

**National Park Service
Channel Islands National Park**

**ISLAND FOX RECOVERY PROGRAM
SAN MIGUEL AND SANTA ROSA ISLANDS
2007 ANNUAL REPORT**

Technical Report 08-01

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Table of Contents

EXECUTIVE SUMMARY	1
INTRODUCTION	4
INTEGRATED ISLAND FOX RECOVERY TEAM.....	6
GOALS AND OBJECTIVES FOR CAPTIVE BREEDING	7
<i>Overall Goal</i>	7
<i>Overall Objective</i>	7
<i>Specific Objectives</i>	7
PROGRAM GUIDANCE	7
STANDARD OPERATING PROCEDURES	8
<i>Facility Design and Construction</i>	8
<i>Veterinary Care</i>	8
<i>Caretaking and Handling</i>	8
<i>Breeding Strategy</i>	9
<i>Diet</i>	9
OVERALL BREEDING SUCCESS	10
<i>Study of Factors Affecting Reproductive Success</i>	10
RECOVERY OF SAN MIGUEL ISLAND FOXES	12
CAPTIVE BREEDING	12
REINTRODUCTION	15
MONITORING	16
<i>Methods</i>	16
<i>Mortality Monitoring</i>	18
<i>Wild Population Monitoring</i>	20
FUTURE PLANS	24
RECOVERY OF SANTA ROSA ISLAND FOXES	25
CAPTIVE BREEDING	25
REINTRODUCTION	28
MONITORING	29
<i>Mortality Monitoring</i>	29
<i>Wild Population Monitoring</i>	31
FUTURE PLANS	32
LITERATURE CITED	33
APPENDIX A INJURIES TO CAPTIVE ISLAND FOXES, 2007	36
APPENDIX B ISLAND FOXES CURRENTLY IN CAPTIVITY	42

List of Tables

Table 1. Summary statistics for wild and captive island fox populations, San Miguel and Santa Rosa Islands, 2007	2
Table 2. Basic diet for captive island foxes	9
Table 3. Reproductive success among captive island foxes on the northern Channel Islands, 2006-2007	10
Table 4. Growth of captive island fox population, San Miguel Island	13

Table 5. Reproductive success, or lack thereof, of captive San Miguel Island foxes, 2006-2007 breeding season.....	14
Table 6. Island foxes released to the wild, San Miguel Island, 2007.	15
Table 7. Island fox mortalities, San Miguel Island, 2007.....	19
Table 8. Density estimates for small grids, San Miguel Island, 2007.	21
Table 9. Annual rate of population increase (lambda) for island fox populations on the northern Channel Islands. Santa Cruz data is from Smith et al. (2006).	21
Table 10. Sex and age distribution of foxes trapped on both grids and transects, San Miguel Island, October 2007 – February 2008.	22
Table 11. Island foxes born in the wild on San Miguel Island, 2007, and subsequently caught during fall trapping efforts.....	22
Table 12. Adult population size and reproductive effort for island foxes on San Miguel Island, 1993-2007.....	23
Table 13. Trap efficiency for fall/winter trapping efforts, San Miguel and Santa Rosa Islands, 2007-2008.....	24
Table 14. Growth of captive island fox population, Santa Rosa Island.	26
Table 15. Reproductive success of captive Santa Rosa Island foxes, 2006-2007 breeding season.	27
Table 16. Island fox pups born in captivity, Santa Rosa Island, 2007.	27
Table 17. Island foxes released to the wild, Santa Rosa Island, 2007.....	28
Table 18. Island fox mortalities, Santa Rosa Island, 2007-2008.....	30
Table 19. Island foxes born in the wild on Santa Rosa Island, 2007 and subsequently caught during fall trapping efforts.....	31
Table 22. Injuries to captive San Miguel Island foxes, 2007.	36
Table 23. Injuries to captive Santa Rosa Island foxes, 2007.....	37

List of Figures

Figure 1. Reproductive success of captive female island foxes on San Miguel and Santa Rosa Islands, 1999-2007 (n = 189).....	11
Figure 2. Location of island fox captive breeding facilities, San Miguel Island.....	12
Figure 3. Locations of trap sites and fox captures for 4 grids, San Miguel Island, October 2007.	18
Figure 4. Mortality locations for released and wild-born island foxes on San Miguel Island, 2007.	19
Figure 5. Annual Kaplan-Meier survival for island foxes on San Miguel and Santa Rosa Islands.	20
Figure 6. . Locations of traps and fox capture locations on transects trapped November 2007 – February 2008, San Miguel Island.....	23
Figure 7. Reproductive effort (pups/female) versus adult population size, for island foxes on San Miguel Island, 1993-2007.....	24
Figure 8. Location of island fox captive breeding facilities, Santa Rosa Island.....	25
Figure 9. Locations of island fox mortalities, Santa Rosa Island, 2007-2008.....	29
Figure 10. Locations of foxes trapped on transects September 2007 - February 2008, Santa Rosa Island.	32

Executive Summary

During 2007, the National Park Service continued its program of captive breeding and release of island foxes (*Urocyon littoralis*) on San Miguel and Santa Rosa Islands. Summary statistics for the wild and captive populations are provided in Table 1. Reproduction in captivity in spring 2007 was relatively poor, as it was in 2006: no pups were born on San Miguel, and only 9 on Santa Rosa. Ultrasound examinations conducted as part of a reproductive study indicated a high rate of neonatal loss and low pregnancy rates. Five of 7 pairs on San Miguel became pregnant, but all failed to produce pups, and a total of 8 pups observed on ultrasound were not brought to term. On Santa Rosa, 9 of 14 pairs became pregnant, but only 4 females produced litters. A total of 12 pups observed on ultrasound were lost prior to pup emergence from the den. The cause of reproductive failure is unknown. Two foxes died in captivity in 2007. On Santa Rosa a paired female being treated for an aggression-caused injury died during surgery, in an apparent reaction to the anesthetic lidocaine. On San Miguel, a 13-year old female was euthanized on 30 October, 2007 due to declining health (heart and kidney disease, cancer). Due to high reproduction in the wild and the declining contribution of captive foxes to fox recovery on San Miguel, NPS closed the captive breeding program on that island after releases in fall 2007. At the end of the year there was 1 unreleasable fox in captivity on San Miguel, and 24 foxes (12 pairs) in captivity on Santa Rosa. In the summer, 14 foxes were released from captivity on San Miguel, and 12 on Santa Rosa. Four of the released Miguel foxes died, as did 3 of the Santa Rosa released foxes.

In 2007 annual survival of released and wild-born foxes continued to be high on San Miguel (90%) and, for the first time since releases began in 2003, annual survival on Santa Rosa (93%) matched that on San Miguel. A total of 3 island foxes died in the wild on Santa Rosa Island in 2007, and 5 on San Miguel. None of the mortalities were conclusively due to golden eagle predation, although 2 carcasses had characteristics that could be interpreted as signs of incomplete predation. Those carcasses were intact (neither eviscerated or degloved) but had talon-shaped puncture wounds in the thorax that, in one case, may have been the cause of mortality. In April 2008 two mortalities occurred on Santa Rosa that were more conclusively due to predation (they were both degloved and eviscerated). Prior to this the last confirmed case of predation on either island was in March 2006. On Santa Cruz Island, a number of mortalities in spring/summer 2007 were attributed to eagle predation, as were several in winter 2007/2008. The mortalities may have been due to 1 transient golden eagle present on the islands at those times.

Trapping was in fall 2007 to monitor the small wild populations on each island. On San Miguel foxes were trapped on 4 small (3 x 6 trap) grids, in order to estimate fox density, and on transects in order to replace radiocollars, gauge reproduction through capture of pups, vaccinate wild foxes, and check physical conditions. A total of 88 individuals were trapped, 61 on the grids and 40 on transects. The density estimates for the 4 grids, as calculated with program DENSITY, were 2.9, 1.0, 2.2, and 2.9 foxes/km². Multiplying the average density (2.2 foxes/km²) by the island area (38.1 km²) yielded a population estimate of 86 foxes. This population estimate was lower than the known population on the island. At the time there were 110 foxes known to be alive on San Miguel: 88 caught on the grids and transects and 22 radiocollared animals known to be alive but not caught on grids or transects.

A total of 27 wild-born pups were caught on San Miguel during fall trapping, with 23 caught on the grids. Reproductive success was estimated as the number of grid pups (23) divided by the

number of adult females caught on the grids and known to be alive on the island in spring 2007 (16). The estimated reproductive success of 1.4 pups per female was lower than those of the previous two years, but high when compared with the pup/female ratios from the early 1990s.

A total of 49 individuals, including 12 wild-born pups, were captured on Santa Rosa during fall trapping. Reproductive success was 0.80 pups/female (12 pups/15 females).

Table 1. Summary statistics for wild and captive island fox populations, San Miguel and Santa Rosa Islands, 2007.

	San Miguel	Santa Rosa
<i>Wild Population</i>		
MNKA	110	62
Annual survival	90%	93%
Mortalities of radiocollared foxes	6	3
Trap efficiency		
Captures	38.8%	12.4%
Individuals	21.7%	5.2%
Recruitment		
Pups	27	12
Pups/female	1.4	0.8
Rate of growth (λ)	1.18	1.11
<i>Captive Population</i>		
Recruitment		
Pups	0	9
Pups/female	0	0.64
Released	14	12
Left in captivity	2	24
Pairs for 2007-2007 breeding season	--	12

For the San Miguel and Santa Rosa wild populations, we calculated the minimum number known to be alive (MNKA) at the end of 2007 as the sum of the number of individuals caught during fall trapping and the number of radiocollared individuals not caught during trapping but known to be alive. At the end of 2007, the MNKA was 110 on San Miguel and 62 on Santa Rosa. The rate of population growth (λ) was 1.18 for San Miguel (compared to 1.7 in 2006) and 1.11 for Santa Rosa (compared to 1.00 in 2006). Trap success or trap efficiency, calculated as the percentage of traps occupied by foxes, was higher on San Miguel than on Santa Rosa, both for overall fox captures and individuals.

All captive foxes, including those released to the wild, were vaccinated against canine distemper virus and rabies, as were foxes captured during fall trapping efforts. Fifty-four of the 61 foxes known to be alive on Santa Rosa were vaccinated, the remainder being foxes known to be alive via radiotelemetry but not captured, and thus not vaccinated, during fall/winter trapping. On San Miguel, 98 of the 110 foxes known to be alive were vaccinated.

During 2007, island foxes were held in captivity on San Miguel and Santa Rosa Islands for the purpose of captive breeding and release to the wild. The San Miguel captive breeding facility was closed after the release of 14 foxes in summer 2007, with the only remaining captive foxes being 2 older females deemed unfit for release. One of those older females later died of natural causes.

The San Miguel captive facility failed to produce pups in 2007, for the first time since foxes were brought into captivity in 1999. Of the 7 captive pairs, 5 became pregnant, and ultrasound examination revealed 8 fetuses, though no pups were eventually produced. The Santa Rosa captive pairs also experienced significant perinatal mortality. Nine of 14 pairs became pregnant, but only 4 litters were produced. Of the 21 pups observed on ultrasound, only 9 were whelped. An ongoing investigation utilizing pen cameras and fecal hormone monitoring did not identify any one cause for the perinatal mortality. On Santa Rosa, 1 male was observed consuming pups, and 4 pairs had to be split during the breeding season due to aggression by males. On the other hand, camera monitoring revealed aggression in every pen, even those which produced litters. One paired female, which was not pregnant, died of shock due to reaction to the drug lidocaine, while undergoing surgery for an aggression-caused wound.

New pairings were implemented for Santa Rosa captive island foxes in November 2007, according to the recommendations of the AZA's population management plans for those subspecies of island foxes. On Santa Rosa Island, the 4 successful pairs were retained, as were 5 other pairs which failed to breed in 2007 but which had become pregnant, according to ultrasound testing. Two other pairs were split, and 3 new pairs were created. Three pairs which failed to breed in 2007 were released to the wild.

All captive San Miguel and Santa Rosa island foxes were given annual veterinary examinations, at which time blood samples were taken from all animals for hematology and complete blood chemistry. Captive animals requiring treatment for injuries or other ailments were given veterinary care as required.

Island fox captive breeding and monitoring on Santa Cruz Island are conducted by the Institute for Wildlife Studies (IWS) under a separate U. S. Fish and Wildlife Service recovery permit, and actions conducted under that permit are reported separately, in a report prepared by IWS. In 2007, all remaining captive foxes were released to the wild on Santa Cruz, and the captive breeding facility was closed. The contribution of captive breeding and release to island fox recovery on that island had been greatly outstripped by population growth of the wild fox population itself, this despite some predation by at least 1 golden eagle in the spring and summer of 2007.

For the same reasons, the San Miguel captive breeding facility was closed in 2007. A total of 53 pups were born in the facility from 2000-2006, but production had declined in recent years, especially compared to reproduction in the wild. In 2006, the 12 captive Miguel females produced 6 pups, whereas the 15 wild females produced at least 32 pups, and in 2007, the wild population produced at least 27 pups, while none were produced in captivity. For this reason, as well as the high survival in the wild, the San Miguel captive breeding facility was closed after releases in summer 2007.

On the other hand, we anticipate operating the Santa Rosa captive facility indefinitely, due to the fact that the Santa Rosa wild population is considerably lower than that on San Miguel, as is reproduction in the wild (Table 1).

Introduction

The island fox, a diminutive relative of the gray fox (*U. cinereoargenteus*), is endemic to the California Channel Islands. The fox exists as different subspecies on each of the 6 largest islands, a distinction upheld by morphological and genetic work (Wayne et al. 1991, Collins 1993). In 2004, the U.S. Fish and Wildlife Service listed as endangered 4 island fox subspecies, including the 3 subspecies in the Park (San Miguel Island fox [*U. l. littoralis*], Santa Rosa Island fox [*U. l. santarosae*], and Santa Cruz Island fox [*U. l. santacruzae*]) as well as the subspecies on Santa Catalina Island (*U. l. catalinae*) (U.S. Fish and Wildlife Service 2004). The 3 park subspecies had declined due to high levels of predation by golden eagles (*Aquila chrysaetos*).

Annual population monitoring detected the fox declines on San Miguel and Santa Cruz Islands. The island fox population on San Miguel declined from an estimated 450 adults in 1994 to 15 in 1999 (Coonan et al. 2005c). The Santa Cruz population declined from as many as 2,000 adults in 1994 to 50-60 in 2000 (D. Garcelon, Institute for Wildlife Studies, unpubl. data). Foxes on Santa Rosa may have numbered more than 1,500 in 1994 (Roemer et al. 1994) but declined to 14 animals by 2000 (Coonan and Rutz 2001). Prior to implementation of island fox recovery efforts, Roemer (1999) estimated time to extinction at 5 years for island foxes on San Miguel and 12 years for island foxes on Santa Cruz.

