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Population Size and Reproductive Success of California Gulls at Mono Lake, California in 2010

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Summary

An estimated 36,372 adult California Gulls (*Larus californicus*) nested at Mono Lake in 2010. This total is well below the annual average of 47,648 ± 1440 for the period 1983–2009 (*n* =27 years), and the second-lowest population size recorded for Mono Lake since 1983. Seventy-six percent of the gulls nested on the Negit Islets, 15% on the Paoha Islets, and 8% on Old Marina Islet. No nests were found on Negit Island. Lake-wide reproductive success of 0.26 ± 0.04 chicks fledged per nest was also well below the1983-2009 average of 0.97 ± 0.06. An estimated 4,759 ± 197 chicks fledged from the Mono Lake islets in 2010, which is the lowest estimated annual chick production recorded over the tenure of this study. April and May 2010 set many cold weather records in the Mono Lake region which likely contributed to the depressed population size and reproductive success for Mono Lake's gulls. For the 178 chicks banded and weighed in early July, weight at banding was significantly greater for those that survived to fledging than for those that did not. Weight at banding was not significant on the survival of the 22 chicks banded during a second round of late-season banding July 31. One-hundred fourteen chicks were banded with coded red color bands, the remaining 86 were banded with a green color band on the left leg. Six code-banded juvenile gulls (5.7% of those that survived to fledging) from Mono Lake were found in coastal California locations in August and September 2010. The nesting populations at Mono Lake and the San Francisco Bay show a strong negative correlation over the time period 2000-2010. This suggests gulls that decide not to nest at Mono Lake in spring may instead nest at the San Francisco Bay.

INTRODUCTION

We continued long-term monitoring of population size and reproductive success of California Gulls (*Larus californicus*) at Mono Lake, California, in 2010. Our objectives are to measure year-to-year variation in population size and reproductive success as they relate to changing lake levels and other environmental conditions. Through color banding, we aim to better understand gull movements, fall and winter distribution, and investigate whether individual gulls breed in different colonies in different years. This

study provides an important long-term data set that is a useful measurement of Mono Lakes' ecological condition.

STUDY AREA AND SPRING CONDITIONS

The study area has previously been described in detail (see Wrege et al. 2006, Mono Basin Ecosystem Study Committee 1987). Locations of the Mono Lake nesting islets are shown in Figures 1 and 2. The lake level was approximately 1945.2 m (6382.0 ft) in May 2010, virtually identical to the level in May 2009. (Lake-level data from Los Angeles Department of Water and Power are available on the Mono Lake Committee website www.monolake.org.)

The similar lake level experienced in 2009 and 2010 despite higher precipitation experienced in the Sierra-Nevada in 2010 is apparently due to the difference between precipitation and subsequent water runoff measured in the mid-upper elevations of Sierra Nevada versus areas just to their east. Precipitation was 103% of average at Lee Vining in the winter of 2010, but just to the east of the Sierra as Mono Lake is situated, precipitation was only 74% of average, as measured at Cain Ranch (about 16 km SSW of the gull colony) (G. Reis, Mono Lake Committee fall 2010 newsletter).

Fig. 1. Location of gull nesting islets within Mono Lake.

A spring 2010 weather summary from Greg Reis of the Mono Lake Committee based on data collected from Lee Vining since 1988 brought the spring 2010 conditions spring into context. The average temperature in May 2010 was 8.1 Deg. C (46.6 F); only May 1998 ranked lower in average temperature (note the similar estimated annual chick production [fig. 3] in 1998 and 2010, in which May temperatures were similarly cold). May 2010 broke several local records – it had the lowest minimum temperature recorded for that month -6.7 C (20.0 F), as well the lowest average minimum temperature, 1.0 C (33.9 F). Eight daily records were also set in May - 4 each of lowest maximum and lowest minimum daily temperatures; seven of which occurred during the nest count period in late May. May was also exceptionally windy, with an average wind speed of 8.6 kmph (5.4 mph), and a maximum recorded wind gust of 89.6 kmph (56 mph), making it the second windiest month on record for Lee Vining since 1998. Seven point one cm of snow was recorded in Lee Vining in May, ranking the third most snow in May since 1988. April 2010 was also remarkable, with 37.6 cm of snow (the second highest since 1988) and an average temperature that was the second-coldest recorded for that month.

Fig. 2.View of individual islets within the Negit Islet complex.

