Restoration and Management of Bald Eagles on Santa Catalina Island, California, 2005

A Report Prepared for:

Montrose Settlements Restoration Program

Prepared by:

Peter B. Sharpe, Ph. D.
Institute for Wildlife Studies
Post Office Box 1104
Arcata, California 95518

September 2006

INTRODUCTION

Bald eagles (*Haliaeetus leucocephalus*) were extirpated from the Channel Islands by the early 1960s as a result of human persecution and the introduction of the organochlorine pesticide DDT into the Southern California Bight (Fig. 1). The decline in bald eagle populations in southern California was concurrent with declines in seabird breeding success in the Southern California Bight and with continent-wide declines in bald eagle populations, much of which was attributed to the impacts of DDT (Risebrough et al. 1971, Anderson et al. 1975, Grier 1982, Wiemeyer et al. 1984). DDE (a metabolite of DDT) levels have been found to be inversely correlated with eggshell thickness and productivity in bald eagles (Hickey and Anderson 1968, Wiemeyer et al. 1984).

The Institute for Wildlife Studies (IWS), in cooperation with the United States Fish and Wildlife Service (FWS) and California Department of Fish and Game (CDF&G), initiated a program to reintroduce bald eagles to Santa Catalina Island, California (Fig. 1) in 1980. Between 1980 and 1986, 33 eagles were released on the island from hacking platforms (Garcelon 1988). Many of these birds matured and formed breeding pairs on the island, but the eggs produced by the first breeding attempts in 1987 and 1988 broke in the nest.

Figure 1. California Channel Islands located off the coast of Southern California, USA.

Concentrations of DDE in the remains of eggs removed from failed nests implicated this contaminant as the causal agent of the lack of productivity (Garcelon et al. 1989). Eggs removed from nests on Santa Catalina Island exhibited thinning of the shell (L. Kiff, Expert Report) and areas of gross structural abnormalities of the eggshell that resulted in rapid water loss and a weakening of the eggshell (Risebrough 1998). Mean levels of DDE in egg remains removed from nests in 1987 and 1988 were twice as high as that which has been shown to cause complete reproductive failure (Wiemeyer et al. 1984), indicating that there was still a large amount of DDE in the food chain.

Since 1989, the reintroduced population has been maintained through manipulations of eggs and chicks at each nest site and through additional hacking of birds. Because of the high DDE concentrations in the eggs, this active program of manipulation and augmentation is the only way to maintain the Catalina Island bald eagle population at this time. In the egg manipulation process, artificial eggs are substituted for the structurally deficient eggs laid by the birds affected by DDE. The adult eagles continue to incubate the artificial eggs while the removed eggs are relocated and artificially incubated. Chicks that hatch from these removed eggs, or those produced by captive adults at the Avian Conservation Center (ACC) at the San Francisco Zoo, are then fostered into the nests. From 1989 through 2005, adult bald eagles successfully reared 45 of 54 chicks that were either fostered into nests (52 chicks) or hatched from two of three healthy eggs that were placed into nests. Three of these 54 birds were removed from the nest prior to fledging because of injuries and six died due to accidents, predation, or unknown causes. An additional 21 eagles have been released through hacking activities since 1991 (20 chicks and a 1-year-old bird; Table 1).

The purpose of this project is to maintain the breeding bald eagles on Catalina Island until they are capable of reproducing without human assistance. This report summarizes the results of the egg and chick manipulations and subsequent monitoring for the 2005 nesting season.

Table 1. Summary of Bald Eagle egg and chick manipulations on Santa Catalina Island, 1989-2005.

	Year																
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
# of Active Nests	1	2	2	3	3	2	3	3	2	3	4	3	4	4	5	5	5
# of Eggs Laid	2	2-3	3	5	5-6	3	5	5-6	6	7	8	7	8	8	9	11	11
# of Eggs Collected	1	1	3	5	4	3	5	4	5	6	6	4	7	7	8	11	11
# of Catalina Island Eggs Hatched[a]	0	0	1	2	0	0	0	0	1	1	1	2	0	2	1	3	3
# of Eggs Fostered Into Nests on Catalina Island	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0
# of Chicks Fostered Into Nests on Catalina Island	1	0	0	3	2	2	1	5	1	4	3	4	5	7	4	5	5
# of Chicks Fledged From Nests on Catalina Island	1	0	2	3	1	1	1	2	1	3	2	4	5	6	3	5	5
# of Eagles Hacked Onto Catalina Island	0	0	2	0	2	0	2	5	0	4	2	0	4	0	0	0	0
# of Island-Produced Eagles Breeding on Island	0	0	0	0	0	0	0	0	1	1	2	1	2	2	3	3	3
# of Second Generation Eagles Fledged	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2

[a] Hatched by the Santa Cruz Predatory Research Group (1991), San Francisco Zoo (1992-2004), and IWS (2005).

STUDY AREA

Santa Catalina Island is located 34 km south of Long Beach, California. The island is 34 km long, 0.8 to 13.0 km wide, and covers 194 km^2 (Fig. 2). Elevations range from sea level to 648 m. Mean annual temperatures range from 12 to 20^o C near the coast, and yearly precipitation averages 31 cm (NOAA 1985).

Nesting Territories

Five territories of nesting bald eagles have occurred on the island since 1984 (Fig. 2). A brief description of each territory is provided below.

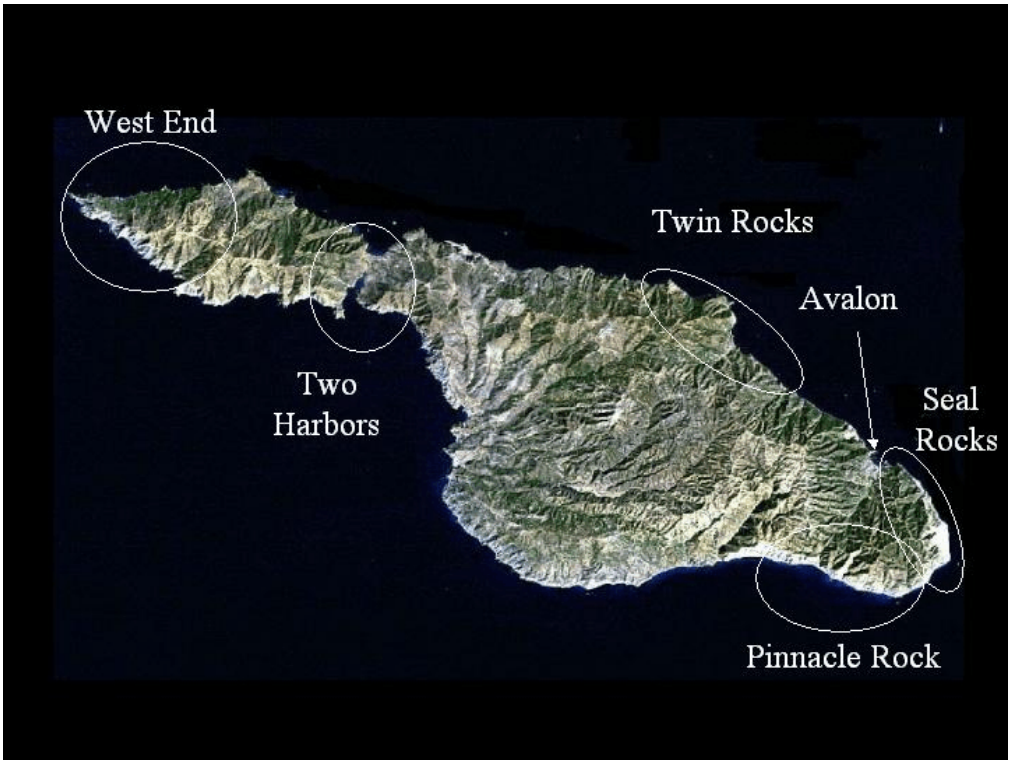

Figure 2. Active bald eagle territories and points of reference on Santa Catalina Island, California.

