Point Blue Report

# Population size and reproductive success of California Gulls at Mono Lake, California

Annual Report

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## Acknowledgements

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I greatly appreciated the help of volunteers and others who assisted with field work – without dedicated people like these, this long-term effort would not have been possible. Volunteers and participants for the 2017 season were: Nora Livingston, Sara Matthews, Gabby Renteria, Jennifer Rieke, and Tina Weedman.

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**Cover photo:** The Little Tahiti West plot on May 28, 2017. The yellow vegetation in the background is dead *Bassia hyssopifolia*, representing growth from the previous year. Note the young, green germinating *Bassia* plants in the foreground. *Bassia* has rapidly invaded the Negit Islets.

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## EXECUTIVE SUMMARY

Point Blue conducted the 35th year of monitoring the California Gull (*Larus californicus*) breeding population on Mono Lake in 2017. Following 2 years of pilot study, in 2017 I shifted to aerial photography to count nesting gulls. Results indicated that counting nesting gulls from aerial photographs matched ground counts by 96%. Reproductive success was measured by counting the number of chicks in the plots in July (rather than banding them as has been done in past years), and applying the long-term average post-banding mortality rate to the number counted to estimate the total number of chicks that successfully fledged per nest.

After 5 consecutive years of severe drought and lake level decline, the surface elevation of Mono Lake rose over 1 m during the 2017 nesting season, bringing the surface elevation to 1945 m by the end of the season. Coyotes (*Canis latrans*) were not detected on Negit Island or the Negit Islets in 2017, due to the effective electric fence erected on the land bridge.

The population size of California Gulls in 2017 was the lowest recorded in the 35 year the history of the project. The estimate of 27,094 breeding California Gulls is well below the long-term average of 45,988 ± 1347 for the period 1983–2016 ($n$ =34 years). Reasons for this decline are not fully known, but declines in brine shrimp (*Artemia monica*) densities, abandonment of islets that were raided by Coyote(s) in 2016, and the encroachment of *Bassia hyssopifolia,* a non-native weed, likely contributed to a decreased number of nesting gulls.

Average reproductive success in the sample plots was the lowest ever recorded at Mono Lake at 0.235 ± 0.07 chicks fledged per nest. The 1983 - 2016 average is 0.90 ± 0.06 chicks fledged per nest. Based on plot data, I estimated 3,181 ± 217 chicks fledged from Mono

Lake in 2017. The previous low estimate in chick production was in 2010 when an estimated 4,728 chicks successfully fledged from Mono Lake.

# INTRODUCTION

Mono Lake in eastern California is a large hypersaline lake of great ecological importance. Its large seasonal populations of endemic brine shrimp (*Artemia monica*) and alkali flies (*Ephydra hians)* provide important food resources for a large numbers of birds. Mono Lake supports one of the largest breeding colonies of California Gulls in the world (Winkler 1996).

In 1983, Point Blue Conservation Science (founded as Point Reyes Bird Observatory) began standardized monitoring of the population size and reproductive success of California Gulls at Mono Lake. The goal of the project is to use gulls as an indicator to help guide long-term management of the lake ecosystem. Specifically we aim to track the long-term reproductive success and population size of the gulls through changing lake conditions and identify the ecological factors influencing fluctuations in these metrics. This study represents one of the longest term ongoing studies of birds in North America. It is a powerful tool for assessing the conditions at Mono Lake and can be an invaluable tool in understanding how wildlife populations respond to ecological change that manifests over longer periods (e.g. climate change).

In 2017, I conducted Point Blue's 35th consecutive year monitoring the population size and reproductive success of California Gulls (*Larus californicus*) at Mono Lake. I continued to collect information on nest numbers, reproductive success, and predator visitation to the colony, although these parameters were measured with new methodologies in order to reduce disturbance to the gulls. In this report I provide a detailed summary of the 2017 results with reference to historical conditions. I also discuss the impacts of Coyote (*Canis latrans*) activity on the gull colony in 2016, and the tremendous growth of the invasive weed *Bassia* which overtook most of the nesting areas on the Negit Islets in 2017.

**Study Area**

Mono Lake, California, USA, is located at 38.0° N 119.0° W in the Great Basin of eastern California at an altitude of 1945 m. The lake has a surface area of approximately 223 $km^2$, a mean depth of about 20 m, and a maximum depth of about 46 m. As a terminal lake with no outlet, it is high in dissolved chlorides, carbonates, and sulfates, and has a pH of approximately 10.

