STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

CALIFORNIA ISLAND FOX SURVEY[1/]
1973

by
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ABSTRACT

The current status of inland fox (Urocyon littoralis) populations on the six Channel Islands offshore of southern California were determined. Through live trapping an index to fox density was calculated for San Miguel Island, Santa Rosa Island, Santa Cruz Island, San Nicolas Island, Santa Catalina Island, and San Clemente Island. Additional knowledge was gathered on habitat use, food habits, and life history. With the exception of Santa Catalina Island all island fox populations appeared normal and healthy. The Santa Catalina island fox (W. l. catalina) may prove to be endangered.

1/ Wildlife Management Branch Administrative Report No. 73-3 (June 1973). Supported by Federal Aid in Wildlife Restoration Project W-54-R "Special Wildlife Investigations."

RECOMMENDATIONS

1. Surveillance of the island fox population on each of the six Channel Islands be continued.

2. A detailed study be immediately instigated to determine more fully the status of the Santa Catalina island fox and factors threatening its continued existence.

3. A coordinated research program by state and federal agencies and scientific institutions of the Channel Islands be immediately undertaken to better understand the ecology of California's insular biota and effects of man. From such research, management program be developed to assure preservation of the native flora and fauna on both privately and publicly owned islands.

INTRODUCTION

Six of the Channel Islands, offshore of southern California, support a diminutive form of the gray fox known as the island fox (Urocyon littoralis). Scientific accounts of this animal are extremely limited and consist mostly of taxonomic descriptions of each island population (Baird, 1857; Merriam, 1903; Grinnell and Linsdale, 1930; and Grinnell, Dixon, and Linsdale, 1937).

Prior to 1971 this species was given no legal recognition under the protective laws of the Fish and Game Code or rules and regulations of the California Fish and Game Commission. With passage of the California Endangered Species Act in 1970, authority was granted the Fish and Game Commission to declare for California its rare and endangered animals. On May 21, 1971, the Commission adopted a rare and endangered listing of 43 animals. The island fox was classified as a rare species; thusly, extending long needed protection to this unique and little known animal.

In compliance with the California Species Preservation Act of 1970, the Department of Fish and Game, Special Wildlife Investigations, initiated an Island Fox Survey. The author while pursuing his doctorate on the Santa Cruz Island fox was intermittently employed from July, 1971 to September, 1972 to survey the islands and determine the current status of the island fox.

OBJECTIVES

Specific objectives of the study were for each of the six Channel Islands occupied by the island fox determine: (1) Habitat distribution and relative abundance, (2) Food habits and availability of food; and, (3) Identify factors affecting its welfare.

STUDY AREA

General Description

Location

The California Channel Islands consist of 8 continental islands off the coast of southern California (Figure 1). They are separated into two groups on the basis of location. The Northern Channel Islands consist of Anacapa, Santa Cruz, Santa Rosa, and San Miguel islands; whereas, the Southern Channel Islands are Santa Barbara, San Nicolas, Santa Catalina, and San Clemente islands. Table 1 gives each island's area in square miles, its distance from the mainland and from its nearest neighbor island.

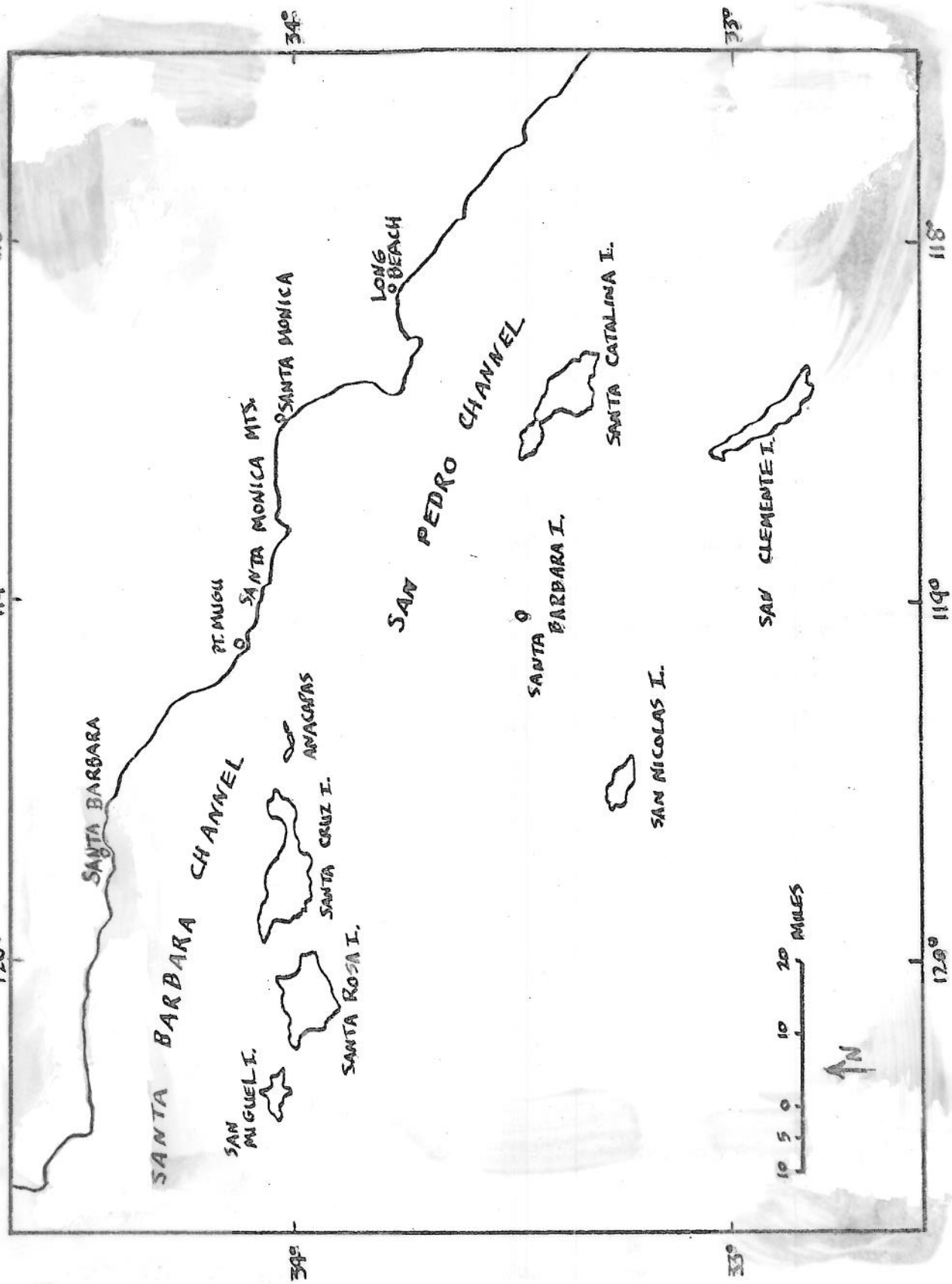


FIGURE 1. Map of the California Channel Islands

TABLE 1: Distance from the Mainland and Area (square statute) of the California Channel Islands with the Names of the Island Fox Subspecies Found on Them.[1]

Island	Distance from Mainland (Statute Miles)	Area (Square Miles)	Subspecies of Island Fox
San Miguel	26 (3 to SR)[2]	14	U. l. littoralis
Santa Rosa	27 (6 to SCr)	84	U. l. santarosae
Santa Cruz	19 (5 to A)	96	U. l. santacruzae
Anacapa	13	1.1	
Santa Barbara	38 (24 to SCa)	1.0	
San Nicolas	61 (28 to SBa)	22	U. l. dickeyi
Santa Catalina	20	75	U. l. catalinae
San Clemente	41 (21 to SCa)	56	U. l. clementae

1/ Figures from Philbrick, 1967
2/ Distance to nearby intervening island

Appended are detailed descriptions of the islands inhabited by island fox together with notes concerning their biology. For further detail, the reader is referred to an excellent account of the Channel Islands along with some of their insular phenomena presented by Thorne (1969).

Climate

The overall climate of the Channel Islands is similar to adjacent coastal mainland areas and is best described as maritime Mediterranean. Island temperatures, except in the larger central valleys and canyons of Santa Cruz and Santa Catalina, tend to fluctuate less both diurnally and seasonally. Rainfall records show a rather close correspondence to the nearby mainland. The outer islands tend to receive more fog and wind, especially San Miguel and San Nicolas.

Vegetation

The same plant communities occur on the islands under appropriate climatic and edaphic conditions as occur on the mainland. The overall aspect of each habitat is similar, with the differences being due to the presence or absence of certain species or in some cases in the dominance of a species. The following prevalent insular habitat types are much the same as their mainland counterparts: Coastal Sage Scrub, Chaparral, and Scrub-Oak Woodland.

Because of the many factors responsible for the resulting diversity of habitat types between the different islands, a more complete discussion of the communities will be given under specific island accounts. The general flora of the Channel Islands has been discussed by Dunkle (1950). Several of the islands have had their flora's characterized rather completely. These include San Clemente (Raven, 1963), Santa Catalina (Thorne, 1967), and Santa Barbara (Philbrick, 1972). In addition, Philbrick is currently

completing a thorough investigation of the flora of the northern Channel Islands.

Wildlife

Because of isolation in terms of distance and geological time, there has developed a few endemic species and subspecies of terrestrial animals. As one would expect this occurred with those animals--amphibians, reptiles, and mammals--with poor dispersal ability. In contrast, many insects, and most birds and bats, were able to cross the not too distant barriers of the Santa Barbara and San Pedro Channels and successfully colonize the islands. Despite this, however, there are conspicuous absences. For example, amongst the insular avifaunas in the chaparral habitats there are no wrentits, thrashers, or brown towhees. Presumably, poor dispersal ability, poor colonizing ability, and prior arrival of potential competitors are some of the factors involved in the dynamics of determining total faunal composition. The most distinct member of the insular avifauna is the island jay. This subspecies is larger and more intensely blue in coloration than its mainland counterpart, the scrub jay. Recent changes in the avifaunas includes disappearance of breeding populations of bald eagles, ospreys, and peregrine falcons and a reduction in the nesting of the brown pelican.

Further evidence of the depauperate fauna can be learned from examination of the listing of amphibians, reptiles, and mammals given in Appendix A-7. Also, of note is the dissimilarity between island faunas, especially the herptofauna. For further details see Savage (1967). Even greater attenuation is shown in the mammalian faunas. The deer mouse is the most widespread, being on all eight islands. Next is the island fox on the six largest islands. Several of the islands have introduced rodents as noted in the table and all have suffered from the introduction of domestic livestock. Several interesting mammals have existed on the islands in the past as Pleistocene fossil sites have yielded remains of such animals as the dwarf mammoth (Mammuthus exilis) and the giant mouse (Peromyscus nesodytes).

STUDY METHODS

Scope of Study

Due to the limited scope of the study and trip logistics, plans were to spend only 3-4 days on each island. Circumstances developed that allowed for revisitation to San Clemente and Santa Cruz islands.

During each island visit an attempt was made to reconnoiter as much of each island as possible. General observations were made of the flora and fauna, noting vegetation types, condition of the habitat, and presence of food species. All areas visited were searched for signs of fox use. Island fox food habits were assessed by scat analysis in the field and in the laboratory. The importance of the different food items was estimated by volume of item per scat. Although this did not give an accurate nutritional contribution for food items, it was adequate for the purposes of this study. Table 2 summarizes the food habits of the various island foxes.