Predation by golden eagles is the primary mortality factor for island foxes on the northern Channel Islands, and is responsible for the massive decline of the 3 northern subspecies from 1994 to 2000 (Roemer et al. 2001a). Evidence from several studies supports this. Golden eagle predation was identified as cause of death for 19 of 21 island fox carcasses found on Santa Cruz Island from 1993 to 1995 (Roemer et al. 2001a). On San Miguel Island in 1998-1999, 4 of 8 radiocollared island foxes were killed by golden eagles in a 4-month period (Coonan et al. 2005c). Recent work on Santa Cruz Island confirms the continuing influence of eagle predation. From January 2001 through March 2006, 34 of 47 mortalities of radiocollared foxes on Santa Cruz Island were due to golden eagle predation (D. Garcelon, Institute for Wildlife Studies, unpubl. data).

Until the 1990s, golden eagles never bred on the Channel Islands, and their recent appearance is due to a prey base, feral pigs (*Sus scrofa*) and mule deer (*Odocoileus hemionus*), that was not present prehistorically (Latta et al. 2005, Collins and Latta 2006). The absence of bald eagles (*Haliaeetus leucocephalus*), which bred historically on the islands and whose presence may have kept golden eagles away, may also have allowed golden eagle colonization of the islands (Roemer et al. 2001a). Island foxes evolved in the absence of significant diurnal aerial predators such as golden eagles, and therefore may have been more vulnerable to predation than other small carnivores. Moreover, on much of the northern Channel Islands, historic sheep grazing changed the predominant vegetation from shrub to non-native grasslands, which offer much less cover from aerial predators.

Upon receiving recommendations from a convened panel of experts, the Park began taking emergency recovery actions in 1999, focusing on two measures, the removal of the existing golden eagles on the islands, and captive breeding of the critically low island fox populations. In summer 1999, the Park constructed pens on San Miguel and began capture of wild island foxes.

By January 2000, 14 island foxes had been captured and placed in the pens, leaving only 1 in the wild. Four of the captured foxes were males, and so were paired with 4 females for breeding. In 2004, after 5 years of breeding the San Miguel captive population had increased to 50 animals, exceeding the target captive population size of 40 animals and allowing initial releases back to the wild in fall 2004.

A captive breeding program was initiated for Santa Rosa Island in 2000. The initial captive population on Santa Rosa was 15 animals, which proved to be the island's remaining fox population. Some females were pregnant when captured, and 3 litters were born in captivity in 2000. With an increase to 56 foxes in 2003, the captive population on Santa Rosa exceeded the target captive population size of 40 foxes, and initial releases began in winter 2003/2004.

The status of eagles and foxes on Santa Cruz Island was assessed at the 2001 meeting of the Island Fox Conservation Working Group, and consensus was that captive breeding was warranted for that island fox population. In February 2002, a 10-pen captive breeding facility was built on Santa Cruz Island by the National Park Service and The Nature Conservancy. This facility was stocked with 12 adult island foxes caught as known pairs or individuals from separate areas of the island. A second facility was added in 2004. No releases occurred in either 2004 or 2005, and the captive population grew to 62 animals in 2005.

The Park established a cooperative agreement with the Santa Cruz Predatory Bird Research Group (SCPBRG) in 1999 for the purpose of relocating golden eagles from the northern Channel Islands. Personnel from the SCPBRG began eagle survey and removal on Santa Cruz Island, the island with the most recent sightings, in late summer 1999. Golden eagles were discovered to breed on both Santa Cruz and Santa Rosa Islands. By the end of 2006, 44 golden eagles had been removed from Santa Cruz Island, the majority by bownet trapping. Captured birds were released in northeastern California, and satellite telemetry on the first released birds indicates that none attempted to return to the islands (Latta et al. 2005).

In 2003, the Park completed a recovery strategy for island foxes on the northern Channel Islands (Coonan 2003). The recovery strategy is in the format of a U.S. Fish and Wildlife Service recovery plan, identifying threats to the species, delineating goals, objectives and recovery criteria, and presenting a schedule and cost estimates for recovery actions. Appropriate recovery goals for each of the 3 island fox subspecies in the northern Channel Islands were determined via demographic modeling (Roemer et al. 2001b). Population viability analysis was used to identify target population levels which would minimize the chance of extinction. Modeling was then used to set an augmentation (captive breeding and release) schedule that would achieve those targeted goals in a reasonable timeframe.

The island fox recovery strategy calls for a continuation of the emergency actions of island fox captive breeding and golden eagle removal, as well as the separately funded actions of feral pig removal from Santa Cruz Island and reintroduction of bald eagles to the northern Channel Islands. The document predicted that full recovery of island foxes on San Miguel and Santa Rosa Islands may take over a decade, although recovery on Santa Cruz Island might be achieved sooner.

The Park's island fox recovery strategy will be superseded by an official island fox recovery plan currently being developed under the direction and authority of the U.S. Fish and Wildlife Service.

Integrated Island Fox Recovery Team

From 1999-2003, the NPS convened a group of experts annually to help evaluate the status of island foxes on Park lands, and to make findings regarding appropriate recovery actions. The Island Fox Conservation Working Group, as it was called, comprised a loose affiliation of public agency representatives, landowners, conservancies, zoological institutions, non-profits and academics concerned about conservation efforts for the island fox.

The working group served as a forum for information exchange and evaluation of recovery efforts, dividing into subject matter groups to tackle most issues. The group annually reported the status of island foxes on all islands and listed findings in regard to threats to the species and appropriate mitigation actions (see Appendix A in Coonan et al. 2004).

After listing 4 island fox subspecies as endangered in 2004, the U.S. Fish and Wildlife Service established an island fox recovery team that retained the characteristics of the Island Fox Conservation Working Group. Although many recovery teams comprise a small number of individual experts, the Service established an integrated island fox recovery team comprising all 70+ individuals from the former working group. The individuals served as members of specific technical expertise groups, from which individuals were chosen to work on task forces in response to requests from land management agencies (NPS, TNC, Santa Catalina Conservancy) regarding management and recovery of island foxes. The task requests were allocated to task groups by the island fox recovery coordination group, which also received the resulting analyses from the task groups and passed on recommendations to the land management agencies, via the Service.

The integrated island fox recovery group first met in June 2004 to establish technical expertise groups and task forces, and begin addressing the task requests formulated by the land management agencies. The team met again in 2005 and 2006 to exchange information on fox conservation and research, review completed work on task requests and recommendations to land managers, continue work on task requests, and provide input to FWS on development of the draft island fox recovery plan (which had been tasked to the recovery coordination group). The 2007 island fox meeting marked a return to a format similar to the island fox conservation working group meetings. This included exchange of information and small workgroups addressing issues raised by the land management agencies, but not in the formal task analysis request process established by FWS. Information on the integrated island fox recovery team, and on the draft island fox recovery plan (to be released in 2008), is available from the Ventura Field Office of the U.S Fish and Wildlife Service.

Captive Breeding Program Development

Captive breeding was identified as emergency recovery action required to prevent extinction of island foxes on the northern Channel Islands (Coonan and Rutz 2001). The Park's island fox recovery strategy (Coonan 2003) also identified captive breeding as a critical recovery element necessary to recover island fox populations to viable levels on the northern Channel Islands.

Goals and Objectives for Captive Breeding

The following goals and objectives for the island fox captive breeding program at Channel Islands National Park were developed upon consultation with the captive breeding sub-group of the Island Fox Conservation Working Group (see Coonan and Rutz 2001).

Overall Goal

To develop a captive breeding program for island foxes on San Miguel Island (*U. l. littoralis*), Santa Rosa Island (*U. l. santarosae*) and Santa Cruz Island (*U. l. santacruzae*) in order to increase their wild populations to viable levels.

Overall Objective

To design and implement captive breeding programs for the primary purpose of generating animals suitable for reintroduction into appropriate habitat, once the threats to the populations in those habitats have been minimized or eliminated.

Specific Objectives

1. Define scope and duration of program; set facility size and configuration.
2. Construct and populate breeding facilities for the San Miguel, Santa Rosa and Santa Cruz Island fox populations.
3. Pair animals for breeding; monitor breeding behavior and results.
4. Develop appropriate release strategies.
5. Release foxes annually back into the wild; monitor wild foxes.

Program Guidance

Guidance for the captive breeding program was provided generally by the captive breeding and veterinary sub-groups of the Island Fox Conservation Working Group, and their findings and recommendations were incorporated into the Park's captive breeding program (Coonan and Rutz 2001, 2002, 2003, Coonan et al. 2004, 2005a, 2005c). For guidance in design of captive enclosures and development of husbandry protocols, we consulted the American Zoological Association's management recommendations for small canids in captivity, as well as the American Society of Mammalogists' guidelines for the capture, handling and care of mammals (American Society of Mammalogists 1998). Moreover, the Santa Barbara Zoo has organized two

island fox husbandry workshops and has produced island fox husbandry guidelines incorporating recent experience in island fox husbandry. The results from those workshops have been incorporated into the park's captive breeding program.

Standard Operating Procedures

The following general standard operating procedures have been developed for the captive breeding program. More specific standard operating procedures are updated annually to reflect new knowledge gained in island fox husbandry:

Facility Design and Construction

- In order to minimize the chance of disease, parasites or other catastrophe causing extirpation of captive populations, San Miguel and Santa Rosa Islands each have two separate breeding facilities.
- Staff level must be adequate for caretaking 40-50 animals at two sites.
- Sufficient distance is maintained between pens. Within the pens hiding places are provided; thus animals have visual contact with others when they choose.
- Annual pen construction is completed by October to allow pairs sufficient time to bond prior to breeding.
- There should be a minimum of two isolation areas at each facility.
- The threat of wildfire at captive breeding facilities is addressed by the Park's fire management program, and Vari-Kennels are available for immediate evacuation of foxes.
- Perimeter or electric fences are required at most facilities to prevent contact between captive and wild foxes. Aggressive encounters through the pen walls have been a source of injuries to both captive and wild foxes.

Veterinary Care

- If foxes are brought to the mainland for veterinary care, they cannot be returned to the islands, because of possible disease/parasite transmission.
- Captive foxes are given annual veterinary examinations, using a standardized veterinary protocol.
- Each captive breeding population has access to a veterinary/quarantine facility where animals may be treated.
- Protocols are implemented to minimize the risk of people or equipment transferring pathogens among islands, and to minimize parasite loads in the captive populations.
- Captive foxes are vaccinated annually against canine distemper virus, using a Canary pox vectored recombinant vaccine (Purevax Ferret Distemper vaccine, Merial Ltd., Athens, GA), and against rabies (IMRAB 3 rabies vaccine, killed virus, Merial Ltd., Athens, GA).

Caretaking and Handling

- Human contact with captive foxes is minimized to avoid acclimating them to humans, and to ensure they are as wild as possible upon release.

- Handling and disturbance of captive island foxes is avoided during the full extent of the breeding season (January through June).

Breeding Strategy

- In order to insure the genetic integrity of the captive fox populations, selection of animals for pairing and for release to the wild is accomplished via an analysis and population management plan produced annually for each subspecies by the American Zoo and Aquarium Association’s Population Management Center. Birth, death and breeding records are maintained in a studbook.
- Mated pairs are kept together as long as they reproduce successfully; non-reproductive pairs are kept together for at least two breeding seasons.
- Excess females may be housed together if compatible to allow for social interaction or to possibly test reproductive potential of one male with two females. However, no more than two females should be housed together in one pen.

Table 2. Basic diet for captive island foxes.

Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
1/2 C kibble*	1/4 C kibble	1/2 C kibble	1/2 C kibble	1/2 C kibble	1/2 C kibble	1/2 C kibble
			1/2 Egg		1/2Egg	
	Fruit		Fruit		Fruit	
Insect	Insect	Insect	Insect	Insect	Insect	Insect
Mouse				Mouse		
						Nuts / Seeds
	Quail					
Starch		Starch		Starch		Starch
	Vegetables*		Vegetables		Vegetables	

* Non-reproductive diet: 2:1 ratio of adult dog and adult cat kibble; reproductive diet: 2:1 ratio of puppy and kitten kibble

Diet

In 2006 a new captive fox diet (Table 2) was implemented in order to better manage weight problems in captive foxes. The new diet was based upon the Santa Barbara Zoo’s island fox diet (designed by Dr. Karl Hill). The new diet introduced cat kibble into the kibble mix being fed to foxes. Under the new diet, each adult fox is fed a 2:1 mixture of adult dog (Science Diet Adult Dog; Hill’s Pet Nutrition, Topeka, KS) and adult cat kibble (Science Diet Cat) daily. As in the previous diet, the kibble is supplemented with fruits, vegetables and hard-boiled eggs. Additional supplements in the new diet include insects (such as mealworms) and frozen mice. To increase calories and nutrition during breeding, each fox pair is switched over to a 2:1 mixture of puppy (Science Diet Puppy) and kitten (Science Diet Kitten) kibble, and the amounts of supplements are increased.

Table 3. Reproductive success among captive island foxes on the northern Channel Islands, 2006-2007.

	2006			2007		
	Litters/pairs	Pups	Per pair	Litters/pairs	Pups	Per pair
San Miguel	3/12 (25%)	6	0.50	0/7 (0%)	0	0.00
Santa Rosa	5/16 (31%)	9	0.56	4/14 (29%)	9	0.64
Santa Cruz	8/29 (28%)	21	0.72	6/11 (55%)	10	0.91

Overall Breeding Success

Reproductive success among captive island foxes on San Miguel and Santa Rosa was relatively poor (Table 3), as it has been in recent years, and was less than that of captive Santa Cruz Island foxes. For the first time since the program's inception in 1999, San Miguel captive foxes failed to produce any pups, despite the fact that 5 of the 7 pairs became pregnant. In fact, ultrasound examination by Drs. Deana Clifford and Winston Vickers in March 2007 revealed a high rate of pregnancy on both San Miguel (71%) and Santa Rosa (10/14, or 71%) (Clifford and Vickers 2007). However, as in previous years, high perinatal mortality considerably reduced the number of fetuses brought to term. On San Miguel, all 8 pups in 5 litters were lost, whereas on Santa Rosa 14 of 21 fetuses were lost. As in previous years, juvenile females and those animals paired for the first time generally did not breed. Neither of the 2 paired juvenile females bred, and none of 7 pairs which were paired for the first time successfully produced a litter.

Study of Factors Affecting Reproductive Success

A number of factors may have contributed to the captive reproductive failure. First, the 3 wild born females were fairly old (8-9 years) and there is some evidence that reproductive output in island foxes declines with age (T. Coonan, National Park Service, unpubl. data). Moreover, one of those females (E2677) which had produced 13 pups previously with her mate, injured her mate and the male was removed from the pen on 5 March; she was not pregnant at the time. Second, one female (85764) developed mastitis, which may have been a factor in the loss of the 1 pup observed on ultrasound. Another pair had been paired the previous fall, and success of first-year pairings is low in captivity (Carlstead 2005, Coonan and Dennis 2006a). However, that female had become pregnant, and ultrasound revealed three pups in March. Finally, 6 of the 7 pairs had been directly observed from January through April as part of an ongoing reproductive study (Sovada et al. 2007), and it is possible that nightly visits disturbed fox pairs to the point where breeding was disrupted.

