# REPRODUCTIVE SUCCESS, MULTIPLE PATERNITY, AND INBREEDING IN A POPULATION OF GUNNISON'S PRAIRIE DOGS


By

SARAH BETH MOORE

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

2000


Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
August, 2002

REPRODUCTIVE SUCCESS, MULTIPLE

PATERNITY, AND INBREEDING IN A

POPULATION OF GUNNISON'S

PRAIRIE DOGS

Thesis Approved:

Thesis Advisor

Dean of the Graduate College

## ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Ron Van Den Bussche, for introducing me to the field of genetics and helping me to find my own research interests and for his guidance, encouragement, support, and friendship during the time that I have known him. I would also like to convey my appreciation to my committee members, Dr. Meredith Hamilton and Dr. Anthony Echelle, for their assistance and guidance.

I would also express my gratitude to Dr. John Hoogland for his collaboration and assistance with this project. Without all of his hard labor in the field, making observations on mating behavior, capturing, and collecting blood samples from this population of Gunnison's prairie dogs, this project truly would not have been possible. I would also like to thank Dr. Dennis Gilbert and Applied Biosystems for funding the equipment and materials essential for completion of this research.

In addition, I would like to thank everyone who has worked in Dr. Van Den Bussche's laboratory while I worked there. I would especially like to thank Michelle Haynie, Eric Hansen, Steve Hoofer, and Greg Wilson for being kind enough to teach me the laboratory procedures and techniques. I would also like to express my gratitude to Serena Reeder, Matt Bahm, and Seth Patterson for aiding me in my research project. I am also grateful for the assistance and friendship of Derrick Chappell, Raymond Ary, Matt Leslie, Sarah Weyandt, Stacey Davis, Luke Norton, and the many students I have met and worked with in the Department of Zoology along the way.

Finally, I would like to express my sincere appreciation to my parents, Lonnie and Linda Moore, as well as my entire family who have been extremely supportive and have always believed in me. Without the help and support of these people, I would not have been able to accomplish all that I have.

TABLE OF CONTENTS

## LIST OF TABLES

Table Page

## LIST OF FIGURES

CHAPTER I


**Abstract**

Nine microsatellite loci were used to determine parentage of all juveniles within a population of Gunnison's prairie dogs (*Cynomys gunnisoni*) over a four-year period. The purpose was to investigate reproductive success, multiple paternity, inbreeding, and relatedness, and to assess how these factors changed over time. Parentage assignments were made for 836 of 900 (92.9%) juveniles. Mean female reproductive success for the population was 3.82 ± 0.185 (mean ± SE) and was negatively correlated with population size. Mean male reproductive success for the population from 1991-1994 was 7.82 ± 1.15 and was positively correlated with population size. Multiple paternity was detected in 166 of 221 (75%) litters composed of more than one juvenile over the four-year period. Frequency of multiple paternity varied slightly over the four years of the study, but was within the range reported for other sciurid species. Only 22 of 732 juveniles resulted from unequivocal inbreeding in this population from 1992-1994. Mean relatedness values (r) between individuals at differing social and spatial scales indicated that females within each clan are related similarly the relatedness expected for half-siblings, most likely due to the high level of multiple paternity occurring in this population. Males within each clan, males compared to females within each clan, females between nearby clans, and males between nearby clans are essentially unrelated. In conclusion, these aspects of social structure probably helps explain the low level of close inbreeding, and thus, the breeding system may have evolved to increase the effective population size and maintain genetic diversity within this population of Gunnison's prairie dogs.

# CHAPTER II

## Introduction

To investigate reproductive success, multiple paternity, inbreeding, and other demographic characteristics, parentage of individuals must be accurately resolved. Traditionally, behavioral observation was used to determine parentage in natural populations, but this can be error-prone, especially for species whose social behavior and population structure are not conspicuous (Hoogland 1995; Taylor *et al.* 1997; Coltman *et al.* 1998; Hoogland 1998a; Worthington Wilmer *et al.* 1999). Molecular techniques, such as allozyme analysis, DNA fingerprinting, and most recently, microsatellite analysis, have been employed to address genetic structure and parentage to evaluate conclusions based on behavioral data or to investigate relatedness in organisms that are difficult to observe (Ellegren 1992; Morin *et al.* 1994; van Staaden *et al.* 1994; Travis *et al.* 1996; Gullberg *et al.* 1997; Taylor *et al.* 1997; Gompper *et al.* 1998; Yu *et al.* 2001). In this study, microsatellite DNA markers were used to identify parentage of juveniles and analyze other aspects of the genetic structure of a population of Gunnison's prairie dogs (*Cynomys gunnisoni*) over a four-year period. Numerous studies have demonstrated the value of microsatellites in studies of parentage resolution and genetic structure in natural populations (Craighead *et al.* 1995; Paetkau *et al.* 1995; Garza *et al.* 1997; Alderson *et al.* 1999; Kays *et al.* 2000; Burland *et al.* 2001). Some of this research has found that behavioral estimates of male reproductive success may differ significantly from genetically determined paternity thus, illustrating the importance of analyzing genetic mating systems (Coltman *et al.* 1999; Worthington Wilmer *et al.* 1999).

Long-term investigations are critical for understanding the social complexities of animals because populations respond dynamically to the environment (Hoogland 1995; Travis *et al.* 1996; Coltman *et al.* 1998; Worthington Wilmer *et al.* 1999; Slate *et al.* 2000a; Rossiter *et al.* 2001). Long-term ecological/behavioral and genetic studies have been performed on several prairie dog species (*Cynomys*), especially the most widely distributed and abundant black-tailed prairie dog (*C. ludovicianus*; Foltz & Hoogland 1981, 1983; Chesser 1983; Hoogland 1995; Dobson *et al.* 1997; Dobson *et al.* 1998). Recently, Hoogland (1997, 1998a, b, 1999) conducted a long-term behavioral examination of a population of Gunnison's prairie dogs to understand their reproductive behavior and social organization.

Gunnison's prairie dogs are medium-sized (650-1200g) colonial, diurnal, burrowing rodents of the family Sciuridae. They inhabit portions of Arizona, Colorado, New Mexico, and Utah where they hibernate from November to February (Longhurst 1944; Pizzimenti & Hoffman 1973; Fitzgerald & Lechleitner 1974; Rayor *et al.* 1987; Hoogland 1997, 1998a, b, 1999). Colonies of Gunnison's prairie dogs are subdivided into small social groups called clans, which are composed of several breeding females, one to two breeding males, and numerous non-reproductive yearlings and juveniles (Rayor 1988; Travis *et al.* 1996; Hoogland 1999).

Philopatry creates a situation where the females in a clan are closely related resulting in matrilineal structuring within the colony (Chesser 1983; Dobson *et al.* 1998; Gompper *et al.* 1998). Female prairie dogs are strikingly philopatric, tending to remain in their natal clan for life (Rayor 1985, 1988; Hoogland 1997, 1998a, b, 1999). Hoogland's behavioral data indicated that 95% of females in a Gunnison's prairie dog colony remained in their natal clan for their entire life. Most juvenile males disperse from their natal clan before they reach sexual maturity and breeding males do not remain in a particular clan for more than one year (Hoogland 1999). These behaviors should result in a low level of inbreeding in the colony (Hoogland 1992; Dobson *et al.* 1997), a prediction that was investigated using the combination of behavioral and genetic data in this study. Based on previous behavioral data, it is unknown how males residing in the same clan are related.

Microsatellites were analyzed to determine parentage of juveniles and relatedness of all individuals in a population of Gunnison's prairie dogs. Microsatellites are small tandemly repeated DNA sequences found in the genomes of a large number of eukaryotes (Jarne & Lagoda 1996; Hancock 1999). Microsatellites have been used in numerous parentage, population genetic, and reproductive success studies due to their high level of polymorphism, codominance, Mendelian inheritance, ease of use, and high reproducibility (Bruford *et al.* 1996; Pemberton *et al.* 1999). Some of the species for which microsatellites have been used to study reproductive characteristics include chimpanzees (*Pan troglodytes*; Morin *et al.* 1994), deer (*Cervus* sp.; Marshall *et al.* 1998; Okada & Tamate 2000), seals (*Halichoerus* and *Phoca* sp.; Coltman *et al.* 1998; Worthington Wilmer *et al.* 1999), bears (*Ursus* sp.; Paetkau & Strobeck 1994; Craighead *et al.* 1995; Paetkau *et al.* 1995), wombats (*Lasiorhinus* sp.; Taylor *et al.* 1997), cowbirds (*Molothrus* sp.; Alderson *et al.* 1999), swallows (*Hirundo* sp.; Primmer *et al.* 1995), cichlids (*Pseudotropheus* sp.; Knight *et al.* 1998), and turtles (*Podocnemis* and *Chrysemys* sp.; Valenzuela 2000; Pearse *et al.* 2002).

In this study, a combination of behavioral (obtained from Hoogland) and genetic data was utilized to assess relatedness and reproductive characteristics of individuals in a population of *C. gunnisoni* over a four-year period. The ultimate goal of this study was to gain a better understanding of the evolution of social structure and mating system in this species and be able to extrapolate to other social mammals.

CHAPTER III

## Materials and Methods

### *Study site & population*

Blood samples and behavioral data were collected from essentially every individual in a Gunnison's prairie dog town located in Petrified Forest National Park, Apache County, Arizona from 1991-1994 (Hoogland 1997, 1998a, b, 1999); however, there were some individuals from which blood samples could not be obtained . Methods for capturing prairie dogs, collecting blood samples, and documenting behavior are described by Hoogland (1995).

### *Laboratory techniques*

Using approximately 50 μl of blood, whole genomic DNA was isolated following the protocol described by Longmire *et al.* (1997). Nine microsatellite loci were amplified via polymerase chain reaction (PCR) using primers originally developed for Columbian ground squirrels (*Spermophilus columbianus*; Stevens *et al.* 1997) which were redesigned by Haynie (2000) and primers developed for Idaho ground squirrels (*S. brunneus*; May *et al.* 1997) (Table 1). Amplification was conducted in reactions containing 1.2 μl genomic DNA (50ng/μl), 1.0 μl fluorescently-labeled (6FAM, HEX, or NED) forward primer (5μM), 1.0 μl unlabeled reverse primer (5μM), 9 μl ABI PRISM™ True Allele® PCR Premix, and 3.8 μl dd$H_2O$. The cycling conditions were 95 °C for 12 min, 10 cycles of 94 °C for 15 sec, 48 °C to 55 °C for 60 sec, 72 °C for 30 sec, 25 cycles of 89 °C for 15 sec, 55 °C for 60 sec, 72 °C for 30 sec, followed by a final 30 min 72 °C extension period. PCR products were visualized on a 5% Long Ranger polyacrylamide gel using an ABI PRISM™ 377 DNA Sequencer with GENESCAN® 400HD [ROX] internal size standard. All gels were analyzed and scored using GENESCAN® Analysis 2.1 and GENOTYPER® 2.0 software.

*Data analyses*

Maternity and paternity were determined for all juveniles in the population for each year using genetic exclusion and CERVUS 2.0 computer software (Marshall *et al.* 1998; Slate *et al.* 2000b). CERVUS 2.0 was also used to calculate allele frequencies, observed and expected heterozygosity, frequency of null alleles, polymorphic information content (PIC-index of variability), and average exclusion probabilities for each locus separately and for all 9 loci combined. Probability of identity (PI), the probability of randomly selecting two individuals with identical genotypes from a population, was calculated for each locus and all loci following the method of Paetkau *et al.* (1995, 1998).

Maternity was analyzed for each juvenile first by exclusion, which seeks to exclude all but a single female as the parent by comparing the juvenile and female's genotypes. If a female cannot be excluded, then that individual is designated as the potential mother (Chakraborty *et al.* 1988; Morin *et al.* 1994). In most cases, the female assigned as the potential mother of a litter based on genetic exclusion was suggested by behavioral observation because female Gunnison's prairie dogs can be observed guarding nursery burrows (Hoogland 1997, 1999). In some instances throughout the study, there were females who shared burrows or juveniles could not be captured before mixing with other litters; this prevented the elimination of all but a single female as the potential mother. For these juveniles, CERVUS 2.0 (Marshall *et al.* 1998) was used to determine which of the remaining adult females was the most likely mother.

CERVUS 2.0 determines parentage by calculating a likelihood ratio for each candidate parent at each locus. Likelihood ratios are the likelihood that the candidate parent is the true parent divided by the likelihood that the candidate parent is a randomly chosen individual based on the given genotypes and allele frequencies in the population. The overall likelihood ratio for each potential parent is determined by multiplying the likelihood ratios at each locus together. Each potential parent is then assigned an LOD score, or the log of the overall likelihood ratio. The potential parent with the largest LOD score is the most likely parent. Then a Delta statistic, the difference in LOD scores between the most likely parent and the next most likely parent, is assigned to the most likely parent at specified confidence levels (e.g., 95%, 80%, etc.). The magnitude of the Delta statistic shows the level of likelihood of the most likely parent (i.e., if Delta is small, both are equally likely to be the true mother) (Marshall *et al.* 1998).

Paternity was assigned once maternity was assessed. Again, exclusion was used first to exclude as many adult males as possible. Males known to have copulated with the mother (based on observational data) were tested first. If more than one of these remained as a potential father, CERVUS 2.0 was used to determine the most likely father. If there were cases where all males were excluded, the list of potential fathers was expanded to include males in clans surrounding the clan where a female resided. If paternity could not be determined using these methods, it remained unassigned because there were a few unsampled males in the colony known to have copulated with females in the colony.

Annual and lifetime female reproductive success was calculated for each breeding female in the population and for the female population as a whole for each year and all years combined. This reproductive characteristic was calculated by determining the number of offspring produced by each female. For the population as a whole, female reproductive success was analyzed as the ratio of total offspring to the number of breeding females. Annual and lifetime male reproductive success was calculated in the same manner.

Frequency of multiple paternity was calculated as the number of litters consisting of more than one pup sired by more than one male divided by the total number of litters containing more than one pup. Juveniles with undecided maternity were not included in this analysis. If paternity was not completely resolved for all juveniles within a litter, it was included in this analysis only if there was unequivocal evidence for multiple sires for the juveniles with paternity resolved. This calculation was determined for each year included in the study and these values were compared to similar data from other sciurid species.

Finally, inbreeding was evaluated for the entire population by comparing observed heterozygosity with the expected heterozygosity, both calculated by CERVUS 2.0. If the observed heterozygosity is significantly lower than the expected heterozygosity, it is an indication that inbreeding might be occurring in this population. Inbreeding was also determined by assessing the degree of relatedness among individuals in the population and in each clan. These assessments were based on pedigree path analysis and the results from RELATEDNESS 5.0.8 (Queller & Goodnight 1989; Taylor *et al.* 1997). Pedigree path analysis was used to document which individuals were inbreeding and to determine the nature of inbreeding (i.e., extreme or moderate). If the relatedness for the population and each clan was greater than zero, it was also an indication that inbreeding might be occurring.

Pairwise relatedness (r) was calculated using RELATEDNESS 5.0.8 (Queller & Goodnight 1989; Taylor *et al.* 1997) to test pedigree relationships between pairs of individuals in the population (e.g., mother-offspring, father-offspring, full siblings, maternal half-siblings, and paternal half-siblings) based on parentage assignment. Information about clan composition and maps of the colony were used to investigate the relatedness of adult females within each clan and between geographically close clans, relatedness of adult males within each clan and between geographically close clans, and relatedness of adult males and females within each clan for each year of the study.

CHAPTER IV

## Results

### *Genetic Variability*

For the nine microsatellite loci examined, number of alleles per locus ranged from 2-10 with a mean of 6.11 for the four years combined (Table 2e). All loci had lower heterozygosity than expected (Table 2a-e). PIC and PI values indicated that the most informative loci were GS08, GS14, IGS1, and IGS6, while GS17 and GS20 were the least informative (Table 2a-e). First-parent exclusionary power (i.e., the ability to exclude females as potential mothers) was 86% for all four years combined. Second-parent exclusionary power (i.e., the ability to exclude males as potential fathers when the mother is known) was 98% for all four years combined.

### *Parentage, Reproductive Success, & Multiple Paternity*

Maternity was determined for 169 of 169 (100%) juveniles and complete parentage (maternity and paternity) was resolved for 161 of 169 (95.3%) juveniles for the samples obtained during 1991. During 1992, maternity was clarified for 235 of 235 (100%) juveniles and complete parentage was ascertained for 223 of 235 (94.9%) juveniles. Maternity was resolved for 226 of 235 (96%) juveniles and complete parentage was determined for 201 of 235 (85.5%) juveniles for samples collected during 1993. For the nine juveniles not assigned a mother in 1993, maternity was restricted to two females; however, neither female could be excluded and each was equally likely to be the true mother (see Table 3†). Maternity was resolved for 261 of 261 (100%) juveniles and complete parentage was determined for 251 of 261 (96.2%)

juveniles sampled during 1994. Over the four years of this study, maternity was determined for 891 of 900 (99%) juveniles and complete parentage was resolved for 836 of 900 (92.9%) juveniles.

Based on parentage assignments, the population was composed of 23 clans consisting of 38 adult males (28 breeding), 41 adult females (37 breeding), and 168 juveniles in 1991, 30 clans with 67 adult males (26 breeding), 81 adult females (57 breeding), and 235 juveniles in 1992, 24 clans with 98 adult males (22 breeding), 107 adult females (65 breeding), and 238 juveniles in 1993, and 22 clans with 100 adult males (24 breeding), 116 adult females (81 breeding), and 261 juveniles in 1994.

Female reproductive success was $4.51 \pm 0.20$ (mean $\pm$ SE), $4.12 \pm 0.19$, $3.47 \pm 0.19$, and $3.22 \pm 0.16$ in 1991, 1992, 1993, and 1994, respectively, with a mean female reproductive success over the four-year period of $3.82 \pm 0.185$. Across years, female reproductive success was negatively correlated with population size (Figure 1a). Male reproductive success was $5.68 \pm 0.80$, $8.58 \pm 1.0$, $9.50 \pm 1.3$, and $10.5 \pm 1.5$ for 1991, 1992, 1993, and 1994, respectively and mean success was $7.82 \pm 1.15$ over the four years. In contrast with females, male reproductive success was positively correlated with population size (Figure 1b). Lifetime reproductive success was also determined for each breeding female (Table 4) and male (Table 5) in the population over the four years of the study.

In 1991, multiply sired litters included 26 of 36 (72.2%) litters with more than one offspring, 45 of 55 (81.8%) in 1992, 47 of 57 (82.5%) in 1993, and 48 of 73 (65.8%) in 1994. Mean frequency of multiple paternity over the four-year study was $75.58\% \pm 8.0\%$.

*Inbreeding & Relatedness*

In this population, observed heterozygosity was lower than expected for all years at all loci, which may be indicative of inbreeding. $F_{IS}$ was 0.195, 0.241, 0.230, and 0.236 for 1991, 1992, 1993, and 1994, respectively, with a mean of 0.217 for the four-year period. However, pedigree path analysis revealed only 22 of 732 juveniles from 1992-1994 were the result of an unequivocal inbreeding event (Table 6, Figure 2a-d). Inbreeding could not be determined for individuals sampled during 1991 because relationships of the breeding adults were not known. Inbreeding coefficients for these 22 individuals range from 0.0313 – 0.25 with a mean ± SE of 0.172 ± 0.017. Relatedness values (r) for the population as a whole (Table 7a) and for each clan in each year (Table 7b) reveal r values near zero, indicating that the individuals in the population and clans are unrelated.

Over the four years of the study, mean mother-offspring, father-offspring, and full sibling relatedness values are close to the expected relatedness value of 0.50 (Figure 3a-e). Mean maternal half-sibling r values are close to the expected value of 0.25, somewhat higher than for paternal half-siblings. Mean relatedness of adult females within a clan was approximately 0.25, equivalent to a half-sibling r value. All other comparisons that were made (adult males within each clan, adult males-females within each clan, adult males between nearby clans, and adult females between nearby clans), had mean relatedness values near zero, indicating they are not closely related.

CHAPTER V

## Discussion

A few studies have shown that social structure may not be the same as the breeding structure, and that observational data about the mating system may not reflect the genetic mating system (Coltman *et al.* 1999; Worthington Wilmer *et al.* 1999). Long-term behavioral and genetic studies for understanding social structure and mating system evolution are important because such systems are dynamic and complex (Slate *et al.* 2000a; Burland *et al.* 2001; Rossiter *et al.* 2001).

### *Parentage*

Parentage determination can be performed using genetic exclusion probabilities (Chakraborty *et al.* 1988; Morin *et al.* 1994; Keane *et al.* 1997) or likelihood-based analyses (Foltz & Hoogland 1981; Taylor *et al.* 1997; Marshall *et al.* 1998; Slate *et al.* 2000b). Genetic exclusion may not always assign the correct parent because exclusion probabilities require an exact match between the parent and offspring's genotype. With microsatellites, a variety of factors can generate mismatches, including null alleles, mutations, and errors in determining the correct allele size for an individual's genotype (Callen *et al.* 1993; Paetkau & Strobeck 1995; Pemberton *et al.* 1995; Haberl & Tautz 1999; Chambers & MacAvoy 2000).

Null alleles occur when there are mutations in the DNA sequence flanking the repeat motif of the microsatellite locus, resulting in the primer not binding during PCR. Individuals heterozygous for the mutation will appear to be homozygous and homozygotes, fail to produce an amplification product. The frequency of null alleles increases when the primers were developed for a species other than the study species (Callen *et al.* 1993; Chambers & MacAvoy 2000). This poses a potential problem in this study because the primers utilized were developed for Columbian ground squirrels and Idaho ground squirrels. To account for problems such as genotyping error and mutation rate, likelihood-based analyses and relatedness coefficients were used in addition to genetic exclusion to assign and verify parentage (Chakraborty *et al.* 1988; Queller & Goodnight 1989; Marshall *et al.* 1998). A potential problem with likelihood methods for determining parentage is that it assumes that each locus is in Hardy-Weinberg equilibrium and it is not clear how violation of this assumption will affect parentage assignment.

Previous studies attempting to assign parentage using microsatellite data had varying degrees of success. Alderson *et al.* (1999) were able to assign 55 of 61 (90%) brown-headed cowbird chicks (*Molothrus ater*) to their parents or sibling groups using seven loci. Coltman *et al.* (1999) assigned parentage to 226 of 365 (62%) Soay lambs (*Ovis aries*) using ten microsatellite and five protein loci. Worthington Wilmer *et al.* (1999) were able to assign parentage to only 320 of 811 (39.5%) grey seal pups (*Halichoerus grypus*) using nine microsatellite loci. In this study, parentage was assigned to 836 of 900 (92.9%) offspring using nine microsatellite loci, which was aided by having an extensive behavioral data set. In a previous study of the same colony, Haynie (2000) used seven of the nine microsatellite loci utilized in this study and was able to assign parentage to only 31% of the 1994 cohort of juveniles, and subsequently estimated multiple paternity at 27%. The addition of two highly polymorphic loci in my study greatly increased the ability and accuracy in resolving parentage. This in turn probably explains the disparity between the estimates of multiple paternity (65.8% of litters) in this study compared with that in Haynie's (2000) work. The inability to resolve paternity for some juveniles (5.8%) in this study may result from lack of DNA samples for some males, null alleles, and decreased genetic variation from using heterologous primers. The one instance where maternity could not be resolved was when the potential mothers were full siblings having identical genotypes.

*Reproductive Success*

The correlations between mean female and male reproductive success and population size would not have been elucidated without examining consecutive years of the same population. The number of males attaining reproductive success remained nearly constant over the four-year period (range = 22 - 28) even though the population as a whole increased in size and the number of adult females increased. Reproductive success in males siring offspring appears limited by the number of females in the population, whereas female reproductive success appears limited by increased population density, and possibly reduced availability of burrow space (Fig. 1a, b).

Generally, the longer an individual lived, the greater its lifetime reproductive success. In a few instances, some males living only one or two years had high reproductive success compared to males who lived three or four years. Hoogland (2001) suggested that mating success, and probably reproductive success, is highly correlated with mass in both males and females. Parentage assignments provided in this study should allow a more thorough investigation into the possibility of a positive correlation between body size and reproductive success in this species.

