturalists frequently failed to report on what we know today were extensive prairie dog complexes (Knowles et al. 2002), while other reports wildly exaggerated the extent of colonies (Virchow and Hygnstrom 2002; see Hubbard and Schmitt 1984). Records from the poisoning campaigns of the 1920s and 1930s provided acreage estimates of some areas being treated but frequently failed to identify the species being targeted, often describing them simply as "rodents." Prairie dog colonies also regularly fluctuate in size due to plague or drought, and, unless such impacts are monitored and quantified, estimates of total occupied hectares can be flawed, even today. In short, the information available to us is imprecise and oftentimes conflicting. The formerly extensive distribution of ferrets, along with the current distribution of other species that likely co-evolved with prairie dogs, such as burrowing owl (*Athene cunicularia*) and mountain plover (*Charadrius montanus*), provide strong evidence that *Cynomys* species were not only once widespread but also abundant in interior North America (Knowles et al. 2002).

At the beginning of the 20th century, the three species of prairie dogs on which ferrets are dependent occupied an estimated 41 million ha (101,313,206 acres) of the grasslands and shrublands of western North America (Nelson 1919; Anderson et al. 1986). Federally sponsored rangewide campaigns to eradicate prairie dogs, conversion of grasslands for agricultural purposes, and sylvatic plague all reduced the extent of their

range by 97% to approximately 1.2 million ha (2,965,264 acres), with two-thirds of the remaining colonies being small and isolated (Miller and Reading 2012). For the black-footed ferret, a species inextricably linked to large, healthy populations of prairie dogs, the loss of so much habitat and the fragmentation of what little remained resulted in a precipitous population decline throughout the early and mid-20th century, culminating in the near extinction of the species by the 1980s (USFWS 2013a).

In New Mexico, Shriver (1965) estimated that prairie dog colonies covered 4,836,398 ha (11, 951,000 acres) in the state in 1919 (equivalent to about 15% of New Mexico's surface area). Hubbard and Schmitt (1984) estimated that federally sponsored prairie dog poisoning campaigns treated 4,370,604 ha (10,800,000 acres) of prairie dog colonies from 1931 to 1981. Recent estimates suggest there may be 736,932–1,311,586 ha (1,820,998–3,240,999 million acres) of prairie dog colonies remaining in New Mexico (NMDGF, unpubl. data). As is the case throughout most of North America, New Mexico now supports only a fraction of its historical prairie dog population.

By 1987, the known population of the black-footed ferret had been reduced to 18 individuals, all of which were in captivity, making the species one of the rarest mammals on Earth. Today the number of free-ranging, reintroduced ferrets varies from year to year, and survivorship is mainly affected by the presence or absence of plague epizootics. In 2012, the USFWS (2013a) estimated the wild ferret population to be 364 animals, which was down from an estimated 500–1,000 animals just a few years before. As part of the federal recovery effort, there were approximately 250–300 black-footed ferrets being maintained in captive breeding facilities throughout the United States. Six years later, after more reintroductions rangewide, the wild ferret population may not exceed 340 animals, or less than in 2012 (J. Hughes, pers. comm.).

Legal Status

The black-footed ferret was listed as Endangered throughout its range in 1967 under the Endangered Species Preservation Act, an anemic set of rules (which did little to prevent the decline and eventual extirpation of the Mellette County, South Dakota population), and later under the more robust Endangered Species Act (ESA) of 1973. In 2013 the US Fish and Wildlife Service (2013a) finalized a revised recovery plan for the black-footed ferret and outlined the criteria by which the species could be considered "recovered" in the wild. Downlisting from Endangered to Threatened status would require, among other criteria, a total of at least 1,500 free-ranging ferret adults in 10 or more populations with no fewer than 30 breeding adults in any one population (USFWS 2013a). The criteria for delisting (removal from the ESA list) included reaching a total of at least 3,000 free-ranging ferrets in 30 or more populations with no fewer than 30 breeding adults in any one population (USFWS 2013a). In the revised recovery plan, the US Fish and Wildlife Service (2013a) adopted a model developed by Ernst et al. (2004), described as a "technique to allocate hypothetical black-footed ferret recovery goals in an equitable fashion," based on the historical rangewide distribution of prairie dogs. Based on this allocation model, New Mexico would be responsible for 220 of the 1,500 wild free-ranging black-footed ferrets necessary to downlist and 440 of the 3,000 needed to delist.

