# Island Fox

## Management Guidelines for Species at Risk on Department of Defense Installations

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Front cover photo: Island fox (*Urocyon littoralis*).

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# ISLAND FOX

## MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS

### SAN CLEMENTE ISLAND AND SAN NICOLAS ISLAND CALIFORNIA

Sandy Vissman

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NatureServe
A Network Connecting Science With Conservation

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## Executive Summary

The island fox (*Urocyon littoralis*) is endemic to six of the eight California Channel Islands and is the largest native land mammal on these islands. In addition to being the smallest fox species in the United States, it is the only mid-sized mammal unique to California, and California's only endemic carnivore (Juola *et al*. 2002). The island fox is currently classified as threatened by the state of California (California Department of Fish and Game 1987), and four fox subspecies were classified as endangered by the U.S. Fish and Wildlife Service in 2004 (69 FR 10353).

The island fox occurs on two Department of Defense (DOD) installations in the Pacific Ocean: San Clemente Island (*Urocyon littoralis clementae*) and San Nicolas Island (*Urocyon littoralis dickeyi*). A unique subspecies is found on each island, although the subspecies share similar traits and biology. Both subspecies are of concern to Department of Defense as closely related subspecies on nearby islands have experienced precipitous declines in the past six years. The only two subspecies of island fox that have not dramatically declined and been placed on the Endangered Species list are the two subspecies addressed by these Species at Risk Guidelines (SAR Guidelines).

The overall Conservation Objective of this guidance document is to maintain stable or increasing island fox populations that are large enough to reduce extinction risk on San Clemente and San Nicolas Islands. To accomplish this conservation objective, the guidelines describe a plan to effectively monitor the population and implement adaptive management actions if the population declines to pre-determined levels. Using these guidelines, DOD would:

(1) use population modeling techniques combined with understanding of the species demography and historical population size to determine a population size necessary to reduce extinction risk;
(2) monitor the demography and health of island fox populations on DOD installations;
(3) incorporate island fox conservation needs into facilities and range planning;
(4) implement measures to reduce the potential for population declines by removing or minimizing mortality factors and stressors;
(5) identify the magnitude of population decline (or catastrophic event) that would warrant increased monitoring or remedial action; and
(6) identify response mechanisms to be taken if population decline does occur.

The island fox has been identified in Integrated Natural Resource Management Plans for both San Clemente Island and San Nicolas Island. Management Guidelines identified in this document may be incorporated into future revisions of the INRMPs.

## 1. Species Identifiers

**Scientific Name:** *Urocyon littoralis*
**Common Name:** Island fox
**Department of Defense Installation(s) where species occurs:**
San Clemente Island and San Nicolas Island

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**Authorities**

The authorities for the conservation are derived from the following statutes and regulations:
Endangered Species Act of 1973 (16 U.S.C. *et seq*.)
Sikes Act Improvement Act of 1977 (Public Law 105-85: 16 U.S.C. 670a *et seq*.)

Department of Defense Directive 4715.1 (Environmental Security)
Environmental and Natural Resources Program Manual (OPNAVINST 5090.1B CH-2)

**Partners**
Department of Defense will be using the guidelines described herein in partnership with the U.S. Fish and Wildlife Service, California Department of Fish and Game, non-profit wildlife and research organizations, and universities.

## 3. Species Range, Status, and Life History

The island fox (*Urocyon littoralis*), inhabits the six largest Channel Islands off the California coast. Each island (Santa Catalina, San Miguel, Santa Cruz, Santa Rosa, San Nicolas, and San Clemente) supports a unique subspecies of island fox. The species is listed as "threatened" by the State of California. Four of the six island subspecies (San Miguel Island fox, Santa Cruz Island fox, Santa Catalina Island fox, and Santa Rosa Island fox ) have recently experienced catastrophic population declines and were listed as Endangered under the Endangered Species Act on March 5, 2004 (69 FR 10353).

Although island fox subspecies that inhabit DOD lands on San Clemente Island and San Nicolas Island have not experienced the dramatic declines observed in the northern Channel Islands, these subspecies may be vulnerable to future declines due to the small size of the populations, potential for exposure to canine diseases, potential for vehicle collision, and possible sensitivity to habitat changes, disturbances, competition, and wildlife management. In summer, 2004, the San Clemente Island subspecies represents approximately 45 percent and the San Nicolas subspecies approximately 31 percent of the existing *Urocyon littoralis* population (Dave Garcelon, pers. Comm. 2004). DOD lands, therefore support approximately 76 percent of the island fox species, as well as each supporting a unique subspecies. The management guidelines found within this document are intended to reduce potential threats to the island fox subspecies on San Clemente Island (*Urocyon littoralis clementae*) and San Nicolas Island (*Urocyon littoralis dickeyi*).

**Island Fox Biology**

Island foxes are omnivores, taking a wide variety of seasonally available plants and animals (Collins and Laughrin 1979; Collins 1980; Kovach and Dow 1981; Moore and Collins 1995; Crowell 2001). Island foxes forage opportunistically on any food items encountered within their home range. Diet is determined largely by availability, which varies by habitat and island, as well as seasonally and annually. Island foxes prey on native deer mice (*Peromyscus maniculatus*) and harvest mice (*Reithrodontomys megalotis catalinae*), as well as introduced house mice (*Mus musculus*) and rats (*Rattus rattus* and *R. norvegicus*). Small mammals may be especially important prey during the breeding season, because they are large, energy-rich food items that adult foxes can bring back to their growing pups (Garcelon *et al*. 1999). In addition to small mammals, island foxes feed on ground-nesting birds such as horned larks (*Eremophila alpestris*), Catalina quail (*Callipepla californica catalinensis*) and western meadowlarks (*Sturnella neglecta*), and a wide variety of insect prey (Moore and Collins 1995). At certain

