SAN FRANCISCO BAY
BIRD OBSERVATORY

Citizen Science-Based Colonial Waterbird Monitoring
2019 Nesting Summary

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PROGRAM SUMMARY

The San Francisco Bay Bird Observatory (SFBBO) is a nonprofit organization dedicated to the conservation of birds and their habitats through science and outreach. The Colonial Waterbird Program (CWB) is one of SFBBO's long-standing citizen science programs, initiated in 1982 to monitor waterbird nesting colonies in the San Francisco Bay. The program has engaged hundreds of citizen scientists in waterbird nest-monitoring activities and introduced hundreds of local community members to the presence of birds and their needs for protection and management. Trained citizen scientists independently collect observational data on nesting status, timing of breeding, waterbird behavior, and evidence of disturbance at selected colonies each year. Citizen scientists also assist SFBBO staff in conducting annual walkthrough counts of all known California Gull colonies in the South San Francisco Bay (South Bay), which enables comparison of colony sizes over time. This information is shared with landowners, resource agencies, and other conservation organizations and contributes to the conservation and management of these species. In addition to monitoring colonies, many citizen scientists in the program help SFBBO develop relationships with landowners and local communities and lead presentations and bird viewings to share these birds with the public.

INTRODUCTION

Colonial waterbirds are essential components of wetland and aquatic habitats across the globe (Hoffmann et al. 1996). These species play key roles within their ecosystem, require specific habitat types and qualities in order to survive, and thereby can be viewed as biological indicators of environmental health and function (Kushlan 1993). In densely inhabited areas like the San Francisco Bay, human encroachment and habitat degradation are a few of the many factors that affect wetland habitats (Lotze et al. 2006) and therefore colonial waterbird populations.

Colonial waterbirds are attractive candidates for citizen science monitoring. In addition to their ecological value, they are conspicuous and intriguing animals, especially when aggregated in large breeding groups (Parnell et al. 1988). SFBBO's colonial waterbird monitoring not only provides information on the health of Bay area ecosystems, but also encourages the public sentiment that fuels many of these conservation efforts.

Since colonial waterbird colonies can be comprised of several species utilizing a large geographic area, significant changes within these populations may not be detectable for many years by standard research methods. In addition, funding and personnel limitations may prohibit professional-level monitoring at the required scale. Citizen science initiatives are excellent methods for contributing to long-term, geographically expansive research goals at low cost (Dickinson et al. 2010; Cooper et al. 2014). Furthermore, citizen science studies provide opportunities for public involvement, which foster local stewardship and environmental appreciation.

Since 1982, SFBBO has annually recruited and trained citizen scientists to monitor nesting herons, egrets, cormorants, gulls, and terns in the San Francisco Bay as part of our CWB Program. The CWB emphasizes community engagement and citizen science in order to: 1) increase monitoring capacity across a large geographic area, and 2) generate public interest in protecting waterbirds and their habitats. Many of the colonies monitored by SFBBO citizen scientists would not otherwise be tracked.

In this report, we summarize results from SFBBO's CWB Program in 2019.

SURVEY METHODS

Study area

Our study area encompasses colonies within the counties of Santa Clara, San Mateo, Alameda, Contra Costa, San Francisco, and San Joaquin (Figure 1). Colonies are located as far north as San Francisco, as far east as Brentwood, as far south as Coyote Valley and as far west as Pescadero (Figure 1). The Audubon Canyon Ranch manages a similar monitoring program for herons and egrets in the North and Central Bays and Point Blue Conservation Science manages a program in the San Joaquin Valley.

Waterbird colony monitoring

The observational study methods for waterbird colony monitoring have remained largely unchanged since the program's initiation in 1982. Our monitoring efforts are divided based on two guilds: 1) gulls, terns and shorebirds; 2) herons, egrets and cormorants. Our gull, tern and shorebird monitoring includes primarily colonies of California Gull (*Larus californicus*), Forster's Tern (*Sterna forsteri*) and Caspian Tern (*Hydroprogne caspia*), with secondary species, including American Avocet (*Recurvirostra americana*), Black-necked Stilt (*Himantopus mexicanus*), and Black Skimmer (*Rynchops niger*), when nesting with our primary species of interest. Our heron, egret and cormorant monitoring includes primarily colonies of Great Blue Heron (*Ardea herodias*), Great Egret (*A. alba*), Snowy Egret (*Egretta thula*), and Double-crested Cormorant (*Phalacrocorax auritus*). Additionally, we monitor Black-crowned Night Heron (*Nycticorax nycticorax*) and Green Heron (*Butorides virescens*) when nesting with these species. For a list of all species monitored and their 4-letter species code, please see Appendix I.

Each season, citizen scientists receive training in waterbird identification, natural history, proper "etiquette" around nesting birds, and observational study methods through a standardized protocol. Citizen scientists are assigned colonies based on a prioritization method developed by SFBBO staff. Priority for monitoring is based on the number of years the colony has been monitored, date of most recent nesting activity, accessibility and citizen scientist availability. Colonies are located on both public and private lands and are either detected opportunistically or visited with the existing knowledge of nesting activity.

Monitoring occurs from February to August and includes 7-9 survey dates per colony, depending on the species observed. Great Blue Heron colonies are monitored from early February to July, Double-crested Cormorant and egret colonies are monitored from early March to early August, and gull, tern and shorebird colonies are monitored from early April to early August. Our goal is to monitor once a month (first weekend) during the early and late nesting months and twice a month (first and third weekends) during the peak nesting months. During each monitoring session, citizen scientists use binoculars and spotting scopes to estimate the number of breeding adults, active nests and chicks. They also note nesting behaviors, such as incubation, nest-building and courtship displays, and any evidence of human disturbance or predation.

