REVIEW OF BLACK-FOOTED FERRET REINTRODUCTION IN ARIZONA, 1996-2001

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Technical Report 222
Nongame and Endangered Wildlife Program
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2221 West Greenway Road
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November 2003

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Van Pelt, W.E. and R.A. Winstead, 2003. Review of black-footed ferret reintroduction in Arizona, 1996-2001. Nongame and Endangered Wildlife Program Technical Report 222. Arizona Game and Fish Department, Phoenix, Arizona.

ACKNOWLEDGMENTS

We acknowledge the efforts of the following people, whose assistance is greatly appreciated: Lisa Anderson, Duane Aubuchon, Laurie Averill-Murray, Roy Averill-Murray, Buzzy Ayers, Tom Bagley, Tim Baumgarten, Lee Black, Dave Boyd, Mark Brennan, Jill Bright, Bob Broscheid, Don Buckley, Shawn Castner, Sandy Cate, Tom Christensen, John Clark, Basil Coffman, Jennifer Cordova, Dave Dilly, Betsy Dunkirk, Carolyn Engel-Wilson, Gunnar Erickson, Steve Ferrell, Arlen Flax, Nick Freeman, Justin Gaekel, Dr. Ben Gonzales, Gerald Hammett, John Harvey, Janis Hooge, Kristin Hoss, Dave Hunt, Josh Hurst, Terry Johnson, Kim Kime, John Koehler, Mike Kuhns, Melissa Kreighbaum, Rod Lucas, Don Mathis, Barbara Mauer, Angela McIntire, Ed Moody, Dexter Oliver, Bill Ough, Chris Parish, Dave Patriquin, Jeff Pebworth, Tim Pender, Mark Peterson, Bob Posey, Paul Puckett, Tom Puckett, Richard Rico, Larry Riley, Michelle Rodebaugh, Tom Selby, Mike Senn, Jimmy Simmons, Rob Simonson, Tom Silvia, Bruce Sitko, Laura Smith, Joey Sneva, Tim Snow, John Strocchio, Bill Sturgeon, Bruce Taubert, Frosty Taylor, Ron Tinseth, Luke Thompson, Darren Tucker, Tiffany Volz, Jon Wangnild, Richard Wilde, Jim Witham, Lara Zeisler, Arizona Game and Fish Department; Bill Austin, Pete Gober, Mike Lockhart, Paul Marinari, and Bruce Palmer, U.S. Fish and Wildlife Service; Earl Carter, Gino Fornara, and J. Brad Miller, USDA Wildlife Services; Dean Biggins and Jerry Godbey, Biological Resources Division of the U.S. Geological Survey; Stephen Williams, Arizona State Lands Department; Mike Fink and Craig Levy, Arizona Department of Health Services; Drs. Robert Glock, T. H. Noon, and Carlos Reggiardo, University of Arizona; Tom Blackledge, Jerry Brown, Joe Christman, Mike Seidman, and Jeff Williamson, The Phoenix Zoo; Larry Leist and Tip Tipton, Cholla Cattle Company; Kerry Christensen, Hualapai Nation; Larry Benallie Sr., Dave Mikesic, Gloria Tom, and Debra Yazzie, Navajo Nation; Aaron Clark, Black-footed Ferret Recovery Foundation; Tom Thorne, Wyoming Game and Fish Department; Sharon Biggs; Dr. Steve Brown; and the many volunteers who built pens and spotlighted in hopes of seeing the fabled green eye-shine. Cover photo by George Andrejko.

PROJECT FUNDING

Funding for this project was provided by: voluntary contributions to Arizona's Nongame Wildlife Checkoff; Arizona Game and Fish Department's Heritage Fund; Project W-95-M under the State Trust Fund Grants (Pittman-Robertson Act), and Title VI of the Endangered Species Act (Project E-5, Job 29).

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INTRODUCTION

With the release of 35 black-footed ferrets (*Mustela nigripes*) into the Aubrey Valley Experimental Population Area (AVEPA) in September 1996, Arizona became the fourth reintroduction site in the United States for this species (Van Pelt and Brennan 1997). The primary goal of the Arizona reintroduction effort is to establish a free-ranging, self-sustaining population of black-footed ferrets in the shortest period of time as possible. To accomplish this goal, we employed various reintroduction strategies such as pre-conditioning reintroduction candidates on-site prior to release, breeding and releasing animals from on-site acclimation pens, and timing releases (spring versus autumn) to take advantage of optimal conditions. A secondary goal is to manage ferrets and their habitat in a manner that will not negatively impact the lifestyles and economy of local residents.

Ferret reintroduction activities are evaluated on an annual basis to help ensure that objectives outlined in the release protocol (Van Pelt 1996) and annual allocation proposal are being implemented in AVEPA. These evaluations determine which protocols or procedures need modification to address unforeseen circumstances or events. Specifics can be found in various annual reports (Van Pelt and Brennan 1997; Van Pelt and others 1998; Winstead and others 1999; Winstead and others 2000; Winstead and others 2002a; Winstead and others 2002b). This report reviews and summarizes the reintroduction strategies implemented during calendar years 1996-2001 and makes recommendations for future activities.

INVOLVED AGENCIES AND PARTIES

The Arizona Game and Fish Department (Department) has been involved with various elements of black-footed ferret reintroduction since 1987 (Yarchin 1988; Belitsky and others 1994a, 1994b). Cooperators in the Arizona black-footed ferret reintroduction project with the Department include: Arizona State Land Department, The Phoenix Zoo, U.S. Fish and Wildlife Service (USFWS), Navajo Nation, Hualapai Nation, Cholla Cattle Company, and other private land managers. The Department and USFWS are charged with project leadership, with the Department assuming primary responsibility for implementing field activities identified for this reintroduction program. All cooperators are invited to participate in the Arizona Black-footed Ferret Working Group, which holds annual meetings to discuss project progress and direction, and if necessary, settle disputes.

In addition, the Arizona Department of Health Services, University of Arizona (UA), and USDA Animal and Plant Health Inspection Service (APHIS) Wildlife Services assist with implementing and monitoring of diseases that may impact this reintroduction project.

PROJECT AUTHORIZATION AND SITE IDENTIFICATION

The Arizona black-footed ferret reintroduction effort is authorized under the terms of the Department's Section 6 agreement through the Endangered Species Act. An annual work plan and allocation proposal is developed and coordinated with the USFWS and other participants and become provisions of the endangered species permit authorizing the Aubrey Valley black-footed ferret reintroduction project.

Beginning in 1990, matching funds were made available to the Department through Section 6 to evaluate existing habitat for possible reintroduction of black-footed ferrets in Arizona. After the evaluation of 8 different prairie dog complexes, the Aubrey Valley was selected as Arizona's highest-ranking site for potential ferret reintroduction (Van Pelt 1995).

In October 1993, after recommending Aubrey Valley as a reintroduction site to the Black-footed Ferret Interstate Coordinating Committee, the Department and the USFWS initiated the nonessential experimental population designation process. In November 1995, a proposed rule was published in the Federal Register (USFWS 1995). A public hearing was held in Seligman, Arizona, on December 12, 1995, to facilitate public comment. The public comment period closed on January 2, 1996. A final rule designating the Aubrey Valley Experimental Population Area (AVEPA) was published on March 20, 1996 (USFWS 1996).

As primary investigator for Arizona, the Department obtained permission for reintroduction activities outlined in Belitsky and others (1994b) and received letters of support from cooperators.

LAND OWNERSHIP AND MANAGEMENT

The AVEPA encompasses 89,820 ha (221,894 ac) of land in Coconino, Yavapai, and Mohave counties and is comprised of approximately 25,598 ha (63,253 ac) privately owned land, 45,686 ha (112,839 ac) tribal land, and 18,536 ha (45,802 ac) state trust land. The core reintroduction area outlined in Figure 1, and identified in the Final Rule, is approximately 12,144 ha (30,000 ac) and is comprised of privately owned and state trust lands.

The principal land use in the Aubrey Valley, livestock grazing, is compatible with the maintenance of prairie dog towns and thus with black-footed ferret reintroduction (Belitsky and others 1994b). Other major uses include hunting, recreational shooting, and wildlife viewing. The Navajo Nation owns 90% of the private land within Aubrey Valley and foresees no change in land use patterns in the immediate future.

