

TENTH ANNUAL MEETING
ISLAND FOX WORKING GROUP
Sheraton Four Points Hotel, Ventura, California
JUNE 24TH – 26TH, 2008

Sponsored by:
National Park Service
The Nature Conservancy
Catalina Island Conservancy
Friends of the Island Fox

SUMMARY REPORT

Prepared by Cathy A. Schwemm
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The following island designations will be used throughout the report: San Miguel Island (SMI), Santa Rosa Island (SRI), Santa Cruz Island (SCI), Santa Catalina Island (CAT), San Clemente Island (SCL) and San Nicolas Island (SNI).

ABSTRACTS AND SUMMARIES OF SCHEDULED PRESENTATIONS

Status Of The Draft Recovery Plan

Eric Morrissette

Abstract

The Island Fox Recovery Coordination Group (RCG) submitted their draft of the recovery plan ('Draft Recovery Plan for Four Subspecies of Island Fox [*Urocyon littoralis*']') to the U.S. Fish and Wildlife Service's (Service) Ventura Office on August 1, 2007. Internal review then began at the Ventura Office. At the completion of this review a copy of the draft recovery plan was sent to the relevant land managers. Continuing the coordination and collaboration in island fox recovery efforts, the land managers were provided a few weeks to read and become acquainted with the draft recovery plan. The Service then held a meeting with the land managers and the Chair of the RCG in May 2008 to discuss the plan. As a result of this meeting a few edits were made to the draft plan that would make the plan more useful and usable for land managers, however, the overall intent, approach, and content of the plan were basically unchanged.

In June 2008, the Ventura Office sent the draft plan to the Regional Office (Region 8) in Sacramento, California. The Regional Office is currently conducting its review, which typically takes approximately 3 to 4 months. After Regional Office review, the Service will publish a Notice of Availability (NOA) in the Federal Register that the draft recovery plan is available for public comment, and the public comment period will last a minimum of 60 days. The notice will also be posted on the Ventura Office's webpage, and a CD copy of the draft plan will be mailed to everyone on the Island Fox Working Group contact list. The Service will review and address all comments that are received within the public comment period, and the RCG, outside experts, Technical Expertise Groups, and/or land managers may be asked for assistance in addressing the comments received. The final recovery plan will then be released approximately 10-12 months after the close of the public comment period.

The Service thanks the many people, agencies, and organizations that have been involved in island fox recovery efforts and those that provided assistance in developing the draft recovery plan.

San Nicolas Island Update

Grace Smith

Grace presented the results from the 2007 SNI IF monitoring, a joint effort between the U.S. Navy and the Institute for Wildlife Studies (IWS). Fox monitoring has been conducted on SNI since 2000 using three permanent grids (Redeye, Tufts and Skyline). Grace described the grid locations, habitat types, and trapping methods, which are all similar to past monitoring, and presented the following results:

Trapping Results

Grid	# traps	# pups	2007 adults	2006 adults	2005 adults
Redeye	48	14	54	58	59
Tufts	50	9	52	54	35
Skyline	50	4	3	28	22

Grid	2007 adult population est.	2007 adult density est.	2006 adult density est.
Redeye	60	16.8/km ²	18.3
Tufts	69	20.4	17.9
Skyline	48	8.9	8.8

Age class structures

Grid	Percent in age class				
	0	1	2	3	4
Redeye	21%	43	16	13	7
Tufts	15	24	18	12	31
Skyline	9	42	18	12	18

Islandwide, almost 37% are age class 1, and growth rates since 2000 on all the grids is generally greater than 1.0 (mean = 1.05).

Survivorship results

Class	Survivorship (%)	95% CI
Adult males	74	67 – 81%
Juvenile males	66	53 – 79%
Adult females	75	72 – 79%
Juvenile females	79	64 – 93%

Survivorship results for females differed between years, while those for males did not.

The estimated adult population size for the island grew between 2001 – 2007, with an estimate for 2007 of 725. Because of the challenges of expanding the grid estimates to all habitats on the island, this estimate is probably high, and for population status purposes Grace suggests it is more valuable to look at survival rates (which are also very high).

Fox mortalities on the island continue to be primarily caused by vehicles, and losses to vehicles are higher this year than in past years. Entrapment and human-related trauma are also sources of mortality. There have been 17 mortalities to date (June 2008), compared to 19 in 2007 and 24 in 2006.

Last year 49 individuals were vaccinated against distemper and rabies. The automated monitoring system (described last year) is working well, and diet research is also ongoing. Overall the SNI population is stable with high survival, and there is no indication of disease.

Questions/comments

Q: Have you seen any alterations in habitat use with vegetation change on the island over the last decade?

A: Vegetation does not appear to be changing at this point, and there are fairly consistent abundance relationships between the grids. Distribution is also fairly consistent; higher densities are generally found near water sources, and there may be a relationship between foxes and invasive species such as snails and invasive plants, which they may be utilizing as food resources. There has been some conversion from annual grasslands to shrubs in areas on the west end, and perhaps there has been some increase in fox habitat use there, but fox distribution across the island does not generally change from year to year.

Q: Why do you suggest that population estimates are high?

A: Some areas that aren't sampled likely have lower densities than those that are sampled, so extrapolating density estimates from the grids to those areas is probably invalid. True fox home range size is often underestimated by CAPTURE (the program used to estimate density), and if so the estimates of density are higher than true densities.

Q: Why do you suggest that young male survival is higher than estimated?

A: Social structure is different across the grids, and this affects movement and density estimates. When individuals disperse off the grids they are not recaptured (known to survive) but may be alive off the grid. Dispersal is most common in young males.

Q: How is the telemetry study working?

A: There are some challenges to using it for monitoring, but it will likely be a good tool to detect sudden changes in survival, i.e. disease outbreaks.

Q: What is the status of the cat removal project?

A: Still in the planning stages. The public comment period has closed so now the planners are addressing submitted comments.

Q: How many cats do you think there are?

A: We don't know, but we're working with an estimate of 100 – 200.

Catalina Island Update

Julie King

Abstract

Island-wide transect trapping was conducted on Catalina Island (CAT) from July 30-October 19, 2007 using 604 trap sites. This design resulted in 72% of the island effectively sampled (79% on the west end and 71% on the east end). 365 individuals foxes were captured, resulting in an islandwide population estimate of 572. The mean density estimate was 3.5 foxes/km². (For the west end it was 6.5 foxes/km², and for the east end 2.9 foxes/km²). Weekly aerial telemetry flights were conducted throughout 2007 to monitor 57 radio collars, 21 of which were unvaccinated disease sentinels. Frequent monitoring resulted in the detection of 14 known mortalities, 4 of which were from vehicle trauma.

Threat abatement initiatives using signage, education, a speed feedback machine and other policies were implemented to reduce human-caused mortalities of foxes. Approximately 12,000 people visited 'Tachi', the captive 5-year-old fox ambassador, during 2007. These encounters provided a diverse audience the opportunity to learn about island foxes. The Catalina Island Conservancy (CIC) continued its collaborative effort with the Institute for Wildlife Studies (IWS) and UC Davis to research the potential causes and treatment of ear tumors found in Catalina Island foxes (summarized below).

The timing of the fire that occurred May 10-16, 2007 likely caused considerable pup loss in the affected areas. However, very few collared adults were undetected in the same area during subsequent trapping efforts. The overall east end population continued to increase despite a year of drought and the fire. In response to the fire, 20 GPS collars (Televilt AVP, Tellus Mini C3) were deployed on 10 foxes (5F, 5M) inhabiting burned areas and on 10 (5F,5M) living in an undisturbed area of similar size. Collars were programmed to collect data every 3 hrs (8 pts/day) for 7 months. Data from these collars will be analyzed in the fall of 2008 to determine habitat use, home range size, and seasonal activity patterns of these individuals.

Additional Notes

CIC is currently planning to continue to use transect trapping (vs. other monitoring designs) though it is labor intensive. However, implementing transects requires an intense level of effort. Of the 365 individuals captured using this method in 2007, 333 were vaccinated (58% of the estimated population). The highest densities of foxes were near human camp areas on the west end.

Current threats to foxes on CAT include vehicles, feral cats (the current island-wide estimate is over 700), domestic dogs, humans (people feeding foxes is the biggest problem), ear tumors, and raccoons. The threat abatement effort is going well, but some of the signs have been stolen. (Friends of the Island Fox donated money for new signs.) CIC has also

purchased and installed poop bag stations, but it is a challenge to keep these supplied as people often take many at a time. There is also a new Pets and Wildlife policy that all leasees on the island must sign that directs that only long-term employees can have pets and all pets must be vaccinated and continuously confined. A feral cat task force was also created that will look at many issues related to cats. One proposal is to trap and sterilize all the feral cats and confine them in a sanctuary for the remainder of their lives.

Causes of mortalities to IF in 2007 (in addition to vehicles) included starvation (3), euthanasia due to poor physical condition (2), septicemia (2), drowning (1), gunshot (1), and 1 environmental death due to unauthorized trapping. To date in 2008 there have been 9 mortalities (5 from unknown causes, 1 euthanasia, 1 drowning, and 2 others). The causes of two very recent deaths (June 2008) of unvaccinated sentinels near Avalon are currently unknown, but an epidemic is a possibility. These carcasses have been sent to U.C. Davis for necropsy.

The ear tumor study is ongoing, and CIC assists this effort with field support. Field personnel carry otoscopes and check the ears of all trapped animals, and collect ear mites as well as bacterial, fungal and viral cultures.

The fire in May 2007 burned approx. 10% of the island (4,750 acres). The fox that was recovered with burned paws was released in July 2007 and recaptured in June 2008. At that time she was doing well and lactating. At the time of the fire pups were too young to leave the area independently and it is thought that many may have perished. If the fire had occurred later in the season the pups would have been older and would likely have survived. Adult fox abundance did not decline after the fire. Foxes with GPS collars did not lose significant weight, and collars on males were more heavily damaged (due to aggressive interactions) than were those on females.

Questions/Comments

Q: Given the high population, how close do you think you are to the (draft) recovery criteria?

A: In 2006 mortality was 16%, and when combined with abundance puts the CAT population close to the recovery criteria.

Q: Why was 500-meters used as a buffer between grids?

A: To prevent double captures of individuals across grids.

Q: Are you planning to switch to the Ruben et al. (2007) protocol?

A: Not at this time. The transect effort is very labor intensive, but it samples important areas that the plan currently does not, and provides all the data they currently need.

San Clemente Island Update

Bill Andelt

Abstract

Population size, survival, and causes of mortality of the San Clemente Island (SCL) IF population were estimated from data on 53 foxes radio-collared from July 2006 to March 2007 at random locations and from 19 foxes captured near primary roads on the northern 2/3 of the island. The estimate of population size is a collaborative effort among Colorado State University (CSU), Garcia and Associates, and the US Navy, and integrates trapping and telemetry data. Mark-recapture grids have been used to generate estimates of density that are dependent on an estimate of the size of the area being sampled, but determining this 'effective trapping area' is difficult. The sampling area of the trapping grids have been estimated from the mean, or half the mean, maximum distance moved (MMDM) by individual foxes on trapping grids or from estimates of home range size. MMDM are dependent upon the size of the trapping grids, number of nights the grids are monitored, and perhaps other factors. Estimates of home range also can be variable depending on methods used to monitor animals and methods used to estimate home range size. Thus, they combined telemetry data with data from trapping grids to provide a more accurate estimate of population size and density.

Garcia and Associates set and monitored, for 4 nights each, 10 5x8 trapping grids on the northern 2/3 of SCL from June 27th to July 24th, 2007. They used 59 of the radio-collared foxes as the "marked" population and the number of marked and unmarked foxes captured each morning on the trapping grids to estimate population size via mark-resight population estimation. They used a closed population model, but an open population model should be considered as well. We estimated a population of 386 (95% CI = 320-481) foxes on the northern 2/3 of SCL.

Seven of the random sample of 53 collared foxes died from July 2006 – December 2007. Causes of these mortalities included roadkill plus secondary emaciation and mineralization likely due to rodenticide poisoning (1), abdominal puncture (1), trauma (1), and undetermined (3). Foxes killed by vehicles on SCL from 2003 – 2007 averaged 33 per year. Randomly captured foxes had an annual survival rate of 0.908 (95% CI = 0.802 – 0.958). Foxes that had home ranges that encompassed the primary roads on SCL (n = 29) had an annual survival rate of 0.648 (95% CI = 0.457 – 0.786) which was lower than the annual survival rate of 0.926 (95% CI = 0.814 – 0.971) for foxes that had home ranges away from the primary roads (n = 43). Overall, vehicles are taking about 5% of the population each year.

Questions/Comments

Q: Are there estimates for the entire island?

A: Yes.

Q: Could the roads be acting as sinks?

A: Perhaps, but home ranges are fairly stable. Further data should explain this better.

Q: Are there age/sex class differences between road and non-road animals?

A: They are going to analyze those data in the near future.

Q: What was used to determine the random points for trapping?

A: They used a GIS program (RRQR) that was developed by Dave Theobald at CSU.

Q: Do you do recaptures on the grids?

A: Yes.

Q: Could you collect recapture data using the radio collars?

A: Yes, and the suggestion was made that night spotlighting could be used if there were some way to determine which animals were marked (such as colored collars at night).

Q: Are you catching cats in the traps?

A: Yes, but not many.

Q: Could it be that roadside habitat is highly used by foxes because it good bird habitat?

A: They are looking at why foxes are using these areas, and their suggestion is that the roads provide easy access, but also that there may be fewer cats near roads (just speculation at this point).

Q: Do you know how the shrike population is doing?

A: Very well; there are 34 pairs in the wild with good fledgling survival.

Q: Where are the rodenticide poisoning locations, and are people allowed to use rodenticide?

A: These locations are near buildings, and use of this type (around buildings) is allowed.

Santa Cruz Island Update

Rachel Wolstenholme

Thirteen pups were produced in captivity in 2007, 10 of these survived, and aggression was the only known cause of mortality (1 mortality was unknown). 66 pups and 160 adults were caught during census trapping, resulting in an island-wide population estimate of 411. There were 31 animals released in 2007, mostly on the western 2/3 of the island, and 10 of these were pups. Half of the adults released were born in the wild and were between 7-10 years old. 11 of these 31 released animals died, but none of those were pups. The survival rate was nearly 89%, which is greater than in past years. The survival of released foxes is lower than for wild animals, but many of these died early after release. Survival of past released animals increased during their second year in the wild, and in the absence of predation survival begins to decline at about age 6.

Mortality was caused primarily by predation, but predation overall has declined. Predation events from May 2007 – April 2008 were spatially distributed across the island, suggesting

the absence of nesting activity by golden eagles (GOEA). Predation is also temporally variable, suggesting that these eagles are transients. Several predation events occurred in late February and early March of 2008, which is the GOEA nesting season, so there was concern that a breeding pair was present. TNC conducted aerial surveys on SCI and SRI and checked many of the historic nest sites, with negative results. GOEA were noted by other researchers on the islands, but only after the predation event was reported.

This effort (aerial surveys) cost \$6000, and if an eagle had been located trapping would have greatly increased those costs. Given the high costs, frequent negative results (of eagle sightings) and often negligible fox population impacts, managers are faced with the question of how to allocate resources in response to predation events. On SCI, radio collared animals are distributed widely across the island, and it is expected that predation events will be quickly detected. GOEA are known to regularly disperse from the mainland, so there may always be a small number of GOEA present with a corresponding persistent low level of predation. At what point (how much predation, how many eagles) do managers respond? (Further discussion included below.)

The TNC monitoring program is based primarily on the Rubin et al. (2007) protocol, and they are especially interested in proactive, adaptive management. Any monitoring program must also be affordable over the long-term. Given these conditions, they are proposing to adopt Scenario B (Rubin et al. 2007), using small grids that obtain mark-recapture data that can be used in program DENSITY. This year (summer 2008) they are also going to continue the IWS transects and integrate results from the two methods. (There is a question of whether or not this is logistically feasible.) Their goal is to have 50-60 collared animals, and vaccination protocols will be included in trapping methods. They will also be incorporating aerial telemetry to shorten the carcass recovery time. Flights are expensive, but with a reduced ground crew the costs might be equivalent to the field-intensive transect trapping and monitoring, and can be scaled quickly to changing conditions.

Vickie Bakker presented a model that incorporates parameters of eagle numbers, rates of eagle capture, predation rates, and fox abundance to predict fox extinction risk given variable response strategies. Assumptions that generated discussion were 1) that the 2007 predation losses were due to one eagle, and 2) that captive and wild born foxes had an equal chance of predation. While estimations of predation rate and fox abundance are calculable with reasonable confidence, the number of eagles present at a given time and the capture/effort rate for eagles is generally not. There was much discussion on the values that were used in the model and whether or not they were justified. Using the values she presented, the model predicted results suggest that managers could wait for a week to respond to mortality events if eagle capture rates were relatively high, (which most people agreed they are not), but that a wait of 2 weeks would greatly increase the probability of extinction.

Questions/comments

Q: How sensitive is the eagle risk analysis to changing fox population size?

A: The simulation incorporates population increase over time.

Q: How big a crew will your small grid trapping (18 small grids) require?