times of the year, foxes feed heavily on orthopterans (e.g., grasshoppers and crickets) (Crooks and VanVuren 1995), especially Jerusalem crickets (*Stenopelmatus fuscus*). Less common in the diet are amphibians, reptiles, and carrion of marine mammals (Collins and Laughrin 1979). Island foxes feed on a wide variety of native plants, including the fruits of manzanita (*Arctostaphylos* spp.), summer holly (*Comarostaphylis* spp.), toyon (*Heteromeles arbutifolia*), cactus (*Opuntia* spp.), island cherry (*Prunus ilicifolia*), sumac (*Rhus* spp.), rose (*Rosa* spp.), nightshade (*Solanum* spp.), and huckleberry (*Vaccinium* spp.) (Moore and Collins 1995).

The island fox is docile and shows little fear of humans in many instances. Although primarily nocturnal, the island fox is more diurnal than the mainland gray fox (Collins and Laughrin 1979; Fausett 1993). Diurnal activity is thought to be a result of the historical absence of large predators and freedom from human harassment on the islands (Laughrin 1977).

Mated island foxes maintain territories that are separate from the territories of other pairs (Crooks and Van Vuren 1996; Roemer *et al*. 2001a). Island fox home range size varies with sex, season, population density, landscape features, and habitat type (Laughrin 1977; Crooks and Van Vuren 1996; Thompson *et al*.1998; Roemer *et al*. 2001a). Estimates of territory size range from 0.24 square kilometer ($km^2$) (59 acres (ac)) in mixed habitat (Crooks and Van Vuren 1996) and 0.87 $km^2$ (214 ac) in grassland habitat (Roemer 1999) on Santa Cruz Island, to 0.77 $km^2$ (190 ac) in canyons on San Clemente Island (Thompson *et al*. 1998). Island fox territory configuration changes after the death and replacement of paired male foxes, but not after the death and replacement of paired females or juveniles, indicating that adult males are involved in territory formation and maintenance (Roemer *et al*. 2001a).

Although island foxes appear monogamous, copulations with individuals other than the mate are common and often result in offspring. Courtship activities occur from late January to early March; genetic evidence suggests that inbreeding avoidance occurs (Roemer *et al*. 2001a). Recent endocrine assays on fecal samples from San Miguel Island indicate that, unlike all other canids studied to date, island foxes are induced rather than spontaneous ovulators (Bauman *et al*. 2001). Young are born from late April through May after a gestation period of approximately 50 days. Island foxes give birth to their young in simple dens, which are usually not excavated by the foxes themselves (Moore and Collins 1995). Any available sheltered site (e.g., brush pile, rock crevice, and hollow stump) may be used (Laughrin 1977). Litter size ranges from one to five pups (Moore and Collins 1995). Laughrin (1977) found an average litter of 2.17 for 24 dens on Santa Cruz Island; this estimate likely reflected the number of pups weaned rather than born. The average size of 35 litters born in captivity since 1999 is 2.3 (Coonan et al. in prep.). Both island fox parents care for the young (Garcelon *et al*. 1999). By 2 months of age, young foxes spend most of the day outside the den and will remain with their parents throughout the summer. Some pups disperse from their birth territories by winter, although others may stay on their natal territories into their second year (Coonan 2003a). Island foxes can mate at the end of their first year (Collins and Laughrin 1979), although most breeding involves older animals. Coonan *et al*. (1998) found that only 16 percent of females under the age of 2 bred over a 5-year period, in contrast to 60 percent of older females.

Due to the low reproductive output of island foxes, survival of adults is considered the most important factor influencing population growth rate (Roemer 1999; Roemer *et al*. 2001b, d).

Compared with the gray fox, island fox populations are skewed toward older adults (Laughrin 1980; Garcelon 1988). Adult island foxes live an average of 4 to 6 years (Moore and Collins 1995), although this may be an underestimate (Coonan *et al*. 1998). Island foxes may live 8 to 10 years in captivity or in the wild in the absence of catastrophic mortality forces (Tim Coonan, National Park Service, *in litt*. 2002).

Island foxes are approximately 0.3 meter (1 foot) tall and weigh approximately 1.4 to 2.7 kilograms (3 to 6 pounds). The base of the ears and sides of the neck and limbs are cinnamon-rufous in color, the back is grayish-white and black, and the underbelly is a dull white. Island foxes display sexual size dimorphism, with males larger and heavier than females (Moore and Collins 1995).

## 4. Habitat Requirements

The island fox is a habitat generalist, occurring in valley and foothill grasslands, southern coastal dunes, coastal bluff, coastal sage scrub, maritime cactus scrub, island chaparral, southern coastal oak woodland, southern riparian woodland, Bishop (Pinus muricata) and Torrey pine (Pinus torreyana) forests, and coastal marsh habitats. Although foxes can be found in a wide variety of habitats, they prefer areas of diverse topography and vegetation (Von Bloeker 1967; Laughrin 1977; Moore and Collins 1995). Laughrin (1973, 1980) found higher fox density in woodlands, while Crooks and Van Vuren (1995) found more island foxes in fennel grasslands. On San Clemente Island, higher fox densities have consistently been reported on grids located in Maritime Desert Scrub, lycium phase, than in non-native grasslands (Dave Garcelon, pers. Comm. 2004). Likewise, higher fox densities have been recorded in maritime dune communities on San Nicolas Island than in annual grasslands.