All existing reintroduced populations of the black-footed ferret in the United States are currently categorized by the US Fish and Wildlife Service as experimental populations under either Section 10(j) or 10(a)(1)(A) of the ESA. Both categories permit "incidental take" (i.e., unintentional harming or killing) of individual black-footed ferrets and therefore allow less protection than what would otherwise be provided by a "fully Endangered" designation where any "take" of the species is illegal. Despite the ferret's

close ecological relationship with prairie dogs and their colonies, no critical habitat (i.e., areas of habitat believed to be essential to the species' conservation) has been proposed thus far by the US Fish and Wildlife Service.

In New Mexico, the black-footed ferret is categorized by state law as a protected furbearer, though no legal harvest has been allowed since at least the 1960s, at which time wildlife managers considered the species to be rare (Berghofer 1967). The black-footed ferret was listed as an Endangered species under the New Mexico Wildlife Conservation Act in 1975, only to be delisted in 1988 after extensive survey efforts indicated the species was likely extirpated in the state (Jones and Schmitt 1997). Following the rediscovery of the black-footed ferret in Wyoming in 1981, the New Mexico Department of Game and Fish and US Bureau of Land Management initiated a publicity campaign to "ferret out"(!) reports of the species by New Mexico residents via the dissemination of advertisements, posters, and popular articles (Hubbard and Schmitt 1984; Photo 22.10). Although these efforts, combined with intensive surveys of many prairie dog colonies, failed to identify any remaining ferret populations in the state, they did serve to raise public awareness about the species. This increased awareness is reflected in the many reports from the public of black-footed ferret sightings that are still received today by the New Mexico Department of Game and Fish and other resource management agencies. Unfortunately, when photographs or details of observations are available, all such reports turn out to be sightings of long-tailed weasel (J. Stuart, pers. obs.).

Throughout the species' range, the conservation and recovery of the black-footed ferret is inextricably tied to the conservation of prairie dogs (Miller and Reading 2012). All three species of prairie dog within the former range of the ferret have previously been considered for listing under the ESA. The US Fish and Wildlife Service

Photo 22.10. 1982 poster produced jointly by the New Mexico Department of Game and Fish and the US Bureau of Land Management to obtain any possible black-footed ferret observation records from the public in New Mexico. The species was suspected of being extinct throughout its North American range when a small population was discovered in Wyoming in 1981. All known surviving ferrets today are descended from that population. No verifiable reports were obtained from New Mexico in the 1980s, and the species was likely extirpated in the state by the time the poster was made. Photograph: © James N. Stuart.

determined that the status of the black-tailed prairie dog and of montane populations of Gunnison's prairie dog in northern New Mexico and Colorado, both former federal Candidate species, did not warrant listing (USFWS 2009, 2013b). In New Mexico, both species of prairie dogs are considered Species of Greatest Conservation Need (SGCN) under the StateWildlife Action Plan (NMDGF2016), but otherwise do not receive any formal protection, except by those public land managers, tribal governments, or private

property owners who seek to conserve the species on their lands. As of 2016, the black-footed ferret is also classified as a SGCN due to current efforts to reintroduce the species.

Recovery Efforts

With the demise of most wild populations of the black-footed ferret by the 1950s, conservation biologists eventually turned to what was believed to be the only option to save the species: captive propagation. The ferret population in Mellette County, South Dakota—believed to be the last at the time—had been studied since the mid-1960s, and in 1971 the first attempt was made to capture a sample of these animals for a captive breeding program at the Patuxent Wildlife Research Center in Maryland. Unfortunately, the program was stymied by both mortalities of adult captive ferrets caused by vaccine-induced canine distemper and poor survivorship of offspring (Lockhart et al. 2006). With the extirpation of the South Dakota wild population in 1974 and the death of the last captive ferret at Patuxent in 1979, it appeared the species had been lost.

Dr. James Carpenter (pers comm.), leader and research veterinarian at the Endangered Species Propagation Program at Patuxent at the time, relayed the events leading up to the black-footed ferret's presumed extinction. His account bears witness to the many challenges of developing a captive breeding program and the dedication and investment required for the conservation of a species.