**Fig. 1**. Locations of islands and islets within Mono Lake. Note when this photograph was taken the surface elevation of Mono Lake was >1 m above that measured during the 2017 gull breeding season.

Gulls nest on a series of islands located within an approximately 14-km² area in the north-central portion of the lake. At various times the gulls have nested on Negit (103 ha) and Paoha (810 ha) islands, and on two groups of smaller islets referred to as the Negit and Paoha islets, which range in size from 0.3–5.3 ha (Wrege et al. 2006).

**Fig. 2**. View of the nesting islets within the Negit Islet complex. Note when this photograph was taken the surface elevation of Mono Lake was > 1 m above that measured during the 2017 gull breeding season.

**Fig. 3**. The Paoha Islet complex. Piglet Islet, on the lower right, was connected to Paoha and not used by gulls in 2017


# METHODS

## Nest Counts

**Aerial Surveys:** In 2017, I adopted a new standardized method using aerial photography to count gull nests. This new methodology allows for the population size to be accurately measured without the disturbance involved in ground counts. This switch came following two years of pilot study testing and calibrating aerial photography results with the traditional ground counts. Aerial photo-based nest counts were found to be a good alternative to the ground counts, with results reflecting 90% - 100% of ground count tallies when photographs with sufficient detail were used (Table 1). In 2015, images used for counting were coarse and covered large areas (i.e. only 4 images used to count Twain). This reduced time spent "stitching" images together, but details like bird posture were difficult to see and accuracy was relatively low compared to ground counts on the larger islets. In 2016 closer, more numerous photographs in which bird posture was clear were used for counting. This resulted in much more accurate counts. In 2017 and beyond, the new methodology aims to recreate images similar to those used in 2016.

**Table 1.** Number of images used to count nests per islet and photo count results in comparison to ground counts, 2015 – 2016. Also number of images used to count nests in 2017

| | 2015 | | 2016 | | 2017 |
|---|---|---|---|---|---|
| **ISLET** | # Images used | **% of ground count** | # Images used | **% of ground count** | # Images used |
| Pancake A | 1 | **92%** | 4 | **102%** | 10 |
| Twain | 4 | **75%** | 26 | **91%** | 41 |
| L. Tahiti | 4 | **84%** | 22 | **95%** | 45 |
| Steamboat | 2 | **97%** | 7 | **94%** | 9 |
| Java | 1 | **51%** | 5 | **93%** | 4 |
| Coyote | 3 | **97%** | 8 | **116%** | 12 |
| Browne | 1 | **102%** | 1 | **100%** | 2 |
| Spot | 1 | **100%** | 1 | **101%** | 2 |
| Tie | 1 | **67%** | 1 | **100%** | 1 |
| Hat | 1 | **100%** | 1 | **91%** | 1 |
| | | | | | |
| **Totals** | 19 | **81%** | 76 | **96%** | **127** |

On 26 May 2017, I photographed all islets from the open window of a Cessna 180 flying at an altitude approximately 215 m (700’) above the lake using an 18 – 200mm zoom lens. The typical focal length used was 150 – 170mm. The goal was to obtain images with resolution similar to that in figure 3, where incubating and standing gulls are easily differentiated, and the area captured in each photograph is maximized in order to reduce time spent “stitching” images together. For larger islets (Twain, Tahiti) first I photographed the perimeter of the islet, then the interior systematically. The plane made several passes of each islet so that a large number of photos were available to choose from.

**Plot Counts:** I continued to count the number of nests within the nest plots with ground based counts in 2017. On 28 May Nora Livingston and I counted the number of nests in each plot and recorded clutch size. We walked systematically through the plot and marked each nest with a small dab of water soluble paint to avoid double-counting.

**Figure 3.** Sample of a cropped image used for counting gulls showing resolution detail

**Counting Nests from Aerial Images:** I selected images for counting based on clarity (i.e. fig. 3) and by area captured. The images I chose contained overlapping zones with adjacent images, covering the entire islet. I then used Adobe Photoshop to draw boundary lines on each image with the Brush Tool. In images with overlapping landmarks, I drew corresponding boundary lines following matching landmarks between the two images (i.e. rocks, vegetation, etc.). In some cases individual nests were woven around to ensure the boundary lines matched exactly (figure 4).