The West End territory is located 0.5 km from the northwest end of the island (Fig. 2), and was established in 1991. The territory was initially occupied by a 10-year-old male and a 5-year-old female, but a second female has assisted in breeding activities since 1992. The nest is located on a rock pinnacle approximately 75 m above the water, and has been used since 1991.

The Pinnacle Rock territory is located 4.3 km southwest of the city of Avalon, extending from Silver Canyon to approximately 1 km east of the East End Light (Fig. 2). It was initially occupied in 1990 by a 5-year-old female and a 4-year-old male, and this territory has contained active nests each year since 1990. The pair has remained intact and has used six different nest sites from 1990-2005.

The Twin Rocks territory is located 5 km northwest of Avalon, extending from Torqua Springs to Little Gibraltar (Fig. 2). This territory was first occupied in 1984 and contained active nests in 1985, 1987 and 1989. The female remained in the territory until January 1995 when she was joined by a 4-year-old male. The pair exhibited incubation behavior in 1996, but no eggs were found in the nest (Phillips and Garcelon 1996). The first eggs were laid by the new pair in 1997, but the birds did not return to the nest after the egg switch. In 1998, the female was replaced by a 12-year-old female and the pair has nested every year through 2005.

The Seal Rocks territory is located 4.5 km SE of the city of Avalon (Fig. 2). The pair first nested in 1988, using several different nests through 1993. The female from this territory died on 5 May 1993 from DDE contaminant poisoning (Garcelon and Thomas 1997). In 1995, another adult female (the current Twin Rocks female) laid two infertile eggs. Because no male was observed in the territory, the eggs were removed to prevent excessive stress associated with incubation by only one adult. The female abandoned the nest and the territory remained unoccupied until a new pair moved into the Seal Rocks territory in 1997. There was no evidence of nesting in 1998. Prior to the 1999 breeding season the female was replaced by a 6-year-old bird. In 1999, the pair built a nest and laid one egg, but the nest blew out of the tree the following evening and there was no further nesting activity. The pair did not attempt to nest in 2000, but successfully fledged a fostered chick in each year from 2001 through 2005.

The Two Harbors territory is located 2 km SW of the town of Two Harbors (Fig. 2) and was first occupied by a pair of 5-year-old birds in 2003. The nest was constructed on a rock outcrop on a narrow ridge about 50 m above the ocean. This pair fledged a single chick in 2003 through 2005.

METHODS

Nest Manipulations

Observations of adult eagles began in January this year at each of last year's nest sites. Once we confirmed that the eagles were going to use the same nests as last year, we set up blinds from which to observe the nests. From the blinds we monitored and quantified chronology of nesting, behavior during incubation, nestling and adult behavior during brood rearing, taxon of prey delivered to the nest, and rates of prey deliveries. At the West End, Seal Rocks, and Two

Harbors nests we had established video cameras prior to the breeding season that allowed close observations of nesting activity. Through a collaborative effort with the University of Southern California's Wrigley Institute for Environmental Studies we were able to get the live video from the West End and Two Harbors nests on the internet (http://www.iws.org). This allowed us to monitor these nests via the internet to save the 1-2 hour drive time to the nests, or when roads were impassable due to the record rainfall in winter/spring 2005.

We replaced eggs laid by nesting pairs with artificial eggs within 2-7 days of the date that eagles were confirmed incubating. We replaced the artificial eggs with healthy chicks after the adults had incubated approximately 35 days and returned to the nests when chicks were 8 weeks old to equip them with federal leg bands, wingmarkers, and a backpack-style radio-transmitter. At this time we also collected a blood sample (~10 cc) for contaminant analyses and made morphological measurements to determine sex (Bortolotti 1984, Garcelon et al. 1985).

Artificial Incubation

In winter 2004/2005 we established an incubation facility at our office in Avalon, California. The facility has two incubators, candler, hatcher, brooder, and all the other equipment necessary to hatch the eggs (Fig. 3). The two incubators are a forced-air Grumbach and a Brinsea Contaq X8 contact incubator. Unlike the Grumbach, which surrounds the eggs with warm, moist air, the X8 uses an air bladder inflated with warm air that rests on top of the eggs. This more closely mimics the conditions in a nest. Eggs were weighed and measured upon arrival in the facility so that we could estimate weight loss trends. Eggs should typically lose about 15% of their weight during the 35-day incubation period. If weight loss was above the predicted weight loss of a healthy bald eagle egg, then we covered portions of the egg below the aircell with Tegaderm. This reduced water loss through the shell, but allowed gas exchange. The Grumbach incubator, which can be set at higher humidity levels than the Brinsea, was used for eggs for which Tegaderm alone could not control water loss. The remaining eggs were placed in the Brinsea.

Incubation Behavior

We recorded incubation behavior at each nest for approximately 6 hours/day for 1-3 days/week, recording the exact times that adults laid on and stood from the eggs, probed the nest, or rolled the eggs. The identity of adult birds was determined by patagial wingmarkers or leg

Figure 3. Incubation facility with Brinsea incubator (left), Brinsea hatcher (center), and Grumbach incubator (right).

bands. Additionally, descriptive notes were recorded to summarize general behavior and interaction of adults during the incubation period.

We used the Mann-Whitney U-test to evaluate sex-specific differences in duration of complete incubation bouts. Complete incubation bouts were defined as those in which we observed the incubating bird both start and end its attendance at the nest (i.e., switch with its mate).

Chick-Rearing and Nestling Behavior

We monitored behavior of chicks and adults at all nests using interval sampling (Tacha et al. 1985) following the fostering of chicks. Postures and behaviors (see Appendix I) of chicks and any adults on the nest were recorded at 1-minute intervals, and sampling generally was

conducted 2-3 days/week, up to 8 hours/day. Fog occasionally prevented or delayed sampling of behavior. We distinguished the roles of adult male and female eagles during the chick-rearing period by comparing the proportion of time that each sex spent on the nest. We calculated the proportion of time that chicks spent in postures and behaviors for each day that birds were monitored. We evaluated the relationship of the age of the chicks to the proportion of time spent in each posture and behavior to document the onset of particular behaviors as chick development progressed. Changes in the frequency of occurrence of key postures and behaviors were plotted over time to demonstrate trends in behavior during the nestling period.