METHODS

Nest Counts

Between May 24-29, 2010 field workers walked through colony islets in sweep-lines counting each nest with a tally meter and marking them with a small dab of water-soluble paint to avoid duplicate counts. For some small, steep-sided islets, incubating adults were counted from a small motor boat.

Clutch Size, Chick Banding, and Reproductive Success

We sampled 11 fenced plots on 4 islets to estimate clutch size and reproductive success. Six fenced plots measuring 10 x 20 m are located on the Negit Islets (four on Twain, two on Little Tahiti), another plot approximately 20 x 20 m is located on Little Tahiti, and four fenced plots of various but smaller sizes (Jehl 2001) on the Paoha Islets (two on Coyote A, two on Piglet Islet).

We estimated average clutch size by counting the number of eggs per nest for all nests within the 11 plots censused in late May. From 1-3 July 2010, we banded all chicks within the plots with a silver U.S. Fish and Wildlife Service band as well a color band – either a single green color band (applied to small, less vigorous chicks) or a red coded band stamped with field-readable numeric code unique to each banded individual. Due to the unusually high proportion of nests with eggs still being incubated during banding July 1-3, we returned July 31 to band chicks that hatched from these protracted nests. A second round of banding had never before been necessary over the 28 year tenure of this project, underscoring the nature of this springs' unusually cold and delayed spring.

From 9-11 September 2010, we searched the islets with plots to determine the number of banded chicks that died before fledging. We estimated the fledging rate for each plot in which data was collected, and, using the average fledging rate for the entire population, the total number of gulls successfully fledged from Mono Lake in 2010. We calculated the fledging rate for each plot **(f_{plot})** as:

$$f_{plot} = (C_b - C_d) / N_p$$

where $\mathbf{C_b}$ is the number of chicks banded in that plot in July, $\mathbf{C_d}$ is the number of chicks from that plot found dead in September, and $\mathbf{N_p}$ is the number of nests counted in that plot in May. We calculated the total number of gulls successfully fledged **(F)** from Mono Lake as:

$$F = (N/P)\sum_{i=1}^{P} f_i$$

where **N** is the total number of nests on Mono Lake, **P** is the number of plots, and **fi** is the number of young fledged per nest in each of the fenced plots.

We analyzed results using a nonparametric test (Wilcoxon/Kruskal-Wallis) with Stata 8.0 (Stata Corp. 2003). Results are presented with plus or minus one standard error.

Tick Infestations

Because of the potential effect on gull reproductive success, we recorded the presence and abundance of the bird tick *Argas monolakensis* for all banded chicks. Each bird received a score of 0-3 based on the approximate proportion of the fleshy part of the leg (tibia) covered by tick larvae: 0, no ticks; 1, up to one-third covered; 2, up to two-thirds covered; and 3, more than two-thirds covered. For more information on the life cycle of this endemic tick, see Schwan et al. (1992) and Nelson et al. (2006).

Chick Mass at Banding

We used hand-held Pesola scales to weigh the chicks that were banded.

Color-band Resight Efforts on Southeast Farallon Island

Following relatively high detection rate of color-banded Mono Lake gulls at Southeast Farallon Island (SEFI) in fall 2009 (Nelson and Greiner 2009), SEFI biologists began daily standardized searches of roosting flocks of California Gulls to detect color-marked birds during fall migration. These occurred from Aug 21 to Nov. 28, 2010 and less frequently thereafter as numbers diminished (Jim Tietz, pers comm.). Southeast Farallon is an offshore island approximately 48-ha, located 43 km west of San Francisco and 32 km south of Point Reyes, California. Flocks of California gulls were scanned with

binoculars and a spotting scope in late afternoon-evening periods when numbers appeared greatest. Island biologists also made daily estimates of the number of California Gulls present on and near the island breaking down numbers of adults, sub-adults, and juveniles.

RESULTS AND DISCUSSION

Number of Nests and Breeding Adults

In 2010, we recorded a lake-wide total of 18,186 California Gull nests and estimated a population of 36,372 nesting adults. This is below the mean population size of 47,648 ± 1440 for the period 1983-2009 (n = 27 years), and represents a 23% decline both relative to the population size in 2009 and the long-term average. Only in 1998 has the population been lower since monitoring efforts began in 1983 (Nelson and Greiner 2009). However, our population estimate reflects the number of nests present in late May, which could be artificially low if many nests were initiated later in the season after nest count (see Phenology, below). Although the overall nesting population declined 23% from 2009 to 2010, the number of nests in the study plots was generally similar, but reproductive success was much lower (table 1).