The AVEPA is the only reintroduction site to occur entirely on private, state and tribal lands. Although habitat conservation may be more tenuous in these jurisdictions than on federal lands, this is an important precedent to consider. By releasing black-footed ferrets in AVEPA, the project cooperators have demonstrated to the public the flexibility of the Endangered Species Act, and have shown that actions under the Act do not necessarily create a negative impact on land uses, life styles, or incomes.

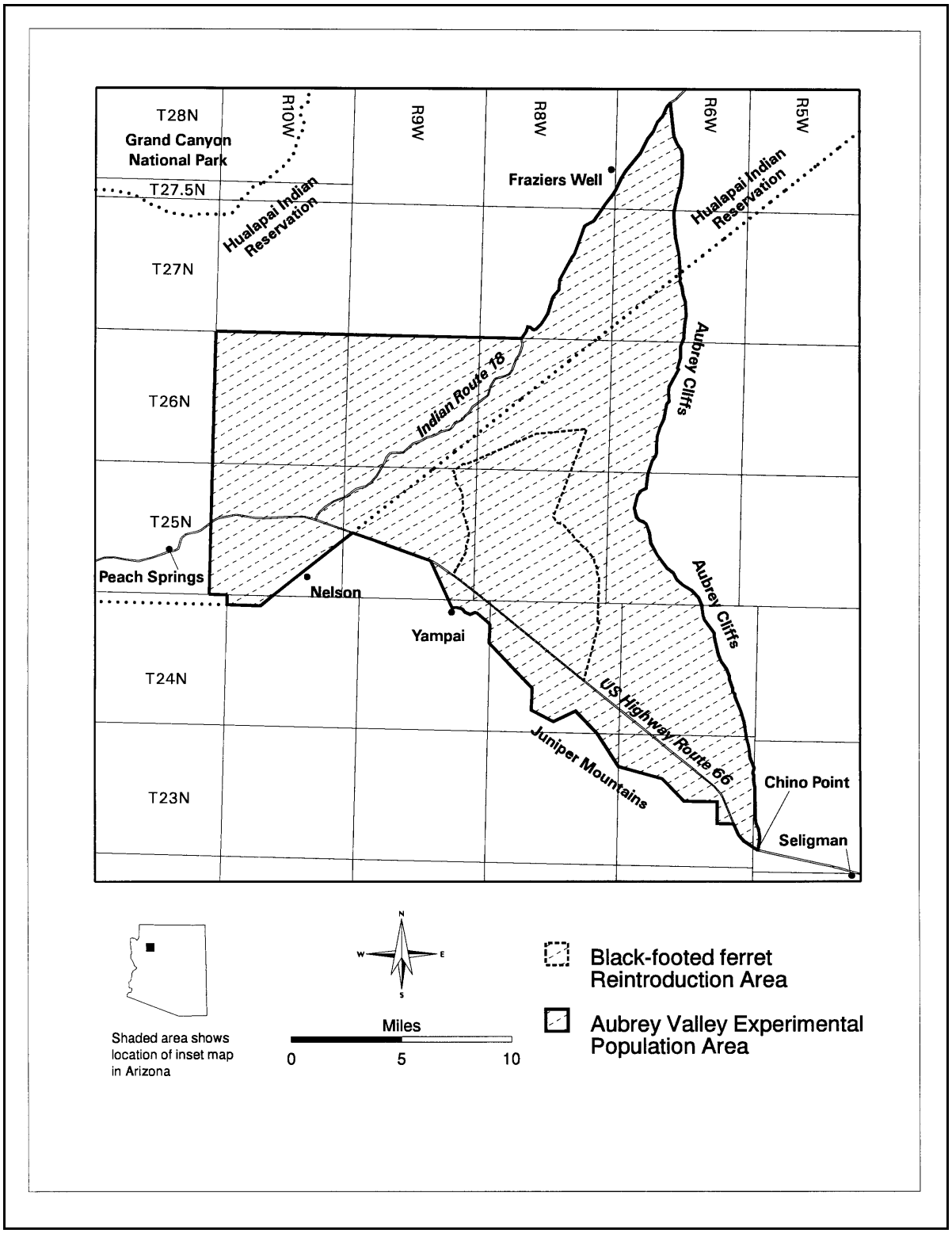


Figure 1. Delineation of the Aubrey Valley Experimental Population Area.

HABITAT CHARACTERISTICS AND COMPLEX DESCRIPTION

Brown (1982) characterizes Aubrey Valley as a Plains and Great Basin Grassland community, with annual precipitation averaging 25 to 30 cm. The valley floor is approximately 220 km^2 in area and ranges in elevation from 1600 to 1900 m. It is bounded on each side by pinyon-juniper ridges along a 41 km northwest-southeast axis. The valley is 12 km wide near mile marker 124 on Highway 66.

Prairie dog colonies have been mapped in Aubrey Valley since 1990 with acreage estimates ranging from 6959 ha (17,196 acres) to 7,838 ha (19,368 ac). In 1997, Global Positioning System (GPS) units were first used to map prairie dog towns in the Aubrey Valley Complex (AVC) (Fig. 2). The AVC is composed of 16 separate Gunnison's prairie dog (*Cynomys gunnisoni*) towns encompassing 12,001 ha (29,653 ac). The observed expansion of AVC was likely due to a combination of more accurate mapping, expansion of towns, and habitat conditions favoring expansion (Van Pelt and others 1998).

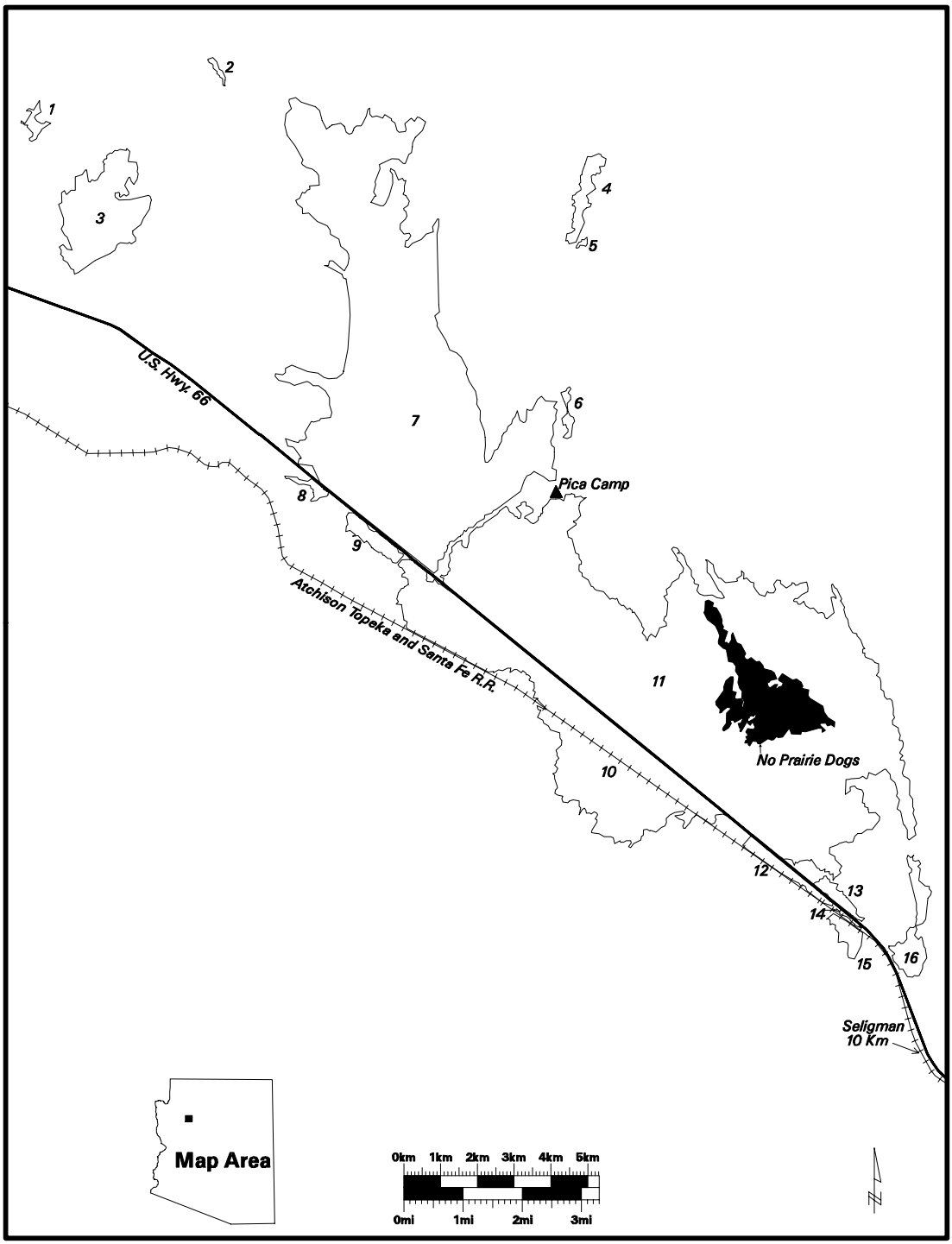
In 1999, the USFWS requested reintroduction proponents to identify and describe a subcomplex in which ferrets would be placed using a modified 1.5-km circumscription rule. For the AVC, this eliminated towns 1 through 5 from the subcomplex evaluation. The Aubrey Valley Subcomplex (AVSC) is comprised of 11 towns, towns 6 though 16, encompassing 11,391 ha (28,147 ac). Two primary towns, Pica Camp and North Audley, encompass the highest quality habitat in the valley and make up 83% of the AVSC (Winstead and others 2000).