Post-Fledging Behavior

We used radio-telemetry to locate and observe fledged eagles every 1-3 days during their first month of flight and then at least once per week through August, or until they left the island. We recorded each bird's location, behavior, and interaction with other eagles. The length of observations of each bird varied greatly, but generally lasted from 15-60 min.

Collection of Tissue Samples

We collected ~10 cc of blood for contaminant analyses during banding activities. We also collected samples of egg shells and embryos from eggs that failed to hatch. Egg contents were placed in chemically clean jars and frozen.

RESULTS

Manipulations and Monitoring

Nests were located in February 2005 in all five previously occupied territories: Twin Rocks, Pinnacle Rock, Seal Rocks, West End, and Two Harbors (Fig. 2).

Twin Rocks

The territory was used by the same pair that used it from 1998-2004. The male (K-33) was a bird that hatched from a Catalina egg in 1992 and the female (K-17) was a bird released at the Bulrush hacktower in 1984. In early February, the pair was seen working on the same nest that they used in 2004. The pair worked on the nest until 16 February, when the first egg was

confirmed. On 19 February, a second egg was observed and we entered the nest by foot on 20 February. We removed both eggs, replacing them with artificial eggs. Both eggs were fertile, but neither egg hatched (see below).

On 23 March, we fostered a chick produced by breeding pairs at the ACC into the Twin Rocks nest. We returned to the nest on 5 May and equipped the eaglet with leg bands, transmitter, and wingmarkers and obtained a blood sample (Table 2; Fig. 4). We continued nest observations until the bird fledged around 26 May. The eaglet was tracked following fledging and remained on the island until at least 24 August, after which it is believed to have left the island.

Table 2. Biographical data for bald eagle chicks successfully fostered into nests on Santa Catalina Island, California during 2005.

Federal Band	Sex	Wing Marker	Date Fledged	Foster Nest	Status[a]	Comments
629-47394	Male	K-50	5/26/05	Twin Rocks	Unknown	No reports once it left the island
629-47395	Male	K-51	6/17/05	Pinnacle Rock	Alive	On Catalina Island
629-47396	Female	K-54	7/5/05	West End	Alive	On Catalina Island
629-47397	Male	K-55	6/28/05	Two Harbors	Unknown	Seen in San Luis Obispo Co. on 10/9/05
629-47398	Female	K-56	7/14/05	Seal Rocks	Alive	On Catalina Island

[a] As of 12/31/05

Figure 4. Twin Rocks chick, K-50, following banding.

West End Territory

The West End trio of birds used the same nest that has been used since 1991. The male has lost his wingmarkers, but is believed to be K-77, a 24-year-old bird released from a hacktower in 1981. The original female (Female 1) was not marked with patagial tags, but is believed to be a 19-year-old bird released at the Sweetwater hacktower in 1986. The second female (Female 2), which joined the original pair in 1992, is a 19-year-old bird (K-69) that was also released at the Sweetwater hacktower in 1986. We observed Female 1 copulate with the male at the nest on 8 February. Birds were seen at the nest regularly, but rainy weather in mid-February restricted access to view the nest directly and we lost the video feed from the nest on 21 February. On 23 February we were able to view the nest and found one of the birds in incubation posture. We entered the nest on 27 February and removed four eggs, two fertile and two infertile, replacing them with artificial eggs. One egg hatched on 4 April (see below) and was fostered back into the nest on 10 April.

On 27 May, we returned to the nest to install a leg band, transmitter, and wingmarkers on the chick and to obtain a blood sample (Table 2). We continued monitoring the nest until the chick fledged around 5 July. We continued to monitor the fledgling and it remained on the island through the end of December.

Pinnacle Rock

The Pinnacle Rock pair used the same nest as in 2004. The 19-year-old male (K-65) was hacked at the Bulrush tower in 1986. The female, who has lost her wingmarkers, is a 23-year-old bird hacked at the Salta Verde tower in 1982. The birds were first seen at the nest on 8 February. The first egg was seen in the nest on 21 February. We observed a second egg in the nest on 23 February. On 28 February, we removed two eggs via helicopter, both of which showed signs of development but died before hatching.

On 8 April, we fostered a chick that hatched from an egg at the ACC into the nest. We returned to the nest on 24 May to install leg bands, transmitters, and wingmarkers on the eaglet and to obtain a blood sample (Table 2). The eaglet was observed out of the nest for the first time on 17 June. We followed the bird via telemetry and it remained on the island through the end of the year.

Unfortunately, on 7 December we recovered the carcass of the territorial female in a canyon on the eastern end of the Pinnacle Rock territory near Church Rock. The carcass was mostly mummified and there was no indication of what may have caused her death. Her carcass was shipped to the Eagle Repository in Colorado.

Seal Rocks Territory

The Seal Rocks pair used the same nest as in 2004. The 12-year-old female (K-34) is from the captive ACC eagles and was hacked at the Bulrush tower in 1993. The 13-year-old male (K-25) hatched from an egg from the West End territory and was fostered into the Pinnacle Rock nest in 1992. The first activity at the nest was on 5 February and the first sign of incubation behavior was on 23 February. We entered the nest on 4 March and removed two eggs, replacing them with two artificial eggs. Both eggs were fertile and one hatched on 4 April.

On 9 April we fostered the chick that hatched from the Seal Rocks egg back into the nest. We returned to the nest on 31 May to install leg bands, a transmitter, and wingmarkers on the chick, and to obtain a blood sample. We continued to monitor the nest until the bird fledged on 14 July (Table 2). We relocated the bird via telemetry and it remained on the island through the end of December.

Two Harbors Territory

The Two Harbors pair used the same nest as last season. The 7-year-old male (K-81) is an ACC-produced eagle that was fostered into the West End nest in 1998. The 7-year-old female (K-82) hatched from an egg laid in the West End territory in 1998 and was fostered into the Pinnacle Rock nest. The birds were first observed incubating on 23 February. On 25 February we entered the nest and removed one egg, replacing it with two artificial eggs. The egg was fertile and hatched on 4 April.

On 10 April the chick was fostered into the nest. We returned to the nest on 28 May to install leg bands, a transmitter, and wingmarkers on the chick, and to obtain a blood sample. On 28 June, the bird was seen outside the nest for the first time (Table 2). This bird left the island around 4 September and was reported in San Luis Obispo Co., California on 9 October.

Artificial Incubation

In 2005, we collected 11 eggs from the five active nests on the island, of which nine were fertile. Of these eggs, we successfully hatched three eggs (33%), the highest success rate since the artificial incubation aspect of the program began in 1989 (Table 3).

Table 3. Summary of artificial incubation of eggs removed from bald eagle nests on Santa Catalina Island, California in 2005.