A: This year it will be a big effort with crew of 6. Next year they hope to get by with a crew of 2-3. Aerial telemetry currently costs about \$45,000/year but can allow managers to reduce the number of field personnel.

Q: What is the status of the captive population?

A: The captive facility is closed except for a few non-releasable animals.

Q: How well does DENSITY perform on transect data?

A: There is a question of how well the resulting estimates (for each transect) can be scaled to the rest of the island. But the design is good, and the hope is that grid trapping will take less time (than current trapping methods).

Q: Are there any habitat improvement efforts underway?

A: They are working to reduce the abundance of most of the aggressive weedy species and restore native shrubs. Fennel is not their priority given the more aggressive potential of other species.

Santa Rosa Island Update

Tim Coonan

Abstract

In 2007-2008, annual survival of Santa Rosa island foxes (*Urocyon littoralis rosae*) climbed to 90%, marking the first time since releases began in 2003 that survivorship increased to levels estimated to be required for population increase. However, the islandwide population remains small and reproduction in the wild has not approached that on San Miguel. Reproduction in captivity was also low in 2007. If captive production were higher, continued captive breeding could contribute significantly to wild population growth. However, it is questionable whether future captive breeding will exceed that seen in the wild.

Twelve foxes were released to the wild in fall 2007. As on San Miguel, population monitoring comprised tracking annual survival and causes of mortality, evaluating reproductive success in the wild, and estimating the islandwide population size of island foxes. The islandwide population size, or the minimum number known to be alive (62), was calculated as the sum of the total number of foxes caught during fall trapping (49) and the additional radiocollared foxes known to be alive (13). The MNKA was about half that on San Miguel. A total of 12 wild pups were trapped in the fall, and thus wild reproduction was half that on San Miguel (27 pups in 2007).

Annual Kaplan-Meier survival estimated from the 50+ radiocollared foxes climbed above 90% in late 2007 and as of June 2008 was 88% (80% CI = 85-95%). Six radiocollared foxes died in 2007, including one case of incomplete predation, in which a raptor's talons punctured the thoracic cavity but the carcass was intact (no evisceration or degloving). The case of incomplete predation occurred in December 2007, within days of the incomplete

predation event on San Miguel. Two other cases of complete predation occurred in spring 2008, representing the first predation mortalities in almost two years.

Four of 12 captive females produced litters in spring 2008, and weaned a total of 8 pups. The number of pups, success rate, and pups produced per captive females (0.66) were comparable to that of previous years. Ten pups were lost to neonatal mortality. To preclude incidents of mate aggression and the possibility of males killing newly-born pups, paired males were removed from pens after ultrasound examination confirmed pregnancies in March, but this, along with increased observations to detect problems, did not result in additional pups being produced. Apparently aborted fetuses were found in two pens and were saved for necropsy. Results from one indicated massive bacterial infection, which likely caused abortion. Although all pregnant females were administered antibiotics to prevent mastitis, treatment did not begin in time to save the two litters.

The annual rate of increase (λ) for the wild Santa Rosa population was 1.11, compared to 1.0 for the previous two years. At these rates of survival and population increase, it may be several years before the subspecies attains demographic recovery.

Questions/comments

Q: What are this year's release plans?

A: Similar to last year, 8-10 animals, and they will likely release only young animals. Some of the pairs aren't producing, so they would change some of those. They would maintain about the same number (12 pairs) in captivity for the next year. (Ed. note: this proposed release scenario was greatly modified by the discussion on Thursday; see SRI Captive Population discussion with the Wild Population Management TEG notes.)

Q: Are there plans for switching animals between the wild and captive populations?

A: This was done for one male this year and the female did become pregnant. So it could work, but they would have to consider genetics, and it would probably only work to bring in new males (not females).

Q: How often is survival monitoring done?

A: They try and get 1-2 mortality checks per week for each individual.

Q: How does the current productivity of the wild population compare to that seen prior to the decline?

A: They don't know, because there was no monitoring done on SRI before the decline.

San Miguel Island Update

Tim Coonan

Abstract

With the closure of the San Miguel captive breeding facility in 2007, focus has shifted to tracking recovery of the small but increasing wild populations. This is accomplished via

tracking annual survival and causes of mortality, evaluating reproductive success in the wild, and estimating the islandwide population size of island foxes.

The National Park Service (NPS) decided to close the San Miguel captive breeding facility after releases in 2007, due to the declining contribution of captive breeding to recovery of the wild population. For the first time since captive breeding began in 1999, the captive population produced no pups in 2007. In contrast, pup production and survival in the wild has been high. In fall 2007 14 of the 16 remaining captive foxes were released, leaving two older foxes in captivity, one of which subsequently died. From 1999 through 2007 the San Miguel captive facility produced 53 pups, 8 of 15 potential founders bred successfully, and 62 foxes were released to the wild.

The islandwide population size, as estimated from the densities on four small grids using program DENSITY, was 85 foxes, with an average density estimate of 2.2 km². This was less than the minimum number known to be alive (110), calculated as the sum of the total number of foxes caught during trapping (88) and the additional radiocollared foxes known to be alive (22). Annual Kaplan-Meier survival estimated from the 50+ radiocollared foxes was 90% (80% CI = 85-95%) in 2007. Six radiocollared foxes died in 2007, including one case of incomplete predation, in which a raptor's talons caused a punctured lung but the carcass was intact (no evisceration or degloving). This was the first incident of apparent predation on San Miguel in almost two years. Other sources of mortality included emaciation and septicemia, and it appears that older foxes have lower survival.

The annual rate of increase (λ) for the San Miguel population was 1.2, compared to 1.6 for the previous year. At these rates of survival and population increase, the subspecies may attain demographic recovery within 2-3 three years. SMI was one of the islands that had a severe decline due to golden eagles, so a real success that the captive breeding program was closed there last year. At this point NPS is particularly interested in determining the best monitoring methods to know when the population is close to (draft) recovery goals.

Questions/comments

Q: Has anyone suggested the potential effects of such a small founder population?

A: They will continue to study this with more samples in future years, and will continue to look at the potential for inbreeding effects, but no one knows how inbreeding might manifest. For example they won't know if these animals are more susceptible to disease until there is a disease challenge. Manifestation of inbreeding will not necessarily be the same on each island, i.e there could be different combinations of 'bad genes' in each population. Comment from the audience that inbreeding can affect sperm quality, but testing was done on successful and unsuccessful breeders, and they didn't see any obvious differences. But they might want to look at this again.

Q: Could the higher increase of late-term abortions seen in the SRI captive population this year be due to inbreeding?

A: Disease and genetics are the two most likely causes.

Q: Do you have pup production data from early 90's?

A: Yes, and they are comparable to current levels.

Mainland Populations Update

Alan Varsik, Santa Barbara Zoo

The number of animals in the mainland population is the same as it was last year. There is only one female left, and all of the animals in zoos are from San Clemente. The Santa Barbara zoo has Finnegan, an ambassador fox who was an offspring of one of the last mainland females. Finnigan was taken to over 80 presentations and events in 2007-2008, and he and the other mainland island foxes have contacted over 450,000 people. But in spite of continued interest to have IF in zoos, the mainland population is headed for extinction. (Alan gets frequent calls from other institutions asking if there will be any opportunity to have IF in the future.) For example, at the LA zoo they only have one IF left, and when it dies, if there are no additional IF available, the space will be used for other species. The plan (as it stands) is to bring more SCL foxes (or perhaps another subspecies) to the mainland. The status of this effort will be discussed in detail later this week.

Mainland populations of IF have a high conservation benefit. These animals provide opportunities for people to see a rare, endangered carnivore, and help communicate the need for protection of the islands and fox habitats to zoo visitors who would otherwise be unaware of these resources.

Friends of the Island Fox – Pat Meyer

The mission of FIF is to support the protection of IF through education and research and to increase awareness of the threats to IF and their habitats. They work mostly in the three counties of Los Angeles, Ventura, and Santa Barbara. Within these areas only 10% of the people they contact have ever heard of the IF. During the last 2 ½ years, 2,700 children and adults were reached through FIF education programs, and thousands more at regional events. Twenty-nine radio collars have been funded by donations from schools and other donors as a result of these presentations. They have a very popular website receiving over 18,000 hits per month, and an active email list.

Research shows that conservation efforts often fail if they are not supported by the local public, and increased community awareness can help support endangered species protection. People who have personally seen a live individual of an endangered species will be much more involved in protecting the species, so not having IF in zoos will significantly reduce the support the public provides to FIF's efforts. Many of the IF currently in zoos are solitary and aging, and hopefully the efforts to introduce more animals to the mainland can proceed quickly.

2008 Update On Fox Health

Linda Munson and Winston Vickers

Health surveillance of all 6 subspecies of island fox has been in progress since 1998. The principal aim of surveillance has been to determine the primary and contributing causes of death, to determine what other diseases occur in island foxes that die, and to determine exposure to infectious agents and general health of live foxes. This comprehensive surveillance includes complete gross and histopathologic exams on all fox carcasses and surveillance of pathogen exposure through serology, assessment of parasite burdens, and veterinary exams of captive and wild foxes. Blood tests, cultures, and biopsies of foxes with clinical disease have also been conducted. To date 565 necropsies and 221 biopsies representing all six subspecies have been evaluated. During the past year (June 2007-May 2008), 53 carcasses and 80 biopsies were received. A database of health information is being accrued which is continually analyzed to determine 1) whether diseases differ among subspecies, 2) whether diseases are associated with population declines, and 3) whether disease is associated with deaths after captive releases. Diseases that are prevalent or appear to affect population viability are further investigated to determine the pathogenesis and risk factors for disease development so that preventive strategies can be implemented if possible.

In 2007-8, vehicular trauma continued to be a major cause of death on the southern islands. Causes of death in San Clemente (SCL) foxes other than trauma included emaciation due to amyloidosis or systemic mineralization. On the northern islands, eagle predation was confirmed in 26 carcasses last year and suspected in others, most of which were SCZ foxes. A single fox on SCL appeared to have died from raptor injuries. As in 2007, several foxes died from infected fight wounds. In several foxes from San Miguel Island (SMI) and SCL that died, emaciation was the only finding and the cause of emaciation was not apparent.

Although a variety of diseases are found in island foxes, several diseases are notable for their high prevalence: 1) ceruminous gland carcinomas and severe otitis in Santa Catalina (SCA) foxes; 2) colonic spirocercosis; 3) systemic amyloidosis; 4) systemic mineralization on SCL, and 5) thyroid disease. Canine distemper virus (CDV), rabies, and canine adenovirus (CAV) are infectious agents of concern due to their potential to cause catastrophic declines in foxes, but only one fox in 1999 was determined to have died from CDV and no cases of rabies or CAV have been identified.

Sixty four cases of ceruminous gland carcinoma have been identified to date in SCAT foxes; this cancer has not been found in foxes from other islands. The prevalence in SCAT foxes > 3 yrs old is approximately 40%. These cancers can occlude the ear canal, invade surrounding tissues, and metastasize causing considerable morbidity. Why SCAT foxes have such a high prevalence of this cancer is under investigation.

Spirocerca is a parasite that causes large fibrous nodules in the colon. Infected foxes have been found on all islands, but the prevalence ranges from 56% - 71% on SNI, SCZ, SRI, and SMI to only 3% on SCL and 1% on SCAT. Although most cases are subclinical, these parasites can cause rectal prolapse, intestinal blockage, or intestinal perforation in

approximately 15% of affected foxes. Treatment has not been recommended in subclinical cases, because the treatment may cause more harm than benefit. Although a similar spirurid has recently been seen in mainland grey foxes, transfer of infected animals should still be avoided.

Many foxes have systemic amyloidosis, a condition where abnormal protein is deposited in the oral cavity, larynx, lungs, heart, kidneys, liver, spleen, skin, and other organs leading to organ failure and emaciation. The most severe cases have occurred in captive foxes, and the prevalence is higher in SCL foxes. A genetic predisposition and chronic stress are suspected as the causes.

Mineralization of vascular structures and multiple organs has been noted in SCL foxes. Most cases appeared to be subclinical, but mineralization appeared to be a major contributing cause of death in some animals. Exposure to Quintox® is suspected.

Thyroid disease is highly prevalent in all fox subspecies. Adult foxes have small thyroids with little hormone storage, and numerous tumors have been noted. Preliminary studies suggest that circulating thyroid hormone concentrations are low. Because adequate thyroid function is essential for general health and reproduction, thyroid atrophy may affect the ability of foxes to remain healthy during times of stress. Further studies evaluating thyroid function and determining if environmental contaminants are associated with this condition (as is true for other species) are recommended.

Infectious diseases, such as CDV, CAV and rabies, are still considered a threat to the recovering populations. The suspected CDV epidemic on SCA illustrates the impact such diseases can have on small populations. Many foxes have antibodies to a CDV-like virus and only one fatal case has been identified, so a low-pathogenic CDV strain is likely present on the islands. The fatal case in 1999 is presumed to have occurred because a more pathogenic strain was introduced. In 2007, three raccoons were accidentally transported to SCA on boats, providing a means for this introduction. Foxes on most islands have evidence of exposure to CAV, which is usually highly lethal in foxes, yet no disease or deaths have been attributed to CAV, suggesting a low pathogenic strain is present on the islands. A serosurvey was conducted in SCL foxes in 2007, and the results indicated that fewer foxes have antibodies to CDV, CAV, and canine parvovirus than in 2003. This lower seroprevalence usually indicates a more vulnerable population. Similar comparative serosurveys are recommended for the other islands to determine the susceptibility of the population.

Health concerns for captive animals include amyloidosis, fight wounds, mastitis, and abortions/reproductive failure/neonatal deaths. This year two captive SRI foxes aborted during mid-gestation, one from a bacterial infection and the other from unknown causes. If additional foxes are to be moved to the mainland to supplement the captive population, efforts should be made to reduce the risk of these diseases.

Continued disease surveillance is recommended in all populations to detect emerging diseases. Necropsy of all deceased foxes will be continuing, and risk factor analyses for

these prevalent diseases will be conducted. Research contributing to the understanding of major health problems of island foxes is ongoing. Continued efforts should be made to better understand causes of reproductive failure and mastitis in captive foxes, and to reduce injuries due to aggression. Vaccination against CDV and rabies should be used to protect the majority of foxes on islands with small populations and core populations on other islands.

Questions/comments

Q: Do island foxes have more health problems than other wild animals?

A: We can't really say, because this level of surveillance hasn't been done for most species. It is surprising that they live with some of the things that they do, and the level of disease and parasite loads in IF is certainly high compared to other populations.

Q: Has there been any study of (diseases in) skunks?

A: We are still waiting on funding (and enthusiasm) to study this question in greater detail. We could ask people who have studied skunks in the past, but we don't know if they saved samples from past work.

Q: Are there things going on in captivity that could explain the low reproductive success?

A: Disease prevalence is high but there isn't yet a direct connection between disease and low reproduction. They have more injuries, which implies stress, and that could most certainly affect success.

Q: Is bacteria in the placenta the cause of the abortion?

A: Yes. If there is an infection wouldn't that show up in the mother? It wouldn't necessarily show up in other parts of the body, and it could clear up after the abortion happens. Bacteria can cross into the fetus without being detectable in the fetus. It is also surprising that these fetuses weren't consumed by the adults.

Q: Can we do anything different next year?

A: That might depend on how invasive you want to be. We have been pretty aggressive so far with antibiotics to prevent mastitis, and maybe these could be administered earlier. The aborted fetuses were 30-32 days old.

Q: Could you alternate facilities on SRI each year to clean up infections?

A: Possibly.

Q: Is there a concern that the bacteria are becoming resistant?

A: Yes, and few antibiotics are known to be safe in pregnancy.

Q: Is this happening in older females?

A: The one with the known infection was 1 year old.

Captive Breeding Success Study

Cheryl Asa, Karen Bauman, Deana Clifford, and Winston Vickers

Abstract

We continued to monitor reproductive failure, aggression, injuries and disease in captive foxes on Santa Rosa during the 2008 breeding season. Results in prior years indicated that most reproductive failures were occurring in late pregnancy, at parturition, or early post-parturition, so this year we concentrated monitoring during those times. Ultrasound was used to detect pregnancy around mid-gestation (Mar 23 and 24), and video was used to monitor pregnant females. Males were removed at the time of ultrasound exams to eliminate any chance for male aggression toward females or pups. Fecal sampling for hormone analysis began Mar 26, and volunteers reviewed video starting at least 2 days before first predicted parturition. There was one pen camera plus one camera in each den box (2 den boxes/pen; R10 also had a rock den with no camera), but only one DVR/pen due to power limitations. Daily quick reviews looked for the female to “choose” a den box after which the camera could be switched to that den to monitor for parturition or signs of pups.

All females confirmed to give birth (i.e., pups detected) successfully raised those pups. A pregnancy rate of 75% (9/12) but with only a 33% live pup detection rate indicates that serious problems continue to occur. Two confirmed abortions plus three pregnant females never seen with pups suggest that some losses may be prior to parturition, and failure this late in pregnancy is rare in canids. However, the fate of those other litters was not detected on video and the losses may have occurred either pre- or post-parturition. Several factors might be responsible for the fact that some births and the abortions were not recorded: video monitoring may have started too late (if there was early parturition or abortion, since other US estimates of date range were good), video malfunctions (there were a few camera and infra-red light failures, seemingly due to aging and heavy usage), blind spots (e.g., from L- or Z-shaped pens, vegetation in pens, dark corners), inability to record from more than one camera, females not continuously on-camera, or the female may not have given birth in a den (so the camera missed it).

