Population Size and Reproductive Success of California Gulls at Mono Lake, California, in 2002

Justin M. Hite
Elizabeth O'Hara
Tricia Wilson
and
Melissa T. Hite

Contribution No. 1013

PRBO Conservation Science
4990 Shoreline Highway
Stinson Beach, CA 94970

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Abstract

In 2002, nest counts estimated that 45,716 adult California Gulls (*Larus californicus*) were breeding at Mono Lake in late May. Of these, roughly 81% nested on the Negit Islets, 17% on the Paoha Islets complex, and 2% on Negit Island. Twain Islet remained the most populous nesting island, holding 47% of Mono Lake's breeding gulls, followed by Little Tahiti islet with 17% and Coyote A islet with 11%. The number of nests on Negit Island continued to increase, by 44% compared to 2001. The fledging rate on the Negit Islets was 1.16 chicks per nest, which tied with last season as the fifth highest rate in the 20 years of monitoring since 1983, and the fledging rate on the Paoha Islets complex was 1.13 chicks per nest. The overall fledging rate for chicks in all plots on Mono Lake was 1.15 chicks per nest. An estimated 26,287 ± 2,286 chicks fledged from all the lake's nesting islands in 2002, making this the third consecutive year of high reproductive success. For 950 chicks banded and weighed on 1-4 July, mass at banding was significantly greater for those that survived to fledging than those that did not. No evidence of coyotes *(Canis latrans)* were found on any of the islands, though seven species of avian predators were observed throughout the season in the vicinity of the islands. Four of these species, Peregrine Falcon *(Falco peregrinus)*, Golden Eagle *(Aquila chrysaetos)*, Black-crowned Night-Heron *(Nycticorax nycticorax)*, and Common Raven *(Corvus corax)*, were observed preying on gull eggs, chicks, or adults. During a prior six-year period of meromixis (persistent salinity stratification) in the lake in the 1980s, gull nesting success was low the first two years but increased thereafter. During the current period of meromixis, which began in 1996, gull reproduction was extremely low for four years, then above average for the next three. This trend suggests a recovery similar to that in the 1980s and is consistent with observations that meromixis is eroding more rapidly than initially projected.

Introduction

The long-term study of California Gull (*Larus californicus*) population size and reproductive success at Mono Lake, California, under the direction of David Shuford of PRBO Conservation Science, was continued between May and August 2002. During this period, spanning most of egg laying through the fledging of young, three standardized measures of reproduction were obtained on gulls nesting on the Negit and Paoha islets. The foraging ecology of nesting adults was again a parallel focus, continuing the observational study initiated in 2000 (Wrege et al. 2001). Here we summarize the results obtained from the nest counts and chick banding surveys.

The objectives of this ongoing study are to measure year-to-year variation in population size and reproductive success and to determine their relationship to changing lake levels. This report focuses on the three areas on Mono Lake that support nesting California Gulls: Negit Island, the Negit Islets, and the Paoha Islets complex. Negit Island supported the majority of the lake's gulls until abandoned in 1979. It was then recolonized in 1985, and through 1993 it supported up to 13% of the lakewide total until abandoned again in 1994. In 1999 it was recolonized for a second time and has supported greater numbers of gulls in each subsequent season, reaching 2% of the lakewide total in 2002. The nearby Negit Islets have supported the majority of the lake's nesting gulls since the abandonment of Negit Island, including 71-91% from 1985 to the present. The Paoha Islets complex has supported 9-29% of the total since 1985.

The effects of recent changes in the Mono Lake ecosystem are of special interest to biologists (Patten et al. 1987, Botkin et al. 1988) and to public agencies charged with protecting the lake's valuable natural and scenic resources (Jones and Stokes 1993). Because court-mandated protection of the Mono Lake ecosystem will allow the lake's surface elevation to rise to 6392 feet (SCWRCB 1994), there is a continuing need to monitor the lake's resources, including nesting gulls, to document their responses to the changing conditions.