*Multiple Paternity*

Multiple paternity has been documented in a variety of animal species having more than one offspring per litter and in some species it may occur at a high frequency (Boellstorff *et al.* 1994; Schenk & Kovacs 1995; Berteaux *et al.* 1999; Haynie 2000; Valenzuela 2000). Many scuirid species have been found to exhibit multiple paternity. Boellstorff et al. (1994) found this to occur at a frequency of 89% in California ground squirrels (*Spermophilus beecheyi*), whereas Hanken & Sherman (1981) observed multiple paternity in Belding's ground squirrels (*S. beldingi*) in 78% of the litters examined. At the other end of the range of levels of multiple paternity, Murie (1995) found that 16% of Columbian ground squirrel litters were multiply sired, whereas Hoogland (1995) estimated multiple paternity occurred in black-tailed prairie dogs at a rate of 5%. The high frequency of multiple paternity observed in this Gunnison's prairie dog population (76%) was within the range observed for other scuirid species. The level of multiple paternity in this population varies over the four-year period and Travis *et al.* (1996) suggested that it may vary among populations of this species.

Explanations for such a high frequency of multiple paternity include group selection arguments such as increasing the effective population size and maintaining genetic diversity in isolated populations (Moran & Garcia-Vasquez 1998; Martinez 2000), and individual benefits such as reducing the potential for inbreeding, increasing genetic variability in a female's offspring, and promoting sperm competition. Because male reproductive success is directly associated with the number of offspring sired, males will mate with multiple females to increase the number of offspring they sire. In contrast, female reproductive success is related to creating genetically superior offspring and keeping them alive; thus, females are expected to be more selective in mate choices (Krebs & Davies 1993). The reasons why females mate with multiple males are not completely understood. Hoogland (1998a) found that 100% of female Gunnison's prairie dogs that mated with three or more males became pregnant and gave birth to pups, and he concluded that multiple matings by females may be necessary to ensure pregnancy. He also found that litter size was directly related to the number of males with which a female mated. Sperm competition has been studied in numerous organisms and probably benefits females by allowing more fit offspring (Knowlton & Greenwell 1984).

*Inbreeding*

Inbreeding in a population can be heightened by sociality and philopatry. Some level of inbreeding can maintain co-adapted gene complexes and increase ability of locating mates, but higher levels are often associated with decreased fecundity, survival, and dispersal of offspring (Hoogland 1992; Brown & Brown 1998; Crnokrak & Roff 1999; Daniels & Walters 2000; Slate *et al.* 2000a; Rossiter *et al.* 2001). In order to determine the level of inbreeding occurring in a population, it was necessary to know the level of heterozygosity and degree of relatedness of individuals. Black-tailed prairie dogs appear to avoid extreme inbreeding (e.g., are mother-son, father-daughter, and full sibling matings), but matings among more distant relatives (e.g., cousins, aunt-nephew, and uncle-niece) apparently can be tolerated (Hoogland 1982; Foltz & Hoogland 1983; Dobson *et al.* 1997). Factors reducing extreme inbreeding in black-tailed prairie dogs include male dispersal from natal territory, adult male dispersal from breeding territory when daughters become sexually mature, delay of sexual maturity in females when their father remains in the territory, and behavioral mechanisms to avoid mating with related individuals (Hoogland 1992, 1995, 1999).

The 22 instances of inbreeding detected in the study population from 1992-1994, were fewer than expected from previous estimates of inbreeding in this species (Travis *et al.* 1997) and the low level of observed heterozygosity in this population. Travis *et al.* (1997) also found low genetic diversity using DNA fingerprinting and speculated there was limited gene flow among populations and, as a result, heightened inbreeding within each colony. The estimate of inbreeding in the study population is likely to be an underestimate because if we extended farther back in time, we would likely find more instances of inbreeding. However, pedigree path analysis provided a more reliable measure of inbreeding than simply looking at levels of heterozygosity ($F_{IS}$). $F_{IS}$ values range from negative one (a population that is extremely outbred) to positive one (population that is very inbred). The values calculated in this study are relatively high (mean over four years = 0.217), but high $F_{IS}$ values are also an indication of further population subdivision, which can be explained by the clan social structure of Gunnison's prairie dogs. Processes accounting for both the low level of inbreeding and the high $F_{IS}$ values include high frequency of multiple paternity, high population turnover (low yearly survival rate), and frequent dispersal of males from clans that occurred in this population (Hoogland 1999). There appears to be no evidence for inbreeding depression, but further investigation of this would be needed.

An observation that arose when examining the inbreeding paths was that there were no cases where a female bred with any of her progeny. The majority of instances of inbreeding arose from father-daughter, grandfather-granddaughter, paternal half-siblings, etc., and this could have resulted from the high level of multiple paternity in the population. Fathers may not be able to recognize their offspring and paternal half-siblings may not know they share the same father, but mothers should be able to recognize their offspring and full and maternal half-siblings should be familiar (Michener 1974; Holmes & Sherman 1982).

*Relatedness*

Recently, a few studies have assessed genetic relatedness of individuals in one or more populations to gain insight into a species' social structure. Kays *et al.* (2000) found that kinkajous (*Potos flavus*) may form family groups and that females seem to disperse more often or farther than males. Burland *et al.* (1999) found essentially zero within colony relatedness in brown long-eared bats (*Plecotus auritus*), even though behavioral studies reported natal philopatry in this species.

Relatedness calculations allowed independent testing of parentage assignments and estimated relatedness of individuals within the population at varying spatial and social scales. This examination revealed that parentage assignments for the colony studied were remarkably accurate. The relatedness structure of the Gunnison's prairie dog clans documents that adult females within a clan (mean $r = 0.24$) are lower than indicated by behavioral data. Such data had suggested that females in a clan are primarily mother-daughter, full sibling, aunt-niece, and cousin relationships (Rayor 1985, 1988; Hoogland 1997, 1998a, b, 1999, whereas the present study revealed a large number of half-siblings among adult females within each clan as a result of the high frequency of multiple paternity. The males in clans with multiple breeding males appear to be unrelated (mean r =-0.13). Both sexes between nearby clans are effectively unrelated (mean r = -0.06 and -0.08), increasing the genetic heterogeneity of social structure in this species. All relatedness comparisons were not significantly different between years, suggesting that this social structuring of Gunnison's prairie dog colonies remains constant over time.

In conclusion, this study provided significant insight into the social structure and mating system of Gunnison's prairie dogs. A correlation between reproductive success and population size occurred in both males (positive) and females (negative). Prior to this research, high levels of multiple paternity appeared charactersistic in this species, but it was not fully known, as well as the fact that this changes over time within a colony and possibly between populations. Inbreeding was estimated to be somewhat high, based on decreased observed heterozygosity, but was found to be much lower by pedigree path analysis in this study. Females within each clan are less related than once believed, while males within a clan are unrelated. Between geographically close clans (those that share a boundary), males are unrelated and females are unrelated. This social structure and mating system of Gunnison's prairie dogs may have evolved to decrease inbreeding, increase the effective population size, and maintain genetic diversity within a population.

## References

Alderson GW, Gibbs HL, Sealy SG (1999) Parentage and kinship studies in an obligate brood parasitic bird, the brown-headed cowbird (*Molothrus ater*), using microsatellite DNA markers. *Journal of Heredity*, **90**, 182-190.

Berteaux, D, Bety J, Rengifo E, Bergeron EA (1999) Multiple paternity in meadow voles (*Microtus pennsylvanicus*): investigating the role of the female. *Behavioral Ecology and Sociobiology*, **45**, 283-291.

Boellstorff DE, Owings DH, Penedo MCT, Hersek MJ (1994) Reproductive behaviour and multiple paternity of California ground squirrels. *Animal Behaviour*, **47**, 1057-1064.

Brown JL, Brown ER (1998) Are inbred offspring less fit? Survival in a natural population of Mexican jays. *Behavioral Ecology*, **9**, 60-63.

Bruford MW, Cheesman DJ, Coote T, *et al.* (1996) Microsatellites and their application to conservation genetics. In: *Conservation genetics: case histories from nature* (eds. Avise JC, Hamrick JL) pp. 278-296 Chapman & Hall Press, New York.

Burland TM, Barratt EM, Nichols RA, Racey PA (2001) Mating patterns, relatedness and the basis of natal philopatry in the brown long-eared bat, Plecotus auritus. *Molecular Ecology*, **10**, 1309-1321.

Callen DF, Thompson AD, Shen Y, *et al.* (1993) Incidence and origin of "null" alleles in the $(AC)_n$ microsatellite markers. *American Journal of Human Genetics,* **52**, 922-927.

Chakraborty R, Meagher TR, Smouse PE (1988) Parentage analysis with genetic markers in natural populations. I. The expected proportion of offspring with unambiguous paternity. *Genetics*, **118**, 527-536.

Chambers GK, MacAvoy ES (2000) Microsatellites: consensus and controversy. *Comparative Biochemistry and Physiology, Part B*, **126**, 455-476.

Chesser RK (1983) Genetic variability within and among populations of the black-tailed prairie dog. *Evolution*, **37**, 320-331.

Coltman DW, Bowen WD, Wright JM (1998) Male mating success in an aquatically mating pinniped, the harbour seal (*Phoca vitulina*), assessed by microsatellite DNA markers. *Molecular Ecology*, **7**, 627-638.

Coltman DW, Bancroft DR, Robertson A, *et al.* (1999) Male reproductive success in a promiscuous mammal: behavioral estimates compared with genetic paternity. *Molecular Ecology*, **8**, 1199-1209.

Craighead L, Paetkau D, Reynolds HV, Vyse ER, Strobeck C (1995) Microsatellite analysis of paternity and reproduction in arctic grizzly bears. *Journal of Heredity*, **86**, 255-261.

Crnokrak P, Roff DA (1999) Inbreeding depression in the wild. *Heredity*, **83**, 260-270.

Daniels SJ, Walters JR (2000) Inbreeding depression and its effects on natal dispersal in red-cockaded woodpeckers. *The Condor*, **102**, 482-491.

Dobson FS, Chesser RK, Hoogland JL, Sugg DW, Foltz DW (1997) Do black-tailed prairie dogs minimize inbreeding? *Evolution*, **51**, 970-978.

Dobson FS, Chesser RK, Hoogland JL, Sugg DW, Foltz DW (1998) Breeding groups and gene dynamics in a socially structured population of prairie dogs. *Journal of Mammalogy*, **79**, 671-680.

Ellegren H (1992) Polymerase-chain-reaction (PCR) analysis of microsatellites - A new approach to studies of genetic relationships in birds. *The Auk*, **109**, 886-895.

Fitzgerald JP, Lechleitner RR (1974) Observations on the biology of Gunnison's prairie dog in central Colorado. *The American Midland Naturalist*, **92**, 146-163.

Foltz DW, Hoogland JL (1981) Analysis of the mating system in the black-tailed prairie dog (*Cynomys ludovicianus*) by likelihood of paternity. *Journal of Mammalogy*, **62**, 706-712.

Foltz DW, Hoogland JL (1983) Genetic evidence of outbreeding in the black-tailed prairie dog (*Cynomys ludovicianus*). *Evolution*, **37**, 273-281.

Garza JC, Dallas J, Duryadi D, *et al.* (1997) Social structure of the mound-building mouse *Mus spicilegus* revealed by genetic analysis with microsatellites. *Molecular Ecology*, **6**, 1009-1017.

Gompper ME, Gittleman JL, Wayne RK (1998) Dispersal, philopatry, and genetic relatedness in a social carnivore: comparing males and females. *Molecular Ecology*, **7**, 157-163.

Gullberg A, Olsson M, Tegelstrom H (1997) Male mating success, reproductive success and multiple paternity in a natural population of sand lizards: behavioural and molecular genetics data. *Molecular Ecology*, **6**, 105-112.

Haberl M, Tautz D (1999) Comparative allele sizing can produce inaccurate allele size differences for microsatellites. *Molecular Ecology*, **8,** 1347-1350.

Hancock JM (1999) Microsatellites and other simple sequences: genomic context and mutational mechanisms. In: *Microsatellites: Evolution and Application*, (eds. Goldstein DB, Schlotterer C), pp. 1-9. Oxford University Press, New York.

Hanken J, Sherman PW (1981) Multiple paternity in Belding's ground squirrel litters. *Science*, **212**, 351-353.

Haynie ML (2000) *Parentage, multiple paternity, and reproductive success: using microsatellites to study social interactions in two species of prairie dogs*. M.S. thesis, Oklahoma State University, Stillwater, OK.

Haynie ML, Van Den Bussche RA, Hoogland JL, Gilbert DA (0000) Parentage, multiple paternity, and reproductive success in Gunnison's and Utah prairie dogs. *Journal of Mammalogy*, submitted.

Holmes WG, Sherman PW (1982) The ontogeny of kin recognition in two species of ground squirrels. *American Zoologist*, **22**, 491-517.

Hoogland JL (1982) Prairie dogs avoid extreme inbreeding. *Science*, **215**, 1639-1641.

Hoogland JL (1992) Levels of inbreeding among prairie dogs. *The American Naturalist*, **139**, 591-602.

Hoogland JL (1995) *The black-tailed prairie dog: social life of a burrowing mammal.* Chicago University Press, Chicago, IL.

Hoogland JL (1997) Duration of gestation and lactation for Gunnison's prairie dogs. *Journal of Mammalogy*, **78**, 173-180.

Hoogland JL (1998a) Why do female Gunnison's prairie dogs copulate with more than one male? *Animal Behaviour*, **55**, 351-359.

Hoogland JL (1998b) Estrus and copulation of Gunnison's prairie dogs. *Journal of Mammalogy*, **79**, 887-897.

Hoogland JL (1999) Philopatry, dispersal, and social organization of Gunnison's prairie dogs. *Journal of Mammalogy*, **80**, 243-251.

Hoogland JL (2001) Black-tailed, Gunnison's, and Utah prairie dogs reproduce slowly. *Journal of Mammalogy*, **82**, 917-927.

Jarne P, Lagoda PJL (1996) Microsatellites, from molecules to populations and back. *Trends in Ecology and Evolution*, **11**, 424-429.

Kays RW, Gittleman JL, Wayne RK (2000) Microsatellite analysis of kinkajou social organization. *Molecular Ecology*, **9**, 743-751.

Keane B, Dittus WPJ, Melnick DJ (1997) Paternity assessment in wild groups of toque macaques *Macaca sinica* at Polonnaruwa, Sri Lanka using molecular markers. *Molecular Ecology*, **6**, 267-282.

Knight ME, Turner GF, Rico C, van Oppen MJH, Hewitt GM (1998) Microsatellite paternity analysis on captive Lake Malawi cichlids supports reproductive isolation by direct mate choice. *Molecular Ecology*, **7**, 1605-1610.

Knowlton N, Greenwell SR (1984) Male sperm competition avoidance mechanisms: the influence of female interests. In: *Sperm competition and the evolution of animal mating systems* (ed. Smith RL) pp. 61-84 Academic Press, Orlando, FL.

Krebs JR, Davies NB (1993) *An introduction to behavioural ecology*, 3rd edn, Blackwell Science, Oxford, England.

Longhurst W (1944) Observations on the ecology of the Gunnison's prairie dog in Colorado. *Journal of Mammalogy*, **25**, 24-36.

Longmire JL, Maltbie M, Baker RJ (1997) Use of "Lysis Buffer" in DNA isolation and its implication for museum collections. *Occasional Papers, The Museum, Texas Tech University*, Lubbock, **163**, 1-3.

Marshall TC, Slate J, Kruuk LE, Pemberton JM (1998) Statistical confidence for likelihood-based paternity inference in natural populations. *Molecular Ecology*, **7**, 639-655.

Martinez JL, Moran P, Perez J, *et al.* (2000) Multiple paternity increases effective size of southern Atlantic salmon populations. *Molecular Ecology*, **9**, 293-298.

May B, Gavin TA, Sherman PW, Korves TM (1997) Characterization of microsatellite loci in the Northern Idaho ground squirrel *Spermophilus brunneus brunneus*. *Molecular Ecology*, **6**, 399-400.

Michener GR (1974) Development of adult-young identification in Richardson's ground squirrel. *Developmental Psychobiology*, **7**, 375-384.

Moran P, Garcia-Vasquez E (1998) Multiple paternity in Atlantic salmon: a way to maintain genetic variability in relicted populations. *Journal of Heredity*, **89**, 551-553.

Morin PA, Wallis J, Moore JJ, Woodruff DS (1994) Paternity exclusion in a community of wild chimpanzees using hypervariable simple sequence repeats. *Molecular Ecology*, **3**, 469-478.

Murie JO (1995) Mating behavior of Columbian ground squirrels. I. Multiple mating by females and multiple paternity. *Canadian Journal of Zoology*, **73**, 1819-1826.

Okada A, Tamate HB (2000) Pedigree analysis of the sika deer (*Cervus nippon*) using microsatellite markers. *Zoological Science*, **17**, 335-340.

Paetkau D, Strobeck C (1994) Microsatellite analysis of genetic variation in black bear populations. *Molecular Ecology*, **3**, 489-495.

Paetkau D, Strobeck C (1995) The molecular basis and evolutionary history of a microsatellite null allele in bears. *Molecular Ecology*, **4**, 519-520.

Paetkau D, Calvert W, Stirling I, Strobeck C (1995) Microsatellite analysis of population structure in Canadian polar bears. *Molecular Ecology*, **4**, 347-354.

Paetkau D, Waits LP, Clarkson PL *et al.* (1998) Variation in genetic diversity across the range of North American brown bears. *Conservation Biology*, **12**, 418-429.

Pearse DE, Janzen FJ, Avise JC (2002) Multiple paternity, sperm storage, and reproductive success of female and male painted turtles (*Chrysemys picta*) in nature. *Behavioral Ecology and Sociobiology*, **51**, 164-171.

Pemberton JM, Slate J, Bancroft DR, Barrett JA (1995) Nonamplifying alleles at microsatellite loci: a caution for parentage and population studies. *Molecular Ecology*, **4**, 249-252.

Pizzimenti JJ, Hoffmann RS (1973) Cynomys gunnisoni. *Mammalian Species*, **25**, 1-4.

Primmer CR, Moller AP, Ellegren H (1995) Resolving genetic relationships with microsatellite markers: a parentage testing system for the swallow *Hirundo rustica*. *Molecular Ecology*, **4**, 493-498.

Queller DC, Goodnight KF (1989) Estimating relatedness using genetic markers. *Evolution*, **43**, 258-275.

Rayor LS (1985) Effects of habitat quality on growth, age of first reproduction, and dispersal in Gunnison's prairie dogs (*Cynomys gunnisoni*). *Canadian Journal of Zoology*, **63**, 2835-2840.

Rayor LS (1988) Social organization and space-use in Gunnison's prairie dog. *Behavioral Ecology and Sociobiology*, **22**, 69-78.

Rayor LS, Brody AK, Gilbert C (1987) Hibernation in the Gunnison's prairie dog. *Journal of Mammaolgy*, **68**, 147-150.

Rossiter SJ, Jones G, Ransome RD, Barratt EM (2001) Outbreeding increases offspring survival in wild greater horseshoe bats (*Rhinolophus ferrumequinum*). *Proceedings of the Royal Society of London Series B*, **268**, 1055-1061.

Schenk A, Kovacs KM (1995) Multiple mating between black bears revealed by DNA fingerprinting. *Animal Behaviour*, **50**, 1483-1490.

Slate J, Kruuk LEB, Marshall TC, Pemberton JM, Clutton-Brock TH (2000a) Inbreeding depression influences lifetime breeding success in a wild population of red deer (*Cervus elaphus*). *Proceedings of the Royal Society of London Series B*, **267**, 1657-1662.

Slate J, Marshall T, Pemberton J (2000b) A retrospective assessment of the accuracy of the paternity inference program Cervus. *Molecular Ecology*, **9**, 801-808.

Stevens S, Coffin J, Strobeck C (1997) Microsatellite loci in Columbian ground squirrels *Spermophilus columbianus*. *Molecular Ecology*, **6**, 493-495.

Taylor AC, Horsup A, Johnson CN, Sunnucks P, Sherwin B (1997) Relatedness structure detected by microsatellite analysis and attempted pedigree construction in an endangered marsupial, the northern hairy-nosed wombat *Lasiorhinus krefftii*. *Molecular Ecology*, **6**, 9-19.

Travis SE, Slobodchikoff CN, Keim P (1996) Social assemblages and mating relationships in prairie dogs: a DNA fingerprint analysis. *Behavioral Ecology*, **7**, 95-100.

Travis SE, Slobodchikoff CN, Keim P (1997) DNA fingerprinting reaveals low genetic diversity in Gunnison's prairie dogs (Cynomys gunnisoni). *Journal of Mammalogy*, **78**, 725-732.

Valenzuela N (2000) Multiple paternity in side-neck turtles *Podocnemis expansa*: evidence from microsatellite DNA data. *Molecular Ecology*, **9**, 99-105.

van Staaden MJ, Chesser RK, Michener GR (1994) Genetic correlations and matrilineal structure in a population of *Spermophilus richardsonii*. *Journal of Mammalogy*, **75**, 573-582.

Worthington Wilmer J, Allen PJ, Pomeroy PP, Twiss SD, Amos W (1999) Where have all the fathers gone? An extensive microsatellite analysis of paternity in the grey seal (*Halichoerus grypus*). *Molecular Ecology*, **8**, 1417-1429.

Yu HT, Liao YY, Kao CH (2001) Relatedness structure and individual identification in a semi-fossorial shrew (Soricidae: *Anourosorex squamipes*) - an application of microsatellite data. *Zoological Studies*, **40**, 226-232.

**Table 1** Microsatellite locus names and primer sequences organized in 5' → 3' orientation. HEX, NED, and 6FAM are fluorescent labels attached to forward primers.

| Locus Name | Labeled forward primer | Reverse primer |
|---|---|---|
| GS08[*‡] | HEX-ACCAATGGGAGACACATCCAA | GTGTCTTAAACTCCTTGTAATAGCCCCCTG |
| GS12[*‡] | NED-CCAAGAGAGGCAGTCGTCCAG | GTGTCTTTCGAGCAGAGCACTTCACAGA |
| GS14[*‡] | 6FAM-CAGAATCAGGTGGGTCCATAGTG | GTGTCTTGATGAAACCTATTTGCCTTCCTTC |
| GS17[*‡] | 6FAM-CAATTCGTGGTGGTTATATC | GTGTCTTCTGTCACCTATATGAACACA |
| GS20[*‡] | 6FAM-GCCCAGCCATCACCCTCACC | GTGTCTTTCCAGAGTTTTTCAGACACA |
| GS22[*‡] | 6FAM-AGAGAACAACATCAACAGGGTGTG | GTGTCTTGGTCCTCATCCTGCCAATTTC |
| GS26[*‡] | NED-GGCTCCAAGTCCCAGGGAC | GTGTCTTGGTCCTCATCCTGCCAATTTC |
| IGS1[†] | HEX-ATAACAGCACCCTGCACCAC | AATCCATCCTCTACCTGTAATGC |
| IGS6[†] | HEX-GGGCATTAATTCCAGGACTT | GGGCTGGAATTAAAGGTATCA |

*Locus names described by Stevens *et al*. (1997)
‡Primers redesigned by Haynie (2000) for multiplex gel loading
†Locus names described by May *et al*. (1997)

**Table 2** Locus names and descriptive statistics for genetic variability at each locus for the Gunnison's prairie dog population at Petrified Forest National Park, Apache County, Arizona for each year from 1991-1994 separately (a - d) and for all four years combined (e). A = number of alleles, N = sample size, $H_O$ = observed heterozygosity, $H_E$ = expected heterozygosity, PIC = polymorphic information content, PI = probability of identity, PE1 = first-parent exclusionary power, and PE2 = second-parent exclusionary power.