TABLE 2

A Comparison of the Diets of the Various Island Fox Populations Showing Common Food Items Expressed in Percent of Occurrence in Scats

FOOD ITEMS	San Miguel	Santa Rosa	Santa Cruz	San Nicolas	Santa Catalina	San Clemente
Vegetable						
Cacti	---	--	4	--	45	23
Toyon	---	--	67	--	57	--
Iceplant	45	--	--	2	--	--
Saltbush	---	18	--	60	--	7
Insect						
Coleoptera	90	61	45	25	26	57
Grasshopper	24	16		16		6
Jerusalem Cricket	65	42	40		16	
Birds	2		2	4	4	4
Mammals	32	6	1	3	28	6
Deer Mouse	---	--	--	--	--	--
Number of Scats	125	85	96	95	58	70

Population Estimate

Trapping

Some quantitative estimate for abundance was desired so a procedure utilizing live-trapping was developed. Traps used were a collapsible National wire mesh type of 8" x 8" x 18". Bait was usually sardines or bacon.

Traplines were laid out in more or less straight lines with the traps placed at intervals of 0.2 miles. For convenience, whenever possible, traplines were set along secondary roads with traps being 10-20 feet from the road edge. Traps were baited, set, and checked in the early morning and usually again in the evening, though in some circumstances they were only checked in the morning once a day. Foxes captured were tagged with numbered clips in their ears (right ear for males, left ear for females). The tags used were "Jiffy" poultry wing bands (National Band and Tag Company) and were clamped to the ear with a special pliers. Foxes were examined for ectoparasites, pelage condition, and sign of disease. Females were examined for reproductive state.

To determine the population's age structure an estimate of age was obtained from the degree of wear of the first molar (Wood, 1964). With this technique the distinction between year classes becomes difficult with age groups beyond 5-6 years. It was found best to lump all animals older than 5-6 into one group; although, on occasion 7-8 year individuals were recognized. Following field examination, the fox was released. Records were kept of recaptures and distance moved.

Trapping Effort

Actual trapping effort (number of trap periods is defined as time between each trap check) varied from island to island due to the number of traps available at the time and to the opportunity for repeated visits. Since most traplines were of similar design, relative estimates are reliable enough for present requirements.

As is true of virtually all attempts to estimate populations of higher vertebrates from trapping, some assumptions and factors operate that influence accuracy of the results. An assumption in this study is that such factors would operate similarily for each of the different populations. However, since populations were not sampled at the same time of year this may or may not have been true. In order to make comparisons of the status of the various populations, the trapping data was presented as indices of abundance. One comparison was the ratio of the number of captures to the number of trap periods (trap efficiency). To reduce the variables as much as possible the comparisons were based upon the mean trap-period efficiency and not the total number of trap-periods listed in Table 3. In calculating trap efficiency traps that were empty but closed and those that caught other species (cats, skunks, ravens) were excluded. The successful captures included recaptured animals.

TABLE 3

Island Fox Trapping Results

Island	Number of trap-periods	Total captures of foxes	Total individual foxes captured	Mean trap-period efficiency (%)	Density estimate (fox/mi.2/
San Miguel	45	18	18	43	7
Santa Rosa	120	43	34	50	11
Santa Cruz	426	195	115	72	33
San Nicolas	40	24	24	72	7
Santa Catalina	60	2	2	6	0.3
San Clemente	384	150	103	52	11

Several approaches were made to compute fox density from the number of different individuals caught for the area of the trapline. The assumption was made that the line sampled an area 0.5 mile in width. This was based upon the average distance of movement for recaptured individuals on San Clemente Island (see appended account of San Clemente Island).

A Lincoln Index estimate of fox abundance was calculated for two islands with available recapture data (Appendices A-2 and A-6). However, differences in trapline design and underlying assumptions inherent in the Lincoln Index formula made it meaningless.

Finally, an estimate of the fox population of each island was explored by multiplying fox density by the island's size. Due, however, to the unreliability of density estimates and inappropriateness of applying these estimates to the entire island, a determination of population size was abandoned. Future studies--utilizing one standard trap design, either line or grid--might offer a method of determining population. In addition, to standardizing trap design, future attention should be directed to (1) trapping the various islands as close in time as possible; (2) more adequately covering habitat types; and, (3) repeated sampling.

LIFE HISTORY

The following life history discussion is based on the author's three-year study of the Santa Cruz island fox, information available in literature, and unpublished notes by other workers.

Morphology

Adult island foxes in good health average between 4 1/2 to 5 pounds as compared to the mainland gray fox average weight of 9 pounds. Minor differences from the gray fox also occur in skeletal morphology while color and color patterns are similar. Differences have been previously described for color patterns and body size proportions for the different island populations (Grinnell, et al., 1937).

Reproduction and Behavior

Courtship activities may be as late as May; however, most copulation occurs as late as February and early March with Gestation period of approximately 50 days. For the most part, young are born from late April through May with a peak in parturition about the first week in May. Juveniles may remain with their parents throughout the summer. Usually by August or early September, parents will begin forcing young to become independent. Average number of young raised to maturity is approximately two. Litter size may be as many as five.

Young are born in a den, but unlike many other canids, it is usually not excavated by the parents. Island foxes, like the gray fox, seem to use any readily available site. They often use a brush pile, rock pile, or even man-made structures. This fox is a very agile tree climber and dens have been reported and observed in hollowed limbs or stumps. The den is rather simple in structure, usually at the end of a short tunnel or a depression under a rock or log. Protection is primarily needed only from the weather.

Island fox social behavior is based upon single family units. They are solitary or occur in pairs throughout the year except during the reproductive season when pups are with their parents.

Activity patterns vary diurnally and seasonally. Daily foraging usually occurs in the early morning and late afternoon to early evening hours. However, it is common to observe individuals moving about at virtually any hour of the day or night. The times of least activity are mid-day (especially on hot, sunny days) and the very early morning hours (0200 - 0500). Presumably, derived from a basically nocturnal ancestor, the island fox seems to prefer lower light intensities, but the reduced predation, competition, and in some cases food availability restrictions have allowed adaptation to a more diurnal existence than its mainland relative.

Investigations have indicated a potential home range of approximately .05 square miles. This is based primarily upon retrapping records of the Santa Cruz and San Clemente Island populations which had an average of about 0.2 miles between recapture points. Movement varied with age. Distances up to one mile between first and subsequent recapture sites have been recorded for animals in their first year. Animals in their prime (2 - 4 years old) appeared to be fairly sedentary. As these foxes advance in age greater movement seems to occur; for example, an individual of at least 6 years old was moving back and forth over a distance of 2 miles daily.

Longevity

Certain aspects of population dynamics are still under investigation. Normal life span is yet unknown, but is assumed to be somewhat comparable to a dog of similar size. A pair in captivity at the University of California at Santa Barbara died when at least eight years old and the female did not reproduce during her final year. Estimated age structure of the island fox populations indicates that a substantial proportion of old individuals are retained within the population. A comparison of the age structures of the island fox populations (Figure 2) shows that this phenomenon is a common occurrence. Comparable data for the gray fox indicates that most of the population members are younger animals.

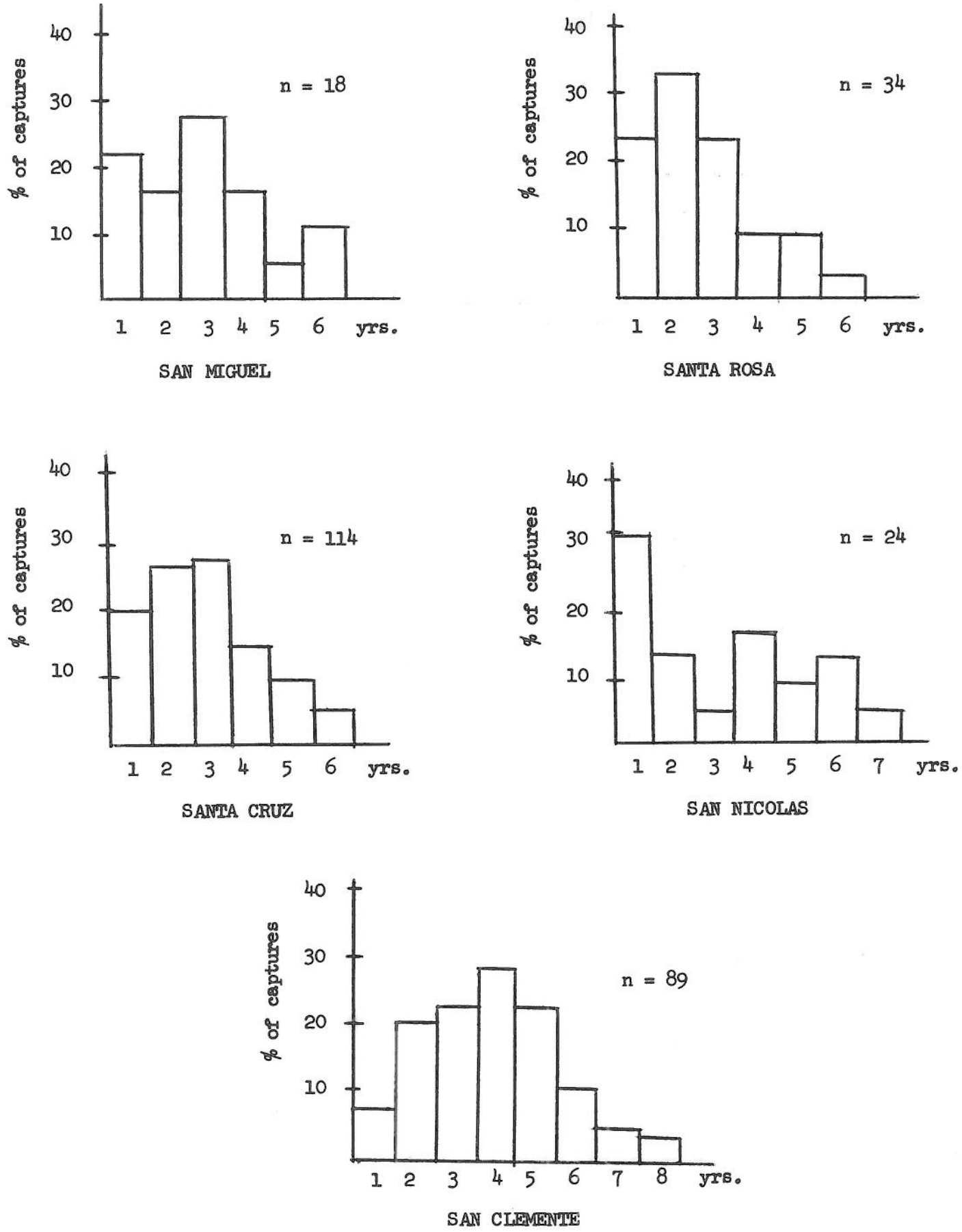
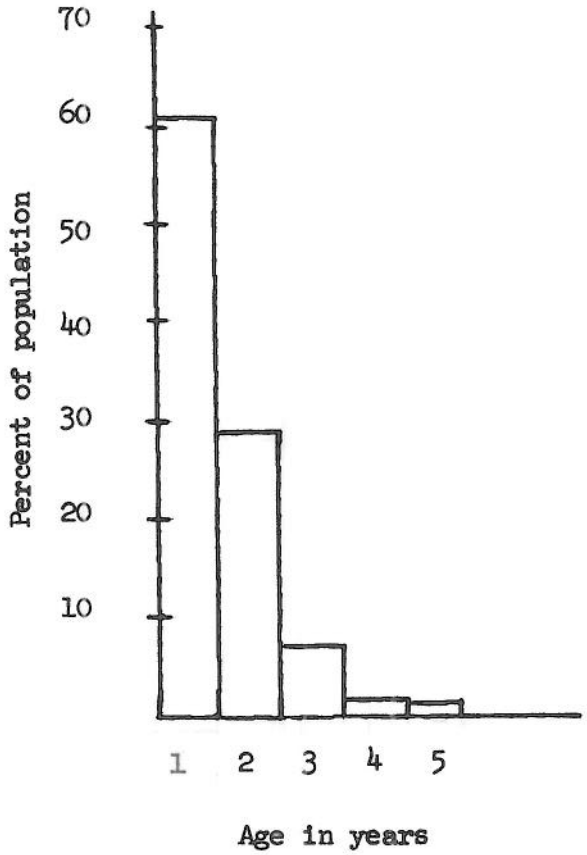


FIGURE 2. Estimated Age Structure of Island Fox Populations.