In addition to the above methods, SFBBO biologists survey California Gulls through a walkthrough method. Walkthrough surveys occur each year in early to mid-May, during the late incubation and early hatching period for the majority of the population. During surveys, teams of observers systematically walk through each colony and visually tally all active nests present. Empty and fully depredated nests are excluded. To minimize the potential for opportunistic gull predation due to human disturbance,

particular areas where conspecifics nest are avoided during walkthroughs. Active nest numbers are estimated from the closest possible vantage point within the colony. California Gull nest counts are multiplied by two birds per nest to produce an estimate of the adult breeding population.

In order to estimate the number of nests of Double-crested Cormorants that nest within California Gull colonies, we survey from kayaks adjacent to the colony. This is done in order to limit disturbance, prevent California Gull predation on nests, and to coincide with our walkthroughs. For this reason, these Double-crested Cormorants are only surveyed once in early May when SFBBO is also counting California Gull nests.

RESULTS AND DISCUSSION

Waterbird colonies (observational)

SFBBO monitored a total of 50 potential GUTE and HEP colonies across 49 sites, 49 of which became active breeding colonies in 2019 (Table 1, Table 3). Some known colony sites were not surveyed due to access issues or observer availability. Lake Merced South was monitored last season, but not this year due to inactivity. Sites that were not monitored last season, but were monitored this year comprise: Moffett AB1, Moffett AB2, and Moffett A3W. A scouting visit also occurred at Ravenswood RSF2.

Waterbirds nested in a variety of habitats, including islands within former salt ponds at Alviso A16, power towers along the Dumbarton Bridge, and eucalyptus trees within a residential neighborhood at Ruus Park. The number of nests at each colony site varied from one American Avocet nest (Moffett AB2) to over 100 nests (e.g. Downtown Oakland, Dumbarton Bridge PG&E Towers, Hayward Shoreline, and Steinberger Slough). Species composition at the colony sites monitored also varied considerably. In 2019, Almaden Lake had four species actively nesting, comprising Great Egrets, Black-crowned Night Herons, Great Blue Herons, and Snowy Egrets. In contrast, Alviso pond A16 had American Avocet, Black Skimmer, Black-necked Stilt, Caspian Terns, and Forster's Terns.

We monitored 16 sites with active gull, tern and shorebird colonies (Table 1). Of the species that we monitored using observational methods (i.e. excluding California Gulls), Forster's Terns were the most abundant nesting species at the sites that we monitored. American Avocet nesting was most active at Alviso A16 and New Chicago Marsh. We observed one active Black Skimmer nest at Redwood Shores, Nob Hill Market, two nests at Alviso 16, and twenty nests at Hayward Shoreline. Black-necked Stilts were most active at Alviso 16 and New Chicago Marsh. Caspian Terns again nested on islands at Alviso A16, which was part of a successful Caspian Tern social attraction study initiated in 2015 by USGS and USFWS (Hartman et al. 2018). Caspian Terns were also observed nesting at Ravenswood RSF2 during a scouting visit in 2019. The most active nesting sites for Forster's Terns were Hayward Shoreline and Moffett AB1.

Elegant Terns were observed nesting in San Francisco Bay for the first time during the 2019 season. The northward movement of nesting behavior in this species was previously linked to climate change (Velarde et al. 2015). Elegant Terns historically nested in Mexico, but moved their breeding activities northward to southern California in response to warm oceanographic anomalies. Their arrival as far north as San Francisco Bay during the breeding season may indicate further response to warming ocean conditions. Their arrival indicates that local conditions appear good for nesting, but these terns will be sharing nesting habitat with three species of terns that are already established in the area. SFBBO will

continue to track breeding activity at the Elegant Tern site to determine if they will return to nest in future years, and how their nest numbers may impact the nesting attempts of other species at the site.

We monitored 31 sites with active heron, egret and cormorant colonies using observational methods (Table 3). Double-crested Cormorants were the most abundant nesting species at these sites. The largest cormorant colony monitored was at the Dumbarton PG&E towers with an estimated 103 nests, but this species also nested in large numbers at Lake Merced Mesa and Steinberger Slough. Great Blue Herons occupied one large colony (20+ nests) at Ovation Court, with several smaller colonies throughout the region. Similar to 2015-2016, we observed three Green Heron nests at Lake Cunningham this season. We monitored 9 colonies that included Snowy Egret nests. Nesting for this species was most active at Lakeshore Park in Newark, with 130 nests. We monitored 10 colonies that included Black-crowned Night Heron nests. The most active nesting areas for this species were Lakeshore Park in Newark with 80 nests and Downtown Oakland with 55 nests. However, the Downtown Oakland colony declined significantly by the end of the season because one of the primary nesting trees fell down and was then removed in mid-July 2019. Some birds perished when the tree fell and a larger number were transported to International Bird Rescue. By August 4, the total active nest count was down to three nests.

With the exception of California Gulls, the nesting sites monitored here should not be viewed as a comprehensive list of all active waterbird colonies for these species in the region; nor should the peak nest numbers observed be used for Bay-wide population-level trend analyses. More intensive nest-monitoring, a strategic sampling approach, and a broader geographic scope would be better-suited to such goals. While SFBBO citizen scientists visited some colonies that were also surveyed by other agencies, the data collected by the different entities should not be directly compared due to the difference in monitoring methods used.