**a.**

| 1991 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Locus | A | N | $H_O$ | $H_E$ | PIC | PI | PE1 | PE2 |
| GS08 | 6 | 252 | 0.643 | 0.678 | 0.632 | 0.147 | 0.266 | 0.440 |
| GS12 | 7 | 266 | 0.327 | 0.501 | 0.464 | 0.282 | 0.136 | 0.293 |
| GS14 | 7 | 267 | 0.745 | 0.789 | 0.754 | 0.077 | 0.399 | 0.578 |
| GS17 | 3 | 268 | 0.153 | 0.174 | 0.162 | 0.693 | 0.015 | 0.083 |
| GS20 | 2 | 263 | 0.084 | 0.121 | 0.114 | 0.778 | 0.007 | 0.057 |
| GS22 | 6 | 269 | 0.401 | 0.664 | 0.606 | 0.168 | 0.250 | 0.412 |
| GS26 | 4 | 269 | 0.212 | 0.298 | 0.282 | 0.506 | 0.045 | 0.160 |
| IGS1 | 8 | 269 | 0.647 | 0.735 | 0.695 | 0.111 | 0.336 | 0.514 |
| IGS6 | 6 | 267 | 0.536 | 0.690 | 0.644 | 0.139 | 0.277 | 0.452 |
| Mean | 5.44 | 266 | 0.416 | 0.517 | 0.484 | | | |
| Total | | | | | | $2.24 \times 10^{-6}$ | 0.872 | 0.981 |

**b.**

| 1992 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Locus | A | N | $H_O$ | $H_E$ | PIC | PI | PE1 | PE2 |
| GS08 | 7 | 356 | 0.542 | 0.662 | 0.617 | 0.157 | 0.252 | 0.426 |
| GS12 | 8 | 369 | 0.274 | 0.461 | 0.442 | 0.307 | 0.120 | 0.284 |
| GS14 | 6 | 396 | 0.684 | 0.782 | 0.748 | 0.080 | 0.394 | 0.573 |
| GS17 | 3 | 398 | 0.206 | 0.205 | 0.185 | 0.650 | 0.021 | 0.093 |
| GS20 | 2 | 371 | 0.070 | 0.121 | 0.114 | 0.779 | 0.007 | 0.057 |
| GS22 | 6 | 399 | 0.361 | 0.634 | 0.571 | 0.195 | 0.222 | 0.376 |
| GS26 | 4 | 399 | 0.185 | 0.313 | 0.293 | 0.490 | 0.050 | 0.166 |
| IGS1 | 10 | 388 | 0.639 | 0.729 | 0.690 | 0.110 | 0.332 | 0.510 |
| IGS6 | 6 | 388 | 0.492 | 0.645 | 0.606 | 0.163 | 0.242 | 0.420 |
| Mean | 5.78 | 385 | 0.384 | 0.506 | 0.474 | | | |
| Total | | | | | | $3.34 \times 10^{-6}$ | 0.854 | 0.978 |

**c.**

| 1993 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Locus | A | N | $H_O$ | $H_E$ | PIC | PI | PE1 | PE2 |
| GS08 | 8 | 359 | 0.568 | 0.710 | 0.667 | 0.125 | 0.301 | 0.478 |
| GS12 | 8 | 374 | 0.297 | 0.439 | 0.424 | 0.327 | 0.109 | 0.272 |
| GS14 | 6 | 458 | 0.627 | 0.791 | 0.758 | 0.075 | 0.408 | 0.586 |
| GS17 | 2 | 438 | 0.155 | 0.159 | 0.146 | 0.719 | 0.013 | 0.073 |
| GS20 | 2 | 426 | 0.106 | 0.176 | 0.160 | 0.693 | 0.015 | 0.080 |
| GS22 | 6 | 460 | 0.304 | 0.527 | 0.476 | 0.273 | 0.147 | 0.295 |
| GS26 | 4 | 461 | 0.137 | 0.208 | 0.199 | 0.634 | 0.022 | 0.109 |
| IGS1 | 10 | 451 | 0.659 | 0.692 | 0.647 | 0.138 | 0.287 | 0.461 |
| IGS6 | 7 | 453 | 0.521 | 0.685 | 0.646 | 0.136 | 0.282 | 0.462 |
| Mean | 5.89 | 431 | 0.375 | 0.487 | 0.458 | | | |
| Total | | | | | | $4.95 \times 10^{-6}$ | 0.847 | 0.976 |

**d.**

| 1994 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Locus | A | N | $H_O$ | $H_E$ | PIC | PI | PE1 | PE2 |
| GS08 | 7 | 433 | 0.603 | 0.693 | 0.647 | 0.138 | 0.278 | 0.453 |
| GS12 | 7 | 439 | 0.335 | 0.476 | 0.458 | 0.290 | 0.130 | 0.299 |
| GS14 | 6 | 485 | 0.645 | 0.798 | 0.766 | 0.071 | 0.419 | 0.597 |
| GS17 | 2 | 478 | 0.159 | 0.164 | 0.150 | 0.711 | 0.013 | 0.075 |
| GS20 | 2 | 465 | 0.088 | 0.148 | 0.137 | 0.736 | 0.011 | 0.069 |
| GS22 | 5 | 487 | 0.300 | 0.639 | 0.584 | 0.184 | 0.226 | 0.389 |
| GS26 | 4 | 488 | 0.357 | 0.377 | 0.348 | 0.415 | 0.073 | 0.202 |
| IGS1 | 9 | 484 | 0.620 | 0.692 | 0.646 | 0.140 | 0.287 | 0.459 |
| IGS6 | 7 | 486 | 0.422 | 0.632 | 0.596 | 0.170 | 0.233 | 0.412 |
| Mean | 5.44 | 472 | 0.392 | 0.513 | 0.481 | | | |
| Total | | | | | | $2.70 \times 10^{-6}$ | 0.860 | 0.979 |

e.

| Combined 1991-1994 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Locus | A | N | $H_O$ | $H_E$ | PIC | PI | PE1 | PE2 |
| GS08 | 8 | 958 | 0.610 | 0.690 | 0.646 | 0.127 | 0.278 | 0.454 |
| GS12 | 8 | 989 | 0.308 | 0.471 | 0.452 | 0.298 | 0.126 | 0.293 |
| GS14 | 7 | 1096 | 0.678 | 0.795 | 0.764 | 0.073 | 0.415 | 0.594 |
| GS17 | 3 | 1079 | 0.176 | 0.179 | 0.164 | 0.688 | 0.016 | 0.082 |
| GS20 | 2 | 1045 | 0.082 | 0.140 | 0.130 | 0.749 | 0.010 | 0.065 |
| GS22 | 6 | 1103 | 0.354 | 0.627 | 0.569 | 0.197 | 0.217 | 0.374 |
| GS26 | 4 | 1104 | 0.255 | 0.323 | 0.303 | 0.478 | 0.054 | 0.173 |
| IGS1 | 10 | 1090 | 0.631 | 0.698 | 0.654 | 0.134 | 0.295 | 0.469 |
| IGS6 | 7 | 1091 | 0.490 | 0.650 | 0.611 | 0.161 | 0.247 | 0.425 |
| Mean | 6.11 | 1062 | 0.398 | 0.508 | 0.477 | | | |
| Total | | | | | | $2.87 \times 10^{-6}$ | 0.859 | 0.979 |

**Table 3** Parentage assignment for each offspring in the Gunnison's prairie dog population at Petrified Forest National Forest, Apache County, Arizona from 1991-1994. The ID listed for each individual is assigned upon capture with the right and left eartags in parentheses. If the father could not be assigned, it is designated as ******. Juveniles designated with † indicate maternity narrowed to two potential mothers, which are sisters with identical genotypes