Study Area and Methods

The study area at Mono Lake has previously been described by Shuford (1985) and Shuford et al. (1984, 1985), though conditions that potentially could affect nesting gulls have changed considerably over time. Since 1941, the lake has dropped almost 45 vertical feet and nearly doubled in salinity because of diversions of its inflowing streams. Wet winters in the early and mid-1980s caused a temporary reversal of the downward trend. The winters of 1986-87 through 1993-94 averaged very dry, and the lake level fell to a surface elevation of 6374.5 feet by May 1992. Very wet winters returned in 1994-5, 1996-97, and 1997-98, and, reinforced by reduced diversions of water from the watershed, the lake level rose to 6384 feet in 1999 (P. Kavounas in litt.) and 2000. Lake level dropped to 6383.3 feet in 2001 then to 6382.3 feet by 2002.

Additionally, for the six-year period 1983 to 1988, Mono Lake experienced persistent salinity stratification (meromixis), which lowered the lake's productivity (Jellison and Melack 1993). Since 1996 the lake has entered another episode of meromixis, which initially was predicted to last for up to several decades (Jellison et al. 1998). Deeper than expected mixing in the fall of 1999, along with mild and early springs in 2000 and 2001, contributed to an early abundance of brine shrimp (*Artemia monica*) in both of the latter years (Wrege et al. 2001, R. Jellison pers. comm.). As with the earlier episode, several years (2000-2002) of modest declines in lake level have resulted in weakening of meromixis and a return to average levels of primary productivity even prior to its breakdown (R. Jellison pers. comm.). The lake is currently well-mixed above 28 m depth, and while meromixis is expected to break down in 2003, productivity is predicted to remain near or above average even if it persists (R. Jellison pers. comm.).

Over the years, small numbers of gulls have intermittently initiated nesting on a peninsula of Paoha island (immediately adjacent to the Paoha Islets), which is either partially or completely (e.g., 1999-2002) isolated as a small islet by the rising lake (J. R. Jehl, Jr. in litt.). The Paoha Islets together with this peninsula/islet are referred to below as the Paoha Islets complex.

Nest Counts: Nests on Negit Island, the Negit Islets, and the Paoha Islets complex were counted from 24 to 27 May. Field workers walked through all the colonies tallying each nest and marking them with a dab of paint to avoid duplicate counts. For some small, steep-sided islets incubating/brooding adults were counted from a small motorboat to estimate the number of nests present. Separate subtotals were compiled for nests within seven 10 x 20 m fenced plots on three of the Negit Islets (four on Twain, two on Little Tahiti, and one on Little Norway) and four fenced plots of various sizes (described in Jehl 2001) on two of the Paoha Islets (two on Coyote A and two on Paoha Islet). These detailed counts were used to estimate reproductive success. Within plots, counts included the number of eggs in each nest.

Chick Counts and Reproductive Success: From 1-4 July, we banded all chicks of at least 100g in weight within the eleven fenced plots on the Negit and Paoha islets. From 9-11 August, we searched the nesting islands to determine the number of banded nestlings that died before fledging. Using the data from nest, chick, and mortality counts, we estimated the total number of gulls successfully fledged from Mono Lake in 2002. PRBO has calculated the number fledged **(F)** on Negit Island and the Negit Islets as:

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

where **N** is the total number of nests on Negit Island and the Negit Islets, **P** is the number of plots, and $\mathbf{f_i}$ is the number of young fledged per nest in each of the Negit Islet fenced plots. From 1983 to 2001, J. R. Jehl, Jr. conducted similar standardized nest counts, chick bandings, and mortality counts on the Paoha Islets complex, yet he calculated the number fledged **(F)** as:

$$F = N*(C/P)$$

where **N** is the total number of nests on the Paoha Islets complex, **C** is the total number of chicks fledged from the four Paoha Islets complex fenced plots, and **P** is the total number of nests within those four plots. The PRBO method provides an estimate of fledging success with error bounds reflecting the variation in success among different parts of the colony, whereas Jehl's method produces a simple straightforward average that does not account for sampling variation.

Researchers have historically calculated the total number of chicks fledged from Mono Lake in a given season by summing these two estimates, even though they are calculated in different manners. In this report, however, estimates of the number of gulls fledged in 2002 are calculated using PRBO's method for all of the lake's 11 plots.

Effect of chick weight at banding on survival: We used hand-held Pesola scales to measure the mass of all 950 chicks that were banded in the eleven fenced plots. We analyzed the effect of mass at banding on survival to fledging using a nonparametric test (Wilcoxon/Kruskal-Wallis) in JMP 5.0.

