

Restoration and Management of Bald Eagles on Santa Catalina Island, California, 2007

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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). 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 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 also attributed to the impacts of DDT (Risebrough et al. 1971, Anderson et al. 1975, Grier 1982, 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 all the eggs produced broke in the nest. 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).



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

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. 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 2007, adult bald eagles successfully reared 59 of 70 chicks that were either fostered into nests (64 chicks), hatched from two of three healthy eggs that were placed into nests, or hatched from eggs left in the nest (4 chicks) (Table 1). Four of these 70 birds were removed from the nest prior to fledging because of injuries and seven died due to accidents, predation, or unknown causes. An additional 21 eagles have been released through continued hacking activities since 1991 (20 chicks and a 1-year-old bird).

Table 1. Summary of Bald Eagle egg and chick manipulations on Santa Catalina Island, 1989-2007.

	Year									
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
# of Active Nests	1	2	2	3	3	2	3	3	2	3
# of Eggs Laid	2	2-3	3	5	5-6	3	5	5-6	6	7
# of Eggs Collected	1	1	3	5	4	3	5	4	5	6
# of Catalina Island Eggs Hatched ^a	0	0	1	2	0	0	0	0	1	1
# of Eggs Fostered Into Nests on Catalina Island	0	0	2	0	0	0	1	0	0	0
# of Chicks Fostered Into Nests on Catalina Island	1	0	0	3	2	2	1	5	1	4
# of Chicks Fledged From Nests on Catalina Island	1	0	2	3	1	1	1	2	1	3
# of Eagles Hacked Onto Catalina Island	0	0	2	0	2	0	2	5	0	4
# of Island-Produced Eagles Breeding on Island	0	0	0	0	0	0	0	0	1	1
# of Second Generation Eagles Fledged	0	0	0	0	0	0	0	0	1	0

Table 1. Continued

	Year								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
# of Active Nests	4	3	4	4	5	5	5	5	5
# of Eggs Laid	8	7	8	8	9	11	11	10	13
# of Eggs Collected	6	4	7	7	8	11	11	10	9
# of Catalina Island Eggs Hatched	1	2	0	2	1	3	3	5	11 ^a
# of Eggs Fostered Into Nests on Catalina Island	0	0	0	0	0	0	0	0	0
# of Chicks Fostered Into Nests on Catalina Island	3	4	5	7	4	5	5	5	7
# of Chicks Fledged From Nests on Catalina Island	2	4	5	6	3	5	5	3	11
# of Eagles Hacked Onto Catalina Island	2	0	4	0	0	0	0	0	0
# of Island-Produced Eagles Breeding on Island	2	1	2	2	3	3	3	3	3
# of Second Generation Eagles Fledged	0	0	0	0	0	1	5	3	6

^aFour eggs left in two different nests hatched; seven of 9 eggs collected hatched.

IWS began a similar reintroduction program on the northern Channel Islands in 2002. In 2006, two separate pairs on Santa Cruz Island successfully hatched and fledged one chick (Sharpe 2007). These were the first known bald eagle chicks to hatch naturally in the wild on the California Channel Islands since 1949. In 2007, only one of the two nests was successful at hatching and fledging an eaglet. Because of the recent successes on the northern Channel Islands, we decided to leave eggs in two nests on Santa Catalina Island in 2007 to see if they could hatch on their own. This report summarizes the results of this experiment, egg and chick manipulations at other nests, and subsequent monitoring for the nesting season of 2007.

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 km² (Fig. 2). Elevations range from sea level to

648 m. Mean annual temperatures range from 12 to 20° C near the coast, and yearly precipitation averages 31 cm (NOAA 1985).

