Population Status and Golden Eagle Removal Efforts on Santa Cruz and Santa Rosa Islands 2005-2006

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Submitted to

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INTRODUCTION

The island fox (*Urocyon littoralis*) is the smallest North American canid and one of the most geographically restricted canid species, being found on only six of the eight California Channel Islands (Coonan 2001). During the 1990s, fox populations declined precipitously on 4 of the 6 islands. On Santa Catalina Island, one of the southern Channel Islands, a 90-95% decline in the fox population (*U. l. catalinae*) was attributed to an outbreak of canine distemper virus (Timm et al. 2000). Fox densities on Santa Cruz (*U. l. santacruzae*) and San Miguel islands (*U. l. littoralis*) declined from an estimated mean of 7.1 foxes/km^2 (~1300 and 350 adults, respectively) in 1993 to 0.8 foxes/km^2 (~130 and 15 adults, respectively) in 1998 (Roemer et al. 2001). Although regular surveys were not conducted for the foxes on Santa Rosa Island (*U. l. santarosae*), trapping data from 1998 and 2000, as well as anecdotal evidence, indicated that the fox densities had declined on that island as well (Suckling and Garcelon 2000).

Evidence from fox carcasses recovered on Santa Cruz Island indicated that golden eagles (*Aquila chrysaetos*) were the primary cause of fox mortality on the northern Channel Islands (Roemer et al. 2001). The decline in island fox populations occurred concurrently with an increase in golden eagle sightings on the northern Channel Islands. Breeding by golden eagles on the northern Channel Islands, which represented the first breeding record of this species on the islands, was confirmed in 1999 (Roemer et al. 2001).

Because of the threat posed by golden eagles to island fox populations, The Nature Conservancy and the National Park Service, the two land management organizations responsible for the island fox on the northern Channel Islands, desired immediate and intensive actions to ensure that fox survival in the wild was brought to a level sufficient for population recovery. Starting in 1999, a sustained effort to live-capture golden eagles and remove them from Santa Cruz and Santa Rosa Islands resulted in a substantial reduction of the golden eagle population (Latta et al. 2005). Between 1999 and 2004 a total of 29 free-flying and 8 nestling eagles were trapped and removed from the island by the University of California Santa Cruz Predatory Bird Research Group (SCPBRG) (Latta 2005). Those efforts primarily used traditional means of capturing the birds (e.g., baited and remotely triggered bow nets). Despite the considerable successes of the program, a number of golden eagles remained on the islands and subjected the wild fox population to unacceptable predation risk.

When the SCPBRG ended their field season in June 2004, they had removed 36 (80%) of the 45 golden eagles estimated to be on Santa Cruz Island since 1999. The nine eagles thought to be remaining on the island as of June 2004 included six adults (Coche Point female [not sighted since October 2003]), the Cascada/Cañada del Puerto female, the Laguna female, the Lady's Harbor male, and the Christy Water Tank pair) and three subadults (No Man's Land Subadult II, the Portezuela Subadult II, and a Subadult I).

There have been only two known pairs of golden eagles on Santa Rosa Island: Trap Canyon and Trancion. When SCPBRG ended the 2004 field season it appeared that only the Trap Canyon pair remained on the island. The Trap Canyon male was captured in 2003 and an eaglet removed from the nest. In 2004, the Trap Canyon female had a new mate and the Trancion pair had vanished. SCPBRG surmised that the 2003 Trancion male had become the 2004 Trap Canyon male and the Trancion female either had departed the island or was being very secretive, as she was not seen in 2004.

Because the success of island fox recovery depends upon effective removal of golden eagles, the U.S. Fish and Wildlife Service's Island Fox Recovery Coordination Group produced

Task Analysis 4.1, a document that evaluated removal efforts to date and recommended methods and strategies to be used in 2005 (Garcelon et al. 2005). It was determined that the remaining eagles may be less susceptible to capture by traditional means for a variety of reasons, including having observed other eagles being captured. The document suggested that traditional approaches be augmented with novel and more intensive means of eagle capture. This type of experimentation is critical to prevent further delay in the recovery of the island fox. In 2005, the Institute for Wildlife Studies (IWS) was contracted by The Nature Conservancy (TNC) and the National Park Service (NPS) to develop some new approaches to golden eagle capture, as well as implement traditional capture techniques, when appropriate. This mandate was extended through the 2006 season.

The 2005-2006 golden eagle capture effort focused on 1) understanding the current distribution and breeding status of golden eagles on the islands, 2) development and use of methods to increase capture success, and 3) strategic deployment of effort and allocation of resources. This report summarizes our efforts during the 2005 and 2006 seasons.

METHODS

Survey Techniques

We used both ground-based and aerial surveys to locate golden eagles. Aerial surveys were used primarily to assist in locating potential nesting pairs in areas of the island too remote to be efficiently surveyed from the ground. We used a Bell 206 Jet Ranger or Long Ranger helicopter, which allowed observers to make relatively slow passes along the cliffs and within the canyons on the islands. Use of a helicopter also made it possible to make repeated passes along a section of the island if additional observation was necessary.

Ground-based surveys were conducted primarily by positioning personnel at high points with large vistas to detect flying eagles. Priority was given to conducting observations in locations where golden eagles have previously been know to occur or where sightings of golden eagles had been made since the last survey/trapping effort. Field personnel were equipped with binoculars and spotting scopes and communicated with UHF handheld radios to assist in following the flight track of eagles that were detected.

Golden eagles were aged according to guidelines described by Liguori (2004). The same eagle seen by two or more observers during the same day, regardless of observer location or the number of observations, was counted as only one eagle in 2005. In 2006, we recorded all observations of golden eagles as individual sightings. We recorded general information on location, age, and unique plumage characteristics to better determine the number of individuals present on the islands. We recorded bald eagle sightings on IWS bald eagle data sheets, maps, and/or in a GIS database. A bald and golden eagle identification poster was created, laminated, and posted in key locations on Santa Cruz and Santa Rosa Islands to assist in collecting information on eagle sightings from non-project personnel.

Nest Monitoring

When nests were located, observations were made either from a blind or from a distance where the presence of field personnel did not elicit a response from the adult eagles. Nest sites and eagle activity around the nests were observed using spotting scopes and binoculars.

Observations of the nests had two purposes: 1) to learn as much as possible about the behavior of the adult birds for locating possible trap sites, and 2) to determine the breeding stage in order to plan for implementation of different trapping methods.

Trapping Techniques

We used a variety of traditional and new techniques in our attempts to capture the remaining golden eagles on the islands.

Figure 1. Bownet trap set with a feral pig (*Sus scrofa*) hindquarters as bait.

Radio-Controlled Bow Net. – The radio-controlled bow net has been the most effective golden eagle capture technique used on the northern Channel Islands. The bow net used on this project was specifically designed for the capture of large eagles (Jackman et al. 1994). The trap was buried in the ground and camouflaged with dirt, sand and/or vegetation (Fig. 1). When properly set, only the bait is visible. The trap can be baited with carrion or live bait. We primarily used feral pig carcasses in trap sets, but occasionally used live piglets and other prey as allowed by our permits. Traps were monitored from a blind within sight of the trap, usually 200-1500 m away. When a target bird lands on the bait, the net is set off with a remote control and a large net is carried up and over the bird by the bow within about 0.5 sec. (Jackman et al. 1994).