**San Clemente Island**

On San Clemente Island, foxes use all areas of the island, but higher densities are apparent in the northern part of the island, which is dominated by low vegetation including maritime desert scrub, *lycium* phase and in the southern part of the island, which is characterized by deeply incised, narrow canyons, canyon woodland surrounded by desert scrub and native grassland. The central island plateau, which is dominated by non-native grasslands, supports lower fox densities.

San Clemente Island has been divided into 18 Management Units as part of the Integrated Natural Resources Management Plan (Figure 1). These Management Units were designed primarily to address fire management requirements - the boundaries of individual units are primarily roads, canyon rims, or fuelbreaks, all of which are expected to slow spread of wild fire. In the San Clemente Island Integrated Natural Resources Management Plan (INRMP), the military value and ecological value of each management unit was assessed on a subjective scale, rating from lowest to highest, however relative importance to the island fox was not considered since island foxes inhabit all Management Units on San Clemente Island. Based on the techniques used for island-wide population estimation and the overall acreage and vegetation cover in each management area, a fox population estimate was derived for each of the

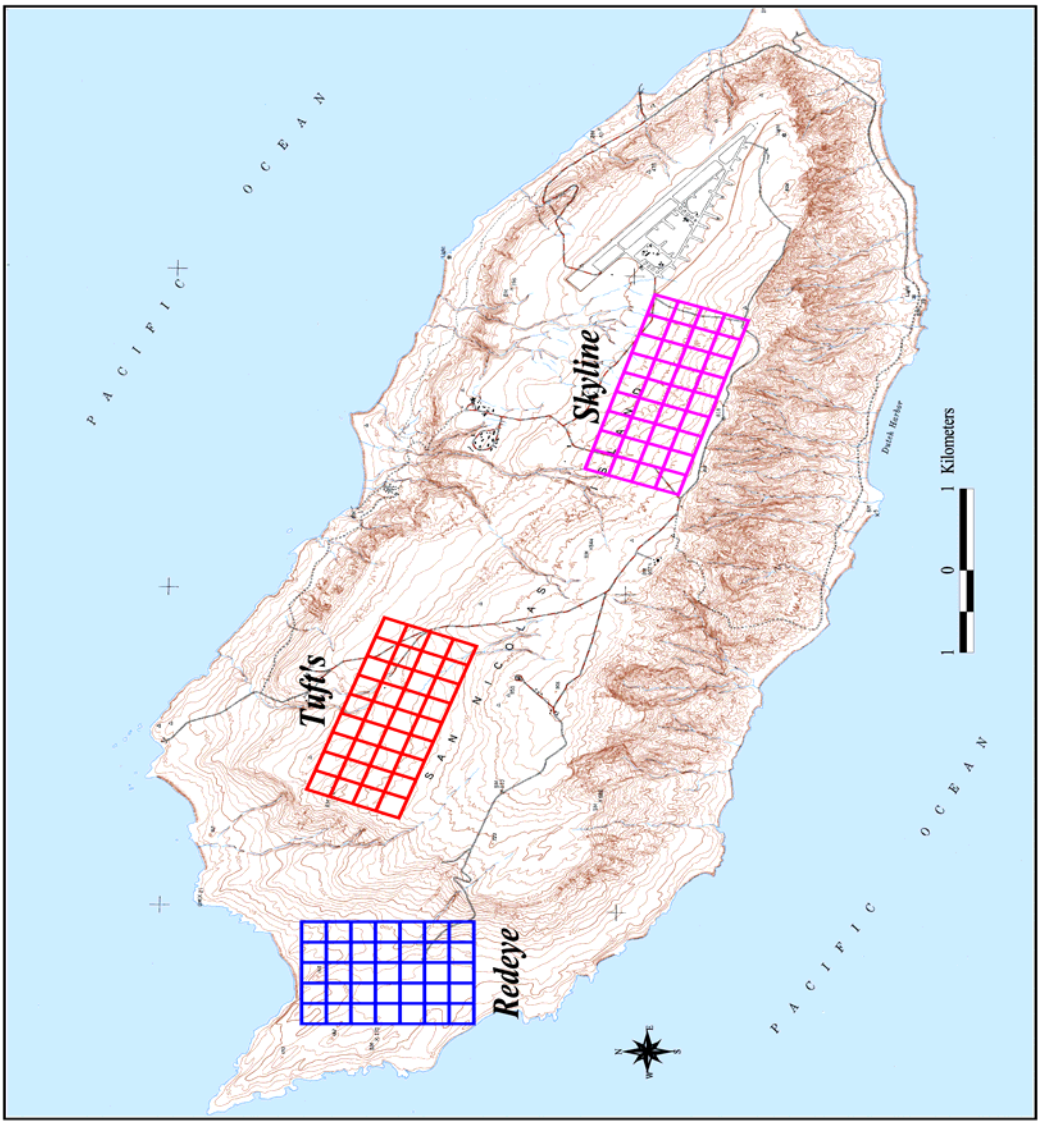
management units on SCI (Table 1). The fox density estimated for each vegetation type (Wolstenholme *et al*. 2003) was applied to the acreage of each plant community in each management unit to provide an estimate of the fox population size in each management unit. The fox population estimates for each management, therefore, are a function of the size of the management unit and the area recorded for each plant community rather than monitoring of each unit. Using this technique to estimate population size, the importance of maritime desert scrub communities stands out. Population estimates for each management unit may be used in future iterations of the INRMP to better address the importance of each management unit to the conservation of island fox on SCI.


**Figure 1.** Management units and fox grids on San Clemente Island.

**San Nicolas Island**

Island foxes occupy all San Nicolas Island habitat types, with densities being highest in areas of native vegetation and lowest in barren areas or those comprised primarily of non-native annual grasslands. Annual monitoring of the population is conducted to evaluate current demography and monitor changes in population parameters. Three capture-recapture sampling grids have been established overlaying several vegetation communities. The grids dominated by coastal scrub and inland dune habitats on the central and western portion of the island, support the highest densities of foxes. Fox population estimates for the entire island are developed by applying fox density values to each island vegetation type and extrapolating for the total area for each vegetation type.