> Of the five black-footed ferrets used in the breeding program from 1976–1978, two were females. Only one of the females was ever receptive to the males. In 1976 this female produced the first litter of black-footed ferrets ever born in captivity. Unfortunately, four of the five kits were stillborn, and the remaining kit died because its mother did not provide it with adequate care.
>
> Since earlier studies had shown the European polecat females readily accepted young from other polecats, as well as from other mustelids, our research team decided to remove the black-footed ferret kits immediately after the second birth in 1977 and to place them with a lactating European polecat. The black-footed ferret produced four stillborn kits and one weak kit. Although the surviving kit was readily accepted by the lactating European polecat and also received intermittent medical care, it died two days later.
>
> In view of the female black-footed ferret's advancing age and her history of stillborn litters, in 1978 it was decided to take the young by caesarian section, hoping that they might be saved. The female black-footed ferret was "bred" successfully, and her abdomen became distended over the following 6 weeks. At 42 days the female was taken to a veterinary hospital and, although the surgery was successful, the female did not contain any young—she had a false pregnancy, probably a reflection of her age. Once again, producing black-footed ferrets in captivity had eluded us.

The species received another reprieve from extinction in September 1981, when another, and indeed the last, wild population of black-footed ferrets was discovered by ranchers John and Lucille Hogg near Meeteetse, Wyoming. Their dog, Shep, "got in a tangle" (Gustkey 1985) with and killed a black-footed ferret one night. John Hogg found the ferret carcass on his doorstep the following morning and, not knowing what it was, "threw it over the fence" (K. Frasier, pers.com.) (It bears mentioning that the Hogg family had been ranching in the area for generations and had never seen a black-footed ferret, illustrating just how secretive the species can be.) Lucille decided she wanted to have the unusual animal mounted,

so she and her husband retrieved the carcass and delivered it to a local taxidermist. The taxidermist immediately recognized the animal, called the authorities, and informed the Hoggs that the carcass was being confiscated (Gustkey 1985). Thus, the black-footed ferret recovery community forever owes a debt of gratitude to the Hoggs and their dog Shep, for without that chance encounter between a ferret (probably a "wayfaring" juvenile; Carr 1986) and Shep that September night it is almost certain that the species would now be extinct.

Immediately following the fortuitous discovery, research began on the Meeteetse population and much of what we know today about the behavior, habitat, and ecology of the black-footed ferret was learned during those early studies. The white-tailed prairie dog colony complex that sustained the last black-tailed ferret population consisted of 37 colonies covering 2,995 ha (7,400 acres) (Clark 1986). During surveys in 1982, 1983, and 1984 the ferret population at Meeteetse was estimated at 61, 88, and 129 individuals, respectively (Clark 1986). In June 1985 sylvatic plague was detected in the prairie dog population at Meeteetse and ferret numbers declined sharply over the summer; by August the population had been reduced to an estimated 58 individuals (Lockhart et al. 2006). While researchers knew prairie dogs were susceptible to plague, it was thought that black-footed ferrets were immune, since Siberian and European polecats and other mustelids had demonstrated resistance to the disease (Lockhart et al. 2006). Due to declining numbers in the wild in September 1985, the decision was made to capture six black-footed ferrets for captive breeding. Concurrently, it was discovered that the ferret population at Meeteetse was not only being impacted by plague but was also in the midst of a canine distemper outbreak. All six individuals brought into captivity died of distemper (Lockhart et al. 2006). Before the confirmation of canine distemper in the wild ferret population, field researchers were also beginning to question whether black-footed ferrets were indeed immune to the plague; however, the confirmation of canine distemper seemed to explain the observed declines at Meeteetse (D. Biggins, pers Comm). Not until the mid-1990s, and the loss of 27 ferrets in captivity, was susceptibility to plague again considered—and subsequently confirmed as—a direct threat to ferrets (Godbey et al. 2004). After the loss of the first six ferrets brought into captivity and the confirmation of canine distemper in the wild population, the decision was made to try to capture all remaining ferrets in the wild and bring them into captivity; thus ended the last naturally occurring black-footed ferret population (Lockhart et al. 2006).

Black-footed ferrets captured at Meeteetse during 1985–1987 provided the captive breeding stock for all the ferrets alive today. Since 1991, captive-bred ferrets have been released in eight states (Arizona, Colorado, Kansas, Montana, New Mexico, South Dakota, Utah, and Wyoming), southern Saskatchewan in Canada, and northwestern Chihuahua in Mexico. However, even after more than 25 years of effort, the survival of the black-footed ferret still hangs in the balance. Reintroductions have so far failed at half of the release sites, including in northern Mexico and Saskatchewan. The wild ferret population reintroduced at the Conata Basin/Badlands, South Dakota site had reached 355 individuals in 2007, but by the fall of 2018 it had been reduced to just 119 (USFWS, unpubl. data).