Observers from the reproductive study directed by Dr. Cheryl Asa of the St. Louis Zoo monitored behavior of all 14 fox pairs during breeding season (January – June) via pen cameras. Preliminary results indicate that most losses occurred in the perinatal period, either as late term abortions, stillbirths, or neonatal deaths. Camera coverage in dens was insufficient to distinguish exact cause. An adult male was observed consuming pups in one pens (R21), though it is not known whether the pups were alive or dead at that point. One female, 2410E, showed signs of mastitis after losing her litter in early April. No other females showed signs of mastitis, and all had been placed on prophylactic dosage of antibiotic (Amoxicillin) prior to projected parturition date. Thus, it is unclear why pup loss occurred on Santa Rosa Island in 2007.

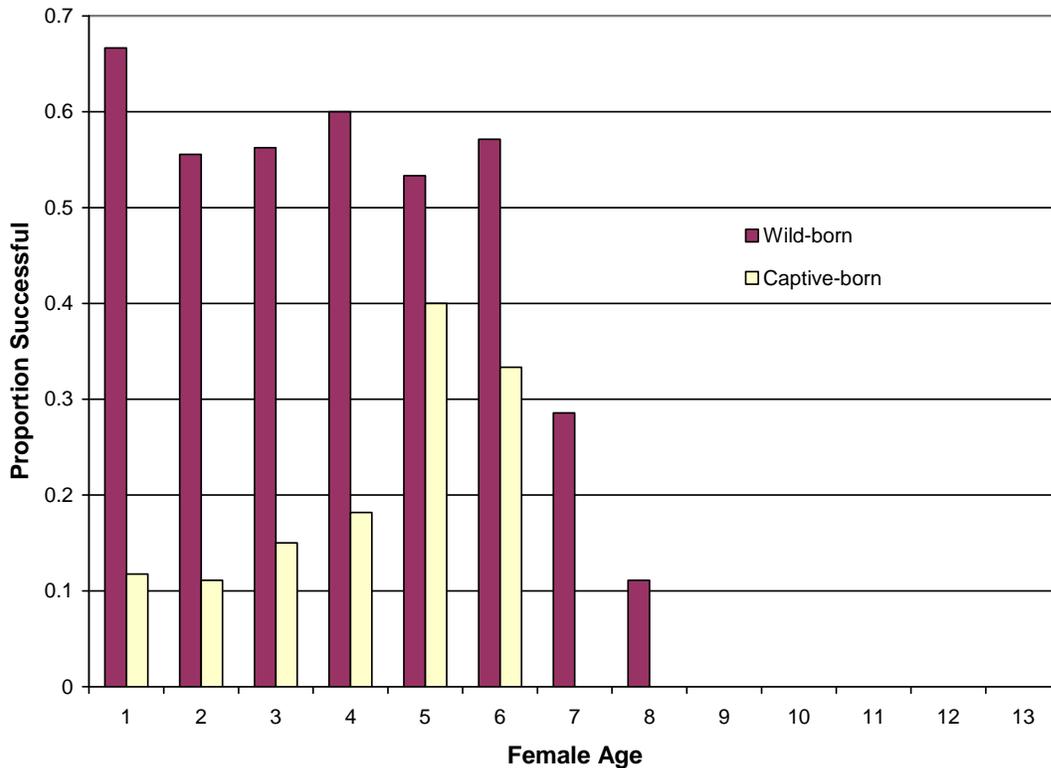


Figure 1. Reproductive success of captive female island foxes on San Miguel and Santa Rosa Islands, 1999-2007 (n = 189).

Captive-born foxes have been considerably less successful than wild-born foxes in producing litters in captivity (Fig. 1). Wild-born females, which, for the San Miguel and Santa Rosa programs, comprised those individuals brought into captivity in 1999-200, consistently had over 50% success until age 7, at which time production rapidly declined, and no 9-year olds have been successful in captivity. In contrast, reproductive success for captive foxes remained low, between 10 and 20%, until age 4 and 5, at which time females experienced modest success (30-40%). No 7-year old captive-born females produced a litter in captivity.

It is unclear why-captive born females have been less reproductively successful in captivity than wild-born females. It is likely that one or several elements of the physical or social environment are inadequate, compared that in the wild, or that foxes raised in captivity have failed to acquire the necessary behaviors or experience required for successful mating and breeding.

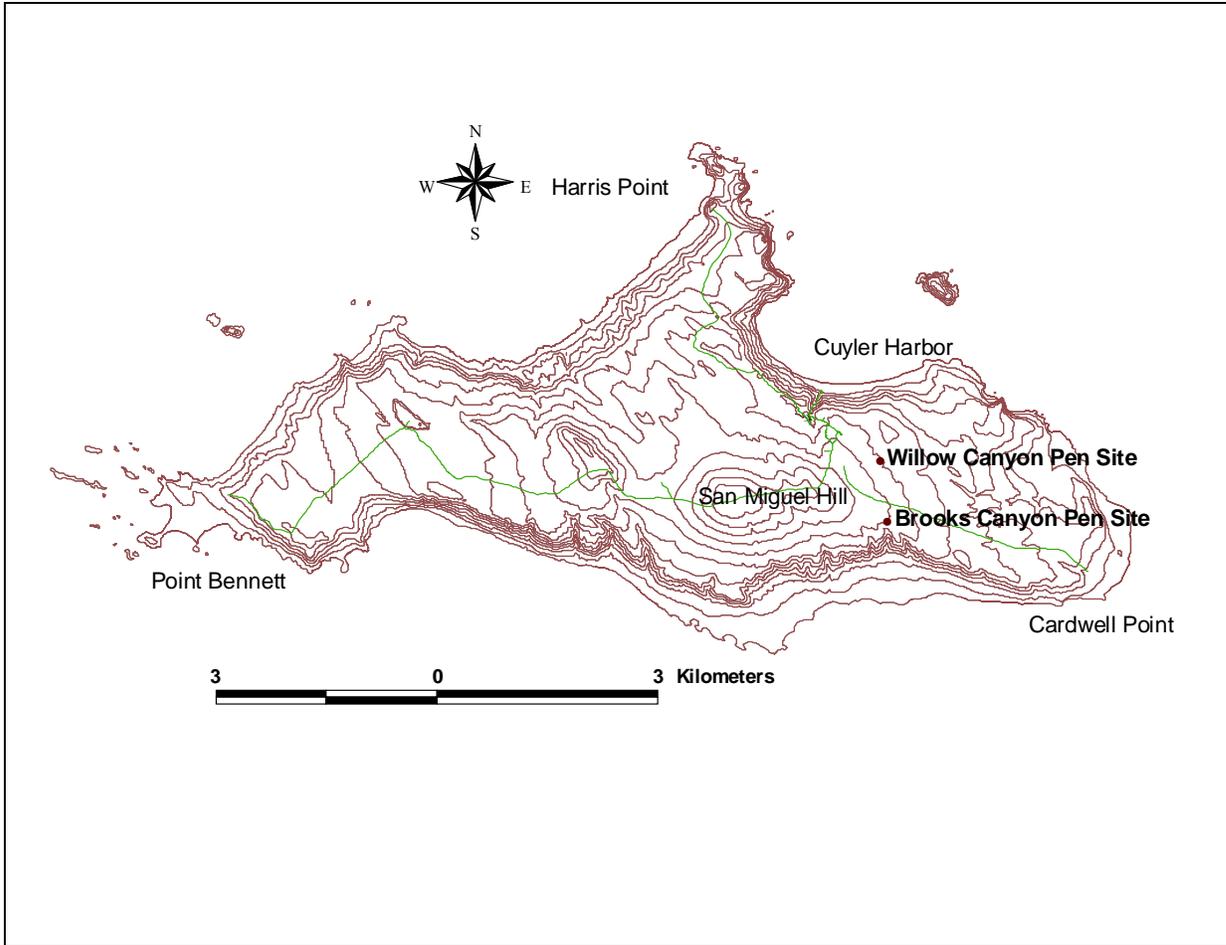


Figure 2. Location of island fox captive breeding facilities, San Miguel Island.

Recovery of San Miguel Island Foxes

In 2007 the small wild San Miguel island fox population increased to at least 110 foxes, showing high annual survival (90%) and reproductive success, with at least 27 pups born in the wild. The annual rate of population growth was 1.18, lower than that of the previous year (1.7). In captivity, no pups were born in 2007. Due to the declining contribution of captive breeding to wild population growth, compared to the high reproduction and high survival in the wild, NPS closed the San Miguel captive breeding facility after releases in fall 2007.

Captive Breeding

No pups were born in captivity on San Miguel Island in 2007, marking the first year the program had failed to produce any pups since its inception in 1999 (Table 4). The captive island fox population remained at 16 foxes, of which 14 were released to the wild in fall 2007. After

releases, one older female died in captivity, leaving one captive fox considered unreleasable due to age and physical condition.

On San Miguel, none of 7 captive pairs produced litters in 2007 (Table 5). Copulatory ties were observed for 6 of the 7 pairs (Sovada et al. 2007), and ultrasound evaluation in March revealed that 5 pairs became pregnant (Clifford and Vickers 2007), but none of the 8 pups seen on ultrasound survived. No new founders bred in 2007, leaving the number of founders for the San Miguel population at 8. Three wild-born females, all of which were successful founders but had not bred recently, failed to breed in 2007, as did 4 captive-born females.

A number of factors may have contributed to the captive reproductive failure. First, the 3 wild born females were fairly old (8-9 years) and there is some evidence that reproductive output in island foxes declines with age (T. Coonan, National Park Service, unpubl. data). Moreover, one of those females (E2677) which had produced 13 pups previously with her mate, injured her mate and the male was removed from the pen on 5 March; she was not pregnant at the time. Second, one female (85764) developed mastitis, which may have been a factor in the loss of the 1 pup observed on ultrasound. Another pair had been paired the previous fall, and success of first-year pairings is low in captivity (Carlstead 2005, Coonan and Dennis 2006a). However, that female had become pregnant, and ultrasound revealed three pups in March. Finally, 6 of the 7 pairs had been directly observed from January through April as part of an ongoing reproductive study (Sovada et al. 2007), and it is possible that nightly visits disturbed fox pairs to the point where breeding was disrupted.

Table 4. Growth of captive island fox population, San Miguel Island.

Year	Adults			Pups			Died	Released	Total Captive
	F	M	Total	F	M	Total			
2000	10	4	14 ¹	1	1	2	0		16
2001	11	5	16	0	5	5	1		20
2002	10	10	20	2	6	8	0		28
2003	13 ²	16	29	3	7	10	1		38
2004	15	23	38	8	4	12	0	10	40
2005	19	21	40	6	4	10	2	22	26
2006	14	12	26	2	4	6	0	16	16
2007	9	7	16	0	0	0	1	14	1

¹Founding population

²Includes the last wild fox, female 33053, brought into captivity in September 2003; died in December 2003

All captive San Miguel island foxes were given veterinary examinations by Dr. Winston Vickers, D.V.M., at the time of ultrasound examinations in mid-March 2007, and again in July. During vet exams, blood samples were taken from all animals and processed by IDEXX Laboratories (West Sacramento, CA) for hematology and complete blood chemistry. Injuries and other conditions requiring veterinary treatment are summarized in Appendix A.

Table 5. Reproductive success, or lack thereof, of captive San Miguel Island foxes, 2006-2007 breeding season.

Pen	PIT tag	Studbook		Sex	Age	Born	Paired	Result	Litter Size	Pups on Ultrasound
		Number								
M01	87F53	133		M	5	Captive				
	85764	135		F	5	Captive	11/2/2002	No Litter	--	1
M02	E4B2D	237		M	3	Captive				
	C5D00	231		F	3	Captive	12/14/2005	No Litter	--	2
M03	C4A16	82		M	6	Captive				
	71071	46		F	8	Wild	10/17/2001	No Litter		
M04	E666D	167		M	4	Captive				
	B0B25	48		F	8	Wild	10/24/2004	No Litter	--	1
M09	C311C	165		M	4	Captive				
	2033F	270		F	2	Captive	12/14/2005	No Litter	--	1
M10	07541	266		M	2	Captive				
	3167E	271		F	2	Captive	12/14/2005	No Litter	--	3
M11	47B06	63		M	7	Captive				
	E2677	36		F	9	Wild	10/17/2000	No Litter		

Injuries and ailments of San Miguel foxes included just 2 cases of mate aggression, one incidence of mastitis in a potentially breeding female (85764, pen M01), and infirmities due to old age in 2 unpaired female foxes considered unreleasable. These infirmities included arthritis, hardened stool, and waxy build-up in the ears from lack of grooming. The health of one of the older females, 92804, declined over the year and in the fall she began exhibiting symptoms such as labored breathing and weight loss, which could not be reversed. She was euthanized on October 30, 2007. This fox was the first that required euthanizing since the captive breeding program began in 1999. Dr. Karl Hill of the Santa Barbara Zoo provided veterinary care for her in 2007, and his summary of her final stage of decline is instructive:

This older female Channel Island Fox had been diagnosed with heart disease and possibly kidney disease on 9/18/07. She had a grade 3/5 heart murmur and a large lipoma like mass on the abdomen. Radiographs revealed increased soft tissue opacity in lungs and with small masses in lung fields possibly cancer of fluid pockets with pleural edema. Urinalysis revealed isosthenuric urine but could have been from the Salix treatments, unknown. Bloodwork indicated increased BUN and creatinine indicating kidney disease. Her diet was changed to decrease protein load and placed on Enacard for the heart murmur and Salix was slowly decreased. She ate only mice though and decreased in weight (2.8kg – 2.1kgs), so was placed back in exhibit and fed there and given meds in mice. She continued to lose weight (1.6kgs 10/24/07) despite meds and being out of foxpital. She became weak and off balance according to fox techs. So from 10/24 to 10/26 she was force fed Nutrical and Ptettinic with her Enacard and given fluids. She continued to not show interest in eating. On 10/30 she became much worse and was found in a den box on her side unable to get up or walk. I was then called and due to age, condition, and deterioration of body with unlikely recovery even with further drastic measures I recommended euthanasia with Euthasol 1-2 mls IV. Fox techs gave her 5 mls Euthasol IM due to inability to get in vein. She died around 20:20. Body sent to Linda Munson for necropsy.

Subsequent necropsy by Dr. Linda Munson of University of California, Davis, revealed metastatic mammary gland carcinoma that had spread to the lymph nodes, pyelonephritis and chronic glomerulonephritis of the kidneys, and cardiomegaly and myocarditis in the heart.

Mastitis had occurred previously in the captive facility, and had impacted breeding success in 2005 (Coonan and Dennis 2006a). To prevent occurrence of mastitis in captive breeding females, all females which were pregnant or nursing, or suspected to be pregnant, were given an antibiotic (Amoxicillin) as a preventative during breeding season. Treatment began prior to predicted birth date in each pen, with dates ranging from March 30 – April 25. Confirmation of mastitis in the pen M01 female prompted a switch from Amoxicillin to the stronger antibiotic Baytril for her.

