State of California
The Resources Agency
Department of Fish and Game
Wildlife Branch

Breeding Biology of the California Least Tern at Venice Beach, Marina Del Rey, California in the 2008 Breeding Season

by
Thomas Ryan and Stacey Vigallon

Nongame Wildlife Program, [2008-XX]

Draft Report

To

State of California
Department of Fish and Game
Office of Spill Prevention and Response
1700 K Street, Suite 250
Sacramento, California 95814

Breeding Biology of the California Least Tern at Venice Beach, Marina Del Rey, California in the 2008 Breeding Season

Thomas Ryan, Senior Biologist/Project Manager
Ryan Ecological Consulting
135 North Meridith Avenue
Pasadena, CA 91106

and

Stacey Vigallon, Field Biologist
Los Angeles Audubon
7377 Santa Monica Blvd.
West Hollywood CA 90046-6694

Prepared 27 October 2008

State of California
The Resources Agency
Department of Fish and Game

Breeding Biology of the California Least Tern at Venice Beach, Marina Del Rey, California in the 2008 Breeding Season [1]

by

Thomas Ryan, Senior Biologist/Project Manager
Ryan Ecological Consulting
135 North Meridith Avenue
Pasadena, CA 91106

and

Stacey Vigallon, Field Biologist
Los Angeles Audubon
7377 Santa Monica Blvd.
West Hollywood CA 90046-6694

ABSTRACT

In 2008, California least terns (*Sternula antillarum browni*) arrived at the Venice Beach Colony on April 22 and departed after August 27. We estimate 468 breeding pairs were present at the site in 2008. Nesting began slowly because of intense predation by American crows. This remained a problem into mid-June. It is difficult to estimate the total number of breeding pairs because while many renested, many likely departed as well.

Courtship activities began on April 22 and the first nest was found on May 13. All nests were predated until June 16. We observed the first chick on July 8, although measurements taken while banding indicated that the first chick hatched around July 3. This year there was a very brief peak of hatching between July 8 and 29. The last hatchlings were observed around August 5. We observed the first fledgling within the enclosure on July 29 and the last on August 21. Least terns were present in the vicinity until at least August 27. We counted a total of 928 nests

[1] Ryan, T., L. Seckel and S. Vigallon. 2008. Breeding biology of the California least tern at Venice Beach, Marina Del Rey, California in the 2007 breeding season. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report, 2008-XX. Sacramento, CA. 14 pp.

and 1236 eggs, resulting in a mean clutch size of 1.3 eggs per nest. We estimate 476 chicks hatched (38.5%) and of those 296 fledged (62.1%).

In 2008, American crows were the primary predators on eggs. Nocturnal visits by what were likely black-crowned night-herons and great blue herons may have caused high mortality among small chicks; peregrine falcons (*Falco peregrinus*) were the primary predators on adult least terns. In 2008, we estimate American crows removed approximately 761 eggs (61.6%), a large increase from 12% in 2007 and 20.6% in 2006. Most predation occurred before June 16, when there were fewer than 60 active nests at any given time due to predation. There was little predation on eggs after June 20, when the colony grew to 173 active nests . This reduced predation was observed after implementing predator control measures.

Human disturbance of fledglings roosting outside the colony may be a potential source of mortality for newly fledged least terns, and we recommend implementation of additional protective measures between July 10 and August 15.

INTRODUCTION

The California least tern (*Sternula antillarum browni*) (least tern) is one of three least tern subspecies breeding in North America. It nests from April through August along the coast from the San Francisco Bay in California to lower Baja California. This subspecies presumably winters in southern Mexico, Central America, or northern South America, although their wintering range remains unknown (Ryan and Kluza 1999, Keane 2001).

Least terns historically nested in several small, scattered aggregations on sandy beaches and salt flats along the California and Baja California coast, although the progressive loss throughout the last century of undisturbed sandy beaches resulted in a severe reduction in both nesting sites and numbers of nesting pairs (Chambers 1908). By the 1940's, least terns were gone from most beaches of Orange and Los Angeles counties and were considered sparse elsewhere in the state (Grinnell and Miller 1944).

Least terns have nested near Venice Beach since 1894 (Western Foundation of Vertebrate Zoology records). Nesting in the area from that time through 1976 was poorly documented. In 1977, three pairs of least terns nested on the sand at Venice Beach north of the Ballona Creek mouth (Atwood et al. 1977). Beach managers placed emergency fencing around the area to protect the nests and it has remained in the same general location since. This fence has allowed the colony to continue nesting with minimal disturbance (Comrack 2001). Since 1977, Venice Beach has supported up to 16.6 percent of the statewide pairs of breeding least terns and over 30 percent of statewide fledglings (Table 1). However, during the past ten years, the percentage of statewide pairs contributed by the Venice Beach colony has declined from a maximum of 12.4 percent in 1994 to 0.4 percent in 2004. Additionally, the proportion of fledglings produced at the Venice Beach colony declined from 12.4 percent in 1994 to 6.9 percent in 2003, and with no productivity in 2003, 2004, and 2005 (Table 1). From 1999 to 2005, this site has failed to fledge young four of seven years. American crows (*Corvus brachyrhynchos*) likely caused these desertions in 1999, 2002, 2004, and 2005 (L. Comrack pers. comm.). Since 2005, efforts by project biologists and California Department of Fish and Game (CDFG) staff to recover this colony have included: increasing the colony size, replacing the enclosure fence, earlier and aggressive predator control, vegetation management, and volunteer monitoring.

Following recommendations made by biologists and CDFG, the size of the nesting area was enlarged in March 2006 from 4.2 acres to 7.7 acres (3.3 hectares) and a new fence was installed. The fence has thin mesh wire (chick fencing) around the bottom to prevent chicks from wandering out of the site and an angled top to keep people and other mammals from climbing into the site. However, since its installation, the chick fence on the north and west sides has become covered in sand. so a temporary 2-foot high fabric fence was installed inside the enclosure approximately 10 feet from the new chain link fence to prevent chicks from escaping from the colony.