At present, black-footed ferrets destined for release are produced from the captive stock at several breeding facilities located throughout the United States, the largest of which is managed by the US Fish and Wildlife Service at Carr, Colorado. Since 1986, and as of the 2019 breeding season, approximately 9,600 kits have been produced in captivity, many of which have been reintroduced to the wild (Black-footed Ferret Connections 2015; R. Bortner, pers. comm.). In most years,

Photos 22.11a and b. "Triple-shooter" dispenser mounted on an ATV, used to distribute sylvatic plague vaccine (SPV) baits on a prairie dog colony in New Mexico. SPV baits are peanut-butter flavored pellets that contain the vaccine against plague. They are distributed on a prairie dog colony to inoculate a large percentage of the rodents against plague and are one of the more recent tools to manage the disease on reintroduction sites for black-footed ferret. Photographs: © James N. Stuart.

about 200 preconditioned black-footed ferrets are available for release at reintroduction sites (J. Hughes, USFWS, pers. Comm.). "Wild preconditioning" is a key component of captive-rearing of ferrets and involves exposing young captive ferrets to live prairie dogs, thus allowing them to develop hunting skills before their release. The allocation of captive-born ferrets to new or existing reintroduction sites is based on a ranking system that considers such factors as habitat quality; ongoing site management; disease presence and monitoring; ferret survival and population monitoring (for older reintroduction sites); local reintroduction program management; and local research programs. The captive breeding program has been so successful that availability of animals is no longer the limiting factor in re-establishing the species; rather, the availability of suitable habitat and release sites is the primary obstacle to recovery (Lockhart et al. 2006), together with disease.

Disease Management in the Wild

For many years, there were only two possible main methods for mitigating the effects of the plague at black-footed ferret reintroduction sites: the application of a pulicide (an insecticide that kills fleas) into prairie dog burrows (Seery et al. 2003) and the vaccination of ferrets (Rocke et al. 2006). The most common and effective pulicide used at black-footed ferret release sites today is deltamethrin, which is applied to prairie dog burrows in the form of a fine powder (Seery et al. 2003). Without prophylactic pulicide treatment, most prairie dog complexes sufficient in size to support black-footed ferrets fall into a plague cycle characterized by population build-ups followed by precipitous declines (Oldemeyer et al. 1993). Such tremendous fluctuation in prairie dog populations renders most untreated sites unsuitable for ferrets due not only to the black-footed ferret's own susceptibility to the disease but also the loss of its primary food source during plague

epizootics (Matchett et al. 2010). Deltamethrin may lead to an 88.5% vector reduction (Roth 2019), but the application of this and other pulicides has drawbacks, including the fact that It is labor-intensive. It may also fail to halt outbreaks if "dusting" is used too late (Abbott et al. 2012).

The US Geological Survey also developed a recombinant, injectable vaccine for black-footed ferrets that has proven effective in inducing an antibody response, thus reducing their susceptibility to plague (Rocke et al., 2006). About 69% of vaccinated ferrets exposed to high levels of the plague bacterium survived whereas similarly exposed unvaccinated ferrets all died (Rocke et al. 2006). Immunization requires two doses, preferably administered at a two-week interval—a task which is often problematic when working with animals as secretive and difficult to capture as black-footed ferrets. An obvious shortcoming of relying on the recombinant vaccine is that it also does not protect prairie dogs against plague epizootics (Abbott et al. 2012).

In 2012 the US Fish and Wildlife Service, the US Geological Survey, and several state, tribal, and private entities began field trials on an oral plague vaccine (also called sylvatic plague vaccine or SPV), which is delivered to prairie dogs through peanut butter–flavored bait. The goal of this vaccine program is to significantly reduce the impact of plague on prairie dog colonies, thereby benefitting both prairie dogs and ferrets. Lab results and preliminary field trials proved encouraging, but it remains to be determined just how effective the vaccine is in the field, whether other species might be affected, and if the vaccine can be produced at a reasonable cost (Abbott et al. 2012).

Canine distemper, which is not as devastating to black-footed ferret populations as plague, is treated with a recombinant vaccine that can be administered to both captive animals and captured wild ferrets. The disease does not affect prairie dogs. Despite its impact to wild and captive ferrets in the 1970s and 1980s, at present the disease is more easily managed than plague and therefore is of secondary concern at most release sites (USFWS 2013a).