While the biased sampling scheme (toward known, occupied, and accessible sites), low frequency of colony visits, and observational methods used as part of the CWB Program have their limitations, these data have many values. Due to the consistency of data collection over the course of the program, this dataset can be used to track colonies over time and provide local managers with information on the histories of particular colony sites. Additionally, this program provides essential data that serves as a valuable starting point for the development of more comprehensive regional efforts to track population sizes and trends on a larger scale. For example, SFBBO collaborated with other scientists in the region to synthesize counts from Double-crested Cormorant colonies and to create a population model showing regional trends over the last few decades (Rauzon et al. 2019). Additionally, some of SFBBO's CWB data were previously incorporated into a San Francisco Bay heron and egret atlas by Kelly et al. (2007). SFBBO has also partnered with the U.S. Fish and Wildlife Service in their effort to understand and manage the relationship between Double-crested Cormorants and special status fish species along the Pacific Flyway (Adkins et al. 2014).

In addition, SFBBO has consistently monitored many sites for 20-30 years, which provides a detailed account of activity within and around these localized populations. For example, areas adjacent to the Llagas Creek heronry in the city of Morgan Hill experienced high levels of human disturbance for several years as a result of residential development. While there are no direct observations of detrimental effects from construction activity on the active heron colony, we have documented changes in the size and species composition of the colony since the start of development in 2003. This may be related to natural species composition changes over time, or to other factors such as the differential tolerance of,

response to, or habituation to disturbances by species, as noted in Carney and Sydeman (1999). In 2018 this colony was abandoned early in the season and observations suggested that the likely cause was conflict with neighboring Red-tailed Hawks.

In the future, we hope to incorporate more habitat characterization elements into the protocol. For example, many heron and egret rookeries are located in urban greenspaces (e.g., parks, residential areas, and athletic fields), and many waterbird nests are located on artificial structures, such as old hunting blinds and power towers, and in invasive or ornamental vegetation (e.g., Eucalyptus trees). Training citizen scientists to collect some additional information on site characteristics and nesting substrate could heighten our understanding of waterbird use of these highly modified landscapes and features.

Focusing on these long term sites, in addition to urban habitat characterization and documenting breeding responses to habitat changes would greatly increase our understanding of waterbird ecology and would further assist resource managers in making well informed decisions related to maintaining valuable breeding locations throughout the San Francisco Bay.

California Gulls (walkthrough)

California Gulls are the most abundant nesting waterbird in the South San Francisco Bay and SFBBO has been monitoring the growth of the breeding population since 1980. In 2019, SFBBO monitored 10 California Gull colonies via walkthrough surveys from May 12–30 (Table 2). These colonies encompass all known South Bay breeding locations of this species. California Gull colony sizes ranged from 2 breeding birds (A1) to 18,072 birds (PAFCC). The Alviso A9/10/11/14 colony was the second largest colony in previous years, but shrank significantly to an estimated 4 individuals. The former colony site at Alviso A5/7 was used again to a greater extent this year following two years of disuse. In 2019, 6,108 birds bred at Alviso A5, a significant increase from the 276 birds that nested at this location in 2014.

We estimated a total of 45,026 California Gulls breeding in the San Francisco Bay in 2019, a -2% decrease from the 46,766 estimated in 2018 (Table 2). The magnitude and direction of the change varied greatly by colony, from a -99% decrease at Alviso A9/A10/A14 to a 37% increase at Moffett AB2. This range indicates that gulls are changing their distribution and selection of breeding sites (Figure 3). The fluctuation in size and location of active gull colonies over the study period is likely due to a suite of changing environmental and demographic factors (Table 2).

Alviso pond A6 formerly held an average of 76% of the breeding population of California Gulls in San Francisco Bay (Strong et al. 2004, Table 2). In December 2010, A6 was restored to tidal action as part of the South Bay Salt Pond Restoration Project. Gulls appear to have redistributed to several nearby colonies, particularly A9/10/11/14 and the Palo Alto Flood Control Basin (Figure 3). In 2019, we re-sighted 40 banded gulls on our walkthrough counts and through volunteer submissions. Forty of these birds were banded at the A6 colony from 2008–2010. The subsequent band re-sighting data gathered through this project, as well as from other long-term banding efforts (Schacter et al. 2008, Robinson-Nilsen et al. 2010, and Ackerman et al. 2013) provide useful information regarding gull life span, dispersal, and the potential impact of encroachment into breeding areas for other sensitive species.

Given the size and geographic proximity of South Bay gull colonies to other sensitive species' nesting habitats, there is an urgent need to protect rare species, such as the Western Snowy Plover, against

potential gull impacts (Robinson-Nilsen et al. 2011). In response, SFBBO and the U.S. Fish and Wildlife Service pursued selective, nonlethal gull hazing during the gull nest initiation stage from 2011-2015. In subsequent years, the U.S. Fish and Wildlife Service removed California Gull nests from habitats proximate to colonies of sensitive shorebird species, specifically Moffett AB2. Ongoing monitoring, hazing and evaluation of other actions will be required over the long-term to limit gull impacts to sensitive species.

RESEARCH AND MANAGEMENT RECOMMENDATIONS

1. Regulatory agencies, such as the U.S. Fish and Wildlife Service and California Department of Fish and Wildlife, should work directly with private landowners to protect colonies on privately-owned land. In the case of wading birds, Kelly et al. (2007) urged prioritized protection for larger, more stable colonies of 20 or more nests, and especially for those with 100 or more nests. Since many small colonies (5-50 active nests) exist in the South Bay, and small colonies can be more vulnerable to human disturbance and abandonment than larger colonies, protection and management efforts should take these factors into consideration (Kelly et al. 2007).

2. It remains largely unknown what factors, or interactions of factors, are influencing the overall rapid population growth and the recent stabilization of the California Gull population in San Francisco Bay. No systematic study of California Gull reproductive success has been conducted – as a result, we recommend a comprehensive study of California Gull demographics in San Francisco Bay. Enhanced monitoring of gull nest success, breeding site fidelity/movement, chick survival, and adult and chick diets (to assess use and importance of “natural” vs. landfill-derived food items) could be especially informative.

