Populations and Status of the Island Fox

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INTRODUCTION

The six largest of southern California's Channel Islands support populations of a diminutive relative of the Gray Fox (*Urocyon cinereoargenteus*) known as the Island Fox (*U. littoralis*). Each of these islands is considered to contain its own endemic subspecies: *U. l. littoralis* on San Miguel Island, *U. l. santarosae* on Santa Rosa Island, *U. l. santacruzae* on Santa Cruz Island, *U. l. dickeyi* on San Nicolas Island, *U. l. catalinae* on Santa Catalina Island, and *U. l. clementae* on San Clemente Island. The inter-island taxonomic affinities of this species and the degree of relationship to the mainland Gray Fox are not well understood. Discussions, though partially speculative, of the Island Fox's evolutionary history, systematics, and zoogeographical relationships can be found in Merriam (1903), Grinnell and Linsdale (1930), Grinnell *et al.* (1937), Stock (1943), von Bloeker (1967), Savage (1967), Orr (1968), Remington (1971), and Johnson (1975). Natural history observations can be found in Grinnell *et al.* (1937) and Laughrin (1973, 1977).

Prior to my studies, the only indications of the status of any of these fox populations had been derived from casual observations, some of which were reported in the literature (Grinnell *et al.* 1937). Dr. C. Stanton (pers. comm.) of the Santa Cruz Island Company, whose family first came to the island in 1937, stated that he remembered years when foxes were seldom seen. Company records show that, prior to Prohibition in 1918, foxes were so abundant that ranch hands were employed to kill them because they were destroying the grapes in the vineyards. H. H. Sheldon (unpubl. ms.) found foxes to be plentiful during 1928 on Santa Cruz Island; he trapped 155 of them over the course of that year. Sheldon also stated that "Mr. Fred Caire [then owner of the island] . . . had noticed a scarcity of foxes at certain periods during the forty years he [had] been at the island." During the 1950s, a mammal collecting group from the Museum of Vertebrate Zoology at the University of California, Berkeley observed only two or three individuals during a two-week visit to Santa Cruz Island (Bills 1969). Fluctuations in numbers have also been noted for Santa Rosa Island (A. Vail, pers. comm.) and Santa Catalina (Grinnell *et al.* 1937, D. Propst, pers. comm.). Comparable observations for the other Island Fox populations are unknown.

In 1971, because of the low abundance of the Santa Catalina Island Fox population and the geographical restrictions of all the island populations, the Island Fox was classified by the Fish and Game Commission as a rare species, according to the California Endangered Species Act of 1970. This classification and the lack of prior information on this species led me to begin studies of its natural history. This report is an attempt to provide information on the status of the six populations; as such, it focuses on abundance, distribution, and age structure. Other investigations are concerned with food habits, behavior, and home range movements.

METHODS

Abundance and population structure data for the six Island Fox populations were obtained by live-trapping methods. Accessibility, logistics, and facilities permitted more intensive investigation of the Santa Cruz Island population, though all of the other islands were visited at least once.

Quantitative estimates of fox abundance for different habitats, years, and islands were

TABLE 1. Population data of California Island Foxes.

	San Miguel	Santa Rosa	Santa Cruz	San Nicolas	Santa Catalina	San Clemente	Gray Fox	Red Fox
Number of trap periods	45	120	1310	165	126	384		
Total captures	18	43	543	29	2	150		
Total individuals	18	34	307	29	2 55*	103		
Trap efficiency (%)	43	50	67	27	3 11*	52		
Number fox/mi²	7	11	20.4	3	0.8	11	4†	0.8-1.4‡

* Propst (1975). † Lord (1961). ‡ Sargeant (1972).

desirable, so a procedure providing comparative indices was necessary. A live-trapping modification of the methods used with Gray Foxes in the southeastern U.S. (Wood 1959a, 1959b) was the basis of my trapping technique. Two sizes of National collapsible wire mesh traps were used: 8" x 8" x 18" and 6" x 6" x 14". The traps were placed in a line along roads or trails at 0.2-mile (0.32 km) intervals and were baited and set, then checked the following morning. Traplines were run for three nights and usually contained thirty traps. The techniques and bait used were the same for all of the islands.