The project team modified predator control efforts to better target egg-depredating crows, including beginning efforts earlier in the season. A volunteer colony monitor program began in 2005 (Ryan 2005). Volunteers provide timely reports of disturbance and predation events and

assist biologists in monitoring tern populations. In 2007, Los Angeles (LA) Audubon coordinated volunteer efforts.

Since 2006, the project team has studied the placement and success of nests in relation to habitat conditions and location within the colony. We have used measures of nest placement, hatching success, and predation rates to make recommendations for long-term habitat management and restoration at the site. We will summarize these efforts in a separate report (Ryan et al. In Prep).

Overall, the goals of this report are to:

- Document the timing of the nesting cycle.
- Provide estimates of productivity at the colony.
- Document predation and other causes of mortality.
- Provide results of studies examining how the implementation of previous recommendations has affected the productivity of the colony.
- Provide further recommendations based on these results and on observations made during the 2008 nesting season to improve productivity at the colony.

Table 1. Summary of least tern nesting and productivity at the Venice Beach nesting site, 1977 to 2007 (Ryan and Taylor 2004, Ryan 2005).

Year	Number of Pairs[a]	Percent of Statewide Pairs[b]	Number of Nests	Number of Fledglings	Fledglings Per Pair	Percent of Statewide Fledglings[b]
1976	Nesting site not active					
1977	35	4.1%	N/A	30	0.86	5.7%
1978	68	8.2%	N/A	75	1.1	17.9%
1979	88	8.8%	N/A	140	1.68	20.1%
1980	158	13.5%	N/A	240	1.52	31.2%
1981	150	15.4%	N/A	195	1.3	23.4%
1982	170	16.6%	N/A	60	0.35	11.7%
1983	145	12.1%	N/A	140	0.97	15.7%
1984	83	8.6%	N/A	94	1.13	18.1%
1985	96	9.4%	N/A	113	1.18	17.3%
1986	104	10.8%	N/A	113	1.09	12.8%
1987	109	11.7%	N/A	82	0.75	13.0%
1988	165	13.2%	N/A	192	1.16	17.0%
1989	137	11.0%	N/A	134	0.98	17.5%
1990	206	12.1%	N/A	279	1.35	17.3%
1991	198	10.8%	N/A	200	1.01	11.2%
1992	229	10.9%	275	245	1.07	17.4%
1993	246	10.6%	219	288	0.85	14.2%
1994	345	12.4%	345	224	0.65	12.4%
1995	310	11.9%	354	44	0.14	4.1%
1996	271	8.0%	361	92	0.33	4.6%
1997	375	9.4%	400	263	0.7	8.2%
1998	383	9.2%	387	200	0.52	7.3%
1999	43	1.2%	50	0	0	0.0%
2000	274	5.9%	308	150	0.55	3.9%
2001	331	6.9%	348	388	0.91	8.5%
2002	2	0.1%	2	0	0	0.0%
2003	348	5.1%	371	181	0.52	6.9%
2004	24	0.4%	24	0	0	0.0%
2005	105	1.5%	90	0	0	0.0%
2006	276	3.9%	384	266	0.97	7.3 -10.3%
2007	453	6.5 - 6.7%	546	413	0.91	15.6 - 18.0%
2008	468	N/A	928	296	0.63	N/A

[a] Values are number of least tern nests minus estimated number of renesting pairs.

[b] Percent of statewide total of nesting pairs and fledglings, derived from means of ranges presented in annual reports prepared for the California Department of Fish and Game (see Marschalek 2008). The Venice Beach site is one of approximately 38 sites statewide.

N/A – not available

METHODS

Colony Preparation

The project team first re-marked the existing grid system using a Trimble GEO-XT GPS unit, then surveyed the site for special status plant species on March 7 and 11 (Figure 1). We marked areas with sensitive plant species and they were not disturbed during the vegetation clearing. Next, assisted by crews from the Los Angeles County Department of Beaches and Harbors (LACBH), local volunteers, CDFG and U.S. Fish and Wildlife Service, we conducted site maintenance on March 15, 22, 29, and April 1, 2008. This included removing as much sea rocket (*Cakile maritime*) as possible and modifying 20 x 20 m grids as part of the vegetation study (Ryan et al. 2007). In total, eight grids were cleared of existing vegetation, ten others were already less than 5 percent vegetated, ten grids were reduced to less than 30 percent vegetation cover, and nine others were already less than 30 percent vegetated. In addition, LACBH crews used heavy equipment and hand crews to remove the sand from the chick fence on March 18. On June 30, prior to the first expected chick hatching, a two-foot tall chick fence was installed on the north, west, and part of the south fence, where sand blown by strong winds had built up over the existing chick fence, rendering it useless.

Colony Monitoring

The project team conducted site visits from April 22 to August 27 to observe and monitor nesting activities. Once the adult least terns arrived, we recorded observations of nest building, courtship, and anti-predator behavior. Nest monitoring consisted of walking through the colony, visually searching the sand surface for nests with eggs. When a nest was encountered, we marked it using a wooden tongue depressor with a letter indicating date and a number indicating order of detection. We then recorded the contents and mapped the nest using a Trimble GEO-XT GPS unit. In an effort avoid predators associating markers with nests, we did not mark nests until 100 nests were present. We counted all chicks not in nests as well as fledglings within and adjacent to the colony and also buried dead chicks and predated eggs at the site.

After completing each survey, biologists downloaded nest locations using Trimble Pathfinder. GIS specialists then used the shape-files generated to map each nest and its alphanumeric identifier on an aerial photograph, with the grid system super-imposed. GIS specialists generated field maps each week to aid biologists in locating active nests on their next visit.