After boundary lines on each image were drawn, the Count Tool on Adobe Photoshop was used to count gulls. Each gull or pair was given a color-coded dot representing one of three count groups: 1. **Incubating**: a gull sitting/incubating within a nesting area. Most but not all of these were obviously nestled in a nest; 2. **Standing**: gulls that are obviously standing (upright posture and shadow angle were useful for assessment). Additionally, I considered gulls that were sitting in an area known not to contain as standing. The third count group were **Pairs**: An obvious gull pair, in which one bird is sitting/incubating. Combining the totals for Incubating and Pairs were used to count the number of nests for each islet. If it was uncertain if a gull was sitting or standing, it was considered Incubating. Results from the pilot study showed that combining "Uncertain", "Incubating" and "Pairs" consistently provided the closest match to nest numbers obtained by ground counts.

**Figure 4.** Example of images used for counting with drawn boundary lines. The top line on the left image matches the lower boundary line on the right image. Other boundary lines match on adjacent images.

For counting, most images were enlarged to 150% of the original resolution (this varied between 100 – 200%), and each image was systematically scanned by thirds (i.e. visually concentrating on the upper third, then mid- and lower thirds of the image on the monitor), and gulls were marked with the Count Tool to their corresponding count group. Following this process, the entire image was scanned again for any missed gulls.

Gulls are remarkably camouflaged against the Negit Islet topography. Images need to be carefully scrutinized to obtain an accurate count. The bright white heads, clear-cut white neck and gray mantle, and overall shape of nesting gulls were useful search images.

## Clutch Size and Reproductive Success

I continued to sample 9 fenced plots on 3 islets to estimate clutch size and reproductive success in 2017. 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 two smaller rounded fenced plots approximately 100 -120 $m^2$ are located on Coyote Islet of the Paoha Islet complex. Average clutch size was estimated by counting the number of eggs per nest for all nests within the 9 plots in late May.

On 7 July 2017 all chicks within the sample plots were counted. In two plots older, mobile chicks were temporarily corralled into holding pens within the plot in order to obtain an accurate count. Un-corralled chicks were tallied, and then corralled chicks were counted as they were released. This temporary corralling was used during banding efforts in past years. Chick count trials conducted last year in which volunteers visually counted chicks within the plots using tally meters (i.e. no corralling) consistently underestimated the actual totals. Thus temporary corralling would be necessary to obtain an accurate count in plots with moderate to large numbers of chicks. However, in 2017 the number of chicks per plot were so low, corralling to aid in counting was unnecessary in most plots.

The post-banding mortality count (counting the number of dead, banded gull chicks to measure the post-banding mortality rate) was dropped this year and instead I used the long-term average post-banding mortality rate obtained from 2000 – 2016 data. An analysis showed that the post-banding mortality rate is fairly constant and contributes relatively little to the overall annual reproductive success estimate. Thus counting chicks in July and applying the long-term average post-banding mortality rate is an excellent way of estimating overall reproductive success while reducing the disturbance and efforts of banding and mortality counts.

I estimated the fledging rate for each plot, and, applied the average fledging rate to the entire population to estimate the total number of gulls successfully fledged from Mono Lake in 2017. I calculated the fledging rate for each plot **(fplot)** as:

$$fplot = (Cb - Cd) / Np$$

where **Cb** is the number of chicks counted in that plot in July, **Cd** is the number of chicks from that plot that were estimated to have died after being counted in July (obtained using the long-term average post-banding mortality rate applied to the number of chicks counted in July), and **Np** is the number of nests counted in that plot in May. I 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. Overall chick production is estimated by multiplying the average reproductive success by the total number of nests.