PRAIRIE DOG MANAGEMENT

The Department classifies Gunnison's prairie dogs as nongame mammals and may be taken under auspices of a hunting license. In the AVEPA, visitors to the Boquillas Ranch are required to sign in and to obtain an access permit. Upon signing out, hunters are asked to record the numbers of prairie dogs taken. Informational signs are posted at all major entry points into the valley advising shooters of the ongoing reintroduction effort .

In 2001, the Arizona Game and Fish Commission established a seasonal closure for hunting of Gunnison's prairie dogs across the state from April 1 to June 15 each year (Commission Order 14). To help monitor the effects of a closure, the Department started surveying small game hunters in 2000 to determine the number of prairie dogs taken on an annual basis. Results from 2000 and 2001 are 91,864 and 75,791 respectively. These numbers represent information prior to the first seasonal closure and establish a baseline to compare future surveys. The Department will continue monitoring the take of prairie dogs for management decisions.

Historically a prairie dog management artifact occurred in Commission Rule 12-4-309. In 1997, this rule prohibited hunting within certain hunt units by all persons not possessing a valid big game tag required for that season. This effectively closed prairie dog shooting for 1 month in most of Aubrey Valley. However, 12-4-309 was repealed in 2002.



1. Reservation	5. Owl track	9. Mission	13. North Caterpillar
2. Prairie Hills	6. Valley	10. South Audley	14. Streamline
3. Grand Canyon	7. Pica Camp	11. North Audley	15. Railroad Corner
4. Cliff	8. Devil Horn	12. Tin Shack	16. South Caterpillar

Figure 2. Prairie dog towns within the Aubrey Valley Complex.

PRAIRIE DOG MONITORING

The AVEPA prairie dog population has been continuously monitored since 1990. This is the longest and most consistent population and habitat monitoring of any of the ferret reintroduction sites. Consistent monitoring allows biologists to detect changes in habitat and in predator and prey populations, permitting ferret management decisions to occur early in the planning process.

Prairie dog distribution and densities are inventoried annually using transect surveys (Van Pelt 1995). Field personnel survey 64 established transect-blocks in the AVEPA between the months of May and August. Results are compared to data from prior years to determine if notable changes have occurred in distribution and densities (Table 1). When a notable change is observed, additional surveys are run to determine the extent of change. Point-counts from a vehicle by on-site biologists also occur throughout the year.

Table 1. Summary of prairie dog surveys, 1996-2001.

Year	Blocks sampled	Transects completed	Percent good habitat	Mean active burrows/ha (range)	Mean prairie dogs/ha (range)
1996	62	457	36	21 (0-69)	5.32 (3.94-7.76)
1997	64	295	37	22 (0-62)	6.52 (3.94-11.15)
1998	64	390	56	33 (0-121)	8.02 (5.11 – 9.48)
1999	64	354	61	33 (0-126)	7.43 (5.24-10.72)
2000	64	389	50	32 (0-130)	6.12 (0-10.57)
2001	64	384	33	23 (0-153)	5.76 (0-11.21)

As with any site, ferret family rating in Aubrey Valley fluctuate (Fig. 3). A ferret family is defined by Biggins and others (1993) as 1 female, 3.3 young and 0.5 male. In AVEPA, it appears as though ratings fluctuate as a result of prairie dog populations responding to climatic events instead of diseases. Higher prairie dog numbers tend to occur following mild winters and above average rainfall while lower numbers tend to occur during times of drought. Since 1996, the ferret family rating for the AVEPA has ranged from 24 to 79 ferret families which has been above the 30 breeding adult (or 20 ferret family) threshold outlined in the Black-footed Ferret Recovery Plan (USFWS 1988).

DISEASE SURVEILLANCE

Along with other black-footed ferret reintroduction sites, the Aubrey Valley faces the constant threat of catastrophic events that would detract from its suitability as a viable release site. The main threats to Arizona are potential outbreaks of canine distemper or sylvatic plague events. With assistance from the Arizona Department of Health Services Vector and Zoonotic Diseases Division (VZD), the USDA APHIS Wildlife Services, and the UA, a disease monitoring program similar to that described by Williams (1991) has been conducted annually.

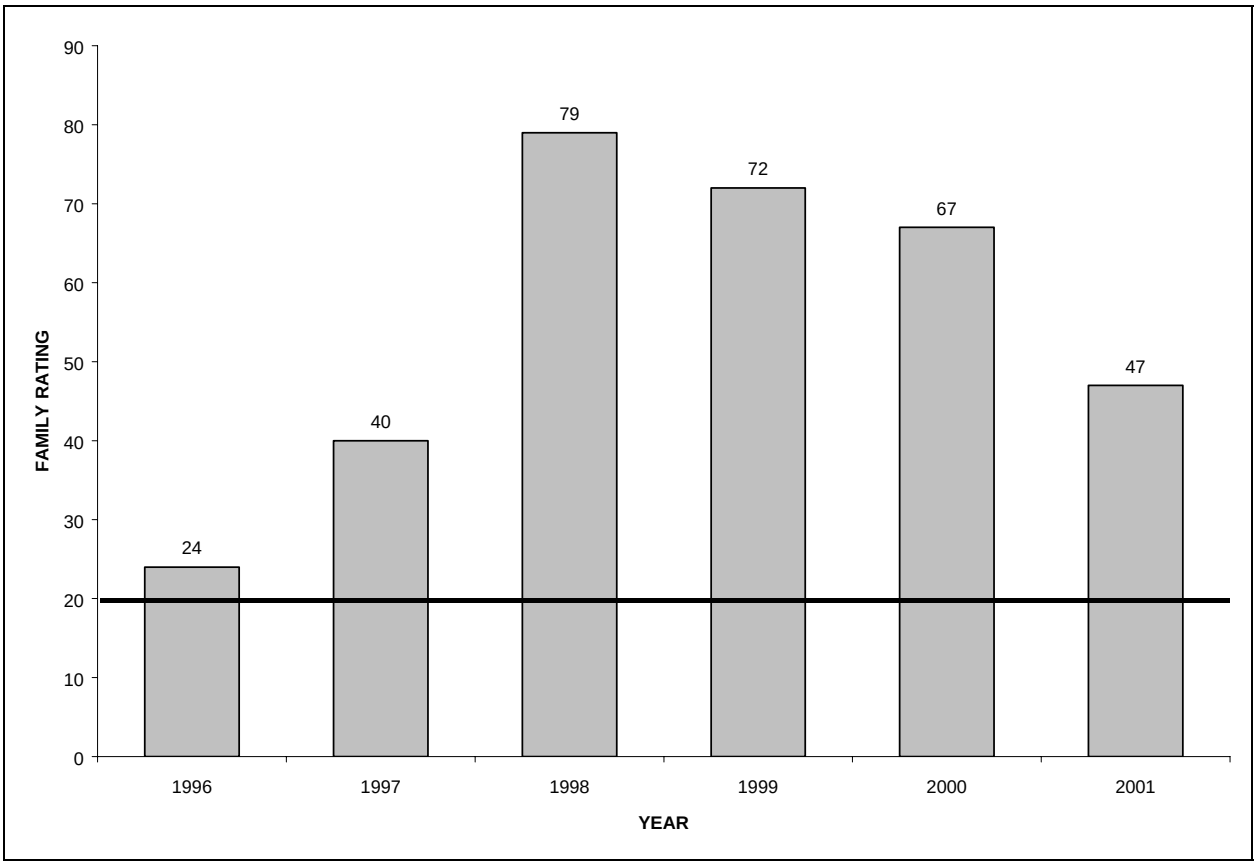


Figure 3. Ferret family rating for Aubrey Valley from 1996-2001.