**Figure 2.** Fox monitoring grids on San Nicolas Island.



## 5. Threats to the Species

On San Clemente Island and San Nicolas Island numerous stressors to the island fox population exist that have some potential to threaten the population in the future. Increasingly intensive use may adversely effect the fox population if habitat modification (loss to facilities, fires, and ranges), increasing levels of vehicle use, and increasing disturbances associated with noise, vibration, and human presence occur. In addition, disease, endangered species predator management activities, competition with feral cats, rodent control around facilities and unfavorable habitat changes from historical management practices may also affect foxes. On San Nicolas Island, the lack of genetic variation observed in the fox population has been noted as an additional point of concern. Genetically depauperate populations may be particularly vulnerable to disease epidemics (O'Brien and Everman 1988).

## 6. Regional Conservation Actions

The island fox subspecies found on San Clemente and San Nicolas Islands are endemic, and are found wholly on DOD owned and managed lands. No regional conservation actions are developed to protect these subspecies, because the subspecies do not occur throughout the region. However, extensive efforts aimed at preventing the extinction of the island fox subspecies on surrounding islands include: 1) predator management; 2) captive breeding and release; 3) translocation; 4) distemper vaccinations; 5) wild population monitoring; 6) public education.

## 7. DOD Conservation Actions

On San Clemente Island, the Navy has supported ongoing island fox monitoring and several island fox studies since 1988. In addition, the Navy and the Fish and Wildlife Service signed a Conservation Agreement to address and offset potential threats to the San Clemente island fox in 2003 (Appendix 1). The agreement outlined conservation actions that the Navy had begun to implement, and those for which they had sufficient funding to implement in the near future. Conservation measures identified in the conservation agreement include: 1) expanded cat control efforts intended to reduce cat numbers and thereby reduce competitive interactions between cats and foxes; 2) use of alternatives to box trapping for cat control to minimize incidental impacts to foxes; 3) discontinuation of fox management activities to protect shrikes to minimize impacts to the island fox; 4) modification of rodenticide bait boxes to reduce the potential for foxes to be exposed to rodenticide; 5) continuation of habitat augmentation by propagation and outplanting of native plants, and potential initiation of habitat augmentation through the use of controlled burns; 6) implementation of a 35 mph speed limit to reduce incidents of vehicle-fox collision; 7) installation of "watch out for foxes" signs and education of island personnel about the island fox; 8) maintenance of a clear shoulder on road edges to allow drivers to more easily see foxes along the road edge and reduce incidents of road kill; 9) consideration of impacts to island foxes for military activities proposed in the upcoming Environmental Impact Statement for SCI; 10) modification of monitoring to allow more

accurate assessment of fox population size and trend; 11) submission of fox carcasses to a wildlife pathologist to allow timely identification of disease issues and potential remedies; 12) establishment of a data base to allow ongoing documentation and quantification of road kills, and identification of remedial measures for spikes in road kill numbers. These Island Fox Management Guidelines incorporate measures identified in the Conservation Agreement (marked by an asterix *).

On San Nicolas Island, the Navy has supported study of island foxes since the 1980's, with consistent annual monitoring beginning in 2000. In addition, the Navy has implemented numerous measures to reduce human-caused impacts to island fox. These proactive protection measures include: 1) maintenance and enforcement of the 35 mph speed limit to reduce incidents of vehicle-fox collision; 2) installation of "watch out for foxes" signs in areas of high fox density; 3) education of island personnel about the island fox; 4) maintenance of a clear shoulder on road edges to allow drivers to more easily see foxes along the road edge and reduce incidents of road kill; 5) implementation of pest management practices that minimize harm to island fox; 6) restriction of rodenticides to avoid secondary poisoning of foxes; 7) modification of all refuse bins to exclude foxes and prevent injury during refuse transfer; 8) submission of fox carcasses to a wildlife pathologist to allow timely identification of disease issues and potential remedies; and 9) establishment of a data base to allow ongoing documentation and quantification of road kills.

The guidelines described below may be incorporated into future iterations of the INRMPs for San Clemente and San Nicolas Islands to address the future management and protection of the island fox on these installations.

## I. Monitor the size and health of island fox populations on San Clemente Island.*

*A. Assess the validity of the current population estimation techniques. Refine monitoring to allow determination of additional demographic variables.* Fish and Wildlife Service biomonitor staff can contribute to review of current monitoring techniques and provide recommendations for any modifications that could improve precision of current estimates. Future implementation of intensified monitoring or other adaptive management actions is dependent upon accurate assessment of the island fox population size, growth, stability, and health.

*B. Continue to use grid trapping and density estimates to derive island fox population estimate during periods of non-catastrophic population fluctuation.**

1. Increase grid coverage to address fox densities in currently underrepresented habitat types.
2. Update vegetation maps to allow more accurate estimate of population size if densities will be extrapolated to plant community coverage for determination of population size.

*C. Continue to use monthly spotlight fox counts to identify rapid changes in distribution and abundance of foxes on SCI and SNI.*

*D. Incorporate transects into monitoring efforts if lambda is less than .94 over two breeding seasons, as identified in the Adaptive Management section.* Include at least one transect in each of the 18 Management Units on San Clemente Island. Increase the frequency of monitoring on the 3 transects currently run on San Nicolas Island, and increase the number of transects if transect monitoring becomes necessary. Collect blood samples from all trapped individuals and conduct serology investigation. Collect vital statistics and information about general condition for all foxes captured on transects.