In contrast, comparable data for the gray fox (Figure 3) indicates that most of the population members are younger animals.

FIGURE 3

f. Age Structure of a Gray Fox Population in Southeastern United States (Wood, 1959).



Recruitment of young and mortality have yet to be assessed. General deteriorating health of older individuals may be a principle mortality factor. Some individuals appear to develop glaucoma to the extent that they are almost completely blind and, generally, their fur condition is poor. These animals are almost always very old (6 to 7 years) and have very poor teeth, usually with many completely missing and the molars worn to the gum line.

Comments are often seen concerning the "poor" eyesight or eye problems of these foxes. Trapping experience indicates that young healthy animals (1 - 4 year age classes) seldom have any eye problems. Some of these comments probably stem from the squint-eyed appearance of the animal under conditions of high light intensity. Their ancestors were undoubtedly nocturnal animals and their eyes would be expected to be best adapted for low light intensity conditions.

Red-tailed hawks may prey upon unhealthy adults and young foxes. The fur of

fox kits has been found in the casting of these hawks. It is doubtful that hawks could take healthy adults. Ravens may be exact a toll of young foxes, but this requires substantiation. In the past, bald eagles may have preyed on foxes, but they no longer exist on the Channel Islands. Golden eagles have been seen on occasion, but none are resident on the islands.

To date, no information is available to account for known fluctuations in island fox populations. Observed ratio of males to females of captured animals was not significantly different from 1:1.

Food Habits

Island foxes, like gray foxes, can be considered to be omnivorous. The results of the food habits investigation are found in Table 2 and Appendix A-8.

CONCLUSION

This investigation into the status of the island fox has indicated that on 5 of the 6 islands where they occur, they are widespread and relatively abundant. On the sixth island--Santa Catalina Island--the fox population appears to be very low and possibly restricted in distribution.

Observed variation in abundance of fox populations on the other islands is best explained by apparent differences in habitat availability and food productivity. Since a substantial portion of the diet is plant food, one would expect the greatest fox density to occur in those islands with diversity in food source. These tend to be those islands with the woody, perennial plants characteristic of woodland and chaparral. Also, because insects are a substantial item of diet, one would expect a similar correlation to exist.

An example of correlation between fox abundance and habitat productivity was revealed from data of the Santa Rosa population. Two habitat types were sampled. One was basically one-layered in structure, dominated by annual grasses and perennial forbs usually less than two feet in height, and grazed by cattle. Taller shrubs were sometimes present either in gullies and canyon bottoms or widely scattered on uplands and were not a significant part of the cover. This situation was almost certainly low in productivity of appropriate vegetative material for fox consumption. Insect availability may have been lower here too. Fox density was about 6 animals per square mile. In contrast, a second area with a greater plant species diversity was sampled on the eastern side of the island and the density estimated to be 15 foxes per square mile. This more complex vegetative association was grouped into three layers: grasslands and forbs (0-1'), perennial woody shrubs (1-6'), and trees (6-20'). Presence of the middle layer of fruiting shrubs is probably the important addition as it includes much of the vegetative aspect of the fox's diet while the total increased diversity increases the insect availability.

Habitat difference, both in structure and species diversity, is probably the most important factor accounting for the high fox population on Santa Cruz Island. Relatively low fox densities on San Miguel and San Nicolas Islands were comparable to those observed in the sampling of Grassland habitat on

Santa Rosa Island. This is not surprising as the habitats are quite similar especially in terms of structural aspect and probably productivity. Considering the limited investigation it is impossible to say whether the differences are significant.

Densities that were comparable to the chaparral-woodland situation of Santa Rosa Island were observed on San Clemente Island. The density estimates for San Clemente were actually higher than expected from the type of habitat present. On San Clemente the woody shrubs and trees were confined to canyon bottoms and precipitous cliffs, especially along the southeast edge of the island. The rest of the island's vegetation is of three types: (1) One-layered grassland of the mid-upper part of the island, (2) Two-layered grassland-cactus of the southern end; and, (3) Two layered cactus scrub of the lower terraces on the west side. The first two types had comparable densities of 10 and 12 foxes per square mile. The density observed at the southern end of the island was also surprising in that this area still received quite heavy grazing from goats in comparison to the middle upper grasslands. Perhaps without goats the area would support a greater density of foxes.

In terms of island fox populations this leaves only Santa Catalina Island to be discussed. With only two captures very little can be said except that the fox density appeared to be drastically reduced and their distribution rather limited. The habitats sampled appeared to be comparable in complexity, productivity, and extent to those of Santa Cruz Island. Plant diversity certainly was similar and comparable fruit bearing species were present. Frequency and productivity of these forms was not obtained and this should be done for comparison during future investigation. Superficial observations in areas trapped indicated that the present state of the vegetation was probably not responsible for the low observed density. Other parts of Santa Catalina such as grasslands and areas still under grazing pressure from goats might be expected to show low densities but these were not sampled.

Discussion of other factors potentially responsible for reducing fox density can only be speculative at this time but should be included for the sake of future investigation. Fluctuations in fox abundance have apparently occurred in the past on several of the islands. Whether such fluctuations had any regularity correlated with rainfall patterns or food availability is unknown. Fluctuations could have occurred in response to changes in intensity of grazing pressures by feral livestock. Disease has been unknown in these island fox populations and no reports of particularly unhealthy foxes have been received for Santa Catalina Island.

Future monitoring and investigation of these island fox populations will be necessary to establish the roles and interactions of the factors determining the abundance of these animals.

Some other aspects of the island fox's biology were observed during this investigation. It is sufficient to say that this fox consumes just about everything that is available, carrion, any fleshy fruits or seeds, almost all insects and smaller vertebrates except slender salamanders. Food habits analysis data (Table 2) gives only an approximation of the fox's diet. For the most part, it represents samples from one time of the year and a limited portion of each island. Thus, the items themselves, and their contribution to the diet would be expected to vary throughout the

year as well as from year to year. Appendix A-8 contains a more complete listing of items identified from the fecal material. It also gives the distribution of many of these items by island with an approximation of abundance. Under conditions of relatively abundant food resources, reduced competition, almost no predation, and absences of disease one would expect the longevity of these animals to have increased and this apparently has happened judging from a comparison of the age structures of these island populations and a gray fox mainland population.

The geographic proximity of these islands to a major human population center virtually assured them of coming under modern man's influence. The one activity that most drastically affected the habitat and organisms on these islands was the introduction of grazing livestock during the 19th century. The early uncontrolled overgrazing (which still occurs on parts of some of these islands with feral animals) undoubtedly led to the extinction of insular species (Philbrick, 1972). Overgrazing probably had a detrimental effect upon food resources of some of the island animals and may have been responsible for fluctuations in fox populations. To varying degrees these situations have improved and under the present landholders and administrators further improvements are being instigated or continued. Another potentially detrimental pressure upon the insular habitats could come from the intensity of human activity and its associated developments.

Brief comments on this situation follow. On San Miguel livestock have been removed for a number of years with the exception of about 20 feral burros. The vegetation is in fairly good state of recovery. The nonnative iceplant which has spread readily on the unstable dune areas appeared to be a significant part of the fox's diet. Under the Navy and with surveillance from the National Park Service, access to the island is severely restricted and there are no permanent inhabitants or facilities. This island is currently the least affected by man's activities.

Santa Rosa Island, a privately owned cattle ranch, is unaccessible to the general public. Feral sheep have been removed completely but feral pigs still exist in limited numbers. Cattle grazing pressure is not severe and the vegetation has recovered to a stable condition. The amount of grazing and the isolation apparently have not been detrimental to the fox population as it is in good condition. The present human population is small and there is limited development at the ranch headquarters. The landowner and ranch personnel have had a positive attitude toward protection of the fox and this will undoubtedly continue.

Santa Cruz Island, under two landowners, has a very limited human development. On the Santa Cruz Island Company's part of the island, an extensive feral sheep removal program was begun in the early 1960s. A series of fences now restricts them to a portion on the north side of the island and a hunting program continues to control and reduce their numbers. Feral sheep still exist in numbers on the eastern part of the island. Where the sheep have been removed, vegetation is in good condition and continuing to improve. Feral pigs are still present and are hunted. Cattle grazing is regulated and not severe in areas without sheep. Dr. C. Q. Stanton of the Santa Cruz Island Company has always had an excellent preservation attitude toward the island fox and the island in general.

San Nicolas Island, administered by the Navy through the Pacific Missile Range, has a human population of several hundred during the working week.

Public access is almost exclusively limited to research scientists. Feral animals have been completely eliminated except for about a half dozen recently introduced house cats. These should be removed. The fox appears to be compatible with the amount of activity now present as its population is doing well. Naval personnel have been interested in the preservation and well-being of the fox.

Santa Catalina Island, privately owned and containing an incorporated city, has the largest human population, most activity and easiest accessibility of all the islands. Human activity is concentrated at two resort locations, Avalon and the Isthmus. Most of it is restricted to the beach areas but access is available to much of the island's interior. There is also a greater intensity of activity associated with the ranching aspect on this island than on the other islands. Large portions of the island have had the feral animals removed and vegetative recovery continues to occur though regulated grazing by cattle and bison continues. Areas with feral goats still suffer from severe overgrazing. Feral pigs occur and these along with boats are hunted, though complete elimination is not foreseen. The present wildlife manager for the island is greatly in favor of doing all that is possible to improve the status of the fox, but until more is known about the interacting factors responsible for its decline it will be difficult to propose a management plan.

San Clemente Island also contains a fairly large and active Naval facility. There is a human population of several hundred with buildings and roads scattered throughout the island. Human impact upon the environment has been further increased by the Navy's long-term use of part of this island as a gunnery bombardment range. Past overgrazing on this island was perhaps most severe of the islands. Sheep ranching was at one time conducted here but all feral sheep have been eliminated. Feral goats are still present in great numbers as well as feral cats and feral pigs. Feral cats, which are widespread over the island, are perhaps the greatest potential threat to the island foxes from two considerations. First, they are potential competitors as the cats consume an appreciable amount of insect, reptiles, birds, and small mammals. Secondly, they are potential reservoirs of disease, though fox susceptibility has not been established. A cooperative wildlife management plan by the U. S. Navy, California State University at San Diego, and Department of Fish and Game is being devised. Hopefully all feral animals will be removed enabling the native vegetation to reestablish itself. In spite of all this seemingly adverse activity the island fox population appears in good condition at this time. Personnel concerned with the island are in favor of doing all possible to ensure that it continues to remain in good condition.

The current legal status of the island fox is that it is classified as a rare animal under authority of the California Endangered Species Act. At this time, with the limited information available, the Santa Catalina Island fox can be considered at a point of endangerment. The other island populations appear to be doing well considering the habitat available and current land ownership and land use. Until further monitoring of island fox populations and intensive study of the Santa Catalina situation is accomplished, a change in legal status is not in order.

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APPENDIXES

SAN MIGUEL ISLAND

Location: San Miguel Island lies at the western end of the chain of northern Channel Islands. This island is under the jurisdiction of the U. S. Navy's Pacific Missile Range at Point Mugu. The Navy has no facilities on the island and public access to it is restricted. Civilian researchers are permitted, coordinated through the office of the Channel Islands National Monument in Oxnard.