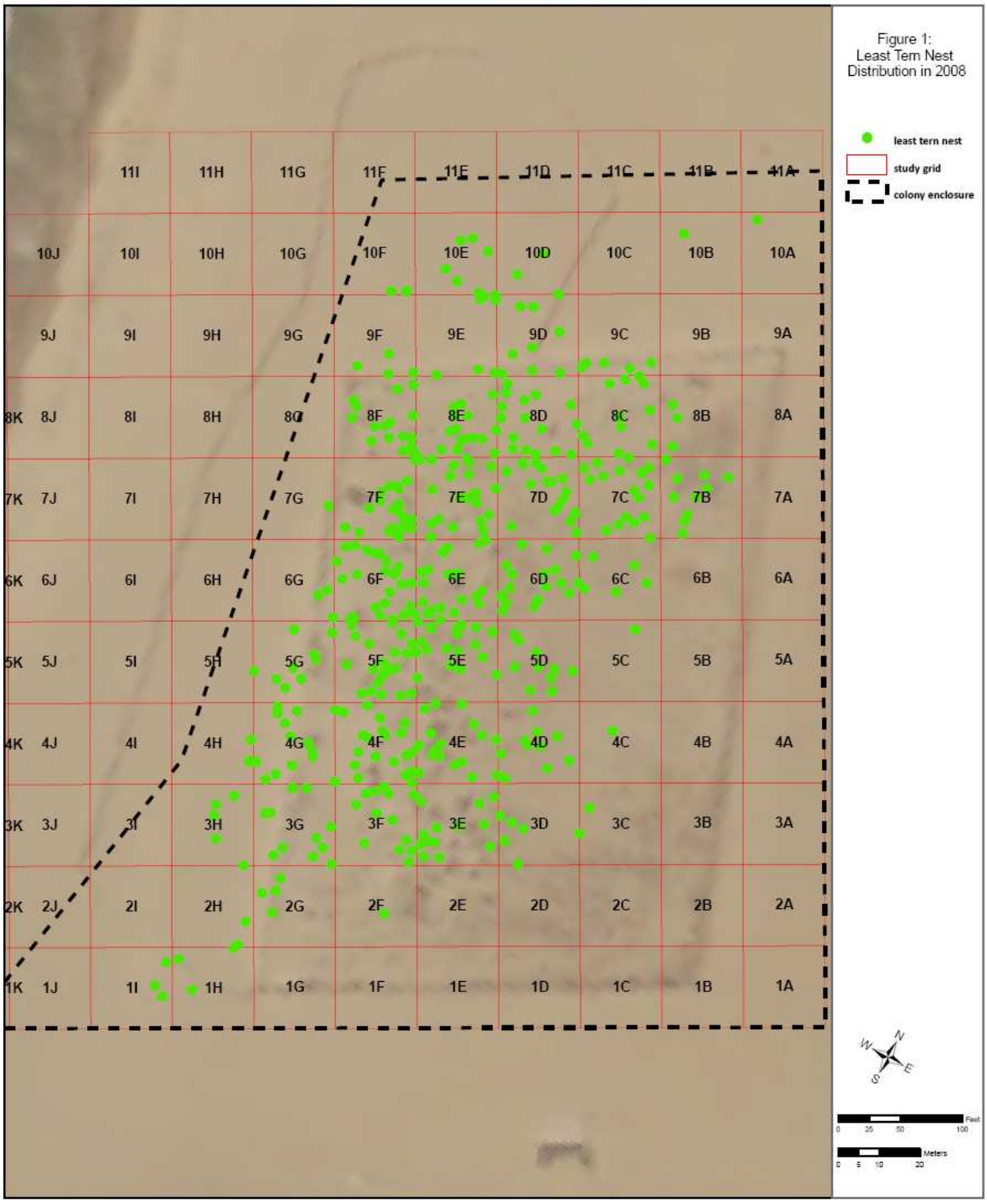
Figure 1:
Least Tern Nest
Distribution in 2008
least tern nest
study grid
colony enclosure
11I 11H 11G 11F 11E 11D 11C 11B 11A
10J 10I 10H 10G 10F 10E 10D 10C 10B 10A
9J 9I 9H 9G 9F 9E 9D 9C 9B 9A
8K 8J 8I 8H 8G 8F 8E 8D 8C 8B 8A
7K 7J 7I 7H 7G 7F 7E 7D 7C 7B 7A
6K 6J 6I 6H 6G 6F 6E 6D 6C 6B 6A
5K 5J 5I 5H 5G 5F 5E 5D 5C 5B 5A
4K 4J 4I 4H 4G 4F 4E 4D 4C 4B 4A
3K 3J 3I 3H 3G 3F 3E 3D 3C 3B 3A
2K 2J 2I 2H 2G 2F 2E 2D 2C 2B 2A
1K 1J 1I 1H 1G 1F 1E 1D 1C 1B 1A
N
W
E
S
Feet
0 25 50 100
Meters
0 5 10 20

The project team visited and noted the condition of each nest during each visit. We considered eggs predated that disappeared within three weeks of detection, were visibly predated, or were missing and other signs of predation (such as American crow tracks) were observed. We considered eggs "did not hatch" if they remained in the nest more than 28 days. We considered eggs "presumed hatched" if they remained in the nest a minimum of three weeks, but no more than 28 days, or if they were located at nests that showed signs of hatching such as a pipped eggshell or tracks from chicks. We considered eggs "confirmed hatched" when chicks were observed at the nest or small chicks were observed within 1 m of the nest. For purposes of analysis, presumed and confirmed hatched are combined into "total hatched." We included unknown-outcome nests in nest counts, eggs produced, and mean clutch size calculations, but not in measures of productivity. In 2008, we observed heavy predation resulting in the removal of all eggs from nests prior to June 16. We counted the number of predated eggs away from nests and used volunteer observations to estimate the number of eggs removed from the colony. Both the predated eggs and weekly estimates were used in producing the estimates of the total number of eggs, nests and total pairs in 2008.