*E. Conduct necropsies on all recovered island fox carcasses.* In cooperation with UC Davis pathologists, create a database that summarizes the results of all necropsies conducted to date on fox carcasses from SCI and SNI. Document the identification number of each fox (if known) and the recovery location of the carcass. Continue this database into the future.

## II. Incorporate island fox conservation needs into facilities and range planning.

***A.*** *To the extent possible, include affects to island foxes and mechanisms to minimize affects to island foxes in all NEPA documents. Determine the extent to which current and future shore installation activities, as well as range and training activities, overlap areas of importance to island fox reproduction, and avoid or minimize impacts when feasible and in accordance with no net loss to Navy readiness requirements. The core of the pupping season (March-June) is a particularly sensitive period for this species.* On SCI and SNI the training mission is of paramount importance. In some instances, long range planning may allow training or facilities construction projects to be conducted outside the pupping season. Little information is currently available about fox den distribution/use to allow avoidance of dens if surface disturbing projects are necessary during the pupping season, however avoidance of this time period is likely to contribute to fox reproductive success by avoiding the potential for den disturbance or modification during the most sensitive period.

***B.*** *Identify key areas of importance to the fox population (i.e. population concentrations, areas of resource availability,) and protect these areas from disturbance as uses on-island intensify.* Based on density estimates derived from grid trapping, maritime desert scrub communities on SCI and SNI support the highest densities of island foxes and are therefore important to maintain. These communities are distributed primarily along the western third of SCI and in the central region of SNI. The SCI INRMP provides data regarding the vegetation coverage in each recognized management unit on the island. Based on the acreage of each management unit and MDS coverage, NAME THE MOST IMPORTANT MANAGEMENT UNITS HERE…..are extremely important units for island fox conservation.

***C.*** *Incorporate measures to encourage reduced speeds of travel into new facilities and improvements on the island.* Island foxes appear prone to collision with vehicles due

to their behavior patterns, densities in the vicinities of roads on SCI and SNI, small stature, and coloration. Foxes are difficult to see if they are standing in roadside vegetation and sometimes run across the road in front of vehicles. Slower speed of travel and increased public awareness can help reduce the number of fox/vehicle collisions that occur and reduce the impact of vehicle-related mortality on the fox population.

***D.*** *Incorporate measures that increase roadside visibility into new or improved* roadways. Foxes are difficult to see if they are standing in roadside vegetation and sometimes run across the road in front of vehicles. Maintenance of short vegetation or gravel/pavement can increase visibility and help reduce the number of fox/vehicle collisions that occur and reduce the impact of vehicle-related mortality on the fox population.

## III. Reduce the potential for an island fox population decline by removing or minimizing mortality factors and stressors.*

*A. Expand Island Fox Outreach and Education**

Some of the potentially adverse human impacts to the island fox population on San Clemente Island and San Nicolas Island could be reduced by raising the level of public awareness among Navy personnel stationed on the island. Although foxes are visible members of the island fauna, many residents are unaware of the species' vulnerabilities and needs.

1. Conduct a survey among on-island personnel to identify the current perceptions regarding natural resource management and the current level of public awareness about native species, including the island fox.
2. Use information gained during the survey effort to initiate an improved education program. Such an education program could educate personnel about the biology and conservation needs of the species, and train personnel how to spot foxes and avoid hitting them.
3. Continue to distribute island fox information pamphlets. Distribute a pamphlet to each visitor who leases a vehicle from the transportation department, to user commands during pre-training briefings, and assure pamphlet availability at the air terminal for all arriving visitors.
4. Continue to post informal "fox flyers" that educate personnel about island fox needs (i.e. potential detriment of feeding foxes, "watch out for foxes", etc.)

*B. Control the speed of roadway travel.**

The speed limit on SCI Ridge Road and paved surface roads was reduced on 5 February 2002 from 45 mph to 35 mph upon instruction from the Commanding Officer of Naval Base Coronado, and the Officer In Charge of San Clemente Island. Five speed limit signs were posted. The speed limit on dirt roads remains 15 mph.

1. On SCI, post and maintain additional speed limit signs in areas where fox collisions have occurred repeatedly and further south on Ridge Road in areas where drivers are consistently observed speeding.
2. Enforce the speed limit with appropriate actions.

The speed limit on San Nicolas Island is 35 mph on paved roads, 15 mph on dirt roads, and 15 mph in the living compound and airfield area.

1. On SNI, post and maintain additional speed limit signs where necessary.
2. Enforce the speed limit with appropriate actions.

*C. Minimize, where possible, the number of vehicles traveling on island roads.*

1. Encourage carpooling to worksites and training areas.
2. Determine the number of vehicles currently on SCI and SNI. Monitor the number of vehicles, determine and encourage a desired "carrying capacity" for vehicles on SCI and SNI.

*D. Reduce potential adverse effects of pest management on the island fox.*

Non-native rodents are absent from San Nicolas Island. Current efforts to prevent non-native rodents from colonizing this island are beneficial to the island fox and should be continued. Non-native mice and rodents are abundant and therefore controlled on San Clemente Island around facilities and in the field to protect listed avian species. Rodenticides can adversely affect island fox individuals if they ingest either the toxin itself or rodent(s) that have eaten the toxins. To avoid adverse effects to island foxes, the use of rodent traps, rather than rodenticides, should be maximized. Only rodenticides that have a minimal potential for secondary toxicity should be utilized on SCI and SNI. When rodenticide use is necessary, the poisons should be distributed only in bait boxes (rather than broadcast), and bait boxes should be modified to prevent fox access. To modify bait boxes to prevent fox access, the box should be securely staked to the ground (so a fox cannot drag the box), and size of the entry hole should be reduced to preclude a fox's head from fitting in the hole.