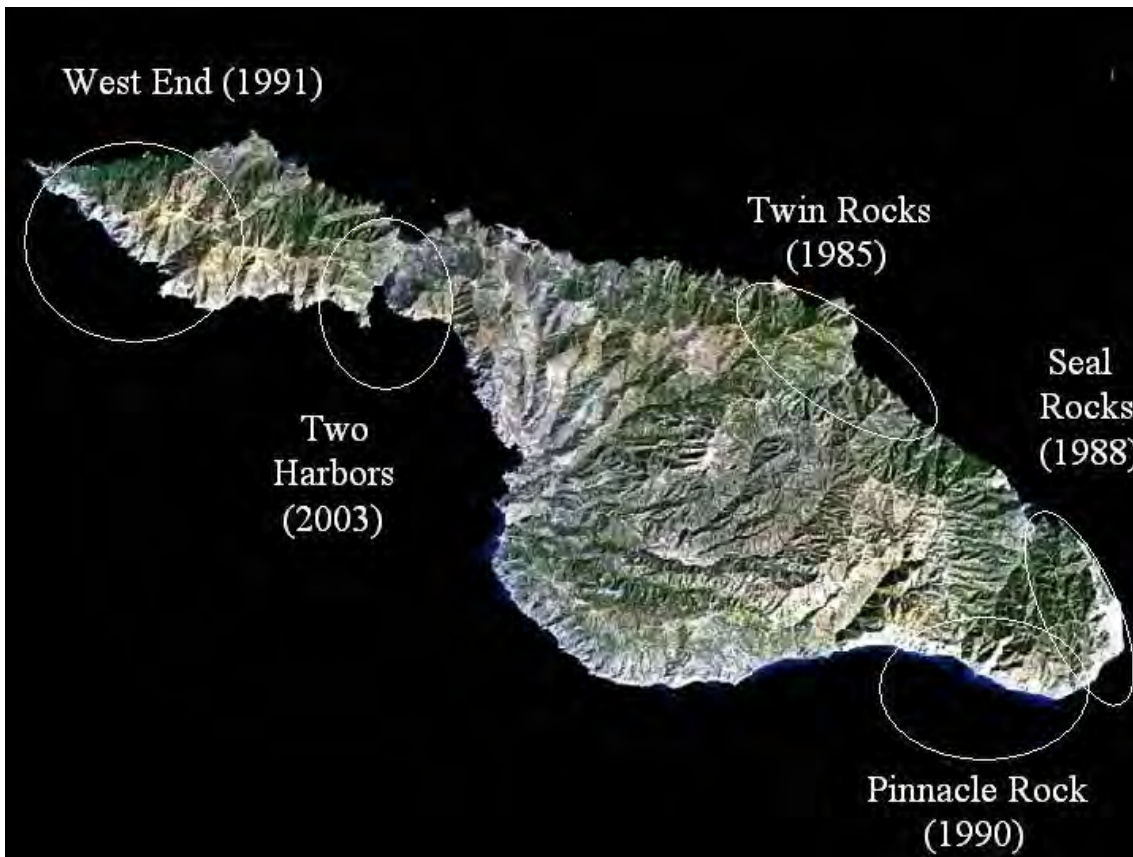


Figure 2. Active bald eagle territories on Santa Catalina Island, California and the year they were first occupied.

Nesting Territories

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

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 original male disappeared between the 2005 and 2006 breeding seasons. In 2006, male K-01, fostered into the Pinnacle Rock nest in 2000, was observed in the vicinity of the nest and was apparently accepted by the two females. The new trio bred again in 2007. 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. In the fall of 2005 the female was found dead in a canyon on the southern edge of their territory. The female was replaced by a 7-year-old female in 2006 and the pair remained together in 2007. There have been six different nest sites in this territory from 1990-2007.

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 2007.

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 nested in each year from 2001 through 2007.

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 at least one fostered chick each year from 2003 through 2007.

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 observation blinds from which to observe the nests. From the blinds we monitored the

chronology of nesting through incubation and chick-rearing. 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 rainfall.

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).

Natural Nesting Experiment

This season we allowed two nests, Seal Rocks and Pinnacle Rock, to keep their eggs to determine whether they could hatch without human assistance. The average DDE concentrations in the eggs from the Seal Rocks nest consistently have been in the 6-8 ppm range since 2001, so we thought there was a chance they could hatch on their own. The female at the Pinnacle Rock nest is the youngest breeding female on the island at 8 years of age, so it is likely that she has the lowest body burden of DDE, and therefore, the lowest egg contamination. One of her eggs hatched in our incubators in 2006, the first to ever hatch from the Pinnacle Rock territory.

Monitoring

We monitored each nest from incubation through fledging of chicks. We used radio-telemetry to locate and observe fledged eagles every 1-3 days during their first month of flight. We attempted to observe, or at least determine that the birds were moving, at least once per week through December, or until they left the island.

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). We acquired a Grumbach incubator from the San Francisco Zoo and purchased a Brinsea Contaq X8 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



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

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. The Grumbach can also be used as a hatching unit if it is not needed for incubation.

RESULTS

Manipulations and Monitoring

Nests were located in February 2007 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 1998-2006. 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. The birds were seen at the nest several times during February and the first egg was laid around 25 February. A second egg was observed on 1 March and we hiked to the nest on 4 March to remove the two eggs. Both eggs were fertile and both hatched (see below).

On 9 April, we fostered both of the chicks that hatched from the Twin Rocks eggs back into the nest. We returned to the nest on 28 May and equipped the eaglets with leg bands, transmitters, and wingmarkers and obtained blood samples (Table 2). We continued to observe the eaglets in the nest until they fledged around 25 June. Eagle K-75 remained on the island through the end of the year. K-76 was last seen on Catalina Island on 7 September. It was sighted at Mad River Beach in Humboldt County, California on 15 September.