Table 1. Nest Numbers, Chick Production and Reproductive Success in 2010 Compared to 2009

Site	% Change in Nest Number	Decline in Chick Number	Decline in fledge rate
Cornell	-7%	-72.0%	-69.3%
Little Tahiti East	50%	--	-100.0%
Little Tahiti West	-7%	-69.0%	-70.9%
Twain North	-16%	-52.2%	-40.1%
Twain South	-15%	-79.2%	-77.8%
Twain West	-13%	-73.0%	-70.3%
Twain New	6%	-67.3%	-67.7%
Coyote Cove	-45%	-78.1%	-59.1%
Coyote Hilltop	-24%	-98.2%	-97.5%
Piglet East	27%	-55.5%	-58.5%
Piglet West	-14%	-71.4%	-69.4%
Lakewide Average =	**-5%**	**-71.6%**	**-71.0%**
SE =	**0.08**	**0.039**	**0.051**

The exceptionally low temperatures in April and May resulted in a delayed brine shrimp hatch, which contributed to the depressed California Gull population this year, as gull population size at Mono Lake has found to be closely associated with average spring temperatures and spring-time brine shrimp density on Mono Lake (Wrege et al. 2006).

Seventy-six percent of the gulls nested on the Negit Islets, 15% on the Paoha Islets, and 8% on Old Marina Islet (Figures 1, 2). Of the individual islets, Twain was the most populous, holding 45% of the lake-wide total, followed by Little Tahiti Islet with 13% and Coyote A Islet with 9% (Appendix 1). No nests were found on Negit Island.

Phenology in 2010

Many adults were still incubating nests with eggs in early July. Relative to the number of nests counted in May, nearly 27% were being incubated (Table 2). These gulls either initiated nesting later than usual or re-nested as a result of intra-specific egg predation or other type of loss of their first clutch. Most years have few or no incubating adults in July (KNN).

During the late May nest count, the authors observed that intra-specific egg predation was unusually high. This was apparently driven by hunger from depressed shrimp concentrations as well as a high number of non-breeding individuals. These non-breeders loafed near the islet shorelines, and were attracted to disturbance (including our presence) for the opportunity to predate any unattended nests. The authors had never experienced such high predation rates or seen obvious groups of non-breeding individuals on the colony since personally working on this project since 2005.

Five nests containing small chicks were detected during the May 24-29 2010 nest count. This number is roughly average or slightly above, which indicates protracted nest initiation was not colony wide.

Clutch Size

In 2010, average clutch size at Mono Lake was 1.80 ± 0.03 eggs/nest (range = 1-3 eggs [except one 4-egg nest], n = 618 nests). Twenty-nine percent of the nests contained one

egg, 62% had two, and 9% had three. The average clutch size for Mono Lake since 2002 (n = 8 years) is 1.98 ± 0.06 eggs/nest.

Table 2. Number of nests with eggs in May, early July and number of chicks banded in early July

Site	Number of nests with eggs late May	Number of nests with eggs July 1-3	Nests w/ July eggs as a percentage of May nest number	Number of chicks banded July 1-3
Negit Islets:				
Cornell	127	6	5%	38
L. Tahiti East	18	4	22%	0
L. Tahiti West	90	15	17%	34
Twain North	51	4	8%	21
Twain South	78	34	44%	16
Twain West	70	20	29%	20
Twain New	54	11	20%	13
Paoha Islets:				
Coyote Cove	28	15	54%	11
Coyote Hilltop	39	10	26%	1
Piglet East	33	8	24%	10
Piglet West	30	14	47%	14
Totals:	**618**	**141**	**26.7%**	**178**

Overall Reproductive Success

The seven plots on the Negit Islets held an average of 69.7 ± 13.0 nests and fledged an average of 0.25 ± 0.05 chicks per nest in 2010. The four plots on the Paoha Islets held an average of 32.5 ± 2.4 nests and had fledged and average of 0.27 ± 0.08 chicks per nest (Table 3). Combined, the 11 plots held an average of 56.2 ± 9.8 nests and fledged an average of 0.262 ± 0.04 chicks per nest, which is below the long-term average of 0.97 ± 0.06 chicks fledged per nest. The long term average is calculated for the Negit Islets only from 1983-2002, and Negit and Paoha Islets combined since 2002.

