SubAssignment Cover Sheet

Ventura Fish and Wildlife Office

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SubAssignment Profile

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Status:	ACTIVE	Priority: 1	1687	2001	3055
Title:	*Island Fox Recovery Coordination Group - letter regarding Task Force 5 recommendations on Analysis 4.1 (eagle control)*		Divison:	SBVL	
			Assigned To:	CARSWELL	
Service Document	LETTER TO INTERESTED PARTIES		Final Due:	09-FEB-05	
Usfws Permit No:	NULL		Draft Due:		
			Amend Date:		
Mandate:	NO VALUE HAS BEEN SELECTED		Date Recd:	10-JAN-05	
Program Area:	NO VALUE SELECTED				
Project Type:	NO VALUE SELECTED				
Clients Project#:					
Client Name:	NO VALUE SELECTED				
Client Agency:	National Park Service				
Agency Branch:	Channel Islands National Park				

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ventura Fish and Wildlife Office
2943 Portola Road, Suite B
Ventura, California 93003

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IN REPLY REFER TO:
PAS 1687.2001.3055

January 14, 2005

Lotus Vermeer, Ph.D.
Project Director, Santa Cruz Island
The Nature Conservancy of California
3639 Harbor Blvd., Suite 201
Ventura, California 93001

Dear Dr. Vermeer:

The Island Fox Recovery Coordination Group (RCG) held a meeting on January 6-7, 2005, during which the group concluded discussion of the analysis provided by Task Force 5 of the Island Fox Working Group (Analysis 4.1) and eagle control recommendations for the coming year. The RCG's recommendations and the requested analysis are enclosed here.

Analysis 4.1—*Analyze efficacy of golden eagle control and capture methods utilized to date and recommend innovative program for removal methods, taking into account the most up-to-date information on the status of the wild fox populations*—provides a comprehensive review of eagle control and capture methods employed thus far and suggests additional experimental methods that should be tested for their efficacy. The RCG's recommendations stress the need to test these techniques in a coordinated and flexible manner: eagle management efforts should follow a written plan, the recommendations state, while at the same time remaining adaptive. The RCG also recommends that concerted efforts be made to locate golden eagles in the course of other field activities and that food sources for eagles from carrion be minimized.

I agree with the enclosed recommendations of the RCG and urge The Nature Conservancy to put them into practice to the fullest extent possible. I would like to emphasize in particular the importance of recording the methods employed, the effort expended, and the resulting success of all future eagle capture attempts. Only with careful documentation of ineffective methods can the agencies involved progress toward more effective ones.

Please let me know in writing what actions you intend to take, the relevant implementation timelines, and an explanation for your rejection, if applicable, of any of the abovementioned recommendations.

If you have questions, please contact me at (805) 644-1766.

Sincerely,

Diane K. Noda
Field Supervisor

Enclosures

cc: Peter Schuyler, Catalina Island Conservancy

FILE COPY

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January 14, 2005

Russell Galipeau, Park Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93003

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ISLAND FOX RECOVERY RECOMMENDATION
FROM THE CHANNEL ISLAND FOX RECOVERY COORDINATION GROUP

TECHNICAL ANALYSIS REQUEST TITLE AND NUMBER IDENTIFICATION

Technical Analysis 4.1: Analyze efficacy of golden eagle control and capture methods utilized to date and recommend innovative program for removal methods, taking into account the most up-to-date information on the status of the wild fox populations

Relates to: Santa Rosa Island, Santa Cruz Island, San Miguel Island
Technical Expertise Group involved: GE, WP[1]

DATE: 7 January 2004

EXECUTIVE SUMMARY

The RCG thanks Task Force 5 for its extensive review of golden eagle control and capture methods and commends this document as an important reference in its own right. We do not repeat in this document, other than in summary, the factual findings of Task Force 5 in Technical Analysis 4.1. When considering all known factors affecting island fox survival, the RCG concludes that any residence of golden eagles on any of the northern islands is incompatible with the recovery and long-term survival of fox populations and seriously compromises releasing captive foxes to the wild. Additional methods for the capture of golden eagles should be tested as soon as possible to determine if they can accelerate the rate of eagle removal from the islands. We also urge that the widest possible net be cast to discover additional means of capturing golden eagles or suppressing their ability to prey upon foxes. Further analyses of eagle food habits are called for to determine the relative function of different prey items in supporting the island eagle population. Lastly, an analysis of the genetics of golden eagles captured on the islands should be conducted as soon as possible to determine, if possible, if the island population is based on a single or multiple founder events; this determination will be helpful in estimating the risk of reinvasion should the present population be successfully eliminated. At this time it is unknown whether recently introduced bald eagles will play a role in inhibiting the island golden eagle population.

BACKGROUND

There are no historic records of golden eagles breeding on the northern Channel Islands, and island foxes are naive to aerial predation. Shortly after it was established that recently established golden eagles were the cause of the rapidly declining fox populations on the northern Channel Island in the late 1990s, the National Park Service initiated a program—conducted by the Santa Cruz Predatory Bird Research Group—to capture eagles and translocate them. From 1999 through June 2004, 37 golden eagles were removed from Santa Cruz Island (35) and Santa Rosa Island (2), using a variety of techniques. The cost for this effort over the period has been approximately one million dollars. During this time, however, one or more breeding

[1] Golden Eagle Management, Island Fox Wild Population Management

pairs of eagles has remained uncaptured, and successful reproduction has continued. Eagles continue to prey on the remaining wild population on Santa Cruz Island, as well as on foxes released from captivity on Santa Rosa Island.

The best evidence suggests that golden eagles are primarily supported by feral pigs remaining on Santa Cruz Island and the remains of deer and elk on Santa Rosa Island. Forthcoming efforts to eradicate pigs on Santa Cruz Island may lead to a carrion supply in the short term, while the absence of pig prey may increase pressure on the remaining wild foxes.

RECOMMENDATIONS

Recommendation 1: Follow a written golden eagle control plan for 2005. Given the great complexity of eagle control in the context of fox protection, pig eradication, cervid hunts, and the costs involved, it is critically important to have everyone involved and sharing a common set of explicit principles. Ensure that methods for recording costs, degrees of effort, and success of each capture technique tested are included and that a mechanism for timely communications among critical parties exists.

Recommendation 2: Ensure that the plan has the flexibility to adapt to new information and changing conditions: Evaluate all known means of capturing golden eagles, or suppressing their ability to prey on foxes, as soon as possible. Prioritize timing and degree of effort by estimating the likelihood of success. Although it is important to test capture methods in such a way that reliable and quantitative comparisons among them may be made, it is equally important to quickly adopt techniques that are most successful. This means that communications between capture teams and island managers must take place frequently and openly to allow for adaptive management as new information is acquired. Continue to seek additional capture techniques that have been used successfully elsewhere; the RCG will assist in this effort.

Recommendation 3: Maximize all opportunities to locate eagles whenever any field activities are undertaken.

Recommendation 4: Minimize the availability of food resources for golden eagles. The minimization of food resources is important both to inhibit successful establishment of territories and subsequent reproduction and to direct eagles toward capture baits. Carrion (pigs on Santa Cruz Island and deer and elk—including gut piles—on Santa Rosa Island) should be made unavailable to eagles by removal or covering. Some form of monitoring will probably be needed to determine the most efficient means of eliminating these carrion food sources. We recognize that these actions may direct more predation pressure toward wild foxes, particularly on Santa Cruz Island. However, we repeat that long-term success of the island fox recovery depends upon eliminating golden eagles from the northern Channel Islands.

ANALYSIS REQUEST RESPONSE
TO THE
CHANNEL ISLAND FOX RECOVERY COORDINATION GROUP

DATE: 25 October 2004

ANALYSIS REQUEST STATEMENT:

Analysis 4.1
Assessment of Golden Eagle Removal Efforts and Suggestions for Future Directions

TASK FORCE LEAD:

DAVID GARCELON

CHAIR OF EXPERTISE GROUP ASSIGNED TO TASK FORCE:

DAVID GARCELON—GOLDEN EAGLE EXPERT GROUP

TASK FORCE MEMBERS:

SCOTT MORRISON
PHILLIP DETRICH
PAUL COLLINS
SANDY VISSMAN
GARY ROEMER
DAN STEELE
TIM COONAN
LINDSAY MARTIN
DAVID GARCELON

OUTLINE

OVERVIEW
HISTORIC AND CURRENT DISTRIBUTION
RESULTS OF EAGLE REMOVAL EFFORT 1999-2004
POTENTIAL STRATEGIES FOR FUTURE EFFORT
RECOMMENDATIONS

I Overview

Predation by golden eagles *(Aquila chrysaetos)* poses an ongoing risk to the persistence of Island Foxes on three of the northern Channel Islands. Reduction of that mortality factor through the relocation of golden eagles is a primary recovery action for the fox. In 1999, the National Park Service established a cooperative agreement with the Santa Cruz Predatory Bird Research Group for the relocation of golden eagles from the northern Channel Islands to northeastern California. To date, 29 fully-grown eagles (juveniles to adults) and 8 nestlings have been removed; none have returned.