Possible causes of late pregnancy loss (abortion) include disease, fetal genetic or developmental defect, inbreeding, stress, endocrine disruptors, and low thyroid hormone levels. One aborted pup was found by Dr. Munson to have perished due to a bacterial placentitis. This finding can be suggestive of reduced maternal immune response that could contribute to bacterial infections (as has been implicated in some cases of mastitis seen in this population), or exposure of the female to a bacterial agent that has a primary effect in the reproductive tract (such as *Brucella*). To evaluate the potential role of stress, fecal corticoids were measured and compared to levels following ACTH stimulation tests at the Santa Barbara Zoo. There were no clear associations between pregnancy losses and corticoid levels.

We recommend that: 1) more data be collected on thyroid function, 2) there be better camera coverage (multi-channel DVR could run cameras in both den boxes as well as one or more cameras in pen simultaneously onto split-screen monitor), 3) vegetation be trimmed to reduce interference to the cameras or there be more pen cameras, 4) remaining pens that are

not rectangular be reconfigured, 5) archived serum samples be tested for possible disease exposures that could contribute to reproductive failure, 6) prophylactic antibiotic therapy be initiated earlier in pregnancy (currently done in the last week), and 7) thyroid therapy be initiated prior to the breeding season.

Questions/Comments

Q: How much is genetics related to personality (e.g. aggressive behavior)?

A: Certainly they are related, but we don't know how genetics might be related to these aggression issues.

The point was made that glucocorticoid levels during gestation should be compared against the normal hormone level of each individual animal when they are not pregnant and against wild females.

A comment was made that more placid/calm females are actually better for life in captivity (zoos), but are probably less adapted for life in the wild.

Q: Has there been any research into individual glucocorticoid profiles (i.e. how 'naturally' variable are glucocorticoid levels during pregnancy?).

A: Not really, and with fecal samples hormone results are more variable than they would be with blood samples.

Summary of results

Total # of females	12
# of pregnant females	8
# of females actually pregnant	9*
# with live births	4
Litter sizes	1-3
# of pups	8
# of pups surviving	8
# of abortions	2
# of females that lost pregnancy or pups	3

* pregnancy too late to detect on ultrasound

Ceruminous Gland Carcinoma in Catalina Island Foxes

Winston Vickers and Linda Munson

Abstract

During health surveillance following the fox population declines, an unusually high number of ceruminous gland tumors, both adenomas (benign but with potential to become cancerous) and carcinomas (cancer) were detected in foxes on Catalina Island (CAT). Most tumors were confined to the ear canal, but some cancers had extensive local invasion and metastasis leading to death. No tumors (adenomas or carcinomas) were detected in foxes from other islands.

In 2006 a 2 year epidemiologic study of risk factors for the cancer was initiated with the support of the Morris Animal Foundation, the Institute for Wildlife Studies, and the Catalina Island Conservancy. This study is still ongoing. Risk factors for the cancer that are being assessed include:

- Severity of inflammation
- Ear mite species and genetics
- Ear mite antigenicity
- Co-infection with viruses, bacteria, yeast, or fungi
- Exposure to toxins
- Genetics of foxes (predisposition?)
- Spatial distribution

Data have been collected from over 2000 veterinary exams and 500 necropsies. Random sampling was conducted across CAT in 2007. Findings to date include a high prevalence (>95%) of ear mites on CAT, San Nicolas (SNI), and San Clemente (SCL), but no mites detected in foxes from any of the northern islands. (All of these islands have feral cats, but the cats have very few ear mites.) Inflammatory reactions within the ear canals of foxes with mites are substantially more severe in CAT foxes than in foxes on SNI or SCL. Sixty four cases of cancer have been identified to date in CAT foxes, and 17 CAT foxes have been identified with adenomas. The prevalence of cancer in CAT foxes > 3 yrs old is 35 - 40%. Recent sampling suggest more tumors in females, but this may be because they live longer.

Rates of viral, bacterial, fungal, and yeast infections are being analyzed in foxes from CAT, SNI, and SCL. Analysis of the genetics of foxes and mites, antigenicity of mites, toxin analyses, and other risk factors are also in progress. An assessment of the impact on ear canal inflammation (a cancer risk factor) of mite reduction in a group of SCA foxes is planned for 2009 - 2010.

Questions/comments

Q: What treatments could be used?

A: These were discussed in detail and are available in the Health Working Group notes.

Q: Is there any variability in susceptibility?

A: Animals that were captives and were previously treated appear to have been slower to develop tumors once they are released, but we don't know why. Very few animals are mite-free.

Q: Do you think there were mites on the northern islands historically?

A: Foxes can develop resistance to mites, so perhaps this happened on the northern islands. We don't know why the feral cats don't have mites, but mites could have evolved a closer association with foxes. So wouldn't this have happened as well in the northern populations? Don't know.

Q: How are exams of cats' ears done?

A: Visually and with swabs.

WORKGROUP SUMMARIES

Wild Population Management and Recovery Planning Group

Topics:

1. Living with Eagles – Can recovered island fox populations and golden eagles coexist?
2. Population and disease monitoring methods
3. Future of Santa Rosa captive population

- 1. Living with Eagles** – As part of the recovery plan, each land management agency will be required to have an eagle management plan. At this point many people agree that a small population of transient golden eagles (GOEA) may always be present on the northern islands, and fox mortalities from eagle predation will continue to occur periodically, albeit (hopefully) without population level impacts. Given increases in fox abundance and GOEA population structure on the islands, the suggestion was made that an adaptable GOEA response plan be developed that will protect fox populations but not put an undue burden on managers (i.e. continuous intense efforts to remove all eagles may not be necessary and are certainly very expensive).

A. Decision Criteria

- Predation events observed now are less predictive of future patterns than in the past; not only are there fewer eagles and more foxes, but fox behavior has perhaps changed, and non-breeding birds (hopefully the majority of birds at this point), behave differently than birds that are nesting or feeding young. So how should managers respond, given that predation observations now do not necessarily portend the serious population impacts that they did in the past?
- Response decisions should likely be based on the status of birds (GOEA) in relation to metapopulation dynamics. For example if birds were born on the island they might show more fidelity to the island, whereas immigrants or transients might be less of a threat. However the suggestion was made that transient eagles might actually take significantly more foxes than residents. (Higher energy requirements?) If it were possible to collect DNA from kill sites we could potentially determine whether there is more than one responsible bird and their familiar relationships. Breeding status will also affect predatory behavior. (Nesting birds return carcasses to the nest and require more prey to feed young, whereas non-breeders perhaps eat less and also leave carcasses in place.) Any management actions that reduce nesting by GOEA will support fox recovery.
- There is still a question of whether predation events are always caused by GOEA, as opposed to bald eagles (BAAE) or other raptors. One GOEA was observed on the west end of SCI last year, but none were seen on SRI or SMI even though there were fox mortalities there. Personnel on both islands were confident that if birds had been present they would have been detected. Montrose is going to be funding BAEA nest surveys next year that may pick up GOEA nests as well.

- The point was made that hazing might be a less-expensive but effective technique, however, you still have to locate the birds to haze them.
- It would be useful at this juncture to have more integration and communication between the fox recovery and BAAE restoration efforts. Are GOEA perhaps using areas that BAAE don't? We should also be looking more closely at how the deer/elk hunt on SRI affects GOEA presence and behavior.

B. Simulation Model for Eagle Risk

- Several of the assumptions of the model may need to be revisited. For example the data as presented were for transient eagles, so if there is a known GOEA nest the situation could be different. Also the success rates used were for the entire history of eagle trapping on SCI, and those rates have changed dramatically now that bird density is so low and, (as far as we know), there are no breeding birds present. Given these conditions, trapping success is likely going to be lower than it was in the past.
- Another assumption of the model is that only 1-2 transient birds pass through in 12 months. But Paul C. made the point that this is exactly the number of GOEA we 'guessed' were present at the beginning of the decline when there were actually many times that number.

2. Monitoring – Several different IF monitoring protocols are currently in place across the islands. The question for this discussion was how much standardization is necessary, which approaches work best under which conditions, and when/should agencies move to implementing the monitoring plan presented last year (Rubin et al. 2007).

A. Trapping for population monitoring

- What is the best approach for monitoring a low density population, specifically the current population on SRI? The proposed method (Rubin et al. 2007) requires significantly more effort when populations are low, and that level of effort is currently infeasible on SRI. So at what point would it be beneficial to 'ramp up' to the proposed plan on SRI? This population is not close to recovery, so how much confidence in the estimates is needed? Greater confidence surrounding SRI estimates would provide better comparisons with estimates from other islands, and NPS would like to have more confidence in their estimates. 40 recaptures is proposed within the plan as the optimal recapture rate, but on SRI they very likely would not reach that level given existing densities. NPS still does a lot of target trapping for collars and it might be useful to do a cost/benefit analysis of target versus grid trapping given the different goals of each method. Because there are currently over 50 collared animals on SRI and the plan recommends starting each year with a new population of collars, the transition from one method to another would be a challenge (due to staffing limitations and equipment costs.)

- TNC is particularly interested in a flexible plant that is adaptive over the long term.
- Bit of a separate question, but is there really a benefit at this point to delisting?
- There is an issue of ‘blind spots’ in the proposed monitoring plan for each island (i.e. areas that are not sampled). The general consensus from this discussion was that the existence of these blind spots, while something to consider, is not enough of a concern that additional effort be expended at this point to add new grids. TNC now has more collared foxes at the west end of the island and on the north shore, so they should be able to quickly detect GOEA in those areas. There are sites where the specified trap location is infeasible or unsafe (for foxes and/or people), so field crews would like to know how much flexibility there is for moving individual traps. Response was that this is just a matter of judgment, and that movement within about 50 feet should be acceptable. If two traps at one end of the ‘ladder’ both need to be moved, then the whole ladder should probably be shifted. For analysis in program DENSITY trap placement relative to other traps is irrelevant; the ladders were not placed according to habitat, so changes like this (moving a few traps) can be incorporated into the analysis.

B. Remote monitoring system (SNI)

- The radio telemetry system on SNI is working well, for example one person can monitor mortality within the entire population. They don’t currently obtain location information, but by the end of the year they will have GPS collars deployed and will be collecting these data. There have been some mortalities that the towers have not detected, but no ‘false alives’.
- Towers will hopefully be installed on SMI this summer and collars are available once that is done. On SCI they are currently looking at using aerial telemetry, but if that is too expensive they may also investigate using this system. Given the topography they would need a lot of towers.
- Towers are 3-5 feet high, and cost about \$5k each. Currently the transmitter sends a morse code signal which is translated, but the next version will collect digital signals.

C. SRI population monitoring

- On SRI NPS is currently doing transect trapping. It is useful to them at this point to have MKNA data, but they are wondering when they should move to methods that provide smaller confidence limits. If they know what the mortality levels are, would it be possible to use the MKNA and known survival measures to determine at what point they should implement the larger plan (Rubin et al. 2007)? They currently have about 50 collars on animals and estimate island density at approximately 0.5 foxes/km². So there was a discussion of what level of trapping success they might have if they implemented the plan now, and the guess was that it would be pretty low, maybe 1-4 individuals per grid. Murray Efford suggested that once there are densities

of 1.7/km² the trapping success should provide adequate precision in the estimates. Bill Andelt suggested that he could take the current trapping data from SRI and suggest what their confidence estimates might be if they implemented the plan now.

- TNC is going to begin implementing the plan on SCI this summer (2008). Their experience over the next few years could assist NPS in deciding how to proceed with monitoring on SRI. The consensus was that it will be several years before there are enough animals in the population to make the Rubin et al. (2007) design useful and practical. (This estimate will likely change if all animals are released this year; see discussion below.)

D. Collaring for population monitoring

- The Doak model suggested that there should be a representative sample of 60 collared animals distributed as evenly as possible across each island. Most islands currently have collared populations at or near this number. Given that attempts are made to spatially distribute collars, how should they be deployed demographically? On SNI their collared population is skewed toward older animals, because they want to have the same number of collars in each age group and the overall population age distribution includes a greater proportion of younger animals. The average age of the collared animals on SNI is increasing, and survival estimates for these animals are likely going to be different (lower) than for the entire population. Would it be worthwhile to focus on younger animals if the goal is to detect predation? Perhaps you could do this (have more younger animals collared) and estimate survival for the population if the age structure of the entire population is incorporated into the analysis.
- Is reproductive data being collected on collared animals? Not on SCI, somewhat on SCL.
- The logistics of collaring are an issue. On SCL they create a new sample set each year of both individuals and sampling locations. They take off old collars only when they are found (i.e. they don't target trap to remove old collars). On SCI they want to remove any collars that aren't currently in the sample set, but they may leave some on for other study purposes. So they will do target trapping to remove old collars.
- The point was made that using age classes is less precise than following known aged animals; as populations increase the proportion of collared animals will decline, so the ability to detect these animals will also decline.
- Are there plans to collect pup mortality data (i.e. from animals that can't be fitted with standard collars)? Could we use break-away collars? Confidence in these collars (to function properly) is low, and Brian Cypher mentioned that their kit fox research has not found anything that they feel comfortable using. On SNI they tracked females that had been ultrasounded to determine pup fate.

- Can pit tag data be used to increase information from collars? Yes, but it hasn't been.

E. Collaring for sentinels

- What should the abundance and age distribution of the vaccinated population be? Within the goal of having 50-60 collared animals on each island, Doak's model suggested that 20-30 of these should be unvaccinated. These should be 1-year olds, or as young as possible. They should be spread randomly across the island, and there should be a new set of yearlings each year to maintain the age distribution.
- There should be a total of 80-100 animals vaccinated on each island (suggested by the model). Land managers might want this to be higher if they desire a larger post-outbreak surviving population. Any animals recaptured in the core area (geographic core, like at the points of entry, but managers may want to have a more density-oriented secondary core), should be given boosters.
- The comment was made that if this vaccination protocol is adopted, these will be intensively managed, quasi-wild populations. And we may in fact be suppressing the natural occurrence of disease in the wild. If so, and because NPS stewardship (a consideration on SMI, SRI and SCI), requires management goals of populations that function as naturally as possible, perhaps we should not be so enthusiastic in working to prevent all disease in the wild (i.e. vaccinating at these levels).
- The vaccinated population on SNI is smaller than recommended because collaring has been the priority. But they do have 140 vaccinated animals. On SRI nearly all animals are vaccinated. On SCL they haven't vaccinated for several years, and their protocol this year will likely depend on the recommendations from this meeting. If they went back and got all the PIT tag numbers of animals that were vaccinated in the past and revaccinated them, these animals could be included in the 80-100 total. But this would certainly skew the age distribution of vaccinated animals to older age classes.
- Efficacy is estimated at a year or more, but this hasn't been specifically tested for IF.
- A decision tree for vaccination was developed by the Health group. In theory, even if an animal was only vaccinated once it will have greater immunity than if it was never vaccinated. Are there any additional risks of the vaccine or the vaccination process? None that are known.
- The health group also recommended that 25 blood samples be collected each year on each island from 4 specific groups, with the highest priority group being 1-year olds. (A detailed discussion of collecting blood samples for disease detection is included in the Health Group notes.) These blood samples could be archived and examined when there is some funding or if there is an epidemic.

- 3. Future of the captive population on SRI** – The suggestion was made that given the low productivity and increasing incidence of aggression in the captive population, it might be worth considering closing the captive facility on SRI. Survival of the wild population is not as high as it was on those islands when captive breeding ended, so this is a more risky approach. However, because the SRI population was not studied prior to the decline we don't know what the natural growth rate in this population is. We also don't yet know what the wild production will be in 2008, so this proposal is made on the assumption that trapping data from summer-fall 2008 indicate production at a level similar to past years. If it is significantly less, then this proposal (to release all the captive animals in fall 2008) is not supported.
- If productivity in the wild is even the same as in captivity, (and certainly if it is higher), then the suggestion was made that there is really no biological reason to keep any potential breeders in captivity. Further, there may actually be greater risks to survival and reproduction in captivity than in the wild. What is the tradeoff of keeping animals in captivity longer vs. releasing them? Do they adapt to captivity?
 - The point was made that releasing these animals is perhaps not as risky as it sounds, since most of the population could be quickly returned to captivity if necessary.
 - If it were decided to end captive breeding on SRI, how would the process work? NPS would send USFWS a release plan, and USFWS could either 1) take no action, in which case NPS could move forward, 2) approve the plan, or 3) not approve the plan. Eric Morrisette (USFWS) said that they would want to have this year's data to make such a decision. A counter argument was made that actually the onus should be on USFWS to demonstrate (if it opposed the plan) why it is more beneficial to recovery to keep animals in captivity.
 - The suggestion was made that trapping this year should target pups (to get as good an estimate as possible of how many were produced). A rebuttal to this was that trapping should probably be done just as it has been done in the past so that results are comparable (i.e. we don't want the data to suggest that productivity was higher because more pups were caught, if in fact the results were due to an increased effort to catch pups.)
 - There was a concern expressed that we still have not determined the causes for reproductive failure in the captive population, and that those questions can't be studied further if all the captive animals are released. It is possible that conditions or events in the future will require that animals be brought back into captivity. There is an enormous research benefit of having captive animals. Perhaps those important research questions, which clearly still exist, could be addressed just as well (and perhaps better, i.e. in the absence of island logistical challenges), by having an established research population on the mainland.
 - If there are no captive populations on the islands, could some of these research questions be addressed in wild populations? For example hyperthyroidism occurs

across all the islands, but may be normal in this species. The questions of whether this is a natural condition or not might be addressed by studying both mainland and wild populations.