Territory/ Egg #	Estimated Lay Date	Estimated Initial Wt.	Days Incubated	End Wt.	Comments
Twin Rocks					
05-01	2/16/05	132.67 g	36	110.91 g	Died in shell close to hatch
05-02	2/18/05	132.76 g	37	110.13 g	Died in shell close to hatch
Two Harbors					
05-03	2/23/05	140.09 g	39	.	Manual hatch, fostered
West End					
05-04	2/23/05	142.16 g	10	134.98 g	Infertile
05-05	2/25/05	135.66 g	37	.	Manual hatch, fostered
05-06	2/23/05	134.13 g	12	125.75 g	Infertile
05-07	2/25/05	138.86 g	30	119.81 g	Died in shell
Pinnacle Rock					
05-08	2/21/05	131.92 g	37	111.41 g	Died in shell close to hatch
05-09	2/23/05	127.25 g	13	117.25 g	Died in shell early in development
Seal Rocks					
05-10	2/27/05	142.02 g	36	.	Manual hatch, fostered
05-11	3/01/05	133.26 g	34	113.07 g	Died in shell close to hatch

Incubation Behavior

We monitored incubation behavior for 6 days at the Twin Rocks nest (26 February-16 March), 4 days at the West End nest (2 March-7 April), 16 days at the Pinnacle Rock nest (26 February-8 April), 15 days at the Seal Rocks nest (3 March-8 April), and 9 days at the Two Harbors nest (26 February-7 April).

All adults took part in incubation duties. We only recorded enough full bouts to compare bout length by sex at the Pinnacle Rock and Seal Rocks nests. At these two nests the mean bout length did not differ significantly between adults ($P > 0.45$; Table 4). We collected little incubation data for the West End and Two Harbors nests because of poor road conditions due to heavy rains and malfunctioning camera systems and we recorded no full incubation bouts at the Twin Rocks nest. When we compared length of complete incubation bouts by territory we found no significant differences ($P = 0.78$).

Chick-Rearing and Fledgling Behavior

We made behavioral observations for 21 days at the Pinnacle Rock nest (8 April-14 June), 13 days at the West End nest (13 April-24 June), 26 days at the Seal Rocks nest (10 April-

Table 4. Number (n), mean, and standard deviation (SD) of length of complete incubation bouts (hrs:minutes) for adult eagles observed during incubation at the Pinnacle Rock, Seal Rocks, Two Harbors, and West End nests on Santa Catalina Island, 2005.

	Male			Female 1			Female 2[a]		
Territory	n	Mean	SD	n	Mean	SD	n	Mean	SD
Pinnacle Rock	9	1:01	0:47	6	0:45	0:42	.	.	.
Seal Rocks	5	1:09	0:23	3	1:01	0:23	.	.	.
Two Harbors	.	.	.	1	0:59	.	.	.	.
West End	.	.	.	1	1:29	.	.	.	.

[a] Second female that was released from a hacktower with Female 1 in 1986 and joined the West End birds in 1992.

24 June), 16 days at the Two Harbors nest (11 April-22 June), and 24 days at the Twin Rocks nest (26 March-19 May). All five chicks fostered into nests this year successfully fledged. Adult females spent a significantly greater portion of their time at nests than males at the Pinnacle Rock (79% vs. 29%, $P = 0.0001$) and Seal Rocks (61% vs. 23%; $P = 0.0001$) nests. Although females spent more time at the nest than males, the difference was not significant at the Two Harbors (39% vs. 22%; $P = 0.1472$) and Twin Rocks nests (43% vs. 34%; $P = 0.4104$). At the West End nest there was no significant difference in the amount of time Female 1, Female 2, and the male spent at the nest (20%, 30%, and 19%, respectively; $P > 0.39$). There was also a significant negative relationship between time spent at the nest and the age of the chick for all adults, except for the males at the Pinnacle Rock ($P = 0.11$) and Twin Rocks ($P = 0.08$) nests (Fig. 5).

The proportion of time the chicks spent standing increased rapidly at an age of about 43-45 at all five nests (Fig. 6). Reported proportions are for periods the chicks were in view. During the first two to three weeks in the nest, the chicks were sometimes out of view for up to 95% of an observation period, primarily because they were being brooded. Self-feeding by the chicks did not increase substantially until they were at least 58 days of age (Fig. 7).

Prey Deliveries

We observed 8 prey deliveries at the Pinnacle Rock nest during 59.1 hours of observations (0.14 items/hr), 9 prey deliveries during 39.7 hours of observations at the West End nest (0.23 items/hr), 19 prey deliveries during 64.4 hours of observations at the Seal Rocks nest (0.30 items/hr), 18 prey deliveries during 46.1 hours of observations at the Two Harbors nest