3. There were no known instances of California Gulls successfully nesting in new sensitive habitats in 2019. In previous years this was presumably due to the intensive surveys and removal of nest bowls from sensitive habitats by the U.S. Fish and Wildlife Service and SFBBO. In the future, without these activities, gulls may colonize nesting habitats preferred by Western Snowy Plovers or other sensitive waterbird species, such as the islands at Alviso pond A16. Therefore, we recommend the continuation of this monitoring and nest-removal regime in 2020. In addition, gull depredation is a concern for nesting Least Terns at Eden Landing and other shorebird species. A study of the impact of gull predation on nesting success would be informative.

4. Significant decreases in the number of California Gulls using the Newby Island Landfill have been recorded in response to on-site abatement programs. Controlling access to anthropogenic food sources may affect the location and size of active gull colonies and, over time, could reduce the number of nesting California Gulls in the San Francisco Bay. While abatement has been effective at decreasing gulls locally, the degree to which individual gulls move between anthropogenic sources of food is unknown. We recommend the implementation of gull abatement programs at other refuse management locations. We also recommend a study to describe the movement of gulls between sites and the impact of coordinated control efforts on gull populations.

5. Continued monitoring of South Bay waterbirds, from broad topics of study to focused, localized populations will be crucial as the South Bay Salt Pond Restoration Project progresses with its Phase Two actions. This includes construction activity near or at waterbird colony sites and conversion of some habitats currently supporting breeding waterbirds to tidal marsh. We believe that the

combined efforts of professional scientists and citizen scientists alike are needed in this endeavor. However, we advise against direct comparisons of waterbird nesting data collected using different methods and encourage future collaboration and communication among different entities collecting these data in the South Bay.

6. The scientific and social benefits that these educational opportunities provide, not only to our research but also to our citizens, are still not fully understood (Jordan et al. 2012). We encourage community engagement in ecological research and recommend that scientists work to develop multi-disciplinary measures of success for such programs.

COMMUNITY OUTREACH THROUGH CITIZEN SCIENCE

Since the establishment of SFBBO's CWB Program in the early 1980s, hundreds of citizen scientists have helped carry out this research to help us better understand how birds in the Bay Area are doing. Each nesting season, around 65 new and veteran citizen scientists receive the CWB Volunteer Manual and then attend a special training and orientation with SFBBO staff. At this meeting, staff give citizen scientists an overview of SFBBO and the CWB Program, highlight the results from the previous season's efforts, go over monitoring protocols, answer questions, and address common issues people experience in the field. Following training, the citizen scientists spend one or two mornings each month (from February through August) monitoring their colony.

Citizen scientists observe breeding activity; count birds, nests, and chicks; and record environmental conditions and human impacts. The commitment of this strong network of citizen scientists has produced a valuable, long-term dataset that helps land managers, organizations, and the public make informed decisions to conserve birds. In addition to providing valuable scientific data, SFBBO's CWB Program is one of the strongest parts of SFBBO's Outreach Program. By engaging people from the community in avian research, we build their awareness about birds and conservation and nurture their understanding of and appreciation for science. In turn, our citizen scientists carry their experiences and passion for birds, conservation, and science into the wider community.

Several years ago, we channeled our citizen scientists' expression of passion and experience into new avenues of action by adding several initiatives to the CWB. These new components augment the ways citizen scientists in the program support each other, grow our scientific reach, educate the community, and impact bird conservation. These changes came about in response to ideas from some of our most active citizen scientists and from feedback that we collected from the group through a survey in late 2013. We are excited about the direction our citizen scientists are helping SFBBO take the CWB Program and are very grateful for their energy and dedication. Each of these new components is described briefly below.

In 2019, 84 SFBBO citizen scientists contributed 835 volunteer hours to the CWB Program. This includes office work, colony monitoring, and California Gull walkthrough counts. If valued at a rate of $16 per hour, this amounts to $13,360 in donated labor. Many CWB citizen scientists are long-term participants and supporters, highlighting the interest in and value of this citizen science program.

Mentoring and Scouting

We continued our mentoring and scouting activities in 2019. Our Mentoring Program gives new citizen scientists an opportunity to learn the monitoring protocols from our veterans. Scouting is a less directed

survey method where citizen scientists visit either previously un-surveyed potential nesting sites or previously surveyed abandoned colony sites. This allows our staff to reduce their time commitments and also allows the program to grow through the discovery of new colony sites.

Online Training

Program participants are spread out geographically, and many expressed the desire to minimize the driving time required for the in-person training. In 2017, SFBBO hosted its first virtual training in the format of a live online webinar. Volunteers logged in from any computer or called in over the phone to learn about the program and participate in a question-and-answer session with SFBBO staff. A video recording of the webinar was later viewable for all program participants on a pilot training website: https://colonialwaterbirdprogram.weebly.com/. In 2018, SFBBO converted the training into a multi-part video series and posted them to the training website. These online training materials were refined in 2019 and will be expanded upon in future seasons.

Ambassador Program

In 2019, citizen scientists in our CWB participated as ambassadors in the following SFBBO activities:

1. Community Partnerships: Our CWB citizen scientists helped SFBBO share our data in 2019 with land managers and others working to conserve Bay Area birds. In addition to writing this Annual Report, throughout the season SFBBO staff wrote and shared several reports on specific colonies in response to requests from landowners and community members; including the San Francisco Public Utilities Commission and Santa Clara County Parks. These requests for information grew from relationships that were developed and nurtured by our citizen scientists as they worked in the field, and with their help, we plan to build on this process and provide more site-specific information for people in the community in 2020.