We estimated total chicks present by summing: a) the number of chicks hiding within the colony, b) the number of running chicks in congregation areas in the southwest and north end of the colony, c) the number of chicks hiding along the fence-line, and d) the number of fledglings observed. We estimated total adults present by taking multiple counts of the flock flying above the colony when flushed.

Volunteer Monitoring

Following the recommendations made in previous annual reports (Ryan and Taylor 2004, Ryan 2005, Ryan 2006), the project team recruited volunteer observers from the local community and Audubon Chapters. LA Audubon biologist S. Vigallon coordinated volunteer recruitment, site maintenance, and monitoring efforts in 2008. The team held a volunteer training session in conjunction with the site clean-ups on March 22 and 29. The project team discussed methods, purpose, and least tern identification.

Each volunteer observed the colony for a one-hour period at the same time once per week. They reported their observations via e-mail or phone to Audubon biologist Stacey Vigallon. Ms. Vigallon conveyed urgent reports immediately to Mr. Ryan and summarized each week's observations in a brief report to Mr. Ryan. Volunteers monitored the colony from April 15 to August 22. There were an average of five visits per week by the thirteen volunteers, totaling 114 hours spent observing the colony. Volunteer J. Trefts lives adjacent to the colony and spent approximately 50 hours observing the colony, submitting 25 reports over the 2008 season. Additionally, volunteers spent approximately 518 hours conducting the pre- and post-season site maintenance. Volunteers from Dorsey High School accounted for approximately 320 of these hours. We documented that volunteers spent over 682 hours assisting with the Venice Beach colony in 2008.

Population Parameters

The project team estimated the total number of breeding pairs by subtracting an estimate of re-nesting pairs from the total number of nests. Estimates of fledging success are notoriously

difficult to obtain. We used two methods suggested by CDFG, and attempted to corroborate them using banded chicks to generate an estimate of daily mortality.

Method 1: Sum the number of dead chicks found on the colony and the number of estimated predated chicks and subtract this number from the number of total estimated eggs hatched.

Method 2: Count the number of fledglings present during three predetermined surveys and sum those counts.

The overall fledgling estimate used in comparisons with previous years was made by averaging Methods 1 and 2 (Ryan 2006). Additionally, we banded chicks and estimated the average age of banding. We then recorded all dead banded chicks. We divided the total dead by the total banded to generate an estimate of mortality. We then subtracted the average age of banding (13 days) from the oldest estimated chick age (20 days), generating an estimate of average number of days on the colony (7). We then divided the estimate of mortality by the average number of days to generate a daily estimate of mortality. This estimate was then multiplied by 20, which is the average number of days until fledging (Thompson et al. 1997), to obtain an overall estimate of mortality/survivorship. We then multiplied the estimated total eggs hatched by the survivorship estimate to obtain a third estimate of total fledged.

Banding

The project team conducted three banding sessions in 2008. These occurred on July 17, 22, and 30. We captured chicks by hand that had hid against the chick fence and under vegetation, and banded them upon capture. Team biologists banded chicks using standard banding pliers with USGS 1A bands. We measured wing chord using a metal wing rule and weight using a Pesola spring balance scale.

Predation and Disturbance Monitoring

The project team monitored predation through personal observations during the colony monitoring and by reports from the team of volunteer observers. We estimated predation rates adding the number of eggs, adults, and chicks reported killed and removed from the colony by the volunteers to the number of eggs, chicks, and adults found dead at the colony. The project team combined counts of dead chicks to estimate mortality, which we then used to estimate fledging success. We also estimated egg predation as part of the monitoring of individual nests (described above). In addition, volunteers reported all helicopters flying below 500 feet directly over the colony enclosure as well as any other human-related disturbance they observed.

RESULTS and DISCUSSION

Population Estimate

Least terns arrived at the Venice Beach Colony on April 22, 2008: the same calendar date as 2007, 16 days later than their arrival date in 2006, and six days later than in 2005. We estimate 468 breeding pairs were present in 2008 (Table 1). Their numbers continued to increase through April and May, with peak numbers of individuals present in June and July. Numbers declined through August (Table 2). Team biologists estimated about 700 individuals attended the colony

in July (Table 2). Least terns were present until at least August 27. This was the highest number of birds in attendance and the highest number of nests in this colony's history (Table 1).

Table 2. Summary of least tern population estimates in 2006–2008.

	Volunteer Population Estimate Peak (Average)			Biologists' Population Estimate			Number of Nests Present		
Month	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
April	100 (17.0)	65 (45.4)	85 (22.5)	100	200	157	0	0	0
May	150 (63.4)	273 (86.6)	300 (74.7)	250	400	268	97	159	30
June	300 (151)	350 (221.4)	300 (176.2)	544	900	500	272	410	252
July	600 (241)	325 (205.7)	300 (177.4)	500	600	700	98	261	375
August	251 (146)	140 (79.0)	316 (93.2)	300	250	300	3	25	25

Nesting Activity

Nest Timing

Courtship activities began immediately upon arrival on April 22. These included fish exchanges and courtship flights between adults. Egg laying began on May 13, but colony terns faced heavy predation by American crows. This predation resulted in low numbers of active nests at any one time (see Nesting Activity below). Between May 13 and June 11, typically a time when the numbers of nests are continuously increasing, the total numbers of nests present remained between 2-30 nests and corresponding counts of adults by the volunteers remained fewer than 300 individuals. Meanwhile, the project biologists found 262 predated eggs (an average of 32.8/week) and we estimate, based on volunteer observations, that the crows removed 275 eggs from the colony before June 16. As has been observed in previous years, when there are fewer than 150 nests, the terns appear to be unable to defend the colony against crow predation.