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1991 | 2RSx (H97, H98) | 2RS (583, 584) | 25 (287, 288) |
| 1991 | 2RSx (H99, I0) | 2RS (583, 584) | 2 (C61, C62) |
| 1991 | 2RSx (I1, I2) | 2RS (583, 584) | 25 (287, 288) |
| 1991 | 2RSx (I27, I28) | 2RS (583, 584) | 25 (287, 288) |
| 1991 | 2RSx (I29, I30) | 2RS (583, 584) | 25 (287, 288) |
| 1991 | 2RSx (I3, I4) | 2RS (583, 584) | R20 (B17, C69) |
| 1991 | 3SBSx (E31, E32) | 3SBS (529, 530) | 18 (C49, C50) |
| 1991 | 3SBSx (E39, E40) | 3SBS (529, 530) | 14 (C55, C56) |
| 1991 | 3SBSx (E41, E42) | 3SBS (529, 530) | 45 (901, 902) |
| 1991 | 3SBSx (E91, E92) | 3SBS (529, 530) | 14 (C55, C56) |
| 1991 | 3SBSx (I41, I42) | 3SBS (529, 530) | ****** |
| 1991 | 3SRSx (F99, G0) | 3SRS (A23, D0) | R10 (B29, B30) |
| 1991 | 3SRSx (G19, G20) | 3SRS (A23, D0) | 17 (C59, C60) |
| 1991 | 3SRSx (G5, G6) | 3SRS (A23, D0) | 38 (765, B37) |
| 1991 | BSOx (J1, J2) | 3SRS (A23, D0) | R10 (B29, B30) |
| 1991 | C0x (F53, F54) | 3SRS (A23, D0) | 38 (765, B37) |
| 1991 | C0x (G21, G22) | 3SRS (A23, D0) | R10 (B29, B30) |
| 1991 | 4strx (I37, I38) | 4str (947, 948) | 04 (497, 498) |
| 1991 | 4strx (I39, I40) | 4str (947, 948) | 04 (497, 498) |
| 1991 | 4strx (I57, I58) | 4str (947, 948) | 04 (497, 498) |
| 1991 | 4strx (I81, I82) | 4str (947, 948) | 04 (497, 498) |
| 1991 | 50x (H37, H38) | 50 (925, 926) | R20 (B17, C69) |
| 1991 | 50x (I11, I12) | 50 (925, 926) | 44 (495, 496) |
| 1991 | 50x (I23, I24) | 50 (925, 926) | 44 (495, 496) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1991 | 50x (I25, I26) | 50 (925, 926) | 23 (C45, C46) |
| 1991 | 50x (I5, I6) | 50 (925, 926) | 44 (495, 496) |
| 1991 | 50x (I7, I10) | 50 (925, 926) | 44 (495, 496) |
| 1991 | HBSx (I65, I66) | 57 (141, 142) | 19 (351, 352) |
| 1991 | HBSx (I83, I84) | 57 (141, 142) | 04 (497, 498) |
| 1991 | HBSx (I9, I55) | 57 (141, 142) | 19 (351, 352) |
| 1991 | HBSx (J17, J18) | 57 (141, 142) | 19 (351, 352) |
| 1991 | BSx (H65, H66) | 59 (C48, C51) | 05 (73, 74) |
| 1991 | BSx (H77, H78) | 59 (C48, C51) | 41 (231, 232) |
| 1991 | BSx (I31, I32) | 59 (C48, C51) | ****** |
| 1991 | 61x (F75, F76) | 61 (893, C25) | 44 (495, 496) |
| 1991 | 61x (F91, F92) | 61 (893, C25) | 03 (C43, D3) |
| 1991 | 61x (F93, F94) | 61 (893, C25) | 03 (C43, D3) |
| 1991 | 61x (F95, F96) | 61 (893, C25) | 44 (495, 496) |
| 1991 | 61x (G29, G30) | 61 (893, C25) | 44 (495, 496) |
| 1991 | 4x (E49, E50) | 64 (C85, C86) | 09 (50, C27) |
| 1991 | 4x (E51, E52) | 64 (C85, C86) | 04 (497, 498) |
| 1991 | 4x (E53, E54) | 64 (C85, C86) | 41 (231, 232) |
| 1991 | 4x (E55, E56) | 64 (C85, C86) | 44 (495, 496) |
| 1991 | 4x (E57, E58) | 64 (C85, C86) | 04 (497, 498) |
| 1991 | 6x (F55, F56) | 66 (215, 216) | 17 (C59, C60) |
| 1991 | 6x (F57, F58) | 66 (215, 216) | 17 (C59, C60) |
| 1991 | 6x (F69, F70) | 66 (215, 216) | 21 (13, 14) |
| 1991 | 6x (G41, G42) | 66 (215, 216) | ****** |
| 1991 | 7x (I15, I16) | 70 (103, 332) | 29 (877, 878) |
| 1991 | 7x (I17, I18) | 70 (103, 332) | 39 (463, 760) |
| 1991 | 7x (I19, I20) | 70 (103, 332) | R20 (B17, C69) |
| 1991 | 7x (I43, I44) | 70 (103, 332) | R20 (B17, C69) |
| 1991 | 72x (H63, H64) | 72 (A87, A88) | 05 (73, 74) |
| 1991 | 72x (H93, H94) | 72 (A87, A88) | 05 (73, 74) |
| 1991 | 72x (H95, H96) | 72 (A87, A88) | 05 (73, 74) |
| 1991 | 72x (I35, I36) | 72 (A87, A88) | 05 (73, 74) |
| 1991 | CBSx (H59, H60) | 80 (297, 298) | R03 (915, 916) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1991 | CBSx (H61, H62) | 80 (297, 298) | R03 (915, 916) |
| 1991 | CRRSx (J25, J26) | 80 (297, 298) | 19 (351, 352) |
| 1991 | WARSx (H45, H46) | 80 (297, 298) | R03 (915, 916) |
| 1991 | 81x (H35, H36) | 81 (275, 276) | 29 (877, 878) |
| 1991 | 81x (H49, H50) | 81 (275, 276) | 29 (877, 878) |
| 1991 | 81x (I79, I80) | 81 (275, 276) | 29 (877, 878) |
| 1991 | 81x (J29, J30) | 81 (275, 276) | 29 (877, 878) |
| 1991 | FRx (F73, F74) | 88 (115, 116) | R15 (A43, C35) |
| 1991 | FRx (G7, G8) | 88 (115, 116) | R15 (A43, C35) |
| 1991 | FRx (G9, G10) | 88 (115, 116) | 42 (643, 644) |
| 1991 | FRx (J27, J28) | 88 (115, 116) | R15 (A43, C35) |
| 1991 | 0x (D57, D58) | 90 (465, 466) | 45 (901, 902) |
| 1991 | 0x (D59, D60) | 90 (465, 466) | 45 (901, 902) |
| 1991 | 0x (D61, D62) | 90 (465, 466) | 45 (901, 902) |
| 1991 | 0x (D63, D64) | 90 (465, 466) | 45 (901, 902) |
| 1991 | 0x (D87, D88) | 90 (465, 466) | 45 (901, 902) |
| 1991 | CRSx (I97, I98) | 91 (A9, A10) | 22 (499, 500) |
| 1991 | CRSx (J11, J12) | 91 (A9, A10) | 38 (765, B37) |
| 1991 | CRSx (J13, J14) | 91 (A9, A10) | 21 (13, 14) |
| 1991 | CRSx (J9, J10) | 91 (A9, A10) | 22 (499, 500) |
| 1991 | RSBBx (I87, I88) | 95 (322, 324) | ****** |
| 1991 | RSBBx (J59, J60) | 95 (322, 324) | ****** |
| 1991 | BBx (E11, E12) | BB (564, C53) | 03 (C43, D3) |
| 1991 | BBx (E13, E14) | BB (564, C53) | 03 (C43, D3) |
| 1991 | BBx (E21, E22) | BB (564, C53) | 03 (C43, D3) |
| 1991 | BBx (E23, E24) | BB (564, C53) | ****** |
| 1991 | BBx (E3, E4) | BB (564, C53) | 03 (C43, D3) |
| 1991 | BBx (E5, E6) | BB (564, C53) | 03 (C43, D3) |
| 1991 | BB01x (J39, J40) | BB0 (A71, A72) | 17 (C59, C60) |
| 1991 | CBSx (H55, H56) | BB0 (A71, A72) | ****** |
| 1991 | WARSx (G47, G48) | BB0 (A71, A72) | R03 (915, 916) |
| 1991 | BB6x (G45, G46) | BB6 (291, 292) | 31 (207, 208) |
| 1991 | BB6x (G71, G72) | BB6 (291, 292) | 31 (207, 208) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1991 | BB6x (H83, H84) | BB6 (291, 292) | 31 (207, 208) |
| 1991 | BB6x (H85, H86) | BB6 (291, 292) | 31 (207, 208) |
| 1991 | BB7x (G25, G26) | BB7 (A55, A56) | 44 (495, 496) |
| 1991 | BB7x (H91, H92) | BB7 (A55, A56) | 44 (495, 496) |
| 1991 | BB7x (I33, I34) | BB7 (A55, A56) | 44 (495, 496) |
| 1991 | C9x (D51, D52) | BB9 (705, 706) | 45 (901, 902) |
| 1991 | C9x (D53, D54) | BB9 (705, 706) | 29 (877, 878) |
| 1991 | C9x (D55, D56) | BB9 (705, 706) | 7 (431, 432) |
| 1991 | C9x (D81, D82) | BB9 (705, 706) | 7 (431, 432) |
| 1991 | C9x (D91, D92) | BB9 (705, 706) | ****** |
| 1991 | BSBBx (D95, D96) | BSBB (91, 92) | 04 (497, 498) |
| 1991 | BSBBx (D97, D98) | BSBB (91, 92) | 04 (497, 498) |
| 1991 | BSBBx (D99, E0) | BSBB (91, 92) | 04 (497, 498) |
| 1991 | WA6x (E45, E46) | BSBB (91, 92) | R44 (971, C32) |
| 1991 | WA6x (E47, E48) | BSBB (91, 92) | 04 (497, 498) |
| 1991 | WA6x (E71, E72) | BSBB (91, 92) | 04 (497, 498) |
| 1991 | BB0x (J15, J16) | C5 (A25, C47) | 17 (C59, C60) |
| 1991 | CBSx (H57, H58) | C5 (A25, C47) | 05 (73, 74) |
| 1991 | RR5x (I13, I14) | C5 (A25, C47) | 17 (C59, C60) |
| 1991 | CRx (I47, I48) | CR (A53, A54) | 17 (C59, C60) |
| 1991 | CRx (I49, I50) | CR (A53, A54) | 31 (207, 208) |
| 1991 | CRx (I89, I90) | CR (A53, A54) | 05 (73, 74) |
| 1991 | CRx (I91, I92) | CR (A53, A54) | 19 (351, 352) |
| 1991 | CRx (I93, I94) | CR (A53, A54) | 05 (73, 74) |
| 1991 | CRx (I95, I96) | CR (A53, A54) | 31 (207, 208) |
| 1991 | Hx (H27, H28) | H (876, C42) | 22 (499, 500) |
| 1991 | Hx (H69, H70) | H (876, C42) | 22 (499, 500) |
| 1991 | Hx (I63, I64) | H (876, C42) | 22 (499, 500) |
| 1991 | HBBx (G73, G74) | HBB (260, 759) | 15 (307, 308) |
| 1991 | HBBx (H29, H30) | HBB (260, 759) | 15 (307, 308) |
| 1991 | HBBx (H33, H34) | HBB (260, 759) | R03 (915, 916) |
| 1991 | HBBx (I45, I46) | HBB (260, 759) | 15 (307, 308) |
| 1991 | HBBx (I67, I68) | HBB (260, 759) | 15 (307, 308) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1991 | HBBx (I69, I70) | HBB (260, 759) | 15 (307, 308) |
| 1991 | HRBx (H21, H22) | HRB (963, 964) | 38 (765, B37) |
| 1991 | HRBx (H23, H24) | HRB (963, 964) | 19 (351, 352) |
| 1991 | HRBx (H25, H26) | HRB (963, 964) | 04 (497, 498) |
| 1991 | HRBx (I59, I60) | HRB (963, 964) | 19 (351, 352) |
| 1991 | HRBx (I85, I86) | HRB (963, 964) | 21 (13, 14) |
| 1991 | HRSx (E19, E20) | HRS (34, 738) | 03 (C43, D3) |
| 1991 | HRSx (E25, E26) | HRS (34, 738) | 03 (C43, D3) |
| 1991 | HRSx (E27, E28) | HRS (34, 738) | 03 (C43, D3) |
| 1991 | HRSx (E29, E30) | HRS (34, 738) | 03 (C43, D3) |
| 1991 | RCx (G75, G76) | RC (B2, C58) | 29 (877, 878) |
| 1991 | RCx (H79, H80) | RC (B2, C58) | 41 (231, 232) |
| 1991 | RCx (I51, I52) | RC (B2, C58) | 38 (765, B37) |
| 1991 | RCx (I53, I54) | RC (B2, C58) | 38 (765, B37) |
| 1991 | RCx (I61, I62) | RC (B2, C58) | 29 (877, 878) |
| 1991 | RCx (I77, I78) | RC (B2, C58) | 29 (877, 878) |
| 1991 | RCx (J7, J8) | RC (B2, C58) | 29 (877, 878) |
| 1991 | BSOx (I21, I22) | RR0 (213, 214) | 38 (765, B37) |
| 1991 | C0x (F51, F52) | RR0 (213, 214) | 17 (C59, C60) |
| 1991 | C0x (F77, F78) | RR0 (213, 214) | 38 (765, B37) |
| 1991 | C0x (F79, F80) | RR0 (213, 214) | 38 (765, B37) |
| 1991 | RSx (F43, F44) | RS (505, 506) | 21 (13, 14) |
| 1991 | RSx (F45, F46) | RS (505, 506) | 04 (497, 498) |
| 1991 | RSx (F47, F48) | RS (505, 506) | R20 (B17, C69) |
| 1991 | RSx (F49, F50) | RS (505, 506) | 04 (497, 498) |
| 1991 | RSx (F63, F64) | RS (505, 506) | 21 (13, 14) |
| 1991 | RSx (F65, F66) | RS (505, 506) | 21 (13, 14) |
| 1991 | RSx (F67, F68) | RS (505, 506) | 21 (13, 14) |
| 1991 | TSx (F97, F98) | TS (625, 737) | R20 (B17, C69) |
| 1991 | TSx (G17, G18) | TS (625, 737) | R20 (B17, C69) |
| 1991 | TSx (G23, G24) | TS (625, 737) | R20 (B17, C69) |
| 1991 | TSx (G67, G68) | TS (625, 737) | R20 (B17, C69) |
| 1991 | WA4x (H71, H72) | WA4 (755, C54) | 15 (307, 308) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1991 | WA4x (H73, H74) | WA4 (755, C54) | 19 (351, 352) |
| 1991 | WA4x (H75, H76) | WA4 (755, C54) | 19 (351, 352) |
| 1991 | WA4x (H81, H82) | WA4 (755, C54) | 05 (73, 74) |
| 1991 | WA6x (E69, E70) | WA6 (921, C57) | 04 (497, 498) |
| 1991 | WA6x (E73, E74) | WA6 (921, C57) | 04 (497, 498) |
| 1991 | WA6x (F71, F72) | WA6 (921, C57) | 04 (497, 498) |
| 1991 | WA7x (E81, E82) | WA7 (365, C30) | 44 (495, 496) |
| 1991 | WA7x (E83, E84) | WA7 (365, C30) | 7 (431, 432) |
| 1991 | WA7x (E87, E88) | WA7 (365, C30) | 7 (431, 432) |
| 1991 | WA7x (E89, E90) | WA7 (365, C30) | 7 (431, 432) |
| 1991 | WA7x (F41, F42) | WA7 (365, C30) | 7 (431, 432) |
| 1992 | 2RSx (M43, M44) | 2RS (583, 584) | 19 (351, 352) |
| 1992 | 2RSx (M45, M46) | 2RS (583, 584) | R41 (L67, L68) |
| 1992 | 2RSx (M47, M48) | 2RS (583, 584) | 19 (351, 352) |
| 1992 | 2RSx (M49, M50) | 2RS (583, 584) | 19 (351, 352) |
| 1992 | 2RSx (M73, M74) | 2RS (583, 584) | ****** |
| 1992 | 3SBSx (S83, S84) | 3SBS (I67, I68) | R13 (H21, H22) |
| 1992 | 3SBSx (T11, T12) | 3SBS (I67, I68) | 0 (L95, L96) |
| 1992 | 3SBSx (U9, U10) | 3SBS (I67, I68) | 0 (L95, L96) |
| 1992 | H0x (Q95, Q96) | 3SBS (I67, I68) | R13 (H21, H22) |
| 1992 | H0x (T57, T58) | 3SBS (I67, I68) | 0 (L95, L96) |
| 1992 | H0x (T59, T60) | 3SBS (I67, I68) | R13 (H21, H22) |
| 1992 | H0x (T73, T74) | 3SBS (I67, I68) | 0 (L95, L96) |
| 1992 | 4SBSx (P41, P42) | 4SBS (F71, F72) | 19 (351, 352) |
| 1992 | 4SBSx (P67, P68) | 4SBS (F71, F72) | R24 (H76, M26) |
| 1992 | 4SBSx (Q9, Q10) | 4SBS (F71, F72) | 44 (495, 496) |
| 1992 | 4SBSx (R51, R52) | 4SBS (F71, F72) | R24 (H76, M26) |
| 1992 | 4strx (Q67, Q68) | 4str (M5, M6) | 01 (768, B59) |
| 1992 | 4strx (R97, R98) | 4str (M5, M6) | 01 (768, B59) |
| 1992 | 4strx (S39, S40) | 4str (M5, M6) | 38 (C77, C78) |
| 1992 | 4strx (S41, S42) | 4str (M5, M6) | 38 (C77, C78) |
| 1992 | 4strx (T45, T46) | 4str (M5, M6) | 01 (768, B59) |
| 1992 | RSBSx (R49, R50) | 55 (G47, G48) | 07 (B17, C69) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | RSBSx (R5, R6) | 55 (G47, G48) | 07 (B17, C69) |
| 1992 | 5strx (M81, M82) | 5str (I27, I28) | R15 H99, I0) |
| 1992 | 5strx (O41, O42) | 5str (I27, I28) | ****** |
| 1992 | 5strx (P1, P2) | 5str (I27, I28) | ****** |
| 1992 | 5strx (P17, P18) | 5str (I27, I28) | 19 (351, 352) |
| 1992 | 5strx (Q27, Q28) | 5str (I27, I28) | R15 (H99, I0) |
| 1992 | 61x (N49, N50) | 61 (893, C25) | R41 (L67, L68) |
| 1992 | 61x (N5, N6) | 61 (893, C25) | 23 (C45, C46) |
| 1992 | 61x (O35, O36) | 61 (893, C25) | R41 (L67, L68) |
| 1992 | 61x (O37, O38) | 61 (893, C25) | R41 (L67, L68) |
| 1992 | 61x (O39, O40) | 61 (893, C25) | R41 (L67, L68) |
| 1992 | 2x (S35, S36) | 62 (H39, H40) | 5 (L77, L78) |
| 1992 | 2x (S79, S80) | 62 (H39, H40) | 5 (L77, L78) |
| 1992 | 2x (U39, U40) | 62 (H39, H40) | 5 (L77, L78) |
| 1992 | 2x (U57, U58) | 62 (H39, H40) | 5 (L77, L78) |
| 1992 | 2x (U87, U88) | 62 (H39, H40) | 5 (L77, L78) |
| 1992 | 3x (T41, T42) | 63 (L1, L2) | ****** |
| 1992 | 66x (P73, P74) | 66 (215, 216) | R23 (G17, G18) |
| 1992 | 6strx (P11, P12) | 6str (H73, H74) | 21 (13, 14) |
| 1992 | 6strx (P13, P14) | 6str (H73, H74) | 21 (13, 14) |
| 1992 | 6strx (P47, P48) | 6str (H73, H74) | 21 (13, 14) |
| 1992 | 6strx (P9, P10) | 6str (H73, H74) | 01 (768, B59) |
| 1992 | 6strx (Q15, Q16) | 6str (H73, H74) | 21 (13, 14) |
| 1992 | 3x (T23, T24) | 70 (K99, L0) | 38 (C77, C78) |
| 1992 | 3x (T61, T62) | 70 (K99, L0) | 43 (971, C32) |
| 1992 | 3x (U11, U12) | 70 (K99, L0) | 43 (971, C32) |
| 1992 | 70x (Q21, Q22) | 70 (K99, L0) | 38 (C77, C78) |
| 1992 | 73x (P57, P58) | 73 (I93, I94) | 0 (L95, L96) |
| 1992 | 73x (P59, P60) | 73 (I93, I94) | R10 (L8, M23) |
| 1992 | 73x (P85, P86) | 73 (I93, I94) | R10 (L8, M23) |
| 1992 | 73x (P87, P88) | 73 (I93, I94) | 02 (L80, L84) |
| 1992 | 73x (Q17, Q18) | 73 (I93, I94) | 0 (L95, L96) |
| 1992 | 73x (Q19, Q20) | 73 (I93, I94) | R10 (L8, M23) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | RR3x (T43, T44) | 74 (H47, H48) | 26 (D13, D14) |
| 1992 | TSx (T93, T94) | 74 (H47, H48) | 26 (D13, D14) |
| 1992 | TSx (U21, U22) | 74 (H47, H48) | ****** |
| 1992 | 76x (Q93, Q94) | 76 (F15, F16) | 26 (D13, D14) |
| 1992 | 76x (S49, S50) | 76 (F15, F16) | R03 (H63, H64) |
| 1992 | 77x (N53, N54) | 77 (J59, J60) | 26 (D13, D14) |
| 1992 | 77x (N75, N76) | 77 (J59, J60) | 26 (D13, D14) |
| 1992 | 77x (N9, N10) | 77 (J59, J60) | 26 (D13, D14) |
| 1992 | 77x (O27, O28) | 77 (J59, J60) | 26 (D13, D14) |
| 1992 | 77x (P45, P46) | 77 (J59, J60) | R03 (H63, H64) |
| 1992 | 79x (Q65, Q66) | 79 (H35, H36) | 44 (495, 496) |
| 1992 | 79x (R59, R60) | 79 (H35, H36) | 44 (495, 496) |
| 1992 | 79x (S19, S20) | 79 (H35, H36) | 44 (495, 496) |
| 1992 | BB2x (S55, S56) | 79 (H35, H36) | 44 (495, 496) |
| 1992 | 80x (Q45, Q46) | 80 (H11, H12) | R48 (G23, G24) |
| 1992 | 80x (Q83, Q84) | 80 (H11, H12) | R48 (G23, G24) |
| 1992 | 80x (Q97, Q98) | 80 (H11, H12) | R46 (F59, F60) |
| 1992 | 80x (S11, S12) | 80 (H11, H12) | R48 (G23, G24) |
| 1992 | 80x (S37, S38) | 80 (H11, H12) | R48 (G23, G24) |
| 1992 | 81x (S21, S22) | 81 (I9, I55) | 23 (C45, C46) |
| 1992 | 81x (S53, S54) | 81 (I9, I55) | R13 (H21, H22) |
| 1992 | 81x (T21, T22) | 81 (I9, I55) | 23 (C45, C46) |
| 1992 | 81x (T31, T32) | 81 (I9, I55) | R23 (G17, G18) |
| 1992 | 81x (T9, T10) | 81 (I9, I55) | 0 (L95, L96) |
| 1992 | 86x (M79, M80) | 86 (J93, J95) | 01 (768, B59) |
| 1992 | 86x (Q71, Q72) | 86 (J93, J95) | 01 (768, B59) |
| 1992 | 86x (Q87, Q88) | 86 (J93, J95) | 38 (C77, C78) |
| 1992 | 86x (R95, R96) | 86 (J93, J95) | 01 (768, B59) |
| 1992 | 9x (T13, T14) | 91 (I51, I52) | R03 (H63, H64) |
| 1992 | 9x (T15, T16) | 91 (I51, I52) | R03 (H63, H64) |
| 1992 | 9x (T17, T18) | 91 (I51, I52) | R03 (H63, H64) |
| 1992 | 9x (T19, T20) | 91 (I51, I52) | R03 (H63, H64) |
| 1992 | 9x (T29, T30) | 91 (I51, I52) | R03 (H63, H64) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | 5x (N23, N24) | 95 (322, 324) | 26 (D13, D14) |
| 1992 | 5x (N25, N26) | 95 (322, 324) | 26 (D13, D14) |
| 1992 | 5x (N27, N28) | 95 (322, 324) | 26 (D13, D14) |
| 1992 | 5x (N29, N30) | 95 (322, 324) | 26 (D13, D14) |
| 1992 | 6x (M85, 86) | 96 (K81, K82) | 01 (768, B59) |
| 1992 | 6x (N21, N22) | 96 (K81, K82) | 38 (C77, C78) |
| 1992 | 6x (O5, O6) | 96 (K81, K82) | 01 (768, B59) |
| 1992 | 6x (S57, S58) | 96 (K81, K82) | 38 (C77, C78) |
| 1992 | 98x (P51, P52) | 98 (J79, L65) | 43 (971, C32) |
| 1992 | 98x (P53, P54) | 98 (J79, L65) | 43 (971, C32) |
| 1992 | 98x (R17, R18) | 98 (J79, L65) | 43 (971, C32) |
| 1992 | 98x (R55, R56) | 98 (J79, L65) | R35 (F41, F42) |
| 1992 | BBx (P37, P38) | BB (I87, I88) | 26 (D13, D14) |
| 1992 | BBx (S1, S2) | BB (I87, I88) | 26 (D13, D14) |
| 1992 | BBx (T85, T86) | BB (I87, I88) | 26 (D13, D14) |
| 1992 | 79x (R19, R20) | BB2 (179, J3) | 23 (C45, C46) |
| 1992 | 79x (R63, R64) | BB2 (179, J3) | 44 (495, 496) |
| 1992 | BB2x (Q47, Q48) | BB2 (179, J3) | 44 (495, 496) |
| 1992 | BB6x (R61, R62) | BB6 (291, 292) | 02 (L80, L84) |
| 1992 | BB6x (S17, S18) | BB6 (291, 292) | 02 (L80, L84) |
| 1992 | BB6x (T3, T4) | BB6 (291, 292) | 02 (L80, L84) |
| 1992 | BSx (O11, O12) | BS (F43, F44) | 5 (L77, L78) |
| 1992 | BSx (O13, O14) | BS (F43, F44) | R41 (L67, L68) |
| 1992 | BSx (O15, O16) | BS (F43, F44) | R41 (L67, L68) |
| 1992 | BSx (O19, O20) | BS (F43, F44) | 21 (13, 14) |
| 1992 | BSx (O21, O22) | BS (F43, F44) | R41 (L67, L68) |
| 1992 | BSx (Q55, Q56) | BS (F43, F44) | 21 (13, 14) |
| 1992 | BSBBx (Q43, Q44) | BSBB (I95, I96) | 02 (L80, L84) |
| 1992 | BSBBx (Q59, Q60) | BSBB (I95, I96) | R10 (L8, M23) |
| 1992 | BSBBx (Q61, Q62) | BSBB (I95, I96) | R10 (L8, M23) |
| 1992 | BSBBx (Q63, Q64) | BSBB (I95, I96) | 02 (L80, L84) |
| 1992 | fBSBBx (R53, R54) | BSBB (I95, I96) | 02 (L80, L84) |
| 1992 | 4strx (Q85, Q86) | C1 (O89, O90) | 01 (768, B59) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | 4strx (T65, T66) | C1 (O89, O90) | R10 (L8, M23) |
| 1992 | C5x (S13, S14) | C5 (J13, J14) | 23 (C45, C46) |
| 1992 | C5x (S33, S34) | C5 (J13, J14) | ****** |
| 1992 | C5x (S61, S62) | C5 (J13, J14) | R23 (G17, G18) |
| 1992 | C5x (S77, S78) | C5 (J13, J14) | 21 (13, 14) |
| 1992 | C5x (T67, T68) | C5 (J13, J14) | 21 (13, 14) |
| 1992 | C5x (T95, T96) | C5 (J13, J14) | 21 (13, 14) |
| 1992 | C7x (T69, T70) | C7 (K37, K38) | 43 (971, C32) |
| 1992 | C7x (U37, U38) | C7 (K37, K38) | 43 (971, C32) |
| 1992 | Fx (N89, N90) | F (471, 715) | R06 (I91, I92) |
| 1992 | Fx (O9, O10) | F (471, 715) | 19 (351, 352) |
| 1992 | Fx (O99, P0) | F (471, 715) | R24 (H76, M26) |
| 1992 | Fx (P15, P16) | F (471, 715) | ****** |
| 1992 | Hx (Q11, Q12) | H (F67, F68) | 5 (L77, L78) |
| 1992 | Hx (Q37, Q38) | H (F67, F68) | R16 (E19, E20) |
| 1992 | Hx (R93, R94) | H (F67, F68) | 5 (L77, L78) |
| 1992 | 3SBSx (U19, U20) | H0 (I45, I46) | 0 (L95, L96) |
| 1992 | 3SBSx (V11, V12) | H0 (I45, I46) | R41 (L67, L68) |
| 1992 | H2x (Q13, Q14) | H2 (I29, I30) | R15 (H99, I0) |
| 1992 | H2x (Q23, Q24) | H2 (I29, I30) | 19 (351, 352) |
| 1992 | H2x (S71, S72) | H2 (I29, I30) | ****** |
| 1992 | H2x (S73, S74) | H2 (I29, I30) | R15 (H99, I0) |
| 1992 | H2x (S81, S82) | H2 (I29, I30) | R15 (H99, I0) |
| 1992 | H2x (U15, S16) | H2 (I29, I30) | 19 (351, 352) |
| 1992 | H3x (R69, R70) | H3 (J7, J8) | 44 (495, 496) |
| 1992 | H3x (R91, R92) | H3 (J7, J8) | 44 (495, 496) |
| 1992 | H3x (S15, S16) | H3 (J7, J8) | 44 (495, 496) |
| 1992 | H3x (S43, S44) | H3 (J7, J8) | R48 (G23, G24) |
| 1992 | H3x (S99, T0) | H3 (J7, J8) | 44 (495, 496) |
| 1992 | RR9x (Q73, Q74) | H4 (L97, L98) | R23 (G17, G18) |
| 1992 | RR9x (R45, R46) | H4 (L97, L98) | R35 (F41, F42) |
| 1992 | H9x (R79, R80) | H9 (E15, E16) | 26 (D13, D14) |
| 1992 | H9x (T1, T2) | H9 (E15, E16) | R03 (H63, H64) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | HBSx (Q25, Q26) | HBS (H45, H46) | 5 (L77, L78) |
| 1992 | HBSx (R7, R8) | HBS (H45, H46) | R23 (G17, G18) |
| 1992 | HBSx (R71, R72) | HBS (H45, H46) | R41 (L67, L68) |
| 1992 | HBSx (R73, R74) | HBS (H45, H46) | 07 (B17, C69) |
| 1992 | HBSx (R75, R76) | HBS (H45, H46) | R41 (L67, L68) |
| 1992 | HRBx (S3, S4) | HRB (M17, M18) | 38 (C77, C78) |
| 1992 | HRBx (S87, S88) | HRB (M17, M18) | 01 (768, B59) |
| 1992 | HRBx (S89, S90) | HRB (M17, M18) | 01 (768, B59) |
| 1992 | HRBx (T25, T26) | HRB (M17, M18) | 01 (768, B59) |
| 1992 | HWAx (N45, N46) | HWA (H85, H86) | 02 (L80, L84) |
| 1992 | HWAx (N47, N48) | HWA (H85, H86) | 02 (L80, L84) |
| 1992 | HWAx (Q57, Q58) | HWA (H85, H86) | 02 (L80, L84) |
| 1992 | RR3x (P81, P82) | RR3 (H53, H54) | 26 (D13, D14) |
| 1992 | RR3x (P93, P94) | RR3 (H53, H54) | 26 (D13, D14) |
| 1992 | RR3x (Q31, Q32) | RR3 (H53, H54) | 26 (D13, D14) |
| 1992 | RR3x (Q33, Q34) | RR3 (H53, H54) | 26 (D13, D14) |
| 1992 | RR3x (U23, U24) | RR3 (H53, H54) | 26 (D13, D14) |
| 1992 | TSx (T71, T72) | RR3 (H53, H54) | R46 (F59, F60) |
| 1992 | TSx (T89, T90) | RR3 (H53, H54) | 26 (D13, D14) |
| 1992 | TSx (T91, T92) | RR3 (H53, H54) | R46 (F59, F60) |
| 1992 | RR8x (P31, P32) | RR8 (I49, I50) | R41 (L67, L68) |
| 1992 | RR8x (P63, P64) | RR8 (I49, I50) | 4 (L87, L88) |
| 1992 | RR8x (P65, P66) | RR8 (I49, I50) | R10 (L8, M23) |
| 1992 | RR8x (P89, P90) | RR8 (I49, I50) | 02 (L80, L84) |
| 1992 | RR9x (O17, O18) | RR9 (K67, K68) | R13 (H21, H22) |
| 1992 | RR9x (R15, R16) | RR9 (K67, K68) | R35 (F41, F42) |
| 1992 | RR9x (S5, S6) | RR9 (K67, K68) | R35 (F41, F42) |
| 1992 | RSx (O29, O30) | RS (K89, K90) | 43 (971, C32) |
| 1992 | RSx (O31, O32) | RS (K89, K90) | 43 (971, C32) |
| 1992 | RSx (P3, P4) | RS (K89, K90) | R23 (G17, G18) |
| 1992 | RSx (P5, P6) | RS (K89, K90) | 43 (971, C32) |
| 1992 | RSx (P55, P56) | RS (K89, K90) | ****** |
| 1992 | RSBBx (R25, R26) | RSBB (H27, H28) | 21 (13, 14) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | RSBBx (R27, R28) | RSBB (H27, H28) | ****** |
| 1992 | RSBBx (R57, R58) | RSBB (H27, H28) | 23 (C45, C46) |
| 1992 | RSBBx (S51, S52) | RSBB (H27, H28) | R23 (G17, G18) |
| 1992 | 55x (Q39, Q40) | RSBS (H93, H94) | 02 (L80, L84) |
| 1992 | 55x (Q77, Q78) | RSBS (H93, H94) | 21 (13, 14) |
| 1992 | 55x (R47, R48) | RSBS (H93, H94) | 21 (13, 14) |
| 1992 | RSBSx (Q35, Q36) | RSBS (H93, H94) | R10 (L8, M23) |
| 1992 | RSBSx (R39, R40) | RSBS (H93, H94) | 21 (13, 14) |
| 1992 | RSBSx (R41, R42) | RSBS (H93, H94) | 21 (13, 14) |
| 1992 | WAx (P33, P34) | WA (H55, H56) | ****** |
| 1992 | WAx (P69, P70) | WA (H55, H56) | 07 (B17, C69) |
| 1992 | WAx (P7, P8) | WA (H55, H56) | 07 (B17, C69) |
| 1992 | WAx (Q69, Q70) | WA (H55, H56) | 07 (B17, C69) |
| 1992 | WAx (Q7, Q8) | WA (H55, H56) | 07 (B17, C69) |
| 1992 | WAx (R77, R78) | WA (H55, H56) | 07 (B17, C69) |
| 1992 | HxR (R29, R30) | WA0 (F91, F92) | 5 (L77, L78) |
| 1992 | WA0x (R31, R32) | WA0 (F91, F92) | R23 (G17, G18) |
| 1992 | WA0x (R33, R34) | WA0 (F91, F92) | 5 (L77, L78) |
| 1992 | WA0x (T27, T28) | WA0 (F91, F92) | R41 (L67, L68) |
| 1992 | WA0x (U77, U78) | WA0 (F91, F92) | R23 (G17, G18) |
| 1992 | WA1x (P49, P50) | WA1 (I89, I90) | 0 (L95, L96) |
| 1992 | WA1x (R11, R12) | WA1 (I89, I90) | 0 (L95, L96) |
| 1992 | WA1x (R21, R22) | WA1 (I89, I90) | R10 (L8, M23) |
| 1992 | WA1x (R9, R10) | WA1 (I89, I90) | R10 (L8, M23) |
| 1992 | WA3x (O7, O8) | WA3 (F36, F61) | R48 (G23, G24) |
| 1992 | WA3x (P35, P36) | WA3 (F36, F61) | R48 (G23, G24) |
| 1992 | WA3x (P79, P80) | WA3 (F36, F61) | 6 (B29, B30) |
| 1992 | WA3x (Q79, Q80) | WA3 (F36, F61) | R46 (F59, F60) |
| 1992 | WA3x (Q81, Q82) | WA3 (F36, F61) | R46 (F59, F60) |
| 1992 | WA4x (R23, R24) | WA4 (755, C54) | R10 (L8, M23) |
| 1992 | WA4x (R43, R44) | WA4 (755, C54) | R10 (L8, M23) |
| 1992 | WA4x (R65, R66) | WA4 (755, C54) | R10 (L8, M23) |
| 1992 | WA4x (R67, R68) | WA4 (755, C54) | R10 (L8, M23) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1992 | WA4x (S9, S10) | WA4 (755, C54) | R10 (L8, M23) |
| 1992 | WA5x (S59, S60) | WA5 (L89, L90) | 43 (971, C32) |
| 1992 | WA5x (T5, T6) | WA5 (L89, L90) | R23 (G17, G18) |
| 1992 | WA5x (T7, T8) | WA5 (L89, L90) | 43 (971, C32) |
| 1992 | WA7x (N11, N12) | WA7 (365, C30) | 5 (L77, L78) |
| 1992 | WA7x (N51, N52) | WA7 (365, C30) | 5 (L77, L78) |
| 1992 | WA7x (N57, N58) | WA7 (365, C30) | 44 (495, 496) |
| 1992 | WA7x (N59, N60) | WA7 (365, C30) | 44 (495, 496) |
| 1992 | WA8x (Q29, Q30) | WA8 (H91, H92) | R15 (H99, I0) |
| 1992 | WA8x (Q41, Q42) | WA8 (H91, H92) | R16 (E19, E20) |
| 1992 | WA8x (S97, S98) | WA8 (H91, H92) | 7 (431, 432) |
| 1992 | WABBx (S45, S46) | WABB (I53, I54) | 44 (495, 496) |
| 1992 | WABBx (S47, S48) | WABB (I53, I54) | 44 (495, 496) |
| 1992 | WABBx (S7, S8) | WABB (I53, I54) | 44 (495, 496) |
| 1992 | WABBx (T47, T48) | WABB (I53, I54) | ****** |
| 1993 | 3SBSx (Y47, Y48) | 3SBS (R55, R56) | ****** |
| 1993 | 3SBSx (Y59, Y60) | 3SBS (R55, R56) | 34 (G5, G6) |
| 1993 | 3SBSx (Z27, Z28) | 3SBS (R55, R56) | 34 (G5, G6) |
| 1993 | 3SBSx (Z57, Z58) | 3SBS (R55, R56) | 34 (G5, G6) |
| 1993 | 3SRSx (37, 38) | 3SRS (O39, O40) | 44 (495, 496) |
| 1993 | 3SRSx (Z33, Z34) | 3SRS (O39, O40) | 12 (E89, E90) |
| 1993 | 3SRSx (Z35, Z36) | 3SRS (O39, O40) | 44 (495, 496) |
| 1993 | 3SRSx (Z91, Z92) | 3SRS (O39, O40) | 44 (495, 496) |
| 1993 | 4SBSx (39, 40) | 4SBS (F71, F72) | 13 (H75, M23) |
| 1993 | 4strx (Z67, Z68) | 4str (S33, S34) | 12 (E89, E90) |
| 1993 | 4strx (Z69, Z70) | 4str (S33, S34) | 12 (E89, E90) |
| 1993 | RR0x (91, 92) | 51 (T11, T12) | R27 (N47, N48) |
| 1993 | 57x (Y35, Y36) | 57 (N59, N60) | 13 (H75, M23) |
| 1993 | 57x (Y37, Y38) | 57 (N59, N60) | 13 (H75, M23) |
| 1993 | 57x (Y39, Y40) | 57 (N59, N60) | 13 (H75, M23) |
| 1993 | 57x (Y95, Y96) | 57 (N59, N60) | 13 (H75, M23) |
| 1993 | 3SRSx (Z89, Z90) | 60 (R93, R94) | 13 (H75, M23) |
| 1993 | 61x (13, 14) | 61 (893, C25) | 12 (E89, E90) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993 | 61x (35, 36) | 61 (893, C25) | 44 (495, 496) |
| 1993 | 61x (5, 6) | 61 (893, C25) | 44 (495, 496) |
| 1993 | 61x (59, 60) | 61 (893, C25) | 07 (B17, C69) |
| 1993 | 61x (7, 8) | 61 (893, C25) | 07 (B17, C69) |
| 1993 | 61x (Z71, Z72) | 61 (893, C25) | 44 (495, 496) |
| 1993 | 6x (197, 198) | 62 (U89, U90) | R47 (V81, V82) |
| 1993 | 6x (199, 200) | 62 (U89, U90) | 34 (G5, G6) |
| 1993 | 6x (221, 222) | 62 (U89, U90) | 34 (G5, G6) |
| 1993 | 6x (223, 224) | 62 (U89, U90) | 29 (D75, D76) |
| 1993 | 65x (Y11, Y12) | 65 (B52, V87) | 14 (J49, J51) |
| 1993 | 65x (Y29, Y30) | 65 (B52, V87) | 35 (F41, F42) |
| 1993 | 65x (Y5 , Y6) | 65 (B52, V87) | 35 (F41, F42) |
| 1993 | 65x (Y7, Y8) | 65 (B52, V87) | 35 (F41, F42) |
| 1993 | 65x (Y9, Y10) | 65 (B52, V87) | 35 (F41, F42) |
| 1993 | WA2x (X23, X24) | 65 (B52, V87) | 35 (F41, F42) |
| 1993 | 67x (Y51, Y52) | 67 (S85, S86) | 14 (J49, J51) |
| 1993 | 67x (Y69, Y70) | 67 (S85, S86) | 43 (971, C32) |
| 1993 | 67x (Z15, Z16) | 67 (S85, S86) | 14 (J49, J51) |
| 1993 | 6strx (255, 256) | 6str (V97, V98) | 14 (J49, J51) |