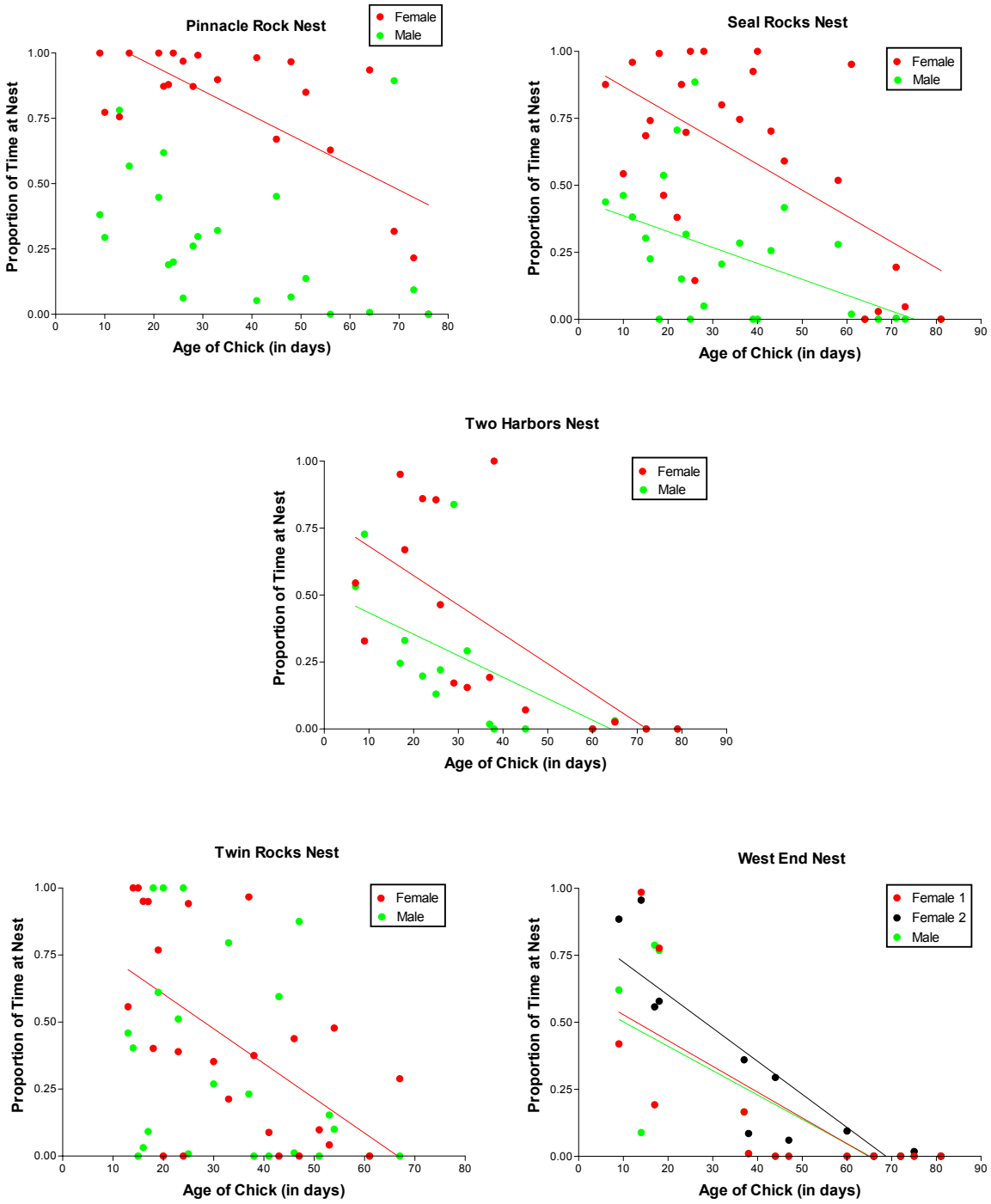

Figure 5. Proportion of time spent at five nests by adult bald eagles on Santa Catalina Island, California during 2005. The lines in the graphs are the significant lines of best fit for the female (—), male (—), and Female 2 at the West End nest (—).

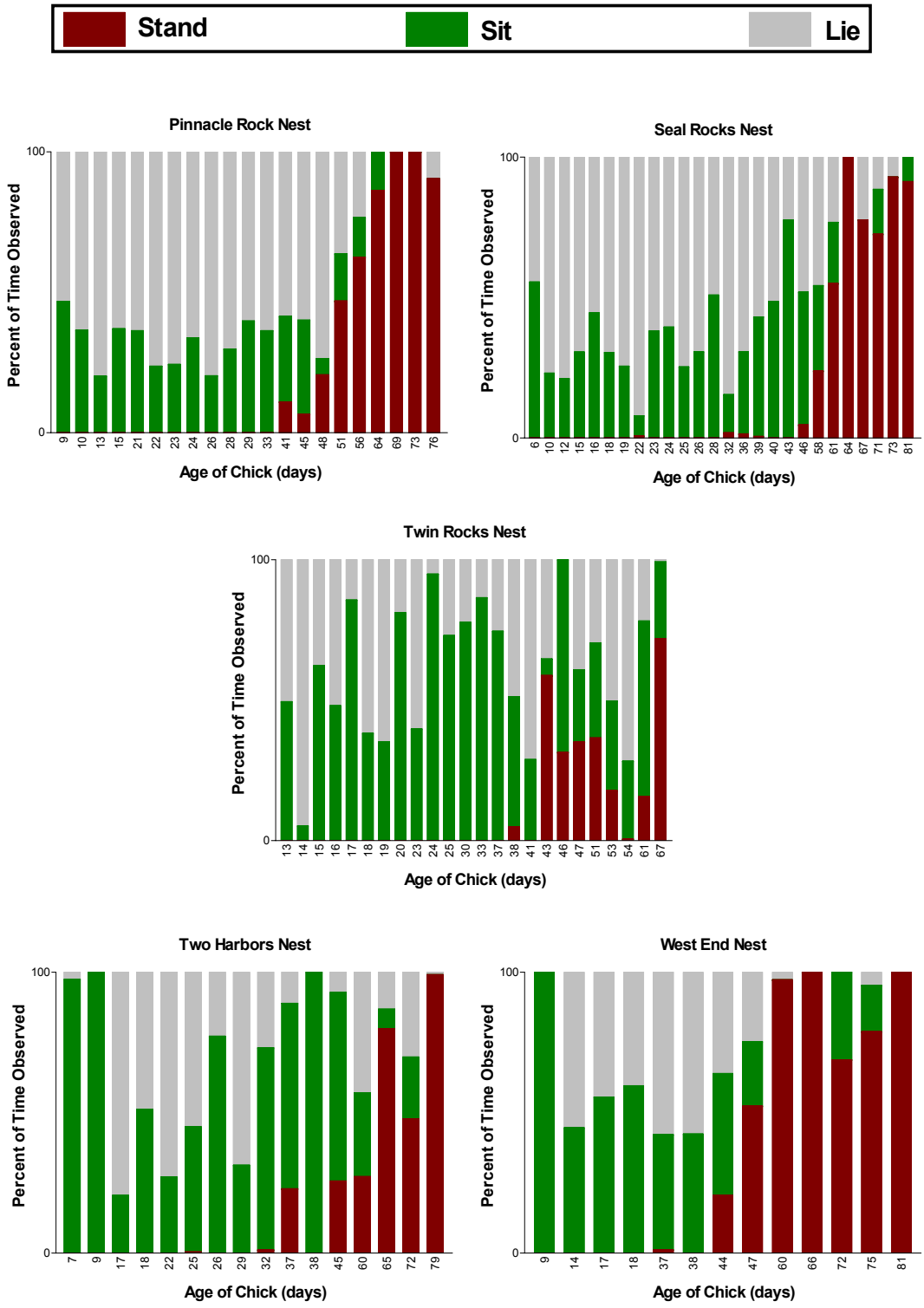

Figure 6. Percent of time that chicks spent in three different postures at five nests on Santa Catalina Island, California, 2005.