Between June 11 and June 16, the number of active nests increased to 62. Between June 16 and June 20, biologists found 22 predated eggs, but as the number of nests further increased to 174 on June 20 and then to 375 on July 8, egg predation declined. Between June 20 and August 5, 49 eggs were found predated (an average of 7.0/week) and we estimated that 28 eggs were removed. This again demonstrates that there is a negative relationship between egg predation and the number of nests present, with predation declining as the number of nests increases to 150 or greater.

We detected the first chick on July 8, but based on chick size estimates, hatching began around July 4-5. This is 17-18 days later than last year when the first chick was detected on June 18. The number of chicks in nests peaked between July 10 and July 15. We observed the first fledgling on July 29, 20 days later than 2006. Between 21 and 102 fledglings were present within the enclosure and between the enclosure fence and the ocean between July 29 and August 21.

Productivity

The project team counted 928 nests at the Venice Beach colony in 2008. These nests produced 1236 eggs, resulting in a mean clutch size of 1.33 eggs per nest (Table 3). Of the 1236 eggs laid, we confirmed that 344 (27.8 percent) hatched, 132 (10.6 percent) likely hatched, 720 (58.3 percent) were predated, 35 (2.8 percent) did not hatch, and five (>0.1 percent) were unknown result. We estimate that 468 chicks hatched (70.0 percent) (Table 3). Of the chicks that hatched, we found 134 dead in the colony of non-predation-related causes (28.6 percent); we did not detect any predation among the chicks (Table 3).

Estimates of fledging are notoriously difficult. We present three measures:

1) Total estimated hatched (468) – mortality (134) = 334 fledglings (71.4%).

2) Counts of fledglings present from CDFG window survey dates July 12, 26, August 9 = 182 fledglings (38.9%).

3) Counts of feathered, pre-fledged chicks from surveys 2 weeks apart = 324 fledglings (69.2%).

4) Estimate generated from banding=343 fledglings (72.1%)

Each of these estimates presents many problems. Because three of the 2008 estimates are consistent and one is not, we are going to use the average of all four estimates to estimate fledging success. This is a departure from past years when we only used the average of the highest and lowest estimates (which would be 263 fledglings). Our official estimate for 2008 is **296** fledglings (Table 3). Even this lower estimate is the third highest number of fledglings produced by the colony since re-colonization of the site in 1977. However, the pair-to-fledgling ratio is lower than in the past two years and is another reflection of the relatively high predation suffered by the colony in 2008 (Table 3).

Table 3. Least tern breeding statistics for Venice Beach, 2003-2007.

Statistic	2008	2007	2006	2005	2004	2003
Total Nests	**928**	**546**	**384**	**90**	**24**	**371**
Estimated Re-nesting least terns	460	97	108	0	Unk.	23
Total Estimated Nesting Pairs[a]	468	453	276	105	24	348
Total Eggs	**1236**	**775**	**597**	**177** [b]	**26**	**629**
Mean Clutch Size (*mean eggs per nest*)	1.33	1.42	1.55	1.07 [b]	1.08	1.70
Number of Eggs Hatched	476	571	382	0	0	532
Hatching Success (*eggs hatched of total eggs*)	38.5%	73.7%	64.0%	0	0	84.6%
Eggs lost to Predators	720	110	123	177 b	26	24
Percent of Total Eggs Lost to Predators	58.3%	14.2%	20.6%	100%	100%	3.8%
Eggs abandoned and/or infertile	35	89	60	0	0	72
Percent of Total Eggs Abandoned/Infertile	2.8%	11.5%	13.3%	0	0	11.4
Known Mortality (*dead chicks and fledglings*)	134	131	57	0	n/a	135

Table 3. Least tern breeding statistics for Venice Beach, 2003-2007.

Statistic	2008	2007	2006	2005	2004	2003
Percent Mortality (*of total chicks hatched*)	21.2	16.9%	14.9%	0	n/a	25.4%
First Fledgling count	124	121	23	0	0	41
Second Fledgling count	183	182	120	0	n/a	56
Third Fledgling count	17	111	85	0	n/a	84
Total Fledglings counted[c]	**296**	**414**	**266**	**0**	**0**	**181**
Fledglings per Nest	0.32	0.76	0.69	0	0	0.49
Fledglings per Hatched Egg (chick survival)	0.62	0.73	0.70	0	n/a	0.34
Fledglings per Pair	**0.63**	**0.91**	**0.96**	**0**	**0**	**0.52**

[a] The estimated number of pairs is the total number of nests, minus the estimated number of nests initiated by renesting pairs (from the same or other sites). This is impossible to determine accurately without uniquely banded birds and varies from site to site and year to year. However, based upon expected renesting after the loss of eggs and young to predation, abandonment and natural mortality, the estimated number of renesting least tern pairs at Venice Beach in 2007 is 97.

The number of pairs is used to derive a statewide population estimate. Although less accurate than the number of nests, it is generally a better indicator of population status, as nest numbers will be high during years of high nest predation followed by renesting.

[b] In 2005, both the number of eggs and estimated numbers of nests were derived from observation of predation events. This provided us with a measure of the number of eggs removed from the colony by Crows (177). This was then divided by the mean clutch size (1.98) provided by Massey and Atwood (1981) to estimate the number of nests. The mean clutch size presented here is the summary of observed nests (n = 14).

[c] See Methods section of text.

Predation and Human Disturbance

Predation

In 2008, as in the past, American crows were the primary predator of least tern eggs at the Venice Beach colony. In 2008, volunteer observers noted 64 least tern eggs removed from the colony by American crows. When extrapolated for volunteer effort and removals per hour, we estimate 335 eggs were removed from the colony. The project team found an additional 311 predated eggs within the colony. Nest surveys by the project team found a similar number of 115 nests predated based on nest outcomes. We estimate that American crows predated 761 eggs (61.6%) from 554 nests. Nearly all of the predation occurred on or before June 16 (632 eggs, 83%). Our observations indicate that crows consume approximately 56% of eggs predated at the colony and remove approximately 44% of the eggs they predate.