Based on current understanding and reasoned inference, we assume that 9 golden eagles, possibly three breeding pairs, exist on Santa Cruz Island or will so during the 2005 breeding season. Similarly, we assume that two adults, possibly one pair, will exist on Santa Rosa Island. Although considerable successes have been attained in removing golden eagles from the islands, further reductions in golden eagle population size on the islands is proving to be exceedingly, and increasingly, challenging. This document outlines the current status of the golden eagle population on the northern Channel Islands, the results of and challenges encountered during earlier eagle removal efforts, and recommendations for reducing eagle-induced fox mortality in the future.

The recommended strategy is to continue live-capture efforts on Santa Cruz Island, with capture efforts occurring during all phases of eagle breeding. Adequate sized crews must be hired to allow work at multiple territories simultaneously. On Santa Rosa Island, where there are only two known territories, no feral pigs, and less rugged terrain than on Santa Cruz Island, one option would be for crews focus on harassing eagles attempting to establish nests, using regular helicopter surveys to detect re-nesting attempts.

II Background

A. Historic and Current Abundance

Golden eagles were not known to breed on the northern Channel Islands until the mid-1990s, and there are no historic records of them breeding on the islands. Since the mid-1990s, golden eagles have successfully bred on both Santa Cruz and Santa Rosa Islands, but not on San Miguel. Five successful nesting territories have been recorded on Santa Cruz, and two on Santa Rosa, where eagles have been breeding since before 1999. The recent colonization of the northern Channel Islands by golden eagles is likely due to a combination of three factors. First, the existence of feral pigs and sheep on Santa Cruz Island and deer and elk on Santa Rosa Island represented prey sources historically unavailable. The depauperate endemic vertebrate island fauna would have provided little prey for golden eagles, which primarily rely on a diet of terrestrial vertebrates. Before the ranching era, transient golden eagles landing on the islands would have encountered insufficient prey to support permanent residence. Second, bald eagles have been absent from the northern Channel Islands since the mid-20th century due to the effects of organochlorine poisoning and direct persecution by humans. Nesting bald eagles would have likely discouraged foraging golden eagles from establishing residence by aggressively defending their already established territories. Third, while mainland golden eagle populations have recovered from years of persecution, in more recent years they may have been forced to look for alternate nesting sites due to mainland urbanization and thus have now dispersed to the Channel Islands.

The current status and population trends of golden eagles in the Western United States are not well understood. Some states have reported declining populations of eagles while other suggest their populations are stable (White 1994, Kochert and Steenhof 2002). Hunt et al. (1999) modeled the breeding eagle population in Central California in the area of Altamont Pass and concluded the population was either stable or decreasing. A long-term monitoring program of golden eagles in San Diego County indicates the breeding population has decreased by about 50% since the 1970s, principally due to urbanization (Bittner and Oakley 1999). A recent population level survey of golden eagles in the Western United States was initiated in 2003 using 148 aerial transects approximately 100 km in length (Good et al. 2004). As this was only the first year of a survey designed to determine population trends, no data are available on the status of the eagle population in the areas surveyed.

Focused surveys for golden eagles on the northern Channel Islands were initiated in 1999 by the Santa Cruz Predatory Bird Research Group (PRBG). A narrative of the summary of those findings is provided in Appendix A.

B. Golden Eagle Removal Program Results to Date

From 1999 through June 2004, 37 golden eagles were trapped from Santa Cruz (35 eagles) and Santa Rosa (2 eagles), by the Santa Cruz Predatory Bird Research Group, working under a cooperative agreement with the National Park Service and as a contractor to The Nature Conservancy (Fig. 1, Table 1). Of the 37 eagles, 8 were nestlings removed by hand-capture from a total of 5 nests. The other 29 comprised 17 adults, 3 near adults, 6 sub-adults, and 3 juveniles, Three eagles died after capture and the remaining birds were released in northern California, or hacked out (nestlings) in central California. Releases were restricted to California as no other state contacted would the eagles to be translocated to their area. Within California, the goal was to release the eagles as far as possible from the Channel Islands to reduce the probability of their returning. Thus far, none have returned to the Channel Islands. Six basic methods have been used by field staff during the five-year trapping effort:

- *Bownets* Dug-in, radio-controlled bownets are placed in areas that eagles were known to visit, baited with live or dead bait and activated when an eagle enters the trap.

- *Hand Removal of Young* Eagle eggs or nestlings may be removed by hand from nests prior to fledging, and the fostered into golden eagle nests on the mainland. One eagle chick was removed in this manner in 2001, two in 2002, two in 2003 and three in 2004.

- *Nest Nets* Parent birds may be captured directly at the nest, using a net rigged at the nest site to capture the adults returning to the nest. This technique was attempted at the Coche Point nest in 2002, but was unsuccessful; the net snagged on a shrub when deployed, and the bird was not captured.

- *Phai Traps:* A Phai trap is a halo of monofilament nooses attached to a 30-cm diameter ring. The ring is deployed around a tethered rabbit from a vehicle when a perched raptor is sighted. Although the technique has been used successfully in other areas of California,

Santa Cruz eagles seem especially skittish, and did not stay perched long enough for the trap to be deployed. A Phai trap was used unsuccessfully in attempts to capture eagles in the initial phase of the removal effort.

- *Dho-gaza Net:* A dho-gaza net is a fine mesh net placed within the line of sight of a roost or nest site. Bait or a lure is placed behind the net, so that when the target eagle responds it will fly into the net en route to the bait or lure. This technique was also used to successfully capture an adult eagle near a nest site in 2004.

- *Helicopter Net Gunning:* Net-gunning requires an eagle to be pursued in a steady flapping flight until it tires and lands, and then a net-gun is deployed. Birds cannot be netted in rocky cliff areas, due to the possibility of injury, and thick vegetation also prevents a bird from being netted. A helicopter crew is comprised of a pilot, a net-gunner, and an eagle handler.

Most golden eagles were captured with bownets set over live bait (rabbit or pig). However, six golden eagles were captured by bownet in February and March 2003 at a Santa Cruz Island chum site originally established for supplemental feeding of juvenile bald eagles. Drought conditions resulted in a relative lack of pigs on the island in winter 2002-2003, with the result that the golden eagles were more interested in carrion. The only other time the eagles have been caught successfully on dead pig carcasses was during the spring of 2000, when drought conditions had reduced the island-wide pig population; 11 eagles were caught in three months.

Helicopter net-gunning operations were conducted in June and October 2002, and were focused on Santa Cruz Island. During the first net-gunning operation (June 14-24), three golden eagles were observed. One was pursued and landed five times, but did not stay in position long enough for the helicopter crew to maneuver for a shot. On its fifth landing the eagle flew to ground under a medium-sized tree that the helicopter was not able to maneuver over. Weather (fog and wind) prevented operations during a portion of the week, and the Bell Jet Ranger 206 aircraft had inadequate power to keep up with the birds when going upwind. The second operation was conducted October 15-22 with more field observers, a more powerful aircraft (the Bell Jet Long Ranger) and with less wind and fog. The system of ground observers developed for the net-gunning operation proved to be an effective censusing method. Golden eagles were sighted and pursued on 4 of the 8 operational days. No eagles were captured. The helicopter could not tire the eagles because wind, thermals and topography allowed them to rest by soaring and gliding. Pursued eagles also outmaneuvered the aircraft, or were grounded in areas such as cliffs, trees and shrubs that were unsuitable for deploying the net-gun. Over the operational period some eagles learned to avoid the helicopter when it approached an area. One net was deployed, but snagged on a shrub and the eagle escaped. Results from this approximately $60,000 effort indicate that net-gunning is not an appropriate technique for capturing eagles on Santa Cruz Island due to unsuitable terrain and dense vegetation.

Three of the eagles captured in spring 2000 died during holding or release following capture. Necropsies ruled out infectious disease or capture myopathy as mortality factors, and all three birds were in excellent nutritional condition. All three birds tested positive for moderate levels of the anticoagulant rodenticide Brodifacoum, and two of the three tested positive for PCBs and

DDE. The rodenticide may have made the birds more susceptible to capture stress. Following these mortalities, changes were made in holding and transport procedures for captured golden eagles and no further deaths have occurred.

C. Summary

Live trapping and removal have been successful, in that 37 eagles (including 29 adults, near adults or sub-adults) were successfully relocated from the island, none have returned, and this has likely reduced predation mortality of island foxes. On the other hand, live trapping has never removed all the eagles from Santa Cruz Island in any year (Table 2). The most success was realized in spring 2000, when 11 eagles were removed (Fig. 1) out of an estimated population of 21 eagles.

Detailed person-hour effort was available for the work conducted on Santa Cruz Island from 1 March through 30 June 2004. A total of 614 person-days were logged of which 534 were spent on the island. There were 208 person-days spent associated with travel and logistics, 212 days for scouting for eagles, and 85 days were used for setting up and attending to active trap sites. The cost of bownet and other live-trapping (including helicopter net-gunning) has totaled $1,053,000 over six fiscal years (Table 3).

III Findings from Past Effort and Considerations for the Future

Capturing golden eagles requires not only skill and experience, but also intuition and luck. All capture techniques involve risks to the birds – and so must be conducted by skilled staff legally permitted to do so – and some capture techniques involve risk to capture crews as well. Capturing eagles will require having the ability to deploy a diversity of techniques; selection and implementation of those techniques must be strategic and adaptive.

A number of findings and lessons have emerged from the eagle capture effort over the past four years.