*E. Conduct prophylactic vaccination of foxes where possible.*

The potential for disease introduction, or spread of any disease that currently exists in the population at ambient levels remains a significant threat to the fox populations on SCI and SNI. Periodic assessment of blood samples will allow ongoing awareness of the levels of exposure to canine diseases in the fox populations on SCI and SNI. Vaccination of animals trapped during grid trapping or during intensified trapping efforts (transects) may become necessary and would increase immunity to some diseases in the event of an introduction/outbreak.

1. Vaccinate foxes against distemper (CDV) and other canine diseases in accordance with the recommendations of the Island Fox Recovery Team (convened for the listed Channel Islands subspecies). If blood samples reveal an increased level of CDV exposure throughout the population, initiate prophylactic vaccination of all animals handled during trapping.

*F. Do not allow dogs on SCI or SNI.**

Current Navy policies regarding pets on SCI and SNI islands prohibit dogs except those working as military dogs. These policies afford protection against disease introduction and should be maintained into the future. Contingency plans to address the potential for dogs swimming ashore from commercial and swimming vessels should also be established.

*G. Consider establishing shoe cleaning stations at the airfields to reduce the potential for parvovirus transmission.*
Some canine diseases can be transmitted not only be dogs, but by people or equipment that have been near dogs. Assuring that equipment and shoes are clean prior to use on the island would help reduce the potential for unintended disease transmission to SCI and SNI.

*H. Continue to manage the feral cat population on SCI. Reinitiate cat management efforts on San Nicolas Island.**
Feral cats may compete with island foxes for vertebrate prey items and may also represent an additional disease vector. Elimination of feral cat populations on SCI and SNI would be advisable, but is considered unfeasible. Ongoing management of the feral cat populations should be conducted to control the size of the feral cat population. This work is ongoing on SCI to benefit listed avian species, and can also benefit the island fox. Feral cat management efforts should be conducted in a fashion that minimizes the potential impacts to the island fox population. For example, large-scale trapping efforts should be conducted outside the fox breeding season to minimize the potential effects to the island fox. On SCI, the current recommendations of the predator management team are to focus on spot-lighting as the primary means of feral cat management.

*I. Maintain refuse bin modifications on SNI and implement bin modifications on SCI.*
Foxes will rummage through garbage containers and trash bins and may ingest harmful substances or become dependent upon these unnatural food sources. In addition, foxes can become trapped in such containers. On SNI, "exclusion bars" have been placed upon all trash bins. The bars prevent the trash bin lids from being left open by island personnel, thereby preventing foxes from entering.

## IV. Restore native plant communities on SCI and SNI.

*A. Reduce the prevalence of non-native annual grasslands. Remove annual grasslands by conducting controlled burns (outside the fox breeding season) or by using appropriate herbicide.* Lower island fox densities are consistently detected in non-native grassland communities on SCI and SNI. Creating conditions that reduce the abundance of non-native grasslands and favor native grassland and shrubland communities should improve habitat quality for the island fox.

*B. Continue weed control programs on SCI and SNI.*

## V. Employ an adaptive management strategy to assure that the conservation needs of the species are met in the event of a population decline.

*A. Identify the magnitude of decline (or catastrophic event) that would warrant intervention or remedial action.* The table below provides a general adaptive management outline for fox populations on SCI and SNI. This table and the adaptive

management approach should be refined during 2005 for inclusion in the next INRMP. This adaptive management approach is based on the premise that natural fluctuations occur in the island fox populations, but that as a decline begins, intensified monitoring and assessment will begin to better understand the nature of the decline and determine if remedial actions are necessary.

*B.* *Identify response mechanisms to be taken if population decline occurs.* Response mechanisms include intensified monitoring and, if necessary, additional measures such as supplemental feeding, vaccination, and, in a worse case scenario, taking animals into captivity.

Table 1. Adaptive management approach for San Clemente Island Fox.

| **Monitoring and Adaptive Management of Fluctuating Island Population during Periods of Non-Catastrophic Demographic Changes:** | | | | |
|---|---|---|---|---|
| **POPULATION PARAMETER** | **MONITORING METHOD** | **DATA TO BE COLLECTED** | **THRESHOLD FOR INTERVENTION** | **INTERVENTION PLAN** |
| Λ (population growth rate) | **Grid trapping**<br>**Spotlighting** | Number of Animals, Age, Sex Ratio<br>Population size through time | $\lambda < 0.94$ | Further analysis of existing demographic info.,<br>Conduct radio-telemetry to refine demographic information<br>Habitat enhancement |
| Fe (Fecundity) | **Grid trapping** | Body condition indices (Reproductive condition) | Age class structure askew | Radio-telemetry |
| Φ (Survivorship) | **Grid trapping**<br>**Road Kill Database** | Age of individuals<br>Recapture data | Survivorship decline of 30 percent | Vaccinations<br>Radio-telemetry<br>Transect surveys<br>Supplemental feeding |
| Density estimates | **Grid trapping** | Number of animals<br>Movement within and between grids | 30 percent decline | Initiate transects and telemetry in plant community in which decline is observed |
| Population health | **Grid trapping**<br>**Carcass collection and analysis** | Serosurveys,<br>Necropsy,<br>Body condition indices (tooth wear, nutritional condition, weight, ) | Detection of new disease or increased prevalence of CDV… | Vaccinations<br>Radio-telemetry<br>Transect surveys<br>Supplemental feeding |
| **Adaptive Management/ Monitoring during Periods of Catastrophic Demographic Change or Potentially Catastrophic Events**: | | | | |
| Φ, Relative abundance | **Transects,**<br>**Spotlighting** | Serosurveys<br>Necropsy,<br>Body condition indices | 1 rabid animal,<br>15 animals CDV+,<br>30% decline in foxes/km | Vaccinate all trapped foxes<br><br>Increase monitoring-Transects to get foxes in hand and observe condition of individuals |
| New predator, or increased number of predators | **Predator monitoring** | Predator types and abundance | Change in predator population compostion. | Conduct telemetry to determine impact of predators, conduct predator management |