- If we released all the animals and then had to restart a captive population, there would be two genetic issues. First, there would be a smaller founder base, and the low degree of relatedness that we had initially would be absent. Secondly, we would not have the pedigree knowledge that we have now. (The same situation exists on SMI, but λ is > 1.0 there while as far as we know it is still < 1.0 on SRI.)

2009 Wild Population TEG Recommendation

1. A research proposal should be written and submitted that would fund research on the meta-population dynamics of golden eagles on the Channel Islands. Such research will provide information critical to future management decisions regarding response to golden eagle presence on the islands, competitive interactions between golden and bald eagles, and potential impacts of golden eagles on fox populations. The research should also address the potential for other bird species to prey upon island foxes (bald eagles and other large raptors). The research questions should result in information that is both relevant to immediate island fox management as well as long-term predictions of golden eagle ecology on the islands. Kathy Ralls, Dave Graber, Paul Collins, Lyndal Laughrin, Rachel Wolstenholme and Brian Latta (*in absentia*) have volunteered to work on this proposal.

Captive Population Management Group

Topics:

1. Future of reproductive study
2. Immune function and captive breeding
3. Stress and captive breeding
4. Causes of late-term abortions
5. Pen design/maintenance and data collection
6. Parasites and captive breeding
7. Aggression
8. Treatment options
9. Integration of veterinary and captive issues
10. Future of mainland populations

1. Recommendations for future monitoring of captives during breeding seasons

As presented in Cheri Asa's report, all the hormone data from 2006-2008 have been analyzed, and the scoring of the behavioral data from video is on-going. Overall the

project has been largely successful because they have determined that most pregnancy failures are occurring at or near parturition. However, despite considerable effort in 2008 to more closely monitor this time period, they still do not know why pregnant females are losing pups in mid- to late gestation.

Suggestions for future captive monitoring are:

- No video monitoring should be conducted in 2009. Instead, a thorough investigation into disease and/or stress should be conducted to determine whether these factors can lead to mid-gestation abortions (as occurred in 2008).
- The video control boxes and solar panels should be left in place for future work. There are newer video technologies available (such as multi-channel DVR's) that would improve image quality as well as the amount of the pen covered by the cameras, however the power limitations currently operating on SRI may not support such equipment. The potential for incorporating newer equipment in the study should be investigated in 2009.
- Cameras, infra-red lights and DVR's purchased for the project should be moved to mainland zoos that have breeding foxes of different species (fennec fox, swift fox, etc.). Monitoring programs similar to those conducted for island foxes should be implemented for these species and any future island fox populations brought to the mainland. The zoos that should receive the systems are:
 - Living Desert (2 pairs fennecs, 1 pair swift); 3 systems
 - Palm Beach (2 pairs fennecs); 2 systems
 - Brookfield (1 pair fennecs); 1 system
 - Locations to be assigned within AZA that have pair of swift; 1-2 systems
 - Sheri Hanna (1 pair fennecs); 1 system
 - WCSRC (1 pair swift); 1 system
 - WSC (1 pair gray); 1-2 systems
 - Saint Louis Zoo (1-2 pairs fennecs); will use non-grant video equipment
- Fecal samples should be collected from captive populations of other fox species during the breeding season, and should be done weekly (year-round) for fennec foxes since they are not seasonal. Fecal samples should be shipped every 3-4 weeks for analysis, and when increased P4 levels are detected filming should begin.

2. Immune function - A compromised immune system can be indirectly linked to stress, which may result in reproductive failures. However, the determination of what constitutes a compromised system can be made only when information on normal immune function is available and we do not have that for IF. Tests on the immune system are costly and difficult. All tests would require someone on the island who is able to process and test blood samples within 2-3 hours of collection. Blood would be tested for lymphocytes, blastogenesis, cytokines, T4, etc., and analysis costs would be approximately \$40,000. Costs could be reduced by testing only lymphocytes, which would be a crude indicator of

immune function. Finally, regardless of test results, there is no treatment for compromised immune function in island foxes. For these reasons we do not recommend immune function testing at this time unless it is packaged in a grant with thyroid and other tests.

3. Stress - It has been demonstrated that chronic stress can cause individuals to be more susceptible to disease and can lead to reproductive failure. Measuring cortisol values is currently the only method available to measure stress in island foxes. Cortisol levels have been measured for several years (via fecal samples) in captive animals, but there are no comparable samples from wild individuals. (Although the level of stress occurring in wild foxes is not known, these samples would be the best non-stress measurements available.[But see discussion of Tachi and Finnigan below])

It would be extremely useful to have cortisol measurements from mainland zoo populations, and from the foxes that are currently very adapted to humans ('Tachi' and 'Finnigan'), as these individuals may represent a fairly unstressed state. It is therefore recommended that fecal samples continue to be collected from each island and from all populations (captive, wild, trapped and/or free ranging opportunistic samples). A sample request with specific collection protocols, sample data sheets, and a picture chart of fecal age should be sent to all land managers. This chart will help field personnel determine the age of the scat, which is important to know because the age of the sample affects the efficacy of the cortisol assay. Possible funding sources for this multi-island cortisol evaluation are the Nature Conservancy (TNC), the National Park Service (NPS), Catalina Island Conservancy (CIC), and the US Navy, since stress likely impacts the health of wild and captive individuals.

4. Late-term abortions - There are several possible diseases and other factors that could have caused the late-term abortions observed in 2008. One of two litters aborted had signs of bacterial infection, however, Linda Munson pointed out that many times nothing is found at necropsy related to infection so the other litter could have an infection as well. Blood samples and vaginal cultures were collected from all 12 captive females on Santa Rosa at the end of the 2008 breeding season (after the abortions), and nothing unusual was found. Possible factors that could cause late-term abortions and/or reduce reproductive success include,

- Brucella – only tested on Catalina
- Parvo virus
- Toxoplasmosis and/or *Neospora*
- Canine distemper virus (CDV)
- Herpes
- Bacterial infections – general from environmental sources
- Parasites – from environmental sources
- Mastitis
- Low Calcium

although these are all considered to be secondary and not primary causes of late-term abortions. Instead, the primary causes are most likely environmental, related to stress, or

caused by high parasite loads. Tests have previously been conducted for many of these factors, but not consistently or systematically across all islands and all populations. We suggest that results from these previous tests should be compared to blood samples drawn on all twelve females from SRI in 2008 and samples taken between 2003 and 2008 that are now in the serum bank. Individual comparisons should also be made between samples taken from SRI females at the time of ultrasound and then again post-breeding. Finally, it would be useful to compare the vaginal culture results from these individuals to results from necropsy. Money would be needed for all of these studies, as well as a prospective study in 2009 that would involve collecting and analyzing blood samples from periods outside the breeding season.

5. Pen design and maintenance considerations - Several of the factors listed above can be related to the pen environment. Though some factors are difficult to test, others can be managed via continued attention to husbandry standards. We suggest the following priorities for pen maintenance:

- Significant weed growth in pens appears to be a problem for several reasons, and we suggest that weeds, especially cheese weed, be routinely trimmed. Weeds prevent air circulation, resulting in increased soil dampness which leads to greater bacterial growth. A review of videos collected during the reproductive study revealed that the presence of weeds reduces the amount of area available to foxes, in contrast to the prior belief that weeds serve as cover within the pens. Fewer weeds would also make it easier to clean the pens.
- Daily pen cleaning and the administration of antibiotics apparently reduced the occurrence of mastitis, and no pregnant or nursing females or litters were lost to mastitis in 2008. We suggest this be continued in 2009.
- It has been reported that water bowls spill frequently. Alan and Peter will brainstorm different water bowl designs with locking loops and will work with Lisa and Angela to address this problem.
- There was a suggestion made that it might be advantageous to move the SRI captive animals from Windmill Canyon to the Caballo site to reduce the potential for disease. ('Resting' the Windmill site might break any existing disease or parasite cycles.) We suggest that because it takes many years to 'clean' an area of bacteria and parasites, the potential benefits of such a move would not offset the labor and costs required to move these individuals.

6. Parasites – Parasites are a threat to the individual well-being of foxes as well as to productivity. Due to concerns about the risks of treatment, testing for internal parasites in the captive populations is not conducted at present even though past testing (as well as necropsy results) suggests that the parasite load of these animals is high. Decreased calcium levels and anemia in some animals also suggests the presence of internal parasites. Because there is now a viable wild population, our group suggested that potentially treating captive animals for *Spirocerca* be reconsidered.

7. Aggression – In 2008, on-island staff responded to aggression problems by removing the males from pens once females were present. We discussed further steps that staff could take should this problem re-occur in 2009, and suggest the following measures to address aggression using short- and long-term approaches:

- Short-term: Remove aggressive individuals (usually males) from the pen
- Use existing internal pen doors (or install sliding guillotine doors) to limit mate access. With this approach staff would need to be very attentive to timing for introduction, mating, and subsequent removal.
- Elizabethan collars could be applied to males, and then areas in the pen constructed where the female can go but the collar (male) won't fit. This approach would still allow positive social interactions (animals are together in the same pen), but safe sites for the female should there be aggression by the male.
- Long-term: Use data currently being collected from the GPS collars on Catalina to learn more about social structure and mating behavior in the wild.
- Continue analysis of video data
- Continue to collect and analyze behavioral data to detect possible patterns of aggression. We should develop a more efficient method for data collection for all information on captive animals. Currently cleaning, diet, and minor and serious injury records are often recorded and stored separately. It would be helpful if these records (or summaries of these records) could be integrated for individual animals and made accessible to members of the captive population TEG and others to investigate potential correlations between these records and other sources of information such as the video records and blood analysis. To be practical a database such as this would need to be accessible at the pen sites and include a data dictionary for data collection. (Suggests the need for hand-held data loggers.) Karen will work on getting samples of the current forms from field personnel to determine how easy it would be to create a new database.
- Continue investigations into the role of mate choice in preventing/causing aggression. It was discussed that while females appear to receive fewer aggressive injuries in the wild, we still know very little about social structure in these populations and what factors influence aggressive behaviors (e.g. how long males stay with females during the year).

8. Treatment Options – Drug therapies could be used to mitigate some of the diseases (and aggression problems) mentioned above. Possible drugs that could be used include: antibiotics, anti-depressants and thyroxine (for low thyroid). Antibiotics have previously been prescribed prophylactically for mastitis with good results, and we discussed administering antibiotics earlier in pregnancy to prevent other infections. (The potential

for bacterial resistance was also discussed.) However, if both thyroxine and higher doses of antibiotics were administered in 2009 and reproductive success increased, it would be impossible to confirm the positive effect of either treatment because of the absence of control groups. The use of antidepressants to reduce aggression was also discussed, and the following concerns expressed:

- Antidepressants have never been used in island foxes
- The cause of aggression is unknown, so the selection of the most effective drugs is problematic
- Both members of a pair would likely need to be treated
- Initiation and duration of treatment is important but not known for foxes

Several additional factors should be considered in relation to the potential use of antidepressants. First, Tachi (the acclimated ambassador fox on Catalina) has displayed definite behavioral changes during the breeding season. Also, hormone assays show that testosterone levels in female island foxes appear to be naturally higher than in other canids. Cumulatively, these observations and concerns suggest to our group (and the Veterinary Health group) that the use of antidepressants to treat aggression in island foxes is unwarranted at this time as it could decrease individual sex drive and/or increase aggressive behaviors.

9. Integration of Captive and Veterinary Issues - Below is the summary of the discussion on disease and stress issues that resulted from a joint meeting of the Veterinary and Captive Populations Technical Expertise Groups (TEG).

- Thyroid Conditions: We do not know what normal thyroid levels are for island foxes. However, some captive (on-island captive facilities and mainland population) and wild island foxes have already been tested for thyroid levels. Many of these samples showed low thyroid levels when compared to domestic dogs, which is concerning. No clinical signs of disease relating to the thyroid have been seen, but evidence of thyroid disease has been seen at necropsy. The low thyroid levels or hypothyroidism seem to occur only in adults and not juveniles. All the adults at the Santa Barbara Zoo have been treated with thyroxin, since frequent testing and monitoring can occur at the Zoo and there is no harm to the animals from the treatment. All the adults that received (and continue to receive) the treatment had thyroid levels that were considered normal when compared to domestic dog values within one year of the beginning of the treatment.

Suggestions for future work:

1. Prioritize a review of existing thyroid data from captive and wild individuals. Karl Hill has yearly data from all 3 tests on all individuals at the Santa Barbara Zoo including pre- and post-treatment levels. Deanna Clifford and Winston Vickers have additional results from both captive and wild individuals on several islands. There are also blood samples in the serum bank (both captive and wild) that could be tested.

2. If the results of testing of captive individuals show low thyroid function, treatment with thyroxin should be considered using the following protocol: a) start supplementation prior to the breeding season (Dec/Jan) and draw blood and re-test at mid-gestation; b) conduct ultrasounds and adjust the dosage as needed; c) draw blood after the breeding season (summer) to assess thyroid levels.
 3. A prospective longitudinal study should be conducted to further investigate thyroid conditions in foxes. To fund the study a grant proposal to the Morris Foundation to further investigate thyroid, immune function and endocrine testing of island foxes should be considered.
- Genetics – Inbreeding Effects:
1. Genetic testing of founder animals was used during the first several years of captive breeding to make pairing recommendations. Three groups of founders were identified (related, unrelated, and grey area), and pairing choices were made based on these groupings. Since that time studbook data have been used to create pairing recommendations based on relative relatedness. However, a comprehensive study comparing pairings, reproductive success and genetics has not been conducted, and we recommend that such a retrospective analysis now be initiated. Colleen Lynch volunteered to discuss with a statistician associated with the AZA Population Management Center what type of data would be needed and what statistics would be helpful, given the limited data available. Results from this analysis could assist in determining whether more extensive (and expensive) genetic testing should be done.
 2. Sperm quality evaluations, as have been used in other species such as the Florida panther, could be used to evaluate inbreeding effects. However, sperm quality was evaluated from both successful and unsuccessful males in 2004 on Santa Rosa and San Miguel islands, and all samples were of good quality; there were no differences in semen quality between those males that had reproduced and those that had not. Given these results, and the fact that most of the females are getting pregnant, it appears that sperm quality is generally good. We therefore suggest that there would be little value in conducting semen banking on any existing founder males or males prior to release.

10. Future of mainland populations

The discussion opened with a brief review of both the history of the existing mainland population of San Clemente (SCL) foxes and the previous recommendations regarding the creation of a mainland population from:

1. The 2005 Technical Analysis Request 3.6: Assessment of the Potential Benefits and Costs of Long-term Captive Populations on the Mainland and/or Islands.

2. 2006 letter from the Association of Zoos and Aquaria (AZA) Canid Taxon Advisory Group (TAG) to the RCG in response to TAR 3.6.

In summary, the Recovery Coordination Group (RCG) in its review of the TAR 3.6 recommended proceeding with establishing an AZA Species Survival Plan (SSP) program for the Santa Cruz Island (SCI) subspecies. The Canid TAG supported the results from TAR 3.6 and the outcome from the 2006 Integrated Island Fox Recovery Team Meeting by incorporating this request for the potential of a future mainland population into its 2006-2009 Regional Collection Plan for North American zoos. As such the AZA 2006-2009 Canid Taxon Advisory Group Regional Collection Plan created a two-tiered program for Island Fox, with a Species Survival Plan (SSP) for the endangered subspecies on the northern islands and maintaining the existing Island Fox Population Management Program (PMP) for the non-endangered SCL island foxes.

The AZA SSP and PMP programs were then explained in some detail for those not familiar with the different levels of AZA captive management. The two program descriptions below are taken from the AZA website www.aza.org where a full description can be found.

'The Species Survival Plan program began in 1981 as a cooperative population management and conservation program for selected species in zoos and aquariums in North America. Each SSP manages the breeding of a species in order to maintain a healthy and self-sustaining population that is both genetically diverse and demographically stable. Beyond this, SSPs participate in a variety of other cooperative conservation activities, such as research, public education, reintroduction and field projects. The SSP is AZA's most rigorous form of population management.

The Population Management Plan (PMP) provides basic population management recommendations for zoo and aquarium species. Proper population management can ensure the long-term survival of the captive population and the health of individual animals. Population managers use the same genetic and demographic protocols and software used for SSPs. Although population managers use the same tools as SSP coordinators, PMP recommendations are often supplemented with "rules of thumb" not appropriate for the more intensively managed SSPs.'