It is difficult to locate the eagles and nests.
In order to capture birds efficiently, individual patterns of behaviour (foraging patterns, perching sites, etc) must be elucidated. Locating the birds and/or their nests has proven to be exceedingly difficult on these islands and a major obstacle to golden eagle removal. The islands are large, topographically complex, and many areas are without roads. Moreover, the eagle population is small, and eagles move great distances, including between islands.

The eagle program grows more expensive and challenging, as the "easy" eagles have been removed.
Cost per eagle captured is over $28,000 from 1999-2004. Eagles, particularly members of breeding pairs, have become increasingly difficult to capture. The golden eagles currently remaining on the island appear to be very wary of people and have been reported to quickly depart if humans are observed. In 2004, only 3 of 8 pair members were captured, despite available funds of over $400,000. During the 1999-2004 removal period, 8-13 eagles remained on the islands annually after capture efforts were completed.

Eagle capture success is heightened when eagles nest, but predation on foxes may be greatest when eagles are nesting.
Capture success increases with the onset of nesting activity; so too does risk to the foxes and to the capture effort. The decision to delay capture attempts at nests until the presence of 2-3 week old fledglings may have facilitated capture of two adults, but also resulted in less opportunities for trapping, as well as documented mortality to radio-collared foxes during the courtship and incubation phases of eagle nesting.

Staffing and managing a field effort on the islands is difficult.
Field crews must be experienced, dedicated, and managed. Few individuals have the skills and experience necessary to implement the techniques required (rock climbing, eagle handing, interpretation of behaviors in order to identify and seize opportunity, tolerance of difficult field and living conditions, permits to handle birds, etc.). In advance of the season, it is difficult to predict how many crew members will be needed, or when; yet, commitments by field crews must be made long before field seasons begin.

Efficacy during the non-breeding season is low.
Eagle tracking and capture efforts do not appear successful except in the breeding season. Outside the breeding season there has been generally less success in capturing the eagles on Santa Cruz Island. During this time the eagles are only feeding themselves and may take fewer risks associated with obtaining food. The eagles also may not be as closely tied to their territory boundaries and therefore may be more difficult to locate. Birds wandering on an island (or among islands) will be more difficult to trap as field personnel will not be able to set up traps with a high probability of encountering the birds.

Climate and seasonal patterns affect behaviours and so trapping success.
As prey availability fluctuates (with season, with climate conditions, with pig hunting) so too will the efficacy of trapping. Success appears to be heightened when food availability is lowest.

Changes in pig abundance may affect eagles and so the capture program.
The effect that the pig eradication program on Santa Cruz Island will have on efforts to remove golden eagles is unknown at this time. The presence of a significant number of pig carcasses around the island may increase the difficulty of attracting eagles to carcasses associated with trap sites. The availability of this prey would compete with trapping techniques utilizing carcasses as bait (e.g., bow nets, canon nets) and it likely would make trapping of juvenile or subadults more difficult, as they are not associated with a territory and would utilize whatever food sources are available. It is also possible that the abundance of carcasses around the island might induce other "visiting" golden eagles to stay on the island. It is unknown at this point if golden eagles are repopulating the islands from the mainland floating population, but given the number of eagles removed over the last five years it is certainly a possible scenario. The increase in available prey in the form of carrion would decrease competition for food and perhaps intraspecific aggression. Furthermore, the presence of large amounts of available carcasses prior to the breeding season (when the eagles may not stay on their territories) could put the birds in excellent breeding condition.

Changes in bald eagle abundance may affect eagles and so the capture program.
The presence of reintroduced bald eagles on the northern Channel Islands may have an effect on resident golden eagles in both the short- and long-term. One outcome of the presence of bald eagles is that they will compete with golden eagles for the availability of carcasses (both feral pigs and avian species), which may impact the golden eagles if food resources are limited. Bald eagles are also more social and several individuals may congregate around a food source. Golden eagles are more independent in nature and may choose not to compete with the bald eagles at these food sources. However, in light of the proposed feral pig eradication program carcasses will likely not be limiting, therefore we should not anticipate a high degree of competition between the two species. When the bald eagles mature and establish territories, they will aggressively defend those areas against both conspecifics and other raptor species. If bald eagles become successfully established on the northern Channel Islands, and there is sufficient suitable habitat that they occur in relatively high densities, their presence will likely deter re-establishment of golden eagles if they are successfully removed from the islands. While this is by no means certain, the combination of the presence of large number of territorial bald eagles and the absence of a major food sources like the feral pigs, has a good probability of making at least Santa Cruz Island less desirable for golden eagles. Bald eagle effects may have contributed to the challenges encountered during the 2004 capture season.

Food subsidies from Santa Rosa Island may frustrate efforts to remove eagles.
Similar to the potential problems caused by an abundance of feral pig carcasses on Santa Cruz Island, the presence of deer carcasses and elk remains on Santa Rosa Island may complicate the removal of golden eagles on the northern Channel Islands. There are approximately 700 elk and 400-900 mule deer on Santa Rosa Island for a commercial hunt operation, which operates under special use permit from the NPS. Cervids are not native to the island. The elk and deer hunt conducted from August through November leaves gut piles and other remains on the island that can serve as a readily available food source of resident or visiting golden eagles. As during this time of the year the yearling deer are likely of a size that precludes their being taken by golden eagles, without the presence of these hunter kill remains this might normally be a time of high food stress for the eagles. In December, the introduced deer population is typically culled to meet maximum herd requirements emplaced under the adaptive management program to protect rare plants from browsing and to keep the size of the herd down. In the past (and perhaps currently) carcasses of these animals have been left out in the field after being shot. A large number of the bald eagles released on Santa Cruz Island move over to Santa Rosa Island in the Fall and Winter months to take advantage of this available food source. The effect of culling 200-500 mule deer represent a considerable food source for eagles and likely assist in their overwinter survival. Additionally, the availability of fawns in the spring may make trapping difficult.

IV. Field Methods

A. Survey Methods

One of the most challenging, and critical, aspects of this work is assessing the golden eagle population status on the islands and discerning patterns of behavior that might be exploited for capture. Perhaps the most efficient survey period is early in the breeding season when eagles conduct courtship displays of undulating flights. Below are some methods of locating eagles.

1. Ground Searching from High Points

Searching for golden eagles on the northern Channel Islands has primarily been conducted by placing people at high points on the island in or near locations where eagles have previously been observed. This activity requires individuals that cannot only differentiate golden eagles from other raptors such as red-tailed hawks at a long distance, but can differentiate golden eagles from juvenile bald eagles that are very similar in size and plumage. The work can be tedious, as it requires maintaining concentration on detecting the birds even when nothing has been observed for several hours Options for implementation include:

- *Trained Contractor Staff*–Advantages of using contract staff include familiarity with the island, ability to discern among age classes of golden eagles and ability to interpret behavior. While their abilities in these areas will generally exceed that of less experienced observers, the financial cost of having contract personnel conduct this task on a full-time basis may exceed the benefit when compared to other options.

- *Volunteers*–The northern Channel Islands are an exciting place to visit and it would be possible to attract a number of qualified observers simply by advertising the survey by word of mouth. The Point Reyes Bird Observatory brings in a large group of volunteers 2-3 times a year to San Clemente Island to conduct an island-wide census of the endangered San Clemente loggerhead shrike. The observers are generally experienced birders who welcome the opportunity to visit the island, generally arriving on a Friday, leaving Monday. Smaller groups of volunteers should be available to stay for longer periods of time. These individuals are often employees of State and Federal agencies that have responded to notices put up in their office buildings. There is a coordination element to using volunteers that must be factored into using them on projects of this type. Arranging for their transport to the island, transport while on the island, housing (or camping) and food preparation all have to be taken into consideration. In addition, you need a satisfactory communication system (radios) to provide for both safety and coordination. If volunteers or other groups are used there should be a training period to help familiarize each person with how to differentiate golden eagles from immature bald eagles and large hawks at a distance. Posters or fliers with photographs showing the differences between golden eagles and immature bald eagles could be made and placed at key locations such as the Ranch, Navy site and UC Reserve to provide additional training for observers.

- *NPS and TNC Staff*–The NPS organized a large number of staff to participate as observers during efforts in 2003 to capture golden eagles on Santa Cruz Island with the use of a helicopter. While this is a very costly alternative, as those individuals have regular positions and duties to conduct, it is an option that should be considered when other personnel are unavailable. TNC has few staff associated with the Santa Cruz Island

operations, but may be able to attract staff from other offices within California to assist in periodic survey efforts.

- *On-island Personnel*–A valuable source of information on golden eagle sightings could be obtained from individuals that are on the island on a full-time basis. This includes rangers, interpretive and maintenance staff of the National Park Service, the Main Ranch staff of The Nature Conservancy, island fox and bald eagle biologists of the Institute for Wildlife Studies, the Reserve Manager for the University of California Reserve, US Navy personnel, feral pig removal contractors and university graduate students. In addition to these organization representatives, regular visits occur by scientists conducting work on other projects across the island. It may benefit the program to have a coordinated reporting system whereby these visiting and semi-permanent island residents can submit observations they have on golden eagles. While the validity of these observations may vary depending on the background of the observer, even a single valid sighting may be critical a certain stages of the removal effort. On-island staff should receive a training program to ensure that they can properly differentiate golden eagles from other raptors and are familiar with both how to record the sighting and how to transmit the data to eagle trapping personnel.