Since 1993, monitoring for canine distemper and plague has been annually monitored in the AVEPA. Sampling occurs within a 40 km (25 mi) radius of the release sites, with a majority of the specimens collected within the AVEPA. A total of 182 animals were taken for analysis from 1996-2001.

The USDA Wildlife Service is contracted to collect specimens for disease monitoring. For the distemper analyses, tissue samples (blood, kidney, liver, stomach, bladder, and lungs) are collected and analyzed at UA. Plague samples are collected using Nabuto strips and are sent to the VZD for analysis. The VZD has monitored plague activity in Arizona since 1974 by documenting human cases, testing carnivore blood samples for titers, and testing flea pools collected from prairie dog burrows (Van Pelt 1995). Routine sampling of fleas by the VZD stopped after 1997 due to funding constraints. However, field biologists routinely observe prairie dog activity throughout the AVEPA. In the event of a suspicious decrease in prairie dog numbers, prairie dogs will be trapped and fleas will be collected for analysis by the VZD.

Serology of carnivores has shown a low incidence of positive results, indicating that both diseases have been active in the past, but no recent activity has occurred. Since 1996, 24% of the samples were positive (titer ≥ 128) for distemper and 17% of the samples were positive for plague (Table

2). No canine distemper lesions have been noted in tissue samples during this time, which indicates no recent outbreaks. Although plague continues to be active in Coconino and Yavapai counties, outbreaks and die-offs have not occurred within the AVEPA.

Table 2. Summary of disease monitoring efforts in Aubrey Valley, 1996-2001.

YEAR / DISEASE	TEST RESULTS			PREDATORS COLLECTED				
	-	+	NO SAMPLE	COYOTE	BADGER	FOX	TOTAL	JUV
1996				32	-	2	34	5
DISTEMPER	25	6	3					
PLAGUE	16	14	4					
1997				46	-	-	46	11
DISTEMPER	30	4	12					
PLAGUE	37	7	2					
1998				30	1	-	31	2
DISTEMPER	14	15	2					
PLAGUE	29	1	1					
1999				20	-	2	22	3
DISTEMPER	17	2	3					
PLAGUE	10	4	8					
2000				34	1	-	35	7
DISTEMPER	26	8	1					
PLAGUE	31	2	2					
2001				12	1	1	14	2
DISTEMPER	-	-	14					
PLAGUE	14	-	-					
COMBINED				174	3	5	182	30
DISTEMPER	112	35	35					
PLAGUE	137	28	17					

No organized prairie dog control or poisoning effort has occurred in Aubrey Valley since the 1960s (Belitsky and others 1994b).

PREDATOR MANAGEMENT

As with many of the reintroduction sites, the Arizona ferret reintroduction project has identified a variety of potential predators of ferrets and their offspring. The primary terrestrial predators include coyotes (*Canis latrans)*, badgers (*Taxidea taxus)*, bullsnakes (*Pituophis melanoleucus*) and rattlesnakes (*Crotalus* spp.). The primary avian predators include golden eagles (*Aquila chrysaetos*), ferruginous hawks (*Buteo regalis*), prairie falcons (*Falco mexicanus*) and great-horned owls (*Bubo virginianus*). Great-horned owls occur year-round in the AVEPA, although not in large numbers. High numbers of golden eagles and ferruginous hawks are present from March through April but most move on by early summer.

The ferret reintroduction project employs both lethal and non-lethal forms of predator management. Lethal control takes place during disease sampling. Wildlife Services is scheduled to sample for diseases prior to ferret releases, and is directed to initially concentrate their efforts around release pens and in the Aubrey Valley. In 1996, 24 ferrets were radio-collared and monitored by personnel. In 2001, 9 ferrets were also radio-collared and monitored. It was estimated the predation rate on ferrets was approximately 25% and 11% respectively, which is within the predation rate identified in the reintroduction plan. Although additional lethal predator management can occur as outlined in Belitsky and others (1994b), at this time, it does not appear as if additional lethal predator management measures are necessary for pre-conditioning and releasing ferrets.

The electric fence, both inside and outside acclimation pens, provides both lethal and non-lethal predator management. In 1996, project personnel documented deterring badgers from breaching pens, and in 2000, project personnel documented gopher snakes (*Pituophis melanoleucus*) being killed or injured when they attempted to enter the pens and crossed the lower electric fence wires (Winstead and others 2002a).

A variety of non-lethal methods of predator management have been implemented with the Arizona reintroduction effort. Acclimation pens were designed to keep ferrets and prairie dogs in and terrestrial predators and livestock out. Signs of canids and badgers have been noted around the pens, but no mammalian predators have breached pen security systems.

Another non-lethal form of predator management was directed toward avian predators. In 1996, a golden eagle was observed swooping into pens attempting to capture prairie dogs intended for ferret preconditioning. Various avian deterrent measures were immediately implemented, which included stringing ropes diagonally across the pens and erecting gill netting. Neither proved to be effective or financially viable options. Eventually, pens were fitted with monofilament line strung across the top of the pens about three-feet apart (Van Pelt and others 1998). This method eliminated raptor-caused deaths in pens until December 2000 when raptors killed 2 ferrets and wounded another. In January 2001, after an adult female ferret was found dead as a result of raptor attack, considerable effort went into modifying or replacing the monofilament stretched across pen sections to ≤18 inches. No raptors have been observed inside the pens since this action has occurred.

The last form of non-lethal predator management is the constant presence of project personnel maintaining pens, caring for ferrets, and conducting ferret searches. During these ferret activities, project personnel incidentally monitor predator populations and implement necessary management actions.

REINTRODUCTION METHODS AND RESULTS

The primary goal of the Arizona reintroduction effort is to re-establish black-footed ferrets in the Aubrey Valley as quickly as possible. To do this, our focus has been on pre-conditioning release

candidates and on developing on-site breeding protocols that will allow us to obtain the goals identified by the Arizona reintroduction effort. It also includes quarantining, feeding and supplying prairie dogs, which contributes both the Arizona and national recovery effort for black-footed ferrets (USFWS 1988).

PRE-CONDITIONING PENS

The Arizona reintroduction effort includes use and evaluation of a release strategy involving on-site, acclimation pens (Van Pelt 1996). An objective of pre-conditioning is to allow naïve, captive-bred ferrets to become familiar with burrow systems and more natural surroundings. It provides individuals with opportunities to practice hunting skills and to develop appropriate behaviors when interacting with their environment. Overall, a ferret's alertness, escape response, general mobility, and coordination are increased by the on-site experience. Because animals were pre-conditioned, it is assumed that they would disperse relatively short distances and establish home ranges in densely populated prairie dog towns, thus increasing their chances of survival (Biggins and others 1993).

In 1996, 10 acclimation pens were constructed using one-inch chicken wire, 17 gauge electric-fencing wire, solar-powered electric fencers, metal flashing, standard metal fence posts and connectors. Each pen encompasses up to 1 acre, is divided into 4 equal sections, and contains adequate burrows for ferret exploration and habitation. To augment existing holes, and to encourage burrowing within the release pens by prairie dogs and ferrets, starter burrows measuring approximately 1.5 m in length were dug using a 12.7 cm auger. Personnel entered pens using ladders because doors were not built to enter the pens as a form of security. While all ten pens were used in 1996, the design proved to be cumbersome to project personnel. Tremendous amount of time was spent taking care of ferrets and maintaining pen integrity.

In 1997, 8 pens were fitted with sliding metal doors (Van Pelt and others 1998). Each pen was fitted with 4 doors. Two doors are on the outside of the pens and allow personnel to enter the pens. Padlocks prevent unauthorized personnel from entering the pens. The other 2 doors are between pen sections and connect to those sections with doors to the outside. The doors are constructed of tubular aluminum and 0.5-inch hardware cloth. The frames were made from welded channel iron and rebar. This modification allowed easier access for personnel taking care of ferrets and reduced the time spent on ferret husbandry.