| | | | | |
|---|---|---|---|---|
| Population estimate | **Grid trapping, Transects, Spotlighting** | Serosurveys<br>Necropsy,<br>Body condition indices | Population estimate declines by 80% (using 2004 population estimate as baseline) OR number of individuals known alive drops below 50***** | Bring a number (to be determined) of foxes into captivity as hedge against extinction and as potential founders if captive breeding becomes necessary. |

***** based on results of preliminary population viability analysis conducted for Channel Island Fox Recovery Team.

## VI. Support research that provides additional information necessary for effective fox management.

*A. Obtain additional information regarding den use and location.*

*B. Conduct noise study to determine if noise or vibration affects fox distribution and reproduction. If noise does affect foxes, minimize noise sources where possible.*

*C. Obtain additional information regarding fox biology, including survivorship, using radio telemetry.*

*D. Monitor variables that may be related to observed changes in fox population status, including: weather patterns, prey abundance, disease manifestation in the population, roadkill, etc. Where possible, measure these variables as population data is collected rather than conducting retrospective analyses.*

1. Test all carcasses for emergent disease outbreaks. Maintain a database on results of all necropsies conducted on SCI foxes. Develop contingency plan that could be quickly implemented should a disease outbreak occur.

2. Test marine mammal populations for distemper to determine if this is an issue of concern for foxes.

3. Maintain data base of reported roadkills, including narrative (conditions surrounding collision, if known), vehicle speed at time of collision, mapped location, age of animal, and condition of road shoulder. Compilation of this information should assist in future management by documenting roadkill "hotspots".

4. Routinely monitor prey abundance.

5. Assess fox movement patterns on SCI and SNI. Do movement patterns affect the validity of population estimation techniques?

*E. Continue participation on the Island Fox Recovery Team.*
Participate in discussions and determinations regarding off-island breeding of island foxes.

## Geographic Management Recommendations for San Clemente Island

Management Units, Fox Population Estimates, and Recommended Management Actions

| UNIT (Fox population estimate) (% of total 681 foxes) | Management Actions to Benefit Island Fox |
|---|---|
| 1, Northwest Harbor (12 foxes) (1.7%) | -Post and maintain10 additional signs along roadway to alert motorists to fox presence.<br>-Post and maintain10 additional speed limit signs<br>-Conduct additional education of personnel stationed at facilities in this management unit including distribution of pamphlets and fox video.<br>-Increase speed limit enforcement in this management unit.<br>-Maintain road shoulder to increase visibility adjacent to road. |
| 2, Airfield (3 foxes) (0.4%) | -Post speed limit signs at all exits from airfield parking lot.<br>-Distribute pamphlets in airport.<br>-Periodically show fox video in airport waiting area.<br>-Develop exhibit for airport showcase. Include example of caution signs, mount of fox, photographs, info, etc.<br>-Maintain road shoulder to increase visibility adjacent to road. |
| 3, Dolphin Bay (14 foxes) (2.0%) | No recommendations specific to this unit. |
| 4, West Cove (35 foxes) (5.1%) | -Restore disturbances with MDS.<br>-Minimize new disturbance to MDS. |
| 5, Wilson Cove (2 foxes) (0.3%) | -Develop and conduct “natural resources of SCI” course that could be taken by island personnel for college credit.<br>-Increase speed limit enforcement in this management unit<br>-Post signs and distribute pamphlets in galley. Include poster that requests that personnel do not feed the foxes.<br>-Inventory signs currently present in Wilson Cove. Add sufficient signs to assure that speed limit and caution signs are present at: (1) curve from airport approaching Wilson Cove, (2) before the grade into/out of Wilson Cove, (3) at the entrance/exit to the new BEQ buildings, (4) at the exit to the galley, and (5) at the entrance/exit to the older portion of Wilson cove.<br>-Maintain road shoulder to increase visibility adjacent to road.<br>-Conduct pest management using products and distribution techniques that are unlikely to adversely affect island foxes. Only rodenticide with little/no potential of secondary effects should be used. All rodenticide should be distributed in bait boxes that are modified to reduce the size of the entry hole and thereby prohibit fox entry. All bait boxes should be securely staked to the ground to prevent fox movement of/ damage to bait boxes. Recommend the use of Quintox as rodenticide of choice, but also recommend that trapping be emphasized as the primary means of rodent control to reduce the potential for toxicity to foxes. |
| 6, NOTs Pier (8 foxes) (1.2%) | No recommendations specific to this unit. |
| 7, Terrace Canyon (52 foxes) (7.6%) | Place 4 signs on road to West Shore to alert motorists to fox presence. |
| 8, VC-3 (12 foxes) (1.8%) | No recommendations specific to this unit. |
| 9, Lemon Tank (27 foxes) (4.0%) | -Remove annual grasses from this management unit to allow recovery of native shrublands and grasslands. A monitoring unit lies within the boundaries of this management unit, so habitat manipulation should allow assessment of effects to fox |
| 10, Seal Cove | -Minimize disturbance to this area due to relative importance to the island fox. |