Because the land managers have stated in the past that they wish to wait to form a mainland population of the SCI subspecies until the recovery goal in the wild is reached, the SSP is currently a place holder for the future. Due to the high conservation value of this subspecies if and when the SSP is needed, the role of the mainland population prior to that time would be for research and education. The majority of the SSP population would be located at a few larger institutions with special expertise in canids. It is difficult for zoos to 'hold' existing space for an uncertain future need or to create new spaces quickly. Thus, Canid TAG felt the best method to support IF conservation efforts outlined by the Integrated Island Fox Recovery Team would be to re-build the SCL Island Fox PMP to serve the role of education

and immediate research needs. In the future, the spaces occupied by the SCL PMP population could be used for the growing mainland Santa Cruz SSP population by gradually phasing out the SCL animals through a breeding moratorium.

The current SCL PMP population originated as a “rescue” population resulting from conflicts with the endangered SCL Loggerhead Shrike and not as a conservation strategy. Due to the small numbers of animals originally brought from the island, the relatively old age of these animals now and very limited breeding by individuals on the mainland, the current mainland population is not viable. Thus new animals are needed to re-build the breeding portion of the program. The animals currently in zoos would be used to continue to promote the program’s primary mission of educating the public on IF conservation and habitat protection issues.

Permission to transfer SCL foxes to the mainland must be authorized by the U.S. Navy and the California Department of Fish and Game (CDFG). A letter was sent to CDFG in 2006 requesting information regarding the procedures required. Initial discussions with Kelly Brock were favorable, but then further discussions with the Navy were put on hold when Kelly left the San Clemente program. Since that time a proposal to the CDFG and the U.S. Department of Defense/U.S. Navy to move animals from San Clemente Island to mainland facilities has been developed by the following agencies and their representatives:

- Nancy Frost (CA Fish and Game; CDFG)
- Melissa Booker (US Navy/San Clemente Island)
- Peter Siminski (Captive Population TEG Chair)
- Alan Varsik (AZA San Clemente Island Fox Population Management Plan Manager)
- Colleen Lynch (Population Genetics)
- Karen Bauman (Liaison to AZA Canid Taxon Advisory Group)

An MOU and SCP are required by CDFG. The MOU must demonstrate a link between the SCL mainland population and both the draft USFWS Recovery Plan and US Navy’s SCL Plan (currently up for renewal). It must also include details of the number of individuals, how they will be managed on the mainland, and what the role of the mainland population will be. This process generally takes 1-2 months, but because this MOU will need to be reviewed at generally higher levels the process could take up to 6 months from the time the document is completed and submitted.

The Department of Defense/US Navy does not have specific requirements for the project, but approval of a Cooperate Research Agreement (CRA) is required. The CRA will include the same information as the MOU, but must also acknowledge the Navy’s role and define how the Navy will benefit from the agreement. This process could take 3 months, but it can be submitted concurrently with the CDFG MOU. Peter will contact Melissa and Nancy to obtain a sample of an MOU and SCP from CDFG, and a Navy CRA. Peter will then work with Alan, Colleen and Karen to create a draft of each required document. These drafts will then be submitted to Melissa and Nancy for comment prior to final submission.

Eric Morrisette stated that USFWS does not need to be involved, and Melissa Booker will work with Sandy Visman (USFWS) regarding how moving animals off the island might affect the Navy's SCL Fox Recovery Plan.

Funding for the project will likely come from multiple sources. The trapping is already planned and funding is allocated, but the costs of quarantine care and flights will likely be shared or covered by the participating zoos. (The funding mechanisms require further discussion.)

Our group then discussed with the Veterinary TEG what the quarantine and transfer protocols would be. This protocol was written as part of the Veterinary TEG's Risk Assessment document and was included in the draft of the USFWS Recovery Plan. The protocol was applied last year when a fox was brought from Santa Rosa Island to the Santa Barbara zoo. So the question was posed, can the protocol now be adopted for all future island-mainland transfers? It was determined that the protocol would need to be amended to reflect that the requirements for an animal to remain in quarantine can be flexible regarding time on and off island, as long as the 60-day minimum is maintained and the time on the island is sufficient to allow required testing and determination of test results. The protocol still requires a negative fecal sample for 3 weeks, but the sampling can be done either on or off island or in both locations. The Veterinary TEG will have a final approved quarantine protocol by August 1st.

2009 Captive Population TEG Recommendations

- 1) Collect fecal samples for cortisol measurements from wild foxes on all islands from traps and opportunistically as encountered. Install platforms for foxes to defecate on (similar to trap platforms). A detailed protocol will be provided by this group for field use.
- 2) Collect fecal samples for cortisol measurements from all captive foxes on Santa Rosa and Catalina islands and mainland zoos. A detailed protocol will be provided by this group for use in captive facilities.
- 3) Clean pens daily year-round. This protocol would potentially reduce stress during the breeding season when cleaning is increased (to daily from weekly), reduce the parasite load in the pens, and allow better observation of aggressive behaviors. Any instance when daily cleaning is not possible should be recorded.
- 4) Increase weed removal (particularly cheese weed) in the pens. Larger shrubs (coyote bush) should be left as should some small weed patches in each pen to provide cover. All weeds removed from the pens should be taken away from the facility to reduce fire risk.

- 5) Test all captive animals for internal parasites, and include these results in a discussion on treatment options.
- 6) Treat all pregnant females with antibiotics at day 20 - 25 day of pregnancy, and /or test thyroid levels at the time of ultrasound. Given these results, decide if treatment is necessary.
- 7) The Veterinary TEG should review all existing blood sample results for thyroid, calcium, and diseases of concern. These results should be used to determine the possibility for testing various treatments for the most serious factors. A proposal should be constructed for funding for research into immune function in both captive and wild populations.
- 8) Increase research efforts directed at understanding the role of aggression in wild and captive populations. Incorporate this information in development of methods to address aggression in captivity.
- 9) Pursue methods to increase data collection efficiency for captive populations.
- 10) Apply video monitoring techniques to other fox species in captivity.
- 11) Increase efforts to get volunteer help from zoos with island projects. For example The Living Desert and Santa Barbara Zoo would love to send crews (keepers and/or maintenance staff) to help. Possible projects might be re-building pen 1 on SRI into a rectangle or building shelves or den boxes. (These could be build on-site or pre-built and sent out).

Fox Health Working Group

Fox Health Expertise Group Meeting Report – 24 - 25 June 2008

Participants:

Karen Blumenshine - WS
Deanna Clifford - UCD
Francesca Ferrara - IWS
Karl Hill – SB Zoo
Brian Hudgens - IWS
Julie King - CIC
Linda Munson – UCD (Chair)
Jessica Sanchez - IWS
Winston Vickers – IWS (Co-Chair)
Mark Willett

Prioritized major health concerns and needs for 2008

1. Update guidelines for vaccination and blood sampling of captive and wild populations
2. Review and update guidelines for epidemic response, and response to mortality clusters of unknown cause
3. Review status and make recommendations for SRI captive breeding population
4. Address protocol for transfer of foxes off island and management of introduced mammals
5. Recommend physical and social well-being criteria for geriatric or other unreleasable foxes that are in long term captivity on the islands
6. Establish research priorities and prioritize use of archived samples
7. Determine whether live chickens brought from the mainland can be safely utilized as avian disease sentinels for indigenous birds on Santa Cruz Island
8. Complete the veterinary handbook

1. Guidelines for vaccination and blood sampling of captive and wild populations

Review of appropriateness of vaccination

- Canine distemper and rabies are the diseases most likely to cause extinction, so vaccination is still considered important.
- Canine distemper virus (CDV) and rabies vaccines are available and safe for the foxes and the ecosystem.
- Because of continued endangered status, it is desirable to provide a safety net through core population vaccination.
- As long as monitoring is continuing, vaccination does not entail significant extra effort or cost.
- A proportion of foxes in larger populations should not be vaccinated against CDV in order to allow circulation of existent endemic wild viral strains.
- There are no concerns with assuring that wild rabies viral strains circulate in the population, so vaccination of a larger proportion of the population against this disease is acceptable for maximum fox and human protection in the event of an outbreak.
- Rabies has a public health aspect that may influence vaccination numbers, epidemic response, and locations of vaccinated core populations.
- Vaccinating a greater proportion of the population than the minimum required to avoid extinction (based on modeling) is a possible alternative to direct epidemic response and / or resumption of captive population maintenance in the event of an epidemic.

Vaccination recommendations for 2008

- The vaccines to use are Merial's Purevax® Ferret Distemper Vaccine for CDV and Merial's Imrab 3® for rabies.
- Vaccinate all captive foxes for CDV and rabies
- Vaccinate all captured foxes against rabies EXCEPT radio-collared disease sentinels

- Vaccinate all opportunistically caught animals on islands with small populations (SMI and SRI) against CDV. When the populations reach 50% of the recovery goal, then transition to the long-term core vaccination program.
- On islands with larger populations, a minimum of 20 radio-collared animals should not be vaccinated so that they can serve as a disease sentinel population for early detection of an epidemic. These individuals should be juveniles (1 – 2 years old if possible), and should be distributed as randomly as possible across the island.
- On islands with larger populations, vaccinate core group(s) totaling a minimum of 80 - 100 animals against CDV and rabies in strategic geographic location(s) in perpetuity.
- The decision to vaccinate animals radio-collared for purposes other than disease sentinels depends on management goals.
- Animals found to have naturally occurring (not vaccine-induced) CDV antibodies should have serology repeated yearly if possible in order to determine persistence and fluctuation of antibodies in response to exposure to wild viral strains
- The Fox Health Group did not recommend conducting a CDV-challenge study to assess the efficacy of the vaccine because 1) the vaccine has proven efficacious in other sensitive species; 2) a challenge study would result in the death or euthanasia of foxes.

Figure 1 – CDV vaccination strategy

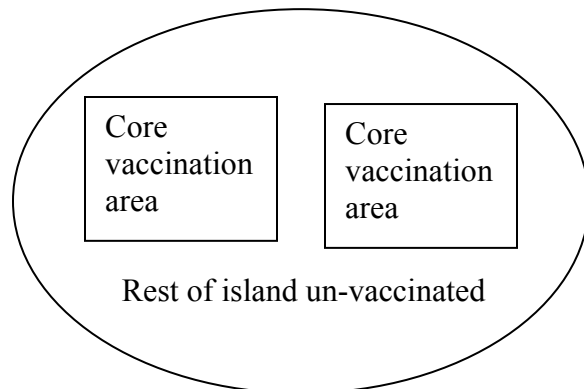
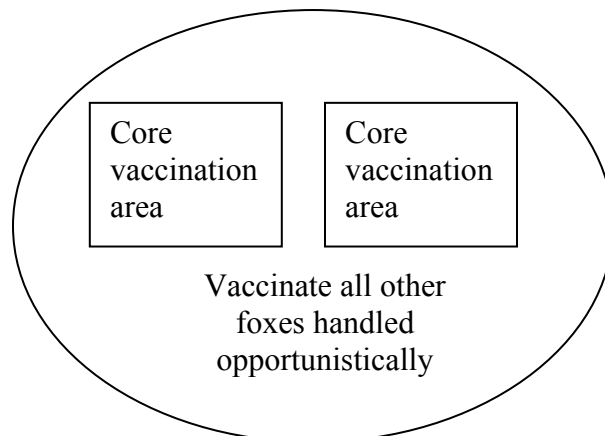


Figure 2 – Rabies vaccination strategy

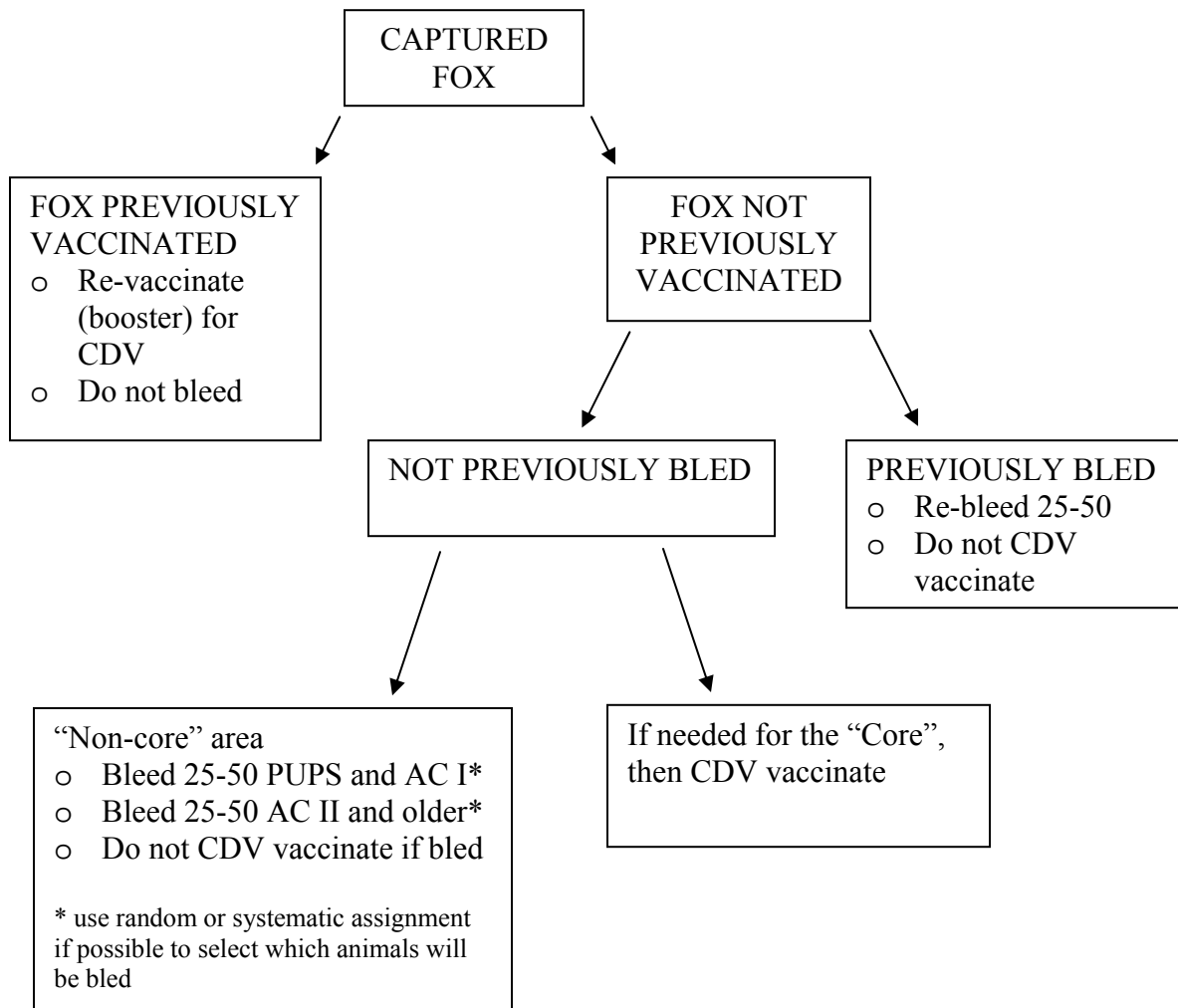


FOX VACCINATION AND BLEEDING DECISION TREE

ALL radio-collared animals should be bled when the collar is placed and in all subsequent captures

Vaccinate ALL foxes against rabies EXCEPT radio-collared disease sentinels

“Core” is a minimum of 80 – 100 foxes vaccinated against CDV and rabies divided into 2-3 groups in strategic areas on all islands. On islands with larger populations, CDV vaccinate additional foxes up to the number that managers desire to have remaining after an epidemic.



Protocols for long term health monitoring

1. Continue collection and archiving of serum and blood from selected animals for health monitoring. The most valuable animals to bleed are pups and AC I, the disease sentinels, and other unvaccinated animals that were previously bled.

If populations are large enough:

- Sample as many previously unvaccinated (against CDV) age class I and pups > 5 mo old as possible (target number 25–50, including yearlings that are being radiocollared).
- Sample all unvaccinated (against CDV) radio-collared animals (target number 25-50)
- Sample 25-50 unvaccinated (against CDV) age class II or above animals that were bled in a previous year.

On islands with smaller populations:

- Sample all unvaccinated (against CDV) foxes over 5 months of age (up to a target number of 100).

For blood sampling and archiving protocols, see Appendix A.

Frozen samples for archiving may be initially kept in standard freezers, but long term storage should be at -60° to -80° C if possible.

Most island fox samples are currently being archived in -80° freezers maintained by IWS in Arcata, CA.

Island managers should consider archiving blood clots from any animal that is bled but has not previously had clot material or white blood cells archived for DNA.

2. . Conduct a serosurvey for antibodies to CDV, canine parvovirus (CPV), canine adenovirus (CAV), and *Toxoplasma*

- Serosurveys should ideally be conducted as often as yearly, but no less often than every 5 years. The last serosurvey was completed in 2002 (Clifford et. al. 2006); therefore it was advised to repeat the survey in 2008.
- Using samples collected under the protocol in #1 above, test approximately 100 - 125 samples per island. The cost per sample is approximately \$50 - 75. If insufficient funds are available, then test 25 juveniles (giving priority to radio-collared animals) and 25 previously bled adults (giving priority to radio-collared animals).