In 1998, thicker flashing was obtained to repair or replace old flashing (Winstead and others 1999). Nearly twice as thick, it resisted wind damage better than the old flashing. Also, the electric fence was modified to a series of 3 electrical wires off set from each other. This strategy was implemented to deter climbing of ferrets. In addition, interior and exterior wires were isolated as separate systems and were powered by separate solar electric-fence chargers (Winstead and others 2000). These actions greatly reduced time needed to maintain the integrity of the pens. Prairie dogs digging under the fencing create potential escape avenues for ferrets. Pen breaches are located using a leaf blower and blowing non-toxic smoke into burrows. Burrows that compromise the pen's integrity are sealed with chicken wire and concrete. To prevent further digging into pens, all prairie dogs within approximately 10 m of the pens are trapped and removed.

The original intent of the acclimation pens was to hold animals for 3 months pending release and allow for an entire release of pre-conditioned animals. We have been quite successful at meeting this objective. In the last 6 years, we have held 179 animals (75%) for more than 90 days (Winstead and others 2002b) and released 144 (60%) (Table 3).

Table 3. Summary of ferret releases in Aubrey Valley, 1996-2001.

Year	Days held (mean ± 95% CI)	Total Released	Soft released (males:females)	Hard released (males:females)
1996	109 ± 14	35	35 (16:19)	0
1997	-	0	-	-
1998	143 ± 55	26	26 (15:11)	0
1999	75 ± 36	52	20 (8:12)	32 (11:21)
2000	231 ± 118	19	9 (5:4)	10 (6:4)
2001	462 ± 149	12	1 (0:1)	11 (3:8)

QUARANTINE CAPABILITIES

Reintroduction protocols require all prairie dogs originating outside of AVEPA be quarantined to rule out the risk of exposing ferrets to plague-infected prairie dogs. Prairie dogs for the ferret project have originated from areas around Seligman, Flagstaff, and Williams. Beginning in 1998, black-tailed prairie dogs were also collected using a vacuum truck in Colorado by the company *Dog Gone* and donated to the project (Winstead and others 1999). The quarantine lasts 14 days at which time prairie dogs are either fed live to ferrets or are euthanized using CO_2 and processed at the facility for later use. Prairie dogs in quarantine are fed, watered and checked daily for signs of disease, stress and dehydration. The facility is regularly cleaned and dusted for fleas using Sevin.

In 1996, quarantine capacity was 96 animals and facilities consisted of banks of cages in rows of 3, stacked on top of each other (Van Pelt and Brennan 1997). Each row consisted of 8 cages measuring 76 cm x 30 cm x 46 cm. However, the size of the quarantine proved to be a bottleneck to the project due to the number of prairie dogs needed to precondition ferrets and to supply to the captive breeding facilities.

In 1997, a quarantine facility with 11 cages was constructed on Arizona Department of Transportation property in Seligman (Van Pelt and others 1998). Each cage measured 61 cm deep by 46 cm high by 244 cm in length, and was divided into 3 sections, which increased the quarantine capacity to 200 prairie dogs.

In 1998, with the possibility of obtaining large numbers of prairie dogs from *Dog Gone*, a room was added to the quarantine facility in Seligman to provide space for an additional 70 prairie dogs in 4 additional cages, providing a total capacity of 270 in 15 cages. Because cages in this room are less than 61 cm apart, all prairie dogs here are treated as being in a single cage and are subject to a concurrent quarantine period (Winstead and others 1999).

In 1999, an additional room was constructed and holds 18 heavy wire rabbit hutches (Winstead and others 2000). Also the original 11 cages were replaced with rabbit hutches. The heavy wire in these cages is more resistant to chewing by prairie dogs and reduces escapes and repair needs. Current holding capacity is 500 Gunnison's prairie dogs or 670 black-tailed prairie dogs. Black-tailed prairie dogs tolerate crowding better than do Gunnison's prairie dogs.

Since 1996, a total of 6652 prairie dogs have passed through quarantine (Table 4). At least 598 (9%) of those were transferred to SSP facilities for use in captive breeding programs and 1,382 (21%) were fed live to ferrets in the pre-conditioning pens in AVEPA. About 4350 kg of processed and frozen meat has been fed to captive ferrets. Most of this has been prairie dog (79%), but rabbit, zoo diet, and cat food have been used when prairie dog reserves have run low. Other reintroduction sites have also provided frozen prairie dogs to cover shortages in food. The amount of prairie dog parts fed in this manner is equivalent to about 5750 animals.

Table 4. Status of quarantined prairie dogs and food resources used for ferrets, 1996-2001.

Year	Total animals	To SSP	Fed live	Food used (kg)		
				Total	Prairie Dog	Rabbit
1996	1138	-	502	482	382	34
1997	974	200	364	464	464	-
1998	1082	80	159	1065	1013	52
1999	1115	93	153	1071	573	477
2000	1778	25	204	1086	861	225
2001	565	200	0	182	158	24
Total	6652	598	1382	4350	3451	778

ON-SITE BREEDING

Since younger ferrets are considered to have the best post-release survival potential, they are preferred candidates for release. On-site breeding, coupled with preconditioning, was expected to take this concept to the next level, because it was assumed ferrets born and raised on-site would behave similarly to ferrets born in the wild, and have higher survivorship than those born in captivity. The on-site breeding program evolved since its inception in 1996 (Table 5). Personnel involved with black-footed ferrets were trained in black-footed ferret husbandry and breeding techniques at the National Black-footed Ferret Conservation Center and at The Phoenix Zoo. Information obtained during these training exercises was used to develop protocols applicable for large, on-site pens.

Table 5. Summary of pen-breeding efforts, 1997-2001.

Year	Females	Males	Pairings	Litters	Kits	Survivors
1997	8	5	8	0	-	-
1998	16	7	17	8	26	18
1999	18	7	18	16	63	11
2000	14	8	14	8	29	15
2001	4	3	4	Released prior to whelping.		

In 1996, 10 pregnant females were allocated to Arizona. All were palpated and determined to be pregnant prior to shipping. Two weeks after arrival, 1 female appeared to have swollen teats, but no young ever appeared above ground and no other ferrets exhibited signs of whelping (Van Pelt and Brennan 1997). It was hypothesized the ferrets were stressed due to the shipping and the ferrets reabsorbed their pregnancy. Although the sample size was small, it was determined that ferrets probably needed to be bred on-site.

In 1997, one of the first tools implemented in the on-site breeding program was placement of ferrets. Ferrets of the same gender were placed diagonally prior to the onset of estrus to determine compatibility and whether they were receptive to each other. In addition, it was done to reduce potential territorial strife and fighting, which could cause injury to ferrets. At least once per week, biologists trapped and monitored the reproductive condition of each ferret.

When ferrets displayed physical and behavioral signs of breeding readiness, males were allowed access to adjacent females through passive introduction, which entailed placing a plastic tube through a hole cut in the fencing between pen sections. However, males could only access 1 female at a time.

Successful breeding was inferred from observation of physical and behavioral signs displayed by the ferret. Physical signs used for determining possible breeding included: orange saliva signs on the back of the neck, decrease in vulva swelling shortly after pairing, and a distended abdomen near potential whelping date. Behavioral characteristics used for determining possible success for breeding included an increase in secretiveness during the gestation period followed by a decrease in activity around the estimated whelping date.

Nine females and 5 males were available at the beginning of the breeding season when field biologists began monitoring animals for reproductive condition. One female was never paired due to health reasons, but 8 pairings were achieved. The first pairing occurred on March 31 and the last pairing occurred on May 24. One female was presumed killed while with the male because the male was observed with blood on his snout soon after pairing and the female was never seen again. Of the 7 successful pairings, 2 females disappeared prior to their whelping date. At least 2 of the females paired exhibited orange saliva stains on the nape of their necks and 1 of the females was observed sharing a burrow with her partner for 3 days.

Although at least 3 females exhibited signs of possible whelping such as difficulty standing, upright, extreme weight loss around her due date, and sign of lactation 40 days past her expected due date, no female brought a litter aboveground in 1997. It was determined a more hands-on approach was needed and the 1997 protocols were modified.