Captured foxes were examined for ectoparasites, pelage condition, eye condition, general health, and age. Ages of the animals were determined by examining the degree of wear of the first upper molars (Wood 1959a). Though this method was developed for Gray Foxes, it also worked well for Island Foxes. On all of the islands, only one litter per pair is produced each year, at about the same time each year, so that differential tooth wear between separate age classes is distinct enough to distinguish ages up to five years. After this period of time, wear is usually to the gum level; age classes beyond five years, therefore, were combined for analysis. For convenience, one-year intervals were arbitrarily established beginning with May 1 (approximately the normal time of birth) and ending April 30. After examination, the foxes were tagged with numbered ear tags and released.

Traplines were placed in different habitat types on the various islands, as follows: coastal sage scrub and grassland-iceplant associations on San Miguel; grassland, coastal sage scrub, and some woodland scrub on Santa Rosa; chaparral and woodland on Santa Cruz; grassland and coastal dunes on San Nicolas; coastal sage scrub, woodland, chaparral, and riparian habitat on Santa Catalina; and grassland and coastal sage scrub on San Clemente. These habitats represent the majority of the important and widespread types available on all of the islands, except that on Santa Cruz trapping was not done in coastal sage scrub, grasslands, or pine forests. The Santa Cruz traplines were placed in the same location each year because sightings and scat frequency indicated it as a possible area of high density. Further studies will compare other habitat types on Santa Cruz Island.

Two abundance indices were used to compare the status of the island populations. One was trapping efficiency, which is the ratio of the number of captured foxes to the number of *available* trap periods (not *total* trap periods). The number of available trap periods is the total of trap periods minus the number of traps not available to capture foxes. Traps were sometimes not available for the following reasons: malfunctions, capture of other animals (*e.g.*, birds, juvenile pigs, feral cats), disturbance of the trap, or removal of the bait by other animals. The second index was devised to estimate densities of the various island populations within the

TABLE 2. Population data of San Nicolas and Santa Catalina Island Foxes.

	San Nicolas Island			Santa Catalina Island		
	1971	1974	1977	1972	1975*	1977
Trap periods	40	52	75	60	597	66
Captures	24	2	3	2	55	0
Individuals	24	2	3	2	55	0
Efficiency (%)	72	4	4.7	6	11	0
Fox/mi²	7	1.3	0.3	0.3	2	0

*Propst (1975).

habitats sampled. Because a grid trap layout was not used, a width factor (0.5 mi, 0.8 km), based upon other studies of recapture distance and home range data (Laughrin 1977), was multiplied by the trapline length to yield an estimate of the true area sampled. The number of individual foxes captured along the line during the three-day session was then divided by the estimated area to give a density estimate. Not all of the island habitats were sampled, nor were the extents of these habitats determined. Sampling was not done over most of each island's area. Thus, only a crude estimate of each island's total fox population is available.

RESULTS AND DISCUSSION

Island Fox populations are distributed over most of the area of the islands on which they occur, though the abundance varies by habitat type (Laughrin 1977). Estimates of the abundance of each Island Fox population are given in Table 1 and are for the habitat types sampled on each island (see Methods). The data for San Miguel Island are from one trapping session in 1971. Data for Santa Rosa are from one session in 1972. Data for Santa Cruz are from seven sessions from 1973 to 1977; the abundance estimates are means. Data for San Nicolas are from three sessions from 1971 to 1977; the abundance estimates for this island also are means. Similarly, data for Santa Catalina are from three sessions from 1972 to 1977, while those for San Clemente are from four sessions in 1972. Also included are data from a study by Propst (1975) on Santa Catalina. For comparative purposes, estimates of densities for midwestern U.S. Gray Foxes (Lord 1961) and Red Foxes (*Vulpes vulpes*) (Sargeant 1972) are given.