| 1993 | 6strx (259, 260) | 6str (V97, V98) | 34 (G5, G6) |
| 1993 | HRSx (15, 16) | 70 (N11, N12) | ****** |
| 1993 | HRSx (269, 270) | 70 (N11, N12) | ****** |
| 1993 | HRSx (271, 272) | 70 (N11, N12) | ****** |
| 1993 | HRSx (273, 274) | 70 (N11, N12) | ****** |
| 1993 | HRSx (329, 330) | 70 (N11, N12) | ****** |
| 1993 | 2x (33, 34) | 72 (O37, O38) | 44 (495, 496) |
| 1993 | 2x (51, 52) | 72 (O37, O38) | 44 (495, 496) |
| 1993 | BB5x (Z81, Z82) | 72 (O37, O38) | 44 (495, 496) |
| 1993 | 75x (Y27, Y28) | 75 (R17, R18) | 14 (J49, J51) |
| 1993 | 75x (Y83, Y84) | 75 (R17, R18) | 14 (J49, J51) |
| 1993 | 75x (Y85, Y86) | 75 (R17, R18) | 34 (G5, G6) |
| 1993 | 77x (135, 136) | 77 (Q41, Q42) | 5 (L77, L78) |
| 1993 | 77x (3, 4) | 77 (Q41, Q42) | 12 (E89, E90) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993 | 77x (Z73, Z74) | 77 (Q41, Q42) | 5 (L77, L78) |
| 1993 | C3x (181, 182) | 77 (Q41, Q42) | 5 (L77, L78) |
| 1993 | RR3x (19, 20) | 77 (Q41, Q42) | 5 (L77, L78) |
| 1993 | 79x (191, 192) | 79 (N45, N46) | R10 (Q61, Q62) |
| 1993 | 79x (Y23, Y24) | 79 (N45, N46) | 02 (L80, L84) |
| 1993 | 80x (117, 118) | 80 (R7, R8) | 35 (F41, F42) |
| 1993 | 80x (126, 127) | 80 (R7, R8) | 35 (F41, F42) |
| 1993 | 80x (128, 129) | 80 (R7, R8) | 35 (F41, F42) |
| 1993 | 80x (130, 131) | 80 (R7, R8) | 35 (F41, F42) |
| 1993 | 80x (157, 158) | 80 (R7, R8) | 02 (L80, L84) |
| 1993 | 81x (45, 46) | 81 (P87, P88) | ****** |
| 1993 | 81x (47, 48) | 81 (P87, P88) | 07 (B17, C69) |
| 1993 | 81x (65, 66) | 81 (P87, P88) | 07 (B17, C69) |
| 1993 | FBSx (177, 178) | 82 (P63, P64) | 07 (B17, C69) |
| 1993 | FBSx (179, 180) | 82 (P63, P64) | R27 (N47, N48) |
| 1993 | FBSx (189, 190) | 82 (P63, P64) | 07 (B17, C69) |
| 1993 | FBSx (351, 352) | 82 (P63, P64) | 02 (L80, L84) |
| 1993 | 91x (113, 114) | 91 (U39, U40) | ****** |
| 1993 | 91x (137, 138) | 91 (U39, U40) | ****** |
| 1993 | 91x (153, 154) | 91 (U39, U40) | 29 (D75, D76) |
| 1993 | 91x (155, 156) | 91 (U39, U40) | R47 (V81, V82) |
| 1993 | 91x (99, 100) | 91 (U39, U40) | 13 (H75, M23) |
| 1993 | 8x (X95, X96) | 98 (J79, L65) | 34 (G5, G6) |
| 1993 | 8x (Y25, Y26) | 98 (J79, L65) | 34 (G5, G6) |
| 1993 | 8x (Y49, Y50) | 98 (J79, L65) | ****** |
| 1993 | BB0x (Y13, Y14) | BB0 (I33, I34) | 7 (431, 432) |
| 1993 | BB0x (Y15, Y16) | BB0 (I33, I34) | 39 (G79, G80) |
| 1993 | 5SRSx (309, 310) | BB3 (P11, P12) | 3 (Q57, Q58) |
| 1993 | 5SRSx (325, 326) | BB3 (P11, P12) | 17 (768, B59) |
| 1993 | BB3x (287, 288) | BB3 (P11, P12) | 17 (768, B59) |
| 1993 | BB3x (467, 468) | BB3 (P11, P12) | 3 (Q57, Q58) |
| 1993 | RR0x (93, 94) | BB3 (P11, P12) | 3 (Q57, Q58) |
| 1993 | RSBSx (363, 364) | BB3 (P11, P12) | 17 (768, B59) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993† | BB4x (X65, X66) | BB4 (N21, N22) or HBB (S57, S58) | 43 (971, C32) |
| 1993† | BB4x (X67, X68) | BB4 (N21, N22) or HBB (S57, S58) | 14 (J49, J51) |
| 1993† | BB4x (Y1, Y2) | BB4 (N21, N22) or HBB (S57, S58) | 14 (J49, J51) |
| 1993† | BB4x (Y53, Y54) | BB4 (N21, N22) or HBB (S57, S58) | 14 (J49, J51) |
| 1993† | HBBx (X63, X64) | BB4 (N21, N22) or HBB (S57, S58) | 14 (J49, J51) |
| 1993† | HBBx (X91, X92) | BB4 (N21, N22) or HBB (S57, S58) | 14 (J49, J51) |
| 1993† | HBBx (X93, X94) | BB4 (N21, N22) or HBB (S57, S58) | 43 (971, C32) |
| 1993† | HBBx (Y41, Y42) | BB4 (N21, N22) or HBB (S57, S58) | 43 (971, C32) |
| 1993† | HBBx (Y43, Y44) | BB4 (N21, N22) or HBB (S57, S58) | 14 (J49, J51) |
| 1993 | 2x (1, 2) | BB5 (N49, N50) | 5 (L77, L78) |
| 1993 | 2x (Z83, Z84) | BB5 (N49, N50) | 5 (L77, L78) |
| 1993 | BB5x (Z87, Z88) | BB5 (N49, N50) | 5 (L77, L78) |
| 1993 | 5strx (193, 194) | BB9 (R21, R22) | 07 (B17, C69) |
| 1993 | WA8x (161, 162) | BS (Q29, Q30) | 07 (B17, C69) |
| 1993 | BSBBx (23, 24) | BSBB (P73, P74) | 12 (E89, E90) |
| 1993 | BSBBx (63, 64) | C0 (V91, V92) | 45 (G41, G42) |
| 1993 | C0x (391, 392) | C0 (V91, V92) | 29 (D75, D76) |
| 1993 | RB3x (149, 150) | C0 (V91, V92) | 29 (D75, D76) |
| 1993 | C2x (W91, W92) | C2 (V71, V72) | R10 (Q61, Q62) |
| 1993 | C2x (X15, X16) | C2 (V71, V72) | R10 (Q61, Q62) |
| 1993 | C2x (X17, X18) | C2 (V71, V72) | ****** |
| 1993 | C5x (27, 28) | C5 (J13, J14) | 13 (H75, M23) |
| 1993 | C5x (Z23, Z24) | C5 (J13, J14) | 45 (G41, G42) |
| 1993 | C9x (X11, X12) | C9 (Q73, Q74) | 35 (F41, F42) |
| 1993 | C9x (X33, X34) | C9 (Q73, Q74) | 3 (Q57, Q58) |
| 1993 | C9x (X35, X36) | C9 (Q73, Q74) | 35 (F41, F42) |
| 1993 | C9x (X5, X6) | C9 (Q73, Q74) | 35 (F41, F42) |
| 1993 | CBx (Z39, Z40) | CB (P47, P48) | R27 (N47, N48) |
| 1993 | CBx (Z41, Z42) | CB (P47, P48) | 17 (768, B59) |
| 1993 | CBx (Z45, Z46) | CB (P47, P48) | 17 (768, B59) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993 | CRx (132, 133) | CR (Q17, Q18) | R27 (N47, N48) |
| 1993 | CRx (41, 42) | CR (Q17, Q18) | R27 (N47, N48) |
| 1993 | CRx (43, 44) | CR (Q17, Q18) | 3 (Q57, Q58) |
| 1993 | CRx (Z99, W54) | CR (Q17, Q18) | 5 (L77, L78) |
| 1993 | FRABx (231, 232) | F (Q87, Q88) | 14 (J49, J51) |
| 1993 | Fx (Z47, Z48) | F (Q87, Q88) | 14 (J49, J51) |
| 1993 | Fx (Z49, Z50) | F (Q87, Q88) | 43 (971, C32) |
| 1993 | FRx (171, 172) | FR (P65, P66) | R27 (N47, N48) |
| 1993 | H3x (261, 262) | FR (P65, P66) | 0 (L95, L96) |
| 1993 | Hx (Y57, Y58) | H (F67, F68) | 44 (495, 496) |
| 1993 | Hx (Y89, Y90) | H (F67, F68) | 44 (495, 496) |
| 1993 | Hx (Y91, Y92) | H (F67, F68) | 44 (495, 496) |
| 1993 | Hx (Y93, Y94) | H (F67, F68) | 44 (495, 496) |
| 1993 | Hx (Z17, Z18) | H (F67, F68) | 44 (495, 496) |
| 1993 | H0x (9, 10) | H0 (R45, R46) | ****** |
| 1993 | H0x (X37, X38) | H0 (R45, R46) | ****** |
| 1993 | H0x (Z51, Z52) | H0 (R45, R46) | 4 (L87, L88) |
| 1993 | H1x (139, 140) | H1 (S35, S36) | 12 (E89, E90) |
| 1993 | H1x (67, 68) | H1 (S35, S36) | 45 (G41, G42) |
| 1993 | H1x (69, 70) | H1 (S35, S36) | 29 (D75, D76) |
| 1993 | H1x (83, 84) | H1 (S35, S36) | 39 (G79, G80) |
| 1993 | BB9x (71, 72) | H3 (R9, R10) | 07 (B17, C69) |
| 1993 | H3x (165, 166) | H3 (R9, R10) | R27 (N47, N48) |
| 1993 | H3x (Z77, Z78) | H3 (R9, R10) | 3 (Q57, Q58) |
| 1993 | RSRABx (105, 106) | H3 (R9, R10) | 07 (B17, C69) |
| 1993 | H6x (263, 264) | H6 (R19, R20) | ****** |
| 1993 | H6x (293, 294) | H6 (R19, R20) | 29 (D75, D76) |
| 1993 | H6x (297, 298) | H6 (R19, R20) | 39 (G79, G80) |
| 1993 | H6x (327, 328) | H6 (R19, R20) | ****** |
| 1993 | BSBBx (49, 50) | H7 (Q89, Q90) | 29 (D75, D76) |
| 1993 | H7x (21, 22) | H7 (Q89, Q90) | ****** |
| 1993 | H7x (25, 26) | H7 (Q89, Q90) | 45 (G41, G42) |
| 1993 | H7x (Y63, Y64) | H7 (Q89, Q90) | 45 (G41, G42) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993 | H7x (Y65, Y66) | H7 (Q89, Q90) | 29 (D75, D76) |
| 1993 | H7x (Y67, Y68) | H7 (Q89, Q90) | 45 (G41, G42) |
| 1993 | H7x (Z21, 2Z2) | H7 (Q89, Q90) | 29 (D75, D76) |
| 1993 | H8x (Y19, Y20) | H8 (M43, M44) | R10 (Q61, Q62) |
| 1993 | H8x (Y21, Y22) | H8 (M43, M44) | R10 (Q61, Q62) |
| 1993 | H9x (119, 120) | H9 (P69, P70) | 35 (F41, F42) |
| 1993 | H9x (88, 0) | H9 (P69, P70) | 35 (F41, F42) |
| 1993 | 10x (61, 62) | HBS (S9, S10) | R27 (N47, N48) |
| 1993 | HBSx (349, 350) | HBS (S9, S10) | 3 (Q57, Q58) |
| 1993 | 79x (Y3, Y4) | HWA (H85, H86) | ****** |
| 1993 | HWAx (W89, W90) | HWA (H85, H86) | 02 (L80, L84) |
| 1993 | HWAx (W93, W94) | HWA (H85, H86) | 02 (L80, L84) |
| 1993 | HWAx (W95, W96) | HWA (H85, H86) | 02 (L80, L84) |
| 1993 | HWAx (W97, W98) | HWA (H85, H86) | 02 (L80, L84) |
| 1993 | HWAx (X89, X90) | HWA (H85, H86) | 02 (L80, L84) |
| 1993 | RR0x (521, 522) | RR0 (T73, T74) | 3 (Q57, Q58) |
| 1993 | RR0x (89, 90) | RR0 (T73, T74) | 3 (Q57, Q58) |
| 1993 | RR2x (107, 108) | RR2 (I29, I30) | 7 (431, 432) |
| 1993 | 77x (85, 86) | RR3 (S97, S98) | 5 (L77, L78) |
| 1993 | 7x (Z73, Z74) | RR3 (S97, S98) | 5 (L77, L78) |
| 1993 | C3x (257, 258) | RR3 (S97, S98) | ****** |
| 1993 | RR3x (31, 32) | RR3 (S97, S98) | 5 (L77, L78) |
| 1993 | RR5x (275, 276) | RR5 (N51, N52) | 44 (495, 496) |
| 1993 | RR5x (Z79, Z80) | RR5 (N51, N52) | 13 (H75, M23) |
| 1993 | RR5x (Z93, Z94) | RR5 (N51, N52) | 13 (H75, M23) |
| 1993 | RR5x (Z95, Z96) | RR5 (N51, N52) | 13 (H75, M23) |
| 1993 | RR9x (X3, X4) | RR9 (K67, K68) | ****** |
| 1993 | RR9x (X87, X88) | RR9 (K67, K68) | 17 (768, B59) |
| 1993 | RR9x (Y71, Y72) | RR9 (K67, K68) | 17 (768, B59) |
| 1993 | RR9x (Z55, Z56) | RR9 (K67, K68) | ****** |
| 1993 | BSBBx (75, 76) | RS (I85, I86) | ****** |
| 1993 | RSx (Z59, Z60) | RS (I85, I86) | 29 (D75, D76) |
| 1993 | RSx (Z61, Z62) | RS (I85, I86) | 29 (D75, D76) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993 | RSx (Z63, Z64) | RS (I85, I86) | 29 (D75, D76) |
| 1993 | RSx (Z65, Z66) | RS (I85, I86) | 29 (D75, D76) |
| 1993 | RSBBx (95, 96) | RSBB (H27, H28) | 12 (E89, E90) |
| 1993 | RSBBx (Y75, Y76) | RSBB (H27, H28) | 13 (H75, M23) |
| 1993 | RSBBx (Y77, Y78) | RSBB (H27, H28) | ****** |
| 1993 | RSBBx (Y79, Y80) | RSBB (H27, H28) | 12 (E89, E90) |
| 1993 | RSBBx (Y81, Y82) | RSBB (H27, H28) | 45 (G41, G42) |
| 1993 | FRx (147, 148) | RSRAB (P89, P90) | R27 (N47, N48) |
| 1993 | H3x (Z97, Z98) | RSRAB (P89, P90) | R27 (N47, N48) |
| 1993 | RSRABx (151, 152) | RSRAB (P89, P90) | 0 (L95, L96) |
| 1993 | RSRABx (163, 164) | RSRAB (P89, P90) | 3 (Q57, Q58) |
| 1993 | RSRABx (97, 98) | RSRAB (P89, P90) | 3 (Q57, Q58) |
| 1993 | TSx (X99, Y0) | TS (T33, T34) | 35 (F41, F42) |
| 1993 | TSx (Y73, Y74) | TS (T33, T34) | 43 (971, C32) |
| 1993 | TSx (Z19, Z20) | TS (T33, T34) | 35 (F41, F42) |
| 1993 | WA2x (X59, X60) | TS (T33, T34) | 35 (F41, F42) |
| 1993 | WA5x (121, 122) | WA (U93, U94) | 29 (D75, D76) |
| 1993 | WA5x (123, 124) | WA (U93, U94) | 29 (D75, D76) |
| 1993 | WA5x (125, 126) | WA (U93, U94) | 34 (G5, G6) |
| 1993 | WA5x (143, 144) | WA (U93, U94) | 12 (E89, E90) |
| 1993 | WA5x (145, 146) | WA (U93, U94) | R47 (V81, V82) |
| 1993 | WA5x (195, 196) | WA (U93, U94) | 12 (E89, E90) |
| 1993 | WA0x (169, 170) | WA0 (F91, F92) | R01 (S61, S62) |
| 1993 | WA0x (X39, X40) | WA0 (F91, F92) | 44 (495, 496) |
| 1993 | WA0x (X69, X70) | WA0 (F91, F92) | 12 (E89, E90) |
| 1993 | WA0x (Z53, Z54) | WA0 (F91, F92) | 44 (495, 496) |
| 1993 | WA2x (X13, X14) | WA2 (K37, K38) | 14 (J49, J51) |
| 1993 | WA2x (X25, X26) | WA2 (K37, K38) | 14 (J49, J51) |
| 1993 | WA2x (X61, X62) | WA2 (K37, K38) | 35 (F41, F42) |
| 1993 | WA3x (77, 78) | WA3 (U57, U58) | 12 (E89, E90) |
| 1993 | WA3x (79, 80) | WA3 (U57, U58) | 45 (G41, G42) |
| 1993 | WA3x (81, 82) | WA3 (U57, U58) | ****** |
| 1993 | WAx (175, 176) | WA4 (Q77, Q78) | R27 (N47, N48) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1993 | WAx (183, 184) | WA4 (Q77, Q78) | 35 (F41, F42) |
| 1993 | WAx (185, 186) | WA4 (Q77, Q78) | 35 (F41, F42) |
| 1993 | WAx (187, 188) | WA4 (Q77, Q78) | R27 (N47, N48) |
| 1993 | WA6x (11, 12) | WA6 (P49, P50) | ****** |
| 1993 | WA6x (17, 18) | WA6 (P49, P50) | 0 (L95, L96) |
| 1993 | WA6x (Y45, Y46) | WA6 (P49, P50) | 0 (L95, L96) |
| 1993 | WA6x (Y87, Y88) | WA6 (P49, P50) | 0 (L95, L96) |
| 1993 | WA6x (Z31, Z32) | WA6 (P49, P50) | 0 (L95, L96) |
| 1993 | 57x (X97, X98) | WA7 (365, C30) | 13 (H75, M23) |
| 1993 | BSx (29, 30) | WA7 (365, C30) | ****** |
| 1993 | BSx (Z85, Z76) | WA7 (365, C30) | 13 (H75, M23) |
| 1993 | WA7x (X19, X20) | WA7 (365, C30) | 13 (H75, M23) |
| 1993 | WA7x (X41, X42) | WA7 (365, C30) | 39 (G79, G80) |
| 1993 | WA7x (Y97, Y98) | WA7 (365, C30) | 13 (H75, M23) |
| 1993 | WA8x (Y17, Y18) | WA8 (H91, H92) | 5 (L77, L78) |
| 1993 | WA8x (Z37, Z38) | WA8 (H91, H92) | 5 (L77, L78) |
| 1993 | HRBx (159, 160) | WABB (R75, R76) | 35 (F41, F42) |
| 1993 | HRBx (167, 168) | WABB (R75, R76) | 35 (F41, F42) |
| 1993 | WABBx (115, 116) | WABB (R75, R76) | ****** |
| 1993 | WABBx (73, 74) | WABB (R75, R76) | 3 (Q57, Q58) |
| 1993 | WABSx (111, 112) | WABS (R27, R28) | 12 (E89, E90) |
| 1993 | WABSx (141, 142) | WABS (R27, R28) | 12 (E89, E90) |
| 1994 | 3SBSx (845, 846) | 3SBS (Y27, Y28) | 6 (971, C32) |
| 1994 | 3SRSx (945, 946) | 3SRS (71, 72) | 19 (V25, V26) |
| 1994 | 3SRSx (947, 948) | 3SRS (71, 72) | 25 (Q21, H84) |
| 1994 | 4SBSx (656, 657) | 4SBS (F71, F72) | 42 (A17, A18) |
| 1994 | 4SBSx (660, 661) | 4SBS (F71, F72) | 36 (343, 344) |
| 1994 | 4SBSx (679, 680) | 4SBS (F71, F72) | 36 (343, 344) |
| 1994 | 4SBSx (681, 682) | 4SBS (F71, F72) | 42 (A17, A18) |
| 1994 | 4SRSx (721, 722) | 4SRS (P1, P2) | 24 (N47, N48) |
| 1994 | 4SRSx (749, 750) | 4SRS (P1, P2) | 24 (N47, N48) |
| 1994 | 4SRSx (753, 754) | 4SRS (P1, P2) | 24 (N47, N48) |
| 1994 | 4SRSx (F15, F16) | 4SRS (P1, P2) | 24 (N47, N48) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | 71x (C75, C76) | 4SRS (P1, P2) | 24 (N47, N48) |
| 1994 | 4strx (737, 738) | 4str (X5, X6) | 6 (971, C32) |
| 1994 | 4strx (799, 800) | 4str (X5, X6) | 0 (J49, J50) |
| 1994 | 4strx (801, 802) | 4str (X5, X6) | 0 (J49, J50) |
| 1994 | 0x (797, 798) | 50 (161, 162) | 7 (L95, L96) |
| 1994 | 0x (811, 812) | 50 (161, 162) | 7 (L95, L96) |
| 1994 | 0x (949, 950) | 50 (161, 162) | 7 (L95, L96) |
| 1994 | 6x (843, 844) | 56 (255, 256) | 46 (P3, V89) |
| 1994 | 6x (857, 858) | 56 (255, 256) | 6 (971, C32) |
| 1994 | 6x (859, 860) | 56 (255, 256) | 6 (971, C32) |
| 1994 | RSBSx (905, 906) | 58 (143, 144) | 46 (P3, V89) |
| 1994 | RSBSx (978, 979) | 58 (143, 144) | R19 (539, 651) |
| 1994 | RSBSx (A81, A82) | 58 (143, 144) | R19 (539, 651) |
| 1994 | BB6x (988, 989) | 59 (T11, T12) | 47 (549, 550) |
| 1994 | BB6x (A32, A33) | 59 (T11, T12) | 47 (549, 550) |
| 1994 | BB6x (A54, A55) | 59 (T11, T12) | 47 (549, 550) |
| 1994 | 5SBSx (677, 678) | 5SBS (X11, X12) | 0 (J49, J50) |
| 1994 | 5SBSx (813, 814) | 5SBS (X11, X12) | 6 (971, C32) |
| 1994 | 5SBSx (A67, A68) | 5SBS (X11, X12) | 40 (W49, W50) |
| 1994 | 5SRSx (931, 932) | 5SRS (P73, P74) | 31 (V81, V82) |
| 1994 | 5SRSx (935, 936) | 5SRS (P73, P74) | 31 (V81, V82) |
| 1994 | 5x (C50, C51) | 5SRS (P73, P74) | 31 (V81, V82) |
| 1994 | 5strx (S33, S34) | 5str (S33, S34) | 32 (Q7, Q8) |
| 1994 | BB0x (F9, F10) | 5str (S33, S34) | 32 (Q7, Q8) |
| 1994 | FCRx (C69, C70) | 5str (S33, S34) | 32 (Q7, Q8) |
| 1994 | 60x (901, 902) | 60 (R75, R76) | 5 (L77, L78) |
| 1994 | 60x (903, 904) | 60 (R75, R76) | 5 (L77, L78) |
| 1994 | 60x (933, 934) | 60 (R75, R76) | ****** |
| 1994 | 60x (953, 954) | 60 (R75, R76) | 31 (V81, V82) |
| 1994 | 6SBSx (961, 962) | 60 (R75, R76) | 5 (L77, L78) |
| 1994 | 6SBSx (972, 973) | 60 (R75, R76) | 5 (L77, L78) |
| 1994 | 61x (829, 830) | 61 (B52, V87) | 46 (P3, V89) |
| 1994 | 61x (no tags) | 61 (B52, V87) | 6 (971, C32) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | BSBBx (927, 928) | 61 (B52, V87) | 6 (971, C32) |
| 1994 | CBSx (793, 794) | 61 (B52, V87) | 40 (W49, W50) |
| 1994 | CBSx (815, 816) | 61 (B52, V87) | 40 (W49, W50) |
| 1994 | CBSx (837, 838) | 61 (B52, V87) | 46 (P3, V89) |
| 1994 | CBSx (853, 854) | 61 (B52, V87) | 6 (971, C32) |
| 1994 | RR0x (767, 768) | 61 (B52, V87) | 6 (971, C32) |
| 1994 | RR0x (787, 788) | 61 (B52, V87) | 6 (971, C32) |
| 1994 | 2x (909, 910) | 62 (U89, U90) | R19 (539, 651) |
| 1994 | 2x (F7, F8) | 62 (U89, U90) | R19 (539, 651) |
| 1994 | 62x (875, 876) | 62 (U89, U90) | 31 (V81, V82) |
| 1994 | RR5x (980, 981) | 62 (U89, U90) | 31 (V81, V82) |
| 1994 | 65x (658, 659) | 65 (R17, R18) | 6 (971, C32) |
| 1994 | 65x (664, 665) | 65 (R17, R18) | 46 (P3, V89) |
| 1994 | 5SBSx (A8, A9) | 6SBS (167, 168) | 5 (L77, L78) |
| 1994 | BB3x (A52, A53) | 6SBS (167, 168) | 5 (L77, L78) |
| 1994 | 6SRSx (967, 968) | 6SRS (R63, R64) | 15 (T85, T86) |
| 1994 | 6SRSx (A58, A59) | 6SRS (R63, R64) | 15 (T85, T86) |
| 1994 | 6SRSx (A95, A96) | 6SRS (R63, R64) | 15 (T85, T86) |
| 1994 | 6SRSx (C10, C11) | 6SRS (R63, R64) | 15 (T85, T86) |
| 1994 | 6strx (869, 870) | 6str (Y59, Y60) | 43 (M35, M36) |
| 1994 | 6strx (877, 878) | 6str (Y59, Y60) | 46 (P3, V89) |
| 1994 | 6strx (923, 924) | 6str (Y59, Y60) | 35 (267, 268) |
| 1994 | 71x (C46, C47) | 71 (55, 56) | 24 (N47, N48) |
| 1994 | 71x (C77, C78) | 71 (55, 56) | 24 (N47, N48) |
| 1994 | 72x (917, 918) | 72 (X37, X38) | 40 (W49, W50) |
| 1994 | BB5x (867, 868) | 72 (X37, X38) | 0 (J49, J50) |
| 1994 | 3x (A62, A63) | 73 (893, C25) | 7 (L95, L96) |
| 1994 | CBx (A64, A65) | 73 (893, C25) | 7 (L95, L96) |
| 1994 | CBx (C64, C65) | 73 (893, C25) | 7 (L95, L96) |
| 1994 | HRSx (685, 686) | 78 (X23, X24) | 6 (971, C32) |
| 1994 | HRSx (713, 714) | 78 (X23, X24) | 6 (971, C32) |
| 1994 | HRSx (733, 734) | 78 (X23, X24) | 46 (P3, V89) |
| 1994 | HRSx (765, 766) | 78 (X23, X24) | 6 (971, C32) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | RR0x (751, 752) | 80 (X61, X62) | 0 (J49, J50) |
| 1994 | RR0x (769, 770) | 80 (X61, X62) | 6 (971, C32) |
| 1994 | RR0x (795, 796) | 80 (X61, X62) | 6 (971, C32) |
| 1994 | RR0x (939, 940) | 80 (X61, X62) | 46 (P3, V89) |
| 1994 | 81x (695, 696) | 81 (R45, R46) | 40 (W49, W50) |
| 1994 | 81x (705, 706) | 81 (R45, R46) | 16 (V85, V86) |
| 1994 | 81x (725, 726) | 81 (R45, R46) | 47 (549, 550) |
| 1994 | 81x (727, 728) | 81 (R45, R46) | 16 (V85, V86) |
| 1994 | BB5x (911, 912) | 81 (R45, R46) | 16 (V85, V86) |
| 1994 | BB5x (915, 916) | 81 (R45, R46) | 16 (V85, V86) |
| 1994 | 4x (C12, C13) | 82 (351, 352) | 19 (V25, V26) |
| 1994 | 4x (C14, C15) | 82 (351, 352) | 47 (549, 550) |
| 1994 | 4x (C16, C17) | 82 (351, 352) | 19 (V25, V26) |
| 1994 | 4x (F47, F48) | 82 (351, 352) | 19 (V25, V26) |
| 1994 | RR2x (C99, F0) | 82 (351, 352) | 47 (549, 550) |
| 1994 | RSRABx (C60, C61) | 82 (351, 352) | 47 (549, 550) |
| 1994 | RSRABx (C62, C63) | 82 (351, 352) | 19 (V25, V26) |
| 1994 | 2x (no tags) | 85 (Z21, Z22) | R19 (539, 651) |
| 1994 | 7x (G12, G13) | 85 (Z21, Z22) | 31 (V81, V82) |
| 1994 | WABBx (A71, A72) | 85 (Z21, Z22) | 31 (V81, V82) |
| 1994 | 87x (976, 977) | 87 (195, 196) | 6 (971, C32) |
| 1994 | H3x (A40, A41) | 87 (195, 196) | 6 (971, C32) |
| 1994 | H3x (A42, A43) | 87 (195, 196) | 6 (971, C32) |
| 1994 | 9x (969, 970) | 90 (159, 160) | 5 (L77, L78) |
| 1994 | 9x (984, 985) | 90 (159, 160) | 0 (J49, J50) |
| 1994 | 9x (986, 987) | 90 (159, 160) | 5 (L77, L78) |
| 1994 | 9x (A22, A23) | 90 (159, 160) | 5 (L77, L78) |
| 1994 | C9x (881, 882) | 97 (Q77, Q78) | 25 (Q21, H84) |
| 1994 | C9x (897, 898) | 97 (Q77, Q78) | 27 (O17, O18) |
| 1994 | C9x (A87, A88) | 97 (Q77, Q78) | 25 (Q21, H84) |
| 1994 | RR4x (A85, A86) | 97 (Q77, Q78) | 40 (W49, W50) |
| 1994 | 8x (644, 645) | 98 (J79, L65) | 6 (971, C32) |
| 1994 | 8x (646, 647) | 98 (J79, L65) | 46 (P3, V89) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | 8x (648, 649) | 98 (J79, L65) | 6 (971, C32) |
| 1994 | 8x (653, 654) | 98 (J79, L65) | 46 (P3, V89) |
| 1994 | BBx (773, 774) | BB (5, 6) | 42 (A17, A18) |
| 1994 | BBx (783, 784) | BB (5, 6) | 01 (T37, T38) |
| 1994 | BBx (885, 886) | BB (5, 6) | 24 (N47, N48) |
| 1994 | BB2x (819, 820) | BB2 (179, J3, V74) | 15 (T85, T86) |
| 1994 | BB2x (839, 840) | BB2 (179, J3, V74) | 15 (T85, T86) |
| 1994 | BB2x (907, 908) | BB2 (179, J3, V74) | 15 (T85, T86) |
| 1994 | BB3x (891, 892) | BB3 (119, 120) | 5 (L77, L78) |
| 1994 | BB3x (941, 942) | BB3 (119, 120) | 5 (L77, L78) |
| 1994 | WA8x (A0, A1) | BB3 (119, 120) | ****** |
| 1994 | BB4x (670, 699) | BB4 (N21, N22) | 46 (P3, V89) |
| 1994 | BB4x (675, 676) | BB4 (N21, N22) | 03 (P5, P6) |
| 1994 | BB4x (709, 710) | BB4 (N21, N22) | 46 (P3, V89) |
| 1994 | BB4x (711, 712) | BB4 (N21, N22) | ****** |
| 1994 | BB4x (771, 772) | BB4 (N21, N22) | R19 (539, 651) |
| 1994 | 72x (835, 836) | BB5 (9, 10) | 16 (V85, V86) |
| 1994 | 72x (A90, A91) | BB5 (9, 10) | 47 (549, 550) |
| 1994 | BB7x (879, 880) | BB7 (Y83, Y84) | 46 (P3, V89) |
| 1994 | BB7x (A18, A19) | BB7 (Y83, Y84) | 46 (P3, V89) |
| 1994 | BB7x (A6, A7) | BB7 (Y83, Y84) | 46 (P3, V89) |
| 1994 | 3SRSx (A46, A47) | BB9 (R21, R22) | 25 (Q21, H84) |
| 1994 | BB9x (831, 832) | BB9 (R21, R22) | 27 (O17, O18) |
| 1994 | BB9x (851, 852) | BB9 (R21, R22) | 27 (O17, O18) |
| 1994 | BB9x (943, 944) | BB9 (R21, R22) | 27 (O17, O18) |
| 1994 | HTSx (955, 956) | BB9 (R21, R22) | 27 (O17, O18) |
| 1994 | HTSx (A77, A78) | BB9 (R21, R22) | 25 (Q21, H84) |
| 1994 | BSBBx (833, 834) | BSBB (Y29, Y30) | 6 (971, C32) |
| 1994 | 74x (C91, C92) | C0 (49, 50) | 31 (V81, V82) |
| 1994 | C0x (A12, A13) | C0 (49, 50) | 31 (V81, V82) |
| 1994 | C0x (A16, A17) | C0 (49, 50) | 31 (V81, V82) |
| 1994 | C0x (A38, A39) | C0 (49, 50) | 31 (V81, V82) |
| 1994 | C0x (A92, A93) | C0 (49, 50) | 31 (V81, V82) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | 5SBSx (777, 778) | C9 (Q73, Q74) | 40 (W49, W50) |
| 1994 | 3x (A28, A29) | CB (7, 8) | 01 (T37, T38) |
| 1994 | 3x (A60, A61) | CB (7, 8) | 01 (T37, T38) |
| 1994 | CRx (779, 780) | CR (Q17, Q18) | 27 (O17, O18) |
| 1994 | CRx (781, 782) | CR (Q17, Q18) | 27 (O17, O18) |
| 1994 | CRx (789, 790) | CR (Q17, Q18) | 27 (O17, O18) |
| 1994 | CRSx (717, 718) | CRS (H91, H92) | 01 (T37, T38) |
| 1994 | CRSx (887, 888) | CRS (H91, H92) | 7 (L95, L96) |
| 1994 | CRSx (889, 890) | CRS (H91, H92) | 7 (L95, L96) |
| 1994 | TSRx (992, 993) | CRS (H91, H92) | 01 (T37, T38) |
| 1994 | CWAx (813, 914) | CWA (115, 116) | 5 (L77, L78) |
| 1994 | CWAx (893, 894) | CWA (115, 116) | 31 (V81, V82) |
| 1994 | CWAx (895, 896) | CWA (115, 116) | 5 (L77, L78) |
| 1994 | CWAx (919, 920) | CWA (115, 116) | ****** |
| 1994 | ABx (A44, A45) | FBS (287, 288) | 25 (Q21, H84) |
| 1994 | FBSx (A30, A31) | FBS (287, 288) | 25 (Q21, H84) |
| 1994 | FBSx (F17, F18) | FBS (287, 288) | 25 (Q21, H84) |
| 1994 | FRx (A34, A35) | FR (Z37, Z38) | 7 (L95, L96) |
| 1994 | FRx (F43, F44) | FR (Z37, Z38) | 7 (L95, L96) |
| 1994 | 00x (C93, C94) | FRB (77, 78) | 42 (A17, A18) |
| 1994 | FRBx (A10, A11) | FRB (77, 78) | 01 (T37, T38) |
| 1994 | Hx (873, 874) | H (Z19, Z20) | ****** |
| 1994 | Hx (937, 938) | H (Z19, Z20) | 6 (971, C32) |
| 1994 | Hx (951, 952) | H (Z19, Z20) | 25 (Q21, H84) |
| 1994 | H0x (785, 786) | H0 (X87, X88) | 16 (V85, V86) |
| 1994 | H0x (C48, C49) | H0 (X87, X88) | 16 (V85, V86) |
| 1994 | RSx (803, 804) | H0 (X87, X88) | 16 (V85, V86) |
| 1994 | RSx (809, 810 | H0 (X87, X88) | 16 (V85, V86) |
| 1994 | H2x (A73, A74) | H2 (N11, N12) | 15 (T85, T86) |
| 1994 | H2x (F31, F32) | H2 (N11, N12) | 15 (T85, T86) |
| 1994 | H2x (F33, F34) | H2 (N11, N12) | 15 (T85, T86) |
| 1994 | H2x (F35, F36) | H2 (N11, N12) | 15 (T85, T86) |
| 1994 | H2x (G84, G85) | H2 (N11, N12) | 15 (T85, T86) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | 87x (957, 958) | H3 (145, 146) | 46 (P3, V89) |
| 1994 | 87x (974, 975) | H3 (145, 146) | 6 (971, C32) |
| 1994 | 87x (998, 999) | H3 (145, 146) | 46 (P3, V89) |
| 1994 | H3x (959, 960) | H3 (145, 146) | 46 (P3, V89) |
| 1994 | H4x (996, 997) | H4 (185, 186) | 27 (O17, O18) |
| 1994 | H5x (739, 740) | H5 (J13, J14) | 26 (687, 688) |
| 1994 | H5x (745, 746) | H5 (J13, J14) | 26 (687, 688) |
| 1994 | H5x (821, 822) | H5 (J13, J14) | 32 (Q7, Q8) |
| 1994 | H6x (A2, A3) | H6 (R19, R20) | 15 (T85, T86) |
| 1994 | H6x (A4, A5) | H6 (R19, R20) | 15 (T85, T86) |
| 1994 | F74x (F77, F78) | H7 (Q89, Q90) | 46 (P3, V89) |
| 1994 | H7x (757, 758) | H7 (Q89, Q90) | 31 (V81, V82) |
| 1994 | H7x (759, 760) | H7 (Q89, Q90) | 31 (V81, V82) |
| 1994 | H7x (761, 762) | H7 (Q89, Q90) | 31 (V81, V82) |
| 1994 | H7x (763, 764) | H7 (Q89, Q90) | 31 (V81, V82) |
| 1994 | H7x (871, 872) | H7 (Q89, Q90) | 31 (V81, V82) |
| 1994 | H9x (847, 848) | H9 (P69, P70) | 5 (L77, L78) |
| 1994 | H9x (849, 850) | H9 (P69, P70) | 27 (O17, O18) |
| 1994 | H9x (861, 862) | H9 (P69, P70) | ****** |
| 1994 | H9x (863, 864) | H9 (P69, P70) | 5 (L77, L78) |
| 1994 | HBBx (723, 724) | HBB (61, 62) | 0 (J49, J50) |
| 1994 | HBBx (C71, C72) | HBB (61, 62) | 47 (549, 550) |
| 1994 | HBBx (C73, C74) | HBB (61, 62) | 47 (549, 550) |
| 1994 | HBSx (805, 806) | HBS (Z27, Z28) | 46 (P3, V89) |
| 1994 | HBSx (807, 808) | HBS (Z27, Z28) | 46 (P3, V89) |
| 1994 | HBSx (817, 818) | HBS (Z27, Z28) | 6 (971, C32) |
| 1994 | FBSx (G58, G59) | HRB (P47, P48) | 25 (Q21, H84) |
| 1994 | HRBx (823, 824) | HRB (P47, P48) | 25 (Q21, H84) |
| 1994 | HRBx (827, 828) | HRB (P47, P48) | 25 (Q21, H84) |
| 1994 | HRBx (929, 930) | HRB (P47, P48) | 0 (J49, J50) |
| 1994 | HRBx (A36, A37) | HRB (P47, P48) | 25 (Q21, H84) |
| 1994 | HTSx (865, 866) | HTS (11, 12) | 27 (O17, O18) |
| 1994 | HTSx (883, 884) | HTS (11, 12) | 27 (O17, O18) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | RACx (G1, G2) | RAC (155, 156) | 32 (Q7, Q8) |
| 1994 | RACx (G3, G4) | RAC (155, 156) | 32 (Q7, Q8) |
| 1994 | RACx (G5, G6) | RAC (155, 156) | 32 (Q7, Q8) |
| 1994 | RACx (G8, G9) | RAC (155, 156) | 31 (V81, V82) |
| 1994 | C0x (A14, A15) | RB3 (V93, V94) | 31 (V81, V82) |
| 1994 | RB3x (F37, F38) | RB3 (V93, V94) | R19 (539, 651) |
| 1994 | RB3x (F37, F38) | RB3 (V93, V94) | R19 (539, 651) |
| 1994 | RB3x (F37, F38) | RB3 (V93, V94) | 26 (687, 688) |
| 1994 | RR2x (C95, C96) | RR2 (Y45, Y46) | ****** |
| 1994 | RSRABx (C58, C59) | RR2 (Y45, Y46) | 14 (S59, S60) |
| 1994 | RR3x (982, 983) | RR3 (Y49, Y50) | 6 (971, C32) |
| 1994 | C9x (899, 900) | RR4 (187, 188) | 16 (V85, V86) |
| 1994 | RR4x (A75, A76) | RR4 (187, 188) | 25 (Q21, H84) |
| 1994 | RR4x (F1, F2) | RR4 (187, 188) | 25 (Q21, H84) |
| 1994 | WAx (A50, A51) | RR5 (Z63, Z64) | R19 (539, 651) |
| 1994 | RR9x (671, 672) | RR9 (K67, K68) | 0 (J49, J50) |
| 1994 | RR9x (673, 674) | RR9 (K67, K68) | ****** |
| 1994 | RR9x (689, 690) | RR9 (K67, K68) | 40 (W49, W50) |
| 1994 | RSx (775, 776) | RS (Y71, Y72) | 16 (V85, V86) |
| 1994 | RSx (855, 856) | RS (Y71, Y72) | 16 (V85, V86) |
| 1994 | RSBBx (729, 730) | RSBB (111, 112) | 01 (T37, T38) |
| 1994 | RSBBx (731, 732) | RSBB (111, 112) | 01 (T37, T38) |
| 1994 | RSBBx (791, 792) | RSBB (111, 112) | 01 (T37, T38) |
| 1994 | RR2x (C97, C98) | RSRAB (105, 106) | 19 (V25, V26) |
| 1994 | TSx (994, 995) | TS (181, 182) | 7 (L95, L96) |
| 1994 | TSx (A20, A21) | TS (181, 182) | 7 (L95, L96) |
| 1994 | RR5x (965, 966) | WA (Z59, Z60) | R19 (539, 651) |
| 1994 | WAx (C52, C53) | WA (Z59, Z60) | 31 (V81, V82) |
| 1994 | WAx (C54, C55) | WA (Z59, Z60) | R19 (539, 651) |
| 1994 | WA2x (697, 698) | WA2 (K37, K38) | 40 (W49, W50) |
| 1994 | WA2x (699, 700) | WA2 (K37, K38) | 6 (971, C32) |
| 1994 | WA2x (701, 702) | WA2 (K37, K38) | 40 (W49, W50) |
| 1994 | WA2x (715, 716) | WA2 (K37, K38) | 6 (971, C32) |