2. Special Events: SFBBO also engaged CWB citizen scientists in SFBBO outreach efforts, including SFBBO Family Science events, bird walks, and participation in various community events in Fremont, Livermore, Los Altos, Menlo Park, Milpitas, Mountain View, Newark, Palo Alto, San Francisco, San Jose, Santa Cruz, Saratoga, and Tiburon.

3. Fundraising: A number of participants in our CWB also helped us conduct fundraising in 2019 to benefit the program. Many volunteers took leadership roles in our California Fall Challenge by serving as fundraisers, judges for our Click Off photo contest, leading guided birding trips, and organizing fundraising teams.

From collecting data and strengthening the field training program to educating the public and raising funds, these citizen scientists continue to be an invaluable asset that allows SFBBO to achieve our mission to conserve birds and their habitats through science and outreach.

NEXT STEPS

Moving forward, we aim to continue utilizing the unique values of this citizen science program. We envision the future of the CWB to have a predominantly outreach/educational objective while maintaining a strong scientific foundation, ensuring the collection of meaningful data. Citizen science experiences may have deeper and more positively significant socioecological impacts than are currently

recognized, that affect not only the quality of scientific studies but also the function of members within their social community (Jordan et al. 2012).

The nature of this program, and much of our organization as a whole, is rooted in community involvement. As in 2019, next year we will continue to expand the community outreach component of our CWB, using the activity of colony monitoring as a vehicle for providing beneficial outreach and educational opportunities, thereby strengthening community connections to local wildlife and habitats.

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TABLES

Table 1. Nests observed within gull, tern and shorebird nesting colonies in 2019; San Francisco Bay, CA. Nest counts represent the peak number of active nests observed for each species and colony in 2019. The observational method indicates that nests were counted from an area adjacent to the colony via binoculars or spotting scope. *Observational counts at this colony are based on a single scouting visit and may not include all nests at the peak of the nesting season. The walkthrough method indicates that the nests were counted while walking through the colony. DESFBNWR = Don Edwards San Francisco Bay National Wildlife Refuge, EBRPD = East Bay Regional Park District. See Appendix I for species codes.

Colony Name	Organization	AMAV	BLSK	BNST	CAGU	CATE	ELTE	FOTE	LETE	Method
Alviso A16	DESFBNWR	70	2	2	0	38	0	12	0	observational
Alviso A5	DESFBNWR	-	-	-	3054	-	-	-	-	walkthrough
Alviso A9	DESFBNWR	-	-	-	2	-	-	-	-	walkthrough
Belmont Slough	Other	0	0	0	0	0	0	15	0	observational
Coyote Hills N2A/N3A/N4AB	DESFBNWR	-	-	-	1129	-	-	-	-	walkthrough
Coyote Hills N6/7	DESFBNWR	-	-	-	4068	-	-	-	-	walkthrough
Hayward Shoreline	EBRPD	1	20	1	0	0	0	578	0	observational
Moffett AB1	DESFBNWR	3	0	0	0	0	0	115	0	observational
Moffett AB2	DESFBNWR	2	0	0	0	0	0	77	0	observational
Moffett AB2	DESFBNWR	-	-	-	326	-	-	-	-	walkthrough
Alviso A1	DESFBNWR	-	-	-	1	-	-	-	-	walkthrough
Mowry M1/2	DESFBNWR	-	-	-	655	-	-	-	-	walkthrough
Mowry M3	DESFBNWR	-	-	-	1813	-	-	-	-	walkthrough
Mowry M4/5	DESFBNWR	-	-	-	2429	-	-	-	-	walkthrough
New Chicago Marsh	DESFBNWR	8	0	2	0	0	0	57	0	observational
Palo Alto Flood Control Basin	City of Mountain View	-	-	-	9036	-	-	-	-	walkthrough
Ravenswood Pond RSF2*	DESFBNWR	0	0	0	0	52	1	0	0	observational
Redwood Shores Parkway, Nob Hill Market	Other	3	1	0	0	0	0	23	0	observational
	TOTAL	**87**	**23**	**5**	**22513**	**90**	**1**	**877**	**0**	

Table 2. Number of breeding adult California Gulls by colony in the South San Francisco Bay from 1980-2019. Estimates were generated by doubling nest counts obtained from walkthrough surveys in late spring, except where otherwise noted. In 2004, several colonies were counted from a single flight over the area and are likely conservative. Dashes (-) indicate that colonies were not surveyed.

Year	Alviso A6	Newark	Alviso A9/A10/A14	Alviso A1	Mowry M4/M5	Mowry M1/M2	Mowry M3	Moffett AB2	Coyote Hills N3A/N4AB	Coyote Hills N6/N7	PAFCC	Alviso A5	A3W Boardwalk	**South Bay Total**
1980	24	-	-	0	-	-	-	0	0	-	-	-	-	**24**
1981	60	-	-	0	-	-	-	0	0	-	-	-	-	**60**
1982	412	-	434	0	-	0	-	0	0	-	-	-	-	**846**
1983	1342	46	-	0	-	0	-	0	0	-	-	-	-	**1388**
1984	2000	44	150	0	-	0	-	0	0	-	-	-	-	**2194**
1985	3000	554	374	0	-	0	-	0	0	-	-	-	-	**3928**
1986	3000	398	97	0	-	0	-	0	0	-	-	-	-	**3495**
1987	4000	22	100	0	-	0	-	0		-	-	-	-	**4122**
1988	4600	30	180	0	-	0	-	0	0	-	-	-	-	**4810**
1989	5310	0	434	0	-	0	-	0	0	-	-	-	-	**5744**
1990	7600	0	122	2	-	0	-	0	0	-	-	-	-	**7724**
1991	5250	0	0	0	-	0	-	0	0	-	-	-	-	**5250**
1992	5500	0	200	0	-	1294	-	0	0	-	-	-	-	**6994**
1993	6912	0	234	200	-	415	-	82	0	-	-	-	-	**7843**
1994	9000	0	300	350	-	1540	-	556	0	-	-	-	-	**11746**
1995	7236	0	4	74	-	2009	-	300	0	-	-	-	-	**9623**
1996	6558	0	1410	0	-	174	-	282	0	-	-	-	-	**8424**