In the previous two years, trapping of American crows has occurred between March and May and prior to nesting. In both 2006 and 2007, among the least terns' most successful nesting years to-date, CDFG personnel trapped and removed four American crows from the local population in both years. After each trapping effort, volunteer observers noted a decline in crow activity (Table 4) and a reduction in the number of eggs taken. These efforts were combined with placing crow carcasses on the colony in both years. In the 2007 report (Ryan et al. 2007), we suggest that the factors originally changed in 2006 that continue in both 2007 and 2008 to allow the least terns to overcome predation by American crows were: (1) a larger least tern population that allowed for better defense of the colony; (2) a larger enclosure that allowed the least terns more time to react to crows entering the nesting area, and may have allowed for the larger

population to be present; and 3) early season trapping that removed four known egg-predating crows from the vicinity prior to nesting.

In 2008, crow trapping was suspended from March to April; trapping did not begin until May 15, when four traps were placed on the colony, fewer than used in previous years. Crow and raven carcasses were placed on the colony in April. An attempt at hazing crows was made on June 6, but it was unsuccessful (Appendix 1). Six additional traps were added on June 21. Volunteer observers noted the highest numbers of crows flying over and landing within the colony yet recorded in April, May, and June (Table 4). We also observed the highest crow predation rates (0.4 eggs/hr) in June. Unfortunately, all nests established between May 13 and June 11 were predated by American crows. Following deployment of traps and the removal of four crows between May 15 and July 21, the numbers of crows flying over and landing in the colony declined, and no eggs were observed removed in July and August. Most nests established by June 16 were successful; all fledged young for 2008 were from these nests.

Table 4. American crow activity near and within the least tern colony in 2005 to 2008.

	Average Obs.				Flying Over/hr.				Landing/hr.				Eggs Removed/hr.			
	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008
Apr	5	3.8	1.3	5.9	3.5	4	1.1	4.8	2.2	1.6	0.5	2.8	0	0	0	0
May	5.1	3.6	2.6	4.3	2.5	3.4	1.5	5.1	1.6	1.6	1.6	3.5	0.1	0.1*	0.4	0.2
Jun	3.6	3	1.5	4.7	2.5	1.4	0.6	2.9	1.7	0.5	0.5	1.7	0.4	0	0.1	0.4
Jul	n/a	1	1.1	4.8	n/a	0.9	1.3	1	n/a	0	2.1	0.1	n/a	0	0.3	0
Aug	n/a	3	3	7	n/a	0.6	2.3	3	n/a	0.4	2.5		n/a	0	0.3	0

*John Trefts reported 18 eggs removed by American crows over a 4-hour period on May 30, 2006 apart from the regular volunteer effort.

An adult peregrine falcon was observed harassing adult terns on June 25. A juvenile peregrine falcon was observed foraging on adult least terns between August 1 and 8. Project biologists documented two dead adults on August 12 that were likely killed by a peregrine falcon (heads missing). A volunteer observed a juvenile Western gull (*Larus occidentalis*) killing and eating an adult least tern on July 18. Least terns chased gulls (*Larus* sp.) on several occasions.

Other potential predators detected include gulls, raccoons (*Procyon lotor*), domestic dogs (*Canis familiaris*), domestic cats (*Felis catus*), and rats (*Rattus* sp.). The project team detected rodent tracks within the colony, as large numbers of rats occur in the adjacent breakwater. We also detected raccoon tracks within the colony and CDFG personnel placed a trap, but no raccoons were captured.

Human Disturbance

Historically, the most frequently reported human disturbance events have involved helicopter flyovers and Fourth of July fireworks.

As in previous years, helicopters continued to fly low over the colony in 2008 (Table 5). There were several incidents where the least terns flushed in response to helicopters. The most frequently reported helicopters were from local police and fire agencies. By far the most common type of private helicopter observed was the Robinson Helicopter R44 Raven model

(Robinson Helicopter Company, 2901 Airport Drive, Torrance, CA 90505 USA, pr@robinsonheli.com, Telephone (310) 539-0508), Fax: (310) 539-5198). This company is located in Torrance and operates out of the Torrance Airport. Another problem came from weflyLA.com who offers a "helisurfing" trip that flies low over the beaches.

This year, the Fourth of July fireworks occurred as scheduled. A CDFG warden visited the colony and provided outreach to celebrants and local police. We found fewer than usual spent fireworks within the colony on the following visit, and many of the eggs hatched as normal between July 2-5th. The fledgling least terns tend to leave the colony and roost in a relatively unprotected area west of the colony. This occurred between July 29 and August 21, 2008. This may be detrimental because the newly fledged tern chicks are still most likely to freeze in response to a potential threat and may not fly away. Observers noted beach goers, off-leash dogs, and vehicles in the area. Many vehicles, including beach groomers, maintenance staff, sanitation workers, lifeguards, and police patrols, regularly transit this area. In late July, the project team requested that LACBH minimize beach grooming to the extent possible in this area and LACBH staff was helpful in implementing this recommendation.

Table 4. Log of helicopters observed flying below 500 feet over the colony.