| | |
|---|---|
| (116 foxes) (17.0%) | -Restore disturbances with MDS.<br>-Minimize new disturbance to MDS |
| 11, Mt. Thirst<br>(40 foxes) (5.9%) | -Distribute pamphlets at facilities at Mt. Thirst. |
| 12, Lost Point<br>(84 foxes) (12.3%) | -Minimize disturbance to this area due to relative importance to the island fox.<br>-Restore disturbances with MDS.<br>-Minimize new disturbance to MDS |
| 13, Cave Canyon<br>(59 foxes) (8.7%) | No recommendations specific to this unit. |
| 14, Eagle Canyon<br>(38 foxes) (5.6%) | No recommendations specific to this unit. |
| 15, Upper China Canyon<br>(24 foxes) (3.5%) | No recommendations specific to this unit. |
| 16, China Cove<br>(37 foxes) (5.4%) | No recommendations specific to this unit. |
| 17, Pyramid Cove<br>(95 foxes) (14.0%) | This management unit supports over 10 percent of the island fox population on SCI, however the area also has high military value, so no recommendations are specific to this unit. |
| 18, Mosquito Cove<br>(23 foxes) (3.4%) | No recommendations specific to this unit. |

## 8. Measuring Effectiveness of Conservation Actions

The conservation actions described herein are expected to reduce threats to the island fox on SCI and on SNI. Specifically, effective implementation of the management guidelines should: reduce the number of collisions between island foxes and vehicles; reduce the potential for transmission of canine diseases; reduce competitive interactions with feral cats; reduce the potential for fox poisoning; increase the extent of native habitat favorable to island foxes; and minimize future disturbances to island foxes.

The effectiveness of the conservation actions can be indirectly measured by the status of the fox population on SCI and SNI. Refining monitoring and demographic studies will be important to the assessment of species status. Additionally, annual reports documenting the number of roadkills, the extent of annual grassland reduction (and effects to fox density estimates), and health of the population will allow determination of the effectiveness of the conservation actions described.

### Implementation Schedule

Many of the conservation actions described in this document are dependent upon the annual availability of funds to support necessary conservation actions. The implementation schedule provided below is intended to provide a suggested schedule and basis for funding of management actions. These management guidelines are not a fund-obligating document.

**Table 2.** San Clemente Island: Conservation actions, expertise needed, projected cost ($) and projected year of implementation.

| Conservation action | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| Feral Cat Management | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 |
| Habitat Restoration | Weed eradication 15,000 | Annual grass removal 20,000 | Annual grass removal 20,000 | Annual grass removal 20,000 | Annual grass removal 20,000 |
| Sign installation and maintenance | Maintain/ Replace previously installed signs 5,000 | Install new signs 20,000 | Maintain/ Replace previously installed signs 7,000 | ---------- | Maintain/ replace previously installed signs 7,000 |
| Road shoulder clearing | 40,000 | 30,000 | 20,000 | 15,000 | 15,000 |
| Conduct Natural Resources Survey | --------- | 30,000 | ---------- | ---------- | ---------- |
| Develop and offer natural resources course | ---------- | ---------- | 20,000 | 20,000 | 20,000 |
| Distribute Pamphlets | Ongoing 0 (zero cost) | Ongoing 0 | Print additional pamphlets, 1000 | Ongoing 0 | Ongoing 0 |
| Conduct monitoring study | | 125,000 | 150,000 | 150,000 | 150,000 |
| Assess current population estimation techniques | 30,000 | ---------- | ---------- | ---------- | ---------- |
| Necropsy all foxes and maintain database | 3000 | 3000 | 3000 | 3000 | 3000 |
| Avoid pupping season, where feasible | 0 (zero cost) | 0 | 0 | 0 | 0 |
| Vaccinate 50 foxes | 500 | 500 | 500 | 500 | 500 |
| Prohibit dogs | 0 (zero cost) | 0 | 0 | 0 | 0 |
| Conduct Research | -------- | 30,000 | 30,000 | 30,000 | 30,000 |
| Employ adaptive management strategy | tbd | tbd | tbd | tbd | tbd |
| Continue Recovery Team Participation | 250 | 250 | 250 | 250 | 250 |
| **TOTAL** | **293,750** | **458,750** | **451,750** | **438,750** | **445,750** |
| | | | | | |

**Table 3.** San Nicolas Island: Conservation actions, expertise needed, projected cost and projected year of implementation.

| Conservation action | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| Feral Cat Management | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 |
| Habitat Restoration | Weed eradication 20,000 | Weed eradication 25,000 | Weed eradication 25,000 | Annual grass removal 20,000 | Annual grass removal 20,000 |
| Sign installation and | 0 | 2,000 | 0 | 0 | 2,000 |

| | | | | | |
|---|---|---|---|---|---|
| maintenance | | | | | |
| Road shoulder clearing | 15,000 | 15,000 | 15,000 | 15,000 | 20,000 |
| Distribute Pamphlets | Ongoing<br>0 (zero cost) | Ongoing<br>0 | Print additional pamphlets, 1000 | Ongoing<br>0 | Ongoing<br>0 |
| Conduct grid-based monitoring study | 30,000 | 30,000 | 35,000 | 35,000 | 45,000 |
| Assess current population estimation techniques | 0 (zero cost) | ---------- | ---------- | ---------- | ---------- |
| Necropsy all foxes and maintain database | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Avoid pupping season, where feasible | 0 (no cost) | 0 (no cost) | 0 (no cost) | 0 (no cost) | 0 (no cost) |
| Vaccinate 50 foxes | 500 | 500 | 500 | 500 | 500 |
| Prohibit dogs | 0 (no cost) | 0 | 0 | 0 | 0 |
| Continue Recovery Team Participation | 0 (no cost) | 0 | 0 | 0 | 0 |
| **TOTAL** | **108,500** | **115,500** | **119,500** | **113,500** | **130,500** |

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