Description: There is little diversity in the topography of San Miguel. Two or three canyons and two hills reaching slightly over 800' provide virtually all of the relief. The majority of the surface is a series of undulating well weathered ridges, small gullies and flatlands. There are only one or two spots with available ground water on the upper part of the island, though several springs occur around the beach perimeters. The island is exposed to frequent and strong winds. The general low relief and types of plants found inhabiting it leads one to believe that rainfall is probably low, though fog occurs commonly.

The vegetation, basically a Coastal Sage Scrub type, is dominated by low growing shrubs and iceplant, especially in the areas with a sandy substrate. Constant shifting and disturbance of the sand by the wind have allowed the introduced iceplants (Mesembryanthemum nodiflorum and M. crystallinum) to become widespread. Other common shrubs are Astragalus, Eriophyllum, Lupinus, and Baccharis. Towards the east side the vegetation is dominated by introduced grasses and Atriplex.

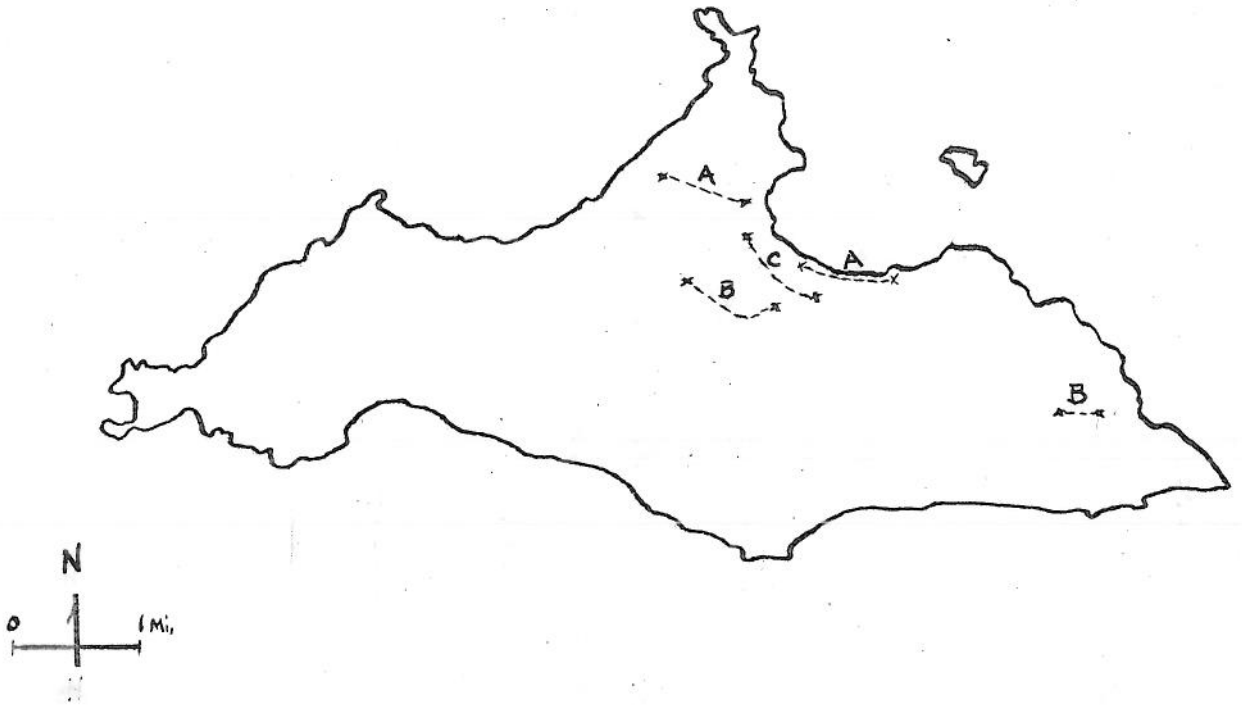
This island's isolation, as well as the low diversity of topography and vegetation are factors in the low diversity of resident fauna (Appendix A-7). Sheep at one time overran the island and vegetative recovery is progressing though the effects of overgrazing are still evident. A small group of feral burros still exists on the island.

Population Survey: Survey of San Miguel Island occurred on October 27-30, 1971. Traps were set on three successive nights and lines were moved each day (refer to the location map). Intervals between trap sites were about 0.1 miles. Traps were set on October 27 in two groups. Transect (A) consisted of 6 traps placed along Cuyler beach at the base of the bluff and 9 traps were placed in a line running Northwest from Cuyler Harbor toward Simonton Cove. The next day the upper group of traps was moved further west from Cuyler Harbor (B) towards the island's interior. This line included an arroyo with dense bush lupine and coyote bush, as well as grassland-iceplant shrub. The other traps were moved to the east side of the old ranch

(C) and placed in a large canyon north of Cardwell Point. One trap was left at a beach site. The afternoon of October 29 the traps were moved again. The 9 upper traps were put along the perimeter of the bluff above the western part of Cuyler Harbor (D). The other 6 traps were again placed along Cuyler Beach (A).

The capture results, estimated densities, and age structure are contained in Fugure 2 and Table 3. In addition to foxes trapped, many animals were seen moving about during our stay on the island, especially during afternoon hikes. For example, during a hike from above the west side of Cuyler Harbor to a large canyon east of the old ranch, and circling around to the north and returning to the east side of Cuyler Harbor, we had 30 fox sightings. Many of these were foraging, probably for insects. Thus, the island fox appears to be abundant on San Miguel at this time.

Food habit analysis showed iceplant and insects to be the principal diet for this time of year (Table 2 and Appendix A-8). Arborescent fruiting shrubs are not available on this island so the foxes probably rely heavily upon insects, iceplant, Atriplex, and scavenging. As the proportion of deer mice remains in scats was greatest on this island, this rodent may be an important part of the fox's year-round diet. Status of the deer mouse population is unknown and should be determined.



A. SAN MIGUEL ISLAND

SANTA ROSA ISLAND

Location: Santa Rosa Island, located in the northern group of islands between San Miguel and Santa Cruz, is owned by the Vail and Vickers Company. The second largest of the Channel Islands, it is about 14.5 miles long and 10 miles wide.

Description: Relative to the other islands, the topography of Santa Rosa is of intermediate relief and diversity with some mountains reaching 1500'. There are numerous canyons many of which are the result of geologically recent dissection of terraces. Some of these carry year-round water, but only three fresh water springs are known on the island and wells are used for domestic purposes (Orr, 1968). The east and west ends contain extensive sand dunes.

Climatically, Santa Rosa receives less rainfall than its higher neighbor Santa Cruz. The average yearly rainfall for 1941-1965 was about 12 inches (Haller, 1967). Its location exposes it to the prevailing northwest winds which are common occurrences.

The predominant vegetation type is an annual grassland dominated by introduced mediterranean annuals. This plant community covers virtually all of the flat terraces, slopes, and rolling ridge tops of the island. Salt-bush (Atriplex californica) is an abundant constituent of the grassland. Toward the eastern and western ends of the island on a sandy substrate the grassland grades into a coastal dune vegetation type. Habitats with perennial vegetation are of limited occurrence. On the island's south side, a depauperate form of coastal scrub community can be found with coastal sage (Artemisia), scattered Opuntia, and coyote bush (Baccharis). Very few lemonade bush (Rhus integrifolia) plans are found.

Throughout the island, the grassland terraces and slopes are dissected by gullies and canyons and it is in these areas that much of the perennial shrubs can be found. The commonest species are coyote bush and California sage, but occurring in some of the larger canyons are island oak (Quercus tomentella), scrub oak (Q. dumosa), and toyon (Heteromeles arbutifolia). The most extensive association of perennial forms occurs on the southeastern portion of the island. Here, on northeastern facing slopes and along the canyons is a woodland-chaparral type of habitat. On seaward exposures and along ridges plants are wind-pruned with a low prostrate aspect, but along the canyons and on leeward slopes they attain a more upright aspect. Species found here include island and scrub oak, toyon, manzanita, chamise (Adenostoma), torrey pine (Pinus torreyana), Santa Cruz Island pine (P. remorata), and ironwood (Lyonothamnus).

Considering that Santa Rosa is the second largest of the islands, it has a surprisingly depauparate fauna. The avifaunal

diversity is relatively low, due largely to the low habitat diversity. The rest of the terrestrial vertebrate fauna is comparable to the other islands (Appendix A-7). Current status of all these forms is unknown. In addition, Santa Rosa Island has had its share of introduced forms. Sheep were once prevalent, but are now completely removed; remaining introduced animals are elk, mule deer, feral pigs, cattle, and horses.

Population Survey:

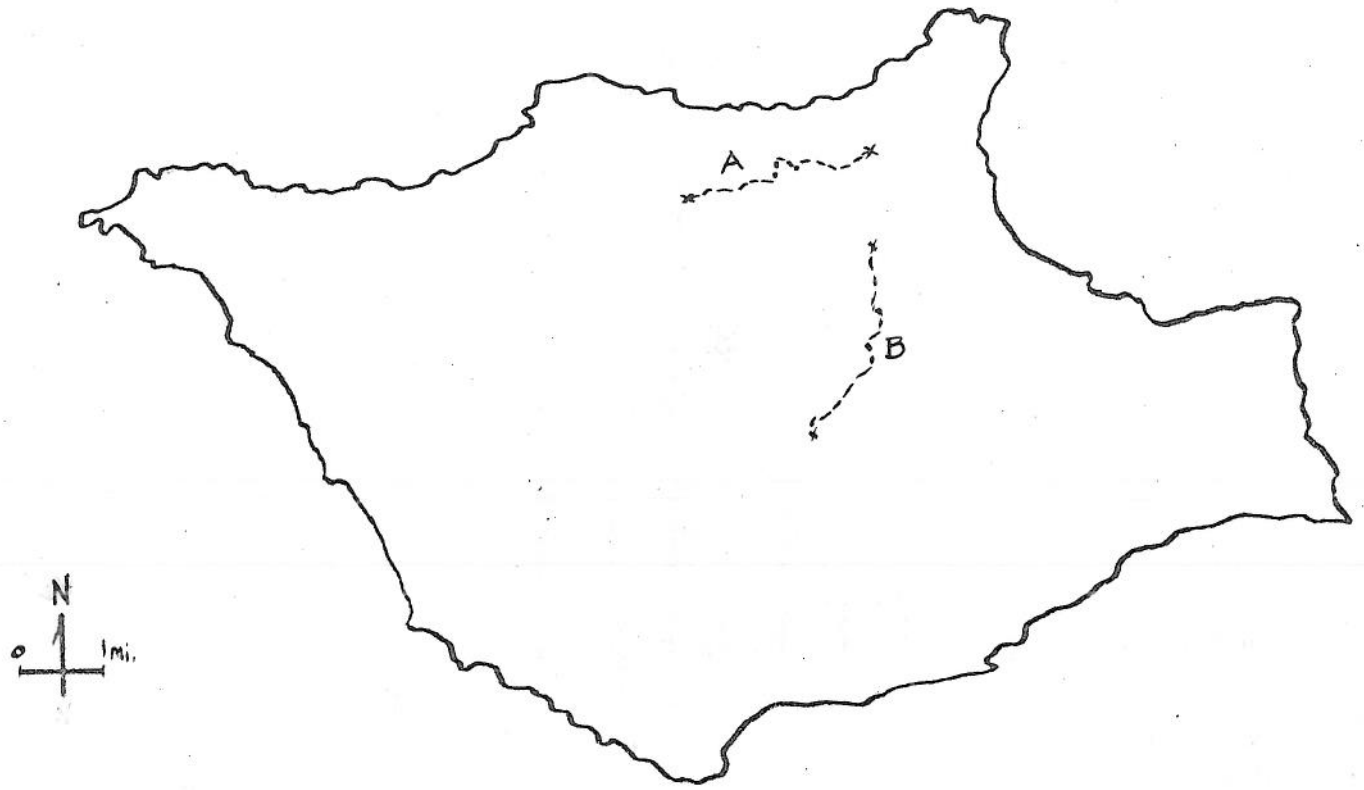
Survey of Santa Rosa Island occurred from October 3-6, 1972. Two series of 15 traps were laid out along dirt roads in two areas of somewhat different habitat types (see map) and the traps remained in the same locations for the whole period. Line A was run in a E-W direction across the lower terraces (approximately 500 ft. elevation) on the north side. The vegetation was almost exclusively annual grasses on the level areas with a few widely scattered Baccharis. On the drier western and southern exposures of these canyons Artemisia was common with a few interspersed prickly pear (Opuntia littoralis). Line B was placed at a higher elevation (1000-1300 ft), primarily along ridges of the central eastern part of the island. This line included a greater diversity of habitats ranging from grassy ridges and slopes, prostrate chaparral, and a small amount of an oak-pine canyon.