Reintroduction

Foxes were first released back into the wild on San Miguel in fall 2004, after having been absent from the wild since 1999. High survival and reproductive success of released foxes allowed for additional releases in 2005 and 2006. In the latter year, half the remaining captives were released with the intent that the remaining captive foxes would be released in 2007. The NPS decided to release all captives and close captive breeding on that island, because reproduction and population growth was so high in the wild that the contribution from captive breeding was negligible in comparison (Coonan and Dennis 2007, Coonan and Schwemm in review).

Fourteen foxes (7 males, 7 females) were released to the wild in late July and early August at a total of 3 release sites on San Miguel Island (Table 4), leaving in captivity 2 older female foxes (92804 and 7534A) considered unreleasable due to physical condition. As of 15 April 2008, 9 of the 14 released foxes were alive, with functioning radiocollars. None of the 5 died from predation. One (M242) had a fractured leg and wounds due to aggression, and another (M238) was emaciated. Cause of death was undetermined for the others (L. Munson, University of California, Davis, unpubl. data).

Table 6. Island foxes released to the wild, San Miguel Island, 2007.

PIT Tag	Other	Sex	Age	Born ¹	Released	Release Site	Type ²	Fate
87F53	M236	M	5		7/19/2007	Hurricane Deck	SP	In wild
85764	F329	F	5		7/19/2007	Hurricane Deck	SP	d. 11/8/2007
47B06	M237	M	7		7/22/2007	Hurricane Deck	SP	In wild
E2677	F330	F	9		7/22/2007	Hurricane Deck	SP	In wild
C311C	M242	M	4		7/25/2007	Dry Lakebed	FP	d. 8/4/2007
2033F	F335	F	2		7/25/2007	Dry Lakebed	FP	In wild
07541	M239	M	2		7/25/2007	Dry Lakebed	FP	d. 8/5/2007
3167E	F332	F	2		7/25/2007	Dry Lakebed	FP	In wild
C4A16	M241	M	6		7/31/2007	Cardwell Point Trail	SP	In wild
71071	F334	F	8		7/31/2007	Cardwell Point Trail	SP	In wild
E666D	M240	M	4		7/31/2007	Cardwell Point Trail	SP	In wild
B0B25	F333	F	8		7/31/2007	Cardwell Point Trail	SP	d. 11/15/2007
E4B2D	M238	M	3		8/4/2007	Hurricane Deck	FP	d. 8/16/2007
C5D00	F331	F	3		8/4/2007	Hurricane Deck	FP	In wild

¹W = wild, C = captive

²Gr = group, Fa = family group, FP = failed pair, SP = successful pair

Monitoring

In 2007 we conducted mortality monitoring via radiotelemetry on San Miguel and Santa Rosa Islands, in order to estimate annual survival of island foxes, and to identify mortality sources. We monitored wild population size and reproductive success via transect trapping on both islands, and small grids on San Miguel.

Methods

Mortality-sensing radio-telemetry collars were placed on all foxes released to the wild and on other wild foxes (such as wild-born pups) in order to assess mortality rates and factors. Collared foxes were monitored regularly to determine their general location and signal type (normal or mortality). If a mortality signal was detected, the dead fox was located and recovered. Data collected at the site prior to removing the carcass included: 1) any information that might indicate cause of mortality, 2) the position of the carcass with respect to its surroundings, including digital photographs, and 3) the general condition of the animal (e.g., eviscerated, intact, damage by insect scavengers, etc.). The location of the carcass was recorded via GPS, and a general description of the habitat was recorded.

Carcasses were tagged with pertinent identification, date and location information. If a carcass could be brought to the mainland within 48 hours of being located, it was refrigerated; otherwise it was frozen and then shipped by overnight carrier to the UC Davis, Wild Carnivore Pathology Laboratory (Dr. Linda Munson) for necropsy. Because freezing of tissues increases autolysis, and therefore decreases data that can be extracted from histological examinations, it is advantageous to have the animal necropsied as soon as possible after death and to avoid freezing if possible. If disease was suspected in the death of the animal, tissues were prepared for histological analysis by UC Davis veterinary staff.

Annual survival of radiocollared foxes was estimated with the non-parametric Kaplan-Meier procedure with staggered entry of foxes as they were released to the wild, and of wild-born foxes as they were radio-collared (Pollock et al. 1989). We calculated an 80% confidence interval about the annual survival rate, because a 95% confidence interval is too conservative (V. Bakker, University of California, Davis, and D. Doak, University of California, Santa Cruz, pers. comm.).

We monitored island fox populations on San Miguel and Santa Rosa Island via transect trapping (both islands) and small grids (San Miguel only). The purpose of the monitoring was to:

- assess condition of individual foxes
- replace radiocollars or affix new radiocollars as required
- vaccinate foxes against canine distemper virus and rabies
- estimate abundance via trap efficiency and the minimum number known to be alive (MNKA), and
- for the San Miguel grids, to estimate density and islandwide population.

Trapping was conducted in October-December, by which time pups had reached adult size and some had dispersed from their natal territories. Box traps (23 by 23 by 66 cm, Tomahawk Live Trap Co., Tomahawk, WI) were baited with dry and wet cat food and a fruit scent (Knob

Mountain Raw Fur Co., Berwick, PA). Captured foxes were protected from the elements by careful placement of traps, and by a shade cloth cover on each trap. A polyethylene tube chew bar was wired inside each trap to reduce incidence of tooth damage. Traps were checked once, in the morning, during every 24-hr period.

Upon first capture, animals were weighed in the trap, and then removed and handled without anesthesia for a complete work-up. Data collected included sex, reproductive status, age class, and general physical condition (e.g., condition of coat, presence of ectoparasites, injuries). Captured foxes were marked with passive integrated transponder (PIT) tags (Biomark, Boise, ID) inserted subcutaneously between and just anterior to the scapulae. Single-use sterile PIT tag applicators were used in order to minimize transfer of pathogens. Prior to insertion of the PIT tag, the insertion site was cleaned and disinfected with alcohol, and antibacterial ointment was applied to the needle.

Upon first capture, or once a year thereafter, a blood sample was collected from the femoral or jugular vein of captured foxes, separated into its component fractions by centrifugation, and stored for later genetic and serologic analyses. Up to 10 ml of blood was collected from adult (>1.25 kg) foxes, and up to 5 ml from pups. Staff taking blood samples have had previous experience in drawing blood, and are supervised by permitted individuals while collecting blood from island foxes. Blood samples were analyzed for serum chemistry and complete blood count by IDEXX Laboratories (West Sacramento, CA).

All trap location coordinates (with or without fox captures) were obtained by a geographical positioning system (GPS) receiver and entered into a database for later spatial analysis using geographic information system (GIS) software. Trapping data was used to estimate distribution and abundance of island foxes, through such measures as trapping success, age structure and sex ratio of foxes, and reproductive success (ratio of number of pups to number of adult females).

To estimate density and islandwide population, 4 small (3 x 6) grids (Fig. 3) were trapped on San Miguel, one per week for 4 weeks in October 2007. Three grids were randomly distributed along the primary east-west cross-island trail, and 1 grid was placed in the Harris Point area, in the only location where placement would not impact cultural sites. For each grid, one line of traps was dispersed along the trail at 250-m intervals, with another line of traps directly north and south of each trap-point on the trail. The grids were designed to be relatively easy to set up and trap, so that a 2-person crew could trap one grid per week while still performing other duties (captive fox care, monitoring radiocollared foxes).

Capture data from each grid was analyzed via program DENSITY (Efford et al. 2004) and density was estimated using both conventional methods and inverse prediction. Average density from the 4 grids was multiplied by island size to estimate islandwide fox population size. This was compared to the minimum number of foxes known to be alive prior to fall releases. Both the standard error for the average density and the standard error for the islandwide population estimate were calculated via the delta method (Cooch and White 2006).

Fox abundance was also measured by estimating trap efficiency, which is the number of fox captures or individuals divided by the number of available traps. The latter does not include traps that were found to be closed when checked.

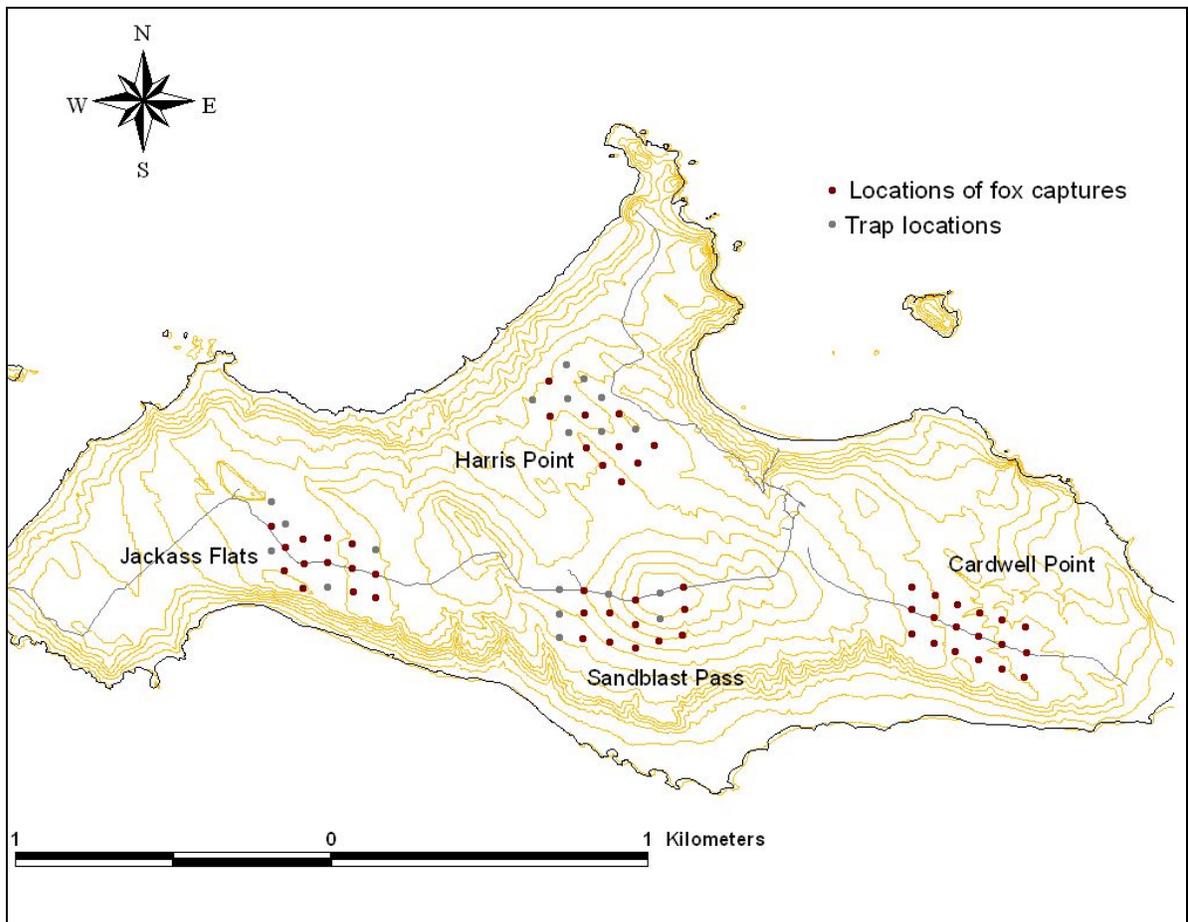


Figure 3. Locations of trap sites and fox captures for 4 grids, San Miguel Island, October 2007.

Mortality Monitoring

Throughout 2007 we maintained a sample of 37-50 radiocollared foxes on San Miguel, and by the end of the year there were 49 radiocollared foxes being monitored. Collared foxes included those released from captivity and some wild-born foxes. During 2007-2008, 6 radiocollared foxes died (Fig. 4, Table 7). Annual Kaplan-Meier survival for San Miguel island foxes in 2007 was 90.0% (80% CI = 85-95%). An annual survival rate of 80% has been estimated to be required for a stable or increasing fox population (Roemer et al. 2001b). Annual survival has remained above 80% since foxes were first released on San Miguel in 2004 (Fig. 5).

In addition to the 5 released foxes that died in 2007, 1 wild-born pup caught and collared in October 2007 subsequently died in early December (Table 7, Fig. 4). Although there were no outward signs of predation, necropsy revealed puncture wounds on the thorax consistent with the talon pattern of a golden eagle (L. Munson, University of California, Davis, unpubl. data). Heretofore, all mortalities designated as caused by predation have been characterized by evisceration and/or degloving of the limbs. The carcass of M243, in contrast, was intact, and the talon-patterned wounds were only evident in necropsy. If this was a case of predation then it was

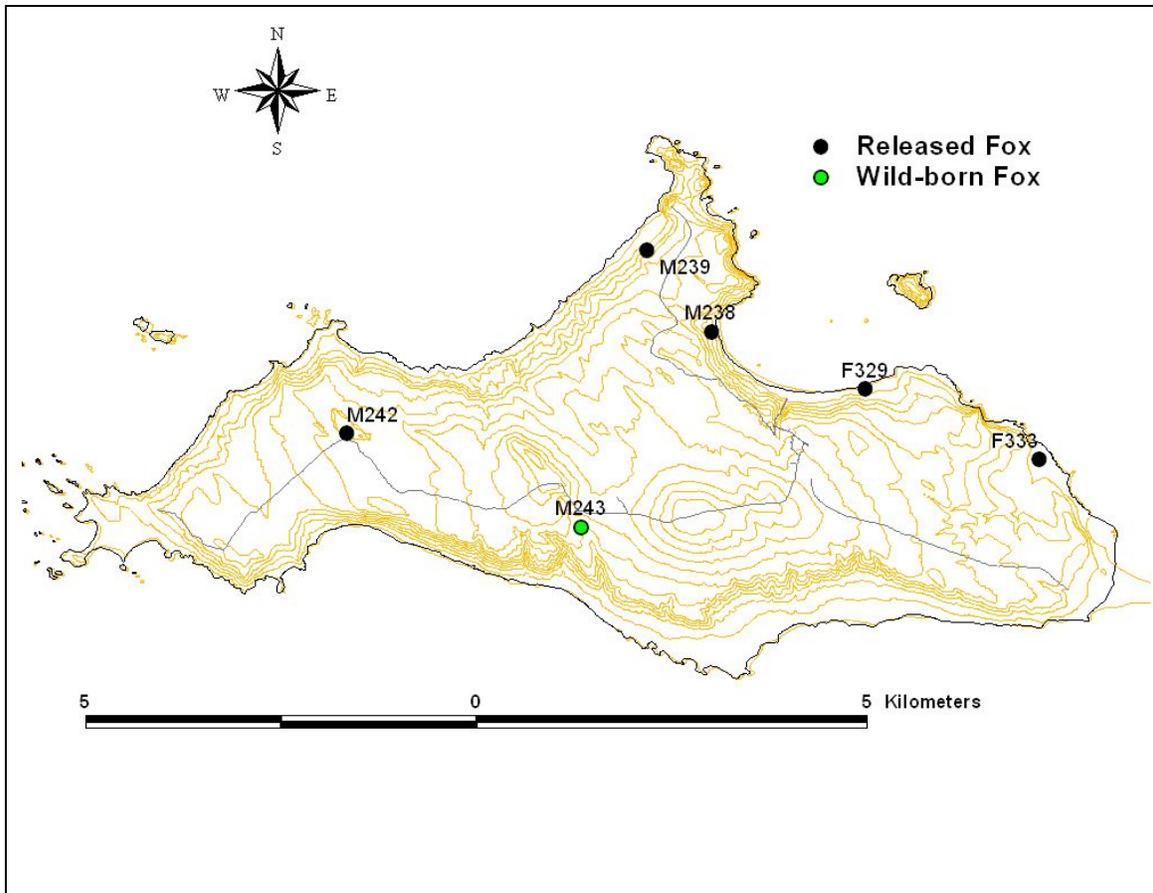


Figure 4. Mortality locations for released and wild-born island foxes on San Miguel Island, 2007.

an incomplete case, for the raptor failed to consume the fox. The punctured lung may eventually have caused the fox' death. The parasite *Spirorcerca* was present on the wall of the colon. In light of this finding, and the puncture wounds found on a Santa Rosa fox that died on December 6, 2007 (see p. 30), it is entirely possible that a golden eagle was present on San Miguel and Santa Rosa in early December. Four of 6 fox mortalities on Santa Cruz in late 2007/early 2008 were also attributed to golden eagle predation (D. Garcelon, Institute for Wildlife Studies, unpubl. data). That the raptor failed to consume the fox in both the San Miguel and Santa Rosa cases is unusual, and unprecedented. This may be an indication of a very inexperienced golden eagle, or even a raptor of another species, such as bald eagle or red-tailed hawk (*Buteo jamaicensis*). As of April 1, 2008, there had been no further instances of predation-caused mortality on San Miguel.