| Year | Juvenile's ID (eartags) | Mother's ID (eartags) | Father's ID (eartags) |
|---|---|---|---|
| 1994 | 4x (C56, C57) | WA3 (Z31, Z32) | 19 (V25, V26) |
| 1994 | 4x (G60, G61) | WA3 (Z31, Z32) | 19 (V25, V26) |
| 1994 | CBSx (925, 926) | WA3 (Z31, Z32) | 6 (971, C32) |
| 1994 | WA4x (825, 826) | WA4 (T73, T74) | 47 (549, 550) |
| 1994 | WA4x (963, 964) | WA4 (T73, T74) | 25 (Q21, H84) |
| 1994 | WA4x (A26, A27) | WA4 (T73, T74) | 47 (549, 550) |
| 1994 | WA4x (A56, A57) | WA4 (T73, T74) | 47 (549, 550) |
| 1994 | WA4x (F19, F20) | WA4 (T73, T74) | 47 (549, 550) |
| 1994 | WA5x (A96, A97) | WA5 (X69, X70) | 32 (Q7, Q8) |
| 1994 | WA5x (F3, F4) | WA5 (X69, X70) | 01 (T37, T38) |
| 1994 | WA6x (841, 842) | WA6 (Y47, Y48) | 46 (P3, V89) |
| 1994 | WA6x (921, 922) | WA6 (Y47, Y48) | 46 (P3, V89) |
| 1994 | RACx (F13, F14) | WA7 (137, 138) | 15 (T85, T86) |
| 1994 | WA7x (A83, A84) | WA7 (137, 138) | 31 (V81, V82) |
| 1994 | 6SBSx (990, 991) | WA8 (128, 129) | ****** |
| 1994 | WABSx (A69, A70) | WABS (H27, H28) | R19 (539, 651) |
| 1994 | WABSx (F11, F12) | WABS (H27, H28) | 01 (T37, T38) |
| 1994 | WABSx (F45, F46) | WABS (H27, H28) | ****** |
| 1994 | WABSx (G10, G11) | WABS (H27, H28) | 32 (Q7, Q8) |