Regardless of what group or groups of people participate in the collection of data on eagle locations, a system should be established that is both standardized in how data are reported and allows for quick dissemination to those involved in eagle trapping operations. Incorporating these data, as well as previously collected sighting data, into a database and Geographic Information System program would provide for spatial analysis and a better understanding of how golden eagles are distributed on the islands.

2. Helicopter Surveys

Helicopters provide an efficient means of covering large portions of the island in a short period of time. The ability to move three-dimensionally across the island, including being able to search canyons and shoreline areas, provides the flexibility to go places where there is an increased chance of encountering golden eagles. Eagles have been observed on both Santa Cruz and Santa Rosa islands in conjunction with other operations (such as deer, elk and bald eagle surveys on Santa Rosa Island), and the helicopter was able to effectively follow eagles during attempted capture efforts in 2003.

Helicopters come at a high cost per hour, but cost-benefit when compared to other methods of locating golden eagles in a rugged landscape may not be disproportionate. This is especially true if success is not being made locating birds via ground-based efforts, if you need locations quickly, or if the birds are not associated with a territory. If golden eagle territories have not been located after the breeding season has begun, helicopters could be an important tool in helping to find breeding birds so that ground-based observers could then help locate the nest. Helicopters might also help locate active nest sites.

To the degree possible, efforts should be made to open a seat for a trained eagle observer on helicopter flights being conducted on Santa Cruz and Santa Rosa islands for other purposes (e.g.,

for wildlife surveys). This would ensure that eagle sightings are properly identified, mapped and that the data gets reported to the proper authorities.

3. Forward-Looking-Infrared Search via Aircraft

Forward-looking infrared (FLIR) has been used to detect a variety of wildlife in open habitats. FLIR functions by detecting the infrared wavelengths radiated by heat (from both biotic and abiotic sources). The advantage of this technology is that cryptic species can be detected by their heat signature without having to detect their body form.

The most common method of employing FLIR in the field for wildlife surveys is through the use of aircraft, although ground-based infrared detectors are also used. Both fixed-wing and helicopters equipped with FLIR devices are used to fly in specific areas or along transects to detect heat signatures. As wavelengths in the infrared are not transmitted through solid objects, animals present under vegetation where their entire bodies are not visible from the air would not be detected. Furthermore, if there are numerous similar-sized objects with like heat signatures in the environment being surveyed, it becomes difficult to differentiate your target object from non-targets. As abiotic features such as rocks can conduct heat and register a signature similar to that of an animal, there are advantages to employing the FLIR system in early morning hours or at night to aid in decreasing the number of conflicting targets. The advantage of using FLIR is the ability to cover large areas quickly and to be able to detect animals that might not be seen by the unaided eye.

4. Radio-tracking Prey

The majority if not all of the wild adult foxes on the three northern islands are radio-collared. Eagles provisioning collared fox prey to the nest may facilitate locating those nests. For example, the Laguna eagle pair was discovered nesting in 2004 only because a radio-collared fox carcass was tracked to their nest location.

B. Techniques to Reduce Predation of Foxes

1. Harassment

A potential means of ridding the islands of golden eagles is creating an environment that is unsuitable for their persistence on the island. Over the long-term an unsuitable environment can be created by introducing competitors, making nesting sites less suitable, and removing food sources. This is currently being accomplished in part with the introduction of bald eagles on the northern Channel Islands and the planned removal of feral pigs on Santa Cruz Island. A more immediate approach to making the environment less suitable would be direct harassment of the birds on the island. This would include direct actions such as hazing, pursuing, and destruction of nests. Harassment in combination with the removal of a main food source and the competition and social interactions with introduced bald eagles may drive the eagles from the islands. However, it is not known whether these techniques would result in emigration of birds from the island. Moreover, direct harassment actions would likely make the birds more wary and more difficult to capture, even in future years, so it is likely that harassment and capture

approaches would be mutually exclusive. Therefore, a decision would need to be made regarding the best course of action given these diametrically opposed approaches to golden eagle removal.

a. Harassment at Nest Sites

Harassment of eagles at the nest sites would first require locating the nests (see Survey Techniques above). Once a nest site was located the following actions could be taken:

- As soon as new nest construction or nest refurbishment is observed, immediately destroy or block off the nest site.

- If the nest is still being constructed, wait until the nest in complete to allow the birds to have the maximum investment and then destroy the nest. This would decrease the amount of time remaining in the breeding season for the birds to find a new location and begin another nest.

- Wait until the eggs are laid and then remove the eggs and destroy or block off the nest. This would push the birds even further into the breeding season and make renesting more difficult. With the production of eggs, the female has greatly increased her energetic investment in the breeding season and it may be too late to recycle and produce another clutch. The removed eggs could be hatched out in captivity and the eaglets either fostered into wild nests or hacked out into the wild at a mainland site. The threat to island foxes may be somewhat increased during this period as the male may be foraging to provide food for the incubating female as well as himself. There have been several mortalities of released or wild foxes during the time associated with nest-building and incubation by resident golden eagles.

- Actively harass eagles from established territories. When nest-building begins in January, staff could haze eagles with airhorns or other explosive devices, on a daily basis. Previous survey work for eagle removal has recorded a number of historic eagle nest locations, all of which have been mapped with a GPS receiver. Helicopter surveys could be used to determine if hazed eagles are attempting to re-nest in other locations. This strategy would probably best be suitable for Santa Rosa Island, where there are fewer eagle territories, less woodland, and less topography than on Santa Cruz (thus a greater chance of detecting re-nesting eagles).

b. General Harassment around the Island

Outside the breeding season golden eagles could also be harassed. Even if they do not depart the island, such harassment may decrease their ability to reproduce due to increased stress. Harassment could be accomplished with the aid of a helicopter in the form of "chasing" the birds around the island, similar to when efforts were made to capture the eagles using a helicopter. As this action may just drive the birds from Santa Cruz Island to Santa Rosa Island, a contingency should be in place to conduct this activity at both locations. The female eagle from the Coches territory was pursued via helicopter as part of the capture effort in and was not observed on the island after that time. It is not known whether she is still resident on the island, or died or

departed for other reasons, but it is possible that the stress of pursuit by the helicopter caused her to leave the island.

2. Removal of Eagles by Capture

a. Capture at Nest Sites

The Institute for Wildlife Studies sponsored an eagle capture experts workshop in February 2004 (Appendix B). Capture at the nest site was considered to be the approach with the greatest opportunity for success. This was based in part on the decrease in success in capturing eagles with traditional trapping methods across the island. PRBG reported that the remaining eagles showed increased reluctance to come to bait sites, perhaps because the remaining birds had observed other individuals captured.

Trapping at nest sites would occur at either the incubation or the nestling stages. Attempting to trap at the nest during the incubation phase creates the risk of eagles abandoning the nest due to disturbance. Both golden eagles and bald eagles are sensitive to disturbance during the incubation period and are known to abandon if disturbance reaches a certain threshold. None of the group had experience in visiting golden eagles during the incubation phase, thus most of the concern was based on the conventional wisdom that visiting nests during this time results in abandonment. In discussions with biologists at the Snake River Birds of Prey Area in Idaho, they related doing clutch assessments approximately 40 times at golden eagle nests during the 1970s. Michael Kochert stated that more than 50% of the birds returned to the nests after being flushed to check eggs. He further indicated that each time you visit a particular nest during the incubation period you likely increase the probability of abandonment. Mr. Kochert believed that while there was considerable individual variation in behavioral response, the length of the visit and the periodicity of the disturbance were the two main factors that contributed to abandonment.

It appears likely that golden eagles, as with other bird species, can be sensitive to disturbance during the incubation cycle. However, work on Santa Catalina Island with bald eagles has shown that nests of this species can be successfully entered on a yearly basis during the incubation phase if the nest is accessed quickly and minimal time is spent in the nest. While golden eagles may respond differently to nest intrusions than do bald eagles, it may be worthwhile to attempt some incubation phase trapping efforts to determine if quick entry and exit strategies might reduce the probability that the golden eagles will abandon. In 2004, two golden eagle pairs (one on Santa Cruz Island and one on Santa Rosa Island) abandoned their eggs during incubation without attempted nest entry by humans. Because eagles may not re-nest after failing, a strategy of waiting until the nestling phase to attempt trapping at the nest may result in missing some pairs if they fail at the incubation phase. Likewise, if attempts to traps birds during the incubation phase result in abandonment, no further attempts could be made during the nestling stage when the adults are less likely to abandon.

Many of the same techniques used during incubation could also be used to capture eagles after chicks have hatched. Some believe that there are considerably more opportunities to capture the eagles if you wait until they have chicks in the nest. It has been recommended that trapping

efforts are held off until the chicks are approximately three weeks of age to prevent their dying if the adults depart the nest for an extended period of time after being disturbed by the trap setting process. At three weeks of age the eaglets can better thermoregulate and do not require feedings as frequently. It was believed that the adult golden eagles would be less likely to abandon a nest containing a chick, even if field crews repeatedly visited the nest in their attempts to trap the birds.