Dho-gaza Net.– The Dho-gaza net we used consisted of one or two panels of a large (3m x 10m) breakaway net suspended between two poles by clothespins clipped onto tape tabs at the ends of the net (Bloom 1987). When a bird hits the net, the tabs are released and the net envelops the eagle. The lightweight net is nearly invisible if placed in front of a dark background, such as vegetation or rock (Fig. 2). We used live bait or

Figure 2. Dho gaza trap (two nets) with a golden eagle used as a lure bird. One net is in the foreground and one in the background.

a disabled golden eagle to attract target eagles to the trap. The bait was centered behind the net when using a single-panel trap. When using two nets, they were placed in a "V" formation and the bait was placed near the intersection of the two nets. The object is to place the net and bait so that the target golden eagle stoops on the bait and hits the net. Nets were observed from nearby blinds so that we could reach the nets quickly once a bird was captured so that it could be immobilized before it became too entangled in the net.

Net Launcher. – The Net Launcher, as described by Latta 2005, was developed by B. Woodbridge (U.S. Fish and Wildlife Service). It uses two handheld .22 caliber dummy launchers, originally designed for training hunting dogs, to propel a 6m x 3m net over a bait site. The launchers were mounted on a frame and aimed so the projectiles would be pass safely over the target area and pull the net over the bird(s). The area can be baited with either carrion or live bait.

Noose Gin. – We made a noose gin as a method to trap adults at the nest, This trap was first shown to IWS biologist Blake Massey by Travis Booms (University of Alaska), who used this technique to trap at gyrfalcon nests. The noose gin was composed of a piece of large gauge electric wire (~2-3 m long) to which we tied monofilament nooses described by Jenkins (1979). The nooses were tied and taped to the electrical wire at approximately 20 cm intervals. One end of the electrical wire was attached to a system of weights that were laid near the nest and then camoflauged. The weight system consisted of a series of 225-500 g fishing weights (2.25-3.5 kg total) that were attached to a 4 m length of parachute cord at approximately 1 m intervals. A length of bungy cord, which when stretched was about 1 m in length, was run along the parachute cord and tied to each of the first 2-3 weights. The bungy cord dampened the pull of the weights on the bird and also caused the weights to bounce to make flying difficult. The noose gin was placed along the leading edge of the nest in 2-3 layers with the electrical wire camoflauged and the nooses sticking up. This trap was used while an eaglet was in the nest, so the nestling was fitted with short leather jesses around one of its legs and tied to the backside of the nest so as not to interfere with the nooses and to encourage the adults to walk across the nest.

Injecto-Egg. – We developed a new technique to capture adult eagles during incubation. Called the "Injecto-egg", this device is a remote-controlled anesthetic injection system that would anesthetize the eagle if triggered while they were in incubation posture. We drilled a hole approximately 1 cm in diameter 95% of the way through an artificial golden eagle egg (Bone Clones, Canoga Park, CA) so that the egg would fit over piece of metal pipe. A smaller hole was drilled through the remainder of the egg to allow the tip of a commercially available 1 cc anesthetic dart (Telinject, Agua Dulce, CA) to emerge from the egg without the entire dart escaping. This dart was placed in the pipe, which was connected by tubing to a remote-controlled triggering device that released gas from a small CO_2 canister. Once a bird sat on the fake egg, the system could be triggered so that the bird would be injected by anesthetics and could then be removed from the nest while unconscious. All of the components except the artificial egg, the pipe in the base of the egg holding the dart, and the tube going from the CO_2 source to the dart tube were contained in a small waterproof box that could be buried within the material of the nest.

We used a combination of two anesthetics: medetomidine hydrochloride and ketamine hydrochloride. The ketamine is "potentiated" by the medetomidine, allowing a smaller dose to

to be effective. The medetomidine acts quickly and the ketamine helps extend the overall period of anesthesia. Another advantage of this combination is that the effect of the medetomidine can be "reversed" with the injection of the antagonist atipamezole (Antisedan). By using a highly concentrated form of ketamine (200 mg/ml), a small volume of the drug combination can be used to anesthetize a golden eagle (~0.2 ml).

The IWS staff veterinarian was on site when the drugs were used to decrease the probability of problems associated with anesthesia recovery in any eagles captured. The veterinarian had a portable oxygen tank and a variety of pharmaceuticals at the capture site staging area to facilitate care of any eagles captured using the anesthetic technique.

To minimize the time at the nest and decrease the probability of abandonment of the eggs by the nest disturbance, we slung a biologist under a Eurocopter AS350 helicopter to deploy the Injecto-egg, which was placed into the nest while the helicopter hovered. We also stationed two climbers from Eco-Ascension Research and Consulting (ERC, Arcata, CA) in a location out of view and above the nest site to allow for quick recovery of the eagles once they were anesthetized.

Nest Net Launcher.– We created a remote-controlled nest net launcher that could be placed above a nest and launched out and over the nest opening when an adult arrived (Fig. 3). The launcher was built from several lengths of PVC pipe and was approximately 2.5 m long. Each end of the launcher had a 2.5 cm diameter piece of PVC (~30 cm long) attached at a right angle to the main length of pipe. These ends could be moved to modify the angle at which the net was launched. Springs were place within these barrels to launch weights (10 cm lengths of steel pipe) attached to a mist net. A single piece of parachute cord ran through the PVC pipe and springs and was tied to a washer slightly larger than the diameter of the springs. To set the trap, the springs were compressed by pushing in the weights and the center of the parachute cord was attached to the trigger mechanism (same as used for the bownet), which was placed on an arm above the center of the trap (Fig. 3). The net was a 5-m long by 2.5 m wide section of mist net with 10 cm mesh. The net was stored in a trough made of 5 cm diameter PVC that was attached to the trap between the barrels. We lined the trough with plastic sheeting so that the net could not catch on anything and had a flap of plastic over the net so that the

Figure 3. Net launcher in place over a golden eagle nest on Santa Cruz Island, California, 2006.

wind would not blow it out of the trough. The front end of the net was tied to the launch weights and the other end was tied to the trough. Once set, the net could be launched using a remote-controlled trigger box (same as for the bownet) from a blind.

Snares.– We also attempted to trap golden eagles with a variety of passive and power snares (Jackman et al. 1994). The passive snares were used with dead domestic rabbits and the power snare with a dead island fox. The nooses for both types of snares were made from 30 lb monofilament line. Two to four nooses were run through the body of the bait and hidden in the fur. A 2-5 m length of monofilament was tied to the nooses underneath the bait and run to the weight system used for the nest nooses (see above) in the case of the passive snare, or to a length of bungy cord for the power snare. For the power snare, one end of the bungy cord was attached to a stationary object, stretched, and the other end was attached to a remote-controlled trigger box (same as used for the bownet), which itself was attached to a stationary object close to the snare. When the release was triggered, the bungy cord would pull the nooses tight around the foot of the eagle. For the passive snare, ifn an eagle flew with the prey item, the weight system would pull the nooses tight and ground the bird.