Results and Discussion

Phenology: In 2002, chicks occupied 59 (0.3%) of the 22,858 nests checked from 24-27 May, indicating that nest initiation began about the same time as in most other years of this study. There were approximately 12 nests with eggs or newly hatched chicks during the chick-banding period (1-4 July), indicating that the laying period was not protracted in 2002 as it had been in some other years.

Number of Breeding Adults: In 2002, late May nest counts estimated that 37,154 gulls were nesting on the Negit Islets, 7,780 on the Paoha Islets complex, and 782 on Negit Island for a lakewide total of 45,716 nesting adults (Table 1). About 81% of the gulls nested on the Negit Islets, 17% on the Paoha Islets complex, and 2% on Negit Island. Twain islet alone held 47% of the lakewide breeding population followed by Little Tahiti with 17% and Coyote A with 11%. Overall, the estimated number of nesting pairs on Mono Lake in 2002 was 1,025 fewer than in the previous year. Nesting numbers again decreased on Twain, Little Tahiti, and Little Norway islets, whereas they rose on Java and Steamboat islets, the Paoha Islets complex, and Negit Island (which increased 44%, from 271 to 391).

In 2002, gulls also initiated nests on an isolated mound of rock off the beach at Old Marina, on the southwest corner of the lake. This islet is currently separated from the

mainland by a channel approximately 10 m wide and 1 m deep and is directly adjacent to both Highway 395 and one of the most visited stretches of Mono Lake's shore. Nesting activity went unnoticed until 5 July when Krisitie Nelson of PRBO used a spotting scope to count at least five sets of chicks that still had some downy feathers. Justin Hite confirmed that these gulls were still too young to have fledged and were being attended by adults. The lakewide total of nesting pairs does not include these gulls from the Old Marina as their numbers are both uncertain and small.

Predation of eggs, chicks, and adult gulls: We saw no evidence of coyotes or any other canids on Negit Island on numerous surveys of the shore and interior. Six species of avian predators were highly visible throughout the season in the vicinity of the Negit Islets: Peregrine Falcon *(Falco peregrinus),* Prairie Falcon *(Falco mexicanus),* Golden Eagle *(Aquila chrysaetos),* Great Horned Owl *(Bubo virginianus),* Black-crowned Night-Heron *(Nycticorax nycticorax),* and Common Raven *(Corvus corax),* and another species, Bald Eagle *(Haliaeetus leucocephalus),* was seen only once. There were at least five individual Peregrine Falcons (together seen on more than a dozen occasions), including at least two immatures and three adults. An adult Peregrine took an adult California Gull on Little Tahiti in late April, and another or the same Peregrine on 18 and 19 June took a single pre-fledging (approximately 400g) juvenile from its nest. Golden Eagles were observed six times on or above Twain islet, once taking an adult California Gull in early May. A pair of Great Horned Owls fledged three chicks on Negit Island and were repeatedly heard calling throughout the season. Black-crowned Night-Herons nest in patches of greasewood (*Sarcobatus vermiculatus*) on Twain and Little Tahiti islets, and an adult grabbed, killed, and swallowed an approximately 200g gull chick on 17 June. We observed Common Ravens regularly throughout the season and three times saw them prey on California Gulls: once taking an approximately 150g chick and twice taking eggs. Additionally, two cracked California Gull egg shells found on the northern plateau of Negit Island were possibly dropped or eaten there by ravens or gulls. Prairie Falcons were observed at least six times flying over the islets, but were never observed pursuing or taking gulls. We observed a single adult Bald Eagle on 19 June being chased away from the islands by a flock of several hundred gulls.

Table 1. Nest counts on Negit Island and the Negit and Paoha Islets from 1991 to 2002. Data from the Paoha Islets in all years but 2002 from J. R. Jehl, Jr. (in litt.).