Table 7. Island fox mortalities, San Miguel Island, 2007.

PIT Tag	ID	Sex	Born	Age	Date	Mortality Cause
C311C	M242	M	Captive	4	8/4/2007	Undetermined; broken leg, aggression injuries
07541	M239	M	Captive	2	8/5/2007	Undetermined
E4B2D	M238	M	Captive	3	8/16/2007	Undetermined; septicimia, emaciation
85764	F329	F	Captive	5	11/8/2007	Undetermined
67A18	M243	M	Wild	0.5	12/1/2007	Puncture wounds suggest predation
B0B25	F333	F	Wild	8	12/15/2007	Undetermined

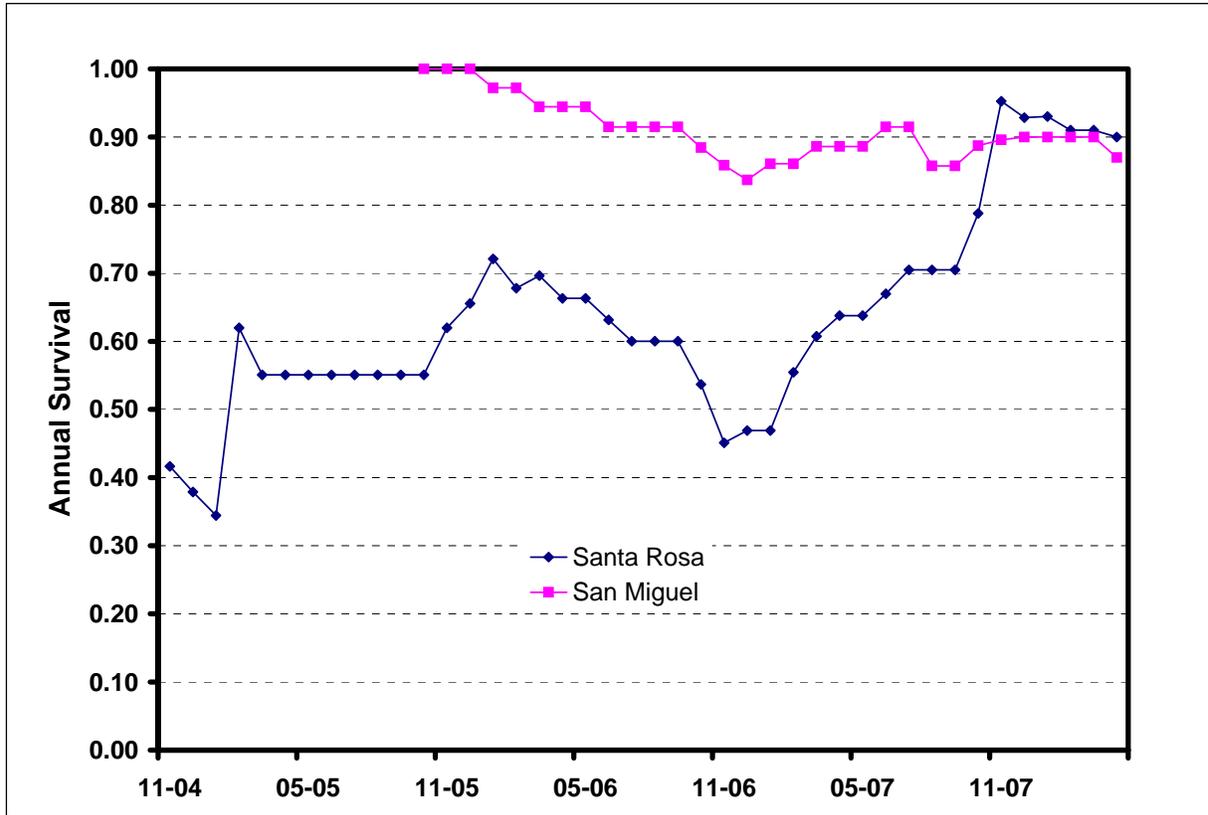


Figure 5. Annual Kaplan-Meier survival for island foxes on San Miguel and Santa Rosa Islands.

Wild Population Monitoring

Transect and grid trapping in fall/winter 2007-2008 yielded the following measures of population health:

- Minimum number of foxes known to be alive (MNKA)
- Islandwide population estimate
- Reproductive effort

The 4 small grids were trapped from mid-October to early November (Table 8, Fig. 3), and the transects (Fig. 6) from mid-November to early February 2008. A total of 88 individuals were trapped, 61 on the grids and 39 on the transects. The minimum number known to be alive (MNKA) at the end of 2007 was the sum of the number of individuals caught during fall/winter trapping (88) and the number of radiocollared individuals not caught during trapping but known to be alive (22). At the end of 2007, the MNKA was 110 on San Miguel.

Density on the 4 grids ranged from 1.0 – 2.9 foxes/km², with the average density, including both adults and pups, being 2.2 foxes/km² (Table 8). The coefficient of variation for the islandwide density estimate was 0.15. A CV < 0.20 is desirable (M. Efford, Landcare Research, pers. comm.).

Table 8. Density estimates for small grids, San Miguel Island, 2007.

Grid ¹	Date Trapped	Individ.	Capture Prob.	Density (foxes/km ²)	SE	CV ²
CHAR	10/03 – 10/06	9	0.4000	1.0	0.50	0.50
CARD	10/08 – 10/11	20	0.3804	2.9	0.76	0.26
SAND	10/18 – 10/21	15	0.3333	2.9	0.81	0.28
JACK	10/22 – 10/25	17	0.4583	2.2	0.50	0.22
average				2.2	0.33	0.15

¹CHAR = Harris Point, CARD = Cardwell Point, SAND = Sandblast Pass, J ACK = Jackass Flats

²Coefficient of Variation = standard deviation/mean

Multiplying the average density by the area of the island (38.1 km²) yielded a population estimate of 85 foxes, with 80% CI = 69-110. The islandwide estimate of 85 foxes was less than the minimum number known to be alive (110 foxes), although the confidence interval included the MNKA. The annual rate of increase from 2006 to 2007 was calculated as the MNKA less the number of foxes released in 2007 (101) divided by the number of foxes known to be alive at the end of 2006 (85). The estimated lambda of 1.18 indicates an increasing population. The rate of increase was less than that of the previous year (1.70), which was the highest recorded on the northern Channel Islands during recovery (Table 9).

We tallied foxes by sex and age for both the grid trapping and transect trapping efforts, as well as the combined effort (Table 10). The adult population was slightly biased toward males, as were the number of pups born in the wild (15 M:12 F). A total of 27 wild-born pups were caught, of which 5 were subsequently radiocollared (Table 11). We measured reproductive success as the ratio of pups caught on the grids (23) to number of known adult females in spring 2007 (16). The estimated reproductive success of 1.4 pups/female was relatively high, but was not as high as in 2006 (2.5 pups/female, 32 pups). This may be because 2007 was one of the lowest precipitation years on record, or because recruitment declines with increasing population size. A regression of reproductive effort on adult population size over the range of the population decline and recovery showed reproductive effort declining as population increases, an apparent density-dependent effect (Table 12, Fig. 7).

Trap success or trap efficiency, measured as either the number of captures or number of individuals per available traps, was 40.7% (captures) and 20.9% (individuals) in fall 2007 (Table 13). The 2007 trap efficiency was higher than that in 2006 (captures, 29.5%, individuals, 13.5%, Coonan and Dennis 2007a) and were almost 3X higher than 2007 values for Santa Rosa.

Table 9. Annual rate of population increase (lambda) for island fox populations on the northern Channel Islands. Santa Cruz data is from Smith et al. (2006).

	Santa Cruz		Santa Rosa		San Miguel	
	N	λ	N	λ*	N	λ*
2001	137					
2002	127	0.93				
2003	100	0.79				
2004	151	1.51	15		10	
2005	207	1.37	15	1.00	40	2.00
2006	264	1.28	40	1.00	80	1.70
2007			62	1.11	110	1.18

*adjusted for number of foxes released from captivity

Table 10. Sex and age distribution of foxes trapped on both grids and transects, San Miguel Island, October 2007 – February 2008.

	Grids	Transects	Combined
Adult Males	21	17	33
Adult Females	16	13	28
Male:Female ratio	1.3:1	1.3:1	1.2:1
Male Pups	12	6	15
Female Pups	11	3	12
Total Pups	23	9	27
Pups/Female	1.4	0.69	0.96

Table 11. Island foxes born in the wild on San Miguel Island, 2007, and subsequently caught during fall trapping efforts.

PIT Tag	ID	Sex	Captured
24908		M	10/3/2007
40C2B		M	10/3/2007
67A18	M243	M	10/6/2007
0085C		M	10/8/2007
0721B		M	10/8/2007
12532		F	10/8/2007
1302A		F	10/8/2007
A3E53		F	10/9/2007
F6C14	F336	F	10/9/2007
F333E		M	10/10/2007
2361A		M	10/11/2007
F3C18		M	10/11/2007
86871		F	10/18/2007
A3211		F	10/18/2007
A7B60		F	10/18/2007
C7A0A	M244	M	10/18/2007
12627		M	10/19/2007
0074A	F337	F	10/22/2007
33E25		M	10/22/2007
65965		F	10/22/2007
90724		M	10/22/2007
14B17		F	10/24/2007
D4845		F	10/25/2007
07378		M	11/30/2007
E723D		M	12/2/2007
D031F		M	1/14/2008
A4743	F342	F	2/2/2008

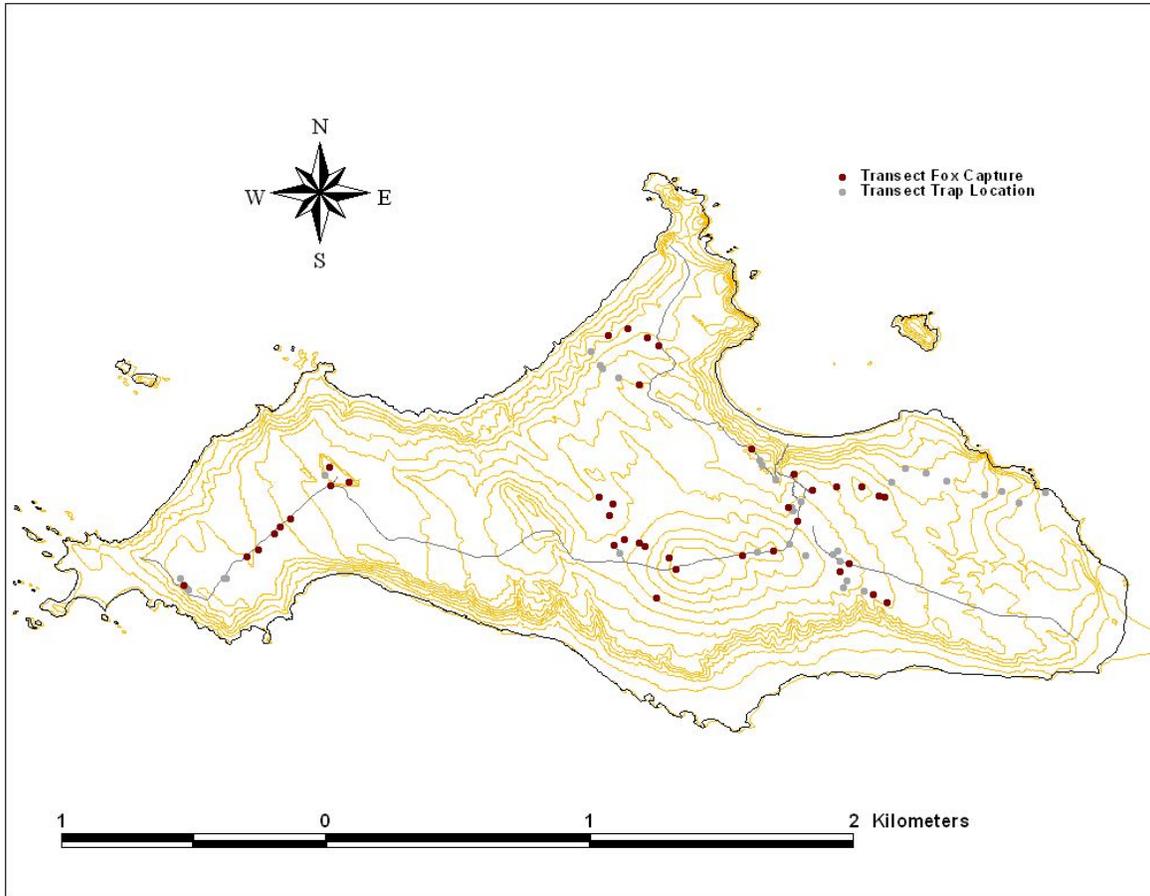


Figure 6. . Locations of traps and fox capture locations on transects trapped November 2007 – February 2008, San Miguel Island.