Eagle Capture and Transport

Free-flying eagles that were captured were transported off the island in large airline pet carriers and driven to Goose Lake in northeastern California for release. Eaglets removed from nests were taken off the island in pet carriers and then fostered into wild golden eagle nests or maintained in and released from a hacking tower in San Diego County by the Wildlife Research Institute. Eggs removed from nests were transported in a portable incubator to the IWS incubation facility on Santa Catalina Island for incubation and hatching.

RESULTS

2005 Season

Rainstorms and the subsequent poor road conditions caused delays in fieldwork on both Santa Cruz and Santa Rosa islands during January through March 2005. In addition, delays in obtaining approvals for various permits necessary to conduct the trapping activities resulted in capture activities being delayed.

During January through May 2005 we logged 460 person-days on Santa Cruz Island and 273 person-days on Santa Rosa Island while conducting all activities associated with the project (Appendix A). For both islands, the largest portion of time was spent scouting for and observing golden eagles, followed by time for transportation and logistics.

Santa Cruz Island

We spent 173 person-days surveying the island from the ground and in two helicopter surveys. We logged a total of 89 daily observations of individual golden eagles representing six individuals: the Christy Water Tank adult pair, a Subadult I and Subadult II observed mostly on the North Slope and near Valley Peak, the No Man's Land Subadult II, and the Laguna adult female. The latter two eagles were not seen after February. We did not see the Lady's Harbor

adult male, the Cascada/Cañada del Puerto adult female, or the Coche Point adult female in 2005, all birds that were believed to be remaining in June 2004. These eagles may have left the island prior to the onset of the 2005 breeding season. However, the Coche Point female had not been seen since October 2003, so she may have left the island prior to the 2004 breeding season.

Christy Water Tank - The Christy Water Tank pair were the only known adult pair on Santa Cruz Island in 2005. The pair frequented the western portion of Laguna Canyon, Sauces Canyon, and Pozo Canyon. The female laid two eggs (the first known nesting attempt by this pair) on 27 February, in a nest on the Christy Water Tank cliff that the pair had been building since 2003. The nest began behind a bush on the cliff in April 2003 and was about three feet tall in January 2005. We trapped 20 days for this pair before and during incubation, in Lagunitas Seca, Laguna Canyon, near Christy Pines, and above the Christy Water Tank, but they showed no interest in our sets. Traps used included radio-controlled bownets and a net launcher.

Based on the 45 day gestation period for golden eagles, the eggs were scheduled to hatch around 13 April. On 11 April, we entered the nest to try the Injecto-egg (Fig. 4). The helicopter left the Christy airstrip at 1220 hours. The Christy Water Tank female was on the nest and the male was not in the area. At 1226 hours the female left the nest and flew east, perching below Peak 1848. We arrived at the nest at 1230 hours and began installing the Injecto-egg. At 1233 hours the female left her perch, circled below Peak 1848, and then flew towards Sierra Blanca at 1239 hours. The helicopter left the nest at 1240 hours and returned to the Christy airstrip. At 1258 hours, the male returned to the nest from the west. The male rolled the egg with his beak (normal behavior during incubation exchanges) and began incubating at 1304 hours. We fired the Injecto-egg at 1305 hours. The male jumped up, moved to the east wall of the nest cave, and resumed incubation posture at 1309 hours. The injection egg was fired again at 1315 hours, and the male jumped up again. At this point, we knew the male had not been injected or the anesthetic was not working. At 1326 hours the injection egg was fired again and the male jumped up again.

Figure 4. An IWS placing the Injecto-egg in a golden eagle nest on Santa Cruz Island, California 2005.

Sometime after 1315, the female returned to the area and perched in a snag above the nest cliff. At around 1345 hours, the female flew around the nest cliff for 4-5 minutes, eventually perching in the oaks on Alta 2.

Because the male was obviously not drugged we considered our options. It was believed that the male had knocked over the egg because there was insufficient nest material to bury the base holding the egg upright. Options included 1) resetting the injection egg via helicopter, 2)

sending the climbers, who had been stationed on the North Slope the previous evening, down to reset the injection egg, or 3) returning the two eggs to the nest. Option 3 was rejected because this would have postponed capture attempts for three weeks while the young reached thermoregulatory age and postponed pig eradication efforts near the nest during that time. Option 1 was rejected because the nest was too difficult to enter via helicopter.

We decided to send the climbers in to reset the egg. First, we created a block of foam padding that could be used to stabilize the injection tube to prevent the eagles from knocking the apparatus over while rolling the egg. .The helicopter left the Christy airstrip at 1415 hours to drop the foam block and a new injection dart to the climbers. At 1435 hours the climbers began rappelling down the cliff to the nest, flushing the male at 1437 hours. The Injecto-egg was reset at 1440 with the stabilizing block and a new dart. At 1456 hours the climbers were back at the top of the ridge, and reported that during the previous set the male had indeed knocked over the apparatus while rolling the egg and when the trap was triggered the egg was shot to the side of the nest cave, bending the needle and lodging the dart through the egg.

The female returned to the nest at 1506 hours. At 1533 hours the injection egg was fired three times, without any reaction from the female. It was decided to check the female via helicopter, and drop a dummy egg to the climbers, who would then rappel to the nest, remove the injection egg for improvements, and place the dummy egg in the nest. At 1611 hours the female flushed from the nest. The dummy egg was dropped to the climbers and the helicopter proceeded to the East End airstrip, landing at 1621 hours. The eagles did not return to the nest after the female was flushed at 1611 hours. The pair moved into Laguna Canyon, and also frequented the Sauces and Pozo Canyon areas, but they were not observed in the Christy Water Tank vicinity after the nest entry.

After dropping the dummy egg to the climbers the helicopter continued on to the East End airstrip with the IWS veterinarian and the two eagle eggs in an incubator. At 1630 hours Channel Islands Aviation landed at the East End airstrip and transported the veterinarian and the eagle eggs to the mainland. The eggs were transported to the IWS incubation facility on Santa Catalina Island on 12 April. Examination of the two eggs was conducted by Peter Sharpe (IWS). One egg was not pigmented and showed no signs of development. The normally pigmented egg (cream colored with brown splotches) contained a nearly fully developed embryo that probably died within a few days of hatching. The transport of this egg may have contributed to the death of this eaglet.

Subadults – We observed three subadult golden eagles on Santa Cruz Island in 2005, the No Man's Land Subadult II, and a Subadult I and Subadult II that frequented the North Slope and Valley Peak. We trapped 21 days for the subadults without success. Trap sites included Lagunitas Seca, Valley Peak, Eagle Canyon, and the south hack tower. Bald eagles frequented our carrion sets, and we captured bald eagle A-02 on a day when the Lagunitas Seca set was completely fogged in. This eagle had a transmitter strap hanging loose, so we captured it for transmitter replacement.