**Table 4** Lifetime reproductive success for females in the Gunnison's prairie dog population in Petrified Forest National Park, Apache County, Arizona from 1991-1994. Female ID listed is assigned upon capture with right and left eartags in parentheses.

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 1 | 1991 | RC (B2, C58) | 7 |
| 1 | 1991 | RS (505, 506) | 7 |
| 1 | 1991 | 3SRS (A23, D0) | 6 |
| 1 | 1991 | 50 (925, 926) | 6 |
| 1 | 1991 | BB (564, C53) | 6 |
| 1 | 1991 | BSBB (91, 92) | 6 |
| 1 | 1991 | CR (A53, A54) | 6 |
| 1 | 1991 | HBB (260, 759) | 6 |
| 1 | 1991 | 3SBS (529, 530) | 5 |
| 1 | 1991 | 64 (C85, C86) | 5 |
| 1 | 1991 | BB9 (705, 706) | 5 |
| 1 | 1991 | HRB (963, 964) | 5 |
| 1 | 1991 | 4str (947, D45) | 4 |
| 1 | 1991 | 57 (141, 142) | 4 |
| 1 | 1991 | 70 (103, 332) | 4 |
| 1 | 1991 | 72 (A87, A88) | 4 |
| 1 | 1991 | 80 (297, 298) | 4 |
| 1 | 1991 | 81 (275, 276) | 4 |
| 1 | 1991 | 88 (115, 116) | 4 |
| 1 | 1991 | 91 (A9, A10) | 4 |
| 1 | 1991 | RR0 (213, 214) | 4 |
| 1 | 1991 | TS (625, 737) | 4 |
| 1 | 1991 | 59 (C48, C51) | 3 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 1 | 1991 | BB0 (A71, A72) | 3 |
| 1 | 1991 | BB7 (A55, A56) | 3 |
| 1 | 1991 | C5 (A25, C47) | 3 |
| 1 | 1991 | H (876, C42) | 3 |
| 1 | 1991 | WA6 (921, C57) | 3 |
| 1 | 1992 | RR3 (H53, H54) | 8 |
| 1 | 1992 | 3SBS (I67, I68) | 7 |
| 1 | 1992 | 73 (I93, I94) | 6 |
| 1 | 1992 | BS (F43, F44) | 6 |
| 1 | 1992 | RSBS (H93, H94) | 6 |
| 1 | 1992 | WA (H55, H56) | 6 |
| 1 | 1992 | 4str (M5, M6) | 5 |
| 1 | 1992 | 62 (H39, H40) | 5 |
| 1 | 1992 | 6str (H73, H74) | 5 |
| 1 | 1992 | 77 (G59, G60) | 5 |
| 1 | 1992 | 80 (H11, H12) | 5 |
| 1 | 1992 | 81 (I9, I55) | 5 |
| 1 | 1992 | 91 (I51, I52) | 5 |
| 1 | 1992 | BSBB (I95, I96) | 5 |
| 1 | 1992 | H3 (J7, J8) | 5 |
| 1 | 1992 | HBS (H45, M12) | 5 |
| 1 | 1992 | RS (K89, K90) | 5 |
| 1 | 1992 | WA3 (F36, F61) | 5 |
| 1 | 1992 | 70 (K99, L0) | 4 |
| 1 | 1992 | 79 (H35, H36) | 4 |
| 1 | 1992 | 86 (J93, J94) | 4 |
| 1 | 1992 | 96 (K81, K82) | 4 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 1 | 1992 | HRB (M17, M18) | 4 |
| 1 | 1992 | RR8 (I49, I50) | 4 |
| 1 | 1992 | WA1 (I89, I90) | 4 |
| 1 | 1992 | WABB (I53, I54) | 4 |
| 1 | 1992 | 74 (H47, H48) | 3 |
| 1 | 1992 | BB (I87, I88) | 3 |
| 1 | 1992 | WA5 (L89, L90) | 3 |
| 1 | 1992 | 55 (G47, G48) | 2 |
| 1 | 1992 | 76 (F15, F16) | 2 |
| 1 | 1992 | C1 (O89, O90) | 2 |
| 1 | 1992 | H0 (I45, I46) | 2 |
| 1 | 1992 | H4 (L97, L98) | 2 |
| 1 | 1992 | H9 (E15, E16) | 2 |
| 1 | 1992 | 63 (L1, L2) | 1 |
| 1 | 1993 | BB3 (P11, P12) | 6 |
| 1 | 1993 | WA (U93, U94) | 6 |
| 1 | 1993 | 80 (R7, R8) | 5 |
| 1 | 1993 | 91 (U39, U40) | 5 |
| 1 | 1993 | RSRAB (P89, P90) | 5 |
| 1 | 1993 | WA6 (P49, P50) | 5 |
| 1 | 1993 | 3SBS (R55, R56) | 4 |
| 1 | 1993 | 3SRS (O39, O40) | 4 |
| 1 | 1993 | 57 (N59, N60) | 4 |
| 1 | 1993 | 82 (P63, P64) | 4 |
| 1 | 1993 | H1 (S35, S36) | 4 |
| 1 | 1993 | H3 (R9, R10) | 4 |
| 1 | 1993 | RR3 (S97, S98) | 4 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 1 | 1993 | RR5 (N51, N52) | 4 |
| 1 | 1993 | TS (T33, T34) | 4 |
| 1 | 1993 | 67 (S85, S86) | 3 |
| 1 | 1993 | 72 (O37, O38) | 3 |
| 1 | 1993 | 81 (P87, P88) | 3 |
| 1 | 1993 | C0 (V91, V92) | 3 |
| 1 | 1993 | C2 (V71, V72) | 3 |
| 1 | 1993 | WA3 (U57, U58) | 3 |
| 1 | 1993 | 6str (V97, V98) | 2 |
| 1 | 1993 | BB5 (N49, N50) | 2 |
| 1 | 1993 | FR (P65, P66) | 2 |
| 1 | 1993 | H8 (M43, M44) | 2 |
| 1 | 1993 | HBS (S9, S10) | 2 |
| 1 | 1993 | WABS (R27, R28) | 2 |
| 1 | 1993 | 60 (R93, R94) | 1 |
| 1 | 1994 | 82 (351, 352) | 7 |
| 1 | 1994 | C0 (49, 50) | 5 |
| 1 | 1994 | 78 (X23, X24) | 4 |
| 1 | 1994 | 80 (X61, X62) | 4 |
| 1 | 1994 | 90 (159, 160) | 4 |
| 1 | 1994 | CWA (115, 116) | 4 |
| 1 | 1994 | H0 (X87, X88) | 4 |
| 1 | 1994 | H3 (145, 146) | 4 |
| 1 | 1994 | RC (155, 156) | 4 |
| 1 | 1994 | 4str (X5, X6) | 3 |
| 1 | 1994 | 50 (161, 162) | 3 |
| 1 | 1994 | 56 (255, 256) | 3 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 1 | 1994 | 58 (143, 144) | 3 |
| 1 | 1994 | 5SBS (X11, X12) | 3 |
| 1 | 1994 | 6str (Y59, Y60) | 3 |
| 1 | 1994 | 85 (Z21, Z22) | 3 |
| 1 | 1994 | 87 (195, 196) | 3 |
| 1 | 1994 | BB (5, 6) | 3 |
| 1 | 1994 | BB3 (119, 120) | 3 |
| 1 | 1994 | BB7 (Y83, Y84) | 3 |
| 1 | 1994 | FBS (287, 288) | 3 |
| 1 | 1994 | FR (Z37, Z38) | 3 |
| 1 | 1994 | H (Z19, Z20) | 3 |
| 1 | 1994 | HBB (61, 62) | 3 |
| 1 | 1994 | HBS (Z27, Z28) | 3 |
| 1 | 1994 | RR4 (187, 188) | 3 |
| 1 | 1994 | RSBB (111, 112) | 3 |
| 1 | 1994 | WA (Z59, Z60) | 3 |
| 1 | 1994 | WA3 (Z31, Z32) | 3 |
| 1 | 1994 | 3SRS (71, 72) | 2 |
| 1 | 1994 | 6SBS (167, 168) | 2 |
| 1 | 1994 | 71 (55, 56) | 2 |
| 1 | 1994 | 72 (X37, X38) | 2 |
| 1 | 1994 | BB5 (9, 10) | 2 |
| 1 | 1994 | CB (7, 8) | 2 |
| 1 | 1994 | FRB (77, 78) | 2 |
| 1 | 1994 | HTS (11, 12) | 2 |
| 1 | 1994 | RR2 (Y45, Y46) | 2 |
| 1 | 1994 | RS (Y71, Y72) | 2 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 1 | 1994 | TS (181, 182) | 2 |
| 1 | 1994 | WA5 (X69, X70) | 2 |
| 1 | 1994 | WA6 (Y47, Y48) | 2 |
| 1 | 1994 | WA7 (137, 138) | 2 |
| 1 | 1994 | 3SBS (Y27, Y28) | 1 |
| 1 | 1994 | BSBB (Y29, Y30) | 1 |
| 1 | 1994 | H4 (185, 186) | 1 |
| 1 | 1994 | RR3 (Y49, Y50) | 1 |
| 1 | 1994 | RR5 (Z63, Z64) | 1 |
| 1 | 1994 | RSRAB (105, 106) | 1 |
| 1 | 1994 | WA8 (128, 129) | 1 |
| 2 | 1991-1992 | WA4 (755, C54) | 9 |
| 2 | 1991-1992 | BB6 (291, 292) | 7 |
| 2 | 1991-1992 | 95 (322, M38) | 6 |
| 2 | 1991-1992 | 66 (215, 216) | 5 |
| 2 | 1991-1992 | F (471, 715) | 4 |
| 2 | 1992-1993 | WA0 (F91, F92) | 9 |
| 2 | 1992-1993 | H (F67, M13) | 8 |
| 2 | 1992-1993 | H2 (I29, I30) | 7 |
| 2 | 1992-1993 | 5str (I27, I28) | 5 |
| 2 | 1992-1993 | RS (I85, I86) | 5 |
| 2 | 1992-1993 | BB0 (I33, I34) | 2 |
| 2 | 1993-1994 | H7 (Q89, Q90) | 13 |
| 2 | 1993-1994 | 60 (R75, R76) | 10 |
| 2 | 1993-1994 | H2 (N11, N12) | 10 |
| 2 | 1993-1994 | 81 (R45, R46) | 9 |
| 2 | 1993-1994 | 62 (U89, U90) | 8 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 2 | 1993-1994 | 97 (Q77, Q78) | 8 |
| 2 | 1993-1994 | HRB (P47, P48) | 8 |
| 2 | 1993-1994 | BB9 (R21, R22) | 7 |
| 2 | 1993-1994 | CR (Q17, Q18) | 7 |
| 2 | 1993-1994 | WA4 (T73, T74) | 7 |
| 2 | 1993-1994 | H6 (R19, R20) | 6 |
| 2 | 1993-1994 | H9 (P69, P70) | 6 |
| 2 | 1993-1994 | 4SRS (P1, P2) | 5 |
| 2 | 1993-1994 | 5str (S33, S34) | 5 |
| 2 | 1993-1994 | 65 (R17, R18) | 5 |
| 2 | 1993-1994 | 77 (Q41, Q42) | 5 |
| 2 | 1993-1994 | BB4 (N21, N22) | 5 |
| 2 | 1993-1994 | C9 (Q73, Q74) | 5 |
| 2 | 1993-1994 | 59 (T11, T12) | 4 |
| 2 | 1993-1994 | 5SRS (P73, P74) | 4 |
| 2 | 1993-1994 | 6SRS (R63, R64) | 4 |
| 2 | 1993-1994 | RB3 (V93, V94) | 4 |
| 2 | 1993-1994 | F (Q71, Q72) | 3 |
| 2 | 1993-1994 | 79 (N45, N46) | 2 |
| 2 | 1993-1994 | BS (Q29, Q30) | 1 |
| 3 | 1991-1993 | WA7 (365, C30) | 14 |
| 3 | 1991-1993 | 2RS (583, 584) | 11 |
| 3 | 1991-1993 | 90 (465, 466) | 5 |
| 3 | 1991-1993 | HRS (34, 738) | 4 |
| 3 | 1992-1994 | RSBB (H27, H28) | 13 |
| 3 | 1992-1994 | 98 (J79, L65) | 11 |
| 3 | 1992-1994 | C5 (J13, J14) | 11 |

| Number of Years of Adult Age | Year(s) at Adult Age | Female ID (eartags) | Number of Offspring Produced |
|---|---|---|---|
| 3 | 1992-1994 | RR9 (K67, K68) | 10 |
| 3 | 1992-1994 | 4SBS (F71, F72) | 9 |
| 3 | 1992-1994 | CRS (H91, H92) | 9 |
| 3 | 1992-1994 | HWA (H85, H86) | 9 |
| 3 | 1992-1994 | WA2 (K37, K38) | 9 |
| 3 | 1992-1994 | BB2 (179, J3) | 6 |
| 4 | 1991-1994 | 61 (893, C25) | 19 |
| 4 | 1991-1994 | 65 (B52, V87) | 15 |

**Table 5** Lifetime reproductive success for males in the Gunnison's prairie dog population in Petrified Forest National Park, Apache County, Arizona from 1991-1994. Male ID listed is assigned upon capture with right and left eartags in parentheses.

| Number of Years of Adult Age | Year(s) at Adult Age | Male ID (eartags) | Number of Offspring Sired |
|---|---|---|---|
| 1 | 1991 | 04 (497, 498) | 18 |
| 1 | 1991 | 03 (C43, D3) | 11 |
| 1 | 1991 | 29 (877, 878) | 10 |
| 1 | 1991 | 05 (73, 74) | 9 |
| 1 | 1991 | 38 (765, B37) | 9 |
| 1 | 1991 | 17 (C59, C60) | 8 |
| 1 | 1991 | 45 (901, 902) | 7 |
| 1 | 1991 | 15 (307, 308) | 6 |
| 1 | 1991 | 22 (499, 500) | 5 |
| 1 | 1991 | R03 (915, 916) | 5 |
| 1 | 1991 | 41 (231, 232) | 3 |
| 1 | 1991 | R15 (A43, C35) | 3 |
| 1 | 1991 | 14 (C55, C56) | 2 |
| 1 | 1991 | 09 (50, C87) | 1 |
| 1 | 1991 | 18 (C49, C50) | 1 |
| 1 | 1991 | 39 (463, 760) | 1 |
| 1 | 1992 | R41 (L67, L68) | 13 |
| 1 | 1992 | R03 (H63, H64) | 8 |
| 1 | 1992 | R15 (H99, I0) | 6 |
| 1 | 1992 | R13 (H21, H22) | 5 |
| 1 | 1992 | R46 (F59, F60) | 5 |
| 1 | 1992 | R16 (E19, E20) | 2 |
| 1 | 1993 | R10 (Q61, Q62) | 5 |

| Number of Years of Adult Age | Year(s) at Adult Age | Male ID (eartags) | Number of Offspring Sired |
|---|---|---|---|
| 1 | 1993 | 39 (G79, G80) | 4 |
| 1 | 1994 | 47 (549, 550) | 14 |
| 1 | 1994 | R19 (539, 651) | 12 |
| 1 | 1994 | 36 (343, 344) | 2 |
| 2 | 1991-1992 | 21 (13, 14) | 21 |
| 2 | 1991-1992 | 26 (D13, D14) | 21 |
| 2 | 1991-1992 | 23 (C45, C46) | 7 |
| 2 | 1991-1992 | 31 (207, 208) | 6 |
| 2 | 1991-1992 | 25 (287, 288) | 4 |
| 2 | 1991-1992 | R10 (B29, B30) | 4 |
| 2 | 1991-1992 | 2 (C61, C62) | 1 |
| 2 | 1991-1992 | 42 (643, 644) | 1 |
| 2 | 1992-1993 | 35 (F41, F42) | 26 |
| 2 | 1992-1993 | 13 (H75, M26) | 19 |
| 2 | 1992-1993 | 12 (E89, E90) | 15 |
| 2 | 1992-1993 | R10 (L7, L8) | 15 |
| 2 | 1992-1993 | R23 (G17, G18) | 10 |
| 2 | 1992-1993 | 4 (L87, L88) | 2 |
| 2 | 1992-1993 | R06 (I91, I92) | 1 |
| 2 | 1993-1994 | 31 (V81, V82) | 26 |
| 2 | 1993-1994 | 46 (P3, V89) | 23 |
| 2 | 1993-1994 | 24 (N47, N48) | 21 |
| 2 | 1993-1994 | 25 (Q21, H84) | 16 |
| 2 | 1993-1994 | 15 (T85, T86) | 15 |
| 2 | 1993-1994 | 16 (V85, V86) | 12 |
| 2 | 1993-1994 | 3 (Q57, Q58) | 12 |
| 2 | 1993-1994 | 27 (O17, O18) | 12 |

| Number of Years of Adult Age | Year(s) at Adult Age | Male ID (eartags) | Number of Offspring Sired |
|---|---|---|---|
| 2 | 1993-1994 | 40 (W49, W50) | 10 |
| 2 | 1993-1994 | 32 (Q7, Q8) | 9 |
| 2 | 1993-1994 | 19 (V25, V26) | 8 |
| 2 | 1993-1994 | R01 (S61, S62) | 1 |
| 2 | 1993-1994 | 03 (P5, P6) | 1 |
| 2 | 1993-1994 | 14 (S59, S60) | 1 |
| 2 | 1993-1994 | 35 (267, 268) | 1 |
| 3 | 1991-1993 | 44 (495, 496) | 45 |
| 3 | 1991-1993 | R20 (B17, C69) | 27 |
| 3 | 1991-1993 | 01 (768, B59) | 20 |
| 3 | 1991-1993 | 19 (351, 352) | 17 |
| 3 | 1991-1993 | 7 (431, 432) | 9 |
| 3 | 1991-1993 | 38 (C77, C78) | 8 |
| 3 | 1992-1994 | 5 (L77, L78) | 41 |
| 3 | 1992-1994 | 0 (L95, L96) | 28 |
| 3 | 1992-1994 | 0 (J49, J51) | 25 |
| 3 | 1992-1994 | 02 (L80, L84) | 20 |
| 3 | 1992-1994 | 29 (D75, D76) | 15 |
| 3 | 1992-1994 | 01 (T37, T38) | 11 |
| 3 | 1992-1994 | 17 (G5, G6) | 10 |
| 3 | 1992-1994 | 45 (G41, G42) | 8 |
| 3 | 1992-1994 | 34 (G23, G24) | 7 |
| 3 | 1992-1994 | 26 (687, 688) | 3 |
| 3 | 1992-1994 | 43 (M35, M36) | 1 |
| 4 | 1991-1994 | 6 (971, C32) | 47 |
| 4 | 1991-1994 | 42 (A17, A18) | 4 |

**Table 6** Inbreeding paths for individuals in the Gunnison's prairie dog population in Petrified Forest National Park, Apache County, Arizona from 1991-1994. The year, juvenile ID (eartags) resulting from inbreeding event, and inbreeding coefficient for each path and juvenile indicated. Each individual in the path is designated by its ID (eartags) and is separated by a dash (-) and the apex of each path is underlined. The ID for each individual is assigned upon capture with the right and left eartags in parentheses.

* Juveniles are represented graphically in Figure 2.

| Year | Juvenile ID (eartags) | Path | $F_I$ | $F_X$ |
|---|---|---|---|---|
| 1992 | 5strx (M81, M82)* | 5str (I27, I28) - 2RS (583, 584) - R15 (H99, I0) | 0.125 | 0.125 |
| 1992 | 5strx (Q27, Q28) | 5str (I27, I28) - 2RS (583, 584) - R15 (H99, I0) | 0.125 | 0.125 |
| 1992 | BSx (O19, O20)* | BS (F43, F44) - 21 (13, 14) | 0.25 | 0.25 |
| 1992 | BSx (Q55, Q56) | BS (F43, F44) - 21 (13, 14) | 0.25 | 0.25 |
| 1992 | H2x (Q13, Q14) | H2 (I29, I30) - 2RS (583, 584) - R15 (H99, I0) | 0.125 | 0.125 |
| 1992 | H2x (S73, S74) | H2 (I29, I30) - 2RS (583, 584) - R15 (H99, I0) | 0.125 | 0.125 |
| 1992 | H2x (S81, S82) | H2 (I29, I30) - 2RS (583, 584) - R15 (H99, I0) | 0.125 | 0.125 |
| 1993 | 79x (Y23, Y24) | 79 (N45, N46) - 02 (L80, L84) | 0.25 | 0.25 |
| 1993 | 79x (191, 192)* | 79 (N45, N46) - HWA (H85, H86) - 31 (207, 208) - BSBB (I95, I96) - R10 (Q61, Q62) | 0.0313 | 0.0313 |
| 1993 | FBSx (179, 180) | 82 (P63, P64) - RR8 (I49, I50) - 31 (207, 208) – HWA (H85, H86) - R27 (N47, N48) | 0.0313 | 0.0313 |
| 1993 | FRx (171, 172) | FR (P65, P66) - RR8 (I49, I50) - 31 (207, 208) – HWA (H85, H86) - R27 (N47, N48) | 0.0313 | 0.0313 |
| 1993 | FRx (147, 148)* | RSRAB (P89, P90) - RR8 (I49, I50) - 31 (207, 208) - HWA (H85, H86) - R27 (N47, N48) | 0.0313 | 0.1563 |
| 1993 | FRx (147, 148)* | RSRAB (P89, P90) - 02 (L80, L84) - R27 (N47, N48) | 0.125 | |
| 1993 | H3x (Z97, Z98) | RSRAB (P89, P90) - RR8 (I49, I50) - 31 (207, 208) - HWA (H85, H86) - R27 (N47, N48) | 0.0313 | 0.1563 |
| 1993 | H3x (Z97, Z98) | RSRAB (P89, P90) - 02 (L80, L84) - R27 (N47, N48) | 0.125 | |
| 1993 | RR5x (275, 276) | RR5 (N51, N52) - 44 (495, 496) | 0.25 | 0.25 |
| 1993 | WA6x (11, 12) | WA6 (P49, P50) - 0 (L95, L96) | 0.25 | 0.25 |
| 1993 | WA6x (17, 18) | WA6 (P49, P50) - 0 (L95, L96) | 0.25 | 0.25 |
| 1993 | WA6x (Y87, Y88) | WA6 (P49, P50) - 0 (L95, L96) | 0.25 | 0.25 |

| Year | Juvenile ID (eartags) | Path | $F_I$ | $F_X$ |
|---|---|---|---|---|
| 1993 | WA6x (Z31, Z32) | WA6 (P49, P50) - 0 (L95, L96) | 0.25 | 0.25 |
| 1994 | 3SBSx (845, 846) | 3SBS (Y27, Y28) - 75 (R17, R18) - 43 (971, C32) | 0.125 | 0.125 |
| 1994 | 65x (658, 659) | 65 (R17, R18) - 43 (971, C32) | 0.25 | 0.25 |
| 1994 | H4x (996, 997) | H4 (185, 186) - 35 (F41, F42) - 27 (O17, O18) | 0.125 | 0.125 |
| 1994 | RACx (G8, G9) | RAC (155, 156) - 31 (V81, V82) | 0.25 | 0.25 |

**Table 7** Relatedness values for the entire population (a) and for each clan (b) of Gunnison's prairie dogs in Petrified Forest National Park, Apache County, Arizona from 1991-1994. Clans are named by male(s) residing in each clan assigned based on observational data.

a.

| Year | Population r ± SE | Population Size |
|---|---|---|
| 1991 | -0.0024 ± 0.0014 | 273 |
| 1992 | -0.0053 ± 0.0009 | 407 |
| 1993 | -0.0016 ± 0.0007 | 463 |
| 1994 | -0.006 ± 0.0016 | 482 |

b.

| Year | Clan Name | Clan r |
|---|---|---|
| 1991 | 03 | -0.0033 |
| 1991 | 04-17 | -0.0036 |
| 1991 | 05-R03 | -0.0018 |
| 1991 | 7 | -0.0027 |
| 1991 | 14 | -0.0023 |
| 1991 | 15 | -0.0037 |
| 1991 | 18 | -0.0037 |
| 1991 | 19 | -0.0026 |
| 1991 | 21 | -0.0023 |
| 1991 | 22 | -0.002 |
| 1991 | 29 | -0.0029 |
| 1991 | 31 | -0.0009 |
| 1991 | 38A | -0.0004 |
| 1991 | 38A | 0.002 |

| Year | Clan Name | Clan r |
|---|---|---|
| 1991 | 41A | -0.0008 |
| 1991 | 41B | 0.0012 |
| 1991 | 44 | -0.0023 |
| 1991 | 45A | -0.0023 |
| 1991 | 45B | -0.0021 |
| 1991 | R15A | -0.0021 |
| 1991 | R15B | -0.0027 |
| 1991 | R20 | -0.001 |
| 1991 | R44 | -0.0034 |
| 1992 | 0 | -0.0048 |
| 1992 | 01 | -0.0064 |
| 1992 | 02 | -0.0077 |
| 1992 | 07-21 | -0.0046 |
| 1992 | 4-R10A | -0.0065 |
| 1992 | 5 | -0.0049 |
| 1992 | 6 | -0.0023 |
| 1992 | 16 | -0.0073 |
| 1992 | 19A | -0.0053 |
| 1992 | 19B | -0.0056 |
| 1992 | 23A | -0.0064 |
| 1992 | 23B | -0.0048 |
| 1992 | 23C | -0.0009 |
| 1992 | 26A | -0.0057 |
| 1992 | 26B | -0.0064 |
| 1992 | 38 | -0.0083 |
| 1992 | 43A | -0.0022 |
| 1992 | 43B | -0.0045 |
| 1992 | 44A | -0.0034 |

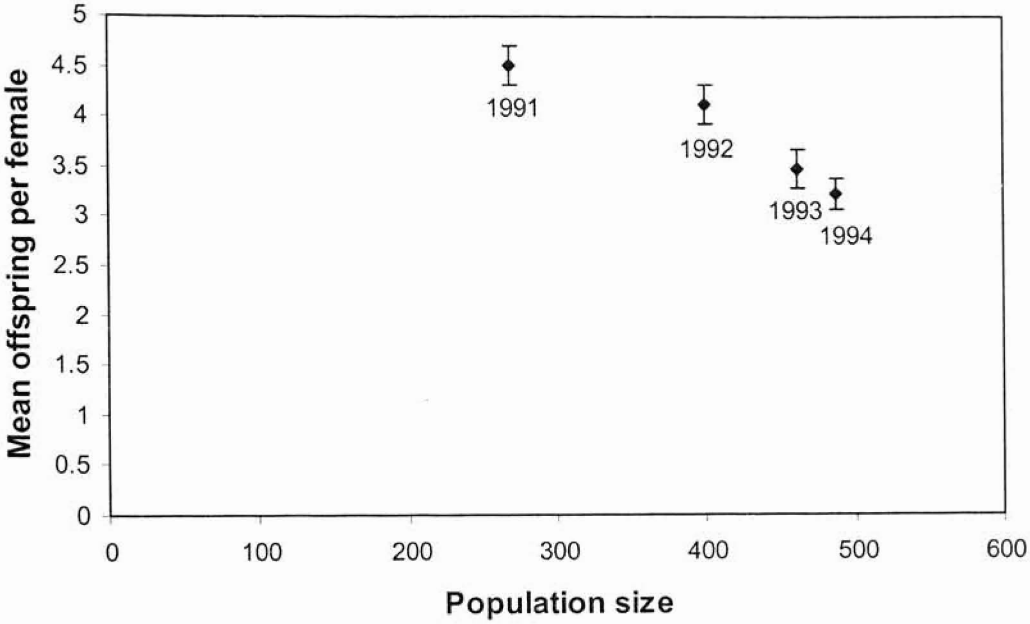
| Year | Clan Name | Clan r |
|---|---|---|
| 1992 | 44B-R24 | -0.0028 |
| 1992 | R03 | -0.0063 |
| 1992 | R06 | -0.0028 |
| 1992 | R08-R14 | -0.0082 |
| 1992 | R10B | -0.0023 |
| 1992 | R13 | -0.0032 |
| 1992 | R23 | -0.0045 |
| 1992 | R35 | -0.004 |
| 1992 | R40 | -0.0046 |
| 1992 | R41 | -0.0037 |
| 1992 | R46 | -0.0081 |
| 1992 | R48 | -0.0042 |
| 1993 | 0-R27 | -0.0021 |
| 1993 | 01 | -0.0019 |
| 1993 | 02 | -0.0011 |
| 1993 | 07 | -0.0031 |
| 1993 | 3 | -0.0011 |
| 1993 | 4 | -0.0019 |
| 1993 | 5 | -0.0021 |
| 1993 | 12A | -0.0012 |
| 1993 | 12B | -0.0012 |
| 1993 | 13 | -0.0013 |
| 1993 | 14 | -0.001 |
| 1993 | 17A | -0.0019 |
| 1993 | 17B | -0.0018 |
| 1993 | 29-R47 | -0.0016 |
| 1993 | 34 | -0.0014 |
| 1993 | 35 | -0.0013 |

| Year | Clan Name | Clan r |
|---|---|---|
| 1993 | 39A | -0.0015 |
| 1993 | 39B | -0.002 |
| 1993 | 43-R03 | -0.001 |
| 1993 | 44 | -0.0025 |
| 1993 | R10 | -0.0013 |
| 1993 | NM1 | -0.002 |
| 1993 | NM2 | -0.0018 |
| 1993 | NM3 | -0.0023 |
| 1994 | 0-16 | -0.005 |
| 1994 | 01A | -0.004 |
| 1994 | 01B | -0.006 |
| 1994 | 5A | -0.005 |
| 1994 | 5B | -0.004 |
| 1994 | 6 | -0.006 |
| 1994 | 7 | -0.005 |
| 1994 | 14-19 | -0.008 |
| 1994 | 15 | -0.008 |
| 1994 | 24 | -0.007 |
| 1994 | 25A | -0.005 |
| 1994 | 25B-27 | -0.005 |
| 1994 | 31-R19A | -0.007 |
| 1994 | 32 | -0.005 |
| 1994 | 40 | -0.005 |
| 1994 | 42A | -0.001 |
| 1994 | 42B | -0.007 |
| 1994 | 46A | -0.007 |
| 1994 | 46B | -0.006 |
| 1994 | 47 | -0.006 |

| Year | Clan Name | Clan r |
|---|---|---|
| 1994 | R19B | -0.011 |
| 1994 | NM | -0.006 |

**Figure 1** Mean number of offspring per female (a) and male (b) ± SE versus the population size each year from 1991-1994.