Based on the total of 18,186 California Gull nests on Mono Lake and an average of 0.26 ± 0.04 chicks fledged per nest, an estimated 4759 ± 197 chicks fledged at Mono Lake in 2010. This is the lowest estimated chick production measured over the tenure of the project, although similarly low chick production occurred in 1984 and 1999 (fig. 3).

Table 3. Summary of Nest Counts, Chick Banding, and Mortality Counts from all plots in 2010.

Site	Number of nests late May	Clutch Size	July 1-3: # chicks banded (# dead)	July 31: # chicks banded (#dead)	fledged/nest all dates
Negit Islets:					
Cornell	127	1.84	38 (6)	0 (0)	0.252
Little Tahiti East	18	2.05	0 (0)	0 (0)	0
Little Tahiti West	90	1.88	34 (7)	1 (0)	0.311
Twain North	51	1.8	21 (0)	1 (0)	0.431
Twain South	78	1.67	16 (2)	5 (2)	0.218
Twain West	70	1.9	20 (3)	6 (2)	0.3
Twain New	54	1.74	13 (1)	4 (1)	0.278
Paoha Islets:					
Coyote Cove	28	1.64	11(3)	3 (0)	0.393
Coyote Hilltop	39	1.72	1 (0)	0 (0)	0.026
Piglet East	33	1.85	10 (2)	2 (0)	0.303
Piglet West	30	1.73	14 (3)	0 (0)	0.367
Lakewide Results					
Totals	**618**	**-**	**178 (27)**	**22 (5)**	**-**
Average =	**56.18**	**1.80**	**16.2 (2.4)**	**2.0 (0.5)**	**0.262**
SE =	**9.83**	**0.36**	**3.57 (0.71)**	**0.66 (.25)**	**0.041**

Mass at Banding

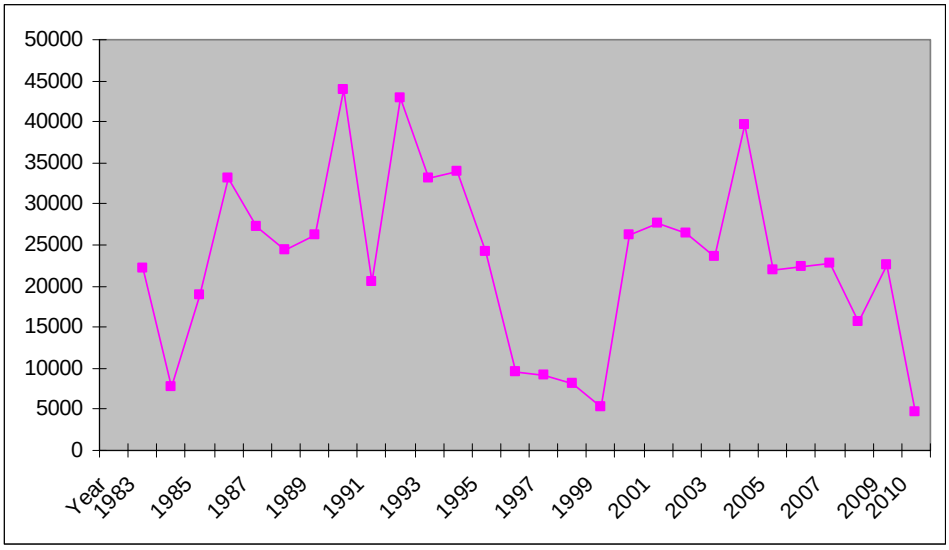
The average mass of the 178 chicks banded in early July was 465 ± 10g, which is below the 2002-2009 average mass of 505g. For chicks banded in early July the average mass for those that survived to fledging (485 ± 10g) was significantly greater than the average mass for chicks that did not survive to fledging (353 ± 25g) ($X^2 = 21.7$, $df = 1$, $p = 0.0001$). This pattern has been consistent through all years in which chicks were weighed. For the late 22 chicks banded July 31, average mass at time of banding (513 ± 16g) was not significantly higher for chicks that survived to fledging than those that did not. This was likely due to the small sample size and overall low survival rate for the late-hatched chicks.

Tick Infestation

Ninety-five percent (n=190) of the chicks had a tick score of 0 and 5% (n=10) had a tick score of 1. Those with ticks had very few, and the presence of ticks was not significantly

associated with chick mortality. Though not experienced in 2010, plots with high levels of tick infestation have had low levels of fledging success (Hite et al. 2004).