Santa Rosa Island

We spent 124 person-days scouting the island and logged a total of 103 daily observations of individual golden eagles (Table 1). However, this represented only 6 individual eagles: the Trap Canyon adult pair, two 2004 juveniles, and two 2005 eaglets.

Subadults. – We observed a 2004 juvenile female on Santa Rosa Island in January 2005, which appeared to be associated with the Trap Canyon adult pair. We set up a chum site for the juvenile and trapped five days, capturing her there on 5 February. The bird was transported off the island on 8 February and released at Goose Lake in northeastern California on 10 February.

We sighted a second 2004 juvenile on Santa Rosa Island on 17 March. We trapped four days for the juvenile at one chum site, then set up two additional sites and monitored the three chum sites daily, but only bald eagles visited the sites. Despite thorough coverage of the island in April and May, we did not see the juvenile, which may have left the island.

Trancion. – We have not seen either member of the Trancion pair since 2003. It is believed the 2003 Trancion male became the 2004 Trap Canyon male, and the female may have left the island prior to the 2004 breeding season.

Trap Canyon. – We observed the Trap Canyon pair copulating and reconstructing nest number 5 to the south of the four nests on the main cliff on 26 February. The female laid two eggs in the nest on 27-28 February and based on the 45 day gestation period for golden eagles the eggs were scheduled to hatch around 13-14 April.

The Trap Canyon pair hatched two young on 14-15 April. We began trapping for the Trap Canyon pair on 6 May, when the young were 3.5 weeks old, and captured the adult male in the bownet on 7 May. During the two days of trapping, both adults foraged most of the day, yet only brought a single small bird to the nest on the morning of 6 May. It appeared the pair was having difficulty locating prey. When we captured the male on 7 May, he had a full crop and smelled of skunk, so he had apparently captured and eaten a skunk, without taking any food to the nest. This is not normal behavior for eagles with young in the nest.

Following the male's capture, the female began behaving abnormally and rarely visited the nest. The female did not appear to be sleeping in the nest, so we initially climbed to the nest at night and fed the young to prevent her from seeing us. The female brought in a newborn duckling on 11 May, but did not feed the young and left after a minute or two. On 13 May, the nest smelled of skunk, and some sticks had been rearranged. Since we had not seen her entering the nest during daylight hours, we assumed she came in just before dark when the nest was not visible from our blind. The young did not appear to have been fed (sunken crops), so we fed them again. Hoping the female would continue to return to the nest at night, we began climbing to the nest to feed the young after we observed the female leave the area to forage in the morning. The first time we observed the female feed the eaglets was at 1410 hours on 15 May. She fed the young again on 16 May and remained in the nest for 15 minutes. On 17 May, she did not bring in prey, but remained in the nest from 1210-1320 hours. We became optimistic that the female would resume normal behavior; however, the female spent about 30 seconds at the nest on 18 May, and we did not see her at all during 20-22 May.

During 10-22 May, we attempted to capture the female with the dho-gaza on two days, bownets on four days, the nest net, a noose system in the nest, and a snare system in the nest. The female was extremely wary, and would land and thoroughly investigate the nest before entering. She was perched on the ground near the nest when we captured the 2005 male, so we know she did not see his capture. However, she may have seen the 2004 juvenile female captured in February, or the capture of the 2003 male. It is also possible that she saw us climbing the nest to feed the young, even though we tried to prevent this from happening. She circled over the

bownet on one occasion, but did not attack the bait. On the first dho-gaza attempt, she flew in parallel to the net and grazed the left top corner with her wingtip, but did not disengage the net.

We removed the eaglets from the nest at 1715 hours on 22 May. Even with our supplemental feeding during 10-22 May, the young seemed to be about one week behind in development. It appeared that one eaglet was a male and the other a female. The female was much larger, with more feather growth, and likely was the first to hatch. The young both ate well, were alert, and their mutes appeared healthy. The young seemed to be fine all day during transport to the mainland on 24 May, and they were asleep when we arrived in Santa Barbara that night. On the morning of 25 May, the smaller eaglet was lying down and cold. We put a heating pad under him and a lamp above him for heat. We called the IWS vet and left a message, then called Dr. Craig Himmelwright (the SCPBRG vet). Based on our description of the eaglet's condition, Dr. Himmelwright said the eaglet was likely obtunded (in shock and on a rapid decline) and needed to be kept warm and given intravenous fluids. We did not have the equipment on hand for this, so we gave the eaglet 10cc of Ringers solution subcutaneously and called a number of veterinary hospitals in the area.

We transported the eaglet to the California Animal Referral and Emergency Clinic in Santa Barbara at around 1100 hours on 25 May, where it was placed under the care of Dr. Deanna Purvis. They put the eaglet on a heating pad, started an intravenous drip, and gave it oxygen. The eaglet arrested at approximately 1230 hours, but recovered with an injection of epinephrine. By 1330 the eaglet was doing better and was alert. By 1630, the eaglet seemed to be in the clear. It was standing up and very alert. Without warning the eaglet died at around 1730 hours. Dr. Purvis could not explain the eaglet's rapid decline over night or its death when it seemed to be doing much better. Dr. Purvis believed the eaglet must have had an underlying infection that was affecting its health.

We transported both eaglets to the SCPBRG facility in Santa Cruz on 26 May. The female eaglet was examined by Dr. Craig Himmelwright at West Side Animal Clinic in Santa Cruz on the morning of 26 May and deemed healthy. The smaller eaglet was necropsied at 1500 hours by Dr. Melissa Miller, California Department of Fish and Game Board Certified Veterinarian and Wildlife Pathologist, at the CDFG Marine Wildlife Veterinary Care and Research Center at Long Marine Laboratory in Santa Cruz. The eaglet had severe hemorrhaging around the heart, possibly from the initial cardiac arrest and epinephrine injection. The only other abnormality was a stick "about the size and diameter of a pinky finger" in the eaglet's stomach. This was likely eaten by the eaglet during a period of extreme hunger. Dr. Miller also reported that the eaglet had a severe bacterial infection.

The Trap Canyon adult male was released at Goose Lake in northeastern California on the morning of 9 May. The female eaglet was fostered into a nest near Cedarville in northern California on 29 May.

By the end of the 2005 field season, it appeared that the adult female from the Trap Canyon territory was the only golden eagle remaining on Santa Rosa Island.

2006 Season

TNC and the NPS decided to create a different model of eagle management on the islands starting in 2006, one that recognizes the difficulty of capturing the remaining birds, takes into account the considerable expense of conducting intensive monitoring and trapping effort at a landscape scale, and recognizes the many additional priorities that exist for limited island

restoration funding. The apparent reduction in golden eagle numbers on the islands, reduced predation of foxes on the islands, an upward trajectory of wild foxes on the islands, and the near island-wide control of the pig population on Santa Cruz supported the premise that the development of this different model would be adequate and more sustainable over the longer-term, should it be so necessary.