There are two potential disadvantages to waiting until the nestling phase to initiate trapping efforts. One, as stated above, is that the eagles could abandon their eggs for one or more reasons and then not renest that season. The second is that golden eagles would be hunting for prey of a size that they could bring back to the nest to feed their chicks during the trapping attempts. As foxes fall into that size category (and have been found in golden eagle nest remains) there could be a spike in mortalities of foxes during this period. In 2004, two radio-collared foxes were predated by a golden eagle pair while trappers waited for their nestlings to reach three weeks of age. Yet, nest-based capture techniques are constrained during the first weeks since hatching, because young eagles are not able to thermoregulate until three weeks of age. This constraint, however, can be mitigated through fostering. Removing eggs late in the incubation phase and replacing them with a surrogate chick such as a red-tailed hawk or Harris's hawk can allow crews to select when the nest-based techniques will be employed. Chicks of these species old enough to thermoregulate could be placed in the nest and would be significantly smaller than a golden eagle of the same age. If the adults accepted the cross-fostered chick, trapping efforts could begin immediately. It would also be possible to keep the pair in the nestling phase for a period longer than normal by periodically replacing the cross-fostered chick with a younger bird. This would allow for aggressive capture effort with little risk to the golden eagle young.

The techniques for capture at nest sites include:

i. Nest net

The nest net capture method utilizes a net secured under the front of a nest that is located in a cave or pothole in a cliff. The bottom of the net is secured under the nest and the top is attached to lines that run along either side of the nest cave up to the top of the cliff. When the eagle is observed entering the nest, weights that are attached to the lines and run through pulleys are thrown over the cliff and the net is pulled over the entrance to the nest. Once the bird is trapped within the nest cave, field personnel can repel down the cliff and secure the eagle. This technique can only be used successfully in situations where the base and upper ledge of the nest cave are reasonably vertical and in the same plane. For this reason, the nest net is not always an appropriate method for capturing eagles at the nest. Juan Vargas, who has considerable experience using the nest net system, has indicated that he has never failed to capture a bird using this system when the situation is appropriate for its use. Trapping via nest net was attempted at the Coche Point nest in 2002, though the attempt was unsuccessful. The net snagged on vegetation and did not fully deploy, and the targeted eagle escaped over the net.

ii. Power Snare

Power snares have been used to capture bald eagles at bait sites and golden eagles on a nest with chicks, but they have not previously been used to capture eagles in the incubation phase of the reproductive cycle. This technique requires placement of a noose in the nest that is connected to a manually or remote-controlled trigger mechanism. The noose is closed when the trigger mechanism releases a bungi cord or other elastic material that is stretched taut and attached to the noose. A power snare was used at the Laguna nest in June 2004, but failed to capture the targeted bird. The female returned to the nest late in the day and the snare was deployed by pulling the noose tight around her legs, but the eagle broke the noose and flew away.

iii. Sticky-Sticks

This method uses several sticks placed into the nest with a sticky substance applied on each stick. The sticks are attached end to end with a light cord or line to make one long string of sticks that are then configured around the interior of the nest. Two additional sticks can be inserted at a 45-60 degree angle into the edge of the nest near where the adults normally land. Finally, the sticky substance can be applied to a piece of burlap or other material at the location where the eagle normally lands when returning to the nest. The concept is that when the eagle returns to the nest they get the sticky burlap on their feet. While trying to remove the burlap and retain their balance using their wings, they hit the angled sticks in the nest and get them stuck to their wing and/or body feathers. If they fall into the nest or resume incubation they get stuck to one or more of the sticks that are attached to each other. With the glue-covered sticks attached to the bird's body and wings, it would be unable to successfully depart the nest. While this might be able to be used as an independent technique to capture golden eagles, there is a risk that the eagle might fall from the nest and being unable to fly would be injured. Another concept discussed by the golden eagle capture group was using this technique in conjunction with the nest net technique to ensure that the eagle would become ensnared in the net once it was raised. The removal of the sticky substance from the feathers of the birds would require time and they could not be immediately released on the mainland, however it should have no lasting effect on the birds.

iv. Anesthetic Egg

A new technique for capture of an incubating female eagle is currently being investigated. It involves entering the nest during the incubation period and replacing the eagle's egg(s) with artificial egg(s) coated with an anesthetic agent. Using an anesthetic that could be transported across the highly vascularized brood patch of the female might allow the adults to be sedated and then captured on the nest by climbers. Wildlife immobilization experts have suggested the use of medetomidine hydrochloride mixed with dimethylsulfoxide (DMSO) to help carry the anesthetic across the epithelial barrier. The compound may also have to be bound to a transparent petroleum product (e.g., Vaseline) to slow evaporation and ensure the anesthetic compound stays on the artificial eggs. Tests are planned on a surrogate species to determine if it is a viable technique.

v. Anesthetic in Food

Another option for capturing the eagles would be placement of a prey item in or around the nest that contained an anesthetic agent in the tissues. While eagles to not commonly eat prey at the nest during incubation, prey brought by the male may be carried away by the female and fed upon elsewhere. A sedative such as oral diazepam (Valium) or diazepam mixed with ketamine hydrocholide, could be injected into the tissue of a prey species (such as a small pig) at a site on the prey where the skin was opened to help direct the feeding of the eagle. Placement of a small telemetry transmitter sewn to the inside of the hide of the carcass could allow triangulation of the food item, and hopefully the anesthetized eagle. Field staff should be in position to begin tracking within a short period of time after the eagle carries the drug-laced prey item away. Helicopter support may be required to ensure that the eagle is found in sufficient time, however, the drug should keep the eagle from flying for several hours if it is all consumed. It is possible that an anesthetized eagle, if perched in a tree or cliff, could fall to the ground after coming under the influence of the drug. This technique could not be employed during the nestling stage. As there would be no control over the adults feeding the dosed tissue to the chick in the nest, it is possible that a chick would succumb to an overdose of the anesthetic if this technique were used.

vi. Night Grab

Grabbing the incubating female by hand at night on the nest requires having climbing ropes prepared in advance on the cliff above the nest and then have two climbers, one descending on each side of the nest, use red lights or night vision goggles to slowly approach the eagle and then capture her on the nest. This was attempted at one nest in 2004 on Santa Cruz Island and the female flew from the nest in the dark when she apparently detected the approach of the climbers. Michael Kochert, at the Snake River Birds of Prey Area, believed that golden eagles would choose to risk flying into the darkness rather than risk being "taken" by what would be perceived as a potential predator. While the risk to human climbers is greater at night than during the daylight, using professional climbers and taking the necessary precautions would limit this increased risk.

b. Capture Away from Nest Sites

i. Bow net

The bow net has thus far been the most successful technique for the capture of golden eagles on Santa Cruz Island. Capture by bownet accounts for 28 of 29 captures of fully developed eagles on the northern Channel Islands (8 nestlings removed by hand-capture). The technique involves digging a shallow depression in the ground and setting the bow net in at ground level. The net apparatus is hinged in the middle and closes like a clam shell when triggered by a radio control. A dead or live prey item is placed on one-side of the net and the bird becomes trapped when the other half springs closed over them. Observers located some distance away in a blind trigger the release of the net. The success of this technique depends on attracting an eagle down to a food source on the ground, and it is often preceded by several days or weeks of pre-baiting or "chumming" of an area where the net will be placed. Once eagles are observed feeding at the site the bow net is set in place.

While the bow net has been very successful in the past, PBRG staff have found that the birds currently resident on the island have not been responding to the bow net in 2003-2004. The remaining eagles may have observed their mates or other individuals captured in these devices or are just naturally more wary. Even though live prey (piglets, rabbits) has been used as bait, targeted eagles have not been captured.

ii. Dho-gaza

A dho-gaza net is similar in principle to a mist net used to capture passerine-sized birds. It is approximately 15 ft tall by 30 ft wide with 6 in squares, and is constructed of 50-lb test fishing line. The net is attached by break-away connections to two long poles. When the eagle flies at or less than 15 ft above the bait or lure, the net breaks away from the poles and envelops the bird. Bungee cord draglines attached to heavy weights prevent the bird from escaping. The net is best set up when existing vegetation can be used to help serve as camouflage to the position of the net. A "lure bird" can be used to help stimulate the target eagles to fly into the net. The lure bird is generally a golden eagle or another raptor that the target golden eagle will attempt to attack or chase from their territory. The lure bird is generally put in place on one side of the net either before light or when the resident eagles are otherwise out of view. As the target eagle attempts to stoop on the lure bird they hit the net and become entangled. Not all golden eagle territories have vegetation or topography that are well suited for the use of this technique, and placing the lure bird outside the territory may not illicit the same defensive response.

iii. Cannon Net/Rocket Net

These are devices capable of launching a large net over the top of a raptor that has come to feed or capture a prey item. Unlike a bow net, they can cover a much larger area and potentially capture multiple birds at one time. One advantage of these types of nets over a bow net it that larger prey items (i.e., whole deer or cattle) can be placed out and still be covered by the span of the net. Another potential advantage is that the "footprint" of the trap is away from the carcass bait and therefore there may be less opportunity for the eagle to detect anything unusual (i.e., ground disturbance) around the carcass. A disadvantage of this type of trap is that they are generally powered by an explosive change that requires special permits to purchase and possess. A second restriction in their use is that a relatively flat area is needed to launch the net and it should be free of any vegetation that might catch the net and prevent its full deployment. Rocket nets have an additional disadvantage of potentially causing a fire if the rockets pulling the net land in dry vegetation such as grass.