Table 12. Adult population size and reproductive effort for island foxes on San Miguel Island, 1993-2007.

Year	Adult Population	Reproductive Effort (pups/adult female)
1993	305	1.15
1994	436	0.64
1995	305	0.73
1996	101	1.75
1997	70	1.50
1998	35	2.25
2005	10	2.50
2006	40	2.50
2007	80	1.44

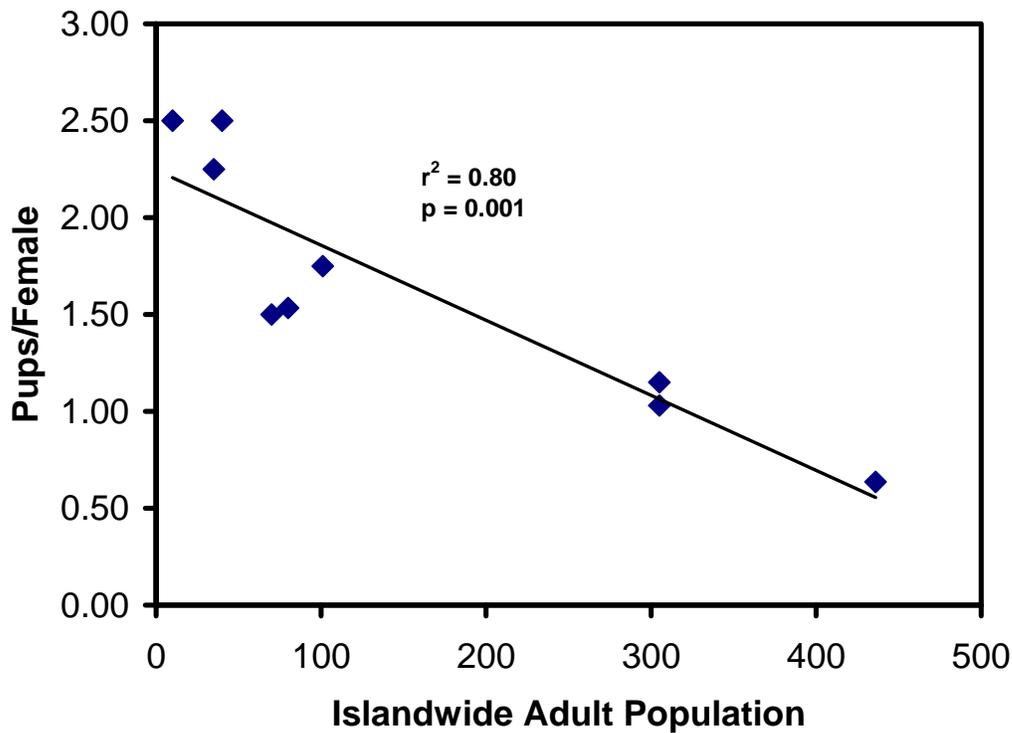


Figure 7. Reproductive effort (pups/female) versus adult population size, for island foxes on San Miguel Island, 1993-2007.

Future Plans

Results from monitoring in 2007 indicate that the wild population on San Miguel is still in a phase of expansion. Survival is high, as is reproductive success, and annual rate of population increase. Although captive breeding has ceased on San Miguel Island, other recovery actions will continue. The 1 remaining, un-releasable captive fox will be given veterinary treatment as required for injuries and other medical conditions. At least 50 wild foxes will be radio-collared and regularly monitored for mortality rate and causes. Trapping will be conducted in the fall to estimate population size and reproductive effort, and all wild foxes encountered during trapping will be vaccinated against canine distemper virus and rabies.

Table 13. Trap efficiency for fall/winter trapping efforts, San Miguel and Santa Rosa Islands, 2007-2008.

Available traps	San Miguel 420		Santa Rosa 656	
	Number	Percent	Number	Percent
Fox captures	171	40.7	115	17.5
individuals	88	20.9	48	7.3
Skunk captures			293	44.7
individuals			257	39.2

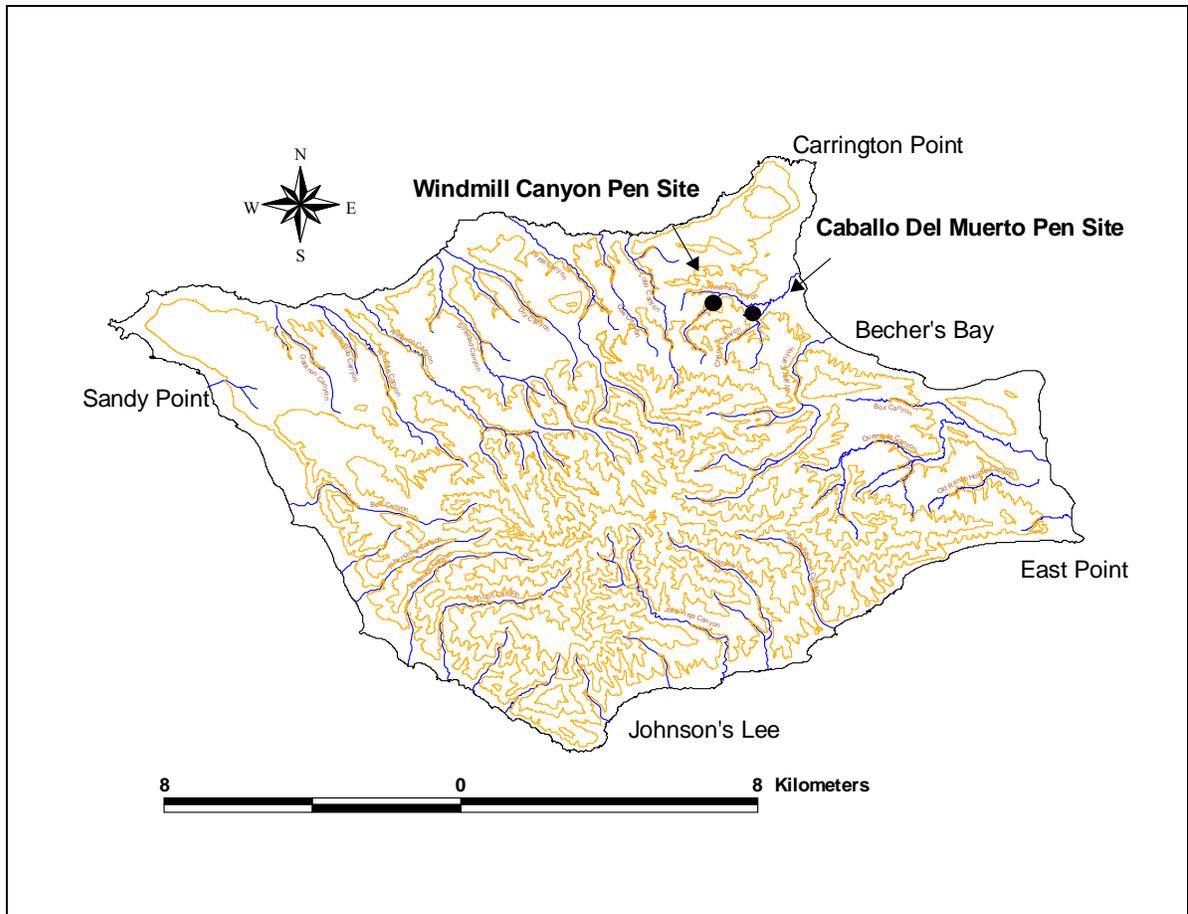


Figure 8. Location of island fox captive breeding facilities, Santa Rosa Island.

Recovery of Santa Rosa Island Foxes

In 2007 the small wild Santa Rosa island fox population increased to at least 62 foxes, exhibiting high annual survival (90%) and moderate reproductive success, with 12 pups born in the wild. The annual rate of population growth was 1.1, higher than that of the previous 2 years (1.0). In captivity, 9 were born in 2007. Considerable perinatal mortality occurred in captivity, but, as in previous years, the cause remained undetermined.

Captive Breeding

With the death of 1 adult female (see below) and the birth of 9 pups in spring 2007, the captive island fox population on Santa Rosa Island grew to 36 foxes, of which 12 were released to the wild (Table 14). All captive pairs were housed in the Windmill Canyon site (Fig. 8) and the Caballo del Muerto site was used for housing injured foxes and for housing males after separating them from females following ultrasounds.

Table 14. Growth of captive island fox population, Santa Rosa Island.

Year	Adults			Pups			Died	Released	Total Captive
	F	M	Total	F	M	Total			
2000	8	4	12 ¹	5 ²	5 ²	10	0		22
2001	14 ³	9	23	7	3	10	1		32
2002	20	12	32	9	4	13	0		45
2003	29	16	45	6	5	11	0	7	49
2004	30	19	49	2	7	9	2	13	43 ⁴
2005	22	21	43	2	6	8	0	17	34
2006	17	17	34	2	7	9	0	13	28 ⁵
2007	14	14	28	3	6	9	1	12	24

¹Founding population

²Includes 8 pups born in captivity, and 2 pups (1 male, 1 female) born in the wild

³An additional female was brought in from the wild on 05/14/2001

⁴Includes 1 female pup born in the wild in spring 2004 and brought into captivity

⁵Male 37E00 transferred to Santa Barbara Zoo on 6/13/2006 and female F4A18 escaped from captivity 5/3/2006

Reproductive success was low in captivity on Santa Rosa in 2007, as it was in 2006 (Tables 3 and 15). Four of 14 captive pairs (29%) produced litters in 2007. Of the 9 pups born in captivity in 2007 (Table 16), 6 were male. No new founders bred in 2005, 1 potential founder (female 07061) failed, and the number of founders remained at 12. Eight captive-born and 2 wild-born females failed to produce litters in 2007. Ultrasound testing for pregnancy in March (Clifford and Vickers 2007) showed that 9 of 14 females became pregnant, and an additional female (25D54, in pen R01) was pregnant but her pups were not detected on ultrasound. Only 4 of those 10 pregnant females produced a litter. Seven females lost a total of 14 pups to neonatal mortality.

Observers from the reproductive study directed by Dr. Cheryl Asa of the St. Louis Zoo monitored behavior of all 14 fox pairs during breeding season (January – June) via pen cameras. Preliminary results indicate that most losses occurred in the perinatal period, either as late term abortions, stillbirths, or neonatal deaths. Camera coverage in dens was insufficient to distinguish exact cause. An adult male was observed consuming pups in one pens (R21), though it is not known whether the pups were alive or dead at that point. One female, 2410E, showed signs of mastitis after losing her litter in early April. No other females showed signs of mastitis, and all had been placed on prophylactic dosage of antibiotic (Amoxycillin) prior to projected parturition date. Thus, it is unclear why pup loss occurred on Santa Rosa Island in 2007.

All captive Santa Rosa Island foxes were given annual veterinary examinations by Dr. Winston Vickers, D.V.M., and Dr. Karl Hill, D.V.M., in September 2007. At time of examination, blood samples were taken from all animals and processed by IDEXX Laboratories (West Sacramento, CA) for hematology and complete blood chemistry. Injuries and other conditions requiring veterinary treatment are summarized in Appendix A. All captive foxes were vaccinated against canine distemper virus and rabies.

Most of the injuries that occurred to Santa Rosa captive foxes (Appendix A) were due to mate aggression. One of 3 new pairs, as well as 3 established pairs, had to be separated during breeding season due to aggression.

ISLAND FOX RECOVERY REPORT

Table 15. Reproductive success of captive Santa Rosa Island foxes, 2006-2007 breeding season.

Pen	PIT Tag	Studbook		Age	Born	Paired	Result	Litter Size	Pups on Ultrasound
		Number	Sex						
R01	80C3F	222	M	3	Captive				
	25D54	149	F	5	Captive	10/24/2004	No Litter	--	
R02	7235F	219	M	3	Captive				
	A5E60	265	F	3	Wild	12/11/2005	Litter	3	3
R03	47E09	178	M	4	Captive				
	A180A	53	F	7	Wild	11/15/2006	No Litter	0	3
R04	64A43	304	M	2	Captive				
	D590E	298	F	2	Captive	12/11/2005	Litter	1	2
R05	1271E	144	M	5	Captive				
	96C2E*	74	F	6	Captive	11/15/2006	No Litter	--	
R06	01262	339	M	1	Captive				
	C4A1F	342	F	1	Captive	11/15/2006	Litter	3	3
R07	F0223	28	M	9	Wild				
	07061	225	F	9	Wild	11/15/2006	No Litter	--	
R08	85420	224	M	3	Captive				
	2410E	54	F	7	Captive	12/11/2005	No Litter	0	2
R09	E5066	343	M	1	Captive				
	E485E	299	F	2	Captive	11/15/2006	No Litter	0	3
R10	B067E	24	M	9	Wild				
	47304	145	F	5	Captive	1/30/2004	Litter	2	2
R11	8024B	348	M	1	Captive				
	90B2D	340	F	1	Captive	11/15/2006	No Litter	--	
R12	C4F63	177	M	4	Captive				
	A3B6D	223	F	3	Captive	11/15/2006	No Litter	--	
R21	97541	305	M	2	Captive				
	31049	218	F	3	Captive	12/11/2005	No Litter	0	2
R22	B6255	302	M	2	Captive				
	A7954	170	F	4	Captive	12/11/2005	No Litter	0	1

*died in surgery 3/28/07, of shock due to reaction to lidocaine

Table 16. Island fox pups born in captivity, Santa Rosa Island, 2007.

PIT Tag	Studbook		Sex	Pen	Sire	Dam
	Number					
3784A	363		M	R02	7235F	A5E60
3343A	364		M	R02	7235F	A5E60
65F0A	365		F	R02	7235F	A5E60
14454	366		F	R04	64A43	D590E
80556	367		M	R06	01262	C4A1F
B1256	368		M	R06	01262	C4A1F
60411	369		F	R06	01262	C4A1F
13B68	370		M	R10	B067E	47304
64968	371		M	R10	B067E	47304

One adult female fox died in captivity in 2007. Female 96C2E had sustained injuries due to mate aggression and underwent surgery on March 28 for a ruptured abscess on her back. During surgery she developed an allergic reaction apparently caused by the local anesthetic lidocaine, and manifested by seizures and respiratory distress. No epinephrine was available to reverse the reaction, and the fox died. This was the first instance of an island fox reacting to lidocaine in this manner; the drug has been used successfully on other island foxes (W. Vickers, Institute for Wildlife Studies, unpubl. data).

Colleen Lynch of the AZA's Population Management Center provided us with recommendations for genetic management of the captive population in summer 2007. Accordingly, in November 2007, 3 new pairs were created, and a number of captive adults were selected for release. There were 24 foxes, or 12 pairs, in captivity on Santa Rosa Island for the 2007-2008 breeding season (Appendix B).