The results in Table 1 show that, generally, Island Fox populations exist at higher densities than fox populations on the mainland. They also show that there is a considerable difference in abundance for different islands. Part of this can be accounted for by habitat differences. The higher estimate for the Santa Cruz Island population is, in large part, due to having trapped in a richer vegetative area of woodland-chaparral—a habitat type quite abundant on Santa Cruz. Areas of greater food productivity and availability can support denser populations (Laughrin 1977).

There is also a discrepancy between estimates for islands of similar habitat types, however. Foxes on San Miguel, Santa Rosa, San Nicolas, and San Clemente Islands were trapped in essentially similar vegetation, but were much less abundant on San Nicolas. This same discrepancy is evident in comparisons between populations on Santa Cruz and Santa Catalina, with Santa Catalina having far fewer foxes.

Because of the low estimates of density on San Nicolas and Santa Catalina Islands, repeat visits were made to gather more information. Data for these comparisons are found in Table 2. While San Nicolas initially showed a population level comparable to similar situations on other islands, data from later visits indicated a decline in abundance. The population on Santa

TABLE 3. Trapping results for population data of Santa Cruz Island Foxes.

	3/73	10/73	5/74	2/75	2/76	9/76	9/77
Trap periods	180	80	75	144	115	150	75
Captures	100	49	35	87	41	63	41
Individuals	53	36	28	45	28	37	32
Trap efficiency (%)	71	66	65	76	49	64	78
Number fox/mi^2	25.4	21.2	16.4	22.2	15.2	18.2	23.8

Catalina appears to have been, and remained, at a rather low level. Propst's (1975) study indicated a slightly greater abundance, or the possibility of an increase, but this was not substantiated in 1977. Other signs of fox activity, such as scat, tracks, trails, and casual sightings by me and other island personnel, were also very limited for these two islands. Qualitative observations of the vegetation in habitats on these islands did not offer any clues for causes of low numbers of foxes. On San Nicolas Island there was an alarming trend of an increase in abundance and dispersal of feral cats. Feral cats have also been trapped on Santa Catalina, but there is no information regarding the extent of their distribution or relationship to fox population levels. San Clemente has a large number of feral cats, but apparently there has been little adverse effect on the fox population (R. Wilson, pers. comm.). I suspect, however, that the fox population would be higher in the absence of the cats.

Table 3 gives Santa Cruz Island abundance estimates for the years 1973 to 1977. There have been some minor fluctuations during this period, especially considering the uncontrollable parameters involved in live-trapping techniques, but, overall, there are indications of relative stability.

The results of age structure analysis indicated a high proportion of older animals in the Island Fox populations. The ratio of juveniles (first-year animals) to adults for Santa Cruz Island was 0.19, while the mean ratio for all the islands was 0.26. Juvenile to adult ratios for Red Foxes are 1.06 to 7.5 (Petrides 1950, Schofield 1958, Phillips 1970) and for Gray Foxes are 1.08 to 1.63 (Petrides 1950, Layne 1958, Wood 1959a, Lord 1961). Thus, first-year animals represent a smaller proportion in island populations and, presumably, there are lower mortality rates among the older age classes of Island Foxes.

SUMMARY

Investigations of Island Foxes, utilizing live-trapping techniques, during the period 1971 to 1977 have shown that the populations on Santa Cruz, Santa Rosa, San Miguel, and San Clemente Islands have maintained themselves at high densities relative both to the populations on Santa Catalina and San Nicolas Islands and to the populations of the closely related mainland Gray Fox. Reasons for the decline and low densities of two of the Island Fox populations remain speculative. An analysis of the age structures of the populations shows there to be a high percentage of old individuals, in contrast to mainland fox populations.

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