Year	Alviso A6	Newark	Alviso A9/A10/A14	Alviso A1	Mowry M4/M5	Mowry M1/M2	Mowry M3	Moffett AB2	Coyote Hills N3A/N4AB	Coyote Hills N6/N7	PAFCC	Alviso A5	A3W Boardwalk	**South Bay Total**
1997	6256	0	1722	164	-	3000	-	1000	0	-	-	-	-	**12142**
1998	6562	0	1628	0	-	480	-	400	0	-	-	-	-	**9070**
1999	9380	0	2117	145	-	475	-	248	0	-	-	-	-	**12365**
2000	11482	0	1986	0	-	2526	-	254	0	-	-	-	-	**16248**
2001	11216	0	3056	278	-	1824	-	624	0	-	-	-	-	**16998**
2002	11302	0	3590	510	-	3120	-	712	0	-	-	-	-	**19234**
2003	13644	0	1010	862	-	4310	-	384	0	-	-	-	-	**20210**
2004	8600	0	1047	321	-	2233	-	219	0	-	0	-	-	**12420**
2005	18418	-	426	1664	-	3044	-	830	5370	-	-	-	-	**29752**
2006	19456	0	234	380	-	5068	-	374	7442	-	-	84	-	**33038**
2007	24696	-	0	92	-	7384	-	-	4384	-	206	-	-	**36762**
2008	26366	-	0	616	5934	8224	-	-	4952	-	690	30	-	**46812**
2009	24190	0	0	446	3640	8842	-	8	4944	-	1164	110	-	**43344**
2010	23108	0	0	428	4780	6020	-	20	6594	2506	1704	890	-	**46050**
2011	0	0	11956	390	6068	4164	-	112	6394	4110	4478	156	2	**37830**
2012	0	0	18328	422	4414	1770	3700	122	7248	6738	9200	230	0	**52172**
2013	0	-	15900	278	3408	1260	5078	120	6256	6914	14014	238	0	**53466**
2014	0	-	14414	404	3616	1314	4878	82	5914	7864	14264	276	0	**53026**
2015	0	-	13204	404	4886	1786	3214	142	2150	8296	13784	0	0	**47866**

Year	Alviso A6	Newark	Alviso A9/A10/A14	Alviso A1	Mowry M4/M5	Mowry M1/M2	Mowry M3	Moffett AB2	Coyote Hills N3A/N4AB	Coyote Hills N6/N7	PAFCC	Alviso A5	A3W Boardwalk	**South Bay Total**
2016	0	-	10086	344	3640	1382	2218	260	1472	5880	12758	0	-	**38040**
2017	0	-	9868	238	5246	2738	396	324	1156	5198	16180	2226	0	**43570**
2018	0	0	1420	172	4716	1514	3368	300	2264	7678	19350	5984	0	**46766**
2019	0	0	4	2	4858	1310	3626	652	2258	8136	18072	6108	0	**45026**

Table 3. Nests observed within heron, egret and cormorant nesting colonies in 2019; San Francisco Bay, CA. Nest counts represent the peak number of active nests observed for each species and colony in 2019. The observational method indicates that nests were counted from an area adjacent to the colony via binoculars or spotting scope. DESFBNWR = Don Edwards San Francisco Bay National Wildlife Refuge, EBRPD = East Bay Regional Park District, SFPUC = San Francisco Public Utilities Commission. See Appendix I for species codes.

Colony Name	Organization	BCNH	DCCO	GBHE	GREG	GRHE	SNEG	Method
Almaden Lake	City of San Jose	2	0	3	8	0	10	observational
Alviso A18	City of San Jose	0	8	0	0	0	0	observational
Bacon Island	Other	0	3	11	0	0	0	observational
Bay Farm Island, Alameda	Other	0	0	0	19	0	4	observational
Coyote Ranch Rd Colony	Santa Clara County	0	0	13	0	0	0	observational
Don Castro	EBRPD	0	0	7	0	0	0	observational
Downtown Oakland	City of Oakland	55	0	0	0	0	32	observational
Dumbarton PG&E Towers	Other	0	103	0	0	0	0	observational
Grant Lake	Santa Clara County	0	0	4	0	0	0	observational
Kings Academy	Other	12	0	0	0	0	0	observational
Lake Cunningham	City of San Jose	7	0	0	0	3	0	observational
Lake Merced Mesa	San Francisco Recreation & Parks	0	95	5	0	0	0	observational
Lake Merced North	San Francisco Recreation & Parks	0	9	0	0	0	0	observational
Lake Merritt	City of Oakland	0	9	0	0	0	0	observational
Lakeshore Park, Newark (Channel Island)	Other	4	0	0	27	0	17	observational
Lakeshore Park, Newark (Ramsgate Island)	Other	24	0	0	1	0	38	observational
Lakeshore Park, Newark	Other	52	0	0	0	0	75	observational