Differences in vegetation between the two trapping areas was reflected in the trapping results for the two lines. As expected the area of greater diversity and greater productivity (plant fruits and insects) showed a greater number of foxes. A comparison for the various methods that I used to estimate abundance is as follows: number of different individual animals trapped was 6.3 foxes / mi^2 for the grassland (A) and 15.0 foxes / mi^2 for the chaparral (B). A Lincoln Index recapture ratio estimate was 11.3 foxes / mi^2 for (A) and 25.0 foxes / mi^2 for (B); and, the trapping efficiency for area A was 40 percent and 61 percent for area B. Estimates given in Table 3 are the means of the results of the two areas.

Signs of fox activity (sightings, fecal deposits) over the rest of the island were compatible with the results. Considering that the grassland habitat is the predominant vegetation type, density estimates in the range of area A would be most typical for the island.

The age structure for this population was comparable to the other islands. No evidence of disease or of eye problems appeared in any of the handled animals. Several animals did have fleas and one or two animals had a tick.

Though no reference to past population conditions for this island appear in the literature, Mr. A. Vail, whose family has been associated with the island since 1902, did mention that fluctuations in fox abundance seemed to have occurred in years past.



B. SANTA ROSA ISLAND

SANTA CRUZ ISLAND

Location: Santa Cruz Island, largest of the Channel Islands, is located in the northern group and is under two ownerships. The eastern end is owned by the Gherinis of Santa Barbara and Ventura. The greater part of the island is owned by the Santa Cruz Island Company. The long axis, which is oriented east to west, is about 24 miles long and the width varies from a little less than 2 miles to almost 8 miles.

Description: The dominant feature of the topography is the east-west running central valley. This is bordered on the north by a rugged ridge extending up to almost 2200' (highest elevation of all the islands) and a lower, older, and more weathered ridge on the south. Narrow, steep canyons are common on the north side of the island while the south side ones tend to be broad bottomed. The coastal perimeter is dominated by precipitous cliffs.

The normal Mediterranean climatic pattern characterizes Santa Cruz Island though it does receive more precipitation than the other islands. The mean annual rainfall for 1904-1972 was 20 inches with yearly totals ranging from 6.5 inches of 1923-24 to 56.2 inches in 1940-41. In the central valley the mean annual temperature of the period 1961-1971 was 60.4° F. Mean monthly temperatures varied from the December low of 53.1° F. to the high of 69.7° of August. The large central valley, which is somewhat isolated from the surrounding ocean, has temperatures that show greater extremes than most areas on the islands.

The interactions of the topographic, geologic, and edaphic characteristics have resulted in a greater diversity of habitats occurring on Santa Cruz Island than on any other of the islands. These include grassland, coastal sage scrub, chaparral, oak woodland, and closed-cone pine. Coastal sage is the dominant feature of the south portion of the island and most south-facing exposures. Along the moisture canyons and north-facing slopes, chaparral and woodlands can be found, while grasslands dominate the central valley and the narrow central region of the island.

The fox utilizes all habitat types, but available food is greatest in the chaparral and oak woodland regions. Some of the principal species within these habitats are important components of the fox's diet. These are prickly pear in the sage scrub, Atriplex in the grasslands, summer holly and manzanita in the chaparral, and toyon in the woodlands.

The fauna of Santa Cruz Island is similar to that of the other larger islands. The habitat diversity reflects itself best in the avifauna, which is the most diverse of the islands. The endemic island jay is only found on this island though similar suitable habitat conditions exist on nearby Santa Rosa Island. All of the reptiles (three lizards, two snakes) are included

in the fox's diet. Foxes prey upon the tree frogs (Hyla), but not the other amphibians. Mammals include various bats, deer mouse, harvest mouse, and spotted skunk besides fox and introduced livestock. The deer mouse inhabits all areas, though in low numbers. It comprises a small percentage of the fox's diet (Bills, 1969). The spotted skunk is quite rare at this time though it is reported to have been fairly abundant in the past. The fox is widespread and abundant though its population has also fluctuated. Bills (1969) cites observations in 1948 by Pearson, University of California, Berkeley. During 23 days no foxes were seen and only four individuals were trapped.

Population Survey:

Though I have worked with the Santa Cruz Island fox population for the past several years I thought it best to use the results from a recent intensive trapping effort for comparative purposes.

Trapping occurred during March of 1973 on three lines. In order to further evaluate trapping procedure the lines were set up in different ways. The first line (A) was run March 4-6. Traps were laid out in a grid pattern of 15 stations (3 x 5) at 0.2 mi. intervals with two traps at each station. This line was located in part of the central valley (Portezuela). One edge was along the bottom of a chaparral covered north facing slope while the rest of the grid covered an open woodland-grassland type of vegetation. Traps of this line were checked on three mornings and two late afternoons for a total of five trap-periods. The second trapline (B) was set March 7-10 along the major east-west ridge above the south side of the central valley. Thirty traps were set individually at 0.1 mi. intervals along the road. The ridge top and south side of ridge had an open chaparral assemblage of plants while the chaparral along the north slope was quite dense. Traps were checked six times (three AM and three PM). The other trapline (C) was run March 11-13 in the central valley along the road starting about 1/4 mile west of the Stanton Ranch and continuing west for about 1 1/2 miles. The 30 traps were set at 15 stations 0.1 mile apart with 2 traps per station. The habitat here was comparable to that of area A except that the line passed through several groups of Eucalyptus trees. Due to inclement weather the complete line was only run three times (two AM and one PM); during one other period (afternoon of March 12 to morning of March 13) only 6 traps were used. A comparison of these traplines follows:

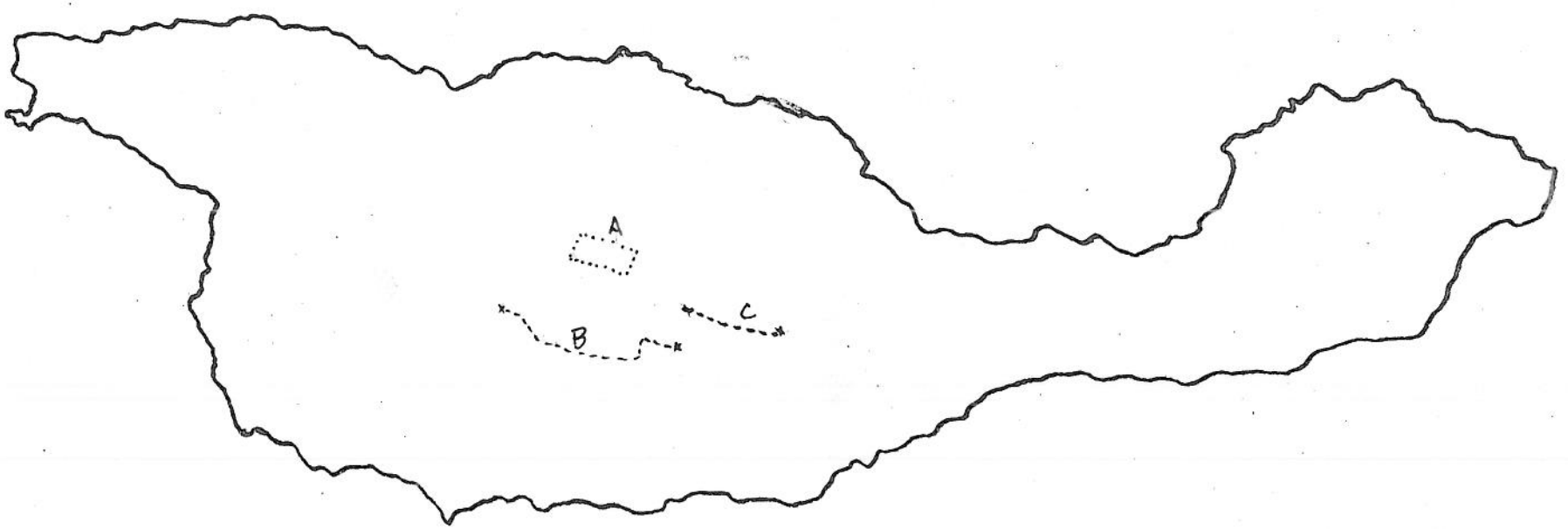
Trap-line	# of Trap Periods	# of Captures	# of Different Foxes	Mean trap-Efficiency (%)	Density Estimate Fox/mi^2
A	150	62	37	52	39
B	180	99	53	72	31
C	96	34	25	48	29

These results, like those from the trap periods on the other islands, are somewhat difficult to compare since they involve different designs of trapline layout and different intensities of trap effort. Furthermore, since each line is really only one sampling there is no check on the potential variation. Even with these problems the density estimates are relatively similar and the low figure for line C would probably have increased if more trap periods had occurred. Differences in the mean trap efficiency might indicate that the design of line B would be a useful type of set up (1 trap at 0.1 mile intervals along a line). It would be easier to set out than a grid system but a grid system probably gives a more reliable density estimate.

The higher densities and efficiences found for Santa Cruz are probably real differences from the other islands. The chaparral-woodland-grassland situation trapped on Santa Cruz is probably an optimum habitat type for the fox in terms of food availability. Habitats of Santa Cruz that are similar to those of the other islands (except Santa Catalina) are expected to have comparable fox densities.

Age structure of this population is shown in Figure 2 and is similar to the other island populations. The majority of the population was composed of young healthy animals. A few old individuals were encountered and one or two had some form of glaucoma or cataracts of the eyes. No diseases have been noticed or reported for this population. Ectoparasites (ticks, fleas, and lice) have been found on captured animals.

Results of the food habits analysis are contained in Table 2 and A-8. A more complete analysis is continuing and shows that almost all of the fruiting chaparral plants contribute significantly to the fox diet at different times of the year.



C. SANTA CRUZ ISLAND

SAN NICOLAS ISLAND

Location: San Nicolas Island, a part of the U. S. Navy's Pacific Missile Range sinze 1945, is the outermost of the Channel Islands. Roughly a long oval in shape, its long axis orients North 60° West and is approximately 9.8 miles long. The maximum width, near the western end is about 3.6 miles.

Description: Topographically, San Nicolas is best described as a mesa falling off rather sharply on all sides except the western end. These sides are dissected with steep gulches giving a "badlands" aspect and are the result of years of wind and water erosion. The western end consists of a series of rolling and almost barren sand dunes that are continually shifted by the wind. Water is not abundant on the island, but several springs and temporary canyon streams provide water for wildlife.

Normally covered with a cool, moist layer of marine air, San Nicolas Island often experiences fog, especially in the spring and summer. The following meteorological data is from Vedder and Norris, (1963). Prevailing westerly winds frequently attain velocities of 35-55 miles per hour. Records for the period 1948-1954 show a mean annual temperature of 57° F. The mean annual rainfall was 6.6 inches. Winslow, (1960), gives data for the period of 1933-1944 as follows: mean annual temperature 60.4° F.; mean maximum 65.5° F.; mean minimum of 55.5° F. and mean annual precipitation of 10.9 inches. The overall characteristic of the climate is one of mild diurnal and seasonal fluctuation.