There are a few variations on this design that have been developed in the last few years. One is the use of a pneumatic net launcher that uses compressed air to propel a weight attached to the leading edge of the net. This type of system negates some of the disadvantages mentioned above removing the need to have explosives and the risk of starting a fire. This system may have to use a somewhat lighter net than explosive powered devices, but that is not necessarily a disadvantage for this application. Another variation is the use of commercial dummy launchers used in dog training. These devices can be attached to a net and then remotely fired to carry a small net over a bird. They are operated by .22 caliber cartridge "blank" or CO^2 canisters that have no risk of causing fire, but have a short launch distance. Commercial hand-operated net launchers (i.e.,

Coda Net Guns) could potentially be set up in a similar fashion to fire a net over a target site. The net is smaller than a canon net but larger than the area covered by a bow net. The net is launched by a rifle cartridge blank and would have minimal chance to cause a fire.

As the eagles have shown increased reluctance to approach carcasses used as bait, attempts have been made to use live prey to better attract the eagles to a trap location. Live rabbits and piglets have been used as prey on bow nets with some success. However, with increased wariness on the part of the eagles, they now seem to detect that the prey is not behaving normally (no moving naturally because they are tied down) and swoop over the prey without attempting a capture. Attempts have also been made to provide the prey with more mobility by putting them on lines, that allow them more movement, and using net launchers to capture the eagles if they capture the prey. Even with this modification the eagles seem to detect that something is not quite right and have avoided capture. A modification of this approach, that has not yet been attempted, would involve allowing live prey such as piglets to have free range within a confined area. A small "wall" could be built and covered with natural vegetation to contain the piglets. A cannon net or net launcher could be used to fire a net over the containment area should an eagle attempt to grab a piglet. As the piglet may not always want to move when an eagle is in view, a remote controlled shock device could be equipped to the piglets to induce them to move when an eagle is in view. While there is no guarantee that eagles would not detect this ruse and avoid the trap set, it is another variation on net trapping that could be attempted.

iv. Leg-hold Traps

Metal leg-hold traps used in the furbearer trapping sport/industry have been widely used to capture golden and bald eagles. The traps used have off-set jaws that do not fully close and are commonly padded with rubber or other material to reduce the chance of injuring the bird. As any animal of sufficient weight that steps on the release pan will set off the trap, it is common to increase the pan trigger's resistance by placing something like a sponge under the release pan. This helps reduce (but does not prevent) the capture of non-target species such as ravens. While the trap jaws are padded, it is possible that leg-hold traps deployed on the islands could injure island foxes if captured.

The traps are placed around a carcass and chained together to increase their weight and thus prevent their being carried off by the bird. The end of the chain is generally tied to the carcass or to a stake driven into the ground under the carcass. The traps are partially buried or otherwise hidden from the view of the birds. Sticks, rocks and selective openings in the carcass are used to help direct the eagles to move to a location around the carcass that increase the probability they will step on a trap. Observers watch from a blind and respond when an eagle is captured.

The disadvantage of this system on the northern Channel Islands is that it is not remotely triggered. Bald eagles could not be prevented from approaching the carcasses where trapping is taking place and would likely be caught. While that in itself may not be a big problem, if a golden eagle witnesses a bald eagle capture and removal from the trap it is unlikely to approach that carcass and perhaps not others. A potential alternative to the traditional leg-hold trap is a radio-controlled leg hold trap. A small servo can be placed along side the trap to control the ability of the trap to close. This has been used in attempts to capture bald eagles, where the radio-

controlled trap is counter-sunk in the top of a vertical perch near a carcass site. Eagles will sometimes perch near a carcass before approaching it. The traps placed around a carcass could likewise be radio-controlled, but it would be somewhat more involved to set up and would be more costly than non-controlled traps. Regardless of what carcass-based trap is used, the other problem, as mentioned above, is that the remaining golden eagles may not visit carcasses due to harassment by bald eagles and potentially having observed other golden eagles captures.

v. Pit Trap

Pit traps were used by Native Americans for capturing raptors such as eagles and condors. It is comprised of a trench dug in the ground and then covered with boards, soil and vegetation. A small basket is placed in such as position that a trapper can stand in the pit and be able to visually inspect a carcass placed right in front of the trap. When a target species feeds upon the carcass the trapper can reach out under the grass and other material placed in front of the basket and grab the raptor by the legs. The bird is then pulled into the pit and you are ready for additional captures. This technique was used extensively to capture golden eagles for heavy metal contaminant studies within the range of the California Condor.

In some areas it would be difficult to construct a pit trap due to the inability to use heavy machinery and the rocky nature of the substraight. It is possible to construct a pseudo-pit trap by using plywood camouflaged and set into a hillside to create a ledge that could support a carcass and still hide the trapper. This type of trap again depends on the willingness of the eagles to visit a carcass-based trap set. A lure bird can be used in conjunction with the pit trap to help entice other eagles to land at the site.

vi. Anesthetic in Carcass (controlled delivery)

As described above, oral anesthetics have been used to capture raptors such as vultures feeding on carcasses. The difficulty with this approach is that you have the potential of dosing any species that feeds upon the carcass, including other birds and even scavenging mammals. In the case of the northern Channel Islands, ravens and bald eagles readily visit carcasses and if anesthetized they would likely be a deterrent to visitation by golden eagles surveying the carcass. Island foxes could also potentially visit and feed upon a dosed carcass. Because you cannot control the amount of tissue eaten by any visiting scavenger, you have the further potential of causing an over-dose related mortality.

One option for overcoming some of these problems is to remotely control the release of the anesthetic and do so only after the target species has arrived. This could be accomplished by placing a battery operated syringe pump inside the cavity of the carcass. A syringe pump is used in hospitals to control the flow of a drug from a syringe into a patient. It basically pushes on the syringe plunger based on a time programmed into the pump. A small line could be put on the end of the syringe containing an anesthetic, and run under the skin to a location where the hide has been opened to expose some of the meat. By integrating a radio control onto the syringe pump, an observer could trigger the dosing of the exposed tissue only when a golden eagle is observed approaching the carcasses.

One potential problem associated with this technique is the time between when the oral anesthetic is eaten by the eagle and when it takes effect. Golden eagles have a crop which serves as a storage organ allowing the quick consumption of food while in a somewhat exposed location (on the ground and exposed to predators). Absorption of the drug from the dosed meat may not readily take place while in the crop, thus the bird may not become anesthetized until flying from the site of the carcasses. If the bird later became anesthetized after landing on a perch, it could fall and be injured. Eagles do sometimes move food from the crop into their stomach during the process of feeding at carcasses. This is to make "room" for more food to be consumed. Under this scenario, the bird would become anesthetized enough to be incapable of flight. This technique has not been tested and it would be prudent to test this system and the various effects on captive raptors before attempting it in a field situation. Once again, this technique would require that golden eagles visit the carcass.

3. Supplemental Food Sources

Providing supplemental food for the resident golden eagles to reduce their need for capturing live prey may offer a reprieve to foxes if the predation rate increases. Using the resident island pigs would be one source of food for this purpose. The success of this may be somewhat limited, however, as the eagle capture group has had little success in getting adult golden eagles to visit bait sites. This is further complicated with the presence of the newly released bald eagles that appear to be able to "out compete" and perhaps drive golden eagles away from carcasses. Supplemental feeding using larger carcasses such as pigs may not be as beneficial during the breeding season, as the eagles would still need to find prey of a size that could be transported back to the nest (such as foxes).

4. Lethal Control

Lethal removal would involve the use of a firearm to shoot and kill birds at or around the nest. This could be accomplished in a variety of ways, including the use of blinds from which to shoot the birds, approaching and shooting at night with the use of weapon-mounted nightvision scopes, or shooting from a helicopter. The weapon of choice would be a caliber capable of shooting at a fairly long range with a flat trajectory. A rifle scope with the capability of high magnification would allow more accurate shots at greater distances. Using a suppressor (silencer) on the weapon would help reduce much of the noise created by the shot and might increase the chance of having an opportunity to dispatch the remaining bird. Use of blinds in the vicinity of the nest might allow a shooter to get closer to the nest and stay out of view until the eagle(s) returned. With the use of a good marksmen in the area of nesting eagles the chance of successfully killing the golden eagles would be very good. The eagles could be dispatched during the nest construction stage, the incubation stage or the nestling stage. Away from their nest sites, raptors often have commonly used or favorite perch sites within their territory, and in many cases a shooter could be positioned to take advantage of eagles perched in these locations. As mentioned above, blinds would be useful tools in attempting to dispatch birds within their territories. To make a safe shot at a perched eagle, planning would need to be done to ensure a solid and safe background in the direction which the weapon is fired. This is to ensure that a missed shot or a bullet passing through the bird would not pose any danger.

Golden eagles are protected under the Eagle Protection Act and the Migratory Bird Act that prohibit their being hunted or shot. Golden eagles are also a fully protected species in California. The lethal taking of golden eagles would require the US Fish and Wildlife Service to issue a special permit and would likely require an Environmental Impact Statement involving public input. Golden eagle populations in the Western United States are not considered in jeopardy, however, until recently there have not been concerted efforts to document their current status and population trends in most parts of the Western US. Regardless of the fact that they are not Federally protected by the Endangered Species Act, public opinion regarding the lethal removal of golden eagles is likely to be contentious. Legal appeals and court orders may further delay the process even if a permit is granted by the US Fish and Wildlife Service, and could stop efforts of capture the remaining eagles even using the techniques currently in place.