Colony Name	Organization	BCNH	DCCO	GBHE	GREG	GRHE	SNEG	Method
(Salisbury Island)								
Livermore VA Park & Hospital	Other	0	0	5	0	0	0	observational
Llagas Creek, Morgan Hill	Other	0	0	2	14	0	0	observational
Moffett A2W	DESFBNWR	0	46	0	0	0	0	observational
Ovation Court	City of San Jose	0	0	24	0	0	0	observational
Pescadero Marsh	Other	0	1	14	0	0	0	observational
Redwood Shores Water Treatment Plant	Other	40	0	0	0	0	22	observational
Ruus Park	Other	0	0	0	30	0	73	observational
Shadow Cliffs	EBRPD	0	37	17	6	0	0	observational
Shorebird Way	Other	42	0	0	51	0	60	observational
St. Francis Yacht Club	Other	0	0	5	0	0	0	observational
Steinberger Slough	DESFBNWR	0	96	2	0	0	0	observational
Stow Lake	San Francisco Recreation & Parks	0	0	8	0	0	0	observational
Sunol Water Temple	SFPUC	0	0	13	0	0	0	observational
Vasona Reservoir Island	Santa Clara County	1	0	2	0	0	0	observational
	TOTAL	**239**	**407**	**135**	**156**	**3**	**331**	

FIGURES

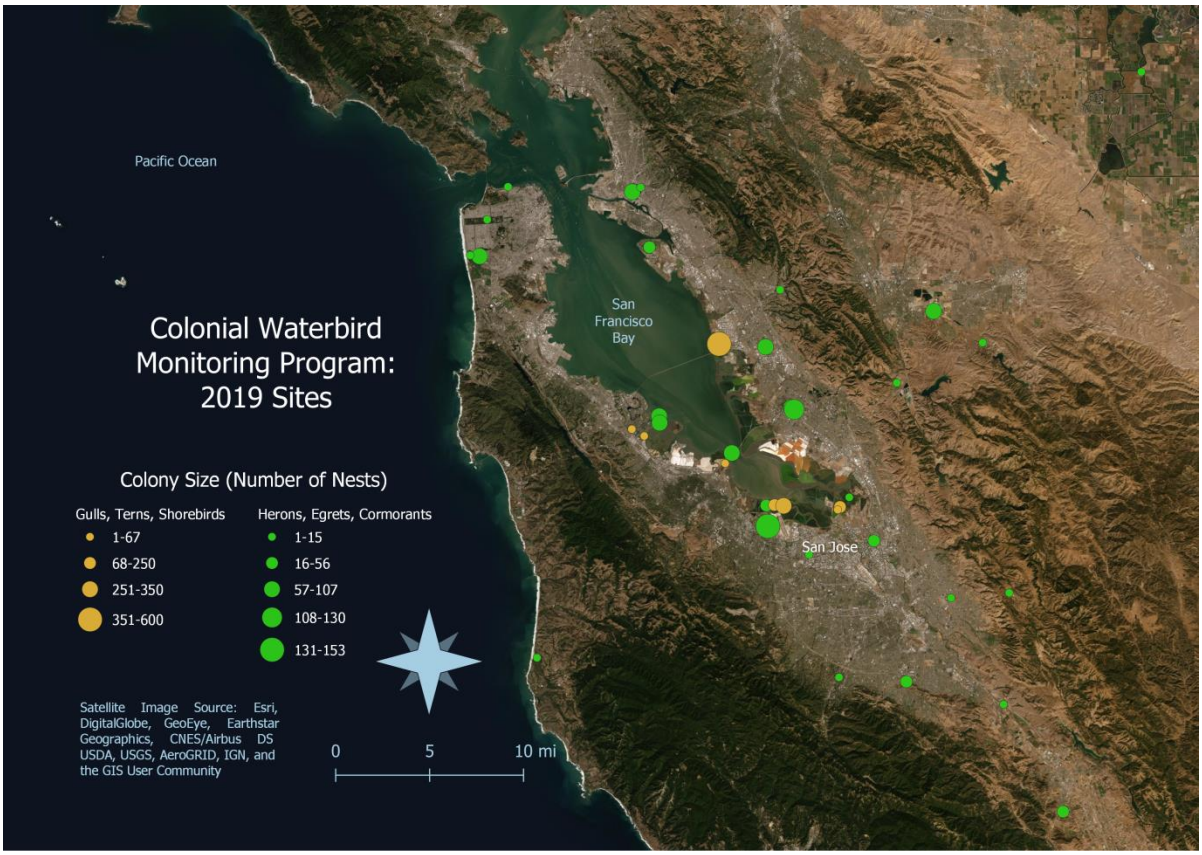

Figure 1. Locations and peak nest counts of colonies monitored as part of SFBBO's Colonial Waterbird Program, San Francisco Bay, CA. Circle sizes represent the peak nest counts of each colony in 2019. Yellow circles show colonies of gulls, terns, and shorebirds, and green circles show colonies of herons, egrets, and cormorants. Data include colonies monitored using observational methods only (i.e. California Gull walkthrough data are not included).