Reintroduction Efforts in New Mexico

New Mexico is a relative latecomer to the reintroduction efforts for the species. In 1998, the Turner Endangered Species Fund (TESF) established a captive breeding and preconditioning facility for black-footed ferrets at the Vermejo Park Ranch, a 238,280 ha (588,800 acres) property in Colfax County. From 1999 to 2005, the black-footed ferrets produced in captivity at the ranch were sent to reintroduction programs elsewhere in the United States as well as Canada and Mexico. In 2005, however, TESF shifted its focus to "wild preconditioning" of captive-born ferrets on black-tailed prairie dog colonies on the ranch. Between 2005 and 2007, 75 black-footed ferrets were released onto black-tailed prairie dog colonies, where they were allowed to hunt and interact in a natural state for a period of several weeks to several months before being recaptured. Initially, in 2005, all wild preconditioned ferrets were held temporarily in a protected 405-ha (1,000-acre) prairie dog colony encircled by electrified predator-exclusion netting. During 2006–2007, black-footed ferrets were again released into the same, protected prairie dog colony but were later recaptured and moved into unprotected colonies. Forty of the 75 thus-released animals were recaptured and, as planned, relocated to reintroduction sites outside of New Mexico for permanent release (D. Long, unpubl. data). The fate of 35 animals released but not recaptured remained unknown, but those were presumed to have perished due to predation or, in at least one case, starvation.

During the same time period of 2005–2007, TESF was actively managing its Vermejo Park

Photo 22.12. Captive born black-footed ferret about to be released at Vermejo Park Ranch, New Mexico as part of a "wild preconditioning" experiment. This female black-footed ferret was subsequently recaptured and transferred to a permanent release site in Arizona. Photograph: © Dustin Long.

Photo 22.13. Credit: Dustin Long: First documented wild born black-footed ferret in New Mexico in perhaps 75 years. Photograph: © Dustin Long.

Photo 22.14. Anesthetized wild-born black-footed ferret at Vermejo Park Ranch, New Mexico. Note ectoparasites on neck. Wild-born black-footed ferrets were captured, anesthetized, and implanted with a small transponder chip to assist in subsequent identification. Photograph: © Dustin Long.

Photos 22.15a and b. Black-footed ferrets were released in the fall of 2012 on a Gunnison's prairie dog colony at Vermejo Park Ranch. Once all ferrets had been released, they were given time to settle into their new home. Staff returned to the release site after dark to check on them using spotlights. Photographs: © Della Garelle.

Photo 22.16. Captive-born black-footed ferret being released onto a Gunnison's prairie dog colony at Vermejo Park Ranch, New Mexico. Photograph: © Vermejo Park Ranch.

Photos 22.17a–d. Black-footed ferret reintroduction on Greg Moore's 25,000-acre ranch near Wagon Mound, Mora County on 26 September 2018. From many years of observation, rancher Greg Moore concluded that the prairie dogs on his ranch could contribute to grassland health if their numbers were kept in check. To that end, he petitioned the US Fish and Wildlife Service to reintroduce black-footed ferrets on his property. A year later, with the help of New Mexico Department of Game and Fish, eight ferrets finally arrived and were released into existing prairie dog holes on the ranch. Photographs: © Scott Wilber / New Mexico Land Conservancy.

Photo 22.18. One of the eight black-footed ferrets released on 26 September 2018 on Greg Moore's ranch in Mora County. The carriers are opened at randomly selected prairie dog burrows and tilted towards the burrow mouth. Most ferrets will not go willingly and instead will typically hide in the short length of corrugated plastic tube that is provided for them inside the carrier. The easiest way to get the ferret in the burrow is to move the tube into the burrow mouth using a stick. The ferret is then allowed to escape from the tube into the burrow, which might take up to a couple of minutes. Photograph: © Robert Muller.

Ranch black-tailed prairie dog colonies, and by 2008 the prairie dog complex was deemed to be of sufficient size (2,790 ha; 6,900 acres) to serve as a ferret reintroduction site. In fall 2008, TESF began releasing captive-born black-footed ferrets in a study to determine whether a viable population could be established on the ranch. On September 16, 2009, the first wild-born black-footed ferret kit in New Mexico in perhaps 75 years was captured at the ranch (D. Long, pers. obs.; Photo 22.12), an encouraging sign that the species could be re-established in the state. Later, multiple litters of wild-born kits were detected on the Vermejo Park Ranch, but despite that success, in late 2012 TESF discontinued black-footed ferret releases due to poor survival. The failure of the ferret restoration project on the black-tailed prairie dog colonies during the 2008–2012 period appeared to be closely linked to prairie dog pup production, which itself is positively correlated with spring and summer precipitation patterns (D. Long, unpubl. data). In short, drought years resulted in the production of few prairie dog pups, which in turn resulted in poor black-footed ferret survival and reproduction. Over the five-year course of the black-footed ferret releases onto black-tailed prairie dog colonies at the ranch, the black-footed ferret population peaked in the spring of 2011 with 19 individuals identified; by the fall of that year the population had been reduced to three individuals—all males. In 2012, black-footed ferret habitat conditions continued to deteriorate due to the intensifying drought and the decision was made to withdraw from further releases until conditions improved.