# RESULTS

## Number of Nests and Breeding Adults

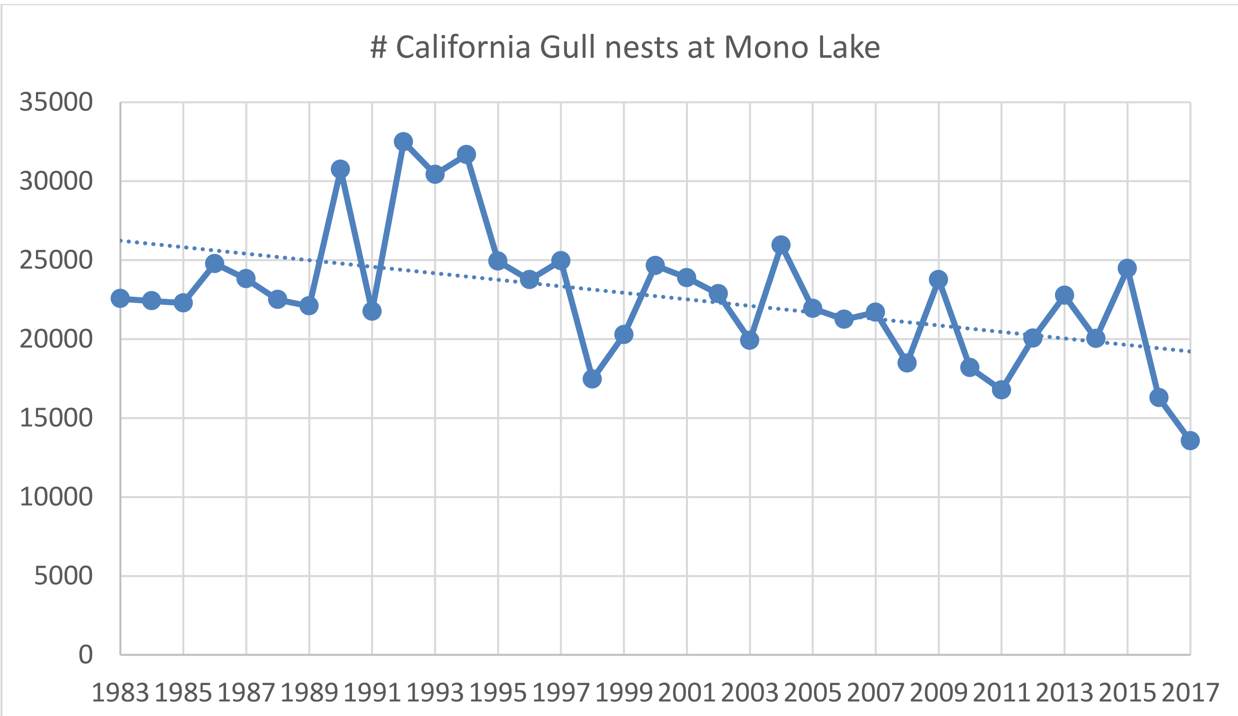
In 2017, a lake-wide total of 13,547 California Gull nests were counted, yielding an estimated population of 27,094 nesting adults. This total is the lowest ever recorded over the course of this study (Fig. 5, Appendix 1), and significantly lower than the population size recorded in 2016, which was the previous low recorded by this project. If the total estimate was increased by 4% (the amount that 2016 aerial photography underestimated the population compared to ground counts), the result would be similar with an estimated 14,089 nests. The long-term mean population size is 45,988 ± 1348 for the period 1983-2016 ($n$ = 34 years), and the mean population over the past 10 years is 40,495 ± 905. The number of nests counted in 2017 represented a relative decline of 17% compared to 2016 nest numbers, and a 45% relative decline compared to 2015 nest numbers. Java Islet was abandoned in 2017, likely due to Coyote presence that occurred there in 2016. Steamboat, Spot, Hat and Tie islets had the largest relative declines in nest numbers in 2017 compared to 2016 (Appendix 1).

Eighty-eight percent of the gulls nested on the Negit Islets, and 12% nested on the Paoha Islets (Figures 1 - 3, Appendix 1). The number of nests on the Paoha Islets increased in 2017 relative to 2016, both proportionally and in the overall number of nests counted. In contrast, the Negit Islets had significantly fewer gulls nesting on them in 2017 relative to 2016. Of the individual islets, Twain was the most populous, supporting 7,672, or 57%, of the lake-wide total number of nests. Twain had a similar number of nests in both 2016 and 2017. Pancake and Little Tahiti islets were the next most populous islets, containing 1,814 and 1,795 nests; each holding approximately 13% of the nesting population. Pancake and Tahiti hosted about 30% and 38% fewer nests in 2017 relative to 2016, respectively.

### Clutch Size

In 2017, the lake-wide average clutch size was below average at 1.78 ± 0.05 eggs/nest (range = 1-3 eggs, $n$ = 433 nests). Overall, 32% of the nests contained one egg, 59% had two, and 9% had three. The average clutch size for Mono Lake since 2002 (*n* = 15 years) is 1.91 ± 0.04 eggs/nest.

**Figure 5.** Number of California Gull nests at Mono Lake, 1983 – 2017 with trend line.




## Reproductive Success

The Negit Islet plots averaged 51 ± 6 nests per plot, with an average nesting density of 0.23 ± 0.03 nests/m². The Negit islet plots fledged an average of 0.26 ± 0.08 chicks per nest. The Paoha Islet plots averaged 37.5 ± 3.5 nests per plot and averaged 0.14 ± 0.06 chicks fledged per nest. Nest density on the Paoha Islets is uncertain due to the irregular sizes of the plots. Combined, the 9 plots averaged 0.235 ± .07 fledged chicks per nest (Table 1). This is below the long-term average of 0.90 ± 0.06 chicks fledged per nest and is the lowest reproductive success value recorded over the course of this project. The previous low was 0.26 chicks fledged per nest, recorded in 2010.