Low rainfall, exposure to wind and salt spray, and overgrazing have affected the vegetation of this island. The steep slopes surrounding the mesa top remain virtually barren. The low terraces along the beach contain Franseria, Haplopappus, Atriplex, and ice plant. On the mesa top a substantial cover of grasses exists, which is dominated by salt grass (Distichlis), interspersed with Atriplex, bur-clover (Medicago), an occasional coyote bush (Baccharis), and the insular endemic Lotus argophyllus. Prickly pear (Opuntia littoralis) and coast cholla (O. prolifera) are not uncommon on the lower terraces as well as giant Coreopsis, bush lupine, and Astragalus. In many areas the two species of ice plant are quite common.

Considering the island's isolation, the habitat type, and its condition, San Nicolas' avifauna is surprisingly complete (Townsend, 1968). However, the rest of the vertebrate fauna is especially depauperate (Appendix A-7).

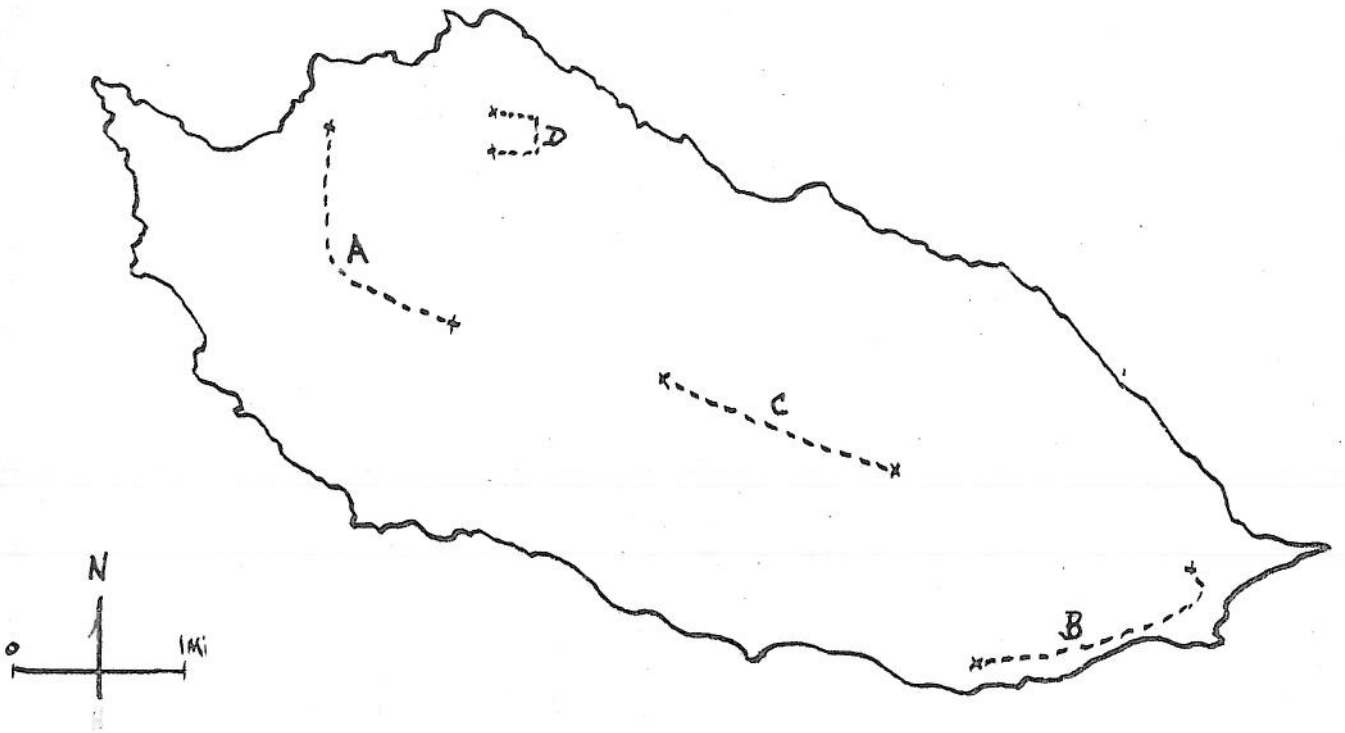
Population Survey: Survey of San Nicolas was conducted November 5-8 of 1971. Three nights of trapping took place with the traps being moved each day. Trapline locations are plotted on the map. The first

trapline (A), consisting of 15 traps, was placed in the north western end of the island on the afternoon of November 5. The line began on an Atriplex-grassland flats and proceeded down a gentle grade to end in sand dunes. The line was moved on November 6 and reset in two parts. Seven traps were set along the lowest beach terrace on the south and southwestern side, (B), approximately 100 yards from the ocean. This area had the sparsest vegetation of the areas sampled. The other eight traps were set along the road parallel to the air strip through the middle of the mesa in an Atriplex--grass--Lotus vegetation (C). Due to logistics the line (D) set out on November 7 consisted of only 10 traps set in the vicinity of the barracks. The line was laid out in an arc through the grasslands on the east side of the buildings with trap intervals of about 0.05 miles, instead of the usual 0.2 miles. The trapping results are summarized in Table 3. The age structure of this population as compared with the other islands is shown in Figure 2.

A comparison of food habits of this population with the others will be found in Table 2 and Appendix A-8. At this time of year Atriplex californica fruits appeared to be an important part of many of the foxes' diet. As on San Miguel Island, the San Nicolas fox does not have as wide a variety of fruiting vegetation to feed upon as do some of the other populations and probably relies more heavily upon insects and scavenging. In addition, personnel at the Navy's mess hall indicated that they put out large amounts of leftover food. This could contribute significantly to the diets of foxes living in the vicinity of the barracks and proportionally more older individuals might persist here than in more remote areas. Though 4 of the 6 animals captured in this area were older than 4 years of age, the limited data makes it difficult to determine if a significantly greater number of older individuals live near the feeding area.

General physical condition of the foxes caught from this population was very good. Animals of 5-6 years or older had missing teeth and worn molars, but fur and eyes appeared healthy. One old male of 6 years had one opaque eye and badly matted fur. Most of the animals had fleas, but no ticks were found.

During my visit only a few feral cats were on this island and they confined their activities to the barracks area. However, during a recent discussion with G. True of the Public Works Department for the Pacific Missile Range, he reported that all of the cats had been removed.



D. SAN NICOLAS ISLAND

SANTA CATALINA ISLAND

Location: Santa Catalina Island, largest of the southern Channel Islands, is under private ownership administered by the Catalina Rock and Ranch Company. With a long NW-SE axis, of about 22 miles, it is 8 miles at the widest point and less than 0.5 miles at the narrow Isthmus. It is the only island with parts of it readily accessible to the general public and the only one with an incorporated city (Avalon).

Description: Santa Catalina's topography is second in diversity to that of Santa Cruz Island. The two high points reach to just over 2000' and there are many deep v-shaped canyons and sharp ridges. The coastline has many precipitous cliffs.

Like coastal southern California and the other islands, Catalina's climate is oceanic and Mediterranean in nature. Warm, dry summers and mild, moist winters with reduced temperature fluctuations are characteristic. The mean annual temperature reported by Dunkle (1950) was 50.9° F. with an 11° annual range. Rainfall occurs in the winter months and a 32 year average was 12.4" (Dunkle, 1950).

The water situation consists of several man-made reservoirs and a few perennial springs and small streams. With a relatively large area, great diversity of topography and somewhat more plentiful water, Santa Catalina supports a greater diversity of habitats than any of the other islands except Santa Cruz. Prevalent plant communities include: Coastal Grassland, Coastal Sage Scrub, Maritime Desert Scrub, Chaparral, Oak and Riparian Woodlands, and Ruderal communities (Thorne, 1967).

Woodland communities of moist, protected canyons and valleys contain island cherry, island oak, scrub oak, toyon, ironwood, cottonwood, and willows. The latter two are confined to canyons with perennial water. On north and east facing slopes chaparral vegetation is best developed. Many of the same genera that exist in mainland chaparral are found here, but with insular species or subspecies. On southern and western exposures Coastal Sage Scrub is prevalent and composed of plants such as Rhus integrifolia, Encelia californica, Artemisia californica, Salvia apiana, Eriogonum giganteum, and Opuntia littoralis.

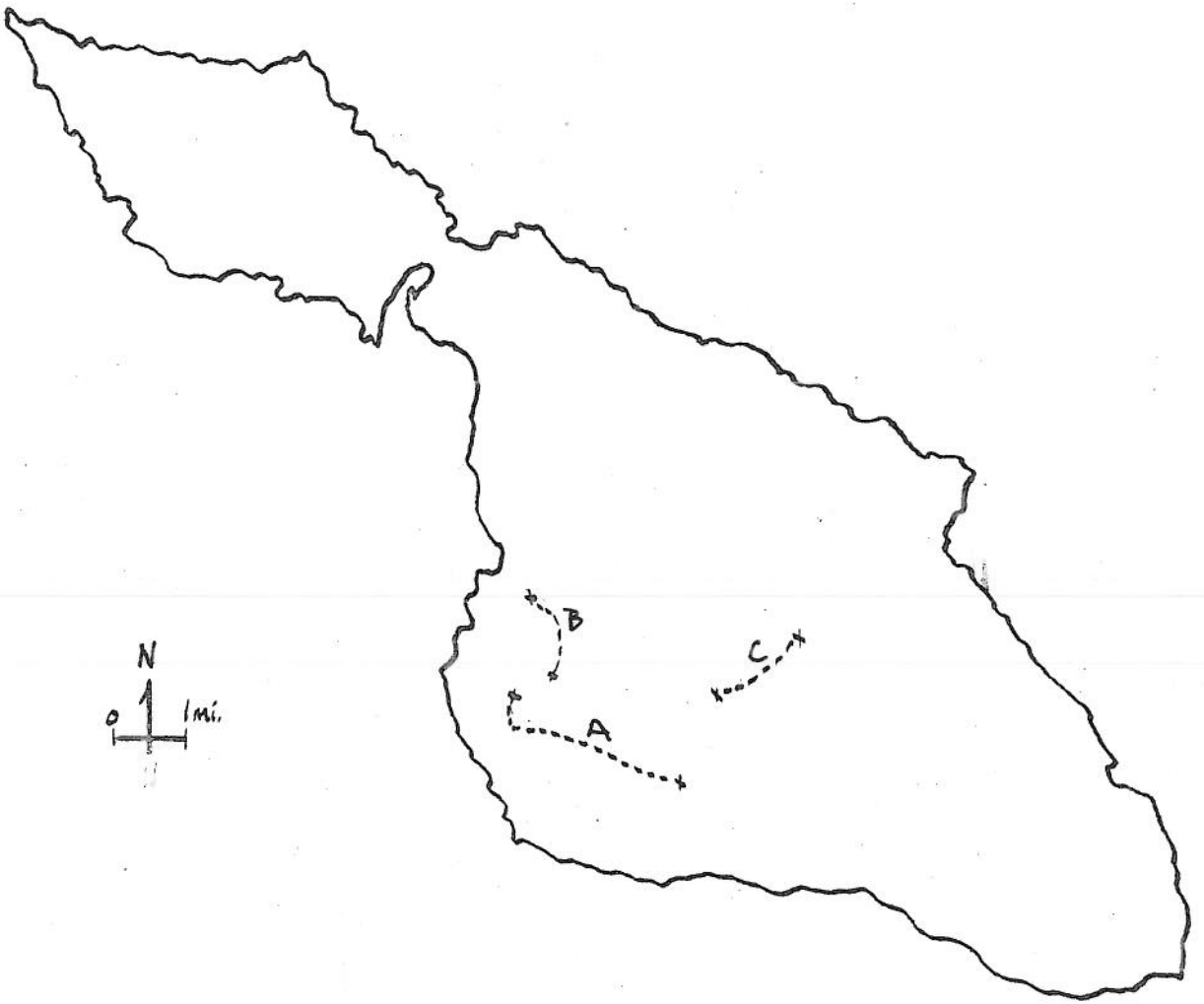
As on many of the islands, many of the interesting plant species are restricted to bluffs, cliffs, or canyon walls protected from past or present overgrazing by goats. Thorne (1967) should be consulted for a complete discussion of Santa Catalina's flora.