3. Collect feces from 20 wild foxes on each island per year for parasite surveillance and store in 5 - 10% formalin for future analysis.

4. Record body weight and body condition score whenever foxes are handled.
5. Record injuries or other lesions and take photographs if possible
6. Continue to transport all deceased foxes to UC Davis for necropsy, histopathology, and other testing by Dr. Linda Munson

- Carcasses should be located as quickly as possible to prevent decomposition. Carcasses should be refrigerated (if to be shipped immediately) or frozen for later shipment. A Submission Form (Appendix B) should be completed and sent electronically to Dr. Munson (lmunson@ucdavis.edu) and a printed form submitted with the carcass.
- Non-fox staff on islands need to be informed of procedures relating to diseased, injured, or deceased foxes to assure that the fox veterinarians are alerted
 - Training and education of non-fox personnel on islands is critical to assuring that fox illnesses or deaths are promptly reported, and key information is not lost due to delays in examining or necropsying foxes
 - Non-fox personnel should be trained to take the following steps if they spot a sick, injured, or dead fox:
 - Get a precise description of the location (GPS if possible) , and mark the location visually (some sort of flagging, stone stacking, or other)
 - Notify fox project personnel immediately – it is critical that non-fox personnel understand the need for rapid communication, and that important information is lost with each hour of decomposition
 - If the fox is deceased, only personnel who are trained and equipped with gloves and plastic bags should bring the body to the designated refrigerator or freezer.
 - If not prepared to transport the body, attempt to protect it from scavengers (plastic sheet, cooler, etc placed over the body and weighted down), and keep it as cool as possible (ice if available, or create shade) until transport is possible.

2. Review and update guidelines for epidemic response and response to mortality clusters or foxes with signs of serious illness of unknown cause

Clusters of mortalities (temporal and/or spatial) or observations of seriously ill animals dictate an increase in monitoring of radio-collared foxes and possibly other measures. See Appendix C.

3. Review status and make recommendations for SRI captive breeding population

In 2008, five of nine foxes lost their litters. Two foxes were confirmed to have aborted, one of which was confirmed to be due to bacteria. Another three foxes were determined to be pregnant

by ultrasound, but pups were not found (indicating late term abortion or neonatal death and removal by the dam). All fox pups observed live shortly after birth survived. Two foxes were detected with mastitis. Mate aggression continued to be present in 2008.

Recommendations regarding late term abortions/stillbirths/neonatal deaths

- Treat females prophylactically with antibiotics earlier in pregnancy (30 days of gestation).
- Improve and continue den observations.
- Increase level of weed control in pen to reduce soil moisture/fecal build up to prevent bacterial overgrowth in the environment.
- Infectious agent titer assessments should possibly be done before and during pregnancy to determine whether active infection or activation of latent infection is playing a role in reproductive failures. Agents to consider testing would include *Brucella*, *Toxoplasma* canine herpes virus (CHV), CAV, CPV, and CDV.
- Assess parasite loads in females. If high parasite loads are detected, then treat females with anthelmintics.
- Intervene if pup neglect observed and foster to another litter
- Supplement captive foxes with thyroid hormone. Further research should be done on thyroid function changes during pregnancy

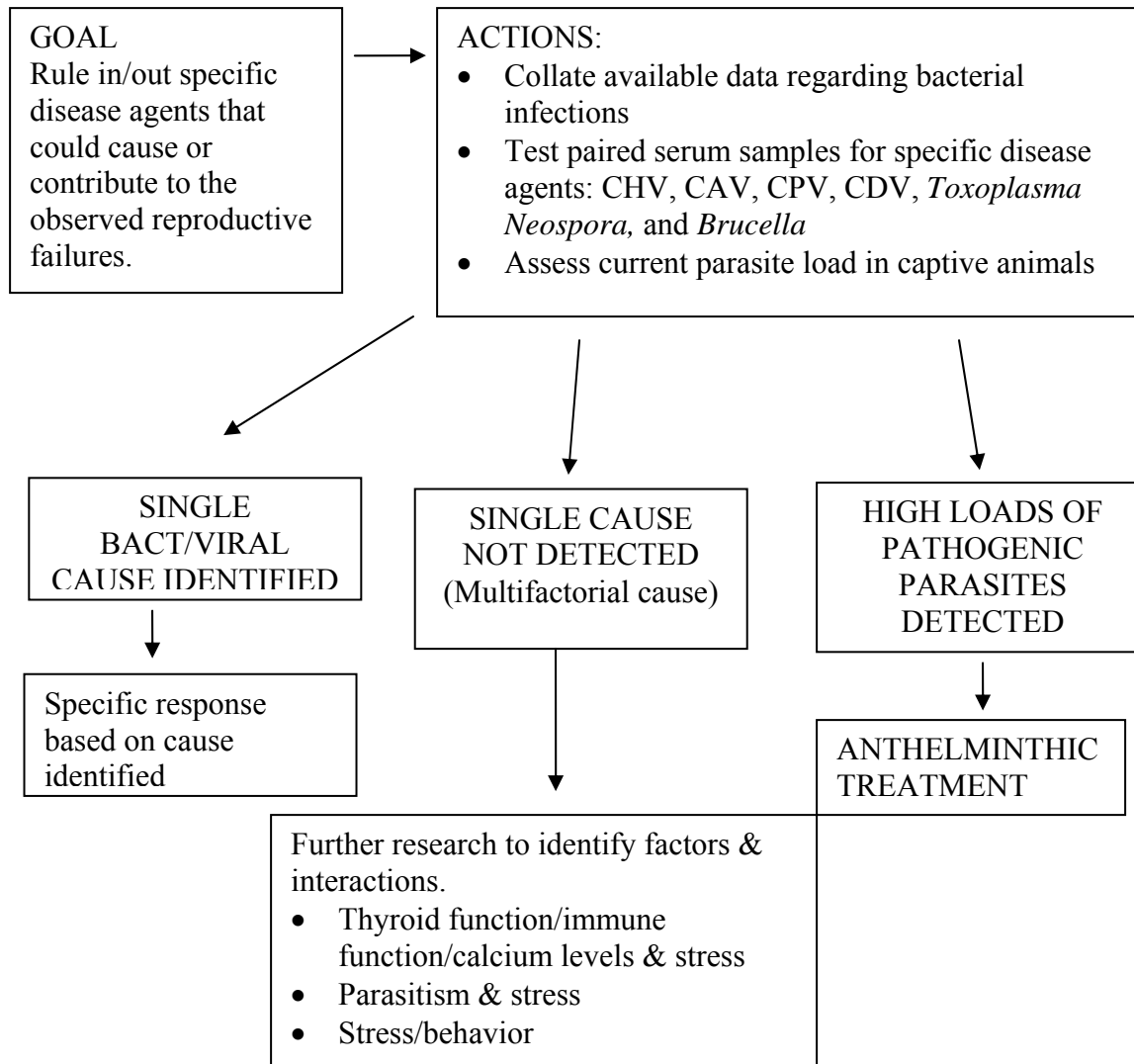
Recommendations regarding mastitis:

- Treat females prophylactically with antibiotics earlier in pregnancy (at approximately 30 days of gestation). At the time of ultrasound, observe the condition of the teats closely and correlate any abrasions with the condition of the den box substrate.
- Clean the pens daily to reduce fecal bacteria throughout pregnancy. Increase level of weed control in pen to reduce soil moisture/fecal build up to prevent bacterial overgrowth in the environment.

Recommendations regarding mate aggression:

- Ensure every pen has two separated food bowls. Other changes may be recommended based on findings of the reproductive study and Captive Husbandry group report
- Create better escape potential in the pen for victims of aggression by providing escape openings and restrict aggressor access to openings (for example place an Elizabethan collar on the aggressor).

The Fox Health Group did not recommend moving the SRI foxes to the second captive breeding facility site because of the labor involved and the history of poor reproduction at that site. The group also did not recommend drug therapy to reduce aggression because of the potential loss of libido and appetite.



4. Address protocol for transfer of foxes off the islands

Selection of population to move to the mainland should consider the following health issues.

- San Clemente foxes have a higher prevalence of amyloidosis and more severe amyloidosis in captivity
- San Nicolas foxes have more severe infestations with *Spirocerca*
- Santa Cruz foxes genetically would be ideal, but the current population is small.

For updated protocol for moving foxes to the mainland see Appendix D.

Management and Removal of Introduced Mammals

As recent incidents illustrate (introduction of 3 raccoons to Catalina Island via stowaway on boats, and carriage of an opossum to the island by commercial carrier), all islands should have protocols in place to deal with invasive animal introductions.

- Protocols should be communicated to non-fox personnel so that proper steps are taken in the event of discovery of invasive animals on boats or on an island.
- Parties involved with protocol development should be cognizant that return of wild animals to the mainland for release back into the wild may risk introduction of unique infectious agents (such as *Spirocerca* or island-evolved viral strains) to naïve mainland wildlife populations, and is not advisable.
- Protocols could include:
 - 1) requiring return of a boat to the mainland before exit of a stowaway animal;
 - 2) capture protocols – these would potentially need to be developed with other agencies (depending on the island) such as CDFG, the Navy, or the city of Avalon;
 - 3) preconditions and protocols for lethal removal – this would be developed with input from CDFG;
 - 4) samples (blood and feces) to be taken from live animals – may need a scientific collecting permit from CDFG;
 - 5) determining which animals would be appropriate to necropsy if lethal removal is utilized

5. Recommend strategies for physical and social well-being of geriatric or other un-releasable foxes that are in long term captivity on the islands

- Maintaining non-releasable animals should include provision for social interaction with other foxes or humans.
- Decisions relating to euthanasia of non-releasable animals should be based on the joint evaluation of fox-care personnel and veterinarians who have examined the animals.
- Though somewhat subjective, quality of life evaluations based on functions such as appetite, drinking, mobility, behavior, level of disease, and apparent pain levels should be the primary considerations in decisions relating to euthanasia.

6. Health research priorities and prioritizing use of archived samples

RESEARCH NEEDS IN 2008:

1. Investigate the efficacy and long term persistence of antibody titers after CDV vaccination
 - Determine length of antibody persistence in island foxes previously vaccinated for CDV or in unvaccinated foxes that previously had anti-CDV antibodies (this could likely be accomplished as part of a serosurvey of wild foxes)

- Determine if doubling the vaccine dose and administering it at two sites, increases protection against CDV (this could likely be accomplished using currently archived samples from the Santa Cruz Island captive facility).
 - Challenge studies are not recommended due to euthanasia requirements and costs. Sufficient data are available from challenge studies in other species to extrapolate to the island fox.
2. Conduct a serosurvey across all islands to determine current disease exposure levels in wild foxes
 3. Investigate thyroid function in island foxes

Because low thyroid function can be a factor in reproduction and general health, and because most adult island fox thyroid glands are small with low thyroid hormone reserves, it is recommended that thyroid stimulation tests be conducted to assess thyroid function using a group of captive foxes and that thyroid function during pregnancy be evaluated.

 - Thyroid stimulation tests and repeat measures of thyroid hormones during life stages (including pregnancy) should be conducted to help define the roll of thyroid function in relation to reproductive and other health issues.
 - Existing data on thyroid levels should be collated and examined.
 4. Investigate levels of stress in captive animals
 - Evaluate and compare stress in captive and wild foxes (stress hormone levels in captives are currently being analyzed as part of the St. Louis Zoo's reproductive study, but more samples from wild foxes and repeat ACTH testing may be needed for valid comparisons).
 - Future studies should include assessing the relationship between stress levels and immune or reproductive functions.
 5. Assess changes in antibody titers to certain diseases before and during pregnancy in female captive foxes
 6. Develop normal reference intervals for island fox blood parameters
 7. Develop a system for managing archived biological samples
 - Protocols need to be reviewed by new fox personnel or researchers to assure appropriate sample collection and consistency. Protocols are in Appendix A.
 - Identify a centralized location and provide support for a curator. Currently many samples are being archived at IWS in Arcata, and SCA samples are being archived on the island, but no central system or funding is in place.
 - Establish a committee to assess appropriate use of biomaterials

8. Reporting of Disease Research Findings from outside investigators to the Fox Health Expertise Group

Any research findings pertinent to the health status of island foxes should be reported to the Fox Health Expertise Group for inclusion in annual reports and dissemination of relevant concerns to managers. For example, results of recent analysis of ectoparasite-borne infectious agents on the Northern Islands are important for determining annual recommendations relating to disease management and mitigation. Island managers should dictate in the memorandum of understanding with researchers that summary information be provided to the Fox Health Expertise Group.

7. Recommendations relating to bringing live chickens to SCZ from the mainland for use as avian disease (West Nile Virus) sentinels

- It may be possible to acquire “specific-pathogen-free” (SPF) birds that minimize disease concerns for resident birds. Possibly the chickens could be hatched on the island to reduce pathogen transfer from the mainland. There are currently no pathogens known to be carried by chickens that would be a population threat to island foxes.
- Enclosures for chickens should be constructed to prevent fecal contamination of the environment and direct contact with resident birds.

8. Complete the Fox Health Handbook and Field Sampling Guidelines

Final draft is in revision and will be sent to Fox Health Expertise Group by Winston Vickers for approval

FUNDING NEEDS

- Funds are needed to conduct serosurveys and vaccine-response studies
- Funds are needed to conduct thyroid function studies
- Continuing funding is needed to support necropsies for ongoing disease surveillance
- Funding needs to be sought for maintenance of the biological sample archives at UC Davis, the Institute for Wildlife Studies, the Catalina Island Conservancy, or other locations where biological samples from island foxes are archived. This will be an on-going expense that should have a continued source of funding.

APPENDICES

Appendix A
MEETING AGENDA

TUESDAY, JUNE 24

Morning

8:30	Introduction/announcements	Tim Coonan/ Dave Graber
8:45	Status of Recovery Plan	Eric Morrissette
9:00	San Nicolas Island Update	Grace Smith
9:15	Santa Catalina Island Update	Julie King
9:30	San Clemente Update	Bill Andelt

Break

10:30	San Miguel Island Update	Tim Coonan
10:40	Santa Rosa Island Update	Tim Coonan
11:00	Santa Cruz Island Update	Rachel Wolstenholme/ Vickie Bakker
11:30	Wrap-up/Questions	Dave Graber

Lunch**Afternoon**

1:00	Pathology	Linda Munson
1:45	Reproductive Study	Cheri Asa
2:30	Catalina Island Ear Tumor Study	Winston Vickers
2:45	Mainland Population Update	Alan Varsik

Break

3:30	Work in groups	
5:00	ADJOURN	
6:00	Pizza and beer	

WEDNESDAY, JUNE 25

Morning

8:00	Announcements	Dave Graber
8:15 – 9:30	Work in groups	

Break

9:45 – 12:00	Work in groups	
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Lunch**Afternoon**

1:15 – 3:00	Work in groups	
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Break

3:30	Plenary session	Dave Graber
5:00	ADJOURN	

THURSDAY, JUNE 26

Morning

8:00	Announcements	Dave Graber
8:15 – 10:00	Work in groups	

Break

10:30	Presentation of group results	Group Leaders
11:15	Meeting wrap-up	Dave Graber
12:00	ADJOURN	

Appendix B
MEETING ATTENDEES

Recent Attendance			Name	Affiliation	Phone	Email	Expertise/Groups
2008			Ackerly, Carol	Friends of the Island Fox 15125 Nordhoff St. # 2 North Hills, CA 91343	(818) 893-9529	Foxylady22@roadrunner.com	Environmental Education
2008			Akers, Kara	The Living Desert 47900 Portola Ave. Palm Desert, CA 92260		sgreely@livingdesert.com	Wild Population Management Captive Population Management
2008	2007	2006	Andelt, William	Department of Fish, Wildlife, and Conservation Biology Colorado State University Fort Collins, CO 80523	(970) 491-7093	billan@warnercnr.colostate.edu	Ecology of Carnivores Managing Conflicts with Wildlife
2008	2007	2006	Asa, Cheryl	Saint Louis Zoo 1 Government Drive St. Louis, MO 63110	(314) 768-5488	asa@stlzoo.org	Captive Population Management
2008	2007	2006	Bakker, Vickie	7391 Freeman Place Goleta, CA 93117	(805) 961-9591	vjbakker@ucdavis.edu	Population Modeling Wild Population Management
	2007	2006	Baldwin, Sandra	1220 Pacific Hwy San Diego, CA 92132	(619) 532-4817	Sandra.baldwin@navy.mil	
2008			Barnhart, Trent	Santa Barbara Zoo 500 Ninos Drive Santa Barbara, CA 93103	(805) 962-5339 x41	Trent_Barnhart@hotmail.com	Wild Population Management Captive Population Management
2008	2007	2006	Bauman, Karen	Saint Louis Zoo 1 Government Drive St. Louis, MO 63110	(314) 781-0900	kbauman@stlzoo.org	Captive Population Management
		2006	Benz, Carl	USFWS – Ventura Office 2493 Portola Road, Suite B Ventura, CA 93003	(805) 644-1766 ext 311	Carl_Benz@fws.gov	
2008	2007	2006	Blumenshine, Karen	Wildlife Services Associates 15 St. Ann Drive Santa Barbara, CA	(805) 962-4414	wildlifeservicesassociates@cox.net	Veterinary/Health Issues Golden Eagle Management
		2006	Blumstein, Dan	University of California, Los Angeles Department Ecology & Evolutionary Biology 621 Charles E. Young Drive, South Los Angeles, CA 90095-1606	(310) 267-4746	marmots@ucla.edu	Captive Population Management Reintroduction