West End Territory

The West End trio of birds used the same nest that has been used since 1991. The male, K-01, was produced by captive birds at the ACC and fostered into the Pinnacle Rock nest in 2000. The original female (Female 1) was not marked with patagial tags, but is believed to be a 21-year-old bird released at the Sweetwater hacktower in 1986. The second female (Female 2), which joined the original pair in 1992, is a 21-year-old bird (K-69) that also was released at the Sweetwater hacktower in 1986. This nest was monitored primarily via our live web cam and birds were regularly seen at the nest throughout February. On 20 February we detected the first egg in the nest. A second, third, and fourth egg were seen in the nest on 23, 25, and 27 February. We entered the nest on 28 February and removed five eggs that were laid in two separate nest bowls (Fig. 4). Although both females were actively incubating, we left only two artificial eggs in a single bowl. All five eggs were fertile, but only three hatched.

Table 2. Biographical data for bald eagle chicks fostered into nests on Santa Catalina Island, California during 2007.

Federal Band	Sex	Wing Marker	Date Fledged	Foster Nest	Status ^a	Comments
629-52425	Male	K-00	~6/20/07	Pinnacle Rock ^b	Unknown	Left the island around 19 September
629-52426	Male	K-71	~6/20/07	Pinnacle Rock ^b	Dead	Found dead on 3 September at west end of Catalina Island
629-52427	Female	K-72	~6/25/07	West End	Unknown	Left the island around 24 August
629-52428	Male	K-73	~6/25/07	West End	Unknown	Seen in Mendicino Co., California on 12 August
629-52429	Male	K-74	~6/25/07	West End	Unknown	Left the island around 27 July
629-52430	Male	K-76	~6/25/07	Twin Rocks	Unknown	Seen in Humboldt, Co., CA on 9/15/07
629-52431	Male	K-75	~6/25/07	Twin Rocks	Alive	Remained on the island
629-52432	Male	K-78	~6/28/07	Two Harbors	Unknown	Left the island around 24 August
629-52433	Female	K-79	~6/28/07	Two Harbors	Unknown	Left the island around 12 September
629-52434	Female	K-03	~6/20/07	Seal Rocks ^b	Alive	Seen at Pardee Reservoir in c. California on 5 November
629-52435	Male	K-77	~6/20/07	Seal Rocks ^b	Alive	Remained on the island

^a As of 12/31/07

^b Natural hatch at nest

On 8 April we fostered the three chicks that hatched from the West End eggs into the nest. We returned to the nest on 27 May and equipped the eaglets with leg bands, transmitters, and wingmarkers and obtained blood samples (Table 2). We continued to monitor the birds at the nest until the eaglets fledged around 25 June.

All three eaglets left the island over the next two months. K-72 was last seen on Catalina Island on 24 August. K-73 left the island around 1 August and was seen in Mendicino County, California on 12 August. K-74 was last seen on the island on 27 July.

Pinnacle Rock

The Pinnacle Rock pair used the same nest as in 2006. The female, K-92, was produced by captive birds at the ACC and released at the Bulrush hacktower in 1999. The 21-year-old male, K-65, was hatched at the Bulrush tower in 1986. This pair was observed copulating on 15 February, a first egg was seen in the nest on 22 February, and a second egg was laid on 25 February. We left the eggs in the nest and observed the nest daily so that we would know within



Figure 4. Five fertile eggs laid by two bald eagles at the West End nest, Santa Catalina Island, California in 2007.

territory and was fostered into the Pinnacle Rock nest in 1992. The birds were seen at the nest throughout February and the egg was seen on 3 March. A second egg was present on 5 March. We left the eggs in the nest to see if they would hatch and monitored the nest daily to determine the outcome of incubation.

The first egg hatched on 7 April and the second egg hatched on 9 April. Both chicks survived and we entered the nest on 31 May to

a 24-hour period when an egg broke. On 31 March, the first of the eggs hatched, and a second chick was present on 1 April.

We climbed to the nest on 23 May and equipped the eaglets with leg bands, wingmarkers, and transmitters (Fig. 5), and collected blood for contaminants analyses (Table 2). The eaglets both fledged around 20 June and began moving around the island a few weeks later. K-71 was found dead near the West End nest on 3 September, and K-00 was last seen on the island on 19 September.

Seal Rocks Territory

The Seal Rocks pair used the same nest as in 2006. The 14-year-old female, K-34, is from the captive ACC eagles and was hacked at the Bulrush tower in 1993. The 15-year-old male, K-25, hatched from an egg from the West End



Figure 5. The two eaglets that hatched at the Pinnacle Rock nest on Santa Catalina Island, California in 2007. These are the first chicks known to hatch naturally on the island in over 50 years.

equip the birds with leg bands, transmitters and wingmarkers and to collect blood for contaminants analyses. We continued to monitor the nest until the birds fledged on or around 20 June (Table 2). We relocated the birds via telemetry 2-3 times per week. K-03 left the island around 29 September and was last reported at Pardee Reservoir in central California on and around 5 November. K-77 remained on the island through the end of the year.