Reintroduction

Annual releases to the wild have been conducted on Santa Rosa since 2003. In 2007, 12 foxes (8 males, 4 females) were released to the wild between 17 October and 23 October, 2007, at a total of 3 release sites on Santa Rosa Island (Table 17). Four of the releasees were older animals (7-9 yrs), and 2 of those foxes died within 1 month of release. Cause of death for 1 of those (F1430 was unknown as of April 2008, and cause of death for another (M45) appeared related to heart and kidney problems (see below). Another mature female (A3B6D, F142) died of puncture wounds that were suggestive of predation. We released 5 adults that had produced or sired litters in the past, including 2 founders, but which had not produced a litter in at least 2 years. We also released 1 potential founder (female 07061, F144) that had failed to produce a litter in 5 years, with 4 different mates.

Table 17. Island foxes released to the wild, Santa Rosa Island, 2007.

PIT Tag	ID	Sex	Age	Born	Released	Release Site	Type ¹	Fate	Founder Status ²	Litters in Captivity
3784A	M39	M	0	Captive	10/17/2007	Old Ranch House	Fa	In Wild		
3343A	M38	M	0	Captive	10/17/2007	Old Ranch House	Fa	In Wild		
47E09	M40	M	4	Captive	10/17/2007	Old Ranch House	SP	In Wild		1
A180A	F141	F	7	Wild	10/17/2007	Old Ranch House	SP	In Wild	F	1
80556	M42	M	0	Captive	10/21/2007	Verde	Fa	In Wild		
B1256	M41	M	0	Captive	10/21/2007	Verde	Fa	In Wild		
64968	M43	M	0	Captive	10/21/2007	Verde	S	In Wild		
A3B6D	F142	F	3	Captive	10/21/2007	Verde	S	d. 12/6/2007		1
85420	M44	M	3	Captive	10/23/2007	China Camp	SP	In Wild		
2410E	F143	F	7	Captive	10/23/2007	China Camp	SP	d. 11/10/2007		1
07061	F144	F	9	Wild	10/23/2007	China Camp	FP	In Wild	PF	0
F0223	M45	M	9	Wild	10/23/2007	China Camp	FP	d. 11/10/2007	F	5

¹Fa = family group (siblings), FP = failed pair, SP = successful pair, S = single

²F = successful founder, PF = potential founder

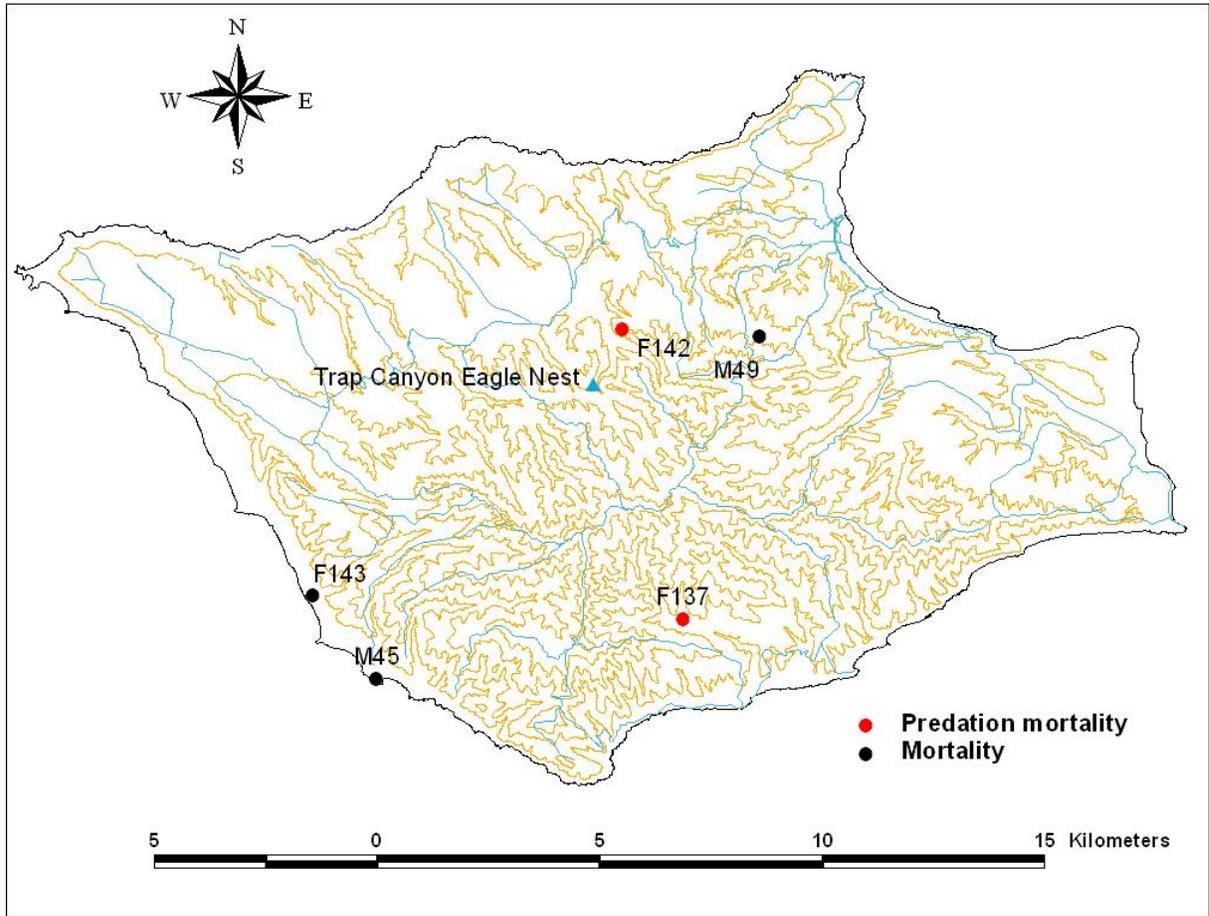


Figure 9. Locations of island fox mortalities, Santa Rosa Island, 2007-2008.

Monitoring

Mortality Monitoring

Throughout 2007 we maintained a sample of 30-48 radiocollared foxes on Santa Rosa, and by the end of 2007 there were 48 radiocollared foxes on the island. Collared foxes included those released from captivity and some wild-born foxes. Three radiocollared island foxes died in 2007 (Table 18, Fig. 9), and annual Kaplan-Meier survival for Santa Rosa Island foxes in 2007 was 93.0% (80% CI = 89-98%). An annual survival rate of 80% is required for a stable or increasing fox population (Roemer et al 2001b). In 2007, annual survival on Santa Rosa, which has always been lower than that on San Miguel, climbed above 80% for the first time since releases began in 2003 (Fig. 5).

The low number of radiocollared foxes that died on Santa Rosa in 2007 (3) contrasts with the 20 mortalities recorded for 2006. An additional 3 foxes died in early 2008. Of the 6 mortalities, one was due to unknown causes, one had trichobezoars in the stomach and duodenum, one had kidney disease and a blood clot in the heart, and 3 had signs of predation (punctures/evisceration).

Table 18. Island fox mortalities, Santa Rosa Island, 2007-2008.

PIT Tag	ID	Sex	Born	Age	Died	Mortality Cause and Findings
2410E	F143	F	Captive	7	11/10/2007	Unknown, not predation
F0223	M45	M	Wild	9	11/10/2007	Kidney disease, blood clot in enlarged heart
A3B6D	F142	F	Captive	3	12/6/2007	Emaciation, puncture wounds
6717B	M49	M	Wild	1	2/1/2008	Emaciation; trichobezoars in stomach/duodenum
F4A18	F137	F	Wild	10	4/3/2008	Predation
21022	M37	M	Wild	2	4/30/2008	Predation

Female F143 (PIT tag 2410E), died due to unknown cause, but not predation, since she was found intact with no signs of predation, fight wounds or emaciation. She was an older fox (7 yrs) that died less than a month after being released.

Male M45 (PIT tag F0223) was another older fox (9 yrs) that died within a month of release. Necropsy revealed no sign of emaciation, but there was evidence of kidney disease and heart problems. The kidneys showed evidence of glomerulonephritis (inflammation of the glomeruli) and acute papillary necrosis. There was a thrombus (blood clot) in the right atrium of the heart, which was enlarged (cardiomegaly), and the left atrial ventricular valve had evidence of endocardiosis (leaky valve).

Necropsy of the remaining mortality (M49) revealed the fox to be severely emaciated, with a large trichobezoar (hairball) in the stomach and several others in the duodenum. Whether the trichbezoars contributed to mortality is unknown at this time.

One female fox (F142, PIT tag A3B6D) died within 2 months of release, was emaciated, but also had puncture wounds suggestive of predation. There were 2 puncture wounds that extended into the thorax, penetrating the rib cage on the right ventrolateral side and puncturing the diaphragm, and 3 additional hematomas from more shallow puncture wounds on the left side of the neck and head. These wounds are similar to those of San Miguel male M243, who died 12/1/2007, within days of F142; he also had puncture wounds extending into the thorax, and a collapsed lung. That these carcasses did not display other characteristics of golden eagle predation such as degloving and evisceration suggests either a case of incomplete predation, perhaps by a young, relatively inexperienced golden eagle (L. Munson, UC Davis, unpubl. data), or attempted predation by another species of raptor (D. Garcelon, Institute for Wildlife Studies, pers. comm.).

Whereas the two mortalities in December 2007 (one on San Miguel and one on Santa Rosa) bore signs of unsuccessful predation (the body was not consumed), 2 cases of more successful predation occurred in April 2008. Female F137 (PIT tag F4A18), which had escaped from captivity on May 2006 and later been captured and radio-collared, was found eviscerated, with severed spine and missing limbs. The mortality location was near the Trap Canyon golden eagle nest site (Fig. 6), last used by golden eagles in 2005, but used by bald eagles in spring 2008 in a failed nesting attempt. Male M37 (PIT tag 21022) was a 2-year old wild-born animal found in Quemada Canyon partially degloved and eviscerated.

Evidence from carcasses thus suggests golden eagle activity on San Miguel and Santa Rosa Islands in November-December 2007 and April 2008. There were no sightings of golden eagles on either island during these times, although on Santa Cruz Island there was an unconfirmed

golden eagle sighting and several fox mortalities attributed to predation (D. Garcelon, Institute for Wildlife Studies, unpubl. data). Four mortalities on Santa Cruz Island in February and March 2008 had characteristics such as degloving, evisceration and whitewash. A helicopter survey and capture operation conducted on April 11, 2008 turned up no golden eagles on either Santa Cruz or Santa Rosa Islands (R. Wolstenholme, The Nature Conservancy, pers. comm.)

Wild Population Monitoring

We used the ratio of pups to females in the fall trapping sample to monitor reproductive success. Fall trapping confirmed that 12 wild-born pups (3 males and 9 females) had survived through the summer and into the fall, and 10 of those pups were subsequently radiocollared (Table 19). Reproductive success for wild Santa Rosa females was 0.80 pups/female (12 pups/14 females), less than that on San Miguel (1.4 pups/female).

Trapping was conducted on 16 transects from November 2007 through February 2008 (Fig. 10). A total of 48 individual foxes were captured on the transects, and trap efficiency was 7.3% for individuals and 17.5% for fox captures (Table 13). Both of these values were one third of those on San Miguel, and were somewhat higher than Santa Rosa values for 2006 (4.5% and 12.2%). During the 2007 trapping period, 293 individual skunks (marked with passive integrated transponder tags) were captured. Relative abundance of skunks was over 5X that of foxes. The 44.7% trap efficiency for skunks was less than that of the previous year (51.5%: 379 skunk captures in 736 trapnights (Coonan 2007).

The minimum number of Santa Rosa Island foxes known to be alive (MNKA) at the end of 2007 was the sum of the number of individuals caught during fall trapping (49; one individual was hand-caught at the housing area) and the number of radiocollared individuals not caught during trapping but known to be alive (13). At the end of 2007, the MNKA was 62 on Santa Rosa, about half of the MNKA for San Miguel (110). However, trapping on Santa Rosa in 2007 did not cover a portion of the southeast sector of the island (Fig. 10) and so the actual number of foxes on Santa Rosa is likely higher than the MNKA.

Table 19. Island foxes born in the wild on Santa Rosa Island, 2007 and subsequently caught during fall trapping efforts.

PIT Tag	ID	Sex	Captured	Died
96B79	F145	F	11/3/2007	
C0102	F146	F	11/8/2007	
47B58	F147	F	11/8/2007	
34F10	F149	F	11/22/2007	
4394C		F	11/29/2007	
E261C	F150	F	11/30/2007	
E7E21		F	12/1/2007	
F1555	M48	M	12/2/2007	
00D05	F151	F	12/9/2007	
6717B	M49	M	1/11/2008	2/1/2008
D0701	F153	F	2/2/2008	
42D3B	M50	M	2/11/2008	

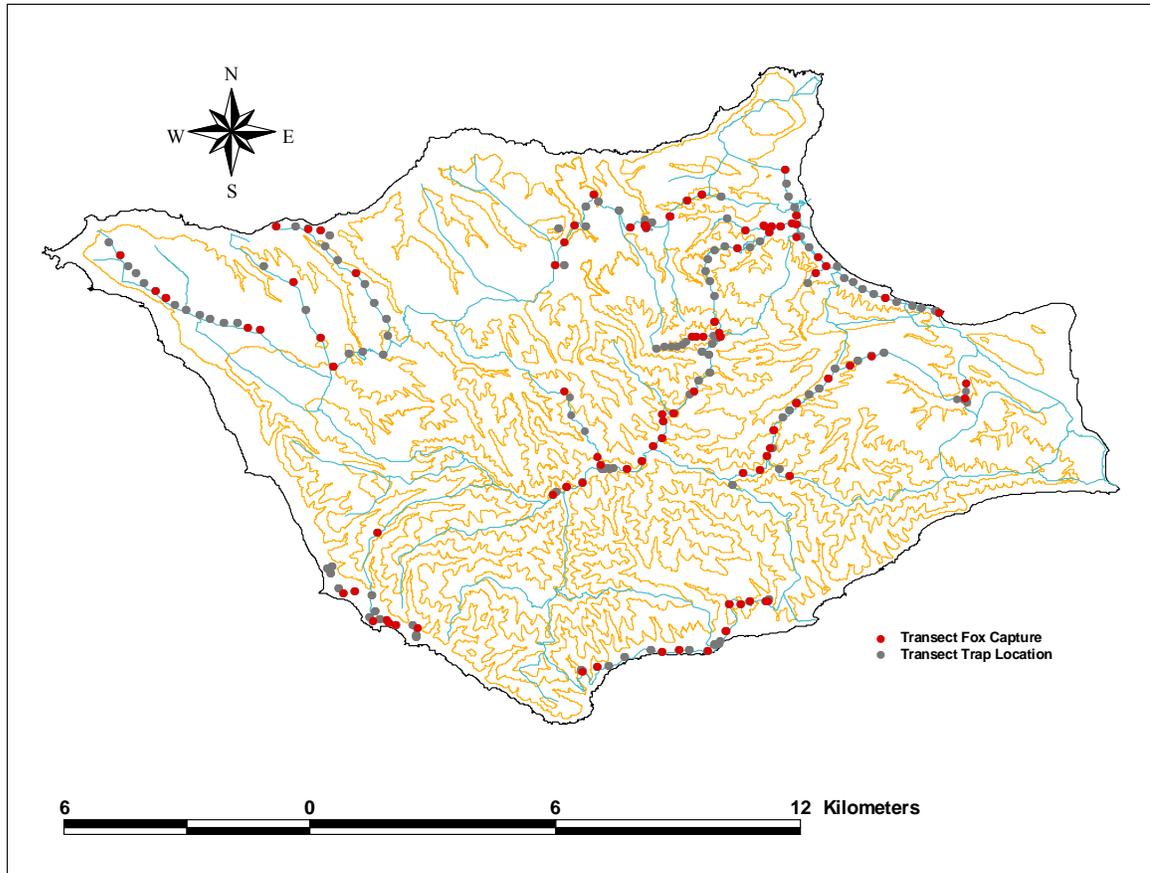


Figure 10. Locations of foxes trapped on transects September 2007 - February 2008, Santa Rosa Island.