Figure 3. Estimated annual chick production at Mono Lake 1983-2010



Other Species Nesting on Mono Lake Islets

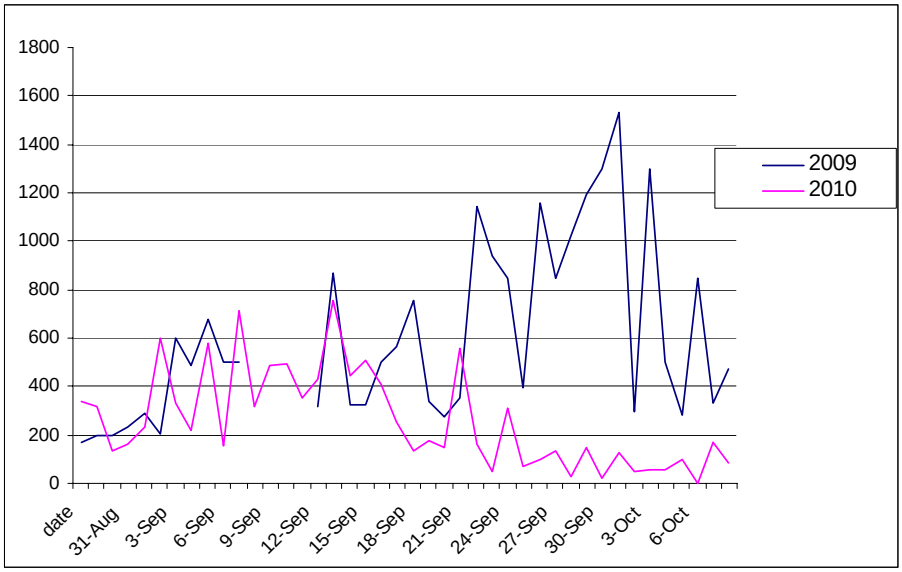
In addition to the California Gull, other species nesting on the Mono Lake islets in 2010 were the Black-crowned Night-Heron (*Nycticorax nycticorax*), Osprey *(Pandion haliaetus*) and Caspian Tern (*Sterna caspia*). Black-crowned Night-heron nests were not thoroughly counted on the Mono Lake islets this year but were present on Twain and Little Tahiti Islets only. The/a Osprey pair returned to nest on the Negit Islet Midget, although they did not successfully fledge young this year. Two Caspian Tern nests were on the Paoha islet Coyote. Caspian Terns have not nested at the Mono Lake Islets since 2006 when they nested on the Negit Islet Twain (Nelson et al. 2006).

Detections of Banded Mono Lake California Gulls in 2010, including Southeast Farallon Island

There were 6 detections of juvenile Mono Lake gulls from coastal California locations during August and September 2010. Most sightings were from Southeast Farallon Island where banded gulls were actively searched for. An additional detection was in western Marin County and another was found dead at Trinidad, Humboldt County, CA on the

relatively early date of Aug. 17 2010. Though there were fewer detections of color-banded juvenile Mono Lake gulls in 2010 than 2009, the detection rate was greater. The 5 sightings of color banded juveniles seen alive in fall 2010 represents 3.6% of 2010 gull chicks that survived to fledging (and 4.4% of those with coded red bands, which accounted for all sightings). In 2009, the 19 color-band detections in fall represented about 2.9% of the surviving banded chicks from Mono Lake that year (Nelson and Greiner 2009).

Figure 4. Daily total of California Gulls visiting Southeast Farallon Island in fall 2009 and 2010



Fall daily totals of California Gulls at Southeast Farallon Island were greatly reduced in 2010 compared to 2009 (PRBO unpubl. data, fig. 4). This would be somewhat expected considering so few juveniles fledged from Mono Lake, as juveniles often outnumber adults by a considerable margin during certain fall periods (KNN pers. obs, PRBO unpul. data). Additionally, California Gulls seemed not to roost on the island in the evening to the same extent they did in 2009 (J. Tietz, pers. comm.), perhaps relating to a difference in oceanic or foraging conditions. Although Mono Lake chick production contributes to the number of migrant California Gulls visiting SEFI, other factors influence that number as well, including the number of gulls from other populations, local foraging opportunities, or other conditions. The San Francisco Bay California Gull colony greatly surpassed Mono Lake's population in 2010 with 23,025 nests tallied there (C. Nilsen,