In 1998, new protocols were implemented to document and improve breeding success included intensive monitoring to determine optimal pairing period (Winstead and others 1999). Ferrets were trapped once a week to determine reproductive condition using testicular and vulva size. Cytological samples were taken from females and used to predict time of estrus (Harder and Kirkpatrick 1994). Experienced Phoenix Zoo personnel stained the samples and interpreted results. Pairing occurred when observed cornified epithelial cells approached 90% of all cells

counted. A pairing was considered successful if samples taken after pairing showed a decrease in these epithelial cells. Biologists also looked for orange saliva staining on the back of the female ferret's neck. Females were confined to nest box connected by an artificial tube to an above ground cage after paring to allow biologist to monitor breeding success.

Six males were used to breed 14 females, with the first pairing of ferrets occurring on April 15 and the last on June 17. Nine females were successfully bred (64%) and 5 (36%) missed their due dates. One female did not become pregnant from the first pairing, came into estrus again, and was successfully paired with a different male. Eight litters, ranging in size from 2 to 5, were produced. Of the 26 kits born, 18 survived and were released from nest boxes into acclimation pens.

Because of the success observed in 1998, the same breeding procedure was followed in 1999, except AGFD biologists stained the samples and interpreted results instead of Phoenix Zoo personnel (Winstead and others 2000). Seven males were used to breed 18 females, with the first pairing of ferrets occurring on April 23 and the last on May 21. Sixteen females (88%) were successfully bred, 1 missed her due date, and 1 died 10 days after pairing. Sixteen litters, ranging in size from 1 to 6, were produced.

Of the 63 kits born, 41 survived the first 2 weeks of life and were released from nest boxes into acclimation pens. Although survival rates in nest boxes were similar in 1998 and 1999 (69 and 65%, respectively), survival was poor for kits taken into burrows within acclimation pens. Only 11 were alive post-weaning.

In 2000, 7 males were used to breed 14 females, with the first pairing of ferrets occurring on April 14 and the last on May 13 (Winstead and others 2002a). The breeding season was approximately 1 week earlier than in 1999.

Eight females (57%) were successfully bred and produced litters ranging in size from 1 to 6. Births occurred between May 27 and June 19. Of the 29 kits born, 24 (83%) survived the first 30 days of life and were released from nest boxes into acclimation pens. Fifteen were alive and PIT tagged in late September. One was missing during tagging, but was found alive in January 2001 for a total of 16 kits (55%) raised to age of release.

In 2001, spring releases were implemented by the Arizona project. Arizona personnel used 3 males to breed 4 females prior to their release (Winstead and others 2002b). The first pairing of ferrets occurred on April 23, with the last pairing occurring on May 9. The other 5 females were not close enough to estrus for breeding prior to their release. Instead of confining females in nest boxes as normally done, they were released 2 to 15 days following pairing and allowed to whelp in the wild. Releases coincided with increased prairie dog activity and prey populations due to birth of pups. The females not in estrus, were released near known locations of wild males to improve chances of breeding occurring in the wild.

Overall, Arizona was very successful with producing black-footed ferret kits in large on-site acclimation pens. While productivity was similar to other captive facilities in 1998, survivability

to weaning age was extremely low in 1999. Modifications in the nest box setup were made that increased survivability to levels similar to captive facilities. Changes were made to address temperature concerns that inevitably affect kit survival. Nest boxes were buried deeper in 2000 than in prior years (the bottom of the box at approximately 30 inches below the surface versus approximately 16 inches). Wood collars extended from nest boxes to the surface to prevent collapse of the hole into the nests. Wood lids, insulated with 1 inch thick Styrofoam, were fitted on top of the collar. Ice blocks (frozen 2-liter soda bottles) were placed on top of the nest box during the warmest days. The intent was to keep the nest box temperature below 27 °C (80 °F).

The Arizona project will continue monitoring release survival to determine benefits of using on-site breeding and spring releases.

FERRET ALLOCATIONS AND DEPOSITION

Since 1996, a total of 365 individual ferrets have been involved in the Arizona reintroduction project (Table 6). Two-thirds of these were allocated and were shipped from breeding facilities across North America. The others were produced on-site.

Table 6. Status of ferrets held in Aubrey Valley, 1996-2001.

Year	Held Over	Allocated	Births	Releases	Escapes	Missing	Deaths	Transfers	Year End Total
1996	0	83	0	35	5	12	10	1	20
1997	20	33	0	0	1	15	5	0	32
1998	32	38	26	26	11	13	17	3	26
1999	26	69	63	52	7	9	62	0	28
2000	28	17	29	19	1	9	22	2	21
2001	21	0	7	12	1	4	3	1	0
Sum		240	125	144	26	62	119	7	

A third of the ferrets involved in the Arizona effort have died prior to release. However, of the 119 deaths that occurred in pre-conditioning pens, 74 (62%) involved kits that did not survive to weaning age. In 1999, 52 kit mortalities (83%) occurred within the project and contributed to 70% of the overall mortality total. It was assumed mortality rates were high because burrows became unsuitable for kit rearing due to excessive waste accumulation or temperatures in nest boxes were too high. Other mortalities included 14 raptor attacks (12%), 4 deaths related to organ failure, septicemia, and pneumonia (3%), 2 possible snakebites (2%) and 1 hit by vehicle (1%). The remaining 24 mortalities (20%) are from unknown causes.

In spring 2000, prairie dogs were used for burrow maintenance and construction within pen sections while female ferrets were confined to breeding cages. This action provided additional burrows for ferrets to use and existing burrows were in better condition when females moved their litters from nest boxes. In addition, changes in the nest box setup were made to address the issue of temperature affecting kit survival.

Nest boxes were buried deeper than in prior years (the bottom of the box was at approximately 76 cm below the surface versus approximately 41 cm). Wood collars extended from nest boxes to the surface to prevent collapse of the hole into the nests. Wood lids, insulated with 1 inch thick Styrofoam, were fitted on top of the collar. Ice blocks (frozen 2-liter soda bottles) were placed on top of the nest box during the warmest days. The intent was to keep the nest box temperature below 27 °C (80 °F).

Optic Stowaway® Data Loggers were used from April 28 to July 21, 2000 to record temperatures associated with nest boxes. Deeper burial and use of ice during hot days improved temperature conditions within nest boxes. Temperatures associated with the new design nest box reached or exceeded 27 °C on fewer days than did the ones associated with the old design nest box. In general, there was less fluctuation in temperature through the whelping season for the new design boxes (5-6 °C) than for the old design (8 °C). As would be expected, temperatures inside a nest box containing ferrets are higher than outside of the same box. Body heat raised internal temperatures 1.3 °C on average (Winstead and others 2002a). Since survival levels were similar to 1998, it was assumed the major factors affecting kit survival were addressed with the modification mentioned above.

Eighty-eight ferrets either escaped or were missing from pre-conditioning pens. Missing is defined as not being able to ascertain whether ferrets died underground, were killed, or escaped. Only 7 ferrets were unsuitable for release and were transferred to zoos or research facilities.

A total of 150 ferrets (41%) were released, or were found after escaping, into AVEPA. Releases occurred every year except 1997, when animals were held over for breeding trials (Van Pelt and others 1998). Prior to their release, animals were held 75 to 462 days on average in pre-conditioning pens. Two release strategies were used in Arizona. Soft releases allowed ferrets to leave on their own accord through tubes inserted into pre-conditioning pens. Hard releases entailed releasing ferrets from transport boxes into a burrow within areas of prairie dog towns with high population densities.

Unlike other reintroduction sites, Arizona has had a larger percentage of their release cohorts made up of adult animals (Fig. 4). Another significant difference is the number of kits per release (Fig. 5). The average number of kits per release in AVEPA is 17 compared to 38 for all of the reintroduction sites combined (data thru 2002 was used). In the 6 releases conducted by Arizona, it has only once released more kits than the national average. Releasing a lower number of kits has probably contributed to the difficulty in establishing a ferret population in Arizona with a growth rate similar to other reintroduction sites.

REINTRODUCTION MONITORING RESULTS

SPOTLIGHTING

The primary technique used in Aubrey Valley to determine short and long term survival of

ferrets is nocturnal searches following procedures outlined by Clark and others (1984). Over 5,550 person-hours have been spent surveying for ferrets over the last 6 years (Fig. 6). Surveys are conducted from vehicles (91% of total effort) or on foot.