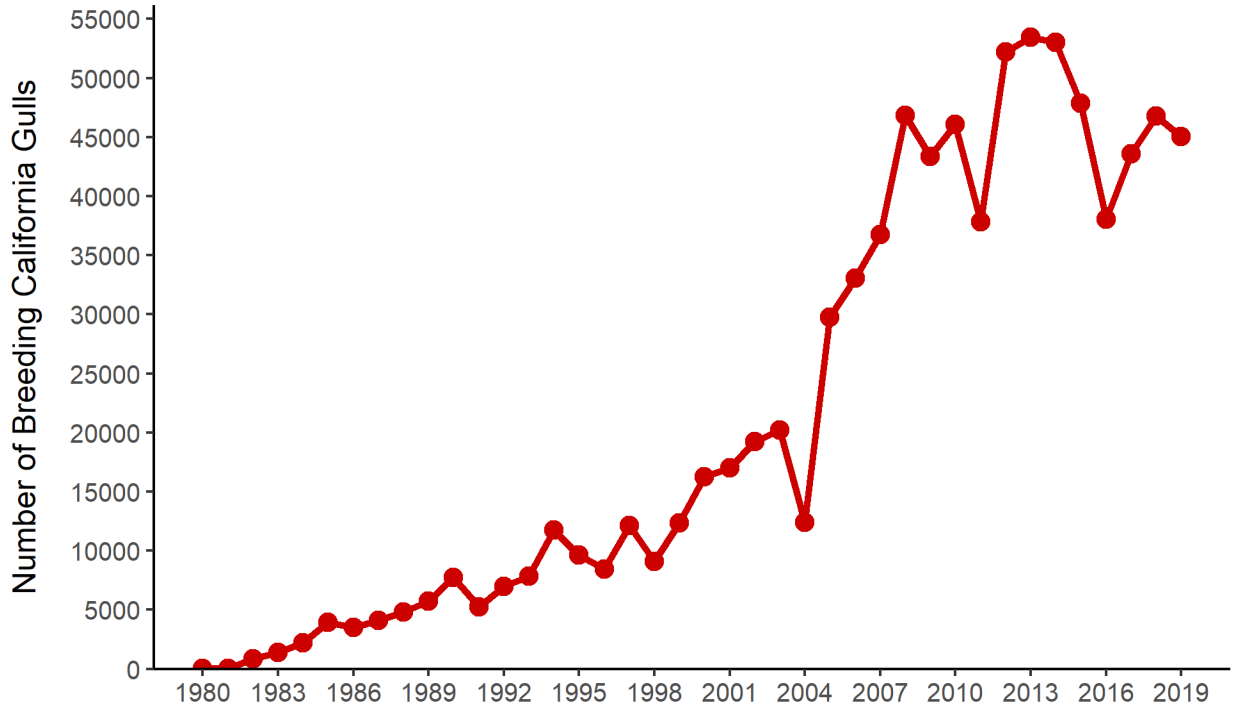

Figure 2. Estimated number of breeding California Gulls in the South San Francisco Bay, CA from 1980-2019.

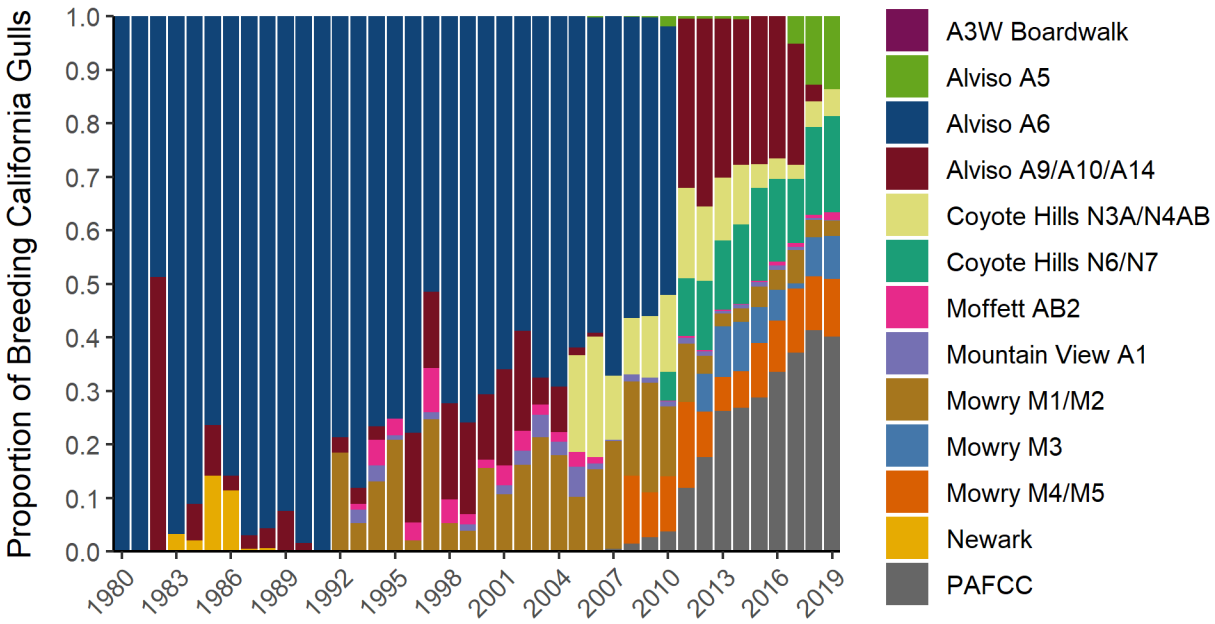

Figure 3. Percentage of breeding California Gulls within each colony site, 1980-2019, South San Francisco Bay, CA. PAFCC = Palo Alto Flood Control Channel Alviso A6 provided dry habitat suitable for nesting gulls until 2010 when the levees were breached and the site was opened to tidal action. Following the loss of Alviso A6 as suitable nesting habitat, gulls redistributed to other nesting sites in the South Bay.

APPENDIX I

Species Code	Common Name	Scientific Name
AMAV	American Avocet	*Recurvirostra americana*
BLSK	Black Skimmer	*Rhynchops niger*
BCNH	Black-crowned Night-Heron	*Nycticorax nycticorax*
BNST	Black-necked Stilt	*Himantopus mexicanus*
CAGU	California Gull	*Larus californicus*
CATE	Caspian Tern	*Sterna caspia*
ELTE	Elegant Tern	*Thalasseus elegans*
FOTE	Forster's Tern	*Sterna forsteri*
GBHE	Great Blue Heron	*Ardea herodias*
GREG	Great Egret	*Ardea alba*
GRHE	Green Heron	*Butorides virescens*
LETE	Least Tern	*Sterna antillarum browni*
SNEG	Snowy Egret	*Egretta thula*
WEGU	Western Gull	*Larus occidentalis*