Apparently the avifauna of Santa Catalina has never been adequately described. Howell (1917) mentions this and I know of no subsequent treatment. However, the island's diversity of habitat and intermediate distance from the mainland would suggest a fairly diverse avifauna. The rest of the native terrestrial fauna shows greater diversity than any of the other islands (Appendix A-7). Introduced forms have included sheep, goats, pigs, rats, and feral cats. Grazing, except by the goats in some areas, is now under control.

Population Survey:

Survey of Santa Catalina Island was conducted April 3-6, 1972. Locations of the traplines are shown on the map. The first night's trapline (A) was set along the road on the bottom of Bulrush Canyon beginning at the west end. Twenty traps were placed at 0.2 mile intervals. This canyon was infrequently traveled except by ranch personnel. Goats had been removed from this area for some time and it had a fairly good vegetative cover of Woodland, Chaparral, and Coastal Sage Scrub. As no foxes were caught here during the first night, I moved 10 of the traps from the east end of the canyon, leaving the rest in place. The 10 traps were moved to a Coastal Sage community along a dirt road above Eagle Nest Rock between lower Middle Canyon and Cottonwood Canyon (B). This line yielded one fox on April 4. The remaining traps of (A) were placed in Cape Canyon (C), which drains into upper Middle Canyon from the northeast. Habitat here was basically Coastal Sage and Scrub Oak, Woodland, and Chaparral with abundant tree tobacco (Nicotiana) along the canyon bottom. On the night of April 5 one fox was caught in the upper part of this trapline. Thus, only 2 foxes (both 2 years old) were caught during three nights trapping and these results are compared with the other islands in Table 3. Considerable time was spent searching for signs of fox activity over other parts of the island. Very few scats were observed and no foxes were sighted, not even during a night spot lighting trip. Both captured animals appeared to be healthy and neither contained ectoparasites.

As on other of the islands fluctuations have occurred in this population. They have been reported as abundant in 1886, rare in 1893, and nearly extinct in 1917 (Grinnell, Dixon, and Linsdale, 1937). Doug Propst, the present wildlife manager for the island, who has resided there for many years, reported that the fox numbers have been down for the past several years.



E. SANTA CATALINA ISLAND

SAN CLEMENTE ISLAND

Location: San Clemente, southernmost of the Channel Islands, is nearly 21 miles long and about 4 miles wide near the southern end. Its long axis runs approximately northwest. Since the treaty with Mexico (1848), San Clemente has been owned continuously by the United States Government, though leased to a sheep and wool company from 1877-1934. It is presently administered jointly by the Naval Ordinance Test Station, Pasadena and the Naval Undersea Center, San Diego.

Description: Topographical features are dominated by a plateau of gentle relief at an elevation of 800' - 1500' with a steep east slope and a more gently sloping west side. Deep canyons dissect most of the slopes, those on the east are particularly precipitous. On the west side of the 18-20 wave-cut terraces indicate the submergenge-emergence pattern of the Pleistocene. Very little surface water is available and few perennial springs exist in the canyons.

Weather data was unavailable, however some inferences are possible. The location and the vegetation indicate a relatively arid climate. Rainfall is low, but temperatures do not vary greatly. The vegetation leads one to believe that the east side receives more moisture than the west.

The major habitat on San Clemente is Grassland dominated by introduced Mediterranean annual herbs. This type of vegetation covers almost all of the upper, central, flat portion of the island. A similar topographical situation at the southern end of the island, used as an impact target range and severely overgrazed by goats, is dominated by Opuntia littoralis and Q. prolifera with very little herbaceous ground cover especially during late summer and fall.

Around the island's perimeter, the bluffs and lower beach terraces not frequented by goats have a Coastal Sage type vegetation. Woody tree or shrub type of vegetation is confined to the canyons, especially on the precipitous east slopes. Here can be found the island iron wood (Lyonothamnus), island oak (Quercus tomentella), island cherry (Prunus ilicifolia Lyonii), toyon (Heteromeles), and lemonade bush (Rhus integrifolia).

On the steep walls and cliffs of these canyons, but out of reach of the persistant goats, precariously remain some of the unique and interesting island endemics such as the tree dandelion (Munzothamnus blairii), island snapdragon (Galvezia), island buckwheat (Eriogonum giganteum), and monkey flower (Minulus flemingii). A complete discussion of San Clemente's flora is given by Raven (1963).

Except for birds, the native vertebrate fauna is very attenuated (A-7). Several species of mammals have been introduced to San Clemente Island, and not all of them intentionally. A few of these are still conspicuous and undesirable members of its fauna. Sheep and goats were early introductions and ranged over the whole island, increasing in such numbers until the severe overgrazing resulted in virtual destruction of the vegetation. Sheep have been completely eliminated; goats are still present in considerable quantity though plans are being instigated for their reduction and elimination. A few pigs are present having been a recent introduction, as well as a small number of mule deer. The deer will probably remain under a program of controlled numbers. A great many feral cats exist on the island and our observations and trapping show them to be widespread. They are very abundant in the vicinity of the barracks. They are a potential hazard to the fox population both as competitors and a reservoir of possible disease. They should be eliminated or at the very least drastically reduced in number. Two rodents, the meadow vole, (Microtus californicus), and the harvest mouse (Reithrodontomys megalotis) were early introductions. We did not capture any during our limited rodent trapping effort. From barn owl pellets that were collected from old, abandoned buildings, I identified house mouse (Mus musculus) and rat (Rattus) skulls. The latter has not been previously reported. We conducted only a limited trapping attempt around the buildings; therefore, their status remains unknown.

Population Survey:

During this survey San Clemente Island was visited on four separate occasions in 1972: February 25-28, May 19-22, July 14-17, 1972, and November 12-13, 1972. The traplines of February and May were placed in different locations, but during each visit the traps were left at the same locations during the entire visit. Thus, this procedure differed from that used on some of the other islands. During the July visit the February area was retrapped for two nights and the May area was retrapped for one night. A beach terrace on the northwest end was trapped during November.

The area trapped during February was at the southern end of the island (A) and within the impact target zone. Prickly pear and cholla were the dominant plants with an interspersed sparse ground cover of Erodium. This area had the greatest proportion of goats on the island, hence was subject to the most severe overgrazing. Traps were placed approximately 20-50' from the road's edge with the line beginning at the Gunnery Observation Bunker above Pyramid Cove and running northwest almost 5 miles along the road. Twenty-five traps were used in this line.

The second trapline was located in the central part of the island during May (B). This area had a fairly good ground cover of introduced grasses and other herbs. Prickly pear

was widespread though not as prevalent as in other areas. The line consisted of 26 traps at 0.2 mile intervals along the road beginning at the old abandoned airfield and continuing southeast for about 5 miles ending northwest of Mount Thirst. A small mammal trapline of 30 traps at 25' intervals was run in the central portion of the fox trapline. This yielded 4 Peromyscus maniculatus, all of which were recaptured the next night.

During the July visit permission was again obtained to work in the impact-target zone and two nights were spent retrapping there. Traps were set over the same distance and intervals as during February, but since 40 traps were available the 15 locations at the southern end of the lines consisted of 2 traps per station. On Sunday, July 16, the line was moved to the central island location trapped during May. Again, the same locations were used with 2 traps per station for the 10 stations at the north end of the line. Four of the smaller traps were set for rats around the buildings with negative results.

In November, 1972, a line of 18 traps (C) were placed along a road on the lower terraces of the northwest portion of the islands in the vicinity of the "Garr" and "Flasher" sites. This area was dominated by Lycium, Opuntia, Bergerocactus, ice plant, and grasses. Traps remained in place for two consecutive nights.

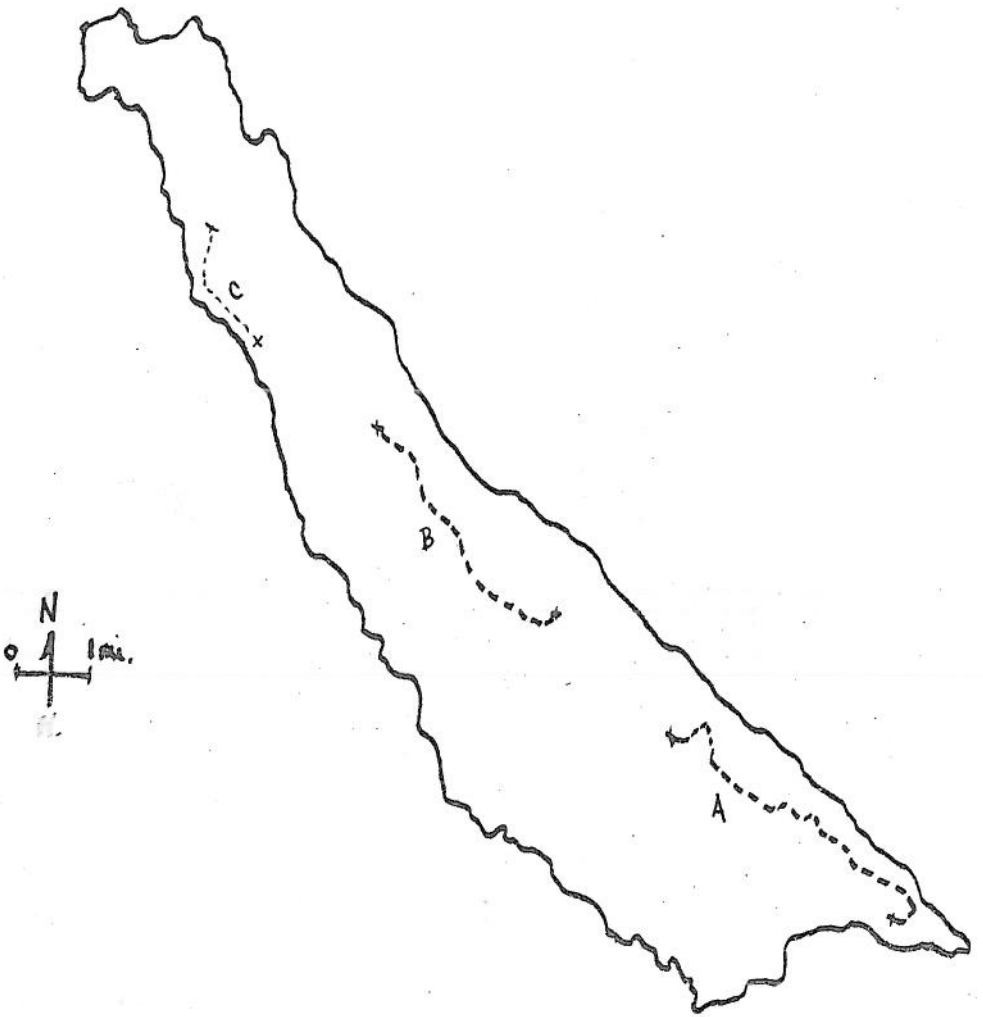
Estimated population density and age structure are given in Table 3 and Figure 2. With a fair number of recaptures (45) it was possible to obtain some estimate of movement for the foxes. Mean movement between recapture sites was 0.21 miles; the greatest being 0.6 miles (3 individuals). This figure was used to estimate the area of effectiveness of the trapline. Recapture data for the two different locations was also used with the Lincoln Index formula to obtain a crude population estimate. Surprisingly, the figures for both areas were very close, 82 for the southern end and 81 for the central area. Assuming that the line was sampling from an area about 0.5 miles wide (.2 + on each side), then the area of the trapline was 2.5 square miles. This gives a density estimate of about 33 fox per square mile. Because of the many uncertainties inherent within the assumptions contained in the Lincoln Index formula, this figure should not be considered as absolutely reliable but rather as only a preliminary estimate. The density estimate of Table 3 is based upon the different individual foxes captured and not the Lincoln Index.