SFBBO, pers. comm.) vs. 18,186 nests at Mono. The ratio of gulls from Mono Lake to San Francisco Bay or other populations visiting SEFI is poorly known at this point, but becoming clearer with color band efforts. This year 500 California Gull chicks were banded with yellow coded bands in colony A6, the largest of the San Francisco Bay complex. Of those (with an unknown number may have died before fledging), 19, or 3.8%, were detected on SEFI in fall (PRBO, unpubl. data), a proportion similar to that of the Mono Lake population. The proportion of San Francisco Bay gulls detected may be somewhat higher if pre-fledge mortality was assessed. Future seasons of color-band searches on SEFI will yield more detections and strengthen the sample size, clarifying and the pattern of California Gull occurrence at this location.

In addition to the Trinidad, CA band recovery mentioned above, the additional band recoveries from Mono Lake gulls acquired from the National Bird Banding Lab (BBL) in 2010 were (Appendix 2):

● One recovered from Castle Airport in Merced, California on January 22, 2010 was banded as a chick July 2, 1987.

● a gull banded in 2009 was found March 15, 2010 near Todos Santos in Baja California Sur, Mexico

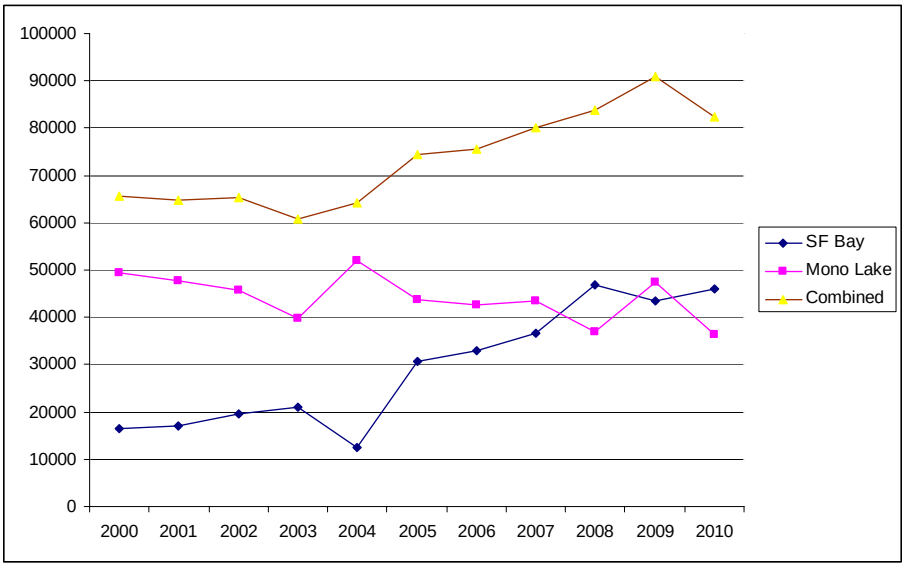
● A band was read on an adult attending a nest in the Little Tahiti West plot in 2009. That gull was banded as a chick at Mono Lake in July 1983. It also had a white color band above the tarsus (color bands were used in the early years of this project). It has been observed in this plot, by recognition of the color band, for at least 8 years, possibly longer (J. Hite, pers. comm.). The bird was 26 years old when the band was read in 2009, falling just under the longevity record by about 2 months according to BBL data, although reports exist for a greater longevity of 27-30 years of age (Winkler 1996). Results from the BBL were not acquired from this gull until after field work was completed in 2010, so we did not look for it in the plot this year. If present in 2010, it would have been the oldest California Gull known by the BBL.

● One found near Vallejo, in Solano County, California on November 23, 2010 was banded as a chick at Mono Lake in 1994.

Population Trends in California

Attention has been given in recent years to the relationship between California Gulls that nest in the San Francisco Bay and Mono Lake (Nelson et al. 2008, Nelson and Greiner 2009). For the time period 2000-2010, the two populations show a strong negative correlation (rho = -0.72; p = 0.02 without 2004; rho= -0.79, p = 0.004 including 2004). This suggests many gulls assess conditions in spring, and nest at whichever location appears best. Mono Lake is highly variable in favorable breeding conditions for gulls; the population size has fluctuated by >45% on an annual basis due to this variability in optimal conditions (Wrege et al. 2006). Wrege et al. found that spring temperatures and spring brine shrimp density on Mono Lake strongly influence the population size of California Gulls in a given year. Exactly how gulls assess spring conditions and make the choice of whether or not to breed at Mono Lake is unknown. However, the significant negative correlation between the Mono Lake and San Francisco Bay populations suggests that gulls which decide not to breed at Mono Lake may respond by returning to the coast (i.e. their wintering grounds) and nesting in the San Francisco Bay. These two locations are at the same latitude. Note 2010 was the first year since 2003 that the combined population size of Mono Lake and San Francisco Bay declined (fig. 5).