This new model called for a smaller golden eagle crew with a focus on rapid location of birds, identification/assessment of individuals (if they are known or new/naïve birds; age class; paired status; breeding status), and location and evaluation of nests (aging of eggs/young, assessment of nest-capture potential). In general, trapping would only be attempted if naïve birds were located or feeding activity was observed that suggested traditional trapping methods (e.g., bownets) had the potential for trapping the birds. Additionally, if nest conditions were suitable, traditional and/or innovative trapping strategies may used in attempts to capture the birds, including bringing additional specialists on to conduct the required work.

Under this new model, the 2006 field crew consisted of three full-time surveyors, who began survey efforts on 17 January on Santa Cruz Island. They worked an 8-day on, 6-day off schedule and the original plan was to spend two shifts surveying Santa Cruz Island (where most of the remaining eagles were believed to reside), followed by one shift surveying Santa Rosa Island.

Santa Cruz Island

We spent 75.65 person-days scouting the island and logged a total of 146 observations of individual golden eagles (Appendix B). However, this is believed to have represented only 5 individual eagles: the Laguna Canyon adult pair and their two chicks, and a subadult II-III.

Although we surveyed most of the island for golden eagles, usually scanning from peaks and ridges with good views of the island, many of our surveys were conducted in areas of known historic golden eagle nests and where fox mortalities were reported (Fig. 5). We conducted a helicopter survey on 16 March to search the north slope of the island and check nests found during the 2005 survey. No eagles were seen and there was no activity at the nests.

We saw our first Santa Cruz golden eagle of the season on 19 March while surveying the north slope of the island near Mt. Diablo. The bird was in adult plumage and was seen three times during the day, first flying towards the west from near Mt. Diablo, and later flying back and forth between the north ridge and the Laguna area. We returned to the area on 20 March to relocate the golden eagle sighted the previous day. Three golden eagles (two adults and a subadult) were seen in the Alta 2 area. The two adults flew east, performed undulating flight and perched together. The subadult flew towards the Laguna area. The birds were seen several times during the day. This was the last day of the scheduled tour of duty.

Laguna Canyon. – We returned to Santa Cruz Island a week later to begin surveying again. On 30 March an adult golden eagle was seen three separate times. Each time the bird was first seen in the Laguna/Willows area and went out-of-view near Sierra Blanca. It was performing undulating flights in the Laguna Canyon and Johnston Canyon areas and looked as if it was delineating a territory.

The same golden eagle was seen several times on 31 March – 2 April, with activity spread from Willows to Alta 2 and a center of activity around the Laguna/Sierra Blanca area. It was not seen carrying any food nor approaching a nest. We began intensively searching the area

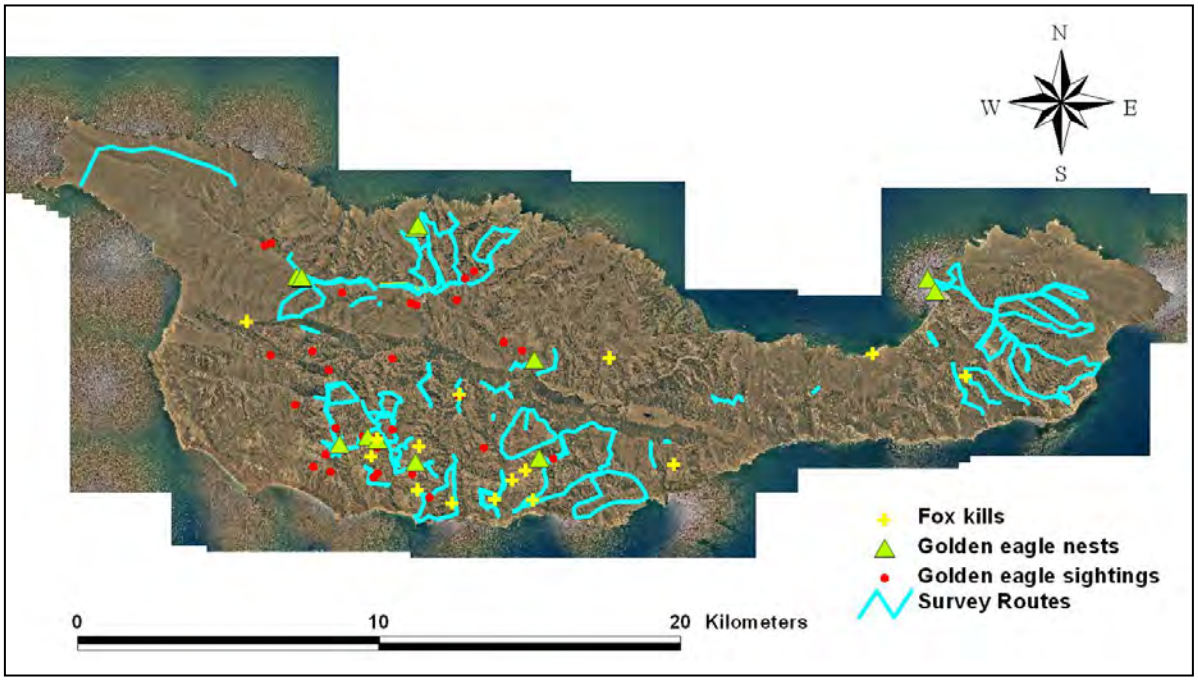

Figure 5. Golden eagle survey routes, locations of known nests and known fox kills, and golden eagle sightings on Santa Cruz Island, California, January-June 2006.

for a nest, which was finally located on 30 April. The nest was on a cliff on the west side of Laguna Canyon, approximately 2.4 km from the ocean (Fig. 6).

When the site was found, the female was lying low in the nest and it was not known whether she was incubating or had chicks. On 1-2 May we observed what appeared to be feeding of a chick, but no chick was seen. We believe that the chicks were less than a week old at this point, as we otherwise would have seen their heads pop up in the nest. Counting back 45 days (average golden eagle incubation period) from the beginning of May indicated that the sightings of what is believed to have been the Laguna pair on 20 March were made within a few days of egg-laying. We are nearly certain that two chicks were seen in the nest during the first week of nest observations, but the second chick disappeared by mid-month.

We began attempting to trap the adults on 7 May when we set up a dho-gaza net using our captive golden eagle as a lure bird. We attached the lure bird's leash to a bolt drilled into a 10-15 kg rock to act as a natural-looking anchor. We also placed a dead rabbit on the rock and occasionally played a rabbit distress call using an electronic predator caller (Lohman Invisi-Predator, Neosho, MO). We hoped that a golden eagle feeding in their territory would motivate the adults to attack our lure bird. The dho gaza set was used for four days in three different locations with no response from the adults.

Our next trapping attempts were on 30-31 May, utilizing two passive snares. The traps initially were placed on a hillside north, and out of view, of the nest. We selected this location so that the female would not see if the male was trapped. The second day, we moved the snares to a ridgeline in view of the nest. None of the sets were approached by the eagles.

Figure 6. Location of golden eagle nest in Laguna Canyon, Santa Cruz Island, California, 2006.