Date & Time	ID/Tail Number	Photo	Notes
April 29, 2008	Univision Helicopter		
May 8, 2008 10:20 am	N83800		yellow and red
May 22, 2008 5:20 pm	N3315		orange & black TV?
May 28, 2008 ~8:00 am	SkyFox News 11		
May 30, 2008 2:17 pm	Sheriff N176DF		flying low over SW corner of colony
May 30, 2008 2:27 pm	N1609		pale grey
May 30, 2008 2:31 pm	weflyLA.com		red
May 30, 2008 2:42 pm	N3067P		orange/yellow stripe
May 30, 2008 2:44 pm	N3811A		
June 4, 2008 ~7:30 am	N43HA		right over the colony
June 16, 2008 ~5:00 pm	LAPD		flew west of area then turned and flew over west fence
June 18, 2008 ~7:30 am	NT2CME		
June 23, 2008 1:27 pm	Sheriff		green with light green/gold striping flew very low over sw corner of colony (below building height)
June 25, 2008 2:30 pm	N3070U		black helicopter, continuous loop ~100' over colony.
July 8, 2008 7:10 and 7:15 am	Sheriff		sheriff helicopter flew low over colony three times going back and forth
July 25, 2008 8:50 am	LAPD N225 PD		Black LAPD helicopter circled VERY low directly over colony and then did it again, as if going in low for a good look.
July 31, 2008 ~10:00 am	LAPD "L6??70",		Low flying LAPD helicopter made deliberate low turn over colony, when he saw me looking at it through binoculars; he dipped very low above me and hovered low.
August 20, 2008	N43HA		Blue/red stripe
August 20, 2008	N57717		-Red and White Hovered 240-280 feet above colony for nearly 20 minutes. Very loud

Band Reports and Banding

Band Reports

The project team found one banded adult least tern dead at the colony (band no. 8061-04427). It was found on May 28 and was banded prior to fledging on June 1, 1991 at Camp Pendleton, Oceanside, California.

Banding

We banded 43 chicks during three banding sessions on July 17, 22, and 30. The project team found four of these dead at the colony prior to fledging. We used growth curves generated at other tern banding sites with chicks of known age to estimate the average age of chicks measured at 12 days old. We estimate the first hatching date to be July 3, and the average hatching date to be July 10th. We then estimated survivorship from day 12 to fledging at 90.7 percent, with a daily survival estimate of 98.7 percent. Therefore, based on banded individuals, we estimated an overall survivorship for hatchlings at 72.1 percent, similar to two of the other fledging estimates (see Productivity, above).

Measurements of wing length and body weight indicate the chicks were in marginal condition. Studies at other colonies indicate that survival is higher in chicks that are above 35 grams once wing length is above 100 mm, or have a wing length: body weight ratio of 2.85 (C. Collins pers. comm.) All four chicks found dead were below this ratio (average 1.95), when banded lower than the average for dead chicks in 2007 (avg. = 2.35). The overall ratio for all chicks banded with wing lengths over 100 mm was 2.70, lower than 2007 (avg = 2.89). The average for all chicks banded was 2.16, which was much lower than 2007 (avg = 2.48). It appears that food problems reported elsewhere in 2008 were also affecting the chicks at the Venice Beach colony, although not to the extent that it caused higher than normal mortality. However, the chicks likely departed the colony in worse condition than in 2007.

Recommendations

We suggest the following recommendations based on observations made at the colony between 2004 and 2008. We suggest that implementation of these recommendations along with recommendations generated from Ryan et al. (2007) will help maintain and increase the number of nesting adults and their productivity at the Venice Beach least tern colony.

1) Continue aggressive predator control activities in March-April before the nesting season. Methods initiated in 2006 and modified in 2007 have proven effective. Non-lethal harassment proved ineffective in 2008, and should only be used to complement lethal techniques. We recommend setting a schedule for these activities and coordinating with CDFG predator management staff on dates before the nesting season. We recommend that more aggressive techniques be used every 1-2 weeks to specifically target and reduce the number of egg-predating crows in the vicinity before the least terns arrive in April. These measures should include:
    a. Continue experimentation with deterrent and aversion techniques for corvids beginning in early March. These may include crow calls and lasers.
    b. Continue placing crow carcasses within the colony in late March. This measure, along with measure (a), will discourage any crows new to the area from going within the colony before the least terns return to the vicinity.

c. Methods targeted at removing egg-predating crows should be implemented in early March and continue until volunteers note a decrease in crow activity. Past methods have proven successful and we recommend that they be implemented again, although experimentation with new methods is advantageous as well because of the crow's intelligence. New techniques may include multiple noose traps and predators surrounded by mist nets.
d. We should deploy at least 10 traps from early March until early May; these traps should then be used whenever volunteers detect high levels of crow activity
e. We should then employ adaptive management techniques to adjust our techniques and level of aggressiveness based on the monitoring reports.

2) Continue vegetation clearing on plots within the colony according to the *Venice Beach Least Tern Colony Habitat Improvement and Restoration Study* Methods before April 1 (Ryan et al. 2007).

3) Continue the volunteer monitoring program with a goal of having at least one monitor checking the colony daily. Provide an updated volunteer training session prior to April 1. Expand volunteer monitoring of the area in front of the colony between July 10 and August 15 and to provide more detailed descriptions and photographs of human-related disturbance events.

4) Request that police and sheriff personnel enforce existing dog regulations west of the colony between July 10 and August 15 (dates to be modified based on first hatching dates).

5) Request that vehicle use by all agencies using the beach be minimized west of the colony between July 10 and August 15 (dates to be modified based on first hatching dates).

6) Have a CDFG or USFWS warden present during and after Fourth of July festivities near the colony.

7) Have the USFWS contact pilots observed flying low over the colony and have them issue a general letter to pilots and local airports on or around April 1, requesting they fly over the water when flying near the Marina del Rey harbor entrance. We should consider working with the FAA on additional airspace restrictions to limit aircraft to flying above 1,000 ft. within ½ mile of the colony between April 1 and August 15, and placing the colony on air-charts with a notation.

8) Placing at least two interpretive signs near the colony as specified by the Coastal Commission permit and place the 6 signs provided by CDFG at the 2008-09 annual meeting.

9) Continue to partner with Dorsey High School and other local community groups and organizations on colony clean-up days.