Recent Attendance			Name	Affiliation	Phone	Email	Expertise/Groups
		2006	Bremner-Harrison, Sam	ESRP P.O. Box 9622 Bakersfield, CA 93389	(661) 835-7810	sbremnerharrison@esrp.csustan.edu	Captive Population Management Reintroduction
	2007	2006	Calkins, Betsy	18 Bowers Rd. Harvard, MA 01451	(608) 449-7159	escalkins@yahoo.com	
		2006	Carlstead, Kathy	Honolulu Zoo 151 Kapahulu Avenue Honolulu, HI 96815	(808) 971-2503	kcarlstead@honzoosoc.org	Captive Population Management
2008		2006	Clifford, Deana	University of California, Davis Wildlife Health Center 1 Shields Ave Davis, CA 95616	(530) 752-5603	dlclifford@ucdavis.edu	Captive Population Management Veterinary/Health Issues Reintroduction Wild Population Management
2008	2007	2006	Collins, Paul	Santa Barbara Museum of Natural History 2559 Puesta del Sol Santa Barbara, CA 93105	(805) 682-4711 ext. 154	pcollins@sbnature2.org	Golden Eagle Management Wild Population Management
	2007	2006	Comrack, Lyann	California Department of Fish and Game		LComrack@dfg.ca.gov	Wild population Management
2008	2007	2006	Coonan, Tim	National Park Service 1901 Spinnaker Drive Ventura, CA 93001	(805) 658-5776	tim_coonan@nps.gov	Wild Population Management Captive Population Management Reintroduction Recovery Planning Golden Eagle Management
2008	2007	2006	Cypher, Brian	ESRP P.O. Box 9622 Bakersfield, CA 93389	(661) 835-7810	bcypher@esrp.org	Wild Population Management Ecosystem Restoration
	2007	2006	Daily, Marla	Santa Cruz Island Foundation 1010 Anacapa St. Santa Barbara, CA 93101	(805) 963-4949	marla@scifoundation.org	Environmental Education
		2006	Daugharty, Kirin	Los Angeles Zoo 705 N. Lamer Street Burbank, CA 91506	(818) 563-5221	kdaugharty@lazoo.org	
2008	2007	2006	Dearborn, Keri	Friends of the Island Fox 20982 Ave San Luis Woodland Hills, CA	(818) 883-5253	islandfoxnews@gmail.com	Captive Population Management Environmental Education
		2006	de la Rosa, Carlos	Catalina Island Conservancy PO Box 2739 Avalon, CA 90704	(310) 510-1299	cdeklarosa@catalinaconservancy.org	

Recent Attendance		Name	Affiliation	Phone	Email	Expertise/Groups	
	2007		Denney, Richard	Animal Hospital of Catalina PO Box 2533 Avalon, CA 90704	(310) 510-1210	ilvmyvet@aol.com	
	2007	2006	Dennis, Mitchell	1901 Spinnaker Drive Ventura, CA 93001	(805) 658-5700 ext. 5785	mitchell_dennis@nps.gov	Captive Population Management Reintroduction Wild Population Management
		2006	deSpain, Forrest	Orange County Zoo 1 Irvine Park Road Orange, CA 92862	(714) 973-6844	forrest.despain@RDMD.ocgov.com	Captive Population Management
	2007		Doak, Dan	Dept. Ecology & Evolutionary Biology University of California Santa Cruz, CA 95064		doak@biology.ucsc.edu	Population Modeling Wild Population Management
2008	2007	2006	Drake, Lisa	National Park Service 1901 Spinnaker Drive Ventura, CA 93001	(406) 599-0346	Lisa_drake@nps.gov	Captive Population Management
		2006	Dratch, Peter	National Park Service 1201 Oakridge, Suite 200 Fort Collins, CO 80525	(970) 225-3596	Peter_Dratch@nps.gov	Genetics
	2007	2006	Duncan, Calvin	Catalina Island Conservancy Mail to : P. O. Box 2739 Avalon, CA 90204	(310) 510-3102	cduncan@catalinaconservancy.org	
	2007		Efford, Murray	Otago University NZ P.O. Box 56 Dunedin, New Zealand	64 3 476-4668	Murray.ifford@stonebow.otago.ac.nz	Wild Population Management Population Modeling Recovery Planning
2008	2007	2006	Faulkner, Kate	National Park Service 1901 Spinnaker Drive Ventura, CA 93001		kate_faulkner@nps.gov	Ecosystem Restoration
2008	2007		Ferrara, Francesca	Institute for Wildlife Studies PO Box 42121 Port Hueneme, CA 93044	(805) 989-2319	ferrara@iws.org	Wild Population Management Veterinary/Health Issues Environmental Education
	2007	2006	Fox, Jodi	Institute for Wildlife Studies P.O. Box 1104 Arcata, CA 95511	(505) 496-3632	fox@iws.org	
	2007	2006	Galipeau, Russell	Channel Islands NP 1901 Spinnaker Dr. Ventura, CA 93001	(805) 658-5700		

Recent Attendance			Name	Affiliation	Phone	Email	Expertise/Groups
	2007	2006	Garcelon, David	Institute for Wildlife Studies P.O. Box 1104 Arcata, CA 95511	(707) 822-4258	garcelon@iws.org	Captive Population Management Ecosystem Restoration Golden Eagle Management Population Modeling Reintroduction Wild Population Management
2008	2007		Graber, Dave	National Park Service 47050 Generals Highway Three Rivers, CA 93271-9651	(559) 565-3173	david_graber@nps.gov	
2008	2007	2006	Gray, Melissa	University of California, Los Angeles Dept. OBEE/Wayne Lab 621 Charles E. Young Dr., So. Los Angeles, CA 90095	(310) 825-5014 (310) 206-3987 (fax)	mgray9@ucla.edu	Captive Population Management Genetics Population Modeling
		2006	Green, Michele	Santa Barbara Zoo 609 Lantana St. #15 Camarillo, CA 93010	(805) 405-8630	Michelezukpr@aol.com	
2008			Greely, Sarah	The Living Desert 47900 Portola Ave. Palm Desert, CA 92260		sgreely@livingdesert.com	Wild Population Management Captive Population Management
2008	2007	2006	Guglielmino, Angela	National Park Service 1901 Spinnaker Drive Ventura, CA 93001	(805) 658-5903	Angela_guglielmino@nps.gov	Captive Population Management
	2007	2006	Guieb, Ruben	San Diego, CA	(619) 556-1854	Ruben.guieb@navy.mil	
	2007	2006	Guttilla, Darcee	Catalina Island Conservancy P. O. Box 2739 Avalon, CA 90704	(310) 510-1299	dguttilla@catalinaconservancy.org	
		2006	Hall, Lynn	12060 Barrance Rd. Camarillo, CA 93012	(805) 495-3747	HLHallandsons@aol.com	
	2007	2006	Hanna, Shari	22660 Hatteras St Woodland Hills, CA 91367	(805) 208-1759	Turacoldy@aol.com	
2008			Hardin, Wes	Santa Barbara Zoo 500 Niños Drive Santa Barbara, CA 93103	(805) 962-5339 ext. 51	enrichment@sbzoo.com	Wild Population Management Captive Population Management
	2007	2006	Hill, Karl	Santa Barbara Zoo 500 Niños Drive Santa Barbara, CA 93103	(805) 962-5339 ext. 30	khill@sbzoo.org	Captive Population Management Veterinary/ Health Issues

Recent Attendance		Name	Affiliation	Phone	Email	Expertise/Groups	
	2007	2006	Horiszny, Sheri	Santa Barbara Zoo 500 Ninos Dr. Santa Barbara, CA 93103	(805) 962-5339 ext 35	shoriszny@sbzoo.org	
		2006	Hudgens, Brian	Institute for Wildlife Studies P. O. Box 1104 Arcata, CA 95570	(707) 822-4258	hudgens@iws.org	
	2007		Keitt, Brad	Island Conservation University of California LML 100 Shaffer Road COH Santa Cruz, CA 05060	(831) 459-1476	Brad.keitt@islandconservation.org	
		2006	Kimble, Katie			ktzoogirl@aim.com	Reintroduction
	2007	2006	King, Julie	Catalina Island Conservancy	(310) 510-1299	jking@catalinaconservancy.org	Captive Population Management Wild Population Management
	2007	2006	Kleiman, Devra	Zoo-Logic, LLC 7216 Delfield Street Chevy Chase, MD 20815	(301) 652-0647	dgkleiman@aol.com	Captive Population Management Population Modeling Reintroduction
	2007		Kunkel, Kyran	Conservation Science Collaborative 1875 Gateway South Gallatin Gateway, MT 59730	(406) 763-4109	kyran@montana.net	
		2006	Latta, Brian	Predatory Bird Research Group University of Santa Cruz - LML 100 Shaffer Road Santa Cruz, CA 95060	(831) 459-2466	blatta@ucsc.edu	Golden Eagle Management Reintroduction
2008		2006	Laughrin, Lyndal	Santa Cruz Island Reserve Marine Science Building University of California Santa Barbara, CA 93106	(805) 448-3491 (805) 893-7247	laughrin@lifesci.ucsb.edu	Wild Population Management Ecosystem Restoration
	2007	2006	Lea, Amanda	UCLA c/o Melissa Grey	(650) 868-7180	ajlea@ucla.edu	
	2007		Leslie, Elaine	National Park Service Biological Resources Management Division 1201 Oakridge Drive # 200 Fort Collins, CO 80525	(970) 267-2135	Elaine_leslie@nps.gov	

Recent Attendance		Name	Affiliation	Phone	Email	Expertise/Groups	
	2007		Little, Annie	U.S. Fish and Wildlife Service 6010 Hidden Valley Road Carlsbad, CA 92011	(760) 431-9440 ext. 219	Annie_little@fws.gov	
2008	2007	2006	Lynch, Colleen	University of South Dakota Dept. of Biology 414 E. Clark St. Vermillion, SD 57069	(605) 677-3115	Colleen.Lynch@usd.edu	Captive Population Management Genetics Population Modeling
	2007		McCrary, Mike	USFWS – Ventura Office 2493 Portola Road, Suite B Ventura, CA 93003	(805) 644-1766	Mike_McCrary@fws.gov	
2008			McMorran, Robert	USFWS – Ventura Office 2493 Portola Road, Suite B Ventura, CA 93003	(805) 644-1766	Robert_McMorran@fws.gov	
2008	2007	2006	Meyer, Pat	Friends of the Island Fox Inc. 3760 Groves Place Somis, CA 93066	(805) 386-3436	pmmgoldens@earthlink.net	Captive Population Management Environmental Education
	2007	2006	Miller, Phil	Conservation Breeding Specialist Group (SSC / IUCN) 12101 Johnny Cake Ridge Road Apple Valley, MN 55124-8151	(952) 997-9802 Fax: 1-952-997-9803	pmiller@cbsg.org	Population Modeling
2008	2007	2006	Morrison, Scott	The Nature Conservancy 201 Mission Street, 4th Floor San Francisco, CA 94105	(415) 963-6603	smorrison@tnc.org	Ecosystem Restoration Golden Eagle Management Population Modeling Wild Population Management
2008	2007	2006	Morrisette, Eric	USFWS – Ventura Office 2493 Portola Road, Suite B Ventura, CA 93003	(805) 644-1766 ext 223	eric_morrisette@fws.gov	
		2006	Moxie, Jeff	395 Stonebrook St. Simi Valley, CA 93065	(805) 520-7768	jeffmoxie@yahoo.com	
2008	2007	2006	Munson, Linda	University of California VM-PMI 4206 VM3A 1 Shields Avenue Davis, CA 95616	(530) 752-5274 (cell) (530) 219-9468 (cell) (530) 752-3349 (fax) (530) 754-7963 (lab)	lmunson@ucdavis.edu	Captive Population Management Veterinary/Health Issues Wild Population Management

Recent Attendance			Name	Affiliation	Phone	Email	Expertise/Groups
2008			Ohmer, Michael	Santa Barbara Zoo 1037 ^a Del Mar Ave. Santa Barbara, CA 93109	(607) 339-5152	Meo25@cornell.edu	Wild Population Management Captive Population Management Reintroduction Environmental Education Population Modeling Ecosystem Restoration
	2007		Orrock, John	National Center for Ecological Analysis and Synthesis 735 State Street, Suite 300 Santa Barbara, CA 93101	(805) 892-2528	orrock@nceas.ucsb.edu	
	2007		Power, Paula	National Park Service 1901 Spinnaker Drive Ventura, CA 93001	(805) 658-5784	paula_power@nps.gov	
	2007	2006	Powers, Robyn	6308 Lorille Ln. Las Vegas, NV 89108	(702) 610-6308	romipo@earthlink.net	
2008	2007		Ralls, Katherine	Smithsonian's National Zoological Park PO Box 6356 Carmel, CA 93921	(831) 620-0505	rallsk@thegrid.net	Captive Population Management Genetics Population Modeling
	2007	2006	Randall, Kara	National Park Service 1901 Spinnaker Drive Ventura, CA 93001	(805) 448-7386	Kara_L_Randall@nps.gov	
		2006	Ruane, Martin	NBVC Point Mugu 311 Main Road, Suite 1 Point Mugu, CA 93042	(805) 989-3808	martin.ruane@navy.mil	
	2007	2006	Rubin, Esther	Conservation Biology Institute P.O. Box 369 Borrego Springs, CA 92004	(760) 767-3576	esrubin@consbio.org	
	2007		Sanchez, Jessica	Institute for Wildlife Studies 159 Silas Avenue Newbury Park, CA 91320	(805) 428-2450	sanchez@iws.org	Veterinary/Health Issues Genetics Recovery Planning Golden Eagle Management
	2007	2006	Sandhaus, Estelle	Santa Barbara Zoo 500 Ninos Drive Santa Barbara, CA 93103	(805) 962-5339	ESandhaus@sbzoo.org	Wild Population Management Captive Population Management Reintroduction
2008	2007	2006	Schuyler, Peter	525 Lorraine Ave. Santa Barbara, CA 93110	(805) 692-8595	peterschuyler@aya.yale.edu	Ecosystem Restoration Wild Population Management

Recent Attendance			Name	Affiliation	Phone	Email	Expertise/Groups
2008	2007	2006	Schwemm, Cathy	Department of Ecology, Evolution and Marine Biology, UCSB	(805) 258-9328	Schwemm@lifesci.ucsb.edu	Ecosystem Restoration Reintroduction
	2007	2006	Scott, Eric	Channel Island National Park 1901 Spinnaker Road Ventura, CA 93001	(805) 658-5700 ext 5910	Eric_L_Scott@nps.gov	
		2006	Scott, Kim	Wild Canid Center P.O. Box 760 Eureka, MO 63025	(636) 938-5900	kbishop_wcc@onemain.com	Captive Population Management
	2007	2006	Shaw, Rebecca	The Nature Conservancy 201 Mission Street, 4 th Floor San Francisco, CA	(415) 281-0480	rshaw@tnc.org	Ecosystem Restoration Wild Population Management
2008	2007	2006	Siminski, Peter	The Living Desert 47-900 Portola Avenue Palm Desert, CA 92260	(760) 346-5690 ext. 2103	psiminski@livingdesert.org	Captive Population Management
2008	2007	2006	Smith, Grace	NAWCWD U. S. Navy Point Mugu Code 52F000E Point Mugu, CA 93044	(805) 989-3807	grace.smith@navy.mil	Wild Population Management
	2007	2006	Sovada, Marsha	USGS Northern Prairie Wildlife Research Center 8711 37 th St SE Jamestown, ND 58401	(701) 253-5506	Marsha_Sovada@usgs.gov	Captive Population Management Reintroduction
		2006	Steele, Dale	State of California Dept. of Fish and Game 1416 Ninth Street Sacramento, CA 95814	(916) 653-3444	dsteale@dfg.ca.gov	Ecosystem Restoration Golden Eagle Management Wild Population Management
	2007	2006	Swarts, Hilary	University of California Department of Wildlife, Fish and Conservation Biology Davis, CA 95616	(530) 753-7419	hmswarts@ucdavis.edu	Wild Population Management
	2007	2006	Thomas, Nancy	USGS – National Wildlife Health Center 6006 Schroeder Road Madison, WI 53711	(608) 270-2463 (608) 270-2415 Fax	nthomas@usgs.gov	Veterinary/Health Issues
2008	2007	2006	Varsik, Alan	Santa Barbara Zoo 500 Ninos Drive Santa Barbara, CA 93103	(805) 962-5339	avarsik@sbzoo.org	Captive Population Management
	2007	2006	Vermeer, Lotus	The Nature Conservancy 3639 Harbor Blvd. Suite 201 Ventura, CA 93001	(805) 642-0345 Ext. 504	lvermeer@tnc.org	

Recent Attendance			Name	Affiliation	Phone	Email	Expertise/Groups
2008	2007	2006	Vickers, Winston	Institute for Wildlife Studies P.O. Box 2500 Avalon, CA 90704	(310) 413-6379 Cell: (949) 929-8643	vickers@iws.org	Captive Population Management Ecosystem Restoration Veterinary/Health Issues Genetics, Population Modeling Wild Population Management
		2006	Vissman, Sandy	U.S. Fish and Wildlife Service 6010 Hidden Valley Road Carlsbad, CA 92011	(760) 431-9440	sandy_vissman@fws.gov	Ecosystem Restoration Golden Eagle Management Wild Population Management
	2007		Widmar, Ali	Student Conservation Assn. Intern 1901 Spinnaker Drive Ventura, CA 93001	(310) 330-1010	swidmar@mac.com	Reintroduction Environmental Education Recovery Planning Ecosystem Restoration Golden Eagle Management
2008	2007	2006	Willett, Mark	651 Alvarado Avenue, Suite #6 Davis, CA 95616	(530) 758-1464 (530) 304-8249 Cell	mwillett@ucdavis-alumni.com	Captive Population Management Veterinary/Health Issues Wild Population Management
2008	2007	2006	Wolstenholme, Rachel	The Nature Conservancy 3639 Harbor Blvd. Suite 201 Ventura CA 93001	(805) 642-0345 ext 510	rwolstenholme@tnc.org	
		2006	Woodroffe, Rosie	University of California, Davis WFCB 1 Shields Avenue Davis, CA 95616	(530) 754-9513	rwoodroffe@ucdavis.edu	Veterinary/Health Issues Wild Population Management

Appendix C:
BLOOD COLLECTION AND ARCHIVING PROTOCOLS

Introduction

1. Blood composition - Blood is made up of several components we are interested in – Cells (red blood cells [RBC's] and white blood cells [WBC's]) and liquid (serum or plasma). The liquid portion of the blood contains a variety of components that we may be interested in measuring, such as antibodies to various diseases, and chemical components that are associated with organ function.