It is important to note that lethal removal will be difficult to implement as well, because it requires finding the eagles, and then getting into a position proximate enough to enable a safe shot to be fired.

V. Recommendations for 2005 Field Season

A. Strategic and Adaptive Application of Capture Procedures

Various trapping techniques may be the best means to attempt to remove the eagles from the island for the 2005 program year. As techniques such as bow net trapping have demonstrated less success during recent efforts, application of new techniques and a more aggressive approach to the removal may be necessary. It is not yet known what techniques and in what sequence is recommended. Those decisions are best made and implemented by experienced field crews in consultation with technical advisers.

The need for an adaptive approach is underscored by the tradeoffs encountered with each implementation decision. During 2004, capture was not attempted during courtship or incubation. Whereas this may have facilitated the eventual capture of the adult male at the Laguna Canyon nest and the adult female at the Lady's Canyon nest, foxes in the wild were exposed to predation from these birds during that time period. On Santa Rosa Island, a released fox which had settled into a use area near the Trap Canyon eagle territory was killed by an eagle on February 20, 2004. That eagle pair, which was thought to be on eggs in early March, abandoned their nesting attempt by the end of that month. On Santa Cruz Island, the El Tigre eagle pair also abandoned their nesting attempt by the end of March 2004, though they were also on eggs. They re-nested in Laguna Canyon, but that nesting attempt was only discovered when a radio-collared fox was found dead near the nest. The Laguna eagle pair was responsible for the mortality of another radio-collared fox as well.

The first decision that must be made is whether or not deterrence (harassment) or continued capture efforts will be employed. As discussed above, these approaches are likely mutually exclusive and therefore a decision must be made regarding how to proceed with golden eagle management. A comparative cost analysis has not been conducted on these two options. Harassment at the nest sites would still require survey efforts to determine nest locations (if nest destruction was incorporated). As the birds often stay in fairly remote areas, the use of a

helicopter would be required to provide more constant harassment of the birds. If nest site harassment alone was conducted, the eagles would still be present on the islands and could continue to impact fox populations. There is also no guarantee that harassment would lead to the eagles departing the island.

B. Project Coordination

The successful implementation of the golden eagle removal program requires careful consideration of a number of factors that may have to be dealt with concurrently. These include, but are not limited to: 1) scheduling of regular project personnel, 2) scheduling of visits by trapping experts, 3) arrangement of transportation to and from the island (including coordination with the Park Service), 4) procurement of lure birds, food for lure birds and eagle bait, and 5) arranging for necessary permits, coordination of volunteer or agency survey personnel (if used). In addition, a Project Coordinator is needed to keep the contracting agencies (TNC, NPS) advised about program status, problems, conflicts with other groups/programs, coordinate with regulatory agencies (USFWS, CDFG) regarding the outcome of permitted activities, and help manage data on effort expended and eagle sightings.

Due to the time necessary to accomplish these tasks, and because some of these tasks will require being on the mainland, the Project Coordinator should not regularly be required to be present in order for field aspects of the project to be conducted (e.g., monitoring, trapping of eagles). Field teams should have the experience and leadership to be capable of operating independently under the stipulations outlined in their contract/permits and under the overall direction of the Project Coordinator.

C. Responsive Contractor and Agencies

For the eagle removal effort to be successful, regulatory agencies and contract organizations will need to be responsive to changes in the program that may need to be implemented on relatively short notice. While sufficient advance planning and latitude in the contractual Scope of Work and permits should reduce the need for changes, mechanisms should be in place to provide timely modification of these documents if the need arises. Specific contacts within these agencies/organizations should be stipulated who will have the authority to implement and follow-up on needed program changes. Delays in implementation of these possible changes will otherwise result in misspent funds and potentially missed opportunities to remove eagles from the island.

As multiple programs run concurrently on the northern Channel Islands, the respective owners/contracting agencies should determine cooperatively, in advance, what priority the golden eagle removal program will take with respect to other on-going or planned programs. This will help prevent conflicts with issues such as transportation, housing, and access. Both the eagle removal contractor and the agencies/organizations can then plan accordingly given the stipulated constraints. Primary and secondary contacts should be established for each organization that can be used to facilitate resolution of problems/conflicts if they arise.

D. Sufficient Personnel

It is not uncommon for eagles to nest somewhat synchronously during the breeding season. It is therefore possible, and even likely, that more than one eagle territory will be actively incubating eggs or rearing chicks concurrently. It is necessary that sufficient field personnel are available to allow for concurrent effort at more than one site and on more than one island. This may be more critical if conducting trapping efforts during the incubation phase, when eagles have a greater probability of natural abandonment.

The field effort in 2004 had insufficient staff to work more than one nest at a time. Eagle capture crews have never actively trapped at more than one nest concurrently, even when there has been sufficient funding to support the increased staffing level required to do so (e.g., in spring 2004, capture crews failed to use all the funds available for eagle removal). This has likely reduced the ability to capture eagles. By the time the crew switched to working another nest, there was not sufficient time to capture both adult birds. Crews have sometimes succeeded in capturing one adult bird from a nesting pair, but have never trapped both birds. In 2004 crews captured the male from the Laguna nest, and the female from the Lady's Canyon nest, but not their respective mates.

E. Sufficient Transportation

Transportation on Santa Cruz Island can be challenging, especially in areas without road access or during the rainy season when roads may be washed out or otherwise closed to travel. Even in areas where roads are accessible, vehicles in good working condition are necessary to move personnel and equipment around the island. Reliable vehicles that are assigned to the eagle removal effort should be made available to ensure the program is not unnecessarily delayed. This will include 4x4 trucks and ATVs. As discussed above under survey methods, access to a helicopter may be necessary as part of the capture effort. This includes not only to support survey work, but to move personnel and equipment into remote locations when necessary.

F. Application for Lethal Control

The live-capture program has yielded diminishing returns in recent years, and it may be that live capture efforts will be relatively ineffective in decreasing fox mortality to the point where wild populations are stable or increasing, and that released foxes survive at acceptable rates. If foxes decline due to increased eagle predation in the next several years, and the agencies have not begun the process to obtain permits for lethal control, then effective eagle control would be further delayed. This could also result in the need to manage increasingly larger captive fox populations and lead to spiraling costs and complex logistics. If releases were inadvisable due to eagle predation, foxes might have no future in the wild and could necessarily have to go to zoos. The initiation of any effort to lethally control golden eagles on the northern Channel Islands will likely bring a swift response from parties that would object to the killing of any wild bird of prey, and especially an eagle. However, because of the likelihood of time delay between when a permit is requested and when it might be granted (if such a permit would be granted), consideration should be given to initiating that process as soon as possible.

Even with the permit, lethal measures should not be implemented unless other measures were unsuccessful or if island fox predation rates exceeded an acceptable threshold (as established by Task Force 3.1). Given the time potentially required to obtain such a permit, it is possible that other actions taken on the island may have reduced golden eagle numbers or removed them entirely from the island (see Items IV and VII). However, getting the permit process started now would put the responsible agencies and organizations in a position to have lethal control as an option should the need arise.

G. Reduction of Food Subsidies

Golden eagles, like bald eagles on Santa Cruz Island, could move to Santa Rosa Island when food sources become less available. Because the presence of carcasses could be supporting any golden eagles resident on Santa Rosa Island, it would be prudent to do everything possible to reduce carcass availability until golden eagles are absent from the islands. This could be accomplished by either covering or burying any deer or elk remains, or collecting deer culled in the field and removing them. Volunteers may be available to assist in this program.

Table 1. Golden eagles captured on Santa Cruz and Santa Rosa Islands, 1999-2003 (data from Santa Cruz Predatory Bird Research Group 2001, 2002, unpubl. data). Only eagle numbers 29 and 31 were from Santa Rosa Island.