The poor survival and reproduction success of ferrets on the black-tailed prairie dogs at the Vermejo Park Ranch may have some historical precedence. It is interesting to note that less than 10% of all ferret specimens collected in New Mexico before the species' extirpation had been found on black-tailed prairie dog colonies. This finding suggests that in New Mexico, populations of ferrets within the range of that prairie dog species may perhaps have always been relatively small. In September 2012, 20 black-footed ferrets were released, this time, onto the Gunnison's prairie dog colony at Castle Rock, the same Vermejo Park Ranch site where former New Mexico Game and Fish director Elliot Barker had trapped one animal and seen another in 1930 (Hubbard and Schmitt 1984; see Table 22.1). Data collected by TESF from 2012 to 2015 and historical records suggested that black-footed ferrets might fare better in areas occupied by Gunnison's prairie dogs at Vermejo Park Ranch, provided that sylvatic plague could be managed. Unfortunately, the Castle Rock Gunnison's prairie dog colony was decimated by the plague in 2015, resulting in the death of all wild ferrets at that site.

Most recently, in late September 2018, eight black-footed ferrets were released on a ranch just east of Wagon Mound in Mora County. The ferrets arrived from northern Colorado, where they had been raised in captivity. The ranch, owned by Greg Moore, harbors a relatively small (approximately 182-ha; 450-acre) black-tailed prairie dog colony that was treated prophylactically with the oral sylvatic plague vaccine in late 2018. Of the eight ferrets, only three appeared to have survived the first few months of their release. Four more ferrets were released in September 2019 on the same ranch, and another three in October 2020, again with captive-reared animals from the breeding facility in Colorado. The New Mexico Department of Game and Fish was not planning a release in the fall of 2021. The most recent nocturnal spotlighting survey and trapping, in September 2021, led to the detection of at least six animals including males, females, and young of the year. The New Mexico Department of Game and Fish has documented reproduction in the small, reintroduced Mora County population since the first summer (2019) following the initial release.

The reintroduction site in Mora County will continue to be monitored for the persistence of ferrets and continued reproduction, and additional releases are possible in the future. More releases are also possible on Vermejo Park Ranch, pending ongoing research on the true effectiveness of the oral sylvatic plague vaccine in field conditions, or the development or more cost-effective techniques. In Montana, the US Fish and Wildlife Service is currently experimenting with baits that contain the insecticide Fipronil (a phenylpyrazole) instead of SPV, for a much-reduced cost.

The twin impacts of sylvatic plague and prairie dog poisoning have had, and continue to have, severe consequences for prairie dogs, both in the extirpation of these rodents from many places in the state and the fragmentation of their remaining range into populations too small and isolated to support black-footed ferrets. Although neither species of prairie dog is likely to become extinct in New Mexico in the foreseeable future, much of New Mexico where prairie dogs still exist is likely no longer suitable for a small carnivore that depends on abundant, robust, plague-free, populations of prey.

Many challenges remain in re-establishing the black-footed ferret in New Mexico and elsewhere, primarily disease management, but also conservation of prey species and habitat protection. Although the ferret likely will never again be as widespread in the state as it was historically, opportunities may exist to establish other black-footed ferret populations on private or public lands in New Mexico where the establishment and protection of large prairie dog populations is feasible. As noted by others—and as is true of an increasing number of organisms worldwide—the black-footed ferret will likely persist as a species only through the intervention of conservation biologists and long-term, careful management of its habitat.

For the time being, we have narrowly avoided the prediction by naturalist E.T. Seton (1929:573) regarding the prairie dog and black-footed ferret: "Now that the big Demon of Commerce has declared war on the Prairie-dog, that merry little simpleton of the Plains must go . . . and with the passing of the Prairie-dog, the Ferret, too, will pass."

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