On 2 and 5 June we tried trapping with the gin noose. For accessing the nest, we contracted with ERC again to facilitate quick and safe entry into the nest. The gin noose was placed in the nest and the remaining eaglet was jessed to the back corner of the nest and a video camera with a video transmitter was placed in the nest (camoflauged inside a log) so that we could watch from a blind across the canyon. An adult returned to the nest, but the eaglet managed to move the gin noose, scaring off the adult. The trap was removed, modified, and placed back in the nest on 5 June, but the chick got tangled in the nooses again and we were unable to capture any birds.

On 11 and 12 June we tried trapping at the nest using a power snare. The snare used a fox carcass that placed on the ledge next to the nest (Fig. 7). We placed the video camera above the trap to be able to watch it during daylight hours. In order to be able to tell if the fox was

Figure 7. Power snare at the Laguna golden eagle nest using an island fox as bait.

moved at night, we fit the fox with a radio-collar with the magnet used to turn it off in place. The magnet was attached to a short piece of monofilament tied to a rock. If the fox was moved, the magnet would be pulled off the transmitter, which would then begin to transmit a signal on the frequency being monitored in the blind. Climbers were in place throughout the night to go into the nest to insure that a bird did not become entangled in or injured by the monofilament if the carcass was moved. We trapped with the power snare for two days with no success. At the end of the second day, we set off the trap to pull the nooses out of the fox so that we did not have to disturb the nest to remove the trap. The trap was removed on our next visit to the nest.

We returned to the nest on 21 June to place the nest net launcher (see Fig. 3). In the period since we were last at the nest, the adults had delivered at least two ravens and six foxes, four of which had radio-collars (Fig. 8). Concurrent with this trapping effort, TNC

Figure 8. A golden eagle nestling in the nest surrounded by prey items, including 6-7 island fox and two ravens, Laguna Canyon, Santa Cruz Island, California, 2006.

contracted with a net-gunner to fly in the Prohunt helicopter and attempt to capture the eagles from the air. An adult eagle arrived at the nest mid-morning and the net was launched. Unfortunately, by this time in the nesting period the adults had begun simply dropping food at the nest and leaving, usually within a few seconds of arrival. Therefore, we missed the bird with the net (which deployed perfectly over the nest), but were able to call in the helicopter and they gave chase to the bird. After about 45 minutes the helicopter had to refuel. We kept the eagles in view (both eagles had begun soaring together during the chase) from a ridge on the east side of Laguna Canyon. We lost sight of the birds on a slope near the bottom of Laguna Canyon. When the helicopter returned, we had them begin their search in the area where the birds were last seen.

Eventually we saw the birds take flight and directed the helicopter so they could again give chase. After another 30-45 minute chase, the net-gunner successfully netted the male along the main ridge road. The bird was hooded and transported directly to the Navy Site, where IWS biologists placed the bird in a large pet carrier.

We continued trapping efforts on 22 June, while the helicopter crew searched the canyons around Laguna Canyon. The second adult was netted from the helicopter mid-morning and transported to the Navy Site. We entered the nest shortly after the capture and removed the eaglet and the nest net launcher. The eaglet was transported to the Navy Site by helicopter, where all three birds were banded and the adults were fit with GPS transmitters (Fig. 9). We transported the birds to the mainland on an Island Packers boat the afternoon of 22 June. The eaglet was transported to the Wildlife Research Institute (WRI) in San Diego, where a hacking tower had been constructed to release this eaglet and another young golden eagle the WRI had acquired. The two adults were transported to northeastern California and released on 23 June. The female's transmitter stopped moving the night of 28 June near the Oregon/Nevada border and we received no more data after 4 July (Fig. 10). It is possible she dropped her transmitter at a night perch and the GPS unit landed with its solar panel pointed towards the ground. The male moved throughout northern California and southern Oregon. We did not get any data from 9 July until 13 August, at which time the bird was in southeastern Oregon. The signal moved until

Figure 9. Placing a GPS/VHF transmitter on one of the 2006 Laguna golden eagles.

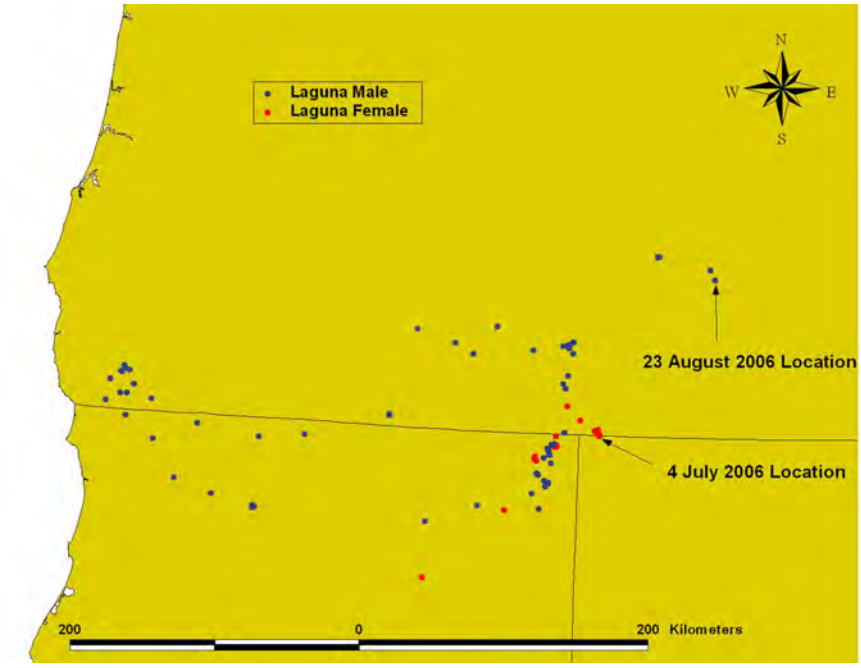

Figure 10. Locations of the Laguna adult golden eagles in northern California, 2006.

19 August, but has since been relatively stationary. This could indicate a dropped transmitter or a dead bird.

As of the August 2006, we know of only one subadult golden eagle remaining on Santa Cruz Island.

San Miguel Island

On 27 January we received a report of a possible golden eagle on San Miguel Island, followed by a report of a possible eagle-related fox mortality on 29 January. Dr. Peter Sharpe traveled to the island on 4 February and searched the island through 7 February, but had no sightings of golden eagles.

Santa Rosa Island

Surveys on Santa Rosa Island were made in areas of known fox kills, near known historic golden eagle nests, and along ridges and peaks that had good visibility of the island.We spent 54.15 person-days scouting the island and logged only three daily observations of individual golden eagles (Fig. 11, Appendix B). All sightings are believed to have been of a single subadult eagle in the Trancion area.