Future Plans

The results of mortality and population monitoring show wild island foxes to be in an improving position on Santa Rosa Island. Although the wild population is half that of San Miguel, despite the fact that releases started a year earlier on Santa Rosa, annual survival has increased to a level (90%) which matches that on San Miguel. Reproduction in the wild on Santa Rosa (12 pups, 0.8 pups/female) was also about half that on San Miguel (27 pups, 1.4 pups/female), and the annual rate of increase (1.11) indicated a growing population. The San Miguel population is on an apparent trajectory toward recovery, with high wild survival and high wild recruitment far outstripping that in captivity, enough to support closing the captive facility in 2007. With the significant increase in survival, Santa Rosa has the same potential for population growth. But until wild recruitment improves on Santa Rosa, captive breeding and release will be an important tool for increasing the small wild population, and so will continue in the near future. Captive breeding and annual releases will continue until wild Santa Rosa island foxes show recruitment rates comparable to or better than those of captive foxes. At that point, which may occur as soon as 2008, maintaining captive foxes will no longer be necessary.

Ten to 20 additional island foxes will be released on Santa Rosa in fall 2008. Pups born in 2008 will be PIT-tagged. All captive foxes will be given veterinary examinations, will have blood samples drawn for testing, will be vaccinated against canine distemper virus and rabies, and will be given veterinary treatment as required for injuries and other medical conditions.

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Appendix A Injuries to Captive Island Foxes, 2007

Table 20. Injuries to captive San Miguel Island foxes, 2007.

Date	ID	Sex	Pen	Injury	Treatment
03/19/07	47B06	M	M11	Multiple wounds on scrotum due to aggression by female E2677	Foxpital, Baytril and then Clavamox; warm compress on wounds, topical treatment with silver sulfadiazine
03/20/07	92804, 7534A	F	M08	Arthritis	Daily nutritional supplement (Cosequin) for joint health
		F		Excessive lice from lack of grooming	Frontline
	92804, 7534A	F	M08	Hardened stool	Lactulose supplement
		F		Wax build-up in ears	Baytril-otic whenever handled
04/14/07	E66D	M	M04	Ripped nail on left hind foot digit	Betadine, antibiotic cream
04/21/07	85764	F	M01	Mastitis – swollen, thickened nipple, yellow milk expressed	Foxpital until 4/27, Baytril
07/31/07	C5D00	F	M02	Scalp injury	Shaved, injectable Baytril, staples, Clavamox. Delay release a week.
09/13/07	92804	F	M08	Labored breathing, weight loss	Foxpital, Salix (diuretic), Clavamox, Enacard – euthanized 10/30/07
10/08/07	E666D (M240)	M	Wild	Emaciated, lethargic, bite wounds	Surgery by Dr. Karl Hill on deep laceration on digit, Clavamox; re-released 12/16/07

ISLAND FOX RECOVERY REPORT

Table 21. Injuries to captive Santa Rosa Island foxes, 2007.

Date	Fox ID	Sex	Pen	Injury	Treatment
01/18/07	A3B6D	F	R12	Large chunk missing from inside inner portion of right ear, several punctures to right ear and healing wound at base of ear.	None
01/18/07	C4F63	M	R12	Large patch of hair loss on right ear with several small healing puncture wounds and 1 larger wound on interior of ear.	none
01/18/07	31049	F	R21	Infected wound on back of neck with some pocketing	Brought to foxpatal, Wounds cleaned, sutured by vet, Baytril for 1 week, returned to pen R21 with mate 01/25/08
01/18/07	97541	M	R21	Swollen anus with swelling at base of tail, hair slightly matted around anus.	none
01/22/07	B6255	M	R22	Right ear small healing wound mid way down on outer edge.	none
02/02/07	C4F63	M	R12	Trauma to both ears with multiple infected wounds, large hematoma on left ear	Brought to foxpatal, Wounds cleaned with chlorahexadine, applied antibiotic ointment, Clavamox for 2.5 weeks; put into pen R23B alone on 02/20/07, put into pen R12 with mate 02/25/07
03/21/07	A180A	F	R03	Some minor new wound to previously injured area of heavy scar tissue.	Started on amoxicillin, continued through breeding season.
03/21/07	C4A1F	F	RO6	Firm swellings tracking up mammary chain, possible mastitis	Started on amoxicillin, continued through breeding season.
03/21/07	2410E	F	R08	Healing bite wounds to top of head and left ear. Approximately 2 weeks old. Also noted firm swelling of caudal mammary glands, possible mastitis.	Cleaned wounds and applied antibiotic ointment, left in pen, pulled male. Started on amoxicillin continued through breeding season.
03/21/08	25D54	F	R01	Hair loss upper 1/3 of right ear with evidence of old healing wound on tip of ear. Old puncture wound on rectum, very small.	none, healing well
03/21/07	8024B	M	R11	Pre-existing grade V heart murmur radiating throughout chest.	Cardiac ultrasound performed and recorded, still needs to be viewed by cardiologist.
03/21/07	96C2E	F	R05	Minor healing bite wounds to	None, healing well

ISLAND FOX RECOVERY REPORT

Date	Fox ID	Sex	Pen	Injury	Treatment
03/21/07	97541	M	R21	right ear noticed at ultrasound exams Rectal prolapse during vet exam	Treated with saline and antibiotic ointment and pushed back in with gloved hand.
03/27/07	96C2E	F	R05	1" X 1" ruptured abscess on lower back.	Brought into foxpital for treatment died during surgery from allergic reaction to lidocaine on 03/28/07.
04/08/07	2410E	F	R08	Loss of litter; Mastitis, severe swelling and firmness of all mammary glands especially caudal two. Expressed yellow milk with difficulty. Mildly dehydrated	Brought into foxpital. Discontinued amoxicillin started on Baytril for 3 weeks. Also given SQ fluids and vitamin B complex. Blood, milk and vaginal cultures taken. Returned to pen 8 alone on 04/20/07.
04/19/07	C4F63	M	R12	Healing puncture wounds and a large hematoma on left ear.	Brought into foxpital. Clavamox for 1 week. Placed in pen R23B alone on 04/20/07
04/27/07	31049	F	R21	Loss of pups, male 97541 was observed eating 2 pups on video on 04/25/07. No evidence of mastitis, milk cultures taken, normal color and consistency	Left on amoxicillin until 05/10/07.
04/28/07	A180A	F	R03	Lost 3 pups, mammary glands appear normal, easily producing milk of normal color and consistency.	Milk cultures taken just in case. Continued on amoxicillin until 05/10/07.
05/06/07	A7954	F	R22	1 week past estimated due date, no pups seen. Swelling of teats but not of mammary glands, all 6 produced translucent fluid. Probably in process of reabsorbtion of milk.	Culture of mammary fluid taken .Kept on amoxicillin until 05/16/07.
05/12/07	A3B6D	F	R12	No pups found at final pup check, caudal 2 mammary glands slightly swollen, produced clear yellow fluid.	Took culture of mammary fluid, kept on amoxicillin until 05/23/07.
05/12/07	25D54	F	R01	Lost 2 pups in last few days. Slight swelling of mammary glands, produced slightly yellow milk. Probably in process of reabsorbtion of milk.	Cultures taken. Kept on amoxicillin until 05/23/07.
05/20/07	7235F	M	R02	Left eye swollen, red, watery and almost sealed shut	Brought into foxpital, flushed eye with saline,

ISLAND FOX RECOVERY REPORT

Date	Fox ID	Sex	Pen	Injury	Treatment
05/20/07	E485E	F	R09	Minor ear wounds, two small slices to right ear and one small but deep puncture to left ear. Skinny, 1.95kg Body condition 2.	proparacaine, BNP for 1 week. Kept searching for foreign object, none found. But back in pen R02 with mate and 2 pups on 05/28/07. Brought into foxpital. Cleaned ear wounds with chlorahexadine and applied antibiotic ointment. Clavamox for 10 days. Moved back into pen R09 solo after moving male to R23C.
07/09/07	7235F	M	R02	Squinty right eye with lower outer edge of eyelid swollen with small scabs. Outer area of right eye cornea slightly opaque.	Brought into foxpital. Flushed eye with saline and applied BNP to eye and antibiotic to eye lid for 1 week. Put into pen RQ1 solo on 07/16/07.
08/22/07	31049	F	R21	Healed large notches to right ear noticed when captured to move her and mate to new breeding pen R12	None
08/24/07	A180A	F	R03	Foxtail in right eye, healing 1" wound on back on area of previous injury with thick scar tissue.	Eye flushed with saline, proparacaine, foxtail removed. BNP for 1 week. Cleaned back wound with chlorahexadine and applied antibiotic ointment. Baytril for 3 weeks.
09/07/07	B067E	M	R10	Ruptured abscess and infected bite wounds on back. (Housed with mate and 2 sons)	Brought into foxpital. Vet resected abscess and removed necrotic tissue. Sutured wound closed internally and stapled externally. Butorphanol, SQ fluids, Vitamin B Complex, nutritional. Cefa drops for 2 weeks. Returned to pen 10 with mate on 09/25/07.
09/07/07	B6255	M	R08	Healing infected puncture wound at base of right ear on the caudal edge	Antibiotic ointment
09/07/07	F0223	M	R07	Firm tissue nodule protruding from inner mucosa at caudal aspect of right lower lip	Removed nodule and submitted tissue to Dr. Munson.
09/07/07	07061	F	R07	4mm darkly pigmented growth in upper third caudal aspect of right ear. Probably a cyst.	Vet surgically removed mass from ear, fluid drained upon removal. Tissue sent to Dr.

ISLAND FOX RECOVERY REPORT

Date	Fox ID	Sex	Pen	Injury	Treatment
09/08/07	31049	F	R12	Ruptured abscess on back of neck with pocketing. And foxtail in right eye.	Munson. Returned to pen after surgery. Brought into foxpital, 2 drain tubes installed and wound sutured by vet, foxtail removed from eye. Flushed wounds with antibiotic. Butorphanol for 3 days, clavamox for 2 weeks. BNP on eye. Put into pen RQ2 solo on 09/13/07.
09/08/07	65F0A	F	R21B	Foxtail in left ear.	Removed foxtail from ear.
10/21/07	60411	F	R06	Numerous infected bite wounds entire length of tail. (2007 pup in pen with 2 brothers and both parents)	Brought into foxpital. Cleaned wounds with chlorahexadine and applied silver sulfadiazine cream for 2 weeks. Clavamox for 2 weeks. Put into pen R05 solo on 11/03/07.
10/31/07	B067E	M	R10	Favoring right front limb	Captured, limbs examined with no significant findings except overgrown nails. Clipped nails.
10/31/07	7235F	M	R02	Small corneal ulcer at cranial corner of left eye near darkened area of vascularized scar tissue (may be permanent). Some conjunctival swelling.	Bought into foxpital. Examined by vet, checked tear production which was normal. Dyed eye and found small ulcer. BNP on left eye for 1 week. Returned to pen R02 with mate on 11/09/07.
10/31/07	97541	M	R12	Rectal prolapse when captured for pen move	Washed with saline and pushed back in with ky gel and gloved hand.
12/01/07	E485E	F	R09	Several healing puncture wounds to ears and head. 2.05 kg. Body condition 2.	Removed male.
12/25/07	B067E	M	R10	Two healing, infected wounds to area of heavy scar tissue from previous injuries. Both wounds heavily scabbed	Brought into foxpital. Cleaned wounds with chlorahexadine and sprayed with topical antibiotic, Cefa drops for 2 weeks. Returned to pen R10 with mate.
01/20/08	B067E	M	R10	Ruptured abscess on back with severe pocketing greater than 6".	Brought into foxpital. Vet removed infected tissue, installed two drains and sutured/stapled closed.

ISLAND FOX RECOVERY REPORT

Date	Fox ID	Sex	Pen	Injury	Treatment
01/20/08	31049	F	R12	Ruptured abscess on back of neck, same location as previous injury, lots of infected scar tissue.	Flushed with cefazolin for 5 days. Cefa drops for 3 weeks. Brought into foxpital. 2 drain tubes installed, wounds stapled. Butorphanol for 2 days,

Appendix B Island Foxes Currently in Captivity

Pen	PitTag	Studbook Number	Sex	Age	Born	Sire	Dam	Date Captured	Capture Area
San Miguel									
M08	7534A	14	F	15	Wild			9/4/1999	Nidever Canyon
Santa Rosa									
R01	80C3F	222	M	4	Captive	F0223	F4A18		
	25D54	149	F	6	Captive	73D0D	3512D		
R02	7235F	219	M	4	Captive	B067E	47304		
	A5E60	265	F	4	Wild	A045A	33131	10/19/2004	Windmill Canyon
R03	C4F63	177	M	5	Captive	D3D76	1612C		
	14454		F	1	Captive	64A43	D590E		
R04	64A43	304	M	3	Captive	B067E	47304		
	D590E	298	F	3	Captive	80C3F	25D54		
R05	13B68		M	1	Captive	B067E	47304		
	60411		F	1	Captive	01262	C4A1F		
R06	01262	339	M	2	Captive	80C3F	25D54		
	C4A1F	342	F	2	Captive	7235F	A5E60		
R07	1271E	144	M	6	Captive	70518	10030		
	65F0A		F	1	Captive	7235F	A5E60		
R08	B6255	302	M	3	Captive	B067E	47304		
	A7954	170	F	5	Captive	0654E	D187A		
R09	E5066	343	M	2	Captive	C4F63	A180A		
	51511		M	2	Wild			12/16/2007	Foxpital
	E485E	299	F	3	Captive	80C3F	25D54		
R10	B067E	24	M	10	Wild			3/26/2000	Smith Highway
	47304	145	F	6	Captive	70518	10030		
R11	8024B	348	M	2	Captive	85420	2410E		
	90B2B	340	F	2	Captive	80C3F	25D54		
R12	97541	305	M	3	Captive	47E09	A3B6D		
	31049	218	F	4	Captive	70518	10030		