In any case, foxes were abundant and widespread. In addition to the trap captures, many were seen in other areas during night spot-lighting observations. The only place foxes were not evident was around the main barracks facilities. This area had a very high concentration of cats and some interaction could be responsible for the fox's absence in this area. The only comments of the past status of this population were those of

Grinnell, Dixon, and Linsdale (1937) who considered them to be abundant.

Food habits analysis are shown in Table 2. A very conspicious part of the summer diet appeared to be a carabid beetle, especially in the southern part of the island.

Fleas were the only ectoparasites noted on the captured animals and even these animals appeared healthy. In fact, the general appearance of all animals captured or observed was one of good physical health.



F. SAN CLEMENTE ISLAND

APPENDIX A-7: List of Terrestrial Vertebrates on the California Channel Islands.[1/]

	San Miguel	Santa Rosa	Santa Cruz	Ana-capas	Santa Barbara	San Nicolas	Santa Catalina	San Clemente
SALAMANDERS								
Aneides lugubris							x	
Batrachoseps pacificus	x	x	x	x			x	
Batrachoseps relictus			x					
FROGS								
Hyla regilla		x	x				x	
LIZARDS								
Uta stansburiana			x	x		x	x	x
Sceloporus occidentalis	x	x	x					
Klauberina riversiana					x	x		x
Eumeces skiltonianus							x	
Gerrhonotus multicarinatus	x	x	x	x		x	x	
SNAKES								
Thamnophis couchii							x	
Diadophis punctatus							x	
Coluber constrictor			x					
Lampropeltis getulus							x	
Pituophis melanoleucus			x				x	
Crotalus viridis							x	
MAMMALS								
Sorex orantus							x	
Citellus beecheyi							x	
Reithrodontomys megalotis			x				x	x[2/]
Peromyscus maniculatus	x	x	x	x	x	x	x	x
Microtus californicus								x[2/]
Mus musculus								x[2/]
Rattus sp.								x[2/]
Urocyon littoralis	x	x	x			x	x	x
Spilogale gracilis		x	x					
Total number of native species	5	7	12	4	2	4	16	4
Number of breeding or summer resident bird species	10	22	32	16	13	10	28	23

1/ Excludes bird species and bats. Number of bird species breeding on each island is indicated.

2/ Forms introduced by man.

APPENDIX A-8: Plant Items in the Diet of the Island Fox as Determined by Analysis of Fecal Material. Insular Distributions of Plants are Given Along with Estimate of Their Abundance and Season of Availability.

A. PLANTS	Island Distribution and Availability 1/	Season
Native Species		
Prickly pear (*Opuntia littoralis oricola*)	SR-u, SCr-c, SCa-c, SCl-c	Fall-winter
Summerholly (*Comarostaphylis diversifolia*)	SCr-c	Summer
Manzanita (*Arctostaphylos* spp.)	SR-u, SCr-c, SCa-c	Summer-fall
Calif. huckleberry (*Vaccinium ovatum*)	SR-r, SCr-u	Summer
Nightshade (*Solanum* spp.)	SR-u, SCr-c, SCa-c SCl-u	Summer
Wild rose (*Rosa californica*)	SCr-c	Summer
Chokecherry (*Prunus ilicifolia Lyonii*)	SR-u, SCr-c, SCa-c, SCl-r	Summer
Toyon (*Heteromeles arbutifolia*)	SR-u, SCr-c, SCl-r	Winter-spring
Coffeeberry (*Rhamnus* spp.)	SCr-c, SCl-r	Summer
Lemonadeberry (*Rhus* spp.)	SR-u, SCr-c, SCa-c, SCl-c	Summer
Introduced Species		
Ice plant (*Mesembryanthemum* spp.)	SM-c, SR-c, SCr-u, SN-c, SCa-u, SCl-c	Spring-summer-fall
Australian saltbush (*Atriplex semibaccata*)	SM-c, SR-c, SCr-c, SN-c, SCa-u, SCl-c	Fall-winter
Pepper tree (*Schinus Molle*)	SCr-r	Winter

1/ Abbreviations:

SM - San Miguel
SR - Santa Rosa
SCr - Santa Cruz
SN - San Nicolas
SCa - Santa Catalina
SCl - San Clemente

c - common
u - uncommon
r - rare

APPENDIX A-9: Animal Items in the Diet of the Island Fox.[1/]

B. ANIMALS

Molluscs
- land snails

Arthropods
- millipedes
- isopods
- crustaceans
- insects
  - larvae
  - beetles - Coleoptera
    - Scarabidae
    - Carabidae
    - Tenebrionidae
    - Prionidae - Prionus
  - Orthoptera
    - crickets
    - grasshoppers
    - Jerusalem crickets - Stenopelmatus

Amphibians - Foxes were observed catching frogs; they probably do not eat slender salamanders.

Reptiles - will take all reptiles present.

Birds - will take whatever they can capture. Following items found in scat and at den entrances: island jay, red-shafted flicker, starling, California quail, mourning dove, sparrow (unidentified), eggs (unidentified).

Mammals - will take all smaller mammals present. Fox puppy fur has been identified from scat.

Carrion - all types of carrion are consumed; fish, bird, feral livestock.

1/ Distribution of invertebrates is not given as it is relatively unknown; refer to Appendix II for distribution of vertebrates.

File

SAN NICOLAS ISLAND FOX

Dates of Visit: 22, 23, 24 October 1974

Objectives: Determine current status of fox population and investigate reports of disease and die off of animals.

Investigators: Lyndal Laughrin, Steven Timbrook, Bill Clark, Jan Larson, Harry Coulombe

Methods

Two traplines of 13 traps with single traps at 0.1 mi. intervals, one in the vicinity of barracks and reported feeding areas and the other south and parallel to the airstrip (away from feeding area). This area was trapped during my November 1971 visit.

Areas were searched for signs of activity (feces and tracks) and a night driving census conducted with a spotlight on 23 October.

Skulls of dead animals were collected as was fecal material for later analysis.

Results

The trapline near the barracks yielded no foxes for 2 nights (26 trap-nights). The one near the airstrip yielded 2 foxes during the night of 22 October and none during the night of 23 October. This compares to 24 foxes for 40 trap periods for 1971 for this area.

During the night of 23 October while censusing in the west end of the island approximately 15-18 foxes were spotted with lights. This was during a 2 hour period covering approximately 12-13 miles of driving (though part of the route involved repetition). This route covered the sand dune area and the vicinity of Thousand Springs.

In addition, about 20 carcasses were located; 16 near the barracks and 4 near the transmitter building at the southwest edge of the mesa. Virtually

Recommendations

A monitoring program involving 2-3 trips over the next couple of years is suggested. Some trapping could be done. This will enable individual animal's conditions to be examined and some information on population age structure to be retained. Abundance and distribution can best be determined by night spotlight census methods. A year round analysis of food habits and food availability would be useful.

Artificial feeding should be prohibited.

California Department of Fish
and Game
Disease Laboratory
November 26, 1974

SAN NICOLAS ISLAND FOX REPORT

Purpose

A reevaluation of the status of the island fox (Urocyon littoralis) on San Nicolas Island was requested after a number of debilitated and dead foxes had been observed.

History

Lyndal Laughrin from the University of California at Santa Barbara conducted a population survey of San Nicolas Island on November 5-8 of 1971. A total of 24 foxes were caught in three nights of trapping. The general condition of the foxes caught was very good. Laughrin did note in his report that animals 5-6 years or older had missing teeth and worn molars. He observed one male of 6 years that had one opaque eye and badly matted fur.

The fact that Navy personnel were feeding large amounts of leftover food to the foxes was also mentioned in his report.

The Navy's concern over numerous sick foxes and possibility of disease prompted submittal to the Disease Laboratory of 3 San Nicolas island foxes on August 16, 1974. The animals were heavily infested with fleas and appeared to be suffering from malnutrition. The Navy ordered a stop to artificial feeding and arrangements were made to evaluate the status of the foxes on the entire island.

Lyndal Laughrin and Steve Timbrook from UCSB, Harry Coulombe from Long Beach, Ensign Ann Siedel and Jan Larson from the Navy and Bill Clark from California Fish and Game conducted a fox survey on October 22-24, 1974.

Trapping Effort

Two traplines were set in approximately the same areas trapped in 1971. One trapline encircled the barracks area and the other ran parallel to the old runway. Approximately 30 collapsible wire live traps were used in the total trapping operation. Canned cat food was used as bait.

Only two foxes were caught in the two nights of trapping effort. One was an old male with worn molars but in otherwise good shape. The other was a young (3-4 year) female in excellent shape. Both were caught in the trapline near the old runway. No foxes were caught in the barracks area, but two feral cats were trapped and removed.

Spotlighting Efforts

It was decided to spotlight one night to better ascertain the fox populations. Eighteen to fifteen individual foxes were spotlighted in a two-hour period (1830-2030) on the N-NW portion of the island.

Discussion

One would think that a comparison of the 1971 trapping effort to our trapping effort would yield a valid evaluation of the present status of the San Nicolas Island fox. This was not the case, as the supplementary feeding which had concentrated the animals had been discontinued. What we did find was abundant fox sign throughout the island and at least fifteen foxes spotlighted in two hours. Some of the spotlighted foxes were as close as five feet and could be closely observed as to general condition. All of the foxes observed appeared to be in good health.

It appears that the fox population of San Nicolas Island was artificially elevated by the practice of feeding the leftover food scraps. When the feeding was stopped, there was a die-off as the high population of foxes could not find enough food or did not know how to forage for their natural food items. In any case, the remaining population appears to be dispersed and healthy on the island.

Recommendations

It would be advisable to conduct another similar survey or evaluation in approximately six months to determine the stability of the present status of the San Nicolas Island fox.

William Clark
Wildlife Pathologist

State of California

The Resources Agency

Memorandum

To : Commander Robert Baker
Code 3250-1 Geo-physical Division
Pacific Missile Range
Pt. Mugu, California 93042

Date: November 26, 1974

From : Department of Fish and Game - Chief, Wildlife Management Branch

Subject: San Nicolas Island Fox Survey
October 22-24, 1974

Enclosed are two reports covering the subject survey.

It appears that the action taken by the Navy in prohibiting the feeding of foxes about the barracks has largely eliminated the problem through the die-off of affected animals. We have fully concurred with the action that was taken and recommend that there be strict adherance to your prohibition against feeding. We feel that another similar survey in May or June is in order to reaffirm the findings of this survey.

Thank you for your keen interest in the San Nicolas Island Fox and the cooperation which you have extended to the Department in remedying the problem confronting this animal.

Harold R. Leach for

Eldridge G. Hunt, Chief
Wildlife Management Branch

cc: Region 5
Marine Resources Region
Ensign Siedel
Laughrin, Lyndal
Clark, Bill
Coulombe, Dr. Harry
Mr. Jan Larson
Mr. Robert Fordice, Region 5
Mr. Franklin Hoover, Region 5

Enclosures