Negit Islets	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Twain	10883	15896	15431	15792	11035	12690	13140	9488	10728	11856	11773	10772
L. Tahiti	3205	3810	3616	4505	4021	4570	4092	3846	5108	5076	4309	3831
L. Norway	355	473	428	533	493	766	794	606	732	887	665	357
Steamboat	671	862	958	1217	981	459	505	405	381	477	570	621
Java	586	1040	399	199	4	70	41	65	149	480	611	706
Spot	311	335	356	449	422	399	341	191	27	29	36	42
Tie	160	220	210	320	264	267	194	81	5	16	23	24
Krakatoa	181	209	146	175	116	57	33	16	76	120	141	129
Hat	10	21	21	14	19	41	58	47	43	29	23	9
La Paz	49	70	77	57	55	44	30	17	0	0	0	0
Geographic	10	68	84	69	51	0	0	0	0	-	-	-
Muir	84	139	131	116	87	4	0	0	0	-	-	0
Saddle	8	14	10	11	21	31	13	1	2	1	1	0
Midget	2	2	3	2	2	2	3	0	3	2	0	0
Siren	7	19	20	14	16	10	0	0	0	-	-	-
Comma	1	1	1	0	0	1	0	0	0	-	-	0
Castle Rocks	5	5	3	3	3	4	4	3	3	1	1	1
Pancake	0	0	0	0	0	0	1	13	1136	2098	2145	2085
Java Rocks	2	13	15	9	5	1	0	0	0	0	0	0
No name	0	3	3	3	1	0	0	0	0	-	-	-
Negit Islet Totals:	16530	23200	21912	23488	17596	19416	19249	14779	18393	21072	20298	**18577**
Paoha Islets												
Coyote A	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	2237	2612
Coyote B	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	22	26
Browne	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	279	261
Paoha Islet[b]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	776	991
Paoha Islet Totals:	4442	9284	8498	8182	7331	4334	5708	2687	1858	3478	3314	**3890**
Negit Island:	788	4	12	0	0	0	0	0[c]	14	100	271	**391**
Mono Lake Totals:	21760	32488	30422	31670	24927	23750	24957	17466	20265	24650	23883	**22858**
Nesting Adults:	43520	64976	60844	63340	49854	47500	49914	34932	40530	49300	47766	**45716**

[a] Data published elsewhere by J. R. Jehl, Jr.

[b] Numbers of nests intermittently attributed to Paoha Islet are from a piece of land immediately adjacent to the other Paoha Islets which in various years is either partially or completely connected to the mainland of Paoha Island by a landbridge.

[c] No nesting gulls were seen on Negit Island in late May, but a nearshore boat survey on 8 July 1998 found five adults apparently incubating and one pre-fledging chick (J. R. Jehl, Jr. pers. comm.)

Fledging Rates in the Fenced Plots: The seven fenced plots on the Negit Islets in 2002 held an average of 80.3 (SE = 10.3) nests and fledged an average of 1.16 (SE = 0.14) chicks per nest (Table 2), which tied for the fifth highest fledging rate recorded in the last 20 years (PRBO unpubl. data). For comparison, the long-term average (1983-2001) of chicks fledged per nest from the Negit Islets is 0.90 chicks per nest. The four fenced plots on the Paoha Islets complex held an average of 38.3 (SE = 10.6) nests and fledged an average of 1.13 (SE = 0.18) chicks per nest (Table 2). Combining the data from all 11 plots, each plot held an average of 65.0 (SE = 9.7) nests and fledged an average of 1.15 (SE = 0.10) chicks per nest (Table 2).

Table 2. Summary of Nest Counts, Chick Banding, and Mortality Counts on the Negit and Paoha Islets in 2002.

Site	Nests/Plot	Chicks/Nest[a]	Chicks Banded (died)	Fledged/Nest
Little Norway[b]	51	0.63	32 (13)	0.37
Little Tahiti East	61	1.26	77 (7)	1.15
Little Tahiti West	93	1.42	132 (8)	1.33
Twain North	73	1.44	105 (5)	1.37
Twain South	122	1.51	184 (10)	1.43
Twain West	106	1.44	153 (18)	1.27
Twain New	56	1.21	68 (2)	1.18
Negit Islet Totals:	**562**	**-**	**751 (63)**	**-**
Average =	**80.3**	**1.27**	**-**	**1.16**
SD =	**27.2**	**0.30**	**-**	**0.36**
SE =	**10.3**	**0.11**	**-**	**0.14**
Coyote A Cove	50	1.60	80 (5)	1.50
Coyote A Hilltop	61	1.25	76 (3)	1.20
Paoha Islet East	14	0.64	9 (0)	0.64
Paoha Islet West	28	1.21	34 (1)	1.18
Paoha Islet Complex Totals:	**153**	**-**	**199 (9)**	**-**
Average =	**38.3**	**1.18**	**-**	**1.13**
SD =	**21.2**	**0.40**	**-**	**0.36**
SE =	**10.6**	**.20**	**-**	**0.18**
Mono Lake Totals:	**715**	**-**	**950 (72)**	**-**
Average =	**65.0**	**1.24**	**-**	**1.15**
SD =	**32.1**	**0.32**	**-**	**0.34**
SE =	**9.7**	**.10**	**-**	**.10**