2. It is important to know the planned use of the blood before collecting so that the proper tubes and handling are employed. Serum and clots are commonly harvested from clot tubes (red or tiger top) and archived for serosurveys or DNA studies. Serum (from clot tubes) and unclotted blood (in lavender top tubes) are also commonly used for lab (Idexx or other) testing. WBC's from unclotted blood (in lavender top tubes) are also commonly harvested for DNA studies.

3. Blood sampling:

Blood can be collected from either jugular or femoral veins in adequate volumes for the following testing.

Collect the following amounts of blood dependent on fox body wt:

Fox Body Weight (kg)	Amount of blood (cc/ml) that can be safely collected
> 1.5	10
1 – 1.5	7 – 8
0.5 – 1.0 (pups)	4 – 5
0.3 – 0.5 (pups)	2 – 3

If lavender top or other anticoagulant tubes are being used, fill those first, before the blood can clot in the syringe, then fill red top tubes. If the blood draw has taken too long and clots are present in the anticoagulant tube, Complete Blood Count (CBC) results may be compromised, so you should draw another sample (1 – 1 ½ cc) and place in a new tube.

Write the following data on the tube: animal ID, date collected, initials for the island (SCI, SMI, SRI), and species (U Lit for foxes).

All blood tubes should be kept in a cooler with an icepack after collection and then refrigerated until processing is complete. Try not to chill the blood sample too quickly by placing it right next to an icepack. Overly rapid chilling can lead to gelatinizing of the serum, making it hard to harvest. Paper towels or other materials in a plastic cup can be used to separate the tubes from the icepack in a cooler during transport from the field to prevent this. Do not leave samples to clot in direct sunlight, this will cause breakage (hemolysis) of the red blood cells, affecting test results.

4. Blood processing:

The blood in an anticoagulant tube (lavender, green, or blue top tubes) is not clotted. The red blood cells (RBC's) and white blood cell (WBC's) float freely in the plasma (liquid portion of unclotted blood). Unclotted blood is used as is for tests such as complete blood counts (CBC's), and certain blood parasite tests, or centrifuged for harvesting of plasma, WBC's, and RBC's.

To submit **unclotted blood** to a lab (ie Idexx) for **CBC's**: collect in glass or plastic lavender top (EDTA) tubes, do not centrifuge, refrigerate as is, and ship within 1 – 3 days on a cold pack.

To submit **unclotted blood** for **Bartonella testing**: collect in plastic (not glass) lavender top tubes, do not centrifuge, freeze, and ship in batches frozen on dry ice.

To harvest **plasma** from **unclotted** blood in lavender or green top (heparin) tubes: centrifuge the blood at 2000 – 2500 RPM for 10 – 15 minutes, then pipette plasma into plastic cryotubes (0.5 – 1 ml per tube)

To harvest **WBC's** and / or **RBC's** from **unclotted blood**: follow the specific protocol of the project for whom the cells are being harvested.

The blood in a red top or tiger top (mottled red and gray top) tube forms a clot with clear or red-tinged serum around it. Clotted blood is used for harvesting of serum and clots.

To harvest **serum** (to submit to Idexx, or for serosurveys) **and clots** (for DNA) from **clotted blood** – Red top or tiger top tubes should be spun in a centrifuge at 2000 – 2500 RPM for 10 – 15 minutes. The serum is then pipetted into plastic cryotubes (0.5 – 1 ml per tube) unless specific protocols dictate otherwise. It can then be kept cold and submitted for testing or frozen for archiving. A portion of the clot may also be placed in a cryotube and submitted for DNA analysis or frozen for archiving. Island managers should consider archiving blood clots from any animal that is bled but has not previously had clot material or white blood cells archived for DNA.

All storage tubes should be labeled with the same information as the original tubes, plus a symbol for the component that is in the tube (ie “S” for serum, “P” for plasma, “Clot” for clot, etc). If possible, the fox ID, component symbol (“S”, “P”, etc.), and island initials should be written on the top of the vial as well.

Frozen samples for archiving may be initially kept in standard freezers, but long term storage should be at -60 to -80 degrees C if possible.

Most island fox samples are currently being archived in -80 freezers maintained by IWS in Arcata.

When shipping frozen samples they should be shipped in regular Styrofoam shippers on dry ice (do not put tubes directly against the dry ice – they will crack.) Insulated bags such as lunch carriers shipped inside a cardboard box do not provide enough insulation to keep samples frozen overnight even on dry ice, so should not be used for this purpose.

Samples should be shipped by overnight courier and recipients alerted to their expected arrival.

Appendix D
CHANNEL ISLAND FOX SUBMISSION FORM

SUBMITTING ORGANIZATION: _____

CONTACT PERSON: _____

ADDRESS: _____

PHONE NUMBER: _____ EMAIL: _____

ANIMAL ID: _____ ISLAND OF ORIGIN: _____

STUD BOOK : _____ SEX: _____ AGE: _____

DATE OF BIOPSY: _____ DATE OF DEATH: _____

SPONTANEOUS DEATH OR EUTHANASIA? _____ CARCASS FROZEN? _____

HISTORY (briefly summarize on a separate page the clinical signs, circumstances of death, include information on site where found, presence of predators, etc) **If possible, send this information to me electronically lmunson@ucdavis.edu**

SHIPPING INFORMATION: Carcasses should be shipped **ONLY** by overnight courier on Monday through Thursday. **CALL BEFORE SHIPPING** so arrangements can be made to receive the carcass. If a carcass can be shipped within 48 hrs of death, place in two plastic bags to prevent leakage and pack with ice packs. If > 48 hrs, then freeze carcass and ship frozen on dry ice or with ice packs on the next Monday-Wednesday. Shipping Address:

Dr. Linda Munson
Anatomic Pathology Service
University of California, Veterinary Medical Teaching Hospital
1346 VM3A, 1 Garrod Dr., Davis, CA 95616
530-752-5274 (Munson work cell); 530-219-9468 (Munson personal cell);
530-752-1368 (Pathology Service); 530-792-5172 (Munson digital pager);
530-757-1368 (Munson home); Fax: 530-752-3349; lmunson@ucdavis.edu

CHANNEL ISLAND FOX BIOPSY SUBMISSION FORM

SUBMITTING ORGANIZATION: _____

CONTACT PERSON: _____

ADDRESS: _____

PHONE NUMBER: _____ EMAIL: _____

ANIMAL ID: _____ ISLAND OF ORIGIN: _____

STUD BOOK : _____ SEX: _____ AGE: _____ WEIGHT: _____

HISTORY: (briefly summarize clinical signs, circumstances of death, include information on site where found, presence of predators, etc):

Please call before shipping a biopsy (530-219-9468 or 530-752-5274). Shipping address:

Dr. Linda Munson
University of California
Dept. VM-PMI, 4212 VM3A
1 Shields Ave, Davis, CA 95616
530-752-5274 (Munson work cell); 530-219-9468 (Munson personal cell);
530-752-1368 (Pathology Service); 530-792-5172 (Munson digital pager);
530-757-1368 (Munson home); Fax: 530-752-3349; lmunson@ucdavis.edu

Appendix E:

EPIDEMIC RESPONSE PLANNING AND RECOMMENDED RESPONSE TO A CLUSTER OF MORTALITIES OR SERIOUSLY ILL FOXES

- Collect and ship dead foxes for immediate necropsy.
- If symptoms of serious illness are observed in one or more foxes, then do not release the fox, quarantine with strict infection control and consult with the Fox Health Group.
- Increase monitoring while awaiting diagnostic results and consultation. Monitoring would include
 - 1) Checking for mortality signals every 1-2 days
 - 2) Conducting walks-in to assess physical appearance of radio-collared foxes to check for signs of infectious disease. Signs include: a) vomiting and/or diarrhea, b) circling, convulsions, twitching, staggering, or stupor
 - 3) Spot-light at night to observe condition of non-radio-collared foxes and get a sense of fox numbers
- If trapping is in progress, vigorous precautions should be taken to not spread a contagious agent from fox to fox via trapping or exams and to reduce risk to people. These steps should include changing or disinfecting traps and clothing between foxes.
- If a cluster of mortalities is observed in one geographic area only, consultation with the Fox Health Expertise Group should be sought as to whether foxes from an unaffected geographic area should be brought into temporary captivity as a precaution, or whether trapping for vaccination should be instituted. This consideration would be influenced by the initial pathology results, symptoms, or other findings. Any foxes brought into captivity would have to be housed in strict isolation from wild foxes and from each other, and strict disinfection protocols would need to be followed by technicians.

Recommended components of an epidemic response plan:

- An incident command structure.
- Contact information for public health authorities (in the case of rabies) and the Fox Health Group.
- For guidance in personnel assignments, documentation of which personnel are rabies-vaccinated and trained in infection-control procedures.
- Provision for careful removal of all fox carcasses that are observed in the environment (to reduce spread of the disease via scavenging), with submission for diagnostic testing. If rabies is confirmed as the disease agent, this task should only be performed by vaccinated individuals.
- Provision for euthanasia of sick foxes (without damaging the brain). If rabies is confirmed as the disease agent, this task should only be performed by vaccinated individuals.
- Methods for tracking of the outbreak (locations and numbers of dead or ill foxes).
- Planning for methods of dealing with aggressive foxes (in the case of rabies) – this could dictate provision for firearm usage under certain circumstances.

- Capture and vaccination – because of concern about disease transfer on equipment or personnel, human health risks, and availability of enough personnel, capture and vaccination may or may not be advisable (especially to in the case of rabies).
- Distribution of oral vaccine in baits may be an option in the future, but they are not currently available in California.
- Confinement and quarantine of apparently healthy animals in a “safe haven”. Because of concerns with the practical aspects of maintaining isolation to avoid introduction of disease to confined animals, this response to an epidemic is probably not advisable. However, individual situations could dictate this course of action – any decisions should be made only after consultation with the Fox Health Group.

Additional Notes:

- The CDC advises that individuals who work with wildlife should be vaccinated against rabies, and should have their rabies antibody titers checked every 2 years. We recommend that managers urge personnel who routinely handle foxes to be vaccinated, and/or require previous vaccination when hiring.

Appendix F:
CHANNEL ISLAND FOX QUARANTINE PROTOCOL

1. Preshipment screening (performed on site and evaluated prior to shipment)
 - a. Physical exam
 - b. Fecal parasite exam
 - c. CBC, hemoparasite exam, and serum biochemical profile
 - d. Ectoparasite exam
 - e. Serum and tissue banking for future testing.
 - f. Serological testing for canine distemper, canine adenovirus, parvovirus, and leptospirosis.
 - g. Permanent identification (microchip recommended)

These results should be reviewed by project veterinarians and agreement on interpretation reached before animals are moved.

2. Preshipment treatment with anthelmintic (regardless of fecal parasite exam finding) and ectoparasite treatment to reduce the chance of transporting endo- and ectoparasites to quarantine facility. Foxes should also start on prophylaxis for canine dirofilariasis (heartworm) before leaving Channel Islands. Injectable doramectin has shown efficacy against *Spirocerca*, which has been identified as a concern in CIF.
3. Preshipment vaccinations for canine distemper (using only the vectored subunit vaccine), rabies (killed virus vaccine) are recommended. Vaccination for canine parvovirus and canine adenovirus would be beneficial once safety of the vaccine is established.
4. Animal shipment. Foxes must be shipped in secure crates, in compliance with IATA transport regulations, and with no association with other animals. Contact with humans should also be minimized. Double crating should be considered as an effective method to prevent contact with other animals.
5. Quarantine facility. The facility receiving CFI should be capable of providing isolation quarantine for the foxes. This could consist of indoor holding (no exposure to feral animals or wildlife), concrete floor pens (no environmental parasite or bacteria exposure), and personnel dedicated to the quarantine facility (to prevent exposure to other canids in the collection). All enclosures should be disinfected (quaternary ammonia compound) before, during (at least weekly) and after the quarantine period. Quarantine staff should be dedicated solely to quarantine. Utensils, equipment, cage furnishings and any object in contact with quarantine animals must remain in the quarantine facility. Disinfectant footbaths should be in place at access doorways. No non-quarantine personnel should be allowed in to the facility.
6. Any fox that dies during quarantine should receive a complete postmortem examination including histopathology. Any foxes quarantined in the same facility should remain in quarantine until all test results are evaluated and project veterinarians agree that no further testing or precautions are necessary.

7. Quarantine period should be AT LEAST 60 days combined between island and mainland sites.
8. Quarantine examination should include repeating all the preshipment test parameters listed above. In addition, radiographs should be taken to document any abnormalities. Quarantine examination may be done any time after the fox enters the quarantine facility. In most cases, it is advisable to allow recently shipped animals several days to acclimate before anesthesia for exam. Exams should be scheduled so that any abnormalities can be addressed efficiently without excessively prolonging the isolation period.
9. Fecal parasite exams should be repeated multiple times in quarantine. All animals should have 3 negative sugar flotations, 3 negative zinc flotations, 3 negative Baermann tests, 3 negative sedimentation tests, and 3 negative direct fecal smears. Repeated tests should be at 1 week (minimum) intervals.
10. At the conclusion of the quarantine period, laboratory results should be reviewed by a designated veterinarian who is qualified to interpret the results. As with the preshipment testing, the significance of the test results should be determined before the results are obtained. That is, specific test results which will prevent shipping or release from quarantine should be stated and agreed upon before any testing begins.
 - a. Fecal parasite exam – As stated above, fecal parasite exams should be negative at preshipment and during quarantine. Animals with persistent enteric parasites should remain in quarantine and continue anthelmintic treatments until clear.
 - b. Ectoparasites – Foxes should be free of ectoparasites
 - c. CBC and serum biochemical profile – Should be considered within accepted canine ranges. Abnormal results may indicate repeating the testing, or may indicate a specific treatment. Results suggesting significant health compromise (ie, elevated renal or hepatic function tests) should preclude shipment of the fox.
 - d. Serology – CDV. Foxes should have a titer measured two weeks after vaccination. If subsequent titers (in quarantine) are higher, this may indicate active infection. If titer results are questionable, they should be repeated.
 - e. Serology – Canine adenovirus. Existence of a titer would indicate exposure if animals are not vaccinated. Either negative or stable positive titers are acceptable (ie, not a rising titer) in the absence of clinical disease. As this disease has been identified as a potential threat with significant mortality in mainland grey foxes, research into the safety and efficacy of the modified-live virus vaccine for domestic dogs should be pursued.
 - f. Serology – Canine parvovirus. Existence of a titer would indicate exposure if animals are not vaccinated. Either negative or stable titers are acceptable (ie, not a rising titer) in the absence of clinical disease. This disease does not appear to be a threat to CIF on the islands (i.e. seropositive animals have been detected with no documented clinical disease and no confirmed deaths due to CPV), yet exposure risks on the mainland would be different.

- g. Serology – Leptospirosis. Serological presence of *Leptospira* serovars should not prevent foxes from leaving Channel Islands. However, evidence of exposure to novel serovars (not documented on Channel Islands) may prevent return of animals, as they may be chronic shedders.

Serology – *Toxoplasma*. Serological evidence of exposure to *Toxoplasma* should not affect movement off or back to the Channel Islands, as *Toxoplasma* is present on the islands and foxes are dead-end hosts. Testing for *Toxoplasma* is for documentation purposes.