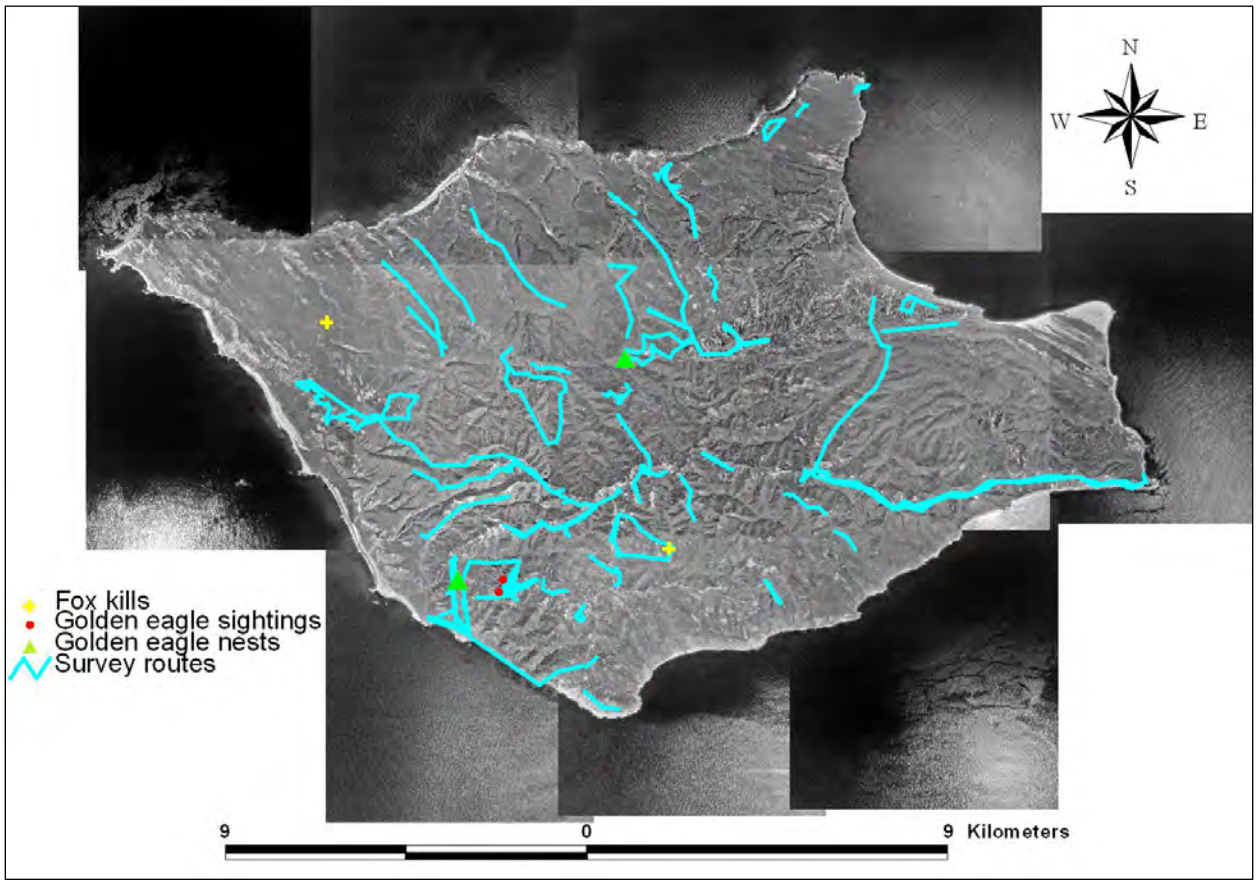

Figure 10. Golden eagle survey routes on Santa Rosa Island, California during 2006. Also shown are the locations of known golden eagle nests and known fox mortalities resulting from golden eagle predation.

The first eagle sighting was of a subadult (probably Subadult II) on 4 February. The bird was seen for about 3 sec. by N. Contreras while riding an ATV along the road near the top of Trancion Canyon. The bird had a stick in its mouth, which it dropped before disappearing into the canyon. Two dead foxes were located on 4 February and the deaths were attributed to golden eagle predation. Therefore, surveys on Santa Rosa Island were extended through 21 February with 1-3 observers in an attempt to relocate the golden eagle seen on 4 February.

An eagle was seen flying and perching in Trancion Canyon on 16 February, which was the last sighting by our crew of a golden eagle on the island this season. The bird was spotted near Grouse Point being harassed by ravens. It eventually flew down into Trancion Canyon, where it disappeared for about an hour. It was later seen flying along the contours of Trancion Canyon, evidently hunting.

On 23 March, Brian Latta reported an adult female golden eagle being chased/herded by a near adult bald eagle (2002 release) near Carrington Point. The birds disappeared to the southeast and then the bald eagle returned alone.

No activity was ever seen at previous nest sites on the island. As of the end of the 2006 season, the subadult may still be on the island, although the lack of fox mortalities suggests it left the island.

DISCUSSION

Our survey results and the lack of eagle-related fox mortalities suggest that there may only be 1-2 subadult golden eagles remaining on the northern Channel Islands. The subadult seen on Santa Rosa Island in February 2006 could have been the same subadult seen on Santa Cruz Island, as golden eagles should be able to move between the islands, as do the bald eagles. The eagle seen on Santa Rosa Island also may have been the same bird that was reported on San Miguel Island in January. The adult golden eagle seen by Brian Latta on Santa Rosa at the end of March could have been the Laguna female from Santa Cruz Island. Since the end of the 2006 survey season there have been several reliable reports of the Santa Cruz subadult on the island.

As shown in 2006, net-gunning is the most time-effective, and likely cost-effective, method of removal of any remaining golden eagles on the islands. However, the effectiveness of net-gunning is conditional upon being able to locate the birds. In 2006, we knew the Laguna pair would be in an area centered on their nest. Because it took two months to spot any golden eagles on Santa Cruz using regular surveys, trying to locate eagles across the entire island using spotters may not be cost effective. Golden eagle areas of activity may be best determined by continued monitoring for fox mortalities and examination of the location data. If fox mortalities appear to be clumped in certain areas then the locations could be intensively surveyed (either ground-based or aerial surveys) in an attempt to locate any eagle(s) before bringing in a net-gunning crew.

With the removal of feral pigs on Santa Cruz expected to be completed by 2007, and the increased number of bald eagles on the islands (now estimated at over 40 birds), we expect that the attractiveness of the northern Channel Islands to golden eagles will decrease because of reduced prey availability and increased competition for space with territorial bald eagles. The usefulness of a full-time golden eagle survey team may be limited because of the small number of golden eagles expected to remain on the islands. However, having personnel available for quick-response surveys of areas around known fox mortalities could be beneficial. Encouraging personnel already present on the islands to monitor for golden eagles during their regular work activities also will increase chances of detecting any remaining golden eagles.

ACKNOWLEDGMENTS

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LITERATURE CITED

Bloom, P. H. 1987. Capturing and handling raptors. Pages 99-123 in B. A. Pendleton, B. A Milsap, K. W. Cline, and D. M. Bird (Eds.), Raptor Management Techniques Manual. Natl. Wildl. Fed. Sci. Tech. Series 10, Washington, DC, U.S.A

Coonan, T. J. 2001. Jumping the gun: island fox recovery efforts at Channel Islands National Park. Pages 118-124 in D. Harmon (Ed.), Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands. The George Wright Society, Hancock, Michigan.