[a] Calculated at the time of banding (1-4 July).

[b] A damaged fence on the north side of the Norway plot may have permitted older chicks to move in and out of the plot. It is not known whether any of the chicks banded originated in nests outside of the plot (not counted in the nest total for the plot) or whether some chicks originating in nests within the plot moved out before banding activities.

Reproductive Success: Based on the average number of chicks fledged per nest from the seven fenced plots on the Negit Islets (1.16 chicks/nest with SE = 0.14; see Table 2) and the total number of nests (18,577 + 391; see Table 1) an estimated 22,003 ± 2,656 chicks fledged from Negit Island and the Negit Islets in 2002. Similarly, the average number of chicks fledged per nest from the four fenced plots on the Paoha Islet complex (1.13 chicks/nest with SE = 0.18) and the total number of nests (3,890; see Table 1) an estimated 4,396 ± 700 chicks fledged from the Paoha Islets complex. Overall, based on the average number of chicks fledged per nest from all 11 plots (1.15 chicks/nest with SE = 0.10; see Table 2) and the total number of nests on the lake (22,858; see Table 1), an estimated 26,287 ± 2,286 chicks fledged from Mono lake in 2002.

Finally, in spite of similar estimates of fledging success for the Negit Islets in the last two years, the 1,025 fewer pairs of adults initiating nests in 2002 than in 2001 resulted in approximately 1,648 fewer chicks fledging from the lake in 2002 than in 2001.

Effect of mass at banding on survival: Of 950 chicks banded on 1-4 July, 72 were found dead on their natal islet on 9-11 August, indicating that 878 chicks succeeded in fledging. The average mass at banding of chicks that survived to fledging (n = 878) was 491.5 g (SE = 3.96), whereas that of chicks that did not survive to fledging (n = 72) was 411.6 g (SE = 13.8). Chicks that survived to fledging were significantly ($X^2 = 33.32$, $df = 1$, $p < 0.0001$) heavier at banding than those that did not fledge.

Overview: The reasons for year-to-year variation in the number of adult gulls breeding at Mono Lake and their nesting success remain imperfectly known. During the tenure of this long-term monitoring program, low reproduction has been associated with each period of meromixis (1983-1988, 1996-1999). During these meromictic episodes, the productivity of Mono Lake has been reduced and brine shrimp phenology has been delayed (Jellison and Melack 1999).

Although it warrants concern, the long-term effect of meromixis on gull productivity at Mono Lake is uncertain. During the previous period of meromixis from 1983 through

1988 (Jellison and Melack 1993), gull productivity on the Negit Islets was low in 1983 and 1984, increased in 1985, and increased further to above average levels from 1986 through 1988 (PRBO unpubl. data) as meromixis weakened with falling lake levels (R. Jellison pers. comm.). These events suggest that over the course of the prior period of meromixis, invertebrate food supplies increased or the gulls otherwise adapted to the meromictic conditions. The four years of poor reproduction from 1996 to 1999 followed by relatively high reproductive success from 2000 to 2002, mirrors the pattern in the previous meromictic event. In 2000, 2001, and 2002 some of the typical effects of meromixis were at least partially absent: adult shrimp were available in the water column three to four weeks earlier than in preceding years, and shrimp population density increased rapidly during the early chick hatching period (R. Jellison pers. comm.; P. Wrege unpubl. data). Although Jellison et al. (1998) initially predicted the current episode of meromixis would last for up to several decades, meromixis is expected to break down in 2003, and primary productivity is predicted to remain near or above average even if it persists (R. Jellison pers. comm.).

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