**a.** r = -0.30.




**b.** r = 0.31.

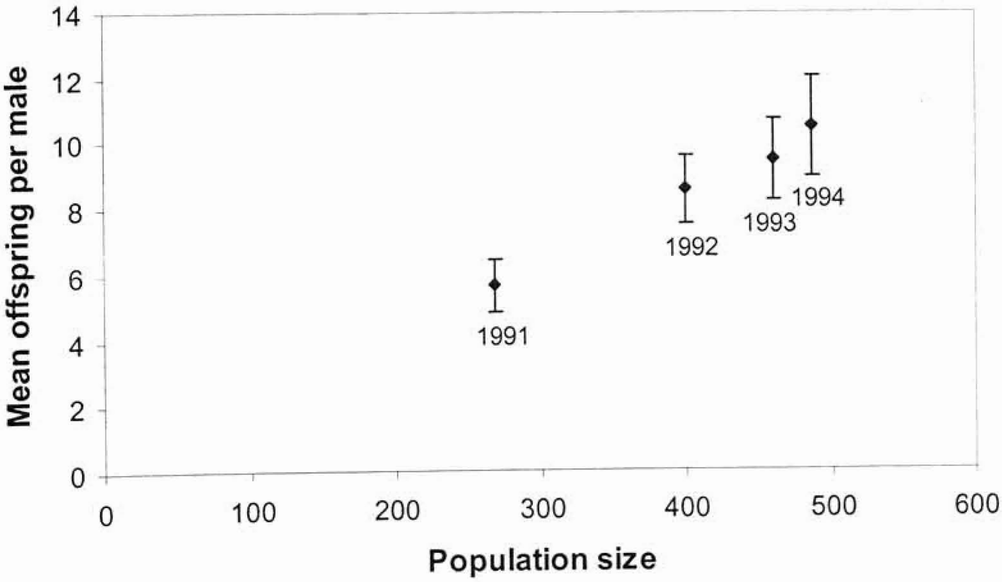
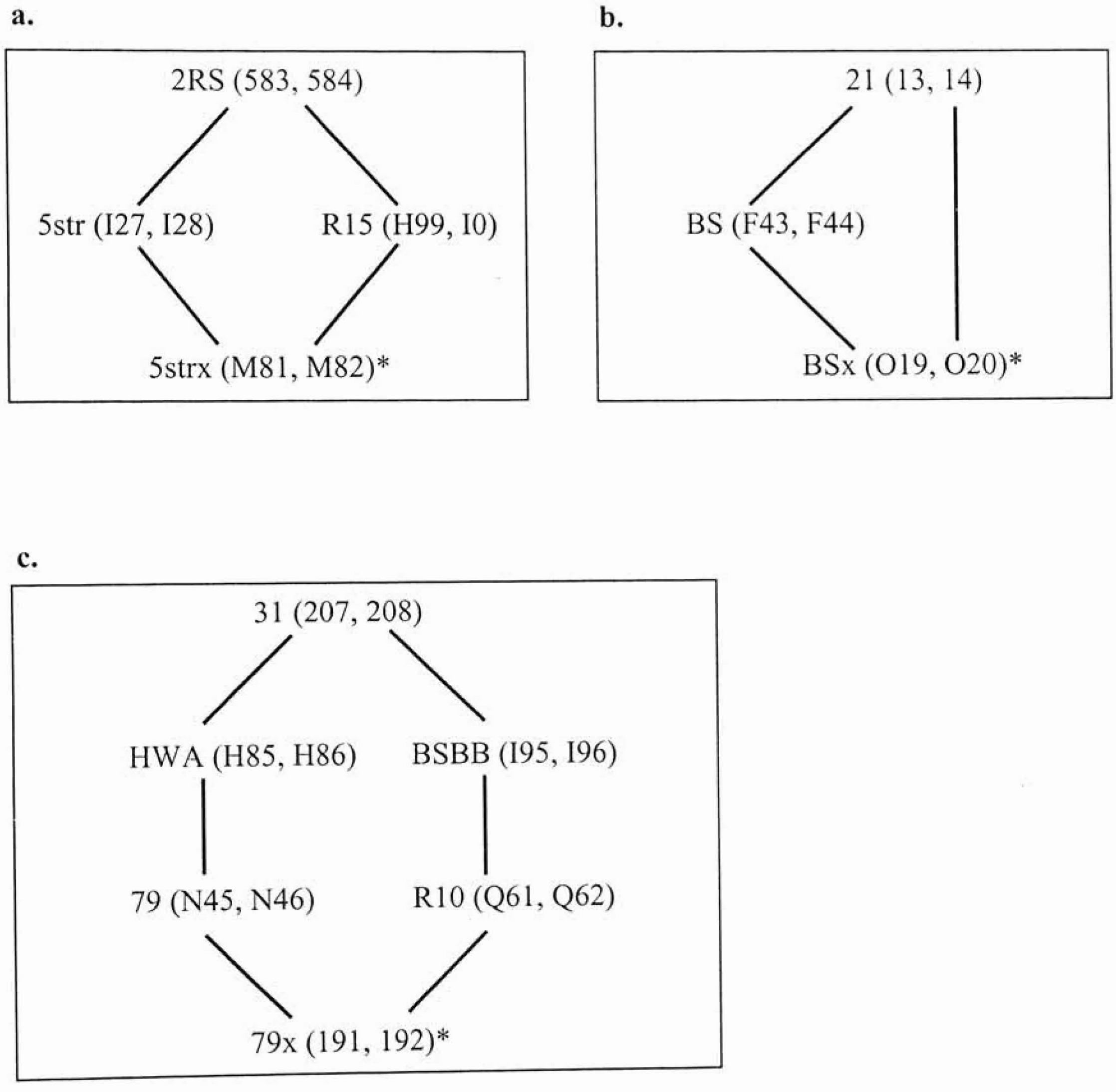


**Figure 2** Inbreeding paths for juveniles designated by an asterisk (*) in Table 6 sampled from the Gunnison's prairie dog population in Petrified Forest National Park, Apache County, Arizona from 1991-1994. The ID for each individual is assigned upon capture with the right and left eartags in parentheses.



**d.**

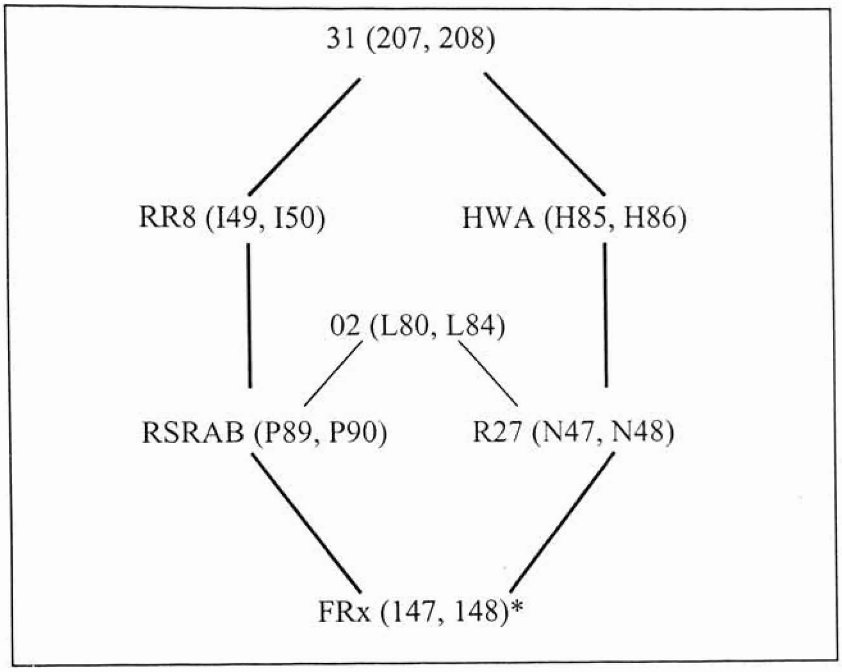
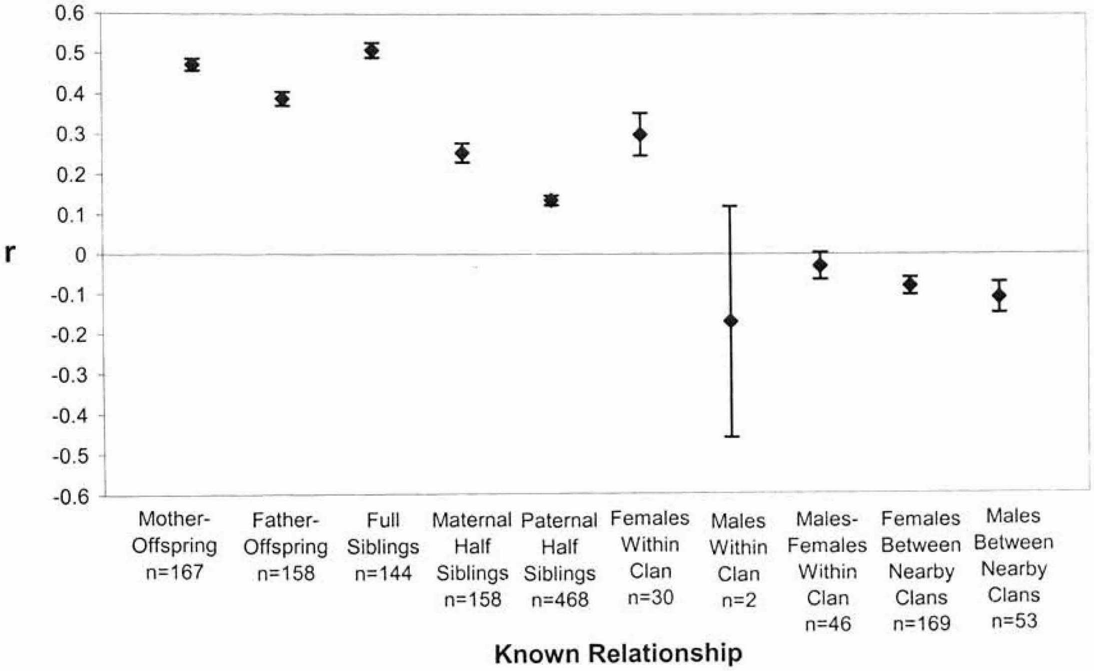
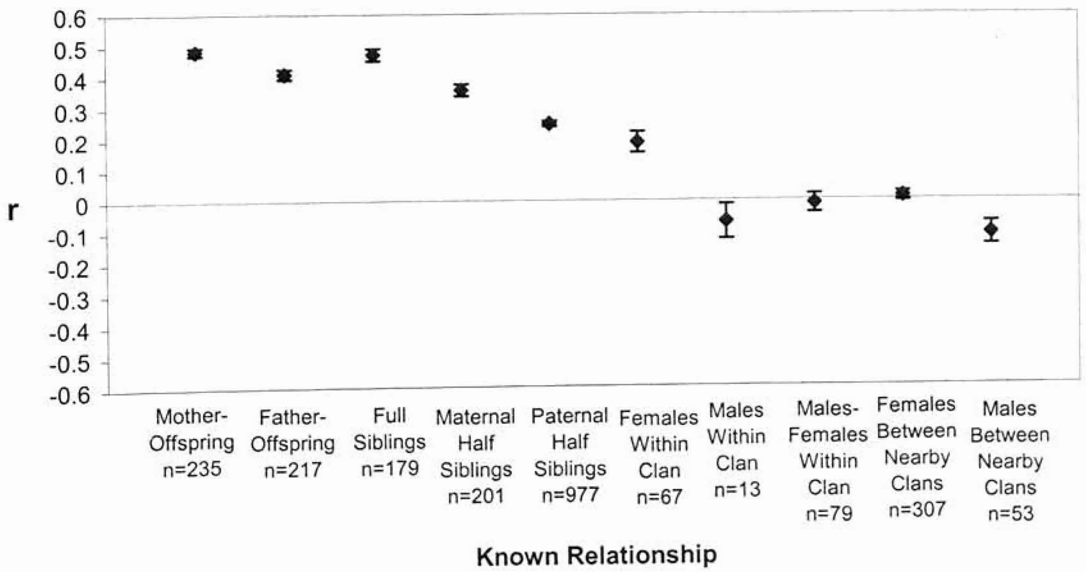

31 (207, 208)
RR8 (I49, I50)
HWA (H85, H86)
02 (L80, L84)
RSRAB (P89, P90)
R27 (N47, N48)
FRx (147, 148)*

**Figure 3** Mean relatedness values (r ± SE) for known relationships among individuals in the Gunnison's prairie dog population in Petrified Forest National Park, Apache County, Arizona for 1991-1994 separately (a-d) and all years combined (e). n = number of pairwise comparisons made for each relationship.

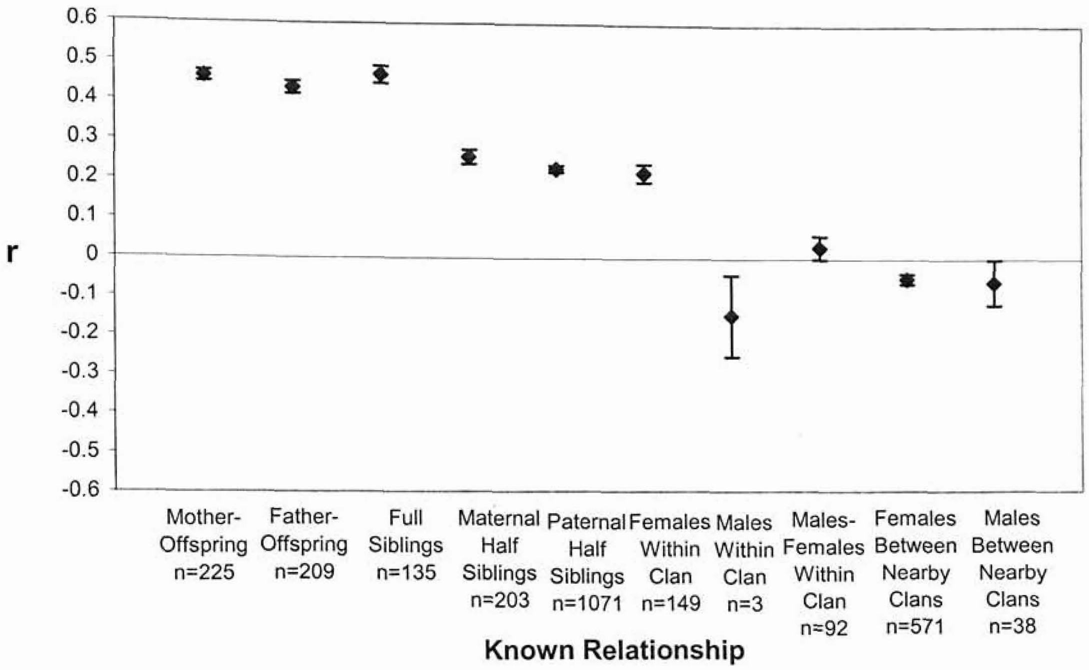
**a.** 1991




**b.** 1992

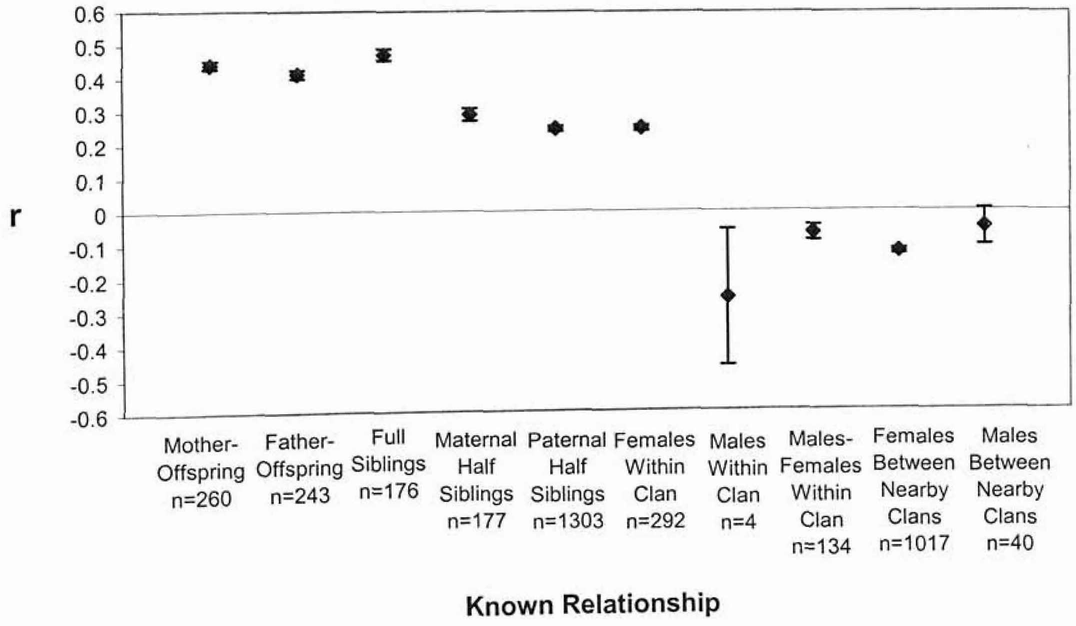


**c.** 1993



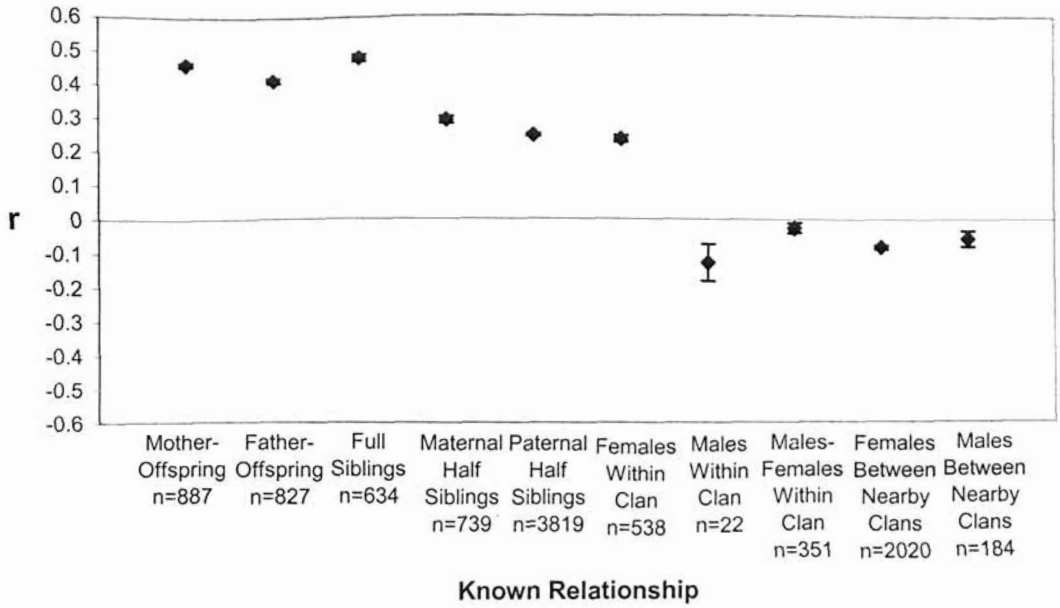
0.6
0.5
0.4
0.3
0.2
0.1
r
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
Mother-Offspring n=225
Father-Offspring n=209
Full Siblings n=135
Maternal Half Siblings n=203
Paternal Half Siblings n=1071
Females Within Clan n=149
Males Within Clan n=3
Males-Females Within Clan n=92
Females Between Nearby Clans n=571
Males Between Nearby Clans n=38
Known Relationship


**d.** 1994



0.6
0.5
0.4
0.3
0.2
0.1
r
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
Mother-Offspring n=260
Father-Offspring n=243
Full Siblings n=176
Maternal Half Siblings n=177
Paternal Half Siblings n=1303
Females Within Clan n=292
Males Within Clan n=4
Males-Females Within Clan n=134
Females Between Nearby Clans n=1017
Males Between Nearby Clans n=40
Known Relationship

e. Combined 1991-1994



VITA 2

Sarah Beth Moore

Candidate for the Degree of

Master of Science

Thesis: REPRODUCTIVE SUCCESS, MULTIPLE PATERNITY, AND INBREEDING IN A POPULATION OF GUNNISON'S PRAIRIE DOGS

Major Field: Zoology

Biographical:

Personal Data: Born in Winfield, Kansas, on April 29, 1978 to Lonnie and Linda Moore.

Education: Graduated valedictorian from Winfield, High School, Winfield, Kansas in May, 1996; graduated *cum laude* with a Bachelor of Science degree in Zoology from Oklahoma State University, Stillwater, Oklahoma in May, 2000. Completed the requirements for the Master of Science degree with a major in Zoology at Oklahoma State University in August, 2002.

Experience: Employed by Oklahoma State University, College of Veterinary Medicine as an undergraduate work-study, 1996-2000; employed by Oklahoma State University, Department of Zoology as a graduate teaching assistant and as a graduate research assistant, 2000 to present.

Professional Memberships: Oklahoma Academy of Science, Texas Society of Mammalogists, American Society of Mammalogists.