Jackman, R. E., W. G. Hunt, D. E. Driscoll, and F. J. Lapsansky. 1994. Refinements to selective trapping techniques: a radio-controlled bow net and power snare for bald and golden eagles. Raptor Research 28:268-273.

Jenkins, M. A. 1979. Tips on constructing monofilament nylon nooses for raptor traps. North American Bird Bander. 4:108-109.

Latta, B. C. 2005. Channel Islands Golden Eagle Translocation Program Summary Report, 1999-2004. Report submitted to The Nature Conservancy and the National Park Service. 83 pp.

Latta, B. C. D. E. Driscoll, J. L. Linthicum, R. E. Jackman, and G. Doney. 2005. Capture and translocation of golden eagles from the California Channel Islands to mitigate depredation of endemic island foxes. Pages 341-350 in D. K. Garcelon and C.A. Schwemm (Eds.), Proceedings of the Sixth California Islands Symposium, Ventura,

California, December 1-3, 2003. National Park Service Technical Publication CHIS-05-01, Institute for Wildlife Studies, Arcata, California.

Liguori, J. 2004. How to age golden eagles. Birding 36:278-283.

Roemer, G.W., T.J. Coonan, D.K. Garcelon, J. Bascompte and L. Laughrin. 2001. Feral pigs facilitate hyperpredation by golden eagles and indirectly cause the decline of the island fox. Animal Conservation 4:307-318.

Suckling, K. and Garcelon, D.K. 2000. Petition to list four island fox subspecies as endangered. Petition submitted to the U.S. Fish and Wildlife Service, 1 June 2000. Center for Biological Diversity, Tuscon, Arizona, and Institute for Wildlife Studies, Arcata, California, USA.

Timm, S. F., J. M. Stokely, T. B. Gehr, R. L. Peebles, and D. K. Garcelon. 2000. Investigation into the decline of island foxes on Santa Catalina Island. Report submitted to the Ecological Restoration Department, Santa Catalina Island Conservancy.

Appendix A. Golden eagles observed and person-days (based on 10 hour day) spent in various activities as part of the golden eagle project on Santa Cruz and Santa Rosa islands, 2005.

Island/ Month	Eagle Obs.	Transport/ Logistcs	Trap Building/ Repair	Obs./ Scouting	Bait Acq./ Husbandry	Trap Setup	Active Trapping	Handling/ Shipping	Paperwork	Project Manage.	Total Person-Days
Santa Cruz Is.											
January	12	40.70	24.60	23.65	3.25	2.70	9.00	0.00	0.00	13.10	117.00
February	31	25.25	2.20	35.50	3.35	2.40	6.00	0.30	1.70	11.50	88.20
March	27	38.30	1.00	44.90	2.30	5.70	5.00	0.00	4.20	7.60	109.00
April	16	19.80	0.70	45.50	2.10	0.40	9.00	0.30	2.40	11.80	92.00
May	3	14.90	0.50	23.00	1.80	1.60	12.20	0.00	0.00	0.00	54.00
Total	**89**	**138.95**	**29.00**	**172.55**	**12.80**	**12.80**	**41.20**	**0.60**	**8.30**	**44.00**	**460.20**
Santa Rosa Is.											
January	3	17.10	0.60	19.10	5.30	1.50	1.00	0.00	0.40	0.00	45.00
February	9	4.70	0.30	12.50	1.10	0.40	4.00	0.00	0.00	0.00	23.00
March	10	17.30	3.00	20.50	3.70	1.60	0.00	0.00	0.30	0.60	47.00
April	38	10.50	1.50	38.20	2.20	2.10	4.00	0.00	0,50	0.00	59.00
May	43	23.50	1.70	33.90	8.90	2.60	20.40	5.80	0.00	2.20	99.00
Total	**103**	**73.10**	**7.10**	**124.20**	**21.20**	**8.20**	**29.40**	**5.80**	**1.20**	**2.80**	**273.00**
Total for Both Islands	**192**	**212.05**	**36.10**	**296.75**	**34.00**	**21.00**	**70.60**	**6.40**	**9.50**	**46.80**	**733.20**

Appendix B. Golden eagles observed and Person-days (based on 10 hour work day) spent in various activities as part of the golden eagle project on Santa Cruz, Santa Rosa, and San Miguel islands, 2006. Time spent on the project by Dr. Sharpe while on the mainland and Santa Catalina Island is also reported.

Island/ Month	Eagle Obs.	Transport/ Logistcs	Trap Building/ Repair	Obs./ Scouting	Bait Acq./ Husbandry	Trap Setup	Active Trapping	Handling/ Shipping	Paperwork	Project Manage.	Total Person-Days
Santa Cruz Is.											
January	0	9.95	0	15.05	0	0	0	0	1.5	1.4	27.9
February	0	1.8	0	0.9	0	0	0	0	0.3	0	3.0
March	40	9.3	0	35.7	0	0	0	0	6.6	0	91.60
April	50	9.1	0	17.1	0	0	0	0	3.8	0	80.00
May	34	12.25	21.4	6.0	0.6	5.73	19.95	0	0.4	1	101.33
June	22	4.4	19.68	0.9	0	0.93	22.4	4	0.3	2.45	77.06
Total	**146**	**56.8**	**41.08**	**75.65**	**0.6**	**6.66**	**42.35**	**4.0**	**12.9**	**4.85**	**380.89**
Santa Rosa Is.											
January	0	2.1	0	0	0	0	0	0	0.6	0.3	3.0
February	3	8.75	0	38.55	1.1	0	0	0	1	0.1	52.5
March	0	0	0	0	0	0	0	0	0	0	0
April	0	8.25	0	13.5	0	0	0	0	2.25	0	24.00
May	0.0	0	0	0	0	0	0	0	0	0	0
June	0	0.2	0	2.1	0	0	0	0	0	0	2.3
Total	**3.0**	**19.3**	**0**	**54.15**	**1.10**	**0**	**0**	**0**	**3.85**	**0.4**	**81.80**
San Miguel Is.											
February	0	1.3	0	2.7	0	0	0	0	0	0	4.0
Total	**0**	**1.3**	**0**	**2.7**	**0**	**0**	**0**	**0**	**0**	**0**	**4.0**
Santa Catalina/ Mainland											
January	0	0.3	0	0	0	0	0	0	0.7	1.2	2.20
February	0	0.85	0	0	0	0	0	0	1.73	0.9	3.48
March	0	0	0	0	0	0	0	0	1.5	0.7	2.2
April	0	0	0	0	0	0	0	0	0	0.25	0.25
May	0	0.4	0	0	0	0	0	0	0	1.85	2.25
June	0	0	0	0	0	0	0	0	0	0.1	0.1
July	0	0	0	0	0	0	0	0	0.1	0	0.1
August	0	0	0	0	0	0	0	0		0	
Total	**0**	**1.55**	**0**	**0**	**0**	**0**	**0**	**0**	**4.03**	**5.00**	**10.58**
Total on Project	**149**	**78.95**	**41.08**	**132.5**	**1.7**	**6.66**	**42.35**	**4.0**	**20.78**	**10.25**	**477.27**