**Table 2.** Summary of Nest Counts and Chick Banding results from all plots in 2017.

| Plot | # nests in May | Avg. chicks/nest in July | # chicks in July | # estimated to die before fledging (# in July x 0.132) | Total successfully fledged/nest |
|---|---|---|---|---|---|
| Cornell | 75 | 0.05 | 4 | 0.53 | 0.046 |
| L. Tahiti East | 30 | 0.00 | 0 | 0 | 0.00 |
| L. Tahiti West | 69 | 0.28 | 19 | 2.51 | 0.240 |
| Twain North | 39 | 0.64 | 25 | 3.30 | 0.560 |
| Twain South | 46 | 0.11 | 5 | 0.66 | 0.094 |
| Twain West | 60 | 0.43 | 26 | 3.43 | 0.380 |
| Twain New | 39 | 0.59 | 23 | 3.04 | 0.512 |
| **Negit Islet totals/averages:** | **358** | **0.30 ± .10** | **102** | **1.92 ± 0.5** | **0.261 ± .08** |
| Coyote Cove | 34 | 0.10 | 4 | 0.53 | 0.085 |
| Coyote Hilltop | 41 | 0.24 | 8 | 1.10 | 0.204 |
| **Paoha Islet Totals:** | **75** | **0.17 ± 0.2** | **12** | **0.79 ± 0.2** | **0.144 ± .06** |
| **Lakewide totals/averages** | **433** | **0.65 ± .09** | **124** | **1.67 ± 0.4** | **0.235 ± .07** |

Based on the total of 13,547 California Gull nests counted in late May, and an average of 0.235 ± 0.07 chicks fledged per nest in the sample plots, an estimated 3,181 ± 216 chicks fledged at Mono Lake in 2017. Since both population size and reproductive success were the lowest recorded over the course of this study, the estimated chick production was also the lowest recorded, and well below the 1983 - 2016 average of 20,686 ± 1258 (*n* = 34 years) chicks produced annually. This long term average is calculated for the Negit Islets only from 1983 - 2002, and Negit and Paoha Islets combined since 2002.

# DISCUSSION

## Population Size

The nesting population size of California Gulls at Mono Lake has been in decline since about 2004, and this year the number of nests plunged at a rate greater than the trend line (Fig. 5). A previous study using data from 1987 – 2003 found that 4 variables explained over 80% of the variability in the Mono Lake gull population, particularly brine shrimp densities around the time of egg-laying, springtime temperatures, and recruitment (Wrege et al. 2006). However, the relationship between the population size and some of these variables appears to be changing. Brine shrimp have been trending significantly towards an earlier peak in abundance - closer to the gull egg-laying period since 2004 (Jellison and Rose 2012, LADWP 2017), yet the gull population has been in decline relative to the long-term mean since that time. Springtime temperatures in California and the Mono Lake region have been trending warmer, and recruitment (measured by average reproductive success at Mono Lake 4 years previously) which was significantly and positively correlated with population size from 1987 – 2003, has since correlated slightly *negatively* with population size.

However, the breeding population size of California Gulls at Mono Lake is likely responding at least in part to changes in their primary food source, brine shrimp. Long-term monitoring has shown that the peak mean abundance of adult brine shrimp at Mono Lake has been in decline since about 1989 (LADWP 2017). During the 3 year period from 2014 – 2016 peak adult shrimp densities were exceptionally low, and peak adult shrimp densities in 2015 and 2016 were by far the lowest on record since monitoring began in 1979 (LADWP 2017). This declining trend in peak shrimp densities generally matches the trend noted in the gull population – a long-term decline that became exceptionally high in the past few years. Further analysis is needed to test this relationship. Shrimp data for 2017 are not yet available.

Coyote activity in 2016 likely contributed to the reduced number of nesting gulls in 2017. Over the course of this stud y we have found that islets raided by Coyotes are typically abandoned by nesting gulls the following year. Thus, islets that were raided by Coyotes in 2016 we would expect partial or complete abandonment in 2017. In 2016, Coyote signs (scat and tracks) were widespread on Negit Island and scat was found on Java Islet in July, confirming that Coyote(s) had swum to Java, probably from Negit Island. The islets surrounding Java - Steamboat, Spot, Hat and Tie - lacked or had greatly reduced numbers of chicks relative to other islets in July 2016, suggesting that these also may have been raided by Coyote(s) (Nelson 2016). This year, following the trend of abandonment following Coyote activity, Java Islet was completely abandoned by nesting gulls. The islets surrounding Java (Steamboat, Spot, Hat and Tie) had greater relative declines in nesting population this year compared to the other Negit Islets (Appendix 1).