No.	Age[1]	Sex	Capture Location	Capture Date	Release Location	Release Date	Distance (km)
1	A	M	Main Ranch area	11/17/99	Warner Range	11/27/99	800
2	J	M	China Harbor	11/20/99	Truckee River	11/24/99	575
3	S	M	Willow Canyon/West End	2/9/00	N/A (died)		
4	A	M	Willow Canyon/West End	2/12/00	Fall River Valley	2/19/00	750
5	N	F	Willow Canyon/West End	2/12/00	N/A (died)		
6	A	M	Christy Pasture	2/21/00	N/A (died)		
7	A	F	Amphitheater Canyon Mouth	3/21/00	Goose Lake	3/22/00	820
8	S	M	Coches-Prietos Ridge	3/25/00	Lake Tahoe Area	3/27/00	640
9	A	M	Portezuela Pass	3/26/00	Lake Tahoe Area	3/27/00	640
10	A	F	Centinela Pass	3/30/00	Goose Lake	4/1/00	820
11	A	M	Centinela Pass	4/1/00	Hallelujah Junction	4/2/00	600
12	N	F	Sauces N. Ridge	4/13/00	Hallelujah Junction	4/14/00	600
13	J	M	Sauces N. Ridge	4/14/00	Tulloch Reservoir	4/15/00	420
14	S	F	Black Point Canyon	3/10/01	Lone Pine	3/11/01	200
15	E	M	Coche Point Nest	5/24/01	Honey Lake	5/27/01	435
16	A	F	Sauces/Pozo Ridge	7/19/01	Goose Lake	7/20/01	820
17	A	M	Griffith Canyon	9/13/01	Goose Lake	9/14/01	820
18	A	M	Griffith Canyon	9/16/01	Goose Lake	9/18/01	820
19	A	M	Griffith Canyon	9/18/01	Goose Lake	9/20/01	820
20	A	M	Coche Point	5/16/02	Goose Lake	5/21/02	820
21	E	?	Coche Point Nest	5/20/02	Honey Lake	5/21/02	435
22	E	?	Coche Point Nest	5/20/02	Honey Lake	5/21/02	435
23	A	M	China Pines Ridge	2/15/03	Truckee River	2/18/03	575
24	S	F	China Pines Ridge	2/17/03	Truckee River	2/18/03	575
25	S	M	China Pines Ridge	2/23/03	Pinnacles NM	2/24/03	220
26	N	M	China Pines Ridge	3/5/03	Truckee River	3/8/03	575
27	S	M	China Pines Ridge	3/6/03	Truckee River	3/8/03	575
28	J	F	China Pines Ridge	3/12/03	Lone Pine	3/13/03	200
29	A	M	Trap Canyon (SRI)	5/30/03	Goose Lake	6/02/03	820
30	E	?	Cascada	6/16/03			
31	E	?	Trap Canyon (SRI)	6/16/03			
32	A	M	Cascada	1/20/04			
33	A	M	Laguna	5/26/04			
34	E	?	Laguna	6/7/04			
35	A	F	Lady's Canyon	6/12/04			
36	E	?	Lady's Canyon	6/13/04			
37	E	?	Lady's Canyon	6/13/04			

[1]A = adult (5+ years), N = near-adult (4-5 years), S = sub-adult (1-4 years), J = juvenile (fledging to 1 year), E = eggs or nestling

Table 2. Results of golden eagle surveys, trapping activities and estimated numbers of golden eagles remaining after specific time periods on Santa Cruz and Santa Rosa islands. Data provided by the Santa Cruz Predatory Bird Research Group. Free-flying birds only; nestlings excluded.

Time Period	**No. Eagles Known**	**No. Captured**	**No. Remaining**
Aug 1999 – Apr 2000	23	13	10
Sep 2000 – Sep 2001	13	5	8
Jan 2002 – May 2002	11	1	10
Jun 2002 and Oct 2002[1]	14	0	14
Feb 2003 – Aug 2003	20	7	13
Jan 2004 – Jun 2004		3	9

Helicopter Capture Efforts[1]

Table 3. Costs of live-trapping (including helicopter net gunning) for golden eagles.

Funding Source	1999	2000	2001	2002	2003	2004	Total
National Park Service	15,000	115,953	35,011	165,411	115,000	88,790	535,165
US Fish and Wildlife Service		68,000					68,000
The Nature Conservancy		25,000	25,000		25,000	375,000	450,000
Total	15,000	208,953	60,011	165,411	140,000	463,790	1,053,165

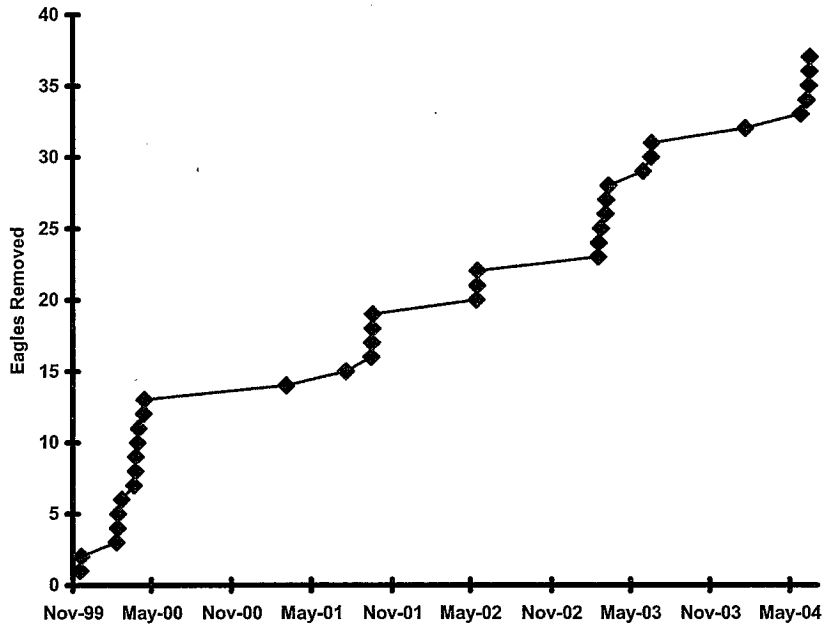

Figure 1. Cumulative number of golden eagles removed from Santa Cruz and Santa Rosa Islands.

Appendix A
Narrative of Golden Eagle Survey Results and Capture Efforts

Santa Cruz Island

In September 1999, survey efforts by PRBG identified 12 golden eagles, with the possibility of five territorial pairs on Santa Cruz Island. In January 2000, the Santa Cruz Island golden eagle population was estimated at 10-13 eagles, comprising mainly territorial adults. Because a total of 13 eagles were captured that spring, with an additional 6 observed in September, the population in 2000 may have been as high as 20 eagles. However, breeding was likely unsuccessful in 2000 due to lack of prey; pig reproduction was lower than usual because of drought conditions. No eggs or chicks were observed in the Coche nest in March, and captured birds were in less than optimum physical condition. The discovery of an alternate nest in the Coche Point territory in 2002 and the continued presence of young eagles of the right age leave open the possibility of a successful nest attempt by that pair in 2000.

In 2001, the Coche pair hatched a chick which was removed at seven weeks of age. Another pair of adults was observed copulating in Laguna Canyon, and the female was observed incubating, but the egg was later abandoned. Another nest was suspected to be on the northern slope of the North Ridge in Alta 2/Black Point Canyon due to the presence of a territorial pair, but a helicopter survey failed to find it. The Coche pair hatched two chicks in 2002, both of which were removed from the nest prior to fledging, along with the adult male of the pair.

Adults and a juvenile observed on the western end of the island in 2002 may have bred there, but it is more likely that the pair bred on Santa Rosa Island. There may be significant movement between Santa Cruz and Santa Rosa Islands for birds on the western end of Santa Cruz Island.

In 2003, the Cascada eagle nest was successful, and at least four golden eagles remained on Santa Cruz: the two adults in the Portozuela/Cascada area which successfully bred in 2003, and one subadult and one juvenile eagle.

In late winter/spring 2004, eagle capture staff tracked three possible eagle pairs on Santa Cruz: El Tigre (Laguna Canyon), Christy Watertank, and a heretofore undiscovered territory on the North Slope, in Lady's Canyon. The Coche female apparently did not breed, and the Cascada male had been caught in January. The Watertank pair never nested. The El Tigre pair abandoned their nesting attempt there in late March but were discovered on eggs in Laguna Canyon in early May. Biologists tracking radio collared wild foxes detected a mortality signal which was traced to a fox carcass at the Laguna nest site. Both the Laguna and North Slope nests successfully hatched chicks in 2004.

Santa Rosa Island

Five golden eagles were observed during a survey by helicopter on Santa Rosa Island in December 2002. Individual eagles observed included two adults near Green Mountain, one immature in Old Ranch Canyon, and two other immature golden eagles. Two active golden eagle nests were discovered on the island (Trap Canyon and Trancion Canyon) in January and

February 2003. As of early March 2003 both pairs were incubating eggs, but the Trancion Canyon pair abandoned their nest attempt, and were not observed again on the island. The Trap Canyon pair produced a chick in 2003, which was removed from the nest in June, after the adult male was trapped.

One golden eagle pair nested on Santa Rosa Island in 2004 (Trap Canyon pair) but failed during the incubation stage, abandoning the nest attempt by late March. The current status of this pair is unknown. The pair is believed to be responsible for the mortality of an island fox released from captivity on Santa Rosa Island in November 2003. That released fox, which died in February 2004, had established a use area in Trap Canyon, close to the active nest of the Trap Canyon eagle pair.

Four alternate nests were found in the Trap Canyon pair's territory, suggesting that the pair had nested in 2002 or before. PBRG staff examined the prey remains of several of the nests, and a cursory examination of the contents revealed numerous island fox bones. Because foxes were last extant on Santa Rosa Island in 1999, the presence of numerous fox bones indicates the golden eagle nest was successful in or prior to 1999. Although there are only a few foxes and pigs on the wild on Santa Rosa, the carrion from the fall commercial deer and elk hunt/cull and availability of skunks, quail, gulls, cormorants, ravens, and mule deer fawns may be sufficient to support more than one golden eagle pair feeding nestlings.

Appendix B
Participants in the Eagle Capture Experts Workshop

Brain Latta
Ron Jackman
Michael McGrady
Daniel Driscoll
Juan Vargas
Peter Bloom
Phillip Detrich
Gregg Doney
Vincent McGlinchey
Paul Andreano
Andrew Grant
David Garcelon–Facilitator

Observers Present
Scott Morrison
Erik Aschehoug
Lotus Vemeer
Jessica Dooley
Lyndal Laughrin