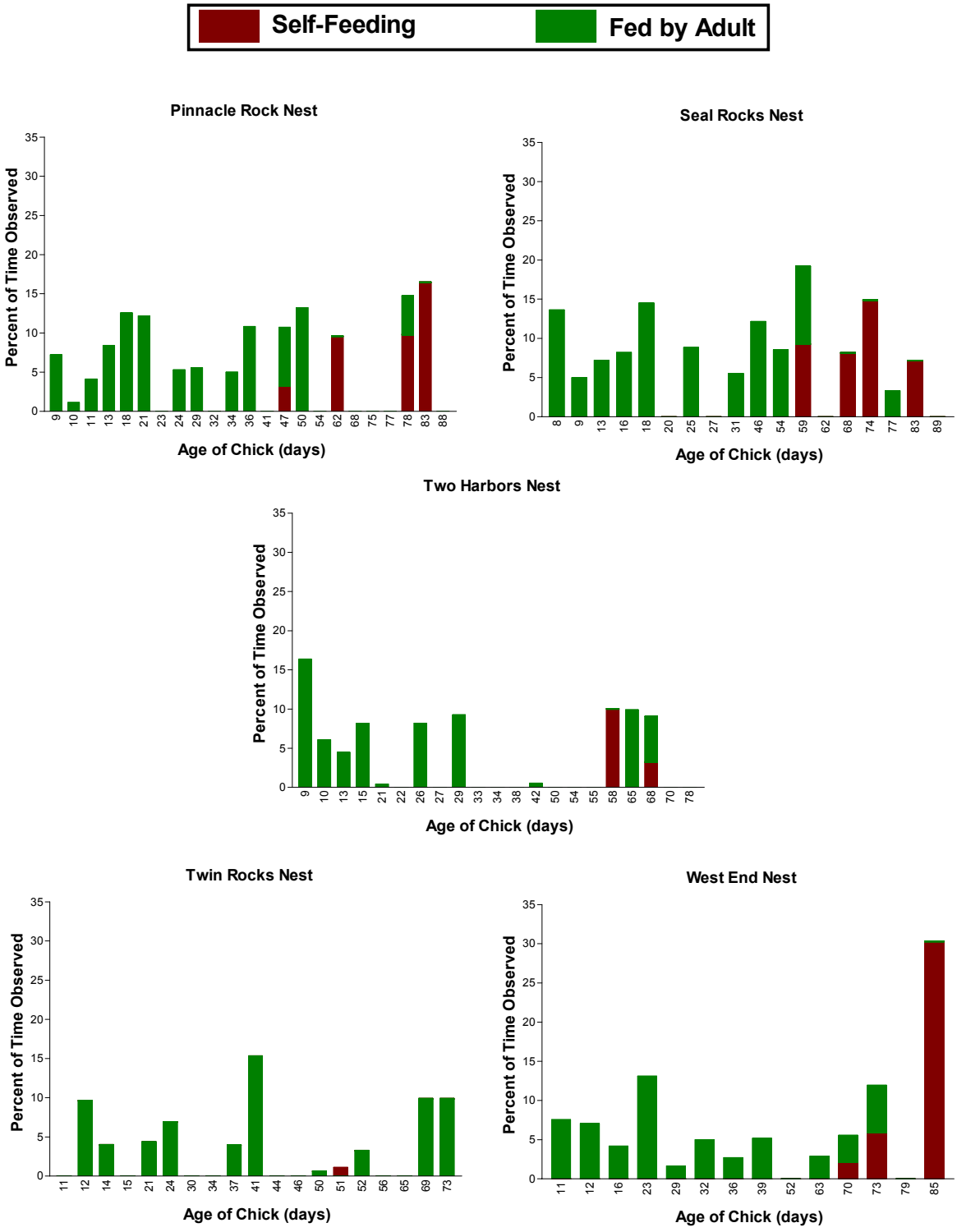

Figure 7. Percent of time that chicks were observed being fed by adults or self-feeding at nests on Santa Catalina Island, California, 2005.

(0.39 items/hr), and 15 prey deliveries during 64.0 hours of observations at the Twin Rocks nest (0.23 items/hr). The males and females made a similar number of prey deliveries at each nest, except the Pinnacle Rock nest, where the male made 6 of 8 deliveries (Fig. 8). Fish made up the largest portion of identified prey items delivered to nests in all territories (79 – 100.0%). A variety of birds, including gulls and quail were seen delivered to nests (Table 5).

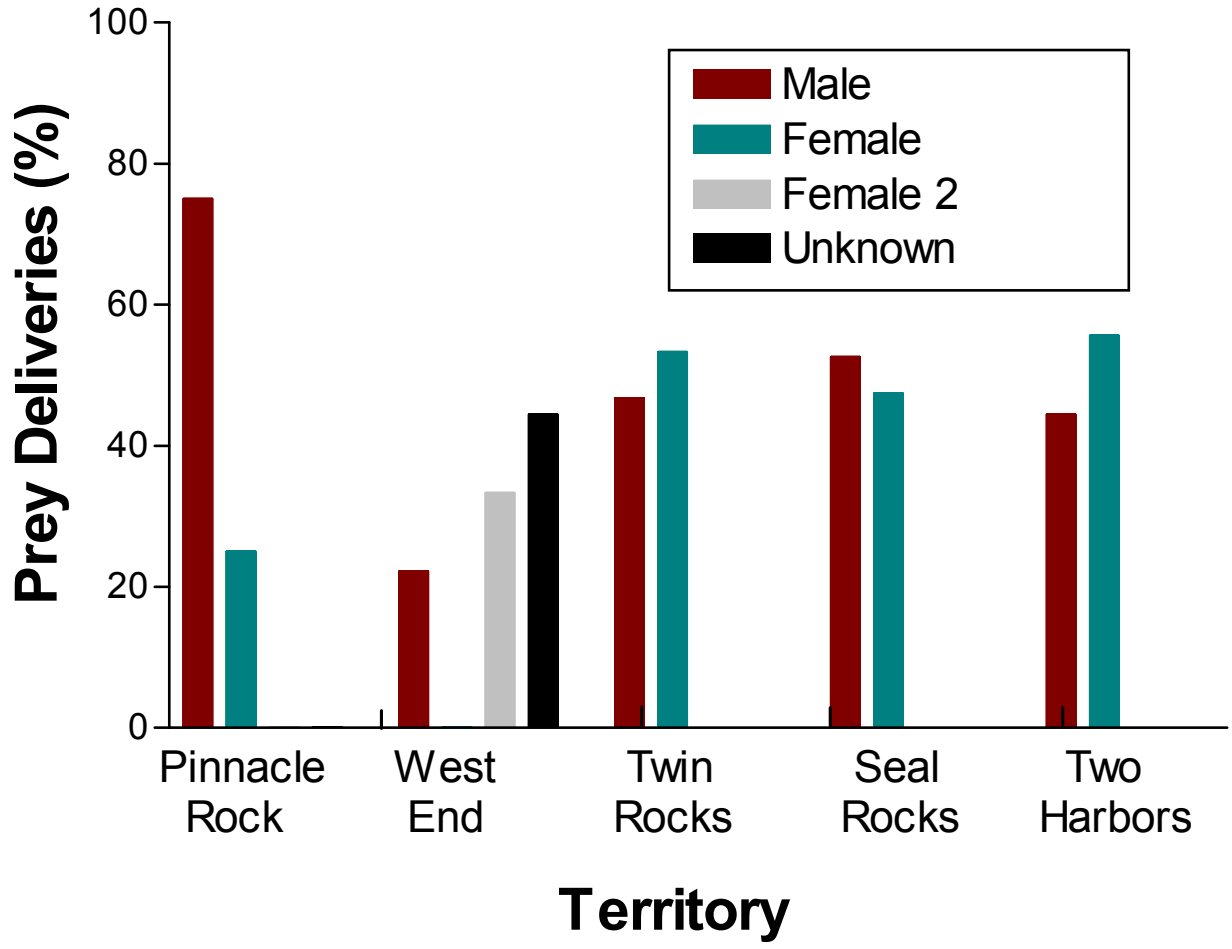

Figure 8. Percent of prey deliveries made by adults to nests in five territories in 2005. Female 2 is the second female at the West End nest with wing markers. We were unable to determine which birds were making deliveries at the West End nest because two of the adults do not have wing markers and we were watching the nest through a spotting scope due to a camera failure.

Table 4. Number and percent of food items delivered to the Pinnacle Rock, West End, Twin Rocks, Two Harbors and Seal Rocks nests during monitoring on Santa Catalina Island, California, 2005.