In 2017, no evidence of Coyotes was noted on Negit Island or Islets. Searches for tracks and scats were made on several occasions in the spring and summer on sandy areas of Negit Island where Coyote sign was common in 2016. None was found in 2017. The lack of Coyotes this year was almost certainly due to the success of an electric Coyote exclusion fence that was funded and managed by the Mono Lake Committee. The fence was erected on the mainland edge of the shoreline of the Gaines Island peninsula ("landbridge") on April 1 and was maintained through the nesting season. Wildlife cameras and site visits (where tracks were noted in soft mud) to the fence revealed multiple Coyote visits to the mainland side of the fence, but none on the Negit side. We attribute this to the successful functioning of the fence. Coyote tracks were abundant on the Negit side of the shoreline up until the fence was installed (K. Nelson, pers. obs.).

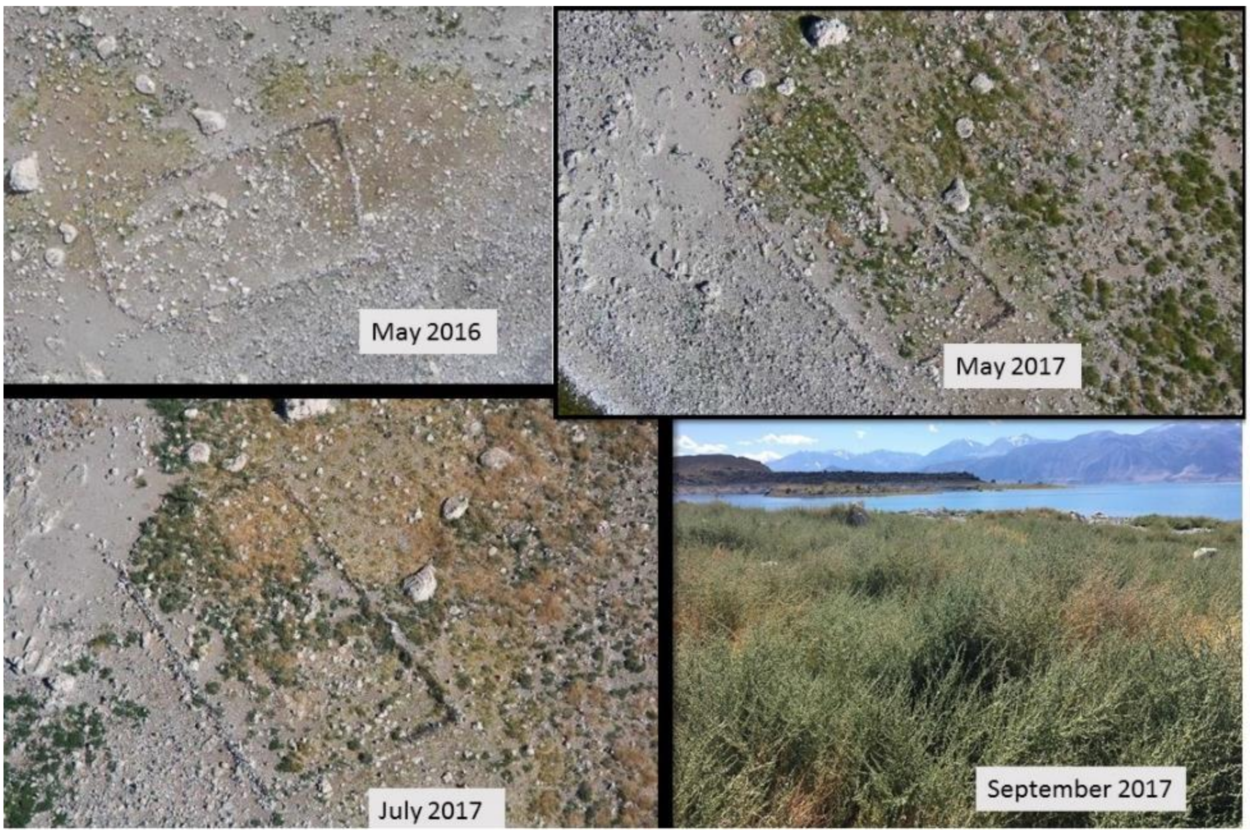
**Figure 6.** Twain South plot in July 2014 and September 2017. Photo on left taken by Erica Tucker