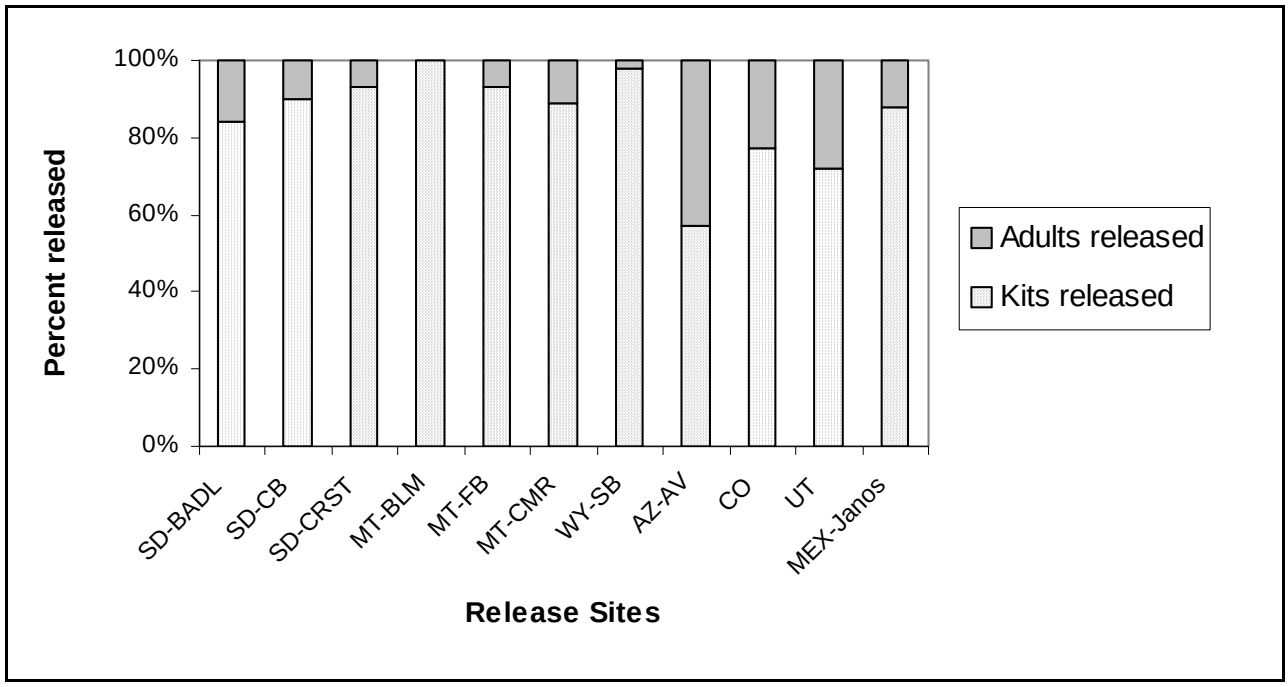


Figure 4. Ratio of kits to adults released at each of the reintroduction sites.

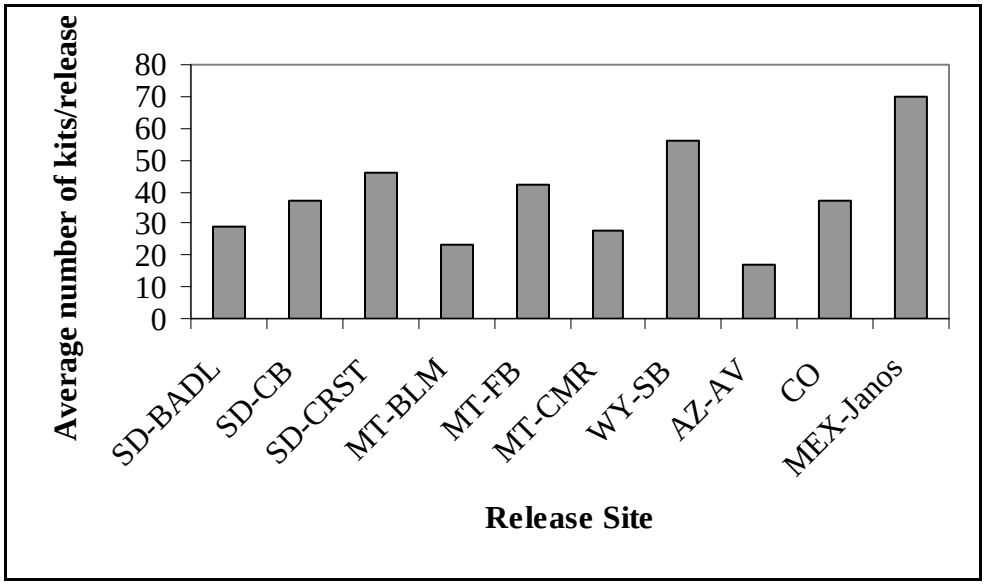


Figure 5. Average number of kits released per site.

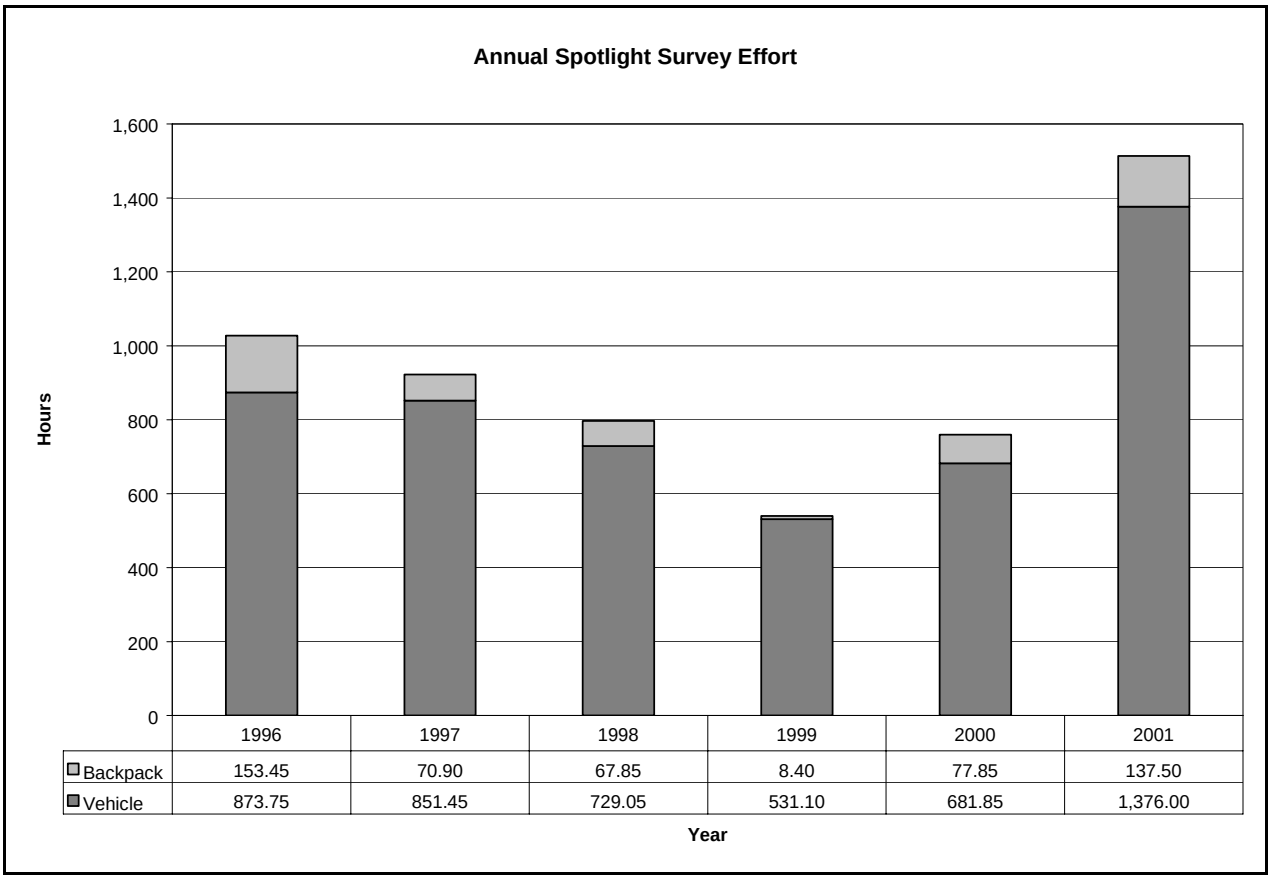


Figure 6. Effort expended on spotlight surveys in Aubrey Valley.