	Prey deliveries									
	Pinnacle Rock		Seal Rocks		Twin Rocks		Two Harbors		West End	
Food Item	n	% of Total	n	% of Total	n	% of Total	n	% of Total	n	% of Total
FISH										
Unknown fish	6	75.0	13	68.4	9	64.3	13	72.2	7	70.0
Unknown rockfish (*Sebastes* spp.)	0	0.0	1	5.3	0	0.0	0	0.0	0	0.0
Unidentified smelt	0	0.0	0	0.0	0	0.0	1	5.6	0	0.0
Garibaldi (*Hypsypops rubicundus*)	0	0.0	0	0.0	1	7.1	0	0.0	1	10.0
California flying fish (*Cypselurus californicus*)	0	0.0	1	5.3	0	0.0	0	0.0	0	0.0
Pacific sardine (*Sardinops sagax*)	0	0.0	0	0.0	0	0	3	16.7	0	0.0
California grunion (*Leuresthes tenuis*)	0	0.0	0	0.0	1	7.1	0	0.0	0	0.0
Fish Subtotal	6	75.0	15	79.0	11	78.6	17	94.4	8	80.0
BIRDS										
Unidentified gull	0	0.0	1	5.3	0	0.0	0	0	0	0.0
Heermann's gull (*Larus heermanni*)	0	0.0	0	0.0	1	7.1	0	0.0	0	0.0
California quail (*Calipepla californica*)	0	0.0	0	0.0	1	7.1	0	0.0	0	0.0
Unidentified petrel (*Pterodoma* sp.)	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0
Unidentified bird	0	0.0	0	0.0	1	7.1	0	0.0	0	0.0
Birds Subtotal	0	0.0	1	5.3	3	21.4	0	0.0	1	10.0
UNKNOWN	2	25.0	3	15.8	0	0.0	1	0.0	1	10.0
TOTAL FOOD ITEMS	**8**		**19**		**14**		**18**		**10**	

Additional Eagle Sightings

In 2005 there were many sightings of bald eagles previously released on Catalina Island at various locations on the mainland and on other of the Channel Islands.

Eagle K-13 (FWS Band # 629-02783), which was fostered into the Pinnacle Rock nest in 2001, was seen many times on mainland southern California in 2005. We began getting reports of the bird in the Laguna Beach area on 14 January, where it was seen for several weeks (Fig. 9). It appears to have remained in southern California and was observed on the Palos Verdes Peninsula in late April and late December.

Eagle K-26 (FWS Band # 629-02793), a female that was fostered into the West End nest in 2002, was reported at Santa Margarita Reservoir, San Luis Obispo County, California on 22 January. We began seeing the bird on Santa Cruz Island on 13 February, where it stayed for the rest of the year, often in the presence of Eagle K-10 (FWS Band # 629-02780), a male fostered into the Twin Rocks nest in 2001 (Fig. 10).

Eagle K-35 (FWS Band # 629-47351), which we fostered into the West End nest in 2003, was reported at Huntington Beach in January.

Figure 9. Eagle K-13 landing in a tree in Laguna Beach, California in 2005.

Figure 10. Eagle K-26 feeding on pig carcasses with K-10 on Santa Cruz Island, California in 2005.

Eagle K-36 (FWS Band # 629-47352), fostered into the Two Harbors nest in 2003, was reported at Wickiup Reservoir, Oregon on 25 June.

Eagle K-37 (FWS Band # 629-47353), fostered into the Seal Rocks nest in 2003, was reported at Big Bear Lake, California from April through June.

Eagle K-42 (FWS Band # 629-47367), fostered into the Twin Rocks nest in 2004, had not been seen or reported since 19 November 2004. It appears to have returned to or remained on Catalina Island and we picked up its transmitter signal again on the west side of the island on 17 May. He remained on Catalina Island until December, at which time its signal appeared to be coming from San Clemente Island. IWS personnel on San Clemente later confirmed its presence on that island.

Eagle K-47 (FWS Band # 629-47371), fostered into the Seal Rocks nest in 2004, was reported on the Olympic Peninsula, Washington on 3 and 15 January, 2005. By 25 June the bird had moved to Wickiup Reservoir, Oregon and we began picking up signals from the bird on Catalina Island at the end of July.

Collection of Tissue Samples

We collected blood samples for chemical analyses from five eaglets on Catalina Island in 2005. In addition, we collected the eggshell and contents from eight eggs that were collected on Catalina Island that either were infertile or failed to hatch (Appendix II). The eggs were analyzed for contaminants and found to have 10.8 – 46.1 ppm DDE. We calculated the contaminant load of fresh eggs based upon the calculated fresh wet weight of the eggs. Calculated DDE contaminant loads of eggs at the time they were laid ranged from 9.2 – 35.8 ppm (Appendix II).

DISCUSSION

There were a few milestones during the 2005 bald eagle breeding season on Catalina Island. We successfully incubated and hatched three bald eagle eggs, the highest success rate since the inception of the nest manipulation portion of the project in 1989. These also were the first bald eagle chicks to hatch on Catalina in nearly 50 years. We fostered five chicks, two of which were from the San Francisco Zoo, into five different nests and all chicks fledged. Three of these remained on the island through the end of the year, including two of the three chicks hatched on the island.

The contaminant loads in eggs that failed to hatch this season continue to be highly elevated and can fluctuate widely within a territory. For instance, the West End eggs had DDE values ranging from 9.2 – 25.9 ppm (fww). This variation may be a result of both females laying eggs. The lowest DDE levels were found in the Twin Rocks eggs (8.6 and 9.4 ppm; fww), one of

the territories that have consistently had the lowest contaminant loads in the eggs. The Seal Rocks pair has had low contaminant levels in previous years, but the one egg that failed to hatch this season had a calculated DDE load of 35.8 ppm (fww), higher than any other territory. We question the results from this particular egg because the value is over five times higher than the value calculated for the 2004 egg from this territory (6.55 ppm fww).

We anticipate the addition of a new breeding pair on Catalina Island in 2006. Eagle K-80, a male fostered into the West End nest in 1998, and Eagle K-92, a female released from a hack tower in 1999, established a territory near Avalon in 2003 and were seen copulating this season, but we found no evidence of nesting.

Bald eagles we released in previous years are continuing to return to Catalina Island and nearby areas on the mainland and other Channel Islands, making it likely that the breeding population on Catalina Island will continue to grow. Even with great care, we were able to hatch only 33% of the fertile eggs collected, indicating that DDE contamination still is having a severe negative impact on Catalina's bald eagles. Therefore, for the foreseeable future it likely will be necessary to continue manipulating nests on Catalina Island if we are to maintain a bald eagle population on the island.

ACKNOWLEDGMENTS

Funding for this project was made available by the Montrose Settlement Restoration Program. We thank Annie Little, of the U.S. Fish and Wildlife Service, for her assistance with contracting and coordination. We thank Cheyenne Lacsek-Johnson, Julie King, Robyn Powers, and Calvin Duncan for their hard work on all aspects of this study during 2005. We also thank Kathy Hobson (San Francisco Zoo) for her assistance in training our staff on how to care for bald eagles eggs and suggestions for hatching and caring for the eaglets. The Santa Catalina Island Conservancy provided access to their land and logistical support, and the U.S. Fish and Wildlife Service and the California Department of Fish and Game provided the necessary permits to conduct the work.