Fig. 5. Population size of Mono Lake and SF Bay California Gulls, 2000-2010. Note in 2004 a different methodology was used to measure the SF Bay population, likely resulting in an underestimate.



California Gulls have demonstrated remarkable ecological flexibility, and spring assessment of Mono Lake conditions with a back-up plan of nesting in the San Francisco Bay if conditions are poor at Mono may be but one of several ways this flexibility is expressed. It has also manifested in the way the Mono Lake population changed its historic colony location immediately following a major predation event. When coyotes gained access to, and decimated, the Mono Lake colony on Negit Island in 1979 due to a landbridge that formed from the lowered level of Mono Lake, the gulls responded the next breeding season, 1980, by moving their colony in to smaller, still water-bound islets which they nest on to this day (Winkler and Shuford 1988). That was also the year gulls began nesting in the San Francisco Bay (SFBBO unpubl. data), suggesting some Mono Lake gulls not only decided not to nest on Negit Island, but not to nest at Mono Lake at all. The San Francisco Bay population has grown tremendously in this new coastal nesting environment, taking advantage of Bay Area garbage dumps as well as local Bayland shorebird nests and chicks as a food source (Ackerman et al. 2006).

The negative correlation between the two populations is only significant for the last 11 years. This suggests the San Francisco Bay population reached a critical mass around 2000 that began influencing birds from Mono Lake, or perhaps it represents a temporary cycle the populations are undergoing. Either way, future research will reinforce the trends and clarify our understandings. Additionally, the use of easily detectable, field-readable color bands on gulls from both Mono Lake and the San Francisco Bay, if detected in or near a colony different from which it was banded, will help establish movement patterns.

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Appendix 1. Nest number by islet, 2003-2010. For islet counts before 2003, see Nelson and Greiner 2009

Negit Islets	2003	2004	2005	2006	2007	2008	2009	2010
Twain	9288	11480	9582	9900	10138	8891	11449	8219
Little Tahiti	2632	3303	2511	2700	3102	2477	2770	2429
Little Norway	249	213	126	165	172	137	119	114
Steamboat	575	635	621	583	631	590	580	509
Java	718	915	779	710	648	482	433	367
Spot	70	98	127	75	9	49	87	122
Tie	38	49	50	33	0	9	37	55
Krakatoa	113	181	184	131	119	24	5	2
Hat	7	9	3	5	10	3	3	0
La Paz	0	1	2	0	0	0	0	0
Saddle	0	0	0	1	1	0	1	0
Midget	0	1	1	0	0	0	0	0
Little Tahiti Minor	[a]	[a]	[a]	[a]	[a]	[a]	152	151
Pancake	1847	2837	2530	2059	1602	1623	2293	1894
Negit Islets Total	**15537**	**19722**	**16516**	**16362**	**16432**	**14285**	**17929**	**13862**
Paoha Islets								
Coyote A	2480	3244	3174	3181	3094	1989	2591	1711
Coyote B	34	55	63	40	0	0	0	0
Browne	224	283	253	225	118	99	135	116
Piglet	1010	1552	1649	1218	1269	1001	1314	997
Paoha Islet Total:	**3748**	**5134**	**5139**	**4664**	**4481**	**3089**	**4040**	**2824**
Negit Island:	452	587	285	120	63	0	0	0
Old Marina	178[b]	511	1	94	723	1089	1775	1496
Old Marina So.	0	0	0	0	0	9	22	4
LakewideTotal	**19915**	**25954**	**21941**	**21240**	**21699**	**18472**	**23766**	**18186**
Nesting Adults	**39830**	**51908**	**43882**	**42480**	**43398**	**36944**	**47532**	**36372**

a Nest numbers for Little Tahiti Minor were previously included within Little Tahiti

b Nests were not counted with water soluble paint on Old Marina Island this year. The pain serves as a counting aid, and counters judged that the 178 nests they recorded was an underestimate.

Appendix 2. Reported locations of banded Mono Lake gulls in 2010