### *Bassia* Encroachment on the Negit Islets

This year I documented an alarming and extremely rapid invasion of *Bassia hyssopifolia* on the Negit Islets. This encroachment likely had an effect on the Negit Islet gull population in 2017, and will certainly affect the population in the future unless it is removed. This Eurasian invasive weed currently covers an estimated 70% or more of the Negit Islets of Mono Lake (figures 6, 7). Aerial photo documentation shows the vast majority of this growth occurred in the past 12 – 18 months, with most occurring in the early fall of 2017. During a plot repair visit in early September, I was stunned to find how thick and extensive the *Bassia* coverage was on Twain and other Negit Islets. The effects this weedy growth had on nesting gulls this year are difficult to measure, but negative impacts were likely. Increased weed coverage through the summer likely reduced the ability of adult gulls to access their nest sites, and may have displaced and entangled chicks. During our site visit in September 1 or 2 dead chick carcasses were found tangled in *Bassia* weeds.

Gulls select open ground areas for nesting, and these open areas have become reduced or eliminated on the Negit Islets due to *Bassia* coverage (Fig. 6, 7). *Bassia* cover likely explains why the Paoha Islets, which lack *Bassia*, experienced an increase in nest number and overall proportion of the population in 2017. *Bassia* coverage increased dramatically after the completion of the 2017 nesting season, and this tangled mass of non-native vegetation will prevent most gulls from nesting at Mono Lake in 2018 and future years unless action is taken. Plans are underway with the Inyo National Forest and California State Parks to initiate a *Bassia* removal project.

**Figure 7.** *Bassia* encroachment on the Twain South plot, 2016 and 2017. Similar encroachment occurred on other parts of Twain and the Negit Islets.




## Reproductive Success

The average of 0.235 chicks fledged per nest in 2017 was the lowest recorded over the course of this project, and well below the 1983-2016 average of 0.90 ± 0.06 chicks fledged per nest. As with population size, the reasons behind such a decline are not completely understood and are likely multi-faceted. Our long-term data show that the gull nesting population size and reproductive success are correlated, suggesting that gulls assess conditions, and may choose not to nest that year if conditions are poor in spring. This year the extremely low population size suggests unfavorable conditions, perhaps relating to reduced shrimp densities and other factors. Further analysis is needed to assess whether shrimp densities in a particular year affect the following years' population size.

Nelson et al. (2014) found that annual average reproductive success of California Gulls at Mono Lake is negatively correlated with meromictic (i.e. highly stratified) conditions. Meromixis occurs following high levels of runoff, which create a stratification of fresh and salty waters. Although the lake rose 1.34 m from January to October 2017, the full effects of the resulting meromictic conditions, which disrupt over-winter nutrient cycling in the lake, would not be expected until 2018.

Activity by Peregrine Falcons (*Falco peregrinus*) could have affected reproductive success in 2017. Peregrine Falcons successfully fledged 3 young on the Mono Lake Islands in 2017, a first in nearly a century (Gaines 1992). Although this pair was detected last year, their nest apparently failed. Last fall, the only prey remains found in the falcon eyrie came from 2 or 3 phalaropes. In October 2017, a visit to the eyrie revealed gull chicks were the primary prey remains in 2017. At least 25 gull chick legs were found around the nest scrape, and one pair of phalarope legs. However, unless the disturbance caused by the hunting activity of these flacons was particularly great, one falcon pair would not be expected to have a significant impact on colony-wide chick productivity. Just as Great-horned Owls (*Bubo virginianus*) have long been persistent predators on the colony with localized areas of high impact (Jehl 1983, Jehl and Chase 1987, Nelson and Greiner 2012), effects of owl predation have not been found to influence colony-wide reproductive success. A diurnal predator may have a greater impact through disturbance, although I would expect colony-wide impacts on chick production would be small.

During field work in July the low chick density was readily apparent. Chicks were generally distributed around the shorelines rather than being constrained to their nest territories. Typically, chicks are not free to move about the islets due to the territorial aggression by neighboring gulls. With so few or no neighbors, and perhaps encroachment of *Bassia* weed on their upland territories, gull chicks were free to roam to the shorelines in July. In 14 years of running this project, I had never observed such a distribution of or low chick numbers. Spot Islet contained only 3 chicks and on Steamboat only 12 chicks were visible on July 7. Based on the number of nests counted in May, these tallies would translate into 0.05 chicks/nest, which is consistent with findings from some of the plots (Table 2). Coyote Islet was also contained notably few chicks in July.