10) Use volunteers to continue the public education campaign.

11) Lead public tours through the colony site on weekends during the off-season (October – February) to explore the unique dune system.

12) Ensure local garbage receptacles have functional lids within ¼ mile of the enclosure.

13) Begin a public awareness campaign to discourage people from feeding local crows, including covering garbage and covering pet food or keeping it inside.

14) Members of the local community have requested that a viewing platform or other structure be erected in a manner that will not interfere with the least terns so that the local community can view the nesting cycle within the fence.

15) Continue to use a sand-colored (burlap) chick fence, installed within 2 weeks of the initiation date of the first nest that survives to two weeks.

LITERATURE CITED

Atwood, J., P. Jorgensen, R. Jurek, and T. Manolis. 1977. California least tern census and nesting survey, 1977. Nongame Wildlife Invest., Final Report. California Department of Fish and Game, Sacramento, CA.

Chambers, W.L. 1908. The present status of the least tern in Southern California. Condor 10:237.

Comrack, L. 2001. Venice Beach least tern colony enlargement and fence replacement. California Department of Fish and Game Report. November 29, 2001.

Grinnell, J., and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27.

Keane, K. 2001. Breeding biology of the California least tern in Los Angeles Harbor, 2001 season. Prepared for the Port of Los Angeles, Environmental Management Division, under contract with the Port of Los Angeles, Agreement No. 2142.

Marschalek, D.A. 2008. California least tern breeding survey, 2007 season. California Department of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report, 2008-01. Sacramento, CA. 24 pp. + app.

Massey, B. W., and J. L. Atwood. 1981. Second-wave nesting of the California least tern: Age composition and reproductive success. Auk 98: 596-605.

Ryan, T. P., and D. A. Kluza. 1999. Additional records of the least tern from the west coast of Mexico. Western Birds 30: 175-176.

Ryan, T.P., and M.D. Taylor. 2004. Breeding biology of the California least tern in Venice Beach, 2004 breeding season. Prepared for the California Department of Fish and Game, Keane Biological Consulting, Long Beach, CA.

Ryan, T. P. 2005. Breeding biology of the California least tern in Venice Beach, 2005 breeding season. Prepared for the California Department of Fish and Game, Keane Biological Consulting, Long Beach, CA.

Ryan, T. P. 2006. Breeding biology of the California least tern in Venice Beach, 2006 breeding season. Prepared for the California Department of Fish and Game, Foothill Associates, Stevenson Ranch, CA.

Ryan, T. P., L. Seckel, and S. Vigallon. 2007. Venice Beach least tern colony habitat improvement and restoration study: 2006-07 preliminary results. Prepared for the California Department of Fish and Game, Office of Oil Spill Prevention and Response, SWCA Environmental Consultants. South Pasadena, CA.

Thompson, B. C., J. A. Jackson, J. Burger, L.A. Hill, E.M. Kirsch, and J. L. Atwood. 1997. Least tern (*Sterna antillarum*). In The birds of North America, No. 290 (A. Poole and F. Gill, eds.). Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, D.C.

Appendix 1: Crow Harassment Study Memo

To: Project Management Team

From: Thomas Ryan

Re: Crow Harassment Study Conducted on June 6, 2008.

Date: June 6, 2008

At the request of Nancy Frost and the staff at the CDFG office in San Diego, and with approval from USFWS, I went out to the Venice Beach Colony today (June 6, 2008) to attempt to haze the American crows predating the least terns. Their suggestion included using volunteers to haze the crows from outside the perimeter fence. I had several concerns including the potential for also harassing the least terns and ensuring that we were effectively using the volunteer's time. I performed a trial today to attempt to determine the reaction of the American crows and least terns to hazing.

Methods: Each time an American crow was observed within the colony, I would attempt to approach it to the closest possible point from outside the fence, then yell and clap my hands in an attempt to scare it from the colony. I recorded the time the crow flew into the colony, the time it took me to reach the closest point, the crow's immediate reaction to the hazing, the reaction of nearby terns, and the overall outcome of the crow's incursion into the colony. I attempted to determine the distance the crow would fly and the time it took to return in reaction to hazing, but as you can see below, I was not able to do so. I estimated my distance to the crow using the 20-m grid markers. These observations took place between 10:20 am and 12:20 pm under clear skies, temperature of 68 F, and light winds 6-8 from the west.

Results: Over two hours, I had 14 encounters with crows in the colony; I was able to haze them on 9 occasions. During these 9 hazings, crows turned to look at me three times, but none flew off or departed the colony in response to hazing. Hazings took place between 15-80 m from the crows (average 38.3 m). Three eggs were predated during hazing events. During one of these events, I was approximately 30 m from an active nest when a crow flew in, I hazed it, it looked at me, descended on the nest and departed with an egg. The entire event took less than 90 seconds. In the past, this would be considered an ideal situation for volunteer hazers, with a hazer observing and attempting to defend a single nest near the fenceline (most are considerably farther inside the colony), yet hazing was still not effective.

During the remaining five encounters, I was unable to reach the crow before it flew back out of the colony. Most incursions take less than 3 minutes and it takes as much as five minutes to walk to the other side of the colony in soft sand.

Overall, during the two hours I was observing, 9 eggs were predated by as many as 6-9 American crows, at least one of which was a hatch-year newly fledged bird.

Discussion and Conclusion: In this trial, hazing from outside the fenceline was ineffective as a technique to prevent predation by American crows on least tern eggs. Even under what would have been considered ideal circumstances, with a nest close to the hazer, crows ignored the hazing and removed the egg. Earlier in the month, we observed predated eggs and crow tracks within one meter of crow carcasses; scattering more crow carcasses is unlikely to work as well. Given the attraction of a large volume of a relatively easy and high-value prey item, I suggest that only lethal measures will work to discourage crows from predating eggs.