During this time, 47 observations of 28 different individuals have been made, 7 of which were wild-born in 2001 (Table 7).In addition, there were 54 observations of ferrets but individuals could not be identified, and 38 were of animals that were ferret-like but not positively identified as ferrets (Table 8). Of the 150 ferrets that were released or escaped, 10 (7%) were known to survive more than 30 days in the wild, of which 3 (2%) were documented surviving into the following spring. Of the 10 surviving 30 days, 8 (80%) were adult and 2 (20%) were kits. Of the animals surviving into the following spring, 2 (67%) adults and 1 (33%) was a kit. Both long and short-term survival is significantly lower than other sites. This could be the result of releasing large cohorts of animals comprised of adult animals or a function of declining search effort from 1996-1999.

Table 7. Ferrets identified during spotlight surveys in Aubrey Valley, 1998-2001.

Studbook	Sex	Age	Release Date	Last Observation	Days Known Alive
597	F	4	10/15/96	11/20/96	35
489	F	4	9/5/96	10/21/96	46
1009	M	2	9/5/96	10/10/96	35
1148	F	A	04/04/97 (escape)	05/01/98	392
2583	F	K	08/17/98 (escape)	08/25/98	8

Table 7 (continued).

Studbook	Sex	Age	Release Date	Last Observation	Days Known Alive
1027	F	A	09/22/98	09/25/98	3
1499	M	A	09/22/98	09/25/98	3
1056	F	A	09/22/98	09/26/98	4
1301	M	A	06/12/98 (escape)	11/16/98	157
1NE98F5[1]	F	K	10/16/98	11/22/98	37
1494	F	4	07/20/99 (escape)	08/02/99	13
1437	F	4	08/03/99	08/09/99	6
1368	F	4	08/05/99	08/09/99	4
3004	M	K	09/01/99 (escape)	09/03/99	2
P112[1]	M	K	10/06/99	10/22/99	16
P113[1]	M	K	10/06/99	10/24/99	18
1303	F	4	10/17/99	10/26/99	9
P76[1]	M	K	10/29/99	10/31/99	2
P36[1]	F	K	11/03/99	11/03/99	0
1610	F	3	11/16/99	11/19/99	3
3035	M	1	09/07/99 (escape)	07/17/00	314
1905	F	3	08/14/00	11/11/00	89
3299	M	A	10/09/00	08/22/01	317
P156[1]	F	A	05/11/01	10/29/01	171
WB01B[2]	F	K	10/29/01 (tagged)	10/29/01	0
WB01C[2]	M	K	10/30/01 (tagged)	11/08/01	9
WB01A[2]	M	K	10/27/01 (tagged)	11/09/01	13
WB01F[2]	F	K	11/10/01 (tagged)	11/10/01	0
WB01G[2]	M	K	11/17/01 (tagged)	11/17/01	0
WB01E[2]	F	K	11/10/01 (tagged)	12/02/01	22
WB01D[2]	F	K	11/03/01 (tagged)	12/31/01	58

[1] Born in pens. [2] Wild-born.

Table 8. Observations of ferrets and possible ferrets during spotlight surveys, 1996-2001.

Year	Identified ferret	Unidentified ferret	Possible ferret
1996	6	6	3
1997	0	1	6
1998	12	11	8
1999	6	3	1
2000	3	3	0
2001	20	30	20
Total	47	54	38

Fourteen transects, 1 to 2 km in length (16-km total length), were established in 2001 within high- and low-density prairie dog areas throughout Aubrey Valley (Winstead and others 2002b). A conservative estimate of land area surveyed per kilometer of transect is 80 ha (198 ac). Areas were delineated using ArcView and based on median prairie dog density from 2000 survey data. High-density areas contain survey blocks with prairie dog densities above the median and low-density areas contain blocks below the median. Transects were equal between high and low areas. Most of the backpack surveys in 2001 (121.5 hr) occurred on these transects, but no ferrets were observed.

TELEMETRY

In 1996, 24 animals were fitted with radio collars and monitored by personnel from the USGS Biological Resources Division. Tracking was conducted using 3 null peak fixed antenna stations located throughout the valley (Van Pelt and Brennan 1997). Three animals (12.5%) were known to have survived at least 30 days after release and 6 animals (25%) were confirmed mortalities. The longest documented movement by a ferret during a single night was 10 km.

Telemetry using Wildlife Materials International, Inc. transmitters (148-149 MHz) attached to wool collars was tried during in 2000 to document ferret survival and movements (Winstead and others 2002a). Eight ferrets were anesthetized using isoflurane and collared following standard protocols. Although all transmitters were tested prior to their attachment, 1 failed later and that animal was not released as planned.

Seven radioed ferrets (5 males, 2 females) were released that evening in 3 locations. Six animals were detected the night following their release, but only 3 were observed. One animal was very close to his release location (40 m). One had moved about 155 m from his release location and the other had moved 1.1 km from his. One collar was recovered and was still attached to a severed head of a male ferret that had been killed and eaten by a predator. It was found under a shrub and had been lightly covered with soil. Eleven other detections of ferrets were strictly signals heard from various locations.

Detection of signals from ground locations on the valley floor and on the sides of Aubrey Cliffs was not frequent. An aircraft was used to attempt location of radioed ferrets with poor success. Two out of 3 test collars were detectable from about 0.5 km (0.3 mi) away although they could be heard from a distance of 0.8 km once located. No ferrets other than the 2 detected by ground-based personnel were found from the air.

A second flight occurred during daylight hours about a month after the first one. One collar was located; no other signals were heard. This collar, retrieved the following day, was found 45 cm inside a burrow and about 30 cm below the ground surface. It was found 0.8 km from the ferret's release location. There was no sign of blood on the collar and likely the ferret had slipped it off. Examination of unused radio transmitters suggested that some were flawed. When rubbed or shaken, the signal became highly variable and some transmitted very weak signals or pulse rates changed and occasionally stopped. Fourteen transmitters were returned to the manufacturer for subsequent testing and evaluation.

Radio collars were also attached to 9 ferrets (3 males, 6 females) that were released into the wild in 2001. One female lost her collar inside a transport box prior to her release. Two data loggers, capable of scanning 5 programmed frequencies at once, were set up to automate data collection. One location was on a hillside 400 feet above the valley floor and was used from May 11 to June 16 (35 days). It used a 5-element Yagi antenna that was mounted on an 8-foot PVC pipe attached to a juniper tree. The other unit was mobile and used at 2 different locations, south of Highway 66 for 12 days and north of Highway 66 for 11 days. This unit used an omni-directional antenna mounted to an 8-foot PVC pipe that was attached to a camper shell on a pickup truck. Both data

loggers used big game transmitters along Highway 66 as beacons, were checked frequently, and had data downloaded every other day. Data loggers detected ferrets 161 times, each lasting 1 to 46 minutes. The hillside and south side setup was functional 90 and 88 percent of the time, respectively (determined by beacon strength recordings). However, the north side setup failed to detect any ferret and was functional only 6 percent of the time.

Ground searches using hand-held telemetry equipment were conducted as often as possible through mid-June. An aircraft flying transects approximately 1/3 mile apart was used for 3 hours to search for radioed animals. Signals were detected 1.5 to 2 miles away from the air. However, only 3 animals were located 2 or 3 times using ground or aerial searches. Eventually collars worn by these animals were recovered. A raptor had killed 1 and its collar was still attached to the carcass. Two other collars were recovered after ferrets had lost them. One was above ground and the other in a shallow burrow. A female was found during a spotlight survey close to her release site in late October. She had shed her collar and survived in the wild for 171 days.

RECOMMENDATIONS

From 1996 to 2001, the Arizona Black-footed Ferret Reintroduction Project has contributed valuable information to project cooperators and the national recovery effort. The following are recommendations Arizona plans to implement over the next 5 years:

1. Replacement of a portion of the pre-conditioning pens with pens using a design to eliminate predation by raptors, and reduce maintenance costs (material and personnel time).

2. Monitor prairie dog populations within the release area using standardized annual surveys and use of the resulting data to determine sites suitable for future ferret releases.

3. Expend no less than 800 hours per year conducting spotlight surveys. If necessary, refine protocols (e.g. timing, length, route location) and test other forms of monitoring (track-plates).

4. Develop a reliable radio telemetry system to determine ferret dispersal, survival and habitat use.

5. Continue evaluating spring releases of ferrets.

6. For releases in Autumn, request no less than 30 kits.

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