In summary, the breeding population size and average reproductive success of the California Gull population were the lowest recorded over the course of this study. Reasons for such major declines in these parameters are not fully understood. The low population size is likely in reaction to the unprecedentedly low peak brine shrimp densities experienced in the previous two years, and reduced nest site availability due to 2016 Coyote activity and 2017 *Bassia* weed encroachment. Reasons for the low average reproductive success are more difficult to explain. Early effects of water stratification and reduced food availability are potential factors. Next year may again be challenging for the gull population. The effects of meromixis are expected to impact the lake, which is associated with poor average reproductive success (Nelson et al. 2014). Additionally, the Negit islets will be unable to host a robust gull population unless *Bassia* is reduced or removed. Hopefully this is accomplished – the future of the gull colony at Mono Lake may depend on it. On a positive note, California Gulls are long-lived (20+ years), and have the ability to "wait out" periods of poor conditions.

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**Appendix 1.** Nest number by islet, 2008 - 2017

| **Negit Islets** | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 [c] |
|---|---|---|---|---|---|---|---|---|---|---|
| Twain | 8891 | 11449 | 8219 | 8704 | 9396 | 9567 | 9144 | 12263 | 7760 | 7672 |
| L. Tahiti | 2477 | 2770 | 2429 | 2049 | 3366 | 3995 | 3899 | 4258 | 2923 | 1795 |
| L Norway | 137 | 119 | 114 | 171 | 390 | 493 | 384 | 505 | 284 [c] | 163 |
| Steamboat | 590 | 580 | 509 | 579 | 871 | 1175 | 1076 | 1010 | 675 | 217 |
| Java | 482 | 433 | 367 | 432 | 325 | 234 | 216 | 439 | 60 | 0 |
| Spot | 49 | 87 | 122 | 151 | 39 | 95 | 162 | 184 | 144 | 55 |
| Tie | 9 | 37 | 55 | 58 | 30 | 56 | 65 | 181 | 170 | 49 |
| Krakatoa | 24 | 5 | 2 | 0 | 12 | 9 | 12 | 84 | 38 | 40 |
| Hat | 3 | 3 | 0 | 7 | 24 | 30 | 29 | 25 | 21 | 2 |
| La Paz | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 7 | 16 | 19 |
| Saddle | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Midget | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| L. Tahiti Minor | [a] | 152 | 151 | 162 | 253 | 282 | 255 | 202 | 116 | 64 |
| Pancake | 1623 | 2293 | 1894 | 1741 | 1972 | 2450 | 1903 | 3159 | 2497 | 1814 |
| ***Negit Islets Total*** | **14285** | **17929** | **13862** | **14054** | **16678** | **18386** | **17149** | **22317** | **14704** | **11890** |
| **Paoha Islets** | | | | | | | | | | |
| Coyote | 1989 | 2591 | 1711 | 929 | 1393 | 2093 | 2618 | 2042 | 1432 | 1505 |
| Browne | 99 | 135 | 116 | 50 | 60 | 75 | 110 | 87 | 146 [c] | 152 |
| Piglet | 1001 | 1314 | 997 | 599 | 344 | 148 | 38 [b] | 0 | 0 | 0 |
| ***Paoha Islets Total:*** | **3089** | **4040** | **2824** | **1578** | **1797** | **2316** | **2766** | **2129** | **1578** | **1657** |
| **Negit Island:** | 0 | 0 | 0 | 0 | 7 | 8 | 28 | 16 | 0 | 0 |
| **Old Marina** | 1089 | 1775 | 1496 | 1133 | 1541 | 1665 | 9 [b] | 0 | 0 | 0 |
| **O.M. So.** | 9 | 22 | 4 | 9 | 36 | 380 | 70 [b] | 0 | 0 | 0 |
| ***Lakewide Total*** | **18472** | **23766** | **18186** | **16774** | **20059** | **22755** | **20022** | **24462** | **16282** | **13547** |
| ***Nesting Adults*** | **36944** | **47532** | **36372** | **33548** | **40118** | **45510** | **40044** | **48924** | **32564** | **27094** |

**a.** Nest numbers for Little Tahiti Minor were previously included within the Little Tahiti Total
**b.** Number of nests known to be depredated or abandoned on Old Marina South; likely an underestimate.
**c.** Nest numbers obtained through aerial surveys and photographs