Two Harbors Territory

The Two Harbors pair used the same nest as last season. The 9-year-old male, K-81, is an ACC-produced eagle that was fostered into the West End nest in 1998. The 9-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 nest was monitored primarily via our live web cam. Activity was noted at the nest throughout February and the birds were first observed incubating on 27 February. A second egg was laid on 2 March and we entered the nest on 6 March to remove the eggs, replacing them with two artificial eggs. The eggs were both fertile and hatched on 6 and 8 April.

On 12 April we fostered both the Two Harbors chicks back into the nest. We returned to the nest on 30 May to install leg bands, transmitters, and wingmarkers on the chicks, and to obtain a blood sample (Table 2). Both eaglets fledged on or around 28 June and left the island around 24 August (K-78) and 12 September (K-79). We have had no reported sightings of these birds on the mainland.

Reports on Previously Released Eagles

Eagle K-80, fostered into the West End nest in 1998, has remained on the island. He has apparently paired up with female K-47, an eagle fostered into the Seal Rocks nest in 2004. The pair's territory encompasses the area around the City of Avalon.

Eagle K-93, released from the Bulrush hacktower in 1999, has remained at Thompson Reservoir on Catalina. He has now paired with a female (A-32) released on Santa Cruz Island in 2004.

Eagle K-02, fostered into the West End nest in 2000, was reported to be breeding at Lake Hemet, California.

Eagle K-10, a bird fostered into the Twin Rocks nest in 2001, again bred with another Catalina eagle, K-26, on Santa Cruz Island. The pair laid two eggs and successfully hatched and fledged one chick.

Eagle K-11, a bird fostered into the West End nest in 2001, again bred with a Santa Cruz female on Santa Cruz Island. The pair nested on the ground for a second year, but the nest failed

about two weeks into incubation.

Eagle K-23, fostered into the Pinnacle Rock nest in 2002, was reported a couple times in 2007. On 21 April he was seen on a tidal flat near Crescent Beach, British Columbia. On 8 December he was photographed at Samish Flats, Washington.

Eagle K-56, fostered into the Seal Rocks nest in 2005, remained on Catalina through 2007.

Eagle K-61, fostered into the Seal Rocks nest in 2006, was seen multiple times between October and December at Lake Nacimiento in central California.

Eagle K-64, fostered into the Pinnacle Rock nest in 2006, remained on Catalina through 2007.

Artificial Incubation

In 2007, we collected 9 eggs (all fertile) from three active nests on the island. Of these eggs, we successfully hatched 7 eggs (77.8%), 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 2007.

Territory/ Egg #	Estimated Lay Date	Estimated Initial Wt.	Days Incubated	End Wt.	Comments
West End					
07-01	2/20/07	141.28 g	24	124.66 g	Died in shell
07-02	2/23/07	139.72 g	37	.	Hatched and fostered
07-03	2/25/07	133.94 g	35		Hatched and fostered
07-04	2/27/07	124.93 g	35		Hatched and fostered
07-05	2/27/07	119.38 g	11	113.68 g	Dead in shell
Twin Rocks					
07-06	2/25/07	128.30 g	37		Hatched and fostered
07-07	2/28/07	121.25 g	35		Hatched and fostered
Two Harbors					
07-08	2/27/07	140.97 g	38		Hatched and fostered
07-09	3/2/07	135.54 g	37	.	Hatched and fostered

DISCUSSION

In 2007, we improved our hatching success of artificially incubated eggs, hatching 7 of 9 eggs, the highest success rate since the inception of the nest manipulation portion of the project

in 1989. This improvement is likely a result of a recalibration of the incubator and increasing the incubation room humidity, which was kept at about 60% Relative Humidity. With the increased humidity, little had to be done in terms of treating the eggshells to reduce water loss. All seven chicks successfully fledged from nests, but only one is known to have remained on Catalina (K-75).

For the first time since 1988, we purposely left eggs in two nests on the island. All four eggs, two in each nest, hatched and the chicks fledged. One chick is known to have died and two have remained on the island. Because of the success with the wild eggs, we plan to leave eggs in the Pinnacle Rock and Seal Rocks nests in 2008. We will also leave eggs in the Twin Rocks nest, which has had slightly higher contamination levels in unhatched eggs when compared to the Seal Rocks eggs. Any new nests will also be allowed to keep their eggs.

In 2008, there is a possibility of two new breeding pairs on the island: the Middle Ranch pair and the Rattlesnake pair. Both pairs have 4-year-old females, so 2008 is the first year we might expect breeding from these birds. We will also survey the island for other new pairs which may have formed in more remote areas.

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