LITERATURE CITED

Anderson, D. W., J. R. Jehl, Jr., R. W. Risebrough, L. A. Woods, L. R. DeWeese, and W. G. Edgecomb. 1975. Brown pelicans: improved reproduction off the southern California coast. Science 190: 806-808.

Bortolotti, G.R. 1984. Sexual size dimorphism and age-related size variation in bald eagles. J. Wildl. Manage. 48:72-81.

Garcelon, D.K. 1988. The reintroduction of bald eagles on Santa Catalina Island, California. M.S. thesis, Humboldt State University, Arcata, California. 58pp.

Garcelon, D.K., M.S. Martell, P.T. Redig, and L.C. Buoen. 1985. Morphometric, karyotypic, and laparoscopic techniques for determining sex in bald eagles. J. Wildl. Manage. 49:595-599.

Garcelon, D.K., R.W. Risebrough, W.M. Jarman, A.B. Chartrand, and E.E. Littrell. 1989. Accumulation of DDE by bald eagles *Haliaeetus leucocephalus* reintroduced to Santa Catalina Island in Southern California. Pages 491-494 *in* B.-U. Meyburg & R. Chancellor, eds. Raptors in the modern world. World Working Group on Birds of Prey and Owls, Berlin, London & Paris.

Garcelon, D.K., and N.J. Thomas. 1997. DDE poisoning in an adult bald eagle *(Haliaeetus leucocephalus*). J. Wildl. Dis. 33:299-303.

Grier, J. W. 1982. Ban of DDT and subsequent recovery of reproduction in bald eagles. Science 218: 1232-1235.

Hickey, J. J., and D. W. Anderson. 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162:271-273.

National Oceanic and Atmospheric Administration (NOAA). 1985. Climatological data annual summary, California 1985. Vol. 89. Nat. Oceanic Atmos. Admin., Washington, D.C.

Phillips, D.M. and D.K. Garcelon. 1996. Research and Management of bald eagles on Santa Catalina Island, California, 1996. Contract report submitted to the Damage Assessment Office, U.S. Fish and Wildlife Service, Sacramento Field Office, California. 31pp.

Risebrough, R. W. 1998. Endocrine disrupters and bald eagles: A response. Endangered Species UPDATE 15:47-50.

Risebrough, R. W., F. C. Sibley, and M. N. Kirven. 1971. Reproductive failure of the brown pelican

Wiemeyer, S. N., T. G. Lamont, C. M. Bunck, C. R. Sindelar, F. J. Gramlich, J. D. Fraser, and M. A. Byrd. 1984. Organochlorine pesticide, polychlorobiphenyl, and mercury residues in bald eagle eggs—1969-1979—and their relationships to shell thinning and reproduction. Arch. Environ. Contam. Toxicol. 13:529-549.

Appendix I

ADULT BEHAVIORS TO BE RECORDED DURING SCAN SAMPLING

POSTURES	
Standing (ST)	Bird is upright on one or both of its feet on any substrate
Sitting (SI)	Bird is resting its weight on its tarsometatarsus (not its feet) and does not have its sternum touching the nest substrate
Lying (L)	Bird is prone on the nest with its sternum touching the nest substrate
Flying (F)	Feet of bird are not touching any substrate (flapping or hovering)
BEHAVIORS	
Brooding (BR)	Bird is sheltering chick under body or wing, and may be pulling nest material around its body
Resting (R)	Bird is lying in nest with its head resting on the substrate
Eating (EA)	The act of pulling at or swallowing food
Feeding (FE)	The act of preparing or giving food to a chick
Preening (PR)	Bird has its beak buried in its feathers or is running its beak along the shaft of a feather
Nest Maintenance (NM)	Bird bringing nest material, or arranging nest material in the nest
Walking (WA)	Moving around the nest either in the standing or sitting postures
Vocalizing (V)	Head back, and appearing to vocalize
Out of view (O)	Bird is either facing away from camera and behavior is unknown, or bird is blocked from view by the nest or another bird
Alert (A)	Bird is attentively looking around or in a particular direction
Non-Descript (N):	Behavior belongs to no definite class (e.g., non-alert scanning, watching chick)

Appendix I (continued)

CHICK BEHAVIORS TO BE RECORDED DURING SCAN SAMPLING	
POSTURES	
Standing (ST)	Bird is upright on one or both of its feet on any substrate
Sitting (SI)	Bird is resting its weight on its tarsometatarsus (not its feet) and does not have its sternum touching the nest substrate
Lying (L)	Bird is prone on the nest with its sternum touching the nest substrate
Flying (F)	Feet of bird are not touching any substrate (flapping or hovering)
BEHAVIORS	
Resting (R):	Bird is lying in nest with its head resting on the substrate.
Eating (EA)	The act of pulling at or swallowing food without help from an adult
Feeding (FE)	Act of taking food from the adult or swallowing food offered by the adult.
Preening (PR)	Bird has its beak buried in its feathers or is running its beak along the shaft of a feather
Playing (PL):	Toying with nest material, feathers, or food
Wing Exercising (WE):	Flapping both wings while the feet are in contact with the nest substrate
Walking (WA)	Moving around the nest either in the standing or sitting postures
Wing-flap/Jump (J):	Flapping wings and jumping from one part of the nest to another.
Wing Stretch (WS):	Extending one wing or a wing and a leg.
Wings Out (WO):	Extending both wings out, usually precedes a wing-flap/jump or flying.
Out of view (O)	Bird is either facing away from camera and behavior is unknown, or bird is blocked from view by the nest or another bird
Non-Descript (N):	Behavior belongs to no definite class (e.g., non-alert scanning, watching chick)

Appendix II

Specimens collected from bald eagles on Santa Catalina Island, California for analyses in 2005. DDE levels are reported for samples that have been analyzed.

Tissue Type	Collection Location	Description	Measured DDE (ppb)	Calculated DDE (fresh wet weight; ppb)
Whole Blood	Twin Rocks Nest	10 cc from 8-week-old eaglet (K-50)	.	.
Whole Blood	Pinnacle Rock Nest	10 cc from 8-week-old eaglet (K-51)	.	.
Whole Blood	West End Nest	10 cc from 8-week-old eaglet (K-54)	.	.
Whole Blood	Two Harbors Nest	10 cc from 8-week-old eaglet (K-55)	.	.
Whole Blood	Seal Rocks Nest	10 cc from 8-week-old eaglet (K-56)	.	.
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-01 (Twin Rocks)	12000	9410.69
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-02 (Twin Rocks)	10800	8605.94
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-04 (West End)	28400	25887.45
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-06 (West End)	10300	9202.04
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-07 (West End)	24500	20381.09
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-08 (Pinnacle Rock)	29200	23694.46
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-09 (Pinnacle Rock)	16000	13945.4
Egg Shell and Contents[a]	Catalina Incubation Facility	Egg 05-11 (Seal Rocks)	46100	35776.89

[a]Egg shells were rinsed in water, air dried, and stored in aluminum foil. Shell contents were placed directly into a chemically clean jar and frozen.